Waioeka Otara Floodplain Management Plan - Woodlands Road Stopbank

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Environment Bay of Plenty
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Working with our communities for a better environment
E mahi ngatahi e pai ake ai te taiao

Cover Photo: Aerial photograph of Woodlands Road, Opotiki

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Chapter 1: Introduction

1.1 Woodland Road Options

In 2004 I looked at the flood risk and options for the Woodlands area (refer to my memorandum of 14 December 2004, Appendix 1). The area is protected against Waioeka River floods by a rural stopbank on the river berm but is not protected to the urban stopbank standard (1% AEP + 450 mm freeboard) used elsewhere for Opotiki township. Refer Appendix 2 for location map.

The minimum level of Woodlands Road between Grants Road and Hukutaia Road is 4.13 m (according to Lidar data), compared to the adjacent 1% AEP flood level of 4.80 m. An unflapgated culvert also runs under Woodlands Road.

Since my December 2004 memorandum, the culvert has been surveyed and an estimate has been made of design flows from the Woodlands catchment. This has allowed me to complete my analysis.

Chapter 2: Model revisions

I have updated the Waioeka Otara MIKE 11 model, by adding the details of the Woodlands culvert and drain (as surveyed in 2005). Sections around the lower culvert under the rural stopbank, as surveyed in 2001, have also been added to the model. The latest MIKE 11 network file is now *Jan07model.nwk11.*

Chapter 3: Model scenarios

The following scenarios have been modelled:

- 1% AEP Waioeka River flow, 5% AEP Otara flow, 5% AEP tide plus sea level rise due to greenhouse effect. No tributary inflows from Woodlands catchment.
- As above, but with an estimate of a 1% AEP tributary flow from the Woodlands catchment.

The latter scenario allows for the effect of internal floodwaters filling up the basin behind Woodlands Road. The 1% AEP inflow from that sub-catchment is based on recent work by Peter West (email of 20 December 2006), Refer Appendix 3. It in turn, is based on output from HIRDS and the rational method. I have phased the hydrograph so that the peak flow (8m3/s) coincides with the peak river levels.

(Previously, in 2004, I modelled two tributary flow scenarios: 0.5m3/s and 12m3/s peak flows).

3.1 Options

Previous options identified were to:

- Improve Woodlands Rd culvert
- Raise Woodlands Rd (to reduce volume of overflow from the river side) – this will be effective provided the Woodlands catchment inflow isn't an issue.
- Bund around the two lower houses
- Raise the two lower houses.
- Purchase either or both of the lower houses and remove them.

In the current assessment, two options have been considered. These are likely to be the simplest options. The first, only putting a flapgate on the culvert under Woodlands Road, is not going to be effective as the peak 1% AEP flood levels on the river side of Woodlands Road are higher than the road.

The second option is to raise Woodlands Road (or put a stopbank adjacent to it) and put a flapgate on the culvert. Looking at the Lidar data, the stopbank extent would need to be as shown in Figures 1 and 2. Although the floor levels of the houses on the river side of Woodlands Road are not known (previous surveyed levels are incorrect), the ground level of the properties are below 4.8m RL and it would be prudent to extend the bank around the boundaries of those properties. Allowing 450mm freeboard, as for the other urban banks, the crest level would need to be at least 5.25m RL, i.e. approximately 1m above ground level.

The Woodlands Road drain is overgrown around the culvert, and regular maintenance would be needed to keep the flapgate functioning. Without the flapgate, river water would continue to flow into the Woodlands area in large events. No account has yet been taken of any land ownership or resource consent issues.

Figure 1 Suggested stopbank extent

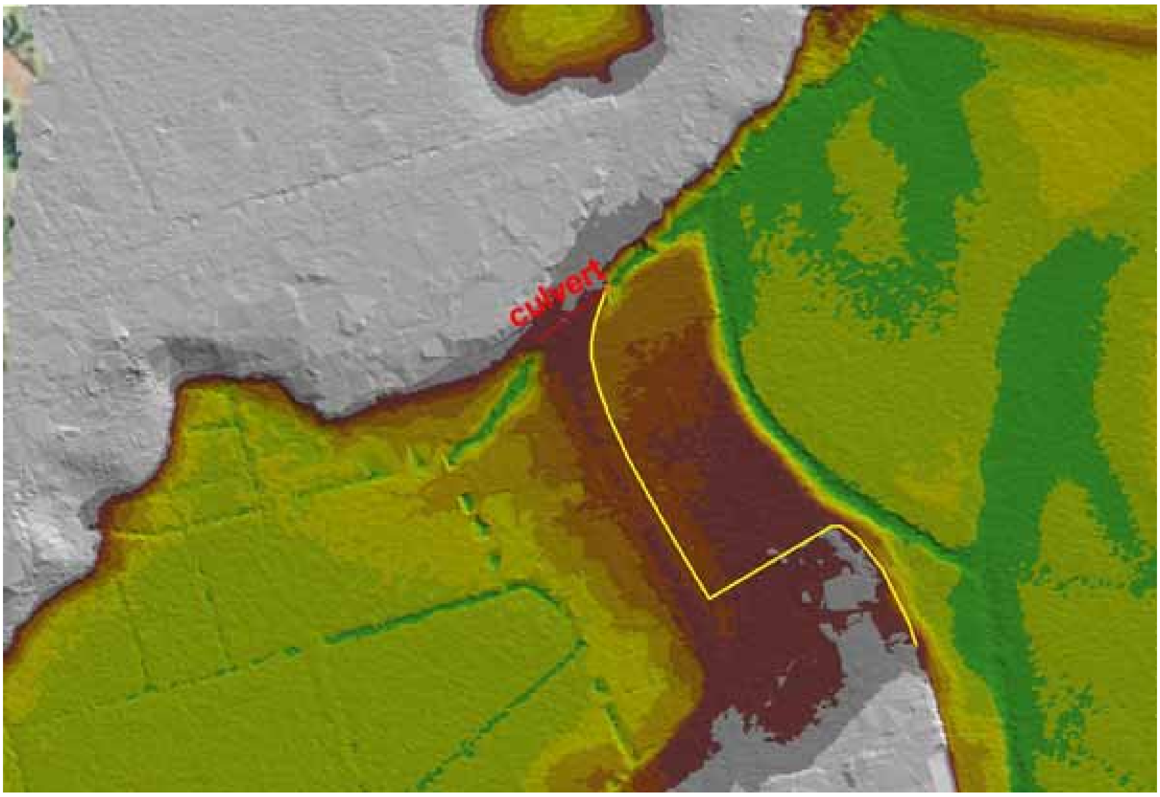

Figure 2 Suggested Stopbank Extent, Overlaid on Topography (Grey = above 4.8m RL)

Chapter 4: Model results

With no Woodlands tributary inflow, the peak 1% AEP Waioeka River flood levels in the Woodlands area reach 4.793m RL (cf previous results 4.789m RL). Assuming a 1% AEP Woodlands inflow at the same time, the peak levels are 4.809m RL, i.e. only 2cm higher.

With the stopbank plus flapgate option, and with the same 1% AEP Waioeka and Woodlands flows, no river flows reach upstream of Woodlands Road and peak levels drop to 3.47m RL (Figures 3 and 4). This gives approximately 600 mm freeboard to the lowest of the houses with known floor levels (18 Woodlands Road, 4.125m).

(The level of 14 Woodlands Rd may need to be checked again. As per my 2004 memo, this had the lowest level in the original, incorrect, survey - but I had thought that Number 18 was the lowest).

As the flood level under this option is lower than the existing level of Woodlands Road, building this new stopbank will not cause additional ponding in the Woodlands area from internal flooding (at least until extreme events in the Woodlands sub-catchment well in excess of the 1% AEP event).

Model results also show that there is no increase in peak river levels in the 1% AEP event.

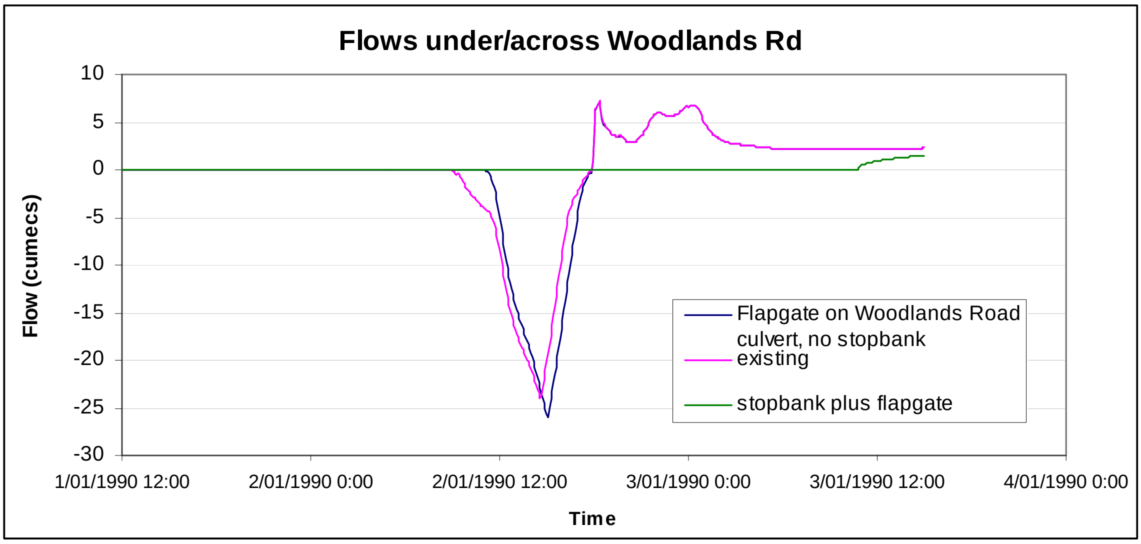

Figure 3 Woodland Road Flows, 1% AEP Waioeka River Flow, 1% AEP Woodlands Sub-catchment Flow (Positive flow is towards the river)

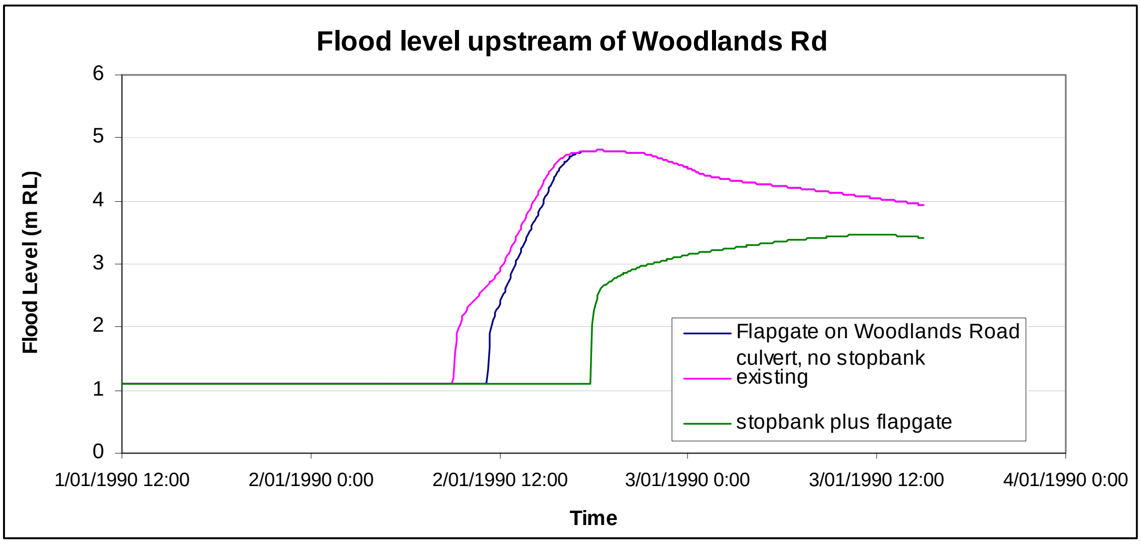

Figure 4 Flood Levels in Woodlands, 1% AEP Waioeka River Flow, 1% AEP Woodlands Sub-catchment Flow

Chapter 5: Discussion

Suggested steps from here include

- Carrying out a ground survey of the suggested stopbank alignment, and estimating costs to construct a bank to 5.25m RL (or higher if some allowance for climate change is to be added).
- Checking the floor level of 14 Woodlands Road. This could be eyeballed at first – if it looks noticeably lower than Number 18, then it may need to be surveyed. If it is proved to be significantly lower, then some other options to reduce risk of internal flooding from Woodlands will need to be considered.
- Checking landownership of preferred route.
- Discussions with Opotiki District Council.
- Consultation with affected landowners, Scheme Liaison Committee etc.
- Check if Consent issues are evident.

Other houses mentioned in my previous memorandum will have higher levels than indicated in that memorandum (i.e. datum for the earlier survey was wrong), and are not considered at risk.

Chapter 6: Model files

No Woodlands inflows, existing situation:

- *w100o20t20gh.sim11* (i.e. overwrite earlier file)
- *Jan07model.nwk11* (this is now latest model)
- *2007model.xns11* (this is now latest model)
- *w100o20t20gh.bnd11* (i.e. overwrite earlier file)
- *w100o20t20gh.RES11* (i.e. overwrite earlier file)

With 1% tributary inflow into Woodlands, existing situation:

- *w100o20t20gh-Q100woodlands.sim11*
- *Jan07model.nwk11*
- *2007model.xns11*
- *w100o20t20gh-1%woodlands.bnd11*
- *W100O20T20GH-Q100WOODLANDS.RES11*

With 1% tributary inflow into Woodlands, stopbank and flapgate option:

- *w100o20t20gh-Q100woodlands-RaiseRd_flapgate.sim11*
- *Jan07model-RaiseWoodlandRdFlapgate.nwk11*
- *2007model.xns11*
- *W100O20T20GH-Q100WOODLANDS--RAISE RD_FLAPGATE.RES11*

Appendices

Appendix I ....Woodlands Road Memorandum

Appendix II .... Location Map

Appendix III .... Woodlands Road Hydrology

Appendix I – Memorandum from Phil Wallace to Peter Blackwood dated 14 December 2004

Woodlands Road Options

Introduction

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Model Revisions

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Model Scenarios

The following scenarios have been modelled:

- 1% AEP Waioeka River flow, 5% AEP Otara flow, 5% AEP tide plus sea level rise due to greenhouse effect. No tributary inflows from Woodlands catchment.
- As above, but with an estimate of a 1% AEP tributary flow from the Woodlands catchment.

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No account has yet been taken of any land ownership or resource consent issues.

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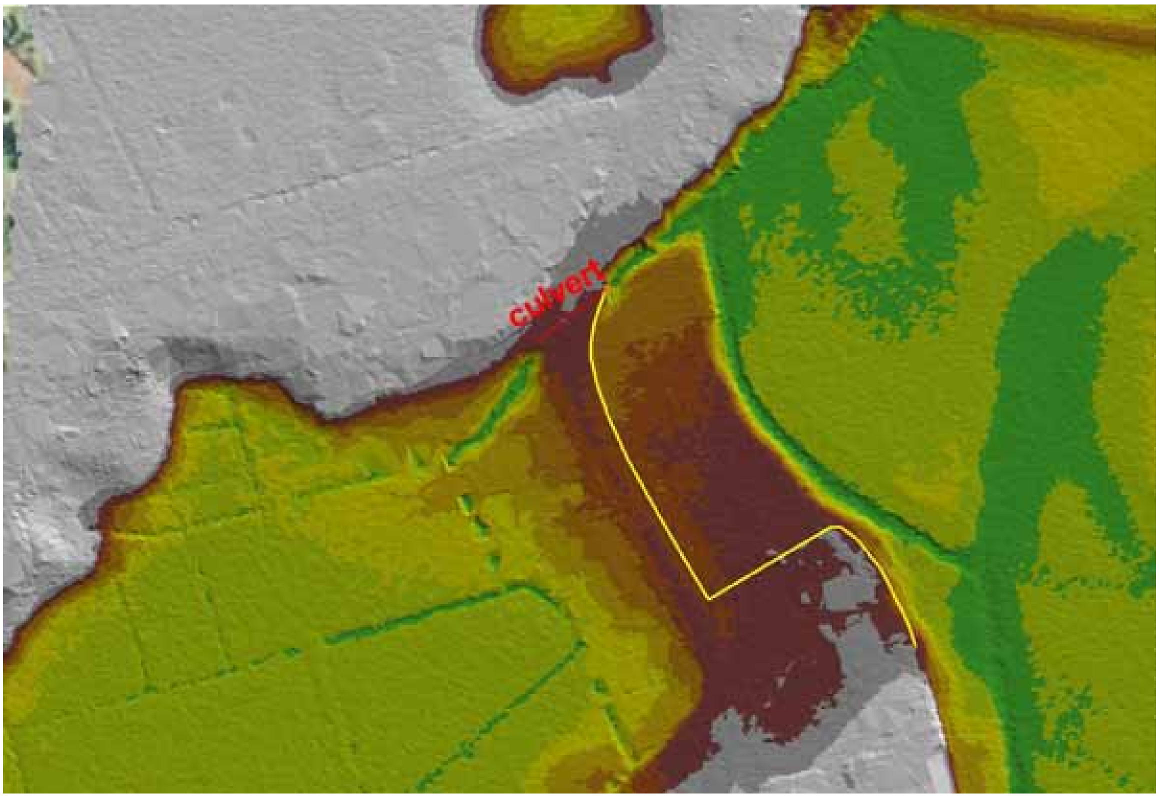

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Model Results

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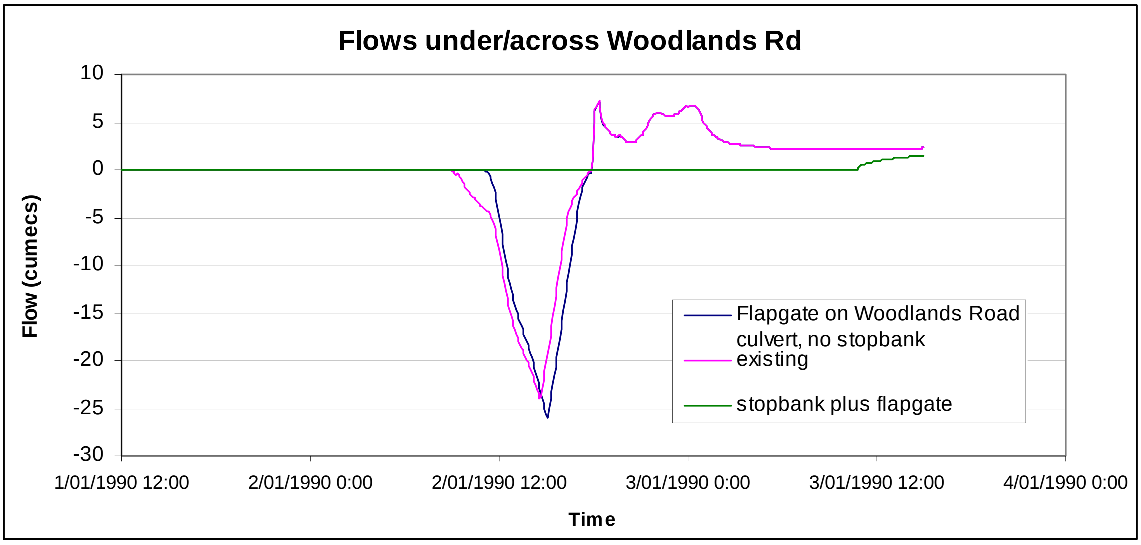

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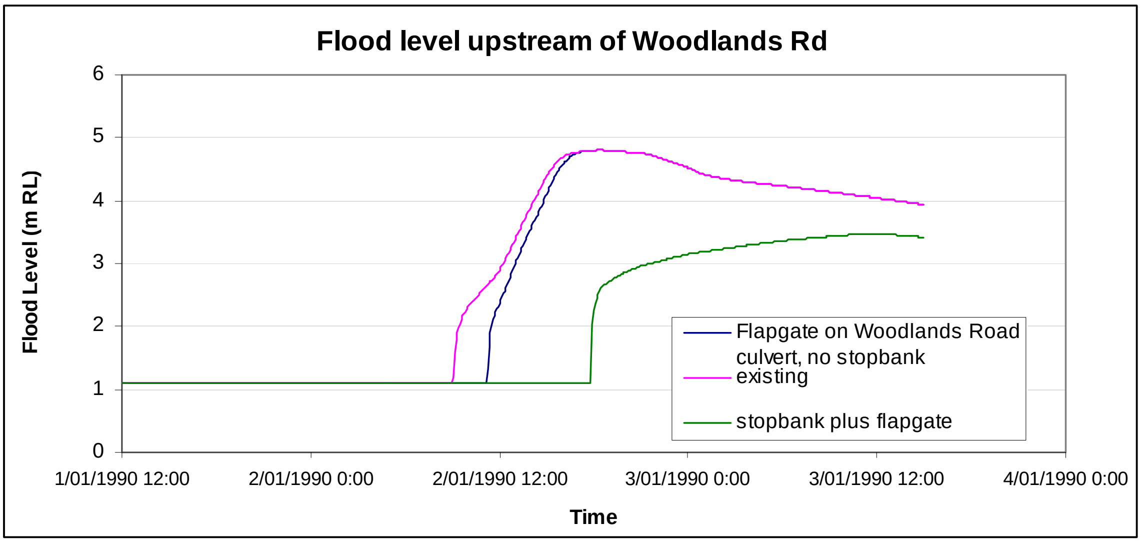

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2007model.xns11
w100o20t20gh-1%woodlands.bnd11
W100O20T20GH-Q100WOODLANDS.RES11

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w100o20t20gh-Q100woodlands-RaiseRd_flapgate.sim11
Jan07model-RaiseWoodlandRdFlapgate.nwk11
2007model.xns11
W100O20T20GH-Q100WOODLANDS--RAISE RD_FLAPGATE.RES11

Appendix II – Location Map

Appendix III – Woodlands Road Hydrology

1% AEP Hirds Data for Woodlands Road Catchment

1/01/2000 12:00

Soil Type: Opotiki Sandy Loam; Medium Soakage, Pasture 75% /residential 25%; Slope<5%:

Use C=0.4 on storm durations over 1 hour because of long term runoff situation (otherwise 0.25)

38.029S 177.265E

	0.007	0.014	0.021	0.042	0.083	0.125	0.25	0.5	1	2	3
Duration	10m	20m	30m	1h	2h	3h	6h	12h	24h	48h	72h
rainfall depths (mm)	29	41	50	69	89	105	141	188	250	310	343
Adjusted	29	41	50	69	89	105	141	188	250	310	343
Bulk intensity (mm/h)	174	123	100	69	45	35	24	16	10	6	5
Incremental depth (mm)	29	12	9	19	20	16	36	47	62	60	33
Incremental intensity	174	72	54.00	38.00	20	16	12	8	5	3	1
Finish time	12:10:00	12:20:00	12:30:00	13:00:00	14:00:00	15:00:00	18:00:00	0:00:00	12:00:00	12:00:00	12:00:00

	Hyetograph				**Hydrograph**		
Time	**Intensity (mm/h)**	Runoff Coefficient C		Q Lower Catchment (m3/s)	**Sum**	Time Increment (s)	Volume (m3)
1/01/2000 12:00	**0.0**	0.25		0.0	**0.0**		
1/01/2000 12:00	**100.0**	0.25		8.3	**8.3**	0.0	0.0
1/01/2000 12:30	**100.0**	0.25		8.3	**8.3**	1800.0	15000.0
1/01/2000 12:30	**38.0**	0.25		3.2	**3.2**	0.0	0.0
1/01/2000 13:00	**38.0**	0.25		3.2	**3.2**	1800.0	5700.0
1/01/2000 13:00	**20.0**	0.40		2.7	**2.7**	0.0	0.0
1/01/2000 14:00	**20.0**	0.40		2.7	**2.7**	3600.0	9600.0
1/01/2000 14:00	**16.0**	0.40		2.1	**2.1**	0.0	0.0
1/01/2000 15:00	**16.0**	0.40		2.1	**2.1**	3600.0	7680.0
1/01/2000 15:00	**12.0**	0.40		1.6	**1.6**	0.0	0.0
1/01/2000 18:00	**12.0**	0.40		1.6	**1.6**	10800.0	17280.0
1/01/2000 18:00	**7.8**	0.40		1.0	**1.0**	0.0	0.0
2/01/2000 0:00	**7.8**	0.40		1.0	**1.0**	21600.0	22560.0
2/01/2000 0:00	**5.2**	0.40		0.7	**0.7**	0.0	0.0
2/01/2000 12:00	**5.2**	0.40		0.7	**0.7**	43200.0	29760.0
2/01/2000 12:00	**2.5**	0.40		0.3	**0.3**	0.0	0.0
3/01/2000 12:00	**2.5**	0.40		0.3	**0.3**	86400.0	28800.0
3/01/2000 12:00	**1.4**	0.40		0.2	**0.2**	0.0	0.0
4/01/2000 12:00	**1.4**	0.40		0.2	**0.2**	86400.0	15840.0
4/01/2000 12:00	**0.0**	0.40		0.0	**0.0**	0.0	0.0
							152220.0

5% AEP Hirds Data for Woodlands Road Catchment

1/01/2000 12:00

Soil Type: Opotiki Sandy Loam; Medium Soakage, Pasture 75% /residential 25%; Slope<5%:

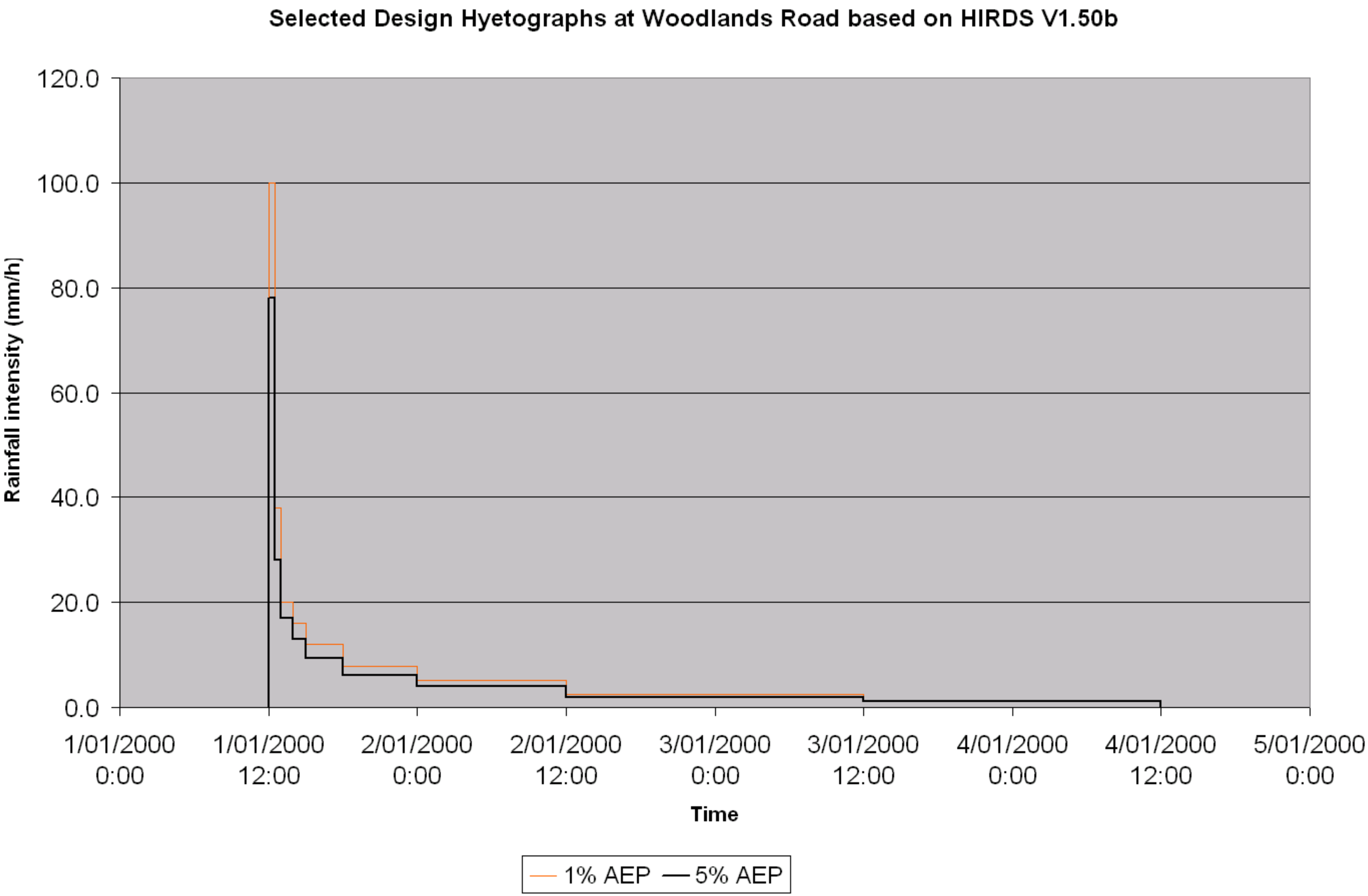
Use C=0.4 on storm durations over 1 hour because of long term runoff situation (otherwise 0.25)

38.029S 177.265E

	0.007	0.014	0.021	0.042	0.083	0.125	0.25	0.5	1	2	3
Duration	10m	20m	30m	1h	2h	3h	6h	12h	24h	48h	72h
rainfall depths (mm)	23	32	39	53	70	83	111	148	196	244	270
Adjusted	23	32	39	53	70	83	111	148	196	244	270
Bulk intensity (mm/h)	138	96	78	53	35	28	19	12	8	5	4
Incremental depth (mm)	23	9	7	14	17	13	28	37	48	48	26
Incremental intensity	138	54	42.00	28.00	17	13	9	6	4	2	1
Finish time	12:10:00	12:20:00	12:30:00	13:00:00	14:00:00	15:00:00	18:00:00	0:00:00	12:00:00	12:00:00	12:00:00

Hyetograph **Hydrograph**

Time	**Intensity (mm/h)**	Runoff Coefficient C		Q Lower Catchment (m3/s)	**Sum**	Time Increment (s)	Volume (m3)
1/01/2000 12:00	**0.0**	0.25		0.0	**0.0**		
1/01/2000 12:00	**78.0**	0.25		6.5	**6.5**	0.0	0.0
1/01/2000 12:30	**78.0**	0.25		6.5	**6.5**	1800.0	11700.0
1/01/2000 12:30	**28.0**	0.25		2.3	**2.3**	0.0	0.0
1/01/2000 13:00	**28.0**	0.25		2.3	**2.3**	1800.0	4200.0
1/01/2000 13:00	**17.0**	0.40		2.3	**2.3**	0.0	0.0
1/01/2000 14:00	**17.0**	0.40		2.3	**2.3**	3600.0	8160.0
1/01/2000 14:00	**13.0**	0.40		1.7	**1.7**	0.0	0.0
1/01/2000 15:00	**13.0**	0.40		1.7	**1.7**	3600.0	6240.0
1/01/2000 15:00	**9.3**	0.40		1.2	**1.2**	0.0	0.0
1/01/2000 18:00	**9.3**	0.40		1.2	**1.2**	10800.0	13440.0
1/01/2000 18:00	**6.2**	0.40		0.8	**0.8**	0.0	0.0
2/01/2000 0:00	**6.2**	0.40		0.8	**0.8**	21600.0	17760.0
2/01/2000 0:00	**4.0**	0.40		0.5	**0.5**	0.0	0.0
2/01/2000 12:00	**4.0**	0.40		0.5	**0.5**	43200.0	23040.0
2/01/2000 12:00	**2.0**	0.40		0.3	**0.3**	0.0	0.0
3/01/2000 12:00	**2.0**	0.40		0.3	**0.3**	86400.0	23040.0
3/01/2000 12:00	**1.1**	0.40		0.1	**0.1**	0.0	0.0
4/01/2000 12:00	**1.1**	0.40		0.1	**0.1**	86400.0	12480.0
4/01/2000 12:00	**0.0**	0.40		0.0	**0.0**	0.0	0.0
							120060.0


Selected Design Hyetographs at Woodlands Road based on HIRDS V1.50b
Rainfall intensity (mm/h)
120.0
100.0
80.0
60.0
40.0
20.0
0.0
1/01/2000 0:00
1/01/2000 12:00
2/01/2000 0:00
2/01/2000 12:00
3/01/2000 0:00
3/01/2000 12:00
4/01/2000 0:00
4/01/2000 12:00
5/01/2000 0:00
Time
1% AEP
5% AEP

HIRDS Version 1.50b
High Intensity Rainfall Design System

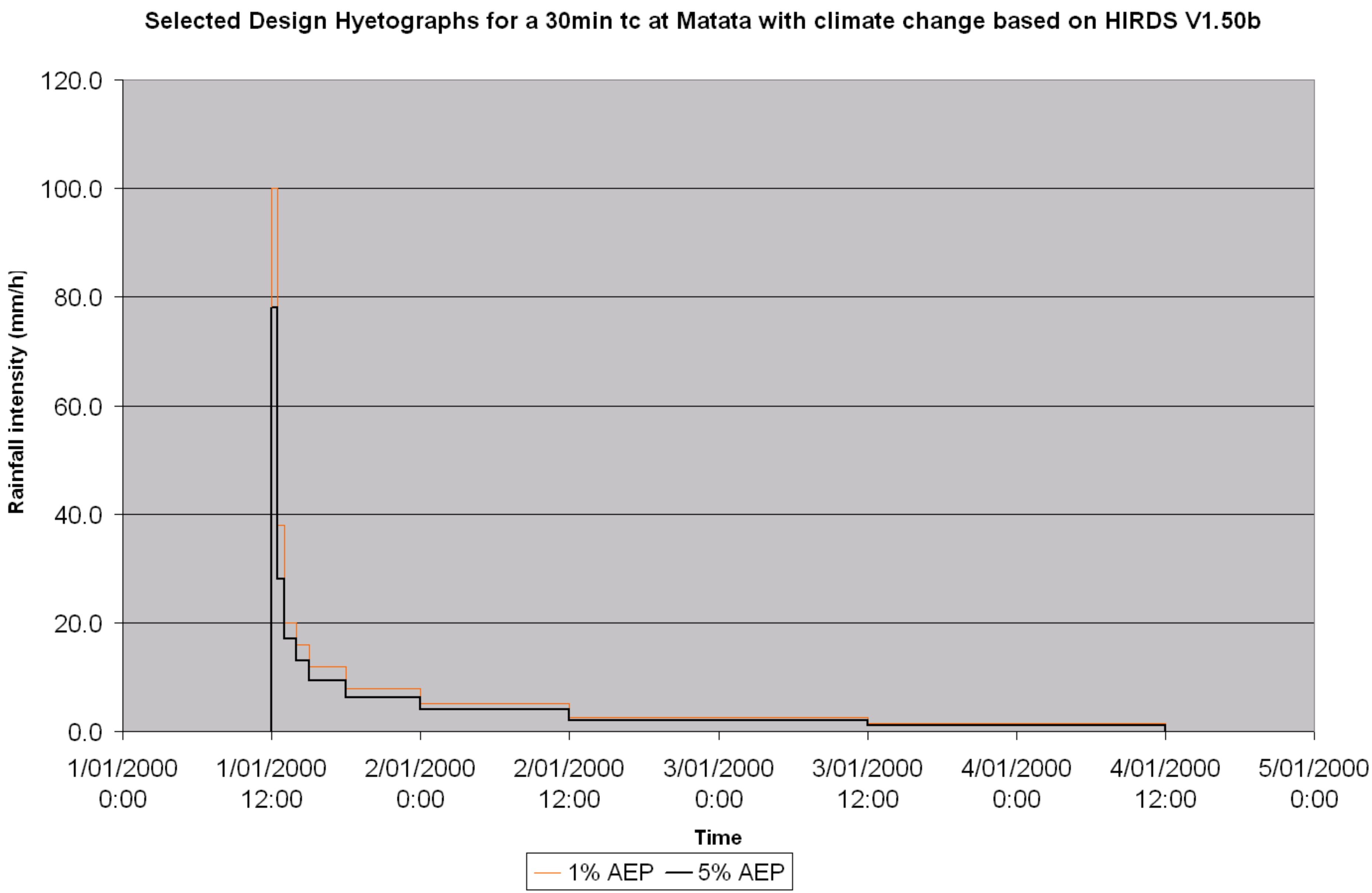
Table of rainfall depths and standard errors (mm)
Location: Woodlands Road 38.03S 177.27E

Rainfall depths (mm)

ARI (y)	10m	20m	30m	1h	2h	3h	6h	12h	24h	48h	72h
2	12	17	21	29	40	47	63	84	112	138	153
5	17	23	28	39	53	63	84	112	149	184	204
10	20	27	34	47	62	73	98	130	173	215	238
20	23	32	39	53	70	83	111	148	196	244	270
30	24	34	41	57	75	89	119	158	210	260	289
50	26	37	45	62	81	96	128	171	227	281	312
60	27	38	46	64	83	98	132	175	233	289	320
70	28	39	47	66	85	100	134	179	238	295	327
80	28	39	48	67	86	102	137	182	242	301	333
90	29	40	49	68	88	104	139	185	246	305	339
100	29	41	50	69	89	105	141	188	250	310	343

Standard errors (mm)

ARI (y)	10m	20m	30m	1h	2h	3h	6h	12h	24h	48h	72h
2	1	2	2	3	3	4	6	8	11	13	15
5	2	2	3	4	4	5	7	9	12	15	17
10	2	3	3	4	5	6	8	11	15	18	20
20	2	3	4	5	6	7	10	13	18	22	25
30	3	4	4	6	6	8	10	14	19	25	28
50	3	4	5	7	7	8	12	16	22	28	31
60	3	4	5	7	7	9	12	16	22	29	32
70	3	4	5	7	7	9	12	17	23	30	34
80	3	5	6	8	8	9	13	17	24	31	35
90	3	5	6	8	8	9	13	18	24	31	36
100	3	5	6	8	8	9	13	18	25	32	36


Selected Design Hyetographs for a 30min tc at Matata with climate change based on HIRDS V1.50b
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120.0
100.0
80.0
60.0
40.0
20.0
0.0
1/01/2000 0:00
1/01/2000 12:00
2/01/2000 0:00
2/01/2000 12:00
3/01/2000 0:00
3/01/2000 12:00
4/01/2000 0:00
4/01/2000 12:00
5/01/2000 0:00
Time
1% AEP
5% AEP

5% AEP Hirds Data for Woodlands Road Catchment

1/01/2000 12:00

38.029S 177.265E

Soil Type: Opotiki Sandy Loam; Medium Soakage, Pasture 75% /residential 25%; Slope<5%:

Use C=0.4 on storm durations over 1 hour because of long term runoff situation (otherwise 0.25)

	0.006944444	0.013888889	0.020833333	0.041666667	0.083333333	0.125	0.25	0.5	1	2	3
Duration	10m	20m	30m	1h	2h	3h	6h	12h	24h	48h	72h
rainfall depths (mm)	23	32	39	53	70	83	111	148	196	244	270
Adjusted	23	32	39	53	70	83	111	148	196	244	270
Bulk intensity (mm/h)	138	96	78	53	35	28	19	12	8	5	4
Incremental depth (mm)	23	9	7	14	17	13	28	37	48	48	26
Incremental intensity	138	54	42.00	28.00	17	13	9	6	4	2	1
Finish time	12:10:00	12:20:00	12:30:00	13:00:00	14:00:00	15:00:00	18:00:00	0:00:00	12:00:00	12:00:00	12:00:00

Hyetograph

Time	Intensity (mm/h)	Runoff Coefficient C		Q Lower Catchment (m3/s)	Sum	Time Increment (s)	Volume (m3)
1/01/2000 12:00	0.0	0.25		0.0	0.0		
1/01/2000 12:00	78.0	0.25		6.5	6.5	0.0	0.0
1/01/2000 12:30	78.0	0.25		6.5	6.5	1800.0	11700.0
1/01/2000 12:30	28.0	0.25		2.3	2.3	0.0	0.0
1/01/2000 13:00	28.0	0.25		2.3	2.3	1800.0	4200.0
1/01/2000 13:00	17.0	0.40		2.3	2.3	0.0	0.0
1/01/2000 14:00	17.0	0.40		2.3	2.3	3600.0	8160.0
1/01/2000 14:00	13.0	0.40		1.7	1.7	0.0	0.0
1/01/2000 15:00	13.0	0.40		1.7	1.7	3600.0	6240.0
1/01/2000 15:00	9.3	0.40		1.2	1.2	0.0	0.0
1/01/2000 18:00	9.3	0.40		1.2	1.2	10800.0	13440.0
1/01/2000 18:00	6.2	0.40		0.8	0.8	0.0	0.0
2/01/2000 0:00	6.2	0.40		0.8	0.8	21600.0	17760.0
2/01/2000 0:00	4.0	0.40		0.5	0.5	0.0	0.0
2/01/2000 12:00	4.0	0.40		0.5	0.5	43200.0	23040.0
2/01/2000 12:00	2.0	0.40		0.3	0.3	0.0	0.0
3/01/2000 12:00	2.0	0.40		0.3	0.3	86400.0	23040.0
3/01/2000 12:00	1.1	0.40		0.1	0.1	0.0	0.0
4/01/2000 12:00	1.1	0.40		0.1	0.1	86400.0	12480.0
4/01/2000 12:00	0.0	0.40		0.0	0.0	0.0	0.0
							120060.0

1% AEP Hirds Data for
Woodlands Road Catchment

1/01/2000 12:00

38.029S 177.265E

Soil Type: Opotiki Sandy Loam; Medium Soakage, Pasture 75% /residential 25%; Slope<5%:

Use C=0.4 on storm durations over 1 hour because of long term runoff situation (otherwise 0.25)

	0.006944444	0.013888889	0.020833333	0.041666667	0.083333333	0.125	0.25	0.5	1	2	3
Duration	10m	20m	30m	1h	2h	3h	6h	12h	24h	48h	72h
rainfall depths (mm)	29	41	50	69	89	105	141	188	250	310	343
Adjusted	29	41	50	69	89	105	141	188	250	310	343
Bulk intensity (mm/h)	174	123	100	69	45	35	24	16	10	6	5
Incremental depth (mm)	29	12	9	19	20	16	36	47	62	60	33
Incremental intensity	174	72	54.00	38.00	20	16	12	8	5	3	1
Finish time	12:10:00	12:20:00	12:30:00	13:00:00	14:00:00	15:00:00	18:00:00	0:00:00	12:00:00	12:00:00	12:00:00

Hyetograph

Time	Intensity (mm/h)	Runoff Coefficient C		Q Lower Catchment (m3/s)	Sum	Time Increment (s)	Volume (m3)
1/01/2000 12:00	0.0	0.25		0.0	0.0		
1/01/2000 12:00	100.0	0.25		8.3	8.3	0.0	0.0
1/01/2000 12:30	100.0	0.25		8.3	8.3	1800.0	15000.0
1/01/2000 12:30	38.0	0.25		3.2	3.2	0.0	0.0
1/01/2000 13:00	38.0	0.25		3.2	3.2	1800.0	5700.0
1/01/2000 13:00	20.0	0.40		2.7	2.7	0.0	0.0
1/01/2000 14:00	20.0	0.40		2.7	2.7	3600.0	9600.0
1/01/2000 14:00	16.0	0.40		2.1	2.1	0.0	0.0
1/01/2000 15:00	16.0	0.40		2.1	2.1	3600.0	7680.0
1/01/2000 15:00	12.0	0.40		1.6	1.6	0.0	0.0
1/01/2000 18:00	12.0	0.40		1.6	1.6	10800.0	17280.0
1/01/2000 18:00	7.8	0.40		1.0	1.0	0.0	0.0
2/01/2000 0:00	7.8	0.40		1.0	1.0	21600.0	22560.0
2/01/2000 0:00	5.2	0.40		0.7	0.7	0.0	0.0
2/01/2000 12:00	5.2	0.40		0.7	0.7	43200.0	29760.0
2/01/2000 12:00	2.5	0.40		0.3	0.3	0.0	0.0
3/01/2000 12:00	2.5	0.40		0.3	0.3	86400.0	28800.0
3/01/2000 12:00	1.4	0.40		0.2	0.2	0.0	0.0
4/01/2000 12:00	1.4	0.40		0.2	0.2	86400.0	15840.0
4/01/2000 12:00	0.0	0.40		0.0	0.0	0.0	0.0
							152220.0

HIRDS Version 1.50b
High Intensity Rainfall Design System

Table of rainfall depths and standard errors (mm)
Location: Woodlands Road 38.03S 177.27E

Rainfall depths (mm)

ARI (y)	10m	20m	30m	1h	2h	3h	6h	12h	24h	48h	72h
2	12	17	21	29	40	47	63	84	112	138	153
5	17	23	28	39	53	63	84	112	149	184	204
10	20	27	34	47	62	73	98	130	173	215	238
20	23	32	39	53	70	83	111	148	196	244	270
30	24	34	41	57	75	89	119	158	210	260	289
50	26	37	45	62	81	96	128	171	227	281	312
60	27	38	46	64	83	98	132	175	233	289	320
70	28	39	47	66	85	100	134	179	238	295	327
80	28	39	48	67	86	102	137	182	242	301	333
90	29	40	49	68	88	104	139	185	246	305	339
100	29	41	50	69	89	105	141	188	250	310	343

Standard errors (mm)

ARI (y)	10m	20m	30m	1h	2h	3h	6h	12h	24h	48h	72h
2	1	2	2	3	3	4	6	8	11	13	15
5	2	2	3	4	4	5	7	9	12	15	17
10	2	3	3	4	5	6	8	11	15	18	20
20	2	3	4	5	6	7	10	13	18	22	25
30	3	4	4	6	6	8	10	14	19	25	28
50	3	4	5	7	7	8	12	16	22	28	31
60	3	4	5	7	7	9	12	16	22	29	32
70	3	4	5	7	7	9	12	17	23	30	34
80	3	5	6	8	8	9	13	17	24	31	35
90	3	5	6	8	8	9	13	18	24	31	36
100	3	5	6	8	8	9	13	18	25	32	36

HIRDS Version 1.50b
High Intensity Rainfall Design System

Table of rainfall depths and standard errors (mm)
Location: Woodlands Road 38.03S 177.27E

Rainfall depths (mm)

ARI (y)	10m	20m	30m	1h	2h	3h	6h	12h	24h	48h	72h
2	12	17	21	29	40	47	63	84	112	138	153
5	17	23	28	39	53	63	84	112	149	184	204
10	20	27	34	47	62	73	98	130	173	215	238
20	23	32	39	53	70	83	111	148	196	244	270
30	24	34	41	57	75	89	119	158	210	260	289
50	26	37	45	62	81	96	128	171	227	281	312
60	27	38	46	64	83	98	132	175	233	289	320
70	28	39	47	66	85	100	134	179	238	295	327
80	28	39	48	67	86	102	137	182	242	301	333
90	29	40	49	68	88	104	139	185	246	305	339
100	29	41	50	69	89	105	141	188	250	310	34