Williamson Park Stormwater Investigation

March 2017 Storm Event Assessment

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Document Details:

Date: 19 January 2018
Reference: 2-69195.00
Status: Draft

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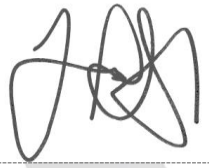

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1 Introduction

This report has been prepared for the Thames Coromandel District Council (TCDC) to investigate drainage issues in the Williamson Park catchment during storm events in March 2017. During those rainfall events, the pond was flooded and it is understood locations in Whangamata had local flooding issues close to habitable floors.

1.1 Scope of Project

The scope of this project includes the following:

- Review previous studies on Whangamata's drainage to understand local stormwater management:
  (1) Whangamata Stormwater Catchment Management Study – Issues and Options (Opus, 2005) and
  (2) Whangamata Groundwater Monitoring Summary Report (Opus, 2012).
  (3) Thames Coromandel District Council Code of Practice for Subdivision and Development (Engineering Standards) (October 2013).
- Gathering rainfall and borehole monitoring data held by TCDC.
- Analysis of rainfall event and comparison with the design event.
- Comparison of groundwater levels in boreholes with rainfall event.
- Identify factors influencing pond performance.

1.2 Stormwater and Land Drainage in Whangamata

The Thames Coromandel District Council Code of Practice for Subdivision and Development (Engineering Standards) (October, 2013) outlined the following design requirements for pipe systems, culverts and detention ponds:

- Primary piped systems in all urban areas are capable of carrying a 5 Year ARI (20% AEP) rain event.
- Culverts in all areas are capable of carrying a 20 Year ARI (5% AEP) rain event.
- Stormwater disposal through soak pits is permitted provided the applicant can demonstrate that:
  a. They can be economically maintained
  b. The long-term soakage capacity is adequate
  c. Soak pits are assessed and designed as per NZ Building Code E1/VM1 or otherwise consented by Council's Development Engineer.
- Stormwater Detention Basins are to be self-draining without the use of pumping equipment and are not permitted to permanently hold water or be used as a water feature.

The Whangamata Stormwater Catchment Management Study (Opus, 2005) indicated the piped stormwater reticulation serves only roadways whereas private properties dispose of stormwater by soakage.

The Whangamata Groundwater Monitoring Summary Report (Opus, 2012) noted TCDC requires private properties in Whangamata to be drained by soakage to ground. The report advised:

1. In general, the Whangamata sandy soil provides excellent soakage.
2. Groundwater levels can rise to a level where the function of soakage could become impaired. The winter groundwater table could rise to a level too high for successful soakage in some areas.
3. A specific study to develop suitable soakage design is recommended.

Should inappropriate soakage design, insufficient maintenance, high groundwater, or a combination of all of these occur, stormwater from private property will form overland flow during even frequent storm events.

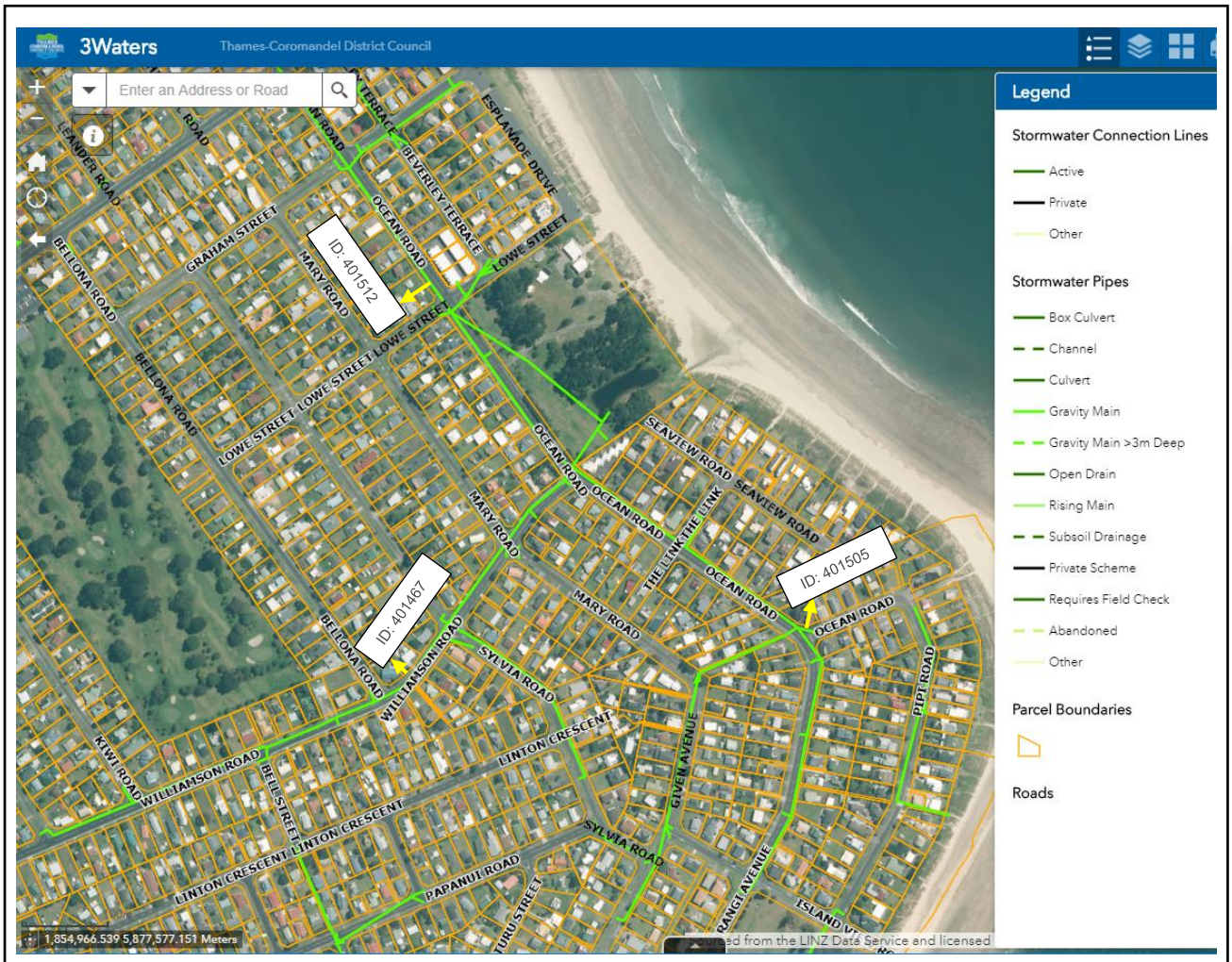
1.3 Purpose of Williamson Park Pond

The pond in Williamson Park is a retention pond, it receives stormwater from a 1200mm diameter pipe, which mainly collects stormwater runoff from a pipe system runs along Ocean Road and Williamson Road.

TCDC staff has advised that the purpose of the pond is for storage/detention, however it has been noticed the pond is permanently full. The pond may also provide a degree of treatment, and reduces the frequency of discharge across the beach and associated scouring (Opus, 2005 and 2012).

There is no known piped outlet for the pond. It is assumed discharge is supposed to occur via soakage, however groundwater levels are likely to limit this (refer Section 3.4). Regular maintenance, such as desilting is also required to enable soakage to occur. Discharge therefore only occurs via overtopping of the pond spillway.

The pond spillway is at 2.5mRL (Opus, 2005) and the upstream pipe outlet is at 0.79mRL (based on TCDC 3Waters Map Portal). As shown in Figure 1 below, the area bounded by Lowe Street, Bellona Road and Ocean Road have stormwater pipe invert levels lower than 2.5mRL. The capacity of this part of the network, and likely beyond, will be effected by the Williamson Park Pond.



SW Pipes: ACTIVE	
Asset ID	401,512
Asset Status	ACTIVE
Owner	UTL
Upstream Asset ID	301134
Downstream Asset ID	301152
Upstream Surface Level	4.85
Upstream Invert Level	2.68
Downstream Surface Level	4.30
Downstream Invert Level	2.38

SW Pipes: ACTIVE	
Asset ID	401,467
Asset Status	ACTIVE
Owner	UTL
Upstream Asset ID	550934
Downstream Asset ID	301163
Upstream Surface Level	3.40
Upstream Invert Level	3.40
Downstream Surface Level	3.63
Downstream Invert Level	2.20

SW Pipes: ACTIVE	
Asset ID	401,505
Asset Status	ACTIVE
Owner	UTL
Upstream Asset ID	301214
Downstream Asset ID	301159
Upstream Surface Level	3.45
Upstream Invert Level	1.89
Downstream Surface Level	3.44
Downstream Invert Level	2.12

Figure 1: Pipeline information screen shot from Thames-Coromandel District Council 3Waters

2 Rainfall Analysis

Rainfall analysis has been undertaken based on rainfall data obtained from three locations:

1. **Dalton Road**
   Two sets of data were received for the Dalton Road site. Daily Rainfall data from January 2015 to October 2017 were received on 17th November 2017. 1 minute cumulative rainfall data from 2015 to 2017 were received on the 11th January 2018. Both data were provided by Vini Dutra from Veolia in Excel format.

2. **Onemana**
   1minute rainfall data from 2015 to 2017 were received on the 12th January 2018. The data was provided by Vini Dutra from Veolia in Excel format.

3. **Golden Cross**
   Daily rainfall total from 1990 to 2017 and 5 minutes data from 2015 to June 2017. The data was received on 26th June 2017 from Waikato Regional Council in Excel format.

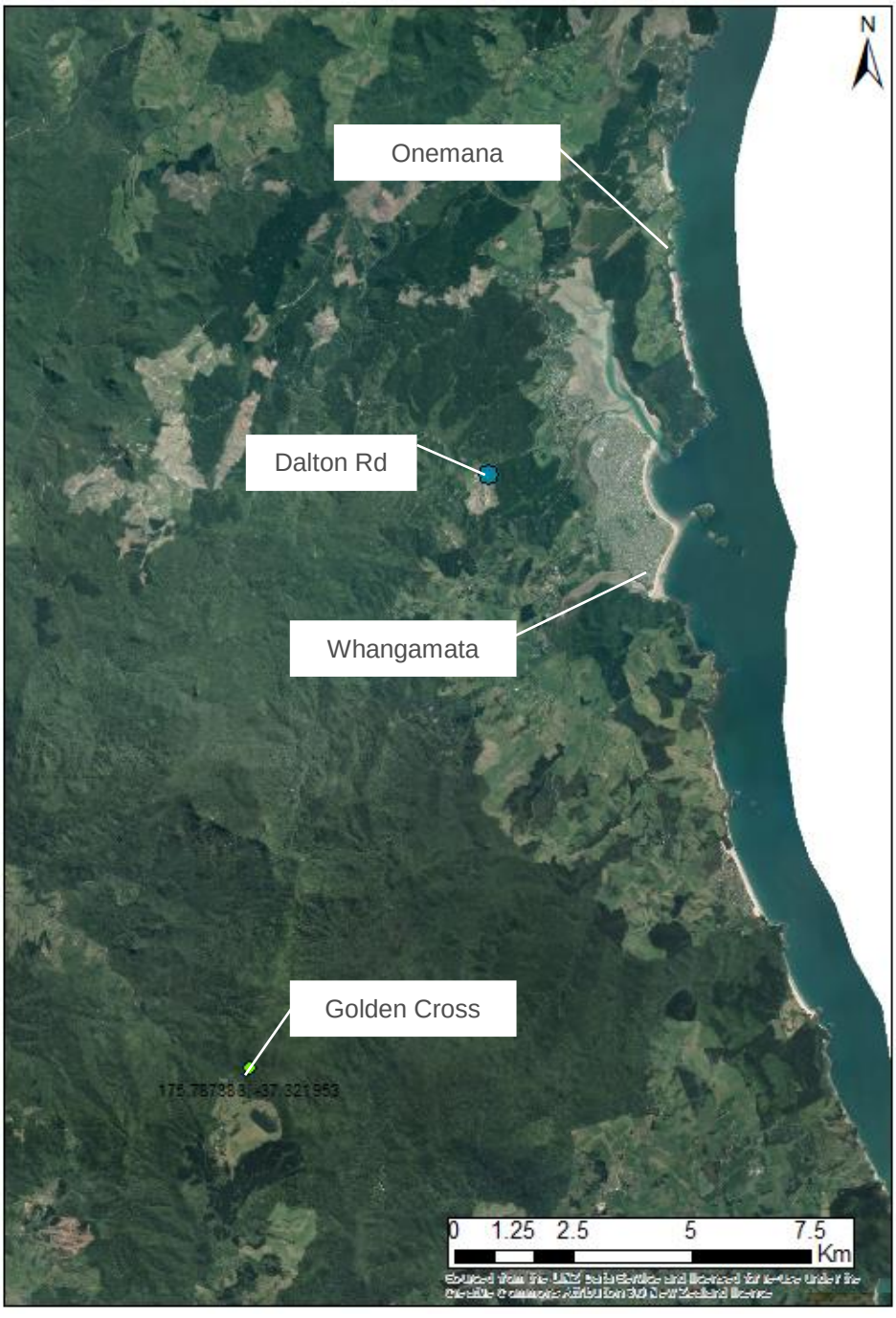


Figure 2: Rainfall site location map

2.1 Data Sources and Limitations

Daily and 1 minute SCADA rainfall data was obtained for the Dalton Road Station. The site is approximately 2.5km from Whangamata town centre and is the closest site with rainfall data available. Daily data from January 2015 to October 2017 was received whereas 1 minute cumulative rainfall data from January 2015 to December 2017 were received. Data screening has been done and noted the following limitation:

- For the 1 minute rainfall data, at 4:34am, 7th March 2017, 184mm rainfall were recorded. It is assumed this is an error occurred with the data recorder (e.g. power cut) hence it recorded data based on the data before recorder shut down which was 182.5mm. Therefore, it was assumed at 4:34am, 1.5mm rainfall has occurred.
- It has been noted that there are various records that show high rainfall depth occurring in 1 minute durations, which are considered unlikely. Such as at 0:00 am, 8th February 2017 and 0:00am, 27th May 2017, 24.5mm and 22.5mm rainfall are recorded respectively.
- It has also been noted there are discrepancy between the 1 minute and daily data sets. Between January 2017 and April 2017, total rainfall recorded by the Daily Rainfall data set was 650mm whereas the 1 minute data set recorded 1084mm of rainfall.
- 1 minute rainfall data from 2015 to 2017 was obtained for the Onemana Station at 436 Onemana Drive, Onemana. The station is approximately 5.6 km away from Whangamata. The total rainfall recorded during January 2017 and April 2017 was 506mm, which is in the same order of magnitude compared to the total amount of rainfall recorded by the Daily Rainfall data recorded at Dalton Road. This gives more confident in using the Daily Rainfall obtained at Dalton Road Station.

Due to above limitations, **the 1 minute rainfall data provided for Dalton Road Station will not be used in this study. The Daily Rainfall data will be used for groundwater level comparison assessment, despite its meaning an assessment of frequent return periods is not possible.**

Five minutes rainfall data from January 2015 to June 2017 was also obtained from Waitekauri River Site at the Golden Cross. The site is 16km away from Whangamata and at a different elevation. The data has been used to provide an indicative pattern when comparing the rainfall pattern with Dalton Road.

2.2 7th – 11th March 2017 Rainfall Event

The daily rainfall for Whangamata and Golden Cross have been plotted in Figure 3 below. At both Dalton Road and Golden Cross, during March 2017 the highest rainfall events occurred between 8th and 11th of March. The rainfall event's return period on both sites have been assessed based on High Intensity Rainfall System V3 (NIWA) as shown in Table 1 below.

Table 1: High Intensity Rainfall System V3 (NIWA)

Depth-Duration-Frequency results (produced on Friday 7th of July 2017)
Sitename: whangamata
Coordinate system: NZMG
Easting: 2765131
Northing: 6439783

Rainfall depths (mm)

		Duration									
ARI (y)	**aep**	**10m**	**20m**	**30m**	**60m**	**2h**	**6h**	**12h**	**24h**	**48h**	**72h**
1.58	0.633	9.9	15.2	19.7	30.4	44.6	82.0	120.3	176.5	231.4	271.0
2.00	0.500	10.8	16.7	21.6	33.3	48.9	89.6	131.3	192.4	252.2	295.4
5.00	0.200	14.4	22.2	28.6	44.3	64.6	117.7	171.8	250.8	328.8	385.1
10.00	0.100	17.3	26.8	34.5	53.4	77.8	141.0	205.3	299.0	391.8	459.0
20.00	0.050	20.7	32.1	41.4	63.9	92.9	167.7	243.6	353.8	463.7	543.2
30.00	0.033	23.0	35.6	45.9	70.9	102.8	185.3	268.8	389.8	510.8	598.4
40.00	0.025	24.8	38.3	49.4	76.3	110.5	198.8	288.1	417.3	547.0	640.7
50.00	0.020	26.2	40.5	52.2	80.7	116.8	210.0	303.9	439.9	576.6	675.5
60.00	0.017	27.4	42.4	54.7	84.5	122.2	219.5	317.5	459.3	602.0	705.2
80.00	0.012	29.5	45.6	58.8	90.9	131.3	235.3	340.1	491.5	644.2	754.6
100.00	0.010	31.2	48.2	62.2	96.1	138.8	248.4	358.7	518.0	678.9	795.3

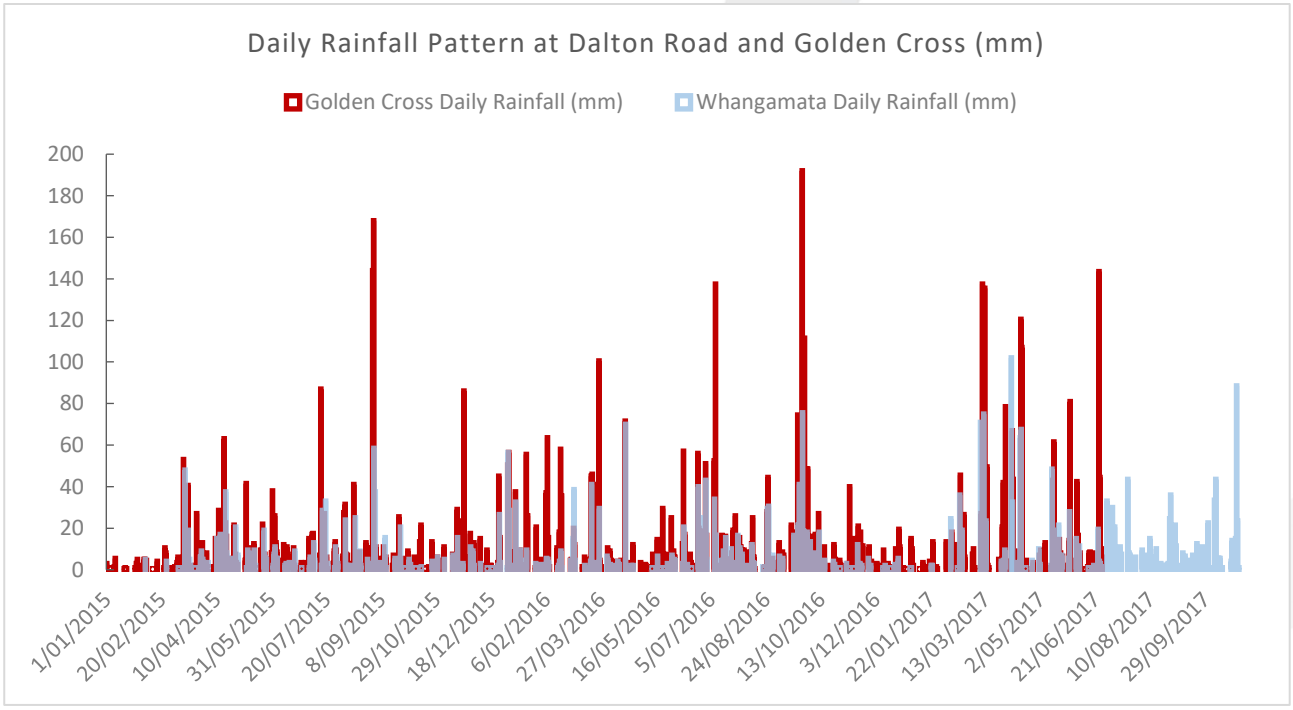


Figure 3: Daily Rainfall Pattern at Dalton Road and Golden Cross Stations

Key points to note from the rainfall records:

- Golden Cross generally records higher daily totals compared to Dalton Road.
- Frequent rainfall occurred between the 8th and 13th of March, among those time there are two large rainfall events occurred on the 8th March and 11th March 2017 at Dalton Road with 71mm and 75mm rainfall respectively.
- There was two higher daily rainfall totals at Dalton Road on the 5th April 2017 and 28th October 2017, with 102mm and 88.5 of rainfall respectively.
- **The rainfall during the March events at Golden Cross is estimated at between 5 to 10 year ARI. The Dalton Road station generally shows less rainfall comparing to Golden Cross, therefore the return periods were potentially lower in Whangamata, however it is not possible to assess on the rainfall return period as only daily rainfall totals are available.**

Table 2: Estimated Rainfall return period analysis for Dalton Road and Golden Cross

Rainfall Duration	Dalton Road Site			Golden Cross Site		
	Maximum Rainfall (mm)	Occurred on (Date)	ARI (V3)	Maximum Rainfall (mm)	Occurred on (Date)	ARI (V3)
Hourly	-	-	-	45	10/03/2017	5 to 10
2hr	-	-	-	67	10/03/2017	5 to 10
6hr	-	-	-	120	10/03/2017	5 to 10
12hr	-	-	-	140	10/03/2017	2 to 5
24hr	75	11/03/2017	<1.58	169	10/03/2017	<1.58
48hr	114.5	8/03/2017	<1.58	210.5	10/03/2017	<1.58
72hr	129	9/03/2017	<1.58	303.5	7/03/2017	2 to 5

3 Rainfall and Groundwater Level Comparison

The reliance on soakage for stormwater disposal in Whangamata means groundwater levels can play an important role in the overall stormwater system performance. This section compares recorded rainfall and groundwater level.

3.1 Data Sources and Limitations

15mins groundwater level data from October 2014 to June 2017 was obtained from BH04 at Memorial Hall, Port Road and BH05 at Rangi Avenue from Thames-Coromandel District Council on the 14th July 2017. BH04 is approximately 1km from Williamson Park, whereas BH05 is approximately 700m away. These boreholes are the only two which have data available for the analysis. BH04 is approximately 2.5km away from the Dalton Road rainfall station whereas BH05 is 3.7km away.

Figure 4: Locator Map

The distance of the boreholes from the Williamson Park catchment, and the pond, mean the absolute groundwater levels should be used with caution – it is likely groundwater levels in the Williamson Park catchment are different from those represented below. However, the data is useful in understand the overall trend in groundwater levels in the area.

3.2 Overall Trend

The daily Dalton Road rainfall data is plotted in Figure 5 with the water level obtained from Borehole No.4 (BH04) and Borehole No.5 (BH05).

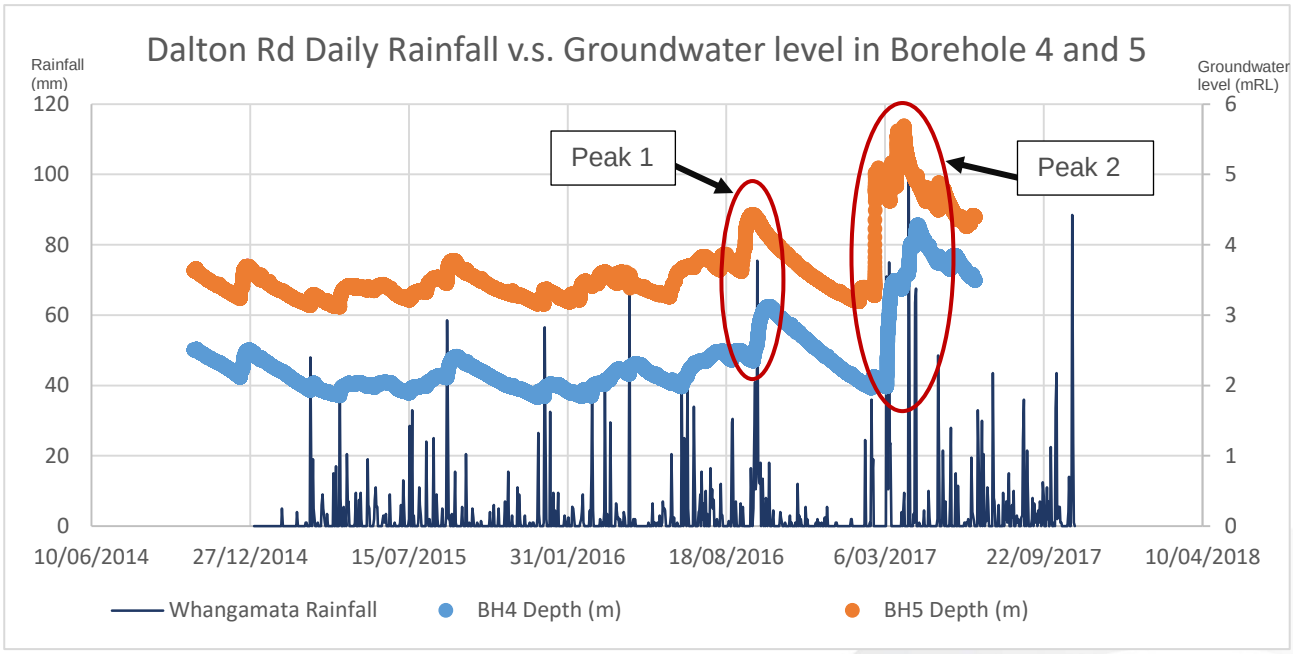


Figure 5: Trend of groundwater level with Dalton Road Rainfall

The data shows a general trend of increase in groundwater level after rainfall events - where there is a high rainfall event, the groundwater level tends to rise.

On March 2017, rainfall occurred everyday between the 8th and the 13th. Two large rainfall totals occurred on the 8th and the 11th with more than 70mm rainfall on each day. One larger rainfall event occurred on the 5th April with 102mm rainfall. This was the highest daily rainfall total during the previous two years.

Peak 1 occurred immediately after the high rainfall event in September 2016. A relatively dry summer and autumn appears to have led to the groundwater level dropping and reached a low point in February 2017.

Peak 2 was influenced by the large rainfall events that occurred in March and April 2017.

3.3 March and April 2017 Events

As shown in Figure 5, Peak 2 highlights the rainfall events that occurred in March and April 2017 with groundwater levels at BH04 and BH05 the highest recorded within the data period. As discussed in Section 3.2, there are many large rainfall events occurred during March and April**. The volume of rainfall that fell in this period was likely a significant factor in the rapid rise of groundwater levels**, however further investigation would be required to determine any other factors that may have influenced groundwater levels.

Table 3 identifies that when groundwater reaches its peak, it is less than 1m below ground level at the borehole sites. If a similar pattern was extrapolated across Whangamata it would have a significant impact on the performance of soakage devices across the town.

Table 3: Peak Groundwater Levels during 8th-11th March 2017 Storm Events

Borehole			
	Peak Groundwater Level (mRL)	Estimate Ground Level (mRL)[1]	Estimated depth to groundwater below surface (m)
BH04	5.64	6.5	0.86
BH05	4.26	5.0	0.74

3.4 Impact on the Williamson Park Pond

In March 2017, anecdotal evidence indicates the pond in Williamson Park was flooded. Based on the above assessment the following factors are likely to have contributed to this:

- The rainfall event that occurred was the largest in the previous two years; however data limitations mean it is not possible to accurately assess the return period of the storm events in Whangamata.
- The groundwater level during March and April 2017 were the highest in the provided data and were significantly higher than the average during this period.
- TCDC Engineering Standards indicate the water table is approximately 1.5m below ground level at the intersection of Williamson Road and Ocean Road. It is not known whether this is a spot level, minimum, maximum or average level. This level equates to an approximate level of 2mRL – which is also the approximate water level surveyed in the Williamson Park Pond in 2005. The pond survey information shows that the pond crest level is at 2.5 mRL, therefore there is approximately 0.5m storage during this scenario.
- **The storage in the Williamson Park Pond is therefore linked to groundwater levels. If the groundwater levels are high, as occurred during the March 2017 storm events, it is likely the permanent water level in the pond was also higher, reducing storage available, and potentially leading to flooding.**
- Further, the high groundwater levels likely impacted on stormwater disposal via soakage. As a result, the surface water runoff to the road network was higher which likely increased runoff discharge to the pond both by stormwater network and overland flow.

[1] Estimated based on the half metre contours provided as part of the Whangamata Stormwater Catchment Management Study (Opus, 2005)

4 Conclusions and Recommendations

1. The rainfall data and groundwater level data analysis shows that the March 2017 flooding in Williamson Park could be a result of:
   a. Multiple large rainfall events.
   b. Water levels in the Williamson Park Pond are linked to groundwater levels. Groundwater levels were the highest in the data period provided.
   c. Private soakage performance was likely decreased due to groundwater levels, which would result in an increase in surface water runoff to the road network, increasing discharge to the pond both by the stormwater pipe network and overland flow.

2. The flooding of the Williamson Park pond is part of a more systemic stormwater management issue in Whangamata. Any decisions on the future of the pond should be informed by catchment management planning, that are cognisant of the effects of climate change and key recommendations from the Whangamata Groundwater Monitoring Summary Report (Opus, 2012, which still remain applicable. In particular the need for careful design and detailing of soakage devices, including measures to keep the device shallow and maximise storage volume.

3. **Importantly, predicted climate change effect could result in a higher sea level and more intense rainfall - minimum groundwater levels are likely to be higher. This is expect to impact on stormwater disposal via soakage as well as pond levels and flooding in the Williamson Park Pond.**

4. The need and benefit of the Williamson Park Pond could be reviewed. Groundwater levels mean it is unlikely to be providing much detention/attenuation benefit. Water quality benefit is also likely to be limited. The benefits will be further reduced without regular maintenance. Alternative arrangements could be considered, including removal, conversion to a wetland or watercourse.

5. Improving the discharge arrangement of the pond, such as an improved pond outlet/spillway from the pond may help improve the pond capacity and upstream network system performance by reducing the tailwater level. However providing a piped outlet from the pond could be viewed as having a detrimental effect on the beach, with scour/erosion of the beach occurring. Community consultation is recommended before any decision is made. If the pond water level is not at risk of causing or exacerbating private property flooding, a ‘Do Nothing’ scenario could also be considered.

6. Data limitations mean a definitive conclusion on the return period of the rainfall events in March 2017 has not been possible to date. Should more detail be required, the following is recommended:
   a. Detailed review of the 1 minute rain gauge arrangement at Dalton Road to understand why there is a significant discrepancy with the daily rainfall totals.
   b. Consider rain radar data as an alternative data source for analysis of rainfall. However, pre-processing including calibration on the rain radar data is required. The benefit would need to be assessed further.

5 References

1. NIWA (2017). High Intensity Rainfall System V3. [Online: https://hirds.niwa.co.nz/].

2. Opus International Consultants (2005) Whangamata Stormwater Catchment Management Study – Issues and Options

3. Opus International Consultants (2012) Whangamata Groundwater Monitoring Summary Report.

4. Thames Coromandel District Council (2013). Code of Practice for Subdivision and Development (Engineering Standards). [Online: https://docs.tcdc.govt.nz/store/default/2708431.pdf]

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