3. LOSS OF BASEFLOW IN THE UPPER KAPUTONE STREAM – POSSIBLE CAUSES

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The purpose of this report is to identify possible causes of loss of baseflow in the Upper Kaputone Stream.

BACKGROUND/INTRODUCTION

In recent years the residents of the upper reaches of the Kaputone Stream have expressed concerns regarding the lack of baseflow in the Kaputone Stream, west of the Main North Road. The Styx Living Laboratory Trust and the Guardians of the Styx have also identified lack of hydrological data on the Styx River and Kaputone Stream flows.

The Styx Living Laboratory Trust initiated a program, working with local residents, to monitor stream flows of the upper reaches of the Styx River and Kaputone Stream. The Guardians of the Styx have also recognised the loss of baseflow and expressed concerns. They have requested any hydrological data available in order to better understand the hydrological regime, water balance, and water quality in the Kaputone stream, which is one of the key environmental components in that area.

There are several existing and proposed developments within the upper reaches of the Kaputone Stream area bounded by Englefield, Main North and Johns Roads. There is also a number of the existing developments adjacent to the Upper Kaputone Stream catchment. Specifically, these are the Clearwater development on the north and the Northwood development on the south of the Upper Kaputone Stream catchment. The residents are concerned that there is a possibility that these developments might have caused some permanent disturbance of the Kaputone Stream springs and groundwater regime within the area, which are important components of the water balance.

In response to these concerns, the Shirley/Papanui Community Board requested a report identifying the problems with the Kaputone Stream baseflow. The present report provides such information.

INTERIM RESULTS

The locations of the groundwater monitoring wells, rainfall site at Pumping Station 62, Belfast, at Tyrone St (SBE), springs and streamflow status site for the Kaputone Stream at Main North Road are shown in Figure 1. The Waimakariri River water levels, borehole groundwater levels for M35_1205 and M35_3739 wells, rainfall at Belfast, (SBE), evaporation at Christchurch Airport and the Kaputone Stream flow status have been plotted for the period of March 1998 to January 2004 in Figure 2. Figure 2 also shows periods of major dewatering within Northwood site during construction of Stages 1 and 5. During construction of the remaining stages dewatering within Northwood site was not significant.

There is no doubt that over last few years the upper reaches of the Kaputone Stream have been subjected to a greater number of days with little or no flow. In particular, the Upper Kaputone Stream dewaters over the summer and early autumn periods. The number of days during which there was no flow in the upper reaches of the Kaputone Stream has been significantly higher in 2001 and 2003 than during other years.

The Kaputone Stream is spring-fed from groundwater, and any changes in groundwater level will be reflected in stream flows. Indeed, the low groundwater levels in boreholes M35_3739 and M35_1205 have appeared to correlate well with dry periods in the Upper Kaputone Stream. A significant increase in the number of days when there was no flow in the Upper Kaputone Stream in 2001 and 2003 is also correlated well with low water levels in the Waimakariri River.

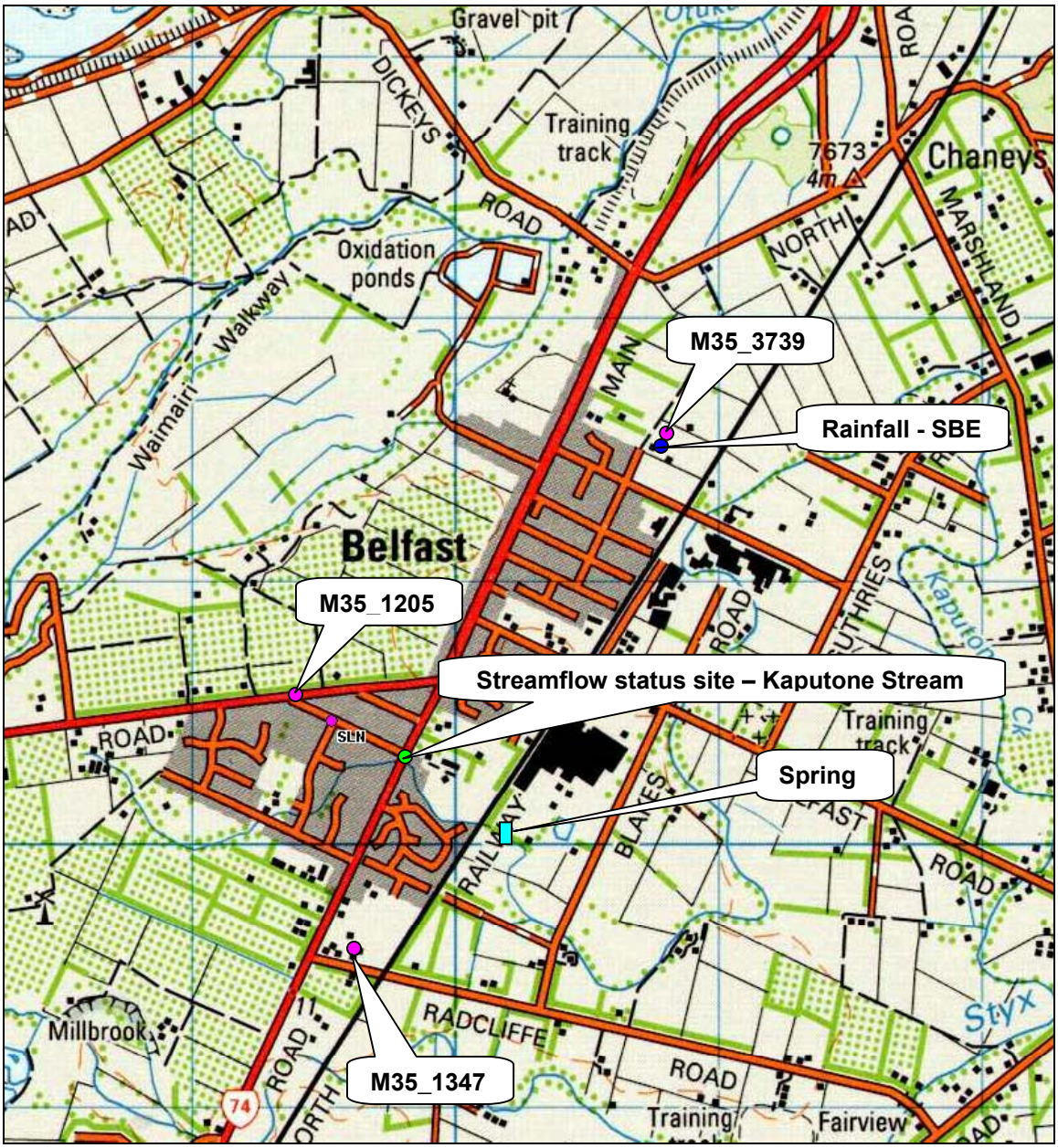
Total yearly rainfall and the percentage of recorded days when there was no flow in the Kaputone Stream at Main North Road are shown in Table 1. As one can see in this Table, the total rainfall for 1999, 2000 and 2002 was 641 mm, 605 mm and 712 mm, respectively, which is above average rainfall of 537 mm. The percentage of recorded days when there was no flow in the Kaputone Stream at Main North Road in 1999, 2000 and 2002 was 8%, 18% and 17%, respectively. From another side, the total yearly rainfall for 1998, 2001 and 2003 was 383 mm, 420 mm and 477 mm, respectively, which is below average rainfall of 537 mm. The percentage of recorded days when there was no flow in the Kaputone Stream at Main North Road in 1998, 2001 and 2003 was 14%, 75% and 96%, respectively. Thus, the rainfall is another well-correlated factor influencing water flow in the Kaputone Stream.

Total yearly rainfall and groundwater levels for 1998, 2001, and 2003 were reasonably similar. Low yearly rainfall and long dry periods during the year may impact on local groundwater levels, which will affect surface flow in the Kaputone Stream. Interestingly, the number of days when there was no flow in the Kaputone Stream at Main North Road was significantly higher in 2001 and 2003 than in 1998. The significant decrease in streamflow in 2001 and 2003 may be attributed to intra annual rainfall distribution and higher evaporation rate. Figure 2 shows that the daily rainfall distribution and pattern were significantly different in 2001 and 2003 compared to 1998. Autumn, winter and early spring in 2001, and early autumn, winter and summer in 2003 were very dry compared to 1998. Figure 2 also shows that the daily evaporation rate in 2001 and 2003 was higher compared to 1998. This could have considerably affected the values of (1) underground flow into and out of the Upper Kaputone Stream catchment, and (2) change in storage within the catchment, either in surface depressions or in underground aquifers.

In 1998, with relatively uniform rainfall distribution there was continuous water flow in the Upper Kaputone Stream from April to December 1998. “No flow” period in March 1998 may be attributed to very low groundwater levels. Longer “no flow” periods in 2001 and 2003 are most probably due to non-uniform rainfall distribution, high evaporation rate, very low groundwater levels and low water levels in the Waimakariri River.

Table 1: Yearly rainfall and number of dewatered days in the Upper Kaputone Stream

Year	Yearly Rainfall (SBE-Belfast), mm	Number of dewatered days-Kaputone at Main North Road, %
1998	**383**	**14**
1999	641	8
2000	605	18
2001	**420**	**75**
2002	712	17
2003	**477**	**96**



Legend

- Rainfall site
- Groundwater monitoring wells (M35_1205; M35_1347; M35_3739)
- Streamflow status site – the Kaputone Stream at Main North Road
- Spring location

Figure 1: The Kaputone Stream – general location plan

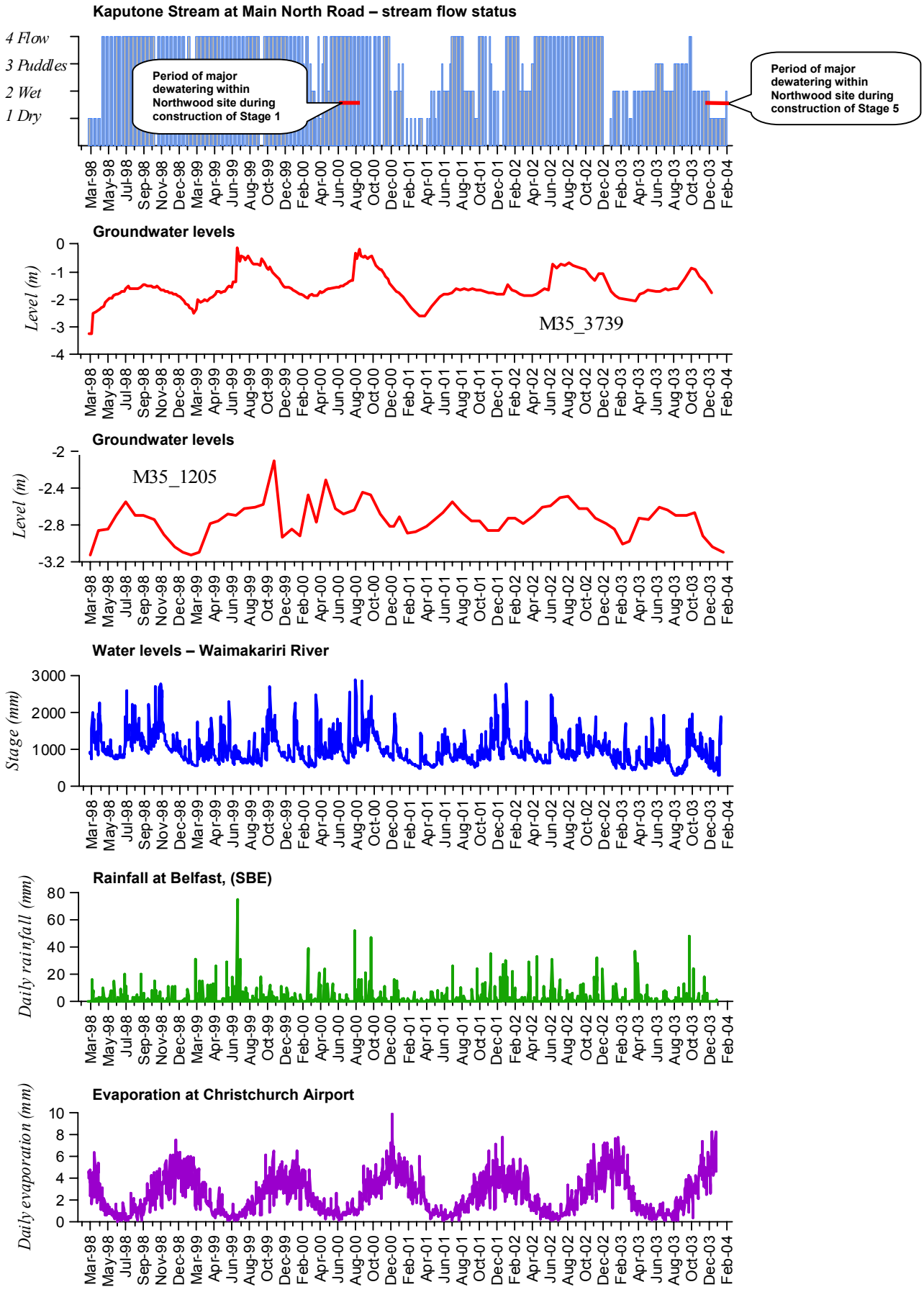


Figure 2: **Stream flow status, groundwater, water levels, rainfall and evaporation data**

EXECUTIVE SUMMARY

Over the last few years the upper reaches of the Kaputone Stream have been subjected to a greater number of days with little or no flow. Longer "no flow" periods may be attributed to (1) very low groundwater levels; (2) low water levels in the Waimakariri River; (3) low total yearly rainfall; (4) variation in intra annual rainfall distribution; (5) high evaporation rate and (6) development of the land within the Upper Kaputone Stream catchment and adjacent to the catchment.

There is no doubt that over the last few years the upper reaches of the Kaputone Stream have been subjected to a greater number of days with little or no flow.

The significant decrease in streamflow in the upper reaches of Kaputone Stream over the last few years may be due to the following factors:

- variation in intra annual rainfall distribution and high evaporation rate
- total yearly rainfall over a few recent years was below the average rainfall of 537 mm
- long periods of low flow in the Waimakariri River within the last few years
- steady decline of groundwater level recorded in M35_1205 and M35_3739
- development of the land within the Upper Kaputone Stream catchment and adjacent to the catchment.

It is important that the Styx Living Laboratory Trust and associated group of residents continue to monitor streamflow in the upper reaches of the Kaputone Stream on a regular basis (weekly or fortnightly).

It is important that for any new subdivision within the Upper Kaputone Stream catchment a preferred stormwater disposal option is to be by soakage.

Shirley/Papanui Community Board

The Board decided to recommend to the Parks Gardens and Waterways Committee that:

1. The feasibility of developing a mathematical groundwater model of the Upper Kaputone Stream catchment should be investigated. (Time to investigate if developing of mathematical groundwater model is feasible – approximately 1 week, estimate is $3,000 excl. GST. If it is feasible, additional time and funding will be required to develop the model).

2. Simultaneous monitoring of the M35_1205 and M35_3739 is to be continued and monitoring of the M35_1347 is to be restarted to better understand the dynamics of the underground flow into and out of the Upper Kaputone Stream catchment. (Estimate to restart M35_1347 is $2,400 excl. GST per year).

3. Relevant meteorological data is to be collated for the purpose of estimating the evaporation and evapotranspiration over the last few years. This would allow a more reliable assessment of water balance dynamics of the Upper Kaputone Stream catchment. (Time to research, collate and analyse relevant meteorological data – approximately 3 weeks).

4. To better understand the effect of urbanisation on surface and groundwater flows, monitoring the following parameters within Northwood site is proposed:
   - groundwater levels at the locations where historical groundwater level information is available
   - groundwater monitoring of groundwater flows around road and trench systems used for sewer and other services
   - groundwater flow rates from the existing and proposed groundwater discharge points.

5. (Estimate is in the order of $25,000 – $30,000. This could be incorporated into the next budget round 2005/2006 as an additional budget item).

Chairman's Recommendation:

1. That the monitoring work outlined in recommendation 2 be actioned for the 2004/05 year.

2. That the estimate of funds (approximately $30,000) for the 2005/06 Plan be utilised for the remediation of the loss of flow rather than more data collection.