Appendix A:

Case Study A – Papawai Stream, Wellington Regional Council

A1. Available Information to Set the Scene

In the Wairarapa, Wellington Regional Council (WRC) have assessed the effects of an irrigation abstraction well (reference number 5G/68/8/1) on the nearby Papawai Stream. WRC have provided the following information contained in two reports: Draft WRC report titled "Papawai Stream Water Allocation Current Information Knowledge", 1999; and "Papawai Stream and Groundwater Monitoring 1995-96 Irrigation Season" by Greg Butcher.

The Papawai Stream is a small springfed stream which originates approximately 100 m south of the intersection of Church Street and East Street in Greytown (Figure A1). At Fabian Road (around 2,000 m downstream of the headwaters) the mean flow is 307 L/s and the median flow is 268 L/s. Between November 1981 and February 1996 the mean annual daily low flow was 209 L/s.

The irrigation well is 8.2 m deep, located approximately 180 m from the south tributary of the Papawai Stream and is permitted to abstract water at a rate of around 40 L/s. It draws water from a shallow aquifer with an average transmissivity of 3,300 m^2/day. Groundwater quality data, environmental isotopes and groundwater hydrographs indicate that the aquifer is recharged by a combination of river flow and rainfall recharge.

Figure A2 shows the correlation between a groundwater monitoring well (located between the irrigation well and the Papawai Stream) and stream flow measured at Fabians Road. This figure indicates a strong relationship exists between measured groundwater levels and the flows in the Papawai Stream (particularly the base flows). The same monitoring well also shows the effect of pumping (at a rate of 40 L/s) from the nearby irrigation well, which appears to cause a drawdown effect of 0.1 – 0.2 m over a period of 80 days.

On the basis of this information the reports concluded that "any significant abstraction of shallow groundwater in the area could cause significant reduction in flow from the Papawai Stream" (Draft WRC report – Papawai Stream Water Allocation Current Information Knowledge, 1999). and "Results of monitoring during the 1995-96 irrigation season suggest that under current levels of groundwater pumping approximately an 18% reduction in the flow of the Papawai Stream may occur at Fabians Road' (Greg Butcher "Papawai Stream and Groundwater Monitoring 1995-96 Irrigation Season").

A2. Analysis

The conceptual hydrogeological setting of a shallow aquifer and a nearby stream, with flows that correlate with groundwater levels, indicate a setting where stream depletion effects have the potential to occur.

The analytical method for calculating stream depletion effects (section 4.1), can be applied to this situation using the following parameters:

Transmissivitiy of 3,300 m^2/day

a separation distance from the stream of 180 m

Storage coefficient of 0.1 (a typical value an unconfined aquifer)

These parameters define a stream depletion factor of 0.98 days which indicates that stream depletion effects are likely, provided that the streambed is conductive.

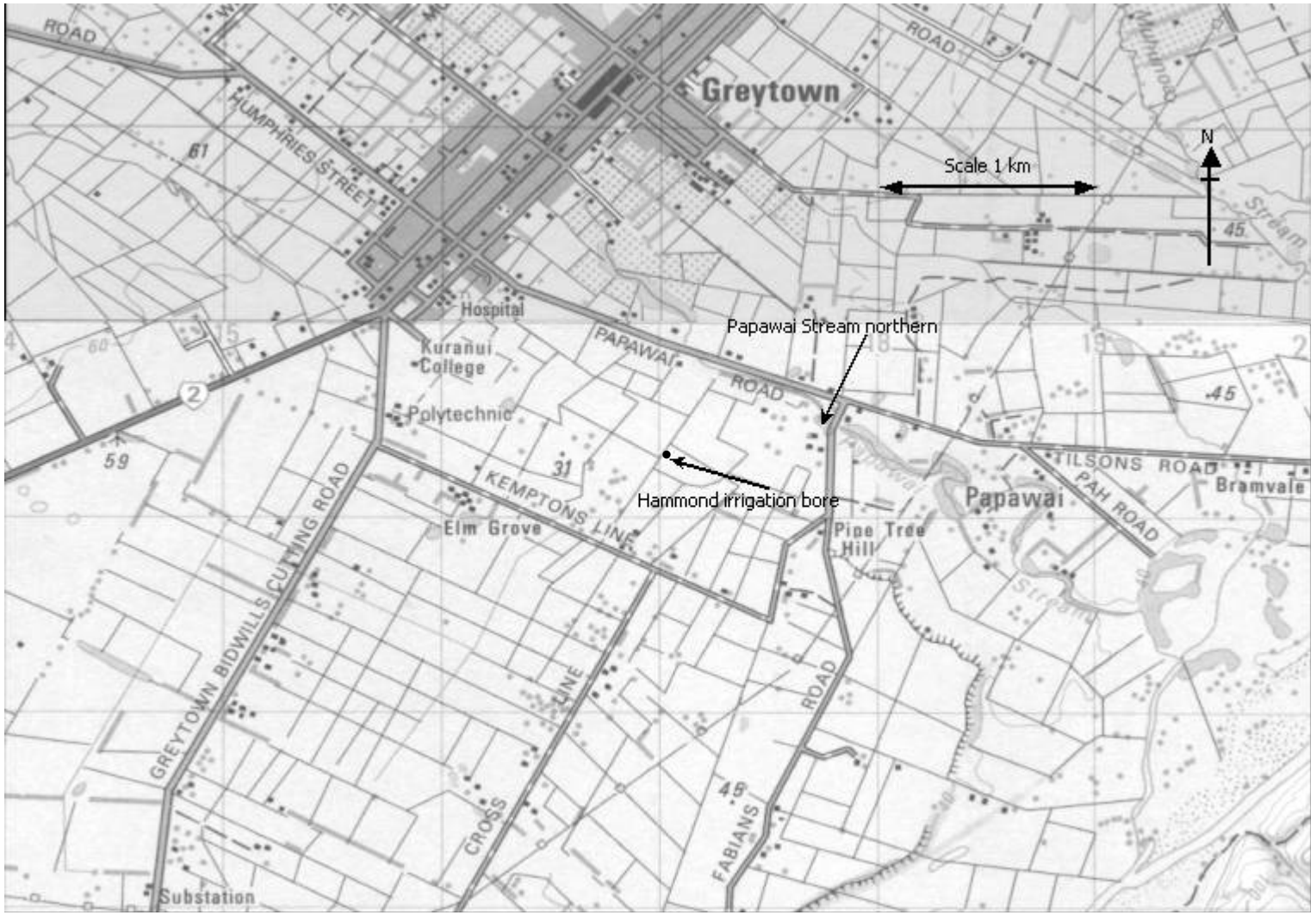
With regard to the streambed clogging layer it can be assumed for the setting described above that, in the absence of any other data, the aquifer transmissivity is indicative of the streambed conductance. Because the irrigation well is 8.2 m deep it is not unreasonable to assume a 10 m thick aquifer, giving a hydraulic conductivity of 330 m/day $\left(K = T/b = K'\right)$.

Assuming a stream bed thickness of 1 m, and a stream bed width of 10 m we are then able to calculate the stream bed conductance, λ as being 3,300 m/day.

Figure A3 shows the calculated effect of this abstraction on stream flow.

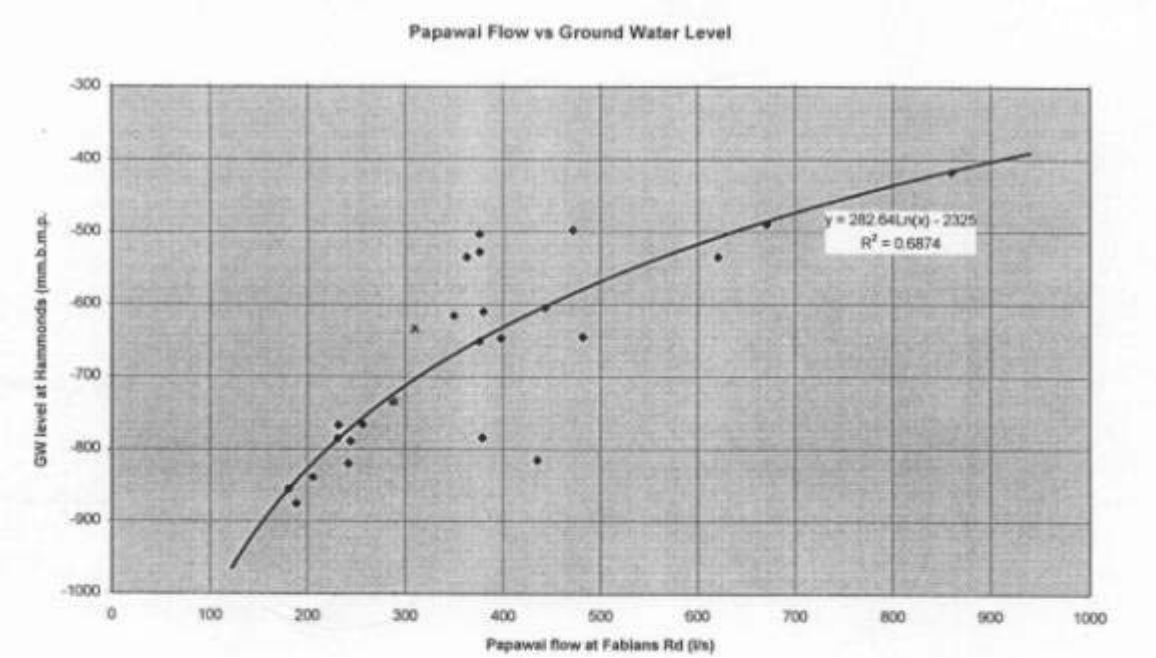
The parameters indicate that stream flow is estimated to reduce by 90% of the bore's average pumping rate after 30 days pumping – a result that is consistent with the Wellington Regional Council's assessment. Stream depletion rates would continue to be around 80% of the well abstraction rate after 30 days pumping even if the stream bed hydraulic conductivity was as low as 3.3 m/day (100 times less than the aquifer hydraulic conductivity, i.e. K' = 0.01 K).

In this case, the quantitative assessment using the technique in this guideline supports the inferences made from the WRC's assessment of groundwater level and stream flow data, whilst giving a more realistic picture of the transient changes in stream depletion effects over a period of prolonged pumping.



NZMS 260 Map S26 & S27.

Figure A1 Location Map for Case Study A



A plot using only the low flow gaugings is shown below.

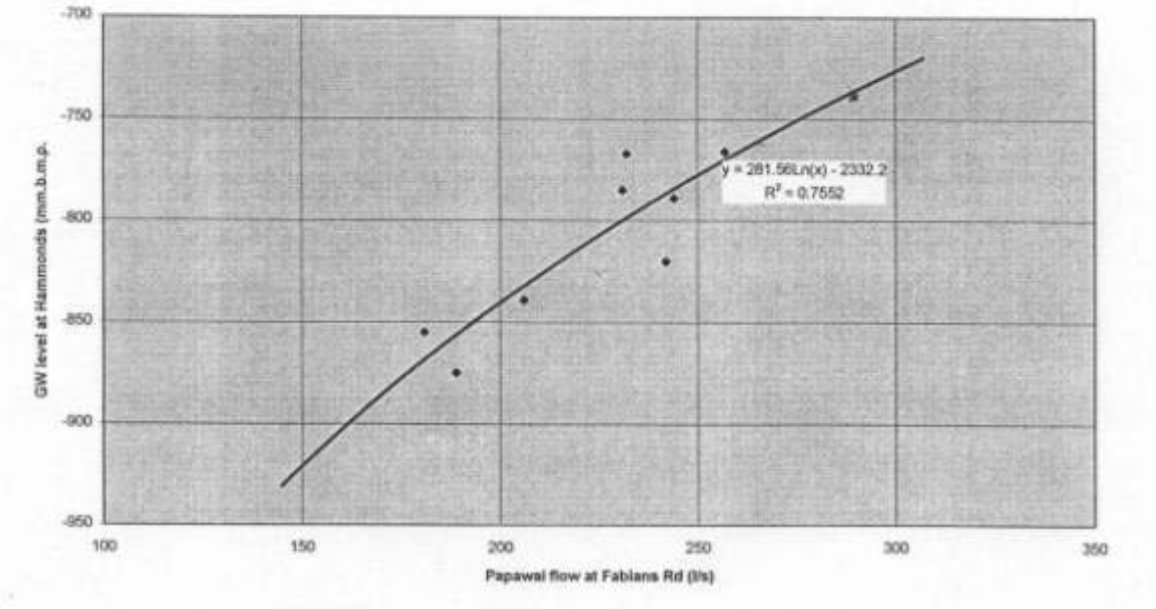


Figure A2 Correlations between Groundwater Level and Stream Flow

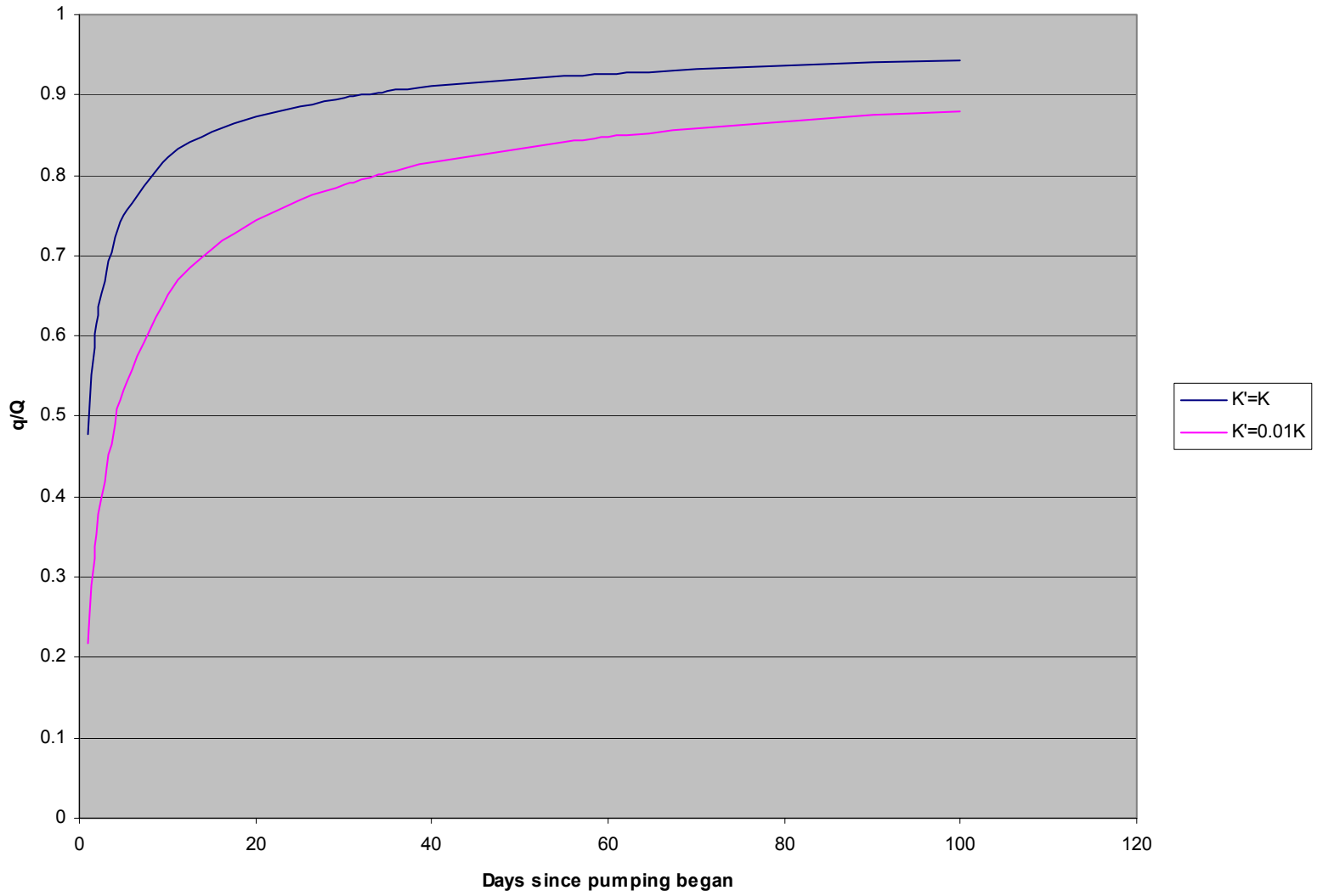


Figure A3: Calculated stream depletion effect