

Appendix C – Monitoring Bore Hydrographs

Hydrographs for NRC monitoring bores are shown in Figures C1 to C3. A summary of the hydrographic response for each bore and the implications from these is provided below.

Hukatere to Houhora Transect Bores

Bores 206 and 48 – Hukatere Piezos and Bore at Houhora

The response of these two bores is identical for the piezo at 20 mBGL. Groundwater pressures decrease with depth, although piezos show similar response at all depths. This indicates that the area is a groundwater recharge area. The difference in groundwater pressure between the top two piezos and the bottom two indicates that the sediments are more homogenous at great depths. The electrical resistivity trace from the borelog is oscillatory but overall shows a trend of decreasing resistivity with depth. This indicates compaction of sediments with depth and the greater presence of lower permeability materials such as bands of silty fine sand, silt and clay.

The hydrographic responsiveness compared to bore 207 (middle of forest) indicates the influence of greater more frequent recharge.

Bore 207 – Forest Piezo at Hukatere

Groundwater pressures reduce with depth indicating a downward pressure gradient (i.e., recharge area). The two deeper piezos at 82.1 and 67.5 mBGL show equivalent groundwater pressures indicating homogenous aquifer conditions at these depths.

The electrical resistivity test indicates a general increase in resistivity with depth, and a marked increase at approximately 52 mBGL, which occurs just after a clayey zone. This indicates that the sands become cleaner with depth and thus vertical anisotropy is anticipated to be significant in only the upper parts of the aquifer.

The hydrographic response is very mitigated at all depths in comparison to the other bores, indicating the effects of afforestation (i.e., reduced recharge). Comparison of the upper and lower piezo hydrographs indicates that the upper aquifer is depressurising slightly faster than the lower.

Bore 208 - Browne Piezo at Houhora

Groundwater pressures decrease with depth in each piezo. There is no distinct confining layer indicated in the borelogs, therefore it is assumed that inherent in the aquifer is some degree of vertical anisotropy (i.e., horizontal permeability is greater than vertical). This is typical in fluvial and aeolian sediments where horizontal or sub-horizontal bedding features are common.



The site displays less oscillatory response to rainfall than bore 209 indicating its close proximity to the forest and possibly that the permeability and storage characteristics of the aquifer materials are slightly higher.

Bore 209 – Burnage Rd Piezo at Houhora

The piezo at 20 mBGL shows significantly higher pressures than the deeper piezos. All the piezos deeper than 20 mBGL show equivalent pressures indicating homogenous aquifer conditions. The borelog indicates a unit of lower permeability silty fine sand with occasional silty clays and peat from approximately 20-30 mBGL. This may impart some degree of semi-confinement on the lower part of the aquifer.

The bore shows some degree of impact from pumping in the deeper piezos as indicated by the mitigated recoveries in comparison to the upper piezo.

Bore 210 Waterfront Piezo at Houhora

Deep piezos at 60 and 70 mBGL have equivalent pressures, which are approximately 2 m greater than the shallower piezos. The piezo at 39.7 mBGL has an average pressure of about 0.5 to 1 m greater than the shallow piezo at 21.5 mBGL. This indicates groundwater discharge to the coast (i.e., upward leakage). Tidal effect is shown in piezos at all depths.

Borelog indicates lower permeability fine to very fine silty sand layer with a peat base from 40 to 50 mBGL. This layer probably acts as a semi-confining bed or imparts a degree of vertical anisotropy, although the lateral extent is not known.

Paparore-Sweetwater Bores

Bore 211 – Paparore Rd Piezo at Paparore

Deep piezos at 67 and 81 mBGL show identical hydrographic responses, as do the two shallow piezos at 21 and 38 mBGL. This indicates two distinct aquifer systems. Deep bores show rapid pumping induced depressurisation (up to 5m head losses) and rapid recovery at the end of the summer growing season.

The bore log indicates a 10 m thick low permeability silty clay layer from 40 to 50 mBGL. This may semi-confine the lower aquifer from the shallow.

Bore 81 – Ogle Drive Bore at Paparore

The hydrograph shows a very attenuated response to rainfall, similar to that of the Lake Heather bores. The borelog indicates the occurrence of low permeability iron pans and clay layers; similar to that of the Lake Heather bores. The absolute variation in groundwater oscillation over the monitoring period is small in comparison to other bores (except Lake Heather which is similar). This indicates that the lakes in the area may be acting as slow release surface reservoirs and maintaining a low but reasonable constant rate of groundwater recharge. The rate would be head driven by lake levels



to some extent, but the depth to groundwater and low permeability layers would attenuate this.

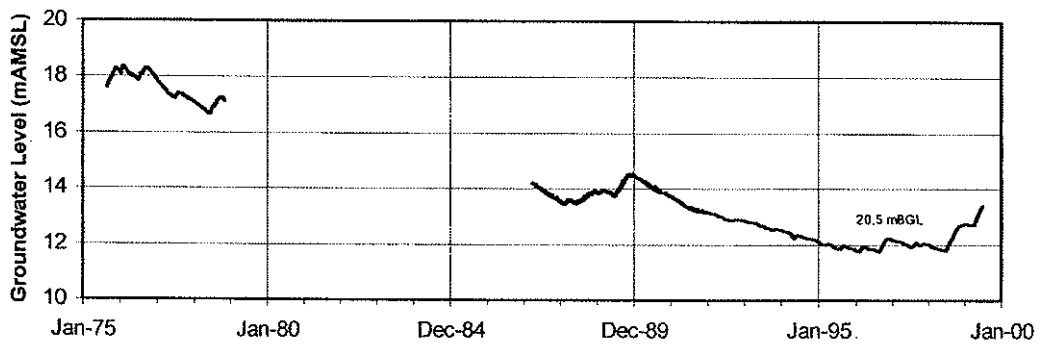
Bores 226, 227, 228 – Lake Heather Piezos

Hydrographs shows a very attenuated response, probably due to the peat layer approximately 7 m thick from 12-19 mBGL. Fine sands prevail throughout the deeper aquifer. Aquifer pressures decrease downwards indicating recharge is occurring.

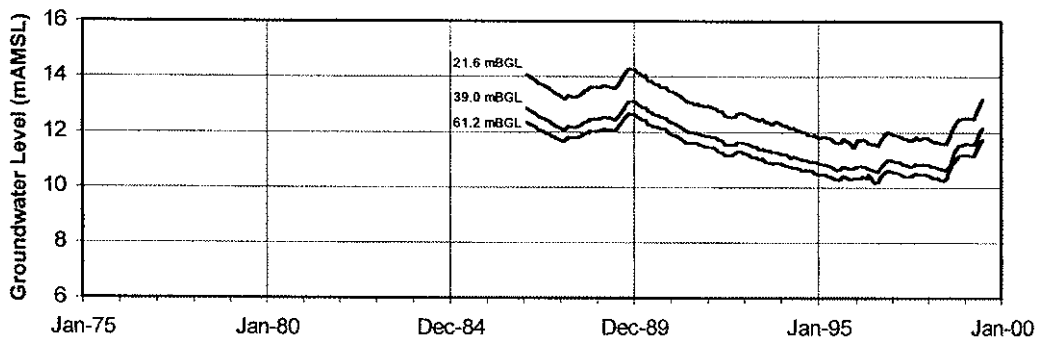
Lake Heather may also act as a slow release leaky reservoir. The lake is perched above the underlying sands probably by a basal confining layer of fine silts, clay and iron pans. The lake system may be likened to a dish that leaks slowly through its base and during extreme wet periods the dish may overflow its rim. Lake water would then percolate downward through the higher permeability materials surrounding the lake.



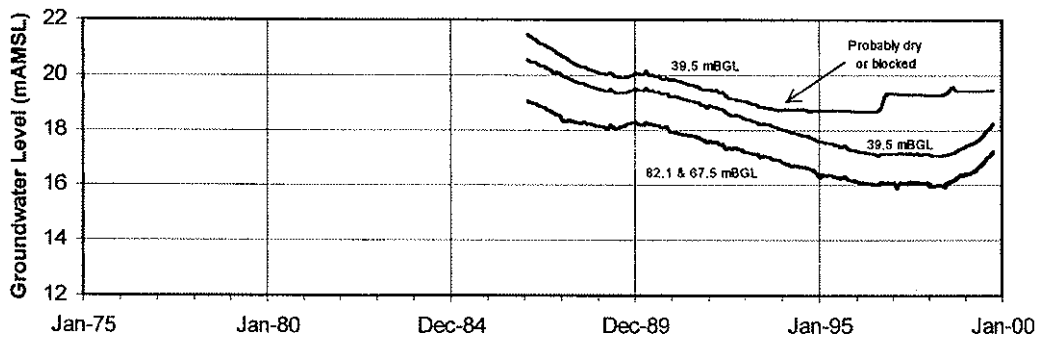
WellArc 048 - Site 5381001 Hukatere Bore at Houhora



WellArc 206 - Site 4380003 Hukatere Piezo at Houhora



WellArc 207 - Site 4381007 Forest Piezo at Houhora



WellArc 208 - Site 4381005 Browne Piezo at Houhora

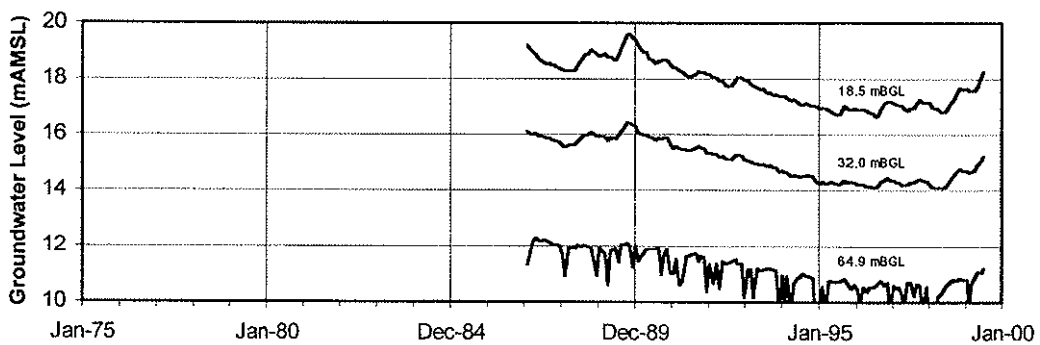
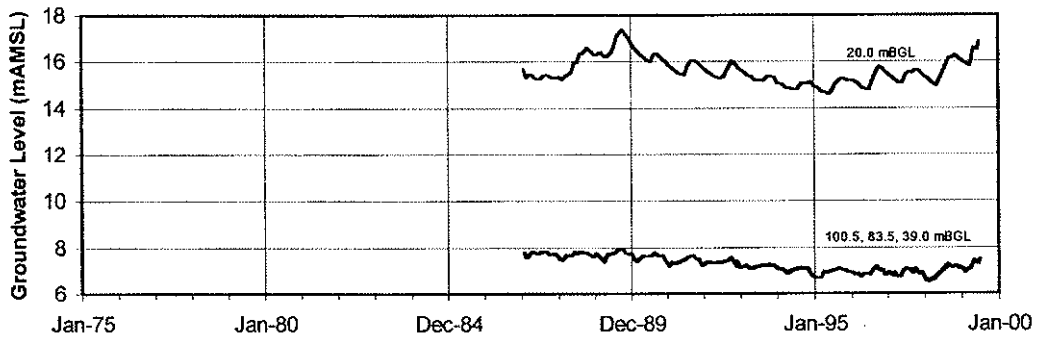
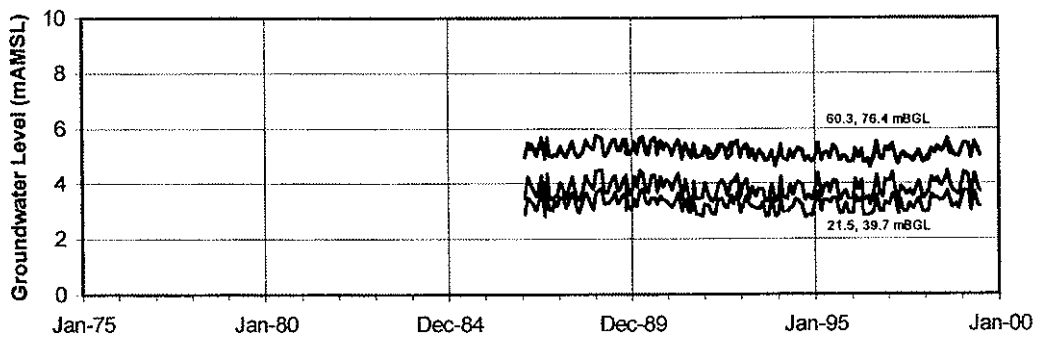


Figure C1

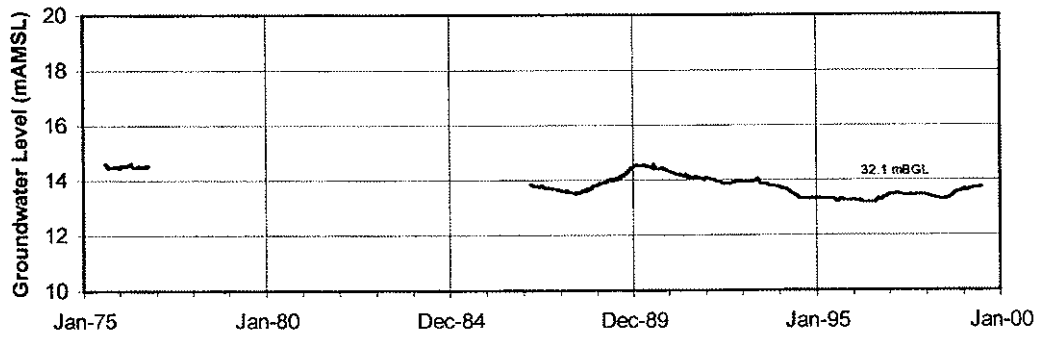
WellArc 209 - Site 4381009 Burnage Rd Piezo at Houhora



WellArc 210 - Site 4381001 Waterfront Piezo at Houhora



WellArc 081 - Site 5301001 Ogle Drive at Paparore



WellArc 211 - Site 4392001 Paparore Rd Piezo at Paparore

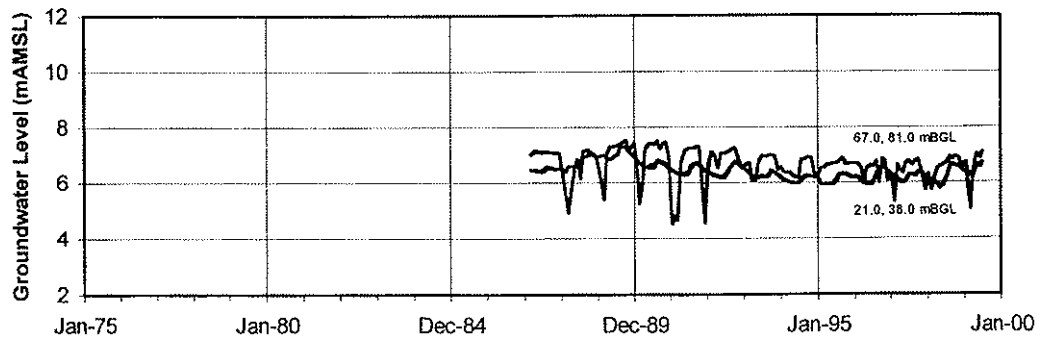
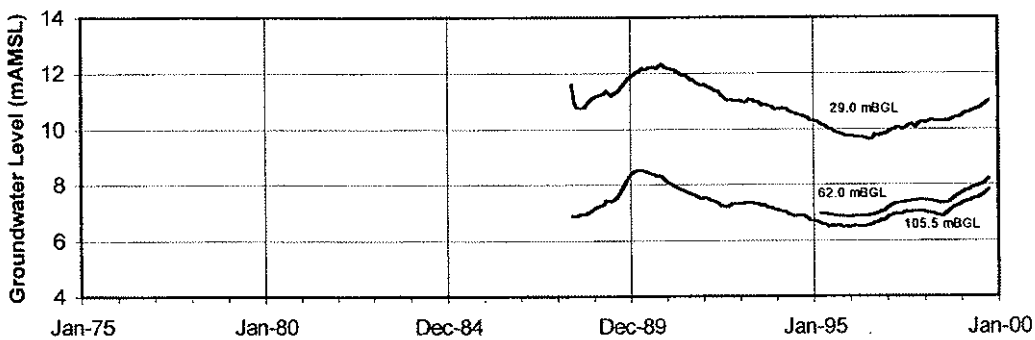
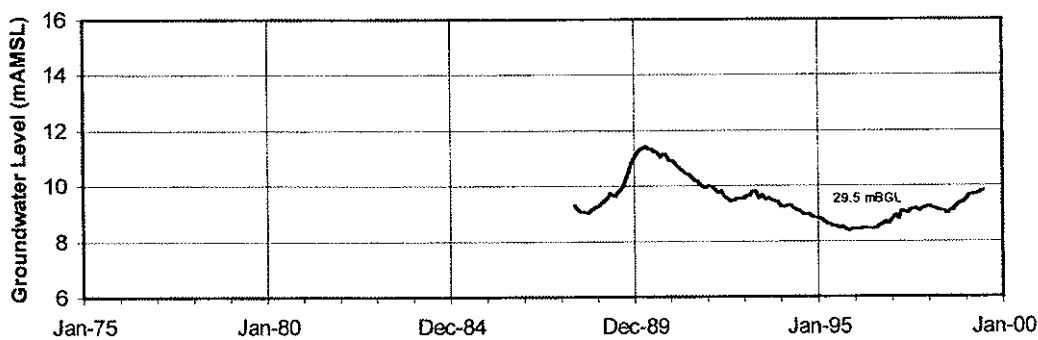


Figure C2

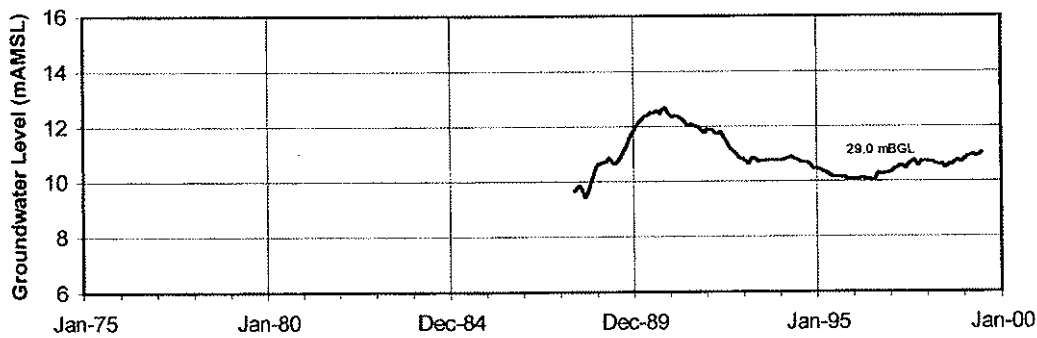
WellArc 226 - Site 5301003 Lake Heather No.1



WellArc 227 - Site 5301005 Lake Heather No.2



WellArc 228 - Site 5301007 Lake Heather No.3



Lake Levels

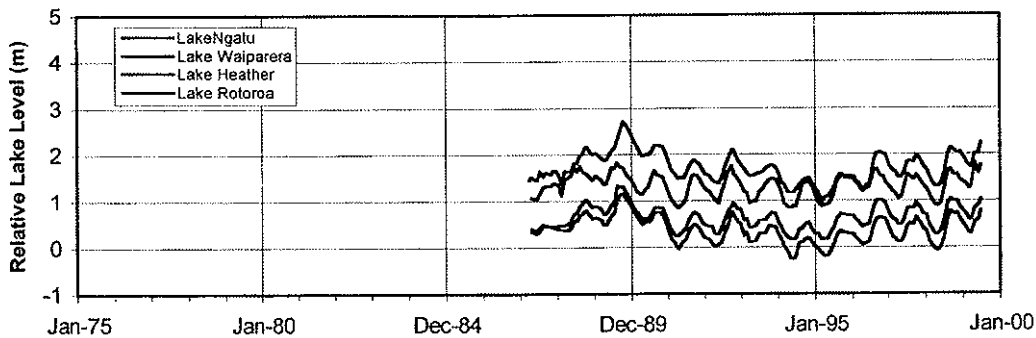


Figure C3