hydraulic barrier under pumping stresses.

Example calculations based on Dupuit-Forcheimer unconfined flow assumptions[2] indicate that a decline in river stage of two feet could not result in water level declines of 10 feet in a 12-inch well pumping 200 gpm at a distance of 150 feet from the river. Therefore, the observed water-level declines during the summer must be complicated by other factors. We believe that there are two possible contributing factors.

One possibility is that there is a less permeable hydraulic barrier between the river and aquifer at or below the low river flow stage elevation. Drilling of the boreholes at the hatchery site during this, and previous investigations, suggests that a natural geologic hydraulic boundary created by mudflow or till deposits is unlikely. Wells PW-1, PW-2, PW-11, TW-5 and test pits TP-3 and TP-4 (located between 50 and 100 feet from the river) encountered coarse grained alluvial deposits of sands and gravels to depths below the low flow river stage elevation adjacent to the hatchery.

A hydraulic boundary could be present if the old railroad embankment or rip rap dike contains low-permeability materials. However, if the embankment was constructed from on-site alluvial materials, then it is unlikely that flow from the river could be impeded. However, if the embankment was constructed with a core of less permeable materials at an elevation at or above the low-flow river-stage elevation, then fl from the river could be reduced.

A second possible explanation is that the permeability of the river bed changes in response to changes in the flow and sediment load in the river. Available sediment-load data suggests that a reduction in river-bed permeability could have occurred during the summer and early fall low-flow period. The response of the aquifer to the high-flow event in November, 1989, suggests that the river-bed permeability could have been restored to its previous condition as a result of the remobilization of finer sediments in the river bed.

Pumping water levels are very sensitive to the hydraulic conductance between the well and the river. For example, using the Dupuit-Forcheimer calculations presented above, a reduction in hydraulic conductance of 50 percent, results in an increased drawdown of nine feet in a well pumping 200 gpm located 150 feet from the river. This reduction in hydraulic conductance could be the result of uniform decrease in river-bed permeability due to sediment deposition in the coarse gravel pavement, or from variable sediment deposition in the pavement and along the sides of the channel within the area of influence of the wells. Given the volume of sediment that is transported by the river, the reduction in the river slope near the diversion dam, and variability in the flow regime of the river throughout the year, we feel that it is possible that some sediment is deposited and re-mobilized during the course of the year in the reach adjacent to the hatchery.

Regardless of the cause of the reduced hydraulic connection between the river and aquifer, there will always be uncertainty in determining the maximum allowable pumping rate

---

[2] Boreli, 1955. Free Surface Flow Towards Partially Penetrating Wells. Trans. American Geophysical Union, Vol. 36, No. 4.