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Evaluating the hydraulic feasibility of brackish groundwater supply for small-scale reverse osmosis plants in community centers in Kuwait

Amjad Aliewi*, Harish Bhandary

Water Resources Development and Management Program, Kuwait Institute for Scientific Research, Water Research Center, P.O. Box 24885, Safat 13109, Kuwait

**email: aaliewi@kisir.edu.kw*

ABSTRACT

The efficient operation of small reverse osmosis units in community centers in Kuwait necessitates a minimal supply of brackish groundwater with suitable water quality standards. Specific requirements were established for a public center in Al-Salmeyeh, Kuwait, demanding a brackish groundwater supply of 250 m³/h with suitable quality parameters (TDS less than 15,000 mg/l and free from contamination). This volume should be extracted without inducing significant drawdowns. The methodology employed combined pumping tests and numerical modeling to evaluate the impact of pumping activities on water levels. Analysis of pumping tests revealed an average transmissivity of 292 m²/d and a specific yield of 12%, indicating promising replenishment potential. However, due to formation damage around the wellbores, the total pumping rate achievable from the six wells (without well development) amounted to 215 m³/h, falling short of the required 250 m³/h. Nonetheless, the maximum drawdown observed after 5 d of continuous pumping stood at 8.04 m, well within the acceptable effective drawdown limit of 14 m, suggesting favorable hydraulic conditions in the project area. Numerical models were constructed using MODFLOW software to simulate long-term drawdown under simultaneous operation of all wells. It was determined that by operating the pumping rate per well at 50 m³/h, the necessary water production of 250 m³/h could be achieved without inducing undesirable drawdowns, with no anticipated significant deterioration in groundwater quality. Salinity analysis indicated levels ranging between 8,000 and 10,000 mg/l, with water classified as Na-SO₄-Cl type.

Keywords: MODFLOW; Small scale RO units; Pumping tests; Community centers; Kuwait

*Corresponding author