

**HISTORICAL ANALYSIS OF CHLORIDE ION CONCENTRATIONS IN PRODUCTION
WELLS IN THE NORTHERN GUAM LENS AQUIFER, GUAM, MARIANA ISLANDS**

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ABSTRACT

The Northern Guam Lens Aquifer is an island karst aquifer in uplifted Plio-Pleistocene limestone supported by early Tertiary volcanic basement rock. The limestone surface forms a plateau 200 to 600 ft (60 to 180 m) above sea level and occupying about half of the island's 212 mi² (550 km²). The relatively impermeable basement rises above sea level beneath about 20% of the limestone plateau but protrudes above only about 1% of the plateau surface. Groundwater descending from the surface is shunted into six sub-basins by the subterranean topographic divides in the basement rock. Regional aquifer hydraulic conductivity estimated from modeling studies is about 6,000 m/day. Estimated total sustainable yield is 70-80 mgd (265,000-300,000 m³/day). Total production in 1999 was about 40 mgd (150,000 m³/day). Pumping rates at the 126 extant wells then on line ranged to 600 gpm (40 l/sec), with 200 gpm (13 l/sec) being typical. Aquifer production accounts for about 80% of the potable water for the island's 130,000 permanent residents and more than 1 million tourists that visit the island annually. Reliable production records begin in 1980. Records of chloride ion concentration begin in 1973.

Previous studies have shown that where the freshwater lens laps onto the flank of the basement rock, the natural background chloride is typically less than 30 mg/l. Where the lens transitions to being supported by seawater, chloride typically ranges up to about 70 mg/l. Seaward, where the lens is underlain entirely by saltwater, fresh water with <150 mg/l chloride can usually be extracted by properly constructed wells. These values therefore provide useful benchmarks by which to predict, evaluate, and manage the performance of wells in the respective zones. Linear regression of the average quarterly chloride concentration in the 128 wells examined showed chloride increasing in 64 wells, and decreasing in six (significant at alpha = 0.05). Twenty-one wells produced water with >150 mg/l chloride, eight of which also exceeded the USEPA Safe Drinking Water Guideline of 250 mg/l. Performance history (chloride vs. pumping rate) and construction (particularly well depth) also were examined in detail for each well.

Each well was assigned to a management category based its performance history, construction, and the range of background chloride appropriate for the zone within which it is located. *Acceptable wells* exhibit chloride consistently within the appropriate background range, show no positive trend, and have no record of chloride having ever exceeded 150 mg/l. *Acceptable but suspect* wells generally exhibit chloride within the appropriate range, but show a positive long-term trend or have occasionally exceeded the appropriate range. *Unacceptable but remediable* wells exhibit chloride exceeding the appropriate range, but are judged likely to be brought within it by lowering the pumping rate. *Unacceptable and irreparable* wells exhibit chloride >150 mg/l and probably cannot be brought below 150 mg/l by lowering the pumping rate (typically because the well was set too deep from the beginning). Four courses of action are recommended: (1) *Continued regular monitoring* at all 126 current wells; (2) *Management plans and preventive steps* at 43 suspect wells; (3) *Reduction of pumping rate* at 34 remediable wells; and (4) *Closure and replacement* of 12 irreparable wells.

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