THE EFFECT OF DEVELOPMENT ON GROUNDWATER IN THE PARKER STRIP[1]

by

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ABSTRACT

The 14.6 miles of the Colorado River bounded by Parker Dam and Headgate Rock Dam has been referred to as the Parker Strip. This river reach has become a high use recreation area during the past decade with 4,000 permanent residents and as many as 120,000 water enthusiasts on long weekends. The riparian area of the river is heavily clustered with mobile homes, marinas and public beaches. The means of sewage disposal is exclusively via septic tanks. Recent surveys by the Environmental Protection Agency, Arizona State Department of Public Health and the University of Arizona have localized surface water bacteria levels that may indicate a developing groundwater problem. The geohydrology of the area indicates that the septic tanks are located in Post-Pliocene Colorado River deposits. The deposits are quite thin and relatively narrow. Since the deposits are locally derived sands and gravels, the horizontal hydraulic conductivities are such that a relatively short flow time to the river may result. Intensive evaluation of the degradation of the water quality in these deposits is needed to determine if the ground water supply was jeopardized by septic tank systems.

INTRODUCTION

Bounded by Parker and Headgate Rock Dam on the Lower Colorado River is a 14.6 mile river stretch referred to as the "Parker Strip" (Figure 1). The riparian area of the Strip includes property rights held by private, Indian, state, county and federal entities. Intense development and exploitation has resulted in clusters of mobile homes, marinas and public beaches. In May, 1973, a joint investigation by the Environmental Protection Agency, Region IX and the State of Arizona, Department of Health (Shimmin and Shafer, 1973) indicated excessive bacteriological levels in this region of the Colorado River. Previous to 1973, frequent complaints of overflowing septic tanks, broken waste lines in trailer parks and fecal contamination were received. Public Health officials have efficiently overseen correction of the structural failures, however, river contamination may still be a problem. The recreational use of the Strip has exploded in the past few years. Approximately 4,000 residents reside in the area, however, on major holidays and weekends the area may receive as many as 120,000 water enthusiasts. Overcrowding of beaches and camping areas may place excessive strain on sanitary facilities. The result would be an overloading of septic tank leach fields and ultimate deterioration of groundwater quality. This paper discusses a methodology to evaluate the groundwater conditions in the "Parker Strip."

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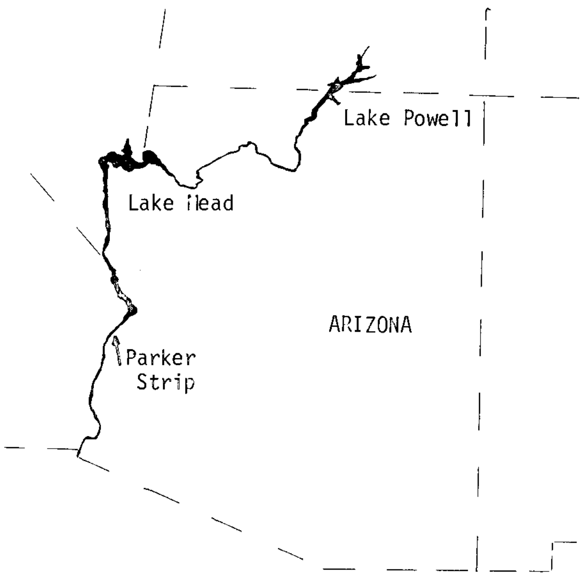

FIGURE 1. Location of the Parker Strip.

GENERAL DESCRIPTION OF AREA

DOMESTIC WATER AND SANITARY WASTE FACILITIES

The drinking water supply on the Strip comes primarily from treated surface water (Colorado River) or groundwater drawn from wells some distance from the river banks. The quality of the treated surface water and groundwater varies considerably from place to place along the Strip. Although poor taste and odors are the obvious water quality problems, chemical analysis has shown many of the groundwater wells to contain high levels of fluoride, chloride, sulfate and total dissolved solids. Many of these constituents have been found at levels higher than USPH Drinking Water Standards (1962). Consequently, the majority of the river dwellers are purchasing bottled water for drinking purposes.

The sanitary facilities along the Strip consist primarily of septic tanks and leach fields. The design criteria for these installations is very difficult because of the geology of the river bank sediments. A concentric ring infiltrometer however, is used to approximate infiltration rates. Some commercial areas have invested in "package" sewage treatment plants that include aeration and sedimentation systems.

RIVER BASIN GEOLOGY

Initially the river cut through bedrock to create a series of gorges. Following this erosional phase a deposition stage occurred during which fanglomerates were laid down. These sediments are a locally derived sequence of cemented gravel fans. During the Post-Pliocene era (Hunt, 1969) an embayment of the Gulf of California allowed the deposition of clays and silts

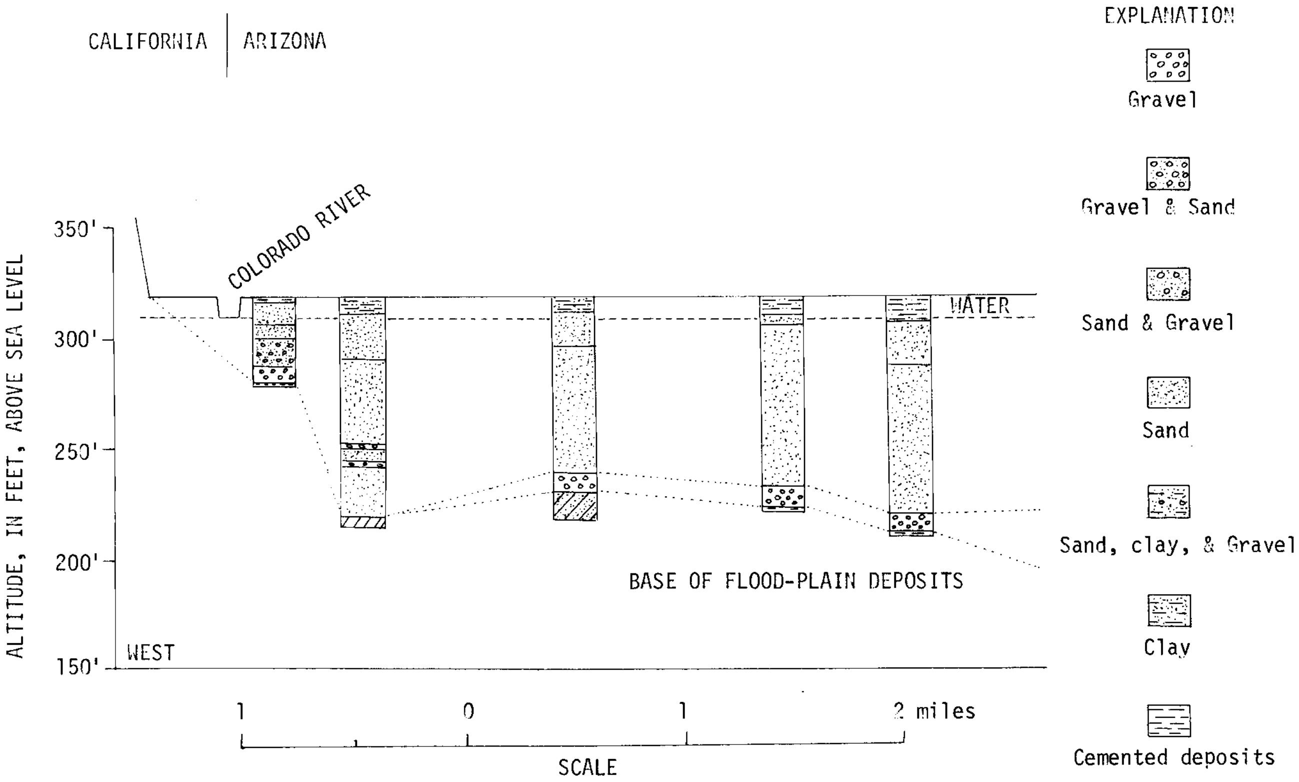

FIGURE 2. WELL PROFILES SHOWING COLORADO RIVER FLOOD-PLAIN DEPOSITS ABOUT 10 MILES SOUTHWEST FROM PARKER, ARIZONA.

commonly referred to as the Colorado River Sediments. Although figure 2 is constructed from well logs and does show a variety of sediment types, the leach fields are located almost exclusively in the clay deposits which include coarser material.

METHODOLOGY

To localize the surface water contamination resulting from leach field drainage the Strip will be divided into 14 river sections (figure 3). Each section will be sampled monthly for biological, chemical and physical parameters. The variables investigated are presented in Table 1. During intense use periods diurnal bacterial cycles will be conducted to determine if "pulsing" occurs over the weekend. Each section will be spatially and temporally compared to see which sections are more contaminated and to determine if the problem increases with the number of "user-days."

The groundwater investigation is complicated by a series of complex hydrologic interactions. It is postulated that the Colorado River in the Parker Strip is both an influent and an effluent river with space and time constraints. The spatial problem will be determined by comparing the historical well records of water chemistries with surface water data. If the quantity of the data is sufficiently long, a cross spectral analysis will be attempted. A review of the historical well data will also show regions of poor quality water as well as provide information on the rate of deterioration of groundwater from septic tank leach fields. The temporal fluctuation results from the diurnal and seasonal releases from Parker Dam. The diurnal cycle causes the level of the river in the upper reaches to vary as much as 10 feet. Automatic water level control gates at Headgate Rock Dam maintain the level in Lake Moovalya. To measure the diurnal effect of fluctuations, water level recorders will be placed in selected wells at various distances down the Strip and at various distances from the river bank.

A more complex problem arises when pumping wells are located close to a leach field. A pumping well will draw water from storage in the area of influence of the expanding cone of depression. Consequently, a pumped well near the River will draw water from the main channel, from the water table and in turn from the leach fields (figure 4). The relative location of the river bank, well site, and leach field can be determined. Knowing the load on the septic tank, the pumping rate and the river level fluctuations a first order approximation can be established for hydraulic conductivities.

DISCUSSION AND CONCLUSIONS

Many interesting management questions are anticipated from the Parker Strip investigation. Commercial marinas, trailer parks, public beaches, etc. must provide sanitary facilities to meet the peak demands of long holiday weekends or they must restrict the use of their facilities. If the leach field system fails by the end of a summer or if the population flux continues, alternative sanitary systems must be considered.

In terms of legal rights, a major question that is developing along the Colorado River deals with water withdrawal from bank storage. The question of whether wells located close to the river bank draw surface water or groundwater may have legal implications.

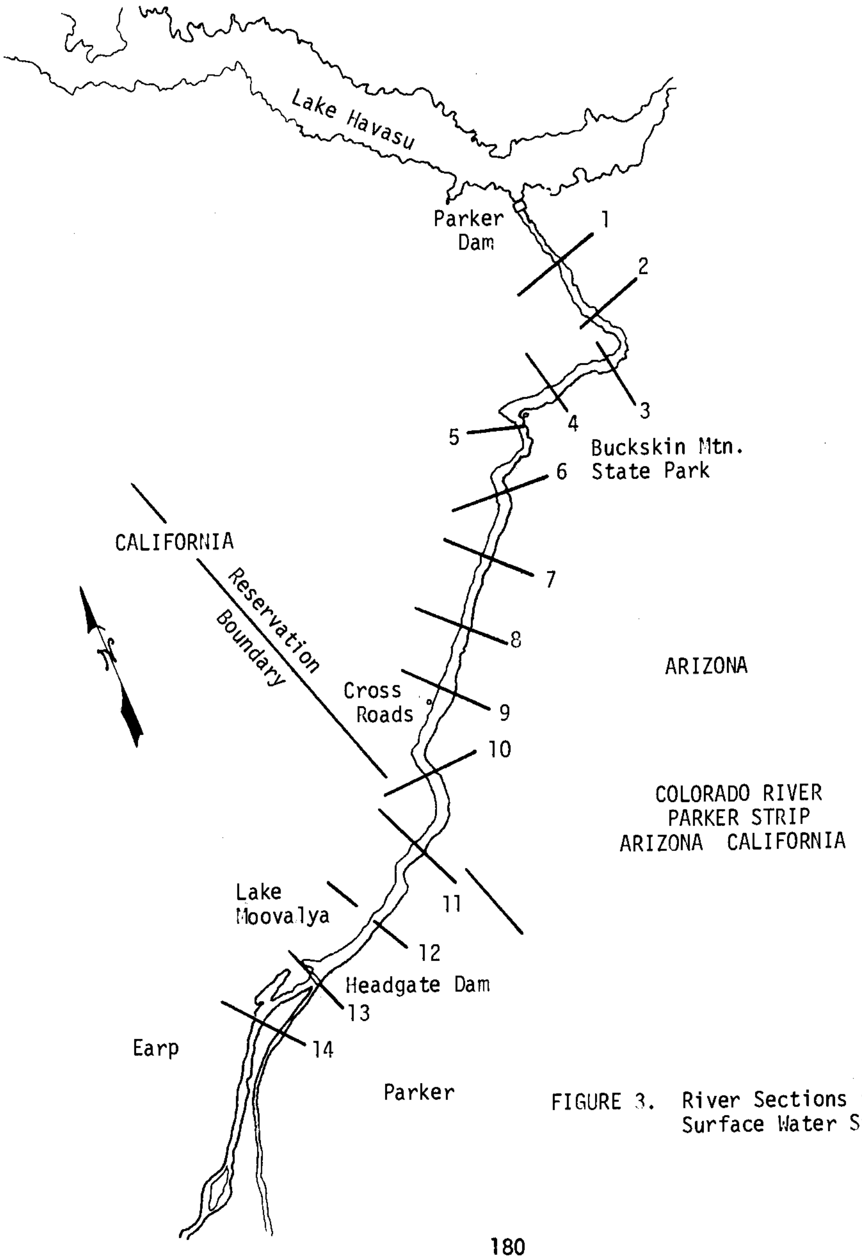

FIGURE 3. River Sections for Surface Water Study.

TABLE 1. Parameters Investigated on the Parker Strip, Arizona.

- Biological
  - Phytoplankton
  - Zooplankton
  - Total Coliform, Fecal Coliform, Fecal Strep
- Chemical
  - Nutrients
    - Micro
      - Fe, Mn, B
      - Zn, Cu, Pb
    - Macro
      - Ca, Mg, K, Na, Sc,
      - So_4, CO_3, NO_3, PO_4,
      - HCO_3, NH_4, NO_2
  - Environment parameters
    - pH, DO, SS, EC,
    - BOD, Cl, F,
    - Hardness
- Physical
  - Temperature
  - Currents and wind effects
  - Light extinction
  - Flow rates
  - Basin morphology

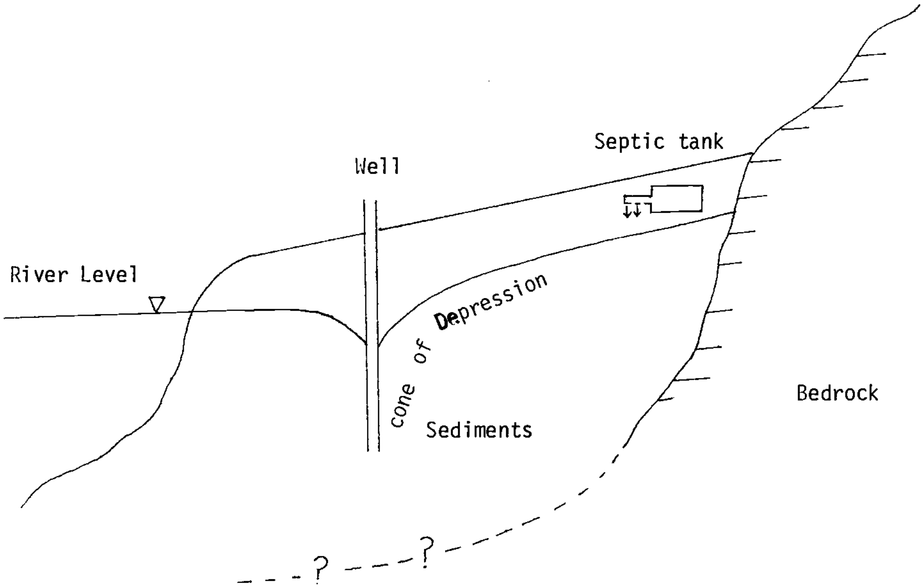

FIGURE 4. Relationship Between River, Wells, and Septic Tanks

The complexity of the water flow regime along the Parker Strip surpasses the level to which hydrologic models have been applied. In addition to unsaturated and saturated flow conditions we are faced with a diurnal river flux, variable pumping rate wells, variable load septic tanks, etc., which make a quantitative understanding quite difficult. It is anticipated however, that first approximations to the hydraulic conductivities in the Parker Strip may provide a basis upon which to expand the utility of existing hydrologic models to quantify a developing water quality problem.

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