Qualification of the Colorado River Alluvium as a Minor Aquifer in Texas

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Abstract

The Colorado River Alluvium has characteristics which qualify it for designation as a minor aquifer by the Texas Water Development Board, although the TWDB has not yet made such a designation. Without recognition as a significant water supply in the state, this resource is vulnerable to pollution and diminution. Major and minor aquifers in Texas were redefined by the TWDB as an update to the Texas Water Plan in 1990. The Brazos River Alluvium was separated from other Quaternary deposits and designated as a minor aquifer because of its importance as a water supply for irrigation use. No other alluvial aquifers have been recognized as significant water supplies in Texas. The Colorado River Alluvium stretches for 200 miles (322 km) from Austin to Wharton, Texas. Water-bearing formations farther downstream are grouped into the Gulf Coast Aquifer. Water in the alluvial aquifer is in direct contact with the Colorado River and has similar water quality characteristics as the river, which is now considered exceptional for aquatic life. Since some communities use the alluvial aquifer for municipal water supply, it is important that groundwater be of high quality.

The Brazos River Alluvial Aquifer has been found to be highly vulnerable to pollution. Using the same assessment criteria, the Colorado River Alluvial Aquifer would also be deemed to be vulnerable to pollution.

Introduction

Water is a limited resource in areas where demand is greater than natural supply. Conservation of water resources including groundwater supplies will be increasingly important in the future to the people of west and central Texas. Conservation includes preservation of not only the quantity, but also the quality of water. In several areas of west-central Texas, water quality restricts the beneficial use of that water (LCRA, 1992, 1994, 1996).

In Texas, groundwater is the property of the landowner (TDWR, 1984). Because the Texas courts have ruled that property owners may pump unrestricted amounts groundwater from beneath their lands, management and protection of groundwater supplies is a delicate and difficult issue. One solution which the Texas legislature has implemented is the creation of "groundwater conservation districts", which have limited ability to preserve groundwater aquifers. In addition, the Texas Natural Resource Conservation Commission is charged with protection of water supplies. In documents prepared under the federal Clean Water Act, the TNRCC has recognized those aquifers designated as "major or minor" by the Texas Water Development Board, to the exclusion of other significant sources of water supply.

Geologic Setting

The Colorado River of Texas stretches from its headwaters in the Trans-Pecos region to the Gulf of Mexico. After passing through the Edwards Plateau where it has eroded canyons in Cretaceous age limestone, which are now impounded by the Highland Lakes chain, the Colorado River flowed through the Balcones Escarpment near Austin. At this point the ancestral river encountered a gently sloping area with low stream gradients, and the river deposited its sediment load in broad floodplain and terrace deposits. Continuing through the Blackland Prairie, the Colorado River eroded the soft Eocene age sediments as it meandered within a restricted floodplain. Multiple older terrace deposits were isolated as the river continued to erode. Younger alluvial deposits were laid down in the newer, more narrow floodplain. These deposits consisted of rounded sand, pebbles and cobbles of quartz, chert and other minerals which were more resistant to chemical weathering than the granite and limestone from which they were derived.

The Colorado River Alluvial Aquifer is a laterally continuous, hydraulically interconnected series of alluvial and terrace deposits. These deposits are mapped in Travis, Bastrop, Fayette, Colorado and Wharton counties (Barnes, 1974). At a point near the town of Wharton, the Colorado River passes through a "watergap" where it has eroded a narrow valley through underlying formations, effectively dividing the deposits of the Colorado River from the Gulf Coast Aquifer (Fig. 1).

The total area of mapped alluvial deposits is 14,500 acres (5,870 hectares). The alluvium is variable in width and depth, but it is found at all points along the Colorado River between Austin and Wharton. The alluvium is up to 4 miles in width, mostly depending on the resistance to erosion of underlying formations. Depth of the alluvium is not well defined at all locations, but is described as being between 20 to 40 feet (6 to 12 m) deep (Rodda et al., 1969). The isopach thickness of the alluvium has been mapped in the Austin area; average thickness is about 30 feet (9 m), ranging from less than 10 feet (3 m) to about 60 feet (18 m) (Garner and Young, 1976).

	All Irrigation:		GW Supplied:		GW / Combined:		Total GW Use:		% of	# of
County	acres	ac-ft	acres	ac-ft	acres	ac-ft	acres	ac-ft	all	wells
Travis	838	931	548	520	0	0	548	520	56%	8
Bastrop	995	546	20	12	458	261	478	273	50%	4
Fayette	1219	620	193	185	201	145	394	330	53%	25
Colorado	34541	111625	7929	23127	801	2670	8730	25797	23%	110
Wharton	82812	249988	54430	132883	600	2400	55030	135283	54%	430
Totals:	120405	363710	63120	156727	2060	5476	65180	162203	45%	577

Table 1. Irrigation in countes including Colorado River Alluvium, 1989 (after TWDB, 1991).

Delineation Criteria

A minor aquifer in Texas is an aquifer which "supplies large quantities of water in small areas or relatively small quantities of water in large areas of the State" (Ashworth and Flores, 1991). This non-quantitative definition allows consideration of aquifers which are important resources in specific areas. For example, the Brazos River alluvium consists of recent alluvial deposits and older terrace deposits in direct contact with the river. It was delineated as an individual minor aquifer based on its importance as a water supply for irrigation use.

Qualifying Features of the Colorado River Alluvium

1) Aquifer characteristics: The Colorado River alluvium is a shallow, unconfined aquifer with moderate hydraulic conductivity, which is interactive with changes in stage and flow in the Colorado River (Harden & Assoc, 1988; Hibbs and Sharp, 1991). During periods of increasing stage and flow in the river, there is a corresponding increase in water table elevation and water storage in the alluvium. Likewise, during periods of decreasing flow in the river, the alluvium loses water from bank storage. The same features are identified in the description of the Brazos River Alluvium as a minor aquifer (Ashworth and Flores, 1991).

2) Water supply: The Colorado River alluvium supplies drinking water for municipalities such as the city of Bastrop and for individual domestic users from private wells. It is estimated that as much as 80 percent of alluvial wells in the area are used for small domestic supplies (Harden & Assoc, 1988). Approximately 50 larger-capacity wells are used for public water supply. Public water systems which have used the Colorado River alluvium include the Cities of Bastrop, Austin, Manor and Garfield, Travis County Municipal Utility District No. 2, Manville Water Supply Corporation, The Colony development of Austin, Colorado River Ranchettes, and the River Timbers development. The City of Bastrop currently operates a system of shallow wells adjacent to the Colorado River which yield more than 1250 gallons per minute (78 l/sec), or 2,000 ac/ft per year for a population of 5,000 people.

Agricultural use of groundwater in counties served by the Colorado River alluvial aquifer was derived from "Surveys of Irrigation in Texas" (TWDB, 1991). In tables of irrigation summaries by county, ground water was identified as the only source for some farmland and as a portion of combined sources for additional lands. The groundwater portion of combined sources was estimated as the remainder from the surface water portion listed in the tables. The percentage of all irrigation from groundwater sources was calculated. The number of wells inventoried in 1989 is also listed. These data are shown in Table 1.

As shown, groundwater contributes a significant percentage of the required irrigation for farms in the five counties between Austin and Wharton. This is especially significant in that the Lower Colorado River Authority provides surface water for rice irrigation in Colorado and Wharton counties. In 1989, a total of 162,203 ac-ft of groundwater was used for irrigation. This amounted to 45% of all water used for irrigation in these counties. A total of 577 wells were inventoried, although some wells were not inventoried on lands with combined surface water/groundwater sources. Therefore, the number of wells used for irrigation is probably higher. From a review of private well records on file with the TNRCC and the TWDB, many of these wells are set in the Colorado River alluvium.

3) Area served: Data on acres served by groundwater sources are also shown in Table 1. In 1989, a total of 65,180 acres (26,380 hectares) were irrigated with groundwater in the five counties supplied by the Colorado River alluvium. The majority of these lands were in Wharton County.

4) Beneficial use: The Colorado River alluvial aquifer

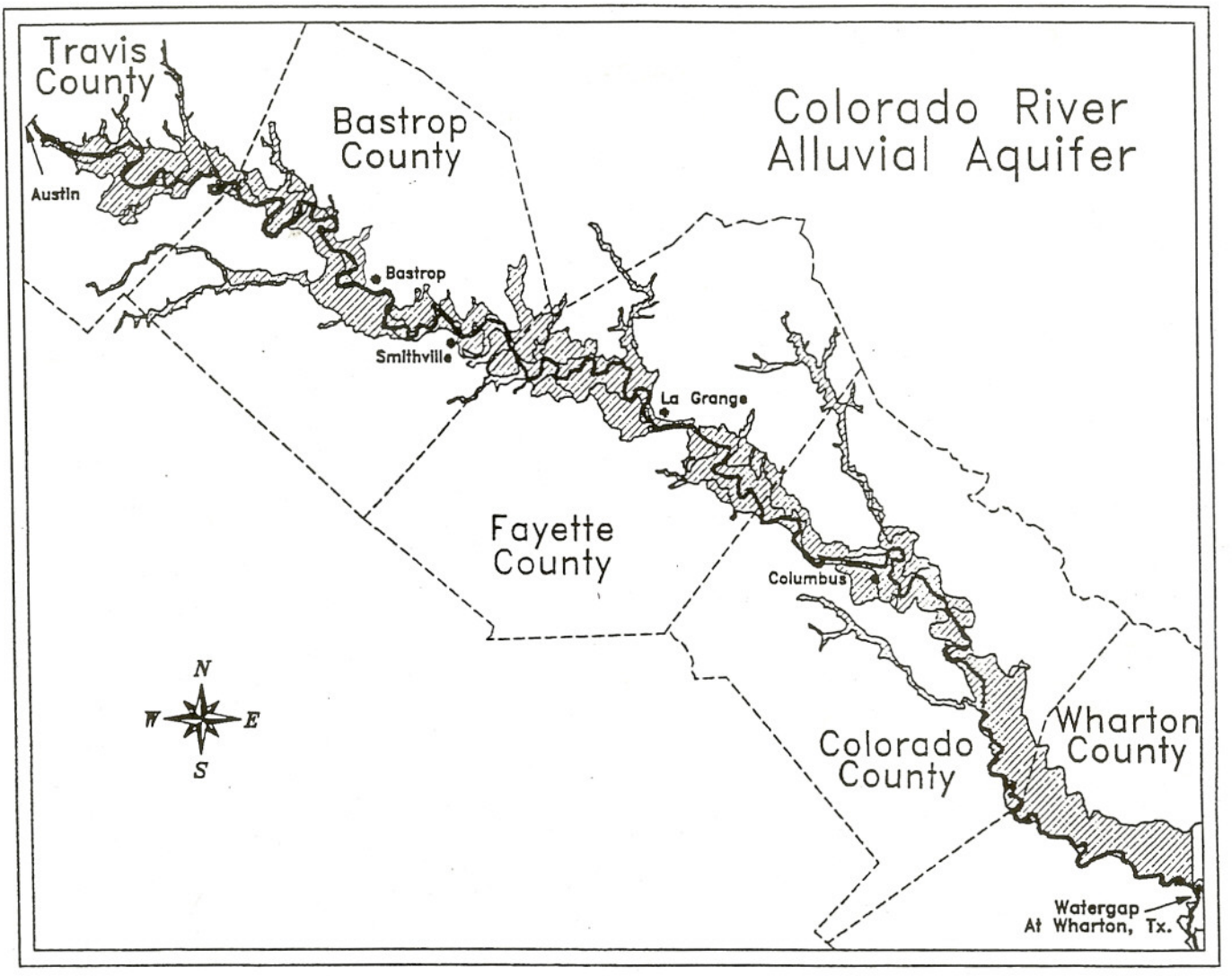

Figure 1. Extent of the Colorado River Alluvium, south-central Texas (after Barnes, 1974).

supplies large amounts of water in a relatively small area of the state. The aquifer is used for municipal, domestic, industrial, irrigation and stock supplies. The aquifer provides an important supply of water, especially during periods of drought, in a five-county area in south-central Texas.

Benefits of Designation as a Minor Aquifer

The Colorado River alluvial aquifer is an unprotected water resource. Groundwater quantity and quality in the alluvium is adversely affected by overpumping in some areas, sand and gravel mining operations, pesticide and fertilizer application, salinity in terms of chloride and sulfate salts, and other threats such as wellhead pollution. These causes of non-point source pollution are essentially unregulated.

Shallow aquifers such as the Brazos River alluvium have been deemed to be highly vulnerable to pollution (TNRCC, 1994). Impacts of sand and gravel mining on water quality in the Brazos River alluvium have been investigated (Ward, 1994). On a biennial schedule under the Federal Clean Water Act, the TNRCC performs a water quality inventory of surface water and ground water in Texas. This inventory includes assessments of water quality conditions in major and minor aquifers, as designated by the Texas Water Development Board. The inventory does not include detailed assessments of other aquifers. For example, the Brazos River alluvium is assessed, but not alluvial deposits of the Colorado River, the Trinity River or other significant alluvial aquifers. The characteristics (shallow aquifer, unconfined, limited assimilative capability) which make the Brazos River alluvium vulnerable to pollution would also apply to the Colorado River alluvium.

In the 74th legislative session in 1995, the creation of Groundwater Conservation Districts was redefined. These districts have limited ability to provide for conservation, preservation, protection and adequate recharge of groundwater. Over 50 conservation districts have been created in a patchwork pattern across the state. Some of these districts (Barton Springs/Edwards Aquifer Conservation District, Hickory Underground Water Conservation District No. 1, Lipan Kickapoo Underground Water District) are

active in the Colorado River Basin. However, no conservation district has been considered for the Colorado River alluvial aquifer.

Conclusions

The Colorado River alluvial aquifer is worthy of protection. It provides an important supply of water in a limited area of the state. Non-point source pollution, overpumping and other unregulated threats to this water resource should be addressed. For these reasons, the Colorado River alluvium should be considered for designation as a minor aquifer by the Texas Water Development Board.

References

Ashworth, J.B. and R.R. Flores, 1991, Delineation Criteria for the Major and Minor Aquifer Maps of Texas, Water Development Board Report LP-212, 27 p.

Barnes, V.E., 1974, Geologic Atlas of Texas, Austin and Sequin Map Sheets: The University of Texas at Austin, Bureau of Economic Geology.

Garner, L.E., and K.P. Young, 1976, Environmental Geology of the Austin Area; An Aid to Urban Planning: The University of Texas at Austin, Bureau of Economic Geology, Report of Investigations No.86, 39 p.

Harden & Associates, 1988, Availability of Ground-Water Supplies for the Wilbarger Creek Basin, report prepared for Terra Associates, Inc, p. 12-27.

Hibbs, B.J. and J.M. Sharp, 1991, Hydrogeology of the Colorado River Alluvial Aquifer between Austin and Smithville, Texas; A Numerical Assessment of the Shallow Flow System, Final Report for the Lower Colorado River Authority: The University of Texas at Austin, Department of Geological Sciences, Hydrogeology Program, 111 p.

Lower Colorado River Authority, 1992, Water Quality Assessment of the Colorado River Basin: Report to the TNRCC, ch. 23, p. 10-12.

Lower Colorado River Authority, 1994, Water Quality Assessment of the Colorado River Basin: Report to the TNRCC, ch. entitled "Basin-Wide Issues", p. 1-6.

Lower Colorado River Authority, 1996, Water Quality Assessment of the Colorado River Basin, report to the TNRCC, ch. entitled "Ground Water - Surface Water Interactions", p. 1-12.

Rodda, P.U., L.E. Garner and G.L. Dawe, 1969, Geologic Map of the Austin West Quadrangle, Travis County, Texas, University of Texas at Austin Bureau of Economic Geology Geologic Quadrangle Map No. 38.

Texas Department of Water Resources, 1984, Water for Texas: A Comprehensive Plan for the Future, v. 2, p. 1 -16 - 1 -19.

Texas Natural Resource Conservation Commission, 1994, State of Texas Water Quality Inventory: 12th ed, v. 1, p. 187-240.

Texas Water Development Board, 1991, Surveys of Irrigation in Texas - 1958, 1964, 1969, 1974, 1979, 1984, and 1989, Report 329, 124 p.

Ward, S.Y, 1994, Water Quality and Pollution Potential of Abandoned Gravel Pits in the Brazos River Alluvial Aquifer, Waco, Texas, in R.A. Marston and V.R. Hasfurther, eds., Effects of Human-Induced Changes on Hydrologic Systems, AWRA Symposium Proceedings, p. 985-994.