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A New Approach to Regional Water Management

Two Plans Are Developed to Manage and Protect the Edwards Aquifer

By Ric Jensen Information Specialist, TWRI

Water users in the Edwards Aquifer region have agreed to a long-range regional water management plan that may eventually limit groundwater pumping in the area.

The Regional Water Management Plan (1988) was agreed to by the City of San Antonio, the Edwards Underground Water District (EUWD) which covers Kinney, Uvalde, Medina, Bexar, Comal and Hays Counties, the Guadalupe-Blanco River Authority (GBRA), the San Antonio River Authority and the Nueces River Authority afler five years of negotiations. The plan is significant because it represents a regional approach to managing the area's water supplies. Recommendations from the plan will be presented to the next session of the Texas Legislature and may form the basis of new water use regulations for the area.

In addition, a regional Drought Management Plan (1988) was agreed to that calls for specific water use reductions when aquifer levels fall or when rainfall is below average levels over a prolonged period of time. That plan takes effect in June, 1989.

The process of negotiating both plans was complicated because of the hydrology and the politics of the area. Because the Edwards Aquifer is interconnected with surface water systems at each end of its boundary, groundwater pumping affects surface water availability. Therefore, both ground and surface water interests had to be weighed and balanced against the amount of water available in the region. For example, increased amounts of pumping in any area or by any group reduces the amount of water available for others. Meanwhile, sole reliance on groundwater was probably the most attractive option in the short-term, because it was least costly. However, overpumping of groundwater denies water to springs and downstream users.

What does the regional water plan mean to the region? Administratively, the plan authorizes the EUWD to develop and implement a comprehensive groundwater management system for the region. The plan would allow EUWD to: 1) Register and permit wells; 2) Determine the validity of water rights claims; 3) Transfer and retire pumping rights as new water supplies are developed; and 4) Issue water rights certificates and withdrawal permits. Implementing the plan will cost $1.3 billion over a number of years and includes construction of four reservoirs and development of conservation and wastewater reuse programs.

Hydrologically, the most important aspect of the regional water management plan is the goal of eventually limiting the pumping of the Edwards Aquifer a "safe yield" of 75% of average annual recharge. This translates to roughly 450,000 acre-feet (AF) per year (an acre-foot is the amount of water needed to cover an acre of land to a depth of one foot or 325,851 gallons). This goal will not be met immediately, but is a target to be reached over an indefinite period of time. Limiting pumping should ensure long-term viability of the aquifer, should keep enough water flowing to make sure San Marcos Springs does not dry up under average conditions, and should provide more reliable flows for downstream users. By preventing aquifer levels from falling substantially, cities and irrigators in the area may benefit from lower pumping costs. The drought management plan will require many water users to come up with specific programs to cut back water use during prolonged periods of below- average rainfall or as aquifer levels fall.

Both plans have come under fire from some aquifer users, who will no longer be able to pump as much groundwater as they want. Instead, after 1995, pumpage will be based on historic rights. Tensions are so high in Uvalde and Medina Counties that petitions have been circulated to withdraw from the EUWD. It isn't clear what would happen if those counties left the district, but the Texas Water Commission (TWC) or the Legislature could potentially form a new district in the area with even tighter restrictions if voters decide to secede. Some San Antonio residents have urged that the plan be modified to allow greater groundwater pumping, because that would cost the city less than surface water development. The GBRA suggested that if a compromise plan was not reached, they might take action to seek recognition of the aquifer as an underground stream. If successful, that would mean that water in the aquifer would belong to the state, not individuals, and would fall under TWC surface water regulations.

The implications of the regional water plan for the rest of Texas are difficult to interpret. It doesn't appear as though comprehensive regional groundwater management plans such as this one will be readily duplicated in other regions of Texas. This plan will probably be unique to the Edwards Aquifer. In particular, the establishment of historic groundwater rights and restrictions on pumping will probably not be imposed in other parts of the state. It should be noted that other groundwater districts limit pumping by regulating well spacing.

The regional water plan is significant because if represents one of the first instances in Texas where ground and surface water would be managed as a system. A benefit of this approach is that ground and surface and water resources can be considered together as

part of a regional approach to water resources problems. In this instance, planning groundwater pumping allowed planners to set targets for aquifer storage and to predict the amount of water that needed to be developed from surface water reservoirs, wastewater reuse, water conservation and other programs.

The Edwards Aquifer

The Edwards Aquifer stretches across south-central Texas encompassing parts of Uvalde, Medina, Kinney, Bexar, Comal and Hays counties (Figure 1). The Aquifer is 5 to 30 miles wide. The amount of water in the aquifer has been estimated at 15 to 19 million AF (CH2M Hill, 1986).

The geology and hydrology of the area affect the aquifer and its properties. The aquifer has cracked and fissured overtime mainly because of faulting (the aquifer is part of the Baicones Fault Zone) and because the groundwaters carved large openings in the limestone and dolomite formations of the aquifer as they flowed through. Hairline cracks, open fractures, honeycombed zones and caverns ranging from less than a foot to more than 90 feet can all be found in the aquifer. These numerous openings give rise to uncommonly large well yields, encouraging the drilling of large, deep wells. Yields of more than 19,000 gallons per minute have been reported.

Because many streams cross over the aquifer, a large portion of the streamflow recharges the aquifer instead of flowing downstream. The faults also connect the higher elevations of the aquifer in the west with downslope portions in the east, in effect creating a natural water pipeline. Springs are located along many of the major faults that occur along the aquifer's boundaries.

The aquifer is characterized by rapid groundwater flow that moves in a definite direction. Waterflow has been measured in some regions of the aquifer at rates of up to 2,100 feet per day. The water first flows toward lower elevations in the south and then proceeds east and north.

Roughly three-fourths of the recharge to the Edwards originates from surface streams in the western part of the aquifer. The watersheds contributing most of the recharge include the West Nueces, Nueces, Dry Frio, Frio, Sabinal, Seco, Hondo, Medina, Helotes and Salado. Annual recharge has varied tremendously, ranging from a record high of more than 2 million AF in 1987 to a record low of just 43,000 AF in 1956. Pumping increased from just under 300,000 AF in 1970 to more than 530,000 AF in 1984 (see Figure 2). Since 1980, annual recharge has averaged 880,000 AF, but has been as low as 197,000 AF during the 1984 drought.

Increasing the amount of water pumped from the aquifer may also make it more vulnerable to contamination. On the southern edge of the freshwater zone is an area which contains higher amounts of total dissolved solids and salts called the "bad water lane." Under normal conditions, the pressure and movement of the fresh water is sufficient to keep saline water out. When aquifer levels are lowered, the poor quality

water may contaminate freshwater portions of the aquifer (this occurred during the prolonged drought of the 1950's). There is not a consensus on the amount of water that can be withdrawn from the aquifer before salt water intrusion becomes a problem or what the long-term effects would be.

Increased pumping also decreases springflows and reduces the flow of the Guadalupe River, making less water available to dilute wastewater return flows and runoff. Ultimately, the amount of freshwater that enters the bays and estuaries is also reduced. One of the major differences between the Edwards Aquifer and others is that pumpage in one part of the system directly affects other aquifer users. For example, the amount pumped by irrigators in Uvalde and Medina counties decreases the amount in the aquifer at San Antonio. San Antonio's pumpage decreases the amount available for springflow and freshwater flow to coastal bays and estuaries. In other aquifers such as the Ogallala, the relationship between pumpage in one area and water levels in another is not as direct because lateral flows are much slower.

The Edwards Aquifer is also unique in that it supports a critical habitat at San Marcos Springs that is home to threatened and endangered aquatic species such as the San Marcos Gambusia, the fountain darter, the San Marcos salamander and Texas wild rice. The aquifer also supports a subterranean ecosystem made up of 40 macro invertebrate and vertebrate species including blind catfish and salamanders. Water levels in the aquifer have to be at least 620 feet above sea level for Comal Springs to flow and at least 575 feet above sea level for San Marcos Springs to flow.

The Regional Water Plan

The Regional Water Management Plan is a document for water resources planning between 1990 and 2040. It recommends specific measures for projected water demands, groundwater withdrawals, conservation, wastewater reuse, downstream flows, surface water projects, aquifer recharge, financing, and implementation.
In 1983, the City of San Antonio and the EUWD signed a Memorandum of Understanding to begin a joint study of long range water needs and alternatives. That regional water resources study (CH2M Hill, 1986) recommended the formation of a task force that would learn about the issues, educate others and develop policy recommendations to be considered for implementation. The task force submitted its recommendations in December 1986.

In early 1987, the EUWD and the San Antonio City Council appointed a Joint Committee on Water Resources to "provide adequate regional representation in the development of the plan and to create a workable decision making process to ensure consensus on policy." The Joint Committee agreed on three critical elements that would guide policy formation: 1) The aquifer should not be overdrafted during periods of average rainfall, in order to ensure natural flows at Comal and San Marcos Springs; 2) The EUWD would seek legislative authority to develop and implement a drought management plan; and 3) The Joint Committee would continue until all issues were resolved.

While the regional water use plan was being developed, the San Antonio City Council was developing a strategy to protect the Edwards Aquifer. A report, The Edwards Aquifer: Perspectives for Local and Regional Action(1987), was devebped that urged cities in the area to adopt ordinances for water quality protection to prevent contamination of sensitive areas of the aquifer. The report recommended that an enhanced mapping process be utilized to identify sensitive recharge features such as

sinkholes, caves and faults. It also recommended specific ordinances that would regulate the production, storage and transportation of hazardous materials across the aquifer and improve standards for sewer lines and septic tanks.

In 1988, the Joint Committee began to reevaluate the recommendations from the 1986 regional study. A planning model was used to determine the effects of using different target levels for groundwater withdrawals, conservation goals, wastewater reuse, and surface water development under average rainfall and drought conditions.

Pumping Levels

As a starting point, the Joint Committee adopted a policy that the aquifer should not be overdrafted to ensure natural flows at Comal and San Marcos Springs) if groundwaterpumping exceeded average recharge for a number of years water levels would decline throughout the region; pumping costs would increase; some wells along the northern edge of the recharge zone might cease producing water; and saline water could move into the portion of the aquifer now yielding good quality water.

A pumping goal of 450,000 AF annually (roughly 75% of the average annual recharge) was set that would leave roughly 150,000 AF for natural springflow. The pumping goal may not be met immediately, but will be met gradually as new sources of water are developed and as existing rights are retired. Actual pumping has exceeded this amount in two of the past five years.

Other amounts of pumping were also considered. The 1986 regional water resource study (CH2M Hill) suggested pumping levels ranging from 350,000 AF to 530,000 AF.

The "Bad Water" Line

One of the major reasons the pumping limit was set at only 75% of annual average recharge was a concern that saline water along the "bad water lane" could migrate into and contaminate freshwater supplies as overpumping occurred. There are disagreements about the effects of pumping on the movement of that line. The U.S. Geological Survey (Perez, 1986) conducted computer simulations to project the effects of pumping and other factors on the movement of the bad water line over a 10-year period. The report summarized that the line would move only 0.2 miles from its present location, even if the aquifer were under drought conditions (582 to 640 feet above sea level) during most of that time. Such a slight movement could jeopardize wells in San Antonio, San Marcos and New Braunfels.

Jay Lehr, the executive director of the National Water Well Association, was a technical expert during the planning process. He said that he believed that there is "no realistic potential for the bad water line to encroach on the vast volume of good water stored in the Aquifer. Lehr recommended a pumping rate of 125% of average annual runoff, allowing the aquifer to be drawn down during dry years and creating storage space to absorb flood flows during wet years when the aquifer could be recharged. Springflow could be augmented with wells during the dry years.

The regional water plan discounted pumping as a method to supplement springflow. The report said that although it may be possible to replace the natural springflow by pumping, "there is a danger of salt water intrusion if the pumping continued excessively." Glenn Langley, director of the Edwards Aquifer Research and Data Center at Southwest Texas State University, said he believes the danger of intrusion of the bad water line cannot be underestimated "You could try to pump augmentation wells to maintain springflow,. Longley said, "but if you pump after the springs have stopped flowing, the bad water line could migrate into the wells. The water supply wells for San Marcos and Southwest Texas State University are located less than a mile from the bad water line and even a slight movement could endanger them."

Projected Demands

The Edwards Aquifer is the sole source of drinking water for more than 1.3 million people including the cities of San Antonio, New Braunfels, San Marcos, Uvalde, and Hondo. The Aquifer also provides irrigation water for Uvalde and Medina counties, is the source of water for Comal and San Marcos Springs, contributes to the flow of the Guadalupe River, and provides freshwater inflow into the Gulf of Mexico.

The plan assumes that population growth will occur, that it is acceptable, and that it should be planned for. Water demands in the region are projected to be 450,000 AF in 1990, 506,000 AF in 2000, 564,000 in 2010 and 650,000 in 2020. The projected population for the region is 1.36 million in 1990, 1.64 million in 2000, 1.95 million in 2010 and 2.33 million in 2020.

Groundwater Pumping

Current water use policies have resulted in a situation which makes coordinated groundwater withdrawals impossible. All pumpers - individuals, cities and irrigators - have the right to pump unlimited amounts of water from the aquifer, even if others will be injured. Springfiows and downstream users are left to depend on whatever water remains after pumping.

Under the regional water plan, both the amount of water withdrawn from the aquifer by new users and increases in withdrawals by existing users will be regulated. The policy recognizes and quantifies the historic right of all users to pump the amounts they have used in previous years. New groundwater withdrawals could be approved in the future,

but those demands would have to be met as conservation, reuse, surface water, and water markets were developed. In other words, new pumping would not be allowed if the overall effect was to further deplete the Aquifer. The plan also allows for non-transferrable "conditional water rights" permits to be granted when there is above-average recharge, recent rainfall, high springflows, or elevated Aquifer levels.

Over time, the total amount pumped will be gradually reduced to a roughly 450,000 AF. To meet the target, the EUWD will organize a "water market " to coordinate the sale, lease or retirement of water rights through voluntary purchases. Each year, EUWD would determine how much additional water had been developed and the amount of groundwater existing rights holders would like to transfer. The district would then facilitate water rights transactions.

All users would be required to report their actual withdrawals to EUWD annually. The district would meter permitted wells and would have the power to enforce measures to prevent waste. Only wells which produce more than 100,00O gallons per day or which supply the domestic needs of 10 or more households would be subject to permitting.

Historic agricultural irrigation rights would be based on the maximum number of acres actually irrigated in any year between 1979 and 1995. The irrigation right would not be expressed as a set volume of water, but would be defined as the amount of water actually needed for growing and incidental processing of crops on the number of acres with an historic right. Some agricultural groups have opposed the establishment of historic rights, because of concern that it may limit the amount they could pump in the future.

EUWD would work with irrigators to encourage efficient water use practices and to maximize water conservation. The system would allow an irrigator flexibility in applying the water right. A farmer could substitute unirrigated acreage for the acreage which established the right, or could sell irrigation rights to a non-irrigation user at a rate of 1.5 AF per acre of irrigation right. To prevent speculation, only irrigation rights established between 1979- 88could be transferred to non-irrigation use.

New irrigation users would be permitted after 1995, up to a total average withdrawal of 200,000 AF per year. When total irrigation pumpage exceeds that figure, new irrigators would have to buy or lease water rights. Any use of water in excess of historic rights will be subject to withdrawal fees to offset the cost of additional water supplies.

Non-irrigation users will be entitled to the maximum amount pumped in any year between 1979 and 1995. Increases would have to be justified based on population growth or increased industrial production. After 1995, new non-irrigation users would also have to buy or lease water rights.

The plan requires municipalities in the region to adopt ordinances and rate structures that encourage conservation. The policy rewards water use efficiency by allowing groundwater rights holders to use or market water developed from conservation or reuse

programs. If EUWD participates in conservation programs, 50% of the amount of water that was conserved would be retired from recognized groundwater rights.

Conservation

The goal is to reduce regional water use by 10% by the year 2000 as demand reduction measures are implemented. This would save the region 50,600 AF by 2000, 56,400AFby2010, and 65,000AF by 2020.

Conservation measures in the regional plan include: 1) Education programs; 2) Increasing block rate and seasonal block rate structures; 3) Leak detection programs; 4) Installation of water-conserving fixtures in new and existing buildings; 5) Landscapes that use efficient irrigation systems and low water-using plants; 6) Efficient agricultural irrigation systems and management practices.

Conservation programs are an attractive method of increasing water supplies because they: 1) Have a small lead time; 2) Can quickly be scaled up or down; 3) May be modified to respond to changing conditions; and 4) Do not place additional demands on other resources.

Rate increases are among the most cost-effective means of conserving water. By 2000, increasing block rates are projected to generate a savings of more than 6,400 AF per year and seasonal block rates are expected to reduce demands by roughly 3,666 AF annually. The report projects that middle to high income residents would experience an 80-90% rate increase. Water saving landscapes ("xeriscapes") are projected to save roughly 10,000 AF.

Wastewater Reuse and Downstream Flows

The plan recommends that San Antonio develop a program to reuse wastewater to supplement groundwater pumping. Regional wastewater treatment plants or "water factories" will generate treated effluents that could be used for landscape irrigation and other uses, and are expected to provide at least 20,000 AF per year by 2000 and up to 131,000 AF by 2040.

The first waterfactory will tentatively be located near the San Antonio Airport and will treat wastewater from the Salado Creek watershed. it will provide advanced secondary treatment and nutrient removal and is expected to produce 4,000 AF by 1995 and 40,000 AF by 2040. Effluent from this plant could be used to irrigate golf courses and to increase the flow of the San Antonio River; aquifer water is currently used for both these purposes. Additional projects include construction of a water renovation center (which could be used to beat surplus effluent to drinking water standards), and other regional water factories that could treat wastewater from a five-county area. The program would maintain a minimum flow of 55,000 AF per year in the San Antonio River.

Surplus wastewater could be treated to drinking water standards and added to the city's

water supply. An initial target is to provide 17,000 AF of drinking water per year by 2000 and as much as 63,000 AF by 2020. This water would be blended into the city's water distribution network.

Surface Water

The plan calls for immediate development of Applewhite Reservoir and eventual construction of Cibolo and Cuero I and 11 Reservoirs. H all the projects are developed, they would add as much as 245,000 AF to the area's water supplies.

The study projects that unless surface water is developed the region would suffer a water deficit by 2020, even if aquifer recharge were at normal levels and significant conservation and reuse programs were implemented. The onset of even a mild drought would bring on a crisis.

Applewhite was recommended in part because it is the only project that can be completed by the year 2000. The project is expected to come on line in six to eight years, will cost more than $113 million, and will produce an average yield of 50,000 AF. There has been criticism of the project. Opponents have said that it is uneconomical; it will produce less than 10% of the water supply for San Antonio under average rainfall conditions and will produce less water during droughts; and water quality from the reservoir will be less than that from the aquifer.

Financial Impacts

The plan recommends that various agencies take a lead role in financing and implementation. For example, the EUWD could manage the groundwater withdrawal

program which could be funded by a district-wide property tax increase. The wastewater reuse program could be financed by increases in San Antonio sewer rates. Development of Applewhite Reservoir may be financed through a San Antonio Water Board bond program, and Cibolo and Cuero I and 11 reservoirs might be funded by the San Antonio River Authority and the GBRA. A 1986 study (CH2M Hill) estimated that average monthly water costs for San Antonio residential users would rise by 50% to 70% to $15 to $17 per month if similar plans were implemented. Despite the increases, average waterbills would be similar to those in other Texas cities.

The Drought Management Plan

The Texas Legislature specifically authorized the EUWD to develop a drought management plan under House Bill 1942. The goals of the drought management plan are to: 1) Protect human health and safety; 2) Protect water quality in the Edwards Aquifer; 3) Share the impacts and hardships caused by a drought; 4) Minimize disruption of the regional economy during a drought; 5) Prevent San Marcos Springs from going dry; and 6) Minimize the time Comal Springs will be dry.

The drought management plan provides objective standards for determining that drought conditions exist, how long they continue and when a drought has ended. Conservation goals and the trigger conditions are listed in Table 1. Because the water flows from the Uvalde area towards San Antonio, it is possible for the western part of the region to be under less severe restrictions than the eastern part of the area. When a drought is declared (based on rainfall amounts, aquifer levels, and springflow) users will be required to implement demand reduction measures. Regional water suppliers will also develop specific plans for their customers.

Aquifer Awareness" (Stage I) occurs when rainfall at Uvalde and San Antonio is less than 80% of the historical average and aquifer levels drop below specified levels. In this stage, non- agricultural water use will be reduced by 10% with voluntary compliance measures. Water waste (allowing water to run off into gutters, ditches or drains, or the failure to repair a controllable leak) is prohibited. The next three stages - "Aquifer Watch" (Stage II), "Aquifer Alert" (Stage III) and "Aquifer Risk" (Stage IV) are declared as aquifer levels fall to specified levels at index wells near Uvalde and San Antonio. In Stage II, the goal is to reduce water use 15% through the introduction of mandatory compliance measures. This may include limiting landscape and golf course irrigation to once every five days, prohibitions against installing new landscape irrigation systems, and bans against washing streets, driveways, patios, and sidewalks. The goal in Stage III is to reduce water use by 25%. Restrictions may include prohibiting landscape irrigation and allowing golf courses to irrigate only tees and greens once every five days. In this stage, water suppliers may establish allocations for customers and may place flow restrictors on the meters of customers who repeatedly exceed allocations.

In stages I, II,and III, no specific reductions in agricultural water use are spelled out. The EUWD expects that farmers will reduce water use as aquifer levels decline and the cost of pumping increases. In an "Aquifer Risk" (Stage IV), the goal is to achieve a 30% reduction. Conservation measures may include prohibitions against landscape irrigation (except with treated wastewater or graywater) and a ban on commercial carwashes. Irrigation pumpage will be reduced to 2 AF per year.

Stage V ("Aquifer Emergency) is based on water quality, not aquifer levels. As springflow at San Marcos Springs falls below 50 cubic feet per second, wells along and near the bad water line will be monitored frequently. If levels of total dissolved solids increase 30% above historical averages an "aquifer emergency warning" may be declared by EUWD. The purpose of the warning is to initiate detailed analyses to determine if significant changes in aquifer quality are taking place and to explore possible remedies. Responses may range from providing alternate water supplies to initiating per capita water allotments for utilities and reducing supplies for industrial or irrigation use.

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