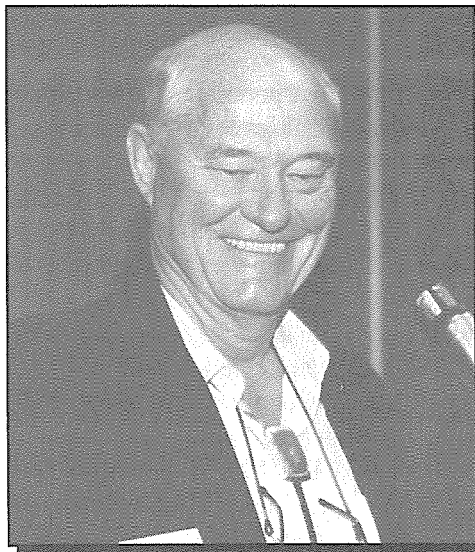


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**RIO GRANDE GROUNDWATER: FIXED RESOURCE VS.  
A GROWING POPULATION  
A Hydrogeologist's View  
or  
MANAGING WATER TO ESCAPE THE BUNGEE EFFECT**

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A few weeks ago I was talking with Mike Kernodle of the U.S. Geological Survey (USGS) about our future water resources predicaments in the Albuquerque-Belen Basin, and I said something like, "...it's not that I think we're going to run into a wall right away, but..." And Mike responded, "It won't be a wall, it'll be more like a bungee cord. When we've stretched it as far as it'll go, we'll discover that we're going to be pulled back, whether we like it or not."

Can a water resource that is rigidly fixed support perpetual population growth? When posed in these absolute terms, the answer is obvious and un-

equivocal. No! So, avoiding the bungee effect—that is, avoiding having to pay back “wet water” after we have over-consumed—is a compelling issue that needs our attention now. Later might be stretching it too much!

The City of Albuquerque has done a service in undertaking its solemn public relations program to gain support that is essential for solving its own problems. The view I present in this paper (which is purposefully pessimistic) is that this is only a first step along a path which, even though unavoidable, will bring stress and more stress to politicians and public alike.

## POPULATION—OF COURSE IT WILL GROW!

Let's deal with population growth first. How many of you think that population in our basin will cease to grow—or will level off at some number? None? Well, that was easy.

Data from the Middle Rio Grande Council of Governments (MRGCOG) and the UNM Bureau of Business and Economic Research (BBER) show that population in our area has been doubling about every 30 years. That doubling rate may drop off some in the future (thank goodness). The 1990 population of Bernalillo County was over 480,000, and that of the Albuquerque-Belen Basin was of the order of 600,000. The MRGCOG/BBER projections are for a million people in Sandoval, Bernalillo and Valencia counties by 2030. After that? Well, why assume that the pattern will change?

## WATER RESOURCES—ARE THEY REALLY FIXED?

Are our water resources truly “fixed”—that is, finite and not expandable? All of us know that the flow of our Rio must be managed in accordance with the Rio Grande Compact. This compact among Colorado, New Mexico, Texas and the federal government (a requisite party) specifies that Colorado will deliver to New Mexico a certain amount of Rio Grande water annually, and that New Mexico will deliver a certain amount annually to Texas and Mexico.

New Mexico's delivery point is Elephant Butte Reservoir. Water credits and debits can be accrued by each of the states, though for limited periods and under strict controls; but whenever the reservoir flows over the spillway at Elephant Butte Dam, all debits and credits of all states are wiped out.

The Albuquerque-Belen Basin has one third of New Mexico's population and most of the irrigable Rio Grande flood plain above Elephant Butte Reservoir. What New Mexicans do to, or with, the water resources in this basin create the dominant human impacts on Rio Grande flow into the reservoir.

Now, so that we are using the same numbers in analyzing the system, let's summarize the aggregate aspects of the water resources in this basin.

The accompanying figure (Figure 1), taken from Thorn, McAda and Kernodle's “Geohydrologic Framework...[of] the Albuquerque Basin...” (USGS 1993, WRI Rept. 93-4149) shows that the basin water budget as we now know it includes the following annual averages:

Inflow (surface and groundwater)	1.26 million acre-feet
Outflow (surface and groundwater)	1.06 million acre-feet

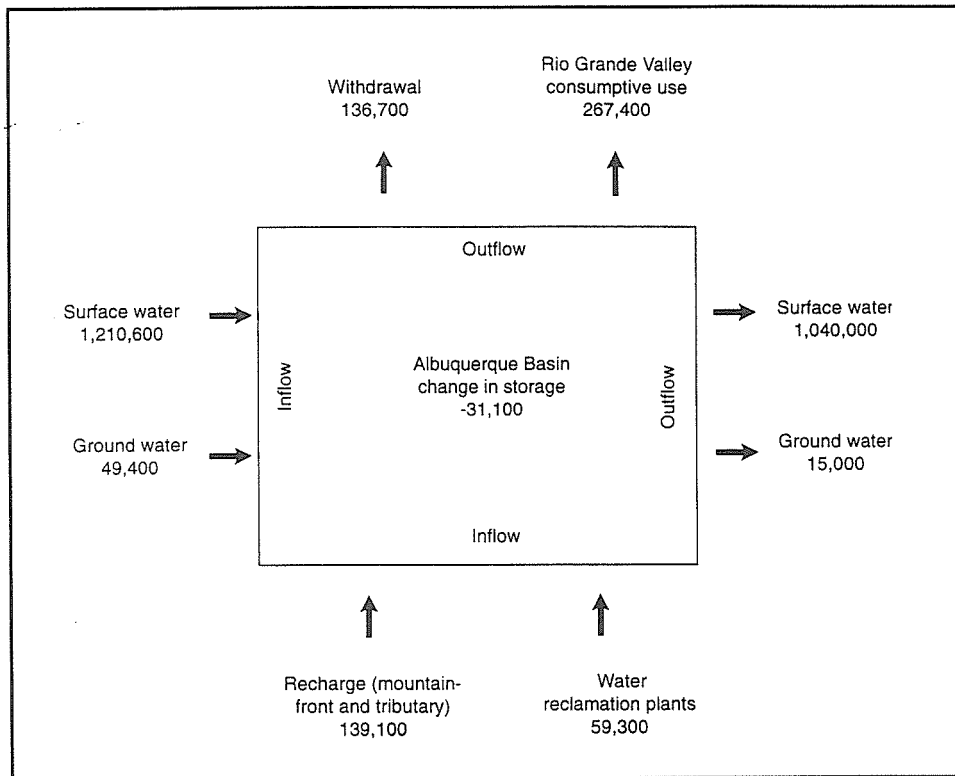
So, our basin transmits about a million acre-feet of water a year to Elephant Butte Reservoir. Nearly all of this probably reaches “the Butte,” because below San Acacia it is transported through a hydraulically efficient channel built by the Bureau of Reclamation.

In the Albuquerque-Belen Basin, they estimated total groundwater pumpage to be 137,000 acre-feet a year. This is “offset” in part by a return flow to the river from “water reclamation plants” of 59,000 acre-feet. Thus, man's net annual consumption is about 78,000 acre-feet. Does this reduce the flow to Elephant Butte by this much? Definitely not! I submit that in reality the river flow is being augmented.

The basis for this conclusion is as follows. The state engineer uses the “Glover-Balmer formula” to calculate when any well that is distant from the river will extend its cone of depression to the river and begin to induce river loss into that cone of depression. This simple formula is based on assumptions of an isotropic aquifer, some specific aquifer parameters, and perfect hydraulic connection between the river bed and the aquifer.

None of these assumed characteristics are proving to be true. The aquifer is highly anisotropic (that is, has horizontal permeabilities at least hundreds of times greater than vertical), has highly variable parameters (most permeabilities being much lower than those around City of Albuquerque well fields), and modeling is now showing that the hydraulic connection between the river bed and aquifer is only one-half to one-fourth as great as that assumed by the Glover-Balmer formula. The cumulative effects of these discrepancies is that the amount of water actually lost from the river by infiltration is lower than is calculated by the formula. I think that error is likely to be dramatic, although I'm sure it can't yet be quantified accurately.

## Rio Grande Groundwater: Fixed Resource vs. a Growing Population



**Figure 1.** Water budget for the Albuquerque-Belen Basin, 1974-1992 (units are in acre-feet per year; budget does not balance because quantities were estimated from independent sources) (Thorn, McAda and Kernodle 1993).

This would mean that most of the effluent to the river from the water reclamation plants is in fact augmenting the river. Stated another way, groundwater pumped from wells, then routed to the river through the treatment plants is analogous to a short circuit. The normal slow groundwater path to the river has been replaced by a direct path that takes only hours or days; meanwhile, the true annual loss of river water to infiltration is still quite small.

Before leaving the water-budget figure, I'll point out that the data it shows are quite adequate for the philosophical kinds of conclusions I am offering herein. However, for the purpose of future management of the resource, much more data of all sorts are needed, and I have joined numerous other specialists in calling for an aggressive data-collection program. The water budget must and will be improved—again and again and again. The improvements will be refinements however, not dramatic revisions. The die has been cast, and I will tell you that some parts of the future—though still decades away—can already be perceived.

Now, back to the issue of river augmentation. Fifty-nine thousand acre-feet a year (the sewage effluent) isn't that large, is it, when compared with the million-acre-feet average flow of the river? (A river flow increase of six percent can't even be measured accurately.) But, there is more to the argument.

For more than two decades 94,000 acre-feet of Colorado River Basin water has been imported annually to the Rio Grande via the San Juan-Chama Diversion Project. There can be little doubt that its net effect also has been to augment the flow of the Rio Grande, even though that water is intended to be used for various in-basin purposes by those who contract for it. (The imported water passing Cochiti Dam is undoubtedly included in the USGS water budget.)

Now we are looking at an augmentation upper limit of more than 150,000 acre-feet per year (94,000 of San Juan-Chama water plus 59,000 treatment-plant effluent). Fifteen percent of the average annual San Acacia flow from the basin is certainly not trivial. I'm not claiming augmentation

by the full 15 percent, but my judgement is that the increased flow is real and is substantial.

What effect might this have? I'll simply note without much comment which years the reservoir at Elephant Butte rose to flow over the spillway (or officially would have, except that storage had been manipulated for flood control). The dam was completed in 1916. Actual (or decreed "actual") spills occurred in 1942, and then again in 1985, '86, '87, '88 and '94. I have no proof that flow augmentation contributed to those spills in recent years, but intuitively the probability seems quite high. Now, what if flow augmentation were to cease? We'll take a brief look at that shortly.

Any inquiry into whether the resource is fixed is incomplete if it doesn't touch on water importation and on water being saved by new technology. I'm going to treat this topic briefly and simply by giving you my thoughts with only sketchy justification. The era of water acquisition and importation from elsewhere is past. Potential source areas are too populated and too sophisticated now to give up their water, and the federal government is essentially out of the dam-, canal- and pipeline-underwriting business. Desalination is a very expensive technology, and the most practical large sources would require piping the cleaned water from out of state (say the Gulf of Mexico or the Pacific Ocean). Therefore, the conservative bottom line is that we cannot depend on saving ourselves with imported water. Technology may make it more practical with time, but expect the true costs to remain high.

#### THE FUTURE—MANIFESTATIONS OF WATER-RESOURCE STRESSES

The future started a few months ago, when Mayor Chavez of Albuquerque—then other political leaders—accepted the bad news of the city's water plight.

It's not that earlier politicians hadn't been told of the need for reliable data, or the need for action. Many readers know of C.V. Theis's statement in 1953 that the city "...is in the embarrassing position of an ostrich in its traditional pose." (Theis, a giant among geohydrologists, was New Mexico district engineer for the Ground Water Branch of the USGS.) And in 1980 Steve Reynolds, New Mex-

ico's distinguished state engineer for 35 years, estimated that 1.5 million people in the Albuquerque Basin would be "manageable" if we were to retire all of the non-Indian surface-water rights between Cochiti Dam and Elephant Butte Reservoir. Many think his estimate was too optimistic—that only a million or so could be accommodated by drying up all of the farms.

Kelly Summers deserves much of the credit for forcing Albuquerque a few years ago to look to the future by his insightful data-collection program and his vexatious insistence that the city's problems couldn't be hidden much longer.

Albuquerque's public relations campaign is now well underway, and officials hope that by a combination of education, pricing, regulation and municipal example, the public will help reduce pumpage from an enormous 250 gallons per capita per day to much less than 200 gpcd. Two conspicuous additional steps are being discussed. First, the City is considering using directly its 48,000 acre-feet per year of San Juan-Chama Project water, or, alternatively, recharging the aquifer with it. Second, the City could recharge the aquifer with its 55,000 acre-feet per year of sewage-treatment-plant effluent after some additional treatment.

Some personnel from the State Engineer Office (SEO) are clearly less than enthusiastic about these proposals. After all, Albuquerque's treatment-plant effluent currently is used to offset pumped-well effects on the river that have been calculated using the Glover-Balmer formula, and also the SEO must approve any injection into the aquifer. Note that if the SEO were to abandon Glover-Balmer as a calculation technique, this would have extraordinary water-rights and regulatory impacts (not to mention requiring a staggering amount of additional staff effort.)

The effects of Albuquerque consuming, or recharging the aquifer with, its San Juan-Chama water, and recharging with its treatment-plant effluent would be striking. This probably would solve Albuquerque's problems of excessive mining of groundwater, but at the same time it would intercept more than 100,000 acre-feet a year of surface water that is now flowing down the river—a full 10 percent of the annual average flow.

And if the city ultimately—say by 2030—had to purchase existing water rights on the Rio Grande

and retire them in lieu of offsetting with treatment-plant effluent and San Juan-Chama water, the purchase would take nearly the entire 59,500 acres of present farm land above Elephant Butte out of production (at two acre-feet of consumptive water rights per irrigated acre) in order to "keep the river whole." (Note that those rights would cost hundreds of millions of dollars.) Even so, this massive retirement of irrigation water rights wouldn't all yield wet water unless we were to prevent phreatophytes (salt cedar, cottonwoods, salt grass, willows, etc.) from ever revegetating the abandoned farms. And after all the farms are dried up—if we elect to go that route—what are we to do next as population continues growing?

Let's not ignore population growth outside of the present metropolitan area. You can bet that a growing population will construct more and larger communities on that gentle slope below the foot of the Manzano Mountains south of Albuquerque; just as Albuquerque grew at the foot of the Sandias. It isn't only the scenery and openness that is enticing—the best groundwater is there too. Hydrologically, the cones of depression of the wells that will inevitably come with the people will likely coalesce to completely disconnect the Rio Grande from its only local area of significant recharge outside of its irrigated flood plain; that is, along the base of the mountains. That process is already well started; consider the several existing communities between Placitas on the north and the Rio Communities east of Belen. While the effect of the hydrologic disconnection will not arrive at the river for a very long time, its ultimate cost to the river will be the mountain-front recharge from the east, which is now estimated at 83,000 acre-feet a year.

When we can no longer deliver an average of about a million acre-feet of water a year to Elephant Butte Reservoir, we will experience the beginning pull of the bungee. Just such a setback has happened already on the Pecos River. The state legislature has had to provide funds for the state engineer to buy and retire water rights on the Pecos so that wet water repayments ordered by the courts can be delivered to Texas. Rio Grande repayments, if we allow such a debt to build, will be appallingly more difficult to resolve.

## REGIONAL WATER RESOURCES MANAGEMENT FORUM (THE WATER FORUM)

As population pressures increase on the fixed water resource, if we are to avoid a chaos of increasing litigation, legislative power politics, and politically based piecemeal decisions we must develop regional planning and cooperation, and substitute these for the present competition and divisiveness over water. To opt for a "no-action alternative" is to opt for agricultural water rights to be bought out faster, for the water crisis to arrive sooner and for the social and economic consequences to be more bewildering.

I can't give you answers to the troublesome questions I have asked. So far, I think none are adequate. Thorough and equitable answers, if they are to be sought and found, require two foundations. First, they must come from multidisciplinary attention to the river, the groundwater basin and the demands being placed on them. Second, all real stakeholders should have access to hard information and should be heard in the negotiations leading to the difficult decisions.

I ask you to consider, therefore, a REGIONAL WATER RESOURCES MANAGEMENT FORUM for the Albuquerque-Belen Basin—an entity intended to be a vehicle for regional planning and cooperation. This Water Forum would be a permanent body designed to represent all jurisdictions in the basin and to give all stakeholders a place to be heard.

Western Network (the environmental conflict management organization headquartered in Santa Fe) has succinctly identified the needs that justify the proposed Water Forum. It has stated that "...there is as yet no forum for consideration of the future of the river...The reality is that the upper Rio Grande has no broad-based policy-making body... The key, then, is to create a process for the future, a way in which different interests can engage each other productively and negotiate new arrangements." (in, "The Upper Rio Grande, A Guide to Decision Making" 1988)

The Forum would have the following makeup, mission, and authority. Its members would be appointed for fixed terms by each jurisdiction; each appointing a politician or manager and a scientist

or engineer as its two representatives. Technical people in equal numbers to the managers and politicians are extremely important in my view, because this can overcome the irrational communications failures that arise when politicians or managers, sensing a political threat, refuse to hear distressing messages from the technical side.

Industrial and commercial entities large and small should certainly participate, through some formal arrangement yet to be devised. In fact, vigorous effort should be devoted to insuring that the Water Forum provides representation, access and communication to every local stakeholder. One of the obstacles to equitable water management in the Rio Grande is that far-reaching decisions are made by several agencies, yet there is no common or overall process by which the public can be assured of foreknowledge and participation.

The mission of the Water Forum would be a broad one, and one that is unique within the system of Rio Grande management. It is as fundamental as planning for, and attempting to optimize, future water-resources reapportionment so that as populations increase, the non-expandable resources will support the greatest use with the least individual and societal discomfort. Additionally, the forum would formulate advisory policy statements on the gamut of water-important matters.

As now envisioned, the Water Forum would have no regulatory authority. (This pragmatism is aimed overtly at diminishing opposition.) Forum pronouncements to member communities and to state and federal agencies would be advisory only. If the Forum can be formed cooperatively, however, if it can include representation from all governments in the Albuquerque Basin, if it can undertake technical studies based on reasoned concern for basin-wide welfare, and if, from this posture, it can become a fountainhead of unbiased water-management information for its members and for the media and public, its recommendations could never be taken lightly by either governing or regulatory entities.

Certain organic criteria are worth repeating. They include: permanent standing, equality among jurisdictional representatives, approximately equal numbers of technical and managerial-political types, isolation from direct political pressures, and independence from regulatory agencies. It seems

likely that these criteria could best be assured if the Forum were set up by action of the governor or of the state legislature.

Questions of funding are serious, and I don't have the answers. Will this be solely a deliberative body, or will it actually fund studies? This and other questions obviously affect costs. These questions should be considered by the jurisdictions that must participate in forming the Forum. But I will be flabbergasted if the state legislature isn't highly supportive of a local initiative aimed at benefitting one third of the state's population by using communication, cooperation and negotiation to proactively plan for the future welfare of the state's Rio Grande watershed. For part of the funding, a modest fee on municipal, commercial and industrial pumpage might be considered; costs would thereby be associated with the areas benefited.

#### ACTION NOW

My purpose here has been to campaign for a rational and forward-looking approach to protecting our aquifer, maximizing our benefits from it, and extending the time period in which flexibility is a characteristic of its use. Clearly, we must do this in a way that allows us to continue protecting individuals' rights, and allows communities to retain reasonable control over their own development. There is no miracle fix for our problem. If it is proficiently handled, it will be through good politics; if not, we will hear a wonderful litany of excuses, accusations, and "if only"s, threaded through, I'm sure, with statements about not being able to afford (something or other).

Several times in the past year I have heard or read the statement that "fortunately" the aquifer will supply Albuquerque with groundwater for the next 10 years or so before the city's situation becomes critical. Such statements are a mirage if they are used to imply that the No-Action Alternative is OK. Developing a consensus, creating a management plan, and implementing it, are all time-consuming activities. (It took six years just to produce the much simpler Groundwater Protection Policy and Action Plan for Albuquerque and Bernalillo County.) In the mean time the population grows, the potential for litigation grows, and the opportunities

## Rio Grande Groundwater: Fixed Resource vs. a Growing Population

for meaningful resource-management become progressively narrower. So let's begin!

“Man will occasionally stumble over the truth, but most of the time he will pick himself up and continue.”

Author Unknown

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