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THE SAN LUIS VALLEY
GROUNDWATER DISPUTE

by

David Harrison
Moses, Wittemyer, Harrison
& Woodruff
Boulder, Colorado

and

Jeris Danielson
State Engineer
State of Colorado, Denver

GROUNDWATER: ALLOCATION, DEVELOPMENT AND POLLUTION

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THE SAN LUIS VALLEY
GROUNDWATER DISPUTE

I. INTRODUCTION

A. The San Luis Valley Situation

1. The San Luis Valley in Colorado is a high elevation flat plain about 50 miles across in an east and west direction and 90 miles in a north and south direction, filled with unconsolidated and consolidated alluvial materials to a depth of several thousand feet. See Attachment 1, map of San Luis Valley.
2. It is generally quite permeable and filled with water in amounts estimated at approximately 2 billion acre-feet.
3. This system of groundwater is separated to a degree into two components: the unconfined aquifer in the upper one to two hundred feet; and, below a series of clay confining layers, the confined aquifer.
4. The unconfined aquifer is under free water table conditions and is in tributary hydraulic connection to the streams in the areas where they flow. The major portion of the San Luis Valley north of the Rio Grande drains into a closed sump area where the only outflows are to evapotranspirative losses. It is generally conceded that this water in the unconfined aquifer of the closed basin is not presently tributary to the Rio Grande stream system.
5. The confined aquifer throughout the entire San Luis Valley tends to be under artesian pressure and since early in the history of the San Luis Valley has been the source for many, many small-capacity domestic and stock-watering wells. It is generally believed to be in hydraulic connection to the surface stream system (1) by receiving recharge from them in the recharge gone around the periphery of the confining layer along the rim of the valley floor; and (2) by interruption in the confining layer allowing artesian spring flow upward into the streams, particularly the Conejos.

B. The Rules and Regulations Case

1. The effect on the stream flows of the Conejos River and the Rio Grande of pumping in both the unconfined and confined aquifers throughout the San Luis Valley

was the subject of major dispute in the Rules and Regulations case (In the matter of the Rules and Regulations Governing Groundwater Withdrawals), which was tried for 13 weeks to the Water Judge for the Rio Grande drainage, during the summer of 1978. The State Engineer and allied surface water rights interests (principally, the Conejos Water Conservancy District) alleged that such groundwater withdrawal substantially damaged stream flows, and the wells being generally junior, they should not be allowed to divert unless pursuant to Court-approved plans for augmentation. Well pumping interests, of course, resisted. These interests were two groups: the San Luis Valley Well Users Association, primarily agricultural users, and the San Luis Valley Communities, which represented collectively most of the municipal interests of the San Luis Valley, who are almost totally dependent upon groundwater.

3. An interesting and important physical phenomenon also occurs in the San Luis Valley which took on a major importance in the case. The high water tables throughout the valley support large amounts of naturally occurring "non-beneficial" phreatophytic growth. As pumping occurs, the resulting drawdown in water tables apparently causes a reduction in this non-beneficial consumptive evapotranspirative loss, thus offsetting to a degree the effect that such pumping would otherwise have on stream flows.
4. This groundwater controversy was imbedded in a knot of other legal issues which came to a head in the same case, principally concerning the proper interpretation and administration of the Rio Grande Compact. The central of these issues was whether such administration should separately impose individual delivery schedules contained in the compact, article III, on the Conejos River and on the Rio Grande mainstem, respectively; or whether the two tables together comprised a unitary Colorado obligation on the State, leaving it to the appropriation system to allocate water between the two streams. The Conejos interests, being generally senior to the mainstem and being faced with a more severe table, contended for the latter. The Rio Grande, and the State Engineer, were persuaded of the correctness of the former view.
5. In the groundwater dispute, the senior surface interests on the Conejos tended to point to the groundwater users as a major aggravating factor in the difficulty of the valley as a whole, and the Conejos particularly, in meeting the obligations of

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the Compact and the 1968 United States Supreme Court stipulation.

6. When all parties had assembled around their various issues in the single case, there were over 200 parties of record, 22 attorneys representing them, and 14 engineers and geologists taking their turn in the witness box. At least 9 separate factions developed and took active roles in the trial.
7. The Judge, William Eakes, who was the regular Water Judge from the adjoining Division at Durango, pronounced judgment on January 31, 1980, throwing out the Rules and Regulations and disallowing any curtailment of groundwater diversions. The case was appealed and has been briefed and argued to the Supreme Court of Colorado. Its decision is pending.

II. THE TEAM OF EXPERT AND LAWYER

A. The Various Roles of the Expert - The Lawyer's View

In a complex groundwater-surface water case, it is obvious that the expert consultants and witnesses take on an extremely important and central position. We have attempted to divide that position into several sub-roles. While these roles are generally fairly obvious, it is interesting to catalog them to permit focus on each. A common theme runs through them all and that is providing the perspective, the whole view of the detail-packed case. The potential for wasting time and talent on some minor side issue is great.

1. Investigator - Basic research into the bibliography, existing data and presently held theories is the crucial starting point. In the San Luis Valley, work of the U.S.G.S. over the preceding decade became the basic starting point; earlier work by geologists Siebenthal and Powell gave important historical perspective. The records of the State Engineer's Office on wells and permits and on surface diversion records provide the bulk of raw data to be assembled.
2. Educator - As important as any function the expert must serve is the education of the lawyer and other team members into the basic technical language of the case. What are the basic definitions and concepts? What is the range and reliability of present data? What are the existing theories and what are their weaknesses?

3. Strategist - The good expert shares co-equally with the lawyer the job of developing basic approaches to the case. What can be done with the evidence? What approaches to opponents and court might be persuasive? What avenues of settlement might be explored? What evaluation should be given to any settlement possibility? In the complex groundwater case, the possibility of a case becoming submerged in technical details calls upon the expert to utilize his perspective on the whole problem and to provide leadership to the litigation team.
4. Workhorse - Not to overlook the obvious, it is of vital importance that the expert and his staff carry the great burden of assembling numbers and charts that tell the story of the case and arrange them into court-suitable form. Likewise, the expert must digest and analyze the data and exhibits of the opponents. Although laborious, these are essential tasks. Again, an important element of these functions is the maintenance of the perspective on the case to be able to see matters of importance and to distinguish the mass of trivia.
5. Trial Preparation - The preparation of the actual testimony is a crucial step in the development of the case. The expert has a great opportunity for leadership in this area by the development of his own outline of testimony. The great risk in presenting a complex groundwater case is that of drowning both audience and participants in the mass of detail that must be handled. The concise and cogent outline of testimony is essential in order for any party to carry the "burden of clarity".
6. Trial Assistance - The expert is indispensable in the process of the trial in hearing testimony of others and advising the lawyer of strengths and weaknesses of the case as it proceeds. The development of the cross-examination of other witnesses falls heavily on other experts. Again, the key principle is the maintenance of perspective. Numerous nitpicking questions will generally not comprise an effective cross-examination. Basic principles of agreement may be much more important.
7. Trial ^{Participation} ~~Preparation~~ - The obvious role of the expert is that of direct testimony. The key here is there should be no surprises. The lawyer and expert have by now worked together well enough and long enough that all answers are known. The demeanor of the expert is important. Is he the relatively objective and well-educated expert that will actually help the

court? Or is he caught up in his role of advocacy of the client?

- 8. Cross-Examination - The role of the expert in cross-examination is perhaps overrated. While it is a wonderful opportunity for the expert to spar with the cross-examining attorney, there is not likely to be much gained from such interchanges. The important thing is for the expert to carefully and honestly stay within the area of his knowledge. "I don't know" can be a perfectly satisfactory answer.

B. The Lawyer - The View from the Expert

In complex technical cases, more so than in usual court cases, the lawyer assumes less of the traditional legal advocate role and becomes the manager of a team of professionals of varying disciplines. Certainly he must have the legal theories well in hand, but, if the complex technical issues are not woven carefully into the legal fabric of the case and, more importantly, developed before the Court in a clear and rational manner, the outcome is likely to be one not sought.

A few of the more important roles the lawyer must play are:

- 1. The Organizer: Any case of such complexity as the San Luis Valley case will have an inordinate number of factual issues as well as legal issues. The lawyer will be inundated by his expert with such detail, that absent a clear plan of what is to be presented and how, the case is doomed to failure. The lawyer must meet at the earliest possible time with his experts, not only to gain at least a rudimentary understanding of the technical issues, but to convey a basic understanding to the expert of the legal theories of the case. Once this basic understanding and exchange is achieved, the lawyer must organize the presentation so that it is best presented to the Court.
- 2. The Strategist: Perhaps as much time should be spent in analyzing the opposition's case and expected presentations as is spent in understanding his own. The lawyer must evaluate the opposing counsel and his weak and strong points and, with the help of his own expert, analyze the likely attack to be taken by the opposing expert to develop a strategy of presentation and a plan for countering the opposition at the appropriate moment.
- 3. The Team Player: The lawyer must realize that complex technical cases are rarely won on one

brilliant ploy or question in the courtroom, but, more than likely, will be won if the facts and legal arguments are carefully presented in a logical sequence. This means that careful attention must be given to what the expert is saying, remembering that the expert is not an advocate but a professional who cannot bend the facts to suit a particular pre-conceived legal theory that the lawyer wishes to advance. A frank and open joint development of the case will avoid the lawyer's frustration of a legal position unsupported by facts and an expert expected to perjure himself.

4. The Listener: Because the type of case is not as dependent on the particular brilliance of the lawyer alone as it is on the joint performance of the lawyer and the expert, the lawyer must be a good listener. He must listen to his own expert with respect to what the facts show and he must listen to the opposing expert's testimony and weigh what is said against the facts that his own expert has tendered. A thoughtful consideration of the two presentations analyzed by a mind trained in the law will often lead to very profitable lines of cross-examination and to redirect examination.
5. The Arbitrator: The involvement of several experts and several lawyers in a long and complex trial will inevitably lead to disagreements among members of the trial team. Experts often become so involved in the detail of their own analyses that they tend to lose sight of the main objectives in the case. The lawyer must be able to arbitrate these disputes and restore a spirit of cooperation and unified direction.
6. The Decision Maker: The lawyer must bear in mind that though his central "starring" role may be somewhat diluted by sharing much of the development of the case with other members of the trial team, the client still expects him to be the ultimate decision-maker in prosecuting the case. When the time comes that he and his co-counsel cannot agree on a particular legal point, or when his experts are hopelessly mired in some technical argument, he must assume a leadership role, make a judgment and tell the team what course of action will be followed.

III. THE SAN LUIS VALLEY GROUNDWATER DISPUTE

- A. Following work by the U.S.G.S. during the early 1970s, the opinion of the State Engineer's Office crystalized to

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the effect that diversions of groundwater from the artesian, confined aquifer, probably throughout most of the San Luis Valley, was having a depletive effect on surface stream flows, particularly on the Conejos River. The assertion was that with pumping came declines in the artesian pressure and, therefore, increases in recharge into the aquifer from the stream in the recharge areas around the periphery of the confining layer (around the edges of the San Luis Valley); and reductions in the flows into the surface streams from springs thought to be fed from the confined aquifer.

1. U.S.G.S. Circular 18 was published in 1973, strongly suggesting the direct hydraulic connection between the confined aquifer throughout the San Luis Valley as whole with the Conejos River.
2. Further U.S.G.S. work on an analog computer model of the San Luis Valley resulted in the publication of Circular 29 in 1975. This publication produced the first estimates of the order of magnitude of that impact, suggesting that it was significant. And sensitivity runs on the analog model gave important basis for the conclusion that these effects were material, regardless of the uncertainties about the degree of hydraulic connection.
3. As a result of this general understanding of the geologic situation, the State Engineer's Office began to disallow new well permits from the confined aquifer.
4. The working leading to Circular 29 also developed and utilized assumptions concerning the leakage of water between the confined and unconfined aquifer and developed and utilized assumptions concerning the lowering of the unconfined aquifer water table and the resultant salvage of non-beneficial use. That model predicted, for example, assuming the pumping of 5 million acre-feet over a 50-year period from the confined aquifer, 38 percent or 1,900,000 acre-feet would be derived from salvaged evapotranspiration; 28 percent or 1,400,000 acre-feet would be derived from groundwater storage; 12 percent or 600,000 acre-feet would be derived from the flow of the Rio Grande; and 22 percent or 1,100,000 acre-feet would be derived from the Conejos.

B. Following the lead of the State Engineer, parties primarily from the Conejos area became increasingly concerned over the impact of groundwater use on the surface streams, and the call for regulation began to be heard. Parties from other areas were less vocal. The Conejos area was typified by more traditional methods of

MSG's Analog Model (Analog)
- said needed more wells to reduce phreatic plants & loss of water

surface irrigation from relatively senior ditches. Surface water users further north on the Rio Grande and in the closed basin area had themselves resorted to large amounts of well pumping to supplement their surface supplies, so they found themselves on both sides of the issue. The agricultural well users throughout the valley had banded together in a voluntary association called the San Luis Valley Well Users Association to resist groundwater regulation and to prepare to meet the requirements of any regulation which did come about. After the proposed Rules and Regulations were promulgated, they were joined by most of the municipal communities of the valley who were dependent on groundwater supplies.

C. Rules and Regulations of Groundwater Elsewhere in Colorado

1. The business of regulating groundwater withdrawals in Colorado was not new. They were preceded by the controversy in the Arkansas River Valley which resulted in the landmark case of Felhauer v. People, 167 Colo. 320, 447 P.2d 986 (1968). In that case, the Division Engineer had selected a handful of wells near the river which were clearly contributing to the depletion of the stream flows, already over-appropriated by the senior surface ditches. The Court, while upholding the application of the prior appropriation doctrine to wells tributary to the stream, disallowed the attempted curtailment effort on Due Process grounds. It held that before such curtailment could be effective, there must be written Rules and Regulations setting out a clear standard of who was to be curtailed, requiring that there must be a reasonable lessening of material injury resulting from the curtailment and providing an affirmative opportunity for the affected wells to propose conditions of operation which would allow their operation without such injury. In Felhauer, Justice Groves first enunciated the now familiar doctrine calling for the maximum utilization of the combined ground and surface water resources.
2. The Colorado legislature addressed the problem in 1969 with the adoption of the comprehensive Water Rights Determination and Administration Act of 1969. That act called for the regulation of wells in the priority system, but simultaneously called for the conjunctive use of groundwater and surface water. It specifically provided the authority and framework for the State Engineer to adopt rules and regulations regarding groundwater (1973 C.R.S., §37-92-501).

3. The first case to come up under the new act was Kuiper v. Well Owners, 176 Colo. 119, 490 P.2d 268 (1971). The State Engineer had written Rules and Regulations on the South Platte calling for curtailment of wells within certain defined zones, depending upon the time of effect of well pumping on the stream. Before the regulations were implemented, well users brought an action to enjoin their implementation based on numerous procedural and substantive arguments. The injunction was issued by Judge Carpenter. The Supreme Court vigorously reversed, with Justice Groves asserting that it was time to get on with it. One important issue in that case was the assertion by the well users that no surface water right holder could call for water until he had first resorted to the use of any wells that he might own and was still unsatisfied. In effect, the well users sought and the trial court granted a ruling construing wells as alternate points of diversion for ditch rights where the two were in common ownership. The Supreme Court reversed, construing the statute to be permissive concerning the tying of surface rights to underground alternate points of diversion, but not mandatory.
4. In 1978, the Supreme Court decided the case of Kuiper v. Atchison, Topeka and Santa Fe Railway Co., 195 Colo. 557, 581 P.2d 293 (1978), reviewing proposed amendments to the Arkansas Rules and Regulations. Leaving undisturbed rules and regulations previously promulgated and unprotested, the Court voided attempted amendments which would have increased the degree of regulation, saying that additional studies had not been done to justify any amendments based upon experience under the original rules and regulations.
5. The San Luis Valley case had itself been to the Supreme Court previously on procedural matters (Kuiper v. Gould, 196 Colo. 197, 583 P.2d 910 (1978)), where it was determined that the present rules and regulations should be promulgated and reviewed in a single proceeding, in light of the State Engineer's dual authority for interstate compact administration under C.R.S. 1973 §37-80-104 and for groundwater administration under C.R.S. 1973 §37-92-501.
6. The substantive legal situations of the San Luis Valley were not fundamentally different from those in the South Platte and the Arkansas. Groundwater diversions, which were generally, but not in all cases, junior to the surface rights, taken

collectively were assertedly impacting stream flows on an over-appropriated river system. The only difference was the complexity and size of the San Luis Valley system. The protestants to groundwater regulation argued that the hydraulic connection between the aquifers and the streams was non-existent or at least over-stated in this complex geologic setting. They also pointed to the huge amount of groundwater in storage (supposedly 2 billion acre-feet) and the relatively large benefit in the salvage of evapotranspiration. As a matter of policy, they submitted, well regulation should not be justified in the San Luis Valley. Proponents countered that all the advantages of salvage and utilization of groundwater storage could be realized by the well pumping community in augmentation plans, allowing pumping to continue; the only question was who would bear the cost.

D. The State's Case

1. Basic Geology - Building on basic published geologic data from the U.S.G.S., the State, through testimony and exhibits, painted the basic geologic situation.
2. U.S.G.S. Published Work - Principally Circulars 18 and 29, derived from basic geology, water level observations, water budget, observed springs in the Conejos River region, and in the case of Circular 29, the analog model. See Attachment 2, Table 1, Circular 18.
3. Review of Basic Surface Water Hydrology - Mass diagrams of stream flows and diversions, inflow-outflow and river gain analyses, cropping patterns, snowpack and precipitation patterns. See Attachments 3 and 4, Tables, Net River Gain, Conejos and Rio Grande, for the Conejos River and Rio Grande River, and Attachment 5, Estimate of Factors Causing Decreases in Net River Gain.
4. Review of Basic Data on Groundwater Withdrawals Over Time - See Attachment 6, Mass Diagram Large-Capacity Well Withdrawals.
5. The State's Own Digital Computer Model of the San Luis Valley Groundwater-Surface Water Situation - Based on the U.S.G.S. analog model and its basic assumptions, but going further to simultaneously look at unconfined aquifer withdrawals and return flows, and increased levels of pumping overall, the State's model showed substantial impacts on the surface streams as well as salvage of

evapotranspiration and removal from groundwater storage. See Attachment 7, San Luis Valley Pumping Effects.

- 6. The State concluded, and Conejos agreed, that well withdrawals by wells, which as a class were junior to the surface water rights, were injuring those surface rights unless they augmented the stream.

E. Opponents' Case

- 1. The opponents attacked the basic assumption of hydraulic connection; while the San Luis Valley Well Users Association admitted there was some small amount of interconnection between the Conejos and the confined aquifer, they denied that it was substantial. Through examination of Phil Emery, author of the U.S.G.S. work, they asserted that the basic fact of hydraulic connection was not basically proven but rather only assumed.
- 2. Opponents further pointed to the offsetting impact of the salvaged evapotranspiration, relying again on Emery who, as matter of policy and resource efficiency, felt that more well pumping rather than less was advisable.
- 3. Opponents' basic argument was that to tie up the 2 billion acre-feet of groundwater and the salvage of evapotranspiration to support the relatively small and inefficient community of senior ditch rights was not legal. They pointed to the case of Colorado Springs v. Bender, 148 Colo. 458, 366 P.2d 552 (1961), arguing that inefficient diversion works (ditches) could not compel curtailment of more efficient juniors unless the senior had penetrated the aquifer to the full extent of this "economic reach". They pointed to the U.S. Supreme Court case of Schodde v. Twin Falls Land and Water Company, 224 U.S. 107 (1912) and its "water wheel doctrine"; no one should be permitted to tie up the whole flow of the stream to facilitate his taking of a fraction thereof.
- 4. They further argued that basic problems existed in the State's factual case. Why did declines in net river gain level off following the 1950s, even though well pumping continued to increase? Attachment 8, Mass Diagram of Net River Gain, Conejos and Rio Grande.
- 5. The models, both the U.S.G.S.' analog model and the State's digital model, may be useful for the prediction of general trends and gross generalizations of

the situation. They were not sufficient for determinations of the effects of individual wells on a case-by-case basis which, they argued, was required by C.R.S. §37-92-501(2) and 502(2). The result was the shifting of the burden to individual's wells to disprove any injurious effect.

- F. The judgment of the trial court accepted opponents policy arguments, even though it found, in effect, that the groundwater was tributary to the streams and that withdrawals could affect stream flow. It ruled that individual well-by-well determinations were required. And, most significantly, it ruled that surface water right users should construct wells and use the groundwater rather than call on their ditch rights. The water wheel doctrine, it felt, must be invoked in view of the tremendous volume of groundwater in storage and the effect of salvaged evapotranspiration. The Court cited the Bender case as authority, and distinguished Well Owners on the imaginative ground that it had held only that existing wells were not mandated as alternate points of diversions; it did not say that surface owners could not be required to drill new wells. It proceeded to suggest kinds of solutions to the overall problem of groundwater-surface water integration in the San Luis Valley, including salvage plans and others, although it did not address the authority of the State Engineer to compel such plans nor the question of who should pay for them. And it did not respond to the proponents' policy argument that the realistic effect of the rules and regulations was to require augmentation plans and not, realistically, to cause wholesale curtailment. It did not address the claim that the groundwater storage, salvage of evapotranspiration and other creative solutions in fact would be the result of such plans for augmentation.
- G. The trial court decision has been hailed by at least one academic observer. Frank Trelease, "Conjunctive Use of Groundwater and Surface Water", 27 Rocky Mountain Mineral Law Institute, 1853. Trelease characterized the holding as a giant leap forward in its recognition that the problem is one of reasonableness of means of diversion and not whether the court should enforce a property right in a specific means of diversion. Trelease went on to concede that he viewed all agriculturalists as being essentially on an equal footing and what was reasonable for some could reasonably be imposed on others. We disagree. Characterizing the problem as one of efficiency and reasonableness of diversion means is fair enough if one will look to the economic realities of the whole case. Here, the very efficiencies, the advantage of salvage and use of storage, that well owners point to is a demonstration of the relative ease of large

088100
001888

voluntary plans for augmentation. Since the well owners as a class can hold senior surface appropriators harmless with relative economic ease, then the very principles of Bender and Schodde dictate that the senior water rights must be protected rather than obliterated.

IV. WHERE FROM HERE

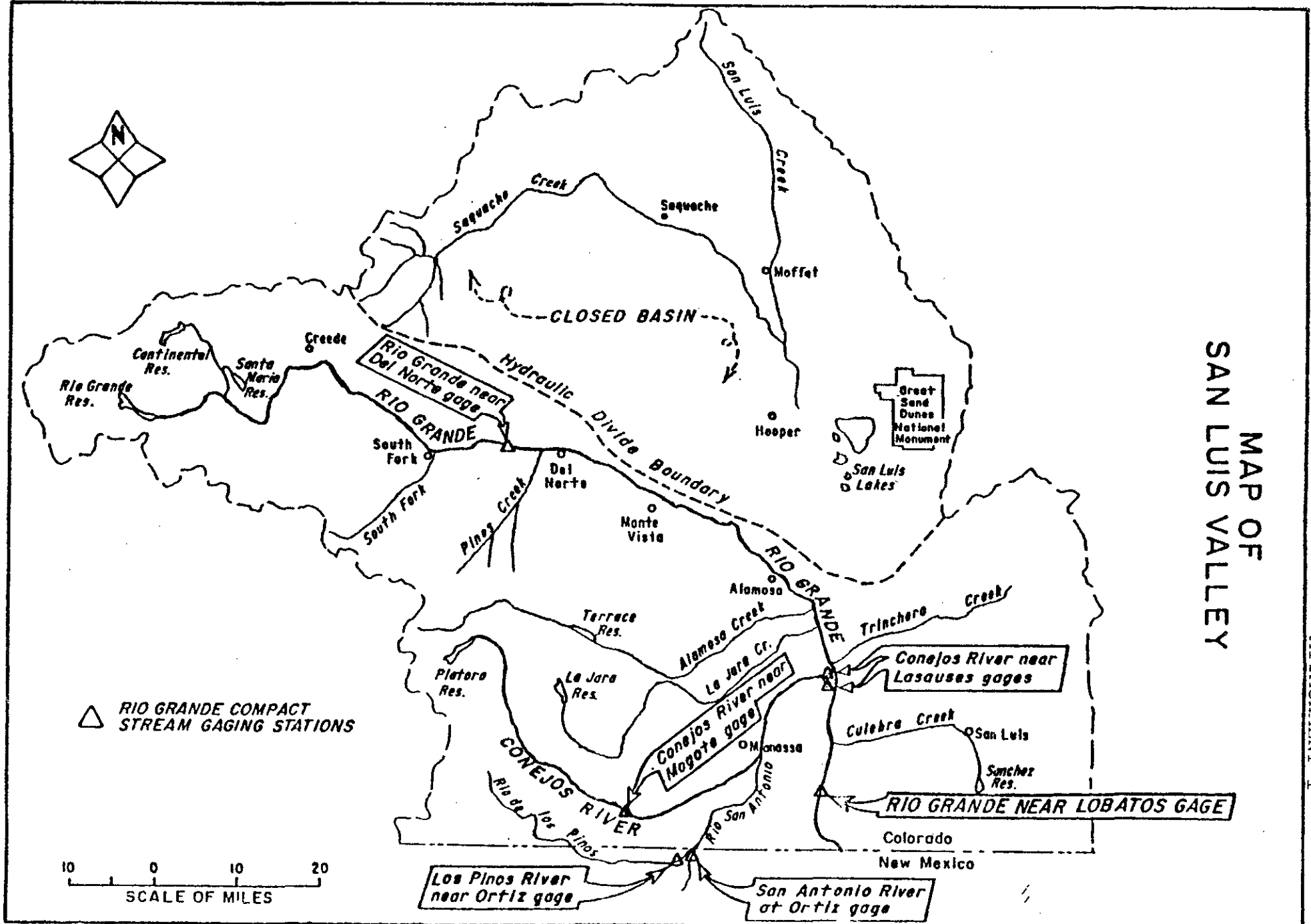
- A. The case has been briefed and was argued to the Colorado Supreme Court on February 22, 1983. Decision is pending.
1. If the trial court is affirmed, the senior surface right community, particularly on the Conejos, will be on its own to construct whatever self-help facilities they may be able to afford. Some users undoubtedly will not find any realistic alternatives available and will simply take their lumps.
 2. If the decision is remanded to the trial court for approval of the rules and regulations, a number of interesting augmentation alternatives will be up for consideration.
- B. The Closed Basin Project of the Bureau of Reclamation is currently under construction under the sponsorship of the Rio Grande Water Conservation District. While this water is not finally allocated (and indeed considerable question remains as to the ultimate yield of the project), it is not likely to go directly to the benefit of well users for augmentation purposes. It can be expected, however, to contribute to the overall Colorado obligation on the Rio Grande Compact and be of general benefit.
- C. Other drainage/pumping-type projects to take water from shallow groundwater sources and to induce salvage of evapotranspiration have been suggested and could be built on a private or public basis for direct use in augmentation plans.
- D. Pumping from confined aquifers into stream systems would appear to offer an immediate and effective augmentation source. The advantage of removal from groundwater storage and the indirect salvage of water by the reduction of leakage into the unconfined aquifer would be utilized. The problems involved will be to adequately design and locate such wells so that the stream depletion effects of this pumping will itself be compensated for. Questions about the accuracy of defining those depletions and about estimating actual salvage of evapotranspiration must be faced. Clearly an important element of future development will be the continued improvement of the data base and the modeling capability to be able to adequately

001887

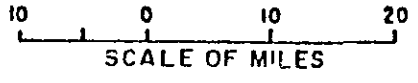
assess and manage such augmentation plans in a non-injurious manner.

MAP OF
SAN LUIS VALLEY

ATTACHMENT 1



-15-



△ RIO GRANDE COMPACT
STREAM GAGING STATIONS

Table 1.--Summary of results

Analog run	Simulated hydrologic condition			Period (years)	Source of ground water withdrawn											
	Hydraulic conductivity between unconfined aquifer and upper part of the confined aquifer along lower reach of Conejos River (feet per day)	Hydraulic connection between unconfined aquifer and Rio Grande and Conejos River	Total simulated withdrawal from the upper part of the confined aquifer for period (acre-feet)		Derived from storage						Salvaged evapo-transpiration		Stream depletion			
					Unconfined aquifer		Upper part of the confined aquifer		Lower part of the confined aquifer		Acre-feet	Per-cent	Rio Grande		Conejos River	
					Acre-feet	Per-cent	Acre-feet	Per-cent	Acre-feet	Per-cent			Acre-feet	Per-cent	Acre-feet	Per-cent
A	59	Restricted..	1,370,000	20 (1950-70)	510,000	37	110,000	8	110,000	8	330,000	24	90,000	7	220,000	16
B	59	.....do.....	5,000,000	50 (1970-2020)	1,200,000	24	100,000	2	100,000	2	1,900,000	38	600,000	12	1,100,000	22
C	59	.....do.....	300,000 (North of Rio Grande only)	10	183,000	61	21,000	7	21,000	7	66,000	22	6,000	2	3,000	1
D	59	.....do.....	700,000 (South of Rio Grande only)	10	252,000	36	84,000	12	84,000	12	91,000	13	42,000	6	147,000	21
E	59	Restricted..	2,000,000	10	900,000	45	200,000	10	200,000	10	300,000	15	100,000	5	300,000	15
F	59	.....do.....	10,000,000	50	2,750,000	27	360,000	4	360,000	4	3,330,000	33	1,170,000	12	2,030,000	20
G	59	Unrestricted	5,000,000	50	885,000	18	95,000	2	95,000	2	1,385,000	28	715,000	14	1,825,000	36
H	.59	.....do.....	5,000,000	50	1,140,000	23	125,000	2	125,000	2	1,575,000	32	360,000	17	1,175,000	24
I	.59	Restricted..	5,000,000	50	1,400,000	28	150,000	3	150,000	3	1,900,000	38	600,000	12	800,000	16

EXHIBIT 159
CONEJOS RIVER MAINSTEM
(ACRE-FEET)

TERM	MEAN ANNUAL 1927-1950	MEAN ANNUAL 1951-1977	CHANGE	MEAN ANNUAL 1928-1937	MEAN ANNUAL 1968-1977	CHANGE
Inflow (Near Mogote)	245646	208126	-37520	240680	206710	-33970
Outflow (Near La Sausas)	154382	90094	-64288	159386	99344	-60042
Side Channel Inflow (San Antonio Near Manassa)	66866	43396	-23470	65633	44308	-21325
Surface Diversions	220626	173565	-47061	196735	163901	-32834
Evaporation from Stream Surface	1717	1717	0	1717	1717	0
Stream Surface Precipitation Inflow	302	332	+30	320	329	+9
Net River Gain	63911	13522	-50389	51204	13615	-37589

Net River Gain = (+) surface diversions
 (+) evaporation from stream surface
 (+) outflow
 (-) inflow
 (-) side channel inflow
 (-) stream surface precipitation inflow

1891

EXHIBIT 72
 NET RIVER GAIN RESULTS FOR REACH FROM GAGE
 NEAR DEL NORTE TO GAGE NEAR LOBATOS
 (ACRE-FEET)

TERM	MEAN ANNUAL 1927-1950	MEAN ANNUAL 1951-1977	CHANGE	MEAN ANNUAL 1928-1937	MEAN ANNUAL 1968-1977	CHANGE
Inflow	653837	546578	-107259	593610	573090	-20520
Outflow	390959	234856	-156103	335751	285762	-49989
Side Channel Inflow	160435	95056	-65379	165021	104591	-60430
Surface Diversions	551825	491782	-60043	539172	479916	-59256
Evaporation From Stream Surface	6618	6618	0	6618	6618	0
Stream Surface Precipitation Inflow	748	823	+75	756	856	+100
Net River Gain	134382	90799	-43583	122154	93759	-28395

Net River Gain = (+) surface diversions
 (+) evaporation from stream surface
 (+) outflow
 (-) inflow
 (-) side channel inflow

EXHIBIT 104
AN ESTIMATE OF FACTORS CAUSING DECREASES IN RIVER GAIN
SAN LUIS VALLEY - COLORADO

(REVISED)

ITEM	RIO GRANDE SYSTEM DEL NORTE TO LOBATOS			CONEJOS SYSTEM ORTIZ AND MOGOTE TO LA SAUSES		
	Average 1927-50	Average 1951-77	Increase+ or Decrease-	Average 1927-50	Average 1951-77	Increase+ or Decrease-
Annual River Gain in Ac-Ft	134,382	90,799	-43,583	71,384	10,847	-60,537
Annual Diversion in Ac-Ft	551,825	491,782	-60,043	274,667	216,470	-58,197
Annual Out of Basin Diversion in Ac-Ft	269,804	227,061	-42,743	52,432	60,822	+8,390
Large Capacity Shallow Well With- drawal in Ac-Ft	9,358*	76,552	+67,193	196	1,839	+1,643
All Large Artesian Well Withdrawal in Ac-Ft	7,075*	100,926	+93,851	7,075*	100,926	+93,851
Harvested Irrigated Acreage	164,236	165,214	+978	36,611	44,678	+8,067
Shallow Well Effect			-12,969			-1,328
Large Artesian Effect			-5,089			-15,089
Transbasin Diversion Effect						-8,390
Increased Acreage Effect	1.5 x 978	=	-1,467	1.5 x 8,067	=	-12,101
Sub-Total			-19,525			-36,908
Unaccounted Decrease in River Gain			-24,058			-23,629

ESTIMATED WITHDRAWAL BY LARGE-CAPACITY WELLS IN DIVISION 3

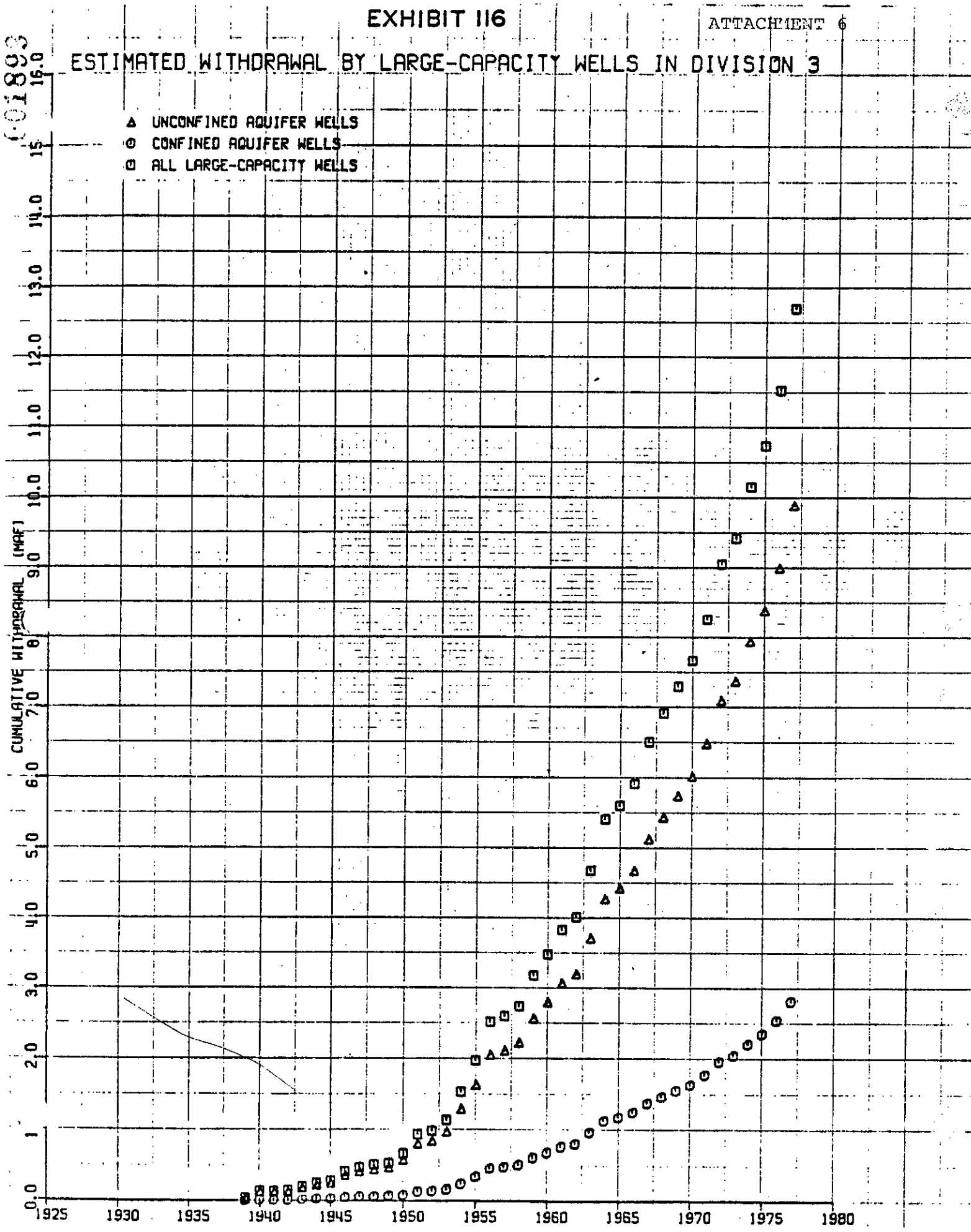
6-01893

CUMULATIVE WITHDRAWAL (MAF)

- ▲ UNCONFINED AQUIFER WELLS
- CONFINED AQUIFER WELLS
- ALL LARGE-CAPACITY WELLS

16.0
15
14.0
13.0
12.0
11.0
10.0
9.0
8
7.0
6.0
5.0
4.0
3.0
2.0
1
0.0

1925 1930 1935 1940 1945 1950 1955 1960 1965 1970 1975 1980



EXHIBITS 100, 101 AND 103
 SAN LUIS VALLEY PUMPING EFFECTS (1941-1975)
 (CUMULATIVE ACRE-FEET)
 CONDITIONS: VARIABLE HEADS, SURFACE DIVERSIONS, PRECIPITATION, 50% RECHARGE

Pumping Effect	W.D. 20 South of Rio Grande	Water District 21	Water District 22	Water District 35-B	Water District 24	North of Rio Grande	Total
Unconfined Depletions							
Storage	41,193	12,983	1,086	102,657	26,592	225,771	410,282
Rio Grande	105,016	1,958	13	5,037	5,582	336,311	453,917
Conejos	7,759	9,362	2,888	8,475	14,123	3,893	46,500
Evapotranspiration Salvage	429,635	19,788	7,170	44,446	22,552	2,606,176	3,129,767
Confined Depletions							
Storage	147,733	33,288	11,675	1,709	421	101,458	296,284
Rio Grande	109,122	14,703	2,387	795	120	50,978	178,105
Conejos	221,998	148,093	145,926	1,561	942	9,603	528,123
Evapotranspiration Salvage	-26,916	-47,509	-39,000	1,541	196	266,734	155,046

EXHIBITS 100, 101 AND 103 CONTINUED
SAN LUIS VALLEY PUMPING EFFECTS (1941-1975)
(CUMULATIVE ACRE-FEET)

CONDITIONS: VARIABLE HEADS, SURFACE DIVERSIONS, PRECIPITATION, 50% RECHARGE

Pumping Effect	Total Basin
Small Artesian	5,251,216
Storage	756,266
Rio Grande	785,111
Conejos	2,939,541
Evapotranspiration Salvage	770,039

001898

EXHIBIT 78 NET RIVER GAIN OR LOSS, BY RIVER

