

**INTEGRATING TRIBUTARY GROUNDWATER
DEVELOPMENT INTO THE PRIOR APPROPRIATION SYSTEM:
THE SOUTH PLATTE EXPERIENCE**

by

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EXECUTIVE SUMMARY

Colorado has abundant supplies of tributary groundwater. The development of this groundwater proceeded virtually unregulated until 1965. By that time, important agricultural economies in the South Platte, Arkansas, and San Luis valleys had become highly dependent on the use of groundwater. However, because of the physical relationship between tributary groundwater and surface water, pumping of this groundwater was affecting the availability of surface flows.

In 1969, Colorado enacted a number of provisions aimed at integrating appropriative rights to surface water and tributary groundwater. This law required that well pumping be regulated according to the priority system but with the important modification that junior diversions not be curtailed unless they cause material injury to senior water rights. A number of provisions such as alternate points of diversion, plans for augmentation, and substituted supplies facilitated continued use of existing wells.

This paper examines the experience of three organizations of well pumpers in the South Platte Valley in integrating their tributary groundwater use into the existing priority system. The Groundwater Appropriators of the South Platte (GASP), which includes about 3000 wells, operates under a legal provision allowing wells to pump so long as adequate replacement water is provided. This program is supervised by the State Engineer under the substitute supply provision and involves annual review

and approval. GASP has been making water available to the Division One Engineer equalling about 20 percent of the water pumped from its wells. This water is released to the stream at times and locations determined necessary by the division engineer to prevent injury to senior surface rights.

The Fort Morgan Reservoir and Irrigation Company has obtained a water court-approved plan for augmentation protecting the pumping of 90 wells on lands it serves. This approach requires a detailed analysis of the depletions to the stream caused by the wells, and a demonstration that the replacement scheme will fully offset those depletions both in quantity and in time. Water for replacement is provided primarily through a recharge program.

The Groundwater Management Subdistrict of the Central Colorado Water Conservancy District originally had sought a single plan for augmentation covering 870 wells in its area. Difficulties in developing a replacement plan for all these wells has caused the Subdistrict to reorient its approach.

Colorado's success on integrating tributary groundwater use into the priority system is demonstrated by the fact that pumping from these wells has never had to be administratively curtailed. This success has resulted from a combination of flexible legal requirements, flexible administration by the State Engineer's Office, and cooperative efforts by well pumpers to meet the legal requirements. Now, nearly 20 years after the original legal provisions were enacted, it is time to move the next step toward clarifying the rules applying to tributary

groundwater development. Requirements applying to pre-1969 Act wells should be distinguished from those applying to post-1969 Act wells. Injury to senior rights should include a consideration of the efficiency of that senior's water use. Efforts to increase usable supplies through conjunctive management should be encouraged.

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I. INTRODUCTION

On June 24, 1966, the division engineer responsible for the Arkansas River basin informed Roger Fellhauer that he would have to cease pumping from the well which he had been using to irrigate about 150 acres of land every irrigation season since 1935 because of alleged injury to senior surface rights. At that moment the inevitable conflict between surface irrigators and irrigators drawing their water from the alluvial aquifer underlying their lands (tributary groundwater) was joined. Since that time Colorado has made real progress in integrating groundwater development with surface water diversions.

This report traces the evolution of that progress and looks specifically at efforts in the South Platte basin to protect existing tributary groundwater development and allow additional development. It begins with a look at groundwater development in the basin and a brief discussion of the relationship between surface and groundwater. Then the legal framework applying to groundwater development is presented. The experience with integrating ground and surface water in the South Platte basin is considered through case studies. Finally some suggestions for further improvements are provided.

II. DEVELOPMENT OF TRIBUTARY GROUNDWATER IN THE SOUTH PLATTE BASIN

The South Platte River drains the most populous and most agriculturally productive region of Colorado. The river and its major tributaries head in the high mountains of the Front Range of Colorado and drain northeast into the high plains. Intensive

use of this modest river during the past 120 years has radically altered its flow patterns. Native water supplies, largely from high mountain snowmelt, are about 1.4 million acre-feet in an average year. Historically, surface water flows reaching into the plains area peaked with the snowmelt, declining thereafter so that by late summer the riverbed often was completely dry--especially at greater distances from the mountains. Annual precipitation in this region of Colorado is very limited--about 10 to 14 inches per year.

Much of the South Platte River, especially that downstream from Denver, is underlain by permeable material such as sand and gravel long ago deposited in channels carved in bedrock. Over time, portions of this alluvial fill became permeated by seepage from surface flows. Substantial additional areas of alluvial fill underlying land adjacent to surface streams have become saturated with water as a consequence of seepage from irrigation water spread over the surface year after year. Eventually the water table in this alluvial aquifer became higher than the river bed. The resulting return flows to the river brought about year-round surface flows. The alluvium in the reach of interest (downstream from about Henderson, Colorado) (shown in Figure 1) varies in width from about one mile to over ten miles. The aquifer in this reach is estimated to contain as much as eight million acre-feet of water.¹

¹ Woodward-Clyde Consultants, **South Platte River Basin Assessment Report 27** (Aug. 1982) (hereinafter South Platte Study).

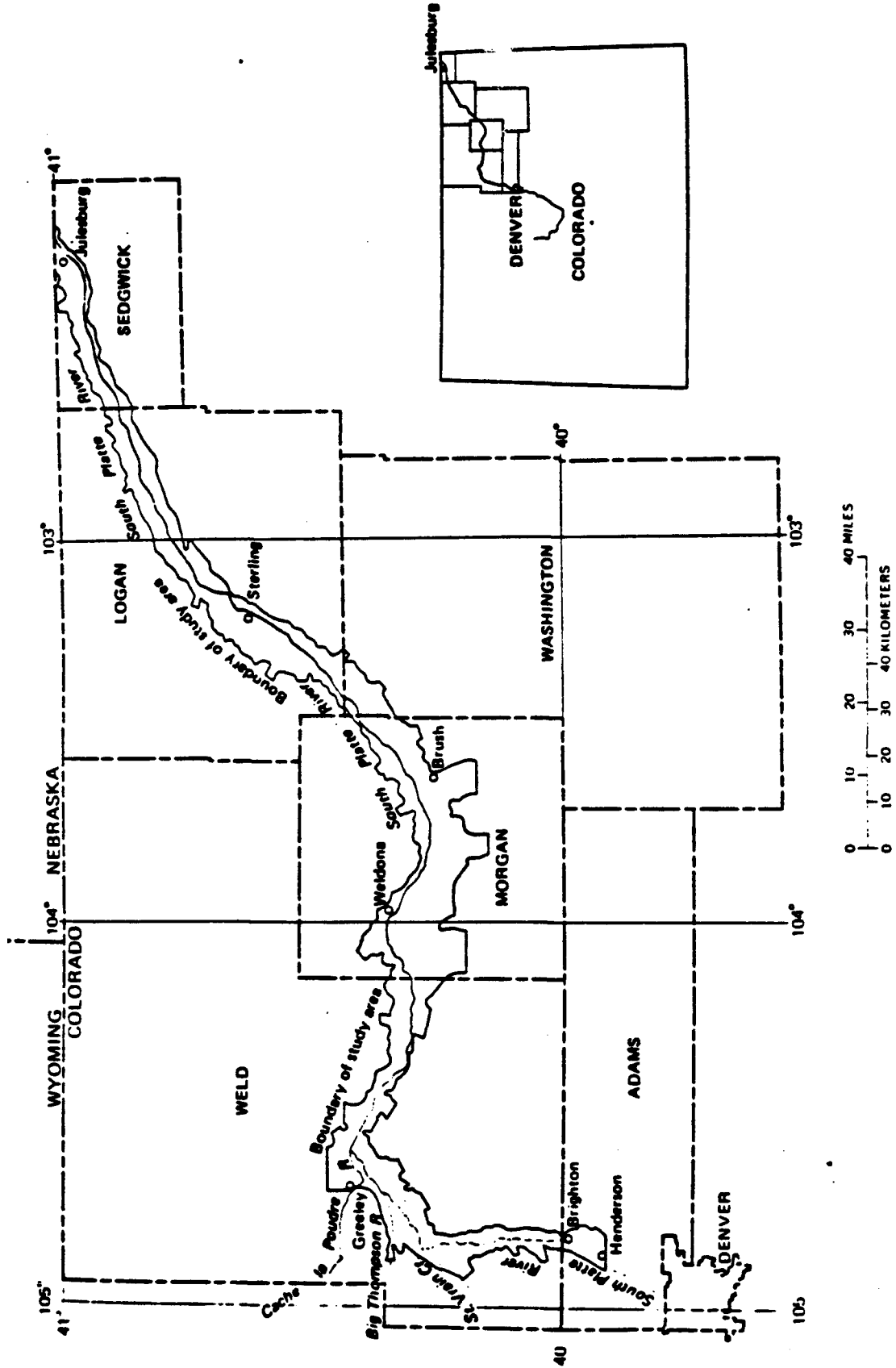


Figure 1 Map of Groundwater Study Area of the South Platte River in Colorado.

Source: Colorado Water Resources Circular No. 28, U.S. Geological Survey and Colorado Water Conservation Board, 1975, p.3.

As early as the 1890s farmers began to draw water from this underground source to supplement their surface diversions.² As shown in Figure 2, the number of wells increased gradually at first, reaching about 250 by 1933, then grew rapidly to 3,200 in 1970.³ Major bursts of growth occurred in the 1930s and 1950s as a result of periods of drought. Improvements in well technology and the increased availability of low cost electricity supported the growing use of wells during this period. The development of this groundwater proceeded without control until the mid 1960s. Of the 1.4 million acre-feet of water estimated to have been diverted for irrigation as an annual average between 1947 and 1970, groundwater supplied an estimated 420,000 acre-feet or about 30 percent of the total.⁴

As an alluvial well is pumped, the water table surrounding the well is gradually lowered, creating a cone of depression. Over time this cone reaches the stream itself and depletes the stream flow, either by reducing the groundwater flow (baseflow)

² Hurr, Effects of Water-Management Practices on the Flow of the South Platte River, Colorado in Science Council of Japan and International Ass'n of Hydrological Science, International Symposium on Hydrologic Characteristics of River Basins 613 (December 1975) (held in Tokyo, Japan) (hereinafter Hurr).

³ Id.

⁴ South Platte Study, supra note 1, at 41. Bredehoeft and Young point out that the amount of installed well capacity in the South Platte Valley in 1970 substantially exceeded that necessary to "maximize expected net benefits" from agriculture. They conclude that this "overcapacity" is a form of insurance which farmers determined to be worthwhile to assure a dependable water supply. Bredehoeft & Young, Conjunctive Use of Groundwater and Surface Water for Irrigated Agriculture: Risk Aversion, 19 Water Resources Res. 1111, 1118 (1983).

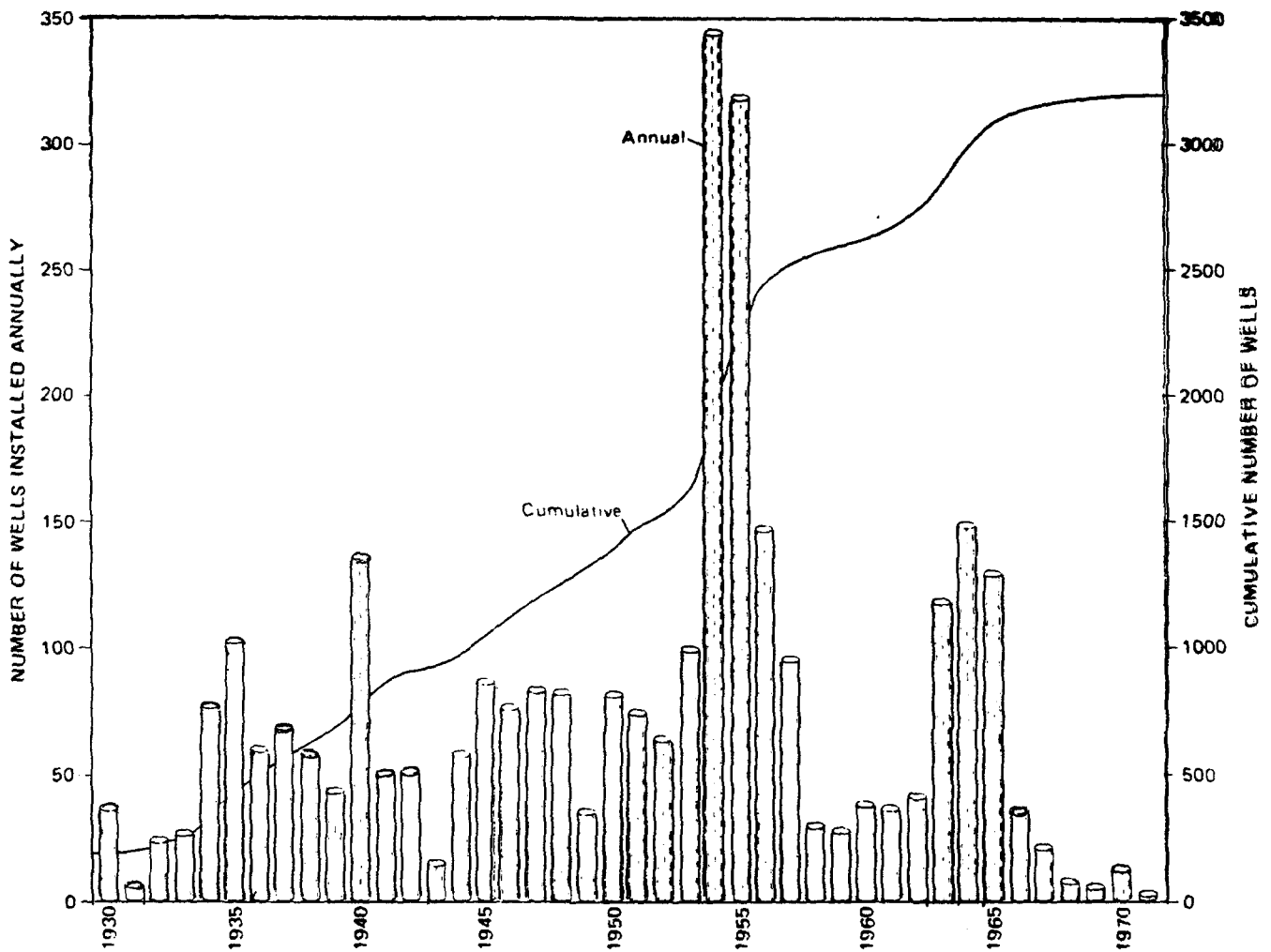


Figure 2. Annual Installation and Cumulative Total of Large-Capacity Irrigation Wells in the South Platte Valley

Source: Hurr, Schneider & Minges, Hydrology of the South Platte River Valley, Northeastern Colorado

Colorado Water Resources Circular No. 28 (1975).

to the stream or by inducing movement of stream water into the aquifer. As pumping continues the drawdown near the stream increases, causing ever greater depletions; when pumping ceases the water table gradually recovers, reducing depletions.⁵

⁵ Mathematical expressions have been developed to quantify these effects. Jenkins, Techniques for Computing Rate and Volume of Stream Depletions by Wells, 6 Groundwater 37 (1968). Unfortunately, equations are complex, and exact solutions were either very tedious or impossible. As a result, simplifying assumptions and graphical solutions were proposed and found to be rather effective in analyzing the interactions between the alluvial aquifer and streams.

One of the graphical solution methods widely used in Colorado today is the "stream depletion factor" (sdf). The sdf describes "the time from the beginning of steady pumping within which the volume of stream depletion is 28 percent of the volume pumped." Id. at 38. The sdf incorporates the aquifer properties of transmissibility and specific yield and the distance between the well and the stream into one parameter. Thus a well with 100 day sdf will have caused stream depletions of 28 percent of the volume of water pumped from the well during 100 days of pumping; and the rate of depletion after 100 days will be 48 percent, i.e., nearly half of the water pumped in any time period will be coming from the stream. Contour maps displaying this relationship can be developed with computer models and aquifer tests which will indicate the effects on stream flows of wells in given locations.

Computer models now exist to solve the complex equations and allow exact solutions. These models can simulate the complex interactions between the surface and subsurface resources and predict how the aquifer and stream will respond to varying stream inflows, diversions, and groundwater use anywhere within the modeled area. See e.g., Morel-Seytoux, Illangeskare, Bittinger & Evans, Potential Use of a Stream-Aquifer Model for Management of a River Basin: Case of the South Platte River in Colorado, 13 Water Science and Technology 175 (1981). The model described in this paper will be used by the division engineer responsible for administration of the South Platte River.

At this point, a major limitation on the use of these models is the difficulty in acquiring accurate data regarding the aquifer and water usage within the system. As such models are further developed and tested, they could help lead the way to more integrated management of the water resource. Grigg, Voluntary Approaches to Basinwide Water Management, in Tradition, Innovation, and Conflict: Perspectives in Colorado Water Law 209 (L. MacDonnell ed. 1987).

The growth in groundwater withdrawals caused a reduction in the annual groundwater discharges to the South Platte, declining from about 800,000 acre-feet in 1947 to about 550,000 acre-feet in 1970.⁶ The expected corresponding reduction in surface flows did not appear, however, apparently because of concurrent increases in transmountain diversions adding new water to the basin and because of decreases in surface diversions from the river.⁷ In the late 1950s the Colorado-Big Thompson Project began adding over 200,000 acre-feet of water per year into the system. In addition, direct diversions from the river decreased about 130,000 acre-feet on an annual basis from 1947 to 1970.⁸

Although overall surface flows were not substantially reduced by groundwater development, problems were developing in certain areas--especially in smaller tributaries to the South Platte in which irrigation had become almost completely dependent on the use of wells.⁹ Moreover, it was widely recognized that groundwater development was reducing discharges to the river, thereby affecting surface flows. A similar pattern of rapid development of groundwater in the Arkansas also was underway.¹⁰

⁶ Hurr, supra note 2, at 613.

⁷ Id.

⁸ Id. at 614.

⁹ Bittinger, Colorado's Ground-Water Problems--Ground Water in Colorado, Colo. St. U. Experiment Station Bull. 504-5 at 21 (1967).

¹⁰ In the Arkansas River valley there were an estimated 40 irrigation wells in 1940 pumping about 2,500 acre-feet of water. By 1972 the number of wells had increased to 1,477 and annual

The need for legislative attention to this issue was obvious.

III. THE LEGAL BACKGROUND

The prior appropriation doctrine developed to govern the allocation of surface water resources in the West. It is a priority system in which senior rights must be fully satisfied before any junior rights can be used. The water right is established through the appropriation of water--that is, by a diversion of water and the application of that water to a beneficial use. Reliable surface flows of water in rivers like the South Platte in Colorado were fully appropriated before the turn of the century.

The development of groundwater occurred slowly, accelerating with the availability of low cost energy which made the cost of pumping the water economically attractive and with the improvement in drilling and pumping technologies. In Colorado there was essentially no control of this development. While the appropriation of surface water was first subjected to legal control in 1879, no attempt was made to regulate groundwater development until the 1950s. Colorado courts long had held that groundwater "tributary" to a surface stream is governed by the doctrine of prior appropriation.¹¹ However, relatively few wells had ever

pumping had grown to about 208,000 acre-feet. Office of the State Engineer, State of Colorado, **Stream Depletion by Wells in the Arkansas River Basin - Colorado** (Mar. 1975), tables 6, 7 at 19, 22 (hereinafter *Arkansas Stream Depletions*).

¹¹ This general principle was recognized by a Colorado court as early as 1893. *McClellan v. Hurdle*, 3 Colo. Ct. App. 430, 33 P. 280 (1893). It was further developed in the context of return flows in the case of *Comstock v. Ramsay*, 55 Colo. 244,

been adjudicated. Thus, although wells drawing water from underground sources tributary to surface flows were subject to the priority system very few actually operated under a decreed right.

Legislation enacted in 1957 required that permits for new wells be obtained from the state engineer.¹² However, the legislation also stated that: "The priority date of a ground water appropriation shall not be postponed to a time later than its true date of initiation by reason of failure to adjudicate such right in a surface water adjudication."¹³ In 1965 the state engineer took the position that he had no authority to regulate well pumping in order to protect surface rights.¹⁴ The legislature responded in that same year with a bill directing the state engineer to "execute and administer the laws of the state relative to the distribution of the surface waters of the state including the underground water tributary thereto in accordance

133 P. 1107 (1913). In *Nevius v. Smith*, 86 Colo. 178, 279 P. 44 (1929), the Colorado Supreme Court held that "seepage and percolation belong to the river ...", not the overlying landowner. *Id.* at 181, 279 P. at 45. This general principle was strongly reaffirmed by the supreme court in *Safronek v. Lemon*, 123 Colo. 330, 228 P.2d 975 (1951).

¹² Ground Water Law of 1957, Colo. Sess. Laws, ch. 289, Section 5 (codified at **Colo. Rev. Stat.** Section 148-18-2(1963)).

¹³ **Colo. Rev. Stat.** Section 148-18-9 (1963), repealed by Colo. Rev. Stat. Section 37-90-109(1973) (effective May 17, 1965).

¹⁴ See Hillhouse, Integrating Ground and Surface Water Use in an Appropriation State, 20 **Rocky Mtn. Min. L. Inst.** 691, 697 (1975) (hereinafter Hillhouse.)

with the right of priority of appropriation. . . ."15

Pursuant to this directive the state engineer ordered 39 wells in the Arkansas River Valley, including Roger Fellhauer's, to cease operations because of adverse effects on senior surface diverters. In Fellhauer v. People,¹⁶ the Colorado Supreme Court upheld the authority of the state engineer under the 1965 Act to regulate such wells in order to protect vested senior rights from material injury, but found this particular exercise of that authority to be unsupported by any rational plan and so a violation of equal protection. The court proceeded to spell out three requirements for any well regulation scheme: (1) that the regulation be done pursuant to a plan which is implemented through rules and regulations; (2) that the regulation must, in fact, result in a "reasonable lessening of material injury to senior rights"; and (3) that an effort should be made to determine if conditions could be placed on well operation in a manner that would permit continued use of groundwater without material injury to senior users.¹⁷ By way of emphasizing its interest in encouraging the use of groundwater the court then stated:

It is implicit in these [Colorado] constitutional provisions that, along with vested rights, there shall be maximum utilization of the water of this state. As the administration of water approaches its second century the curtain is opening upon the new drama of maximum utilization and how constitutionally that

¹⁵ Act of May 3, 1965, 1965 Colo. Sess. Laws, ch. 318, Section 1.

¹⁶ 167 Colo. 320, 447 P.2d 986 (1968).

¹⁷ Id. at 334, 447 P.2d at 993.

doctrine can be integrated into the law of vested rights.¹⁸

At this point it was settled in Colorado that (1) tributary groundwater was subject to the prior appropriation system, that (2) its use was to be administered in conformity with the priority system, but that (3) wells were to be regulated only if their operation caused material injury to senior rights.¹⁹ The need for a better understanding of the problem led the legislature to fund several engineering studies to examine both the South Platte and Arkansas basins.²⁰

Strict application of the priority system in accordance with the 1965 act would have required large numbers of wells with junior priorities to be shut down. The agricultural economy in the South Platte and Arkansas valleys had by this time become significantly dependent on well irrigation. It was important not to curtail pumping unnecessarily, but it was also important to protect senior water rights. Clearly, integration of the use of these closely related resources was necessary.

In 1969 the Colorado Legislature passed the Water Right

¹⁸ Id. at 336, 447 P.2d at 994.

¹⁹ In addition, the Fellhauer case clarified that it was not necessary to demonstrate that a specific well's operation injures a specific senior surface right, only that a "reasonable lessening of material injury to senior rights must be accomplished by the regulation of the wells." Id. at 334, 447 P.2d at 993.

²⁰ See Hillhouse, supra note 14, at 700 n.25.

Determination and Administration Act²¹ which contained a number of provisions aimed specifically at facilitating the integration of groundwater and surface water. The 1969 Act begins with a legislative declaration stating that "it is the policy of this state to integrate the appropriation, use, and administration of underground water tributary to a stream with the use of surface water in such a way as to maximize the beneficial use of all of the waters of this state."²² Water rights are still to be administered in accordance with the priority system but with the important modification that curtailments in junior diversions are to be made only when there is "material injury" to senior water rights.²³

A separate section specifically addresses groundwater diversions, stating that such diversions "shall not be curtailed nor required to replace water withdrawn, for the benefit of surface right priorities, even though such surface right priorities be senior in priority date, when, assuming the absence of ground water withdrawal by junior priorities, water would not have been available for diversion by such surface right under the

²¹ **Colo. Rev. Stat.** Sections 37-92-101 to 37-97-602 (1973 & Supp. 1987).

²² **Colo. Rev. Stat.** Section 37-92-102(1)(a) (Supp. 1987).

²³ **Colo. Rev. Stat.** Section 37-92-502(2) (1973 & Supp. 1987). This provision also states that "[t]he materiality of injury depends on all factors which will determine in each case the amount of water such discontinuance will make available to such senior priorities at the time and place of their need." Id.

priority system."²⁴ This provision recognizes the fact that there is a time lag between well water withdrawals and depletive effects on surface flows. Shutting down wells may not benefit surface right holders in a timely manner. Thus wells are only to be regulated in circumstances where actual injury to senior surface rights will be avoided.

The 1969 Act also sought to encourage well owners to adjudicate their rights, thereby bringing these rights into the administrative system. It did this by providing a three-year period during which previously undecreed well rights could be adjudicated with a priority date as of the date of actual appropriation of the water.²⁵

Many well owners also held more senior surface rights. To encourage integration of these rights the 1969 Act authorized the state engineer to permit the use of wells as an alternate point of diversion for the surface water right.²⁶ The state engineer and the courts were directed to use "the widest possible discretion to permit [this] use of wells. . . ."²⁷

Finally the 1969 Act provided a more general vehicle for facilitating integration called a "plan for augmentation." Defined as a "detailed program to increase the supply of water

²⁴ Colo. Rev. Stat. Section 37-92-501(1) (1973).

²⁵ Colo. Rev. Stat. Section 37-92-306 (1973).

²⁶ Colo. Rev. Stat. Sections 37-92-102(2)(C) and -301(3) (1973 & Supp. 1987).

²⁷ Colo. Rev. Stat. Section 37-92-301(3)(d) (1973).

available for beneficial use,"²⁸ it provides a highly flexible tool enabling new uses of water without strict regard for the priority system so long as existing rights are not injuriously affected.²⁹ The statute cites numerous ways this may be accomplished, including "the development of new or alternate means or points of diversion, by a pooling of water resources, by water exchange projects, by providing substitute supplies of water, by the development of new sources of water or by any other appropriate means."³⁰ Such augmentation plans must be approved by the water court.³¹

In a companion bill passed the same session the legislature authorized water users to provide a "substituted supply of water" to senior appropriators to satisfy their priorities.³² So long as it is of a "quality and continuity to meet the requirements of use to which the senior appropriation has normally been put,"³³ the senior appropriator must accept this substituted supply.³⁴ Approval of the state engineer but not the water court is required for such programs.³⁵ Voluntary arrangements of this

²⁸ **Colo. Rev. Stat.** Section 37-92-103(9) (1973).

²⁹ See MacDonnell, Plans for Augmentation: A Summary, in Tradition, Innovation, and Conflict: Perspectives on Colorado Water Law 137 (1987).

³⁰ **Colo. Rev. Stat.** Section 37-92-103(9) (1973).

³¹ **Colo. Rev. Stat.** Section 37-92-301(2) (Supp. 1987).

³² **Colo. Rev. Stat.** Section 37-80-120(2) (1973).

³³ **Colo. Rev. Stat.** Section 37-80-120(3) (1973).

³⁴ See, Colo. Rev. Stat. Section 37-80-120(2) (1973).

³⁵ See, Colo. Rev. Stat. Section 37-80-120(1) (1973).

sort had existed previously in Colorado. Now, however, such practices do not require the approval of senior right holders.³⁶

In the meantime the state engineer continued to try to develop regulations governing tributary groundwater use. Regulations issued for the 1969 irrigation season were upheld by the Colorado Supreme Court against an attack by well owners in the South Platte Basin.³⁷ Nevertheless, the state engineer decided to abandon this approach. Draft rules were issued in 1972 and subsequently were approved by the water court as amended in 1974.³⁸ The approach taken in these rules was to phase out all groundwater pumping over a three-year period, except from wells operating under a decreed plan for augmentation or otherwise able to operate without impairing senior water rights.³⁹

³⁶ See, Colo. Rev. Stat. Section 37-80-120(2) (1973).

³⁷ *Kuiper v. Well Owners Conservation Assn.*, 176 Colo. 119, 490 P.2d 268 (1971). These regulations are discussed in greater detail infra at text accompanying notes 100-101.

³⁸ In the Matter of the Rules and Regulations Governing the Use, Control, and Protection of Surface and Ground Water Rights Located in the South Platte River and Its Tributaries (March 15, 1974) (hereinafter South Platte Rules and Regulations).

³⁹ Id. Final rules were adopted for the Arkansas River Basin in 1973 which limited well pumping to no more than three days per week. In 1974 the state engineer proposed an amendment phasing out well pumping over three years in the same manner as with the South Platte. The Colorado Supreme Court disallowed this amendment because it was not based on adequate proof that it would make additional water available for senior priorities. In re Arkansas River, 195 Colo. 557, 581 P.2d 293 (1978). No new rules have been issued for this area.

IV. CONJUNCTIVE USE ACTIVITIES IN THE SOUTH PLATTE VALLEY:

THREE CASE STUDIES⁴⁰

As a consequence of the legislative decision that rights to tributary groundwater be governed by the general priority system, groundwater users in the South Platte and Arkansas valleys faced the possibility that their junior wells would have to shut down. The case studies which follow illustrate approaches taken to integrate tributary groundwater uses in the South Platte with the general appropriative water rights system.

A. Groundwater Appropriators of the South Platte River

In 1972 a group of well owners in the South Platte Valley, with the active encouragement of the state engineer, established an association "to provide remedy to any legitimately determined injury which may result to prior vested rights" as a result of pumping from its members' wells.⁴¹ In its 1972 letter of intent to the state engineer, this nonprofit corporation, called Ground Water Appropriators of the South Platte (GASP), described its efforts already underway to provide replacement water through such means as exchanges and augmentation of supply to offset any such injury to prior vested rights. To avoid curtailment of its members' well pumping, GASP proposed to make replacement

⁴⁰ Most of the case study material was collected by Stephen Miller, J.D., 1987, University of Colorado School of Law. His valuable research assistance is gratefully acknowledged. Also, the valuable cooperation of Bart Woodard and Jack Odor of GASP and Thomas Cech and Karen Rudeen of the Central Colorado Water Conservancy District greatly facilitated our research.

⁴¹ Letter from Ground Water Appropriators of the South Platte to State Engineer Clarence Kuiper (April 5, 1972).

water available to the state engineer. It promised to provide a list of its members to the state engineer, as well as an estimate of the amount of groundwater its members would be withdrawing from the tributary aquifer in the coming season and an accounting of the amount actually withdrawn the preceding year. The state engineer warmly greeted the formation of GASP. His letter of reply indicates that his primary concern was that the GASP projects be able to supply replacement water that might be needed "during a time of call" to prevent injury to senior rights.⁴²

GASP now has about 1,400 members operating more than 3,000 wells within the South Platte River Basin--all the way from Fairplay to Julesburg. Most of these wells supply irrigation water, although there are also member wells supplying water for municipal and industrial uses.⁴³ The vast bulk of its member wells are located in the South Platte basin below Greeley.

GASP members pay annual fees based on the amount of water

⁴² Letter from State Engineer Clarence Kuiper to GASP (April 11, 1972). According to the minutes of a GASP Board of Directors meeting on June 6, 1972, State Engineer Kuiper stated that the replacement water to be made available by GASP should equal 18 percent of the amount pumped from member wells.

⁴³ GASP uses four types of contracts. Class 'A' contracts apply generally to pre-1969 wells adjudicated prior to December 31, 1972 and located in areas where replacement water is available. In 1981, Class 'A' contracts covered 2907 out of a total of 3040 wells in GASP. Class 'B' contracts apply to new wells which must provide 100 percent replacement water. Class 'C' contracts apply to existing wells which, for some reason, do not meet the requirements for Class 'A' contracts. Such wells must provide 5 percent replacement water. Class 'D' contracts apply to wells seeking membership only for one year. Such wells are to be covered by the replacement water supplied by GASP.

that the well owner expects to pump each year.⁴⁴ For each 100 acre-feet of water pumped, or fraction thereof, one unit of membership must be purchased. The per unit fee is set by the board of directors each year. The original unit fee in 1972 was \$15; by 1986 it had increased to \$90. To join GASP as a new member a special fee representing the cumulative unit charges for each year since 1972 must be paid. In subsequent years the unit charge is the same as for other members.⁴⁵ Membership payments are used to purchase and lease the replacement water needed to offset any injury arising from the pumping of member wells.

The GASP program operates under authority of the Colorado substitute supply provision.⁴⁶ This provision permits a junior appropriator to use water traditionally taken by a senior

⁴⁴ In 1981 the number of wells of each type and their estimated total pumping was as follows:

	<u>No. of Wells</u>	<u>Estimated Pumping (AC-FT)</u>
Commercial	134	9,700
Industrial	15	2,200
Municipal	155	18,800
Irrigation	<u>2,736</u>	<u>369,974</u>
Total	3,040	400,674

Letter from Donald Brazelton, Colorado Division of Water Resources to Earl Phipps, Northern Colorado Water Conservancy District (May 27, 1981).

⁴⁵ Thus in 1986 the fee for new members was \$720 per unit. This policy is intended to recover indirect benefits GASP has provided to nonmember pumpers since it started providing replacement water to the basin in 1972.

⁴⁶ **Colo. Rev. Stat.** Section 37-80-120(2) (1973).

appropriator so long as adequate replacement water is provided. Only the approval of the state engineer is required. However, unlike a court-decreed plan for augmentation, substitute supply plans must be reviewed and approved annually.

The GASP approach has been characterized as "call management."⁴⁷ GASP obtains rights to "replacement" water which it makes available to the division engineer and the water commissioners to use as they deem necessary. There is no clear policy governing the amount of replacement water that is needed. According to the 1974 Amended Rules and Regulations for the South Platte issued by the state engineer, the amount of replacement water an augmentation plan should make available to the division engineer is to equal "5 percent of the projected annual volume of a ground water diversion. . . ."⁴⁸ The Rules also state that if such replacement is shown not to be adequate then actual stream depletions caused by a well are to be calculated using the "Glover method" or some approved variant thereof.⁴⁹

It is evident that this so-called "five percent rule" has never been the basis for GASP's plan of operation. Nor does

⁴⁷ Rudeen, Ground Water Management in the South Platte Basin of Colorado, Proceedings of 1987 Regional Meetings on Water Management, U.S. Committee on Irrigation and Drainage 313 (1988).

⁴⁸ South Platte Rules and Regulations, supra note 38, Rule 3(1).

⁴⁹ South Platte Rules and Regulations, supra note 38, Rule 4(1). See also, Glover, The Pumped Well Technical Bulletin 100, Colorado State University Experiment Station, Fort Collins, September 1968.

it appear that there has been any complete analysis of the stream depletions caused by the well operations of GASP members.⁵⁰ Instead, emphasis has been placed on developing a supply of replacement water adequate enough and strategically situated so as to satisfy senior appropriators. The measure of need is not some calculation of the stream depletions but the existence of a valid senior call on the river at a time when historically there would have been adequate surface flows.⁵¹

As shown in Figure 3, the total supply of replacement water made available by GASP to the division engineer has increased from about 12,000 acre-feet in 1973 to more than 50,000 acre-feet in 1986.⁵² A unique feature of this replacement supply is that more than half of it is itself provided by wells. Thus ground-water from new wells is used to offset depletions caused by other

⁵⁰ No basis has been found for the 18 percent replacement water figure quoted by State Engineer Kuiper. See supra note 42. Nor did we find this figure cited anywhere other than in the GASP Board minutes.

⁵¹ In approving the South Platte Amended Rules and Regulations the Water Court for Division One stated:

To avoid a deprivation of water to some senior appropriator, ground water appropriator, shall make replacement water available for delivery as reasonably required by the Division Engineer, in a quantity, during a period, and at a place so as to prevent a deprivation of water to a senior appropriator caused by such ground water diversion. The Division Engineer shall use valid senior water calls as the normal criteria for requiring such replacements.

In re South Platte River, Case No. W-7209, (Water Division No. 1, Colorado, March 15, 1974) reprinted in Radosevich, 1 Colo. Water Laws IV-8(23) (1979) (hereinafter Radosevich).

⁵² Jack Odor Engineering Services, Feb. 25, 1987.

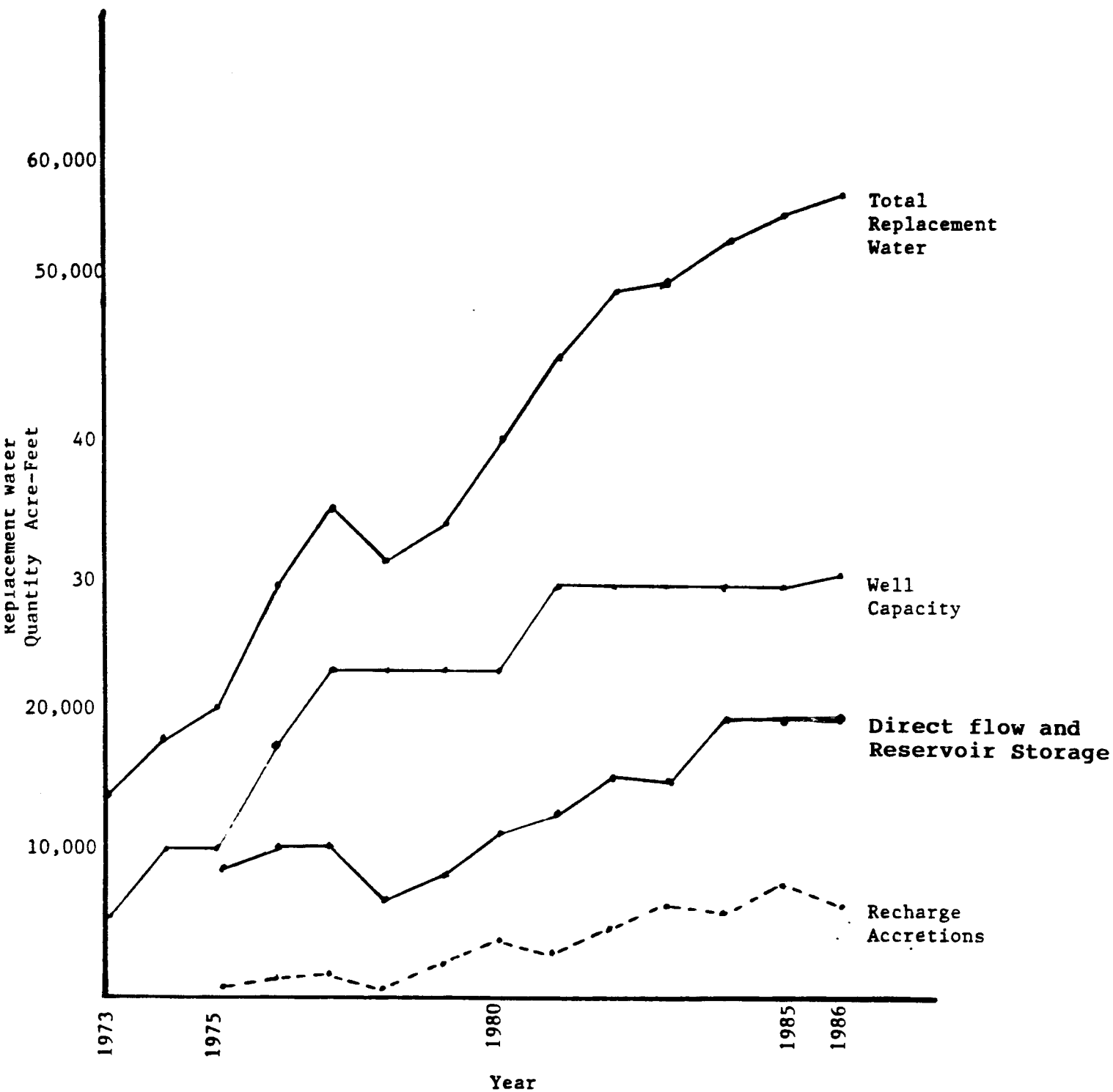


Figure 3. GASP Replacement Water Available Total by Source

Source: Jack Odor Engineering Service
2/25/87

wells.

GASP wells are used to provide replacement water directly to senior surface water rights which, because of their seniority, rate and volume of diversion, and location, historically have placed a call on the river in low flow periods. In 1973 GASP installed wells directly adjacent to the Sterling Number 1 ditch.⁵³ This ditch, with its headgate located several miles upstream of Sterling, had an 1873 priority for 114 cubic feet per second and historical diversions of 25,000 acre-feet per year. Calls placed by this right often extended many miles up the river forcing numerous junior appropriators to cease diversions until it was satisfied. GASP wells now can supply more than 50 cubic feet per second of groundwater directly into the ditch thereby helping to keep the call off the river.⁵⁴ Subsequently GASP has

⁵³ In 1972 when GASP was forming, the Sterling Number 1 had placed a call on the river that required a number of upstream juniors to cease diversions, including the Weldon Valley system located upstream of Fort Morgan with its 1881 priority right to 165 cubic feet per second. Weldon Valley resisted the order to stop diverting and demanded that the state engineer instead shut down the more junior irrigation wells. The Division One water court upheld the state engineer's request for an injunction to require Weldon Valley to close its headgate but also directed the state engineer to regulate well pumping under his proposed regulations that limited such pumping to three days a week. This explosive situation was defused by the installation of wells able to provide water sufficient to keep this call off the river.

⁵⁴ Control of the wells is exercised by the division engineer and the water commissioner. GASP paid for the installation of the wells and also pays for their operation and maintenance. Apparently, because of their location, most of the depletions resulting from their operation reach the stream after the irrigation season. So far no injury to other downstream appropriators appears to have resulted from the operation of these wells.

installed wells at several other key locations where such a physical solution appeared possible.⁵⁵

Reservoir storage and direct flow rights comprise the other major source of replacement water provided by GASP. Most of this water is leased on an annual basis, but GASP does own some reservoir shares as well as surface rights.⁵⁶ Reservoir rights provide a highly flexible supply of replacement water and generally are quite reliable. However, the limited storage space along the South Platte between Henderson and Julesburg makes it difficult to have the replacement water near the point of injury.⁵⁷

The final source of replacement water relied on by GASP is obtained through recharge projects. Recharge projects generally involve the diversion of water into a specially prepared area with high infiltration rates so that the maximum possible amount

⁵⁵ For an excellent discussion of the "physical solution" concept, see Dunning, The Physical Solution in Western Water Law, 57 U. Colo. L. Rev. 445 (1986).

⁵⁶ GASP's 1987 plan of operation filed with the state engineer indicated total reservoir rights of about 9,000 acre-feet, roughly 14 percent of which (about 1,250 acre-feet) was owned by GASP. Direct flow rights (with some reservoir support) totalled about 10,800 acre-feet, 24 percent of which (about 2,600 acre-feet) was owned by GASP.

⁵⁷ Another limitation on the use of storage water for replacement is that the state engineer now requires that two acre-feet of such water be released for every one acre-foot of replacement credit sought. This ruling apparently is based on court decisions holding that a change in use of storage water must be limited by the historical consumptive use of the water. See Southeastern Colo. Water Conservancy Dist. v. Fort Lyon Canal Company, 720 P. 2d 133 (Colo. 1986). Reservoir water previously used for irrigation is assumed to have been 50 percent consumed.

of water is stored in the underlying aquifer. GASP does not operate its own recharge projects. Instead it purchases excess credits for accretions supplied to the river by the recharge projects of others.⁵⁸ This method of augmentation is especially attractive because it usually involves taking water that would not otherwise be diverted (for example, during periods of low demand and high supply) and storing it underground so that it is available at times of need.

Information provided by GASP indicates that it replaced (or had the capacity to replace) about 20 percent of the total quantity of well water pumped by its members in 1985, compared to about 13.5 percent in 1981.⁵⁹ This change is due both to an increase in available replacement water and a decrease in the amount of groundwater pumped.

The modest cost to GASP members (essentially 90 cents per acre-foot of groundwater pumped) has been made possible in part by the informal way in which GASP operates. Only relatively recently has GASP been providing much of the data it promised to the state engineer in 1972. In addition to the amount of groundwater pumped during the preceding period, the amount of

⁵⁸ For a description of recharge activity in the South Platte basin generally and a discussion of the projects in which GASP is involved see Warner, Sunada, & Hartwell, Recharge as Augmentation in the South Platte River Basin, Colorado Water Resources Research Institute Completion Report No. 144 (Nov. 1986).

⁵⁹ Jack Odor Engineering Services, Feb. 25, 1987. Total groundwater pumped in 1981 was about 335,000 acre-feet while replacement water totalled about 45,500 acre-feet. In 1985 total water pumped was about 275,000 acre-feet while replacement supplies were 56,000 acre-feet.

acreage irrigated, and a projection of the amount of groundwater to be pumped during the next period the state engineer now wants GASP to provide detail regarding cropping patterns and other information to enable a more complete analysis of the effect of GASP members' groundwater pumping.

B. The Fort Morgan Plan for Augmentation

Rather than operate under the GASP umbrella some well owners in the South Platte Valley have opted to protect their well operations by means of a plan for augmentation. Such an approach places these appropriations directly and permanently within the state priority system. An example of this approach is provided by the plan for augmentation developed by the Fort Morgan Reservoir and Irrigation Company ("Fort Morgan") and approved by the Division One Water Court in 1985.⁶⁰

The Fort Morgan Reservoir and Irrigation Company is a mutual ditch company providing water to about 11,000 acres of farm lands in Morgan County, Colorado.⁶¹ Fort Morgan has a direct flow decree for 323 cubic feet per second with a priority date of October 18, 1882. In addition it owns 1,030 shares (of the 1,550 total) of the Jackson Lake Reservoir Company, a mutual company which owns and operates Jackson Lake Reservoir. The storage

⁶⁰ In re Fort Morgan Reservoir and Irrigation Company, No. W-2692 (Water Division No. 1, Colorado, April 22, 1985) (hereinafter Fort Morgan Decree).

⁶¹ The background information provided here comes from the engineering study performed by HRS Water Consultants, Inc., Fort Morgan Reservoir and Irrigation Company Plan for Augmentation, (January 1985) (hereinafter Fort Morgan Report).

capacity of this reservoir is about 30,000 acre-feet.

Members of the Fort Morgan Company also use wells as a part of their irrigation water supply. Most of these wells were adjudicated in 1974 but because of their junior status could not operate except under some kind of augmentation plan. Under a provision then available in the law these wells were permitted to operate under a "temporary" plan for augmentation.⁶² During this period Fort Morgan collected data on its total water demand to grow crops, its surface supply, and members' groundwater use. It also implemented its program for providing augmentation water. By 1985 Fort Morgan thought it had the data necessary to support its request for a final plan for augmentation.

The court decree approving this augmentation plan is viewed by many as providing a model for bringing irrigation wells into the priority system. There are two critical aspects to this plan: calculation of depletions to the stream attributable to the pumping of Fort Morgan member wells, and operation of the replacement scheme to offset those depletions. To calculate depletions, the analysis in support of the plan first calculated the average annual irrigation water requirement for the Fort

⁶² Temporary augmentation plans were authorized by a 1974 law, S.B. 7, 1974 Colo. Sess. Laws 440, ch. 111. The state engineer was given authority to approve such temporary plans pending final court action. This section was repealed in 1977 by S.B. 4, 1977 Colo. Sess. Laws 1702, ch.483, Section 6, codified at **Colo. Rev. Stat.** Section 37-92-305(8) (1973). See MacDonnell, Plans for Augmentation: A Summary, in **Tradition, Innovation, and Conflict: Perspectives on Colorado Water Law** 147 (L. MacDonnell ed. 1987).

Morgan lands between 1960 and 1980.⁶³ Using diversion records for direct flow and reservoir deliveries the annual surface water supply was then determined.⁶⁴ Groundwater use represented the difference between surface supplies and crop requirements.⁶⁵ The effect to the river from this pumping was calculated using the "stream depletion factor" value for each well. This factor indicates both the amount of loss to the stream from well pumping and the timing of that loss.⁶⁶

The Fort Morgan replacement plan is based primarily on a recharge program. Under this program, water is diverted from the South Platte under a 1972 priority and carried to several recharge locations.⁶⁷ Surface flows brought into these recharge areas are measured on a daily basis. Evaporation losses are calculated as well as any flows out of the recharge sites. The

⁶³ Crop records as well as acreage involved are maintained by Fort Morgan. The Blaney-Criddle method was utilized to calculate the water requirements for these crops. Fort Morgan Report, supra note 61, at 3.

⁶⁴ Surface supplies were further adjusted to account for water losses between the headgate at the river and application to the crop. Fort Morgan Report, supra note 61, at 4.

⁶⁵ Actual groundwater pumping appears to be nearly twice the consumptive use amount calculated. Pumping between 1977 and 1980 was reported to be 6,752 acre-feet per year; the calculated groundwater use for this period was 3,811 acre-feet per year. Fort Morgan Report, supra note 61, at 5.

⁶⁶ See the discussion of the stream depletion factor, supra note 5.

⁶⁷ Those sites include the Fort Morgan canal itself, a generally dry streambed known as Badger Creek, and several ponds. The total recharge capacity of these sites is estimated to be 13,000 acre-feet per year. Fort Morgan Report, supra note 61, at 5.

difference is considered to recharge the groundwater aquifer.

Accretions to the stream from these recharge efforts are then measured against depletions to the stream resulting from groundwater pumping.⁶⁸ The result is the "net stream effect." For the recharge program to fully offset the effects of well pumping, accretions must at least equal depletions to the stream at any time when a senior priority would be injured by the unavailability of that water.

The water court essentially adopted the analytical approach suggested by Fort Morgan. The decree requires the well owners to report crop and acreage information each year by May 1st. Fort Morgan then is to analyze the "net groundwater extractions" applicable to each well.⁶⁹ Also by May 1st, Fort Morgan is to "project the net effect on the South Platte River in the upcoming year resulting from prior and projected pumping and from prior recharge operations under Fort Morgan's system."⁷⁰ Monthly updates are required.

If the recharge accretions are inadequate to prevent material injury, Fort Morgan is committed to use supplies from

⁶⁸ The stream depletion factor also is used to analyze accretions to the stream.

⁶⁹ Two methods are provided. If actual well pumping is measured then the net extraction is to be based on 65 percent of the total amount pumped. If pumping is not measured then the groundwater use is to be calculated based on estimated crop requirements less estimated deliveries of surface water. Evaporation losses from sprinkler systems are assumed to be five percent of water use. Fort Morgan Decree, supra note 60, at 5.

⁷⁰ Id. at 6.

its Jackson Lake Reservoir or, if necessary, to bypass diversion of its direct flow rights.⁷¹ Recharge credits beyond that needed to offset depletions may be used by Fort Morgan for other purposes, or they may be sold. The decree provides for retained jurisdiction for five years to assure no injury to vested water rights. As stated in the decree:

This plan for Augmentation will allow the [Fort Morgan] wells ... to be pumped at times and in amounts which would not otherwise be permitted under Colorado law. The Plan for Augmentation, if operated and administered in accordance with the Decree entered herein, will prevent injury to vested water rights or decreed conditional water rights by replacing out of priority depletions resulting from the consumptive use of water diverted from the wells....⁷²

In summary, the Fort Morgan approach involves full replacement of well depletions to the stream, primarily by means of an off-irrigation season recharge program.

C. Central Colorado Water Conservancy District -- Groundwater Management Subdistrict

The Central Colorado Water Conservancy District (CCWCD) was formed in 1965 with the objective of helping provide water supplies to members within the district boundaries (see figure 4). The CCWCD encompasses the area along the South Platte River from Brighton to Fort Morgan and includes about 460,000 acres (720 square miles) in parts of Weld, Morgan, and Adams counties. In 1973 the Groundwater Management Subdistrict

⁷¹ Credit for releases of reservoir water is specifically limited to account for historic use constraints.

⁷² Fort Morgan Decree, supra note 60, at 3.

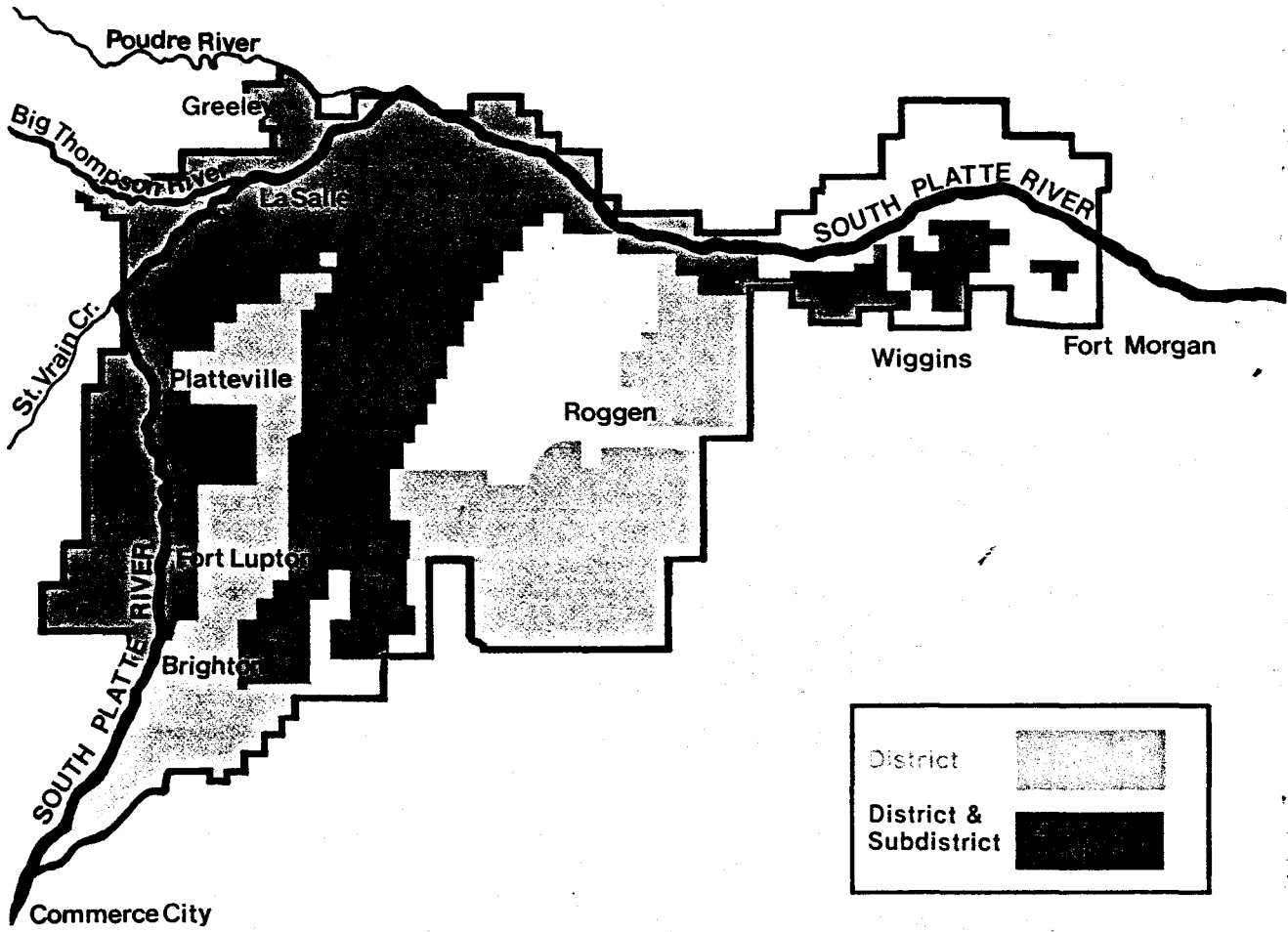


Figure 4. The Central Colorado Water Conservancy District/Groundwater Management Subdistrict

(Subdistrict) was established to help integrate existing ground-water pumping of the wells within its area into the water rights system. About 196,000 acres, a little over 42 percent of the CCWCD area, is included within the Subdistrict.

Initiated in the same year as GASP, the Subdistrict took a different approach to integrating groundwater development. Rather than operate on a year-to-year basis under the supervision of the state engineer, the Subdistrict decided to seek water court approval of a plan for augmentation. Under a statutory provision then in effect the state engineer gave the Subdistrict "temporary" approval pending the development of a permanent plan that could pass water court muster. As discussed in connection with the Fort Morgan plan for augmentation, this requires proof of ability to replace all depletions caused by the pumping from wells involved in the plan.⁷³

The Subdistrict has been operating under its temporary plan for augmentation on the basis of replacing five percent of the water pumped each year by member wells. This approach was authorized by the 1974 Rules and Regulations.⁷⁴ The number of wells involved in the Subdistrict plan has varied from year to year but the average has been about 870 between 1983 and 1987,

⁷³ See supra notes 69-72 and accompanying text.

⁷⁴ South Platte Rules and Regulations, supra note 38, Rule 3(1).

irrigating an average of about 62,000 acres.⁷⁵ The anticipated annual pumping from these wells averaged about 106,000 acre-feet. Replacement of five percent of this pumping meant providing about 5,280 acre-feet of water per year.

Table 1 shows the distribution of well pumping and depletions within the Subdistrict in 1986. About 60 percent occurs in the area along the South Platte River and Box Elder Creek from Platteville north to Kersey. Finding replacement water in this heavily used area of the South Platte has been difficult and expensive. Table 2 shows the availability and use of replacement water between 1981 and 1986. In contrast to GASP, which relies heavily on augmentation wells, the Subdistrict relies largely on surface water. Table 3 gives a detailed breakdown of the replacement water identified in the Subdistrict's 1987 plan. As shown, the Subdistrict itself owns about 864 acre-feet of water rights. It leased another 672 acre-feet from CCWCD, its parent organization, and it leased an additional 3,636 acre-feet from a variety of other sources. Municipal effluent represented most of this leased supply.

⁷⁵ Groundwater Management Subdistrict, Plan of Operation (1983-1987) (on file, Division One Engineer's Office, Greeley, Colorado).

TABLE 1
 CCWCD -- Groundwater Management Subdistrict
 1986 Distribution of Depletions

<u>River Reach (S. Platte)</u>	<u>Location</u>	<u>Well Pumping (acft)</u>	<u>Depletions 5% of Pumping</u>	<u>% of Total Depletions in each reach</u>
84,88	Littleton to Brighton (approx. 30 miles)	11,260	563	10.4%
85,82,77	Brighton to Platteville (approx. 20 miles)	8,150	408	7.5%
75,70	Platteville to LaSalle includes confluence with St. Vrain Creek (approx. 13 miles)	9,240	462	8.5%
62,57	LaSalle to Kuner includes confluence with Cache la Poudre (approx. 15 miles)	31,600	1,580	29.1%
54	Kuner to Bijou Headgate includes Box Elder Drainage (approx. 8 miles)	34,790	1,739	32%
51,48	Bijou to Weldon Valley Headgate (approx. 5 miles)	0	0	0
46,42	Weldon Valley to Narrows includes Kiowa Creek Drainage (approx. 15 miles)	13,620	681	12.5%
<hr/>				
TOTAL		108,660	5,433	100%

Source: CCWCD Master Plan 1987-1992

TABLE 2
CCWCD Subdistrict Replacement Water
Availability and Actual Releases
(in acre-feet)

Item	1981	1982	1983	1984	1985	1986
<hr/>						
Replacement Water Available in Plan	6400	6145	7568	6356	6811	8472
Length of River Call	76 days	85 days	5 days	10 days	48 days	61 days
Actual Replacement Water Released	3638	2976	73	249	3313	2940
Release as % of Availability	57%	48%	1%	4%	49%	35%
<hr/>						
Sources of Replacement Water Released						
<hr/>						
Surface Rights (includes effluent)	2354	2629	0	249	2916	2439
CBT/Windy Gap	830	85	0	0	175	0
Reservoir Releases	0	0	73	0	84	338
Augmentation Wells (net credits)	854	250	0	0	0	0
Recharge Projects (credits)	0	12	0	0	138	163

TABLE 3
 CCWCD -- Groundwater Subdistrict
 1987 Replacement Water
 (Source: Master Plan & 1987 Plan of Operation)

Surface Water:

[includes direct flow and reservoir
 (unadjusted for historic consumptive use)]

Owned by Subdistrict	864 acft
Leased from CCWCD	672 acft
Leased for year	3636 acft

Augmentation Wells:

Owned by Subdistrict	1500 acft
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Recharge Projects:

Accretions from Recharge Occurring during 1987 South Platte Anticipated Calls	2503 acft
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TOTAL ALL SOURCES 1987 REPLACEMENT WATER	9175 acft
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Since 1979 the Subdistrict has been actively pursuing the use of recharge projects to provide replacement credits. Over 9,500 acre-feet of water have been recharged to the aquifer in five separate locations between 1979 and 1986.⁷⁶ This recharged water provided an estimated 2,503 acre-feet of possible replacement credits in 1987.

The Subdistrict owns sixteen wells between Fort Lupton and Brighton capable of pumping 20 cubic feet per second to the river via a short ditch. Apparently, depletion to the river caused by pumping these wells occurs not long after pumping begins, so this source is used only at the end of a long call period.⁷⁷ These wells were not used as a replacement source between 1983 and 1986.

As a unit of the CCWCD the Subdistrict has taxing authority⁷⁸ and, in 1985, it received property tax revenues of \$227,288.⁷⁹ The other major source of revenue available to the Subdistrict is known as Class D assessments, the charge levied against each acre-foot of well water pumped by Subdistrict members. The per-acre-foot charge increased from \$7.50 in 1981 to \$11.50 in 1985. These assessments generated \$130,000 in

⁷⁶ **Central Colorado Water Conservancy District and Ground-water Management Subdistrict, Master Plan, 1987-1992, 9-11**(January 20, 1987) (hereinafter Master Plan).

⁷⁷ Id.

⁷⁸ **Colo. Rev. Stat.** Section 37-45-121(1973).

⁷⁹ The mill levy was 2 mills and the assessed valuation of the 196,000 acres of land within the Subdistrict was about \$115 million. See Master Plan, supra note 76, at 6, and Table 2.

1985. The assessments are one-year contracts which essentially pay the Subdistrict for providing replacement water to cover for the depletions caused by the pumping from members' wells.⁸⁰

In 1987 the Subdistrict announced that it no longer would pursue its application for a single permanent plan for augmentation for all wells in its area. Instead it intends either to operate as a substitute supply plan or to seek court approved augmentation plans for logical units of wells on a river-reach-by-river-reach basis.⁸¹

The major problem facing the Subdistrict is to find adequate sources of permanent replacement water at a cost it can afford. Between 1981 and 1986 the Subdistrict purchased water rights yielding about 851 acre-feet at a cost of \$571,260 or about \$671 per acre-foot.⁸² Such purchases sorely press the financial capacity of the Subdistrict and are not a financially feasible option for providing the large additional replacement water requirements. The most cost effective strategy to date has been

⁸⁰ The Subdistrict has eight types of Class 1 contracts. Irrigation users are distinguished primarily according to their dependence on groundwater. About 95 percent of the contracts serve irrigation wells decreed prior to July 8, 1972. The remaining contracts serve wells decreed as an alternate point of diversion, wells decreed after July 5, 1972, and wells used for non-irrigation purposes. Assessments vary according to the type of contract held. Groundwater Management Subdistrict, Plan for Augmentation Status Report 4-6 (May 1988) (hereinafter Subdistrict Status Report).

⁸¹ Subdistrict Status Report, supra note 80, at 35. In either case the Subdistrict intends to obtain the water supplies and prepare all information necessary to satisfy the requirements for plans for augmentation.

⁸² See Master Plan, supra note 76, at 12, and Table 6.

the recharge program, but this option is not available in all reaches where depletions must be offset.

D. An Evaluation of the South Platte Experience

Widespread irrigation activity in the South Platte Basin beginning in the 1860s caused the alluvial material underlying the irrigated lands to gradually fill with water, changing the surface flows of the South Platte River from intermittent in the downstream reaches to year-round flows. Essentially this irrigation activity can be viewed as an unintended recharge program storing large quantities of water in the alluvial aquifer. The slow return of these stored waters to the stream made surface flows available at times when normally little or no water had been in the stream. Senior water rights were made more reliable and junior rights became usable. A rough equilibrium between water recharged through irrigation and return flows to the South Platte River was reached by about 1930.⁸³

This equilibrium was altered by the rapid development of groundwater from these alluvial aquifers beginning at about this time. The water table was drawn down, causing a decline in groundwater discharges to the river.⁸⁴ The effect of these

⁸³ Bittinger, Colorado's Groundwater Problems, Colo. St. U. Experiment Station Bull. 504-S (Mar. 1967) at 21.

⁸⁴ One source calculated total depletions from well pumping in the South Platte basin to be about 266,000 acre-feet per year. Glover, South Platte River Flow Correlation, J. of the Irr. & Drainage Division, ASCE (Vol. 101, No. 3) 175, 182 (1975). See also, Hurr, Schneider, & Minges, Hydrology of the South Platte River Valley, Northeastern Colorado, Colorado Water Resources Circular No. 28 (1975) which reports a decline in accretions to the river of about 250,000 acre-feet per year

groundwater withdrawals on surface flows was largely masked by the imported water being added to the South Platte system by transmountain diversions. Between 1941 and 1981 transmountain diversions have added an average of about 259,000 acre-feet of water per year.⁸⁵ An analysis of calls placed on the river by senior rights below Denver during the critical irrigation period shows a clear reduction in their number and duration in recent years.⁸⁶ In all likelihood the availability of this imported water coupled with the fact that many surface diverters also utilized substantial groundwater eased concern about the impacts of groundwater development.

As illustrated by these case studies the approaches taken to integrate tributary groundwater development in the South Platte basin have varied considerably. GASP operates on a year-to-year basis under state engineer approval. No effort is made to quantify the depletions to the stream caused by the pumping of member wells. Instead, emphasis is placed on offsetting injury by providing replacement water targeted in substantial part at keeping the call off the lower part of the river where most of the GASP wells are located. Much of the replacement water is provided by GASP-installed wells apparently able to operate

between 1947 and 1970.

⁸⁵ Blatchley Associates, Inc., 'Tunnel Vision': An Analysis of River Call Data in the South Platte River Basin (July 1984), Table 4, at 11. Transmountain diversions have been substantially greater between 1964 and 1981, averaging 362,000 acre-feet per year.

⁸⁶ Id. at 15.

without injury to downstream users. Without question, GASP has benefited from its primary location on the portion of the river where replacement water supplies are available at reasonable costs and where return flows from upstream uses supported by transmountain importations have substantially increased since the 1960s. Under the GASP approach injury is not measured by depletions to the stream but by the existence of calls on the river. The advent either of prolonged drought or a major increase in use of return flows from imported water⁸⁷ could tighten supplies in the lower South Platte, thereby raising issues about the adequacy of the GASP approach.

The Fort Morgan approach specifically analyzes depletions to the stream caused by each well. It is a true augmentation scheme in that it diverts and recharges flows available in periods of low demand. Analysis of the Fort Morgan system and operation of its plan for augmentation are greatly facilitated by the fact that these wells irrigate lands linked together as part of one mutual ditch company. About 90 wells are involved, pumping less than 7,000 acre-feet per year on average.

In contrast, the Groundwater Management Subdistrict is located in an area of intense water use. There are about 870 wells, pumping an average of 106,000 acre-feet per year. The Subdistrict has given up on its effort to obtain a single

⁸⁷ Under Colorado law imported water may be 100 percent consumptively used by the importer. *City and County of Denver v. The Fulton Irrigating Ditch Co.*, 179 Colo. 47, 506 P. 2d 144 (1972) and **Colo. Rev. Stat.** Section 37-82-106 (Supp. 1987).

augmentation plan under which all these wells would operate and is, instead, planning to segment the system into logical units and seek separate decrees for each of these units.

V. SUMMARY AND CONCLUSION

Recognizing the importance of Colorado's tributary groundwater resources, the legislature and the courts have taken steps to permit their development and use. Curtailment of the groundwater pumping which had developed prior to the 1969 Act (hereafter pre-1969 act wells) has been avoided. Presumably all these pre-1969 act wells have now been adjudicated and are operating either under their own priority, if senior enough; as an alternate or changed point of diversion for a surface right; as part of a plan for augmentation; or under a substitute supply plan. By this very pragmatic measure, Colorado's efforts to integrate use of tributary groundwater have been successful.

Nevertheless, two fundamental and interrelated questions remain: first, have these wells been integrated on a rational basis that will ensure their future protection? and second, do the laws and practices applying to tributary groundwater encourage optimum use of the related surface and groundwater resource? The differences in the standards applying to tributary wells have been mentioned in connection with the South Platte case studies. GASP wells operate on a year-to-year basis under an informal approach which appears to be protected by their ability to supply as much as 20 percent replacement water. Injury is measured not by depletions but by the existence of a call. Groundwater Subdistrict wells have been operating on the basis of providing five percent replacement water. Fort Morgan wells provide replacement for all depletions. In addition, it appears that the

pre-1969 act wells in the Arkansas Valley are only required to provide replacement water for pumping in excess of three days a week.

Of course there are important differences among and even within basins which should be reflected in requirements attaching to groundwater use. Indeed, the 1969 Act specifically recognizes this fact and directs the state engineer, in developing rules and regulations, to be guided by the "[r]ecognition that each water basin is a separate entity, that aquifers are geologic entities and different aquifers possess different hydraulic characteristics even though such aquifers be on the same river in the same division, and that rules applicable to one type of aquifer need not apply to another type."⁸⁸ However, the differences now present do not reflect the kind of rational analysis suggested in this legislative directive. Rather, they reflect variations in the outcome of litigation and in the attitudes of water right holders in the basins.

The real objective of the 1969 Act was to allow the large number of irrigation wells already in existence to continue to operate so long as means could be found to protect senior surface rights. The state engineer actively encouraged cooperative efforts by well owners to protect senior rights. Emphasis was placed on call management -- keeping those seniors most likely to complain about well usage happy by assuring adequate supplies through additional wells or other means. In the South Platte and

⁸⁸ Colo. Rev. Stat. Section 37-92-501(2)(a) (1973).

Arkansas valleys this approach benefited from the transmountain water which, especially since the 1960s, substantially augmented native flows each year thereby helping to reduce calls. Simplifying assumptions like the five percent replacement requirement were developed, based on a generalized analysis that reflected the increased surface flows from transmountain water and return flows from irrigation recharge of the alluvial aquifer. There appears to have been considerable ambivalence as to whether these associations of wells would have to obtain a court-approved plan for augmentation. During the period when the state engineer could approve temporary augmentation plans there probably was little difference. However, as the standard applying to court-approved augmentation plans became clearly established as requiring that depletions to the stream from out-of-priority well pumping be measured and fully offset by reliable replacement supplies, it was obvious that call management would not pass court muster. Consequently, there is now a clear dichotomy between state-engineer-approved substitute supply plans and court-approved plans for augmentation.

The incongruity of this approach is apparent in a place like Beebe Draw, a narrow valley with no natural surface flows adjacent to the South Platte River downstream from Denver. There are wells operating in Beebe Draw under the GASP umbrella and other wells operating as part of Central's Groundwater

Subdistrict.⁸⁹ Neither GASP nor Central replace water to the alluvial aquifer underlying Beebe Draw though, of course, they do provide replacement to the South Platte with which this alluvial aquifer is connected. Now the Farmers Reservoir and Irrigation Company (FRICO) is seeking court approval of an augmentation plan that would include additional well development in Beebe Draw. FRICO is being required not only to show that its recharge program will fully replace depletions to the South Platte, but also that the pumping from its new wells will not interfere with pumping from existing wells.

Perhaps the implicit rationale here is an assumption that, in general, pre-1969 act wells do not harm senior rights because they are drawing from the water stored over many years in the alluvial aquifer as a result of infiltration from irrigation and because of the "extra" water available in the South Platte and Arkansas from transmountain diversions. The importance of these wells to the economies of these areas and the absence of any clear rules governing such groundwater development until 1969 argue strongly for making this implicit rationale explicit. Thus, as to wells installed prior to the 1969 act and decreed as required thereafter, the state engineer should be directed to develop rules of operation with clear standards by which evidence of no harm can be measured. He should be given considerable flexibility in the kinds of rules developed and clear authority

⁸⁹ Interview with John P. Akolt, III, in Denver, Colorado (April 26, 1988).

to implement these rules. Conditions on the river and between aquifers can vary enormously so no single set of rules can be devised. The key to these rules is that they be able to provide a more rational basis for the operation of those wells that will provide greater certainty for them while assuring protection of senior rights. Legislative intent to accord great deference to the findings of the state engineer in establishing these rules should be clearly noted.⁹⁰ As to post-1969 act wells it should be made clear that they must seek court approval as part of a plan for augmentation. Of course, owners of pre-1969 act wells wishing to follow this approach may do so as well. The use of recharge programs as a means of replacing depletions from new well pumping should be encouraged. Though not without its problems, recharge of the substantial alluvial aquifers found in Colorado offers considerable opportunities for fuller use of available water resources.

This leads directly to our second question concerning optimum conjunctive use. There are those who believe we are still underutilizing the tributary groundwater resource, in part because of overly restrictive regulations of its use.⁹¹ Almost certainly if the surface and groundwater resources were managed in a more unified manner than under the existing highly frag-

⁹⁰ Clyde O. Martz has suggested a number of possible elements to such an approach. See The Groundwater Resource, in **Water and the American West** 99-101 (D. Getches ed. 1988) (hereinafter Martz).

⁹¹ See, e.g. Martz, supra note 90.

mented system, overall use of the water resource could be substantially improved. This suggests the importance of moving in the direction of integrated management. The value of a basinwide perspective generally is appreciated.⁹² At the same time, the difficulties with broad-based approaches are apparent.⁹³

The impetus to improve utilization of the interrelated surface and groundwater resource could come from several different directions. New users wanting to take additional water from the tributary aquifer have the most obvious interest in expanding the availability of that resource. In recent years the major source of demand probably has come from residential and commercial development outside existing water service areas. However, the quantities of water involved in such development are typically relatively small, and the cost of complying with the plan for augmentation requirements generally is a small part of the overall development costs. Conceivably, however, urban areas seeking more substantial quantities of water could initiate major recharge projects and other activities that would extend use of the total available resource. Such large-scale management programs may at some point prove more economic than other sources

⁹² See, e.g., Colorado Water Resource Research Institute, **Voluntary Basinwide Water Management -- South Platte River Basin, Colorado**, Completion Report No. 133 (May 1987).

⁹³ A Colorado statute authorizing river basin management authorities was repealed in 1987. **Colo. Rev. Stat.** Section 37-93-101 et seq. (1973), repealed 1987 Colo. Sess. Laws 1307, Sec. 1.

of raw water supply. If the economic picture for agriculture were to change, this sector could once again become a major source of new demand for water, thereby accelerating the need for better use of the resource.

Less positively, the impetus could come as a consequence of legal actions. One possible source of litigation is from those installing new wells who feel that the plan for augmentation requirements imposed on them are unfairly restrictive, especially in comparison with the requirements applying to wells operating under substitute supply plans. Another possible source of litigation is from junior appropriators faced with reduced surface supplies either as a consequence of a drought or more extensive reuse of transmountain return flows. Interstate issues provide still another source of legal action. Litigation concerning the Rio Grande Compact focused attention on surface and groundwater development in the San Luis Valley.⁹⁴ Similarly, the action by Kansas against Colorado concerning the Arkansas River almost certainly will involve an evaluation of the ways in which use of surface and groundwater in Colorado affect the availability of water in Kansas. Water quality issues, especially those associated with control of nonpoint sources, represent another possible source of litigation that could motivate

⁹⁴ Alamosa-La Jara Water Users Protection Ass'n v. Gould, 674 P.2d 914 (Colo. 1983).

action in this area.⁹⁵

As illustrated in the South Platte case studies, there are a number of activities already in use which serve to better manage the resource. These include the use of strategically located groundwater wells to supply certain senior surface water rights which may drive the system in an inefficient way, the purchase and lease of senior surface and storage rights which can be utilized to provide needed replacement water, and the development of recharge projects which can store unused flows of water at certain times and at locations that both resupply the aquifer and provide return flows to the stream at a later time when these flows are needed. The San Luis Valley litigation also highlights issues concerning existing diversion and irrigation practices. Inefficient means of diversion and inefficient irrigation practices may not be legally protectable.

Whatever approach is taken, the following set of general principles is offered for consideration:

1. The goal is optimum utilization of Colorado's related surface and groundwater resources;
2. Optimum use must be determined with full regard for "all significant factors, including environmental and economic concerns";⁹⁶

⁹⁵ The 1987 Water Quality Act suggests that pollution from nonpoint sources will be receiving much closer scrutiny than in the past. See 33 U.S.C.A. Section 1329 (West Supp. 1987) Pub. L. No. 100-4, 1987 U.S. Code Cong. Admin. News (101 Stat.) 53.

⁹⁶ Alamosa-La Jara Water Users Ass'n v. Gould, 674 P.2d 914, 935 (Colo. 1983).

3. Vested rights are protected as to the duty of water, historically available at the time and place of need, and in the quality needed. Inefficient means of diversion and inefficient usage practices are not protected;

4. Groundwater use should be permitted to the fullest extent feasible, consonant with protection of preexisting rights;

5. Actual injury to existing rights from pre-1969 act wells must be found to exist as a matter of fact, not simply presumed because there are depletions and the river is "over-appropriated"; and

6. Post 1969 act wells should be required to show no injury to existing rights either by replacing all depletions to the stream relied on by senior appropriators or through other means able to prevent injury.

In many respects, Colorado has been the leader among the western states in integrating use of tributary groundwater with surface water. Perhaps uniquely, Colorado has grasped the fact that the essence of the prior appropriation system is not simply priority but the protection of senior rights from injury. As our understanding of this fundamental concept develops, a logical outgrowth should be a management system for water enabling fuller, more effective use of our interrelated surface and groundwater resources.