

Steven E. Vandiver started with the Colorado Division of Water Resources in 1973 as a hydrographer-in-training in Denver. He came to Alamosa as a hydrographer shortly thereafter and continued to move up through the ranks as Lead Hydrographer, Dam Safety Engineer, and Assistant Division Engineer. In 1981, Steve assumed the responsibilities of the Division Engineer for Division 3, the Rio Grande basin in Colorado. Steve, as Engineer Adviser for Colorado, was involved in the administration of the Rio Grande Compact and the Costilla Creek Compact. He was also a member of the Rio Grande Silvery Minnow Recovery Team. Steve holds a bachelor's degree in civil engineering from the University of Colorado, Boulder and is a registered professional engineer.



The Administration of the Rio Grande Compact in Colorado

The Administration of the Rio Grande Compact in Colorado

INTRODUCTION

The Rio Grande Compact requires Colorado to deliver certain amounts of water annually to the stateline according to the delivery schedules in Article III. On any given year this can require from 25 to 50 percent of the water generated in the Rio Grande and Conejos River basins to arrive at the Lobatos gage just above the border with New Mexico. Since the diverters have the capability of diverting and using most of the water generated in both basins, it is necessary that a process be in place that enables Colorado to ensure that her obligation is met. One can imagine the turmoil that can be generated when water is bypassed to the stateline when there is a significant demand for that water in Colorado from the water rights owners on the rivers. A great amount of work was required by the State of Colorado and the water users in the San Luis Valley to reach an administrative scheme that allowed Colorado to use her entitlements under

the Compact and still meet her obligations to the downstream states.

Since 1939, the administration of the Rio Grande Compact in Colorado has been an evolutionary process marked by three distinct periods. The first period from 1939-1967 was a time when Colorado officials made the decision to continue with the administration of water rights as they had during the study period of 1927 to 1936. This action worked well until 1952 when Colorado under-delivered approximately 154,000 acre-feet. The reasons for this under-delivery are largely unknown, but it began a period of under-deliveries and accrued debit that continued until 1967 when that accrued debit reached approximately 940,000 acre-feet. The year before, in 1966, the states of Texas and New Mexico had brought an action against Colorado in the U.S. Supreme Court to force Colorado to comply with the provisions of the Compact. In May of 1968, the Court granted the three states and the U.S. a stipulation for continuance of the case as long as Colorado met her Compact obligation until she was once again in compliance.

The second period, from 1968 to 1985, Colorado administered the Compact pursuant to the stipulation and was forced to determine a way to curtail water rights in a manner that would allow the appropriate delivery of water to the

Lobatos gage near the stateline. Since this administrative scenario had never been attempted, the Colorado State Engineer entered a very difficult time of working with the water users on both the Conejos River and the Rio Grande to determine how this issue might be resolved. In 1975, after several years of negotiated informal annual operative criteria, the State Engineer promulgated rules and regulations for the intrastate administration of the Compact on each river and between the two rivers. In 1979, the numerous protests to the proposed rules were heard in the local District Court in an eleven-week trial. The decision rendered by the Court upheld the State Engineer's Compact rules but the ruling was appealed to the Colorado Supreme Court. The Supreme Court decision upholding the State Engineer's rules was made in 1983. Therefore, from approximately 1968 to the present, the Colorado State Engineer has directed that the Compact be administered as a two-river system with each river responsible for its own delivery obligation dictated by Article III. The rules also provided that any curtailment of diversions would come from the junior water rights, which would have otherwise been in priority on any given day of administration. During this period of litigation over the rules, Colorado met or exceeded its obligation each year from 1968 through 1984 because of the incentive provided by the U.S. Supreme Court stipulation. In fact, because of the hydrologic and climatologic vagaries of the Upper Rio Grande Basin, coupled with the negative consequences of noncompliance with the stipulation, Colorado was forced to over-deliver to ensure that she met the obligation. This very conservative administration resulted in a reduction in the accrued debit of approximately 430,000 acre-feet in 17 years.

The third and current period began in June of 1985, when the Rio Grande Project in Southern New Mexico spilled and eliminated the debt of Colorado and New Mexico. This gave cause for the three states to recommend to the U.S. Supreme Court that the 1966 case be dismissed, which it was on December 9, 1985. Since 1985, Colorado has operated under the Compact as it was written and has met or exceeded its obligation since that time. What is required to accomplish this administration is the topic of this paper and will be described in detail below.

PERTINENT COLORADO WATER LAW

When the State of Colorado achieved statehood in 1876, her corresponding constitution included and adopted the Doctrine of Prior Appropriation as the basis for the appropriation of the water. This was a matter of necessity due to the water-short characteristics of many of the streams in the State. It was recognized early on that because of the large numbers of competing appropriations that some judicial confirmation would be required to allow for the orderly distribution of the State's water. It was also authorized by the legislature in 1883 that a State Engineer would be given the responsibility to administer the water rights of the State.

As early as 1883, general adjudications were held on the Conejos River that confirmed and decreed water rights in relative priority based on the date of appropriation and the amount required to satisfy the irrigation requirements under each ditch. The first general adjudication that occurred on the Rio Grande mainstem was signed on May 1, 1896. These adjudicatory processes were widely noticed and all individuals who had completed their appropriations were allowed to come forward and provide proof of their claims. The date of appropriation, the legal description of the point of diversion, the flow rate of the appropriation, and the use to which the water right was to be placed was determined by the court and confirmed. The court referee investigated each claim for accuracy, ranked the water rights according to the appropriation dates, and recommended the court decree them accordingly. The State Engineer, through water commissioners, used these decrees to administer and deliver the available water to those who were entitled to it. Subsequent supplemental adjudications would include all new or existing claims not previously decreed and create additions to the water rights administrative list. All water rights in these subsequent adjudications were "junior" to all previously adjudicated rights regardless of their appropriation date. Therefore, a water right may have a very early appropriation date, but having failed to participate in the original adjudication, would end up junior to all others in the original adjudication.

The following table describes the adjudication dates and the amounts decreed in each on the two

Compact streams in Colorado. The Conejos adjudications include the Los Pinos and the San Antonio rivers because they are tributaries. It is readily apparent that the vast majority of the water available in both systems was decreed by around the turn of the century. The hydrology of the two basins described later in the text will show the grossly over-appropriated nature of the two streams.

Rio Grande and tributaries	Conejos River and tributaries
1896: 3209 cfs	1883: 1459 cfs
1903: 2501	1890: 1312
1916: 678	1914: 502
1934: 353	1915 to present: 375
1959: 765	
1960 to present: 140	
Total including instream flow: 9139 cfs	4104 cfs

These adjudications established early on the system of administration that has followed for more than 100 years. Gaging stations were established on all streams that had become fully appropriated that allowed the water commissioners to determine the amount of water that was available for distribution. Recognition of return flows and tributary inflow to the stream make the task even more interesting. On the Rio Grande mainstem, gages were established routinely along the course of the river to help recognize the changes in the flow throughout the system. Through the years, the State Engineer has hired a staff of hydrographers to operate and maintain the gaging stations and to rate the measuring flumes on the ditches. The State Engineer is responsible for the distribution of water in the system to ensure the water is available at the time and place of demand by water right owners who are in priority. His staff is also responsible for ensuring that the ratings on the ditches are kept current to ensure the proper amount of water is delivered to each ditch. Headgates and measuring flumes are required by statute on each diversion and the State Engineer has the authority to refuse water to the owners who fail to maintain these structures in proper order. In recent developments, most of the larger diversions have installed satellite-monitoring equipment, which allows the user as

well as the State to acquire real-time data in order to ensure better administration.

HYDROLOGY OF THE RIO GRANDE AND CONEJOS RIVER

The headwaters of the Rio Grande mainstem and the Conejos River are ringed by the Continental Divide. This area of southwestern Colorado normally receives a significant snowpack that provides the majority of the water that arrives at the upper index gages on the two rivers. These headwater areas are in relatively close proximity to the index gaging stations near Del Norte, Mogote, and Ortiz. Normally, the day's snowmelt or rain event runoff arrives at the gages during the next 12 to 24 hours, depending on what location in the basin one might consider. Since the operating reservoirs on both systems control only a fraction of the flow, the flows at the index gages are primarily a reflection of snowmelt and rainfall events. All these reservoirs hold relatively junior priorities and during the runoff, the reservoirs store under those decrees on a very limited basis when the flows at the index gages are very large. Therefore, during the irrigation season, the reservoirs bypass the inflow to them except for the highest portion of the runoff, if at all. Three ditches own the three irrigation reservoirs on the Rio Grande and the water from their decrees is not available to any other ditches on the river. The Conejos Water Conservancy District, on the other hand, operates Platoro Reservoir and the water from it is available to the member ditches. It is a commonly held belief that all the irrigation reservoirs on the Rio Grande are available to all the ditches, or to store water for other purposes. This is obviously not the case and only the owners of the reservoirs can use the water available to them. Since Platoro is a post-Compact reservoir, any water stored under its decree is accounted for as if it had passed the Mogote gage on a monthly basis. This stored water is then subtracted when it is released to ensure that the native water in the basin is properly accounted for and that the index supply and the corresponding obligation are not altered because of storage. The annual volumes of flow at the index stations are therefore relatively unaffected by the reservoirs on either of the Compact streams except on the occasion of a very wet year when some carryover can result.

The Administration of the Rio Grande Compact in Colorado

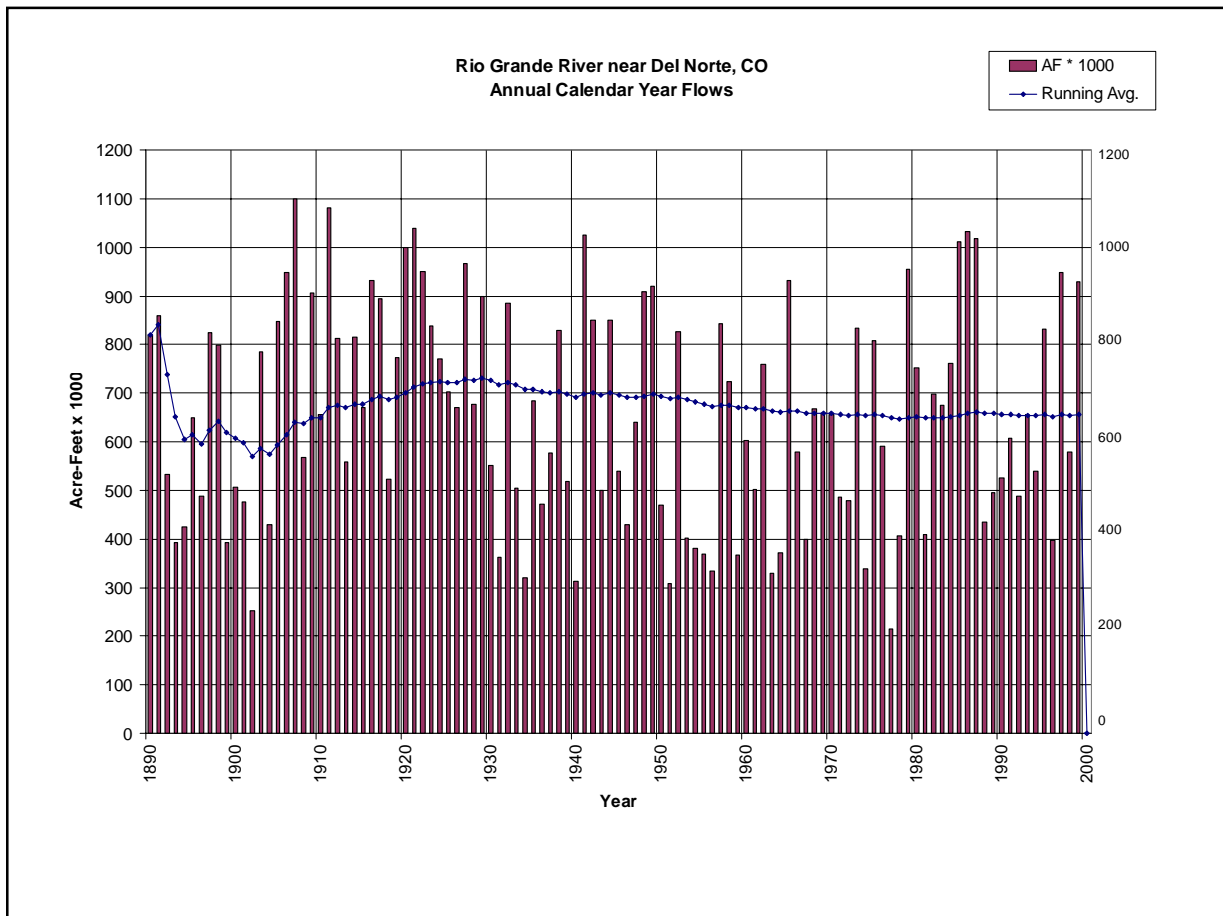


Figure 1. Rio Grande near Del Norte, CO, Annual Calendar Year Flows

The hourly, daily, seasonal and annual flows at the index stations are extremely variable. The daily diurnal effect during the runoff season as well as the variability of high altitude snowmelt can cause large changes within the day as well as from day to day. As is the situation with most western streams, the seasonal and annual flows are also highly variable. The past 25 years are a wonderful case study on variability of the water supply for the Rio Grande Basin. On the Rio Grande mainstem in Colorado, we have seen the historic low year in 1977 of 215,000 acre-feet and just a few years later saw three consecutive annual flows of more than 1,000,000 acre-feet, a volume which has been exceeded only in seven of the 110 years of recorded history. Figure 1 “Rio Grande River near Del Norte, CO – Annual Calendar Year Flows” shows the annual variability of streamflow at the Rio Grande near Del Norte gage. This gage is the upper index gage for the Rio Grande and is used to determine the amount of water owed to the downstream states as well as the water available for distribution in priority to water rights owners.

Peak flows on both systems are also reflective of the large variability of the low from year to year. On the Rio Grande near Del Norte gage, the peak averages around 5,400 cfs and varies over the history of the record from 1,730 cfs in 1977 to 18,000 cfs in 1912. The Conejos near Mogote gage shows a similar pattern with peak flows from 882 cfs in 1972 to 9,000 cfs in 1912 with the average around 2,000 cfs.

Average flows for the two rivers reflect that the historic mean flow is demonstrative of the fact that neither carries large flows on the average and that the large majority of the flows occur in the spring months of May through July. The rest of the year the flows are near base-flow conditions except for the runoff from the occasional rainfall event during the summer and fall. The mean flow for the Rio Grande near Del Norte gage is 907 cfs, for the Conejos near Mogote is 331 cfs, for the Los Pinos near Ortiz is 121 cfs, and for the San Antonio near Ortiz is 26 cfs. Base flows on the four rivers would be approximately 400 cfs, 150 cfs, 40 cfs, and 10 cfs, respectively.

The Administration of the Rio Grande Compact in Colorado

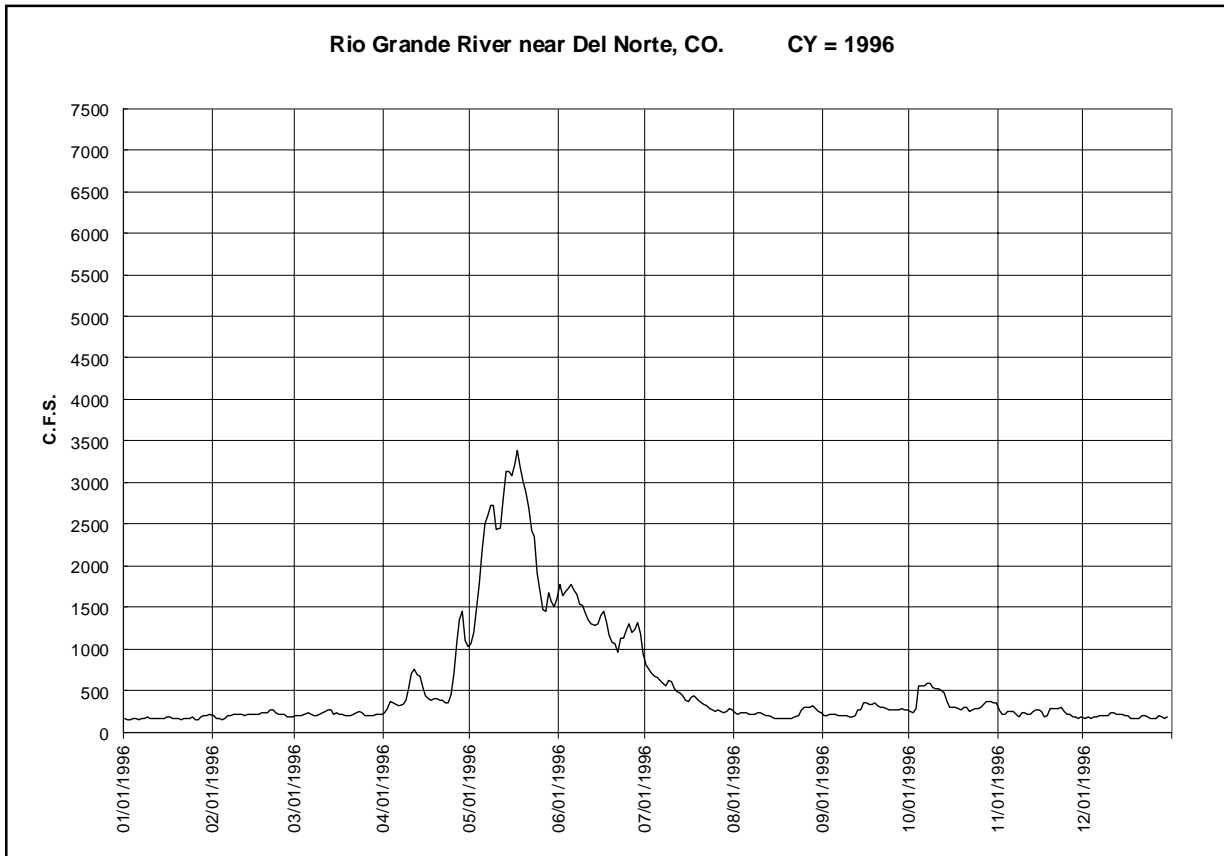


Figure 2. Rio Grande near Del Norte, CO for 1996

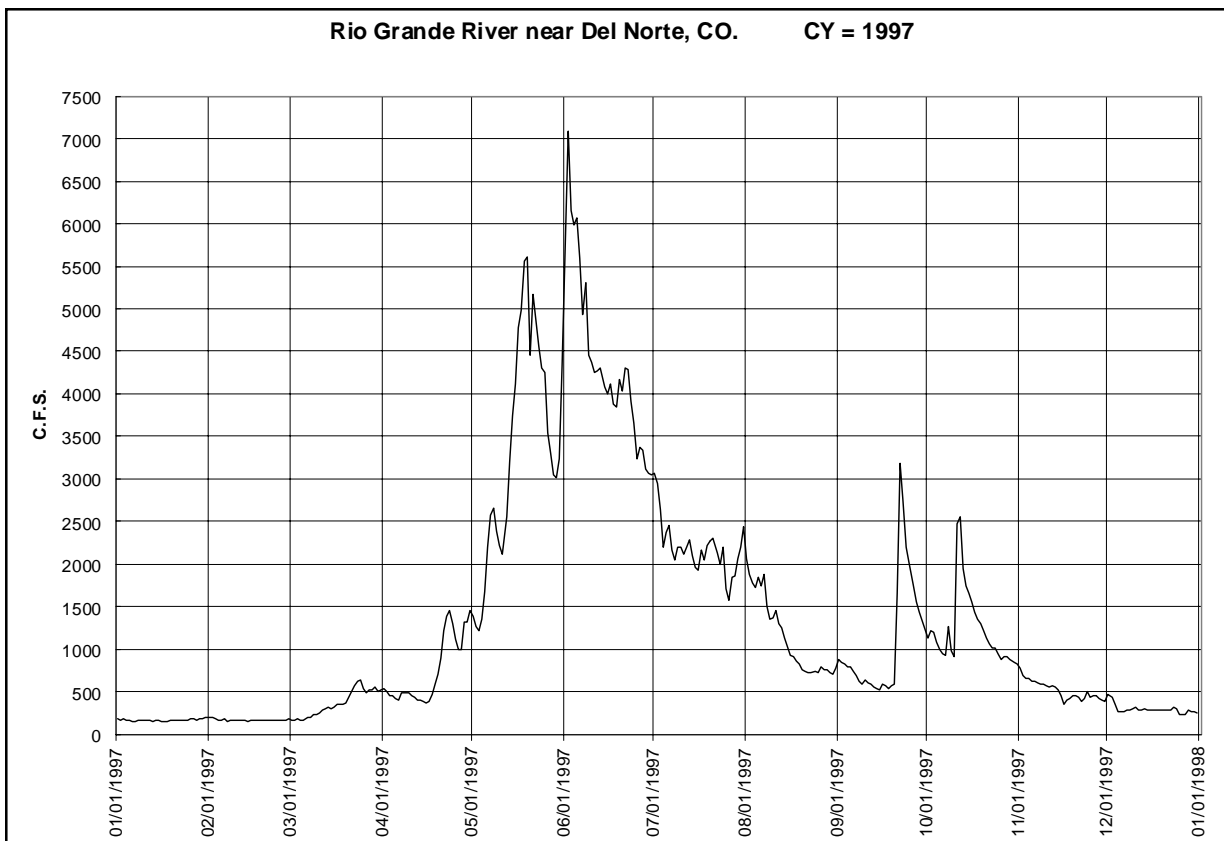


Figure 3. Rio Grande near Del Norte, CO for 1997

These statistics and Figures 2 and 3, "Rio Grande River near Del Norte, CO – CY=1996" and "Rio Grande River near Del Norte, CO – CY=1997" are provided to illustrate the large variability in the hydrology of the Upper Rio Grande Basin in Colorado and provide the setting in which the Compact in Colorado has to be administered. This variability creates a difficult challenge to the managers of the diversion systems and especially to those responsible for ensuring that Colorado meets her Compact obligation to deliver water to the downstream states. The constantly moving target demands that the Compact be administered on a daily basis. The staff involved in this effort must be able to readily analyze the past, current, and future conditions of streamflows of the calendar year. Real-time data, calendar year flows-to-date and good historic streamflow data are all required to calculate what must be done to stay current with deliveries. The challenge then is to use that knowledge to administer the priority system on both river systems while concurrently bypassing the proper amount of flow to the stateline to meet the required delivery for Compact purposes. It is imperative to water right owners as well as the water managers to ensure that Colorado is able to utilize her full entitlement allowed under the Compact while meeting her obligations. As conditions change during the year, they must be recognized in a timely manner and adjustments made to the administration of the river to accomplish those two goals.

TOOLS

There are a number of tools that the State of Colorado uses to administer effectively the Rio Grande Compact. These include legal, physical and political tools that are employed to determine the actions that must take place for Colorado to meet its obligation at the Lobatos gage.

Legal Tools:

- Doctrines of Prior Appropriation system contemplated by the Constitution;
- Case Law that reinforces and refines the Doctrine;
- Historic and current adjudication process;
- 1969 Water Right Determination and Administration Act;

Rules and Regulations governing Rio Grande Compact administration

Physical Tools:

- Extensive stream-gage network;
- State Hydrographic Program;
- Satellite Monitoring System on stream gages and major diversions;
- Spreadsheets for water accounting;
- 10-day reporting;
- Natural Resources Conservation Service monthly forecasts;
- Communication protocol with National Weather Service;
- Closed Basin Project

The Administration of the Rio Grande Compact in Colorado

Political Tools:

- Active water user associations;
- Water conservation and water conservancy districts;
- Continuing education programs to inform users and public;
- Media relationship to inform public of significant events;
- Strong relationship between the State Engineer staff and water user community

CURRENT ADMINISTRATION

Since 1968, the Rio Grande Compact has had a significant impact on water rights administration in the Upper Rio Grande in Colorado. The State Engineer has administered the Compact on a two-river system since that time. Both the Rio Grande and the Conejos are administered independently according to their respective delivery obligations. Therefore, two separate accountings and administration schemes are used for day-to-day administration. The following administration process is used for both rivers and is linked only by certain adjustments to the deliveries that are explained later.

Article III of the Rio Grande Compact is the pertinent section that describes what administration of water rights is required to provide the appropriate flow to the stateline to meet Colorado's annual obligation. That article sets the annual delivery obligation for each river based upon the native water that flows past the index stations. The combination of the two separate delivery schedules determines Colorado's

total obligation less the 10,000 acre-feet credit provided by the Compact. The delivery schedules are reflective of the inflow-outflow relationships developed during the Rio Grande Joint Investigation Study from 1927 to 1936. The delivery schedules set in place the amount of consumptive use that is allowed in each basin for given flows into that basin. The consumptive use that is allowed in each basin is reflected in their delivery schedules by subtracting the delivery obligation from the index flow. For each given annual flow, there is a theoretical consumptive use for each river and all additional flows must be passed through the system. The maximum

consumptive uses are 570,000 acre-feet on the Rio Grande and 224,000 acre-feet on the Conejos system. These peak consumptive use amounts occur when the annual flow is quite large and considerably above the average flow. Figures 4 and 5, "Rio Grande Compact Delivery Requirements Verses Annual Index Flows" and "Rio Grande Compact Delivery Requirements As Percent of Annual Index Flows" graphically demonstrate the delivery schedules in Article III. They represent both the percentage of the index required as well as the numeric value of the obligation for the corresponding index supply.

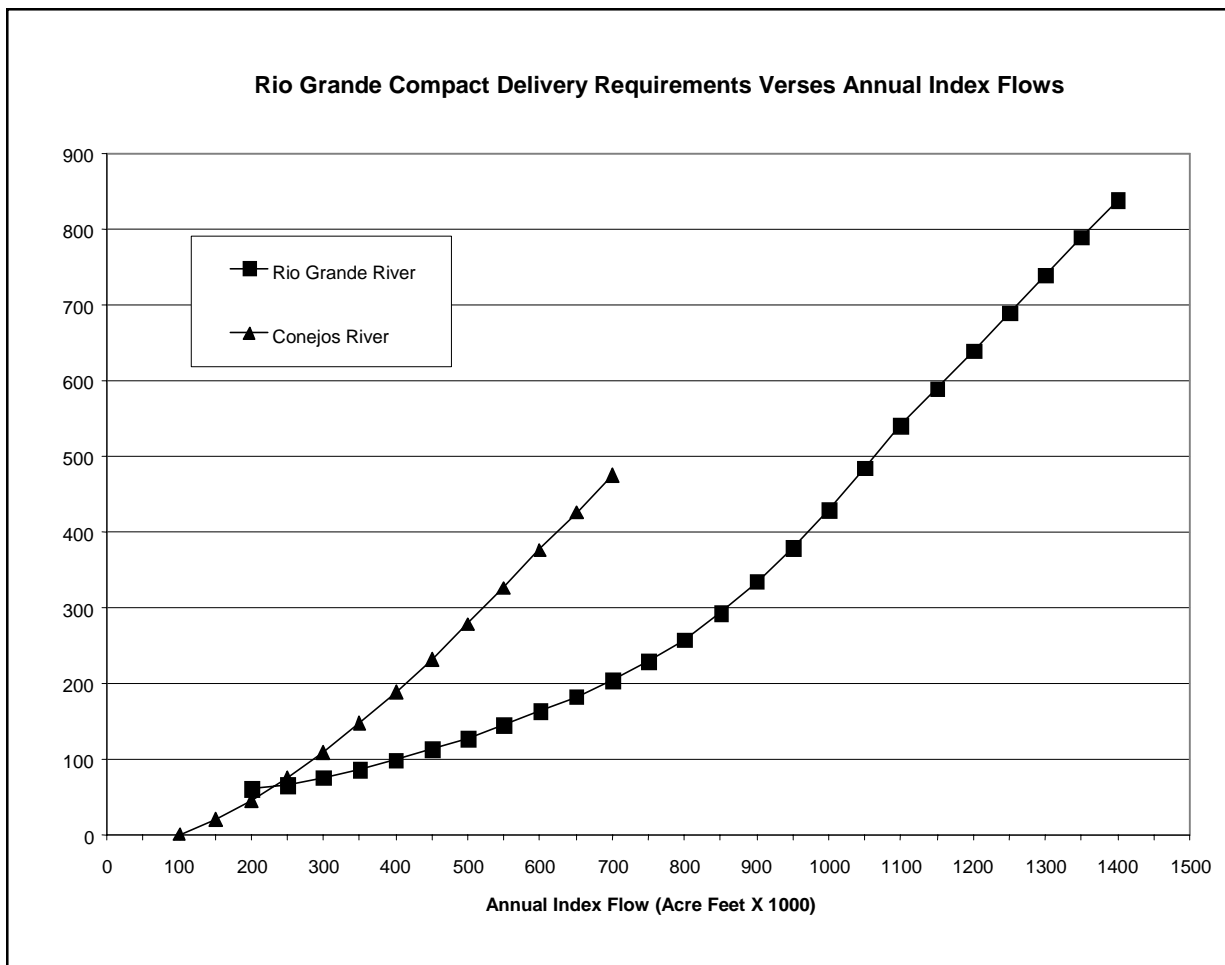


Figure 4. Rio Grande Compact Delivery requirements as percent of annual index flows

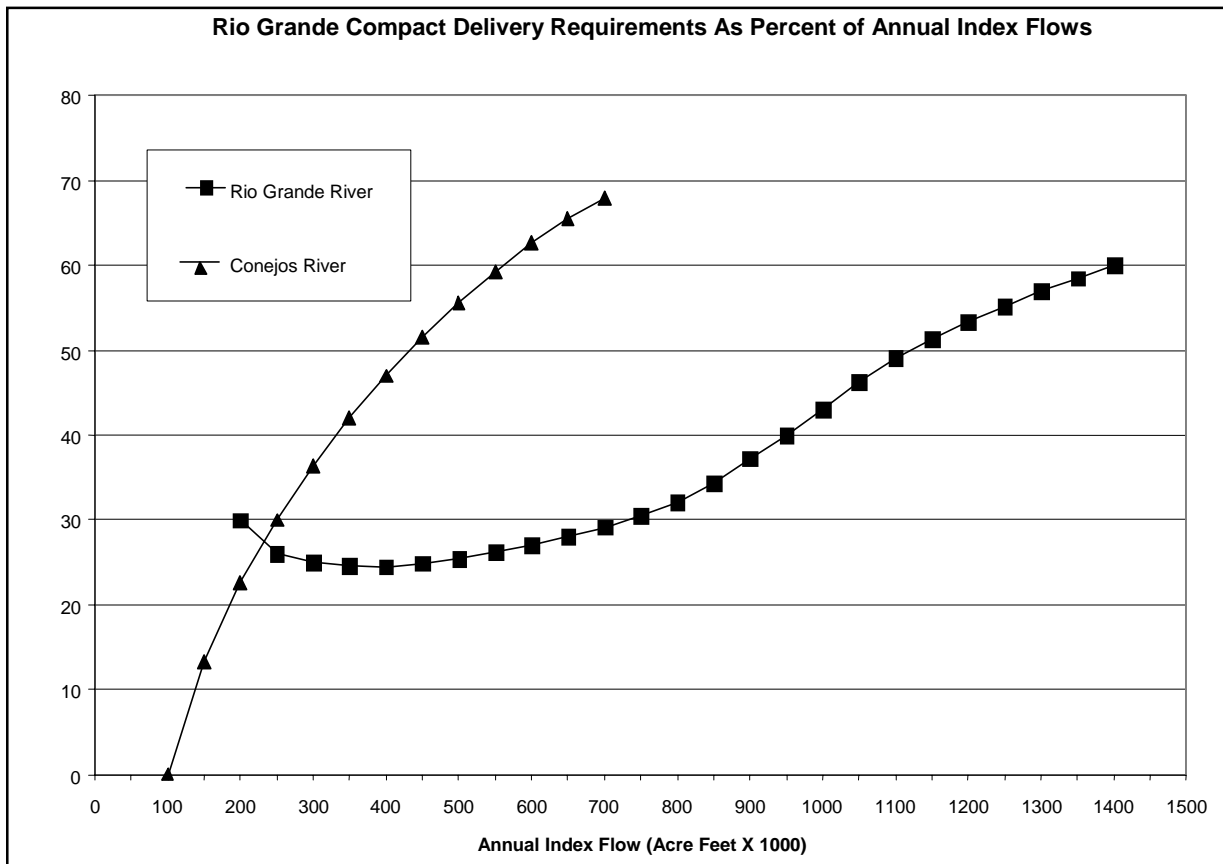


Figure 5. Rio Grande Compact delivery requirements as a percent of annual index flows

Deliveries to the stateline are not required to adhere strictly to the Compact's delivery schedules on an annual basis. The Compact in Article VI allows for the accrual of Compact credits and debits. Colorado may under-deliver by as much as 100,000 acre-feet in any particular year, and may accrue up to 100,000 acre-feet of annual debit over multiple years. Colorado may also receive up to 150,000 acre-feet of annual credit in any given year and may accrue an unlimited credit over multiple years. This credit and debit accounting provision of the Compact provides Colorado with some flexibility in managing water use from year to year, and allows the state to utilize the credit to enhance water supply in years when it will provide relief to a shortage in the system. The only downside to having credit water stored in Elephant Butte is that approximately 10 percent of the water is lost to evaporation each year. Current administration practices are to make deliveries that approximate the obligation on an annual basis. Because of the vagaries of the climate and hydrology, it is very difficult to forecast accurately enough during the runoff to exactly meet the delivery requirements.

SEASONAL ADMINISTRATION

Since 1968, Colorado has attempted several different scenarios to ensure that Colorado would meet her obligation. What has evolved over time is a very successful routine that guides administrators through the year. It provides a reasonably accurate method for meeting the obligation within a few percentage points, thus allowing Colorado to utilize fully her entitlements and at the same time meet her obligation to the downstream states. It requires recognizing the indexes and deliveries from the first of the year to the present, assuming deliveries for the early winter months and adjusting the forecast for the irrigation season as it progresses. After the annual index supply forecasts for both rivers are established, then water rights are curtailed as is necessary to ensure that the Compact delivery requirement is met. If the actual runoff and summer thunderstorm activity changes the forecasted index supply, adjustments are made to deliveries to account for those changes. Large late season increases in the indexes require significant changes in administration that can cause

considerable hardship to very senior pre-Compact water rights.

As described above, day-to-day administration of the Rio Grande Compact for inter- and intrastate purposes involves a series of detailed calculations using historical, real-time, and forecasted streamflow information at all seven of the Compact gages as well as at the intermediate gages between them.

The upper index gages are:

- Rio Grande near Del Norte
- Conejos River near Mogote
- Los Pinos River near Ortiz (April – October)
- San Antonio River at Ortiz (April – October)

The lower index gages are:

- Rio Grande near Lobatos
- Conejos near La Sauses (two stations)

Flows at these locations are used to determine the total annual delivery obligation, to determine deliveries to date, and to establish a “curtailment” of water use if needed to meet the delivery obligation of the year. The State Engineer, through the Engineer Adviser and the staff in the Division of Water Resources office in Alamosa, makes these calculations every 10 days when diversions are being made, and monthly during the remainder of the year for both river systems. It is critical to remember that each river is analyzed separately and that each river has its own delivery obligation.

The general methodology for making these calculations is described in the four following steps. The dates are for illustrative purposes only and vary depending on the forecast and Compact status of the State of Colorado. Examples of the 10-day analysis sheets and report are attached.

January 1st through March 31st

Both the Rio Grande and the Conejos River diversions are curtailed 100 percent, that is, no diversions are allowed except for storage in pre-Compact reservoirs. Any storage in post-Compact reservoirs is accounted for and subject to Compact rules. An exception to the 100 percent curtailment can occur if Colorado has a large accrued credit, a spill of Elephant Butte has or will occur, or if drought conditions prevail and

thus the anticipated obligation is very low. This action will maximize deliveries to the stateline during this period and will allow for lower curtailment during the irrigation season. The Closed Basin Project is pumped at a prudent level considering the limitations of winter operations and well production. The March 1 forecast is used to make some of the initial analyses for how the Compact will be administered for the early part of the irrigation season. The Rio Grande headwater areas typically receive large accumulations of snow during this month and therefore it is normally assumed that significant changes will be made to the projected index supply when the April forecast is received.

April 1st through October 31st

Diversions are normally allowed to commence around April 1 but because of the normally cold springs and low demand, Compact obligations are usually made without any curtailment. As soon as the April forecast is received from the Natural Resources Conservation Service (NRCS) on or about the 7th of the month, the first comprehensive analysis is done to determine the projected index supply for the year. Upper index flows that have occurred through the end of March are added to the forecast (April–September) and to average flows for October through December. This will provide the first estimate of the annual index supply for each river.

From that estimate of the annual index, the obligation for each river is determined using the delivery schedules in Article III. Deliveries through the end of March are added to the normal (average) deliveries for November and December, the anticipated Closed Basin Project deliveries and the appropriate portion of the 10,000 acre-foot credit. The sum of those deliveries, subtracted from the projected obligation determines the amount of water needed at the stateline during the irrigation season (April–October). Adjustments to the amount needed are made for variables, which include Colorado’s accrued credits or debits, return flows, tributary inflows or accretions to the rivers.

Once the amount to be delivered during the irrigation season is determined, it is necessary to determine how much of the available index supply must be delivered on a daily basis to achieve the

desired delivery. This is accomplished by dividing the amount of delivery required by the amount of index supply available during the irrigation season. This quotient then represents the percentage of the daily available index supply that must bypass the Colorado diverters and be delivered to the stateline. Again, return flows, tributary inflows and groundwater accretions must be taken into consideration and the curtailment reduced accordingly or substantial over-deliveries can result. Weather conditions present of the greatest challenges for administrators as the weather can cause substantial changes to the index supply and the forecast, adding significantly to the delivery obligation. Late summer or early fall rainfall events can have very dramatic effects on administration and must be handled in a timely manner to prevent large under-deliveries. A study of delivery schedules shows that in higher years like 1999, the incremental amount of water that has to be delivered when an unexpected event occurs can reach as high as 90 percent of the increased amount of water indexed. Therefore, during the entire irrigation season it is imperative that a continual monitoring of daily administration occurs to ensure that the forecast is indeed tracking as was expected and that deliveries are being made accordingly.

November 1st through December 31st

Diversions on both the Rio Grande and the Conejos River are curtailed 100 percent if necessary to deliver water to the stateline to complete the remaining deliveries. Reservoirs are typically allowed to go into storage on November 1. Consultation with the water users on both rivers can result in some diversions extending into November if the Compact will be met with the remaining deliveries. In fact, six large ditches on the Rio Grande have obtained decrees to divert water to recharge the aquifers in the San Luis Valley to the extent the water is not needed to meet the Compact obligation. Typically, by no later than Thanksgiving, the winter weather has made diversions of water impossible and all diversions are concluded. Closed Basin Project deliveries are made to the river at the sustainable level necessary and in accordance with winter operations.

Because the Compact is river specific in Colorado, the process for determining curtailment percentages occurs independently for both the Rio Grande and the Conejos River and different curtailment percentages are applied to the two systems pursuant to the analysis described above. It is important to note this process relies heavily on forecasted inflows at least through the end of June. As the snowmelt runoff recedes, the summer thunderstorm activity or lack thereof begins to control the index supply for the remainder of the summer and fall seasons. The actual flows are not, and cannot be known until very late in the calendar year. While Colorado attempts to match the delivery requirement on an annual basis, over- and under-deliveries can and do result from inaccuracies associated with inflow forecasts and uncertainties associated with natural stream systems. These over- and under-deliveries are added or subtracted from the accrued debit or credit carried forward from previous years, and the resulting status as of January 1 of each year is considered in the following year's curtailment calculations.

The State of Colorado relies heavily on the coordinated forecast inflows to the basin that are developed and provided by the Natural Resources Conservation Service in cooperation with the National Weather Service. These forecasts are published monthly, typically beginning in January and ending in May or June. Since Colorado analyzes her Compact status and considers adjustments to the curtailment every 10 days, there is often a need for more up-to-date information, especially during periods of high runoff. Colorado has routine discussions with the Natural Resources Conservation Service and the National Weather Service concerning trends and intermediate forecasts prior to the release of updated monthly forecasts.

As previously discussed, the effect of applying a curtailment to the Rio Grande and the Conejos River is to make a percentage of the water flowing past the index gages unavailable for diversions such that it can be delivered at the stateline. As curtailment information is developed during the irrigation season, the calculated percentages are communicated to the appropriate water commissioners, who use this data in their water rights administration.

RESERVOIR STORAGE, TRANS-BASIN DIVERSIONS, AND COMPACT ACCOUNTING

Most reservoirs within the Rio Grande Basin in Colorado were constructed prior to signing and ratification of the Rio Grande Compact. As such, storage and releases by these reservoirs are not reflected in the Compact accounting performed by the State of Colorado. By contrast, reservoirs constructed after 1939 (“post-Compact” reservoirs) are subject to special Compact restrictions concerning how and when they can store water and require adjustments to observed flows at index gages during the accounting procedures. For example, operations at Platoro Reservoir, which is the largest post-Compact reservoir in the Basin, affect the flows in the Conejos River at the Mogote Index Gage. Observed flows at the Mogote Gage must therefore be adjusted (upward when the reservoir is storing water, and downward when it is releasing) in order to calculate accurately the Compact delivery obligation for the Conejos River.

Similar adjustments are made to streamflow gages affected by trans-basin diversions into the Rio Grande Basin. Annual storage, releases and evaporative losses by post-Compact reservoirs and Basin inflows from trans-basin diversions are explicitly accounted for in the administration of the Compact.

DAILY ADMINISTRATION

Once the water commissioners for each river have received the curtailment percentage for the next period of the season, they incorporate that requirement into the delivery of water to ditches. After determining the amount of native flow at the upper index station each morning, they apply the curtailment percentage to that flow and thereby establish what water has to bypass the ditches and flow to the lower index delivery points. The remainder of the water is distributed to the ditches on their river in accordance with their relative priorities. Because of the distance involved between the index gages and the ditches and delivery points, the delivery to them is time-lagged. The intermediate gaging stations on the rivers help the water commissioners track the

Compact water through the system. These gages also help establish return flows and tributary inflow that are available to help Colorado meet delivery requirements on both rivers.

Depending on the actual deliveries made during a 10-day period and considering what water is in transit, adjustments may be made to the curtailment. A monthly analysis of how the actual runoff compares to the forecast or how rainfall events may be affecting the annual index supply is also made. This continual updating and reevaluation provide Colorado administrators and water users the information to make informed decisions on if or how adjustments to the curtailment should be made. It also provides a process to assess the current conditions and if there have been changes from the assumptions used to establish the forecast. Extreme drought or flood conditions that change those assumptions are recognized and the administration varies accordingly. If normal summer and fall rainfall does not occur and lower than normal flows result, then the curtailment may be reduced. If the summer monsoon season provides vastly increased flows, then large increases in the curtailment may have to be made to remain current on deliveries. The 1999 season is a perfect example of how the curtailment must be increased due to significant changes in the river hydrology during the latter half of the year. As is very evident to the observer, the flows in the later summer months on the Upper Rio Grande were well above normal because of an unusual “monsoon” flow. This rainfall dramatically increased the index supply on the river and caused Colorado to increase the curtailment from 12 percent to more than 40 percent as the summer proceeded. The only way to compensate for the increased obligation from the increased index supply was to increase the curtailment. These types of unforeseen events show that without regular and routine monitoring and adjustment in operation, Colorado cannot expect to meet her obligation within reasonable tolerances. The vagaries in the hydrology and climate and the inability of man to predict weather in advance makes the administration of the Compact a dynamic and challenging process.

One of the goals of the State of Colorado is to try to determine the curtailment percentage that can be applied throughout the irrigation season so

that the resulting effect of that curtailment is applied evenly across the priorities as the hydrograph rises and recedes. Large changes in the curtailment within the season can transfer the effect of the Compact and disproportionately affect the water rights in the system. This issue is extremely important to the water users on both rivers who decided long ago that the impact of the Compact should be shared as uniformly as possible by the water rights that were in priority in any given year.

REMARKS

Since 1968, the State of Colorado has worked diligently to develop a methodology that allows her to meet her Compact obligation. The ability to do so is hampered by a number of variables that are either unknown or subject to change without notice. Thus a system has been developed that recognizes and accounts for these variables. The system also is flexible enough that changes can be made to maintain deliveries that are required. The original curtailment and changes to it during the year directly affect the water supply for many water-right owners on the Conejos River and the Rio Grande. It is extremely important for Colorado to utilize fully the entitlements allowed under the Compact. Colorado's entitlements provide water to over one-half of the irrigated land on the Rio Grande above Fort Quitman, Texas. That system has to be run without large reservoirs and is primarily a run-of-the-river operation. For this reason, it is critical for Colorado to analyze continuously and improve her methodology of Compact administration. Improved snowmelt runoff forecasting as well as improved weather forecasting would greatly enhance the ability of Colorado to meet her obligations while reducing its impact on water users. It is, and always will be, the variability and the unknowns of the hydrologic system that provide the challenges to administrators and users on the system.

The Administration of the Rio Grande Compact in Colorado

RIO GRANDE COMPACT TEN DAY REPORT

PRELIMINARY DATA

DATE: November 22, 1999

Period Ending: November 20, 1999

CBP Allocation: 60% as of 1/1/99

RIO GRANDE

(Units in Thousands of Acre-Feet)

Projected Annual Index: 918,000

Obligation: 351,200

% of Index: 38%

MONTH	RIO GRANDE INDEX SUPPLY		ADJUSTED DELIVERIES	
	Recorded Flow near Del Norte	Accumulated Total	Rio Grande Lobatos less Conejos-La Sauses *	Accumulated Total
JAN	13.3	13.3	17.6	17.6
FEB	11.3	24.6	17.1	34.7
MAR	22.5	47.1	12.8	47.5
APR	41.9	89.0	4.2	51.7
MAY	170.0	259.0	27.2	78.9
JUN	245.3	504.3	63.3	142.2
JUL	147.1	651.4	34.4	176.6
AUG	110.7	762.1	66.2	242.8
SEP	84.9	847.0	52.7	295.5
OCT	38.0	886.0	26.0	321.5
NOV 1-10	8.4	894.4	6.6	328.1
NOV 11-20	5.7	900.1	8.1	336.2
Annual Credit				
APR-SEP	799.9			
TOTAL	900.1		338.2	

* Deliveries include: Rio Grande Portion of Adjusted Closed Basin Project Production to Date **10,913 Acre-Feet.**

Delivery Target	(% of Index)	Estimated Curtailment of Ditches	(% of Index)
January 1 - March 14	100%	January 1 - March 14	100%
March 15 - May 7	10%	March 15 - May 7	0%
May 8 - July 13	17%	May 8 - July 13	12%
July 14 - July 21	20%	July 14 - July 21	17%
July 22 - August 5	33%	July 22 - August 5	30%
August 6 - September 2	40%	August 6 - August 23	Vol. Bypass
September 3 - October 18	50%	August 24 - September 2	30%
October 19 -	40%	September 3 - October 18	40%
		October 19 - 31	30%
		November 1 -	0% (recharge)

Respectfully submitted,

Steven E. Vandiver, Division Engineer, Division III

cc: Hal Simpson(3) Paul Clark Dennis Feinlee Jim Horton Bill Paddock
 Steve Baer Ralph Curtis Bob Robins David Harrison David Robbins
 Dale Pizel Roy Helms John Allen Davey Mike Gabaldon George Whitten

The Administration of the Rio Grande Compact in Colorado

RIO GRANDE COMPACT TEN DAY REPORT
PRELIMINARY DATA

DATE: November 22, 1999

Period Ending: November 20, 1999

CBP Allocation: 40% as of 1/1/99

CONEJOS RIVER

(Units in Thousands of Acre-Feet)

Projected Annual Index: 313,000

Obligation: 118,900

% of Index: 38%

MONTH	CONEJOS INDEX SUPPLY						ADJUSTED DELIVERIES		
	MEASURED FLOW			PLATORO SUPPLY			Conejos River at Mouths near La Sauses *	Accum. Total	
Conejos at Mogote	Los Pinos near Ortiz	San Antonio at Ortiz	Storage End of Month	Change in Storage	Supply in Month	Accum. Total			
JAN	2.7	---	---	21.7	0.2	2.9	2.9	5.6	5.6
FEB	3.1	---	---	21.9	0.2	3.3	6.2	5.5	11.1
MAR	5.9	---	---	22.8	0.9	6.8	13.0	7.2	18.3
APR	11.0	9.5	3.8	23.3	0.5	24.8	37.8	2.8	21.1
MAY	42.4	30.7	7.6	28.9	5.6	85.3	124.1	21.8	42.9
JUN	80.5	16.4	0.8	40.0	11.1	108.8	232.9	27.9	70.8
JUL	32.9	3.7	0.2	35.4	-4.6	32.2	265.1	8.9	79.7
AUG	18.7	4.6	0.4	38.1	2.7	26.4	291.5	12.6	92.3
SEP	13.7	1.9	0.1	33.5	-4.6	11.1	302.6	3.1	95.4
OCT	7.7	1.2	0.1	29.7	-3.8	5.2	307.8	2.1	97.5
NOV 1-10	1.0	---	---	29.7	0.0	1.0	308.8	0.7	98.2
NOV 11-20	0.9	---	---	29.6	-0.1	0.8	309.6	0.8	99.0
Annual Credit									
APR-SEP	199.2	66.8	12.9						
TOTAL	220.5	68.0	13.0		8.1	309.6		99.0	

* Deliveries include: Conejos Portion of Adjusted Closed Basin Project Production to Date

7,277 Acre-Feet

Delivery Target	(% of Index)	Estimated Compact Curtailment	(% of Index)
January 1 - March 8	100%	January 1 - March 8	100%
March 9 - April 6	0%	March 9 - May 7	0%
April 7 - May 7	10%	May 8 - June 15	20%
May 8 - August 25	20%	June 16 - 30	0%
August 26 - October 4	28%	July 1 - August 5	35%
October 5 -	0%	August 6 - 25	0%
		August 26 - 31	30%
		September 1 -	0%

The Administration of the Rio Grande Compact in Colorado

RIO GRANDE COMPACT
July 20, 1999 Analysis (Modified for Estimated Index)
Closed Basin Project Split: 60/40

RIO GRANDE BASIN

April - September Index

NRCS Forecast = 568,000
 DWR Forecast = 668,000

Index Supply

Index

In the bank: Apr - pres 554,500
 YTD 601,600

January - February 24,600 *
 March 22,500 *
 April 41,900 *
 May 170,000 *
 June 245,300 *
 July 1 - 20 97,300 *
 July 21 - September 113,400 estimate
 October 30,000 estimate
 November - December 30,000 estimate

Total 775,000

Obligation = 243,000

Deliveries

Delivery

In the bank: Apr - pres 113,600
 YTD 161,300

January - February 34,800 *
 March native 12,900 *
 April 4,500 *
 May 26,700 *
 June 63,000 *
 July 1 - 20 19,400 *
 July 21 - Oct native 41,600 needed
 Nov - Dec native 34,000 estimate

Total 236,900

Curtailment

Req Deliv 41,600 29.0%
 Native Index 143,400

Paper Credit 5,000
 SC Norton Drain Flow -5,500 estimate
 Remaining CBP Share 6,600 estimate

Total Required Delivery 243,000

Expected Overdelivery 0

- * = Actual measured flows (Deliveries include Closed Basin Project share)
- All values in acre-feet
- Assumes 60% of the Closed Basin Project flows are creditable to the Rio Grande (Projected delivery of creditable CBP production to the Rio Grande is 24,000 acre-feet)
- Assumes no recharge diversions after November 1, 1999
- Trinchera Creek flow to the Rio Grande will increase delivery

The Administration of the Rio Grande Compact in Colorado

RIO GRANDE COMPACT
July 20, 1999 Analysis (Modified for Estimated Index)
Closed Basin Project Split: 60/40

CONEJOS RIVER BASIN

DWR Estimated

April - September Index
Flows = 287,000

Conejos = 209,000
Los Pinos = 65,000
San Ant. = 13,000

Index

In the bank: Apr - pres 243,800
YTD 256,800

Obligation = 116,600

Index Supply

January - February 6,200 *
March 6,800 *
April 24,800 *
May 86,300 *
June 108,800 *
July 1 - 20 23,900 *
July 21 - September 33,200 estimate
October 10,000 estimate
November - December 10,000 estimate

Total 310,000

Deliveries

Delivery

In the bank: Apr - pres 58,700
YTD 76,800

January - February 11,000 *
March native 7,100 *
April 2,500 *
May 22,300 *
June 27,900 *
July 1 - 20 6,000 *
July 21 - Oct native 7,400 needed
Nov - Dec native 6,000 estimate

Total 90,200

Curtailment

Req Deliv 7,400 17.1%
Native Index 43,200

Paper Credit 5,000
SC Norton Drain Flow 5,500 estimate
Carryover Credit in E.B. 11,500
Remaining CBP Share 4,400 estimate

Total Expected Delivery 116,600

Expected Overdelivery 0

- * = Actual measured flows (Deliveries include Closed Basin Project share)
- All values in acre-feet
- Assumes 40% of the Closed Basin Project flows are creditable to the Conejos (Projected delivery of creditable CBP production to the Rio Grande is 24,000 acre-feet)