A Methodology and Synopsis Report Regarding

Surface and Ground-water Dynamics of the

Southwest Quarter of the San Luis Valley of Colorado

by

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Statement of Need

This report was implemented because of:

- The increasing importance and demand for water in the Southwestern United States,
- History of water disputes in the San Luis Valley and the likelihood of future disputes,
- A confusion of facts regarding the truth of water dynamics within the system,
- History of distrust of government, regarding the overall welfare of San Luis Valley residents,
- The impending creation of a new subdistrict in the southwest quarter of the valley and its need for clear facts regarding past and present water inflows, outflows and inventory.

Overview

The graph on page seven shows some of the problems when dealing with groundwater. The hardest thing so far has been to figure out the out-of-area connections of this water to areas to the north and east of the Rio Grande as well as possible underground outflows to the south. There seems to be more water in the system than the monitoring wells show. This water goes somewhere since the gaging stations account for its presence. This and other anomalies create challenges for statistical analysis.

Data and Statistical Confidence

Available data for the production of this report consists of:

- SnoTel data since 1983
- Precipitation bands in inches of water for the San Luis Valley and its mountain region
- Topographic map data
- Evapotranspiration data tables of four sites
- River gaging stations on the San Antonio, Los Pinos, Conejos, La Jara, Alamosa, and Rock Creek as well as inputs from the Rio Grande at the Monte Vista, Empire and Centennial canals.
- Confined and Unconfined monitoring wells
- Aquifer pumping rates from newly installed flow meters (not part of this preliminary report).
- Conversations with long-time valley residents.
- *In-situ* observation of wells and meadowland surface water levels

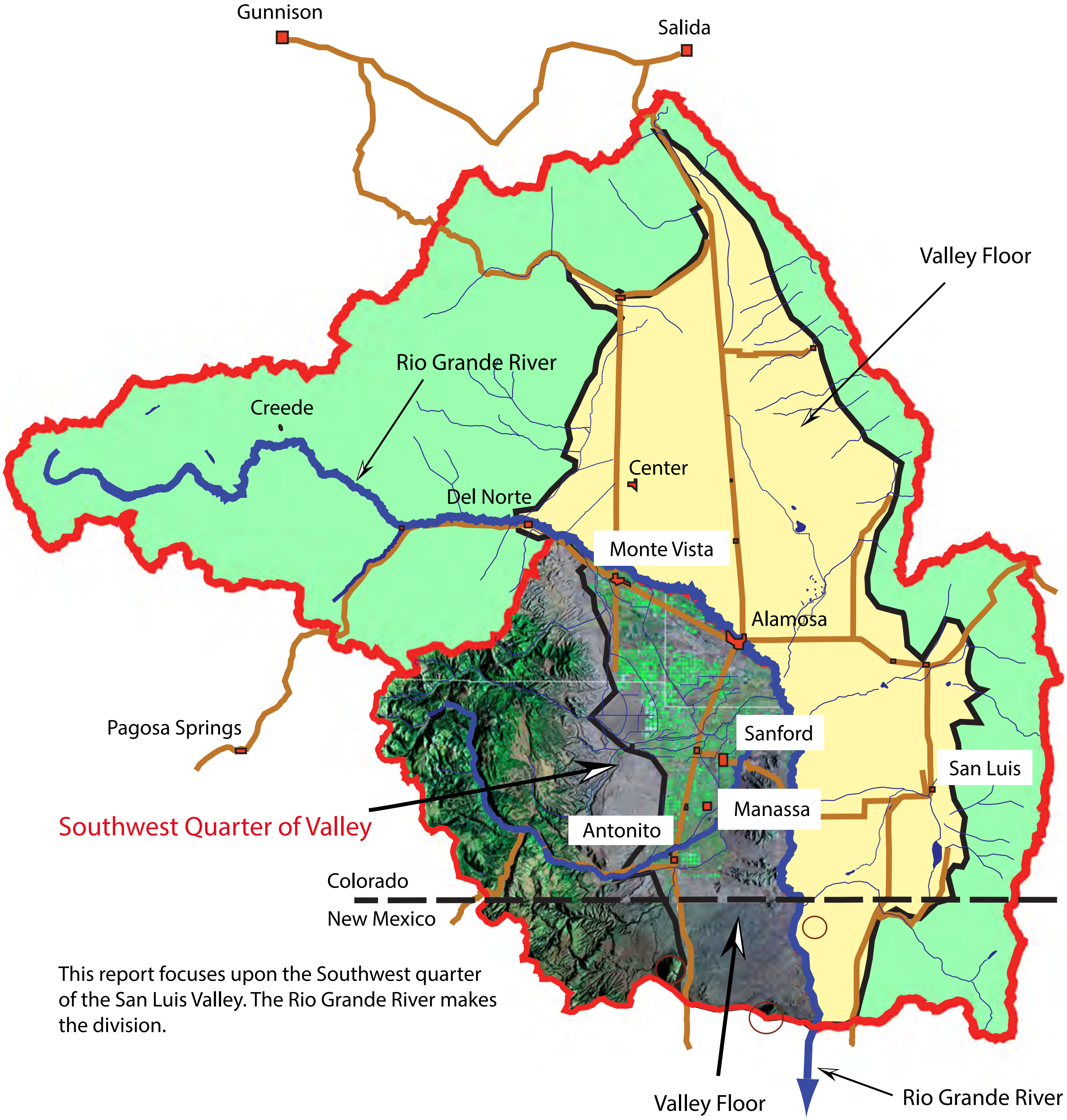
There is a finite maximum of confidence that the science of statistics allows regarding the formulation of numeric conclusions from disparate data sources. With these fundamental limitations in mind we may move forward as best we can.

Missing data may be extrapolated from existing data by way of algorithmic trending regarding past data sets or by way of bivariate data comparisons of partial data-sets with existing data-sets and then filling in of an average (in correlation to existing temporal data) to cover periods where no data measurements were taken. A certain confidence can be discovered from this by way of correlation coefficients (Pearsons) between two complete data sets and then moving to extrapolations in order to fill in missing data. If a positive correlation of .5 or better is seen then we can have reasonable confidence in our extrapolation.

The problem in the San Luis Valley is not within the analysis of surface water dynamics but in the comparisons of this with what is happening under the ground. This becomes even more complex because of the fact that we have a surface (unconfined) aquifer and a deep (confined) aquifer. The dynamics of groundwater interactions and flow-rates between these aquifers is largely unknown. Within the confined aquifer itself there are multiple blue-clay and confining layers interspersed within a largely unknowable interaction of geologic structures down to a depth of nearly 30,000 feet (though only the upper 2000 feet of this is relevant to valley irrigation and water supply).

To try and make sense of these interactions along with surface flow interactions within these aquifers tests the limits of statistical probability and interpretation to a maximum of extent. Still, numeric conclusions within a certain confidence are possible. Either way, we can only do what we can do and what is possible --- **which is our absolute best** considering the importance of the resource and the economic and environmental consequences that will ensue from whatever decisions the government and local subdistrict groups make.

San Luis Valley

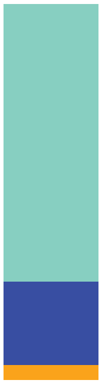


This report focuses upon the Southwest quarter of the San Luis Valley. The Rio Grande River makes the division.

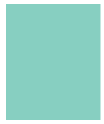
Southwest corner of San Luis Valley

Water Inventory (inflow/outflow) based
upon 1978-2000 year average.
(all values are in acre/feet per year)

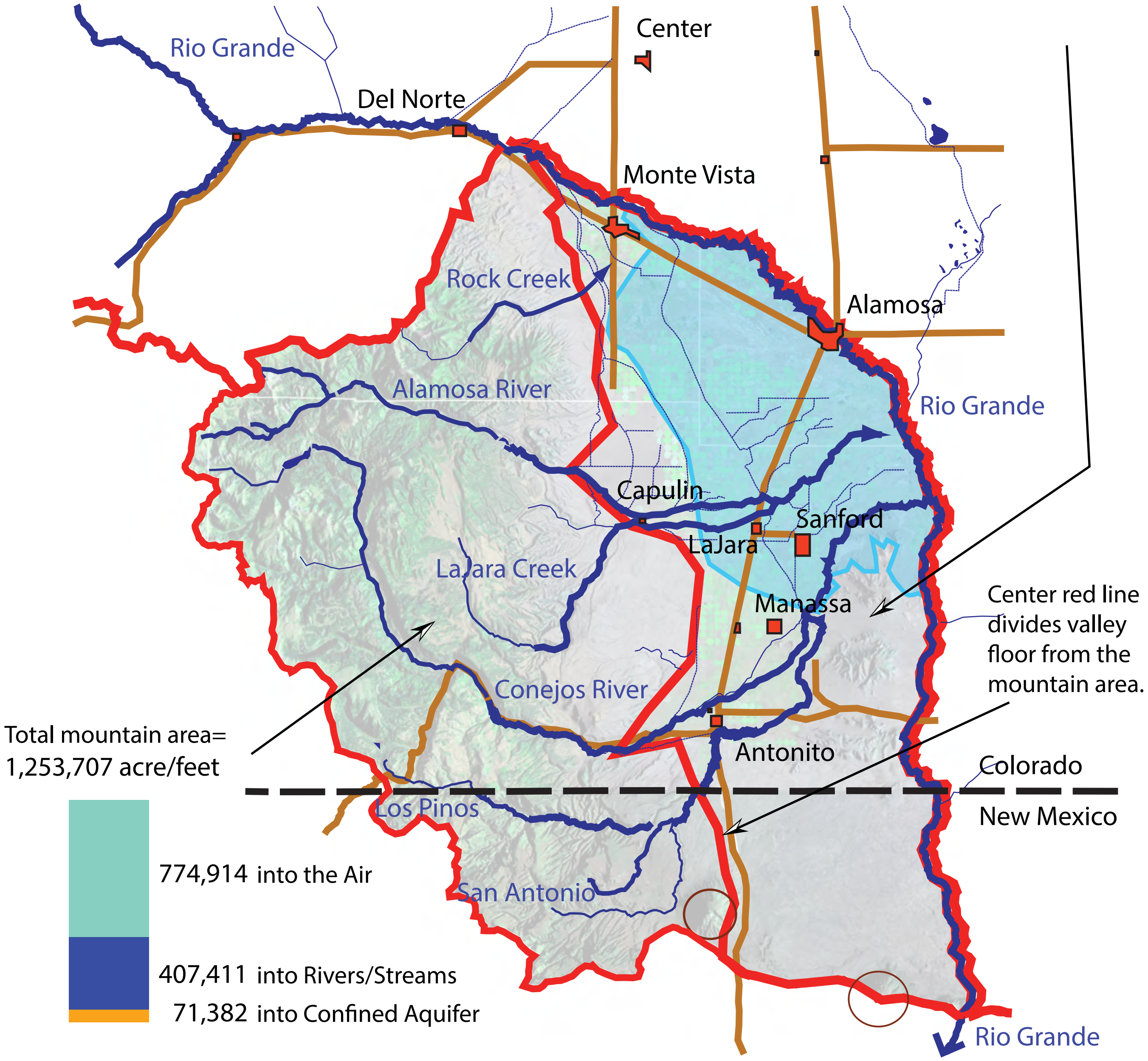
Total Area = 1,811,627 gross acre/feet per year



Total valley floor =
557,920



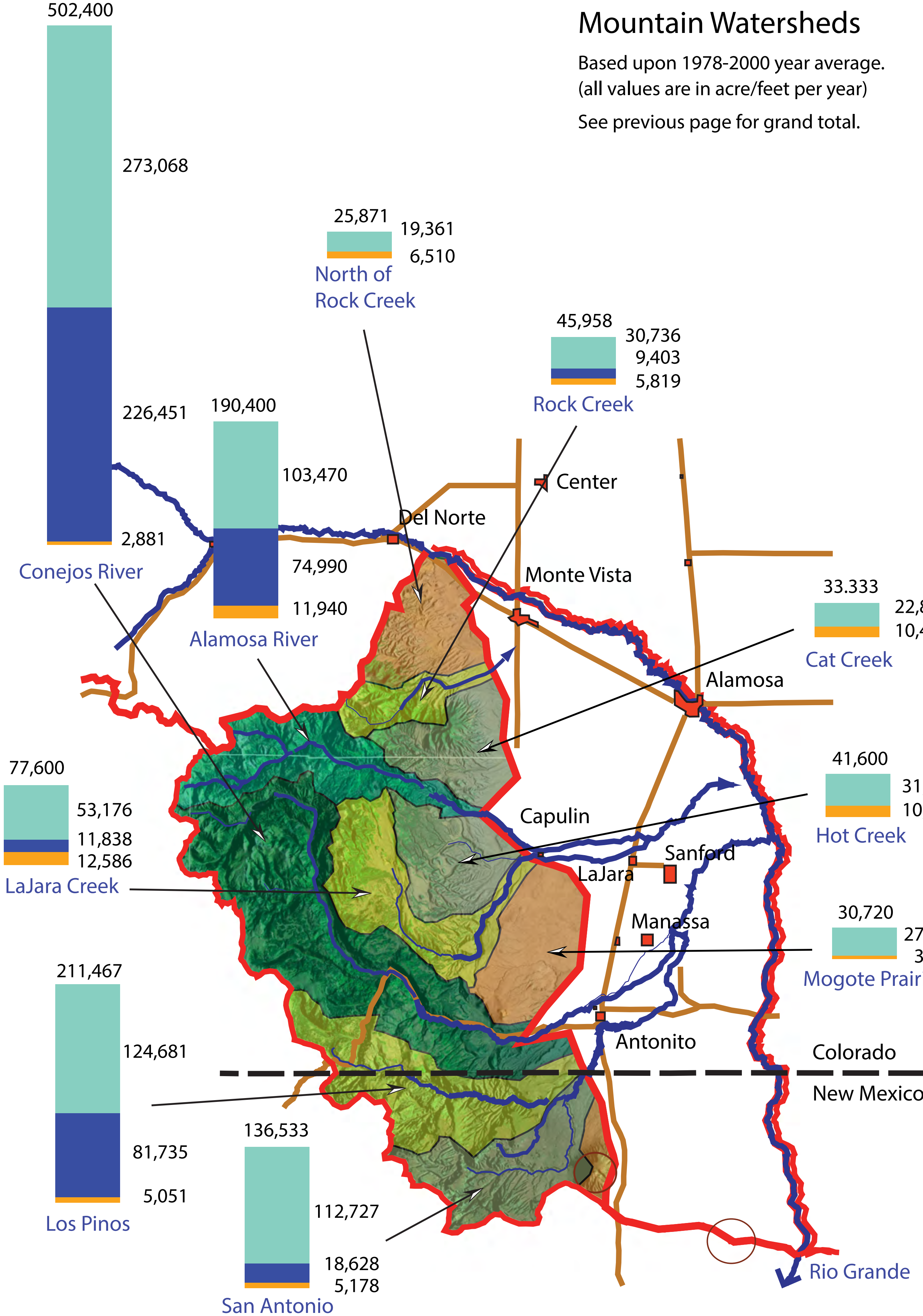
Note: Nearly (99%) of valley floor precipitation - evaporates, sublimates, or evapo-transpirates.



Mountain Watersheds

Based upon 1978-2000 year average.
(all values are in acre/feet per year)

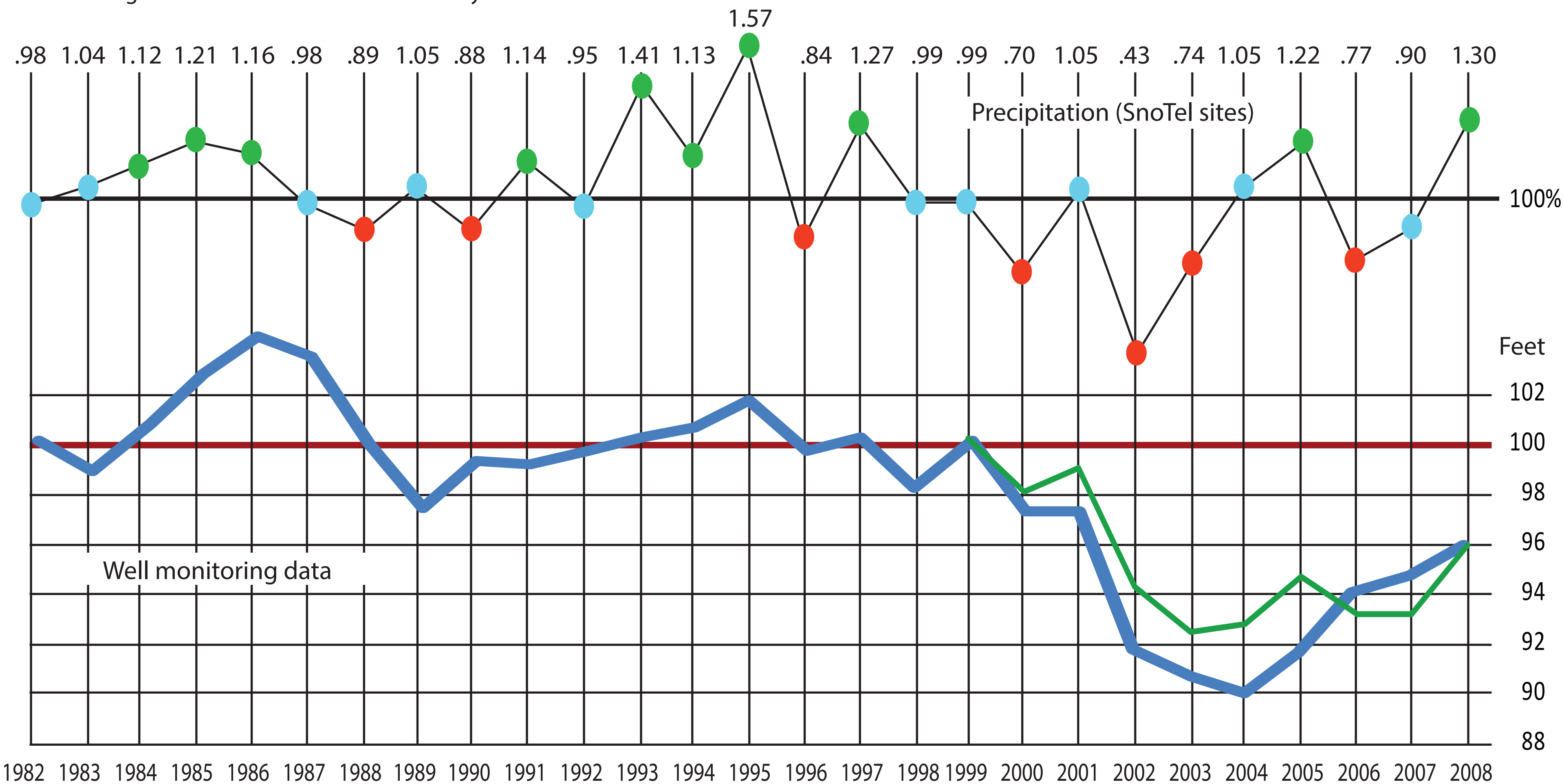
See previous page for grand total.



Confined Aquifer and Precipitation Graph (South of Rio Grande)

In an ideal world where this entire area was an enclosed system and underground aquifers were just one big lake, then the green and blue lines would be identical. As you can see they are not. The blue line of actual well height data shows more water being withdrawn than can be accounted for. The green line shows what wells would show if surface water conditions translated underground. This is the complexity of underground waters of the San Luis Valley.

SnoTel's are an average of Cumbres, Lily Pond, Greyback and Wolf Creek sites averaged over November through June months. Higher years are shown in green, average in blue and poor years in red.



Well height in feet (shown by the blue line) averages ***eleven wells in the confined aquifer south of the Rio Grande***. The number 100 is calculated to be the average of all the wells from year 2000 backward as far as readings were kept.

Future confined aquifer recharge and maintenance chart

Preliminary conclusions show that if we have a completely average year of SnoTel precipitation (SnoTel average is based on the averages of years 1978-2000); and if farmers pump an exact amount averaged per year since the year 2000, then the confined (deep) aquifer receives a net recharge of 54,847 acre feet of water for that year. This is within the southwest quarter of the San Luis Valley as shown on previous maps.
Calculations show that one foot of well water averaged over the same part of the valley equates to 34,800 acre/feet of water. Our wells show an average of four feet below normal is an average from the years leading up to the year 2001); this means that we are 139,200 acre/feet short at the beginning of year 2009. This means that if we recharged at the normal rate of 54,847 acre/feet per year and pumping remained normal (no more) then it would take 2.5 years (actually 3 years) to bring the aquifer back to normal. This may seem too optimistic to a large group of people and possibly it is since connections to the confined aquifer north of the Rio Grande are not taken into account at this point nor is well flow data considered in this report. Both parameters will be included in the final report scheduled for early 2010.

Grand Total Average Year Aquifer Recharge in acre/feet = 143,410

Average Year Withdrawn (pumped) from Aquifer = 88,563

Net left over to recharge the aquifer = 54,847

To continue to recharge the aquifer at the rate of 54,847 acre feet when SnoTel sites average below normal then pumping would have to be reduced by the corresponding percents as shown below.

SnoTel percents of average	Pumping percent of average
100	100
99	97
98	94
97	92
96	89
95	87
94	84
93	81
92	78
91	76
90	73
89	70
88	68
87	65
86	62
85	60

Excel Spreadsheets showing the algorithms for these correlations are available free from this analyst .

To maintain an already recharged aquifer at its present level when SnoTel sites average below normal then pumping would have to be reduced by the corresponding percents as shown below.

SnoTel percents of average	Pumping percent of average
anything greater than or equal to 77	100
76	97
75	94
74	92
73	89
72	87
71	84
70	81
69	78
68	76
67	73
66	70
65	68
64	65
63	62
62	60

Summary:
These numbers could change substantially when flow rate data is analysed near the end of year 2009. Also, interactions between the confined aquifer to the south of the Rio Grande and that north of the Rio Grande is not part of these equations and could show significant effects --- very likely to the negative. So the disclaimer of this preliminary report is that these present numbers could likely be too optimistic, even on the order of 20-30%. I'm sure Mr. Wolfe and Sullivan from the Denver office might think so.
However, it is certain that whatever the final data and analysis shows and after rigorous peer review, it is possible that final numbers (if there is such a thing) might not be too different from those of this preliminary report. It is important to keep in mind that this analyst guarantees the integrity of analytical and statistical procedures as well as data collection which is double and triple checked for accuracy.