To: Ray Alvarado, Colorado Water Conservation Board

From: Colorado River Basin Roundtable
Submitted by Jim Pokrandt, chair

Regarding: Comments on Phase 1 of the Colorado River Water Availability Study

Date: July 21, 2010

The Colorado River Water Availability Study intends to answer the following question:

How much water from the Colorado River Basin System is available to meet Colorado's current and future water needs?

Phase 1 considers existing water uses, and Phase 2 intends to include absolute water rights that are not being used and conditional water rights (water rights that have not yet been exercised but which have a senior priority date in the event they are later exercised). Phase 1 concluded that 0 to 1 million acre feet of water in the Colorado River is available for further development in Colorado. To derive this range, the CRWAS considered 112 different climate projections for 2040 and 2070. Five of these projections were chosen because they represent the full range of future water available under the 112 climate scenarios.

The Colorado River Basin Roundtable submits the following comments after reviewing a draft of the Phase 1 report.

The draft report is available at http://cwcb.state.co.us/NR/rdonlyres/49D5DEE3-C6DF-4D6C-80C9-4F21284ACD9F/0/20100322_CRWAS1_Task10_Phase1Report_Draft.pdf

1. The 0-1 million acre foot range lends itself to political mischief. The CRWAS Executive Summary concludes that "Phase 1 demonstrates a broad range of water availability;" CRWAS Executive Summary, p. vii. This conclusion leaves the reader with no feel for what scenario is most likely. The five scenarios were apparently chosen because they show the most likely range of possible outcomes, not because they are the most likely scenarios. The result is that the Phase I report can be quoted as authority that there is no water left to develop, or that there is 1 million acre feet left for development. This ultimately means that any decision to develop

additional water supplies could be a political one, and not one based on science.

It could also justify a decision to not do anything: it could permit Colorado water policy makers to keep avoiding the hard questions that the Colorado River Basin Roundtable believes should be asked regarding (1) land use and xeriscape requirements, (2) agricultural to municipal transfers, (3) oil shale development, or (4) pumpback proposals to pump water in the Gunnison, Colorado, and Yampa River Basins to the Front Range.

The CRWAS Phase 1 study is inconclusive, but the data shows a host of possible scenarios and the Colorado River Basin Roundtable is especially concerned that the most likely scenario under existing uses is that shortages and gaps will occur. The Colorado Basin Roundtable recommends that the 0-1 million acre foot range be discussed in terms of risk, as Colorado River District General Manager Eric Kuhn has advocated. If additional water supplies in the Colorado River are developed, what is the risk that these supplies will be called out and curtailed in the future, and what is the risk that prior senior water rights could be called in order to meet Colorado's delivery requirements under the Colorado River Compact?

2. Reservoir evaporation must be subtracted from available water supplies. The suggestion that one million af is still available for development is misleading since it fails to account for the expected 200,000 af evaporation loss from Lake Powell and Flaming Gorge Reservoirs and the Aspinall Unit. After subtracting these evaporation losses, the projected range is 0 to 800,000 af, and this is the range that should be quoted in future publications and discussions.

3. The water demands of an oil shale industry have not been considered in Phase I and must be incorporated into Phase II.

4. Nonconsumptive uses for environmental and recreational flows have not been considered. Phase 1 has only considered water rights in which the water is consumed; it has not considered nonconsumptive water rights or needs. The final draft of the Water Availability Study should not be released until the Nonconsumptive Needs Analysis has been completed and integrated into the Water Availability Study. The scoping process for Phase 2 of the WAS should include the Nonconsumptive Needs Analysis.

Nonconsumptive needs should not be at risk while municipal water rights are considered sacrosanct.

5. More detail is needed about where the additional supplies will come from. Specific sources for the 0-1 maf range should be indentified so that their impact can be gauged: What rivers are targeted and when will diversions be made.

6. Phase 1 assumes that all future climate projections are equally probable. Phase 1 concludes that 100 randomly generated sequences of annual precipitation based on 56 years of water flow records from 1950-2005 is adequate to provide a full range of potential future water supply scenarios; Executive Summary, page III. This is a statistical technique known as a Monte Carlo analysis. It is used commonly in investment research, especially to estimate the effects that withdrawals will have on investment fund balances and the likelihood of outliving one's money. Many, like Warren Buffet, believe that too much attention is paid to it, and that it is misleading because it treats every scenario as having an equally likely chance of occurring, and because it assumes all distributions are normal. MIT professor Bernard Mandelbrot who researches fractals believe that Monte Carlo simulations and other statistical techniques underemphasize extreme events.

   Precipitation in the last 56 years is at the upper range of the amount of precipitation that has occurred over the past 1,300 years as illustrated by tree-ring studies. The past century is probably not a reasonable guide for future water management even if the climate wasn't changing; see *Global Climate Change Impacts in the United States*, Thomas R. Karl, Jerry M. Melillo, and Thomas C. Peterson, (eds.), Cambridge University Press, 2009, p. 49. Mega droughts lasting several decades from 900-1300 AD were substantially worse—over 40% of the West was in drought from 900-1300 AD, while under 30% was in drought from 1900-2000.

   Treating every potential future precipitation scenario as equally likely needs to be justified. Three of the five precipitation scenarios chosen in Phase 1 indicate that no water is available for future consumption. By suggesting that 1 million acre feet may be available can falsely lead policy makers to underemphasize the risk that no additional Colorado River water is available for future consumption.

7. Global Climate Models (GCMs) specific to the Colorado region are needed. The Executive Summary on page IV suggests that more detailed Global Climate Models are needed. Susan Hassol, a scientist in Basalt and Senior Science Writer of *Global Climate Change in the United States*, states that weather modeling is particularly difficult in mountainous areas. In a talk at the Aspen Center for Environmental Studies on May 1, 2010, she commented that most climate models suggest that the southwest continental US will have less precipitation, while the northwest may have more. Colorado is at the junction of where the lower and higher precipitation model predictions intersect, but only the far northern part of the state is expected to have more precipitation.

   Scientists whose contributions are reported in *Global Climate Change in the United States* strongly suggest that the entire state of Colorado will have less precipitation except for the Yampa-White river basins:

   a. Storm tracks will move northward, with the result that dry areas will become dryer and wet areas will be come wetter (p. 42);

   b. Mid continental areas (eastern Colorado) and the Southwest (western Colorado) are particularly threatened by future drought (p. 45);

   c. Earlier runoff will produce lower late-summer streamflows, which stress human and environmental systems because less water is available and temperatures are higher (p. 46);

   d. Numerous studies over the past 30 years have indicated that the Colorado River is likely to experience reductions in runoff due to climate change (p. 51);

   e. Water is being pumped from the Ogallala aquifer faster than it can recharge, suggesting that less water will be available for the Front Range even if agriculture dry ups continue (p. 125);

   f. Recent warming in the Southwest including Colorado is among the most rapid in the nation, significantly more than the global average in some areas (p. 129);

   g. Runoff during the early 1900s, upon which the Colorado River Compact calculations are based, turned out to be part of the greatest and longest high-flow period of the last five centuries (p. 130);

h. The Southwest remains in a drought that began around 1999. This event is the most severe western drought of the last 110 years, and is being exacerbated by record warming. The most likely future for the Southwest is a substantially drier one (p. 130);

i. Temperature increases have made the current drought in the Southwest more severe than the natural droughts of the last several centuries (p. 130);

j. Paradoxically, a warmer atmosphere increases the risk of flooding, both because runoff begins sooner and because extreme weather events will be more likely. The greater flooding potential means reservoirs cannot be filled to capacity since reservoir space must be reserved for flood events. This happened in the Roaring Fork Valley in June 2010 when, despite an average snowpack of only 75% on May 17, the Roaring Fork River on June 10 reached its highest levels since 1995, a high snow year (p. 133)

These studies, coupled with the fact that it is difficult to model in mountainous areas, makes suspect any prediction of future precipitation in the Upper Colorado River Basin. **The Colorado Water Availability Study must be based on regional studies of future water availability that are specific to Colorado.**

8. Drier 2070 projections should be used. Table 1, the Phase 1 Technical Approach Summary reported on page V of the CRWAS Executive Summary, ignores the drier 2070 projection, since it states: "Subsequent analysis of the selected projections showed that the 2040 projections were representative of streamflow conditions at both time frames, while the 2070 projections were biased toward dry conditions. For this reason the 2040 projections are used." This is an example of irrational bias. The five selected future climate models showed more precipitation in 2040 than in 2070, so Phase I ignores and discounts the drier 2070 projections. Query whether Phase I would have ignored the 2070 projection if it had been wetter than the 2040 projection? Planning and development based on short term precipitation gains while ignoring the longer-term outlook for drier conditions makes no sense. It will only insure that water supply problems will be worse, not better, after 2040.

9. What is the definition of "basin-wide?" Table 2, the Primary Phase 1 Findings Based on 2040 Climate Projections reported on page VI of the

CRWAS Executive Summary, describes a variety of changes expected for the Colorado River Basin. These include temperature increases of 3.3 to 3.7 degrees Fahrenheit, increased winter precipitation of 6-13%, decreased summer precipitation of 4-10%, and an increased crop irrigation requirement of 20%. Does *basin-wide* refer to just the Upper Colorado River Basin within Colorado or the entire Colorado River Basin? If it refers to the entire Colorado River Basin, it could matter significantly if most of the projected 6-13% increase occurs in the Green River Basin. The climate change models suggest this, as stated above, because more precipitation is expected to fall in the northwest and less in the southwest, and Wyoming is north of Colorado. In that case, more water could be diverted from the Upper Colorado River Basin but in fact less water is available, resulting in lower flows for agriculture and nonconsumptive uses. **River health and agricultural production could decrease dramatically under a scenario of more diversions and decreasing native supply.**

10. Increased agricultural consumption could utilize the entire increased winter precipitation. Agricultural consumption is about 70% of Colorado statewide consumption, which means that the 20% projected increase in irrigation will increase agriculture's share of statewide consumption by 14%; see Table 2, p. vi of the CRWAS Executive Summary. This is more than the 6-13% entire Colorado River Basin winter precipitation increase that is projected under the most positive scenarios in 2040.

11. The CRWAS fails to consider non-consumptive needs. In general, stream flows decrease statewide; see Table 2, p. VI of the CRWAS Executive Summary. This is at odds with Phase I's general conclusion that up to a million acre feet may be available for future development. The suggestion that stream flows will increase in April and May is likely a transitory phenomenon, reflecting the earlier runoff. Lower flows in the later summer and fall months can cause drastic reductions in river health if minimum flows aren't preserved. **The CRWAS should calculate the stream flows needed to maintain healthy rivers year-round before concluding how much additional Colorado River water is available for development. This includes minimum and optimal flows, flushing flows and occasional high flows for riparian health. These stream flows need to be considered as a legitimate demand on the calculated water available for development.**

12. Dust events. Dust accumulations on snow will exacerbate the earlier runoff, and the snowmelt runoff will largely take place before the summer irrigation season. **Phase I should incorporate the effect that dust accumulations have on runoff which, though recent, are obvious to West Slope residents.**

13. Whether higher elevation streamflows increase or decrease must be clarified. The CRWAS concludes that "Higher elevations generally have less flow available;" see Table 2, p. VI of the CRWAS Executive Summary. This conflicts with the conclusion stated immediately above in Table 2 that "Annual modeled streamflow decreases basin-wide, expect in the Yampa River basin, and higher elevation locations in the Upper Colorado River basin." The latter sentence suggests that upper elevation streamflows in fact increase.

14. "Reservoir use" must be clarified. The phrase "Reservoirs show increased use" in Table 2, p. vi of the CRWAS Executive Summary is misleading, since it is not clear whether "increased use" refers to increased use by recreationists or increased fluctuations resulting from increased draw downs in summer months. These uses are generally incompatible as attested by recent draw downs in Dillon and Powell Reservoirs that rendered them unsuitable for boating. If increased use refers to increased fluctuations, then the statement should read, "Reservoirs show increased fluctuation."

15. 10825 Water is not absolute. Phase 1 states that the USFWS fish flow recommendations for the 15-mile reach above the confluence of the Colorado and Gunnison Rivers are junior to other basin demands, and that they therefore decrease the reported water available for future diversion from the Colorado River; CRWAS Executive Summary, p. viii. This is a recommendation to eliminate 10,825 Water as an absolute water right, since it is junior and may not run every year. **If 10825 Water is not shown as an absolute water right and it is available for further diversion, CRWAS Phase 1 should state what impact this will have to the four endangered fish that are protected by these flows.**

16. San Juan fish flows are also junior and not absolute. CRWAS Phase 1 states that flows needed for the San Juan Recovery Program are junior and that by showing them as absolute, reduce the water available for further diversion. **If San Juan Recovery Program flows are not shown as**

an absolute water right and are therefore available for further diversion, CRWAS Phase 1 should state what impact this will have to the four endangered fish that are protected by this right.