PHASE II GUIDANCE DOCUMENT

Why the Roaring Fork Watershed Plan Matters

October 15, 2008

Roaring Fork Watershed Plan, Mission Statement:

> *To assist local, state, and federal agencies and organizations to efficiently plan and manage for land and water uses within the Roaring Fork Watershed.*

Preface

With Phase I complete, the Roaring Fork Watershed Plan is at a critical juncture. Phase I produced the State of the Watershed Report, a comprehensive analysis of the current status of water quality, water quantity, and riparian and instream habitat conditions within the watershed, as well as an overview of water management issues at both the local and state level. With the State of the Watershed Report as the foundation, Phase II of the plan will call on interested stakeholders to work together to generate objectives and recommendations for the future management of the Roaring Fork Watershed. The move from Phase I to Phase II will involve a conceptual shift for the project and require a number of new people to become actively involved in the planning effort.

This "Guidance Document" is intended to generate momentum for the collaborative effort that Phase II will require. This document attempts to explain exactly why the Roaring Fork Watershed Plan matters, particularly in the context of current regional and statewide developments. This document is not intended to provide a legal analysis of the issues, or advice or opinion on a course of proceeding. It is simply an attempt to galvanize interested stakeholders to participate in, and contribute to, the Roaring Fork Watershed Plan as it enters its second and most critical phase.

Why the Roaring Fork Watershed Plan Matters

The Roaring Fork Watershed Plan presents a unique opportunity for local governments, water providers, residents and other interested stakeholders to participate in the creation of a cohesive, holistic plan for the future development and conservation of the valley's water resources.

First, from a political standpoint, the Roaring Fork Watershed Plan constitutes a local component of the state government's long-term management plan for Colorado's water resources. The watershed plan provides stakeholders with the opportunity to help formulate the state's policy for the future development and use of the watershed's water resources.

Second, from an economic standpoint, the watershed plan offers a means for interested stakeholders to influence the free market forces that will largely determine how Colorado's remaining available water is allocated as the state continues to grow over the next several decades.

Finally, Colorado's water supplies are defined by variability, a trend that is likely to be magnified by global climate change. Given the complexity and uncertainty of this challenge, the Roaring Fork Watershed Plan is a means of ensuring that climate change and the inherent variability of western water supplies is not overlooked as Colorado prepares for subsequent decades of growth and water management.

Colorado Water Resource Management

The Interbasin Compact Process – The New "Bottom-up" Approach

Colorado is facing significant challenges as the state enters the 21st century – challenges that are already leading the state to reconsider the fundamentals of its historical approach to water resource management. The dramatic statewide population and economic growth that is anticipated for the next two decades is expected to exert new pressures on the state's already strained water supplies. In response to such projections, the state has adopted an innovative planning process, known as the Interbasin Compact Process, which gives local water interests a far greater role in developing a vision for the future of Colorado's water resources.[i]

The Interbasin Compact Process has its origins in the drought of 2002, the driest year on record for Colorado and a year in which rivers around the state ran dry.[ii] In the wake of this drought, the 2003 Colorado General Assembly passed Senate Bill 03-110, authorizing the Colorado Water Conservation Board (CWCB) to conduct the Statewide Water Supply Initiative (SWSI).[iii] With a $3 million budget, CWCB was directed to oversee a basin-by-basin study of "all aspects of water supply and water demand in Colorado over the next thirty years."[iv] Phase I of SWSI was completed in November, 2004.

The SWSI Phase I Report provided a detailed account of where and why Colorado would likely experience severe water shortages in the future. Specifically, the report included projections from the Colorado Department of Local Affairs estimating that the state's population would grow from just over 4.3 million residents in 2000 to approximately 7.1 million in 2030.[v] Due to the increased municipal water demand associated with this population growth, the report identified a 20 percent shortfall (118,200 acre-feet) between projected statewide water demand and supplies.[vi] Indeed the study recognized that this was a conservative estimate and that the actual shortfall could in fact be far greater.[vii]

Having authorized SWSI, state government was forced to confront the study's alarming findings.[viii] In 2005, the General Assembly passed the *Colorado Water for the 21st Century Act*, formally establishing what is now commonly referred to as the Interbasin Compact Process.[ix] The state government recognized that given the increasing complexity and contentiousness of statewide water management, a new approach – one with a far greater emphasis on public involvement – was necessary to address future statewide water demand.[x] In particular, the state acknowledged the need to "provide Colorado's water users with a means of addressing potential conflicts among themselves."[xi] The

Interbasin Compact Process was intended as a "locally driven process where the decision-making power rests with those living in the state's river basins."[xii]

Understanding the Interbasin Compact Process is essential to understanding how members of the public can influence decisions on how Colorado's water resources will be developed and conserved. The framework of the Interbasin Compact Process, outlined in the *Colorado Water for the 21st Century Act*, begins with nine "basin roundtables," one for each major river basin in the state, plus one for the Denver metro area.[xiii] The basin roundtables are comprised of members nominated and chosen by a wide range of local regional interests.[xiv] To each basin roundtable, the General Assembly delegated three specific responsibilities:

1. Develop a basin-wide consumptive and nonconsumptive water supply needs assessment;
2. Conduct an analysis of available unappropriated waters within the basin; and
3. Propose projects or methods, both structural and nonstructural, for meeting consumptive and nonconsumptive needs and utilizing any unappropriated waters, "where appropriate."[xv]

These responsibilities give each of the basin roundtables a considerable degree of responsibility for setting the direction for future development of water resources within their respective basins. And while basin roundtables are required to use the results from SWSI as the starting point, they can address local and regional interests by incorporating additional sources of reliable information into their assessment.[xvi] The By-Laws for the Colorado Basin Roundtable specifically include "any other local and regional water supply/demand studies and studies addressing the environmental, economic and social impacts associated with changes in allocation and use of water resources" among the sources to be used for a basin-wide water needs assessment.[xvii]

In order to facilitate the process of interbasin compact negotiations, the *Colorado Water for the 21st Century Act* also established an Interbasin Compact Committee (IBCC), comprised primarily of representatives from each of the basin roundtables.[xviii] The IBCC has the authority to ratify legally-binding compacts and other agreements between roundtables.[xix]

The Interbasin Compact Process represents a departure from Colorado's traditional approach to water resource management, but it does not supplant established Colorado water law. To reassure stakeholders with vested water rights that the Interbasin Compact Process will not interfere with their constitutionally protected right to appropriate water, the General Assembly added the following provision to the *Colorado Water for the 21st Century Act*:

> It is the policy of the general assembly that the current system of allocating water within Colorado shall not be superseded, abrogated, or otherwise impaired by this article. Nothing in this article shall be interpreted to repeal or in any manner amend the existing water rights adjudication system. The general assembly affirms the state constitution's recognition of water rights as a private usufructuary property right, and this article is not intended to restrict the ability of the holder of a water right to use or to dispose of that water right in any manner permitted under Colorado law.[xx]

Rather than changing the law, the Interbasin Compact Process is intended to allow the State of Colorado to develop its remaining available resources, in accordance with state water law, in a coordinated, efficient manner.[xxi] Simply put, neither the basin roundtables nor the IBCC have the authority to challenge Colorado's established water law.

With the framework of the Interbasin Compact Process developed in the *Colorado Water for the 21st Century Act*, the General Assembly next provided the financial funding for the system. In the 2006 legislative session, the General Assembly passed Senate Bill 06-179, which authorized the State Treasurer to annually transfer $10 million from the Severance Tax Trust Fund to the newly-formed Water Supply Reserve Account (WSRA).[xxii] The CWCB

oversees the account, but the funds are specifically reserved for studies and projects that have been endorsed by one of the basin roundtables as furthering their specific mandated responsibilities.[xxiii]

Any public or private entity can apply to CWCB for funding.[xxiv] After a proposal receives the support of the roundtable for the basin in which the project would occur, CWCB will conduct its own review of the request and make a final decision regarding funding.[xxv] Under Senate Bill 06-179, CWCB must take into account, among other criteria, whether the specific proposal will contribute to the larger, statewide effort to address future water supply demand.[xxvi] Once approved, the applicant enters into a legally-binding contract with CWCB for completion of the project.[xxvii] Thus, while the program is administered by the state, the recipient of WSRA funding, acting as the state's agent, oversees the actual work.

Through this system of locally-developed, state-approved water planning, the Ruedi Water & Power Authority (RWPA), an intergovernmental entity comprised of representatives from the counties and municipalities within the Roaring Fork Valley, became lead sponsor of the Roaring Fork Watershed Plan. In March of 2007, with the support of the Colorado Basin Roundtable, CWCB formally approved a grant of $40,000 for Phase I of the watershed plan.[xxviii] This past May, CWCB approved another $40,000 for Phase II.[xxix] When complete, the Roaring Fork Watershed Plan will be integrated into the Colorado Basin Roundtable's assessment of the consumptive and nonconsumptive water supply needs for the Colorado River Basin – influencing how the state administers the region's water resources over the next two decades.[xxx]

The Roaring Fork Watershed Plan is therefore not just another study. Rather, it is an opportunity for interested stakeholders (from anywhere within the state) to help set the direction for long-term management of the Roaring Fork Watershed's water resources.

Free Market Forces

As the Interbasin Compact Process identifies available water resources and sets the direction for future development, both public and private water interests around the state will respond. In particular, the two basins on the Front Range, the South Platte and the Arkansas, will need to secure additional sources of water to meet their future demands. On the West Slope, the oil and gas industry is preparing for major expansion of its operations, possibly increasing its future water needs. Finally, the Colorado River Basin is expected to experience some of the fastest population growth in the state, requiring not only additional municipal water supplies but also further land development. Amidst these rapidly changing circumstances, the Roaring Fork Watershed Plan will be a valuable tool for both preparing for, and dealing with, statewide developments.

The Colorado River Water Availability Study

In May of 2007, the General Assembly approved Senate Bill 07-122, authorizing the Colorado Water Conservation Board (CWCB) to conduct what is now referred to as the Colorado River Availability Study (or simply, the Availability Study).[xxxi] The Availability Study is intended to provide the definitive answer to a single, critical question: "How much water from the Colorado River Basin System is available to meet Colorado's current and future water needs?"[xxxii] As the state grapples with the potential demand of 2.8 million new residents by 2030, the answer to the seemingly simple question of the amount of water available in the Colorado River Basin is of utmost importance.

The Availability Study will provide an in-depth estimate of the amount of potentially developable water in the Colorado River system, including all of its major tributaries such as the Gunnison, Yampa, White, and San Juan rivers. Taking into account factors such as natural variations in hydrology, climate change, and differing legal interpretations of interstate compacts, the study is expected to identify both the amount and the location of water in the Colorado River Basin that is potentially available for the state's future water need.[xxxiii] Ultimately, this information is

intended to "provide valuable input" to basin roundtables around the state in evaluating "various water supply alternatives."[xxxiv]

Given that the Roaring Fork River is the second largest tributary in the state to the Colorado River, the Availability Study could identify the Roaring Fork Watershed as one of the more important water resources for meeting future statewide water demand. Such a finding would have far-ranging implications for the watershed, from renewed interest in transmountain diversion projects to further investment by the oil and gas industry in local water resources. With the initial results of the Availability Study expected sometime next summer, it is critical that interested stakeholders be aware of, and prepared for, the study's potential implications for local water resources.

Front Range Water Interests

The Statewide Water Supply Initiative (SWSI) found that while Colorado, as a state, was not prepared to meet future water demand, the Front Range was particularly at risk of experiencing severe water shortages before 2030. According to the SWSI Phase I Report, most of the state's projected 2.8 million new residents by 2030, almost 2.4 million, will reside on the Front Range, where water supplies are already stressed. Given the substantial increase in municipal and industrial water demand associated with this growth, SWSI anticipated that approximately 75 percent (90,500 acre-feet) of Colorado's total statewide water shortfall would occur in the South Platte River Basin, with roughly another 15 percent (17,100 acre-feet) of the shortage falling within the Arkansas River Basin.[xxxv] Thus, with almost 90 percent of the shortfall expected to occur east of the Continental Divide, water providers on the Front Range will be forced to look to the West Slope for new sources of water if the region is to sustain the type of growth that is expected.

It is also important to recognize that the SWSI study, in arriving at an estimated statewide shortfall of 118,200 acre-feet, took into account all the structural and non-structural solutions that local water providers had identified as "reasonably expected to occur" between now and 2030.[xxxvi] That is, the 20 percent gap that SWSI identified between projected water demand and supplies assumes that these "Identified Projects and Processes" (IPPs) will in fact be fully implemented by 2030.[xxxvii] This assumption, which the SWSI report describes as "the most optimistic scenario," has two significant implications for water management in Colorado.[xxxviii]

First, given the well-acknowledged uncertainty of many of the IPPs, the actual statewide shortfall could far exceed the 20 percent gap SWSI predicted. SWSI did not attempt to "judge the merits or probability of success of any individual project or group of projects," but rather classified projects based on the expectations of local project sponsors and collaborators.[xxxix] Yet the SWSI report recognized that the IPPs might not be fully implemented for any of a number of reasons, including the fact that many of the IPPs target the same future water sources.[xl] The concern is that if the IPPs are not fully implemented, the actual statewide shortfall will be even greater, thus increasing the demand and competition for water, and making the allocation of Colorado's remaining undeveloped water resources all the more challenging.[xli]

Second, if the IPPs fail to generate their projected yield, water providers will be forced to consider alternative sources for future water supply.[xlii] For the cities and suburbs on the Front Range facing serious future shortages, such alternative sources could include any of the proposed major transmountain diversion projects that SWSI specifically excluded from the list of IPPs, such as the Ruedi Pumpback or the so-called "Big Straw."[xliii] Thus, as Front Range water providers scramble to secure additional sources of water, major transmountain diversion projects may be recommended as potential solutions to the projected gap.

The Colorado River Availability Study is not directly addressing the feasibility of any large-scale, structural projects. Nevertheless, if the study identifies unappropriated water in the Colorado River Basin, it may encourage such proposals. The study may also lead Front Range water providers to consider the possibility of enlarging existing transmountain diversion systems in order to realize existing conditional water rights. (*See* Table 1 for a list of the existing conditional rights for the Fryingpan-Arkansas Project and the Independence Pass Transmountain Diversion System).

Table 1. Existing conditional water rights of the major transmountain diversion projects in the Roaring Fork Watershed.[xliv]

PROJECT	DIVERSION STRUCTURE	CONDITIONAL RIGHTS (cfs)	WDID	APPROPRIATION DATE
Fryingpan-Arkansas Project				7/29/1957
	North Side Collection System			
	Carter Creek	17	381585	
	Ivanhoe Creek	7	381592	
	Granite Creek	5	381592	
	South Side Collection System			
	No Name Creek	10	381608	
	Main Stem Fryingpan River	38	381590	
Independence Pass Trans-mountain Diversion System	**New York Collection System**			4/30/1973
	New York Creek (Headgate No. 1)	20	381764	
	Brooklyn Creek (Headgate No. 2)	35	381765	
	Tabor Creek (Headgate No. 3)	61	381766	
	Roaring Fork Collection System			8/23/1930
	Lost Man Diversion	24	381767	
	Tunnel No. 2	28	381763	
	Connection Canal	20	381768	

With the Arkansas and South Platte roundtables currently in the process of developing solutions to future water shortfalls, the results from the Availability Study, when released next year, could generate an immediate response from Front Range water providers. This possibility is one issue that can be addressed by stakeholders during Phase II of the Roaring Fork Watershed Plan.

Oil Shale Development on the West Slope

Recent studies have indicated that the oil shale deposits in the Green River Formation found in western Colorado, particularly in the Yampa, White, and Colorado River basins, may contain anywhere from 1.5 to 1.8 trillion barrels of recoverable oil.[xlv] This is in addition to the natural gas and coal resources currently being extracted from the area. The Green River Formation thus represents a "relatively untapped" energy reserve, a situation not likely to escape the attention of the oil and gas industry, especially as the nation's demand for energy continues to grow.[xlvi] In fact, the U.S. Department of Energy is predicting that the current oil shale boom will directly employ another 70,000 workers on the West Slope.[xlvii] And in July of 2008, the Bureau of Land Management (BLM) released proposed regulations for a commercial oil shale program on federal lands, which comprise approximately 72 percent of the land in the Green River Basin.[xlviii] The BLM estimated that these regulations would allow for the extraction of upwards of 800 billion barrels of oil.[xlix]

The extraction and processing of petroleum from oil shale deposits is a water-intensive industry. Significant amounts of water are used during the production process, along with a large amount of energy.[l] The electricity used by the oil shale industry would likely come from coal power plants, the predominant power source in northwest Colorado, which likewise require a significant amount of water.[li] Finally, the industry's labor requirements would also contribute to the increasing municipal water demand in the Colorado River Basin.[lii] While the exact amount of water necessary for oil shale development is still unknown, experts predict that the industry's water demand could far exceed the needs of other energy sources, including natural gas, coal, and uranium.[liii]

Working through the Interbasin Compact Process, the Yampa/White/Green Basin Roundtable and the Colorado Basin Roundtable are currently collaborating on an Energy Needs Assessment, a study that is intended to

quantify the potential water demand of the oil and gas industry in the region.[liv] This study will ultimately be integrated into CWCB's Availability Study, so that any estimate of the available water in the Colorado River Basin will also account for the potential water demand associated with energy development on the West Slope.[lv]

The initial results of both the Energy Needs Assessment and the Availability Study are expected to be released sometime next summer, and these studies' findings could further encourage the oil and gas companies to invest in water rights within the Roaring Fork Watershed, particularly if either or both studies identify local water resources as a potential source for additional water supplies. In addition to purchasing local irrigation rights, energy companies could seek to acquire unallocated water from Ruedi Reservoir.[lvi] Thus, with the potential for considerable energy development on the West Slope, local water interests must not become so concerned with statewide population growth that they ignore the implications of renewed energy development closer to home.

Of particular concern with respect to energy development on the West Slope is the possibility of oil and gas companies contracting with the U.S. Bureau of Reclamation for direct delivery of water from Ruedi Reservoir. Most of the existing contracts for Ruedi water are for augmentation purposes, which generally require releases from the reservoir towards the end of the summer, when river flows are low and senior water rights "call out" junior rights.[lvii] If, however, oil and gas companies contracted for direct delivery of water from Ruedi Reservoir, the Bureau of Reclamation may be required to release significant amounts of water over a short period of time from the reservoir into the Fryingpan River.[lviii] Such releases could drastically alter the hydrology and flow regime in the Fryingpan River below Ruedi Reservoir, as well as the Roaring Fork River downstream of its confluence with the Fryingpan, in Basalt.[lix]

Exactly how such releases might impact the local fishery is difficult to predict, but this possibility should concern local interests, given the value of this resource. Fishing is estimated to generate more than $17 million annually for businesses in the watershed, and the water downstream of Ruedi Reservoir attracts anglers from around the world.[lx] In fact, the section of water from Ruedi Reservoir to the confluence of the Roaring Fork and the Colorado rivers in Glenwood Springs constitutes the longest contiguous stretch of Gold Medal trout water in Colorado.

Energy companies already recognize the potential value of Ruedi Reservoir water to their future oil and gas operations on the West Slope. To date, the largest single contract for Ruedi water belongs to Exxon, executed in May of 1980, the same month in which Exxon terminated its Colony Oil Shale Project near Parachute (an event that was so disruptive to the local economy, it is still referred to as "Black Sunday" by many residents on the West Slope).[lxi] A spokesman for Royal Dutch Shell recently explained the strategy of energy companies for securing the water necessary to develop the oil shale deposits of the Green River Formation: "We're just situating ourselves so that when the time comes, we'll have the resources we need."[lxii]

With initial estimates of the energy industry's potential water demand upwards of 200,000 to 300,000 acre-feet, energy companies will have to pursue all potential sources of additional water supplies.[lxiii] While energy companies are currently buying up land and water rights in preparation for their future operations, Ruedi Reservoir is likely to become an important source of water for the industry.[lxiv] Approximately 16,700 acre-feet of uncontracted water remains in Ruedi Reservoir's West Slope Pool, and this water is available to any entity, public or private, that can put it to a legally-recognized beneficial use.[lxv]

The Roaring Fork Watershed Plan provides stakeholders with an opportunity to identify means to mitigate the potential impact of West Slope energy development on local water resources.

Local Population Growth and Land Development

While external influences, like statewide water shortages and the possibility of oil and gas development, present considerable planning challenges, the most immediate threat to local water resources is likely to arise from within the watershed. Specifically, with the Colorado River Basin's population predicted to nearly double between

2000 and 2030, local population growth and land development could significantly alter the Roaring Fork Watershed's water resources, both in terms of quality and quantity.

While the Front Range stands to potentially gain several million new residents over the next two decades, the West Slope is actually expected to experience the more dramatic rate of population growth. Within the Colorado River Basin, SWSI predicted a 2.3 percent rate of annual growth, a figure that dwarfs the rates predicted for the Front Range (1.5 percent for the Arkansas River Basin and 1.7 percent for the South Platte).[lxvi] Overall, the population in the Colorado River Basin is expected to nearly double between 2000 and 2030, growing from 248,000 to 492,600.[lxvii]

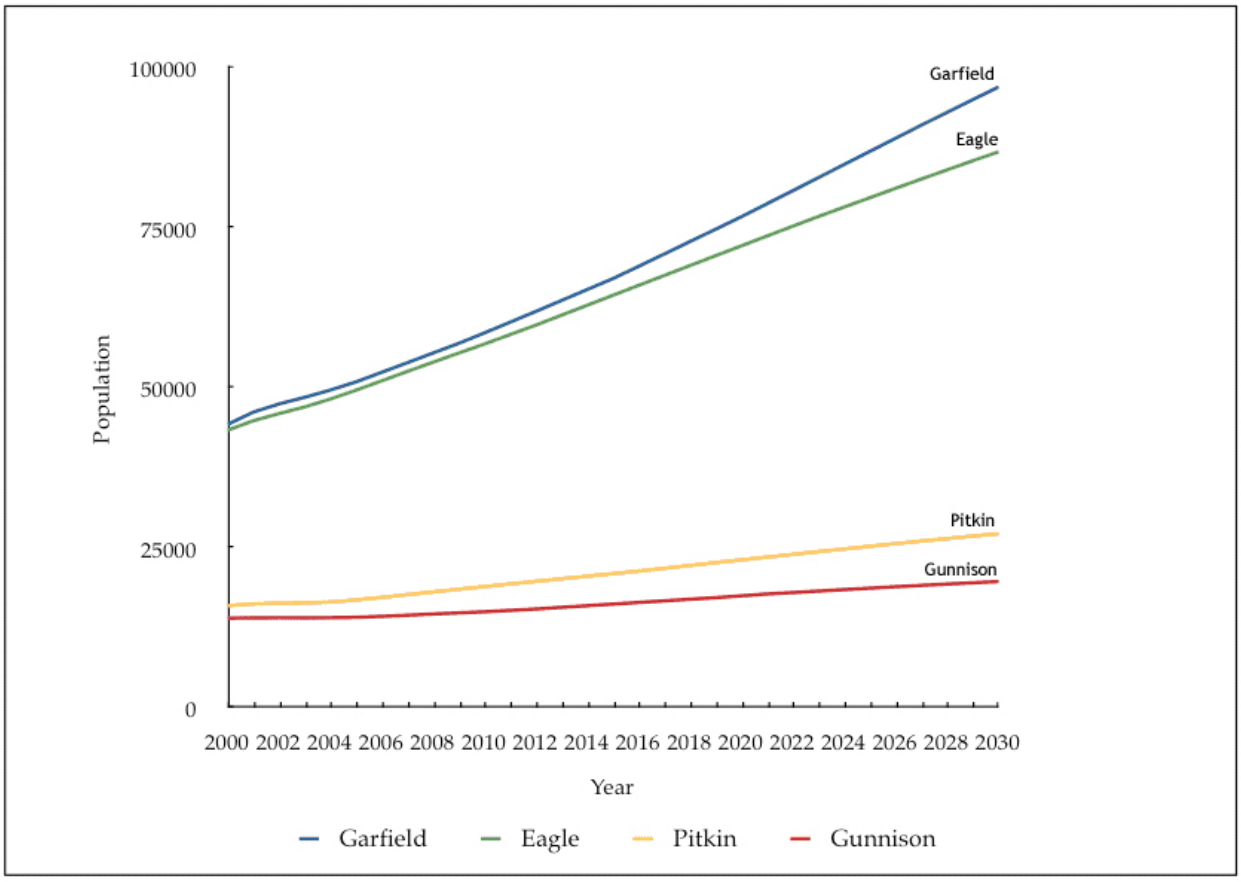
At the county level, the population predictions reveal a significant disparity between the four counties within the watershed, with annual growth rates of 2.3 percent for Eagle County, 2.6 percent for Garfield County, 1.8 percent for Pitkin County, and 1.2 percent for Gunnison County.[lxviii] (*See* Table 2 and Figure 1). Collectively, the four counties are expected to gain 113,144 new residents, though not all these people would reside within the Roaring Fork Watershed.

Adding to overall population growth, the Roaring Fork Watershed is also likely to continue to experience considerable growth related to second homeownership. Since the 1980s, a major part of Pitkin County's residential growth has been driven by second homeownership, a fact not revealed by population figures and projections.[lxix] Portions of the lower watershed, including Carbondale and Glenwood Springs, are also seeing an increase in second homeownership.[lxx] While such houses may be occupied for part of the year, they can use considerable amounts of water, given their size and landscaping. In addition, these houses are often outside the municipal service areas (requiring onsite wastewater treatment systems) and may be adjacent to streams and rivers (impacting riparian and wetland areas).[lxxi] Larger developments may also involve the subdivision of what was formerly agricultural land, changing water use patterns and altering the timing of stream flows.[lxxii] Thus, second homeownership can have a significant impact on not only domestic water demand but also water resources in general.

Table 2. Projected population growth for the counties in the Roaring Fork Watershed.[lxxiii]

COUNTY	2000	2030	POPULATION INCREASE	PERCENT CHANGE 2000 TO 2030	ANNUAL GROWTH RATE
Eagle County	43,354	86,842	43,488	100%	2.3%
Garfield County	44,267	96,969	52,702	119%	2.6%
Pitkin County	15,913	27,152	11,239	71%	1.8%
Gunnison County	13,967	19,682	5,715	41%	1.1%

Figure 1. Projected population growth for the counties in the Roaring Fork Watershed.[lxxiv]



Given the population projections for the Colorado River Basin, SWSI projected that municipal and industrial gross water demand would grow by 61,900 acre-feet between 2000 and 2030, assuming only minimal conservation efforts.[lxxv] This gain represents an 84 percent increase in the region's gross demand from 2000, the largest increase projected in the state.[lxxvi] Beyond the direct relationship with municipal water demand, population growth and land development can impair water resources in other ways that are more difficult to quantify. For instance, land development can disrupt and degrade valuable ecosystem functions that help to maintain water quality and quantity, such as the filtering capacity of natural runoff patterns, the recharge of groundwater supplies, and the flood protection provided by riparian areas.[lxxvii] And overall domestic wastewater, particularly from onsite waste treatment systems, impairs water quality to some degree by adding nutrients (e.g., fertilizers) and organic compounds (e.g., pesticides, industrial solvents, and pharmaceutical products).[lxxviii]

The SWSI Report predicted that 95 percent of the Colorado River Basin's future municipal and industrial water demand, through 2030, could be met by Identified Projects and Processes (IPPs), with a projected 3,000-acre-foot gap falling within Garfield, Grand, and Summit counties.[lxxix] But, for the Roaring Fork Watershed, the ability of most public water providers to meet future water demand is not what is at stake when it comes to the issue of population growth and land development, at least not in the immediate future.

Instead, the concern with population growth and land development lies with the ability of the watershed to withstand the growing human footprint while still preserving the valuable natural ecosystem services that sustain our environment, our economy, and our quality of life.[lxxx] Striking this balance between population growth and protecting natural resources presents a considerable planning challenge for local stakeholders. Phase II of the Roaring

Fork Watershed Plan will serve as a forum for this process. Local governments, particularly counties and municipalities, can use the watershed plan to ensure that land use planning at a local and watershed-wide level is coordinated with water resource planning.

Natural Forces

Natural variations in the distribution and abundance of water resources are difficult to predict, much less control. Accordingly, water resource planning has historically tended to focus on future demand, with consideration of the supply-side of the equation largely confined to sparse hydrologic records.[lxxxi] When hydrologic variability is overlooked, or simply disregarded, the result is a system of resource allocation and use that is incompatible with the physical laws of nature.[lxxxii] Thus, for water management to be efficient and sustainable, the potential for variation in the natural water supply must be properly evaluated and accounted for.

In light of the potential implications of global climate change for western water resources, incorporating hydrologic variability into water resource planning has never been more important than it is now. While the research on climate change is still raising more questions than it answers, the research so far reveals several overarching trends that any long-range water resource plan must confront. Given the complexity of the science involved and the scope of the problem, climate change is yet another example of a serious concern that the Roaring Fork Watershed Plan must address.

Climate Change

The possible effects of climate change on a headwater area like the Roaring Fork Watershed are widespread and severe. The latest climate models predict a 2 to 3 °C (3.6 to 5.4 °F) increase in annual temperature for the western United States by the end of this century.[lxxxiii] This type of change could have serious social, economic, and environmental repercussions for the watershed, some of which are readily apparent (e.g., decreased snowpack, earlier spring runoff), and some of which are more complicated (e.g., severe wildfires, increased flooding).[lxxxiv] Rather than catalogue all the potential effects of climate change in this document, two specific examples of such impacts demonstrate broader, more concerning trends that should be incorporated in any water management plan, and which the Roaring Fork Watershed Plan is already in the process of addressing.[lxxxv]

Dust storms: Accounting for new information in water management plans.

Recent research on climate change reveals that the interactions between climatic conditions and the hydrologic cycle are far more complex than previously recognized. This new information demonstrates the need for an approach to water management that can readily adapt to new information. A vivid example of this trend is the ongoing research on the effect of windblown dust on mountain snowpacks, which is being conducted by the Center for Snow and Avalanche Studies (CSAS) in the San Juan Mountains, near Silverton. The initial idea for the project arose from concern over the effect of windblown dust on snow stability and the resulting risk of avalanches; however, as the research has progressed, the scope of the study's implications have proven far larger.

Windblown dust storms are a common natural phenomenon, during which large amounts of dirt and sand can be transported hundreds, even thousands, of miles in the air, before being deposited, in some cases, on a mountain snowpack.[lxxxvi] Snow naturally reflects upwards of 90 percent of the solar radiation that strikes it, whereas dirt and sand particles reflect far less light, as little as 30 percent.[lxxxvii] Thus, when dust is deposited on mountain snowpacks, the radiative heat of the warmer dust particles can drastically change the rate at which the snowpack melts.[lxxxviii] Specifically, the initial findings from the CSAS study indicate that windblown dust storms can reduce the duration of snow cover by as much as one month.[lxxxix]

Even more concerning than the overall impact of dust on snow cover duration is the possible upward trend for these type of dust storm events. The CSAS study determined the dust falling in the San Juan Mountains is pri-

marily coming from the Colorado Plateau, and that such events occur at a far greater frequency during dry years.[xc] Thus, if precipitation decreases in the Southwest as a result of global climate change, as climate models forecast, windblown dust could play a major role in Colorado's future water supply.

In addition, the CSAS study noted that expansion and intensification of grazing, recreational use, and agriculture over the past century on the Colorado Plateau has likely increased the region's dust emissions.[xci] This trend is likely to continue, particularly given the rapid growth rates of states like Arizona, New Mexico, and Utah.[xcii] Thus, as the Southwest becomes more populated over the next century, the relative contribution of human activities to windblown dust events is also likely to increase.

The research on windblown dust demonstrates the complex interaction between human activities and climate. (*See also* Figure 2). Increased atmospheric carbon dioxide levels and global temperatures are only one facet of the issue of climate change. Seemingly insignificant human activities, like dryland farming in northeastern Arizona, can have far-ranging consequences. From a water management perspective, any system of resource allocation, conservation, and use must therefore be designed to account for this type of new information.

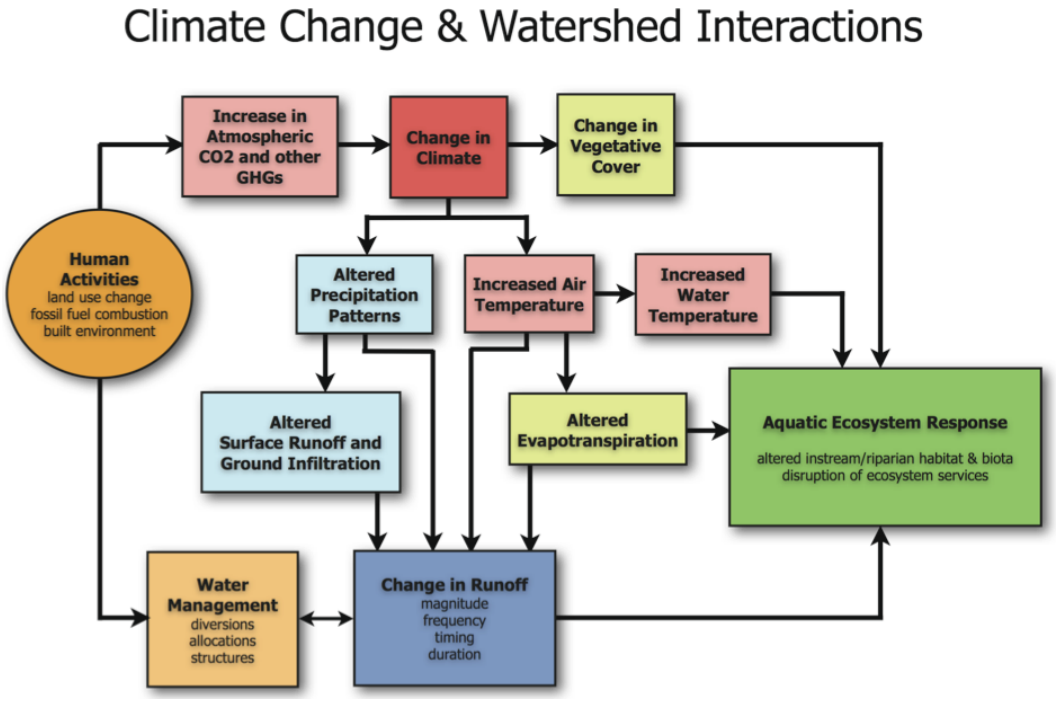
The advantage with long-range resource planning efforts, like the Roaring Fork Watershed Plan, is that such uncertainties can be identified and addressed before their impact becomes pronounced. A major component of Phase I of the Roaring Fork Watershed Plan has involved identifying existing data gaps. In Phase II, such gaps can be prioritized for purposes of research, and the potential ramifications of emerging issues like windblown dust can be incorporated into the long-term management plan for the watershed's water resources.

The 2007-2008 Winter: Accounting for extreme weather events in water management plans.

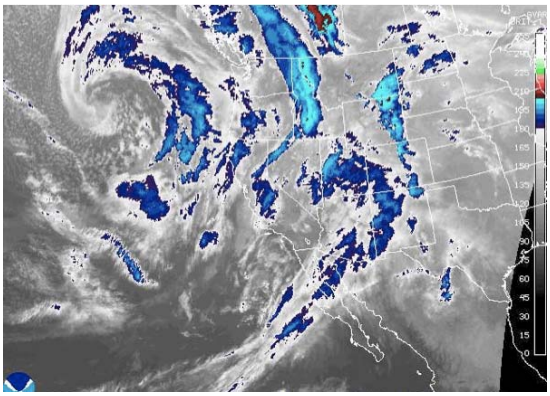
The greatest challenge presented by climate change for water resource planning is the potential for extreme variability in the weather and, as a result, in water supplies. Climate change is expected to increase both the frequency and the intensity of extreme weather events, particularly in high-altitude regions because increased temperatures can produce two very different extremes for snowmelt driven systems. On the one hand, rising temperatures can inhibit snowpack accumulation, thereby reducing available water supplies.[xciii] Conversely, rising temperatures are also expected to produce changes in atmospheric circulation and increases in evaporation, which may ultimately result in increased levels of precipitation.[xciv] Thus, the challenge with climate change in regions like the Colorado River Basin is that it can cause drought in one year, and flooding in the next.

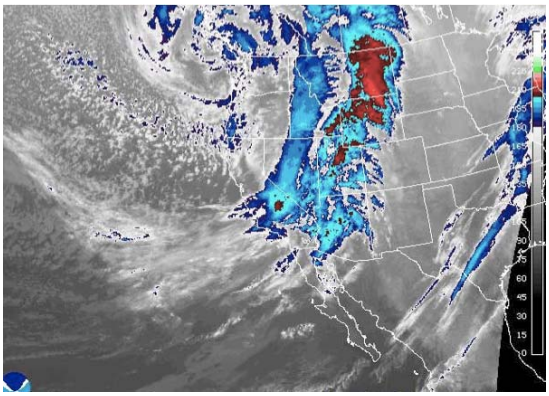
The 2007-2008 winter represented a period of increased precipitation, one in which snowfall totals from around the state reached record highs.[xcv] Though no research, as of yet, has linked the record snowfalls for the 2007-2008 winter with climate change, anyone who closely followed the weather saw the energy and the size of the storms that rolled off the Pacific Ocean during January and February. (*See* Figures 3 and 4). On April 1, 2008 the snow water equivalent at the Independence Pass SNOTEL site was 137 percent above average, and the concern among residents was with the possibility of flooding.[xcvi] (*See* Figure 5). After a warm week at the end of May, temperatures cooled off in early June, thus slowing runoff and avoiding what could have been record flows and severe flooding.[xcvii]

Figure 2. The complex interactions between human and natural systems.[xcviii]



Figures 3 and 4. Radar images of the western United States from the January 5 storm that left 18" of new snow in Aspen.[xcix]





While the record snowfall during the 2007-2008 winter was undoubtedly beneficial in terms of water supplies, it is important to recognize all the potential implications of an above-average winter. Travel during the 2007-2008 winter was often hampered by the weather, a serious problem for the tourism industry.[c] In addition to the risk of flooding, high river flows can negatively impact water-based recreation. Many fishing guides in the watershed were forced to avoid the Roaring Fork River during June and most of July of 2008 due to the high flows.[ci] Also, a winter like 2007-2008 can have long-term ramifications. For instance, increased precipitation increases plant productivity, thereby allowing for the buildup of the organic matter that can fuel wildfires in drought years.[cii] Extreme weather events, even if they serve to alleviate drought concerns, can still have serious costs, and the possibility of such events must be part of any long-term water resource plan.

In the Colorado River Basin, there has always been a degree of variability with respect to weather and water supplies. (*See* Figure 6). But climate change is expected to increase both the frequency and intensity of such events.

Incorporating such natural variability into any system of resource management requires sound scientific information, a cautious approach, and a long-term perspective.

Figure 5. Snow water equivalent for the 2007-2008 winter at the Independence Pass SNOTEL site compared with the previous winter and the historical average.[ciii]

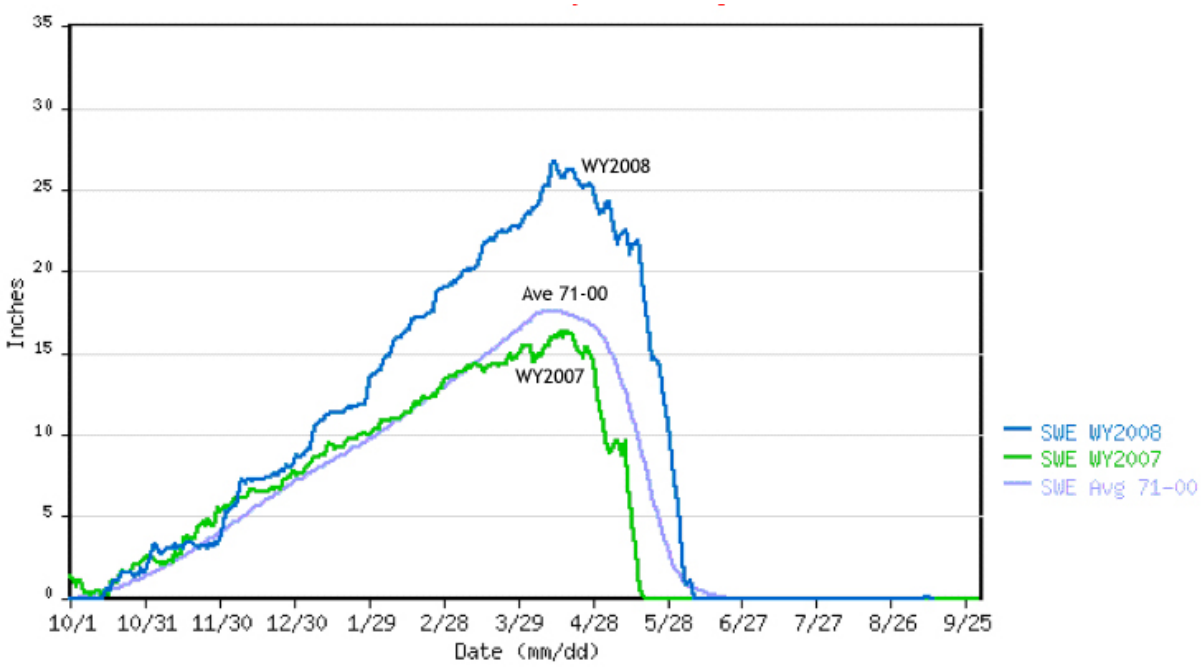
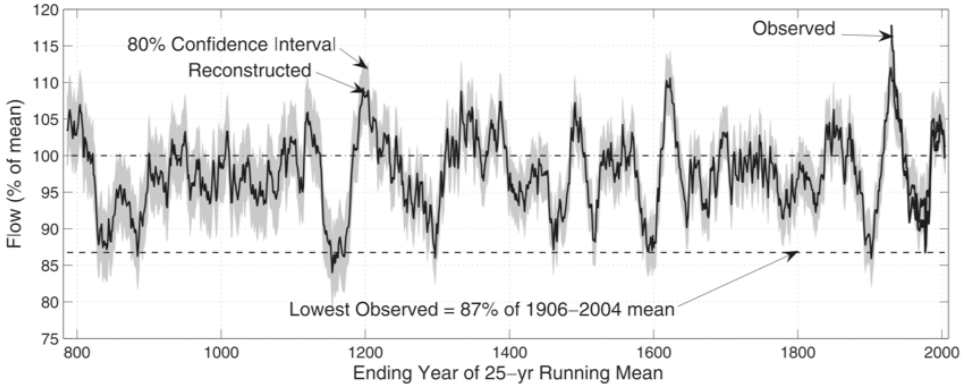


Figure 6. Upper Colorado River Basin flows reconstructed from tree ring data plotted as a percentage of the 1906-2004 mean of observed natural flows (dashed line at 100%). Lowest of the dashed lines is the 25-year running mean of observed flows for 1953-1977.[civ]



The potential ramifications related to climate change, including extreme weather events and hydrologic variability were documented during Phase I of the plan. The data and information accumulated during that process will now become part of the recommendations and objectives generated during Phase II for the long-term management of the watershed's water resources. Thus, in spite of the complexity and uncertainty of the problem, the Roar-

ing Fork Watershed Plan is a means of ensuring that climate change is not forgotten as Colorado prepares for the next decades of growth and water management.

Conclusion

Colorado is entering a new era of water management, one in which the next several years will prove critical. As the Interbasin Compact Process develops the framework for the long-term management of the state's water resources, both public and private interests will take steps to secure additional water supplies. New projects are already being authorized (e.g., Southern Delivery Pipeline, Windy Gap Firming Project, Moffat Collection System Project), in what could be one of the largest water development eras in Colorado history.[cv] This unprecedented demand for new structural solutions is the result of, as Harris Sherman, Chairman of the Department of Natural Resources, recently described the situation, Colorado's transition "from an era of developing an undeveloped resource to one where we are managing a fully developed resource."[cvi]

As Colorado enters these unchartered waters, the Roaring Fork Watershed Plan will serve as the management plan for local water resources. In this respect, the watershed plan will provide an invaluable tool for interested stakeholders in confronting the challenges presented by water management in a rapidly changing world. As the local component of the Interbasin Compact Process, the watershed plan provides local interests with the opportunity to play a significant role in deciding how the state administers the watershed's water resources in the immediate future. And as public and private interests around the state prepare for future water demand, the watershed plan will establish the framework in which free market forces must operate. Thus, from both a political and economic perspective, the Roaring Fork Watershed Plan constitutes the primary means for interested stakeholders to have a say in the future of our precious water resources.

[i] *Interbasin Compact Process, Quarterly Newsletter, 2nd Quarter 2008*, Interbasin Compact Comm., 1 (Jul. 2008) (available at http://ibcc.state.co.us/News/).

[ii] Natl. Climatic Data Ctr., *Climate of 2002 - August Colorado Drought*, http://www.ncdc.noaa.gov/oa/climate/research/2002/aug/st005dv00pcp200208.html (last updated Sept. 2002).

[iii] Senate Bill 03-110 at § 14 (May 19, 2003).

[iv] *Id*.

[v] *Statewide Water Supply Initiative Report*, Colo. Water Conserv. Bd., § 2.1.1 (Nov. 2004) (available at http://cwcb.state.co.us/IWMD/SWSITechnicalResources/SWSIPhaseIReport/SWSIPhaseIReport.htm).

[vi] *Id*. at § 6.3.

[vii] *Id*. at Executive Summary, 13.

[viii] Gov. Bill Owens, *Colorado State of the State Address 2003* (Jan. 2003) (available at http://www.stateline.org/live/details/speech?contentId=16157).

[ix] Colo. Rev. Stat. § 37-75-101-106 (Lexis 2008); *see* Interbasin Compact Comm., *Overview of the Interbasin Compact Process*, http://ibcc.state.co.us/Process/Overview/ (last accessed Jul. 28, 2008).

[x] *Interbasin Compact Committee Annual Report*, Interbasin Compact Comm., 1 (Oct. 2007) (available at http://ibcc.state.co.us/News/InterbasinCompactCommitteeNews.htm).

[xi] *Owens Signs Landmark Water Legislation*, Colorado Governor's Message, Jun. 7, 2005.

[xii] *See* Interbasin Compact Comm., *supra* n. 10.

[xiii] Colo. Rev. Stat. § 37-75-104(3)(b) (Lexis 2008).

[xiv] *See id*. at (5).

[xv] *Id*. at (2)(c).

[xvi] Interbasin Compact Comm., *supra* n. 10 at 4.

[xvii] *By-laws for the Colorado Basin Roundtable*, Colo. Basin Roundtable, § 3.9 (approved Jan. 23, 2006) (available at http://ibcc.state.co.us/Basins/Colorado/).

[xviii] Colo. Rev. Stat. § 37-75-105 (Lexis 2008).

[xix] *Id*. at (3)(c).

[xx] Colo. Rev. Stat. § 37-75-102(1) (Lexis 2008).

[xxi] Harris D. Sherman, *Forward to Interbasin Compact Committee Annual Report*, 3 (Oct. 2007) (available at http://ibcc.state.co.us/News/ InterbasinCompactCommitteeNews.htm).

[xxii] Senate Bill 06-179 at § 1 (May 26, 2006).

[xxiii] *Id*.

[xxiv] *Water Supply Reserve Account Criteria and Guidelines*, Colo. Water Conserv. Bd. and Interbasin Compact Comm., 8 (Oct. 2006) (available at http://cwcb.state.co.us/IWMD/RelatedInformation/ToolsResources/).

[xxv] *Id*. at 13.

[xxvi] *Id*. at 14.

[xxvii] *Id*. at 9.

[xxviii] *Water Activity Summary Sheet – Roaring Fork Watershed Plan*, Colo. Water Conserv. Bd., 1 (Mar. 2007) (available at http://ibcc.state.co.us/Basins/Colorado/WaterActivitiesWaterSupplyReserveAccount/).

[xxix] *Water Activity Summary Sheet – Roaring Fork Watershed Plan, Phase II*, Colo. Water Conserv. Bd., 1 (May 2008) (available at http://ibcc.state.co.us/Basins/Colorado/WaterActivitiesWaterSupplyReserveAccount/).

[xxx] Colo. Water Conserv. Bd., *supra* n. 28 at 7.

[xxxi] Senate Bill 07-122 at § 15 (May 31, 2007).

[xxxii] *Water Availability Study of Colorado River and Its Tributaries – Phase I Scope of Work*, Colo. Water Conserv. Bd., 1 (Oct. 2007) (available at http://ibcc.state.co.us/Process/Needs/WaterSupplyAvailability/).

[xxxiii] *Id*. at 14.

[xxxiv] *Id*. at 7.

[xxxv] Colo. Water Conserv. Bd., *supra* n. 5 at § 6.3.

[xxxvi] *Id*. at § 6.1.1.

[xxxvii] *Id*. at Executive Summary, 13.

[xxxviii] *Id*.

[xxxix] *Id*.

[xl] *Id*. at § 6.2.

[xli] *Id*.

[xlii] *Id*.

[xliii] *Id*. at Executive Summary, 3; *see* section 2.2.3 of the *State of the Watershed Report* for further details on major structural projects currently being considered that would impact the Roaring Fork Watershed.

[xliv] Water structures database, Colorado's Decision Support System website, http://cdss.state.co.us/DNN/ViewData/ Structures-Diversions/tabid/75/Default.aspx (accessed August 14, 2008).

[xlv] *Water Needs Assessment for Yampa/White and Colorado River Basins – Scope of Work*, Yampa/White/Green and Colorado Roundtables, 1 (Sept. 2007) (available at http://ibcc.state.co.us/Basins/Colorado/Subcommittees/Energy/ColoradoEnergySubcommittee.htm).

[xlvi] *Id*.

[xlvii] *Id*. at 8.

[xlviii] *Western Oil Shale Potential: 800 Billion Barrels of Recoverable Oil*, U.S. Dept. of the Interior, official news release (July 2008) (available at http:// www.doi.gov/news/08_News_Releases/080722.html).

[xlix] *Id*.

[l] Yampa/White/Green and Colorado Roundtables, *supra* n. 45 at 8-9.

[li] *Id*.

[lii] *Id*.

[liii] Gary Harmon, "*Oil shale 800-pound gorilla" with predictions of water use*, Grand Junction Sentinel (Sept. 19, 2008)

[liv] Yampa/White/Green and Colorado Roundtables, *supra* n. 45 at 1.

[lv] *Id*. at 3.

[lvi] *See* section 2.2.4 of the *State of the Watershed Report* for further details on the potential local impact of oil and gas development.

[lvii] *Id*. at section 2.1.3.

[lviii] *Id*. at section 2.2.4.

[lix] *Id*.

[lx] *Id*. at section 1.2.2.

[lxi] *Id*. at section 2.1.3.

[lxii] Steve Lipsher, *Shell makes a run on water*, Denver Post (May 4, 2008).

[lxiii] *Id*.

[lxiv] *Id*.

[lxv] *State of the Watershed Report*, section 2.2.4.

[lxvi] Colo. Water Conserv. Bd., *supra* n. 5 at § 2.1.1.

[lxvii] *Id*.

[lxviii] *Id*. at Appendix A.

[lxix] *State of the Watershed Report*, section 1.2.1; for more information on the direct and indirect effects of second homeownership, *see Transitions in Mountain Communities: Resort Economies and their Secondary Effects*, Northwest Colorado Council of Governments, (2006) (available at http://www.nwc.cog.co.us/Programs/Reports%20&%20Studies/reports_&_studies.htm).

[lxx] *Id*.

[lxxi] *Id*. at section 1.3.1.

[lxxii] *Id*.

[lxxiii] *Id*.

[lxxiv] *Id*.

[lxxv] Colo. Water Conserv. Bd., *supra* n. 5 at Executive Summary, Table ES-1.

[lxxvi] *Id*.

[lxxvii] *See* sections 1.2.1 and 1.2.3 of the *State of the Watershed Report* for further details on the impact of population growth and land development, and a description of ecosystem services, in general.

[lxxviii] *See* sections 3.2.2, 3.2.3, and 3.2.5 of the *State of the Watershed Report* for further details on the impacts of population growth and land development on water quality.

[lxxix] Colo. Water Conserv. Bd., *supra* n. 5 at § 6.3.

[lxxx] *See* sections 1.2 of the *State of the Watershed Report* for details on the value, both tangible and intangible, of environmental quality to the Roaring Fork Watershed.

[lxxxi] For example, the 1922 Colorado River Compact apportioned the Colorado River among the seven western states based on a period of river flows that were unusually high; *see* Eric Kuhn, *Certainty in Uncertain Times: Policy Implications of the Colorado River Compact*, 9-10 (available at http://www.crwcd.org/page_154).

[lxxxii] *Id*.

[lxxxiii] Section 3.5.1, *State of the Watershed Report* for a discussion on current climate projections

[lxxxiv] *See* section 3.5 of the *State of the Watershed Report* for detailed information on the range of possible impacts associated with climate change; in addition, *see Climate Change in Colorado: A Synthesis to Support Water Resources Management and Adaptation*, Colo. Water Conserv. Bd. (Oct. 2008) (available at http://cwcb.state.co.us/).

[lxxxv] *Id*.

[lxxxvi] Painter et al., *Impact of disturbed desert soils on duration of mountain snow cover*, Geophys. Res. Lett., 34 (2007).

[lxxxvii] *Id*.

[lxxxviii] *Id*.

[lxxxix] *Id*. at 38.

[xc] *Id*.

[xci] *Id*.

[xcii] *Id*.

[xciii] Stephen Saunders and Maureen Maxwell, *Less Snow Less Water*, Rocky Mtn. Climate Org., 6-7 (2005) (available at http://www.rockymountainclimate.org/programs_4.htm).

[xciv] Saunders and Maxwell, *supra* n. 93 at 6-7.

[xcv] Natl. Climatic Data Ctr., *Northern Hemisphere Snow and Ice Winter 2007/2008*, (May 2008) (available at http://www.ncdc.noaa.gov/ oa/climate/research/2007/snow0708.html).

[xcvi] Natl. Resource and Conserv. Serv., *SNOTEL Data* (available at http://www.wcc.nrcs.usda.gov/snow/) (accessed Sept. 13, 2008); staff report, *Roaring Fork Valley braces for flooding*, Aspen Times (Apr. 25, 2008).

[xcvii] Pete Fowler, *Colorado River seeing peak flows*, Aspen Times (Jun. 5, 2008).

[xcviii] Figure 3.5.5, *State of the Watershed Report*.

[xcix] Natl. Oceanic and Atmospheric Admin. (NOAA), *National Environmental Satellite, Data, and Information Service* (available at http://www.goes.noaa.gov/index.html) (accessed Jan. 5, 2008).

[c] Staff report, *Storm hampers travel, delights Aspen skiers and students*, Aspen Times (Feb. 6, 2008).

[ci] Katie Redding, *High water challenges anglers*, Aspen Times (Jun. 23, 2008).

[cii] Section 3.5.2, *State of the Watershed Report*.

[ciii] Natl. Resource and Conserv. Serv., *Site Information and Reports for Independence Pass* (available at http://www.wcc.nrcs.usda.gov/snotel/snotel.pl?sitenum=542&state=co)

[civ] Figure 3.5.3, *State of the Watershed Report*.

[cv] Jered Smith, *Water expansion builds worries for some*, Rocky Mountain News (Jul. 18, 2008).

[cvi] Interbasin Compact Comm., *supra* n. 1 at 1.