

**STREAMFLOW ASSESSMENT  
OF THE  
ROARING FORK RIVER  
UPSTREAM OF ASPEN, COLORADO**

**November 2007**

**Prepared for:**

**City of Aspen  
and  
Pitkin County**

The logo features a stylized blue river flowing from left to right, with a white highlight on the upper curve. Below the river, the text "GrandRiver" is written in a bold, blue, sans-serif font. Underneath that, "Consulting Corporation" is written in a smaller, black, sans-serif font.  
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# **STREAMFLOW ASSESSMENT OF THE ROARING FORK RIVER UPSTREAM OF ASPEN, COLORADO**

Stream flow is frequently less than desired in the upper Roaring Fork River, particularly upstream and through the City of Aspen. Reduced stream flow is due in large part to upstream diversions by the Independence Pass Transmountain Diversion System (Twin Lakes Project) and by the Salvation Ditch. In cooperation with staff of the City of Aspen, Pitkin County, the Roaring Fork Conservancy, the Nature Conservancy, the Ruedi Water and Power Authority, and the Colorado River District, we have evaluated opportunities to enhance stream flow in these important areas. The results of our study are briefly summarized in this report.

## **1.0 SUMMARY**

Four specific stream flow objectives have been identified by the above interest groups. These objectives are listed below in no particular order, as each interest group may have different priorities for the objectives:

- (1) Meet flow recommendations for the Roaring Fork River above Difficult Creek as established in the Fryingpan-Arkansas Project Operating Principles
- (2) Maintain the State of Colorado instream flow water right through the City of Aspen
- (3) Support viable aquatic ecosystems below key Twin Lakes Project points of diversion with year-round bypasses
- (4) Provide additional flushing flows in the upper Roaring Fork watershed

We estimate that these objectives would require an additional 11,000 to 12,000 acre feet of water per year, on average, in addition to the 3,000 acre feet of water that is currently available for stream flow maintenance through an exchange with the Twin Lakes Project. In individual dry years, the demand for additional water to satisfy these four objectives would exceed 20,000 acre feet.

The senior water rights for the Twin Lakes Project allow this project to divert all water physically available at the collection system on a year-round basis except during the summer months of below average years. Additional bypasses from the Twin Lakes Project would benefit most of the objectives outlined above, with the exception of the maintenance of an instream flow through the City of Aspen. In order to provide a minimum flow through the city, reduced diversions by the Salvation Ditch are required.

We have studied six alternatives that would respect the water supply of the Twin Lakes Project and the Salvation Ditch, and that may also provide additional water yield for stream flow enhancement in the upper Roaring Fork watershed. The cumulative water demands outlined

above are large and will be difficult to supply in their entirety. The implementation of more than one alternative would likely be required to supply a significant portion of the identified demand.

## **1.1 Potentially Viable Alternatives**

We believe that three alternatives are a potentially viable source of water to satisfy a portion of the identified demands.

***1.1.1 Use of Colorado River District Water in Grizzly and Twin Lakes Reservoirs.*** Water in Grizzly Reservoir and Twin Lakes Reservoir is available to the Colorado River District pursuant to a recent Water Court settlement. Specifically, the Colorado River District may acquire up to 800 acre feet of water in these reservoirs during wet years. We understand that the Colorado River District has not yet committed any of this potential water to a specific use. No capital expenditures would be required for this alternative.

This alternative merits further consideration, even though it may only yield a small amount of water. The available water could either be released from Grizzly Reservoir (100 acre feet per year maximum), or given to the Twin Lakes Project for a bypass of water from the West Slope collection system in return. During dry climatic cycles, such as has occurred from 1997 to the present, no water would be available from this alternative.

***1.1.2 Reduce Fry-Ark Project stream flow bypasses for the Thomasville Gage.*** This alternative would enhance the yield of the Fryingpan-Arkansas diversion project by reducing stream flow bypass requirements in the Fryingpan River above Ruedi Reservoir. Any enhanced yield would be delivered to the Twin Lakes Project within the Arkansas River watershed. In return, the Twin Lakes Project would bypass a commensurate amount of water at the Twin Lakes diversion sites. Stream flow in the Fryingpan River below Ruedi Reservoir would be unaffected. This alternative may provide an annual water supply of 500 acre feet or less. No capital expenditures would be required for this alternative.

Two difficult implementation issues are associated with this concept:

- The Federal Fryingpan-Arkansas Authorizing Legislation must be amended by Congress to reduce Thomasville bypass flows, and to credit any additional yield to Twin Lakes
- The Colorado Water Conservation Board must decree a reduction in instream flows for the Fryingpan River

***1.1.3 Acquisition of Arkansas River Basin Water.*** In this alternative, Roaring Fork interests would acquire water in the Arkansas River watershed and trade this water to Twin Lakes. In return, Twin Lakes would bypass water at the collection system intakes. This alternative would dry-up agricultural lands, store the water in acquired east slope reservoir space, and trade the

water to Twin Lakes Project shareholders. Federal contracts to use existing reservoirs must be secured and extensive Water Court actions would be required. We estimate the cost of this alternative to range between \$18 million and \$40 million for the acquisition of 5,000 acre feet of water. While this alternative is costly, it may provide the opportunity to acquire relatively large amounts of water.

## **1.2 Alternatives that are not Practicable**

We believe that three of the alternatives that were studied are not practicable.

***1.2.1 Purchase shares of Twin Lakes Water.*** We do not believe that this alternative is practicable for the following reasons:

- Very few shares of Twin Lakes Project water are on the market, and large blocks of shares are not available for purchase
- Based on recent sales for a small amount of water (over \$25,000 per acre foot), the price of acquiring enough shares of water to supply a significant portion of the identified demand would be in the hundreds of millions of dollars.

***1.2.2 Exchange Water between Ruedi Reservoir and the Twin Lakes Collection System.*** This concept would involve an exchange of water between Ruedi Reservoir and Twin Lakes Reservoir. If the exchange could be used to increase diversions by the Twin Lakes Project, the increased yield could be bypassed to the Roaring Fork watershed at other times of the year. However, exchanges can only occur if water rights decreed to the Colorado Water Conservation Board for instream flow purposes, and kayak park water rights decreed to the City of Aspen, are fully satisfied. Exchange opportunities are very limited and no exchange potential would have occurred at anytime during the last 13 years. Given the lack of exchange potential, we do not believe that this alternative is practicable.

***1.2.3 Increase the Capacity of Grizzly Reservoir.*** This alternative would rebuild the existing 570 acre foot Grizzly Reservoir to a capacity of between 2,600 acre feet and 4,600 acre feet. “Surplus” water during the height of the snowmelt runoff period would be stored in the rebuilt reservoir. This surplus water is infrequently available when physical inflow exceeds the capacity of the Twin Lakes Tunnel.

We do not believe that this alternative is practicable because the enlargement of Grizzly Reservoir will eliminate a sizable area of high quality wetlands that may include fens. The wetland issues will be difficult to overcome.

### **1.3 Other Alternatives**

The alternatives that we have studied to date are those outlined above. Other potential water supply alternatives may include:

- The construction of a pump station from the Roaring Fork River to the Salvation Ditch in the vicinity of the regional wastewater treatment plant. The pump station would allow the Salvation Ditch to obtain irrigation water downstream of Castle Creek and Maroon Creek at a location where Roaring Fork instream flow issues are not prevalent.
- Construction of the undeveloped diversion points of the Fryingpan-Arkansas Diversion. A portion of the water diverted through these facilities could be delivered to the Twin Lakes Reservoir and Canal Company in substitution for additional Roaring Fork River bypasses.

To our knowledge, neither of these alternatives have been recently studied in any detail.

## **2.0 KEY DIVERSION FACILITIES**

### **2.1 Twin Lakes Project**

The Twin Lakes Project diverts water from six tributaries near the headwaters of the Roaring Fork River watershed, these tributaries include Lost Man Creek, the Roaring Fork River, Lincoln Creek, Tabor Creek, Brooklyn Gulch, and New York Creek. The general location of this project is depicted in the schematic diagram (Attachment 1). The project first diverted water in 1936, and was developed to import water to the heavily over-appropriated Arkansas River watershed. The project has been operating in a relatively consistent manner for the last 71 years.

Twin Lakes has historically diverted an average of about 40,000 acre feet of water per year to the Eastern Slope of Colorado. The amount of water diverted varies substantially throughout the year and from year to year. The project diverts up to about 625 cubic feet per second (cfs) during peak snowmelt runoff conditions in average and in wetter than average years. During the winter months diversions are minimal, as very little water is physically available at the headwater diversion sites at this time.

In below average years, the project water rights are curtailed for a duration of between one and four months, depending upon how dry the year is. In average and wetter than average years, the project water rights are in-priority the entire year and the project can divert essentially all of the water that is physically available at the diversion sites. Historical diversions by the project are illustrated for a wet year, an average year, and a dry year on Attachment 2.

An exchange of water between the Twin Lakes Project and the Fryingpan-Arkansas Project has been authorized. The objective of this exchange is to enhance stream flow and environmental conditions in the upper Roaring Fork watershed. Pursuant to this exchange, 3,000 acre feet of water may be bypassed to the upper Roaring Fork River watershed. In return the Twin Lakes Project receives 3,000 acre feet in the Arkansas River basin that was previously diverted through the Fryingpan-Arkansas Project upstream of Ruedi Reservoir.

### **2.2 Salvation Ditch**

The Salvation Ditch diverts water from the Roaring Fork River just upstream of the City of Aspen. The ditch delivers irrigation water to properties north of the Roaring Fork River and terminates at a location below the Woody Creek drainage. The Salvation Ditch began diverting water in 1902.

The Salvation Ditch is decreed a water right for 58 cfs. In the last several decades, the ditch has commonly diverted about 25 cfs of water. Unlike the Twin Lakes Project, the Salvation Ditch water rights have never been curtailed. Accordingly, the ditch can divert water during the entire irrigation season, even in critical drought years. Average annual ditch diversions total about 7,700 acre feet per year.

### 3.0 QUANTIFICATION OF STREAM FLOW DEMANDS

Based on our conversations with City and County staff, and with the Roaring Fork Conservancy, the Nature Conservancy, and the Ruedi Water and Power Authority, we understand that additional stream flow is desired in the upper Roaring Fork River above Aspen for the following four primary objectives. Please note that these objectives are not listed in any particular order, and that each group may have different priorities for the objectives.

- (1) Meet Flow Recommendations for Roaring Fork River above Difficult Creek established in the Fryingpan-Arkansas Project Operating Principles
- (2) Maintain the State of Colorado instream flow water right through the City of Aspen
- (3) Support viable aquatic ecosystems below all Twin Lakes Diversion Points
- (4) Provide flushing flows in the upper Roaring Fork watershed

A brief overview of the objectives occurs below. We have estimated, at a reconnaissance level, that 11,000 to 12,000 acre feet of water per year are required to meet all of these demands on average (Table 1). In dry years, over 20,000 acre feet of water would be required to meet all four objectives. This water would be in addition to the 3,000 acre feet of water that is currently available through the Twin Lakes / Fryingpan-Arkansas exchange. It is important to note that each of these individual objectives often require a different amount of water at different times of the year. Accordingly, water that may satisfy a single objective, may not necessarily benefit other objectives.

1. Roaring Fork River / Fry-Ark Flow Recommendations	4,500 acres feet
2. Maintain Minimum Flow in Aspen	3,100 acres feet
3. Ecosystem below Twin Lakes Diversion Sites	1,300 acres feet
4. Flushing Flows	3,000 acres feet

#### **3.1 Flow Recommendations for Roaring Fork River above Difficult Creek (OBJ #1)**

The Operating Principles for the Fryingpan-Arkansas Project outline recommended average monthly and daily flows for the Roaring Fork River above Difficult Creek. The monthly flow recommendations vary from a low of 24 cubic feet per second (cfs) in March to a high of 120 cfs

in June. The daily minimum flow recommendations are 15 cfs from August through April, and 60 cfs from May through July.

Flow in the Roaring Fork River is commonly less than these recommended flows. The flows are not met for two reasons; (1) natural virgin stream flow is often less than the recommendations and (2) diversions by the Twin Lakes project impact stream flow of the Roaring Fork River during certain times of the year.

A continuously recording stream gage has been operated on the Roaring Fork River below Difficult Creek from 1980 to the present. During much of this period of record an exchange with the Twin Lakes Project has occurred. As a result, the gaged stream flows reflect conditions that occur after a substantial Twin Lakes Project bypass. Remaining stream flow deficits at the Difficult Creek gage (after the Twin Lakes exchange) are summarized in Table2.

Table 2			
Average Stream Flow Deficits at Roaring Fork below Difficult Creek From Recommended Flows in Fry-Ark Operating Principles			
Monthly Targets:	Natural Flow Deficit =	5,675	acre feet / yr
	<u>Twin Lakes Influence =</u>	<u>4,492</u>	<u>acre feet / yr</u>
	Total deficit =	10,167	acre feet / yr
Daily Targets:	Natural Flow Deficit =	537	acre feet / yr
	<u>Twin Lakes Influence =</u>	<u>1,184</u>	<u>acre feet / yr</u>
	Total deficit =	1,751	acre feet / yr

As noted above, natural native stream flow is not adequate to meet the flow recommendations. If all upstream diversions were curtailed, the native flow of the Roaring Fork River would be about 5,700 acre feet short of the flow recommendations. Diversions by the Twin Lakes Project (in excess of the 3,000 acre feet bypass) contribute to about 4,500 acre feet of the monthly flow deficits. Accordingly, about 7,500 acre feet of Twin Lakes diversions occur at a time when these flow recommendations are not satisfied.

**3.2 Maintain Instream Flow through the City of Aspen (OBJ #2)**

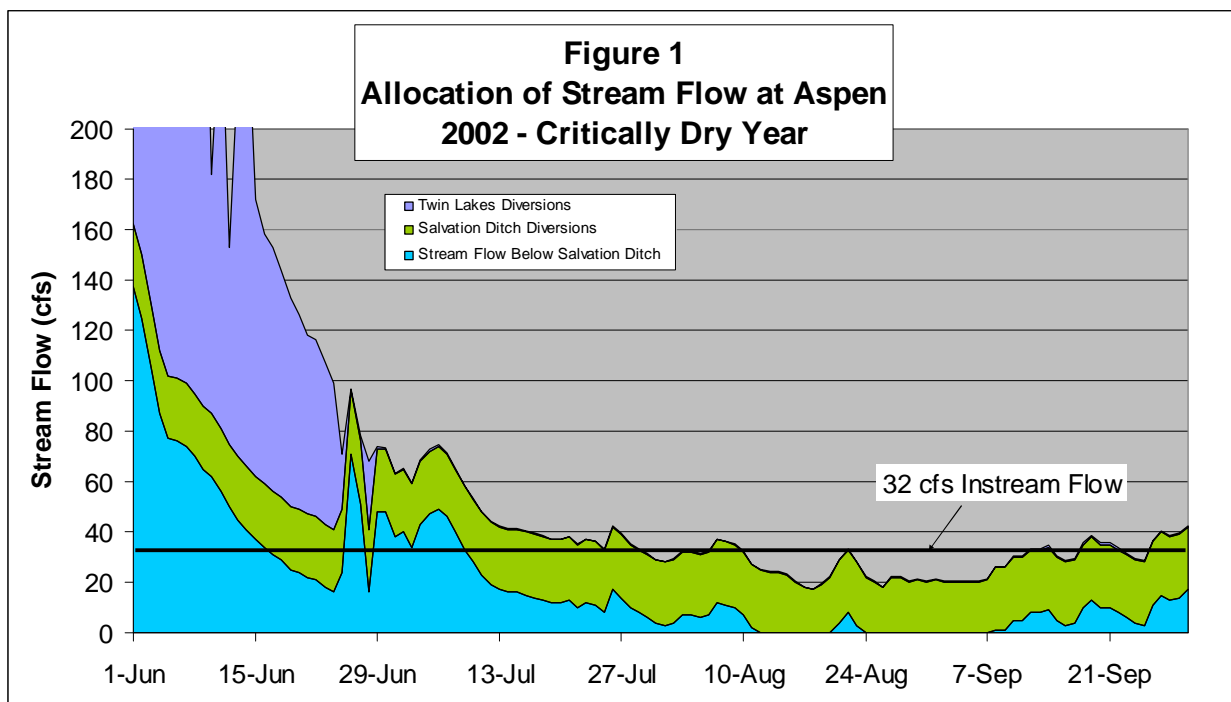
The Colorado Water Conservation Board has adjudicated an instream flow right of 32 cfs on the Roaring Fork River through Aspen. This water right is intended to “protect the environment to a reasonable degree” and is junior to water rights of the Salvation Ditch and the Twin Lakes Project. During late summer months (most typically August and September) the stream flow through the City of Aspen is considerably less than 32 cfs, primarily because of upstream

diversions. In critically dry years, the Roaring Fork River can actually be dried-up in the city limits in response to diversions by the Salvation Ditch.

On a volume basis, an average of about 5,700 acre feet of additional water would be required to maintain a flow of 32 cfs in the Roaring Fork River below the Salvation Ditch year-round. An average of about 3,100 acre feet of additional water would be required during the July through October period when the Salvation Ditch and the Twin Lakes Project are diverting substantial amounts of water. The remaining deficit occurs during the winter months when native flow is often less than 32 cfs. In dry years, over 10,000 acre feet of additional water would be required.

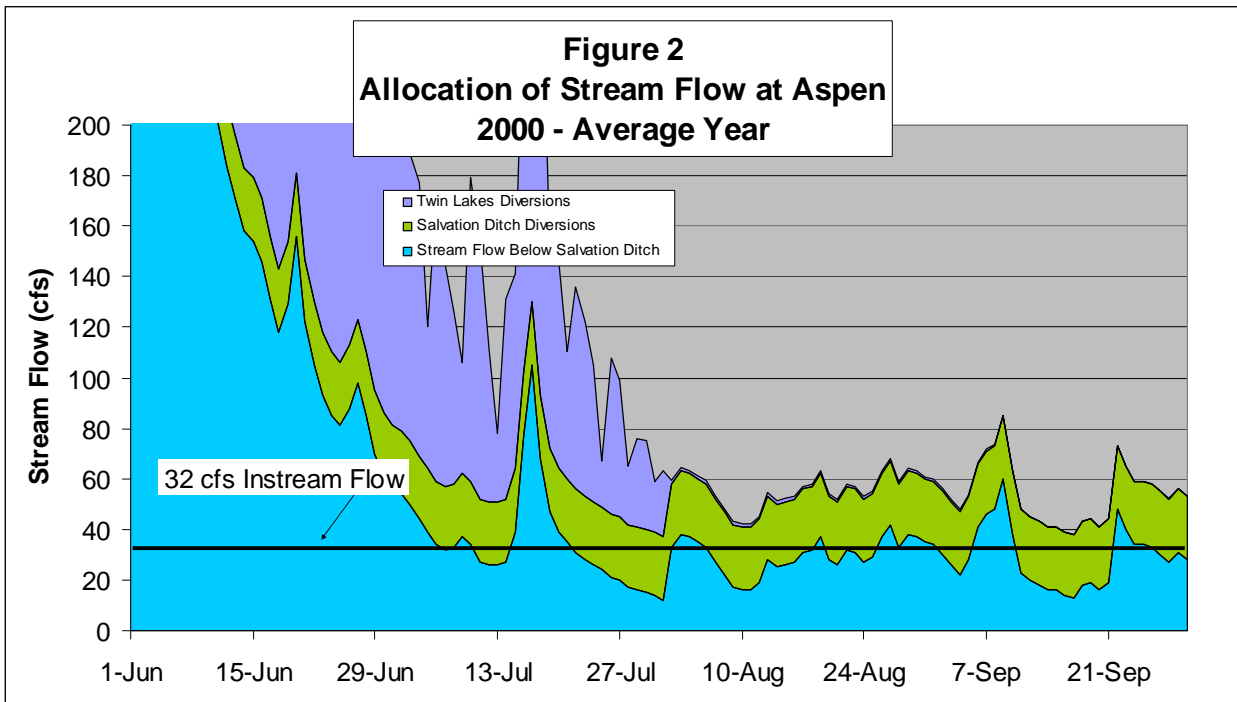
Bypasses from the Twin Lakes Project could partially satisfy this objective, however bypasses from the Salvation Ditch would be absolutely required to maintain an instream flow through the City. Figures 1, 2 and 3 illustrate stream flow of the Roaring Fork River at Aspen in dry, average and wet years.

**3.2.1 Dry Year.** For the 2002 dry year, stream flow is below the 32 cfs instream flow for most of the irrigation season. During this year, the Twin Lakes Project diverted water through June 24<sup>th</sup>. After June 24<sup>th</sup>, the water rights for the project were called out, and project diversions were minimal the rest of the irrigation season. The instream flow deficit that occurred prior to June 24<sup>th</sup> would have benefited from a bypass of Twin Lakes water. However, the deficit that occurred from June 24<sup>th</sup> through the end of the irrigation season could be mitigated by the Salvation Ditch only.

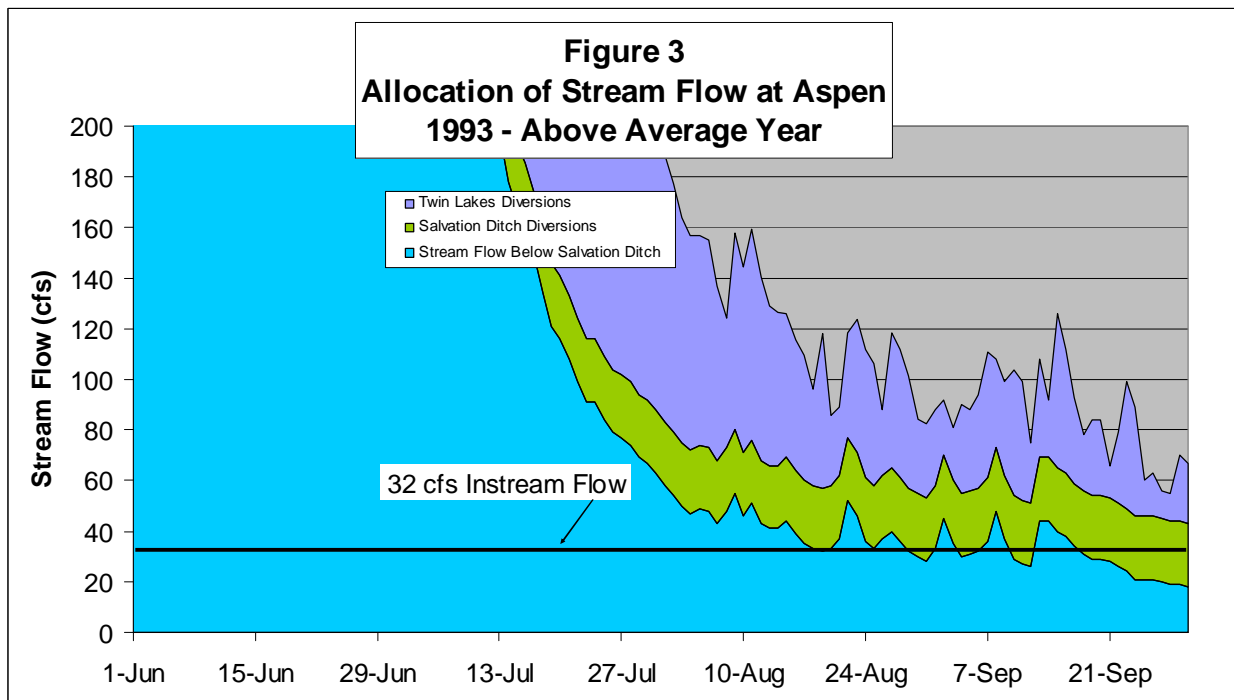


**3.2.2 Average Year.** In the near average year of 2000, stream flow was less than the 32 cfs instream from July 22<sup>nd</sup> through most of the remaining irrigation season. The Twin Lakes

Project water rights were curtailed on August 2<sup>nd</sup>. From July 22<sup>nd</sup> through August 4<sup>th</sup>, bypasses from the Twin Lakes Project could have maintained the 32 cfs instream flow water right. After August 4<sup>th</sup>, bypasses from the Salvation Ditch would have been required.



**3.2.3 Above Average Year.** In the above average year of 1993, the 32 cfs instream flow was not maintained during the later part of September. Bypasses from either Twin Lakes or the Salvation Ditch could have maintained instream flows during this period.



### **3.3 Support Viable Aquatic Ecosystems Below All Twin Lakes Diversion Points (OBJ #3)**

The Twin Lakes Project diverts from six individual streams in the headwaters of the Roaring Fork watershed; Lost Man Creek, the Roaring Fork River, Lincoln Creek, Tabor Creek, Brooklyn Gulch, and New York Creek. Bypasses were not required on any of these six tributaries because stream flow maintenance was not as important in the 1930's as it is today. Pursuant to the 3,000 acre foot Twin Lakes / Fry-Ark exchange, bypasses are voluntarily provided at two of the primary tributaries that are diverted; the Roaring Fork River and Lincoln Creek. Total annual bypasses at these two sites have historically been limited to less than 3,000 acre feet, pursuant to the exchange limitations. In the 2007 water year, the exchange was used to deliver 3 cfs of water to Lincoln Creek from October through May, and 4 cfs from June through September. On the Roaring Fork River, 4 cfs was bypassed during June and July, 3 cfs was bypassed in August and September, and no water was bypassed the remainder of the year.

Additional water is desired for bypasses at these two streams. The goal of these bypasses, as relayed by the Roaring Fork Conservancy, is to essentially keep the bed of the stream channel wet and to maintain a viable aquatic ecosystem. The specific amount of water desired for this use is not known at this time, and we understand that several studies are underway to evaluate this issue. In the late 1970's, the Forest Service conducted site specific studies of bypass requirements and concluded that 3.0 cfs was desired in Lincoln Creek and 10.5 cfs was desired on the Roaring Fork River. For general planning uses in this study we have assumed that bypasses of 3.0 cfs and 10.5 cfs, or natural flow whichever is less, are desired at Lincoln Creek and the Roaring Fork River sites respectively.

The annual amount of Twin Lakes bypasses required to meet the above criteria averages about 4,300 acre feet per year. To meet the above objectives, an additional 1,300 acre feet of Twin Lakes bypasses, over and above the existing 3,000 acre foot exchange, would be required.

### **3.4 Provide Flushing Flows In The Upper Roaring Fork Watershed (OBJ #4)**

Peak stream flows in the headwaters of the Roaring Fork watershed are significantly reduced by Twin Lakes Project diversions. The Twin Lakes Project can divert a maximum of about 625 cfs of water during snowmelt runoff periods. Commonly during the height of snowmelt runoff, the flow below the Twin Lakes Project is reduced by about 625 cfs, or a total of about 1,240 acre feet per day. In most dry and average years, the Twin Lakes Project diverts all water available at the collection system. Only in wet years when peak runoff can exceed 625 cfs for short periods, are peak flows bypassed.

The Roaring Fork Conservancy and the Nature Conservancy have recognized a need to periodically supply "flushing flows" in the Roaring Fork watershed. The Roaring Fork Conservancy specifically suggested a target peak snowmelt runoff flow of 1,100 cfs in the river at Aspen, with an average recurrence of five times every ten years. The median duration of time that the peak flow would naturally exceed 1,100 cfs is about 6 days.

Without bypasses from the Twin Lakes Project, peak flows in the river near Aspen will exceed 1,100 cfs about once every ten years, instead of the 5 out of 10 years that the Roaring Fork Conservancy has suggested. Accordingly, we have assumed that peak flow enhancement might occur in 4 out of every ten years, during which time the Twin Lakes Project would bypass all potentially diverted water during a six day period at the height of the hydrograph (typically 625 cfs). This bypass would reduce Twin Lakes diversions by about 7,500 acre feet in each year that a bypass was made, and over a long-term period would reduce the yield of the project by about 3,000 acre feet per year.

## 4.0 POTENTIAL WATER SUPPLY ALTERNATIVES

We have investigated several alternatives to supply a portion or all of the 11,000 to 12,000 acre feet of potential demands summarized in Table 1. The concept for these alternatives is to develop additional water supplies for either the Twin Lakes Project or the Fryingpan-Arkansas Project, and then trade these additional supplies to Twin Lakes for stream flow bypasses to the Roaring Fork watershed at critical times of the year. If possible, this manner of trade or exchange would not diminish the yield of the Twin Lakes Project, and would result in higher local stream flows during certain periods of the year. The following alternatives have been assessed:

- (1) Purchase Twin Lakes Water
- (2) Twin Lakes / Ruedi Reservoir Exchange
- (3) Enlargement of Grizzly Reservoir
- (4) Use of Colorado River District Water in Grizzly and Twin Lakes Reservoirs
- (5) Reduction of Thomasville Gage Bypass Requirements (Fry-Ark Project)
- (6) Acquisition of Arkansas River Basin Water

### **4.1 Purchase Twin Lakes Water (ALT #1)**

Shares of Twin Lakes water are sold on the open market, although very few shares are typically available for purchase. The yield of each share varies from year to year, but on average one share provides about one acre foot of water. The majority of the water associated with a Twin Lakes share is derived from West Slope diversions, however a portion of this water is also derived from diversions on the East Slope.

The price of water in the Arkansas River watershed is considerably greater than the price of water in most areas of the Colorado River watershed, because of the over-appropriated nature of the Arkansas River. Recent transactions for Twin Lakes Project shares have occurred at a price of over \$25,000 per share. If larger blocks of shares were available, the purchase price may decrease, however no comparable transactions for large blocks of shares are available. Assuming a price of \$25,000 per acre foot of yield, the cost of purchasing water would be about \$25,000,000 per thousand acre feet, or \$275,000,000 for the entire demand of 11,000 acre feet.

**We do not believe that this alternative is practicable for three reasons:**

- Very few shares of Twin Lakes Project water are on the market, and large blocks of shares are not available for purchase

- The project is not decreed for the use of water on the West Slope, therefore, substantial Water Court actions may be required to allow the use of Twin Lakes water on the West Slope.
- The price of acquiring water enough shares of water to supply a significant portion of the identified demand would be in the hundreds of millions of dollars. No source of funds of this magnitude have been identified to date.

#### **4.2 Twin Lakes / Ruedi Reservoir Exchange (ALT #2)**

This concept would involve an exchange of water between Ruedi Reservoir and Twin Lakes Reservoir. If the exchange could be used to increase diversions by the Twin Lakes Project, the increased yield could be bypassed to the Roaring Fork watershed at other times of year. The opportunity for this exchange would occur solely in the late summer months of dry years when the Twin Lakes Project is currently curtailed by senior irrigation rights. Throughout average and wet years, and in the snowmelt runoff period of dry years, the Twin Lakes Project is currently diverting all available inflow and an exchange would not increase the yield of the project nor facilitate a trade of water for instream purposes.

The exchange would operate in the following manner:

1. The Twin Lakes Project would divert water when they are out-of-priority (in the late summer months of dry years). Currently Twin diversions during this period are curtailed.
2. An amount of water equal to the out-of-priority diversions by Twin Lakes would be released from Ruedi Reservoir. This release would keep downstream irrigation users on the Colorado River “whole” and would prevent injury to these senior water rights.
3. Since the exchange would be operated under a junior water right priority, Twin Lakes could only divert that amount of water that is in excess of the State’s instream flow water right in the Roaring Fork River and in excess of the City of Aspen’s kayak park water right.

We have estimated the amount of water that would have been available through this exchange on a daily basis for the historical 1950 through 2007 period. Exchange opportunities are very limited as outlined in Attachment 3. We estimate that on average, exchange potential is about 70 acre feet per year. No exchange potential would have occurred at anytime in the last 13 years. Exchange potential is limited because when the Twin Lakes Project is out-of-priority (the summer of dry years), no additional water can be diverted while still maintaining the 32 cfs instream flow right through the City, and the City of Aspen kayak park water right.

**Given the lack of exchange potential, we do not believe that this alternative is practicable.**

### **4.3 Enlargement of Grizzly Reservoir (ALT #3)**

The existing Grizzly Reservoir is a component of the Twin Lakes Project. This small reservoir of 570 acre feet is located on Lincoln Creek at the site of the Twin Lakes Tunnel inlet. The reservoir is essentially a forebay to the tunnel, which is used to regulate inflow between the collection system and the tunnel.

This alternative would rebuild Grizzly Reservoir to a capacity of between 2,600 acre feet and 4,600 acre feet. In our experience, development costs for small reservoirs of this nature are typically in the \$5,000 to \$10,000 per acre foot range. It is not unreasonable to expect that the construction of a 4,600 acre foot reservoir would cost between \$23 million and \$46 million .

“Surplus” water during the height of the snowmelt runoff period would be stored in the rebuilt reservoir. This surplus water is available when physical inflow exceeds the capacity of the Twin Lakes Tunnel. Water for storage in Grizzly Reservoir would be available infrequently. For example, in only two of the last 12 years could a significant amount of water have been stored in a larger Grizzly Reservoir. During the last 12 years (1996 through 2007) we estimate that a cumulative total of about 6,000 acre feet would have been available for diversion into an enlarged Grizzly Reservoir, or an average of about 500 acre feet per year (Attachment 4). Most of this water was available for diversion in 1997 and 2003. As a result, it will be necessary to capture the available water in wet years and hold this water for subsequent release in dry years. We believe that a reservoir enlargement between 2,000 acre feet and 4,000 acre feet in capacity would be best suited to capture the large amounts of water available in wet years, and still allow Grizzly Reservoir to function as a forebay.

Permitting and construction issues for rebuilding Grizzly Reservoir at a larger capacity are significant. It is likely that the existing embankment must be completely removed, and a new embankment constructed. At a minimum, the following approvals will be required for reservoir enlargement:

- A Special Use Permit from the Forest Service, with accompanying environmental impact statement
- A 404 Permit from the U.S. Army Corp of Engineers, with an alternatives study to confirm that this is the “least environmentally damaging practicable alternative”
- A decreed water right through the Water Court System
- A Pitkin County 1041 Permit
- An agreement with the Twin Lakes Reservoir and Canal Company

**We do not believe that this alternative is practicable** because the enlargement of Grizzly Reservoir will eliminate a sizable area of high quality wetlands that may include fens. The wetland issues will be difficult to overcome.

#### **4.4 Use of Colorado River District Water in Grizzly and Twin Lakes Reservoirs (ALT #4)**

The senior water rights for the Twin Lakes Project allow the project to divert all water physically available at the collection system during most years. However, in very wet years the senior water rights can be curtailed during isolated periods at the height of snowmelt runoff. Specifically, the original water right decree for the Twin Lakes Project recognizes that the Project cannot divert water to the Arkansas River watershed if (1) the project has already stored 54,452 acre feet of water in Twin Lakes Reservoir in a given year and (2) 756 cfs of water is available for diversion by the Colorado Canal, located in the lower Arkansas River basin.

In Case No. 95CW321, the Twin Lakes Reservoir and Canal Company applied for junior water rights with a 1995 adjudication date that would allow diversion of water to the Arkansas River during the infrequent wet periods that the above criteria curtail diversions. The Water Court decree entered in this case specifies the following:

- Of the first 2,400 acre feet of water diverted by the junior Twin Lakes water right in any water year, two-thirds of the water will be allocated to Twin Lakes and one-third of the water will be allocated to the Colorado River District
- Of the water allocated to the Colorado River District, the first 200 acre feet will be allocated to a Grizzly Reservoir account
- The Colorado River District can call for the release of up to 100 acre feet of water allocated to Grizzly Reservoir in an individual water year
- All diversions under the junior water right in excess of 2,400 acre feet accrue to the Twin Lakes Project

This water is available in wet years only. Historical stream flow records suggest that the junior right may divert water as frequently as one in every 10 years. The last time this junior water could have diverted water was in 1997, which was prior to the entry of a decree in the 95CW321 case. It is our understanding that no water has yet been diverted under this junior decree, and that no water has yet accrued to the Colorado River District. We also understand that the Colorado River District has not yet committed any of this potential yield to a specific use.

**This alternative merits further consideration**, even though it may only yield a small amount of water. The available water could either be released from Grizzly Reservoir (100 acre feet per year maximum), or given to the Twin Lakes Project for a bypass of water from the West Slope collection system in return. If the junior right is actually utilized an average of one out of three years, the average annual yield to the Colorado River District could be as great as 266 acre feet per year (800 acre feet divided by 3). During dry climatic cycles, such as has occurred from 1997 to the present, no water would be available from this source.

#### **4.5 Reduction of Thomasville Gage Bypass Requirements (Fry-Ark Project) (ALT #5)**

This alternative would enhance the yield of the Fryingpan-Arkansas diversion project by reducing stream flow bypass requirements to the Fryingpan River above Ruedi Reservoir. Any enhanced yield would be delivered to the Twin Lakes Project within the Arkansas River watershed. In return, the Twin Lakes Project would bypass a commensurate amount of water at the Twin Lakes diversion sites. Stream flow in the Fryingpan River below Ruedi Reservoir would be unaffected.

The Fry-Ark Project is required to bypass a certain amount of water at the headwater diversion sites, and to also maintain a certain flow regime in the Fryingpan River above Ruedi Reservoir (the Thomasville Gage). The required flow regime at the Thomasville gage is:

April = 100 cfs	July = 100 cfs
May = 150 cfs	August = 75 cfs
June = 200 cfs	September = 65 cfs

During some years, the bypasses at the upstream head gates are insufficient to meet the Thomasville Gage requirement. During these times, the Fry-Ark Project bypasses additional water and project diversions are reduced. If the Thomasville gage requirements were relaxed, additional water would be available for diversion, while still maintain the required bypass amounts at the headwater diversion structures.

A reconnaissance level estimate of the potential increase in yield associated with the relaxing flow at the Thomasville gage is provided in Attachment 5. If flow requirements were relaxed to 100 cfs in both May and June, an average of 980 acre feet of additional diversions was simulated. Please note that these estimates of increased yield are likely high. When considering hydrology and physical constraints of each individual point on the Fry-Ark collection system, and considering the complexities of water right administration, actual increases in yield will likely average less than 500 acre feet per year.

**We believe that this alternative may be practicable to a limited extent.** However, two difficult implementation issues are associated with this concept:

1. The Federal Fryingpan-Arkansas Authorizing Legislation must be amended by congress to reduce Thomasville bypass flows, and to credit any additional yield to Twin Lakes.
2. The Colorado Water Conservation Board (CWCB) has decreed instream flow water rights in the same amount as the existing Fry-Ark bypass flow requirements. The CWCB must decree a reduction in instream flows through the Water Court before this concept can be implemented. The CWCB cannot trade impacts (i.e. help the Roaring Fork while impacting the Fryingpan River. In order to reduce the instream flow water right the CWCB must first determine that the existing Fryingpan River

instream flows are more than the amount of water needed to protect the environment to a reasonable degree. Specific instream flow studies will be required, and the outcome of these studies is not known. Opposition in Water Court to any application to reduce the instream flow water rights may occur from conservation groups & Fryingpan River interests.

#### **4.6 Acquisition of Arkansas River Basin Water (ALT #6)**

In this alternative, Roaring Fork interests would acquire water in the Arkansas River watershed and trade this water to Twin Lakes. In return, Twin Lakes would bypass water at the collection system intakes. The Arkansas River has been over-appropriated for more than a century; hence the historical development of the Fry-Ark Project, the Twin Lakes Project and others. As a result, the acquisition of water from this basin is difficult, and would involve both the purchase of agricultural water rights and the acquisition of reservoir storage. All of the following actions would likely be required:

1. Acquire Upper Arkansas storage space; and
2. Acquire Arkansas River water (agricultural rights) to put into storage; and
3. Acquire space in Pueblo Reservoir as a holding bucket for agricultural rights until they can be exchanged upstream; and
4. Obtain a Water Court decree to allow change of use and exchange of agricultural rights; and
5. Reach an agreement with Twin Lakes to “trade ” Arkansas River water to the Roaring Fork River

**4.6.1 Upper Arkansas River Storage Space.** Storage space in either Twin Lakes Reservoir or Turquoise Reservoir is required. These are the only two reservoirs upstream of the intake to the Otero Pipeline, which is used to deliver water Twin Lakes Project water to Colorado Springs and Aurora (see Attachment 1). Twin Lakes Reservoir space is preferred since there is much more opportunity to transfer water into Twin Lakes Reservoir than into Turquoise Reservoir. Space in reservoirs downstream of Twin Lakes Reservoir will not provide water to most of the shareholders of the Twin Lakes Reservoir & Canal Company.

**4.6.2 Acquire Arkansas River Water Rights (agricultural water rights).** The acquisition of storage space does not provide any water to put into the acquired storage. Water (or yield) must be acquired to put into any reservoir storage that is secured. The only sizeable amount of water available for acquisition is associated with the permanent dry-up of agricultural lands from around the City of Pueblo or downstream. The further the distance downstream of Pueblo, the easier and cheaper it is to acquire agricultural water.

Recent agricultural purchases in the lower Arkansas River watershed have ranged from \$3,000 to \$7,000 per acre foot. To acquire an annual yield of 5,000 AF, initial purchase costs between \$15,000,000 and \$35,000,000 could be expected. Additionally, a substantial area of crop land (about 2,500 acres) must be permanently removed from irrigation. Several East Slope water providers have found the permanent dry-up of agricultural land to be controversial.

An alternative to the purchase of agricultural water rights is the lease of “spot market” water. During certain average or wetter than average type years, “spot market” water is available for purchase in the Arkansas River watershed. Specifically, the Pueblo Board of Water Works, Colorado Springs Utilities, the City of Aurora and others, lease water on a year-to-year basis when excess supplies are available. This water is most often associated with agricultural water transfers from lower Arkansas River ditches and canals. During recent years this spot market water has been very reasonably priced, but is typically available only in the lower Arkansas River a considerable distance east of the City of Pueblo. The spot market water is not usually available at upstream locations where the water can be delivered to Twin Lakes Project shareholders. The spot market water is commonly water that the municipal interests have not been able to use or to transfer to their upstream diversions facilities.

**4.6.3 Acquire Lower Basin Storage (Pueblo Reservoir).** Any agricultural water is not available upon demand. This water is only available at small, relatively constant rates throughout the growing season commensurate with the evapotranspiration of the crops that are no longer irrigated. It is only possible to transfer the agricultural water upstream at times that the flow of the Arkansas River is high, primary because of kayak park water rights and prior exchanges that have been decreed. Accordingly, a lower basin storage reservoir must be acquired to store the agricultural water over the course of the summer, so that it can be exchanged upstream during the snowmelt runoff period of the following year.

“If-and-when space” can be acquired from Pueblo Reservoir though the Bureau of Reclamation. This space is only available if Pueblo Reservoir does not fill and spill with other water (i.e. Fry-Ark water). If and when space is generally available in dry years and average years, but not wet years.

The acquisition of if-and-when space for out of basin entities (such as West Slope groups) would be controversial. For example, Aurora (another out of basin entity) recently spent over \$2,000,000 and 4 years of effort in securing an if-and-when account in Pueblo Reservoir from the U.S. Department of Interior. Local Arkansas River interests are extremely opposed to the use of Pueblo Reservoir by out-of-basin parties and have opposed this use. In the fall of 2007, these interest groups brought suit against the U.S. Department of Interior to block Aurora’s use of Pueblo Reservoir and other Fryingpan-Arkansas facilities. The outcome of this litigation will not be determined for some time. It is reasonable to expect that any West Slope use of these facilities will be at least as controversial as Aurora’s proposed use.

Annual storage costs in Pueblo Reservoir are about \$50 / AF currently and are expected to increase. Annual costs for the use of 5,000 AF of space when it is available would be about \$250,000 each and every year.

**4.6.4 Decree an Exchange of Agricultural Water in Water Court.** A water right decree must be secured to allow an upstream transfer of water rights. This decree must protect all existing water rights along the Arkansas River between the location of the agricultural rights and Turquoise or Twin Lakes reservoirs. These exchange decrees are difficult to obtain, and may only allow water transfers during several weeks of peak runoff each year. No exchange may be possible in dry years. The time required to decree an exchange would exceed 5 years. Engineering and legal support for these types of exchanges will typically costs in excess of \$1,000,000. Most importantly, the likelihood of successfully decreeing an exchange is uncertain at best.

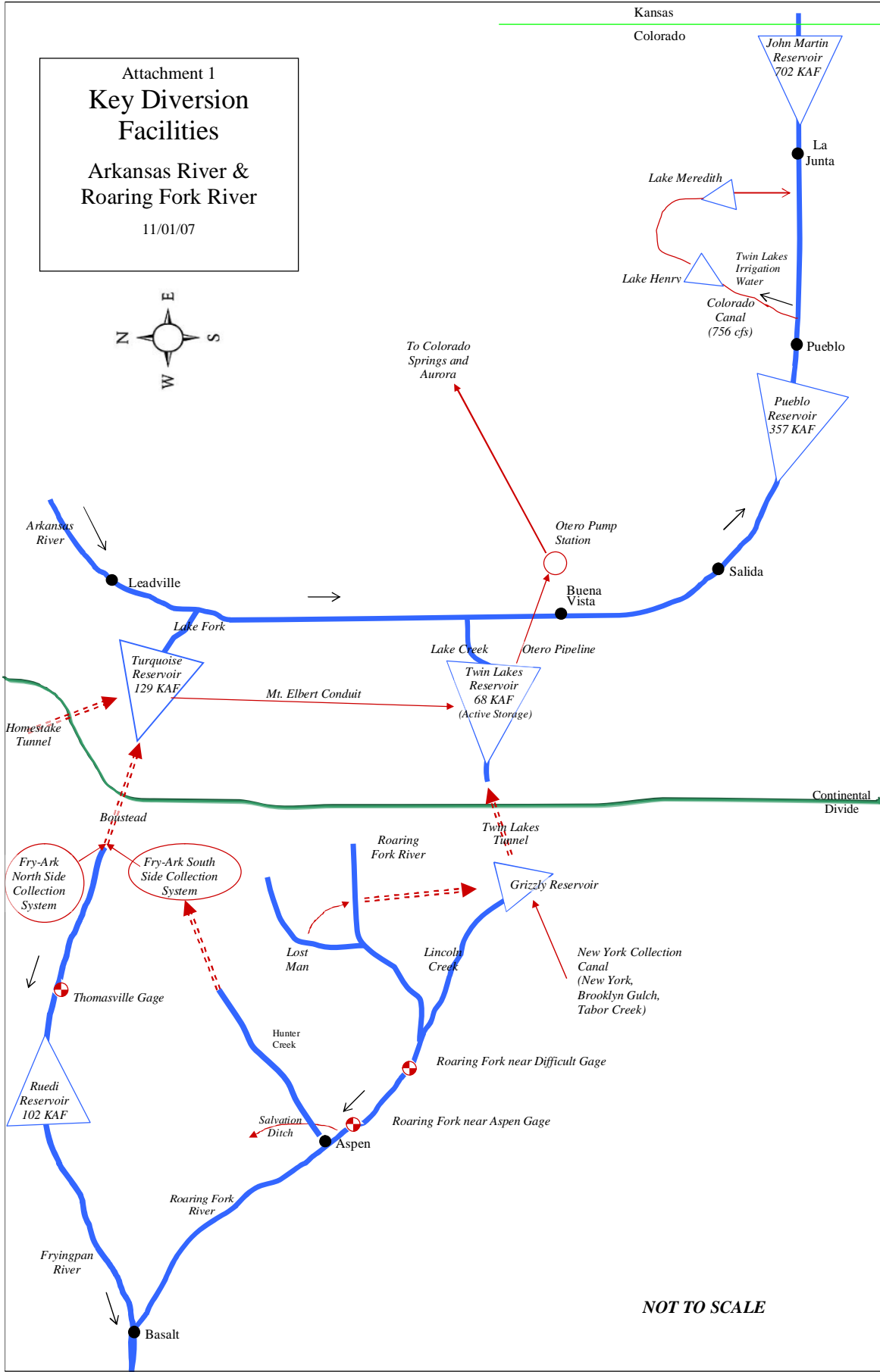
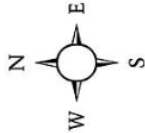
**4.6.5 Acquire Twin Lakes Cooperation.** Upon completion of the above tasks, water in either Twin Lakes Reservoir or Turquoise Reservoir would be available for West Slope use. Cooperation with the Twin Lakes Reservoir and Canal Company would be required to trade this water for bypasses in the Roaring Fork River.

**4.6.6 Potential Total Costs and Timeline.** Reconnaissance level costs for securing 5,000 acre feet of supply (excluding the cost of Twin Lakes or Turquoise Reservoir space) are outlined below. These costs are in addition to a \$250,000 annual fee for the lease of if-and-when space in Pueblo Reservoir.

Acquire water to put into storage (ag water):	\$15 million to \$35 million
Acquire lower basin if-and-when storage:	\$2 million to \$3 million
<u>Water Court Decree:</u>	<u>\$1 million to \$2 million</u>
Total Up Front Costs:	\$18 million to \$40 million

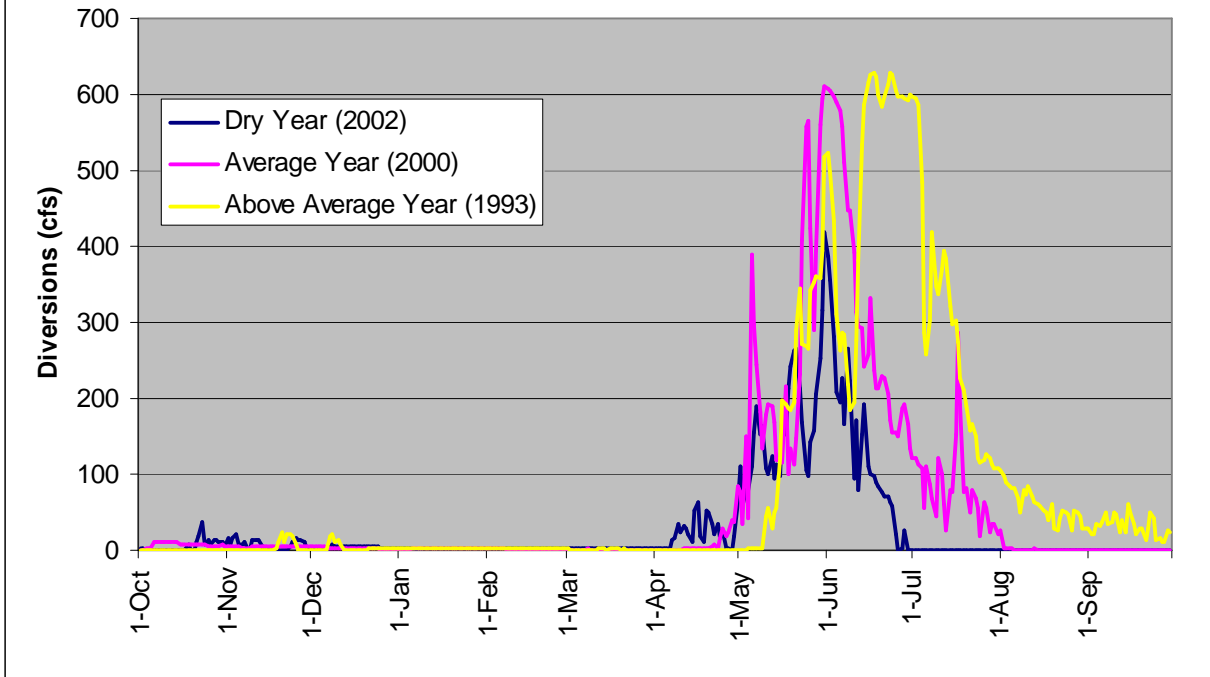
**While this alternative is costly, it may provide the opportunity to acquire relatively large amounts of water.**

Attachment 1  
**Key Diversion Facilities**  
 Arkansas River &  
 Roaring Fork River  
 11/01/07



NOT TO SCALE

## Attachment 2 Historical Twin Lakes Diversions



**ATTACHMENT 3  
EXCHANGE POTENTIAL - TWIN LAKES PROJECT - W/ ASPEN RICD (Acre Feet)**

	<b>April</b>	<b>May</b>	<b>June</b>	<b>July</b>	<b>August</b>	<b>Sept</b>	<b>Oct</b>	<b>Annual</b>
1950	0	190	0	0	0	0	0	190
1951	0	0	0	0	0	0	0	0
1952	0	0	0	0	0	0	0	0
1953	0	0	0	0	0	0	0	0
1954	0	735	0	0	0	0	0	735
1955	0	0	0	0	73	0	0	73
1956	0	0	0	0	0	0	0	0
1957	0	0	0	0	0	0	0	0
1958	0	0	0	0	0	0	0	0
1959	0	0	0	0	0	0	0	0
1960	0	0	0	0	0	0	0	0
1961	0	107	0	0	0	139	0	246
1962	0	0	0	0	0	0	0	0
1963	0	0	0	0	29	3	0	32
1964	0	0	0	0	0	0	0	0
1965	0	0	0	0	0	13	0	13
1966	0	0	0	0	0	0	0	0
1967	0	0	0	0	0	0	0	0
1968	0	0	0	0	0	0	0	0
1969	0	0	0	0	0	0	0	0
1970	0	0	0	0	0	127	0	127
1971	0	0	0	0	0	0	0	0
1972	0	0	0	0	0	0	0	0
1973	0	0	0	0	0	0	0	0
1974	0	0	0	0	0	0	0	0
1975	0	0	0	0	0	9	0	9
1976	0	0	0	0	0	2	0	2
1977	0	1595	0	0	0	0	0	1595
1978	0	0	0	0	0	0	0	0
1979	0	0	0	0	0	0	0	0
1980	0	0	0	0	0	0	0	0
1981	0	520	0	0	0	0	0	520
1982	0	0	0	0	0	127	0	127
1983	0	0	0	0	0	9	0	9
1984	0	0	0	0	0	0	0	0
1985	0	0	0	0	0	0	0	0
1986	0	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0
1989	0	42	0	0	17	0	0	59
1990	0	24	0	0	0	0	0	24
1991	0	0	0	0	0	15	0	15
1992	0	0	0	0	0	0	0	0
1993	0	0	0	0	0	94	0	94
1994	0	0	0	0	0	50	0	50
1995	0	0	0	0	0	0	0	0
1996	0	0	0	0	0	0	0	0
1997	0	0	0	0	0	0	0	0
1998	0	0	0	0	0	0	0	0
1999	0	0	0	0	0	0	0	0
2000	0	0	0	0	0	0	0	0
2001	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0
2006	0	0	0	0	0	0	0	0
2007	0	0	0	0	0	0	0	0

**ATTACHMENT 4  
MAXIMUM POTENTIAL STORAGE IN AN ENLARGED  
GRIZZLY RESERVOIR**

	<b>May</b>	<b>June</b>	<b>July</b>	<b>Annual</b>
1966	0	0	0	0
1967	0	0	0	0
1968	0	644	0	644
1969	30	0	0	30
1970	749	85	0	834
1971	0	3162	0	3162
1972	0	208	0	208
1973	0	3205	106	3311
1974	0	0	0	0
1975	0	0	0	0
1976	0	0	0	0
1977	0	0	0	0
1978	0	492	0	492
1979	0	378	157	534
1980	0	644	0	644
1981	0	4	0	4
1982	0	4	0	4
1983	0	6594	1317	7911
1984	1524	3802	1418	6745
1985	4	2878	0	2882
1986	0	72	0	72
1987	0	309	0	309
1988	0	0	0	0
1989	0	0	0	0
1990	0	1681	0	1681
1991	0	132	0	132
1992	0	0	0	0
1993	0	1678	0	1678
1994	0	0	0	0
1995	0	10458	6340	16798
1996	0	186	0	186
<b>1997</b>	<b>0</b>	<b>3937</b>	<b>0</b>	<b>3937</b>
1998	0	0	0	0
1999	0	200	0	200
2000	81	55	0	136
2001	0	0	0	0
2002	0	0	0	0
<b>2003</b>	<b>1363</b>	<b>580</b>	<b>0</b>	<b>1943</b>
2004	0	0	0	0
2005	0	0	0	0
2006	0	0	0	0
2007	0	0	0	0

\* Estimate for entire collection system; the actual diversion capacity of individual system components will likely reduce these estimates considerably

**ATTACHMENT 5**

**SIMULATED INCREASE IN FRY-ARK YIELD  
WITH REDUCTION IN THOMASVILLE GAGE REQUIREMENTS**

PRELIMINARY ESTIMATE (1976 - 2006 WATER YEARS)

April		May		June		July		August		September		Oct - March	
Thomasville Gage (cfs)	Avg Yield Increase (AF/yr)	Thomasville Gage (cfs)	Avg Yield Increase (AF/yr)	Thomasville Gage (cfs)	Avg Yield Increase (AF/yr)	Thomasville Gage (cfs)	Avg Yield Increase (AF/yr)	Thomasville Gage (cfs)	Avg Yield Increase (AF/yr)	Thomasville Gage (cfs)	Avg Yield Increase (AF/yr)	Thomasville Gage (cfs)	Avg Yield Increase (AF/yr)
<b>100</b>	<b>0</b>	<b>150</b>	<b>0</b>	<b>200</b>	<b>0</b>	<b>100</b>	<b>0</b>	<b>75</b>	<b>0</b>	<b>65</b>	<b>0</b>	<b>30</b>	<b>0</b>
90	120	140	152	190	127	90	75	70	21	60	0	0	0
80	233	130	280	180	227	80	138	60	27	50	0		
70	304	120	372	170	303	70	175	50	27				
60	310	110	449	160	254	60	178						
50	310	100	520	150	391	50	178						
		90	573	140	418								
		80	607	130	433								
		70	616	120	441								
		60	617	110	451								
				100	460								

\* Actual increases in yield may be less