Stakeholder's Cooperative Management Analysis for the Upper Arkansas River Basin

Prepared for the Arkansas River Roundtable

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RESOURCE BASED INTERNATIONAL

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Stakeholder's Cooperative Management Analysis for the Upper Arkansas River Basin

1.0 Background

The basis of this study originated as a result of a stakeholder meeting held by the Southeastern Water Conservancy District in March 2009 in Pueblo, Colorado. The purpose of the meeting was to discuss various effects of seasonal water flows in the upper Arkansas River Basin, and investigate potential alternatives for future flow management. All interested parties were invited to the meeting, and the list of stakeholders in attendance represented a variety of different interests including landowners, fishery experts, recreationists, small business owners, elected officials, state and federal agencies, and water right holders. Participants agreed that issues affecting the stakeholders varied according to the various types of years (wet, average, and dry), and that the overall "movement" of water in the upper basin was complex and not fully understood by all parties. Therefore, it was concluded that a *stakeholder analysis* should be conducted to provide participants the ability to predict the effects of current water activities, and determine if there were more appropriate management alternatives to these activities.

This study is a direct outcome of this 2009 meeting. Many of the issues addressed in this analysis are well known to upper Arkansas River residents, water managers, and elected officials. (For purposes of this study, the upper Arkansas is defined as the geographical area from the headwaters to Pueblo Reservoir – see Figure 1.0). As demonstrated at the 2009 meeting, many of the upper Arkansas River constituents perceive a lack of an overall management strategy to resolve "chronic" water-related issues. Consequently, this analysis was designed to address the highest priority issues of the stakeholders, and do so in the most expedient manner.

1.1 Integration with Arkansas River Decision Support System

In many ways, this analysis is a precursor to the ongoing Decision Support System ("DSS") that is presently being conducted by the State of Colorado. Members of this study team did collaborate with the State in developing data sets and modeling strategies that allow information from this study to be utilized in the DSS development for the Arkansas River basin. However, the time-lines and purposes for the two projects are very different. The stakeholder's expressed a desire to not only address water resource issues on a technical level, but they also wanted an analysis to include social, economic, and environmental aspects of water

management. Therefore, this study was tasked with combining a hydrological investigation with stakeholder-driven alternatives. Consequently, from the outset, this study had definitive objectives as determined by the upper basin participants, was designed to analyze management alternatives in a relatively short period of time, and, perhaps most importantly, evaluated water issues from a wide-range of perspectives. It is anticipated that aspects of this study (data bases, model results, stakeholder feedback) will be eventually incorporated in the final DSS.

1.2 Study Objectives

There were four primary objectives of this project:

1. Identify and asses (at a reconnaissance level) specific stakeholder-supported management alternatives/suggestions for upper Arkansas River operations related to high, average, and low stream flow regimes. These management topics were reviewed with respect to their potential "ease-of- implementation", and their predicted impacts on other water users and stakeholders in the basin;
2. Create a better understanding among upper basin stakeholders of the rationale for water management decisions;
3. Promote and increase cooperation and collaboration among upper basin stakeholders to more effectively and efficiently address multiple needs and interests;
4. Provide baseline data for future use by stakeholders and the Decision Support System.

An over-riding consideration of the study was that alternatives, outcomes, and conclusions had to be supported by the stakeholders. The study results had to have credibility among the participants, because without it, there is little possibility of modifying operations for the benefit of those involved.

1.3 Purpose and Need Statement

The purpose of this study was to integrate hydrological data, water management operations, and stakeholder-initiated recommendations into a single comprehensive analysis. The analysis will be used to provide a basis for future operational alternatives.

The need for the study is that many of these issues identified by stakeholders have been on-going, and thereby creating a higher level of misunderstanding. It was the recommendation of the Arkansas River Roundtable that these water management matters should be addressed prior to the completion of the proposed DSS project.

2.0 **Study Process**

The approach used in this analysis was threefold:

1. Develop a list of stakeholder issues/topics in the upper Arkansas River Basin;
2. Develop a historical hydrological "operational" model; and
3. Use the model to analyze stakeholder supported management recommendations.

2.1 Develop Stakeholder Issues List

The objective was to solicit stakeholder topics and evaluations regarding past and current aspects of upper river management. The purpose of this solicitation was to categorize areas of concerns and objectives derived from a multiple set of sources, and subsequently, identify river management impacts. The focus was to develop a stakeholder's assessment of river management impacts related to: 1) water management operations; 2) implementation of various stakeholder agreements; and 3) "non-consumptive" user needs.

The development of a stakeholder's "issues" list involved direct interaction with a variety of interested parties in the upper basin. Surveys, interviews, meetings, teleconferences, and other forms of communication (i.e. newspaper clippings, newsletters, etc.) were used to identify not only the list of issues to investigate, but also to separate the issues from lowest to highest priority – based on frequency of comments and impacts to the largest number of stakeholders.

2.2 Analytical Model

The development of the analytical model involved gathering related operational data for the upper basin. The data collected was separated into two main categories: Project and non-Project water. "Project" water is defined as water that is involved with the operation of the United States Bureau of Reclamation's (USBR) Frying Pan- Arkansas Rivers Project ("Fry-Ark"). Non-Project water included all other waters, including portions of Arkansas River native flow, municipal water supplies, rights held by regional water districts, and agricultural water rights.

Historical hydrological conditions and water operations were examined for specific facilities (reservoirs, gage sites, stream reaches) identified by the stakeholders. For example, annual water quantification was evaluated regarding: 1) Fry-Ark imports; 2) Turquoise and Twin Lakes Reservoirs' seasonal releases; 3) daily flows at the Wellsville gauge; 4) municipal upstream exchanges; and 5) Pueblo Reservoir elevations.

Other tasks involved in the development of the analytical model included:

- Review of significant decrees, as recommended by the Water Division 2 Engineer's office and the USBR, and their accompanying management requirements;
- Review of intergovernmental agreements, state and federal permits, and other operating guidelines (e.g. Fry-Ark operating objectives). Operational rules derived from these documents were incorporated into the analytical modeling tool;
- Review of existing water management models and data bases. When appropriate, pre-existing data bases were utilized, particularly from the USBR.
- Review of socio-economic impacts (small business revenues, county tax revenues, recreational visitation data for fishing and rafting activities).
- Review of the "Arkansas River Water Needs Assessment" to determine specific fishery and recreational impacts.

2.3 Stakeholder Study Topics Analysis

The third step in the analytical process involved incorporating stakeholder management alternatives/suggestions into the operational analysis. This was done to evaluate their feasibility and ease-of-implementation during high, average, and low water years. "What-if" scenarios were created by integrating stakeholder comments into the operational model to determine impacts at multiple sites in the upper basin.

2.3.1 Selection of Stakeholder Study Topics

A key component in assessing the feasibility of selected management topics was to build the administrative framework by which alternatives had to conform. This was done through an initial appraisal process for each alternative, on the basis of following:

1. Compliance with existing water right administration;
2. Compliance with existing contracts, agreements, and permits; and
3. Compatibility with federal, state, and local operating objectives and management.

The modeling framework consisted of these specific criteria and was not subject to change during the modeling process.

This framework provided a base-line that allowed for a systematic review of stakeholder suggestions and recommendations. Using the certitude of the model's operational framework

listed above, 10 stakeholder alternatives were initially categorized as infeasible – mainly because they adversely impacted vested water rights and/or were inconsistent with Fry-Ark objectives. Therefore, from an original list of 15 "stakeholder issues," the following list of 5 topics was selected as having the highest importance and feasibility for the upper basin participants:

- Lake Fork Creek Flooding below Turquoise Reservoir;
- Recreational Impacts at Turquoise Reservoir;
- Operation of Chaffee County Recreational In-channel Diversion Water Right;
- Exchange Impacts on the Arkansas River Voluntary Flow Management Program;
- Pueblo Reservoir Operations and Spill Sequences.

Because of the geographical locations of the five topics, the upper basin was separated into three sub-basins ("catchments"): 1) The upper catchment consisted of the issues and accompanying facilities located mainly in Lake County; 2) the middle concentrated on stakeholders and issues located mostly in Chaffee County, and 3) the lower catchment focused on stakeholders and issues involved with Pueblo Reservoir operations.

2.4 Study Period

The primary consideration in selecting a study period was to insure that representative dry, wet, and average years would be included. It was an inherent characteristic of the topics selected by the stakeholders that issues were most likely to occur during one of these particular "types" of year, rather than in all years.

After an initial review of the data, the study period of 2001-2011 was selected. This particular time-frame was chosen for the following reasons:

- ***Data availability*** – Data sets from the water-users in the upper basin were independently developed, and therefore, difficult to integrate into one primary data base. The most readily available data that could be integrated into a manageable, cost-effective data base was during this period.
- ***Representative period*** – The study period 2001-2011 had representative dry, average, and wet years for the upper basin. This was confirmed by the stakeholders interviewed by the study team. The 2002 water-year was recognized as a historically dry year, but nevertheless, the data was utilized for demonstration purposes. However, 2002 study results were not considered to be truly representative of more typical dry-year conditions.
- ***Representative of most recent operations*** – The study period is relevant because it represents the most recent water activities and operations.

3.0 Study Results

Each of the topics listed in Section 2.3.1 was analyzed for the purpose of improving water management in the upper basin to meet particular objectives. However, each study topic is only a part of the overall upper basin operations, and therefore, results of the analysis were not considered in an isolated setting. Each study topic was considered as an element of the upper basin operation as a whole, and the results of any given scenario were integrated into the overall administrative framework.

The study's results listed below are presented by individual topic. But because potential impacts and effects affected all three catchments, the consequences of implementing various alternatives related to each topic were not limited to any particular facility or list of stakeholders. Instead, impacts at facilities (in particular, Turquoise, Twin Lakes, and Pueblo Reservoirs) were simultaneously investigated. While the topics were separated into three catchments for study purposes, the results given below are in the context of effects and impacts within the entire upper basin. This approach resulted in an (upper) basin-wide analysis for particular scenario/alternatives suggested by the stakeholders in any given catchment.

3.1 Lake Fork Creek Flooding

3.1.1 Background - Turquoise Reservoir Operation

There are three Fry-Ark reservoirs located in the Arkansas River basin – Turquoise, Twin Lakes, and Pueblo Reservoirs. Turquoise Reservoir is the Arkansas River's upper most storage vessel in the Fry-Ark system on the east slope. Sugarloaf Dam and Turquoise Reservoir are located on Lake Fork Creek, a tributary of the Arkansas River. The Arkansas River flows one mile east of the reservoir, approximately five miles west of Leadville. The reservoir provides storage capacity for the regulation of Project water flowing from the Boustead Tunnel, the Homestake Project water, and native flows on Lake Fork Creek. The study focus on this topic was related to the annual operations at Turquoise Reservoir.

There are several key components related to Turquoise Reservoir operations:

- Turquoise Reservoir Storage Capacity – the reservoir's total capacity is 129,398 acre-feet;
- Bousted Tunnel - constructed under the Continental Divide to deliver Project water collected on the western slope to Turquoise Reservoir. Recent average annual transmountain diversions range between 50,000 – 55,000 acre-feet;

- The Mt. Elbert Conduit - conveys water from Turquoise Reservoir to the Mt. Elbert Forebay. Water delivered to the forebay is used for generation of power at the Mt. Elbert Pumped-Storage Powerplant. Water exits the powerplant into Twin Lakes Reservoir (USBR AOP, 2010).
- Homestake Project – routs west slope water from the upper Eagle River into Turquoise Reservoir via the Homestake Tunnel. Water rights for the Homestake Project are divided between Colorado Springs Utilities and the City of Aurora. The 20-year average annual yield of the project is approximately 26,500 acre-feet.
- Busk-Ivanhoe Collection System – diverts west slope water owned by Pueblo Board of Water Works and the City of Aurora into Turquoise Reservoir. Average annual yields range between 4,600- 5,200 acre-feet, depending on the study period chosen.

Turquoise Reservoir is operated on an annual cycle, primarily utilizing the Mt. Elbert Conduit during winter months to move Project water to Pueblo Reservoir; this management of water subsequently provides adequate storage space for the spring imports from the west slope. The Mt Elbert conduit is used for power production at the Mt. Elbert Powerplant, and to govern flows in Lake Fork Creek. Most of the Lake Fork Creek inflows are routed through the Mt. Elbert Conduit before returning to the Arkansas River via Twin Lakes Reservoir and Lake Creek. Water released from Turquoise Reservoir via the Mt. Elbert Conduit also flows through the Sugarloaf hydro-electric powerplant at the base of the dam. Maximum releases to Lake Fork Creek are usually limited to 400 cfs, considered the target "high- flow" rate to minimize stream bank erosion and creek-side property damage. Conversely, the required minimum by-pass below Sugarloaf Dam is 15 cfs – or the natural inflow, whichever is less (Arkansas River Needs Assessment, 2010).

3.1.2 Flooding Concern – Stakeholder Input

Flooding during high flow years below Sugarloaf Dam was identified as a concern for landowners, Lake County commissioners, and recreational users during the 2008 stakeholder meeting. In addition, Lake Fork Creek flooding and the operation of Turquoise Reservoir during large run-off events were given a "high" stakeholder priority during interviews and surveys conducted for this study.

As a result, it was decided to investigate this topic on the basis of three criteria:

1. The frequency of flooding events;
2. The magnitude of the flooding; and

3. A description of management alternatives to reduce or eliminate flooding occurrences.

3.1.3 Analysis Results

The initial step in the analysis was to review the study period to determine the type of year in which flooding was most likely to occur. Not surprisingly, the review illustrated that flooding was most likely to occur during high snowpack years, or years following high runoff years resulting in less available storage. The analysis showed that during the study period of 2001-2010, the target of 400 cfs was exceeded once, in 2009, for a brief period of time on June 29th. In all other study period years, the target was not exceeded.

In 2009, runoff forecast underestimated actual west slope yields (USBR 2011). As a result, spring-time releases - in accordance with the 2009 forecasts - were insufficient to create adequate storage for west slope imports. Water managers increased outflows from the reservoir as west slope inflows increased- but at a rate that consequently allowed storage levels to rise behind the dam. The shut-down of the Sugarloaf hydro-plant, due to a lightning strike, was the final incident causing the reservoir releases to exceed 400 cfs. The shut-down caused further increases of stored water behind the dam, eventually resulting in a release rate slightly higher (peaking at 425 cfs) than the Lake Fork Creek 400 cfs target (see Figure 3.1.3).

The second phase of the analysis involved a more detailed description of the events leading up to the events on Lake Fork Creek in 2009, including the hydrological conditions of the river and specific water management activities of the water providers with storage accounts at the reservoir. This description included the following facts:

- Neither Twin Lakes nor Pueblo Reservoir were filled to capacity in 2009;
- Beginning on May 12th through June 17th, Mt. Elbert Conduit flow was reduced from 352 cfs to 260 cfs, based on forecasted Turquoise Reservoir inflows;
- From May 12th through June 17th, Mt Elbert Conduit flow was reduced to 25 cfs on each Sunday during this period;
- On June 29th, lightening struck the Sugarloaf Hydroplant, causing the unit to shut down;
- Lake Fork Creek releases were slightly above 400 cfs for approximately two hours on June 29th;
- Water providers reduced Homestake Project imports to reduce storage in Turquoise Reservoir, and thus, alleviated further flooding on Lake Fork Creek.

A final overall review of the yearly storage management in the reservoir was conducted. The management included inflows from the non-Project waters (Homestake and Busk-Ivanhoe)

and the operations of the USBR regarding Project water. This review process underscores several management issues regarding the operation of Turquoise Reservoir:

1. Uncertainty in the runoff projection forecasts;
2. Need for emergency contingency planning;
3. Need for real-time communications with stakeholders and water providers.

First, the uncertainty of annual runoff projections has been identified as the key factor in preventing flooding downstream of Sugarloaf Dam. USBR operations during the spring of 2009 were based on a smaller runoff projection (forecasted on May 1) than the actual runoff event. This forecast was used in the decision to determine the Turquoise Reservoir outflow via the Mt. Elbert Conduit. This lower flow rate in the Mt. Elbert Conduit resulted in more water stored in Turquoise Reservoir, while the two lower storage facilities, Pueblo and Twin Lakes Reservoirs, were maintained at levels below capacity.

Second, the unforeseen events at the hydro- electric plant compounded the challenges presented by the uncertain runoff forecast. The unexpected shut-down at the hydro-electric plant precluded the use of the Mt. Elbert Conduit for a short period of time, forcing the USBR to store more water in the reservoir at time when inflow was increasing. Consequently, the USBR was required to release water at a rate exceeding 400 cfs to Lake Fork Creek.

Lastly, real-time communication with water providers was proven to be a vital operational tool during 2009. The USBR, in conjunction with Colorado Springs Utilities (CSU), reduced the magnitude and longevity of the flooding event because CSU agreed to temporarily curtail Homestake Project inflows from the west slope. This collaboration signifies that cooperation between water providers is essential to deal with real-time events.

Despite the 2009 event, the historical data has indicated that the USBR has been effective in meeting flow targets at Lake Fork Creek – in spite of less than desirable runoff forecasting. Flexible management and the ability to adjust flows on a real-time basis has proven critical in minimizing Lake Fork Creek "wet" year flooding.

3.2 Recreational Impacts at Turquoise Reservoir

Lake County stakeholders were concerned that low-water levels at Turquoise Reservoir may reduce visitation at the reservoir. There was a desire to know if historical water operations were causing consistently low water levels, and consequently, impacting recreational activities at the reservoir. Additionally, there was a request to investigate operational changes that could potentially offset any unfavorable impacts due to low-water elevations.

3.2.1 Turquoise Reservoir Operating Criteria

In general, water stored in Turquoise Reservoir is collected during the spring runoff period. The stored water is then released to Twin Lakes Reservoir for power generation at the Mt. Elbert Powerplant, a pumped-storage facility located on the shore of the reservoir, and/or released during the winter/spring months (November-June) to Twin Lakes and Pueblo Reservoirs. These releases create increased storage capacity in the upper reservoirs, which subsequently, allows the capture of the succeeding year's runoff.

As a result of these annual operations, the reservoir is usually at its lowest level in late spring, usually from Memorial Day weekend through the first 2-3 weeks of June. Historically, annual reservoir water elevations are at their lowest because of the earlier releases. Depending on the type of runoff year, the reservoir may remain low during the early summer recreational season (USFS, 2011).

A second important recreational period is late August through Labor Day. This is a period of high visitation and the period preceding the closing the recreational area.

From stakeholder surveys and personal interviews, it was determined there were three recreational concerns related to water operations at Turquoise Reservoir:

1. Late spring/early summer low reservoir elevations impacting recreational activities;
2. Late summer low reservoir elevations impacting visitation;
3. Low late summer elevations causing increased shoreline.

To investigate the severity of each of these concerns, the historical period was reviewed to determine the frequency of low elevation years – in the spring and fall. The results of this investigation illustrated that 2002 and 2008 had the lowest water levels; in 2002 the elevation of the reservoir dropped to an elevation of 9830 m.s.l (mean seal level) on September 15, and in 2008 the elevation dropped to 9832 m.s.l. on June 15. In 2002, transbasin imports were at their lowest on record, and therefore lack of stored water was the cause for the low reservoir elevations. In 2008, the reservoir was drawn to lower-than-average levels for three days in June - in anticipation of a much higher than average west slope runoff.

With regard to recreational impacts, at no time during the study period, including 2002 and 2008, did the water elevations have an impact on the boat ramp usage. Additionally, there was no direct correlation between reservoir elevation and campground capacity, nor was there a correlation between overall visitation numbers and storage levels (USFS, 2011).

Additionally, the impacts of the increased shoreline were not reflected in visitor use at the reservoir. There are two possible explanations:

1. Most visitors to Turquoise Lake are from the Front Range or out-of-state. Consequently, they are unaware of the low-water aesthetics prior to arrival, and therefore, visitation is not impacted;
2. The low-water bathtub effect (a negative) is offset by increased shoreline (a positive). Increased shoreline at the reservoir allows for more shorebirds to be present, and in some areas, makes shoreline fishing more accessible (USFS 2011).

Given the lack of direct correlation between recreational visitation and water elevations at Turquoise Reservoir, no additional management alternatives were evaluated. Review of the historical record illustrated that the reservoir was operating at 50% of total capacity or higher during that study period (see Figure 3.2.1), and the boat ramps were continually utilized during the June 15 – September 15 recreation season.

3.3 Chaffee County Recreational In-channel Diversions

In 2006, Chaffee County obtained a Recreational In-channel Diversion ("RICD") water right. The purpose of the right is to protect recreational river flows in a reach of the upper Arkansas River – through Chaffee County - for boating, rafting, kayaking, and other white-water activities. Stakeholders in Chaffee County (county commissioner, white-water outfitters, and small business owners) expressed a desire to examine historical management strategies and determine their effects on the operation of the RICD.

For background, listed below are some of the highlights of the Chaffee County RICD:

- The primary component of the RICD is a water right that calls for 1,800 cfs of water in the Arkansas River through Buena Vista and Salida during an eight day period (the FIBArk event) in June of each year;
- The event days vary in June, but usually take place in the middle of the month;
- The water right allows for maximum of 1,400 cfs during the remainder of June,
- The right call for a minimum of 700 cfs from the end of May through the end of June;
- Senior exchanges have the right to reduce stream flow below the RICD's target flow rates;
- During droughts, Chaffee County agreed to reduce flows to 1,500 cfs during the FIBArk event, and 1,100 for the remaining portion of June.

3.3.1 RICD Analysis Results

The first step to analyze the impacts of upper basin water operations on the Chaffee County RICD was to perform a historical stream flow review. The purpose was to determine the frequency in which the RICD was satisfied during the study period. Furthermore, if it was

determined that the RICD was not fully met, stakeholders wanted to develop management alternatives to enhance the operation of the water right.

As illustrated in Table 3.3.1, not all years during the study period met the various RICD target flows. This was mostly attributed to low natural river conditions, rather than upper basin water operations. During this period of time, water management impacts affecting the RICD were minimal. This is partly due to the fact that water management operations are concentrated on the peak runoff in May and June. As illustrated in the study period, upstream exchanges peak during the month of May, at times when stakeholders are not as directly affected by reduced stream flows. This also illustrates a willingness of water providers to work collaboratively with Chaffee County to meet RICD objectives in June (Aurora, Pueblo, Colorado Springs, 2011).

The data indicates that in most cases, Chaffee County RICD targets are not met because there is simply not enough native water in the system to meet the targets. Understandably, this most frequently occurs during below-average and dry years.

The study analysis did demonstrate however, that in some years upstream river exchanges occurred in June, yet they did not significantly affect the implementation of the RICD. In two years, RICD operations were somewhat affected in the following ways:

1. In 2002, exchanges prevented stream flow from reaching the RICD target flow rate of 700 cfs on 7 non-consecutive days during the high flow period. (Note: Project water was not released during this time.)

2. In 2005, exchanges prevented stream flow from reaching 1800 cfs during the first two days in June. (Note: Project water was not released during this time.)

From this data, it is evident that the majority of exchanges that occurred during the study period's June timeframe had no impact on the RICD because the flows, as measured at the Wellsville gauge, were already either well above or below the target flows. Therefore, it was determined that upstream river exchanges do not usually occur at a rate (magnitude) or frequency to diminish the RICD flow targets.

Study results also indicated that Project water was occasionally released during the RICD time period in June, but such releases were a result of Fry-Ark operations rather than a specific action related to FIBArk or the RICD. During the study period, no Fry-Ark releases were made for the sole purpose of meeting RICD flow rates (USBR 2011). This confirms the study's earlier result that the volume of native flow is the primary factor in achieving target flow rates for the RICD.

TABLE 3.3.1
ARKANSAS RIVER STREAMFLOW AT WELLSVILLE GAGE
NUMBER OF DAYS HISTORICAL STREAMFLOW EXCEEDS CHAFFEE COUNTY RECREATIONAL IN-CHANNEL DIVESION WATER RIGHT

YEAR	NO. HFP DAYS	700 CFS*	1,400 CFS* (UP TO 30 DAYS)	1,800 cfs** (UP TO 8 DAYS)	COMMENTS	
					PROJECT WATER RELEASES	EXCHANGES***
2001	37	37	24	6	No Releases	May 25 - June 30 average 70 cfs/day
2002	38	0	0	0	No Releases	May 24 - June 29 average 115 cfs/day
2003	39	39	27	9	No Releases	May 23 - June 9 average 400 cfs/day
2004	34	34	9	4	No Releases	May 28 - June 30 average 90 cfs/day
2005	35	35	21	5	No Releases	May 27 - June 30 average 115 cfs/day
2006	36	36	24	11	June 13 - June 19 average 290 cfs/day	June 5 - June 30 average 50 cfs/day
2007	37	37	31	14	Project Water Released June 20 - June 28 average 240 cfs/day	No Exchanges*
2008	39	39	38	30	No Releases	June 21 - 22 average 60 cfs/day
2009	40	40	40	24	Project Water Released June 25 - June 30 average 440 cfs/day	May 22 - June 30 (int) average 45 cfs/day
2010	34	34	34	24	Project Water Released June 17 - June 30 average 540 cfs/day	May 28 - June 3 average 120 cfs/day

*HIGH FLOW PERIOD (HFP) FRIDAY BEFORE THE LAST MONDAY IN MAY THROUGH JUNE 30
**DURING THE MONTH OF JUNE
***INCLUDES CITY OF AURORA, COLORADO SPRINGS UTILITIES, AND PUEBLO BOARD OF WATER WORKS (EXCLUDES WURTZ, EWING, AND COLUMBINE DITCHES)

3.4 Fishery Flow Recommendations

Fishery flow recommendations, as described in the Arkansas River Flow Management Program Agreement ("Agreement") were considered a high priority "non-consumptive" use in the upper basin. These recommendations, in conjunction with the "summer recreation component," comprise the year-round recreational and environmental flow guidelines stated in the Agreement. There are five signatories to the Agreement:

- Southeastern Colorado Water Conservancy District;

- Colorado Department of Natural Resources (including Colorado State Parks and the Colorado Division of Wildlife);
- Arkansas River Outfitter's Association;
- Trout Unlimited; and
- Chaffee County.

The recommendations outlined in the Agreement are confirmed on an annual basis by the parties, and subsequently submitted to the USBR for final review and approval. The seasonal recommendations are technically based guidelines for fishery protection and recreational boating within the upper basin. The USBR is not legally bound to exercise the recommendations, but has agreed to use its best efforts to meet the suggested seasonal target flows. The Agreement was initiated in 1991, and was formalized by the parties in 2005.

3.4.1 Arkansas Voluntary Flow Program Fish Recommendations

The Agreement outlines optimal target flows to protect and enhance the brown trout fishery in the upper basin. The need for this study topic began as part of the May, 2009 stakeholder meeting, and in particular, the necessity to evaluate the effectiveness of the Agreement's fishery recommendations during average and wet years. In these types of years, achieving Fry-Ark objectives and implementing the fishery recommendations presents unique challenges, and often times requires a "balancing act" to best meet the goals of the stakeholders.

The Agreement's fishery flow recommendations are as follows:

- November 15 – March 31 ---Target flows ranging from 250-400 cfs as measured at the Wellsville gauge, corresponding to specific flow rates occurring during the spawning period of October 15th to November 14th;
- April 1- May 15 --- 250-400 cfs to provide conditions favorable for fry emergence;
- August 15th – Ramp down of USBR "Summer Component" releases (also described in the Agreement) from Twin Lakes Reservoir at a rate of 5-10 percent per day until native flow is reached;
- Further Considerations: "If there is a need to increase flows above 400 cfs during the winter incubation flow period, the Colorado Department of Natural Resources recommends that these increased flows occur prior to March 1. Further, if possible, flows should not exceed 600 cfs from November 16 to February 28. If additional water must be moved, it is preferred these releases occur prior to March 15 or during runoff when native flows exceed 1000 cfs provided that flows do not exceed AHRA (Arkansas Headwaters Recreation Area)

High Water Advisory thresholds of 1200 cfs below Granite or 3200 cfs at the Parkdale Gauge"(Colorado Department of Natural Resources, 2011).

The challenge of the USBR is to integrate these fish recommendations into their pre-existing Fry-Ark operations. Because of the complexities involved, stakeholders with a fishery interest (scientific, recreational, and business) requested an analysis regarding best management practices to achieve this integration, especially as it related to the "Further Consideration" section of the recommended flow rates.

3.4.2 Study Results Scenario

The fishery analysis involved utilizing two specific years within the selected study period: 2005 representing an "average" year, and 2008 to represent a "wet" year (a "dry" year analysis was deemed unnecessary by the USBR because in such years, Fry-Ark operations inherently coincide with the fishery recommendations). Furthermore, in a series of "what-if" scenarios, historical releases from Turquoise and Twin Lake Reservoirs were re-timed to meet November 15 - May 15 fishery flow targets.

The first step of the analysis was to examine an "average" year, using 2005 data. In this scenario, flow targets were varied between 250, 450, and 600 cfs during November 15-February 28 (releases from the upper reservoirs), combined with a target flow rate of 250 cfs during March 1- May 15. It was determined that in average years – as represented by 2005 – high early season release rates from the upper reservoirs to Pueblo Reservoir are not necessary to maintain the Agreement's flow targets. Instead, they can be maintained through "normal" USBR operating criteria, based on management objectives of the Fry-Ark.

This is illustrated in Figure 3.4.2. "Scenario #1- Average Year," using the results of re-timing Fry-Ark releases during the water year 2005. Following the Agreement's guidelines, the flow regime representing the lowest range of recommendations was modeled. As shown in the figure, the USBR was able to meet the fishery flow seasonal target flows (and the Agreement's summer component) while meeting the goals of the Fry-Ark operations in 2005. A November 15 - May 15 flow rate of 250 cfs was maintained after the initial 450 cfs rate between October 15 – November 15 was established. The graph shows that the USBR increased its releases from upstream reservoirs during the October-November period, and then maintained a near-zero release rate for the remainder of the spring. Fry-Ark releases increased in late July and early August to maintain the Agreement's summer component (recreational) flow target of 700 cfs, and subsequently "ramped" back down to native flow rates beginning on August 15th, meeting all of the recommendations of the Agreement.

While 2005 is only a single representative "average" year, and no two years of stream flow regimes were the same during the study period, the analysis demonstrates that

recommended fishery flow recommendations are achievable during specific types of runoff years. In 2005, "May forecasts" were representative of actual runoff, and no major deviations from planned Fry-Ark's – or other water provider's - operations were needed at any point in the year (USBR 2011).

The second step in the fishery flow analysis was to examine a "wet" year, using 2008 data. Again, flow targets were varied between 250, 450,600 cfs during November 15-February 28, combined with a flow rate of 250 cfs during March 1- May 15. The results of this analysis are as follows:

A. Figure 3.4.2 - Scenario #2, "Low Flow Targets" - 250 cfs flow target during November 15 – May 15.

(1) Turquoise and Twin Lakes Reservoirs filled near June 20 and remained near capacity through August 13;

(2) During May and June, Arkansas River stream flow at the Wellsville gauge increased by the following flow rates:
   a. 9 days - - stream flow increased 1,000 – 2,000 cfs;
   b. 12 days --- stream flow increased 2,000 – 3,000 cfs;
   c. 1 day---stream flow increased by more than 3,000 cfs.

(3) No Project water releases were required during March 1- May 15, maintaining the Wellsville gauge near 250 cfs for this time period.

(4) Because more water is stored in the upper basin reservoirs to reduce flows at Wellsville, Pueblo Reservoir's available storage capacity on April 15 increased by 72,395 acre-feet.

In this scenario, major changes to the usual Fry-Ark operations were needed to meet the recommended fishery flows. To maintain the 250 flow rate from November 15 - May 15, the USBR would be required to store more water, for longer periods of time, in the upper basin reservoirs. As a result of maximizing the utility of upper reservoir storage, the likelihood of exceeding 400 cfs on Lake Fork Creek increased significantly. These subsequent high-flow releases, as compared to historical operations, resulted in substantially higher stream flows not only in Lake Fork Creek, but also in Lake Creek and the Arkansas River.

This alternative was not given a high priority over current operations because of the following reasons: 1) the need to make major changes in the historic Fry-Ark operation; 2) the increased risk of higher flows in the late summer at the Wellsville gauge and; 3) the higher

probability of exceeding 400 cfs in Lake Fork Creek. While the additional storage space in Pueblo Reservoir created in this scenario is considerable, historical records indicate that this amount of additional space has never been needed to avoid "If & When" evacuation (see Section 3.6).

B. Figure 3.4.2 – Scenario #3, "Mid-range Target Flows" – 450 cfs target release during November 15- February 28; 250 cfs target release during March 1-May 15. The results of this scenario are as follows:

(1) Twin Lakes and Turquoise Reservoirs filled on July 3rd and remained near capacity through August 13th;

(2) During May and June, Arkansas River stream flows at the Wellsville gauge increased by the following amounts:
   a. 7 days --- stream flow increased by 1,000 - 2,000 cfs;
   b. 1 day --- -stream flow increased by 2,000 - 3,000 cfs;
   c. 1 day -----stream flow increase by more than 3,000 cfs.

(3) Project water releases were avoided during March 1- May 19, maintaining the Wellsville gauge near 250 cfs for this time period.

(4) Pueblo Reservoir's April 15 available storage capacity increased by 43,738 acre-feet.

This scenario begins to illustrate the various "trade-offs" that water managers are confronted with while evaluating specific types of water operations. The results were similar to the previous scenario, except that the USBR was able to move more water during the November 15 – February 28 period, and consequently, summer and early fall Lake Fork Creek releases were less than those shown in Scenario #2. Nevertheless, risk of Lake Fork Creek reaching "flood-stage" remained significantly higher when compared to historical operations. Moreover, late summer flows were higher than the historic norm because of the necessary year-end releases. The "positive" trade-off was that storage in Pueblo Reservoir increased by almost 44,000 acre-feet, relieving the pressure to evacuate "If & When" space on April 15th.

Again, for the same reasons listed for Scenario #2, this alternative was not given a high priority for the stakeholders to consider as a matter of standard practice. It could, however, be implemented under such circumstances that a high runoff year was inevitable. While Scenario #3 fulfilled fishery flow objectives in the spring – and had a positive effect on Pueblo Reservoir's spring storage levels, it was viewed as too disruptive to the usual Fry-Ark operations, especially

given the limited level of forecasting available to operate such an alternative. Additionally, fishery goals were not met in late summer; Scenario #3 resulted in significantly higher late-summer flows due to higher than normal USBR releases from the upper reservoirs. To avoid these increased late summer releases would require the "trade-off" of utilizing more carry-over storage in Turquoise and/or Twin Lakes Reservoir. This additional storage would result in a greater likelihood of exceeding high- flow targets in Lake Fork and Lake Creeks the following spring.

C. Figure 3.4.2 – Scenario #4, "High Target Flows" – 600 cfs target flow during November 15-February 28; 250 cfs target flow during March 1-May 15. The results of this scenario are as follows:

(1) Twin Lakes and Turquoise Reservoirs filled on July 11th and remained near capacity through August 13th;

(2) During May and June, Arkansas River stream flows at the Wellsville gauge increased by the following amounts:
a. 2 days --- stream flow increased by 1,000 - 2,000 cfs;

(3) Project water releases were avoided during March 1- May 15, maintaining the Wellsville gauge flows at 250 cfs during this time period;

(4) Project water from the upper reservoirs was insufficient to maintain 600 cfs through February 28. Beginning in early February, stream flow decreased to nearly 250 cfs at the Wellsville gauge.

(5) Storing Fry-Ark water in the upper reservoirs for longer periods during the spring created an additional 29,183 acre-feet of available storage in Pueblo Reservoir on April 15th.

As in the previous two scenarios, the evaluation of scenarios involves trade-offs and risk assessment. In this alterative, the USBR moves water at a much higher rate from the upper reservoirs to Pueblo Reservoir during the November 15 – February 28 period, creating an opportunity for lower Arkansas River flows (as measured at the Wellsville gauge) from March 1 – May 15 to enhance the brown trout fry emergence and feeding. This early water movement also reduces total upper reservoir storage during late spring and subsequent risk of exceeding the high-flow target on Lake Fork Creek. An added benefit is that available storage in Pueblo Reservoir increases on April 15.

But the trade-off is that the USBR is required to release more water from Turquoise and Twin Lakes Reservoirs in the late summer – which is counter to the fishery flow recommendations (this is also true for Scenarios #2 and #3). And again, forecasting the type of year to operate early releases of 600 cfs is problematic. This scenario works well in wet years, but only if the 250 cfs flow regime at Wellsville can be maintained during March 1- May 15 period. Otherwise, Pueblo Reservoir storage begins to fill the joint-use space before the April 15th evacuation date and jeopardizes If &When accounts. Conversely, in dry years, although not evident during this selected study period, it is conceivable that the early releases from Turquoise Reservoir could have the potential of dropping storage elevations to the point of impacting recreational activities, and/or leaving insufficient storage for the summer component of the Agreement (USBR 2011). Therefore, because of: 1) the cumulative high risk assessment associated with Scenario #4; 2) its significant reliance on early, reliable runoff forecasts to succeed; and 3) because such forecasting is not consistently available, it is difficult to recommend this method of operations as standard practice.

3.4.3 Other Fishery Flow Analysis Results

Study results that apply to the scenarios listed above included:

- The additional storage and sequential releases from Turquoise and Twin Lakes Reservoirs results in the likelihood of surpassing the AHRA High Water Advisory thresholds of 1200 cfs below Granite and 3200 cfs at the Parkdale Gauge in wet years (2008);
- The additional storage, held for longer periods of time, increased the likelihood of exceeding 400 cfs in Lake Fork Creek in "wet" years;
- The ability to generate power at the Sugarloaf and Mt. Elbert Powerplants is diminished because of more frequent releases to Lake Fork Creek;
- In 2008, maintaining higher water elevations in the upper basin reservoirs decreased the risk of spilling If & When accounts in Pueblo Reservoir.

All three scenarios (Nos. 2-4) illustrate the importance of the runoff forecasting in upper basin operations. The ability to accurately predict spring runoff – in timing and amount – would greatly increase the likelihood of adopting any of these scenarios. In fact, the USBR does implement, in part, higher upper reservoir releases when significant snowpack data exists. The problem is that runoff forecasts are variable in their accuracy. Compounding the problem is the prediction of annual needs and operations for individual water entities, that may (or may not) move water into or out of the upper basin in any given year. Scenario #4 accomplishes many of the fishery goals without (comparatively) too many negative trade-offs. However, the entire flow regime is predicated on knowing - in November of the preceding year - the runoff amounts and timing that will occur during the succeeding spring. If the predictions are not reflective of

the actual runoff sequence, the management outcomes could be untenable. For example, Pueblo Reservoir could fill too early in wet years while Turquoise may not meet recreational spring target elevations in dry years. Furthermore, the summer component of the Agreement (see below) may be negatively affected due to lack of upstream stored Project water for recreation. Conversely, during wet years, recommended fishery flows in the fall will be exceeded. The fact is, there are numerous negative outcomes possible if runoff forecasting proves to be inadequate or erroneous. This uncertainty in the runoff forecasting for the upper Arkansas River basin makes it difficult to recommend Scenario #4 as standard operating practice in the upper basin. It does, however, have merit to adopt such a scenario when the runoff data is compelling enough to do so.

Adopting such a management plan requires a more thorough risk assessment analysis regarding: 1) the impacts to fishery and recreational components in the middle catchment; 2) the impacts at all three Fry-Ark east slope reservoirs during wet years; and 3) the preferences and trade-offs stakeholders are willing to undertake. Without this information, the risk associated with forecasting uncertainty is too great to unequivocally implement these scenarios as standard practice. Instead, a more "nuanced" approach is required, utilizing improved communication (especially with regard to real-time runoff predictions and data), collaboration, and cooperation among the stakeholders. Understanding the options and alternatives available to water managers – in advance - while striving to meet fishery flows (given the specific limitations), is a preferred management strategy. From numerous interviews with the various stakeholders, this type of approach is acceptable and understood.

3.5 River Exchange Impacts

In addition to fishery flows, Chaffee County stakeholders were also concerned about the "summer component" of the Arkansas River Voluntary Flow Program ("Flow Program"): maintaining 700 cfs during July 1 – August 15 as measured at the Wellsville gauge. Participant's comments centered on the effects of upstream exchanges from Fountain Creek and Pueblo Reservoir to the upper reservoirs. Since its inception, the Flow Program has been vulnerable to such exchanges because they have the potential effect of decreasing stream flow below the 700 cfs target flow at the Wellsville gauge. Historically, this reduction of flow has caused the USBR to release higher quantities of Project water from Twin Lakes Reservoir to offset the exchanges. However, in dry years, the USBR may not have enough water in upstream storage to fully execute this "offset." As a result, stakeholders wanted a clearer idea regarding the extent of these impacts.

The analysis of "exchange impacts" involved reviewing the historical record to identify the timing and magnitude of the exchanges occurring during July 1 – August 15. Once the

exchanges were catalogued, records from the USBR were examined to determine the amount of additional Project water that was required as an offset.

As shown in Table 3.5, upstream river exchanges do play a role in upper basin management, in varying degrees. In 8 of those years, upstream river exchanges resulted in additional Project water to be released in excess of 200 acre-feet during the summer component period.

TABLE 3.5

PROJECT WATER RELEASES IN RESPONSE TO UPSTREAM RIVER EXCHANGES JUL 1- AUG 15

YEAR	AC-FT
2001	4,271
2002	142
2003	1,293
2004	189
2005	299
2006	496
2007	196
2008	0
2009	24
2010	0

Figure 3.5 Upstream exchange impacts

It should be noted that the necessary additional releases provided by the USBR were in compliance with the Agreement's (Flow Program) terms and conditions. As a result, the target flow of 700 cfs at the Wellsville gauge was maintained. However, in dry periods, it is anticipated that USBR water supplies may not be sufficient to offset the effects of the upstream exchanges. In these circumstances, collaboration between the stakeholders (Chaffee County stakeholders, parties to the Agreement, and water providers) is imperative to reduce the effects of the upstream exchanges while still meeting water/storage yield objectives.

3.6 Pueblo Reservoir Spills

3.6.1 Storage Accounts in Pueblo Reservoir

Pueblo Reservoir is the terminal storage facility in the Fry-Ark Project. It is located on the Arkansas River, six miles west of the city of Pueblo. The reservoir has a total storage capacity of 357,678 acre-feet:

- 30,355 acre-feet of inactive capacity;
- 234,347 acre-feet of conservation capacity;

- 65,952 acre-feet of joint-use capacity; and
- 27, 024 acre-feet of flood –control storage (USBR 2010).

Different types of water storage accounts have been allocated to the conservation and joint-use pools. Three operating criteria for Pueblo Reservoir were the focus of this analysis: 1) If & When accounts; 2) "Winter Water" accounts; and 3) Project water allocated for agricultural uses.

Several temporary If & When accounts reside within the conservation and joint- use pools (See Table 3.6.1). These accounts can only be used *if and when* excess storage capacity exists in Pueblo Reservoir. If & When accounts are categorized into two main groups: out-of-basin storage (accounts allocated to entities located outside of the Fry-Ark district boundaries), and in-basin storage (accounts for entities located within the Fry-Ark district boundaries). If & When accounts are usually associated with one year contracts with USBR, but long term accounts exist for the City of Aurora and the Pueblo Board of Water Works. All If & When accounts are subject to evacuation during wet year scenarios. Out-of –district accounts spill before in-district accounts, and therefore are the most susceptible during high flow year.

Account Type	**Contract Amount (Acre-Feet)**
Agricultural (5 contracts)	9,500
Municipal and Industrial (16 contracts)	31,600
Long Term (2 contracts)	19,000
Miscellaneous (2 contracts)	1,400
TOTAL	61,500

Table 3.6.1 - 2011 Temporary Storage of non-Project Water in Fry-Ark Facilities

Winter Water is agricultural water that historically was diverted during the winter months and early spring to increase soil moisture prior to planting. Under the Winter Water Program, water that historically was diverted to ditches for irrigation in the winter is now stored in Pueblo Reservoir during November 15 – March 15. Winter Water can be stored in the reservoir until it is needed for irrigation – or it can be stored until May 1 of the following year. However, Winter Water can also be "spilled" – or redistributed to the conservation pool account – if Pueblo Reservoir's conservation pool is at capacity on April 15 of any given year.

Fry-Ark water allocated for agricultural purposes is another important type of storage account in the Pueblo Reservoir spill sequence. Eighty (80) percent of allocation of Project water allocated for agricultural use must be used by November 1 of the current year. The remaining twenty (20) percent must be used by May 1 of the following year (SECWCD, 2008).

These three types of accounts are important in the overall operating criteria because they affect the operation of the joint-use pool, and more generally, the operation of the conservation pool.

In summary, as part of the operating criteria, the joint-use capacity must be evacuated by April 15th of each year. Additionally, Project water stored for agricultural use during the previous year – and Winter Water allocated during the previous Winter Water season (one-year carryover Winter Water), must be evacuated by May 1st of each year (SECWCD 2008.)

3.6.2 Study Analysis and Results

Stakeholder's surveys and interviews (mostly from storage account holders in the reservoir) underscored a desire to study the operation of Pueblo Reservoir with respect to "wet" year scenarios, in situations that may cause certain user's accounts to be evacuated. The USBR currently requires Pueblo Reservoir to evacuate the joint-use pool (approximately 66,000 acre-feet) from April 15 through October 31 of each year for flood control. In the past, If & When accounts have been evacuated to comply with this flood control operating criteria (Table 3.6.2.).

The analysis centered on the stakeholder's request of aligning the Winter Water evacuation date with that of Pueblo Reservoir's Joint Use pool. Stakeholders wanted to know the effects of extending If & When storage accounts to May 1 of each year. Furthermore, because the risk of spill is greatest during wet years, the analysis focused on a historical period that included multiple wet year cycles.

Two key components were reviewed to verify the feasibility of extending the use of the joint-use pool for If & When storage accounts. First, it was necessary to evaluate the benefits of moving the evacuation date of the joint-use pool from April 15 to May 1. Second, Turquoise and Twin Lake Reservoirs were assessed to determine if Project water could be stored for longer periods of time to create space in April at Pueblo Reservoir

The study period was extended for both analyses, from the original 2001- 2010 to a longer period including 1983 – 2011. The extended study period provided better assessment of not only individual wet years, but also provided the ability to evaluate wet *periods* that occurred over consecutive years.

As shown in Table 3.6.2, many years during the extended study period were affected by the joint-use pool's April 15th deadline (as mandated by the U.S. Army Corps of Engineers ("Corps"), the joint-use pool must be evacuated by this date for flood control purposes). The figure also demonstrates the magnitude of stored water that must be moved; by all standards, the amounts are significant. For example, in 1998, the table shows that by extending the joint-

use pool evacuation date, 7205 acre-feet of If & When water could have been carried over for future use. Further, examining water year 2010, up to 5256 acre-feet of If & When storage was allowed to carry-over because in that year, the joint-use pool evacuation date was in fact extended to May 1. Therefore, this review of the historical data has illustrated that moving the evacuation date from April 15 to May 1 on an annual basis can provide longer storage for If & When accounts in Pueblo Reservoir – in significant amounts.

However, this is only part of the necessary analysis to confirm this alternative's feasibility. The other major consideration is the need for Pueblo Reservoir to provide adequate flood control. This issue was beyond the scope of the study, and is best analyzed in collaboration with the Corps. Nevertheless, the preliminary results regarding water supply and storage at the reservoir warrants further investigations regarding modification of the flood control operating criteria.

Regarding the option of storing water in the upper reservoirs for longer periods of time – during the winter and spring period prior to May 1 - an analysis of the reservoir content was performed for all three east slope Fry-Ark reservoirs (see Figures. 3.6.2). The figures show the results of the analysis for four years: 1987, 2000, 2010, and 2011. These years are illustrative of the upper basin operations throughout the study period when Pueblo Reservoir storage was near the April 15th joint-use pool restriction. As demonstrated in the graphs, in water year 2000, Pueblo Reservoir's joint-use pool "spilled" (for purposes of this study, the term "spill" references the evacuation of If & When accounts to reduce storage below the joint-use pool or, in the case of 2010, allowed to remain in the joint-use pool under special exemptions). Likewise, during these same years, upstream storage was available in either Twin Lakes or Turquoise Reservoirs – or both. This prompts the question whether additional upstream storage could have been utilized to prevent Pueblo Reservoir's joint-use pool spills. The data shows that this possibility existed in all four years.

But again, hindsight allows for the feasibility of such an alternative to manifest itself. If water providers could have relied upon each year's runoff forecasts with a high degree of certainty, operations to store additional water in the upper reservoirs would have been feasible. However, the uncertainty in the forecasts prevented such "bold" actions by water providers, placing the pressure on Pueblo Reservoir's If & When accounts. As with fishery flows, uncertainty in runoff forecasts inhibits water providers from creating additional storage space in Pueblo Reservoir at the risk of filling the upper reservoirs. While the data clearly shows that such operations are a benefit – in specific circumstances – for If & When accounts in Pueblo Reservoir, it is the lack of assurance in the forecasting that prevents such operations to be undertaken. This cautious approach has proven to be a prudent method of operations,

given the number of years in which the forecasts were not accurate in predicting actual runoff amounts or timing (USBR 2011).

TABLE 3.6.2
PUEBLO RESERVOIR HISTORICAL OPERATIONS (AC-FT)

YEAR	JUNE "IF AND WHEN" STORAGE ACCOUNT SPILLS (1)	ESTIMATED WINTER WATER CARRYOVER EVACUATED APR 15 - APR 30 (2)
1983	0	3,700
1984	0	6,388
1985	0	UNAVAILABLE
1986	0	0
1987	0	0
1988	0	0
1989	0	0
1990	0	3,685
1991	0	4,870
1992	0	4,875
1993	0	6,875
1994	0	7,900
1995	0	3,990
1996	0	0
1997	0	0
1998	7,205	7,394
1999	0	0
2000	2,530	0
2001	0	1,125
2002	0	2,985
2003	0	223
2004	0	421
2005	0	1,311
2006	0	225
2007	0	3,687
2008	0	9,044
2009	0	6,950
2010*	0	5,256
2011	0	11,151

(1) DATA FROM INTERNAL PUEBLO OFFICE USBR RECORDS
(2) DATA FROM USBR ANNUAL FRYINGPAN-ARKANSAS PROJECT OPERATING PLANS 1983-2010
*AVAILABILITY OF PUEBLO RESERVOR JOINT-USE POOL EXTENED TO MAY 1ST

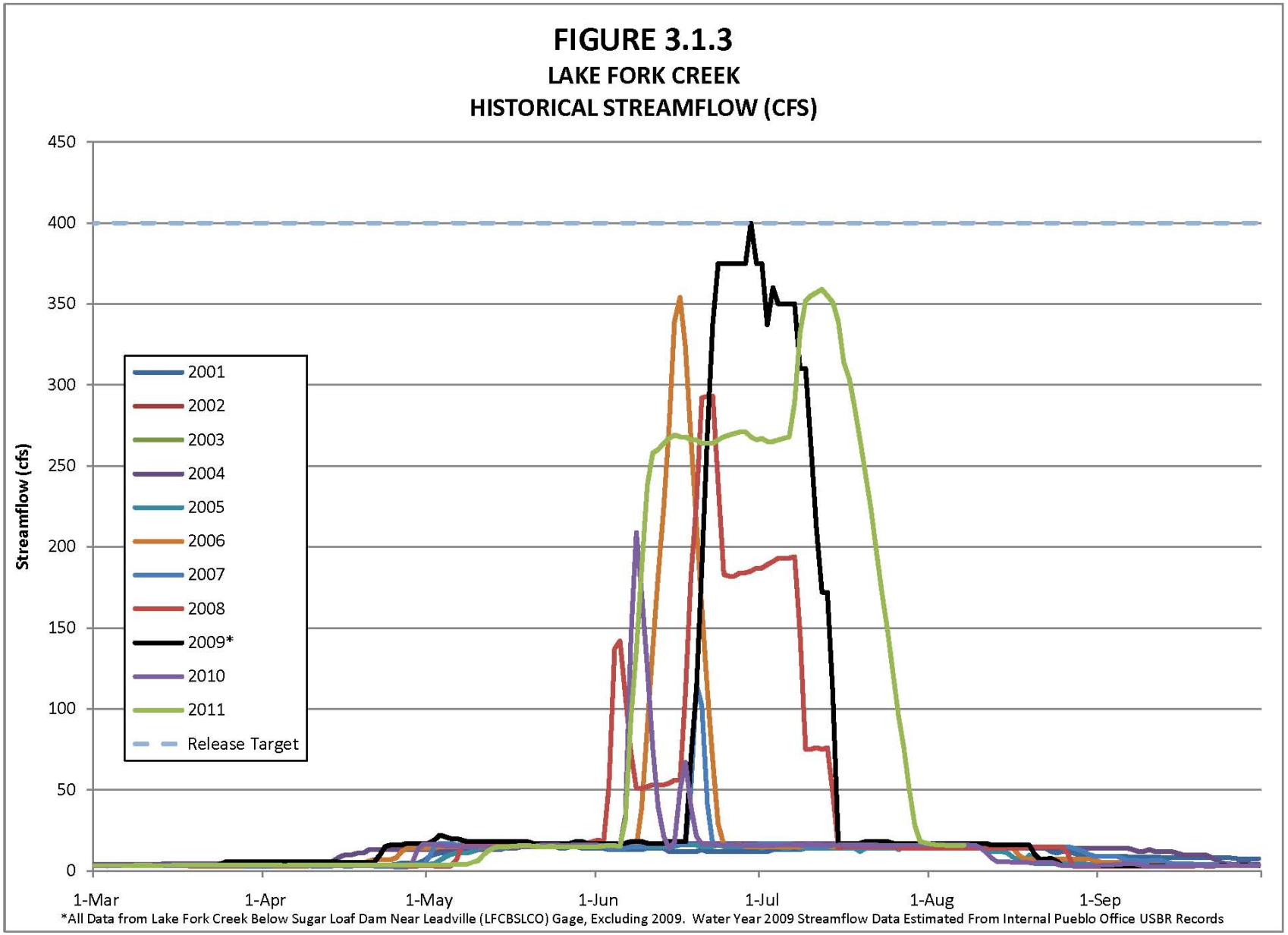


FIGURE 3.1.3
LAKE FORK CREEK
HISTORICAL STREAMFLOW (CFS)
Streamflow (cfs)
450
400
350
300
250
200
150
100
50
0
2001
2002
2003
2004
2005
2006
2007
2008
2009*
2010
2011
Release Target
1-Mar
1-Apr
1-May
1-Jun
1-Jul
1-Aug
1-Sep
*All Data from Lake Fork Creek Below Sugar Loaf Dam Near Leadville (LFCBSLCO) Gage, Excluding 2009. Water Year 2009 Streamflow Data Estimated From Internal Pueblo Office USBR Records

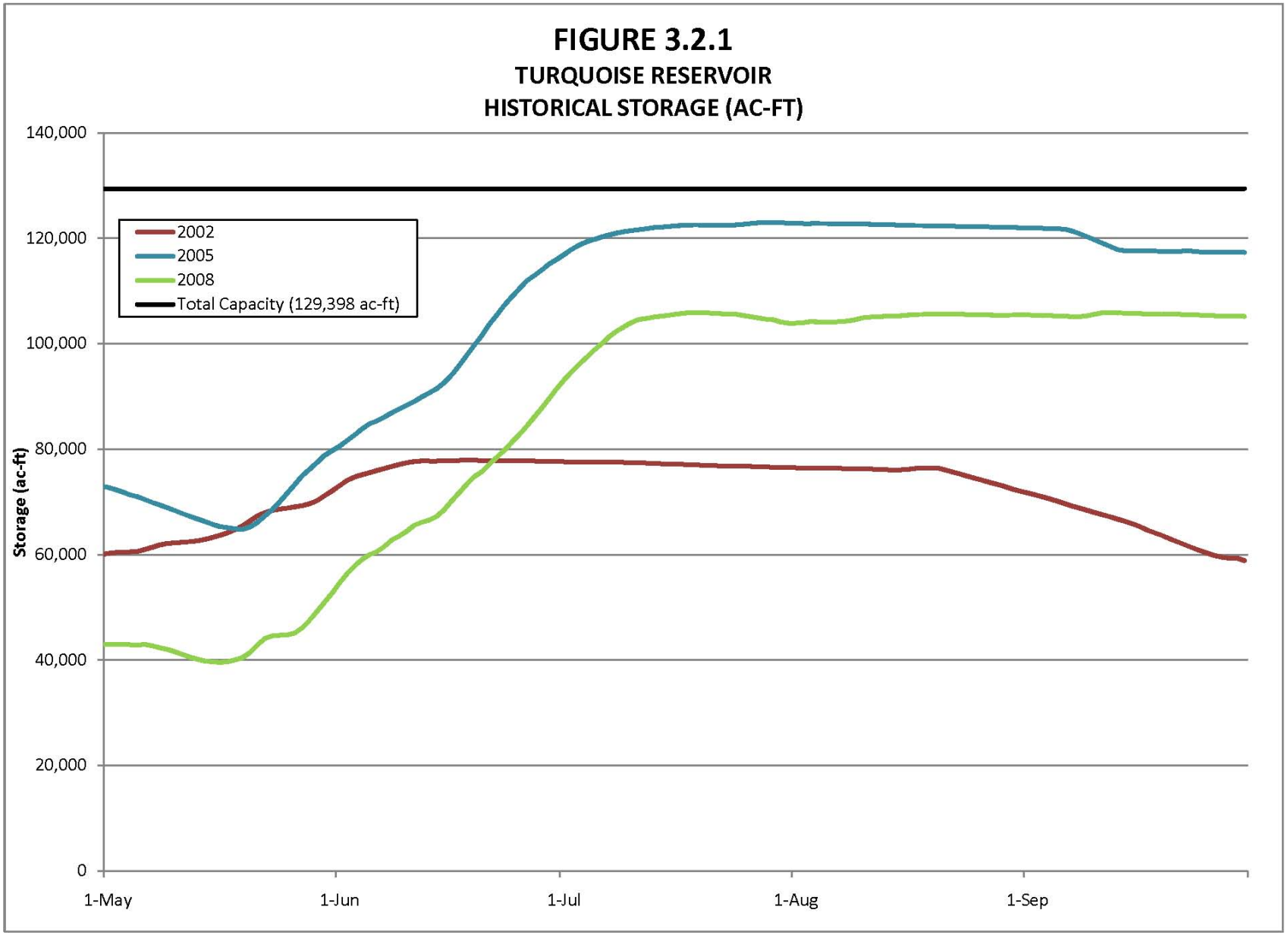
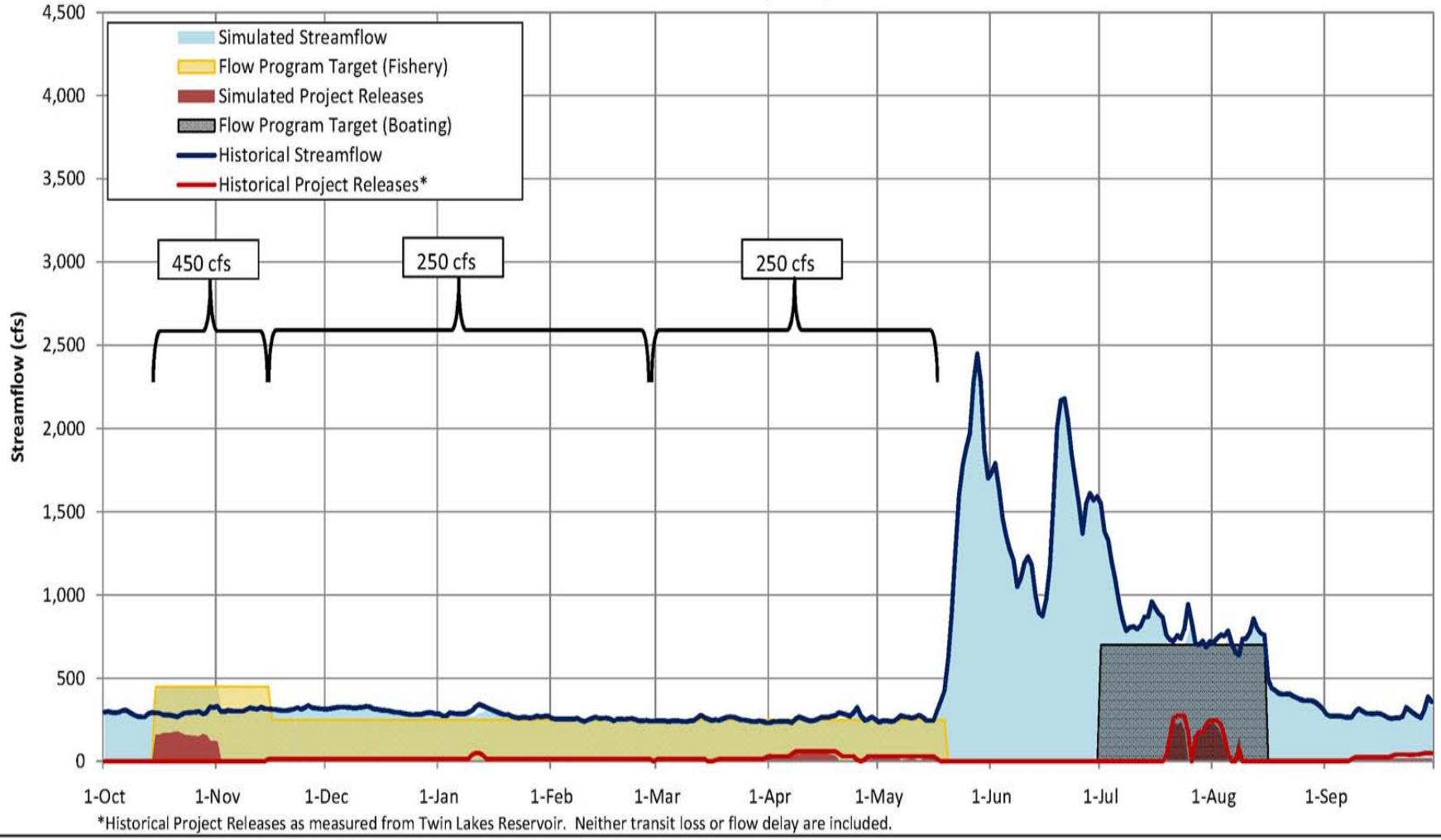


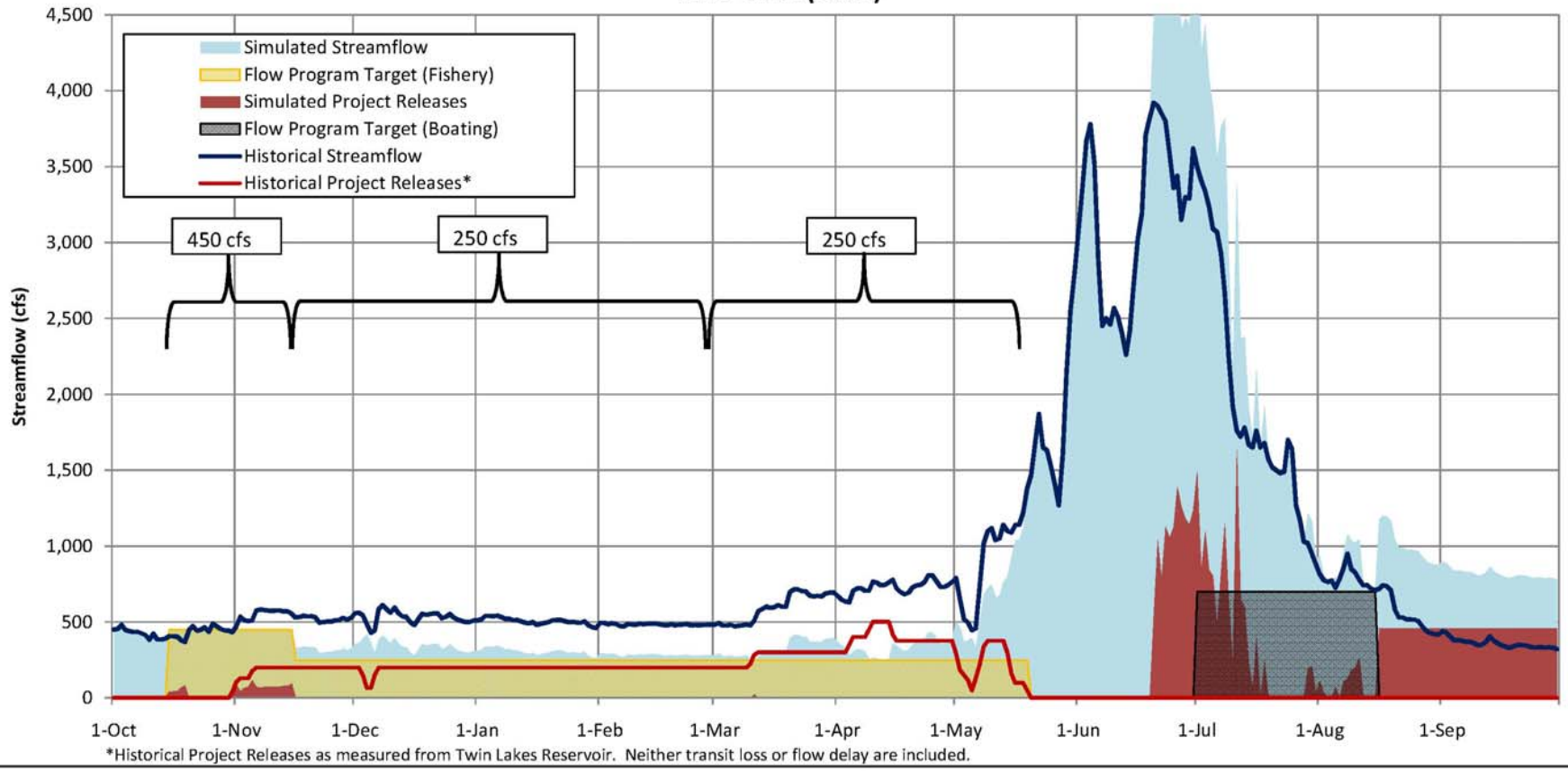
FIGURE 3.2.1
TURQUOISE RESERVOIR
HISTORICAL STORAGE (AC-FT)
140,000
120,000
100,000
80,000
60,000
40,000
20,000
0
Storage (ac-ft)
2002
2005
2008
Total Capacity (129,398 ac-ft)
1-May
1-Jun
1-Jul
1-Aug
1-Sep

FIGURE 3.4.2 (SCENARIO NO. 1)
ARKANSAS RIVER STREAMFLOW NEAR WELLSVILLE
VOLUNTARY FLOW PROGRAM FISHERY FLOW RECOMMENDATION
AVERAGE YEAR (2005)



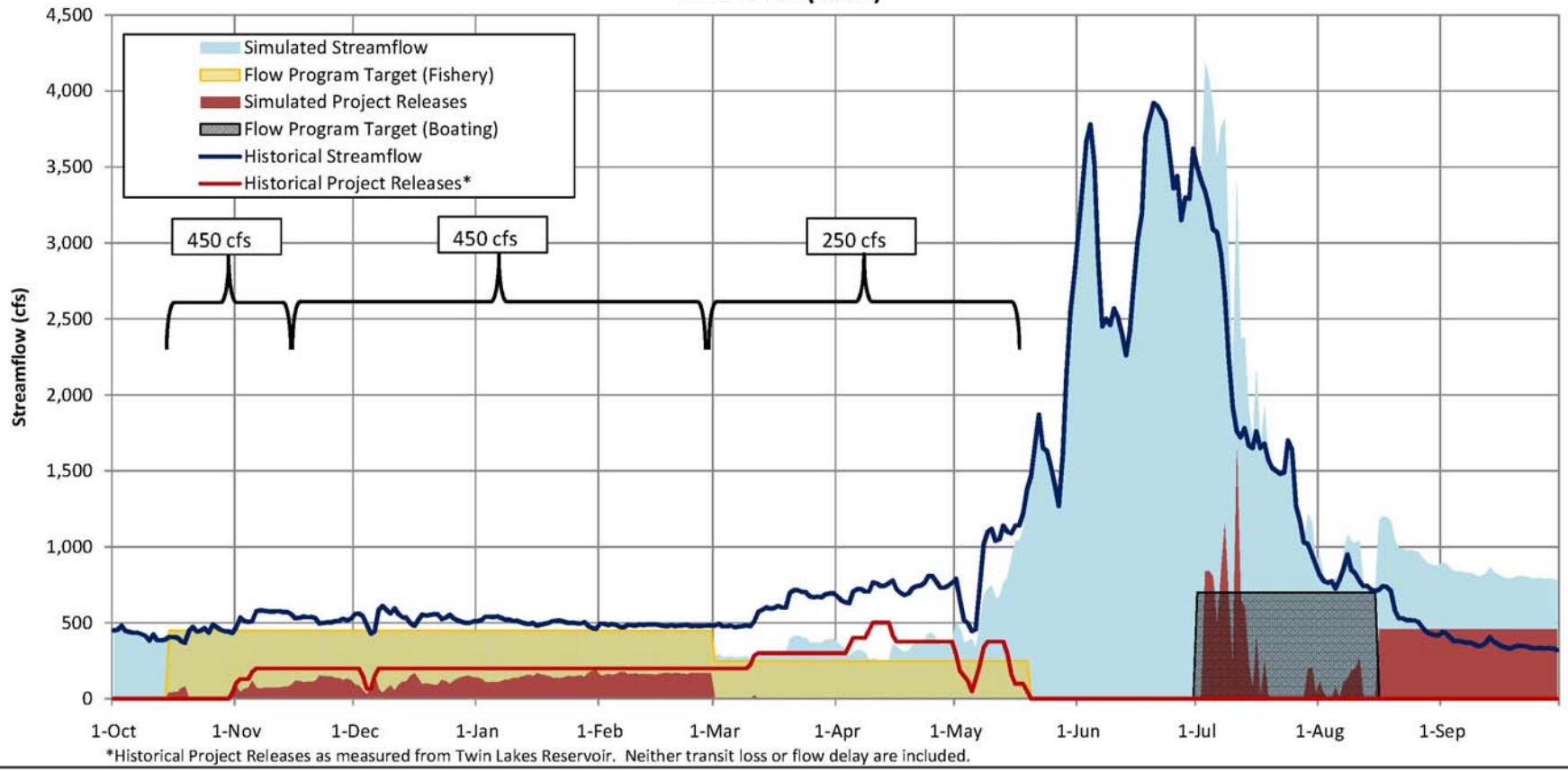
*Historical Project Releases as measured from Twin Lakes Reservoir. Neither transit loss or flow delay are included.

FIGURE 3.4.2 (SCENARIO NO. 2)
ARKANSAS RIVER STREAMFLOW NEAR WELLSVILLE
VOLUNTARY FLOW PROGRAM FISHERY FLOW RECOMMENDATION
WET YEAR (2008)



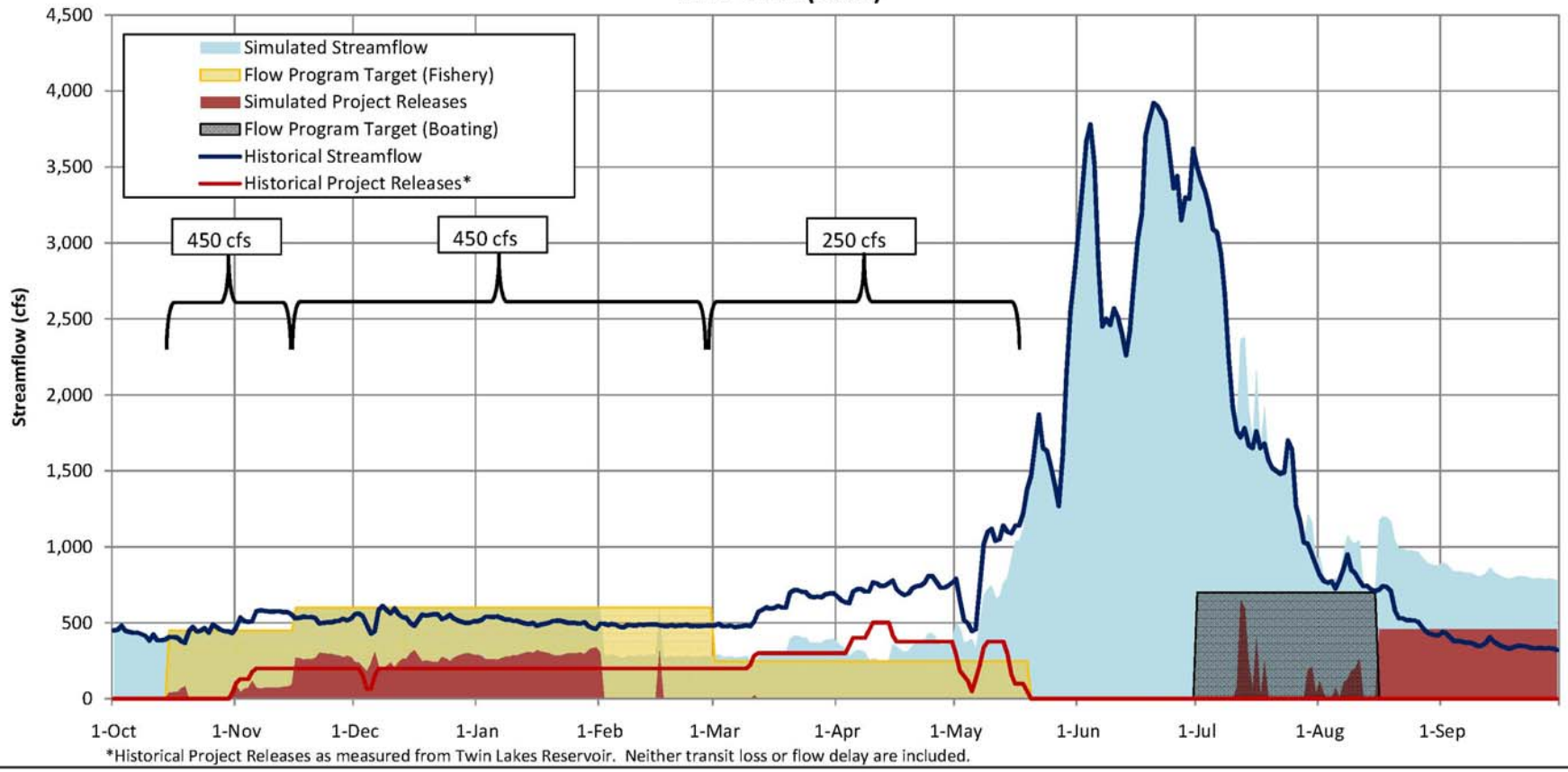
*Historical Project Releases as measured from Twin Lakes Reservoir. Neither transit loss or flow delay are included.

FIGURE 3.4.2 (SCENARIO NO. 3)
ARKANSAS RIVER STREAMFLOW NEAR WELLSVILLE
VOLUNTARY FLOW PROGRAM FISHERY FLOW RECOMMENDATION
WET YEAR (2008)



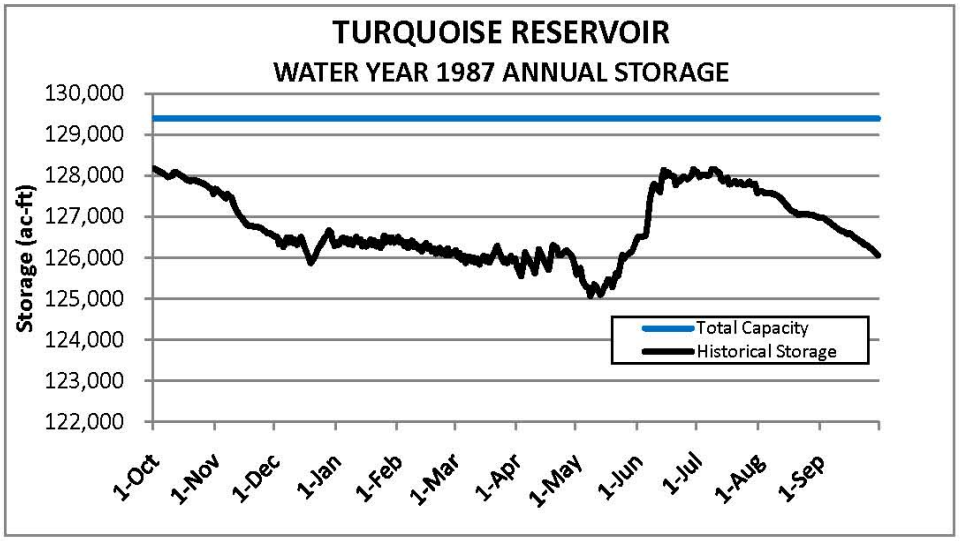
*Historical Project Releases as measured from Twin Lakes Reservoir. Neither transit loss or flow delay are included.

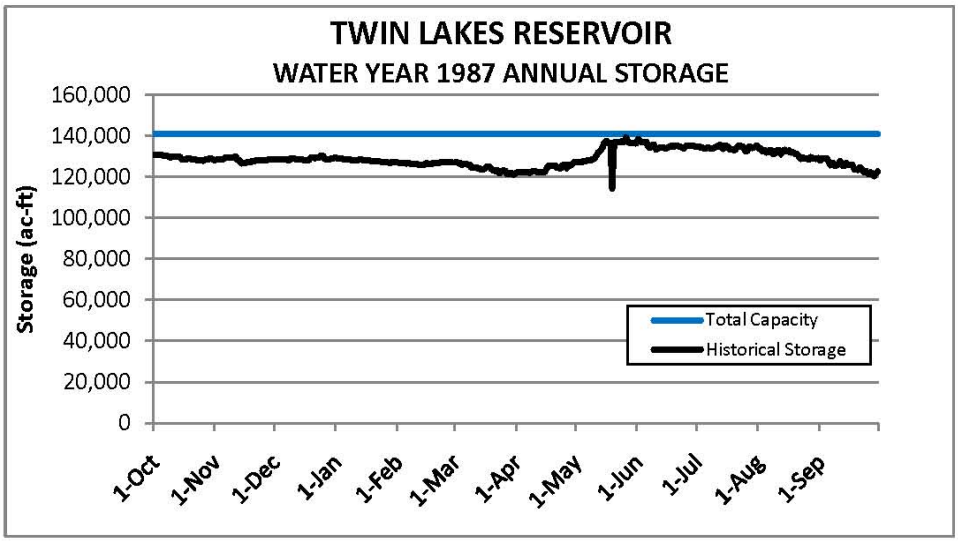
FIGURE 3.4.2 (SCENARIO NO. 4)
ARKANSAS RIVER STREAMFLOW NEAR WELLSVILLE
VOLUNTARY FLOW PROGRAM FISHERY FLOW RECOMMENDATION
WET YEAR (2008)



*Historical Project Releases as measured from Twin Lakes Reservoir. Neither transit loss or flow delay are included.

FIGURE 3.6.2
WATER YEAR 1987





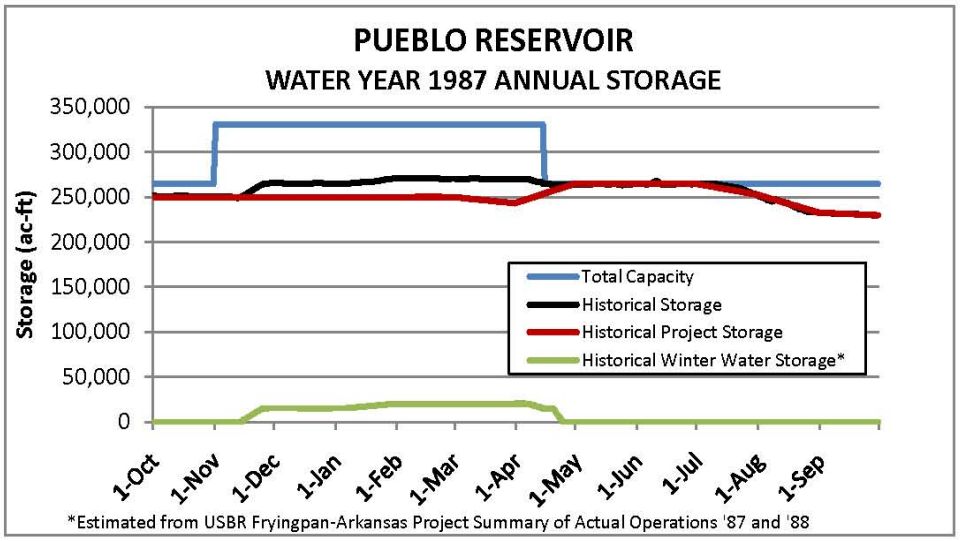
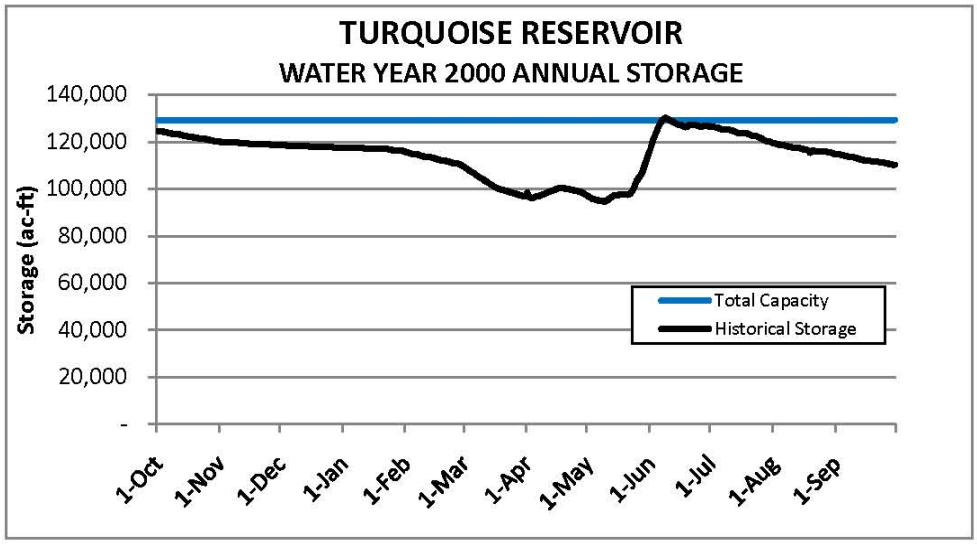
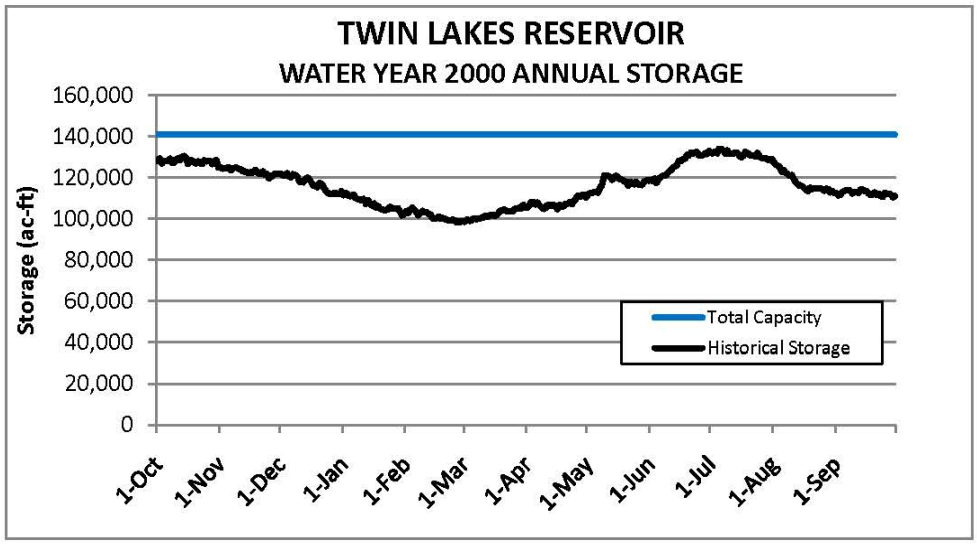


FIGURE 3.6.2
WATER YEAR 2000





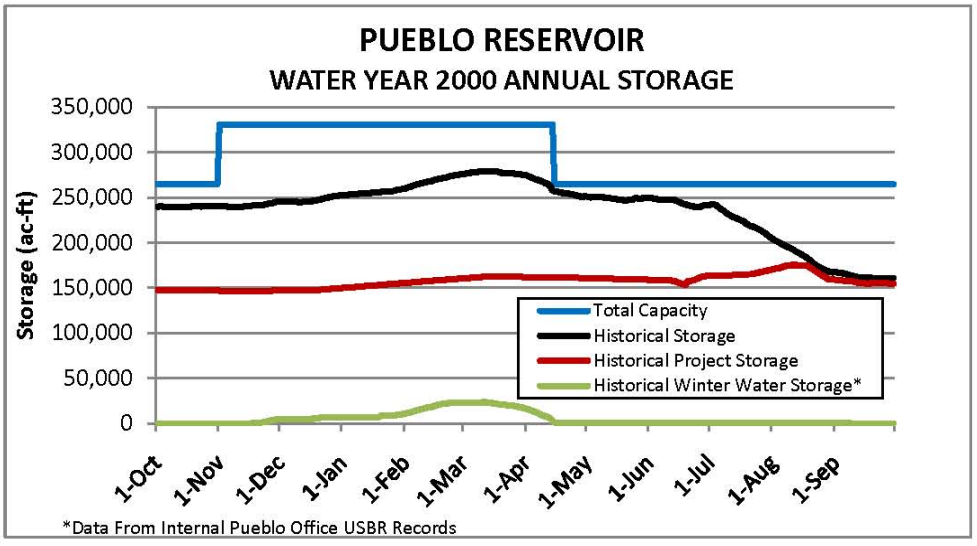
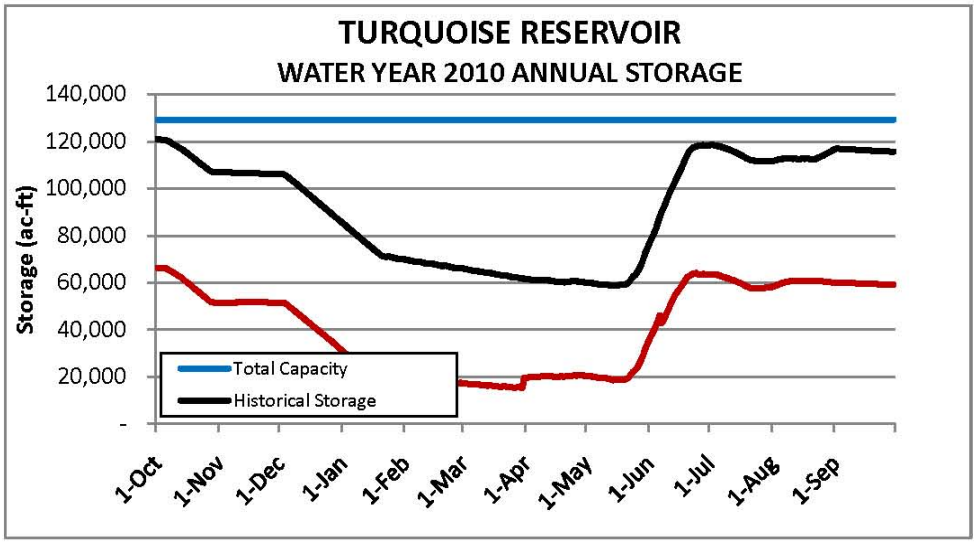
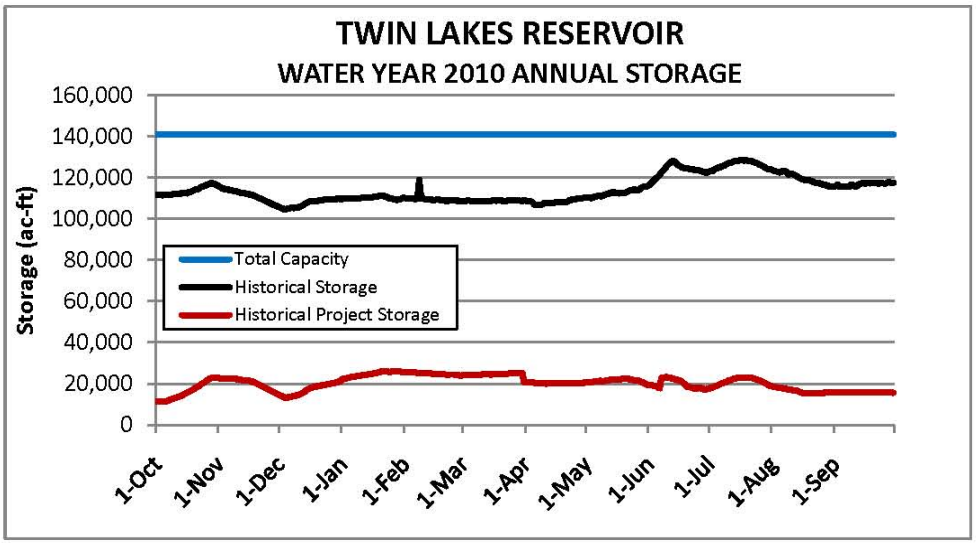
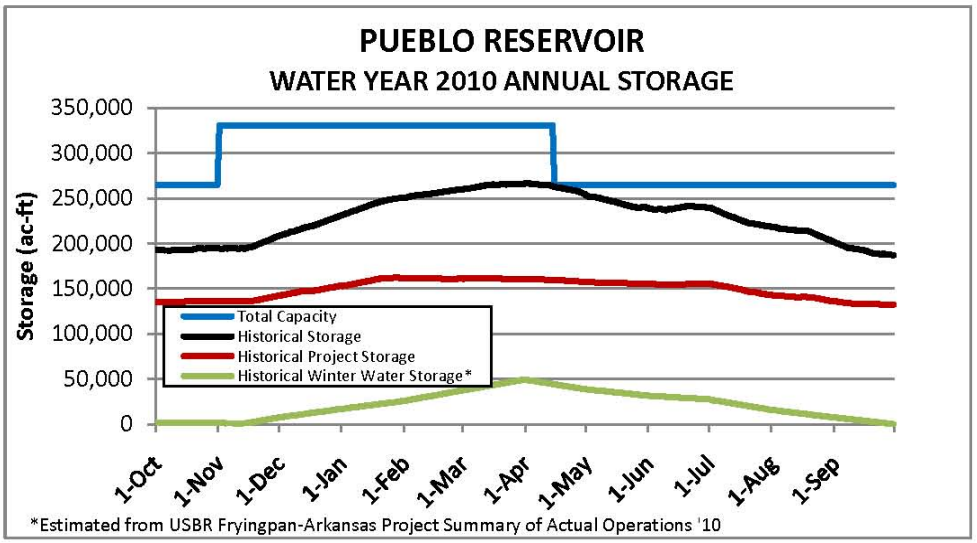


FIGURE 3.6.2
WATER YEAR 2010







4.0 Discussion/Recommendations

The purpose of this study was to integrate hydrological data with stakeholder preferences to analyze potential alternatives for water management in the upper Arkansas River basin. Inherently, because of the variety of participants in the study process, the alternatives had more than hydrological implications; socio-economic and environmental concerns also needed to be addressed. And in the future, the process of determining if any of the alternatives are feasible, trade-offs will have to be evaluated on an integrated basis, combining all of these factors and disciplines.

It was not the goal of this study to select a preferred operational strategy for the upper Arkansas basin. Instead, the study objective focused on stakeholder inputs and the feasibility of implementing them based on an overall, comprehensive analysis of the benefits and impacts. The following discussion of each of the topics addressed in this report is structured to meet this objective.

4.1 General Discussion and Recommendations

It is recognized that communication among water providers and other stakeholders currently takes place within the upper Arkansas River catchments. However two important suggestions are recommended as a result of the study to broaden these ongoing activities:

1) Re-evaluate the "traditional" stakeholders' list; and

2) Appoint the Southeastern Colorado Water Conservancy District to manage . Stakeholder meetings for the upper Basin.

This study has highlighted a need to re-examine the "traditional" stakeholder list to determine if the list is inclusive of all participants. For example, it is recommended to add the U.S. Forest Service to the participants' list regarding spring runoff forecasting and reservoir operations. Further, this study suggests that there should be separate types of stakeholder lists – specific to operational topics that may include all or subsets of the overall stakeholders in the upper basin. In particular, it is also recommended to have specific discussions with entities involved with the fishery flows to discuss probable flow scenarios and provide consistent dialogue throughout the spring of each year. The participants in the Arkansas River Voluntary Flow Program should be extended to include the municipal water providers, the Upper Arkansas Water Conservancy District, and Fremont and Lake County representatives. Chaffee County RICD discussions are recommended between county representatives, state agencies, water providers, and the USBR. Lastly, discussions between upper and lower basin ("sub-basins") representatives are recommended – beyond the Arkansas River Roundtable

participants – to provide an educational forum which would increase the understanding of both sub-basins regarding water operations and the logic behind them.

The recommendation for more intensive dialogue between upper basin stakeholders – regarding very specific topics – is not made without considerable thought to the capacity and administration requirements needed to provide and conduct such meetings. It is fully understood that an increase in the time commitment of the participants will be required, and an organizational framework is needed to carry out meaningful discussions. For this reason, it is recommended that the Southeastern Colorado Water Conservancy District (SECWCD) accept the role to broaden the stakeholder participation. Again, it is realized that SECWCD already plays an active role in planning and policy, but this recommendation is to specifically have SECWCD take on specific leadership roles related to the topics in this study. SECWCD has the capacity to conduct these additional meetings, and is an intrinsic participant in the upper basin. In conjunction, it is recommended that state agencies (Department of Natural Resources) play an active role in the planning and decision-making processes involved with the topics discussed in this text. The added activity of SECWCD and the State will relieve the burden often placed on the USBR to inform and educate upper basin partners.

4.2 Lake Fork Creek Flooding

During the study period of 2000-2011, Lake Fork Creek releases from Turquoise Reservoir exceeded the maximum flow for approximately two hours. This level of infrequency indicates that water operation strategies in the upper basin recognize the 400 cfs target flow and are manage effectively for it. Much of this is attributed to the experience of the USBR. Through the many years of operations, practical knowledge has proven to be the most effective management tool in reducing or eliminating flows exceeding 400 cfs below Sugarloaf Dam.

But other issues were identified in the study to assist the USBR and other water providers using Turquoise Reservoir. First, and perhaps most fundamental, is the development of a comprehensive communication network for stakeholders. While annual spring-time operation meetings are conducted, it would be helpful to maintain a continuous dialogue throughout the runoff season. If events regarding inflows or Mt. Elbert operations change, stakeholders would be informed of such changes and have the opportunity to respond and provide input to address these changes.

More specifically, communication between water providers and other stakeholders is recommended to assess runoff forecasts after May 1. This recommendation is not necessarily focused on weekly or daily meetings, but instead focuses on sharing of data and water operations on a real-time basis, whereby all stakeholders can access the information – e.g. electronic website or "bulletin board." The Colorado State Parks website provides some of this

information, but many stakeholders recommended that more "predictive " information be included, such as two-week runoff forecasts, precipitation patterns, anticipated storage levels in Turquoise, etc.(AROA 2011). An improved communication link would also assist the USBR and other water providers in assessing their short-term (daily or weekly) storage content, and allow non-consumptive users the opportunity to anticipate water flows and storage conditions, especially in Turquoise Reservoir. Additionally, it is recommended that planning workshops be conducted with participating upper basin members to discuss various "what-if" scenarios, and/or historical operational activities to determine strategies and management options. The concept is to identify potential management scenarios to improve communication among stakeholders, and develop collaborative processes to address issues while in a "planning" stage rather than in a "crisis" stage.

Second, a thorough analysis of forecasting procedures would provide the basis to identify areas of improvement. An analysis of historic forecasts would be helpful to identify needed areas of improvement in forecasting models, and provide insight on the management procedures of specific water providers. Snowpack-runoff forecasts are an important element in all aspects of upper basin river management, and therefore the stakeholders collectively should address the issue. Rather than have individual entity's using different forecasting procedures operating simultaneously, it is recommended that a single comprehensive upper basin forecast model be used (developed). This may be an area of study for the DSS.

4.3 Recreational Impacts at Turquoise Reservoir

The study reflects a need to better define the low-end recreational target elevations at Turquoise Reservoir. During the 2000-2010 study period, the reservoir was kept at 56% capacity or higher during the recreation season (Memorial Day through Labor Day) for all but a few days in 2002 and 2008. The two boat ramps – a typical low-elevation target for reservoirs in the western U.S. – had full accessibility during the entire study period (USFS 2011). There was no clear correlation between recreational visitor use at the reservoir and water elevations. The increased shoreline effects did not manifest themselves through fewer visitors' attendance, a reduction in campground use, and/or lower boat counts on the reservoir. Conversely, the study revealed that in some cases, sandy shorelines improved the recreational experience due to an increase in shoreline birds and fishermen access. It is a reasonable assumption from this analysis that more recreational data is required prior to making any determinations regarding current and future water management at the reservoir.

This study illustrates a need for a Turquoise Reservoir recreational study relating water elevations to recreational visitation and usage. This would be helpful in identifying the most appropriate storage targets for the summer recreational pool that the USBR and upper basin stakeholders can base future water management decisions.

Regardless of the recreational targets, the study illustrated that communication with the Forest Service is important in providing information from the water providers to the recreational end-users. It is recommended that the Forest Service have access to forecasting data and real-time information related to water elevations at the reservoir – most notably in the spring, when water levels historically are at their lowest. Such information could assist recreational managers in planning seasonal operations at the reservoir.

The study also revealed that much of the desired recreational improvements at Turquoise Reservoir are not necessarily water-related. Other issues, such as recreational facility improvements and better staffing, were listed as equally important aspects of recreational enhancement at the reservoir. For example, only one boat ramp is currently open to the public due to the lack of personnel operating the zebra mussel inspection stations. There is also an identified need for new boat docks to improve access to the boat ramps. And the comment most received during the study was the need to improve the access road around the reservoir (USFS 2011).

4.4 Chaffee County RICD

Results of this investigation indicate that current water operations in the upper Arkansas River do not significantly impact target flows of the RICD. If water operations occur in June, they usually occur on peaks greater than 1,800 cfs and/or 1,400 cfs. This study identified only one circumstance in 2002 – a historically dry year – that upstream municipal exchanges had an effect on RICD target flows. A more overriding effect on the RICD is the native stream flow itself, and the type of natural runoff experienced in any given year.

The RICD – and its accompanying FIBArk event - are scheduled with pre-set dates that generally predict "high" runoff time periods in June, but these dates are not predicated on annual data. To improve the effects of the RICD, an analysis identifying the most likely periods of peak runoff, coupled with the improved forecasting potential mentioned earlier, would provide the basis to optimize the Chaffee County's selection of the RICD's 8 days to be in priority.

The RICD also provides the framework for Chaffee County stakeholders to discuss with water providers their annual operations during the month of June, and work collaboratively to lessen the effects of municipal exchanges. The RICD is a junior water right, and therefore is not in priority during a senior exchange. But if Chaffee County participants are able to work cooperatively with water providers, especially in dry years, impacts of such exchanges may be reduced or avoided. Therefore, stakeholders (water providers, Chaffee County, FIBArk event

planners) would be well-advised to begin a comprehensive planning process within the upper basin to maximize the benefits of the RICD.

4.5 Fishery Flow Recommendations

From the various stakeholders' perspective in the upper basin, optimizing the fishery flows is the most challenging of the recommendations because it requires a "balancing" act of multiple objectives. Effects resulting from the fish-flow implementation occur throughout the upper basin, and in particular, at the Fry-Ark reservoirs.

The key to the recommendations is to reduce flows during the March 1-May 15th timeframe, and also reduce flows (to native levels) during the fall months. In average and wet years, these objectives may cause the USBR to move more water from the upper reservoirs at a higher rate – or store more water for longer periods in the upper reservoirs. The former option has the consequence of filling Pueblo Reservoir at a faster rate, and possibly affecting the If & When accounts on April 15. Likewise, if more upstream water was released earlier to meet the fishery objectives, springtime water levels at Turquoise Reservoir may be lower, resulting in adverse recreational impacts and/or insufficient amounts of Project water to be stored for use in the summer component of the Voluntary Flow Management Program.

When such "trade-offs" were presented to the wide variety of stakeholders in the upper basin, the participants did not want a "winner-loser" outcome. Instead, the idea was to utilize management strategies that best matched the objectives. This is a positive attribute within the fishery "community" – recognizing the challenges of upper basin management during wet years.

The reliability of snowpack-runoff forecasts is crucial for proper fishery management. The difficulty rests with the ability (inability) to accurately predict spring runoff during the critical time-frame prior to March 1. To alleviate the uncertainty of the runoff forecasts, which are critical for the success of all the stakholder's recommendations, cooperation and collaboration among the water providers and the fishery interests are vital components to the management strategies. Exchange of data and continued dialogue between the parties has proven successful, and needs to be continuously reviewed.

Pueblo and Turquoise Reservoir's stakeholders need regular assessment of storage levels during November- March, and the fishery "community" needs to be apprised of potential flow operations during these critical months. Stakeholders need to be flexible in their preferred targets, and/or have contingency plans to evacuate storage space. It is recommended that wet-year "what-if" scenarios be reviewed and discussed in a "planning" environment, rather than a real-time "action" setting. Workshops, public education, and regular planning meetings to discuss specific fishery flows issues are warranted and encouraged by the various participants.

Refinement of upper basin operations should be considered through the winter months, items such as: monthly reservoir elevation targets, operating at maximum fishery flow rates, and/or adding more SNOTEL sites.

In conclusion, the study process clearly showed that the ability to predict springtime snowpack and stream flow several months in advance was a critical limitation in meeting fish-flow recommendations. The study process also clearly showed that to deal with this uncertainty, stakeholders are willing to work cooperatively if given the forum to do so. It is recommended that SECWCD conduct specialized meetings, with specific stakeholders including Colorado Division of Wildlife, Trout Unlimited, Lake, Chaffee and Fremont Counties, angler businesses, and water providers to begin discussions. The purpose of such discussions would be to initiate the planning process for effective fishery management during wet years, and address the real-time needs of stakeholders in addressing runoff forecasting issues.

4.6 River Exchanges

Upstream river exchanges resulted in the release of additional Project water in 8 of the 11 study years during the July 1- August 15 timeframe. However, the overall amount of exchanges has decreased since 2006. This decrease coincides with the facts that: 1) current storage contracts with the USBR prohibit river exchanges during the Flow Program "summer component" between Pueblo Reservoir and the upper reservoirs; 2) the Agreement, signed in August of 2005, has provided cooperative river planning between consumptive and non-consumptive entities; and 3) there has been a lack of a recent successive dry years in which upstream exchanges are more likely to occur.

Of all the factors listed above, it is important to note that the trend towards fewer exchanges illustrates the recognition by stakeholders that the summer component's flow rates are essential to the economic well-being of the upper basin, especially Chaffee County. A framework has been established – and needs to continue - for water providers to work with upstream entities to reduce the impacts of exchanges, and investigate operational strategies and alternatives that have not been previously considered. An important goal in these discussions is to insure that municipalities can maintain their annual yields while accommodating the Flow Program recommendations. This study illustrated that this can be best accomplished in three ways:

- Re-time the exchanges to occur during the peak runoff period; and/or
- Re-time exchanges to occur prior to July 1st or after August 15th;
- Develop an escalating "stair-step" rate of exchange during the July 1- August 15 period based on target flow readings at the Wellsville gauge.

The concept of these recommendations is to assess water providers' ability to maintain their annual water yields by changing the time of year that exchanges occur; or, "index" the exchange rate during the summer component period to the flow rates measured at Wellsville: the higher the flow rate, the higher the exchange rate. The indexing concept is currently being used by the City of Aurora (Aurora 2007).

4.7 Pueblo Reservoir "Spills"

As with the fishery flows, the main element with the If & When storage accounts is the reliability of snowpack-runoff forecasting. Because of the uncertainty involved with the forecasts, the USBR is required to assess and adjust releases from the upper reservoirs to Pueblo Reservoir on a constant real-time basis. These adjustments not only affect Pueblo Reservoir inflows, but also impact fishery flows through Salida and storage levels in the upper reservoirs.

One concept that is being investigated is the possibility of moving the evacuation dates for If & When accounts from April 15th to May 1st. This was actually done in 2010 to prevent the loss of If & When water that was stored in the joint-use pool. Moving the evacuation date from April 15 to May 1 was proven to be an effective management strategy to preserve If & When water in Pueblo Reservoir. The additional two weeks would allow "carry-over" accounts to be released, creating the required additional storage space to maintain the If & When accounts. However, this study did not address the flood control aspects of this operational change. Clearly, such issues need to addressed (discussion are ongoing between the parties) and operating criteria needs to be established prior to the implementation of this alternative. But because of the significant water savings illustrated in this study, consideration for moving the evacuation date is warranted and compelling.

The second stakeholder option to reduce "spilling" from the If & When accounts is to store water longer in the upper reservoirs. The study indicated that this alternative was feasible in the sense that storage was historically available. However, again, the lack of forecasting certainty – and thus reducing risks associated with Turquoise Reservoir and fishery flow management – is problematic. The risk assessment, as described by the stakeholders, indicated that storing water until runoff begins is likely to create more problems than it solves. Preferred strategies include:

- Educate stakeholders of the trade-offs of various "what-if" scenarios to begin the planning process for management strategies during wet years;
- Develop a comprehensive storage study regarding additional storage in the upper basin, either projects already contemplated or new storage projects;

- Provide analysis within the Decision Support System to provide a more sophisticated reservoir operating criteria analysis;
- Develop specific stakeholder-driven discussions regarding Pueblo Reservoir elevations and If & When account analysis on a monthly basis from March 1 – May 1, and weekly from May 1- June 30;
- Fund a recommended analysis to increase the predictability of runoff forecasts into the upper basin.
- Further inquire stakeholders about their use and management of If & When space. From the historical data, it is evident If & When contract holders were able to move water out of their accounts to other storage locations prior to April 15th. Utilization studies of non-Fry Ark facilities in both the upper and lower basin may offer insight to new alternatives for storage issues in Pueblo Reservoir.

4.8 Other Discussion Items

Through discussions with stakeholders, other management topics were mentioned that are related to the specific topics discussed in this report:

- **Arkansas River Voluntary Flow Management Agreement -** reaches of Lake Fork Creek and the Arkansas River have experienced bank erosion ("sloughing") that many stakeholders believe is a consequence of the ramp-down portion of the Flow Program. It was recommended that Agreement participants investigate the possibility of increasing the length of the ramp-down period to provide a higher level of stream bank protection and/or construct stream bank "improvements" in areas susceptible to erosion;.
- **Turquoise Reservoir Facility Improvements –** stakeholders involved with recreation at the reservoir would like to develop a "facility improvement" study to identify and prioritize facility improvements;
- **Increasing Runoff Forecasting –** many stakeholders mentioned seeking new funds for a new SNOTEL site in the upper basin (location to be determined) to improve runoff forecast into the upper basin;
- **Classification of Year "Type" –** for purposes of this study, no statistical analysis was performed to determine wet, average, or dry years. Such determination was made by consensus of the stakeholders for any particular year during the study period. However, stakeholders realized a need to categorize the historical data (beyond the period used in this study) to aid in the development of trend analysis regarding the frequency and durations of year "types" that have historically occurred in the upper Arkansas River basin.

- **Development of Comprehensive Data Base –** obtaining useable data for this study was problematic. Data availability was not the issue, but rather the difficulty was based on multiple data bases, from various sources, all using different coding methods. These variances made it difficult to accurately interpret the data sets. Therefore, it is recommended to develop a single, accessible, basin- wide data base that incorporates the data from the numerous sources. It is anticipated that such an undertaking will be part of the DSS development.

5.0 Conclusions

The objective of this study was to analyze stakeholder-driven recommendations to meet specific water management objectives in the upper basin of the Arkansas River. Five management operations were selected for the study, were analyzed separately, and in conjunction with current/historical operations in the overall basin. The findings from the study showed that cooperation and collaboration within the upper basin already exists at varying levels. The results also demonstrate areas of water management that require higher levels of stakeholder participation and cooperation, most notably as a result of the uncertainty involved with snowpack –runoff forecasts, and predicting the actions of individual water providers.

The study results indicated the following:

1. Turquoise Reservoir Recreation Pool - storage levels at Turquoise Reservoir should be re-analyzed to verify and, if necessary, re- establish water elevation targets for the USBR. This can be done through a recreational study that would correlate water elevations with visitation data. There may be an opportunity for water providers to utilize additional storage space to meet downstream objectives, but only if such a change in operation does not adversely affect recreational opportunities at the reservoir. Moreover, recreational impacts – if they occur due to lower water levels in the spring and fall – could be mitigated by improving the recreational infrastructure at the boat ramps and surrounding access road. Additionally, a second boat ramp would become operational if funds were available to hire sufficient staffing.

2. Operations at Turquoise and Twin Lakes Reservoirs – an evaluation of storing additional water in the upper basin is warranted because of the benefits in reducing the risk of If & When "spills" at Pueblo Reservoir, and helping meet the winter fishery flow recommendations more frequently. This change effectively keeps more water in Turquoise and Twin Lakes Reservoirs in the spring of each year, which may increase the risk of Lake Fork Creek stream flow exceeding 400 cfs. This additional risk needs more comprehensive study – again, perhaps as part of the DSS process.

3. Additional Upper Basin Storage - A corollary to maintaining storage at Turquoise and Twin Lakes Reservoirs through the spring is to analyze the effects of additional storage in the upper basin. This alternative/additional storage could subsequently allow for more space in Turquoise Reservoir to be utilized for Project water storage.

4. Change Pueblo Reservoir's Joint Use Pool Evacuation Date - Protection of If & When accounts would be improved by moving the evacuation date for such accounts from April 15th to May 1st of each year. This study did not investigate the flood risk involved with this recommendation, but the historical data related to the availability of flood control space indicates that a change in "spill" dates merits consideration. Further, if additional storage is found not to be viable at Turquoise Reservoir or elsewhere in the upper basin, an alternative would be to increase Pueblo Reservoir's total available storage capacity, effectively reducing the risk to If & When accounts. Or perhaps a combination of additional storage – both in the upper basin and at Pueblo Reservoir – could achieve the same goals.

5. Fishery Flow Management - administering recommended flows for fishery maintenance and enhancement is a difficult balancing act between maintaining Wellsville gauge flow requirements and regulating Fry-Ark storage in wet years. Forecasting runoff and predicting water provider's needs are a major complexity in the management process. While improved forecasting is recommended, a higher-level of communication and collaboration is vital to meet the objectives. This is also the case for operating Chaffee County's RICD and protecting the summer component of the Arkansas Voluntary Flow Management Program.

   However, stakeholders committed to water management to enhance fishery flows throughout the study process demonstrated a realistic level of expectations in achieving these goals, and a thorough knowledge of the challenges – especially in high runoff years. Communication and collaboration was found to be well established regarding fishery flows, and it is recommended that such cooperation continue.

6. Runoff Forecasting – predicting, months in advance, the "type" of runoff that will occur will be a difficult task into the foreseeable future. Therefore, improvement is sought by using a stakeholder collaborative process, utilizing data-sharing tools and developing specific "year-type" (wet, average, dry) management plans. However, compounding an already complex situation are the effects of predicting individual water user's needs, future effects of climate change, and additional water operations in the upper basin not yet in effect. Therefore, planning workshops, utilizing "what-if" scenarios mentioned in this report, are recommended to explore management alternatives.

7. Development of Specific Stakeholder Framework - As a result of these challenges listed above, it is clear that operational flexibility among the stakeholders is a key component in meeting water management objectives; with much of this flexibility being a result of cooperation and collaboration rather than changing specific water administration policies. Management alternatives need to be reviewed in organized planning sessions, whereby tradeoffs can be anticipated and evaluated. Because many of the stakeholder objectives have contradictory goals, balancing trade-offs and understanding their consequences should be integrated into management policy - providing guidance and establishing realistic expectations for both consumptive and non-consumptive water users.

It is further recommended that the Southeastern Colorado Water Conservancy District and agencies within Colorado's Department of Natural Resources (CDNR) have an active role in organizing the upper basin stakeholders into effective groups to address the individual topics presented in this report. Networking among the stakeholder groups – and individuals – requires an organized, concerted effort with SECWCD and CDNR providing the leadership and capacity to achieve meaningful collaboration.

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