

RECLAMATION

Managing Water in the West

Final

1995-2004 Review of Operating Principles and Project Operations

**Trinidad Lake Project, Colorado
Great Plains Region
Eastern Colorado Area Office**



**U.S. Department of the Interior
Bureau of Reclamation**

September 2010

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MISSION STATEMENTS

The mission of the Department of the Interior is to protect and provide access to our Nation's natural and cultural heritage and honor our trust responsibilities to Indian tribes and our commitments to island communities.

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

Executive Summary

This 10-year review of the Trinidad Project (Project) summarizes activity related to the Operating Principles for the period 1995-2004 and responds to specific issues raised by interested parties. Previous reviews were concluded in 1988 and 1996. Open issues from the 1996 review include: storage of winter water, development of a real-time irrigation requirement, and development of a substitute water supply plan to implement conditions (d) and (e) of House Document No. 325.

The Operating Principles were amended six times in the period 1995-2004. Three of these principles were temporary amendments allowing stock watering at rates greater than five cubic feet per second during the nonirrigation seasons of 1998-1999, 2001-2002, and 2002-2003; the last two of these also included provisions for verifying that the acreage irrigated was less than 19,717 acres. The 1996 amendment addressed an increase in the allocated capacity of Trinidad Reservoir to 125,967 acre-feet and assigned the increased capacity to the permanent fishery pool. The 1997 amendment addressed change of use to municipal and industrial, and removal of land classification requirements. The 2004 amendment addressed several items, including a permanent seasonal stock watering limitation of 1,200 acre-feet with no flow rate requirement, a water rights “clean up,” acreage verification system (AVS), and water rights changes from the Model Land & Irrigation Company to Colorado State Parks.

A mass balance analysis of the Trinidad and Thatcher gages (above and below the Project) shows no negative impact from the Project. The Project may have a slight positive impact on downstream users as compared to pre-Project conditions.

The conclusions and recommendations of this review are listed below:

- While the Trinidad and Thatcher gages are sufficient to analyze downstream impacts of the Project, an additional mainstem gage would be very helpful. While several locations have been suggested, no specific location has been selected.
- The standardized AVS should be used to improve acreage reporting and increase confidence of other parties in the Purgatoire River Water Conservancy District operations.

Use of the AVS, improved canal gages, and the U.S. Geological Survey canal loss study all provide additional information about the irrigation requirement. A group of interested parties should discuss the expected utility of a real-time irrigation requirement.

- The model made available as part of this review needs further development to extend the period of record and document data needs. A technical team should be convened to direct any further modeling studies.
- Damaging flows may occur at lower levels than previously thought. Results of an ongoing channel capacity study may need inclusion in the Operating Principles.
- Reclamation, along with other interested parties, should participate in annual or biennial processes to address current issues. Doing so will allow the next 10-year review process to be more straightforward and timely.

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I. Introduction

The Trinidad Project (Project) was authorized for construction by the U.S. Army Corps of Engineers (Corps) under Public Law 85-500 (85th Congress S-3910, July 3, 1958, as described in House Document (H.D.) 325, 84th Congress, 2d session, January 1956) as a multipurpose project including flood control, irrigation, fish and wildlife preservation, and recreation. There was an irrigation report published in 1961, and updated in 1964, which altered the details of the Project. The Project includes an irrigation purpose for which the Bureau of Reclamation (Reclamation) has a contract with the Purgatoire River Water Conservancy District (District) for repayment of the reimbursable cost allocated to the irrigation purpose.

The irrigation portion of the Project was constructed to provide a more reliable source of water for lands within the Project area that had been irrigated since the 1860s. The Project lands included areas served by 11 different ditches and that extended about 25 miles downstream of the City of Trinidad on either side of the Purgatoire River. The District was organized to provide overall management of the Project water supply and to contract with Reclamation.

Reclamation developed Operating Principles as part of the irrigation report with an objective to operate the Project in a manner that would secure the greatest benefits from the available water supply consistent with the laws and policies of Colorado and the United States, including the Arkansas River Compact between Colorado and Kansas. The Operating Principles include a requirement for a periodic review of the Operating Principles and Project operations.

Article VI. of the Operating Principles, Trinidad Dam and Reservoir Project, provides:

These Operating Principles may be subject to review and amendment not more than once a year at the request of any of the parties' signatory; provided, that at least one review shall be accomplished within the first 10 years following completion of the Trinidad Dam and at least one review be accomplished every 10 years thereafter. The primary object of such reviews will be obtaining optimum beneficial use of water as conditions change, operating experience is gained, and more technical data become available.

The State of Kansas developed a list of Five Conditions which were made part of the Operating Principles. Condition No. 4 of Kansas' Five Conditions requires:

That 5 years after beginning operation of the Trinidad Reservoir for irrigation purposes, the Operating Principles be reviewed to determine the effect, if any, the operation has had on other Colorado and Kansas

water users and the principles amended as necessary. Each 10 years thereafter, reviews should be provided with amendments as needed.

Signatories to the Operating Principles include the District, the State of Kansas, the Arkansas River Compact Administration (ARCA), the Corps, and Reclamation.

A. Purpose of this Report

The purpose of this report is to:

- (1) Document status of the Operating Principles, including activities that have occurred during the 10-year period, and
- (2) Conduct the November 1, 1994, through October 31, 2004, 10-year review of project operations and effects on other water users, in compliance with the Operating Principles and Condition No. 4.

B. Previous 10-Year Reviews and Recommendations

Reclamation has conducted two previous reviews for the Project. The first review covered the period of 1979 through 1984 and was documented in a 1988 report. A 10-year review was requested by the District in 1994, covered 1985 through 1994, and was documented in a December 1996 report. Conclusions and recommendations from the 1988 review were addressed in the 1996 report and are not restated in this report. A summary of recommendations from the 10-Year 1996 Review (1996 Review), which are pertinent to this review, are presented below. Responses to the recommendations are given in italics following the recommendations.

C. Summary of 1996 Report Recommendations and Actions Taken

A. Suspension of the practice of the transfer of water remaining in storage in the Model Storage right to the joint use pool at the end of the irrigation season has had no effect since all Project lands have been irrigated and the operating principles should not be amended to recognize this practice.

Action Taken: The review further concluded that this practice was a departure from the Operating Principles. This “rollover” has not been allowed since 1989.

B. The storage of winter water under the direct flow rights in any of the irrigation capacity is allowed by the operating principles and the operating principles should be amended to clarify this issue.

Action Taken: The recommendation has not been acted upon by the parties, but it is anticipated that the re-creation of the operational model in this review will allow analysis of this issue in the future.

C. [paraphrased] The Operating Principles should be amended to incorporate the enlargement, initial filling, and maintenance of the permanent fishery pool.

Action Taken: The recommendation was addressed in the 1996 amendment to the Operating Principles.

D. [paraphrased] The Operating Principles should be amended to allow a rate of release up to the rate of inflow to Trinidad Reservoir for stock water release, and the volume limit should be reduced to 1,200 acre-feet.

Action Taken: The recommendation was addressed in temporary stock water amendments and permanently in the 2004 Amended Operating Principles.

E. [paraphrased] The Operating Principles should be amended to reduce the total irrigable acreage from 19,717 to 19,499 acres. Land classifications requirements should be deleted, and irrigable lands should be identified. The District should develop a procedure to verify that no more than 19,499 acres are receiving an allocation of water and/or actually being irrigated in any year.

Action Taken: The recommendation was addressed in the 2004, 1996, and 2004 Amended Operating Principles, respectively.

F. The District should develop a methodology for determining a current real time irrigation requirement as it is a critical element for management of the District water supply.

Action Taken: No action taken to date.

G. The District should determine the water transportation losses of each of the individual ditch systems for allocation of the District water supply and administer the delivery of the District water supply in accordance with the allocations by individual ditch.

Action Taken: The recommendation was partially addressed by the Reclamation and District funded agreement with the U.S. Geological Survey (USGS) for the Canal Loss Study.

H. [paraphrased] The Operating Principles should be amended to allow the City of Trinidad to change Project water to municipal and industrial (M&I) use.

Action Taken: The recommendation was addressed in 1997 and 2004 Amended Operating Principles.

1995-2004 Review of Operating Principles and Project Operations

I. The Operating Principles should be amended to allow the District to implement conditions (d) and (e) of H.D. No. 325 with development and approval of a substitute water supply plan pursuant to Colorado water law.

Action Taken: No action taken to date.

II. Status of Operating Principles

Several amendments to the Operating Principles have been adopted since the 1996 Review. Even prior to the conclusion of the 1996 Review, parties to the Operating Principles were working on amendments. Due to the ongoing litigation in *Kansas v. Colorado*, the State of Kansas had declined to approve proposed amendments to the Operating Principles in the late 1980s and early to mid-1990s. An amendment to the Operating Principles to recognize the enlargement of the permanent fishery pool and the total allocated capacity of Trinidad Reservoir was signed by all the parties by May 1996. This was the last amendment adopted prior to the publishing of the 1996 Review, but a revised version of the Operating Principles including this amendment was not produced until the 1997 Amended Operating Principles. The major points of this and subsequent amendments, and the actions leading up to the amendments, are discussed below. Copies of all the amendments are provided in Appendix A.

A. 1996 Amendment

This amendment recognized the enlargement of the permanent fishery pool from 4,500 acre-feet to 15,967 acre-feet and the total allocated capacity of Trinidad Reservoir to 125,967 acre-feet. The amendment also clarified the filling and replacement of evaporation for the permanent fishery pool. The amendment was approved by ARCA and the other parties at a special teleconference in January 1996 and signed by all parties by May 30, 1996. This amendment addressed the 1996 10-Year Review recommendation C.

B. 1997 Amendment

In 1997, an amendment to the Operating Principles was approved, adopting several changes that had been discussed for numerous years previously. The amendment addresses the City of Trinidad change of use to M&I and removal of land classification requirements. This amendment partially addressed the 1996 10-Year Review recommendations E and H.

The City of Trinidad, the District, the State of Colorado, and Reclamation had sought amendments to the Operating Principles to allow the city to change the use of its water rights to M&I purposes. The need to amend the Operating Principles to allow the M&I use of the City of Trinidad's water rights was also recognized in recommendation H of the 1996 review.

The original Operating Principles limited irrigation of the District lands to those classified as Class 1, 2, and 3 irrigable acres under Reclamation law. Reclamation wrote to the District on April 19, 1996, clarifying that under the

1982 Reclamation Reform Act, the Project was exempt from Reclamation land classification requirements because the Project had been constructed by the Corps. While a previous modification of the contract between Reclamation and the District withdrew this requirement, the Operating Principles had not been amended to recognize the change. Recommendation E of the 1996 Review recommended that the classification requirement be removed by amendment of the Operating Principles.

The 1997 Amended Operating Principles were approved at the December 1997 ARCA meeting and signed by all the parties by April 22, 1998. The 1997 Amended Operating Principles allowed the City of Trinidad to use its water rights for M&I purposes, clarified the use of the City's water rights, and removed the acreage classification requirements.

In response to the 1996 Review recommendations, Reclamation continued in 1998 to pursue additional amendments of the Operating Principles with the parties, including acreage adjustments, adjustments to stock watering practice, and a general cleanup of the language and format of the Operating Principles. A technical meeting was held amongst the parties on February 18, 1998, to discuss the recommendations of the 1996 Review and potential amendments to the Operating Principles. Reclamation sent a letter on October 15, 1998, to the parties, summarizing the February 18th meeting and providing status on the issues. Reclamation noted:

- Kansas had provided language for a proposed stock water amendment.
- The District had provided information explaining acreage verification procedures.
- Reclamation was working with the District to address the ideal head gate requirement.
- Colorado would provide a letter describing flood flow storage and release criteria.
- Kansas had committed to provide general criteria for modeling of storage of winter direct flows in the joint use pool.

Direct flow water rights had not been acquired by the District at its formation, thus reducing the lands eligible for Project water. Recommendation E in the 1996 Review also recommended that the Operating Principles be amended accordingly to reduce the lands served to less than 19,499 acres. The District had worked with a Soil Conservation Service (SCS) employee to conduct a survey of irrigated acres and submitted the survey results to Reclamation. In mid-1996, Reclamation analyzed Operating Principle irrigated acres versus acres submitted by the District and worked with the District to come to resolution on the amounts.

Resolution of these amounts was not accomplished in time to have appropriate amendments included in the 1997 Amended Operating Principles. The modification of the list of water rights and irrigable acreage was not permanently adopted until the 2004 Amended Operating Principles.

On December 1, 1998, prior to the upcoming ARCA meeting, Reclamation sent out a “cleaned up” version of the Operating Principles that were proposed in November 1997, including amendments that were adopted in 1997, as well as amendments that were not adopted at that time. The District had indicated that it wished to have amendments to allow the storage of winter direct flows outside the Model right. However, Reclamation responded by letter of December 4, 1998, that it was not prepared to support such an amendment at the time. Reclamation set up a technical meeting in Lamar on December 7, 1998, prior to the ARCA committee meetings with the parties to discuss the proposed amendments. Reclamation provided a revised version of the “cleaned up” Operating Principles for consideration.

C. 1998 Temporary Amendment

The parties were not able to support adoption of the full, amended, “cleaned up” version of the Operating Principles at the 1998 ARCA meeting. However, at the request of the District, a temporary stock watering amendment was approved for the 1998-99 nonirrigation season that only allowed the District to make releases for stock watering at a rate greater than 5 cubic feet per second (cfs). The language for the amendment removed the prior limitation of 5 cfs release rate, or its volumetric equivalent, and replaced it with a seasonal volumetric limitation of 1,200 acre-feet. The seasonal volumetric limitation of 1,200 acre-feet represented a reduction from the 1,500 acre-feet, which was the previous volumetric limitation. The amendment was signed by all the parties by January 1, 1999.

1. 1998-2000 Activities

On December 2, 1998, the State of Colorado provided a letter with criteria on temporary storage and release of floodflows at Trinidad Reservoir. The Corps provided a letter on February 10, 1999, clarifying its criteria for temporary detention and release of floodflows from Trinidad Reservoir. The Corps referred to its 1992 study and subsequent April 16, 1993, letter to Colorado State Division Engineer, Steve Witte, clarifying that Corps personnel would make the decision regarding releases above 3,000 cfs. The Corps also suggested language in the Division 2 Engineer’s December 2, 1998, letter to Reclamation clarifying that the Corps may direct releases above 3,000 cfs, but not exceed 5,000 cfs, if channel conditions permit. On December 3, 1999, the Colorado State Engineer transmitted the current version of the criteria for temporary detention and release of floodflows. See Appendix L and the Flood Control Operations section IV.A.5 of this Review.

On December 23, 1998, Kansas provided a letter with its criteria on how Reclamation should conduct its modeling for storage of winter direct flows in the joint use pool.

On December 30, 1998, Reclamation provided a list of remaining action items and proposed deadlines pertaining to amendments of the Operating Principles. Substantive issues identified included: providing written comment on the criteria for detention and release of floodflows, providing written comments on permanent stock water language, providing comment on acreage verification information provided by the District, drafting an amendment to address concerns relating to irrigated acreage, and reviewing Kansas' proposed modeling approach.

The Colorado State Engineer sent a letter on February 23, 1999, expressing concern over Kansas' proposed modeling approach. Colorado questioned whether such a complex model could be constructed, given data limitations, and whether it should be constructed to the State line. Reclamation arranged a technical meeting of the parties for July 12, 1999, in Denver, to discuss progress on resolving issues identified in Reclamation's December 30, 1998, letter. The specific focus of the meeting was on issues related to irrigated acreage and approach to addressing concerns over proposed winter direct flow storage.

Prior to the meeting, Reclamation sent out a status of action items and responses by the parties to the issues. The District had proposed listing contracted acres in the Operating Principles, while limiting the overall irrigable acreage to 19,499 acres. Reclamation agreed with this approach and encouraged the District to continue to pursue an acreage verification system (AVS). Kansas had yet to respond to proposed irrigated acreage amendments. Reclamation noted that while "ideal irrigation requirement" was mentioned in the 1988 review, that term is not in the Operating Principles, and it is the responsibility of the District to allocate the District's water supply. Reclamation had offered Field Services program assistance to the District to allow the District to gain a better understanding of diversion and on-farm needs. Reclamation, as well as Colorado, were concerned that Kansas criteria for a model to study the effects of winter storage of direct delivery flows went too far in proposing to study effects to the State line and that there was insufficient data to construct a model that would satisfy Kansas' requirements. Language for a permanent stock water amendment was still being reviewed by the parties, but Reclamation supported the adoption of the District's proposed language.

Reclamation held another technical meeting on the Operating Principles on October 19, 1999, to review and address the action items from the December 30, 1998, letter. Some progress was made on language for a stock water amendment. The District agreed that it should develop an AVS and noted that it was still tabulating the irrigable acres. Kansas continued to express concerns about having an AVS in place prior to agreeing to other amendments. There was still lack of agreement on how to address temporary storage and release floodflows and

storage of winter water. In November 1999, the District again asked that a permanent stock water amendment be considered and adopted at the December 1999 ARCA meeting. Despite the progress made on language for this amendment, ARCA did not adopt any amendments to the Operating Principles in 1999 or 2000.

In 2000, Reclamation proceeded to work on a pilot AVS to present to the District. Reclamation made a presentation of the pilot AVS, and the District began developing their own system that would meet Reclamation's and Kansas' criteria. The District presented an initial version of their AVS to Reclamation on July 18, 2001. Reclamation entered into an agreement September 18, 2001, to provide the District with \$13,500.00 over 2 years towards funding the development of an AVS.

D. 2001 Temporary Amendment

In 2000 and 2001, the District made considerable progress on correcting the lists of irrigable acres and direct flow water rights in the Operating Principles. On May 9, 2001, it sent a letter to the ARCA chairman, requesting that amendments for stock watering and cleanup of the lists be put on the agenda for approval at the 2001 ARCA meeting. Kansas felt it was premature to adopt permanent amendments to the Operating Principles until the AVS had been developed and the lists of acres and rights had been reconciled. Kansas did support, and ARCA adopted, a temporary amendment to the stock watering provision similar to the temporary amendment approved in December 1998, with minor clarifications. As part of the agreement to provide the stock water amendment, a temporary amendment was also approved requiring the District to implement procedures to verify that no more than 19,717 acres would be irrigated in 2002. Both amendments were only for the 2001 and 2002 calendar years.

E. 2002 Temporary Amendment

Resolution was reached on the irrigable acres and water rights listing, and, in October 2002, the District requested that amendments correcting the lists and providing for permanent stock watering be considered at the ARCA meeting that year. The Model Land & Irrigation Company also submitted amended Operating Principle language providing for the transfer of some of its rights to Colorado State parks. Due to scheduling conflicts with the *Kansas vs. Colorado* litigation, ARCA was not able to complete its regularly scheduled business at the December 2002 meeting. The parties were, however, able to adopt another temporary 1-year stock watering and acreage verification amendment similar to the previous temporary amendments. ARCA scheduled a special meeting for May 22-23, 2003, to complete business and consider amendments to adopt the corrected water rights and acreage listings submitted by the District in its letter of May 9, 2001.

F. 2004 Amendment

At the May 22-23, 2003, meeting, ARCA considered amendments to the Operating Principles addressing acreage verification, tabulation of project water rights, tabulation and limitation of irrigated acres, Model Land & Irrigation Co. to State parks water rights changes, and stock watering. Kansas and Colorado both wanted more time to consider two alternatives for the stock watering amendment and to defer voting until the December meeting. The District was not willing to support the adoption of the amendments with Kansas' version of stock watering. ARCA voted to approve all the amendments, except the stock water amendment, deferring it to the December 2003 meeting. This amendment addressed the 1996 10-Year Review recommendations D and E.

In July 2003, Reclamation, with the Corps as a cooperating agency, initiated a National Environmental Policy Act (NEPA) compliance review of the proposed Operating Principles and Operating Criteria amendments. The proposed changes that were considered included: providing for the City of Trinidad's use of a portion of the irrigation capacity for M&I purposes, allowing Colorado State parks to utilize 700 acre-feet of the irrigation capacity, and allowing more effective stock watering practices. The review resulted in an Environmental Assessment (EA) of the proposed changes. The analysis for the EA was concluded in November 2004 and resulted in a Finding of No Significant Impacts (FONSI) associated with adopting the proposed actions. This EA and FONSI are contained in Appendix O.

At the December 2003 meeting, ARCA acknowledged the amendments passed at the previous May meeting and approved an amendment for stock watering. While the language of the amendments was approved by ARCA, it was recognized that there was considerable cleanup of the formats, order of items, and general editing that needed to be done prior to all parties adopting the Operating Principles.

Reclamation completed the cleanup of the Operating Principles and sent them, along with a copy of the final EA, to the signatory parties on November 12, 2004. The cleaned up version included previously discussed corrections to the lists of water rights, acreages, permanent stock water and acreage verification, and Model Land & Irrigation Co. to State parks water rights changes. This version of the Operating Principles was relabeled as "amended 2004." The 2004 Amended Operating Principles were signed by all the parties prior to the December 14, 2004, ARCA meeting. Signed copies were distributed to the parties on December 22, 2004.

There have been no further amendments to the Operating Principles prior to this writing. Copies of the various Operating Principle versions and amendments can be found in Appendix A of this report. A copy of the current Operating Criteria is provided in Appendix B.

III. 1995-2004 Hydrology and Operations Review

Inflow to Trinidad Reservoir is measured at the Purgatoire at Madrid, Colorado, gage operated by USGS. Figure 1 illustrates the record of inflow throughout the period of review. This 10-year period included significant variability. Noteworthy events included a daily average inflow of 1,260 cfs, which occurred on May 3, 1999 (and corresponded with a period of significant storage to be discussed later), and the peak daily average inflow for the period of 1,490 cfs, which occurred on August 4, 2004 (and was associated with flood control operations, also discussed later). Figure 1 also shows the period of extreme drought which began in 2001 and continued into 2003. This drought resulted in the minimum daily average inflow for the 10-year period of only 1.4 cfs, which occurred on September 7, 2002.

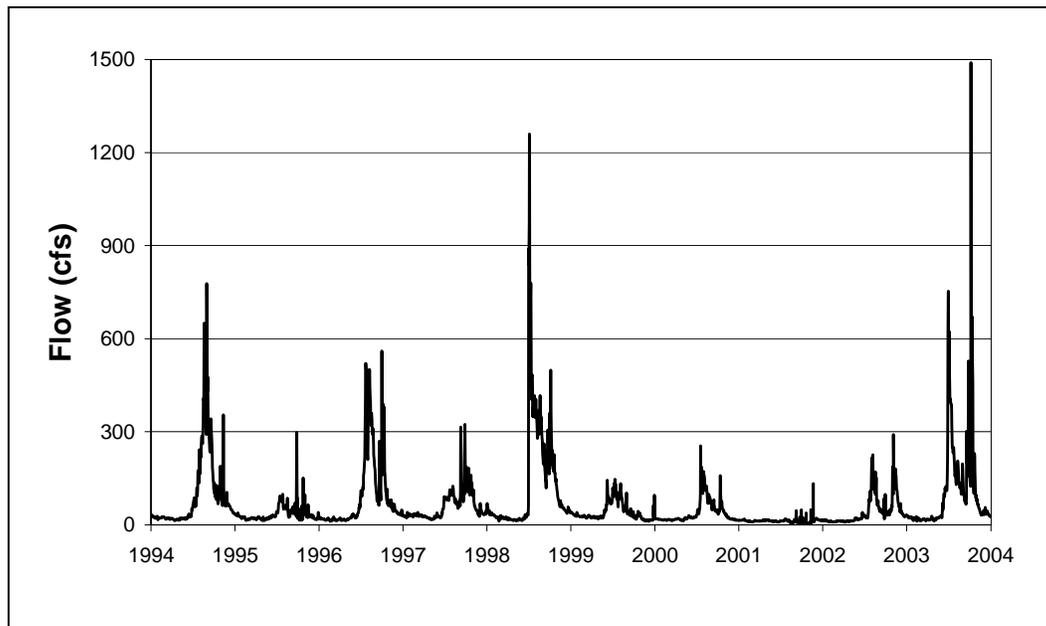


Figure 1. USGS Purgatoire River at Madrid flow.

Figures 2 and 3 reflect the elevation and storage, respectively, of Trinidad Reservoir during the review period. It is noteworthy that the maximum recorded surface elevation for this review period—and also for the life of the Project to date—occurred on August 13, 1999, at 6230.31 feet. The bottom of the flood control capacity is established at reservoir elevation 6229.6 feet. At that point in time, the total quantity of water in storage was 72,600 acre-feet, as shown in Figure 3, which appears to be based upon the Trinidad Lake Elevation-Area-Capacity Table in use from 11/94-11/99. This means that less than 1,000 acre-

feet were held within the flood control capacity at any point in time following the significant storage event that began on or about May 1, 1999, and resulted in a storage increase of approximately 47,900 acre-feet. During the 2000 and 2001 irrigation seasons, significant drafts of stored water were made, which amounted to 41,600 acre-feet and 21,300 acre-feet, respectively.

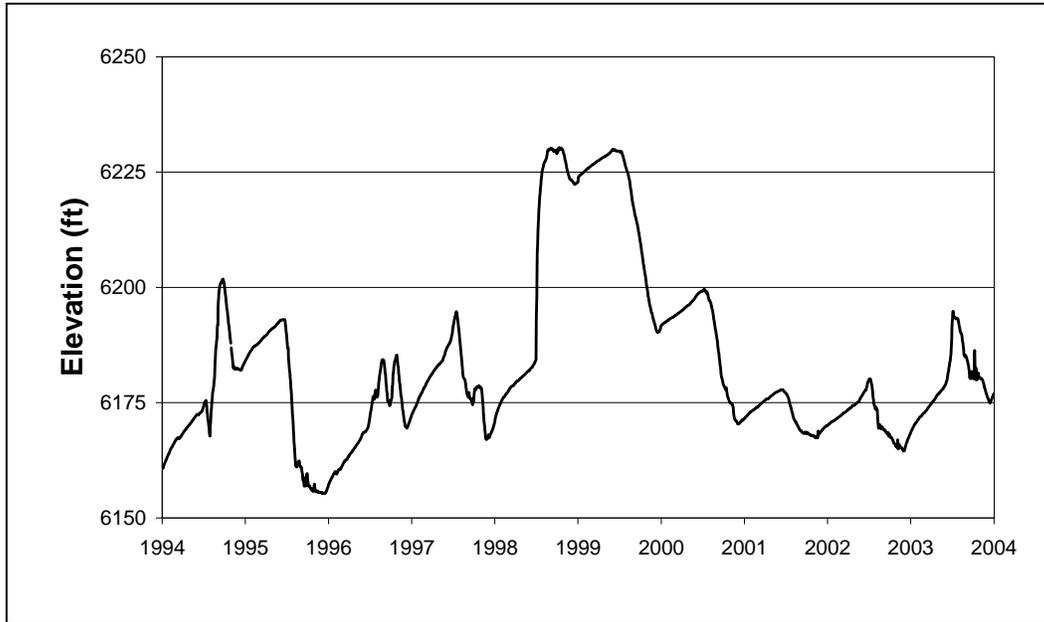


Figure 2. Trinidad Lake elevation.

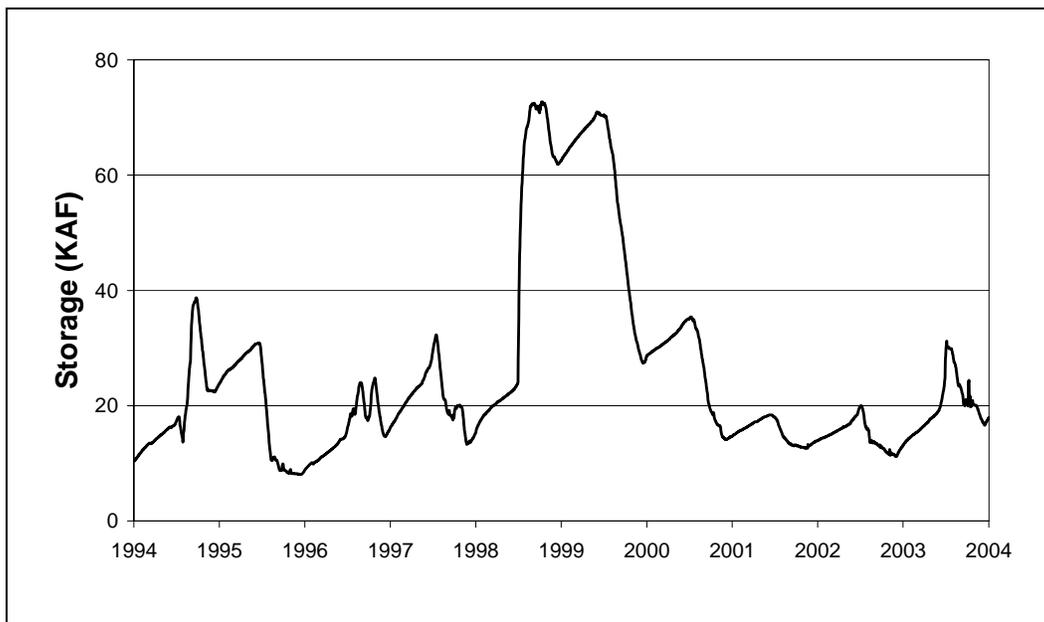


Figure 3. Trinidad Lake storage.

Releases of stored water and bypasses of inflow are measured by the Purgatoire River below the Trinidad Lake, Colorado, gage. Flows at this location are depicted in Figure 4. This graphic reflects the occasional peak releases which correspond to flood control operations discussed elsewhere in this report, as well as the characteristic pattern of releases and bypasses necessary to meet downstream irrigation requirements. The record of flow at this site also reveals the lack of water available during the worst period of drought in 2002.

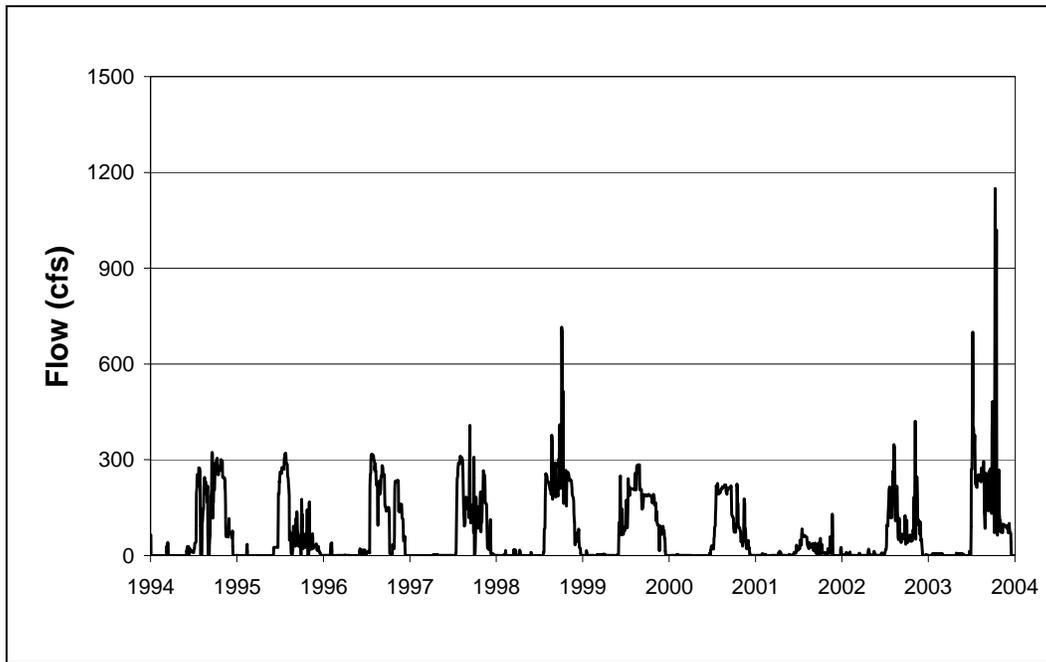


Figure 4. Purgatoire River below Trinidad Lake flow.

The Purgatoire River near the Thatcher, Colorado, gage is located well below the Project service area. The record for this gage over the review period is provided as Figure 5. It captures flows that result from all return flows from the irrigation of project lands, water bypassed through the project area to supply downstream water rights, water released in connection with flood control operations, and, in addition, runoff from precipitation that occurs in areas outside of the Project area and upstream of the gage location.

During this review period, the District's official records of irrigated acreage were tracked from declarations of intended irrigation from the various canal companies. Table 1 summarizes the declared irrigated acres for the period 1995-2004, as well as actual irrigation water delivered. Appendix M contains more detailed records from each of the canal companies. The significant drought years of 2002 and 2003 are very apparent.

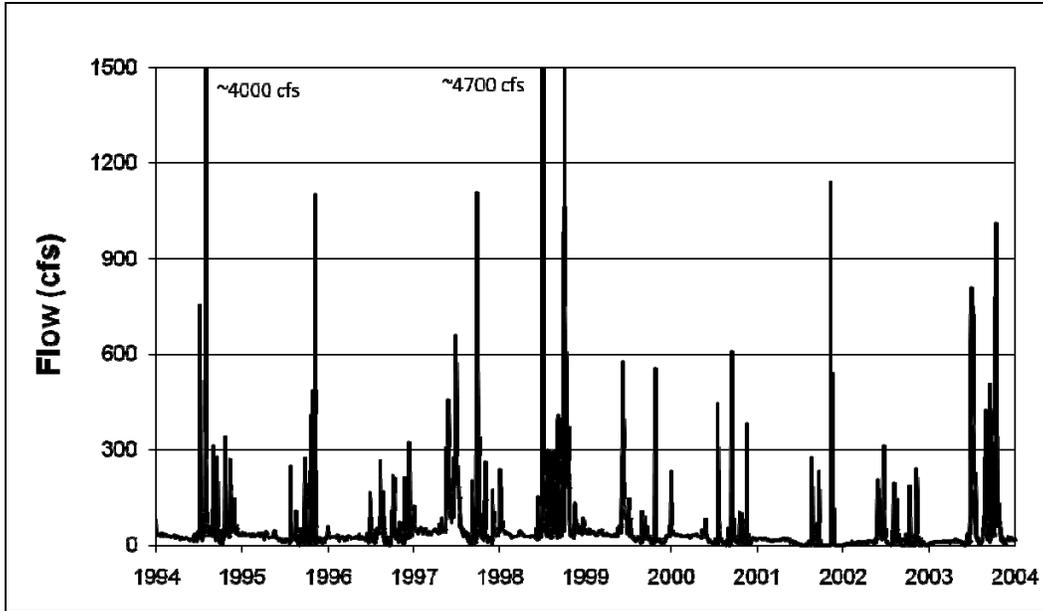


Figure 5. Purgatoire River near Thatcher flow.

Table 1. PRWCD declared irrigation

Year	Irrigated acres intended	Usage (acre-feet)
1995	17,543	58,911
1996	17,543	41,883
1997	17,543	51,745
1998	17,543	45,446
1999	17,543	46,744
2000	17,543	59,696
2001	17,543	40,746
2002	17,543	5,522
2003	17,543	26,603
2004	17,543	43,596

The other significant operation of the reservoir during this period involves the maintenance and enlargement of the permanent fish pool. Table 2 is a summary of the accounting of fish pool filling and maintenance, while Appendix J contains the detailed daily accounting. These data were reported by Division 2, Colorado State Engineer's Office. The Division reported that the daily accounting data for January 1, 2003, to June 5, 2003, have been corrupted; therefore, the ending content from 2002 is also reported as the beginning content of 2003. The daily content in Appendix J also contains the corrupted data for the first 6 months of 2003.

Table 2. Trinidad Lake permanent fishery and recreation pool accounting (acre-feet)

Year	Begin content	End content	Transfers	Inflow	Evaporation	Outflow
1995	4,500	4,500	211	141	352	0
1996	4,500	4,500	349	141	495	0
1997	4,500	10,007	475	5,580	549	0
1998	9,983	11,795	37	2,734	959	0
1999	11,800	15,812	1,562	3,277	822	0
2000	15,812	14,870	0	136	1,078	0
2001	14,870	13,659	0	144	1,355	0
2002	13,659	11,997	0	141	1,804	0
2003	11,997	10,753	121	25	1,496	0
2004	10,753	10,103	132	0	782	0

IV. Review of Operating Principles

Reclamation initiated the 10-Year Review process by sending a letter to the signatories and the State of Colorado on March 3, 2005. Pursuant to the charge in the Operating Principles, the letter stated the objectives of the 10-Year Review as two-fold:

- (1) To help obtain optimum beneficial use of the water supply as conditions change, experience is gained, and more technical data become available (Operating Principles, Article VI); and
- (2) To determine the effect, if any, that the Project operations have had on other Colorado and Kansas water users pursuant to Kansas Condition 4.

The letter requested that recipients submit any issues or comments that their organizations would like to have addressed in the 10-Year Review by April 15, 2005. The State of Kansas and the Colorado State Engineer provided such letters within the specified time period. On October 5, 2005, Purgatoire River Water Conservancy District submitted a letter with its request for issues to be considered for the 10-Year Review. These letters are presented in Appendix C. Reclamation held an informational and scoping meeting in Trinidad on October 5, 2005, to present the issues identified to concerned parties and to solicit additional comments. This meeting included a tour of the project area and presentations by the States of Colorado and Kansas on their issues.

On January 25, 2006, Reclamation held a conference call with Kansas to gain a better understanding of its request, to set up a technical meeting to review issues to be considered, and to review the approach. Kansas again noted that it would like to see impacts of recent changes analyzed. While Reclamation recognized this concern, it noted that changes, such as the stock water and acreage verification, are so recent, very little operating experience or adequate data exist to analyze the impacts.

Kansas also expressed concerns that it had not received data on how recent changes to the Operating Principles were being conducted, including: accounting, drying up of irrigated land, and stock watering. It reiterated its concern that impacts be modeled with and without the Project. It also suggested that this review should make recommendations as to what is needed to conduct this modeling in terms of gages, data, and type of model. It also suggested that the review go over what has been accomplished to date, in terms of real-time data, to allow evaluation of the ideal headgate requirement and what next steps might be taken. In response to Kansas' concern about flood operations, Reclamation suggested that it would be more appropriate to have this concern handled by the Corps outside the 10-Year Review process. Kansas also sought clarification of

the winter water storage proposal and status of other reservoirs in the Project area, including Model Reservoir, for which a recent change had been filed in water court.

On January 31, 2006, Reclamation held a conference call with the State of Colorado to clarify issues it raised in an April 15, 2005, letter. Colorado acknowledged that it appeared that the Luning Arroyo gage, Von Bremmer Arroyo gage, and Thatcher gage issue was already being dealt with, as Reclamation and the Corps agreed to cost-share funding of these gages. Colorado urged that the review stay focused and expressed concern that sufficient data did not exist for an analysis beyond what was performed in 1988 and 1996.

On February 21, 2006, Reclamation held a conference call with Julianne Woldridge, representing the District, to seek clarification of the District's proposed issues to review.

On February 22, 2006, Reclamation held a technical meeting amongst the parties in Denver to discuss the review process, present a table of proposed issues parties had requested be considered, prioritize data collection, and review potential modeling. Representatives of Colorado, Kansas, the District, the City of Trinidad, the U.S. Army Corps of Engineers, and the Nature Conservancy attended. Seventeen issues identified by the parties were included in the table with identification of similar issues and clarifying comments. Discussions centered on what the parties were really looking for in raising an issue, issue status, and the appropriateness of considering the issue in this Review.

Reclamation revised the table of potential issues based upon written comments and those received at the February 22 meeting and issued a letter on April 27, 2006, with a list of issues that would be considered under this review (see Appendix D). David Barfield, with the State of Kansas, provided e-mail comments to the issues on the list. A copy of this e-mail can also be found in Appendix D.

During June 2006, Reclamation had its Technical Service Center (TSC) begin reviewing the 1964 and 1988 model analyses to determine model adequacy and what would be necessary to re-create the 1964 model using a modern computer software program. A series of technical meetings was held to discuss findings and an approach to updating the models. The first meeting was held on February 6, 2007, at the TSC, with Jeris Danielson and TSC staff. A second technical meeting with interested parties was held on February 14, 2007, to review past modeling and a proposed modeling approach. A final meeting to agree on modeling approach was held April 17, 2007, at the TSC. On July 10, 2007, Reclamation held a meeting to discuss progress on water measurement and gaging issues, acreage verification, and to present preliminary results of the modeling.

Based upon comments at the July 10th meeting, further revisions were made to the model, and a final meeting to present modeling results occurred on September 19, 2007.

A meeting to discuss the March 2009 Draft 10-Year Review document was held in Trinidad, Colorado, on April 24, 2009. Aside from the comments that were later communicated in writing prior to June 1, 2009, the group expressed an interest in having meetings and discussing issues more often than the 10-Year Review process allows. This desire will be addressed in the Recommendations of this Review. The comments received on the March 2009 draft 10-Year Review are available in Appendix E.

A. Issues Addressed in this 1995-2004 10-Year Review

Reclamation reviewed the issues submitted by the parties and assembled the Preliminary List of Issues, Appendix D. From this list, Reclamation identified issues that were appropriate to address in the 10-Year Review. By letter of April 27, 2006, Reclamation provided the parties with a list of issues that would be considered. The items identified in the April 27 letter and addressed in this review are presented below:

1. Water Measurement and Gaging

a. USGS Canal Loss Report

Recommendation G of the 1996 10-Year Review of Operating Principles stated that the District should determine the losses of each of the individual ditch systems for allocation of the District water supply. In consultation with Colorado Water Conservation Board (CWCB) and Reclamation, the District agreed to have a canal loss study conducted. Reclamation entered into a 3-year cooperative agreement in September 1999 to assist the District with funding the study. During June 2000, the District contracted with the USGS to conduct a study of losses and gains along selected canals included in the District. USGS originally estimated the cost of the canal loss study to be \$171,000.00. Per the agreement with the District, Reclamation provided a total of \$91,275.00. The CWCB also provided \$39,000.00, and USGS provided \$26,000.00 to fund the study.

USGS staff conducted field studies between July 2000 and June 2004. Due to the severe drought of 2002, no data was collected for that year. Results of the study indicated significant losses and gains in specific canal reaches and dependence upon time of canal wetting. USGS published their findings in a report entitled *Losses and Gains for Eight Unlined Canals Along the Purgatoire River near Trinidad, Colorado, 2000-2004* (Scientific Investigations Report 2006-5164, U.S. Department of the Interior, U.S. Geological Survey). A copy of this study is contained in Appendix N.

One of the major findings of the Canal Loss Study was that the gages on the various ditch diversion structures were underreporting diversions due to gage configuration, maintenance, or calibration issues. In an effort to improve water management, administration, and data collection for future Project reviews, the District, the State of Colorado, and Reclamation worked together to upgrade the diversion gages. The District worked with ditch companies to improve diversions and erect enclosures for new instrumentation. Reclamation provided \$36,000.00 through a Water Conservation Field Services Program grant for the District to purchase six satellite monitoring stations that could collect and transmit real-time data on ditch diversions. The District provided matching commitment to Reclamation's grant for installation and annual operation and maintenance (O&M) of the stations. The State of Colorado, Division of Water Resources (CDWR) provided staff for installation and calibration of the stations. The stations were installed in fall 2007 and were operational and providing data as of November 2007. Real-time diversion data is currently available on the District's Web site (www.prwcd.org) or the State's Web site (www.dwr.state.co.us/SurfaceWater/default.aspx) for the following six gages: Chilili (CILDITCO), Enlarged South Side (SOUDITCO), Hohne (HOEDITCO), John Flood (JOHDITCO), Model Ditch (MODCANCO) and Picketwire (PIKDITCO). A copy of Reclamation's grant agreement for Installation, Operation and Maintenance of Satellite Ditch Monitoring Stations is included in Appendix H. With the improved gaging and data on canal losses, the District is improving delivery of the District water supply in accordance with the Operating Principles and Recommendations F and G of the 1996 10-Year Review.

b. *Documentation of Historic Gages for the Project*

One of the concerns that has been expressed in past 10-Year Reviews was the availability of data to model and review Project operations. Confusion existed among signatory parties as to which gages exist and are currently in service and which data would allow future modeling and analysis. At the February 14, 2006, general technical meeting, Reclamation agreed to compile a preliminary list for parties to review and to convene an ad-hoc technical team to review and analyze the value of the gages. In the April 27, 2006, letter, Reclamation committed to convening an ad-hoc technical team to examine which gages were needed for the Project. During the July 10, 2007, 10-Year Review meeting at the TSC, Reclamation presented a preliminary list of gages in the Purgatoire River basin. Representatives of the parties agreed to participate in the ad-hoc technical team. Entities represented included the Purgatoire River Water Conservancy District, the States of Kansas and Colorado, the Corps, and Reclamation. Reclamation assembled a table of gages, the period of record for each gage, and a location map. An ad-hoc technical team meeting occurred on August 30, 2007, via conference call. The team then determined which gages on the list were important or not for evaluation of Project operations. Appendix F presents the table of gages and a discussion of their importance to evaluation of operations.

c. Cost Sharing of Thatcher Gage O&M by the Corps and Reclamation

Reclamation has an ongoing Cooperative Stream Gaging Program with the USGS to cover costs of gages related to Reclamation Projects administered by the Great Plains Region. The program is renewed annually and includes gages related to projects administered by the Eastern Colorado Area Office. For fiscal year 2008, the Thatcher gage was added to the list of gages for which Reclamation provides funding under the agreement. Reclamation committed to fund 50 percent of the gage O&M costs for a total of \$7,250.00 for 2008.

d. Gages Needed for the Project

An ad-hoc team was convened, and a list of gages in the Purgatoire River Basin was assembled. Gages were identified in the documentation in Appendix F as pertaining to the Project operations. It was determined that in order to better administer Project diversions and provide more accurate data for future analyses of Project operations, improvement of the gaging at the ditch diversion structures was necessary. In response to this, the District, the State of Colorado, and Reclamation worked to improve these gages as presented in the following section.

Reclamation has also concluded, as part of this effort, that the Trinidad gage and the Thatcher gage are sufficient to analyze the effect of Project operations on downstream users. The Model transfer decree had provided that three gages would be used to analyze the effect of Project operations on downstream users. The decree erroneously identified three sites. Two of the sites appeared to be the same site, which is now the site of the Thatcher gage. The third site misidentified Luning Arroyo as Leitensdorfer Arroyo. As a result of investigations and consultations during the 1988 Review, it was decided that existing gages at Thatcher, Luning Arroyo, and Van Bremer Arroyo would address the needs of the decree. A more detailed discussion is presented in the 1988 Review at Section IV.I.

The Model transfer decree provides that the State of Colorado shall regulate the storage in Trinidad Reservoir so that the volume in the Purgatoire River occurring at the site of the Thatcher gage will remain the same during any 10-year consecutive period as it would have been had the Model right not been transferred. The effects of the Project are evaluated by requiring that the flows at the Thatcher gage not be diminished by Project operations. Reclamation conducted a double mass analysis comparing pre- and post-Project flows at the Trinidad gage and the Thatcher gage during the 1996 10-Year Review. Reclamation determined that no material depletion in streamflow occurred from the pre-Project period to the November 1984 through October 1994, 10-Year Review period. In fact, there was a return flow benefit by the Project operations.

The double mass analysis was extended to cover the November 1994 through October 2004 period covered by this 10-Year Review. The cumulative flow of the Purgatoire River at the Thatcher gage was 71.36 percent of the cumulative flow of the Purgatoire River at the Trinidad gage during the pre-Project period.

The cumulative flow of the Purgatoire River at the Thatcher gage was 71.12 percent of the cumulative flow of the Purgatoire River at the Trinidad gage during the period covered by the November 1994 through October 2004 10-Year Review period (see Table 3).

Table 3. Streamflow of the Thatcher gage as a percentage of the Trinidad gage, 10-year periods

10-year Period	Cumulative Thatcher flows for period (acre-feet)	Cumulative Trinidad flows for period (acre-feet)	Thatcher flows as percent of Trinidad flows
November 1966 – October 1976	274,643	384,866	71.36
November 1984 – October 1994	438,106	589,677	74.29
November 1994 – October 2004	364,431	512,445	71.12

November 1984 – October 2004 water year statistics for moving 10-year periods (11 periods in all)	Average	72.74
	Median	73.85
	Minimum	65.12
	Maximum	76.98
	Standard deviation	3.84

Further review of the gaging station records for the past 20 years, November 1984 through October 2004, shows that, on the average, cumulative flow at the Thatcher gage is 72.74 percent of the flow at the Trinidad gage. The minimum percentage is 65.12, and the maximum percentage is 76.98. It is unknown how the flows of the Thatcher gage compared with the Trinidad gage prior to 1967. Appendix G contains a detailed double mass analysis.

Also included in Appendix G are charts showing the cumulative flows for the Trinidad and Thatcher gages, along with trend lines. The slopes of the trend lines for the 10-year period associated with this review, November 1994 through October 2004, and for the 20-year period of November 1984 through October 2004 are greater than the slope of the trend line for the pre-Project period, November 1966 through October 1976. The greater slope indicates that there is relatively more water at the Thatcher gage since development of the Project than during the pre-Project periods, possibly due to more return flows to the river.

The use of the double mass analysis of these two gages was, and continues to be, sufficient to evaluate the effects of the Project. The State of Kansas has continuing concerns about this mass balance approach, as further discussed in comment letters contained at the end of Appendix E.

The current gages at Luning Arroyo and Van Bremer Arroyo were not used in this analysis or in the 1996 analysis. Most of the Project return flow occurs below the Hoehne diversion, and a single, more accurate, gage on the mainstem of the Purgatoire River may provide better information from which return flows may be determined. As previously discussed, it is believed that the Luning Arroyo and Van Bremer Arroyo gages are referenced in the Model transfer decree and, hence, that any replacement or elimination of these gages may require consent of the objectors in that case. The alternative described above would eliminate the need for these two gages. The State of Colorado, Division 2 Office, has suggested that it could take the lead in establishing and maintaining a new gage that may provide for better understanding and management of the Project and contribute to more optimal beneficial use of water.

2. Acreage Verification

a. Tracking of Project Acreage

During the late 1990s, considerable concern was expressed by the State of Kansas that the District was not meeting the 1996 10-Year Review Recommendation No. 5. Recommendation No. 5 is for the District to develop a procedure to verify that no more than 19,499 acres are receiving an allocation of water and/or actually being irrigated in any year. Reclamation worked with input from the District and the State of Kansas to define criteria for an AVS. On August 7, 2000, Reclamation sent a letter to the District, providing an agreement, including the criteria, wherein Reclamation would assist with the costs for the District to develop an AVS.

The District contracted for the development of an AVS, and Reclamation agreed to provide \$7,500.00 in fiscal year (FY) 2001 to the District towards funding the development of an AVS that would meet the criteria. The agreement was extended to provide an additional \$6,000.00 in FY 2002, for a total of \$13,500.00 towards the AVS development which the District estimated would cost \$30,000.00.

On August 29, 2002, the District provided a demonstration of their AVS to Reclamation. Reclamation provided a letter to the District on September 24, 2002, with comments on improvement of the AVS but noted that it appeared to meet the criteria set out in the grant agreement. The District continued to work on the AVS and provided a demonstration to other parties at the December 2002 ARCA meeting.

In 2004, a permanent amendment to the Operating Principles was adopted to provide for acreage verification which included the AVS criteria. The language of the amendment is contained at article B.2. of the Operating Principles and reads:

The **District** shall provide notice each year, prior to June 1, to the State of Kansas, the Bureau of Reclamation and other parties making a written request, of lands expected to be irrigated. Such notice shall include a map and a tabulation of said lands, both showing tracts, their acreage and location. Any interested party may conduct field inspections related to the District irrigable area, and the District shall cooperate with the party in the conduct of such inspections.

The District shall implement substantive procedures to verify each year that not more than the District Irrigable Area, less lands removed from irrigation, are[sic] irrigated in that year. The District shall prepare a report each year including a tabulation showing tracts, acreage and location of lands irrigated in that year. The District shall provide the report to the State of Kansas, the Bureau of Reclamation and other parties making a written request, by February of the following year.

The District has been operating under this amendment since 2004. For a summary of activities related to the AVS after 2004, see the section entitled “Summary of Activities After Review Period.”

3. Documentation of Current and Historic Practices

a. Stock Water Releases

Diversion of riverflows during the nonirrigation season for the purpose of stock watering was contemplated in the original planning and analysis of the irrigation portion of the Project. Reclamation’s pre-Project analysis acknowledged that the ditches forming the District diverted an average of 1,500 acre-feet annually during the nonirrigation season. Pre-Project flow records indicate that stock water diversions occurred as part of winter irrigation diversions. Stock watering occurred at rates and times when the divertible flow in the Purgatoire River was sufficient to reach fields and stock ponds down the lengths of the canals. With the Project’s development, irrigation diversions during the nonirrigation season shifted to storage. The 1,500-acre-foot stock water allowance was addressed in the Operating Principles at IV.D.2., wherein the District was to “. . . provide an allowance for stock watering purposes of not more than a daily mean flow of five second feet or its volume equivalent . . .” The 1,500 acre-feet was later reduced to 1,200 acre-feet as a result of the Division 2 Water Court, Case No. 86CW25, where certain of the Hoehne’s rights to stock watering were terminated.

The Project began operation in 1979, with irrigation available to all Project lands by 1985. During the early years of Project operation, the District apparently released water from the reservoir during the nonirrigation season at sufficient rates to allow for stock water deliveries to flow through the canals and reach the stock ponds, while not exceeding the overall seasonal stock water volume allowance. Records of deliveries for water years 1988 through 1991 and 1993 were available and indicate that between one and six stock water deliveries were made during the nonirrigation seasons of those years at overall rates up to

approximately 80 cfs. The gross deliveries for those years varied between 387 and 980 acre-feet for the whole nonirrigation season.

In September 1993, the Colorado State Engineer concluded that stock watering was not being conducted in accordance with the 5-cfs limitation in the Operating Principles and directed the District to make future stock water releases at the 5-cfs rate. The 1996 10-Year Review of the Project recommended that the Operating Principles be modified to reduce the seasonal volume for stock watering from 1,500 to 1,200 acre-feet.

The District began pursuing amendment of the Operating Principles to allow for stock water releases in excess of 5 cfs without exceeding the 1,200-acre-foot-per-season limitation. A permanent stock water amendment was not adopted until December 2004, but in 1998, 2001 and 2002 temporary stock water amendments were approved for those nonirrigation seasons.

Concerns were raised by some of the parties to the Operating Principles about potential effects of alternative stock watering practices as compared to the practice of limiting the releases to 5 cfs. Reclamation agreed to analyze, to the degree feasible, potential effects of alternative stock watering practices as compared to the practice of limiting the stock water releases to 5 cfs. In July 2004, Reclamation produced a report on Modeling of Stock Water Alternatives and circulated it to the parties. This report was published in November 2004 as part of the *Trinidad Dam and Reservoir Project Operating Principles and Operating Criteria Amendment Final Environmental Assessment* (see Appendix O). The report concluded that there was no significant impact upon downstream water availability by the stock watering practice proposed by the District. Data from that report has been extended to document the District's stock watering practices from the 1995-1996 nonirrigation season through the 2005-2006 nonirrigation season.

Appendix I of this report shows stock watering diversions. Table J-1 provides a summary of the total volumetric diversions and maximum total daily rate of stock water diversions for participating ditches for the review period. Table J-2 provides daily stock water diversions by year.

Stock watering diversions occurred in all of the years of the review period. During the 1995-1996, 1996-1997, and 2003-2004 nonirrigation seasons, stock watering rates exceeded the 5-cfs limitation directed by the Division Engineer. In the 1997-1998, 1999-2000, and 2000-2001 nonirrigation seasons, maximum diversion rates did not (or did not significantly) exceed the 5-cfs limitation. During the remaining years, there was either a temporary or permanent amendment to the Operating Principles that allowed stock watering to occur at rates greater than 5 cfs. At no time did the seasonal diversion exceed the 1,200-acre-foot volume allowance.

b. Permanent Fishery Pool

The capacity of Trinidad Reservoir, as authorized and noted in the original Operating Principles, was 114,500 acre-feet. Of this capacity, 4,500 acre-feet was set aside for fish and wildlife purposes. A 1986 resurvey of the reservoir capacity determined that the as-built capacity was actually 125,967 acre-feet, or 11,467 acre-feet greater than originally planned. The Corps conducted NEPA compliance on a proposal to assign the additional unallocated space to the permanent fishery pool. Upon completion of the EA and FONSI in September 1994, the Corps assigned the additional capacity to the permanent fishery pool, increasing it to a total of 15,967 acre-feet. Since the permanent fishery pool was originally filled by exchange with water brought in from outside the Arkansas River basin by the Colorado Division of Wildlife, the downstream concerned parties and signatories to the Operating Principles did not object to this change. During the 1996 10-Year Review process, the parties agreed to proceed with an amendment to the Operating Principles to permit storage in the enlarged permanent fishery pool. This amendment was adopted by all the parties by May 1996 and is included in Appendix A of this report. The language of the amendment was made part of the 1997 Amended Operating Principles.

Subsequent to the 1997 amendments, the State of Colorado acquired interests in additional water to use for maintenance of the permanent fishery pool, recreation, and fish and wildlife propagation. Antonio Lopez Ditch water was converted for these purposes in Division 2 Water Court case No. 88CW062. Colorado State Parks acquired interest in some of the Model Land & Irrigation Company rights and had those rights transferred, in case No. 03CW108, to storage in the Trinidad Reservoir for maintenance of the permanent fishery pool and with a requisite dryup of certain of Model Land & Irrigation Company lands.

Accounting records for the filling of the permanent fishery and recreation pool were provided by the Division 2 Engineer's Office and are contained in Appendix J. It appears from the accounting and documentation that the permanent fishery pool has been filled in accordance with the Operating Principles.

c. City of Trinidad Use of Municipal and Industrial Water

The City of Trinidad purchased and sought to change the points of diversion and uses for certain shares of the John Flood and Model Land & Irrigation Company water rights. The changes were sought in water court in December 1988 in case No. 88CW061, Colorado Water Division 2. The court ruled in 1993 that the Operating Principles for the Project must be amended to allow the changed uses of water before the decree could be entered. As described above, the Operating Principles were amended in 1997 to allow for the changes of use sought by the City of Trinidad. A final decree was entered in June 2001, awarding the changes of use and points of diversion sought by the city.

Reclamation's contract with the District acknowledges that the City of Trinidad owns a portion of the water rights usable by the Model Land & Irrigation Company. Reclamation, working with the City of Trinidad, determined that the city began using some of its Model water beginning in 2003, with 17.1 acre-feet and 35.3 acre-feet used in 2004.

4. Modeling Review and Verification

a. Review of the 1964 and 1988 Models and Data

In order to respond to modeling concerns presented by the Parties, Reclamation undertook reviewing the previous modeling efforts and re-creating the previous models in a modern computer format. Reclamation's goal was to create a model consistent with the previous analyses in a transparent format that the Operating Principle signatories and other entities could use to conduct their own analysis. In June 2006, Reclamation had its TSC begin review of the analyses conducted for the 1964 Irrigation Report and 1988 10-Year Review of Operating Principles. TSC reviewed the earlier models to determine their adequacy and to re-create the 1964 analytical process using a Microsoft Excel spreadsheet model.

A series of technical meetings was held beginning in February 2007 and running through September 2007 to review findings and determine an approach to updating the model. A report of the modeling effort, documentation, and results is included in Appendix K. An electronic copy of the model and documentation is also included with this report and may be requested directly from Reclamation.

b. Documentation for the 1964 and 1988 Models

The 1964 report included a description of the analysis conducted and a hand calculated spreadsheet. The analysis in the 1988 report reproduced the 1964 hand spreadsheet in a FORTRAN program. Some documentation, but no computer code, was available from the 1988 analysis. As a result, it was necessary to reverse-engineer some of the logic so that the new model would allow replication of the previous modeling efforts.

As the new model was based upon the previous analyses, documentation was provided only for the new model with references to the origins of data and functions in the previous analyses. There are some minor differences from the 1964 and 1988 analyses and the new model developed under this effort. These include differences between recorded historical data and data used in the previous efforts and evaporation data. Appendix K contains these differences, how they were handled, and complete documentation of the model. The model appears to be an adequate update of the original model.

c. Review of Data Being Collected for Future Modeling

The 2007 water accounting computer model requires the following input data:

1. Trinidad Reservoir inflow
2. Late month unusable inflow
3. John Martin Reservoir spills
4. Stock water releases
5. Estimated headgate requirements
6. High inflow bypass
7. Historic Ninemile Canal diversion
8. Historic Highland Canal diversion
9. Reservoir water surface evaporation

All of this input data is either available directly or generally accepted methods of developing the data exist, except for No. 2, late month unusable inflow. This data input represents the amount of water in the river late in the month that can be stored in the reservoir but not assumed useable for diversion. Prior documentation indicates that in prior model analysis, this value was derived from daily flow data, but the criteria for developing the input data could not be identified. A method for developing the data needs to be agreed upon.

The 2007 water accounting computer model was developed based on previous models used for the Project. These previous models include a time period of 1927 through 1957. In order for a technical team, the Operating Principle signatories, or other entities to use the model, the time period needs to be updated from 1958 through the present, or some other representative hydrologic period.

d. Impacts from Storing Direct Flow During Nonirrigation Season

The model has been provided to the signatories to the Operating Principles and the parties represented on the technical team, and it is available to others as part of the publication of this Review (see Appendix K and the model spreadsheet contained on the attached CD). A large part of the intent to update the model and provide it to the parties was to enable them to conduct their own analysis of issues that concern them using a model that is generally available and acceptable. For example, the parties may use the model to analyze the impact of storing direct flows in the irrigation capacity during the nonirrigation season. This and other issues that may be addressed with the model will require further input and consensus from the modeling group.

5. Flood Control Operations of Trinidad Dam and Reservoir

a. Flood Control Operations

Flood operations are to be conducted in accordance with regulations prescribed by the Secretary of the Army and as listed in Article III of the Operating Principles. Flood waters are to be retained to prevent the flows from exceeding, insofar as

possible, the nondamaging flow below the dam. The original Operating Principles identified the nondamaging flow as 5,000 cfs. In 1992, the Corps completed an analysis of the river channel below Trinidad Dam and concluded that the existing channel capacity was then 3,000 cfs. On April 16, 1993, the Corps sent a letter to the Colorado Division 2 Engineer, presenting the finding and stating that any releases in excess of 3,000 cfs should only be made in consultation with the Corps.

The Division Engineer subsequently modified his criteria for temporary detention of floodflows and subsequent release. A copy of the modified criteria was provided by letter of December 2, 1998, to Reclamation and other interested parties. The Corps acknowledged the modified criteria and suggested a minor change to them in a February 10, 1999, letter to Reclamation, with a copy to the State of Colorado. The Colorado State Engineer adopted the Corps' suggestions and reissued the criteria by letter of December 3, 1999, to the signatories of the Operating Principles.

The reduction of the flood release caused concern among downstream Colorado water users and Kansas. The concern was that reduced flood release might result in greater evaporative and channel loss of the waters released than would have occurred if higher flood releases had been made. While this issue was not directly addressed in the 1996 10-Year Review, it has been an increasing concern during the current review period, as there has been significant vegetative encroachment in the river channel in the last 10 years. In 2004, there were two flood water retention and release events at Trinidad Dam. On May 5, a release of 1,051 cfs was recorded, and on August 12, a release of 1,260 cfs was recorded. The Division 2 Engineer's Office received reports of flood damage concerns at these release rates. As a result, there is currently concern that the nondamaging channel capacity below the dam is less than 3,000 cfs.

During the 2004 events, the Corps noted that the outlet works gage immediately downstream of the dam appeared to become unreliable at flows in excess of 1,000 cfs. As a result, the Corps did not release inflows at the rate requested by the Colorado State Engineer under Article III, paragraph 3, of the Operating Principles due to the August 5, 2004 storm event. The Corps acknowledged by letter dated November 1, 2004, that the Division 2 Water Commissioner had requested the release to be increased to 1,500 cfs and that his request was not accommodated due to the outlet works gage malfunction. The Corps worked with the USGS in spring 2005 to establish a secondary gage site below the outlet works gage. This gage will be used to measure releases in excess of 800 cfs. The USGS frequently monitors both gages to gather measurements to calibrate the secondary gage.

Appendix L includes copies of the following letters from the Corps and the State of Colorado establishing the nondamaging flows and Operating Criteria for flood retention and release.

- (1) April 16, 1993, letter from U.S. Army Corps of Engineers to Steve Witte, Division 2 Engineer, indicating existing channel capacity below Trinidad Dam of 3,000 cfs.
- (2) December 2, 1998, letter from Steve Witte, Division 2 Engineer to A. Jack Garner, Reclamation, providing “Criteria for Temporary Detention and Subsequent Release of Flood Flows Stored in the Trinidad Reservoir Conservation Pool”
- (3) February 10, 1999, letter from U.S. Army Corps of Engineers to Jack Garner, Reclamation, clarifying “Criteria”
- (4) December 3, 1999, letter from Hal Simpson, Colorado State Engineer, to A. Jack Garner, Reclamation et. al., providing revised “Criteria for Temporary Detention and Subsequent Release of Flood Flows Stored in the Trinidad Reservoir Conservation Pool”
- (5) November 1, 2004, letter from U.S. Army Corps of Engineers to Steve Witte, Division 2 Engineer, discussing gage performance and outlet control issues during the August 2004 storm event.

b. Corps’ Letter Documenting Current Maximum Nondamaging Flow Capacity

The Corps agreed to conduct a channel capacity study beginning in 2007 and provided \$100,000.00 towards the study. Reclamation also entered into an agreement in September 2007 to provide \$15,000.00 to the Corps to assist in conducting a channel capacity study. The study is ongoing as of this writing. Upon completion of the channel capacity study, the Corps will designate a revised nondamaging flow for the channel below Trinidad Dam.

V. Other Issues

A. Documentation of Operating Principles Amendments

Reclamation also noted in the Preliminary List of Issues for the 2006 Review of Operating Principles, at item 13, that it would maintain a record of changes to the Operating Principles and amendments that occur in the future. All versions of the Operating Principles and amendments during this 10-year review period are included in Appendix A of this report, in reverse chronological order. The current version of the Operating Principles is dated 2004.

B. Development of Real-Time Irrigation Requirements

While the 1996 10-Year Review recommended that the District work towards development and application of a real-time irrigation requirement, several parties have questioned the utility of this development. This issue appears to warrant a meeting of interested parties to discuss the expectations and cost/benefits involved in this development. The USGS canal loss study found great variability in the efficiencies of the canals. Since the canals are owned by other entities, the District can only encourage these canal companies to improve their efficiency.

VI. Conclusions

A. Water Measurement and Gaging

Utilization of the Trinidad and Thatcher gages is sufficient to analyze the effects of the Project operations on downstream users. The double mass balance analysis of the two gages shows that a slightly higher percentage of flow from the Trinidad gage reaches the Thatcher gage since the project became operational. The administration of the Project and measurement of Project return flows would be better accomplished by replacing the current Luning Arroyo and Van Bremer Arroyo gages with a single gage on the Purgatoire mainstem in an appropriate location to analyze project return flows. This effort will require concurrence of the parties involved in the Model water right transfer case.

B. Acreage Verification

The District has established an AVS. The District improved the AVS, both in terms of accuracy and timeliness of submission. The District and the State of Colorado have standardized the District's mapping data into the State's basinwide system.

C. Stock Watering

The District did significantly exceed the 5-cfs diversion for stock watering in 3 of the 11 years that were evaluated during this review. During an additional 5 of those 11 years, there were temporary or permanent amendments to the Operating Principles allowing in excess of 5 cfs to be diverted for stock watering. At no time, however, did the stock watering exceed the seasonal volume allowance of 1,200 acre-feet. The Operating Principles were permanently amended in 2004 to allow up to 1,200 acre-feet of stock water releases to be made during the nonirrigation season at a release rate under the discretion of the District. Records since the 2004 amendment indicate that the District is conducting stock watering in accordance with the amended Operating Principles.

D. City of Trinidad Use of Municipal and Industrial Water

The City of Trinidad is using their water rights in accordance with the Operating Principles.

E. Modeling

Reclamation has documented and re-created the original model. The model was previously distributed to the parties. The model and model documentation are also provided in this 10-Year Review. The model data needs include “late month unusable inflow,” which does not have clear criteria for development. The model also only covers the period 1927-1957. There are several investigations that require an updated and extended model, including winter storage, detailed project impact analyses, and flood control.

F. Flood Control

Uncertainty currently exists regarding the nondamaging flow rate below Trinidad Dam. The Operating Principles still list the estimated nondamaging flow to be 5,000 cfs. Upon recommendation by the Corps, the State of Colorado has established modified release criteria whereby releases may be made by the State up to 3,000 cfs but not above 3,000 cfs, except in consultation with the Corps. The 5,000 cfs listed in the Operating Principles may not reflect a nondamaging flow given the current condition of the river channel. The Corps, the State of Colorado, and Reclamation are currently conducting a study to determine an appropriate nondamaging flow.

G. Determination of the Irrigation Requirement

Through the canal loss study and the improvements in gaging, the District has acquired better knowledge of the irrigation requirement. Findings from the canal loss study show a marked variability in canal losses and efficiencies. Several parties have questioned the benefits, utility, and cost effectiveness of the development of a real-time irrigation requirement.

VII. Recommendations

A. Water Measurement and Gaging

Replace the Luning Arroyo and Van Bremer Arroyo gages with a single mainstem gage at a site identified by the State of Colorado Division 2 Office. This will allow better understanding of Project return flows and assist the District to more optimally use Project water.

B. Acreage Verification

The District and the State of Colorado should use the standardized AVS to improve the ability of the District to report on irrigated acreage and to increase confidence of other signatory parties in the District's operations.

C. Modeling

A technical team should be convened to develop and agree upon a method for determining the water accounting model input data for "late month unusable inflow." Additionally, the technical team should update the period of study to include a time period of 1958 through the present, or some other representative hydrologic period. The technical team should jointly determine model requirements and design effective modeling studies to answer any outstanding modeling questions.

D. Flood Control

The 5,000 cfs listed in the Operating Principles may not reflect a nondamaging flow given the current condition of the river channel. The parties should continue funding the channel capacity study to determine a nondamaging flow rate that reflects the current condition of the channel. Upon determination of the appropriate rate, Flood Operating Criteria and the Operating Principles should be modified to reflect any adjustment in the rate. Channel maintenance and/or restoration issues should also be addressed.

E. Determination of the Irrigation Requirement

The District should use the results provided by the USGS canal loss study and the improved canal diversion gage data to improve determination of irrigation requirements. The District should also encourage canal improvements by the member canal companies to reduce seepage in high loss segments. Interested

parties should meet and discuss the expectations and resulting operational benefits from development of a real-time irrigation requirement.

F. Additional Review Process

This 10-Year Review was published significantly after the close of the review period. A process for more timely and current discussion and resolution of issues should be created. This process should occur approximately annually. Discussion of issues, conclusions, and recommendations created by this process would then be summarized in the following 10-Year Review document.

References

Trinidad Lake Project, Colorado, Review of Operating Principles and Project Operations, Final Report, December 1996, U.S. Department of the Interior, Bureau of Reclamation

