ARKANSAS RIVER COMPACT ADMINISTRATION

COMPACT YEAR 1999

ANNUAL MEETING

TUESDAY, DECEMBER 7, 1999

9:00 A.M. (CST)

HELD AT THE

PLAZA INN

GARDEN CITY, KANSAS

Reported By:

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Approved by motion of the Arkansas River Compact Administration on December 09, 2020, at its Annual Meeting held virtually.

James R. Rizzuto   12/9/20

James Rizzuto, Chairman   Date

1 of 4 originals   Exhibit______

APPEARANCES

Outgoing Chairman: Larry Trujillo

New Chairman: Aurelio Sisneros

Appearing for Colorado:

Mr. Tom Pointon

Mr. James Rogers

Mr. Peter Evans

Mr. Steve Miller

Ms. Wendy Weiss

Mr. David Robbins

Mr. Hal Simpson

Appearing for Kansas:

Mr. David L. Pope

Mr. John Draper

Mr. Dale Book

Mr. Leland Rolfs

Mr. Randy Hayzlett

Mr. David Brenn

Mr. Greg Sullivan

Mr. Mark Rude

Mr. David Barfield

Mr. Don Pitts

MR. LARRY TRUJILLO: At this point, the Arkansas River Compact meeting of 1999, being held at Garden City, Kansas, comes to order.

First order of business is, we have a new Chairman that has been appointed by President Clinton, to represent the U.S.A. on the commission as a non-voting member and Chairman of the Administration. I continue to call it commission, I guess I just never got rid of that dirty habit. We have not received, for the record, we have not received the letter signed by the President. I called the White House last week, talked to staff there, and staff has asked me to rely on the news release that they had made and that the letter is in process, whatever process they go through in the White House to get the President to sign the letter. Anyway, the news release is here in my...has been made available to me. President Clinton names Aurelio Sisneros as Federal Representative and Chair of the Arkansas River Compact commission, Colorado and Kansas. This will be given to you for the record, and I would like copies made for each of the delegations. So, effective now, Mr. Sisneros is your Chairman. I would like, if it's okay with you, Mr. Chairman, to make a few remarks before I leave here to go back to Colorado.

First, I want to thank both members of the commission, State of Kansas and Colorado, for all of the cooperation I've had from them and the diligent work they've performed in the last four or five years that I've been Chairman. It's been a pleasure, certainly to serve the people of the U.S.A. and in particular, people in both of the States, in this capacity. And, if I may be so bold, I would like to make a couple of statements to the advice of Mr. Evans and Mr. Pope, and I guess advice which is worth what you pay for it, and since you are not paying for this you probably won't pay much attention to it, but nevertheless, I think it's important, that is, to me, that I say and express a few of my feelings.

First, to you, Mr. Chairman, I think it's, I commend you for being appointed, and I think if you read the federal statutes along with the state statutes, the Chairman's position here is that of a catalyst. You don't have a vote, but it's extremely important that you serve as a catalyst to continue to have both of these sides looking toward a goal, and working toward a goal, and staying on the business of the Administration. It's extremely important.

I was a little disillusioned during my first year here that I didn't see, and maybe just my own blindness, a whole lot of effort from the other two commissioners from Kansas as well as the other two commissioners from Colorado, and has nothing to do with the present commissioners, because there's been several commissioners in that position. I honestly feel, deep in my heart, that if those four other commissioners would involve themselves a little more, they are really the ones that are, not from a legal and an engineering perspective, work with the water problems of these two States, they are the ones that I think have an intimate knowledge and close to their gut and their heart, what this Administration ought to be doing, and where they ought to be working. And my advice is that I would hope that they would become more of an activist in the commission and take more of an active part in the decision making process, if not at these formal meetings, even in an informal basis of getting together and knowing each other.

I came up with the idea, I don't know if it happened before me, but the idea of having this meeting in Kansas every other year. To me that was a beginning of at least seeing to it that we were sharing the meetings. Yesterday evening, as I drove through Garden City...through Lamar, I was telling Mr. Pope, I was kind of saying why the hell did I do that? I would be in my hotel tonight watching the game. But, I think those things are important. I think overall, a real good job is done, but I really think that Tom...Tom and I have talked about that, and so has Mr. Rogers and I, but Tom...I've known Tom for a long time and I think Tom, I hope the commission listens to you, I think you've got some good ideas, and I wish you folks well in your endeavors in the future, because, as I was telling Mr. Pope this morning, we don't know how long we're going to enjoy the good wet years that we've had in this part of the country, and sometimes when you have real wet years, maybe it's one State has to give in a little more than the other, because we don't control the future, the good Lord does, and maybe in those dry years, the other State has to give a little more, but we have to be cognizant in the fact that it's a long term problem, a long term situation that you're dealing with here, ever changing because of the weather and different other elements that we have no control over. So I hope that the other members of the commission take an active part, and I certainly hope Mr. Evans and Mr. Pope, that you don't take this as negative because of the...I think very, very active role that you two folks seem to take in comparison to your colleagues on the commission. Thank you very much. Good luck.

MR. AURELIO SISNEROS: With that, let me stand up a little bit and kind of introduce myself. Okay. If you can't hear me, let me know, and we'll use a microphone, but I hope you can hear me.

I'm looking forward to representing the U.S. Government in this capacity. I am currently, just give you a little bit of background about myself, I am currently in my third term as Pueblo County Treasurer, and in regard to any water issues, I have been a farmer and rancher for the last 27 years, so I do understand some of the water issues in Colorado and some of the water issues on the Arkansas River. Recently, I've received a little bit of paperwork, about that high (indicating), in regard to what you guys have been doing here for the last several years. I've been trying to play catch-up on it so bear with me, I'm trying to understand what has gone on in the past and what we are trying to do here in the future.

And with that, we're going to go ahead and get started here, and first thing on the agenda here is introduction of our representatives, and if we could start here on the left over here. What I'm going to do here is, in essence of time here, we've got a lot of people here. Generally, I understand that everybody has been introduced. We're not going to do that at this time. We are going to introduce the representatives and the players here, and anybody that speaks will introduce themselves at the time they do speak, or if they have a question, please indicate who you are and take the microphone in the center. With that, let's start with our Kansas reps, and would you introduce the representatives, please?

MR. DAVID POPE: Thank you, Mr. Chairman. My name is David Pope. I'm a member of the Administration from Kansas and Chief Engineer of the Division of Water Resources, Kansas State Department of Agriculture. We would like to, first of all, congratulate you on your appointment as Chairman. Looking forward to working with you and offer our help in any way we can to provide information and assistance as we work together to deal with the issues before the Administration. I would also like to take just a brief second to welcome everyone to Kansas and here to Garden City. To my knowledge, at least, this is the first time that the Compact Administration has held its annual meeting actually in Kansas, and so we are very pleased to have everyone here and we look forward to doing this again in the future. So with that, let me go ahead and do the introductions as you asked. To my far right, Randy Hayzlett, and Randy comes from the Lakin area and is a member of the board of the South Side Irrigation Association. To my right, Dave Brenn, who is the president of the Great Eastern Irrigation Association and also Vice President of the Garden City Company. To my left is John Draper. John is with the firm of Montgomery & Andrews in Santa Fe, New Mexico, and lead counsel for Kansas in the *Kansas v. Colorado* litigation. To his left is Dale Book. Dale is an engineering consultant for the State of Kansas with Spronk Water Engineers out of Denver. To his left, on the end of the table, is Leland Rolfs, an attorney working on water issues for us with the Department of Agriculture in Topeka. And then, just a couple of people on the staff and involved in this issue, that aren't at the head table, Greg Sullivan, who is a partner, Greg, with Dale Book in Denver. Mark Rude, the Water Commissioner for the Division of Water Resources here in this area of the State, here in Garden City, and then David Barfield, an engineer on my staff, that provides staff assistance to these issues, and finally, I'll mention the guy standing in the back of the room is Don Pitts, Special Assistant Attorney General for the State of Kansas. Thank you very much.

MR. AURELIO SISNEROS: Would our Colorado representatives please, Mr. Peter Evans, introduce our people?

MR. PETER EVANS: Certainly, Mr. Chairman, thank you. And we're very glad to be in Kansas, also. I certainly agree with Mr. Trujillo's suggestion that this is a very important function to rotate these meetings back and forth. I would like to welcome you on behalf of the Colorado delegation. Mr. Chairman, you stepped into some very big shoes. Mr. Trujillo has done a fabulous job moving this commission, this Administration, forward. Less I step into the same mistake he was mentioning, but this is an important function that we serve and we take it very seriously. I haven't been here very long, so I'm still learning the ropes too, and I get a lot of support not only from my own team, but from the Kansas delegation as well, and appreciate that.

I'm the Director of the Colorado Water Conservation Board. I was officially appointed to that position just short of a year ago, last February. I've served in that position on an acting basis for several years. To my immediate right is Jim Rogers who has been on the commission for many years, brings lots of depth to our delegation representing the water users of District 67. To his right, is Tom Pointon, also been on the commission for a long time and a dear friend of my mother-in-law, so I take his counsel very carefully, also. To his immediate right is Wendy Weiss from the Colorado Attorney General's Office, who's put many years of hard work into our relationship on the Arkansas River and with our sister State of Kansas, a valued advisor. And if I can introduce our outside counsel, David Robbins has spent lots of time with us, helping us to appreciate the value and wisdom of the Compact and find our way in this relationship of litigation. Steve Miller, sitting next to him, Steve, you want to raise your hand up? Know that everybody is probably aware of Steve, but I want to thank Steve for all of the hard work he does, putting these together. I'll just introduce a couple of other people, we've got lots here on...I'm not only impressed with the size of the crowd that we've got at this meeting, but the number of people that were able to come from Colorado. Hal Simpson, our State Engineer. Steve Witte, our Division Engineer. And one final introduction, it gives me special pleasure to be able to introduce Harold Miskel. Harold, if you wouldn't mind raising your hand. Harold is a new player on our team, appointed last February also, to the Water Conservation Board as the governor's representative for the Arkansas River Basin, and so I think you will see quite a bit more of Harold, and I want to welcome him as he's been an important player on our team. Thank you, Mr. Chairman.

MR. AURELIO SISNEROS: Thank you. And with that, let's go to Item Number 2, excuse me, Item Number 3, "Review and Revisions of Agenda." And at this time, I would ask Mr. Evans if there are any additions or amendments to the agenda?

MR. PETER EVANS: Thank you, Mr. Chairman. There are a couple of revisions that, maybe just deletions that I could suggest as a way of improving the agenda. The first one reflects typographic error, and I discussed this with Mr. Pope. I would propose that we, under agenda Item 6, "Report of Federal Agencies", under "A", for the "U.S. Bureau of Reclamation", that the two sub-elements under (1)(b), which is referring to the Trinidad Operating Principles, be deleted so that item (b) would remain on the agenda, but the sub-elements 1 and 2 would be dropped, and we'll take those up in the course of the discussion. The other suggestion I would make is that we might be able to delete agenda Item 7a, the report from the Southeastern Colorado Water Conservancy District. Mr. Arveschoug, the General Manager for the District, had hoped to be here but was unable to do so. If there's an interest in the agenda items that he was going to discuss, we can provide some information, but he's not here to do that.

MR. AURELIO SISNEROS: What are your comments on this, Mr. Pope?

MR. DAVID POPE: Mr. Chairman, I think the changes on Item 6 are acceptable. I think that probably is better because there are several potential amendments that could be considered. In regard to Item 7, I certainly understand that Steve cannot be here. I think it would be helpful just to leave the item as it is and perhaps some information from someone else could be provided, at least to some degree, would probably be helpful.

MR. AURELIO SISNEROS: Is that agreeable with you, Mr. Evans?

MR. PETER EVANS: That's agreeable.

MR. AURELIO SISNEROS: That will be left on the agenda and will be discussed as by Mr. Evans, as much as you can. The Item Number 6 under b, 1 and 2, will be taken off the agenda until a future meeting. Are there any other corrections or amendments to the agenda? Hearing none, we will go to Item Number 4, and I will have Mr. Peter Evans speak on this issue as well as Mr. David Pope. I'll have Mr. Evans first.

MR. PETER EVANS: Thank you, Mr. Chairman. It's a great pleasure to be able to start the process of acknowledging the important contribution that Larry Trujillo has made to this Administration since his appointment in 1995. As I mentioned earlier, you're stepping into very large shoes. This relationship between the two States has not been an easy one. This is a difficult river to share. I know something about that, having grown up in

Pueblo and experienced both lean years and flood conditions on the river. But Mr. Trujillo has brought an influence to this commission that I think was very important in his persistent effort to persuade the States into an open, regular discussion with the effort to clarify our concerns, to understand our differences, and to resolve them. I suspect that there are a number of people who would like to address this resolution, and maybe after David makes a contribution, we could open the microphone for a few moments.

MR. AURELIO SISNEROS: That would be fine.

MR. DAVID POPE: Okay, and thank you very much. Let me mention, just for information, or ask, are you folks able to hear in the back? My understanding of the microphone system is that it's a directional voice activated mic, and so we are going to need to speak close and directly into the microphone, so if we could kind of pass the microphones around here at the head table, that would be very helpful. Jack.

UNIDENTIFIED PERSON: It really doesn't work. What happens is it breaks out about every other word that you say so you either...you've got to change the microphone, or just don't use it.

MR. DAVID POPE: Can you hear me now, with this mic?

UNIDENTIFIED PERSON: We can.

MR. DAVID POPE: Well, let's just try it this way, and if everybody will speak up, we will do that.

First of all, let me just add to the comments that Peter has made. On behalf of the State of Kansas, and there may be others that would like to comment as well, but we certainly appreciate very much the effort of Mr. Trujillo. I think he was able to run the meetings in an efficient, effective way and we appreciate his independence, his neutrality, in dealing with these important issues and providing that role for the federal interest, and we are certainly very supportive of a resolution that would recognize his years of service to this Administration. I think all of us are cognizant of the fact that this role is not one that pays a lot of money or anything of that sort, it's just a person taking their time to try to serve the people of this area through the Compact Administration, and I think he has certainly done a great job of bringing that to the table.

MR. AURELIO SISNEROS: Any other comments?

MR. STEVEN WITTE: This is just a technical -- if you could pick up the microphone and hold it close to your mouth, back in the back I think everyone would be able to hear, then. Right now, it's not going through.

MR. DAVID POPE: Why don't we try that as we proceed.

MR. STEVEN WITTE: I think you could just pick up out of the holders, and if we could do that...

MR. PETER EVANS: Mr. Chairman, if there aren't additional, if there aren't additional comments then from the public, if it would please the commission, it would certainly be my pleasure, Mr. Chairman, to draft a resolution and circulate it to Mr. Pope and others and then present it back to you for signature.

MR. AURELIO SISNEROS: That would be very appropriate, and so be it. With that, let's go to Item Number 5, and I'm not going to use the microphone, I think my voice will hold up a little bit. Those microphones actually detract from what the conversation is going on here, you pick up a piece here and a piece there, so if you can't hear me back there let me know, raise your hand, I'll raise my voice a little higher.

A: "Report of Officers and Committees for Compact Year 1999." Obviously, I'm on the agenda there, but I have no input at this time. Just trying to learn what's going on from square one here, so we'll move on to 5b, "Engineering Committee", and we'll have Mr.

Pointon give us a report and you're from...okay, Chair Pointon, would you give us...

MR. TOM POINTON: Good morning, that work? (Laughing from audience.) Good, I thought maybe some in the back couldn't hear were the lucky ones and some of the front ones would get to move back to the back.

You know, without the Compact, we wouldn't have John Martin Reservoir. Without John Martin Reservoir, we wouldn't have the Compact. I think there's a lot of beneficiaries from the dam, and we need to work together. We had a report from the USGS at our meeting last evening, and it was on peak flows and the gaging stations that we helped finance on the Big Sandy and the Wild Horse Creek and Two Buttes Creek. It was suggested by the USGS that the gage at Two Buttes isn't as useful as it used to be and that we might want to drop that gage. And I would, at this time, move that we drop the financing of the Two Buttes gage.

MR. AURELIO SISNEROS: Mr. Pope, do you have any comments on it?

MR. DAVID POPE: I would second the motion, and just simply comment that our understanding from the report and the data from these last two or three years now, Ron, how long has it been? These gages were installed to better understand the amount of run-off that is occurring from these tributaries and I think we now know, on this particular one, that really there's...it's not justified to maintain a gage there, so I would add those comments to my second.

MR. AURELIO SISNEROS: The motion's made and seconded. Are there any against? Then it's unanimous.

MR. TOM POINTON: We have a copy up here from that report, if anybody wants some more detail on that report, we can sure make a copy available to them. The other report we had was from the Corps of Engineers on the channel restoration from Pueblo to...I mean, from John Martin Dam east, and the synopsis of that was that it's economically unfeasible to undertake that large of a project, and their recommendation was that there might be some short reaches of the river that they might do some restoration on, or some work on, and that Prowers County is willing to help on some of those short reaches, there is an area just west of Lamar that might use some help, and there's a program called 1135 Program that the Corps supports, that they might go into cooperation and do something like that, and I think that concludes my report, thank you.

MR. AURELIO SISNEROS: Thank you, Tom. Item Number 2, "Army Corps Report on Channel Capacity Studies Below John Martin and Pueblo Reservoirs." I understand that Colonel Fallin is going to speak on that.

LTC FALLIN: Yes sir, I will.

MR. AURELIO SISNEROS: Would you approach the mic?

LTC FALLIN: Yes, I'll try to use this mic. Very quickly, as Mr. Pointon pointed out, we looked initially below John Martin Dam, to the east. Economically, unfeasible for the United States Government to participate in a large channel restoration project. What we are looking at right now, is we've identified five potential, what we call hot spots, where we can go in with a smaller program, the 1135 Program, and perform some activities there to alleviate the channel capacity problems. Additionally, below Pueblo we are just starting right now to look at channel capacity issues on that stretch of the river, and don't have anything to report at this time on that activity. Any questions, sir?

MR. AURELIO SISNEROS: Are there any questions? Having none, thank you.

LTC FALLIN: Thank you very much.

MR. AURELIO SISNEROS: Are there any further comments on Item

Number 5 of the agenda, 5b? Let's progress down to Item C, "Operations Committee." Mr. Brenn, from Kansas, would you speak to the issue?

MR. DAVID BRENN: Thank you, and welcome Mr. Chairman, to the Administration. Our committee met last night and had a good committee meeting with a considerable dialogue on issues. I think we will proceed with a report of the Operations Secretary, Mr. Steve Witte.

MR. STEVEN WITTE: Good morning. Last evening I did present my report, or the verbal discussion of my report, that had been submitted to the Compact Administration on December 1st. Efforts to distribute that were made by express mail and I hope that all members of the Administration received their copies at least by the following day, or else I'll go see the postal service about a refund.

The report this year included three objectives. First of all, to report on the operations that were undertaken with respect to the operation of John Martin Reservoir, in connection with the resolution that's often referred to as the 1980 Operating Plan. To, secondly, to review the status of reports that had been previously submitted to the Administration, as well as to discuss the status of efforts to clarify and resolve certain issues that had been raised with respect to the 1998 Report by the Assistant Operations Secretary. And thirdly, to recommend certain actions to be taken by the Operations Committee.

Briefly, 1999 was a surprising year in many respects. Through the winter and early part of the spring, we were anticipating a relatively water short year, although we had good storage reserves, and we were...I think all of us involved in operations up and down the Arkansas, were anticipating a water short year right up to the time of the flood.

The first spill that occurred, the first spill of John Martin Reservoir, occurred over the period May 2nd through July the 6th. At the conclusion of the spill, of Article II accounts, the reservoir was established, at that moment, effectively at a balance of 60/40. The conservation pool control was split between the two States at the 60/40 ratio for Colorado and Kansas. And was therefore, under those circumstances, balanced exactly at that percentage.

The ownership of, excuse me, the second spill that occurred, occurred over the period of August 8th through August 25th, the total amount of water spilled from the flood pool through both spills was just over 360,000 acre feet. There were concurrent upstream diversions that totaled about 91,500 acre feet or approximately 25.4 percent of the amount that was spilled. Although, during the year, there were several additions to the permanent pool that were made pursuant to previous resolutions of the Arkansas River Compact Administration, none of those additions to the permanent pool were made pursuant to the Resolution of June 14, 1999.

Also, last evening, with respect to the briefing on the status of previous reports, I presented to the committee, a copy of the December 12, 1996 Resolution that specified certain footnotes to be included in the 1994 and 1996 Reports as conditions of final acceptance. I also provided copies of the insert pages that had been previously circulated, were again circulated last night, and that I have confirmed or are included in the copies of those reports that are on file in the Arkansas River Compact Administration Offices in Lamar. Having done that, I asked the committee to review those two documents, and to confirm that the conditions of acceptance have been satisfied, and recommended or requested a recommendation to ARCA of a finding that that was the case, or that is the case.

Also, last evening, with respect to the 1998 Report, we circulated a correction page involving a change to Table 10 of the 1998 Report. That correction had been noted at last year's meeting, although the record is not clear whether that change was specified, and so

I provided that page to the committee and requested acknowledgment of receipt of that corrected page to be included in the 1998 Report.

I also reviewed the efforts that were made to clarify and resolve certain issues raised by the Assistant Operations Secretary with respect to the 1998 Report, during the year, in 1999, and recommended further actions by the Operations Committee. Principally, being future special meetings of the Committee, dedicated to the purpose of addressing those specific issues. And finally then, I suggested five action items to be taken by the Committee, none of which were adopted last evening.

This concludes my report at this point in time. I ask however, that I be allowed an opportunity to make certain preliminary remarks in response to the Assistant Operations Secretary's Report that was provided to me only last night, at the conclusion of Mr. Rude's presentation this morning.

MR. AURELIO SISNEROS: Thank you. Mr. Rude, could we have your comments, please?

MR. MARK RUDE: Thank you, Mr. Chairman. Good morning.

MR. AURELIO SISNEROS: Good morning.

MR. MARK RUDE: If I may, I have copies of the report that I submitted last evening to the Committee which is a narrative, a brief narrative report, without accounting. Attached to that, is the final report that provides the 1998 accounting, that if the commission recalls, at this time last year, I provided a preliminary report and so as attachment to this report is the final for the Compact Year 1998 Report.

I would like to use the overhead projector here to just run through the principal issues discussed in the report, and particularly as a facilitator, to understanding some of the issues that are raised. As Steve said, the narrative report was provided only last evening, so this hopefully will help and facilitate an understanding of the issues.

This is my second year as Assistant Operations Secretary.

John Martin reached the record storage of 456,000 acre feet this year, and I gained additional understanding of John Martin accounting through this process that we had in meeting together, the OS and AOS, in discussing the issues. So we've worked to try and resolve some of these issues raised.

We had three meetings, in essence. We had the first meeting that was held to review the Operations Secretary or the Assistant Operations Secretary's Report, the final version that was submitted to Steve and his staff, at the first meeting. The second meeting was to review the issues raised in that 1998 AOS Report, and the final meeting, which was a two-day meeting, we had some good initial discussions relating to the issues and their potential for resolution.

Review of the issues, we focused on the 1998 Report since we had the complete accounting, completed accounting, attached to that narrative report. That year, most of the issues that are raised are represented in that accounting year, so we chose to focus on that year.

First issue, Pass-Through Water and Administrative Account. We were able to get some additional information on the Pass-Through Water and the Administrative Account that's operated in John Martin to do the accounting. We have an initial step here of assessing the data to make sure that it fills the holes and meets the needs that I identified when trying to do another set of accounting, essentially, and we may, I think, Steve and his staff has agreed to provide spreadsheets monthly and we'll see, if for some reason, that might be needed on a daily report basis.

Interruption of Releases From Conservation Storage to Section II Accounts.

There are two circumstances when this occurs. November 1, beginning of the winter storage period, the releases into Section II are interrupted, as well as, when demand comes off the reservoir during the summer storage period. Kansas doesn't agree with these interruptions. Primarily, reading the ‘80 Plan, it provides for the release, but it doesn't provide for interruption. The ‘80 Operating Plan prescribes the standing call essentially to Section II Accounts, without interruption.

Agreement B, Sub-Accounts. There was a number of sub-accounts that I had identified in this report, that I've distributed, that didn't appear to be specifically authorized by the ‘80 Operating Plan. Agreement B, sub-accounts within the Colorado portion of Section II, is an example. Those aren't necessary for operating the ‘80 Plan and aren't specifically approved by ARCA.

Flood Pool Account. That's another account that OS operates, but there's no provision for a flood flow account in the ‘80 Operating Plan, and it's not necessary to operate such an account, in the approach that I've taken in that accounting. So that's another one of the accounts not provided for by the ‘80 Operating Plan.

Here's a graphics that essentially shows, uses the 1995 spill, since that more clearly represents, or illustrates the flood pool operation, and that's kind of the green snow cap on the peak there, in that graphics. The accounting, the same graphics using the accounting that I put together, doesn't have that. Again, it isn't considered to be necessary to operate the ‘80 Plan.

Inflow Versus Outflow Spill Accounting. This was the essential, or the initial issue that kind of brought to light maybe a need to take another look at the operations of the ‘80 Plan.

Inflow based accounting that the OS uses, this manipulates ownership of accounts in respective to dam operations, and removes reliance on the physical spill over the project spillway as the trigger to initiate a spill.

The outflow based accounting, forced releases out of Section II, relies on the measured physical spill over the dam to dictate the forced loss of account water. Similar method was used in Compact Year 1987 spill, based on my review of the minutes of that meeting. The 1980 Operating Plan language dictates the preferred method essentially to rely on the operations of the dam, and the specific wording says, "In the event that run-off conditions occur," and there's some additional language, "that causes water to spill physically over the projects spillway," and then there's some additional language. So it refers to the operation of that dam as being the controlling factor for the forced loss of Section II Account water.

Depletion Credits in Spill Accounting. Depletion debits, as I tend to look at this anyway, are created for upstream storage. This accelerates the forced releases from accounts to conservation storage under the OS accounting. Accounts again suffer forced release when Pueblo Reservoir subsequently spilled wet water to John Martin. There's no provision by ARCA for depletion credit operations. This was discussed between the two offices through the hope of resolution from our level, I think we both kind of agreed on that.

Out of Priority Storage Upstream From John Martin. Again the same kind of conclusion was discussed briefly without much expectation for resolution at our level.

Evaporation Calculation. During spill events, the evaporation is charged under the '80 Operating Plan as a pro-rata among accounts based upon volume in those accounts. The OS practice is accounts in the flood control space assumes all evaporation.

Evaporation Calculation on Permanent Pool. I think, we recognize that there's a 1976 ARCA Resolution that based the charge on incremental area, change in reservoir, as a result of that permanent pool. The practice however, actually by both the OS and AOS, is a volume-based evaporation charge, similar to the charges placed on accounts. Operations Committee may want to consider recommending either an amendment to the `76 ARCA Resolution or to direct Operations Accounting to reflect the `76 ARCA Resolution.

Winter Water Storage. 1980 Operating Plan requires a 35 percent charge as water is delivered to John Martin Reservoir and the OS defers this until March 15th, using a Winter Water Account, a created account. The AOS charged 35 percent charge as water was delivered to the reservoir. Using the same 1995 graphics to kind of show, in color form anyway, what happens, looking at the Colorado accounting, you can see roughly March 15th there, that a yellow band is created, or that's essentially when water is moved from the Winter Water Account into...the 35 percent charge moves into the Transit Loss Account. That yellow band is the Transit Loss Account. In the Kansas accounting here, as the charge is placed on those deliveries as they are made to the reservoir, so the yellow band account there is essentially continuously created.

Deficit Accounting in the Kansas Transit Loss. This is not a disputed issue per se, but merely an observation I made from this last year's operations. The 1980 Operating Plan allows for a deficit, or deficit accounting if no transit loss water is available when Kansas calls for water. And, I might add, if transit loss is needed, then I guess we find it from someplace, and in a practical sense, it probably comes out of the Kansas Section II Account, and the ‘80 Operating Plan provides that that would be made up with the first available delivery of creation of the 35 percent charge for storage to John Martin. This situation occurred this year, as I said, and it doesn't appear that we are set up in the operation of the accounting to do deficit accounting on the Transit Loss Account. So I just mentioned that.

There are other issues, a few other issues, out there that I think we have touched base on, from a technical standpoint, in the three meetings that we have held, and I hope that we can do that some more, or more thoroughly, in the future. A lot of work has gone into this effort to review these issues by the AOS and the OS and their staffs. Additional discussions would be productive, and at some point, a report to ARCA or one of the subcommittees regarding the issues that we could resolve in these dialogue discussions, as well as those we could not resolve, and any potential need for ARCA resolution or ARCA action. That concludes my report.

MR. AURELIO SISNEROS: Thank you, Mr. Rude. Mr. Witte, did you have any further comments?

MR. STEVEN WITTE: I'll confine my comments to the issue that Mark raised, for the first time this year, related to what he calls the lack of deficit accounting. There was a delivery demand by the State of Kansas for Article II water during 1999. That delivery originally occurred on July the 8th and is illustrated on table 11a of my report. The rate of release demanded, did fluctuate somewhat during the period of that release, however, I would like to note, for the record, that despite the lack of a Transit Loss Account being available, the demand total in acre feet was 32,882 acre feet and the Stateline flow corresponding with the delivery of that demand was 38,000, a little over 38,000 acre feet. So it appears as though there was a delivery in excess of 5,000 acre feet made in connection with that demand for release. I do not understand the suggestion that there was any deficit that needed to be accounted for in that instance.

MR. AURELIO SISNEROS: Thank you, Mr. Witte. Yes, we have a question here.

MR. TOM POINTON: I have a question for Mr. Rude. I'm a country boy, and only the second time I've been to the big city, and I'm glad to be here, but, could you describe and or define for me the Incremental Evaporation System. I don't understand that.

MR. MARK RUDE: I would be happy to, to the extent that I think I can.

The incremental...the charge of, the charge to the permanent pool under that 1976 Resolution, I think could be applied several different ways, but my understanding is that rather than looking at the total volume that's in the permanent pool, and the percentage that that represents of the total storage in the reservoir, that would be a volumetric-based evaporation charge, taking that percentage of the calculated evaporation on a given day, would give you the volumetric percentage charge. That's the method used in the rest of the accounts.

The incremental charge, I can...my assumption is that, that would be whatever additional surface area is created, or evaporation, whatever additional evaporation is created by the fact that the, say 10,000 acre feet of permanent pool is sitting there in the reservoir, that would be the charge to the permanent pool. So in other words, if you have 10,000 acre foot of permanent pool, but the total water in the reservoir is 20,000 acre feet, you would look at the Area Capacity Table and see how much surface area you would have on 20,000 acre foot versus 10,000 acre feet, and that additional surface area, that percentage, that portion of additional surface area created by that permanent pool of water would be the percentage of the charge of evaporation for a given day. That's incremental. Now obviously, the...there would be a larger percentage of charge under that system in the last scenario. If half of the water in the reservoir representing permanent pool than there would be, if there's 10,000 acre foot of permanent pool and a 200,000 acre foot reservoir. Now, that may be different from your understanding. Does that answer your question?

MR. TOM POINTON: Not entirely. That's all right.

MR. AURELIO SISNEROS: Mr. Rude, before you sit down, would you indicate the dates of the three meetings that were held in 1999, for the record?

MR. MARK RUDE: Yes. First meeting was held in Pueblo, just down the hall, or essentially at Steve Witte's office, January 14, 1999. The next meeting was, according to my records, the second meeting was held also in Pueblo on February 25, 1999. And the last meeting was in Garden City, April 8 and 9, 1999. Also wanted to mention, if I may, that additional copies of what I've distributed today are available on the back table.

MR. AURELIO SISNEROS: Thank you. We have a question from Mr. Evans.

MR. PETER EVANS: Mr. Chairman, before we move on, I guess, based on the reports from the Operating Secretary and the Assistant Operating Secretary, I would like to move that the Administration acknowledge, formally, that the specific conditions included in our prior acceptance and approval of the '94 and '96 Annual Reports of the Operating Secretary have been fully satisfied. I offer this motion as a way of starting to clear the deck. We have lots of work to do. It's clear to me that the staff in both States have spent good time working together, I would like to encourage them to continue that effort, but unless we start clearing some of the resolved issues, it would be harder for us to focus on the issues that remain unresolved.

MR. AURELIO SISNEROS: Mr. Pope, do you have any comments on that?

MR. DAVID POPE: Yes, Mr. Chairman. We certainly acknowledge the materials provided last night, I think, to the Operations Committee, as far as the resolution that was adopted and the footnotes that were provided, however, I think it's, it's not something we've had a chance to really look at carefully, but in a broader sense, also, it's clear now that we have reviewed the accounting system, that there are issues that are...could have impact to those other years of reports, and it seemed to us that it would be more appropriate to just table those issues. We are certainly willing to acknowledge that materials have been provided, but to table any further action on the actual reports until we have taken some additional steps to try to resolve these broader questions.

MR. AURELIO SISNEROS: Mr. Evans.

MR. PETER EVANS: If we can explore that a little bit further, I guess it's my understanding, that in 1996, the Administration adopted a resolution that approved those two reports subject to the inclusion of specific footnotes, that those footnotes were provided last year, and so at this point we would simply...I'm simply asking that the...this Administration acknowledge that the specific conditions we tagged those approved reports with, have been satisfied. Now if there are other issues, I suppose we need to understand what those are, but we left the approval of those two reports for 1994 and 1996 subject to a specific condition, and I believe that that specific condition has been satisfied.

MR. AURELIO SISNEROS: Mr. Pope.

MR. DAVID POPE: I would like to confer here just a second, and look at these for a minute. Peter, this may be a situation where we didn't focus our attention on this quickly enough. I didn't recall necessarily that these were provided last year, and no doubt that you're correct in that regard. I think it's one thing to acknowledge receipt of them, which we're certainly willing to do, and are doing, I'm just not comfortable that we really can take the step of saying we've satisfied the conditions at this point in time, because I think you're asking. We'd be happy to focus on that, and take a careful look at those, and be prepared to action, you know, to take action at some appropriate time, whenever we can, whether that's next year's annual meeting or sometime before, if it's appropriate, but we just, you know, these are fairly complicated matters and we just want to be careful with that.

MR. PETER EVANS: Mr. Chairman, that would be acceptable. I think we can probably help you verify that the footnotes added were verbatim what the Administration requested. And maybe we can get back to this and resolve it a little bit later in this meeting.

MR. AURELIO SISNEROS: Mr. Pope, are you in agreement with maybe getting back to this a little bit later on in this meeting, possibly after lunch?

MR. DAVID POPE: Kind of depends on all of the other things we have to be dealing with here today, but we'll make our best attempt to do that and if we can, we will.

MR. AURELIO SISNEROS: We'll try to address this issue right after lunch.

MR. STEVEN WITTE: Chairman Sisneros?

MR. AURELIO SISNEROS: Yes?

MR. STEVE WITTE: I have additional copies of the resolution that was passed in 1996 on that point, available for distribution if people...if that would facilitate the comparison process.

MR. AURELIO SISNEROS: Do you have a copy of that?

MR. DAVID POPE: We have one copy here, it might be helpful to have another couple copies if you have them. I think you indicated, or Peter did, there was a resolution, but a comparison of the footnote items, if that's available, we'll try to look at that over lunch if we get time.

MR. AURELIO SISNEROS: Are there any other comments?

MR. STEVEN WITTE: I'm sorry, did I understand that you also need copies of the footnotes that were provided, to be inserted, for comparison purposes?

MR. DAVID POPE: I'm a little cold on exactly the comment, but I think the, I think the...I think I understood Peter to say there was some footnotes. This is...we can compare these footnotes to ones that had been instructed by the Administration, at the time, and that's the comparison, I think I certainly have a resolution, but is there another document to compare to in regard to...

MR. STEVEN WITTE: Just a comparison of the resolution to the footnotes.

MR. DAVID POPE: I see.

MR. STEVEN WITTE: Do you have a copy of both documents?

MR. DAVID POPE: We have a copy of both of those.

MR. AURELIO SISNEROS: Thank you, Mr. Witte. Moving on to C-2, the committee recommendations regarding 1999 Operations Secretary Report and 1999 Assistant Operations Secretary Report.

MR. DAVID BRENN: Yes, Mr. Chairman. I'm Dave Brenn again, Chairman of the Operations Committee. I would like to recognize Jim Rogers down here, committeeman from Colorado. As was reported earlier, the committee met last night and had a good meeting. From that, the committee recognizes the work and the due diligence of the preparation of both these reports that have been submitted today, and the fact that the process of the meetings between the Operations Secretary and the Assistant Operations Secretary has been a positive step in the right direction in establishing dialogue first, and addressing concerns of both States over the past year. A year ago, our Chairman charged both States to aggressively approach these issues and at least establish dialogue, and I think that that's been demonstrated. However, the committee also recognizes that clear and significant differences in accounting issues and others and in interpretation. This, coupled with the short time frame for Compact members to review the provided reports, which was very short on Kansas' side, and significantly short on Colorado's side, which seems to be consistent with history that the shortness in the time frame in order to review these reports by Compact members, limits us to be objective in consideration for recommendations specific to the issues.

Therefore, the committee recommends to the Administration, a special meeting of the entire committee, which include Compact members, OS and AOS staff, within the next 60 to 90 days. In that meeting, formats should be based informally in a "what if" format, so that we can look at these issues, determine those that we can agree and compromise upon and those that we can't. Hopefully, this will help us move forward in resolution of some of these differences. Thank you.

MR. AURELIO SISNEROS: Thank you, Mr. Brenn. Do you have any comments from this side, or additions? Who would be setting up this meeting and what would be the date of this, Mr. Brenn?

MR. DAVID BRENN: I think, we will, both States will, Mark, you and Steve will have to dialogue sometime after this meeting, come up with some possible dates within the 60 to 90 days, and then I believe we can coordinate it from there.

MR. AURELIO SISNEROS: Mr. Witte?

MR. STEVEN WITTE: I would like to volunteer to take care of that meeting, coordination and scheduling.

MR. AURELIO SISNEROS: Thank you.

MR. DAVID BRENN: Good.

MR. AURELIO SISNEROS: Item C-3, "Colorado Compact Compliance Efforts, 1999 Offset Account Operations, Status Report by Colorado State Engineer," Mr. Simpson.

MR. HAL SIMPSON: Good morning, and welcome to the Administration, Mr. Chairman. I think you're finding out things do not move along quickly sometimes.

For the record, I am Hal Simpson, Colorado State Engineer. I've been asked to provide two brief reports to the Administration concerning Colorado's Compact

Compliance for Compact Year 1999, and a summary of the operations of the Offset Account in John Martin Reservoir, again for Compact Year 1999.

There are copies of the Offset Account Report that are available on the back table, and I believe all members of the Administration should have received that report. It's about an inch thick with a light blue cover. First, I would like to cover Compact Compliance for the Compact Year, then we'll get to the report. I would like to thank Steve Witte, Dale Straw, and Allen for the detailed accounting that is required to provide to you the written reports, as well as the operation of the various replacement plans that Colorado operates to prevent injury to senior water rights in Colorado as well as replacements to depletions to Stateline flow.

Probably nowhere in the United States or probably, again as I've said previously, in the world, is there the nature of accounting for depletions caused by post-Compact wells and proof of how those depletions are compensated through the monthly reports, made available by Mr. Witte and his staff.

For the Compact Year just completed, which is from November 1, 1998 to October 31, 1999, we approved 17 replacement plans that replace depletions caused by existing wells throughout the Arkansas River Basin. In those 17 plans, there were enrolled or registered 1,557 wells, with the majority of these wells in the big three replacement plans. The Arkansas Groundwater Users Association, the Colorado Water Protective and Development Association, and the Lower Arkansas Water Management Association had a total membership of 1,432 wells. So you can see the majority of the wells were in the big three plans that operate, that operate between Pueblo and the Stateline.

At the beginning of the period, we projected, based on estimates by the member wells, that pumping would be 188,333 acre feet. However, due to good surface water supply conditions, the actual pumping was 112,274 acre feet. Second year in a row, since I started reporting to you, that the amount of pumping was significantly less than projected, and again it's a result of the above average surface water conditions.

The total computed depletions from this pumping was 25,631 acre feet, and it consists of two components. That part is, that is related to out-of-priority depletions above senior surface water rights in Colorado, and that total was 21,679 acre feet. Depletions to usable Stateline flow totaled 3,952 acre feet. Some of the depletions to usable Stateline flow were not required to be replaced because of the flow conditions at the Stateline, in accordance with our Offset Account Agreement, if certain flow conditions exist, replacements are not necessary, except for recharge component of usable Stateline flow. That is why the depletions were so low this year.

The actual replacement operations to offset or mitigate the impact of these depletions were as follows: Above the senior surface water rights in Colorado, the actual replacement was 26,876 acre feet. And the amount of replacement water at the Stateline, made available, was 5,567 acre feet. So in both situations, we exceeded the necessary replacement requirement by about 7,800 acre feet total. The reason for this, again, is primarily that above John Martin Reservoir, the replacement plans, in advance, purchased Fryingpan-Arkansas Project return flows, and those are in the system, and even if there's not a need for a replacement when John Martin is spilling, they are there and need to be accredited, or accounted for as a replacement and therefore, we over-replaced in our computations by about 7,800 acre feet in total.

With that, Mr. Chairman, before I move on to the Offset Account Report, maybe I should pause and see if there are any questions.

MR. AURELIO SISNEROS: Are there any questions? Any comments?

There being none, continue please.

MR. HAL SIMPSON: Then, let's move to the written report that Mr. Witte and his staff prepared and have submitted to you. I will focus really, on the first part of that report, just summarizing the activities that took place with the Offset Account, again for the period November 1, 1998 through October 31, 1999.

At the beginning of the Compact Year, the account contained 4,848.68 acre feet. That is shown in Table 1 in Section 3, and I will be referring to some of those tables in, excuse me, in Section 1. Section 1 contains some monthly summaries of some accounts that are important for you to look at, as I move through my report.

The initial charge of the 500 acre feet of consumable water required by the Offset Account Resolution was accomplished on March 31 of 1999, when 500.4 acre feet of fully consumable water was delivered to the Offset Account. And again, you can see that in Table 1, and in Table A, if you turn to the next page, in particular, 500.4 went in in March as an inflow. We had two spills of Offset Account water. Both times that John Martin spilled, the Offset Account water also spilled and that is shown in Table 1 and in table A, the first in May, the second of August. There were also two releases from the Offset Account shown in Table 1, one in January for the return flow obligations, one in the end of October for a correction to the amount of water delivered into the Offset Account from Highlands Account.

If you turn to the second page of my report, you can see the five deliveries made into the Offset Account, their sources and end-up delivery date, as well as the amount, whether it's consumable or return flow. Those deliveries totaled 4,590.51 acre feet, consisted of either consumable water or return flow water. Those are shown in that table at the top of the second page. As I indicated earlier, there were releases from the Offset Account, four specific releases, two for spill, and one for return flow obligation, and one for correction.

We also made deliveries of fully consumable water into the Kansas component of the Offset Account, or transfers maybe is a better term, and those are shown in the bottom table on the second page, and a total of 2,122.5 acre feet, and they are shown in more detail on Table 8.3. This is water that was delivered into Kansas' Offset Account to compensate for computed depletions to usable Stateline flow that were not replaced from other sources. More detail of this accounting was shown in Section 3, where in Section 3, Mr. Witte, as required by the Offset Account Resolution, submits reports to Mr. Pope and to the Administration on the details of each delivery in the amount of water that is consumable.

Section 4 contains the monthly letters required also, by the Offset Account, that are provided to Mr. Pope and to the Administration concerning the accounting of depletions, the amount of Offset Account water that is required to be made available, if necessary, or to show the amount of replacement water made available from other sources to offset depletions to usable Stateline flow. I believe, through this process in the detailed monthly reporting we have made available to Kansas and the Administration reports that hopefully allow all parties to understand the operation of the Offset Account. If not, then possibly this is the time to answer those questions, or if you want detailed discussion on this report, we can include it in the agenda for the special meeting that's going to take place in the next 60 to 90 days. With that, Mr. Chairman, I conclude my report. Again, we'll be glad to answer any questions.

MR. AURELIO SISNEROS: Does anyone have any questions? Yes, we have some.

MR. DAVID BRENN: Could you, now briefly, kind of describe the process that triggers the transfer to the Offset Account, or the main points that you reviewed before doing that?

MR. HAL SIMPSON: Transfers to the Kansas sub account of the Offset Account, or the total, just inflow to the, to the total account? I assume what you asked was the Kansas component?

MR. DAVID BRENN: Kansas component.

MR. HAL SIMPSON: That is addressed in the letters that begin in Section 4 of the report, that's the last section that is shaded, and if you go to that, maybe I can walk through it just briefly. You can see it, and see how we do it. The first one is a letter to Mr. Pope and to Ms. Mary Louise Clay, dated January 7, 1999, do you see that letter? This report shows in Table 1, for instance, the amount of pumping by irrigation wells for the month of November of 1998, and that totaled 1,344 acre feet. And then the next column on Table 1, shows the wellhead depletions to be 619 acre feet. So we have from the previous month's accounting, the amount of acre foot pumped in the month of November, and the depletions. You have to understand that the report is not produced until January because we have to get the data from November, work on it in December, and we send a report out in January.

Then Table 2 focuses, in particular, on the wellhead depletions from irrigation wells below John Martin Reservoir, because above John Martin Reservoir, the letter states that those depletions are offset by operations in Colorado using return flow water from Fryingpan-Arkansas water sources to fully offset depletions above John Martin. You can see in Table 2, the total depletions were 441 acre feet.

Then moving to Table 3, and this is a critical table, and the one you need to understand. We, for the reaches below John Martin, compute what is called a remaining depletion, and that's a function of previous months pumping as well as the current month, but it totals for November of 1998, the far right-hand column of that first line, 1,914 acre feet. Following...and then the next line shows the depletion, and that depletion is computed based upon the Resolution in the Offset Account as to the time of the year, the flow at the Stateline, and in this case it's the, I think, 25 percent depletion factor, roughly 30, but it's in the Offset Account Resolution, second amendment we made so we then had a depletion to usable Stateline flow, then we show how it is offset.

Fryingpan-Ark return flows, in the upper part of the reach where it is available because 87.3 remainder was made available from the Offset Account 585.6, water that was in the Offset Account and placed there by Colorado water users, then is made available to Kansas for use, it is not released. Thirty days after this letter is received or written, that date, there is a transfer then from the Offset Account to the Kansas Consumable Water Account of 585.6, and we just move through the year, month by month, and in each report, for each month, is concluded in this last section. I should point out that this water was not released or called for by Kansas, and in fact spilled. You could have taken it if you wanted it, if you had a dry April, excuse me, there was water there to use, but it was not taken, and it was spilled in May. So it's important, I think, for Kansas to realize that that's an asset they could have taken and they didn't. Colorado gets credit for it under the resolution under the Offset Account, because we placed it there for you to use.

MR. AURELIO SISNEROS: Thank you. Are there any more questions? Comments? Mr. Pope?

MR. DAVID POPE: I don't know that I have a question, but I note, a couple things, first of all, Hal, we do appreciate you and your staff and all of the work and effort that goes into providing the detailed accounting. I guess I do need to note for the record however, and I think everyone is aware of this, that the overall issues related to Compact compliance are still, still in the litigation between the States and so we really are not in a position to say for sure at this point that we accept or not, these particular figures, but we do appreciate the accounting.

MR. HAL SIMPSON: Thank you.

MR. AURELIO SISNEROS: Thank you. Just for clarification, Mr. Pope. The issues in question here that you just mentioned are the ones that we are going to be discussing after lunch? No different issues?

MR. DAVID POPE: No, what I was just referring to was the broader question of Compact compliance with the, in the case of *Kansas v. Colorado* and there are ongoing issues that are still unresolved there, before the Special Master.

MR. AURELIO SISNEROS: Just wanted to make that clear. Moving to Number 4, C-4, "Trinidad Lake Permanent Pool Operations, Exchange and Accounting, Status Report by Colorado Division of Parks and Outdoor Recreation, and...Mr. Witte, is that you?

MR. STEVEN WITTE: Mr. Chairman, I didn't change employers, I'm still employed by the Colorado Division of Water Resources, and I...so it may not be appropriate for me to be addressing you at this point in time, I'm prepared to provide you with a report as is required by the resolution that was passed by the Compact Administration, recognizing the enlargement of the permanent pool at Trinidad Lake by the State Engineer, and if it's appropriate, I'll do so, I'll do that at this time.

MR. AURELIO SISNEROS: We also have someone here from the Parks and Outdoor Recreation, Mr. Paul Flack. Are you going to be speaking? Who is Paul Flack? Oh, okay.

MR. PAUL FLACK: For the record, my name is Paul Flack, Water Engineer, Colorado State Parks. I'll give a brief, very brief overview of our 1999 operations for the recreation pool. Both the original 4,500 acre foot recreation pool and the additional reallocated 11,467 acre foot pool were filled with transmountain water during the 1999 water year. This was achieved through an exchange with water, transmountain water, the Division of Parks and Outdoor Recreation purchased from Colorado Springs. The source of that water was the Colorado River. That water was exchanged from May through July from Lake Meredith into Trinidad Reservoir. I don't know the exact amount of water, approximately about 4,500 acre feet, was exchanged during that time period. Therefore, at this present time, the recreation pool is filled in compliance with the 1996 Amendment to the Operating Plan, and in the future, our next charge will be from the Division of Parks and Outdoor Recreation to find replacement water to offset the annual evaporation, which we are in the process of doing right now. And that basically concludes my report.

MR. AURELIO SISNEROS: Are there any questions for Mr. Flack? Mr. Pope?

MR. DAVID POPE: I do have one brief one, Paul, appreciate the report. Of course you know that the two volumes in the original and in the enlarged pool, recreation pool, I think you just mentioned that the exchange of water through Lake Meredith was about 4,500 acre feet. Was there additional water, or was that just the balance that was needed to bring those up to being full?

MR. PAUL FLACK: That was just the balance.

MR. DAVID POPE: So they had...the difference was already in the reservoir at that point in time.

MR. PAUL FLACK: That is correct.

MR. DAVID POPE: Thanks.

MR. AURELIO SISNEROS: Thank you, Mr. Pope. Are there any other comments or questions for Mr. Flack? Thank you, Paul. Steve, did you have any comments on this?

MR. STEVEN WITTE: Yes, Mr. Chairman. The, as I said before, the resolution of this Administration, dated January 26, 1996, recognizing the enlargement of the permanent pool at Trinidad Reservoir, calls for an annual report of the State Engineer regarding the initial fill and the maintenance of the permanent pool at Trinidad Reservoir, and I'm handing you now, a copy, handing you the original, Mr. Chairman, and copies for the Administration members, of that report.

Mr. Chairman, at last years' meeting there was some discussion about whether I had submitted to Mr. Rude a summary of the exchanges of water that took place, which added to the permanent pool in Trinidad Reservoir during 1998. Subsequent to the annual meeting, I found out that that letter had in fact, not been sent, and so by letter of January 12, 1999, I summarized those 1998 operations and submitted them to Mr. Rude, a copy of that letter is attached to this report.

Regarding the initial fill in 1999, perhaps to supplement and confirm some of the information just provided to you by Mr. Flack, the content of the permanent fishery pool in Trinidad at the beginning of the Compact Year of November 1, 1998 was 11,797 acre feet. If you refer to Table 1 of this report, I've shown the content of the permanent fishery pool in Trinidad as of the first day of each month during the year, as well as the content of the permanent fishery pool on the last day of the Compact Year. Also, I've shown the corresponding evaporation that was charged to the permanent fishery pool, in the third column, during each month of the year. To the right of that, are some columns showing transfers and inflows into the pool. During the early part of, or during the spill which occurred...the spill of John Martin Reservoir, excuse me, that occurred between May 2nd and July 6th, there was water stored in Trinidad Reservoir that began to displace water, that transmountain water that had previously been exchanged into Trinidad Reservoir, into the permanent pool. That amount caused the 1,500 acre feet shown in the transfer column to be added to the permanent fishery pool.

Then, if you will skip over the next column to the column labeled "Inflow - other", you'll see the 3,000 acre feet that was added to complete the initial fill of the permanent pool. The two numbers added together, provide you with the 4,500 acre feet that Mr. Flack was referring to.

Like to emphasize that even though the spill was occurring at that time, the Division of Parks and Outdoor Recreation determined to do an exchange of transmountain water in order to be strictly in compliance with the terms of the resolution that approved the expansion of the permanent pool at Trinidad Reservoir.

There's another column there, shown column heading "Inflow", and then in parenthesis "88-CW-62," that is to distinguish and note the fact that the City of Trinidad has, through Colorado Water Court, changed the Antonio Lopez (ditch) water right to provide for the replacement of evaporation off the Trinidad permanent pool. And the numbers in that column reflect the amounts of water that were provided pursuant to that decree for that purpose.

And then, in closing, I would just note that in an effort to maintain fidelity to the provisions of the resolution, that throughout the time period and concurrent with efforts to establish the initial filling of the Trinidad permanent fishery pool, there were several e-mail advisories provided to Mr. Rude and to his assistant, Mr. Salter, to keep them up to date with our efforts to accomplish that initial filling of the permanent pool. Following the completion of the exchange portion that occurred in 1999, I did submit a letter to Mr. Rude dated August 16th, that provides details concerning the operation of that exchange of water into the permanent pool.

If there are any questions regarding this report, I'll be glad to try to field them. I do have some additional copies for distribution to others besides those of you on the Administration.

MR. AURELIO SISNEROS: Any comments? Mr. Pope?

MR. DAVID POPE: Yes, thank you. Steve, I might ask you to clarify a little more about the...on the December 7, 1999, the letter, there's a reference to the transfer of water displaced by the City of Trinidad into the permanent fishery pool, I'm kind of paraphrasing there, and then, of course, that's shown on the attached table you made reference to. I guess I don't understand that particular aspect of this yet. What do you mean by displaced, and what, why wasn't that water just exchanged directly into the fishery pool to start with, am I missing something here?

MR. STEVEN WITTE: The City of Trinidad had, excuse me. Yes, the City of Trinidad had previously exchanged transmountain water into Trinidad Reservoir, I believe if memory serves correctly, in 1995. That transmountain water remained in the joint use capacity of Trinidad Reservoir for potential use of several different types. However, during the period of spill from John Martin Reservoir, water was being appropriated into storage in Trinidad by the project for storage in the joint use capacity. As that water was added to storage in a joint use capacity, the water available within the joint use capacity that had been exchanged there by the City of Trinidad, began to be displaced, it was displaced by the storage of project water that was appropriated. It was transmountain water, the City of Trinidad, I believe, acknowledged that they consented to the use of that transmountain water to be in addition to the permanent pool, and so it met the criteria as being having the right source of origin and so was added to the permanent pool at that time. Does that answer your question, sir?

MR. DAVID POPE: Yes, I think I understand that now, I just wasn't aware that there were that kind of transfers, I guess, from the joint use pool or into and out of. I don't have any further questions on that.

MR. AURELIO SISNEROS: Thank you, Mr. Witte. Moving to 5-C, "Review Approval Status of Prior Years Operations Secretary Reports." I think this is pretty cut and dried, and if it is, we'll take a short break right after this. Who does that? Mr. Miller?

MR. STEVE MILLER: My name is Steve Miller, from the Colorado Water Conservation Board. I put the agenda together and perhaps I should clarify that. That item refers to issues that were discussed in Steve's report. He went through the series of Operation Secretary Reports, the ones that are provisionally approved, and the ones that have not been approved. So I think that's already been covered, but when we put the agenda together, we didn't know that his report would deal with that directly. I guess I would defer to the Operations Committee if they believe that has already been covered.

MR. DAVID BRENN: I think it's been covered.

MR. AURELIO SISNEROS: 5-C has been covered, and with that, why don't we take about a 15 minute break and then get back here in about 15 minutes, okay?

(Whereupon, a short break was taken, after which the following proceedings were had:)

MR. AURELIO SISNEROS: Ladies and gentlemen, if we can get started here, we're down to item number C-6, "Status Report on Implementation of the New John Martin Reservoir Accounting Software and Reporting System". Mr. Steve Witte will give us a report on that.

MR. STEVEN WITTE: Mr. Chairman, I have a very brief report on that. At last year's meeting I reported that we had done some considerable work to develop a new suite of software, or applications, to conduct the accounting for John Martin, we called it the John Martin Accounting System. We feared, at that point in time, that the old system that we were utilizing, or the old applications that we were utilizing, was subject to failure on January 1, 2000. And so there was a feeling that there was a good deal of urgency to complete that programming. Subsequently, we have found that the old system written in GW basic appears to us as though it will survive the coming of the new millennium, so we are reassured by that and are intending to continue the accounting with that system. The development of the final refinements to the new system has been somewhat stymied or hampered by the ongoing discussion with the Assistant Operations Secretary, given that there are some prospects of different logic needing to be provided. So that's been kind of put on the back shelf, but as I say, it's not as critical. It appears to us, because we think we can continue to use the old system. If we can dispose of some of these issues of lesser importance or non issues through the committee process that the Operations Committee has chosen to follow, then we may be encouraged to develop, or finalize the development of that new system.

MR. AURELIO SISNEROS: Thank you, Mr. Witte. Are there any questions for Mr. Witte in regard to item Number 6? Mr. Pope?

MR. DAVID POPE: Just a brief clarification or follow-up question, Steve, then this apparently is working a little differently.

MR. STEVEN WITTE: I think you got the good mic. I changed mics on you, thinking that one might work better.

MR. DAVID POPE: Okay. Get too close to this thing then I blow up or something. So, I take it you're still committed, at some point in time, to the new software, the new system, but you'd like to defer until issues are resolved in terms of any changes in the accounting? Steve, is that what you were reporting?

MR. STEVEN WITTE: Yes, Dave, I think that is correct. We are committed to it, I think it's a better system, it's more modern and it provides some features that I think make the accounting more understandable, but we didn't want to invest a lot of time in trying to put final refinements into something that potentially could have to be overhauled substantially. So if we can resolve some of these issues, I guess, if for that matter, if these issues that have been raised are all determined that...or it's determined that the way we have been doing things in the past are appropriate, then we can essentially go forward and begin using the system as it exists now. But there were some final refinements that we were wanting to make.

MR. DAVID POPE: Okay, thank you.

MR. AURELIO SISNEROS: Thank you, Mr. Witte. Items C, D, E, and F are deferred until Item Number 10. We'll go now to Item Number 6, "Report of Federal Agencies; A. U.S. Bureau of Reclamation". And I'm not sure who's going to be doing that report. Mr. Jack Garner, yes, I met him earlier.

MR. JACK GARNER: I'm trying to figure out what the secret of this mic is, either stay away or get close. Good morning, Mr. Chairman.

MR. AURELIO SISNEROS: Good morning.

MR. JACK GARNER: For the record, my name is Jack Garner. I'm the Area Manager of the Eastern Colorado Area Office in Loveland, Colorado and Bureau of Reclamation. That office operates and maintains two transmountain diversion projects; the Colorado Big Thompson Project in the northern part of the State and the Fryingpan-Arkansas Project in the southern part of the State. In addition, we have the responsibility for the irrigation repayment contract for the Trinidad, for the Corps of Engineers, Trinidad Dam and Reservoir. To give you just a little bit of background on what has happened in the last year since we, since we last met on the Fryingpan-Arkansas Project, this year we imported both the Fryingpan-Arkansas and the Colorado Big Thompson Project, divert water from the Colorado River Basin transmountain diversion projects. And this year we diverted 40,744 acre feet of water from the Colorado Basin into the Arkansas Basin, that is well below our average that we normally divert because, like Mr. Witte pointed out, of the unusual water year we had.

We stored, which is the other unusual situation, we stored over 130,000 acre feet of water on our Fryingpan-Arkansas east slope decree which only happens, normally one out of about 10 years, but as a result of the unusual year, this was one of those years. We had a major flood event that took place April 30th and the first part of May and whenever the Pueblo goes into flood operations the Corps of Engineers takes over operation of Pueblo for flood, and I would like to very much thank the hard work of Dick Kreiner and Dennis Garcia from the Corps of Engineers on their flood operations. They did an excellent job, Pueblo did...the dam did a good job of storing a lot of water preventing damage downstream during that flood event.

That brings me to an issue associated with the modifications on the safety of dams for Pueblo Reservoir. We have been working on a modification for about two years, on a safety of dams modification. Today we have all of the roller compacted concrete in the stilling basin, that has all been placed in there and the concrete cap is also completed. We finished that this fall, and the concrete cap, we are allowing that to cool and cure and then starting, probably in about June, we will do grouting in the joints to complete that project. It is nearly done. As a result of the excellent weather that we had last year for the work, by getting the roller compacted concrete in there, we were able to take at least partially the restriction off which really helped us in the flood event that took place in April. So that worked out very well and I think that job is going very well.

I think beyond that, we get into the fun part now, which is the Trinidad Operating Principles, and I'll have to apologize ahead of time, as most of you know, I have...I am quote, "The Area Manager", but I have been in the area office for a total of about six months in the last two years. Reclamation has seen to put me in Washington and other places the rest of the time so I have not been as intimately involved in this as, I was going to say as I wanted to, but I'm not sure that's the case. But my trusty staff has done an excellent job, especially when I review what has happened in the last year, and the work that they have put in to try and resolve some of these issues. And the staff, for your information, Mr. Chairman, Alice Johns kind of heads up the staff in Loveland, as far as this issue and Malcolm Wilson works with her on Trinidad issues. Lisa Vehmas is legal counsel out of Denver for us on...out of the Solicitor's Office and represents us. All of them have put a lot of time and effort into what has taken place in the last year and I thank them very much since I haven't been around.

To kind of bring you up to date on some of the issues, and I'm sure a lot of you know a lot more about this than I do, and if you have any questions, you'll ask them.

Some of the issues, probably the easiest one we've got, winter water, that was a joke by the way, that is still the, I would say the largest issue that we have on this, on any amendments, is the winter water issue. Kansas had proposed that we do some additional modeling, we did not feel that the proposal that they presented was feasible at the meeting, there were actually two meetings that took place since the last Compact meeting, and that was...there was one in October, then in July, and another one in October, technical meetings to address a number of these issues, and at the July meeting, District 67 and the Fort Lyon showed an interest in looking into Reclamation, the modeling that was done, to try to determine whether they couldn't get some additional information out of it and make it more of a monthly model instead of a yearly model. That proceeded along fairly well, there was a lot of time and effort put in to looking into that, and then just prior to our October meeting, we received a letter in which they basically said that they weren't going there. As a result of that, I think, because the parties seem to be so far apart on this winter water issue, I believe Reclamation is at a point now where we need to take probably more of an active role in trying to look at the information that was prepared by District 67 and Fort Lyon, and the other parties and Kansas, just try to see if we can't come up with some means to make a determination on whether additional modeling is required and take more of a lead role in that which, the only thing I would say on that is that is going to take time and it is going to take money, and we are programming money but anything we program today is three years from now, and so this is not something that's going to be solved in a real quick time frame.

The next issue that we've got on here is the ideal headgate requirement. And on ideal headgate requirements, I believe Kansas requested that we put some kind of definition as to what is ideal headgate. I believe we have done that. I believe we have taken the various terminology that's been used in various reports and come up with a definition for ideal headgate. We have worked, we have provided dollars to the District from out of our field services program for them to work on some water management programs and dollars for a transit loss study. I think that has gone very well, as far as the water management, seems to be a lot of cooperation. We provided the dollars to the District and other soil conservation districts and everybody else has been really interested in that and I think that's a real positive thing that's taken place as far as looking at ideal headgate. Kansas proposed an amendment for some guidelines to determine the desired limits on diversions, and I don't know that we would actually support that, at this time.

We feel like that there's additional information that can be gathered from the water management and the transit loss study, and are very willing to work with the District in putting that stuff together.

The next issue that we've got on here is the irrigated acreage, and on irrigated acreage, Kansas and Reclamation have been concerned about the verification and the tracking of the district's acreage, and I would also have to say that the District has been concerned about that and willing to work on that issue. Kansas proposed an amendment to address the irrigated acreage issue. We're working with the District to provide them some dollars out of our field services program again, and have developed a, or have a base map and are in the process of working with the District providing them dollars to develop a data base in order to identify those acres. So I think that effort also is going well as far as getting identification. Now, the District has committed to actually putting down a process by which they will go through and verify that acreage. I think what we are doing is providing them the tools to do that, as far as the base map, and the data, and the dollars for developing a data base. As I believe the State is also contributing to that.

Reclamation agrees with Kansas that the District procedures shall annually document the lands receiving water and they need to verify, be able to verify those acreages and also make sure that we can determine what the acreage cap is on an annual basis. So I think the process is being developed, I think the tools are there, it's going on and I see that one is one that we can probably come to some resolution relatively soon, because I think it's all starting to come together.

We do not support the existing amendment or the amendment that Kansas proposed. There's a couple of items in there that put us in kind of an awkward position and so we can work with that and get that resolved.

The next issue is the temporary storage and release of flood flows. As I understand that, Colorado has presented a letter that identifies the criteria and the written confirmation as to how they address this issue, which I think probably meets our requirements, I don't think we have been interested as far as Reclamation in that becoming part of the Operating Principles, but I think that would be discussed later on today, and I would defer questions on that, to the State Engineer's Office.

The last issue that I have down here is stockwater. There's been a lot of activity on stockwater. There was a temporary amendment to the Operating Principles on stockwater last year, that got signed, and actually it was operated last year and, as I understand it, it went very well. There was good response from virtually everybody. As I understand it, the stockwater amendment is, I think pretty well hammered out, but I never cease to be surprised at these things as to what is and what isn't hammered out. I think we support it, we supported it last time, and I believe that will come up later on today, also, as far as addressing an amendment on the stock watering. But that one is one that I think has been exercised considerably, and I see, I hope I see, an end to that issue. That pretty much concludes my summary and my remarks concerning the Trinidad Operating Principles, and I will entertain any questions.

MR. AURELIO SISNEROS: Are there any questions for Mr. Garner?

MR. DAVID POPE: Jack, could you be...can you be a little more...develop habits and have to break them. Can you be a little bit more specific about your concerns about the draft Resolution that we proposed in October regarding the irrigated acreage verification issue? You mentioned that Reclamation had some concerns about that.

MR. JACK GARDNER: I think, David, one of my concerns in reading that was, and I don't have the language right here in front of me, but it was, the responsibility was pretty much put on the Reclamation to verify that acreage on an annual basis, and I don't think Reclamation wants to get into the position of being the river cop or the irrigated acre cop on, in that area, so I think we agree with you that the acreage needs to be verified, but I think it can be verified by virtually anybody. We want to set up a tool so it can be verified by virtually anybody and not have Reclamation have responsibility for that verification, although we may be one of the people who verify that if we, so, you know, if we think that that's appropriate, but I don't know that we want to necessarily be responsible for that verification. So that, that's the type of thing I'm talking about. I don't think that's something we can't resolve.

MR. AURELIO SISNEROS: Any other questions? Thank you, Mr. Garner. 6-B, "U.S. Army Corps of Engineers," Lieutenant Colonel Thomas (sic).

LTC FALLIN: Yes sir, Good Morning Mr. Chairman and members of the Administration. Right now I've got Mr. Dennis Garcia and Mr. Dick Kreiner handing out copies of the reports for the calendar year 1999. Dick, as most of you know, is my water god, he manages water operations for me at the District level. Dennis is the mini water god that works on the Arkansas River Basin. Additionally, with me, if I could introduce them, I have Mr. Mark Stark, who is my Operations Manager at John Martin Dam, Mr. Van Truen, who heads my regulatory office in Pueblo, and Mr. Key Merchant, who is my Operations Manager at Trinidad. It's an honor to be here today and issue a report on our activities within the Arkansas River Basin in 1999.

As you all know, a significant flood this year along the Arkansas River Basin and most of its tributaries and Fountain Creek, that began on the morning of the 29th and the Arkansas River began, essentially on April 30th. Our peak flow through the Arkansas River, at this time, was measured at 30,000 cubic feet per second before reaching John Martin, then I'm going to go through a couple of the reservoir operations during that event.

On April 30th, at Pueblo, we cut our releases and began to capture inflow to mitigate damages downstream. Peak reservoir inflow was measured at a little bit over 10,000 cubic feet per second and was recorded on April 30th. The project had been operating under a deviation.

On May 2nd, the Bureau of Reclamation requested a change to the existing deviation. We approved that on May 3rd, which allowed us to store full capacity in the conservation pool. And by May 8th, we had reached the top of the conservation pool and began to pass inflow into the reservoir.

On Trinidad, we saw a significant increase on the morning of April 30th and began to store inflow. Peak inflow there was 3,000 cubic feet per second and occurred on May 3rd. On June 20th we had reached the top of the conservation pool for the first time and adjusted our releases accordingly. And then on August 8th, we achieved a new record pool elevation for Trinidad. On John Martin itself, we began to see significant inflow on the morning of May 2nd, as the flood waters reached the reservoir. We topped off on May 2nd with the conservation pool, and achieved a maximum inflow there of 3,600 cubic feet per second on May 3rd. Our elevation continued to rise, we eventually filled 43 percent of the flood storage space, and at that time we entered flood release criteria, which managed our release at 3,000 cubic feet per second at the Coolidge, Kansas river gage. We continued releasing through early July until we evacuated all of the stored flood water, at that time.

Construction activities, especially on John Martin, related to the flood events, we did find a small slide on May 6th regarding the Burlington Northern Santa Fe Railway embankment. We notified the railway at that time. They placed a speed limit on traffic and then eventually placed 69 rail cars of riprap to stabilize the slide and protect the embankment.

On Fort Lyons levee, May 12th, we saw sand boils there, while they were not going to violate the integrity of the structure, we went ahead and contracted out to build a stabilizing berm on the hospital side of the levee.

On the south wing dam, also on May 12th, we noticed seepage. Again, it wasn't an integrity issue, but we went ahead and contracted to construct a seepage control berm at the toe of the wing dam.

Overall, for the flood event, we estimate we prevented about 63 million dollars worth in damages.

We did complete hydrographic surveys on Trinidad and John Martin in June of 1999, published new Elevation Area Capacity Tables, and implemented those on November 1st of 1999.

Now, I would like to go through some of the, some of the planning efforts that we've got ongoing within the basin.

First, that we've talked to before, we have completed a Planning Assistance to the States Program in conjunction with the Colorado Water Conservation Board. We completed that study in August of 1999, which dealt with channel capacity issues and riverine habitat below John Martin Dam along the Arkansas River. At that point we identified five problem areas that I addressed earlier this morning and they are available under our 1135 Program to pursue those, should someone wish to do that.

Additionally, we have another Lake Hasty Aquatic Habitat Restoration Feasibility Study on the 1135 Program which was completed in August of '98. The recommended plan there, we're looking at routing five to eight cubic feet per second through Lake Hasty, and to try to improve the aquatic habitat conditions in the lake. We completed detailed plans in November, 1999. Right now we have a potential project sponsor of the Colorado Division of Wildlife. They're anticipating funds becoming available in July of 2001, and we're expecting construction, right now, in the winter of 2001 to 2002.

Additionally, we have conducted a feasibility study along Fountain Creek to determine the extent of riparian wet meadow habitat that may be restored. Feasibility study will be completed next month and the potential local sponsor for that project is the City of Pueblo.

Under our Section 206 Program, we are conducting a feasibility study for improving fish and riparian habitat, and while nine miles of the Arkansas River downstream of Pueblo, we held scoping meetings in November and planned a final feasibility report in December of 2000. Last year, the FEMA has selected us as the Study Contractor for Flood Insurance Study for Oak Creek through the City of Florence, we have studies ongoing right now, it will be complete next year.

Regarding the Regulatory Program, in 1999, we had, we issued eight individual permits in the basin and additionally looked at 182 activities which most were covered under nationwide permits.

As far as Emergency Management Coordination goes, using our Public Law 84-99 Authority, we will repair three flood control works damaged during the May '99 flood. The three projects are located in Pueblo on the Arkansas River, at La Junta, and Las Animas.

La Junta channel, we originally constructed in 1956. After 40 years it's probably only providing an eight year level of protection. The May '99, flood event overtopped and breached the levee, which most of you all know about, and we have currently requested to repair the damaged levee at federal costs.

Las Animas was built by us in 1979, provided say, a 200-year level of protection, also incurred some slope protection damage, during the flood, which we intend to repair at federal cost.

The Pueblo levee project was built by us in 1990, additionally, provides a 200-year level of protection. Again, it incurred some slope protection damage, during the flood, which we intend to repair at federal cost.

Overall, during the past year, the Emergency Management Branch, my office received 22 contacts from local governments and private citizens along the Arkansas River Basin.

Sir, pending your questions, that concludes my report.

MR. AURELIO SISNEROS: Questions from Mr. Pope?

MR. DAVID POPE: I don't believe I do. Thanks for a good report.

MR. AURELIO SISNEROS: Mr. Evans?

MR. PETER EVANS: No questions. We appreciate your support and we have a lot of work to do together.

LTC FALLIN: Yes, sir.

MR. AURELIO SISNEROS: Thank you Mr. Fallin.

LTC FALLIN: Thank you very much.

MR. AURELIO SISNEROS: Let's go to a C-2, "Cooperative Agreements: Ratifying Federal FY 2000 and Pre-Authorize Fiscal Year 2001 Gaging Agreements." And is that, who is giving that report? I've got a name here, Keith?

MR. KEITH LUCEY: I'm Keith Lucey, I'm Public Sub-District Chief in the Colorado District. I've distributed a report there in the format that has been used previously. We have additional copies that we'll put on the back table for other folks.

Proposed cost of the FY 2000 Program had been submitted to the

Administration. Four gages, the operation and maintenance cost of four gages are covered by the Federal CBR Program, this is Collection of Basic Records, as in the previous years.

During 1999...I'm going through items of direct interest to the Administration, the first two items.

The second item is, during 1999 USGS in cooperation with the Colorado State Engineer, completed a study to compare the power conversion co-efficient method to totalizing flow meters for estimating ground water pumpage, it's Water Resources Investigation Report 99-4221. I brought additional copies of this report and also we'll put on the back table. For those that don't want the entire report, we've got the four page executive summary. We have additional copies of that also.

Now, items of general interest to the Administration, USGS operates about 55 continuous recording stream gages in the basin, continuous recording gages of the three reservoirs, continuous recording water quality stations at 13 sites. USGS will conduct sediment data collection at about 15 sites, periodic water quality measurements on Pueblo Reservoir, biological sampling in five sites, and periodic water quality sampling at about 35 water sites. In addition, water quality sampling at about 165 wells, majority of those are at the US Army's Pueblo Chemical Depot facility.

There's several networks of ground water level measurements in the basin including the 70 wells in the lower Arkansas basin and 40 wells in the upper Arkansas.

Much of these data are available through the World Wide Web, through the Colorado District's home page. The URL is complete included in the report that's being distributed.

There's a cooperative program between the USGS, US Army, Coastal Research Service, and Natural Resource Conservation Service, to monitor precipitation, streamflow, water quality, and suspended sediment, at the US Army's Pinion Canyon maneuver site along the Purgatoire River and Fort Carson Military Reservation. These data are being collected to try to improve information, to make land use decisions at these sites. USGS will continue water quality monitoring for the lower Arkansas River between Pueblo and John Martin Reservoir in FY 2000, and also a tech report, prepared by the USGS in cooperation for Colorado Water Conservation Board, that describes high water table conditions at La Junta. The report is expected to be published in the Spring of 2000.

That would conclude a report on the activities from the Colorado District. USGS, Jim Putnam is here from the Kansas District for the USGS and he has some information to share about USGS activities in Kansas. Prior to that, I could field any questions you folks might have.

MR. AURELIO SISNEROS: Anybody have any questions?

MR. DAVID POPE: Might have a brief one. Keith, in regard to the second item on your report, the recently published Report 99-4221, I notice you indicate in there that study has been completed. I think I had understood through, I forget where I heard this, but that there was some continued effort to take additional measurements, is that correct?

MR. KEITH LUCEY: Right. This is the first year of the project. We did a report on just '97-'98 data, and there are plans for two more years to collect concurrent measurements with the PCC and totalizing flow meter methods to check the variability over time.

MR. DAVID POPE: I guess I appreciate that. I won't dwell on this point, but would note that, I think you're probably aware and others, that the method of measurement, and the issue and accuracy of that data, is still an issue of continued concern, I think between the States, as it relates to Compact compliance.

MR. AURELIO SISNEROS: Any other questions for Keith? Mr. Evans?

MR. PETER EVANS: No.

MR. AURELIO SISNEROS: Thank you, Keith. Mr. Putnam.

MR. JIM PUTNAM: Thank you, Mr. Chairman. For the record, my name is Jim Putnam with the Kansas USGS in Lawrence. I don't have a formal report necessarily, but I have two items here that I thought I'd let the Compact know about.

First thing, beginning in October of 1998, Kansas, Oklahoma, and Texas began a regional study, it's called the High Plains National Water Quality Assessment Program. There's really three components of this study. First being a Water Quality Characterization Study, investigation of the effects of land use on ground water, and an Urban Water Quality Study, in the Wichita area. Data collection in southwest Kansas on monitoring wells for water quality has been completed and the analyses are coming in. Nothing really to report at this time on that. We have a project hydrologist in our Lawrence, Kansas office that's running the Kansas operations. If there's any questions, I could get anyone that's interested his name.

There's been several monitoring wells installed within this project and some additional wells to be installed for continuous monitoring this spring. We're hoping to start the phase in the Wichita area for the urban study, spring or early summer.

The second item, part of our...we have an agreement with the Ark River Compact for operation and maintenance of two gaging stations, the Arkansas River, Coolidge, and then Frontier Ditch near Coolidge, those costs were submitted to ARCA.

In addition to that, this year, mid-year, we installed a water quality monitoring probe at the Arkansas River near Coolidge, Kansas. We had some reserve USGS funds to do that with, that water quality probe is interfaced with our telemetry equipment, that probe will measure, continuous specific conductance, as well as water temperature, and other probes can be added to that, turbidity, pH, et cetera.

At this time, we have spoken with a couple state cooperators about match money to keep that operational, still discussing that at this time, I believe there's some utility in that for irrigators in monitoring the water before they make a diversion of that water, so if there's any questions on that, I'll field that. That's really all I have at this time, I'll conclude unless there's some questions.

MR. AURELIO SISNEROS: Are there any questions for Mr. Putnam? I guess we have one, Mr. Miller?

MR. STEVE MILLER: This is always an awkward agenda arrangement but there's an item on here to ratify the GS contracts for the year that we're in, and also to receive some information so we can prepare a budget for next year. I guess we have an option, we can try and deal with that right now, or we can ask these gentlemen to come back after lunch when we do the budget, or maybe we can get the information from them so we can do the budget later and let them get on the road.

MR. AURELIO SISNEROS: What is Kansas' pleasure?

MR. DAVID POPE: Make sure I understand the question. In terms of the dollar values for the co-op gages, is that what you were...

MR. STEVE MILLER: Yeah, there's a couple of actual things that have gone on, it's probably the most confusing year, and this is probably the most confusing year because of budget uncertainties the GS is facing, an effort that they would like to be paid quarterly, which I think we dealt with, it's fairly complex, I don't know that we could solve it in two minutes. If we wanted to let them get on the road, what we probably need is your understanding that the Kansas contract is a 15-month contract rather than a 12-month this year, that's a one-time deal, just to adjust the cycle. That dollar amounts have been provided to the Administration for that 15-month contract and the 12-month contract with the Colorado District. I don't think there's anything wrong with those numbers, I don't think we would want to change the program to adjust those numbers, and then I've been given a ball park estimate that next year's estimate should be 6 percent higher than last year. If you're comfortable with those three items, I think we could let them go and we could ratify those contracts later on during the budget.

MR. DAVID POPE: Just from the standpoint of Kansas, conferring with my colleagues here, I don't think we'd have a problem with that approach if we recognize that these are ongoing data collection efforts and shifting to 15 months to make an adjustment doesn't cause me any heartburn, we just need to work through the budget process.

MR. AURELIO SISNEROS: Thank you, Mr. Pope. Mr. Evans?

MR. PETER EVANS: We're in agreement.

MR. STEVE MILLER: I'll go through the numbers then later on.

MR. AURELIO SISNEROS: Yes, later on, after lunch, we'll deal with that situation. Thank you, Mr. Putnam. Yes, Mr. Evans?

MR. PETER EVANS: Mr. Chairman, before we go on, I guess I would like to take advantage of this opportunity on the agenda, this report from federal agencies, to see if we can't take advantage of the investment of time and effort that was made over the last year to resolve some of these issues. The State of Kansas put a lot of time and effort into this and really appreciate the additional progress that was made this year in understanding what can work and what can't in some of these issues, particularly related to Trinidad Reservoir. On the irrigated acreage issue, I guess I would add the State of Colorado's concurrence that verification of irrigated acreage is very important and that we are certainly encouraged at the progress that is being made. The District has committed to identify acres at the beginning of the irrigation season that will be irrigated during that year, and not to change that during the irrigation year. And working with the Bureau then, it's clear that we can put together a process for verifying that. It's also my understanding that at this point there is no allegation, nor any evidence, that there is irrigation of acres in excess of the contract amounts or the limitation in the Operating Principles. And I trust that that explains the Bureau's reluctance, you know, to take on a verification responsibility. Faced with evidence or allegations that there was irrigation in excess of those limitations, I presume that the Bureau would be directly responsible for resolving those concerns. So, I think that we're making good progress on that front, even though it's not resolved at this point.

We also spent quite a bit of time addressing the concerns raised about the temporary detention of flood waters at Trinidad Reservoir. And through extensive discussion, starting here last year, or at this Administration meeting which was in Lamar last year, we made considerable progress in defining the criteria for temporary storage and subsequent release of flood waters from that Reservoir to the extent that I think we should reasonably be able to satisfy concerns of all downstream water users, including those in Kansas. That that temporary detention will not interfere with downstream uses of water in accordance with the Compact and water rights within the State of Colorado.

The Colorado State Engineer has provided a letter that I would like to distribute now, if you don't already have copies. He's addressed this letter to the signatories to the Operating Principles. The question had been raised as to whether these criteria shouldn't be added to the Operating Principles, and it's our view that they are not appropriate for inclusion in the Operating Principles, but that this letter from the State Engineer provides both the criteria and a commitment for suitable reporting and accounting, as needed, to address any questions or concerns that do arise in the future. So, I think we have been able to resolve those questions, reasonably, as well.

Which leaves me then with the question as to what to do with the stockwater releases, and you will recall that last year this Administration adopted, on a short term basis, resolution provided, providing for an improved administration of those stockwater releases. The concern was raised by the District, and some of the water users under the District, that the manner in which waters had previously been released for stock watering purposes was not effective and that in fact it resulted in a waste of water since the water delivered in that previous manner was not arriving at the stock ponds and not making beneficial use at the end as intended. And so we discussed, negotiated a revised set of release parameters, and we tried that out last year, and while there was some confusion as to exactly when we could begin administering that revised arrangement, it's my understanding that everybody is satisfied that water was delivered to the beneficial use, and that appropriate accounting and reports were provided to answer any questions as to how and when that water was delivered.

So Mr. Chairman, if I can, I would like to distribute a proposed Resolution that I would like to offer for the Administration's consideration, and what this does essentially, is to take advantage of the work that we have done over the last year, to provide a long-term permanent amendment to the Operating Principles incorporating the same basic revisions that we agreed a year ago to try, both in terms of the effectiveness of delivering that water for beneficial use, and our ability to account and provide reports on its use.

We have distributed this in draft form previously, so it should not come as any surprise, and I'm hoping that we can again make reasonable effort to resolve this issue in the form of this amendment to the Operating Principles. And I guess, maybe to start the discussion, I would move the adoption of this Resolution.

MR. AURELIO SISNEROS: Okay. I have a motion to adopt the Arkansas River Compact Resolution Amendment to the Operating Principles for the Trinidad Dam and Reservoir Project, regarding stockwater, watering during the non-irrigation season, can I hear from Kansas?

MR. DAVID POPE: Mr. Chairman, I'm not sure whether this is the appropriate time, I don't think we have a second yet to the motion, but I do have some comments that I would be happy to make about the issue and it would be in reply to the terms of...whether we do that now or break for lunch or...

MR. AURELIO SISNEROS: Yeah, I think this is going to take some...a little bit of work, and being after the lunch hour, I think maybe we should tackle this right after...the first thing right after lunch, give everybody an opportunity to maybe review this a little bit more. My understanding is that you folks have seen a draft of this prior to this and have had some discussion on it already, so why don't we do that, if...we will break for lunch and convene at about 1:15, and we'll address this issue at that time.

(Whereupon, the lunch break was taken, until 1:15, and the following proceedings were had:)

MR. AURELIO SISNEROS: Are we ready to proceed? I believe so. Let's hope everybody doesn't fall asleep after lunch. We're going to start with...where we stopped at was the Resolution on an amendment to the Operating Principles for the Trinidad Dam and Reservoir Project regarding stockwater during the non-irrigation season. Mr. Evans, do you want to address anything at this time with regard to that since you brought it up, kind of refresh everybody's memory maybe?

MR. PETER EVANS: Well, I think we probably need to hear some comments from Kansas. We...as I recall, I had proposed this Resolution, made a motion that we adopt this Resolution, and waiting for some reaction, some thoughts from Kansas.

MR. AURELIO SISNEROS: Mr. Pope, does Kansas have some comments?

MR. DAVID POPE: Yes, Mr. Chairman, we do. I guess, procedurally, do you know...procedurally, I'll proceed however you wish, but shall we get a second on the motion before we proceed with the discussion?

MR. AURELIO SISNEROS: Yes, I think that we should have a second on the motion.

MR. DAVID POPE: At this point in time at least, I would prefer not to, but I think it's perfectly acceptable if someone else would.

MR. AURELIO SISNEROS: For purposes of discussion?

MR. DAVID POPE: For purposes of discussion.

MR. TOM POINTON: I'll second the motion.

MR. AURELIO SISNEROS: We've had a motion on the Resolution, and seconded. It's open to discussion.

MR. DAVID POPE: Well, I think I would start by saying that I appreciated Peter's comments and the fact that there has been quite a bit of effort undertaken this year to deal with the Trinidad related issues, and certainly we've made our best attempt to try to, to try to deal with these various different issues. I think the...probably would be a little bit helpful, in terms of the specific comments on the particular stock watering proposal, to go back and talk a little bit about what happened last year and since, and then I would also like to talk about the interrelationship between that and some of the other issues. But last year, Kansas was asked to consider an amendment to the Operating Principles related to stock watering, we worked pretty diligently, I think, between the members of the Compact Administration and others to try to do that, and ultimately came up with a temporary amendment to the Operating Principles that then was used this last winter. I think it's...I want to point out that in that temporary amendment there was a clause that was included, that to paraphrase, basically indicated that Colorado and Kansas pledged their cooperation in the development and adoption of amendments to the Operating Principles for the verification and reporting of irrigated acreage for the project. So, even at that point in time, we identified that as a significant concern to us, and we have since, as well. So it is certainly our understanding and our desire to have that issue addressed but also be willing to move forward because of the conditions that we were advised of last year about the stock watering issue, it was appropriate to go ahead and deal with that, even though we were reluctant to do it, to some extent.

We...as has been mentioned, of course, the Bureau hosted two meetings, one in July and one in October, so that we could talk about the variety of issues related to the Operating Principles and try to get closure, as much as possible, on those series of issues, Jack Garner has gone over some of that material here today. A number of assignments were made to various parties during the course of those, corresponding to those meetings. We were asked to prepare a draft of a stock watering amendment, we did so on August 13th of 1999, with draft language. We were also asked to prepare our views on a number of other issues and we did that for the temporary detention of flood flows and prepared a draft amendment to the Operating Principles for that issue. We came back to that point, that was August 13th. Also, on October 13th we sent another letter, again in response to comments from our earlier meeting, that on the acreage verification issue, that if Kansas would like to propose language that would be considered. We did so, and submitted draft language to an extensive mailing list of all of the parties as we had done with the other letters, and that was again October 13th of 1999.

And finally, we addressed two other issues, the ideal headgate requirement issue that Jack Garner spoke of, and some issues that had come up regarding operations by the city of...some water rights held by the City of Trinidad and both of those last two issues were also sent October 13th, so there's a total of five fairly extensive letters and quite a bit of effort expended by our team of people to try to lay out our concerns in a real reasonable way and try to move forward so that we could put to rest many of these issues. Many, at least as many as we could come to agreement on.

We're, as we said in our discussion at the meetings and specifically in our October 13th letter about the acreage verification issue, that, I think we made it very clear, in the last paragraph of that letter, that we felt that was an essential item to be addressed before we could move forward with additional amendments to the Operating Principles. And our purpose in doing that was to make our position clear up front and so that there would not be misunderstanding.

At the time of the October meeting in Denver, about the Trinidad issues, there seemed to be substantial support for addressing this issue and relatively limited concerns, as I understood it, about the proposal, but yet we went on until today, when we heard a report from Jack, that was the first real feedback we have had about that particular issue, and now we understand that they're not in support for addressing that issue in terms of an amendment to the Operating Principles at this time.

So, having said all of that, we find ourselves in a position of being asked again to piece meal individual items that perhaps can be dealt with, but without also dealing with other issues of great concern to the State of Kansas. For example again, the irrigated acreage issue is one that we, I think that's one of the key components of the project, and reliance on the fact that we know how many acres are going to be irrigated by April 1 of this year, and that we can rely upon that. And we're still, continue to be willing to try to resolve these issues. I guess finally, I would say there's maybe gone beyond the particular motion, but I would speak to it then, now at this point of saying that the Operating Principles provide that they can be amended no more than once a year, we did amend last year, we're willing to consider additional amendments, but again, I don't think we should be trying to just make repeated amendments of individual items without more comprehensively looking about the items that we really think can be resolved.

Another one that has been outstanding, but hasn't been talked about today, is to actually include the updated list of the actual acres for each ditch in the project. I think the Bureau's report and recommendation recommended that that be done, it's logical to me, I think there's not a problem necessarily, that I understand about those particular numbers and, but yet here we are with partial things and not the rest.

So having said that, on the particular motion and the particular amendment that has been suggested, I believe it's inappropriate to consider that at this time in light of the other issues that are interrelated to this, and would simply continue to offer to work with the State of Colorado about the other related issues and try to resolve these things to the extent that we really can, but it doesn't appear that we are ready to do so today.

Now, I would like to ask Colorado and perhaps the District, in terms of any response or reaction to the various proposals and drafts that we did lay out, we've heard some from the Bureau, but we'd be interested in your views, Peter, and any other from Colorado.

MR. AURELIO SISNEROS: Peter, could we hear from you now, for Colorado?

MR. PETER EVANS: Sure, Mr. Chairman. I guess I'm, I'm not prepared to take the Administration's time to go through each of the letters at this point. I think it suffices to say that we found them to be very constructive and that it was a useful communication, and certainly demonstrated that Kansas was committed to following through on the commitments that we made a year ago to explore this. The letter from the State Engineer, the proposed resolution, and the proposal as to how we wanted to proceed with irrigated acreage were the best way that collectively we thought we could pursue all of those issues. I guess we don't see them as closely related other than that they all affect operations at one reservoir, or water supply provided by one reservoir. So I don't know whether the Bureau wants to add to that, I'm sure that the District is interested in participating at this point.

MR. AURELIO SISNEROS: Does the Bureau have any comments on that?

MR. JACK GARNER: Not at this time.

MR. AURELIO SISNEROS: Mr. Pope?

MR. DAVID POPE: I guess I don't have additional comments other than I...and in light of the assignment that we had last annual meeting and the efforts that they've put in, I would like to ask that the letters that I spoke of be made part of the record so that we'll have those available for referral. And beyond that, unless my fellow commissioners have comments, I don't know what else to say at this point in time.

MR. AURELIO SISNEROS: Okay.

MR. DAVID POPE: We do have extra copies of those available for anyone that would like to review them and I think the actual letters are here for each member, and also the copies, I think, of the drafts actually are on the back table as well.

MR. AURELIO SISNEROS: I would like to invite the District and see if they have any comments.

MR. JERIS DANIELSON: I think I'll address these issues when I give the District report, if I'm allowed to give that report, it's been deferred now for about four hours.

MR. DAVID POPE: If I might just ask one clarifying point too while those are being handled. Peter, do I understand you that Colorado would not be willing to add the additional amendment, the Irrigated Acreage Proposal that we made in October, is that my understanding?

MR. PETER EVANS: I think that's correct. That involved a role for the Bureau that they are not willing to take. So I'm not sure we have the...awkward to consider adding an amendment that the party that the burden would fall on is unwilling to take.

MR. DAVID POPE: Okay.

MR. PETER EVANS: Mr. Chairman, I'm not sure exactly where we are then, procedurally. I think that we've got a second for the sake of discussion.

MR. AURELIO SISNEROS: Right. You're right. No, I'm sitting here thinking, you know, you know this was something that was, you know, decided on a year ago to be done at this meeting and then it wasn't done. Apparently, am I to understand that Kansas did not receive the information required to make those decisions?

MR. DAVID POPE: Well, I think what I was trying to say, Mr. Chairman, is that we were asked to draft up a proposed amendment on this and several issues. We did that, it was made available by the time of the October meeting that was held on this issue in Denver, and we really didn't get any reply. You know, if there were concerns about it before today, we weren't advised of those, and so we find ourselves in a position of...you know, we're willing to support resolving that part of the issue but it doesn't appear that it can be at this juncture and we...so we're sort of left, I think, not in a position where we can act, whether we can defer this issue to next year or some other time, would certainly be an acceptable alternative to us. Our preference really would be able to deal with all of these issues that we can...even, I've suggested, I mentioned the irrigated acreage and particularly because that's an especially important one I think in this overall thing, but our preference would be to consolidate several of these, but I mentioned three or four that I think are doable if we can really just hammer out the final language and then maybe perhaps next year or the appropriate time, we could then act on a more comprehensive set of amendments to the principles. That's really the way it ought to be done.

MR. AURELIO SISNEROS: Mr. Pope, I mean, Mr. Evans?

MR. PETER EVANS: I'm always happy to speak up for Mr. Pope.

MR. AURELIO SISNEROS: Excuse me.

MR. PETER EVANS: But at this point, let me speak up on Colorado's behalf. Mr. Pope, I guess I feel like there has been a good exchange of information. Certainly an honest effort on your part, and I think a thorough discussion at our October meeting, in which we reviewed the reasons for, for example, not wanting to include the temporary detention criteria and the release criteria as part of the Operating Principles. So, while you made a proposal at that point, I think we did orally work through that issue. Similarly, on the irrigated acreage issue, I think we have pursued that discussion, there's, I think a pretty rational reason for not being able to move forward with your proposal. As I mentioned, the Bureau seems to be unwilling to accept that responsibility. We could consider that, that motion, maybe that will get the Bureau back up to the microphone and help us understand better their position, if you want that on the record. So, I mean, I feel like we have responded during the October meeting. We have brought forward the pieces that we can in as much specificity as is possible, right now. The District has indicated to us, and I think you will hear in their report, what their plans are for identifying and verifying irrigated acreage. You know, we've provided a commitment from the State of Colorado as to how flood waters will be detained temporarily, and then released, attempting to meet the concerns that you had raised, so while these aren't being all resolved in one comprehensive amendment, it seems to me like the resolution is here to the extent that it is possible at this point in time. The one area that we clearly need more work on is the irrigated acreage issue, and unless you have another amendment or proposal that we should consider, I think we've heard from the Bureau about as far as we have been able to get at this point. Seems that the Bureau has committed to it, sounds like they've represented, and I'll represent, that we've both heard from the District that they are willing to do it. You've heard Colorado's willingness to support this to make it happen, but we don't have it done yet.

MR. DAVID POPE: Peter, I appreciate those comments, and I did not mean to infer that there had not been dialogue and exchange between the parties, I was trying to be a little bit more specific in regard to actual resolution of that particular item that we felt pretty strongly about, related to irrigated acreage. Certainly, they acknowledge that we received the letter from Hal Simpson in regard to the release of flood waters temporarily detained, we, it's probably something that does deserve some additional dialogue as well, but it certainly goes quite a ways towards addressing the concerns that have been raised, I think as we probably mentioned there, we may need a little better understanding of the meaning of some of the exceptions at the end of the letter, but I think those things are something that are probably resolvable. And I guess we just, I think...at least I feel uncomfortable going ahead with another amendment to the principles at this time, without really having at least as much as possible these other issues able to be resolved as well, you know, each time we amend the principles, it's not a small matter, and there have already been a number of amendments, we tried to work closely with Colorado and the other parties to do that, each time we amend this, you know, it's my responsibility to take these proposed amendments to the governor, it's not just an action that this body can take unilaterally, and I have to judge pretty carefully, as well, how many amendments and for what purposes that it's appropriate to do. So, I just kind of think that's where we are.

MR. AURELIO SISNEROS: Let me ask a question here at this point. Mr. Pope, you alluded to five issues that are of concern, one, one being the acreage issue. Is there any agreement on the four other issues between Colorado and Kansas? Could there be an agreement on that, in view of the fact that only one amendment can be done on a yearly basis?

MR. DAVID POPE: One amendment to the principles can include several items.

MR. AURELIO SISNEROS: Right, right, but if we don't do it in '99, we've missed an opportunity here, I think. We could do one other thing, I don't know if this would resolve the issue, is that based on what information the District maybe can add to this, we can postpone the motion until after that report, and see what they can contribute to this issue.

MR. DAVID POPE: I think Jeris Danielson had indicated he would defer comment on the particular item here, but would comment during the District's report later, and that's certainly fine, so I'm not sure that we'll have...I think it's probably appropriate for us to decide this issue of the motion either, either acting on it or some other procedural matter that's appropriate and, you know, I want to make clear that it's not that Kansas is unwilling to deal with these issues, I think there are some that we are reasonably close on, but there's some work that's under way, and Jack has reported on, and some of the things that we've talked about in the past, and it may be helpful to be able to evaluate and monitor those things, as well, during this next year.

MR. AURELIO SISNEROS: The Chair would certainly entertain a motion, to amend that motion, to try to resolve this.

MR. PETER EVANS: Mr. Chairman, I wonder if an alternative...I understand that the State of Kansas would like to see some progress on the irrigated issue, irrigated acreage issue. At the same time, I wonder if an alternative would be, if we wanted to consider the irrigated acreage issue first. It's my understanding that we can adopt more than one amendment to the principles each year, we just aren't supposed to be meeting to consider amendments more than once a year. So that we could, for example, adopt two resolutions today, each making amendments to the principles in separate resolutions. Rather than trying to combine these, I would offer to withdraw Colorado's motion, the proposed resolution, in order to allow the State of Kansas to make their proposed amendment, by motion, concerning the irrigated acreage issue and maybe we need to discuss that issue first. Maybe we've got the wrong issue on the table first.

MR. AURELIO SISNEROS: Mr. Pope?

MR. DAVID POPE: Well, it's certainly fine if you would like to withdraw the motion. I'm not sure at this point whether that really resolves the issue, because I understood you to say earlier that Colorado wasn't going to be able to support the proposed amendment on the irrigated acreage at this time, at least unless there's some new version, I hate to do that on a fly here, that's always a little dangerous, and it probably is possible to resolve the concerns that the Bureau has raised, but that's hard to do here as we speak. I'm not quite sure why the Bureau is...what their reluctance is, I know they have plenty of things to do. It is their project, and that is kind of a key issue for that project, but nevertheless, that's their view that they have to decide on, so if you think it will help, that's fine, but I'm not sure it gets us to where we need to go. I'm wondering if maybe we shouldn't just table this matter until the next annual meeting or such other time as may be properly brought before the Administration. I guess in terms of...I don't hear a reaction to that, but maybe just procedurally, why don't I just make...I'll just move that we do table the motion on the amendment to the Operating Principles until next annual meeting or such other time as may be appropriately considered by the Compact Administration.

MR. AURELIO SISNEROS: We have a motion to table the resolution, do we have a second on it?

MR. PETER EVANS: Mr. Chairman, I'm not prepared to second that motion, I think we already have a motion on the floor that's been seconded. So what I was proposing was to withdraw the motion Colorado had made so that Kansas could...so that we could collectively explore this other amendment and I would be glad to second a motion by Kansas, for the sake of discussion, as a way of getting that on the table of having the discussion with the Bureau and the District to see if we can't resolve...come to some better definition of a solution at this point in time that would then make it possible also to agree on, on this resolution that I've already offered.

MR. DAVID POPE: Well, that's fine if you want to deal with it that way.

MR. PETER EVANS: Okay, Mr. Chairman, the State of Colorado would like to withdraw the motion that it made just before the lunch break proposing that the Administration adopt this resolution on stockwatering.

MR. AURELIO SISNEROS: So be it. We also have a motion now from Kansas?

MR. DAVID POPE: Mr. Chairman, at this time, excuse me just a second. I think procedurally, to proceed, to get the issue before us so we can have additional discussion then, I would move the adoption of the amendment to Article IV(B)(1) of the Trinidad Operating Principles and the language that's being proposed is the draft that was attached, or is attached, to my October 13, 1999 letter addressed to Jack Garner of the Bureau of Reclamation with distribution to all of the other parties, I think is a fair statement.

MR. AURELIO SISNEROS: Do I have a second on that?

MR. PETER EVANS: Mr. Chairman, the State of Colorado will second for the purpose of discussion.

MR. AURELIO SISNEROS: We have a second on that, it's open for discussion. Who wants to go first?

MR. DAVID POPE: Well, I think it might be appropriate at this point to call upon Jack to...maybe he can explain what the concerns are and if he sees any resolution to that. If not, we certainly don't want to move forward with something the Bureau is unwilling to support.

MR. JACK GARNER: Thank you.

MR. DAVID POPE: In general terms, at least, let me qualify that one.

MR. JACK GARNER: And, I don't think it's actually just the Bureau that doesn't want to be in the position. It says, "Bureau of Reclamation shall monitor compliance with the notice and confirm to Kansas by April 1 of the accuracy of the verification report." Unfortunately, I think the Corps has left, they also do not want to put us in that position since they are not here, I can say they did that. I think what we were really looking at is in your October 13th letter, and I believe it's the very bottom of your October 13th letter, actually the last two words says, "the procedures" and then the following page, that, the rest of that paragraph is really kind of where we would want to be, because the last sentence says, "The procedures should be sufficient to allow other water users and officials to determine whether the acreage limitation is being complied with from the documentation provided by the District." We find that acceptable. I mean, it's not up to us to be the traffic cop, it's available to all water users, or anybody else, to make that determination. In our opinion, it relates to the procedures that are set up to verify that acreage, and I think that is what the District, which we haven't heard from yet, was going to provide us with the procedures. We were providing them with the tools, the base map, the data collection, and dollars associated to develop that procedure, so we feel like if they develop a good procedure, then anybody can verify that information, including us. So we like that last sentence in there and think that would be something that could be woven into the language that you prepared in your amendment. And take us as being the responsible parties for that out of there.

My lawyer just advised me that I misquoted the Corps. Darn. Their concern was on the flood flow criteria, not on the irrigated acreage. Well, they're not here to defend themselves. It made a good argument though.

And I think what...let's see...in our November, or in our...actually, let's see, November 19th letter, we reference the fact that at the October meeting, we did identify this as a concern, so we identified having a problem with this in our October letter, and then we actually met with the District and with Colorado, and the idea was to report on that issue at this meeting. So I think Kansas has been aware of the fact that we had some problems with this, I guess we didn't realize we were going to try to resolve that issue right now, but now you're aware of, totally aware of our concerns about it, and giving you some ideas as far as language that would be acceptable to us. We just don't want to be in the position of being the cop for the valley.

MR. AURELIO SISNEROS: Are there any questions for Mr. Garner?

MR. DAVID POPE: Well, Jack, is it the sentence, the next to the last sentence of the draft amendment, is that really explicitly the one that's causing you the heartburn?

MR. JACK GARNER: Hold on a second here, let me get to that. Yes, it's the next to the last sentence. And I guess what I'm saying there is if you take actually what you had in your letter and you talk about, "the procedure should be sufficient to allow other water users and officials to determine whether the acreage limitation is being complied with," it's not Reclamation's responsibility, it's everyone's, but it's based on the procedures, again.

MR. DAVID POPE: I guess the concern we would have is who would do the monitoring of compliance if the Bureau doesn't do it, you know, I think it's an unreasonable burden for Kansas to have to go up and monitor the project for whatever reasons that we have as the only means of doing that, not saying that we can't and shouldn't be able to do some level of monitoring, but just seems like there needs to be some process to it.

MR. JACK GARNER: I think again, I would get back to...we feel the process is the key point is the District in the preparation of a process for the verification of the acreages, they have got a base map, we identify parcel numbers, by April 1 people identify the actual parcels they are going to end up irrigating, and then the District can provide a tabulation of the acreage and it won't exceed the cap, and you would know what that is. Now, anybody could go monitor that and verify those acres in the field, and what we're saying is Kansas could do it, we could do it, the State of Colorado could do it, anybody could go verify because they'll have the information. We just don't want to be put in the position of yearly having to go in and monitor what the District's doing, you know, the District's preparing. That's not to say that we would not do that, not on a yearly basis, but that we would not verify that information to make sure it's accurate, but I would think that Kansas or anybody else would have the same ability to do that.

MR. DAVID POPE: I think we're still...I understand your point, Jack, but seems to me like we need to have an understanding of who is going to do it. If you're unwilling, and I understand your points, that you've made here, I don't know if the State of Colorado is willing to do that. It seems like we are just left with this, certainly some reference to a process, but how that gets really implemented is our concern.

MR. PETER EVANS: Mr. Chairman, for the sake of discussion, see if I understand where this is headed. It sounds to me like what the Bureau would like to see is that the second to last sentence in Kansas' proposed language be stricken, the sentence starting line 15, "the Bureau of Reclamation shall monitor compliance," that sentence. Strike that and find a place then to take these two sentences from Mr. Pope's letter of October 13 and insert it into the language, maybe, maybe line 11, which starts April 1 of that year, period. You could put, what if you put those two sentences describing the development of these procedures, what needs to be in the procedures, what the procedures need to accomplish. In...at that point, before the next sentences would address that the preparation of a verification report by February 1 of the following year. Does that start to accomplish what it is we are talking about?

MR. JACK GARNER: I think if I follow you, Peter, that's getting close to where we were. I mean, we basically would like to take...you're correct in taking out that second to last sentence and then incorporating the language in, of the October 13th letter, Page 2 really, incorporating that into this, wherever it fits. It's just the general idea, so the ideas are there. And I understand Mr. Pope's concern about, if Reclamation is not on the hook to monitor this on an annual basis, then who is? And that's a good question. I think from Reclamation's standpoint, we would...we would probably monitor at least a portion of it occasionally, but that's not something that I would necessarily want us to be committed to in here, because one of the issues we have is under the Fryingpan-Arkansas Project, we have Reclamation Reform Law and we do extensive monitoring on the Fryingpan-Arkansas Project which is an expensive and time consuming process. The Corps project is exempt from RRA and for us to take on that responsibility in here, I'm not sure I have the authority to do that.

MR. PETER EVANS: Mr. Chairman, if I can explain a little bit, the reason I picked that point as maybe the spot at which you insert this reference to procedures, which clearly have yet to be developed, the language directly out of Mr. Pope's letter, but that's sort of the transition point in Mr. Pope's proposed language, at which we stopped talking about what's happening with the water and you start talking about the verification report. This reference to the procedures could leave a little flexibility as to exactly who's going to be doing what and exactly how the information is going to be gathered, put together into a report, but it doesn't change the language that Mr. Pope had proposed last October with the sense that the District would be the one actually making the report, regardless of who helps them come up with what information, and that if we could agree on something like that, maybe then we learn from the efforts that the State of Colorado and the Bureau of Reclamation are helping, are financing, to look at the, our ability to get this information. But it might be a good idea, unless Mr. Pope has a better idea of how this might come together, maybe what we need to do is take a short break.

MR. AURELIO SISNEROS: Why don't we take about 15 minutes here, or a little longer if need be. I think we can resolve this. It appears that it's just a matter of who's going to be doing the monitoring. So let's go ahead and take about 15 to 20 minutes and see if you guys can resolve this.

(Whereupon, a short break was taken, after which the following proceedings were had:)

MR. AURELIO SISNEROS: Could we reconvene, please. We'll hear first from Mr. Evans.

MR. PETER EVANS: Thank you, Mr. Chairman. Appreciate the opportunity to caucus with other participants in the State's delegation. I think that before we proceed with the discussion, we probably ought to hear from the District directly, especially given that they also are signatory to the Operating Principles.

MR. AURELIO SISNEROS: Mr. Pope, any comments?

MR. DAVID POPE: No, that's fine.

MR. AURELIO SISNEROS: Let's hear from the District.

MR. JERIS DANIELSON: Mr. Chairman, for the record, I'm Jeris Danielson, General Manager for Purgatoire River Water Conservation District. The District will not sign the proposal that Kansas has put before you. It's always nice since it's our water, our land, and our money to have everybody else talk about it. But, we just find the Kansas proposal unacceptable. Any questions?

MR. AURELIO SISNEROS: Mr. Pope, do you have any questions?

MR. DAVID POPE: Well, Jeris, I guess you really haven't explained why it's not acceptable and you don't have to go on, I mean if you don't want to comment on that, that's fine.

MR. JERIS DANIELSON: No, I don't care to comment. I haven't heard any explanation as to why the stockwater amendment was unacceptable. It worked very nicely for a year, and I haven't heard any objections to it. So, I guess it's quid pro quo.

MR. DAVID POPE: Do we have a motion then on the floor?

MR. AURELIO SISNEROS: We have a motion on the floor, would you repeat that motion?

MR. DAVID POPE: Mr. Chairman, the motion was to amend the Operating Principles in Article IV(B)(1) of the Trinidad Project to include the language related to irrigated acreage that was attached to the October 13, 1999 letter from myself to Jack Garner...is the general summary of it.

MR. AURELIO SISNEROS: Do I have a second on it?

MR. DAVID POPE: It was seconded.

MR. AURELIO SISNEROS: Oh, it was seconded, yes.

MR. DAVID POPE: We already had a motion that was just a...

MR. PETER EVANS: I think we are clear on the motion. Mr. Chairman, I would call for the question.

MR. AURELIO SISNEROS: Kansas?

MR. DAVID POPE: Kansas votes Aye.

MR. AURELIO SISNEROS: Colorado?

MR. PETER EVANS: Colorado votes no, based on the testimony of the District.

MR. AURELIO SISNEROS: And it does not pass.

MR. PETER EVANS: Correct. Mr. Chairman, if I could, before we move on then, I would like to reintroduce the proposal, the resolution that I proposed earlier this morning, just before the break, distributed, described as an amendment to the Operating Principles for Trinidad Dam and Reservoir Project regarding stock watering during the non-irrigation season, and I would move that as a proposed amendment to the Operating Principles.

MR. AURELIO SISNEROS: Do I have a second on it?

MR. TOM POINTON: I would second it, if I'm allowed to.

MR. AURELIO SISNEROS: Call for questions, or is there any discussion?

MR. DAVID POPE: Mr. Chairman, I think we have pretty well covered the discussion on the point, I won't reiterate that. Kansas is certainly willing and will continue to work towards resolution of these questions, but we just find ourselves in a position where we can't support this item in isolation and accordingly, Kansas will vote no on the motion.

MR. AURELIO SISNEROS: The motion does not pass. Let's continue, see where we were at here. I believe we were at item Number 7-A. Yes?

MR. PETER EVANS: Mr. Chairman, there was an expression of interest in a report on some of the activities of the Southeastern Colorado Conservancy District. As I indicated previously, no representatives of the District were able to attend today, however, Steve Miller, of my staff, was able to consult with them in advance and I think he can provide some information, especially if maybe there's questions.

MR. AURELIO SISNEROS: Mr. Miller, would you speak on the issue.

MR. STEVE MILLER: I can talk to the item there regarding the Needs Assessment. If there's interest in winter water storage, Steve Witte would probably be the better person. I've got a hand-out here. I'm not really prepared to talk about the entirety of this study. Conservation Board is contributing about $100,000 to the effort and I've been working with the District, but I am not the main author to be talking, certainly.

Let me give you these so maybe we can refer to them. I think what I should offer you is maybe just flip through a couple of pages in here, highlighting for you, tell you where you can go if you have some additional questions.

The Needs Assessment is a multi-party project coordinated by the Southeastern Colorado Water Conservancy District. It's been going on for a little over a year and a half now. Phase one of the study, I believe you were reported to the Administration last December. The first six or so pages that I just handed out are the objective summaries and the final report that came out in December of '98, that report probably wasn't final when Steve Arveschoug talked to you last year.

What phase one came up with, you can see on page Roman Numeral four of that hand-out. It's a need for additional storage identified by the participants of between 139 thousand acre feet and 173 thousand acre feet, a little table on Roman Numeral four of that hand out. And you can see identified there the participants that identified those needs. It was a little hard to mathematically calculate how much storage you need, but they did go through an exercise of looking at water supply and water demand, water conservation prior to coming up with these forecasts, but there's not a simple formula that you put in demand on one end and supply on the bottom and all of a sudden out the other side is the calculated amount of storage, so this number is somewhat soft. And when prices are applied to it you may find that some of the entities don't want all of the storage they identified, they may not be able to afford it, they may not think it's worth pursuing. But that's the target we had and we are now to phase two.

Phase two is described on the last three pages of the hand-out. There are six now seven actually, the storage options that are being pursued. I don't know if you want to go through each of these, I'll just tell you they basically involve a re-operation of the Fry-Ark Project as it is now configured so, no new infrastructure, but the changes to the operating criteria, how storage space is allocated between parties at, that have storage rights at Pueblo. And that may free up space for additional water supplies to be stored in the existing pools at Pueblo. There is a potential to enlarge Pueblo Reservoir, so rather than reassigning space, you create more space there. Likewise, an expansion at Turquoise. Lake Meredith is an existing reservoir that could be enlarged. Gravel lake storage would be new storage vessels created along the alluvium of the Arkansas or Fountain Creek.

Williams Creek Reservoir would be an entirely new reservoir, that's the only brand new construction.

We've added recently, a 7th option which would be non-structural alternatives, things like a water bank or dryland, dry year leasing of ag supplies by municipalities and we'll be exploring that one in some more depth.

I think the main thing the Administration should know in Kansas is that this is an open process. Likely any one of these options will require NEPA compliance of some type so there will be a public NEPA review. And the District and some of the participants are actually scoping out what the environmental issues might be.

Clearly, one of the environmental issues, issues you need to address in the environmental report are institutional and legal obstacles to your project, and at that point they'll have to address how these different options fit within the Compact and within Colorado’s water rights system. I guess the only thing to be aware of is that when you look at the 173 thousand acre foot demand for storage, none of these options are capable of producing that quantity of storage by themselves, so the preferred option that will come out of this phase two, next year, this spring of the year 2000, will be a combination of these. No one thing will meet the entire demand. Of course we also expect as pricing is developed for these, the demand may change also, probably go down. I would call 173 thousand, a wish list, if storage was free, this is what we would like. When a price tag gets put on it, some people may opt out of the program.

I know Larry Gennette, from Mark Rude's office came to one of our meetings fairly recently, certainly welcome to do that, I don't know if you're on the mailing list, but you could do that also and maybe save yourself a drive to Pueblo but receive all of the materials as they are issued. With that, I'll try and answer any questions, but I hope there aren't any.

MR. AURELIO SISNEROS: There being none.

MR. PETER EVANS: I do have some more handouts.

MR. DAVID POPE: That's fine. I won't take any time, I think Steve already alluded to, in his comments, in recognition that as, when studies went forward, then there would need to be recognition of the institutional requirements and certainly the Compact and obviously our interest in protecting usable Stateline flows.

MR. AURELIO SISNEROS: A lot of the facilities are federal facilities, but even if we go to non-federal, we probably have to deal with 404 issues.

MR. DAVID POPE: I take it from what you've said, and what I see here in the report, that the study thus far has not included an analysis of that issue yet, is there?

MR. STEVE MILLER: Not in written product, but, I mean, certainly have been discussed. A lot of these water rights...a lot of the storage, for instance if you're looking on the table, Colorado Springs, 45 thousand acre feet of storage, their water supply that would go into that water space would probably be transmountain water that they are currently leasing or allowed to run into the system. Now, has anybody matched up what their transmountain supplies are versus that quantity of storage? They, perhaps have, but we haven't discussed it on the regional basis of the Needs Assessments. So each entity needs to have its own plan for how they are going to fill that space. There isn't a single regional plan for filling the space. Different entities...some of the agricultural water rights that they are currently leasing back to the farmers. They may go ahead and convert those to M&I water and store that into something useful. No single answer. If there's questions on winter water, Steve Witte is right here, and he probably hopes like I do, that there are no questions.

MR. AURELIO SISNEROS: Thank you, Steve. Let's move on to item B of 7, Mr. Danielson. "The Purgatoire River Water Conservancy District, Status Report on District Operations."

MR. JERIS DANIELSON: Thank you, Mr. Chairman. Again, for the record, I'm Jeris Danielson, General Manager for the Purgatoire River Water Conservancy District. With your permission, I would like to hand out a couple of reports to the chairman and to the Colorado, or to the commission representatives.

Mr. Chairman, we appreciate the opportunity to appear before the Administration and deliver what I believe is the first annual report that the District has provided to the Administration. What I've handed to you is my written report, and I will just hit some highlights. And then the second report with all of the numbers on it, simply is an example of the kind of accounting that the District has developed in terms of the operation of the Trinidad Project. It's the daily accounting sheets that we utilize to administer the waters in Trinidad Reservoir, and I think you can see that we have reached a fairly sophisticated level of definition in terms of that accounting. For those of you who may not be aware of the Purgatoire District and what it is, it is a quasi municipal entity created under State statute, Title 37, Article 45, so the District is a creature of state government. The District was authorized to go into existence on December 2nd of 1960. And the reason for the creation of the District was to create a repayment entity to reimburse the United States for the irrigation component of Trinidad Reservoir.

On February 10, 1967, the District executed a repayment contract with the United States, whereby we agreed to pay $6,465,000 back to the Federal Treasury as repayment for the irrigation component. The repayment period is a seventy year period, our annual payments vary from a low of $118,000 a year to as high as $238,000, which is a substantial burden for a District as small as the Purgatoire District.

The District is governed by a board of nine members. These members are appointed by the senior judge sitting in Trinidad, for Las Animas County, and they serve, there is no term limits on them, they serve as long as the judge is happy with the job they do.

Day to day matters are administered by our Water Coordinator, Dawn Lafonte (sp?), I think all of you have met Dawn at one time or another, she maintains a full time office in Trinidad and deals with the daily Administration of the reservoir as well as the Administration of water calls placed by the participating ditches.

The main feature of the Trinidad Project is Trinidad Dam, itself. The structure was built by the Corps of Engineers. It is, has a full capacity of 125,967 acre feet. And that capacity is broken into four different accounts or pools. Flood control is 51,000 acre feet. The irrigation and M&I, which the transferred Model Right is 20,000 acre feet. The permanent recreation and fishery pool is 15,967, and the joint use and sediment pool, which is also part of the irrigation capacity, is 39,000 acre feet.

The irrigation and joint use pools are utilized to provide storage for irrigation by the 11 project ditches of up to 19,717 acres, within the project area. Now, I have 19,499 here, that's as proposed by the Bureau of Reclamation and the Amended Operating Principles, that we've had so much discussion about. But the Operating Principles right now allow the irrigation of 19,717. During the '99 irrigation season, we, as everyone else, thought early on we were looking at a very, very poor water year. My forecast in April indicated we would have 10 days worth of water in the reservoir and then it would be empty. We all know what happened. When we try and second guess nature we always get a surprise. And, for the first time in the history of the reservoir, we filled the conservation pool to a level of over 72,000 acre feet. There's always discussion about the amount of water that is diverted by the ditches in the Trinidad area, the overuse, some would allege. If you look at the first attachment to this report, you'll see that the average diversion, not consumption, but diversion by the ditches and the project this year was 2.84 acre feet to the acre. This includes reservoir storage as well as direct flow.

We had one incident this year the Model Land and Irrigating Company, which is one of the largest participants in the project, was unable to utilize their intake canal as a result of some very heavy rainfalls and flooding and with the permission of the Secretary of Interior, and I would add I appreciate the help that we got from District 67's Fort Lyon Canal Company, the Model was allowed to irrigate beyond the mandatory end of the irrigation season, which is October 15th. They, in fact irrigated only four days beyond that and ceased operations on the 19th of October.

The project ditches diverted 612 acre feet of stockwater for the calendar year, based on the temporary resolution that was approved by the Administration last year. That, the operation under that resolution, worked extremely well for our water users. We were able to divert far less water for stockwater simply because we were able to time those diversions rather than be dependent on the five CFS limitation that is in the existing Principles. It was a, I think, a very positive water saving measure that we were permitted to operate under last year and it certainly proved itself, in fact, in terms of how it worked.

The Corps of Engineers and the Colonel, I think, indicated that sediment surveys were done at Trinidad Reservoir this year, and the joint use and sediment pool was reduced by 1,227 acre feet of capacity, as a result of sedimentation in the reservoir itself. Since the construction of the dam, we have lost ten percent of that joint use capacity to silt. I, too, would join with the Bureau in applauding the Corps on their flood control activities this past summer. Dick Kreiner and his people did, I think, an outstanding job and deserve to be recognized for that.

Future activities, the District is committed, more or less, to two projects that we're looking at. We've executed a three year contract with the Bureau of Reclamation to begin to develop transit loss numbers for all of the canals in the District. The Bureau has provided $125,000, the District is matching that with $50,000, and at the end of the three year period, we expect to have an excellent handle on what canal losses are within the Project area.

This, of course will help the District board when it makes it's allocation each year of available water to each of the ditches.

The second item you see there is verification of irrigated acreage. Based upon what went on today, I'm going to ask the District to reconsider whether or not we want to participate in what will be, I think, a rather expensive proposition. As someone mentioned early on in the meeting, there is no allegation that the District is exceeding the irrigation cap. We monitor, we are comfortable with our monitoring of that. We have had paid a person three or four years ago to go out and put footprints on every farm, every field, in the project, to define the acreage that's there, and I performed spot checks throughout the summer in terms of acreage that is being irrigated. Each year we require the ditches to report to us what acres they'll be irrigating. And, until they furnish that report they are not allowed to divert water. So we are very comfortable that we are well within the acreage limitation cap, and I think we'll revisit the issue in terms of whether we want to participate in any further activities.

With respect to the conversations in debate that went on over the stockwater issues, and the other issues, Mr. Pope asked that his letter of October 13th be admitted to the record, I would ask that the Bureau of Reclamation furnish all of the documentation that they have with regard to the two meetings, and the other matters that have gone on this past year. I think the record should be complete and I would not want to leave the impression that it was only the State of Kansas that was working very hard. All of us worked hard in those meetings to try to come to some conclusion on some of these issues, and I think it's very regretful the results that we see here today. As a result, in fact, in anticipation of the activities that went on here today, the District board met in executive session last week and my instructions are that unless there is real progress and good faith effort in moving ahead on the Operating Principles, we will not be participating in any further meetings that the Bureau will be conducting until we have an indication that we can make some progress. That's all I have, Mr. Chairman.

MR. AURELIO SISNEROS: Thank you. Are there any questions for Mr. Danielson? Mr. Evans?

MR. PETER EVANS: Mr. Chairman, thank you. Jeris, I understand that the District would be frustrated at this point in these discussions, we have all put a lot of work into these issues this year, and you're absolutely right that the record should reflect everybody's contribution, the District, the other water users, the States, and the Bureau. I would hope that we can continue this discussion, and I would ask that you mention to your board members that if we are able to put together another proposal, one that in consultation with Kansas, we think we could gain full support for addressing the stockwater issue and the irrigated acreage issue, that I would be happy to see if we couldn't arrange a special meeting of this Administration, since we haven't made any amendments in the last...right now, I think that that opportunity would still be open. We have had special meetings in the past and I believe we can do that again in the future, but we can't do it without everybody working together.

MR. JERIS DANIELSON: I certainly understand that, and if you're able, you and Kansas, to come up with language that we like, we'll certainly let you know that we like it.

I heard the State of Kansas say today, these issues are all interconnected, I believe there's five or six. Two of those issues aren't even in the present Operating Principles. The concept of ideal irrigation requirement is some quirky term that came out the Bureau's staff, that doesn't even appear in the Operating Principles. So, if we're going to hold hostage stockwater, which we have proven is a more efficient way to do business, so that

Kansas can try and insert into the Operating Principles, ideas that are not even there now, the District isn't going to participate. We're open, you have our number, you know, we want to get these issues resolved, but we just...I'm not able to participate in what I think is less than productive effort that we have had in the past. Any other questions?

MR. DAVID POPE: Jeris, I would just simply say that I think it is a mischaracterization frankly, and not an accurate portrayal of the efforts that all of the parties put into trying to deal with these issues this last year. You know, I guess I'm disappointed in the, in the reaction. I understand that you would be frustrated, but I think we put a lot of effort into these issues this last year, we made two trips to Denver at substantial expense, we studied out a number of options and put those on the table in good faith. You know, I guess we just, as I've said before, feel like there needs to be fair consideration of the concerns of all parties and that's all we were attempting to do.

MR. JERIS DANIELSON: Well, let me state that the issues of the operation of Trinidad Project were fully aired before the Special Master in *Kansas v. Colorado*, and the Special Master found, I believe, that the operations of the Trinidad Project had not materially depleted the flows of the Arkansas River, and went on, I think, to direct Kansas not to unreasonably withhold approval of the Operating Principles amendments. Why do we amend the Operating Principles? We amend them, not to seek in some administrative forum what we lost in court, we amend them to make the Project more efficient. And the stockwater resolution, while it's a very small item, is one where we have a track record. The facts are it is a better way to do business, and yet we can't even get approval of that because it's held hostage with some other issues, that aren't all just wonderful, that Kansas might like to have on their Christmas tree, but could be very detrimental to the operation of the Project and to the District. So, until we come to the conclusion that we're going to try and make the

Project work better rather than achieve whatever it is we are trying to achieve in terms of some other agendas, it's not going to be successful.

MR. DAVID POPE: I think our dialogue probably is not going to be productive much further, yet, here this afternoon.

MR. JERIS DANIELSON: It hasn't, for a year.

MR. DAVID POPE: I appreciate your comments. I think the decisions of the Special Master need to speak for themselves in terms of what was provided for and what we have tried to accomplish. It's certainly not been unreasonable in my view, and I think a fair reading of the concerns that have been expressed, several years back, in terms of the Bureau's reports and virtually all of the other parties about simply wanting to have a process to know what's going on with the acreage is a fair observation.

MR. JERIS DANIELSON: Well, I want the record to reflect that the District considers Kansas' position, particularly today on the stockwater amendment to be absolutely and unreasonable withholding of approval of an important piece of the Project that could be made more efficient and result in more water for everyone, and I hope the record reflects that.

MR. AURELIO SISNEROS: Tom?

MR. TOM POINTON: Jeris, I have a question. Because the failure of the stockwater amendment, what is the procedure going to be in the year 2000 in regard to stockwater releases, as you see it?

MR. JERIS DANIELSON: We will operate it under the letter of direction from the State Engineer of Colorado, who was a fair, unprejudicious character at the time it was signed, that directs that water will be run at five cubic feet per second, and we will start that as soon as possible, and we'll probably run it, I expect we will probably run certainly up to the 1,200 acre feet, and we probably will put in storage less than half of the water that we put in storage last year, utilizing 600 acre feet under a different mode.

MR. AURELIO SISNEROS: Any more questions? Thank you, Mr. Danielson.

MR. JERIS DANIELSON: Thank you, Mr. Chairman.

MR. AURELIO SISNEROS: Let us proceed. Item 8, "Approval of Transcripts and/or Summaries From Prior Meetings; A. Approval of December, 1998 Annual Meeting Minutes," by Lee Rolf.

MR. STEVE MILLER: Mr. Chairman, if I could, I'll talk for Lee, this is Steve Miller.

MR. AURELIO SISNEROS: Yes, Steve?

MR. STEVE MILLER: I think I've got the next three items here, and I'll save Lee a trip up here. I might also let everybody in the audience know, these are all pretty much administrative, internal business items, so if you have a plane to catch, or a car you want to get into, I think it's safe to leave now, we're done with the substance of the meeting.

On the approval of the minutes, the 1998, December meeting, there was a transcript prepared by the reporter. Through miscommunication and press of other business, we didn't get around to editing that transcript. Colorado now has a copy of the draft, and Lee and I have talked, and probably use some time in January to begin the editing process on that, and so hopefully, if we have a special meeting next year, certainly at next years' annual meeting we'll have it approved...set of minutes for the '98 meeting and the '99. We just basically dropped the ball for '98. That's happened before by the way, and we've survived. We've got the words but we don't have an approved version.

In 1999 we had two special meetings, they were noticed, they were held by conference telephone call. I just thought for the record, we might indicate that on June 14, '99 we met over the phone to see if we could find a way to top off the permanent pool of John Martin during flood conditions. ARCA did adopt the resolution, but we were unable to reach agreement under the terms of that resolution to put extra water in the permanent pool. There's a set of minutes that we've drafted, they are verbatim. We furnished those to Kansas and Kansas is reviewing those and should have a signed, approvable set of those at our next meeting also.

Then in August 4th, '99, we had a special meeting, again by telephone conference call. Purpose of that meeting was to revise our bylaws to allow meeting on today's date, rather than the date that was required by the bylaws, and we further moved to change the meeting date to today from the date next week, when it would have been required under the old bylaws. There's a set of minutes for that that have been drafted, and Kansas is reviewing those.

Lastly, the December, '93 minutes, like I said, we don't always get them done in time. That's the longstanding one, the circumstance there, for your information, Mr. Chairman, was, the court reporter died before we could get the edits done. He used a fairly old system, so we couldn't even work from his notes, so we took tapes of the meeting and we reconstructed verbatim. I need...that's a draft that I have not furnished to Kansas, Lee and I agreed, about the time he gets me the '98 minutes, I'll give him the '93 minutes, so again, we'll have those approved next meeting.

And that would conclude the item on the minutes. I will mention, the District has asked for copies of those minutes, we don't give copies of minutes until they have been approved by the Administration, and at that point, they are available to purchase by anybody, just for the copying cost.

We can move to 9, if you would like.

MR. AURELIO SISNEROS: Yeah, let's go ahead and move onto 9.

MR. STEVE MILLER: Annual Reports have been, it's my responsibility to prepare them, take them to their review process, and get them printed. I'm kind of caught up in the same situation as the Operations Secretary and Assistant Operations Secretary though. The information I use in doing the Administration's Annual Report is largely information from the Operations Secretary. I have drafts of, let's see, '94, '95, '96 and probably part of '97. I think it's unlikely though that Kansas will be able to approve them, or for that matter, Colorado, until we resolve which version of the Operation Secretary's accounting is the correct one, and until we, in fact, approve the Operation Secretary's Annual Reports, so they are somewhat in limbo, there's some work I can do to be prepared. The '94, I thought was approved, footnotes that we talked about this morning, those same footnotes go to the Annual Report. So both '94 and '96 had, with the Administration, ratified the Operation Secretary's Report for those two years, could be distributed for approval, review and approval. Certainly don't want to print them though until there's certainty that the accounting is the version that both States agree on. If we are unable to do that, the Compact requires an Annual Report, and so we're negligent in doing that.

Another option would be to direct me to prepare a report with two sets of accounting. I think that would be very confusing for people that rely on those reports down the road, but that would be another option. It's kind of late today, I don't know if we want to come up with a game plan, maybe you could assign that to the Operations Committee when they hold their meeting in 60 to 90 days, to also discuss how we want to proceed on any reports.

MR. AURELIO SISNEROS: Do you have any comments on that, Mr. Pope?

MR. DAVID POPE: That would make sense, because in the essence, the issue that the Operations Committee has been asked to look at is essentially the issue that relates to the, to being able to do their Annual Reports. So, probably makes sense to tie that together, then we just need to come up with a game plan.

MR. AURELIO SISNEROS: We'll do that. Assign that to the Operations Committee and we'll get to them in a little bit, on changing the chairs, I think on that one. Was there anything else?

MR. STEVE MILLER: Well, I'm going to do number 10, if you're ready.

MR. PETER EVANS: Before we move on, I had proposed earlier in the meeting that we try to bring to closure the question about conditions that were left in the '94, or the acceptance of the '94 and '96 Annual Reports of the Operating Secretary, and I'm hoping that we can quickly agree on that. Although, as a practical matter, looking at the resolution, I think it's relatively clear now that the footnotes that were called for have been provided and added to the report. So I'm not sure that any additional action, in a formal sense, is required of the commission or the Administration. I just was thinking that maybe was clean to get that resolved.

MR. AURELIO SISNEROS: What is your question, Mr. Pope?

MR. DAVID POPE: I think as a practical matter, that's probably correct, Peter. What we were going to do, and...we keep dealing with these various issues, but we were...the only thing that has really not been checked is just which tables, you know, there's reference to the specific tables, and see if all of the right ones had the footnote. I'm confident that they do, but that was what we were going to check, and we didn't have the capability of doing that. We should have got it done before the meeting, but it was just something that we weren't thinking about, and we can double check that by the time of the Operations Committee meeting, and if we have something, we can bring it up at that time, but otherwise, I think we can just assume that this reflects adequately what was done, would that be fair?

MR. AURELIO SISNEROS: Could we do that in a motion?

MR. DAVID POPE: I don't think we need a motion on that one.

MR. AURELIO SISNEROS: No motion for that?

MR. PETER EVANS: We're satisfied without a motion.

MR. AURELIO SISNEROS: Colorado is satisfied, is Kansas satisfied?

MR. DAVID POPE: Yes.

MR. AURELIO SISNEROS: Thank you. Steve?

MR. STEVE MILLER: I could go into Item 10, financial matters.

MR. AURELIO SISNEROS: Please.

MR. STEVE MILLER: Some of these can be...I'll stay here but Jim may talk to some of these. Mary Louise, you're the first item, Recording Secretary's Report, do you have anything that you need to report?

MS. MARY LOUISE CLAY: I think the August report has been sent out, and I need some signature cards taken care of, and other than that, I think everything is fine unless you have questions for me.

MR. AURELIO SISNEROS: I have none.

MR. STEVE MILLER: The Recording Secretary keeps the Administration's files in Lamar at the Municipal Office.

MR. AURELIO SISNEROS: Okay. We'll take care of that after the meeting. Treasurer's Report, Mr. Rogers?

MR. JIM ROGERS: The Treasurer's Report as of 12-2 of1999, the assets, I think I passed out the Audit Report, and the assets amount to cash in the bank, in the bank account for three hundred twenty-six sixty out of the, in the checking account. The money market is ninety-seven two forty point sixteen, for a total of cash in bank accounts of ninety-seven fifty-six seventy-six. That's a total of the assets, there's no liabilities, so that is a total figure on the balance report of what's in the bank as of 12-2-99.

MR. STEVE MILLER: Probably should have done the audit before we did the Treasurer's Report, the treasurer updates what the auditor has told you.

MR. AURELIO SISNEROS: It's backwards here, isn't it?

MR. STEVE MILLER: I mean the Audit Report, maybe we can talk about that, and then if there's questions on either, Jim and I can try and answer them.

MR. AURELIO SISNEROS: All right. Who's our accountant?

MR. STEVE MILLER: Well, our accountant is a gentleman who prepared the audit, Anderson and Associates, Anderson and Company, Jim passed out copies of that this morning, that probably should have been mailed out ahead of the meeting but again, we didn't communicate well.

MR. JIM ROGERS: You guys still got your copies that I passed out this morning?

MR. STEVE MILLER: I got a draft of this about two weeks ago and I just assumed that the mailing was going to occur then but it didn't, so I've looked at it, probably no one else has. It checks, in my view, with the expenditures that we had budgeted, the surplus at the end of the year computes, and I've actually, I've got a spreadsheet that Jim passed around before lunch. The first page of that, it's double sided so it's hard to tell which is the front side, ARCA Audit Summary and Budget Reconciliation, the table. I've just gone through and I show that last year, what he said we had last year, added to what we took in, subtracting what we spent, gives a balance that checks with me, and that balance is $64,563.00. We at one time actually discussed whether we needed to do an audit every year, but we found that the Compact required it, but we haven't had any audit issues in the last 10 years, so I think the approval of this report is required, but it's pretty much a formality, but someone should probably move to approve it.

MR. AURELIO SISNEROS: Do I hear a motion to approve?

MR. PETER EVANS: So moved.

MR. AURELIO SISNEROS: Second?

MR. DAVID POPE: Second.

MR. AURELIO SISNEROS: All in favor, aye?

MEMBERS OF COMPACT: Aye.

MR. AURELIO SISNEROS: Go ahead, Steve.

MR. STEVE MILLER: The number that Jim gave you, the $97,000 would reflect collection of assessments after the date of the audit, which is June 30, 1999, minus some expenditures. I don't know if anybody has any questions, he can certainly tell you what assessments came in and which checks went out, but I assume that's a number that you're used to hearing.

MR. AURELIO SISNEROS: Any questions on the Audit Report? (No response from members.) Did we approve the Treasurer's Report?

MR. STEVE MILLER: You know, I don't know if you need to, I guess it wouldn't hurt to do that.

MR. AURELIO SISNEROS: I think generally, that's the procedure here.

MR. DAVID POPE: Which?

MR. AURELIO SISNEROS: The Treasurer's Report, which was prior to this.

MR. DAVID POPE: Okay.

MR. AURELIO SISNEROS: I don't know if we approved that.

MR. DAVID POPE: I would move approval of the Treasurer's Report.

MR. AURELIO SISNEROS: Second?

MR. PETER EVANS: Colorado seconds.

MR. AURELIO SISNEROS: So approved. Budget review and adoption?

MR. STEVE MILLER: Yeah. This is a point where we sometimes let the court reporter take a break.

(Whereupon, there was an off-the-record discussion, after which the following proceedings were had:)

MR. STEVE MILLER: I think the first action would be to ratify the Cooperative Agreement with the Kansas District of the USGS for a 15 month period, October 1, 1999 through December 31, the year 2000, at an amount of $9,075.00, 9-0-7-5, again, that would be ratifying the agreement we have already signed.

MR. DAVID POPE: Mr. Chairman, I would move we ratify the Cooperative Agreement with the US Geological Survey of Kansas District for a 15 month contract for $9,075, ending December 31, the year 2000.

MR. PETER EVANS: Second.

MR. AURELIO SISNEROS: We have a first and a second and approved, so moved, approved.

MR. STEVE MILLER: I think the next thing would be to direct me, and authorize Jim to sign a contract with the Colorado District of the USGS. That contract has not been prepared or submitted yet, but we have discussed it with GS, it would be a 15 month contract for the same period October 1, '99 through December 31, 2000. The price of that contract would be $32,510.00, that's for...let me just read these off the Apishapa River at Fowler, the Arkansas of Las Animas, Purgatoire at Las Animas, the Arkansas below John

Martin, the Arkansas at Lamar, the Big Sandy Creek, Arkansas at Granada, and Wild Horse Creek. There is an installation at Two Buttes Creek that is no longer going to be serviced by GS, but it won't be torn out, so it's available as, basically a crest stage gage that could be read if there was ever overflow. That was discussed at the Engineering Committee. This dollar amount is based upon that gage being taken out of the program, it's entered here as a zero, which means there'll be no service from GS.

MR. AURELIO SISNEROS: Can we entertain a motion from Mr. Evans?

MR. PETER EVANS: Mr. Chairman, I'd like to move that the Arkansas River Compact Administration authorize its Treasurer to execute a Cooperative Agreement with the U.S. Geological Survey for the period October 1, 1999 through December 31, 2000 in the amount of $32,510.00 as was just described to us.

MR. AURELIO SISNEROS: Mr. Pope?

MR. DAVID POPE: Yes, second.

MR. AURELIO SISNEROS: Passed. Mr. Miller?

MR. STEVE MILLER: Now, if we look at that “budsum” table again, what we have just done is we've shifted some of the GS payments, but at the same amount per month, if we were doing this by the month, in the future years. I don't think we need to adjust the budgets to compensate for this. So I would recommend, for instance, Column O, we show $25,700.00 due basically on...Jim, Treasurer, did we pay GS yet this year?

MR. JIM ROGERS: Yeah.

MR. STEVE MILLER: So, we have made that payment...you've paid them since June 30, right? Is it on your list of descriptions?

MR. JIM ROGERS: No, but she said we had.

MR. STEVE MILLER: Oh, okay. Great. Glad you drove over. So we've already made that payment, to the Colorado District, Column O, the next one is the one that will be due about this time next year, $26,800.00, but we just approved a contract for $32,000.00, but that's a 15 month contract, so we'll just take the money out of, make part of it the following year. I don't think we need to adjust our budgets because of this, is what I'm trying to say.

MR. JIM ROGERS: It won't appear then in the Audit Report?

MR. STEVE MILLER: There might be GS bills in arrears, so, with these two, 15 month contracts, we'll get a bill next, a year from this January, January of the year 2001 will be the next payment due to GS. And, we've got enough in the budget to pay that bill whenever it comes. If it comes later, we've got more money because we're into the next fiscal year, and we'd have the money to pay them. So the audit for this current year-end will not indicate any payments to the GS. You will see though, if we don't change this current year budget or next year's budget, we are going to build a surplus at about a $7,000.00 per year rate.

MR. TOM POINTON: Steve, could I make a suggestion that, in regard to that payment, that might be moved on at the right time? We have 20,000 in contingency, maybe we should take some of the surplus and increase the contingency to make it budget proper, in order that bill comes through, we have it in contingency to pay that bill?

MR. STEVE MILLER: I think, because we're going...we're lengthening the amount of time in the contract, we're actually going to have two years money available to pay for a 15 month contract. I don't think we're...contingent item in the budget actually is one that helps generate surplus, because we never have any contingencies, everything seems to fit within our budget categories, and if we have a big contingency like the lawsuit, the contingent account can't cover it. So, we can make the contingency number higher, we never spend it, and it's just kind of a guess, the fact that we're going to generate a surplus if we make it too high. I think I'm at a point where I want to recommend a FY 2001 to 2002 budget, to you. And you can see...let's work right off of that same “budsum” table. None of our fees for professional services have changed in the last couple of years, and I would recommend leaving them the same, that's rows 8, 9, 10, 11 and 12, on this. The court reporter's fee somewhat varies depending on the length of our meeting, and that would be a use of contingent, if we go over, but I don't think we should budget more than a thousand dollars for that. The items that require some attention are the numbers that we talked about a little while ago on the gaging stations and studies, and right down in here for the Colorado District would be 28,000, that reflects about a seven percent cost increase from the previous year. For the Kansas District, will be 8,000. These numbers were less than what we just talked about because what we just talked about was 15 months, now, by this year we'll be back to a 12 month contract. The Colorado satellite system is becoming more expensive, we've already increased, beginning this year, our contribution to that. I doubt there will be another increase, but if there is, we could review that next year, so I would recommend just budgeting ten five for that. No further changes for any of the other line items, which would generate expected expenses in the year 2001-2002 of $64,100.00. If the States keep their assessments at the current level, which are $40,800 to Colorado, $27,200.00 to Kansas, and with some interest on our surplus account, we would generate about $69,000 in revenue, giving us a surplus of $4,900.00, addition to surplus of $4,900.00 which would generate a total surplus of around $82,000.00 at the end of that fiscal year, and that would be the budget I would recommend to you.

MR. AURELIO SISNEROS: Do we have any discussion on that proposal? I think we need a motion to make it proper.

MR. DAVID POPE: Mr. Chairman, I would move the adoption of the Proposed Fiscal Year 2001 - 2002 Budget as described, just now, by Steve Miller, for a total expenditures of $64,100 and a total income as shown on the sheet, is that correct, 69?

MR. STEVE MILLER: Sixty-nine thousand.

MR. DAVID POPE: Sixty-nine thousand, and the difference between those two numbers would then temporarily add to the surplus.

MR. AURELIO SISNEROS: Do I hear a second on it?

MR. PETER EVANS: I'll second.

MR. AURELIO SISNEROS: Unanimous.

MEMBERS OF COMPACT: Unanimous

MR. STEVE MILLER: That takes care of my items.

MR. AURELIO SISNEROS: Okay. Let's go to Item Number 11, "Election of officers for Compact Year." How have you folks been doing this?

MR. DAVID POPE: Mr. Chairman, I'm not aware of any suggested changes to those in the current slots.

MR. AURELIO SISNEROS: We just keep them the same, is that generally the way it is?

MR. DAVID POPE: If there are other ideas, why certainly we're willing to talk about it, but...

MR. JIM ROGERS: The Chairman should be the only one that changes every other year.

MR. DAVID POPE: We're at (Agenda Item) 11 though, at this point, 12 will be...

MR. AURELIO SISNEROS: Next.

MR. DAVID POPE: ...next.

MR. PETER EVANS: Yeah.

MR. AURELIO SISNEROS: Yeah, Item 11. I would entertain a motion to keep the same officers which are currently, and let me just read these. Election of officers for current year 2000 are Vice-Chairman, currently David Pope from Topeka; Recording Secretary, currently Mary Louise Clay from Lamar; Treasurer, currently Jim Rogers from Lamar; Operations Secretary, currently Steve Witte from Pueblo; Operations, excuse me, Assistant Operations Secretary, currently Mark Rude from Garden City. Do I hear a motion?

MR. PETER EVANS: Mr. Chairman, I'll so move.

MR. AURELIO SISNEROS: Second?

MR. RANDY HAYZLETT: Second.

MR. AURELIO SISNEROS: Passed unanimously. We'll move onto Item Number 12, "Appointment of Committee members and Chairs for Compact Year 19," is that correct, 1999, or is that a typo? It would be year 2000 would it not be? Compact Year 2000, Administrative and Legal, the current Chair now is Hayzlett, and he will rotate with Mr. Evans, Mr. Evans will be the Chair; Engineering, Mr. Pope will replace Mr. Pointon; and Operations, Mr. Rogers will replace Mr. Brenn. Chair would also entertain a motion to adjourn, if there is no further business. Yes, Mr. Evans?

MR. PETER EVANS: Mr. Chairman, before we, before we close this, I guess I would ask for a short discussion of the way we left the stockwater issue at Trinidad Reservoir. Last year we were able, through considerable toil and tension over, while we tried to eat our lunch, put together a one-year authorization to allow them to manage that 1,200 acre foot of stockwater in a more efficient manner. We carefully limited that to just one year, and we combined that with a commitment that the States would continue to work diligently to resolve the other issues related to the Trinidad Reservoir. And, since it did make significant improvement in effectiveness of that water use, since we were able to provide adequate accounting and report, I'm hoping that perhaps I could entice State of Kansas into considering another one-year authorization in the very same pattern, hoping that, that will help us keep the District actively involved in the discussion about irrigated acreage and the other issues, and that in the meantime, we can try to accomplish a much more effective use of the stockwater than is otherwise allowed by the current version of the Operating Principles.

MR. AURELIO SISNEROS: Could we hear a response from Kansas?

MR. DAVID POPE: Peter, I appreciate the comments, and I know you're wanting to try to offer a good faith effort to get this issue on track, it's difficult, and kind of the eleventh hour to deal with some of these things. You know, I certainly understand the reaction of the District, I think it's an overreaction, actually, and I guess I didn't understand that there's that potential. I don't know that we have really hard fast figures to know that this particular year is really going to be that dramatic, in terms of the stockwater issue. You know, everything else being equal, certainly we would be willing to consider things like this, but under the circumstances, I'm just not sure it's the right thing to do right now. I would like to...I need to turn to my fellow Compact members here and maybe we can caucus, but...

MR. AURELIO SISNEROS: The Chair would certainly give time to caucus, if that's appropriate, and if that's what you folks want.

MR. PETER EVANS: Before we take a quick break, I guess I would just comment that it seems to me the advantage of doing this in addition to making better use of the available water supply, is that it does give us the opportunity to extend a bit of a hand to a disappointed and frustrated group of water users, and it would again formalize our commitment to bring these frustrating issues to closure, and we think you have good reason for wanting closure on those issues, and we would like to continue to push on these. Obviously, the resolution isn't necessary for us to continue working on them, but I think it will help us to keep the Conservancy District actively involved. But, with that, I think maybe a short break would be appropriate.

MR. AURELIO SISNEROS: Let's take about a 15 minute break before adjourning, we'll come back.

(Whereupon, a short break was taken, after which the following proceedings were had:)

MR. AURELIO SISNEROS: We're back from recess. We'll take up the issue Mr. Evans proposed. Kansas?

MR. DAVID POPE: Well, we did have a chance to caucus, and discuss the matter, and as I said before, I know, Peter, that you would like to entice the District to work towards some resolution of other matters, you know, actually, that's where we were a year ago, actually in regard to the this very issue. There's another consequence to this, and that is, if we amend the Principles now, we amended the Principles last year, and if we amend them now then no more amendments can be made for another year, and so it seems to me like the better alternative is if the, if the State of Colorado would like to work out one on one, whatever arrangement that you think is a reasonable proposal, we're willing to consider a special meeting, or whatever other appropriate thing, might could be worked out if there's a meaningful dialogue that could occur, and this issue is resolvable. But I don't believe this is the solution, and I think with the nature of the way things are left, I just don't feel good about this approach.

MR. PETER EVANS: Okay. Thanks for giving it consideration.

MR. DAVID POPE: Thank you, appreciate it.

MR. AURELIO SISNEROS: The Chair would, at this point, entertain a motion to adjourn.

MR. PETER EVANS: We don't want to fight for the privilege, but I'll offer the motion.

MR. DAVID POPE: Second.

MR. AURELIO SISNEROS: Unanimous. Thank you, ladies and gentlemen.

(Whereupon, the proceedings conclude.)

C E R T I F I C A T E

STATE OF KANSAS)
) ss:
COUNTY OF FINNEY)

I, Beverly D. Lohrey, a Certified Shorthand Reporter within and for the State of Kansas, certify that the foregoing is a full and correct transcript of all the oral proceedings had in this matter at the aforementioned time and place.

IN WITNESS WHEREOF, I have hereunto set my hand and official seal at Montezuma, Gray County, Kansas this day of____, 2000.

____

Beverly D. Lohrey, CSR, RPR
TRI-STATE REPORTING SERVICE
PO Box 98
Montezuma, Kansas 67867
(316) 846-2962

Note re editing by the States

Due to the retirement of Ms. Lohrey and her unavailability to make editorial corrections to the original transcript she prepared as noted above, this final approved transcript was prepared by Kevin Salter and his staff for Kansas and Steve Miller and his staff for Colorado, using the original transcript file provided by Ms. Lohrey, and presented to ARCA for approval at the 2020 Annual Meeting.

Kevin Salter, Kansas Div. of Water Resources

Steve Miller, Colorado Water Conservation Board

Exhibits to 1999 transcript of the annual meeting of the Arkansas River Compact Administration
December 7, 1999

Exhibit no.	**Item**
1	Notice of Annual Meeting
2	Attendance list
3	Presidential appointment for Mr. Sisneros *(minutes approved in 2020, draft news article was all that was found)*
4	Resolution to honor Chairman Trujillo (Peter Evans to draft) *(minutes approved in 2020, unable to locate exhibit)*
5	USGS Gage Report
6	Arkansas River From John Martin Dam to the Colo-Kans state line: Channel Capacity and Riparian Habitat Planning Study
7	An additional page provided for the 1998 OS report *(minutes approved in 2020, unable to locate exhibit)*
8	Operations Secretary report
9	December 10, 1996 resolution regarding footnotes in the 1994 and the 1996 annual reports or ARCA
10	1999 Assistant Operations Secretary report
11	1996 resolution drafted by Steve Witte *(minutes approved in 2020, unable to locate exhibit)*
12	Witte letter cited in text *(minutes approved in 2020, unable to locate exhibit)*
13	Operations committee report *(minutes approved in 2020, unable to locate exhibit)*
14	Report of Colorado Pumping and Offset Account Operations
15	USGS PCC study (WRI #99-4221)
16	Steve Witte’s resolution, dated January 26, 1996, amending the Operating Principles for the Trinidad Dam and Reservoir Project recognizing the enlarged permanent pool
17	Bureau of Reclamation’s Report *(minutes approved in 2020, unable to locate exhibit)*
18	Corps of Engineer’s Report of civil works activities
19	USGS Report

Exhibit no.	**Item**
20	Letter from Hal Simpson regarding temporary detention of flood water in Trinidad Reservoir (December 3, 1999)
21	Peter Evan’s proposed resolution to amend the Operating Principles for Trinidad Reservoir regarding stock watering during the non-irrigation season
22	Series of letters from David Pope
23	David Pope letter of October 13, 1999, to Jack Garner with proposed amendments to the Operating Principles for Trinidad Reservoir (2 different letters)
24	Bureau of Reclamation letter, dated November 19, 1999, regarding amendments to the Operating Principles of the Trinidad Dam
25	JFA for Kansas *(minutes approved in 2020, unable to locate exhibit)*
26	JFA for Colorado (draft copy)
27	Steve Miller report on the Southeastern Colorado Water Conservancy District *(minutes approved in 2020, unable to locate exhibit)*
28	Purgatoire River Water Conservancy District Reports
29	Bureau of Reclamation documentation from 2 meetings regarding the amending the Operating Principles
30	Treasure’s report *(minutes approved in 2020, unable to locate exhibit)*
31	Auditor’s report
32	FY 2001-2002 Budget

Exhibit 1

Annual Meeting

December 7, 1999

ARKANSAS RIVER COMPACT ADMINISTRATION
307 South Fifth Street, Lamar, Colorado 81052
719-336-9696

For Colorado
Peter H. Evans, Denver
James G. Rogers, Lamar
Thomas R. Pointon, Las Animas

Chairman and Federal Representative
Aurelio Sisneros
Pueblo, Colorado

For Kansas
David L. Pope, Topeka
David a. Brenn, Garden City
Randy Hayzlett, Lakin

NOTICE OF ANNUAL MEETING
ARKANSAS RIVER COMPACT ADMINISTRATION
GARDEN CITY, KANSAS
TUESDAY, DECEMBER 7, 1999,
9:00 A.M. (CST)

GARDEN CITY PLAZA INN
KANSAS AVENUE AND CAMPUS DRIVE
GARDEN CITY, KANSAS
316-275-7471/800-875-5201

The **1999 Annual Meeting** of the **Arkansas River Compact Administration** will be held in **Garden City, Kansas**, at the time and place noted above. The meeting will be recessed for the lunch hour at about noon and reconvened for the completion of business in the afternoon as necessary. Meetings of the Administration are operated in compliance with the federal Americans with Disabilities Act. If you may need a special accommodation as a result of a disability please contact the Plaza Inn at 316-275-7471 [800-875-5201] or Mark Rude at 316-276-2901 at least 3 days before the meeting.

The following Committees of the Administration will meet on **Monday, December 6, 1999** also at the **Garden City Plaza Inn** beginning at **7:30 P.M. CST** and continuing to completion at approximately 9:00 P.M. :

1. Operations
2. Engineering
3. Administrative/Legal

For a description of items to be discussed by the Committees refer to agenda item 5, below. The public is welcome to attend the Committee meetings, but time for comments may be limited.

The tentative agenda for the Annual Meeting, which is subject to change, is set out below.

TENTATIVE AGENDA
(subject to change)

1. **Call to order and introduction of new Federal Representative and Chairman of the Administration:** Mr. Aurelio Sisneros

2. **Introductions of Representatives and Visitors**

3. **Review and revision of agenda**

4. **Resolution honoring past Federal Representartive and Chairman of the Arkansas River Compact Administration:** Mr. Larry Trujillo, Pueblo, Colorado;

5. **Reports of Officers and Committees for Compact Year 1999:**
   a. **Chairman** - Aurelio Sisneros

   b. **Engineering Committee** - Chair Pointon:
      (1) USGS status report on continued operation of tributary gages
      (2) Army Corps report on channel capacity studies below John Martin and Pueblo Reservoirs.

   c. **Operations Committee** - Chair Brenn:
      (1) Reports of Operations Secretary and Assistant Operations Secretary
         (a) Operations Secretary Steve Witte
         (b) Assistant Operations Secretary Mark Rude
      (2) Committee recommendations re 1999 Operations Secretary Report and 1999 Assistant Operations Secretary Report
      (3) Colorado Compact compliance efforts, 1999 Offset Account operations, status reports by Colorado State Engineer, Hal Simpson.
      (4) Trinidad Lake permanent pool operations, exchanges and accounting, status report by Colorado Division of Parks and Outdoor Recreation.
      (5) Review approval status of prior years Operations Secretary Reports.
      (6) Status report on implementation of new John Martin Reservoir accounting ("JMAS") software and reporting system.

   d. **Recording Secretary** - Mary Louise Clay (defer until agenda item 10)

   e. **Treasurer** - Jim Rogers (defer until agenda item 10)

f. **Administrative/Legal Committee** - Chair Hayzlett:
(1) Financial matters (defer to agenda item 10)

6. Reports of federal agencies:

a. **U.S. Bureau of Reclamation:**
(1) Trinidad Project Operating Principles
(a) status report
(b) approval of proposed changes to Trinidad Project Operating Principles
1. Winter stockwater releases
2. Temporary detention and subsequent release of flood flows
(2) Pueblo Reservoir "safety of dams", potential enlargement, and temporary modified operations issues

b. **U.S. Army Corps of Engineers**

c. **U.S. Geological Survey:**
(1) Status of gaging efforts and costs
(2) Cooperative Agreements: ratify federal FY 2000 and preauthorize federal FY 2001 gaging agreements
(3) Overview of other studies and activities

7. Colorado Water Conservancy District Items

a. **Southeastern Colorado Water Conservancy District,**
(1) status report on Water and Storage Needs Assessment Study
(2) status report on Winter Water Storage Program

b. **Purgatoire River Water Conservancy District,** status report on District operations

8. Approval of transcripts and/or summaries from prior meetings:

a. Approval of December, 1998 Annual Meeting Minutes

b. Approval of 1999 Special Meeting Minutes

c. Approval of December, 1993 Annual Meeting Minutes

9. Annual report preparation:

a. Status of 1994, 1995, 1996, 1997 and 1998 draft reports

10. Financial matters:

a. **Recording Secretary's Report** - deferred from agenda item 5.

b. **Treasurer's Report** - deferred from agenda item 5.

c. **Audit Report**, review and approval of FY 98-99 Report (7/1/98-6/30/99)

d. **Budget review and adoption**
(1) Review of current fiscal year (1999-2000) budget
(2) Review of previously adopted FY 2000-2001 budget and assessments
(3) Adoption of FY 2000-2001 budget and assessments

11. Election of officers for Compact Year 2000:

a. Vice-chairman, currently David Pope, Topeka

b. Recording Secretary, currently Mary Louise Clay, Lamar

c. Treasurer, currently Jim Rogers, Lamar

d. Operations Secretary, currently Steve Witte, Pueblo

e. Assistant Operations Secretary, currently Mark Rude, Garden City

12. Appointment of Committee members and chairs for Compact Year 1999:

a. Administrative/Legal (current Chair Hayzlett and Evans)

b. Engineering (current Chair Pointon and Pope)

c. Operations (current Chair Brenn and Rogers)

13. Adjournment

Exhibit 2

Annual Meeting

December 7, 1999

Exhibit 2

NAME	ADDRESS	ORG
Greg Sullivan	1000 Logan St, Denver CO 80203	Spronk Water Eng.
MARK RUDE	GARDEN CITY	KS. DWR
David Barfield	109 S.W. 9th St., Topeka, KS 66612	KS DWR
KEVIN L. SALTER	GARDEN CITY KS	KS DWR
Steve Miller	1313 Sherman St Denver Co	Colo. Water Cons. Bd
David W. Robbins	1441 - 18th #100, Denver, CO	Sp. Ass't A.G. - CO
Ken Knox	1313 Sherman St. Rm 818 Denver, Co	Colorado DWR/SEO
Charles DiDomenico	310 E. Abriendo Ave. Suite B, Pueblo 81004	CO. DWR
HAL SIMPSON	1313 Sherman, Denver, CO 80203	Colorado State Engineer
Bill Howland	1640 W. 6th Las Animas CO 81054	Co. DWR
Dale Straw	310 E. Abriendo Ave, Suite B, Pueblo Co 81004	CO, DWR
Steve Witte	"	"
Tom Falling, LTC	4101 Jefferson Pl NE; Albuquerque, NM 87109	DE, USACE
Dick Kreiner	" " " "	Corps of Engineers
DENNIS E. GARCIA	" " " " "	"
Mark M. Stark	29955 Cty Rd 25.75 Hasty, Co 81044	Corps of Eng
VAN TRUAN	720 N. Main, Rm 205, Pueblo, Co 81003 -	CORPS OF ENGINEERS
Key Merchant	Box 371 Trinidad, CO 81082	Corps of Engineers
Frank Bendrick	PO Box G Greeley CO 80632	ConAgra
DONALD STEERMAN	P.O. Box 390 Lamar, CO 81052	Amity/Dist 67
Ken Smart	33715 Rd 12 LAMAR, CO 81052	Amity
Leroy E. Mauch	8725 Rd NN Lamar, Co. 81052	SECWCD + Fort Lyon
Kori Brown	Box 537 Garden City KS 67846	KS Farm Bureau
Jeanette Bryan	PO BOX 7 Manzanola CO 81058	ARKANSAS Groundwater USERS ASSOC. (AGUA)
VIVIAN BROWN	2934 Lancaster DR, Pueblo, Co 81005	Co, DWR
MARY LOUISE CLAY	P.O. Box 1161 LAMAR, Co 81052	ARCA - Recording Sec
Harold Knoll	4125 N Anderson Rd. Garden City Ks. 67846	Finney Co Water Users
Paul Flack	1313 Sherman, Den, CO 80203	Colo. St. Parks

Al Knoll	G.C Ks, Colo Spgs, Co 80917	G.C Ditch Co,
Harold Miskel	4406 Teeter Totter Way	CWCB
Keith Lucey	201 W. 8th St Suite 200 Pueblo CO 81003	USGS
RON STEGER	201 W. 8th St 200 Pueblo, CO 81003	USGS WRD
JERIS DANIELSON	6805 W. 4th AVE, LAKEWOOD CO 80226	PRWCD
Julianne Woldridge	102 No. Cascade #400 Colorado Springs, CO 80903	PRWCD
Beverly Spady	420 Vail Las Animas CO 81054	PRWCD
Thelma Lujan	314 W. Main Trinidad, CO. 81082	PRWCD
Erma Evans	1206 Alta St Trinidad 81082	PRWCD.
Abel Benavidez	Model, CO	PRWCD
Robert Buerkle	Holcomb, Ks	
THOMAS P. MAKENS	GARDEN CITY KS	KDA-DWR
Byron Bland	Garden City	KS-DWR
W Wiley McFarland	Cimarron Ks	Irrigation Rancher
Scott Knoll	Deerfield Ks	
Robert Knoll	Holcomb Ks.	South Side Ditch
Dan Baffa	Garden City	UABAC
BOB HALLORAN	GARDEN CITY	CITY OF GC
STEVE FROST	GARDEN CITY	SWKS GMD
Bob Trout	1775 Sherman St., #1300, Denver 80203	Model Land & Irr Co.
LISA VEHMAS	755 Parfet St. Ste 151 Lakewood, CO 80215	Dept. Interior Office of Reg. Solicitor
JACK GARNER	Loveland, Colo	Bureau of Reclamation
Allie Johns	" "	" " "
Malcolm Wilson	" "	" " "
Jim Putnam	LAWRENCE, KS.	USGS
BOB GAUGER	HAYS, KS	USGS
Craig Dare	Hays, Ks	USGS.
Julie L. Grauer	Topeka, Ks	KDA - Division of Water Resources
Larry Gennette	G.C., Ks	KDA-DWR

Eric Hargett	Garden City, KS	KS Dept. of Ag./Division of Water Resources
John Roth	Lamar, Colo.	Lamar Canal and Irrigation Co.
Ernie Hofmeister	Lamar, Colo.	Lamar Canal & Irrigation Co
Steven Hines	Box147 Coolidge Ks	Frontier Ditch
Fred Ashren	10465 E 7 Mile Rd Garden City, Ks	Irrigator-Farmer
Hal Scheuerman	POBox222 Deerfield Ks.	Ke Co. Farmers Irrig Assoc.
Donald L. Pitts	301 SW 10th Topeka, Ks	Ks. OAG

Exhibit 3

Annual Meeting

December 7, 1999

DRAFT **DRAFT**

THE WHITE HOUSE

Office of the Press Secretary

For Immediate Release **November 9, 1999**

PRESIDENT CLINTON NAMES AURELIO SISNEROS AS FEDERAL REPRESENTATIVE AND CHAIR OF THE ARKANSAS RIVER COMPACT COMMISSION COLORADO AND KANSAS

The President today announced his intent to nominate Aurelio Sisneros as Federal Representative and Chair of the Arkansas River Compact Commission Colorado and Kansas.

Aurelio Sisneros has been serving as Pueblo County Treasurer in Pueblo, Colorado. Mr. Sisneros has been a farmer and rancher for the past 27 years in the state of Colorado. He has 27 years experience in native grasses, irrigated alfalfa hay, soil conservation, rangeland native grass reestablishment, and in pasture rotation management for cattle, sheep, and horses. From 1996 to 1997, Mr. Sisneros was Owner/Manager of Aurelio's Mexican Food Restaurant. From 1981 to 1983, Mr. Sisneros was Owner/Manager of Aurelio's Truck Stop. From 1980 to 1981, Mr. Sisneros was Plant Administrator at Hughes Drilling Fluids Corporation. Mr. Sisneros is also the former Executive Director of Colorado Hispanic Elected and Appointed Officials, a statewide organization of elected and appointed officials. Mr. Sisneros attended the Pueblo Community College and the University of Southern Colorado.

The purpose of the Arkansas River Compact (Compact) is to divide and apportion equitably between the States of Colorado and Kansas the waters of the Arkansas River and to settle disputes and remove causes of future controversy between these two states.

-30-30-30-

Aurelio Sisneros

Exhibit 3

Exhibit 5

Annual Meeting

December 7, 1999

SUMMARY OF FLOWS FROM SELECTED TRIBUTARIES BELOW JOHN MARTIN RESERVOIR, CO WATER YEAR 1999

07134100 BIG SANDY CREEK NEAR LAMAR, CO
07134990 WILD HORSE CREEK ABOVE HOLLY, CO
07135000 TWO BUTTES CREEK AT HOLLY, CO

Exhibit 5

Summary of streamflow record for tributary gages operated by USGS between John Martin Reservoir and the Stateline in cooperation with Arkansas River Compact Administration, Water Year 1999.

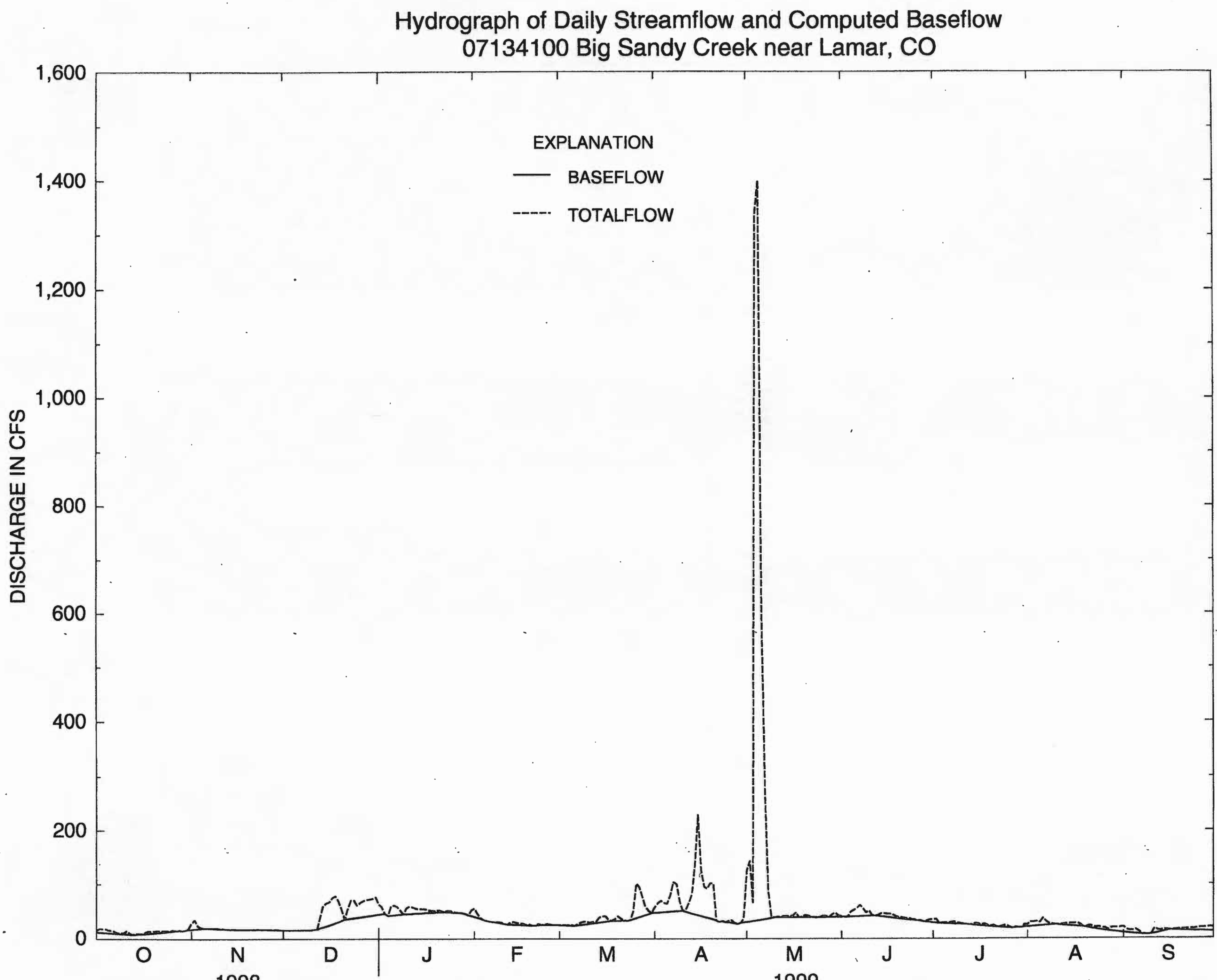
07134100 Big Sandy Creek near Lamar, CO.-- The gage was operated for the entire water year (October 1, 1998 to September 30, 1999). Flow events substantially above baseflow occurred during in April and May. The instantaneous peak for the year of 2,350 cfs occurred on May 4 which was near the peak of record of 2,520 in 1976. The peak flow at the crest stage gage (CSG) upstream was at a preliminary discharge of 2,990 cfs from a flow over the road indirect measurement about 5 miles upstream from the CSG which also occurred May 4. The data are provisional, subject to review, prior to publication.

07134990 Wild Horse Creek above Holly, CO.-- The gage was operated from October 1 to November 4, 1998 and March 24 to September 30, 1999. There were several flow events substantially greater than baseflow during most of the summer. The instantaneous peak for the year of 393 cfs occurred on August 2. The data are provisional, subject to review, prior to publication.

07135000 Two Buttes Creek at Holly, CO.-- The gage was operated from October 1 to November 3, 1998 and March 25 to September 30, 1999. There was no flow at the site most of the period. There was one peak on August 1 with an instantaneous peak for the year of 351 cfs. The data are provisional, subject to review, prior to publication.

Table 1. Comparison of Arkansas River Mainstem and Tributary Flows, John Martin Reservoir to Stateline, WY 1998 and 1999

Station Name	WY1998 Annual Flow in Acre Feet	WY1999 Annual Flow in Acre Feet (Preliminary)
Arkansas River below John Martin Reservoir	379,000	484,000
Arkansas River at Lamar	249,000	342,000
Big Sandy Creek near Lamar	30,400	32,800
Baseflow	21,400	20,100
Above Baseflow	9,000	12,700
Arkansas River near Granada	327,000	421,000
Wildhorse Creek above Holly (April-November)	15,600	17,300
Baseflow	7,000	8,900
Above Baseflow	8,600	8,400
Two Butte Creek near Holly (April-November)	10	290
Frontier Ditch near Coolidge	8,100	9,900
Arkansas River near Coolidge	418,000	527,800


Hydrograph of Daily Streamflow and Computed Baseflow
07134100 Big Sandy Creek near Lamar, CO
EXPLANATION
BASEFLOW
TOTALFLOW
DISCHARGE IN CFS
1,600
1,400
1,200
1,000
800
600
400
200
0
O
N
D
J
F
M
A
M
J
J
A
S
1998
1999

STATION NUMBER 07134100 BIG SANDY CREEK NEAR LAMAR, CO. STREAM SOURCE AGENCY USGS
LATITUDE 380651 LONGITUDE 1022900 DRAINAGE AREA 3248.00 DATUM 3545.00 STATE 08 COUNTY 099
PROVISIONAL DATA SUBJECT TO REVISION

DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1998 TO SEPTEMBER 1999
DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	16	29	16	63	55	25	57	125	41	e35	e25	21
2	19	35	16	58	46	25	65	143	40	36	e30	16
3	18	24	16	46	38	25	69	66	40	28	e30	14
4	18	21	16	42	35	25	65	1340	49	29	31	14
5	16	20	16	58	33	25	64	1400	52	29	29	16
6	16	20	16	61	32	24	79	598	55	29	37	12
7	13	20	16	58	31	27	104	263	61	30	31	7.3
8	11	20	16	52	31	30	100	86	55	31	27	6.7
9	11	20	16	45	31	32	68	42	48	29	26	6.3
10	11	19	16	56	30	31	51	39	51	28	e25	7.1
11	15	19	17	59	27	30	53	40	43	27	e25	18
12	10	18	17	57	26	31	65	40	42	26	e25	15
13	8.3	18	39	55	30	32	81	41	43	25	e26	14
14	10	18	60	54	31	39	137	41	46	26	e27	16
15	9.6	18	65	54	29	41	228	41	46	28	e27	16
16	9.0	17	67	54	28	41	125	42	45	27	e27	e15
17	12	17	75	52	28	35	95	48	e45	25	e28	16
18	14	17	78	51	25	33	92	39	e43	27	e25	16
19	14	17	68	51	26	36	102	40	e40	24	21	e17
20	14	17	53	52	24	41	101	43	e39	23	21	e17
21	15	17	36	51	24	37	33	42	e38	24	23	e17
22	15	18	55	49	27	34	31	40	e37	21	22	e18
23	15	17	70	51	25	33	33	39	e37	21	20	e18
24	15	17	70	51	26	34	30	39	e35	23	21	e18
25	15	17	61	49	27	49	33	40	e35	24	19	e19
26	16	17	66	48	26	101	34	42	e33	21	19	e20
27	15	17	69	48	26	94	29	41	33	19	16	e20
28	16	17	71	47	25	76	27	40	31	21	19	e20
29	15	17	72	46	---	57	29	45	e33	20	20	e21
30	16	16	73	43	---	51	38	47	e35	20	20	e21
31	19	---	76	52	---	47	---	42	---	25	20	---
TOTAL	436.9	574	1418	1613	842	1241	2118	4974	1271	801	762	472.4
MEAN	14.1	19.1	45.7	52.0	30.1	40.0	70.6	160	42.4	25.8	24.6	15.7
MAX	19	35	78	63	55	101	228	1400	61	36	37	21
MIN	8.3	16	16	42	24	24	27	39	31	19	16	6.3
AC-FT	867	1140	2810	3200	1670	2460	4200	9870	2520	1590	1510	937

STATISTICS OF MONTHLY MEAN DATA FOR WATER YEARS 1968 - 1999, BY WATER YEAR (WY)

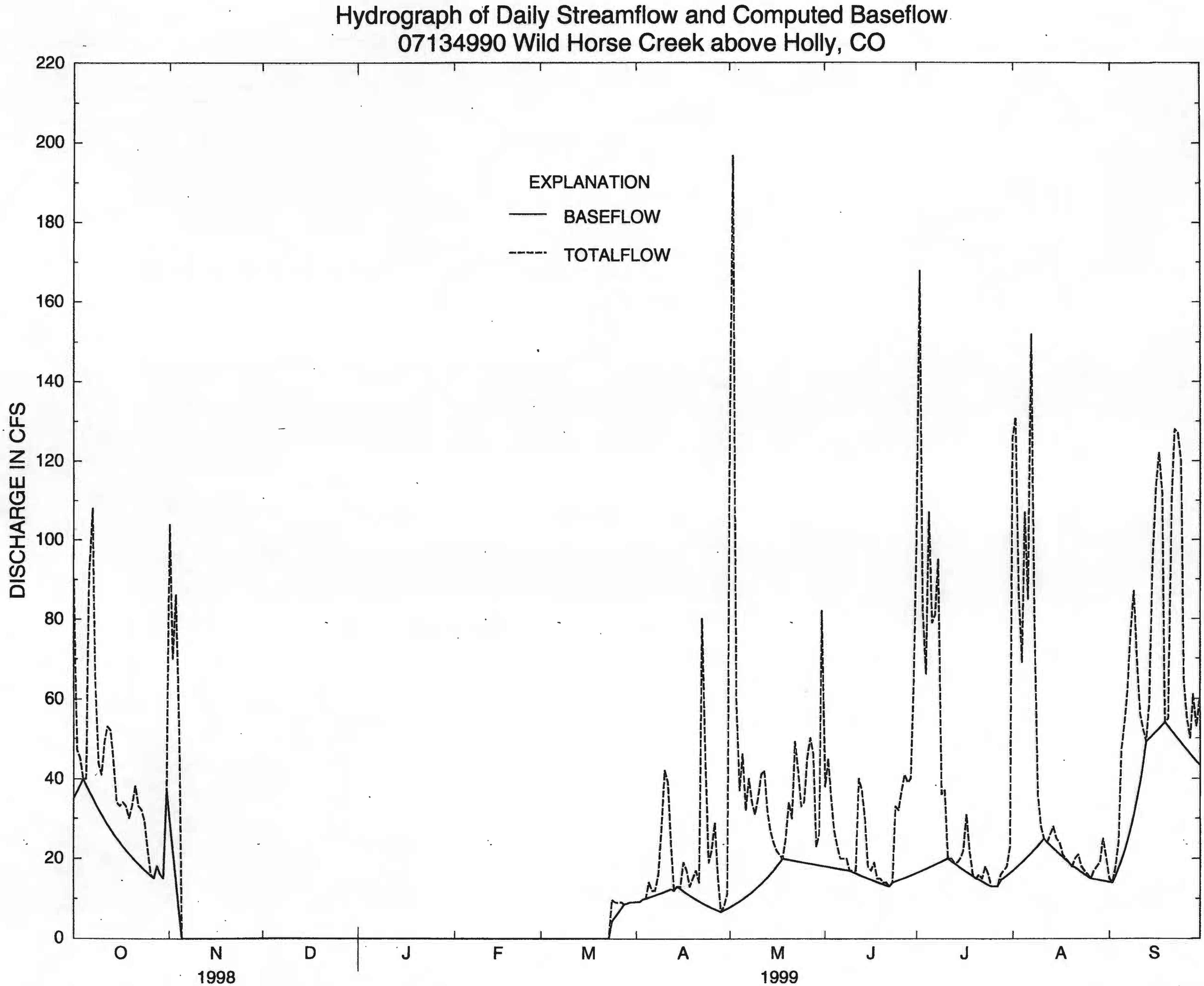
	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
MEAN	7.86	15.7	19.9	21.2	20.8	21.7	21.5	22.7	11.0	10.4	15.2	10.1
MAX	28.4	58.9	63.0	75.5	55.6	59.0	70.6	160	42.4	41.6	85.3	41.8
(WY)	1997	1998	1998	1998	1998	1998	1999	1999	1999	1998	1997	1976
MIN	.087	.41	.34	.50	2.23	2.10	.81	2.14	1.77	.21	.027	.084
(WY)	1979	1978	1978	1978	1978	1977	1978	1975	1976	1978	1976	1978

SUMMARY STATISTICS	FOR 1998 CALENDAR YEAR	FOR 1999 WATER YEAR	WATER YEARS 1968 - 1999	
ANNUAL TOTAL	13209.6	16523.3		
ANNUAL MEAN	36.2	45.3	16.8	
HIGHEST ANNUAL MEAN			45.3	1999

LOWEST ANNUAL MEAN					2.23	1979
HIGHEST DAILY MEAN	276	Jul 25	1400	May 5	1400	May 5 1999
LOWEST DAILY MEAN	6.3	Jun 29	6.3	Sep 9	.00	Aug 13 1976
ANNUAL SEVEN-DAY MINIMUM	8.3	Jun 27	9.9	Sep 4	.00	Sep 1 1976
INSTANTANEOUS PEAK FLOW			2350	May 4	2520	Sep 16 1976
INSTANTANEOUS PEAK STAGE			9.66	May 4	8.48	Sep 16 1976
ANNUAL RUNOFF (AC-FT)	26200		32770		12180	
10 PERCENT EXCEEDS	75		65		43	
50 PERCENT EXCEEDS	19		30		8.0	
90 PERCENT EXCEEDS	12		16		.80	

STATISTICS COMPUTED BY: rdsteger DATE: 12/03/1999 AT: 12:17:13

e Estimated



Hydrograph of Daily Streamflow and Computed Baseflow
07134990 Wild Horse Creek above Holly, CO
DISCHARGE IN CFS
220
200
180
160
140
120
100
80
60
40
20
0
EXPLANATION
BASEFLOW
TOTALFLOW
O
N
D
J
F
M
A
M
J
J
A
S
1998
1999

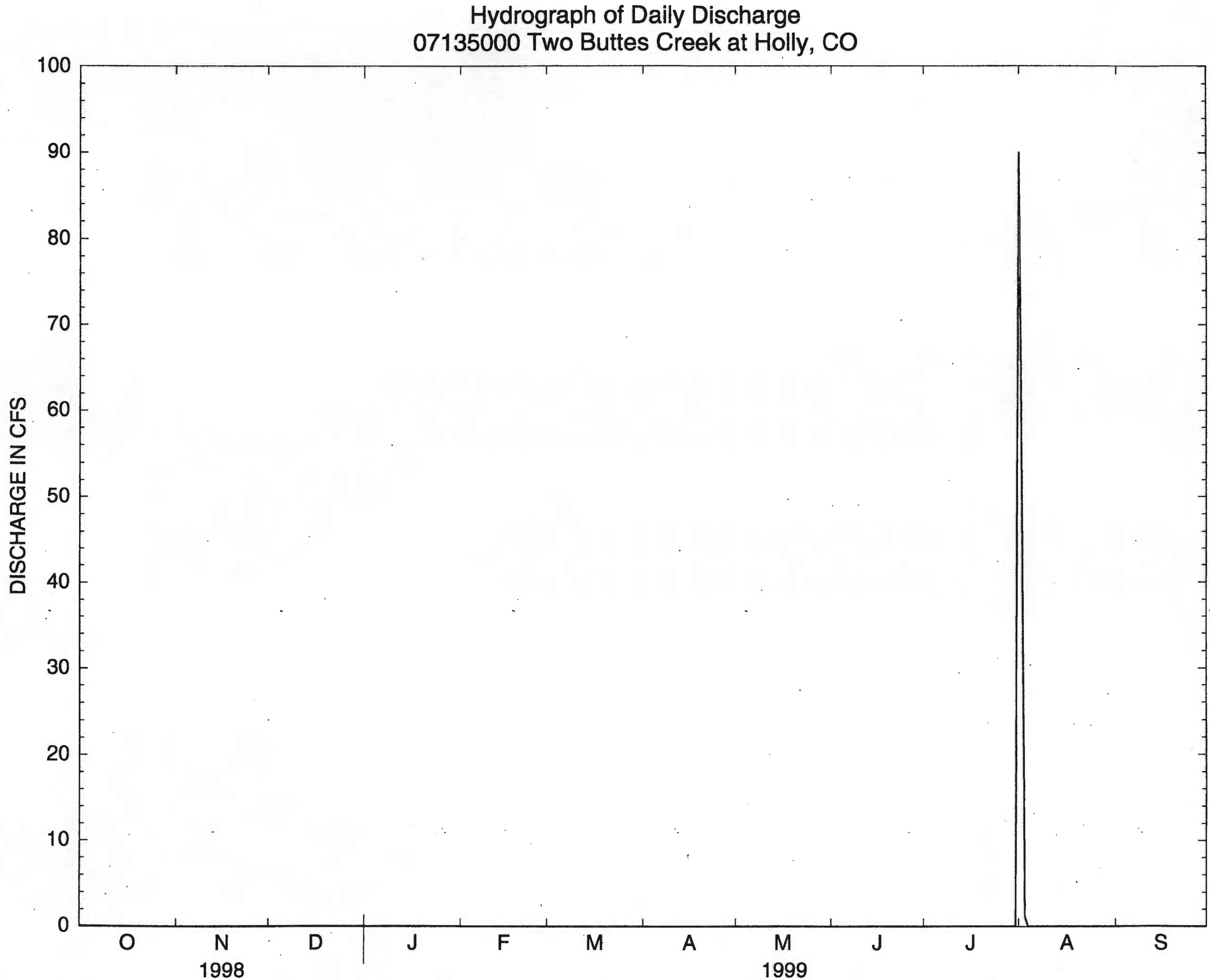
UNITED STATES DEPARTMENT OF THE INTERIOR - GEOLOGICAL SURVEY - COLORADO DISTRICT 12/03/1999

STATION NUMBER 07134990 WILD HORSE CREEK ABOVE HOLLY, CO STREAM SOURCE AGENCY USGS
LATITUDE 380324 LONGITUDE 1020816 DRAINAGE AREA 270 DATUM 3405 STATE 08 COUNTY 099
PROVISIONAL DATA SUBJECT TO REVISION

DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1998 TO SEPTEMBER 1999
DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	90	104	---	---	---	---	9.2	127	38	99	126	15
2	47	70	---	---	---	---	9.2	197	45	168	131	14
3	45	86	---	---	---	---	9.8	59	35	82	86	18
4	40	e54	---	---	---	---	10	37	27	66	69	24
5	40	---	---	---	---	---	14	46	23	107	107	47
6	92	---	---	---	---	---	12	32	20	79	85	54
7	108	---	---	---	---	---	12	40	20	81	152	62
8	65	---	---	---	---	---	16	34	20	95	82	77
9	44	---	---	---	---	---	28	31	17	36	36	87
10	41	---	---	---	---	---	42	35	17	37	28	70
11	49	---	---	---	---	---	39	41	17	20	25	56
12	53	---	---	---	---	---	23	42	40	20	24	52
13	52	---	---	---	---	---	12	32	37	19	26	49
14	44	---	---	---	---	---	13	27	30	19	28	59
15	34	---	---	---	---	---	13	24	18	20	25	95
16	33	---	---	---	---	---	19	22	17	22	24	113
17	34	---	---	---	---	---	17	21	19	31	21	122
18	33	---	---	---	---	---	13	20	15	22	20	112
19	30	---	---	---	---	---	15	25	15	16	19	54
20	33	---	---	---	---	---	17	34	14	15	18	55
21	38	---	---	---	---	---	14	30	14	16	20	111
22	33	---	---	---	---	---	80	49	13	15	21	128
23	32	---	---	---	---	---	45	42	14	18	18	127
24	29	---	---	---	---	e9.7	19	33	33	16	17	120
25	22	---	---	---	---	9.1	22	34	32	13	16	65
26	16	---	---	---	---	9.0	29	45	37	13	15	55
27	15	---	---	---	---	9.1	15	50	41	13	17	50
28	18	---	---	---	---	8.6	6.7	46	39	16	18	61
29	16	---	---	---	---	8.8	8.1	23	40	17	19	53
30	15	---	---	---	---	9.1	11	26	63	18	25	60
31	37	---	---	---	---	9.1	---	82	---	23	20	---
TOTAL	1278	---	---	---	---	---	593.0	1386	810	1232	1338	2065
MEAN	41.2	---	---	---	---	---	19.8	44.7	27.0	39.7	43.2	68.8
MAX	108	---	---	---	---	---	80	197	63	168	152	128
MIN	15	---	---	---	---	---	6.7	20	13	13	15	14
AC-FT	2530	---	---	---	---	---	1180	2750	1610	2440	2650	4100

e Estimated



Hydrograph of Daily Discharge
07135000 Two Buttes Creek at Holly, CO
DISCHARGE IN CFS
100
90
80
70
60
50
40
30
20
10
0
O
N
D
J
F
M
A
M
J
J
A
S
1998
1999

UNITED STATES DEPARTMENT OF THE INTERIOR - GEOLOGICAL SURVEY - COLORADO DISTRICT 12/03/1999

STATION NUMBER 07135000 TWO BUTTE CREEK NEAR HOLLY, CO. STREAM SOURCE AGENCY USGS
LATITUDE 380140 LONGITUDE 1020819 DRAINAGE AREA 817.00 DATUM 3415 STATE 08 COUNTY 099
PROVISIONAL DATA SUBJECT TO REVISION
DISCHARGE, CUBIC FEET PER SECOND, WATER YEAR OCTOBER 1998 TO SEPTEMBER 1999
DAILY MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	.00	.00	---	---	---	---	.00	.00	.00	.00	90	.00
2	.00	.00	---	---	---	---	.00	.00	.00	.00	55	.00
3	.00	.00	---	---	---	---	.00	.00	.00	.00	1.1	.00
4	.00	---	---	---	---	---	.00	.00	.00	.00	.00	.00
5	.00	---	---	---	---	---	.00	.00	.00	.00	.00	.00
6	.00	---	---	---	---	---	.00	.00	.00	.00	.00	.00
7	.00	---	---	---	---	---	.00	.00	.00	.00	.00	.00
8	.00	---	---	---	---	---	.00	.00	.00	.00	.00	.00
9	.00	---	---	---	---	---	.00	.00	.00	.00	.00	.00
10	.00	---	---	---	---	---	.00	.00	.00	.00	.00	.00
11	.00	---	---	---	---	---	.00	.00	.00	.00	.00	.00
12	.00	---	---	---	---	---	.00	.00	.00	.00	.00	.00
13	.00	---	---	---	---	---	.00	.00	.00	.00	.00	.00
14	.00	---	---	---	---	---	.00	.00	.00	.00	.00	.00
15	.00	---	---	---	---	---	.00	.00	.00	.00	.00	.00
16	.00	---	---	---	---	---	.00	.00	.00	.00	.00	.00
17	.00	---	---	---	---	---	.00	.00	.00	.00	.00	.00
18	.00	---	---	---	---	---	.00	.00	.00	.00	.00	.00
19	.00	---	---	---	---	---	.00	.00	.00	.00	.00	.00
20	.00	---	---	---	---	---	.00	.00	.00	.00	.00	.00
21	.00	---	---	---	---	---	.00	.00	.00	.00	.00	.00
22	.00	---	---	---	---	---	.00	.00	.00	.00	.00	.00
23	.00	---	---	---	---	---	.00	.00	.00	.00	.00	.00
24	.00	---	---	---	---	---	.00	.00	.03	.00	.00	.00
25	.00	---	---	---	---	.00	.00	.00	.00	.00	.00	.00
26	.00	---	---	---	---	.00	.00	.00	.00	.00	.00	.00
27	.00	---	---	---	---	.00	.00	.00	.00	.00	.00	.00
28	.00	---	---	---	---	.00	.00	.00	.00	.00	.00	.00
29	.00	---	---	---	---	.00	.00	.00	.00	.00	.00	.00
30	.00	---	---	---	---	.00	.00	.00	.00	.00	.00	.00
31	.00	---	---	---	---	.00	---	.00	---	.00	.00	---
TOTAL	0.00	---	---	---	---	---	0.00	0.00	0.03	0.00	146.10	0.00
MEAN	.000	---	---	---	---	---	.000	.000	.001	.000	4.71	.000
MAX	.00	---	---	---	---	---	.00	.00	.03	.00	90	.00
MIN	.00	---	---	---	---	---	.00	.00	.00	.00	.00	.00
AC-FT	.00	---	---	---	---	---	.00	.00	.06	.00	290	.00

Exhibit 6

Annual Meeting

December 7, 1999

US Army Corps
Of Engineers
Albuquerque District

PLANNING ASSISTANCE TO STATES PROGRAM

ARKANSAS RIVER FROM JOHN MARTIN DAM TO THE COLORADO-KANSAS STATE LINE: CHANNEL CAPACITY AND RIPARIAN HABITAT PLANNING STUDY

Prepared for the

Colorado Water Conservation Board
1313 Sherman Street, Room 721
Denver, Colorado 80203

by the

U.S. Army Corps of Engineers
Albuquerque District
4101 Jefferson Plaza NE
Albuquerque, New Mexico 87109

Under the authority of the
Planning Assistance to States Program

July 1999

CONVERSION FACTORS

	From	Multiplier-->	To
Length	inches	25.4	millimeters
	feet	0.0348	meters
	miles	1.6093	kilometers
Area	acres	0.0407	hectares
	square miles	2.590	square kilometers
Volume	cubic yards	0.7646	cubic meters
	acre-feet	1233.5	cubic meters
Flow	cubic feet/second	0.0283	cubic meters/second
Mass (weight)	tons (short ton)	0.9072	metric tons
Velocity	feet/second	0.3048	meters/second
Salinity	μSiemens/cm	0.32379	parts/million NaCl
	or μmhos/cm		or mg/liter NaCl
Temperature	° Fahrenheit	(°F-32)/1.8	° Celsius

DISCLAIMER

The mention of brand names or trademarks in this report does not constitute endorsement or recommendation for use by the Federal Government.

ARKANSAS RIVER FROM JOHN MARTIN DAM TO THE COLORADO-KANSAS STATE LINE: CHANNEL CAPACITY AND RIPARIAN HABITAT PLANNING STUDY

Prepared for the
Colorado Water Conservation Board
by the
U.S. Army Corps of Engineers, Albuquerque District
under the authority of the Planning Assistance to States Program

July 1999

SUMMARY OF FINDINGS AND RECOMMENDATIONS

The channel capacity of the Arkansas River below John Martin Dam has decreased significantly since the dam was completed in 1948. At that time, the downstream channel capacity was estimated to be 15,000 cubic feet per second (cfs). By 1965, channel capacity had decreased to about 3,000 cfs due to encroachment on the floodway by development and vegetation.

During spring 1995 flood control releases, it was reported that the channel was not able to convey the release of 3,000 cfs through Coolidge, Kansas, without causing backwater effects, including a high water table and subsurface damage to crops in many areas of the flood plain. In December, 1995, the Colorado Water Conservation Board (CWCB) requested planning assistance from the U.S. Army Corps of Engineers, Albuquerque District (Corps) for restoring hydraulic capacity and riverine/riparian ecosystem values in the Arkansas River below John Martin Dam. A Planning Assistance to States (Section 22) agreement (50/50 cost share) was signed by the CWCB and Corps in August 1996.

This study's purpose is to develop and evaluate plans which, when implemented, can improve channel capacity for flood flows and restore riverine and riparian habitat along the Arkansas River below John Martin Dam. Changes in current reservoir operation plans were not a study objective.

The Arkansas River study reach extends from John Martin Dam 58 river-miles downstream to the Colorado-Kansas state line. The CWCB and Corps coordinated with local and state interests to identify five specific problem areas to investigate, totaling approximately 26 river-miles within Prowers County, Colorado. The five areas selected for study do not include all known problems within the reach downstream of John Martin Dam, nor are they necessarily the most crucial. Rather, they were selected as examples of typical problems within the reach.

A geomorphological assessment of the study reach was completed in 1997 by the U.S. Army Corps of Engineers Waterways Experiment Station and provided an overview of the geologic, climatologic, and hydrologic forces influencing the Arkansas River during the past century. The Albuquerque District conducted all hydraulic and ecological investigations.

The Arkansas River within the study reach historically was an ephemeral, braided river with a channel-forming discharge of about 3,000 cfs. Several small, shifting channels occupied a broad, sandy river bottom and were interspersed with numerous bars and islands. In the late 1800s, the bankfull width of the channel was approximately 1,000 feet, and bankfull depth was within the range of 1 to 2 feet. Currently, this reach has become a perennial, narrow, meandering channel. Bankfull width has decreased to approximately 100 feet. Although the channel-forming discharge has decreased to about 800 to 1,000 cfs, bankfull depth has increased to 4 to 6 feet.

Historic flow data for the Arkansas River below John Martin Dam were evaluated. Flow-duration curves for the pre-dam, post-dam, and post-1981 periods were computed and compared. The comparisons show a substantial reduction in peak flows following construction of John Martin Dam. This reduction occurs, expectedly, for large flow events, the type the dam was designed to control, but also for the most common discharges.

Suspended sediment data were analyzed and indicate an apparent change in the suspended sediment transport characteristics. This was, in part, expected since one of the purposes of John Martin Reservoir is retention of sediment. The change, however, is more complex than a simple reduction of suspended sediment load. Unlike upstream reaches of the Purgatoire and Arkansas Rivers, correlations of suspended sediment load and discharge were weak for the Arkansas River below John Martin Dam, indicating that the river has been placed in a state of non-equilibrium. Many factors have contributed to this condition, including John Martin Dam, diversion structures, local channel modification, and encroachment on the floodway and channel.

Numerical hydraulic models were developed for each of the problem areas to analyze current conditions under the 3,000-cfs operational peak discharge. The combined hydraulic and sediment analyses indicate several problems. First, the conveyance capacity is less than the 3,000 cfs necessary for flood control releases in 4 of the 5 Problem Areas. Secondly, the channel profiles show marked disturbances resulting in local scour or deposition and inhibiting effective conveyance of water and sediment. Additionally, erratic hydraulic conditions contribute to seepage problems during high river flows. Thirdly, sediment transport potentials are erratic.

Overall, the channel appears to be impacted primarily by three phenomena: a reduction in peak flows due to the upstream reservoir, changes in floodplain vegetation, and encroachment on the channel and floodway. Reduced peak flows has caused the channel to become smaller and this shrinkage is often exhibited as narrowing. Dense vegetation (primarily salt cedar) has become established on the newly formed bank and inhibits its widening again during high flows. Likewise, agricultural fields have encroached on the floodway with a similar result. The reduced peak flows have induced an expectation that the river needs less room. Lands nearer the river have been put into production and this encroachment inhibits rewidening of the channel. Leveeing further restricts the flow path and causes incision and bank instability. As this cycle continues, the effective conveyance capacity becomes less and less. The current floodway is tightly bounded by farmland and attendant berms. Several agricultural fields were identified as currently at risk from surface water inundation at river discharges near 3,000 cfs.

Historically, riparian vegetation along the Arkansas River in eastern Colorado consisted of a wide band of sparsely distributed plains cottonwood, with scattered stands of sandbar willow along the channel banks and bars. Although relatively dense cottonwood stands occurred between Las Animas and Lamar (the "Big Timbers" area), the majority resembled an open-canopied parkland ranging up to 2 miles wide. Grasslands dominated by salt grass and alkali sacaton occupied areas too saline to support cottonwood and willow.

Currently within the study area, the band of riparian vegetation varies from 250 to 4,000 feet wide and is largely restricted to the 3,000 cfs floodway. Salt cedar, a fast-growing species tolerant of saline soils and shallow groundwater, was first noted in the Arkansas Valley near Lamar in 1913 and has since spread substantially. It has become established in the understory of remnant cottonwood galleries and has replaced broad expanses of riparian grassland communities, such that it is the dominant plant species in the riparian zone. Although salt cedar coverage has increased dramatically, the overall areal extent of riparian vegetation has decreased significantly over the past 100 years due to urban and agricultural development with the floodplain and the reduced effective discharge associated with irrigation and flood control storage in John Martin Reservoir. Additionally, flood control operation has significantly reduced large flood events which formerly scoured extensive areas, creating suitable substrates for cottonwood and willow seed germination. Salt cedar dominates the immediate riverbank throughout most of the study area. While it provides some wildlife shrub cover, its overall value as wildlife habitat is much lower than native cottonwood-willow communities. Additionally, salt cedar root systems can reach a depth of 25 feet or more, contributing to relatively high transpiration rates.

Several alternatives to improve water and sediment conveyance, reduce maintenance, and restore riparian functions and values were evaluated. The study recommendations are as follows:

- *No further reduction of the current 3,000-cfs floodway capacity.* Past reductions already have exacerbated water conveyance, sediment transport, flooding, and groundwater problems. Catastrophic floods can result from storms downstream of John Martin Dam. Floods originating upstream, and of a magnitude similar to the May 1999 event, could likely result in reservoir discharges substantially greater than 3,000 cfs if sufficient storage is not available in the reservoir.

- *Extensive channel improvement through excavation is not recommended* due to high implementation costs and significant adverse environmental impacts.

John Martin Reservoir supplies water to irrigated lands as far downstream as Garden City, Kansas. Current reservoir operations for conservation storage and release follow the plan adopted by the Arkansas River Compact Administration in 1980, as amended. Releases for irrigation and delivery normally are made between April 1 and October 31 of each year. Inflow is stored in November through March except for releases required for flood control. Flood control operations begin when John Martin Reservoir storage exceeds an elevation of 3,851 feet. The current operational channel capacity of the Arkansas River is approximately 3,000 cubic feet per second (cfs) at Coolidge, Kansas. (Actual release from the dam may exceed 3,000 cfs when flows are expected to diminish before reaching Coolidge due to irrigation withdrawal or transit loss).

To illustrate the flood control function of John Martin Dam, Table 2-1 lists the largest mean discharge per year at USGS stream gaging stations upstream and downstream of the dam in 1942 through 1999. Annual hydrographs of recent years (1985, 1987, 1995, and 1999) when John Martin Dam releases exceeded 2,900 cfs are depicted in Figures 2 through 5, respectively.

Table 2-1. Largest mean daily discharges (cfs) per calendar year at USGS stream gages on the Arkansas River above and below John Martin Dam (JMD), 1942 to 1999. Events exceeding 2,900 cfs below the dam are in bold typeface. (Data from USGS).

Year	Las Animas[a]	Below JMD	Lamar	Granada	Coolidge	Annotation for discharges greater than 2,900 cfs below John Martin Dam
1942		**33,400**	**33,400**			Major flood event from above JMD (dam not operational)
1943		952	1,380			
1944		**4,600**	**4,510**			Spring runoff from above JMD (Channel capacity = 15,000)
1945		1,750	943			
1946		2,440	1,510			
1947		**5,060**	**4,910**			Spring runoff from above JMD (Channel capacity = 15,000)
1948		1,280	685			
1949	14,310	1,320	**9,260**			Local storm above Lamar
1950	8,110	1,190	1,010		276	
1951	7,020	1,220	787		**28,900**	Large local storm between Lamar & Coolidge
1952	1,304	1,230	293		1,340	
1953	15,790	1,840	1,260		2,710	
1954	17,346	1,020	2,400		**4,280**	Local storm between Lamar & Coolidge
1955	72,100	1,260	1,130		**5,310**	Local storm between Lamar & Coolidge
1956	6,451	1,410			**4,230**	Local storm above Coolidge
1957	16,880	1,370			**5,050**	Local storm above Coolidge
1958	6,040	1,220			2,380	
1959	731	1,170	715		2,270	
1960	2,575	1,230	996		829	

continued

Table 2-1, concluded.

Year	Las Animas[a]	Below JMD	Lamar	Granada	Coolidge	Annotation for discharges greater than 2,900 cfs below John Martin Dam
1961	2,135	974	984		2,630	
1962	2,610	1,240	1,400		2,650	
1963	4,422	1,100	1,100		986	
1964	1,405	1,100	**3,840**		**11,900**	Local storm above Coolidge
1965	47,900	**3,830**	**25,000**		**101,000**	Catastrophic flood event from storm near JMD
1966	10,310	1,270	883		1,140	
1967	5,470	1,260	**3,230**		1,930	Local storm above Lamar
1968	2,595	1,200	704		810	
1969	5,065	1,040	492		2,400	
1970	1,349	1,290	608		644	
1971	1,116	1,260	768		786	
1972	4,920	1,250	897		**3,140**	Local storm between Lamar & Coolidge
1973	1,938	1,070	600		867	
1974	675	1,080	492		625	
1975	1,513	1,200	955		2,220	
1976	2,858	1,230	787		1,800	
1977	3,200	1,160	781		472	
1978	3,513	1,560	668		2,880	
1979	2,139	1,190	788		503	
1980	5,302	1,540	1,000	73	780	
1981	4,253	1,120	810	611	491	
1982	4,242	1,250	822	704	759	
1983	5,339	1,490	831	715	950	
1984	6,321	1,400	1,090	1,130	2,120	
1985	3,619	**2,980**	2,090	1,960	1,870	Spring runoff from above JMD (Capacity release)
1986	2,231	1,340	947	1,360	2,000	
1987	6,630	**3,100**	**3,110**	**3,330**	**3,290**	Spring runoff from above JMD (Capacity release)
1988	1,118	1,530	858	773	841	
1989	1,207	1,050	865	543	965	
1990	2,930	1,130	686	473	461	
1991	1,007	1,120	985	678	594	
1992	1,250	1,100	810	565	1,050	
1993	1,611	1,280	625	514	570	
1994	3,036	1,190	1,050	723	819	
1995	6,196	**3,160**	2,770	2,380	**2,950**	Spring runoff from above JMD (Capacity release)
1996	2,836	1,160	**3,080**	**2,900**	**3,640**	Local storm below JMD
1997	5,480	1,580	1,830	2,330	2,800	
1998[b]	2,446	1,710	2,270	2,310		
1999[b]	25,490	**3,240**	2,590	**3,900**		Major flood event north and west of JMD. (Data through June 15 only).

[a] Las Animas values are the summed Arkansas River and Purgatoire River discharges.
[b] Data for 1998-1999 are provisional.

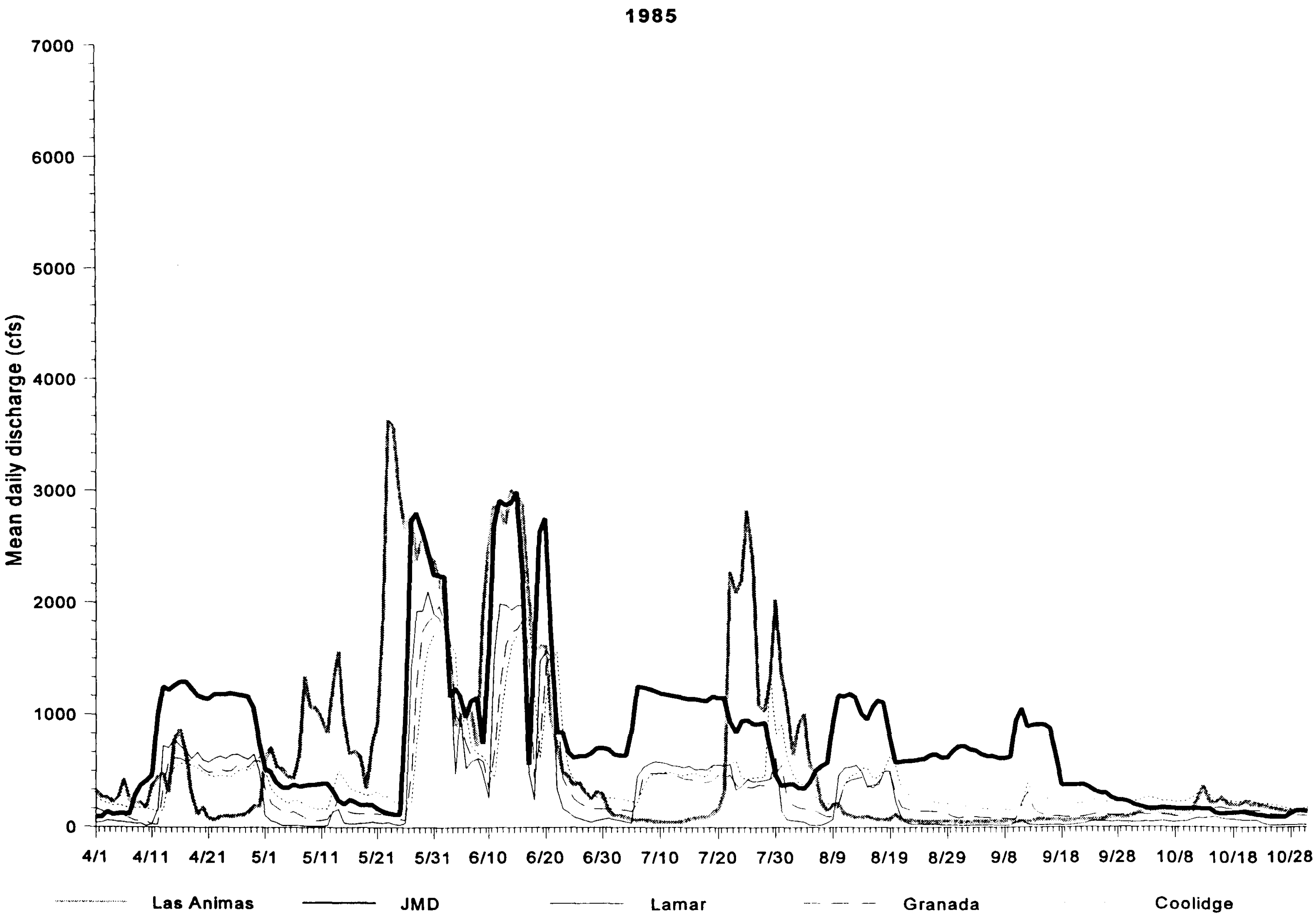


Figure 2. Arkansas River discharge, April through November, 1985. (Data from USGS).

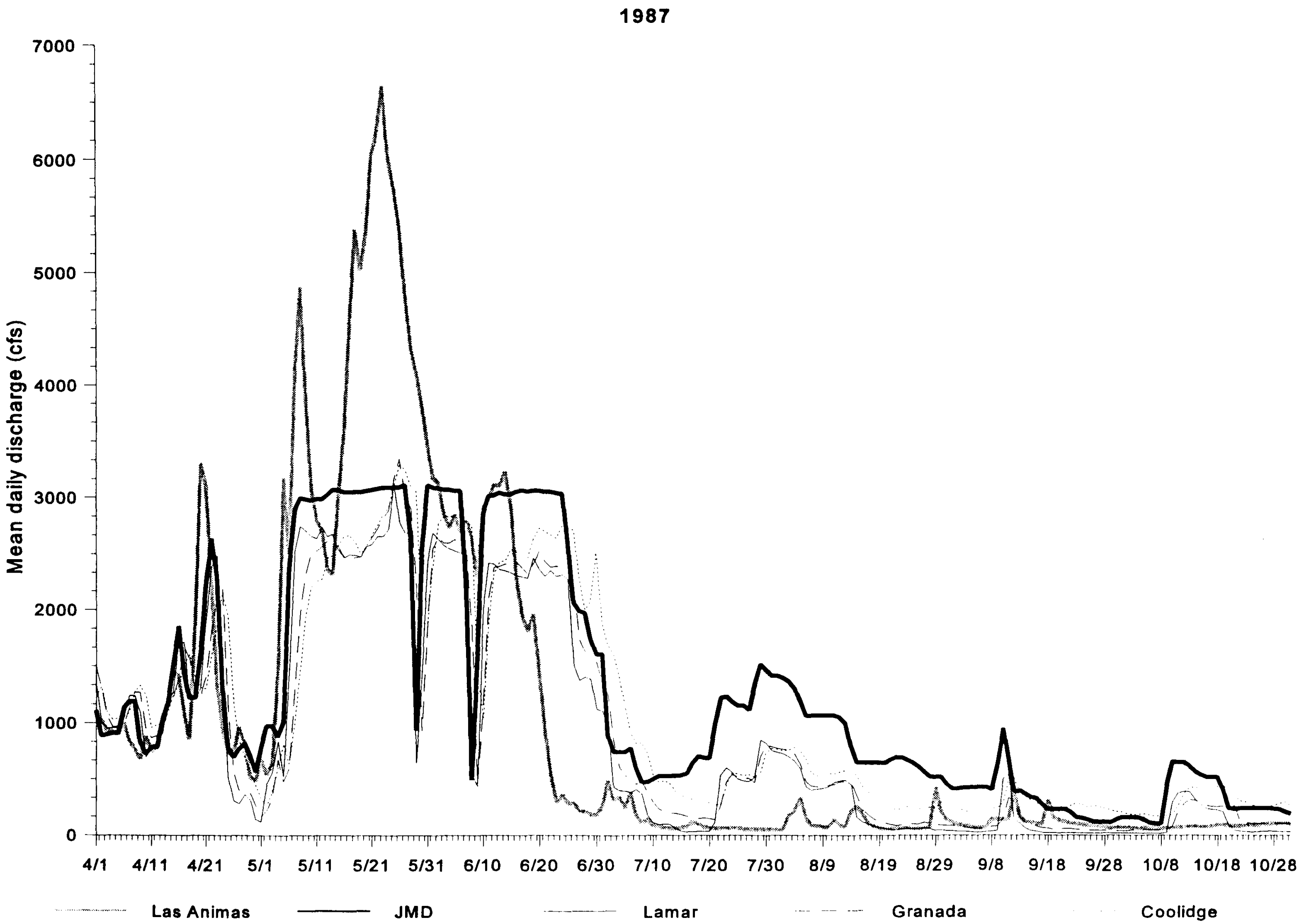


Figure 3. Arkansas River discharge, April through November, 1987. (Data from USGS).

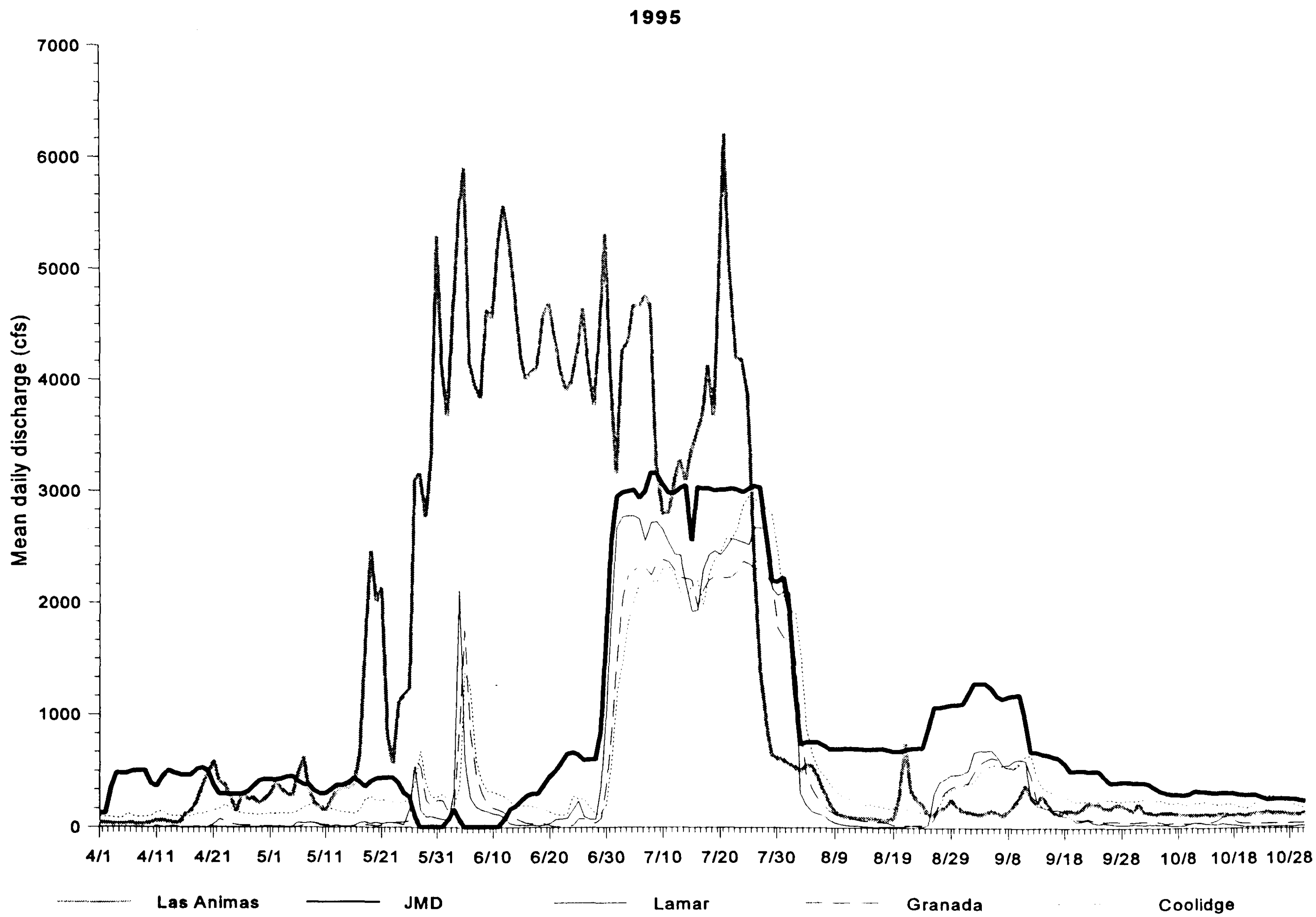


Figure 4. Arkansas River discharge, April through November, 1995. (Data from USGS).

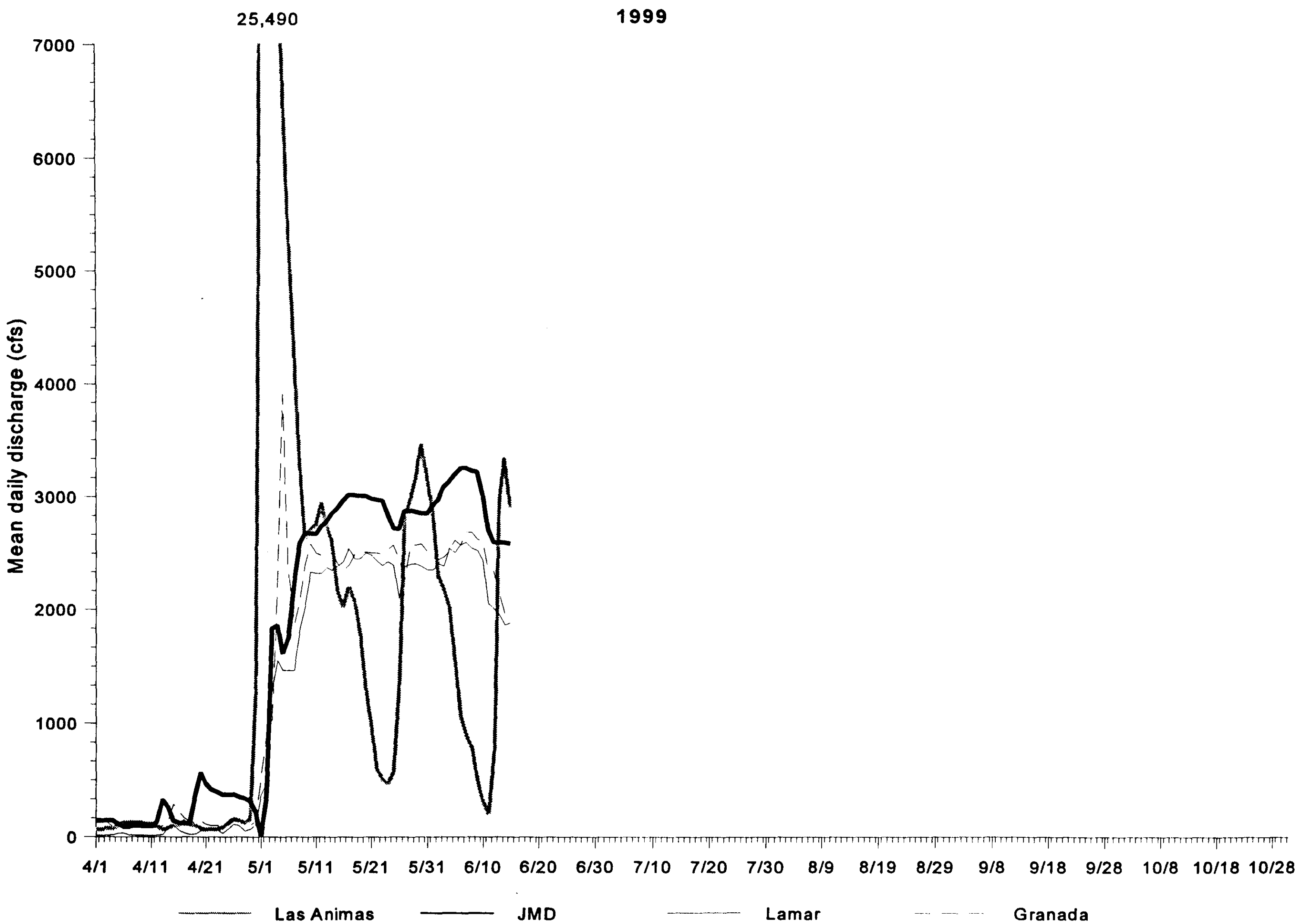


Figure 5. Arkansas River discharge, April through June 15, 1999. (Data from USGS).

2.2 CLIMATE

The climate in Prowers County is characterized as semi-arid/continental with low and variable precipitation, low humidity, and a wide seasonal range in temperature. Weather patterns generally are governed by dry air from the southwest; however, winter storms emanate from the northwest, and moist air from the Gulf of Mexico frequently influences weather during spring, summer, and fall.

During December through February, nighttime temperatures are usually below 32 °F while daytime temperatures generally are above freezing. In June through August, the daily maximum temperature is 90 °F or higher on about 70% of the days. The length of the freeze-free growing season in Prowers County is approximately 166 days (Pannell *et al.* 1966).

Average annual precipitation at Lamar is about 15 inches, nearly 60% of which result from thunderstorms in May through August. The annual snowfall is about 24 inches (Pannell *et al.* 1966). Because rainfall is low and summer temperatures are high, evaporation rates are high during the growing season. Average annual pan (Class A) evaporation at John Martin Dam is 84 inches, of which approximately 66 inches occurs during April through October (USACE 1983). The months of November through March account for approximately 20% of the annual pan evaporation.

2.3 PHYSIOGRAPHY, GEOLOGY, AND SOILS

The Arkansas River in Prowers County lies within the High Plains section of the Great Plains physiographic province (Fenneman 1931) and is characterized by flat to gently rolling uplands with a few shallow valleys and many shallow, undrained depressions. The alluvial bottomland along the river ranges from one to three miles wide and is bounded on the north and south by terraces or sand hills. Slopes within the valley bottomland are less than 2%.

Bedrock underlying the Arkansas River consists of Cretaceous sandstone, shales, and limestones. Most of the channel is within the Lower Cretaceous Dakota formation, composed of fine-grained sandstone and sandy shale. Saturated valley-fill alluvium consisting of gravel, sand, silt, and clay of Pleistocene to Holocene age and 50 to 150 feet thick occupies a trough eroded in the sedimentary bedrock.

Soils within the Arkansas River floodplain belong to the Las-Glendive association which consist of alluvial materials that vary extremely in texture, depth, and drainage. These soils include sand and gravel, silt loams, and clay loams (Pannell *et al.* 1966).

2.4 WATER QUALITY

The Arkansas River comprises Colorado's largest drainage basin. Originating in the Rocky Mountains in the central portion of the State, the river flows eastward for about 235 miles before entering Kansas. The drainage area between John Martin Dam and Coolidge, Kansas, is 5,572 square miles. Snowmelt in the upper reaches of the basin generally begins in April, with the majority of runoff occurring from May through July.

The Colorado Water Quality Control Commission (1989, 1991) has classified beneficial uses and established basic quality standards for surface waters in the state. The Arkansas River from immediately above the confluence with Fountain Creek downstream to the Colorado-Kansas border is designated as "Use-Protected", that is, waters that do not warrant the special protection provided by the High Quality 1 and 2 designations. This reach of the Arkansas River has the following use classifications:

- Class 2 warm water aquatic life — waters which are not capable of sustaining a wide variety warm water biota due to physical habitat, water flows or levels, or uncorrectable water quality conditions;
- Secondary contact recreation — waters are those which are not suitable for prolonged and intimate contact with the body;
- Domestic water supply — waters which are suitable or intended to become suitable for potable water supplies; and
- Agriculture — waters which are suitable or intended to become suitable for irrigation of crops and which are not hazardous as drinking water for livestock.

Numeric water quality and metal concentration standards that must be maintained in surface waters in the study reach are described in Colorado Water Quality Control Commission (1989, 1991) regulations.

Although surface water in most of the Arkansas River basin within Colorado is of a quality suitable for most uses, mining in the headwater areas and irrigation in the primarily agricultural lower basin have substantially degraded water quality in many reaches of the system (Colorado Water Quality Control Division 1990). Generally, the concentrations of dissolved solids, sulfate, total nitrogen , selenium, and suspended sediment increase in the river from the headwaters to the Colorado-Kansas border. However, declining specific conductance (an indicator of salinity and total dissolved solids) measured near the Kansas border between 1970 and 1989 is likely attributable to changes in water management and improved irrigation practices (Middelburg 1993).

3. HYDROLOGIC AND ECOLOGIC INVESTIGATIONS

3.1 GEOMORPHOLOGICAL ASSESSMENT

A geomorphological assessment of the Arkansas River below John Martin Dam was completed in early 1997 by the U.S. Army Corps of Engineers Waterways Experiment Station. The assessment provides an overview of the geologic, climatologic, and hydrologic forces influencing the Arkansas River during the past century and is included as Appendix C of this report.

3.2 HYDRAULICS AND SEDIMENTATION

Historic Hydrology

During the first stage of the present study the historic flow data for the Arkansas River below John Martin Dam were evaluated to some extent. This historic information was obtained from the United States Geologic Survey's (USGS) web site and imported into a spreadsheet program. The data set covers the period from April 1, 1938 through October 31, 1995, although the data have been gathered from three separate gage locations over that time. The three locations are all within two miles of each other with no significant tributary inflow within that distance and are comparable.

The data set was divided into two parts; April 1, 1938 to September 30, 1942, and April 1, 1943 to October 31, 1995. Operation of the reservoir officially began March 11, 1943, though water storage actually began in December 1942. The data set was subsequently divided again to look at flows after Water Year 1981, when operational changes went into effect.

To compare the pre- and post- dam hydrologic conditions, the daily flow values of the respective parts were sorted by magnitude, and the number of days of each flow was divided by the total number of flow days in the group. This generated flow-duration curves for the periods and allowed comparison. The post-dam data were further divided to include only the dates after Water Year 1981 to reflect current "trans-mountain" operations. The resultant curves (Figure 6) agree with those in the Geomorphological Assessment which were based on 1913 through 1996 data from the Lamar stream gage.

The comparisons show a substantial reduction in peak flows following construction of John Martin Dam. Note that the "Post-Dam" curve includes the "Post '81" data within it. This reduction occurs, expectedly, for rare events, the type the dam was designed to impact. But it also shows a dramatic reduction for the most common events, as well. Further, there has been a substantial reduction in the volume of water moving down the river at this point as evidenced by the decrease in area under both the "Post-Dam" and "Post '81" discharge-duration curves. This reduction is too large to be attributed to the dam and represents a change in river hydrology upstream. The "Post '81" curve shows a departure from the "Post-Dam" curve primarily between the 30% and 65% abscissa values. This apparently depicts the change in operations associated with trans-mountain diversions, but could be influenced by the smaller

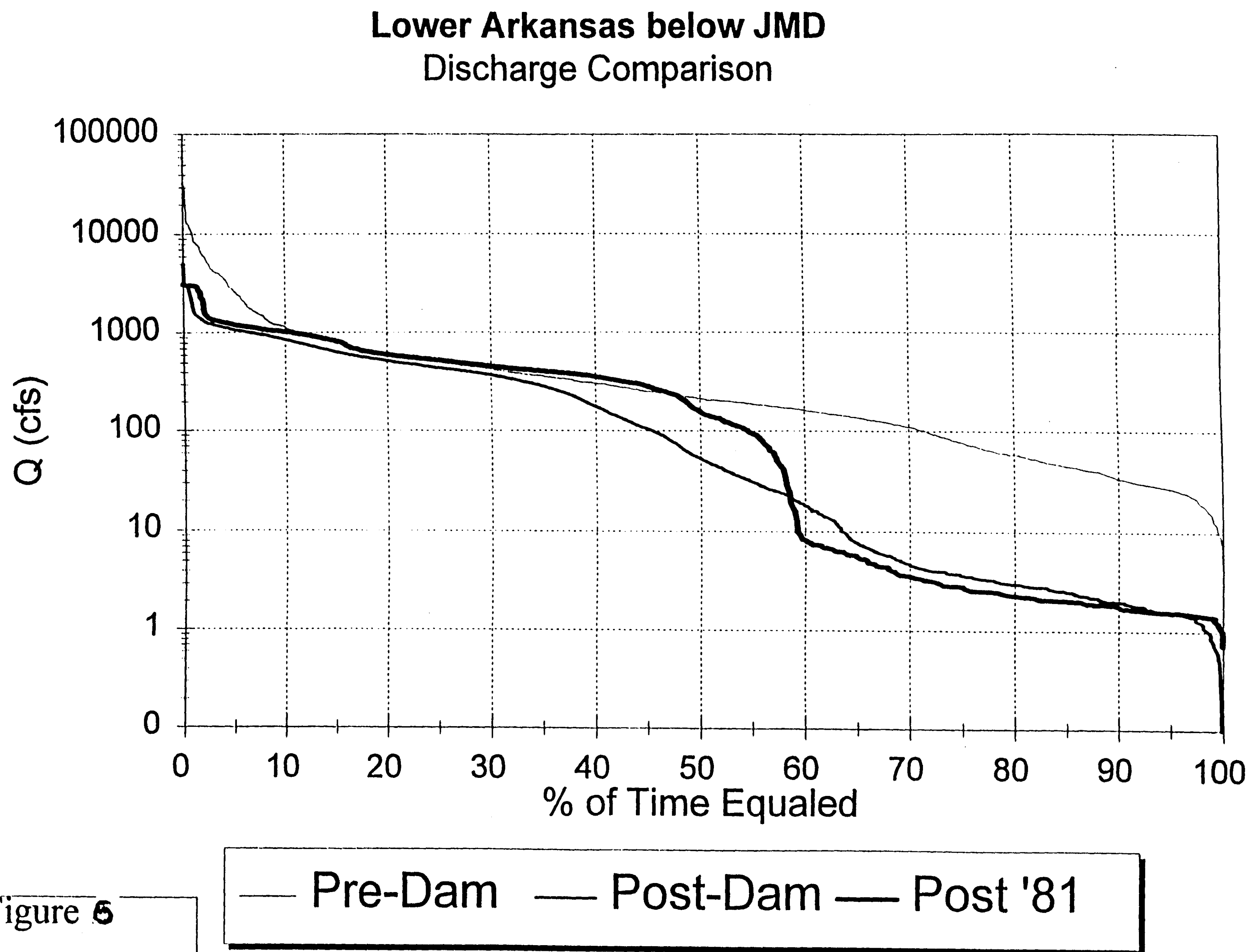

Lower Arkansas below JMD
Discharge Comparison
100000
10000
1000
100
10
1
0
Q (cfs)
0
10
20
30
40
50
60
70
80
90
100
% of Time Equaled
Pre-Dam
Post-Dam
Post '81

Figure 6

Examination of the profile indicated by the survey shows widely varying slopes between adjacent cross-sections. The reach-length weighted average slope for the problem area is 0.00097, but the individual values range from a relatively steep 0.00476 to an adverse -0.00140. More disturbingly, the values change sign quite often, with six consecutive cross-sections being the longest stretch of positive slope within the model, and two to three sections being typical. Tellingly, the portion with the most frequent directional changes in slope, *i.e.*, positive to negative or *vice versa*, coincides with an area heavily encroached upon by agriculture. Aerial photography indicates numerous old river scrolls within the cropland, and shows a large meander bend truncated by encroachment. At the upstream end of this bend the river is oversteep and then bounces frequently between positive and adverse slopes to near the bottom of the reach. It is probable that the encroachment is most responsible for the radically varying slope. This likely occurred as a combination of the actual excavation (and probable over-excavation) performed to move the river channel from the potential agricultural land and the river's adjustment to the imposed disequilibrium of unstable channel and planform geometry. A profile plot of this area is shown in Plate 2.

Problem Area 4 is suspected to be aggrading, although this can not be stated with certainty at this point. This is consistent with the apparent downstream movement of an aggradational trend observed in the degradation rangelines.

The "JR2" particle size distribution was used for this sub-reach for sediment transport calculations. The sediment yield for this problem area under existing conditions was 5,600 tons/yr with a mean daily load of 15 tons/day.

Problem Area 5. Hydraulic modeling of Problem Area 5 indicated that the capacity within the active channel banks is approximately 1,500 cfs. This is the value above which flow begins to significantly inundate the overbank areas adjacent to the river channel. Only one cross-section (out of 75) within the model indicates flows in excess of 4,000 cfs could cause damage to the adjacent agricultural area though, again, much of the flow area for lesser flows is outside the channel proper. The next potentially damaging flow occurs at approximately 6,000 cfs, with a substantial portion of the model sections indicating potential damage at flows above this amount. The 3,000 cfs operational discharge was modeled to indicate potential problem areas under current conditions. The flow area extents for this discharge were not plotted for this area, since it did not indicate potential surface water damages. The area with its cross-sections is shown on Sheet 3.

Examination of the profile indicated by the survey shows varying slopes between adjacent cross-sections, though not to the degree of area 4. The reach-length weighted average slope for the problem area is 0.00118, but the individual values range from a relatively steep 0.00742 to an adverse -0.00059. This steep slope is associated with an irrigation diversion within the reach. Another steep value of 0.00682 along with an adverse value of -0.00032 occurs just upstream of a bridge crossing and is the result of the flow constriction there. The steepest value not related to a known structure is 0.00421, but is again associated with human activities. This value occurs where a meander loop has been cut-off by mechanical means. The adverse slopes are infrequent and not alarming for a natural channel. Compared to other areas investigated, the profile of this reach is fairly well-behaved. A profile plot of this area is shown in Plate 3.

The planform of the river exhibits two different forms in this area. Downstream of the irrigation diversion the channel shows a pronounced meandering channel pattern form with sandy point bars. Upstream of the diversion the river channel is much less sinuous until the upper end of the reach, with fewer and smaller point bars and more braiding. This is consistent with a change in the sediment transport regime and is due to the diversion of a larger proportion of water than sediment. No attempt to quantify this effect was made because of inadequate data.

The "Bristol Bridge" particle size distribution was used for this sub-reach for sediment transport calculations. The sediment yield for this problem area under existing conditions was 30,200 tons/yr with a mean daily load of 83 tons/day (averages of below and above diversion).

Problem Area 6. Hydraulic modeling of Problem Area 6 indicated that the capacity within the active channel banks is approximately 1,500 cfs. This is the value above which flow begins to significantly inundate the overbank areas adjacent to the river channel. Potentially damaging flows begin above approximately 2,500 cfs at some cross-sections. The next potentially damaging flow occurs at approximately 3,500 cfs, upstream of a severe constriction caused by agricultural encroachment. The 3,000 cfs operational discharge was modeled to indicate potential problem areas under current conditions. The flow area extents for this discharge were connected to generate pseudo-floodplains, as described previously, and are shown on Sheet 4.

Examination of the profile indicated by the survey shows varying slopes between adjacent cross-sections, though not to the degree of area 4. The reach-length weighted average slope for the problem area is 0.00129, but the individual values range from a relatively steep 0.00615 to flat. There are no adverse slopes within this reach. Compared to other areas investigated, the profile of this reach is reasonably well-behaved. A profile plot of this area is shown in Plate 4.

The planform of the river reveals extensive encroachment along the reach, with one area near the downstream end where this is particularly extreme (shown in Figure 7). In this area, a circle-irrigation plot, coupled with its appurtenant levee and one on the other side of the river, has restricted most flows (*i.e.*, well above the channel capacity) to a width of only 200 feet. This severely reduces the area available for overbank flows and eliminates channel sinuosity. Without extensive bank stabilization and maintenance, this area can be expected to be very problematic. As mentioned above, this constriction also causes lowered capacity upstream with its backwater effect. A projection of an average slope through the reach shows that the channel bottom is overly deep in the area of this constriction. Again, this is likely the result of the actual channel work performed (probable over-excavation) and the channel's response to it.

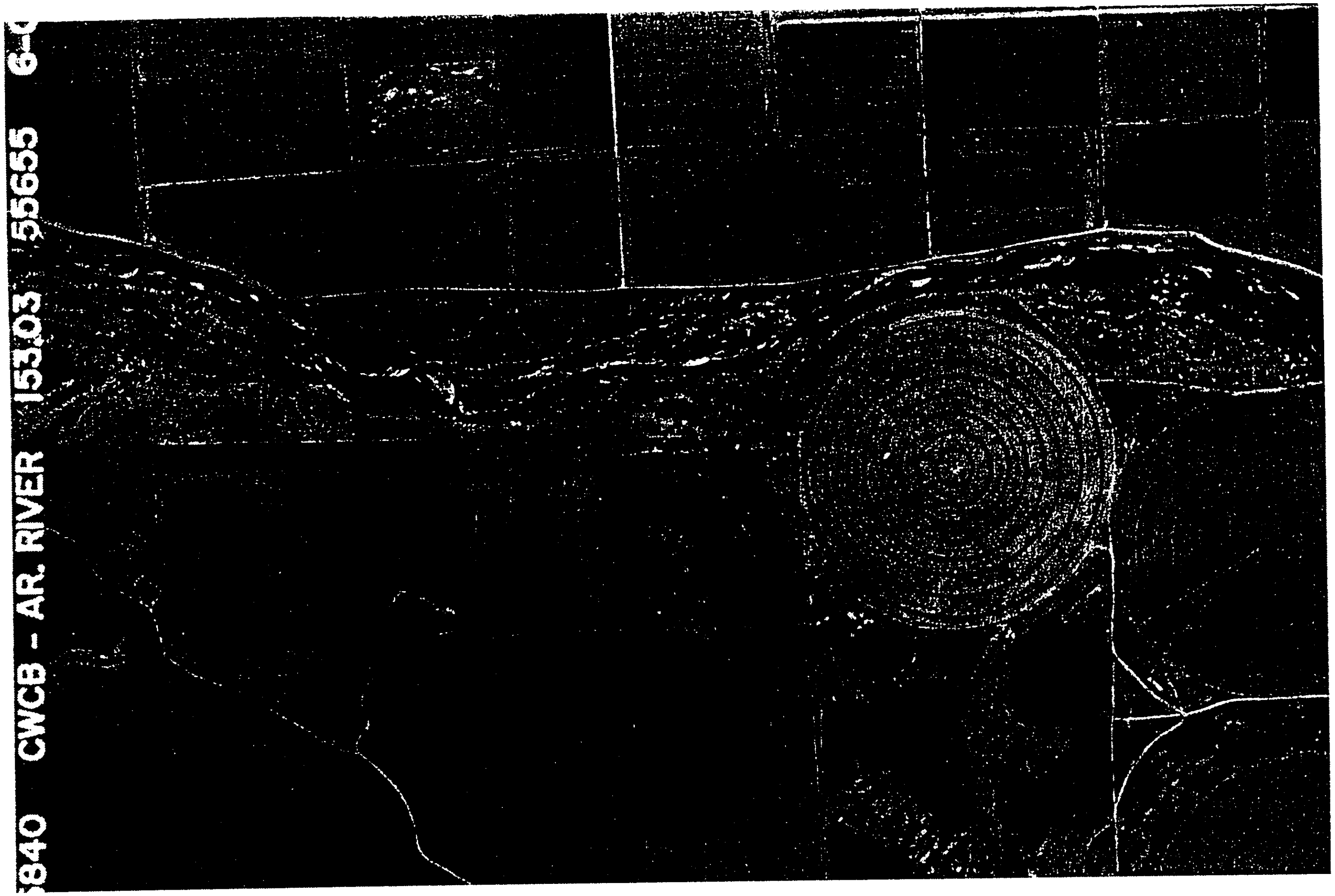


Figure 7. Examples of agricultural encroachment.

Based on the very different behavior of Problem Area 6, it appears that this reach is likely degrading. This can not be stated with certainty at this point, but the high transport rate and cross-sectional shape suggest an incising reach. It is expected that this reach requires high maintenance (Resource Consultants and Engineers, Inc. 1994). The abnormally high transport capacity will likely cause deposition problems downstream as well, if this has not already occurred.

The "Bristol Bridge" particle size distribution was used for this sub-reach for sediment transport calculations. The sediment yield for this problem area under existing conditions was 63,800 tons/yr with a mean daily load of 175 tons/day.

Problem Area 7. Hydraulic modeling of Problem Area 7 indicated that the capacity within the active channel banks is approximately 1,500 cfs. This is the value above which flow begins to significantly inundate the overbank areas adjacent to the river channel. Potentially damaging flows begin above approximately 3,000 cfs, though the flowpath that indicated for this area is quite wide with large undeveloped areas inundated. The 3,000 cfs operational discharge was modeled to indicate potential problem areas under current conditions. The flow area extents for this discharge were connected to generate pseudo-floodplains, as described above, and are shown on Sheet 5.

Examination of the profile indicated by the survey in this reach is relatively uniform, with a reach-length weighted average slope of 0.00122, and maximum and minimum individual values of 0.00477 and 0.00017, respectively. The aerial photography shows relatively little encroachment (compared to other areas studied), with a reasonable buffer zone on either side of the active channel. This appears to correspond with a better behaved bed profile and illustrates the importance of the floodplain cross-section in stability. A profile plot of this area is shown in Plate 5.

The "Bristol Bridge" particle size distribution was used for this sub-reach for sediment transport calculations. The sediment yield for this problem area under existing conditions was 47,500 tons/yr with a mean daily load of 130 tons/day.

Table 3-3 summarizes the sediment yields for the five problem areas in their current state. The large jump in yield from area 4 to area 5 is primarily due to the differing particle size distributions used. However, this is not the case for Problem Area 6, and represents the impact on channel morphology of the severe constriction from agricultural encroachment.

Hydraulic and Sediment Summary

The hydraulic and sediment analyses performed indicate several things. First, the conveyance capacity is less than the 3,000 cfs necessary for flood control releases in four of the five areas. Additionally, the erratic hydraulics likely cause seepage problems from localized high stages in other areas. Second, the channel form and profile are widely variable and these in turn cause a broad range of sediment transport potentials within the individual reaches. The profiles of some of the areas show marked disturbance. The "fits and starts" nature of the areas

Table 3-3. Existing yield summary.

Problem Area	Annual Yield (tons)	Mean Daily Load (tons/day)
3	4,100	11
4	5,600	15
5	30,200[a]	83[a]
6	63,800	175
7	47,500	130

[a] Average of above and below diversion values.

causes scour and deposition and inhibits effective conveyance of water and sediment. Third, the sediment transport potentials along the river area are erratic as well. Even with the approximate methods used in this study, more uniformity and clearer trends would have been expected.

The channel appears to be largely impacted by three phenomena: a reduction in peak flows due to the upstream reservoir, changes in the vegetal makeup of the floodplain, and agricultural encroachment. The reduced peak flows cause the channel to become smaller. This shrinkage is often exhibited as narrowing. Vegetation moves into the newly formed bank and inhibits its widening again during high flows. Likewise agriculture moves closer in and functions in essentially the same manner. Reduced peaks induce the sense that the river needs less room. In much the same way this encroachment inhibits rewidening of the channel. Additionally, leveeing further restricts the flow path and causes incision and bank instability. The battles are fought, sometimes at considerable cost, and the river responds with further instability. The cycle continues and the effective capacity becomes less and less.

Groundwater/Surface Water Interaction

Over the course of the study, many landowners indicated that surface water flooding from the Arkansas River was a secondary problem compared to saturation from groundwater. While groundwater/river flow interaction is outside the scope of this study, some qualitative discussion is offered here because of its relevance to recent events and the operation of John Martin Dam.

Groundwater/surface water interaction is a natural, dynamic process influenced by many variables which change over time. The simplest way to illustrate gross interaction is to consider the relative elevations of both the groundwater and river water levels at a given point in time. If the two water level elevations are the same, they will remain this way. If the river level is lower than the nearby groundwater level, they will attempt to equalize through transfer from groundwater to river. Conversely, if the river level is higher, the transfer occurs in the opposite direction, and this is the case that will be discussed further.

Over the years, the conversion of once-active floodplain to agricultural production fields through berm construction has considerably narrowed the area available for flood flows. Where discharges around 3,000 cfs once could spread over a large overbank area with minimal depth, they are now confined in extent and exhibit greater depth. This greater depth is primarily responsible for many of the adjacent groundwater saturation problems. When the river is at a high stage for an extended period, the local groundwater level rises and the adjacent farmland becomes saturated, either from hampered drainage or direct wetting by groundwater. An extreme example of this is shown in Figure 7 at the center-pivot irrigation plot. At this location, the 3,000-cfs water surface in the river is roughly two feet higher than the adjacent farmland.

As alluded to, the duration of the high river stage has a direct effect on the severity of the saturation problem. This was apparent in 1995 when a relatively high release extended over several weeks (Figure 4). In addition to farmland, berms and their subsurface zones become saturated. If berms are not engineered for this saturated condition, failure through piping and sloughing can occur.

When evaluating these effects, it is worth bearing in mind that a reduction in the flow released from John Martin Reservoir directly translates to an increase in duration for a given volume of water which must be evacuated. Over the years, the safe flood control release from John Martin Reservoir has been decreased. The current 3,000-cfs level is the minimum necessary for effective flood damage reduction operations. A theoretical reduction below this level would result in further channel adjustment, presumably, by narrowing. When upstream rainfall events initiated flood control operations, river stages would remain high for an even longer period of time than the current operation entails. The price paid for reduction in operating capacity were effectively illustrated in 1995. This is why the maintenance of the current 3,000 cfs level, at a minimum, is essential. An increase in operational channel capacity would reduce saturation problems because it would shorten durations; but achievement of this may be difficult, given the extent of encroachment that has already occurred. And increasing the capacity would have to be balanced with availability of flows of this magnitude on a frequent enough basis to maintain the channel at this capacity.

3.3 ECOLOGICAL RESOURCES

Historic and current ecological conditions were determined from scientific literature, government reports, consultation with private individuals and agency representatives, and site visits.

Prowers County lies within the Southwestern Tablelands ecoregion which is transitional between the Southern Rocky Mountain and Western High Plains ecoregions (Bailey 1976). The native plant community outside the Arkansas River floodplain is comprised of short, prairie grasses. Common species include blue grama, side-oats grama, buffalo grass, galleta, alkali sacaton, sand dropseed, western wheatgrass, and three-awn. Throughout the lower Arkansas River valley, agricultural and range lands predominate, often directly abutting the river channel.

Aquatic System

Used here, the "aquatic system" includes the incised river channel and its immediate banks; fish are the primary aquatic fauna. Fish species in the Arkansas River in Prowers County include stoneroller, longnose dace, flathead chub, suckermouth minnow, fathead minnow, red shiner, sand shiner, white sucker, Plains killifish, and, the introduced common carp (Woodling 1985). The Arkansas Darter, listed by the State of Colorado as a threatened species, occurs in Big Sandy Creek.

As described above and in the geomorphological assessment (Appendix C), the Arkansas River historically was an ephemeral, braided river with a channel-forming discharge of approximately 3,000 cfs. Several small, shifting channels occupied the broad, sandy river bottom and were interspersed with numerous bars and islands. In the late 1800s, bankfull width was approximately 1,000 feet. Bankfull depth data are sparse, but was within the range of 1 to 2 feet (see sources in Nadler 1978). These parameters generally describe the aquatic habitat conditions to which native fish species have adapted. The shallow, low-velocity conditions provided abundant feeding, spawning, and refuge areas.

Currently, the river within the study reach has become a perennial, narrow, meandering channel (Appendix C). Bankfull widths throughout the reach have decreased to approximately 100 feet, resulting in a nearly ten-fold decrease in channel area. Although the channel-forming discharge has decreased to about 800 cfs, bankfull depth has increased to 4 to 6 feet, resulting in further reduction of requisite shallow, low-velocity areas.

Riparian System

The riparian zone of a river or stream includes that portion of the terrestrial landscape from the water edge landward where vegetation may be influenced by river-associated water tables or flooding and by the ability of soils to hold water (Mitsch and Gosselink 1986, Naiman *et al.* 1993). Historically, riparian vegetation along the Arkansas River in eastern Colorado consisted of a wide band of sparsely distributed plains cottonwood, with scattered stands of sandbar willow and, less extensively, peach-leaf willow along the channel banks and bars (Lindauer 1970). Although relatively dense cottonwood groves occurred between Las Animas and Lamar, the majority of the area consisted of an open-canopied parkland. Common native grasses and forbs within the riparian corridor included salt grass, alkali sacaton, sand dropseed, vine mesquite, sunflowers, and wild licorice. These species comprised the groundcover throughout cottonwood stands and were the dominant vegetation in areas too saline to support cottonwood and willow.

The 30-mile reach downstream of John Martin Dam historically was known as the "Big Timbers," a scattered grove of gigantic cottonwoods (7 to 8 feet in diameter) which grew on islands in the river and along the banks, and lacked a shrub understory (Vestal 1939). Zebulon Pike first noted this stand on his journey up the Arkansas River in 1806. The area was used extensively by Native Americans, particularly in winter, and by travelers on the Santa Fe Trail; "Big Timbers" was the only cottonwood stand of any appreciable size in the 350-mile segment of the trail between Lamar, Colorado, and Council Grove, Kansas. Wagon trains made use of the wood for fuel and wagon repairs and the stand steadily decreased in size. The last of the large trees were gone by 1863, and the reach downstream from Caddoa was virtually treeless for some period thereafter. Smaller, less spectacular cottonwood stands recolonized the area such that, by the 1940s, they occupied about 40 acres per river-mile (Snyder and Miller 1991).

Salt cedar, a deciduous, needle-leaved tree, was introduced into the United States from Eurasia in the early 1800s (Robinson 1965). This species was first noted in the Arkansas Valley near Lamar in 1913 and had spread substantially by 1923 (Niedrach, cited in Lindauer 1970). Local residents noted that salt cedar spread extensively throughout the valley after the large floods of 1921 and 1937 (Lindauer and Ward 1968). Bittinger and Stringham (1963) found that woody phreatophyte stands (primarily salt cedar) increased by about 43% (or approximately 52 acres/year) from 1936 to 1957 in the floodplain between La Junta and Las Animas. By 1967, woody riparian cover in Bent and Prowers Counties occupied an average of 143 acres per river-mile, 93% of which was monotypic or mixed stands of salt cedar (Lindauer and Ward 1968). Salt cedar has become established in the understory of existing cottonwood galleries, but, more extensively, has replaced broad expanses of riparian grassland communities.

Salt cedar is a fast-growing species and is tolerant of saline soils, shallow groundwater, and poor water quality. It exudes a salty secretion which, when accumulated on the soil surface, suppresses other seeds from germinating. These properties give salt cedar a competitive advantage over native riparian plants and enable it to form dense stands with low plant species diversity. While it provides wildlife with shrub cover, its food value is low. Salt cedar provides lower quality wildlife habitat than native cottonwood-willow communities (Anderson *et al.* 1977, Engel-Wilson and Ohmart 1978, Hink and Ohmart 1984). Additionally, salt cedar root systems are extensive and can reach a depth of 25 feet or more, contributing to relatively high transpiration rates. Conservative estimates indicate that dense stands can utilize 42 to 60 inches of water per year (Robinson 1952, Fletcher and Elmendorf 1955, Bittinger and Stringham 1963).

The width of historic riparian communities along the Arkansas River is not well documented in accounts from the 1800s. Bent noted that the "Big Timbers" stand in 1853 was about two miles wide (cited in Grinnell c. 1920). Currently within the five problem areas studied, the band of riparian vegetation varies from 250 to 4,000 feet wide. Although salt cedar coverage has increased dramatically, the overall areal extent of riparian vegetation has decreased over the past 100 years due to urban and agricultural development with the floodplain and the reduced effective discharge associated with irrigation and flood control storage in John Martin Reservoir. Additionally, flood control operation has significantly reduced large flood events which formerly scoured extensive areas, creating suitable substrates for cottonwood and willow seed germination.

Currently, riparian vegetation along the Arkansas River below John Martin Dam is largely restricted to the 3,000 cfs floodway. From Lamar downstream through Problem Areas 3 and 4, fairly dense sandbar willow occupies the immediate riverbank and mature cottonwoods form a continuous, though sparse band throughout the floodway. A few relatively dense stands of younger (4- to 6-inch diameter) cottonwood are present. Often, within about 60 feet of the channel, the understory consists of mixed willow, salt cedar, grasses, and (especially in autumn of 1998) sunflower. Further from the channel, salt cedar occurs either scattered throughout grassland areas or in dense monotypic stands along abandoned meanders. Kochia grows in very dense strips along the landward edge of riparian in this reach and, in fact, throughout the entire study area.

From the Carlton Bridge downstream through the Granada area (including Problem Area 5), cottonwood is absent and willow is present only in small, isolated patches. Salt cedar dominates the immediate riverbank and entire floodway.

From the railroad bridge west of Amity downstream through Problem Areas 6 and 7, mature, scattered cottonwoods again are present. Several small stands of young trees were observed, however, it is not known whether these originated from seed or are sprouts from beaver cutting or other disturbance. Sandbar willow, and some peachleaf willow, occur in patches near the channel, however, nearly all of the immediate riverbank is dominated by dense salt cedar. These stands extend throughout the entire floodway, particularly in areas of alkaline soil in Problem Area 7.

Functions of Riparian Vegetation

The following discussion highlights the major functions of riparian vegetation and is not intended to be an exhaustive summary. For concise reviews of riparian functions and values see Brinson *et al.* 1981, Minshall *et al.* 1989, Davis *et al.* 1996, and Minckley 1997.

Bank Stabilization. Channel width, depth, and slope are determined to a large degree by bank stability. Vegetation stabilizes banks by directly reducing flow velocities and thus the erosive forces at the soil-water interface (Davis *et al.* 1996). Roots and rhizomes of bank vegetation bind soil material, increase cohesiveness, and reduce weakening and loosening processes which are often the precursors of entrainment (Thorne 1990). The numerous fine roots of sedges and grasses provide greater binding strength than coarse roots of woody plants. A mixture of vegetation is generally preferred since the deeper rooting depth of trees and shrubs provide additional protection to tall banks. Vegetated banks also are drier than unvegetated slopes because soil water is removed by transpiration, effectively reducing the likelihood of mass failure. The net effect of these contributing forces is generally positive; however, in reaches such as the Arkansas River below John Martin Dam, dense bank vegetation (*i.e.*, salt cedar) can exacerbate channel incision and narrowing.

Resistance to flow. Vegetation within the floodway presents an obstruction to water flow that tends to decrease flow velocities. Soil erosion is reduced in vegetated overbank areas and deposition of suspended sediment is enhanced. The magnitude of these effects depends upon the density and type of vegetation. Grasses and short herbaceous groundcover are flattened against the ground surface by flows and present relatively little resistance to flow. Shrubs provide higher resistance due to the stiff, less flexible branches and, if present, large leaf area. Dense mature trees have large cross-sectional areas and can withstand relatively high flows without breaking, therefore, provide the greatest resistance to flow (Vogel 1984). Sparsely distributed trees can actually generate bank scour by accelerating flow around their trunks.

Flood attenuation. Flood discharge is strongly influenced by floodplain area. A larger floodplain will have a lower peak stage than a smaller one for a given discharge. Additionally, larger channel capacity allows a given flood event to pass more quickly.

Sediment load. Riparian vegetation affects stream morphology by regulating sediment supply and points of deposition. As stated previously, overbank vegetation influences sediment transport by reducing flow velocities and causing deposition. Since the primary source of sediment in many streams is bank erosion (Dunne and Leopold 1978), sediment load can be significantly limited by bank vegetation. In agricultural watersheds with significant sediment laden runoff, riparian vegetation traps sediments before they reach the stream (Lowrance *et al.* 1984).

Nutrient trapping and removal. Riparian vegetation traps both suspended and dissolved materials and contributes significantly to the high fertility of floodplain soils. Suspended particles in overbank flow and upland runoff are deposited when flow velocities are decreased by vegetation. Most notably, carbon, nitrogen, and phosphorous concentrations in surface water are effectively reduced by floodway vegetation (Peterjohn and Correll 1984). Additionally, riparian root systems uptake dissolved nutrients in subsurface water.

Wildlife habitat. Riparian habitats provide breeding sites, wintering areas, and migratory stop-over areas for numerous wildlife species. The provision of food, cover, and shelter has long been an important, widely recognized function of riparian vegetation (Brinson *et al.* 1981, Minshall *et al.* 1989). This is especially true in the central and western United States where riparian woodlands provide uncommon and structurally complex habitats relative to the surrounding grassland or shrubland. Lowland riparian forests occupy only 3% of Colorado's land area but contain the highest bird species richness and abundance than any other ecosystem in the state except for marshes (Kingery 1998). The Arkansas River below John Martin Dam harbors a nationally prominent white-tailed deer population (Ed Gorman, Habitat Biologist, Colorado Division of Wildlife, October 1998, *pers. comm.*). Individual deer are known to range throughout 350 to 400 acres of riparian woodland during the course of the year (Kufeld and Bowden 1995). Riparian plant communities serve as travel corridors for local populations of deer and other mammals, and as major migration routes for migratory birds.

Importance to aquatic systems. Bank vegetation also is an important component of aquatic faunal habitat (Platts 1983). Streamside vegetation provides shade and cover for fishes where it overhangs the water surface. The contribution of carbon to downstream aquatic habitats is one of the most widely recognized functions of riparian vegetation (Brinson *et al.* 1981).

Riparian Fauna

The location of the Prowers County in the transition area between the Rocky Mountain and Great Plains ecoregions results in a diverse assemblage of terrestrial animal species. Many zoologists consider the 100th meridian to be the general dividing line between eastern and western species, and representatives of both groups occur in Prowers County.

Amphibians frequently encountered in the Arkansas River floodplain include tiger salamander, Woodhouse's toad, and Northern leopard frog. Plains spadefoot is found in areas with sandy soil. Common reptiles in the area include ornate box turtle, collared lizard, prairie lizard, Great Plains skink, Colorado checkered whiptail, Western hognose snake, bullsnake, corn snake, Northern water snake, Plains garter snake, and prairie rattlesnake.

Wetland- and riparian-dependent bird species breeding along the Arkansas River in Prowers County include Green-backed Heron, Gadwall, Green-winged Teal, Spotted Sandpiper, Belted Kingfisher, Eastern Kingbird, Marsh Wren, Yellow Warbler, Yellow-breasted Chat, Black-headed Grosbeak, Red-winged Blackbird, and Yellow-headed Blackbird. Other commonly encountered species breeding in the general area include Turkey Vulture, American Kestrel, Swainson's and Red-tailed Hawks, Ring-necked Pheasant, Scaled Quail, Great Horned Owl, Western Kingbird, Black-billed Magpie, American Robin, Northern Mockingbird, Brown Thrasher, Blue Grosbeak, Spotted Towhee, Chipping Sparrow, Sage Sparrow, and House Finch.

John Martin Reservoir and the Great Plains Reservoir system provide valuable wetland and deepwater habitats for migrating and wintering shorebirds and waterbirds. Together, these reservoirs represent the largest concentration of surface water in the western Great Plains between the Platte River (approximately 200 miles to the north) and the ephemeral playa lakes of west Texas. Migratory shorebirds and waterbirds commonly found in the area include Snowy Egret, Great Blue Heron, Canada Goose, Snow Goose, Northern Pintail, Northern Shoveler, Blue-winged and Cinnamon Teal, Bufflehead, Ruddy Duck, American Coot, Lesser Yellowlegs, Western Sandpiper, and Wilson's Phalarope.

The Colorado Division of Wildlife manages several areas in the county for harvestable and non-game animals. In addition to waterbirds mentioned above, the major species considered in management plans include white-tailed deer, pronghorn, Ring-necked Pheasant, Scaled Quail, Northern Bobwhite, Mourning Dove, Eastern cottontail, black-tailed jackrabbit, striped and spotted skunk, raccoon, bobcat, beaver, red fox, mink, long-tailed weasel, and muskrat.

4. ALTERNATIVES

4.1 CHANNEL IMPROVEMENT

Improvements to the Arkansas River channel to increase conveyance and reduce maintenance were examined as one of several alternative. Improvements to each of the five Problem Areas were modeled and are described below. The adopted configuration, after numerous trials, consists of a relatively wide, uniform channel capable of carrying at least 3,000 cfs with a meandering 1,000 cfs stable channel within. A stable channel is one that maintains its shape and profile over time without aggrading or degrading, though it may move laterally. The 3,000 cfs minimum was the upper limit of capacity that could be gained without extensive reconfiguration. The 1,000 cfs discharge parameter for the inner channel was chosen based on a pattern of this as the approximate "effective discharge" of the problem areas using the post-1981 discharge-duration data. This value represents a flow that has occurred frequently enough to transport a substantial portion of the sediment load.

It should be noted that in order to maintain the gains of these improvements, some conditions are implied. The sediment modeling performed used the post-1981 hydrologic regime. This hydrology included some flood releases. On average, flows of around 3,000 cfs occurred about four days per year. In actuality they occurred only in certain years for longer periods of time. In order to maintain sediment movement throughout the system, these higher flows must continue. If runoff precludes achieving this value for four days of every year, it should be targeted for 2 weeks every three years. This would require the cooperation of the water users but is important to the maintenance of capacity. This recommendation does not introduce the need for any additional water, but rather what has statistically occurred in the past. Maintaining this may require some coordination and cooperation with water users but will pay large dividends in terms of channel maintenance and conveyance capacity. The second condition implied is no further encroachment on the floodplain. The impacts of encroachment on river behavior should be apparent from the discussions above. The current condition of the river is largely a product of the agricultural encroachment that has occurred in the past. Some means of preventing encroachment, through agreement or easement would be required.

Problem Area 3. The improved channel for this sub-reach uses a 400 ft bottom-width channel along the existing channel alignment with a slope of 0.00105 and 1:3 sideslopes, and a more sinuous interior channel with a 120 ft bottom width on a slope of 0.000822. The sideslopes of this interior channel were modeled at 1:2.5 for the outside of the bend and 1:10 for the inside. The "n" value for the large channel was estimated at 0.060 and the interior channel was modeled using 0.038. This configuration will pass 3,000 cfs. A profile plot of this area with the improved channel is shown in Plate 6 and a typical improved cross-section is shown in Plate 11.

The sediment yield calculated for this configuration was 15,500 tons/yr with a mean daily transport of 43 tons/day. This represents a roughly four-fold increase in sediment transport capacity for this subreach, which would greatly decrease required maintenance and loss of flow capacity. Since the interior channel was designed to be stable at 1,000 cfs, degradation would be minimal, as well.

Problem Area 4. The improved channel for this sub-reach uses a 400 ft bottom-width channel along the existing channel alignment with a slope of 0.00096 and 1:3 sideslopes, and a slightly more sinuous interior channel with a 140 ft bottom width on a slope of 0.000925. The sideslopes of this interior channel were modeled at 1:2.5 for the outside of the bend and 1:10 for the inside. The "n" value for the large channel was estimated at 0.060 and the interior channel was modeled using 0.038. This configuration would pass 3,000 cfs. A profile plot of this area with the improved channel is shown in Plate 7 and a typical improved cross-section is shown in Plate 12.

The sediment yield calculated for this configuration was 19,300 tons/yr with a mean daily transport of 53 tons/day. This represents almost a four-fold increase in sediment transport capacity for this subreach, which would greatly decrease required maintenance and loss of flow capacity. Since the interior channel was designed to be stable at 1,000 cfs, degradation would be minimal, as well.

Problem Area 5. The improved channel for this sub-reach has two configurations; one downstream of the Buffalo diversion structure, and one upstream. The downstream portion uses a 400 ft bottom-width channel along the existing channel alignment with a slope of 0.00110 and 1:3 sideslopes, and a slightly more sinuous interior channel with a 130 ft bottom width on a slope of 0.000723. The sideslopes of this interior channel were modeled at 1:2.5 for the outside of the bend and 1:10 for the inside. The upstream portion uses a 500 ft bottom-width channel along the existing channel alignment with a slope of 0.00110 and 1:3 sideslopes, and a slightly more sinuous interior channel with a 140 ft bottom width on a slope of 0.000723. The sideslopes of this interior channel were modeled at 1:2.5 for the outside of the bend and 1:10 for the inside. The "n" value for the large channel was estimated at 0.060 and the interior channel was modeled using 0.038. This configuration would pass 3,000 cfs. A profile plot of this area with the improved channel is shown in Plate 8 and a typical improved cross-section is shown in Plate 13.

The sediment yield calculated for this configuration was 33,300 tons/yr with a mean daily transport of 91 tons/day for the downstream portion, and 25,800 tons/yr and a mean daily transport of 71 tons/day for the upstream portion. This is a mismatch, but not necessarily bad considering the diversion impacts. More analysis would be required to account for water diversions and their effect on sedimentation. These values compare closely to the existing condition values of 29,600 tons/yr and 30,700 tons/yr for downstream and upstream, respectively. This indicates a slight increase in sediment transport capacity for this subreach. Since the interior channel was designed to be stable at 1,000 cfs, degradation would be minimal, as well.

Problem Area 6. The improved channel for this sub-reach uses a 400 ft bottom-width channel along the existing channel alignment with a slope of 0.00134 and 1:3 sideslopes, and a less sinuous interior channel with an 85-ft bottom width on a slope of 0.000859. The sideslopes of this interior channel were modeled at 1:2.5 for the outside of the bend and 1:10 for the inside. The "n" value for the large channel was estimated at 0.060 and the interior channel was modeled using 0.035. This configuration would pass 3,000 cfs. A profile plot of this area with the improved channel is shown in Plate 9 and a typical improved cross-section is shown in Plate 14.

The sediment yield calculated for this configuration was 51,800 tons/yr with a mean daily transport of 142 tons/day. This is somewhat less than the existing sediment transport capacity for this subreach. This area showed a disturbingly high transport capacity in its current state. This is due primarily to the extreme constriction at the downstream end and its influence on channel morphology.

Problem Area 7. The improved channel for this sub-reach uses a 400 ft bottom-width channel along the existing channel alignment with a slope of 0.00134 and 1:3 sideslopes, and a slightly more sinuous interior channel with a 100 ft bottom width on a slope of 0.00167. The sideslopes of this interior channel were modeled at 1:2.5 for the outside of the bend and 1:10 for the inside. The "n" value for the large channel was estimated at 0.060 and the interior channel was modeled using 0.035. This configuration would pass 3,000 cfs. A profile plot of this area with the improved channel is shown in Plate 10 and a typical improved cross-section is shown in Plate 15.

The sediment yield calculated for this configuration was 53,600 tons/yr with a mean daily transport of 147 tons/day. This is approximately the same as the current condition, while maintaining a higher conveyance capacity.

Table 4-1 summarizes the sediment yield values for the improved channel conditions in all problem areas. Note that there is an increase in yield as we progress downstream. This increase is fairly steady except for Problem Area 6. This is because the improved channel was configured for the abnormally high current transport capacity.

Table 4-1. Improved channel yield summary, Channel Improvement alternative.

Problem Area	Annual Yield (tons)	Mean Daily Load (tons/day)
3	15,500	43
4	19,300	53
5	29,600[a]	81[a]
6	51,800	142
7	53,600	147

[a] Average of above- and below-diversion values.

The prescribed channel improvements demonstrate an approach to achieving a more uniform, gradually varying and stable river channel system in terms of sediment transport while maintaining the necessary conveyance capacity for water deliveries and flood control operations. They are, however, mathematical models and implementation must be considered.

To get an idea of the costs associated with these improvements some preliminary earthwork quantities were calculated and rough dollar figures associated with them. Table 4-2 shows the costs estimated for the earthwork involved. It is important to note that these estimates are crude due to time and scope constraints. The alignments have not been optimized and other factors have not been considered. They do, however, allow some comparison of the five areas and ranking of them.

Table 4-2. Approximate earthwork costs for the Channel Improvement alternative.

Problem Area	Length (mi.)	Cut (cu. yd.)	Fill (cu. yd.)	Earthwork Cost ($)	Cost per mile ($)
3	9.0	458,300	2,169,700	36,211,200	4,027,200
4	2.3	191,200	0	2,485,600	1,082,700
5	8.1	402,800	0	18,821,900	2,313,000
6	4.1	317,400	1,040,000	5,325,100	1,301,400
7	2.6	140,600	119,900	2,599,100	990,100

Based on these preliminary costs, Problem Areas 4 and 7 stand out: they are less expensive per unit length than the others. Problem Areas 5 and 6 require further study because of the diversion within Area 5 and the suspiciously high transport rates of Area 6. Area 3 is the most expensive of the five, both in terms of unit length and overall because of the large volume of earthwork involved.

As described above, channel improvements include the reshaping of the entire 1,000- to 1,500-cfs river channel (approximately 865 acres) throughout the five Problem Areas. To attain the requisite flow depth for channel stability, the 3,000-cfs corridor also would require reshaping (see typical cross-sections on Plates 11 through 15). The entire overbank area (approximately 1,800 acres) would be modified through excavation, fill placement, and the removal (and subsequent re-establishment) of all riparian vegetation. Over all five Problem Areas, the post-project area of river channel and riparian habitats would be within ±3% of the existing acreage; however, pre- *vs.* post-project area varies widely among individual Problem Areas (Table 4-3).

Table 4-3. Pre- and post-project area of river channel and riparian overbank for the Channel Improvement alternative.

Problem Area	Existing area (acres)[a]	Post-project area (acres)[a]	Difference (acres)	Percent change[b]
River channel:				
3	387	220	-168	-43%
4	52	50	-2	-4%
5	265	403	+138	+52%
6	100	105	+5	+5%
7	90	89	-1	-1%
All	894	865	-29	-3%
Riparian zone (overbank):				
3	1,026	354	-672	-65%
4	136	80	-56	-41%
5	254	1,000	746	+293%
6	162	135	-27	-17%
7	227	269	42	+18%
All	1,805	1,838	+33	+2%
Total:				
3	1,414	574	-840	-59%
4	188	130	-58	-31%
5	489	1,283	+795	+163%
6	262	239	-23	-9%
7	137	180	+43	+32%
All	2,489	2,406	-82	-3%

[a] Columns may not sum exactly due to rounding.
[b] Percent change = 100 X difference / existing acreage.

The Albuquerque District believes that modification of the entire 3,000-cfs corridor and removal of all riparian vegetation would represent a significant adverse impact to the Arkansas River system, be highly controversial, and would have limited revegetation success. Successful riparian restoration projects have, of course, been implemented; most projects target a specific component or two of the system for modification. The Channel Improvement alternative outlined here would modify the hydrology, substrate, and vegetation components of the system, effectively rebuilding of the Arkansas River corridor "from scratch." For these reasons, the District does not recommend the Channel Improvement alternative as a cost-effective, implementable solution.

4.2 LIMITED CHANNEL IMPROVEMENT

A scaled-down version of the full channel improvement option also was considered, utilizing essentially the same configuration as the full channel improvement, above, but with improvements focused on the most non-uniform areas. Table 4-4 shows costs for the limited channel improvements. These could be implemented as an interim step to alleviate capacity problems. While the underlying channel shapes from which these limited configurations were derived are based on channel stability concepts, they are not presented as long-term solutions since they were developed based on conveyance only.

Table 4-4. Approximate earthwork costs for the Limited Channel Improvement alternative.

Problem Area	Length (mi.)	Cut (cu. yd.)	Fill (cu. yd.)	Earthwork Cost ($)	Cost per mile ($)
3	9.0	322,100	1,037,600	18,140,600	2,017,500
4	2.3	26,900	0	349,900	152,400
5	8.1	0	414,900	6,233,700	764,800
6	4.1	204,500	62,700	3,285,300	807,900
7	2.6	19,900	4,600	304,100	115,900

4.3 FLOODWAY IMPROVEMENT

Agricultural practices along the Arkansas River have steadily encroached upon the floodway: former riparian areas have been separated from the floodway by berms and then placed into production. While agricultural encroachment has contributed greatly to observed channel instability, high river stages, and decreased conveyance capacity, it has already occurred. The two Floodway Improvement alternatives outlined below look at enhancement of the system already in place. While continued encroachment of the floodway is strongly discouraged, these alternatives would at least provide for 3,000 cfs operational releases and promote sediment transport at higher discharges and maintenance of conveyance capacity.

The impetus for the current study was inundation of agricultural fields during the spring runoff period in 1997. As hydraulic modeling progressed, it became apparent that several agricultural areas within the five study reaches showed a potential for surface-water inundation during a peak release of 3,000 cfs. (The term "agricultural" as used here refers to production cropland [*e.g.*, alfalfa, corn, sorghum, winter wheat] and does not include pasture). Actual inundation of most of these areas was, in fact, confirmed during conversations with landowners and irrigation district personnel.

The hydraulic model identified 8 agricultural areas, totaling 442 acres, as at risk to inundation by Arkansas River flows of 3,000 cfs. Their locations by specific Problem Area are given in Table 4.5 and are depicted on Sheets 1 through 5 (not included within this bound document). Approximately 60% of this acreage was put into production between 1957 and 1988, and approximately 9% was placed in production between 1988 and 1996. Worth noting is that flood control operation of John Martin Dam has not changed appreciably since 1957, except that channel capacity was reduced to 3,000 cfs following the 1965 flood.

Table 4-5. Agricultural areas at risk to inundation at 3,000 cfs.

Problem Area	Number of sites	Acres
3	5	282 (range 9-90)
4	1	35
5	0	0
6	1	5
7	1	120
All	8	442

Structural Alternative: Berm Rehabilitation

This alternative identified where existing containment berms are inadequate and makes recommendations on correcting this to prevent inundation of adjacent agricultural lands by Arkansas River discharge of 3,000 cfs. Sediment yields were not calculated for this alternative since they would be essentially the same as the existing condition, barring changes to the discharge regime. Locations and quantity estimates are given in Table 4-6. (Locations refer to hydraulic cross-sections on Sheets 1-5). Quantity estimates for this alternative assume 3:1 sideslope berms to compute earthwork volumes.

Existing berms primarily consist of random-fill material compacted only by traffic and constructed by local or private entities. The recommended rehabilitation assumes construction of similar structures. Because these berms lack drainage blankets and are not fully compacted, they would be susceptible to piping and sloughing when inundated for an extended period.

The Corps of Engineers does not have an authority to facilitate the described berm rehabilitation; however, local interests have the capability to perform the task.

Table 4-6. Approximate earthwork volumes, Structural Floodway Improvement alternative.

Problem Area	Cross-section No./L or R	Length between (ft.)	Height (ft.)	Volume (cu. ft.)	Cumulative Volume (cu. yd.)
3	3013/L		0		
	3014/L	946	1.4	2,781	
	3015/L	572	0	1,682	165.29
3	3014/R		0		
	3015/R	440	1.2	950	
3	3016/R	330	1.1	1,312	
	3017/R	594	0	1,078	123.71
3	3052/L		0		
	3053/L	330	2.4	2,851	
	3054/L	440	1.3	4,917	
	3055/L	462	2	3,943	
	3056/L	440	0	2,640	
	3057/L	352	1.3	892	
	3058/L	484	1.2	2,272	
	3059/L	484	0	1,045	687.46
3	3056/R		0		
	3057/R	462	1.1	839	
	3058/R	550	1.6	3,110	
	3059/R	528	0	2,028	221.34
3	3086/R		0		
	3087/R	242	1.1	439	
	3088/R	594	0	1,078	56.20
4	4010/R		0		
	4011/R	440	2.3	3,491	
	4012/R	440	0.9	4,026	
	4013/R	308	2.3	2,818	
	4014/R	572	3.2	13,325	
	4015/R	528	4.3	22,754	
	4016/R	418	0	11,593	2148.43
6	6009/R		0		
	6010/R	484	1.8	2,352	
	6011/R	440	0	2,138	166.32
6	6043/R		0		
	6044/R	616	2.9	7,771	
	6045/R	220	2.6	5,006	
	6046/R	440	0	4,462	638.46
7	7003/L		0		
	7004/L	308	1.1	559	
	7005/L	528	0	958	56.20
7	7010/L		0		
	7011/L	374	1.3	948	
	7012/L	770	0	1,952	107.41

Berm rehabilitation in the specific Problem Areas is discussed below.

Problem Area 3. This area would require approximately 1,300 cubic yards (cu. yd.) of material placement to contain the 3,000 cfs discharge. Five sections of berms would be needed at a total length of approximately 8,300 feet. Berm heights would range from 1.1 to 2.4 feet.

Problem Area 4. This area would require approximately 2,200 cu. yd. of material placement to contain the 3,000 cfs discharge. One section of berm would be needed at a total length of approximately 2,700 ft. Berm heights would range from 0.9 to 4.3 feet.

Problem Area 5. No improvements are required for this area to pass the 3,000 cfs discharge.

Problem Area 6. This area would require approximately 800 cu. yd. of material placement to contain the 3,000 cfs discharge. Two sections of berms would be needed at a total length of approximately 2,200 feet. Berm heights would range from 1.8 to 2.9 feet.

Problem Area 7. This area would require approximately 200 cubic yards (cu. yd.) of material placement to contain the 3,000 cfs discharge. Two sections of berms would be needed at a total length of approximately 2,000 feet. Berm heights would range from 1.1 to 1.3 feet.

Non-structural Alternative: Conservation and Restoration

A non-structural solution to surface-water (and, in some cases, groundwater) inundation of agricultural areas is to return them to the floodplain through conversion from crop production to pasture or native riparian vegetation. As stated previously, many of the affected areas were brought into production within the last 40 years and, therefore, are likely only marginally suitable as cropland due to soil wetness. Because these areas are level and lack woody vegetation, the establishment of pasture or riparian vegetation would be fairly straightforward. Typical vegetation restoration techniques are discussed in detail in Section 4.4.

Because the subject areas are privately owned, implementation of this alternative would, of course, be dependent on landowner willingness. Landowners may individually pursue this objective. If restoration is to be conducted by a government agency or conservation organization, compensation to the landowner for retirement of land from production would likely be required. Estates could include fee purchase or some form of conservation easement. The latter likely would include monetary compensation to the landowner for relinquishing the right to develop the area as cropland; all other rights and uses would be retained by the landowner. For instance, the landowner could utilize the area as pasture or lease it for hunting.

This conservation/restoration alternative could be implemented through the Corps of Engineers' Section 1135 authority. A non-Federal entity or conservation organization would be required to serve as the local sponsor of the project, provide 25% of the planning and implementation costs, and hold title to any real estate purchase or easements agreements. (See

Appendix D for the Section 1135 program fact sheet). An example of typical costs is given in Section 4.4 below.

Local Education, Coordination, and Planning

Both the structural and non-structural corrective solutions presented above are sufficient to alleviate current surface flooding problems but should not be construed as a justification or subsidy for further floodway encroachment. Channel capacity has steadily decreased over the years along the Arkansas River below John Martin Dam. Further encroachment will result in serious constraints to conveyance, increased damages, and further loss of ecological values.

Pressure likely will continue for additional floodway encroachment in the future. Local education, coordination, and planning efforts are needed to inform the public of the importance of floodplain functions, identify continuing issues, and address land use conflicts and problems. While the Corps strongly supports floodplain zoning and planning, the determination of land use policy lies primarily with the local, not Federal, government.

4.4 RIPARIAN RESTORATION

In addition to the above-mentioned lands, extensive areas within the current floodway also are suitable for riparian restoration. These primarily entail areas of non-native vegetation or those with significantly altered hydrologic regimes.

Specific areas were not identified as part of the current study because nearly all lands within the study area are privately owned. We do not believe it is within the purview of the Federal government to select privately-held parcels for restoration. Rather, the Corps can assist local governments, resource groups, and individuals who express an interest in restoration efforts. In this regard, the CWCB and the Arkansas River Steering Committee may be especially valuable in coordinating with local interests, identifying private landowners desirous of riparian improvement, and prioritizing restoration goals in the area.

The following sections discuss riparian vegetation restoration and salt cedar removal methods which are applicable to restoration efforts along the Arkansas River. The restoration activities discussed could be accomplished through the Corps of Engineers' Section 1135 program, and example costs are given below.

Natural Regeneration

Under certain conditions, natural regeneration of cottonwood and willows can be enhanced. In New Mexico, cottonwood stands have been reestablished within the floodway of the Rio Grande (Taylor *et al.* 1999). During winter, dense stands of salt cedar were mechanically removed from the 5-year floodplain and the soil surface was regraded after root plowing. Areas inundated by the snowmelt-runoff discharge and settled by cottonwood seeds from nearby trees produced dense seedlings; salt cedar also germinated profusely in the same areas. Favorable flow regimes during that and the following spring resulted in a high survival of cottonwood seedlings. By the end of the third growing season, cottonwood had attained a height of 3 to 5 feet, successfully overtopping salt cedar seedlings which had germinated at the same time.

Several factors are crucial to the germination and survival of cottonwood and willows including available seed source(s); timing of seed release; competition; availability of suitable substrate; the depth, duration, expected frequency, and seasonal timing of inundation; and the rapidity of descending water levels (Mahoney and Rood 1993). Opportunities for natural regeneration of plains cottonwoods and willows along the Arkansas River may exist; however, specific areas with requisite attributes were not identified as part of the present study. Additional field surveys and more accurate hydraulic modeling would be required to determine if and where suitable areas occur.

While natural regeneration of riparian vegetation may be most desirable and, often, inexpensive, most restoration efforts along Southwestern streams and rivers have employed plantings.

Riparian Restoration Plantings

Stands of several species of cottonwoods have been successfully reestablished through pole plantings. Dormant, 15- to 20-foot tall poles are cut from natural stands or nurseries during the late winter. Holes to receive poles are drilled with a soil auger (often gas-powered and tractor-mounted) to a depth sufficient to reach the groundwater surface or at least the capillary fringe. Poles are inserted and the holes backfilled by hand. Poles will generate rapid root growth if they are planted before bud break and their lower ends are sufficiently wet. Supplemental irrigation usually is not required. Best suited to successful pole planting are those areas where the groundwater is within 5 feet of the surface and soils are primarily sandy without large stones or cobbles. Following successful establishment, the above-ground growth rate can be as much as 5 feet per year. Survival rates of 80 to 90% after the third growing season are commonly achieved. Plantings may require insecticidal treatment during the first year or two to control cottonwood beetle damage. Costs average about $20 per pole (including materials, labor, and administration costs).

Sandbar and peach-leaf willows can be easily established through whip plantings. Dormant whips cut from existing stands are hand-planted in suitably moist areas during spring. Given a suitable local source of willow, labor may be the only cost incurred. Willow planting is an excellent restoration activity to utilize volunteer labor.

Soils with high salinity are not viable areas for the establishment of cottonwood or willow. Generally, soils with electrical conductivity greater than 3 mmhos/cm (approximately 980 ppm NaCl) are considered too saline for successful woody plant establishment. These areas along the Arkansas River are best suited for saltgrass and alkali sacaton plantings.

Establishment of riparian grasses and herbaceous vegetation usually follows standard agricultural practices. Areas intended for restoration planting may require disking, scarifying, or other seedbed preparation. Only native plant species should be considered for establishment since these are best adapted to region's climate and floodplain conditions. Species such as saltgrass, alkali sacaton, vine mesquite, and sunflower would be suitable along the Arkansas River. Additional, more palatable grass species may be included where grazing is planned. Local Natural Resources Conservation Service or Soil Conservation District offices can make recommendations on erosion control and suitable plant species (Sutherland *et al.* 1990). Fertilization may be required if rapid establishment and growth is desired. Supplemental irrigation may be necessary if reseeding is attempted during dry periods. Mulching is usually recommended to retain moisture and protect the seeds and seedbed from wind erosion. Crimped hay mulch has commonly been used in Albuquerque District groundcover planting efforts. Costs for grass and herbaceous plantings range from $500 to $900 per acre depending on site preparation needs.

Salt Cedar Removal

While salt cedar cannot be entirely eradicated from Southwestern riparian systems, local stands can be significantly reduced and replaced with native plant species. Several mechanical and herbicidal removal methods have been successfully applied; however, specific techniques to be employed depend largely on site-specific conditions such as stand stem density, stand size, species composition, and location relative to sensitive areas. The following summary of salt cedar removal methods is taken primarily from Sisneros (1994).

Root plowing. Mechanical removal of large, moderately to very dense stands of salt cedar can be accomplished through the root plowing method. An optional first step may be to burn an existing stand to reduce the amount of woody material requiring removal. Above-ground stems are removed by bulldozing. Because the growing meristem of salt cedar is located in the root crown just below the soil surface, the crowns must be removed to prevent resprouting. Root plowing draws a blade through the soil at a depth of 10 to 16 inches and removes the crown from the roostock. Because even severed root crowns will resprout, they are collected for disposal with a root rake. Herbicidal hand-spraying of salt cedar sprouts is a common follow-up practice in the second growing season after root plowing.

Mechanical removal is especially suitable for stands adjacent to waterways where the use of herbicides is restricted or undesirable. Patches of desirable vegetation within a target salt cedar stand can easily be avoided and left intact during clearing. The root plowing method does disturb the entire soil surface and, therefore, often requires reseeding of grasses and groundcover for soil stability and vegetation restoration. A large quantity of woody debris is generated by this removal method. In various projects, this material has been hauled from the work site and disposed in landfills, or piled and burned in place. Costs are estimated to range from $500 to $1,000 per acre depending on tree size and density.

Brush hog. Brush hogs, or brush choppers, are large backhoe attachments used to shred aboveground woody stems. Their use in the Southwest for salt cedar and Russian olive removal is relatively new and results are still being evaluated. Although, perhaps, best suited for removal of small stands or strips of vegetation, it has been used for removal of Russian olive from the understory of cottonwood forest. Small stems are shredded to the ground surface; larger (greater than 6 inches diameter) trees may be topped and then treated with herbicides (see "cut-stump" method below). Shredded debris is often left in place, but may be raked and disposed if there are concerns such as brush-fires. Soil and groundcover are minimally disturbed compared to the root plowing method. Because salt cedar rootstocks are left intact, follow-up treatment with hand-sprayed herbicide would likely be required to control resprouting. No cost estimates for salt cedar removal are available at this time.

Cut-stump method. Large scattered trees, or small patches and strips, may be removed through this manual/herbicidal treatment combination. Trees (or stumps, if trees were previously topped) are cut with a chainsaw near the ground surface. Within a few minutes after cutting, herbicide is hand-sprayed on the exposed cut to be drawn into and kill the roots. Herbicides used successfully include Arsenal, Pathfinder, and Garlon 3A or 4. Because these herbicides are short-lived and are applied only to the stumps, this method of salt cedar removal is generally safe along stream banks. This technique is labor-intensive, usually requiring a 3-person crew: a chainsaw operator, a person to clear debris from the stump, and an herbicide applicator. Costs have ranged from $250 to $1,000 per acre depending on stem density.

Backpack sprayer application. Young, shrubby salt cedar stands and resprouts following other removal methods may be treated with herbicide applied from a backpack sprayer. Foliar applications of Arsenal or Chopper have been successfully used. Cost is estimated to range from $100 to $300 per acre.

Ground-based herbicide application. Low-pressure, trailer-mounted sprayers have been used to apply herbicide (usually Arsenal or Rodeo) to low-density salt cedar stands less than 20 feet tall. Thorough application of herbicide to bark areas of all branches is especially critical for this method to be successful. Non-target species (*i.e.*, species other than salt cedar) within treated stands also will be killed by spraying. Costs have been stated as $1 to $3 per tree, indicating the limited applicability of this method for large-scale removal.

Aerial Herbicide Application. Aerial application of herbicide from either helicopter or fixed-wing aircraft is best suited for treating large, monotypic stands of salt cedar distant from water channels. Aerial spraying will kill non-target plant species within the treatment area. Special attention and, perhaps, equipment, are required to minimize drift of herbicide into adjacent areas. Arsenal and Rodeo (Roundup) have been used in successful aerial applications. Treated stands of salt cedar must remain undisturbed for 18 to 30 months to allow the herbicide to be effectively absorbed into root tissues. Aerial application costs range from $75 to $225 per acre. Physical removal and disposal of dead stems may require an additional $400 to $600 per acre. Along the Arkansas River, the proximity of salt cedar stands to the river channel, residences, and agricultural fields limits the opportunities for aerial spraying.

Example Restoration Costs: Section 1135 Program

As stated, riparian restoration along the Arkansas River below John Martin Dam could be accomplished through the Corps' Section 1135 program. Gross example costs for restoration of 500 acres are given in Table 4-7 (and apply to the Conservation and restoration alternative above, as well as general restoration within the floodway). These costs are based on general unit prices for typical activities and do not reflect site-specific conditions or constraints. The Section 1135 program requires that the local sponsor acquire a real estate interest in the restoration areas. (Appendix D outlines pertinent aspects of the Section 1135 program). In the example costs, conservation easements were assumed to be tantamount to fee value, and range from $800 to $1,200 per acre. Worth noting is that local sponsors could implement riparian restoration through this program for the approximate cost of conservation easements. Areas requiring salt cedar removal would have a correspondingly higher restoration cost.

Table 4-7. Gross cost estimate for a 500-acre riparian restoration project under the Section 1135 program.

Activity	Unit cost (per acre)	Without Salt Cedar Clearing	With Salt Cedar Clearing
Feasibility Study & Compliance		$ 130,000	$ 150,000
Plans & Specifications		80,000	100,000
Implementation:			
Conservation easement	1,200	600,000	600,000
Site preparation and seeding	900	450,000	450,000
Pole planting (33/acre)	700	350,000	350,000
Fencing (3-strand barbed-wire, 250 ft/acre)	625	312,500	312,500
Post-project monitoring	100	50,000	50,000
Salt cedar clearing (average)	1,000	0	500,000
Contingency (15%)		265,000	340,000
Supervision & administration (10%)		175,000	225,000
Total Project Cost		$ 2,412,500	$ 3,077,500
Local Sponsor Share (25%)		$ 603,125	$ 769,375
Local Sponsor Share per acre		$ 1,205	$ 1,540

5. RECOMMENDATIONS

The study recommendations are as follows:

- *No further reduction of the current 3,000-cfs floodway capacity.* Past reductions already have exacerbated water conveyance, sediment transport, flooding, and groundwater problems. Catastrophic floods can result from storms downstream of John Martin Dam. Floods originating upstream, and of a magnitude similar to the May 1999 event, could likely result in reservoir discharges substantially greater than 3,000 cfs if sufficient storage is not available in the reservoir.

- *Extensive channel improvement through excavation is not recommended* due to high implementation costs and significant adverse environmental impacts.

- *Smaller-scale channel modification techniques cannot be approached generically.* Specific points along the river may benefit temporarily from channel modification to avoid or reduce structural damage. Existing erratic hydraulic and sediment transport characteristics demand site-specific design, determination of upstream and downstream effects, and consideration of overall channel stability. Because of the widely varying hydraulic characteristics throughout the study reach, a generic channel configuration addressing conveyance, sediment transport, and vegetation encroachment on banks could not be identified.

- *Inundation of agricultural fields by river flows can be addressed in various ways*:
  - *Structurally, through rehabilitation of existing berms* by local authorities;
  - *Non-structurally, through retirement of lands from production* and conversion to pasture or riparian vegetation. This may be pursued individual landowners, or facilitated by the Corps of Engineers' ecosystem restoration authority (Section 1135).

- *Within the floodway, cost-effective restoration of native riparian vegetation can be accomplished* through the Corps' Section 1135 program. Extensive opportunities for riparian restoration (including salt cedar removal) exist within the study area. Because the majority of these lands are privately owned, this study has not selected specific sites suitable for restoration. Landowners will require the support of a local sponsor to take advantage of the Section 1135 program.

- *To prevent further encroachment on the floodway, coordination and education of local stakeholders is required.* The Colorado Water Conservation Board and the Arkansas River Steering Committee can play a crucial role in coordinating these general objectives in addition to facilitating all report recommendations.

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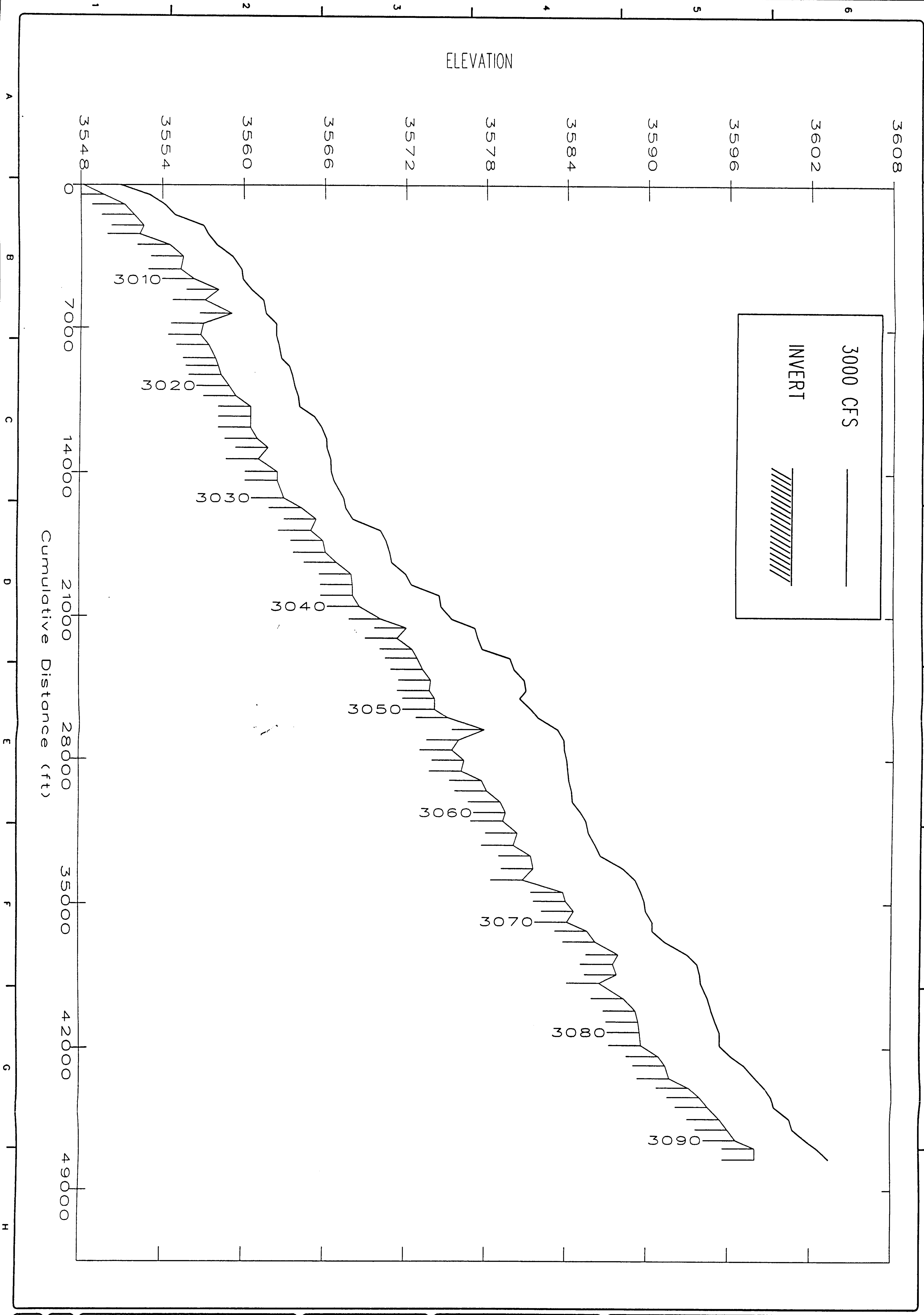
PLATES



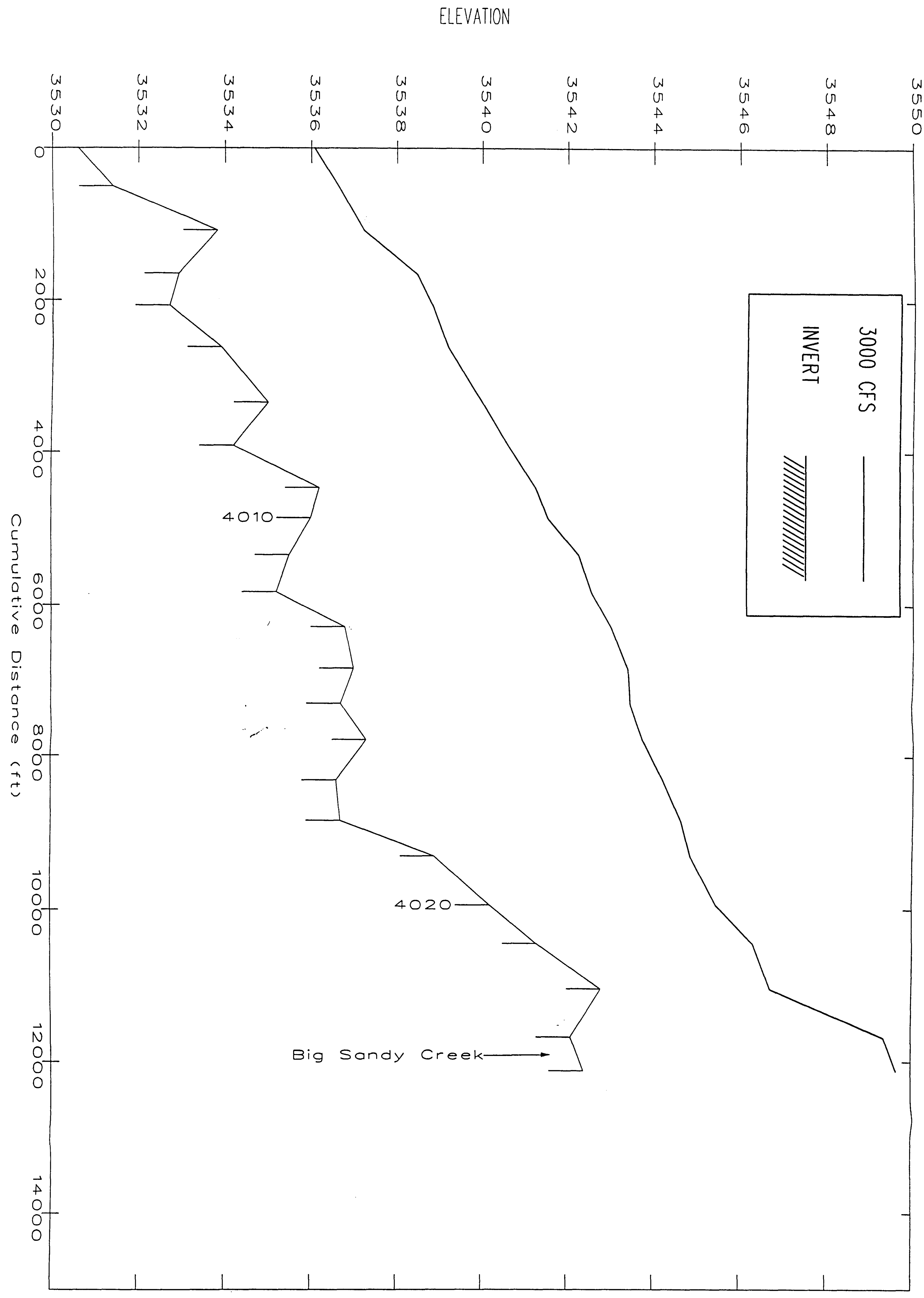
SEQUENCE NO.	PLATE NO. 1 OF 15	Section 22 Colorado ARKANSAS RIVER PROBLEM AREA - 3 EXISTING CHANNEL	U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS ALBUQUERQUE, NEW MEXICO CHIEF, GENERAL ENGINEERING SECTION DATE:	DESIGN BY: DRAWN BY: REVIEWED BY:

File Name: ***
Plot Scale: *** Plot Date: ***
DCAXXX-95-X-XXXX
Zero Accidents Zero Tolerance

REVISIONS

Symbol	Description	Date	Appr.

US Army Corps of Engineers ALBUQUERQUE DISTRICT



Section 22 ARKANSAS RIVER Colorado
PROBLEM AREA - 4
EXISTING CHANNEL

PLATE NO. 2 OF 15

SEQUENCE NO.

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ALBUQUERQUE, NEW MEXICO

CHIEF, GENERAL ENGINEERING SECTION
DATE:

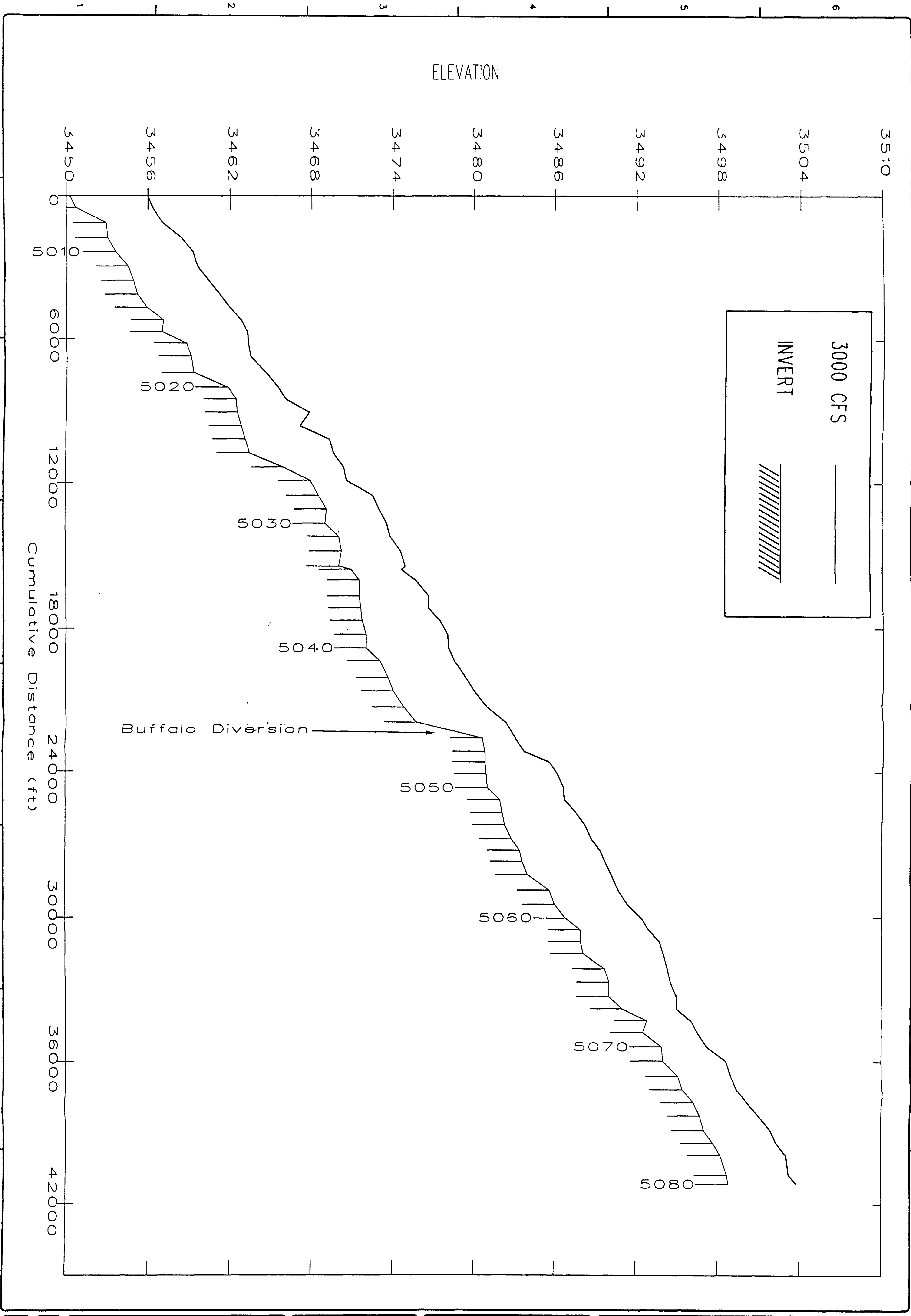
DESIGN BY:
DRAWN BY:
REVIEWED BY:

DCAXXX-95-X-XXXX

Zero Accidents
Zero Tolerance

REVISIONS

US Army Corps of Engineers
ALBUQUERQUE DISTRICT



SEQUENCE NO.

PLATE NO. 3 OF 15

Section 22 Colorado

ARKANSAS RIVER

PROBLEM AREA - 5

EXISTING CHANNEL

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ALBUQUERQUE, NEW MEXICO

CHIEF, GENERAL ENGINEERING SECTION

DATE:

DESIGN BY:

DRAWN BY:

REVIEWED BY:

File Name:

Plot Scale:

Plot Date:

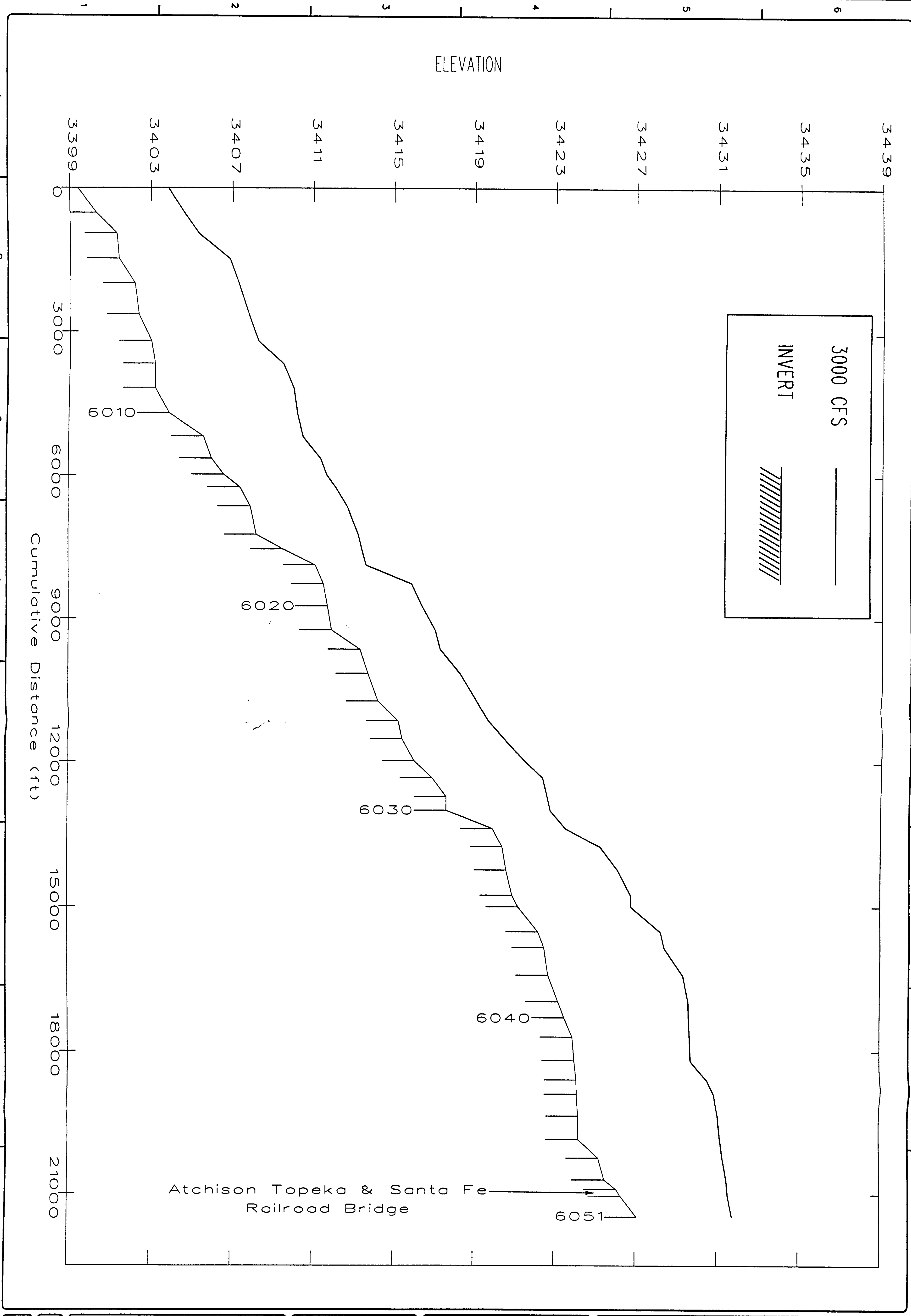
DCAXXX-BS-X-XXXX

Zero Accidents
Zero Tolerance

REVISIONS

Symbol	Description	Date	Appr.

US Army Corps of Engineers
ALBUQUERQUE DISTRICT



SEQUENCE NO.

PLATE NO. 4 OF 15

Section 22 Colorado

ARKANSAS RIVER

PROBLEM AREA - 6

EXISTING CHANNEL

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ALBUQUERQUE, NEW MEXICO

CHIEF, GENERAL ENGINEERING SECTION
DATE:

DESIGN BY:
DRAWN BY:
REVIEWED BY:

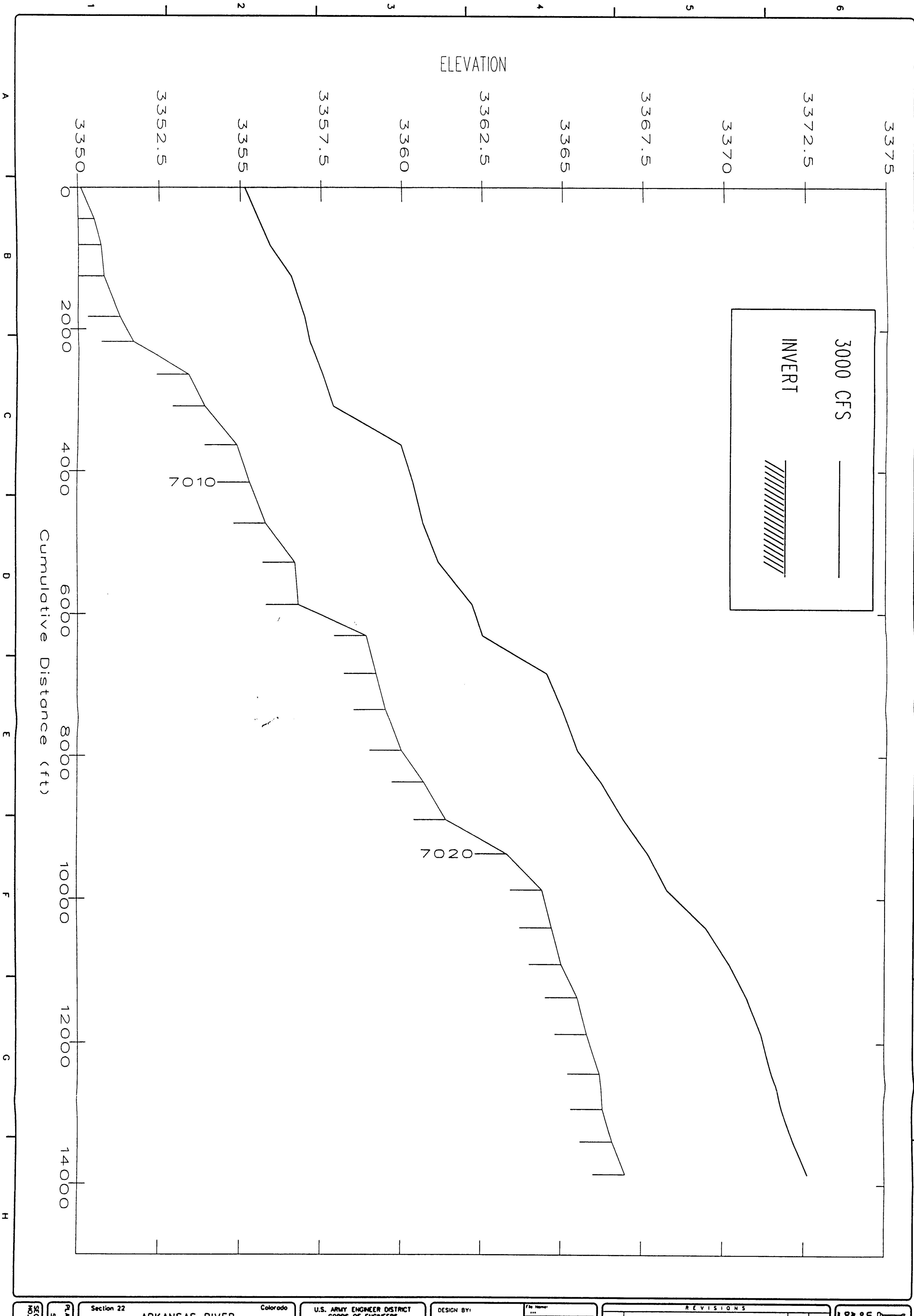
File Name:
Plot Scale:
Plot Date:
DCAXXX-95-X-XXXX

Zero Accidents
Zero Tolerance

REVISIONS

Symbol	Description	Date	Appr.

US Army Corps of Engineers
ALBUQUERQUE DISTRICT

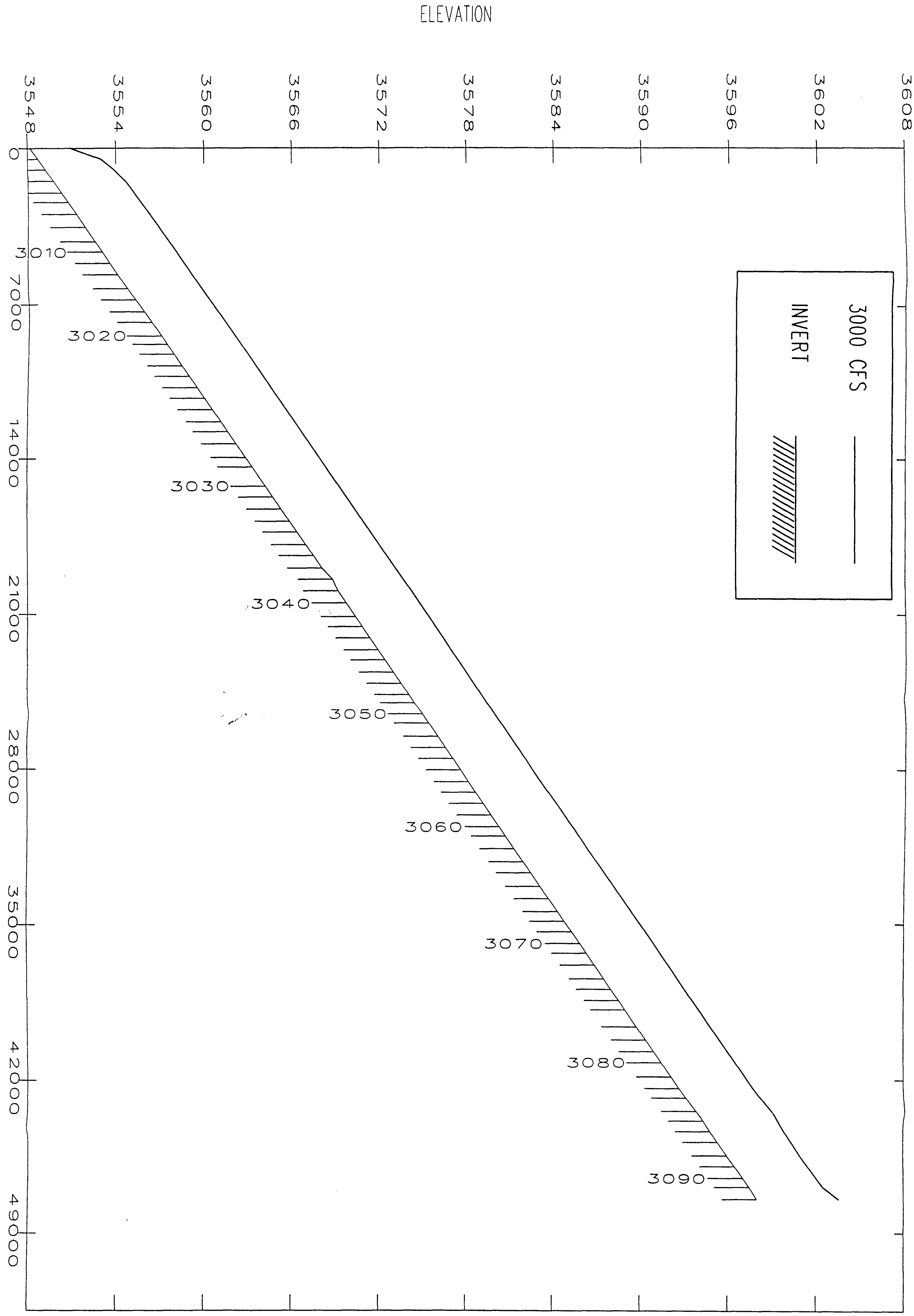


SEQUENCE NO.	PLATE NO. 5 OF 15	Section 22 Colorado ARKANSAS RIVER PROBLEM AREA - 7 EXISTING CHANNEL	U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS ALBUQUERQUE, NEW MEXICO CHIEF, GENERAL ENGINEERING SECTION DATE:	DESIGN BY: DRAWN BY: REVIEWED BY:	File Name: Plot Scale: Plot Date: DCAXXX-05-X-XXXX Zero Accidents Zero Tolerance

REVISIONS

Symbol	Description	Date	Appr.

US Army Corps of Engineers
ALBUQUERQUE DISTRICT



Section 22 Colorado
ARKANSAS RIVER
PROBLEM AREA - 3
IMPROVED CHANNEL

PLATE NO. 6 OF 15

SEQUENCE NO.

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ALBUQUERQUE, NEW MEXICO

CHIEF, GENERAL ENGINEERING SECTION
DATE:

DESIGN BY:
DRAWN BY:
REVIEWED BY:

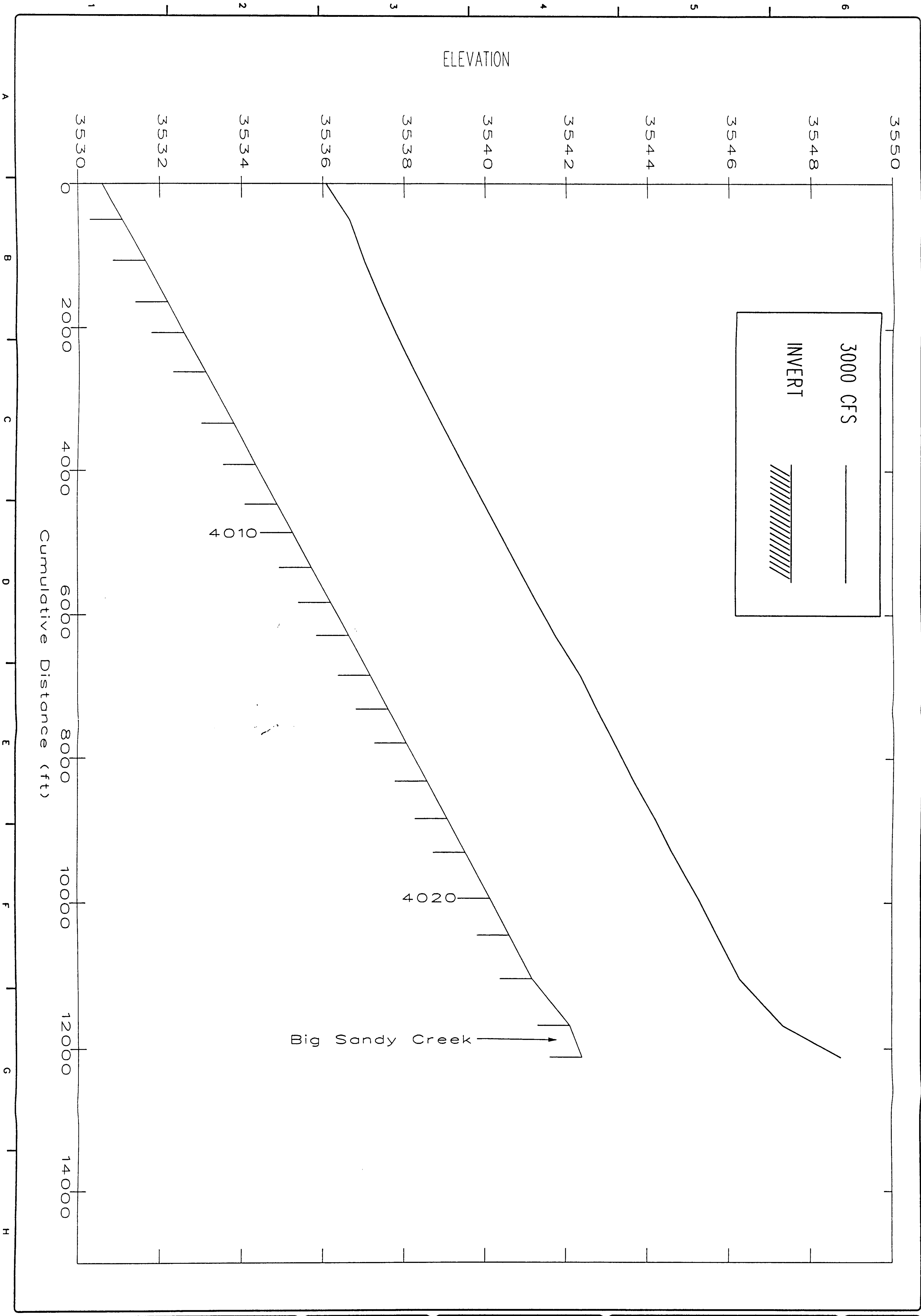
DCAXXX-95-X-XXXX

Zero Accidents
Zero Tolerance

REVISIONS

Symbol	Description	Date	Appr.

US Army Corps of Engineers
Albuquerque District



SEQUENCE NO.

PLATE NO. 7 OF 15

Section 22 — Colorado

ARKANSAS RIVER

PROBLEM AREA - 4

IMPROVED CHANNEL

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ALBUQUERQUE, NEW MEXICO

CHIEF, GENERAL ENGINEERING SECTION

DATE:

DESIGN BY:

DRAWN BY:

REVIEWED BY:

File Name:

Plot Scale: | Plot Date:

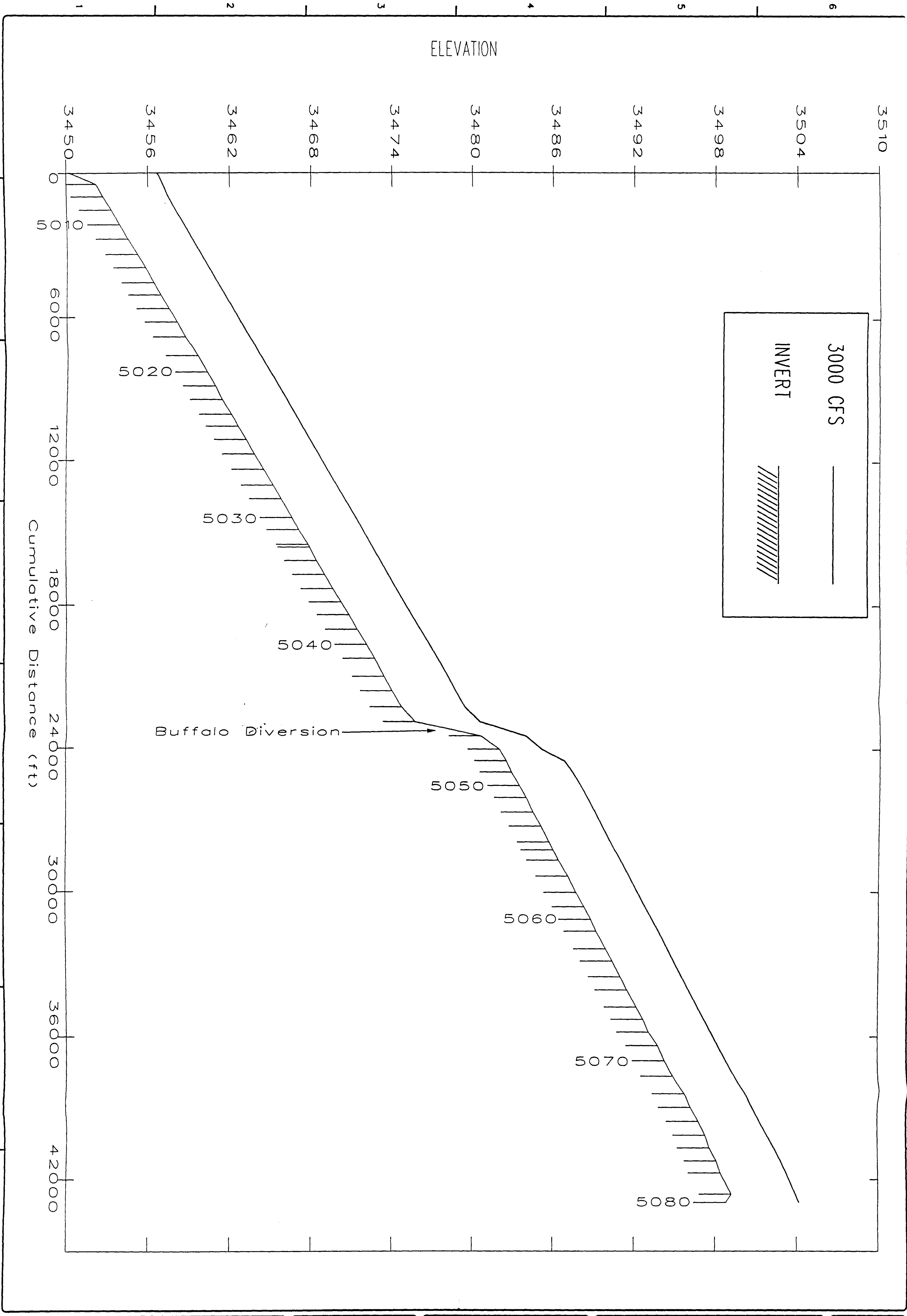
DCAXXX-95-X-XXXX

Zero Accidents
Zero Tolerance

REVISIONS

Symbol	Description	Date	Appr.

US Army Corps of Engineers
ALBUQUERQUE DISTRICT

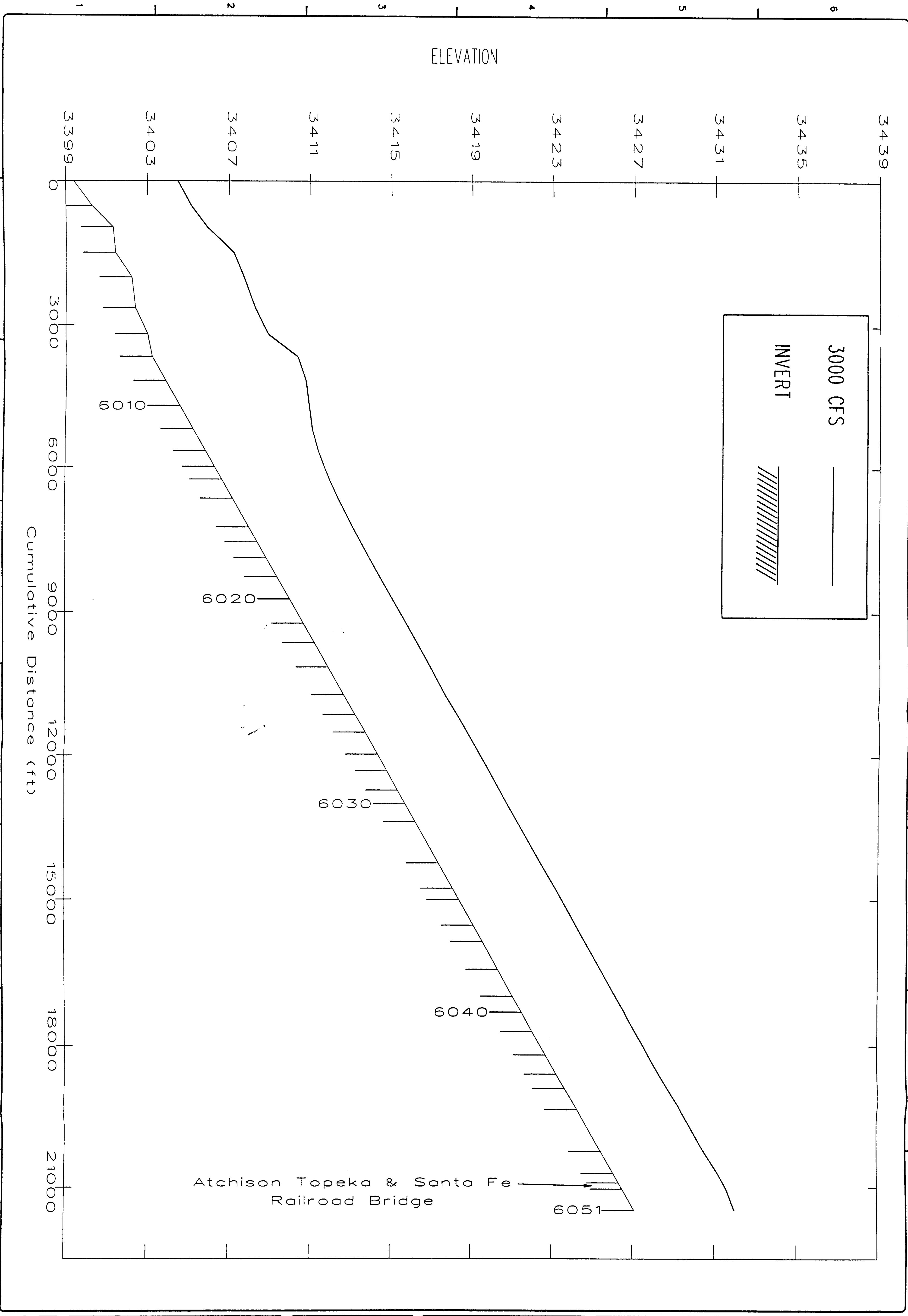


SEQUENCE NO.	PLATE NO. 8 OF 15	Section 22 Colorado ARKANSAS RIVER PROBLEM AREA - 5 IMPROVED CHANNEL	U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS ALBUQUERQUE, NEW MEXICO CHIEF, GENERAL ENGINEERING SECTION DATE:	DESIGN BY: DRAWN BY: REVIEWED BY:	DCAXXX-95-X-XXXX Zero Accidents Zero Tolerance

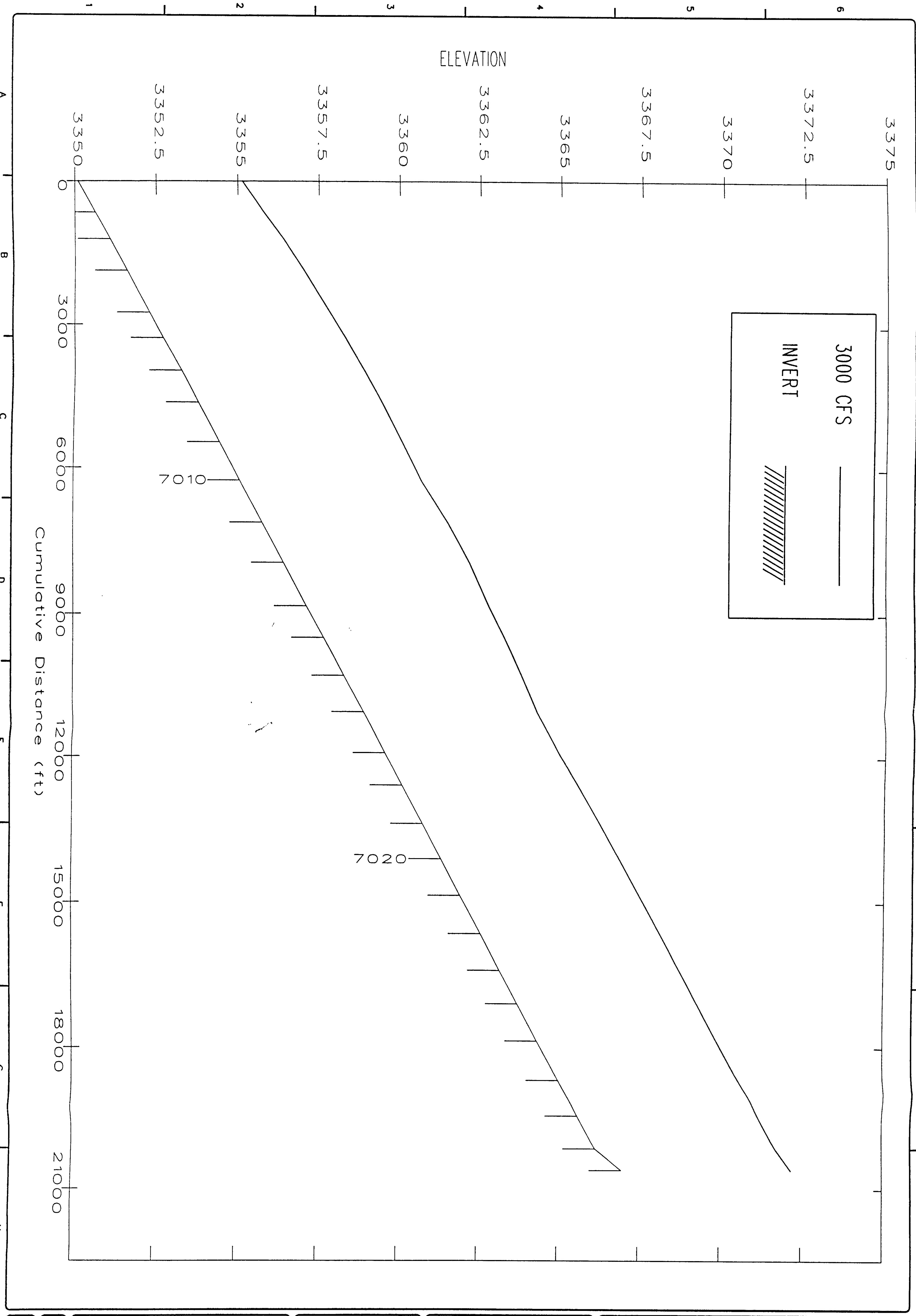
REVISIONS

Symbol	Description	Date	Appr.

US Army Corps of Engineers
ALBUQUERQUE DISTRICT

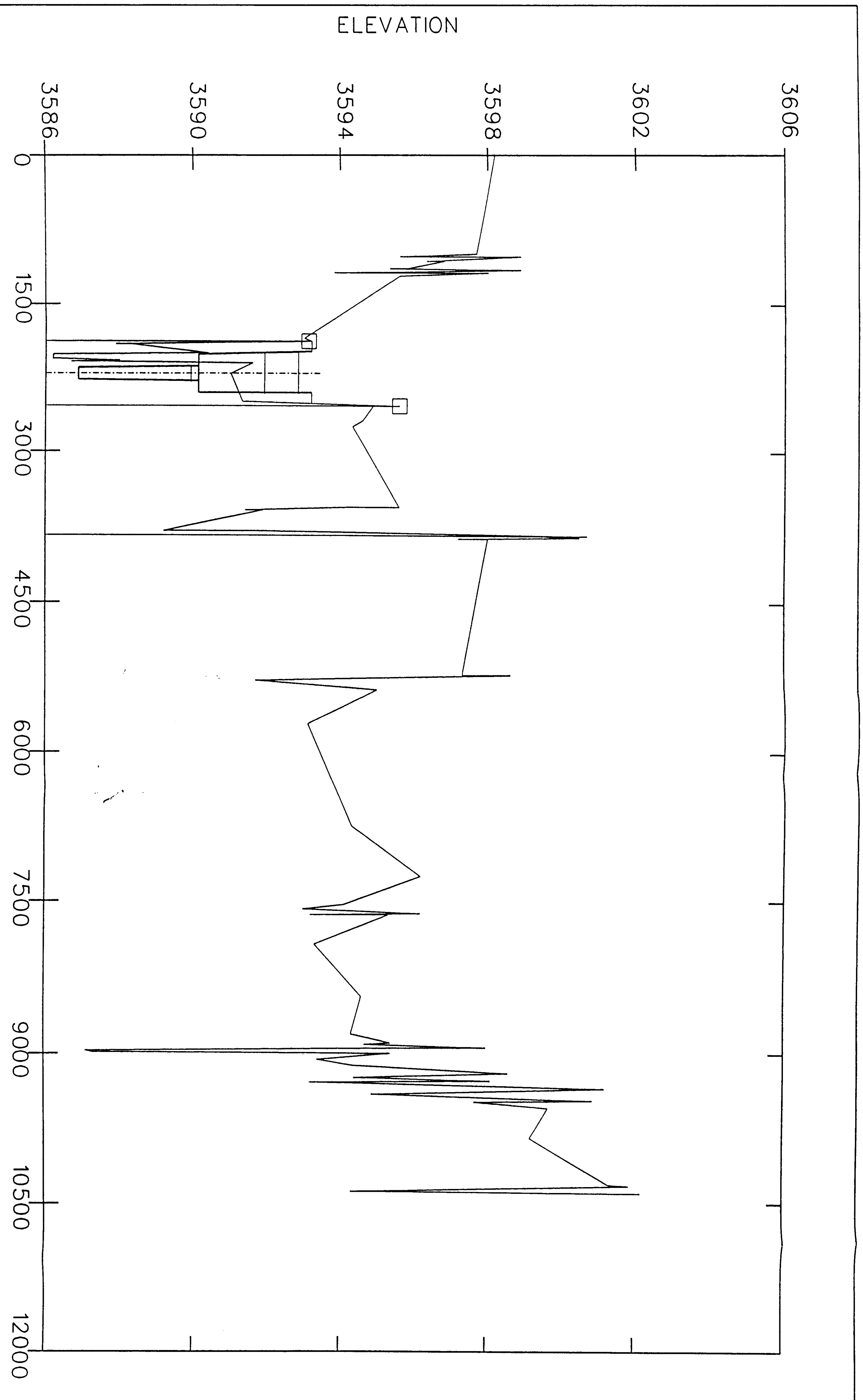


SEQUENCE NO.	PLATE NO. 9 OF 15	Section 22 ARKANSAS RIVER Colorado PROBLEM AREA - 6 IMPROVED CHANNEL	U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS ALBUQUERQUE, NEW MEXICO CHIEF, GENERAL ENGINEERING SECTION DATE:	DESIGN BY: DRAWN BY: REVIEWED BY:	DCAXXX-95-X-XXXX Zero Accidents Zero Tolerance	REVISIONS Symbol Description Date Appr.	US Army Corps of Engineers ALBUQUERQUE DISTRICT



SEQUENCE NO.	PLATE NO. 10 OF 15	Section 22 Colorado ARKANSAS RIVER PROBLEM AREA - 7 IMPROVED CHANNEL	U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS ALBUQUERQUE, NEW MEXICO CHIEF, GENERAL ENGINEERING SECTION DATE:	DESIGN BY: DRAWN BY: REVIEWED BY:	File Name: Plot Scale: Plot Date: DCAXXX-85-X-XXXX Zero Accidents Zero Tolerance	REVISIONS Symbol Description Date Appr.	US Army Corps of Engineers Albuquerque District

SECTION : 3072



SEQUENCE NO.	PLATE NO. 11 OF 15	Section 22 Colorado ARKANSAS RIVER Problem Area - 3 Typical Improved Channel Cross-Section

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ALBUQUERQUE, NEW MEXICO

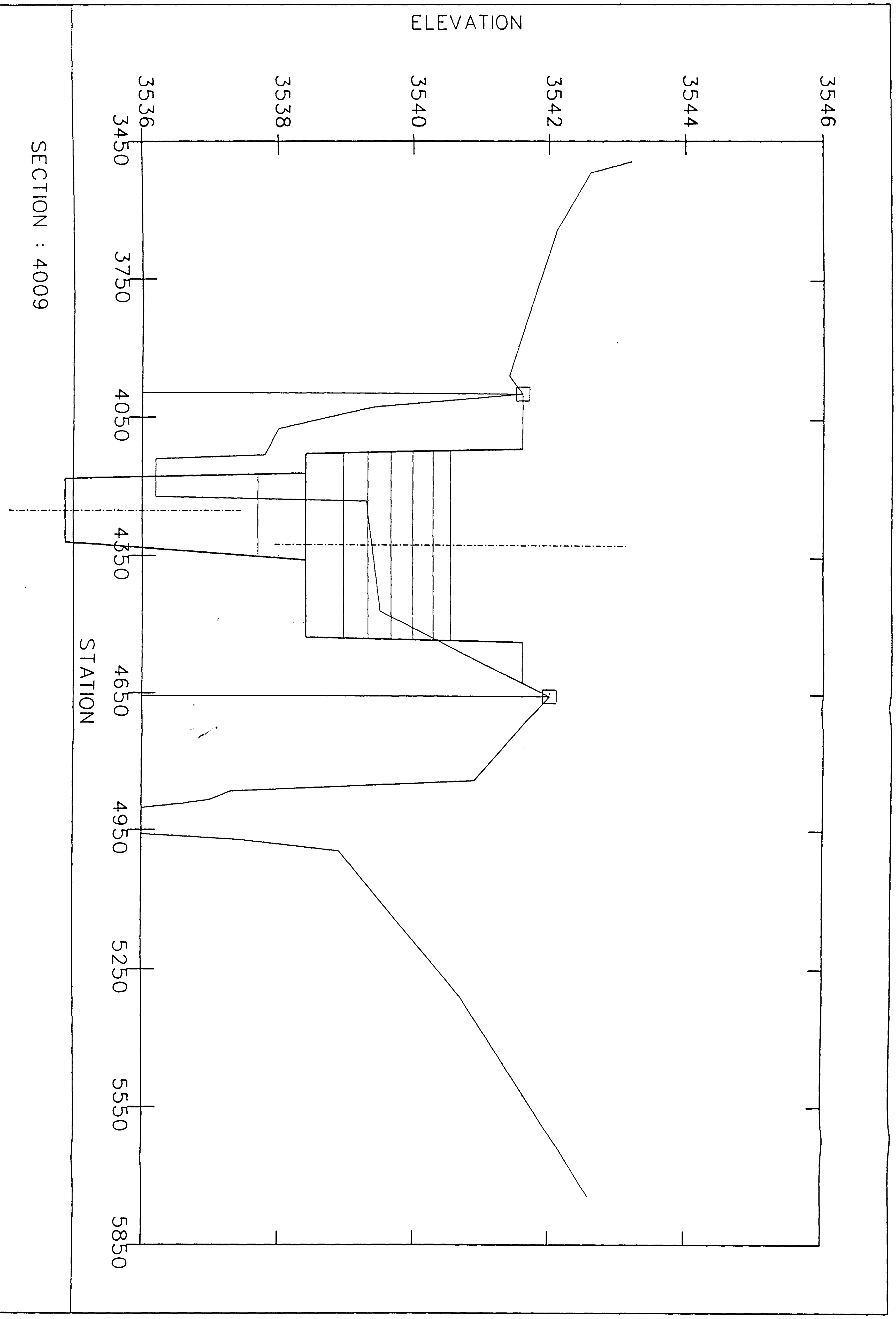
CHK'D:
DATE:

DESIGN BY:
DRAWN BY:
REVIEWED BY:

File Name:
Plot Scale:
Plot Date:
DCAXXX-95-X-XXXX
Zero Accidents Zero Tolerance

REVISIONS			
Symbol	Description	Date	Appr.

US Army Corps of Engineers
ALBUQUERQUE DISTRICT



Section 22 — Colorado

ARKANSAS RIVER

Problem Area - 4

TypicalImproved Cross-Section Channel

PLATE NO. 12 OF 15

SEQUENCE NO.

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
ALBUQUERQUE, NEW MEXICO

CHIEF,

DATE:

DESIGN BY:

DRAWN BY:

REVIEWED BY:

File Name:

Plot Scale:

Plot Date:

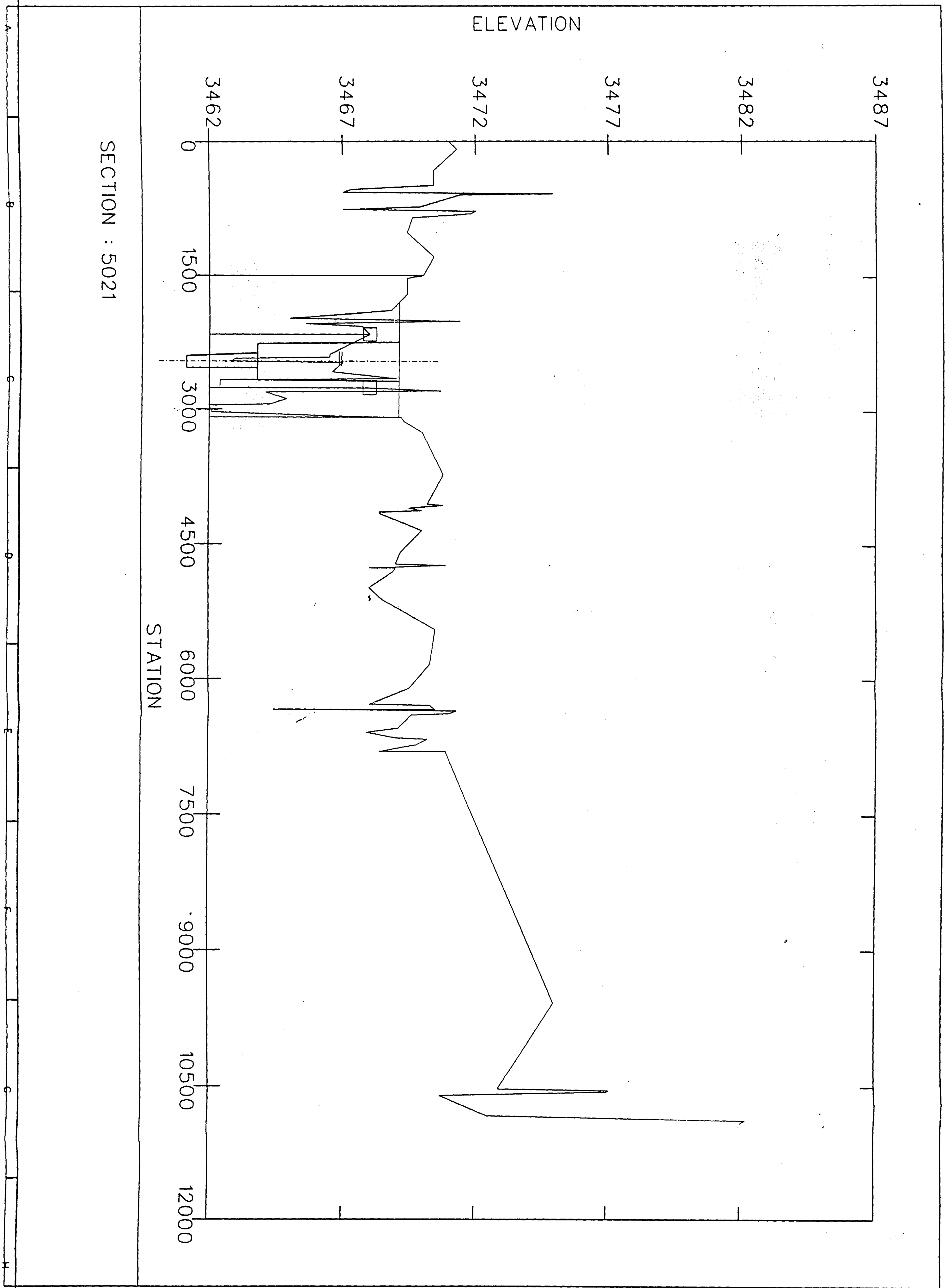
DCAXXX-95-K-XXXX

Zero Accidents
Zero Tolerance

REVISIONS

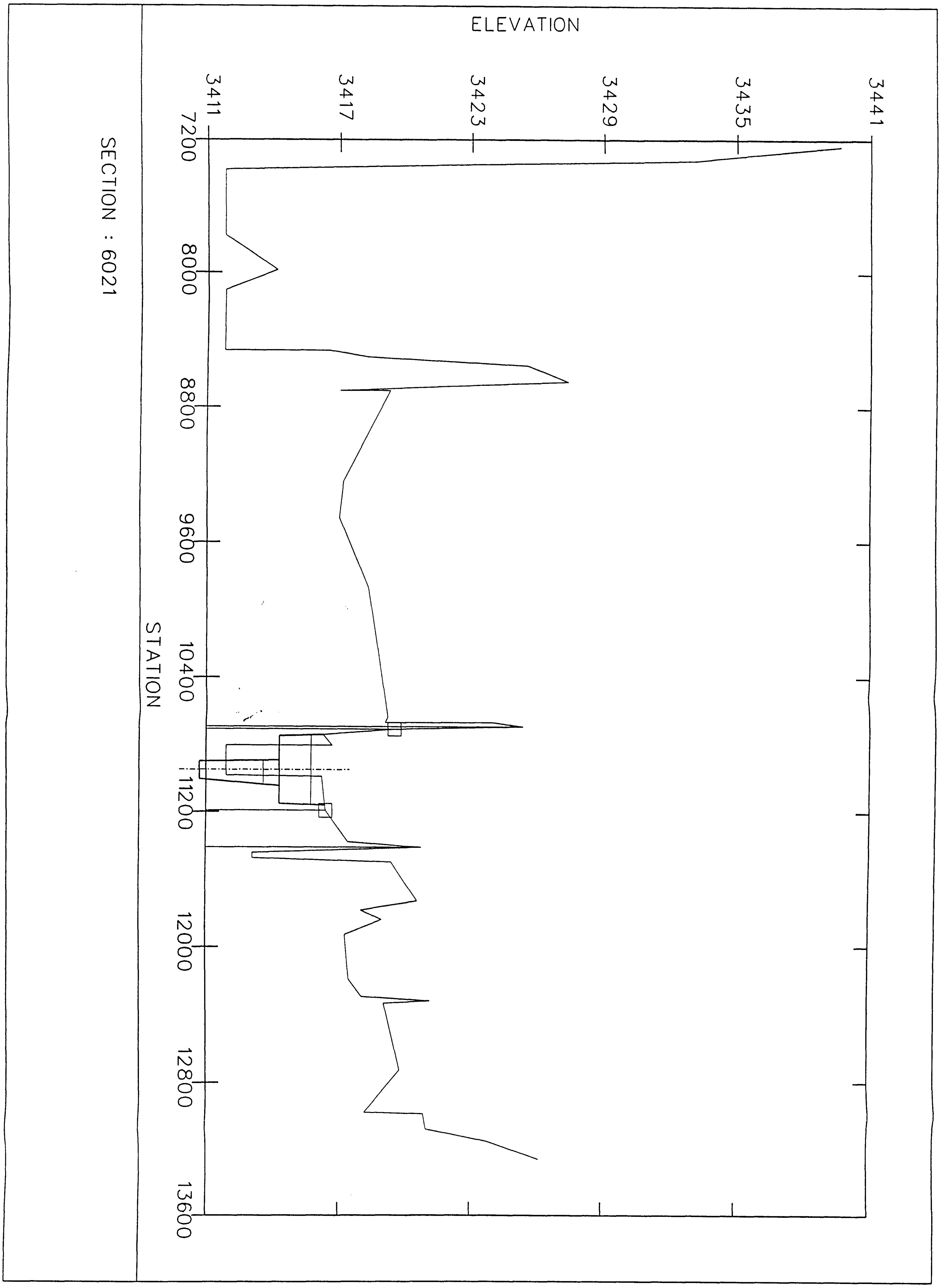
Symbol	Description	Date	Appr.

US Army Corps of Engineers
ALBUQUERQUE DISTRICT



SEQUENCE NO.	PLATE NO. 13 OF 15	Section 22 Colorado ARKANSAS RIVER Problem Area - 5 Typical Improved Channel Cross-Section	U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS ALBUQUERQUE, NEW MEXICO CHIEF, DATE:	DESIGN BY: DRAWN BY: REVIEWED BY:	File Name: Plot Scale: Plot Date: DCAXXX-95-X-XXXX Zero Accidents Zero Tolerance	REVISIONS Symbol Description Date Appr.

US Army Corps of Engineers Albuquerque District



SEQUENCE NO.	PLATE NO. 14 OF 15	Section 22 Colorado ARKANSAS RIVER Problem Area - 6 Typical Improved Channel Cross-Section	U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS ALBUQUERQUE, NEW MEXICO CHEF. DATE:	DESIGN BY: DRAWN BY: REVIEWED BY:

File Name: | Plot Scale: | Plot Date:
DCAXXX-95-X-XXXX
Zero Accidents
Zero Tolerance

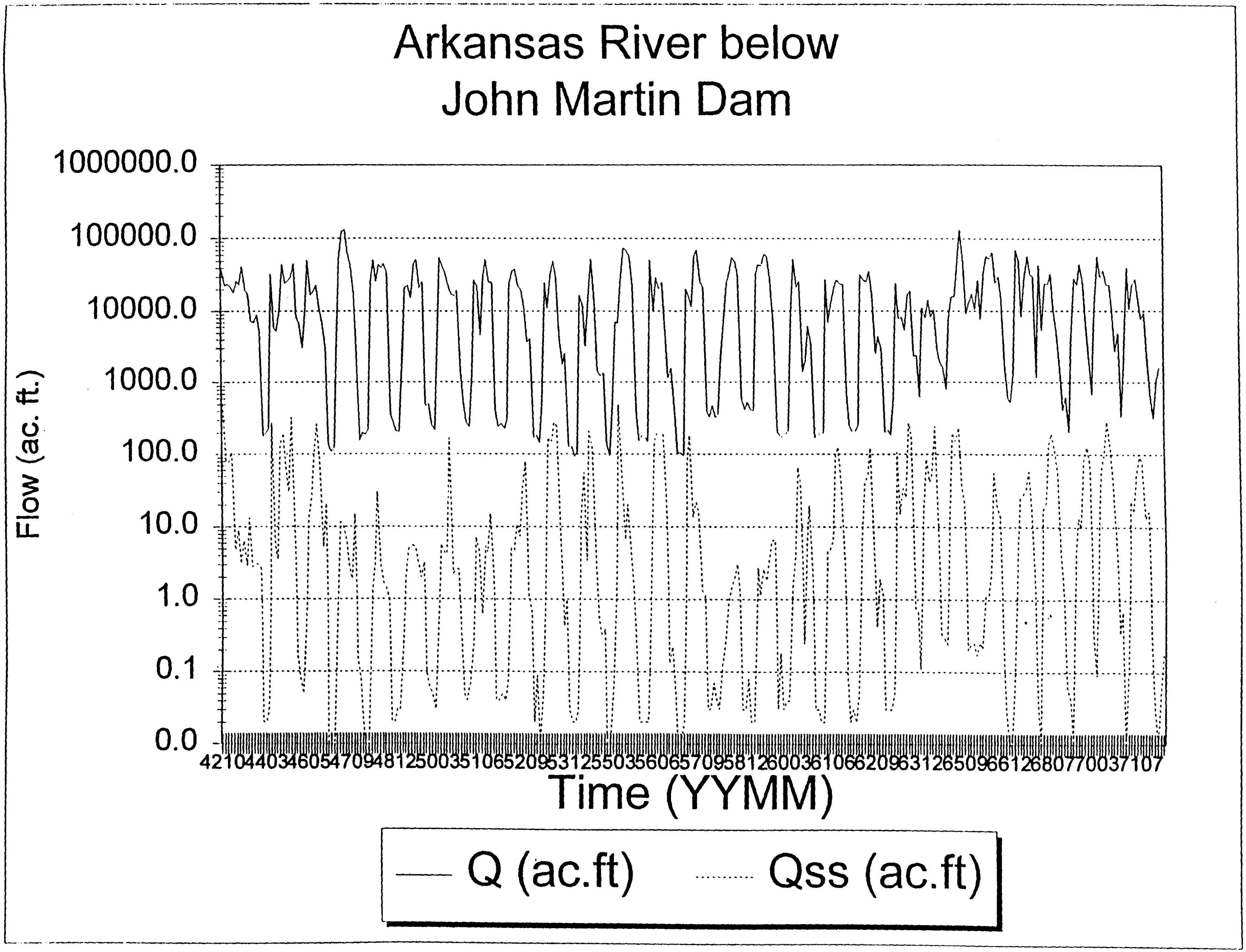
REVISIONS

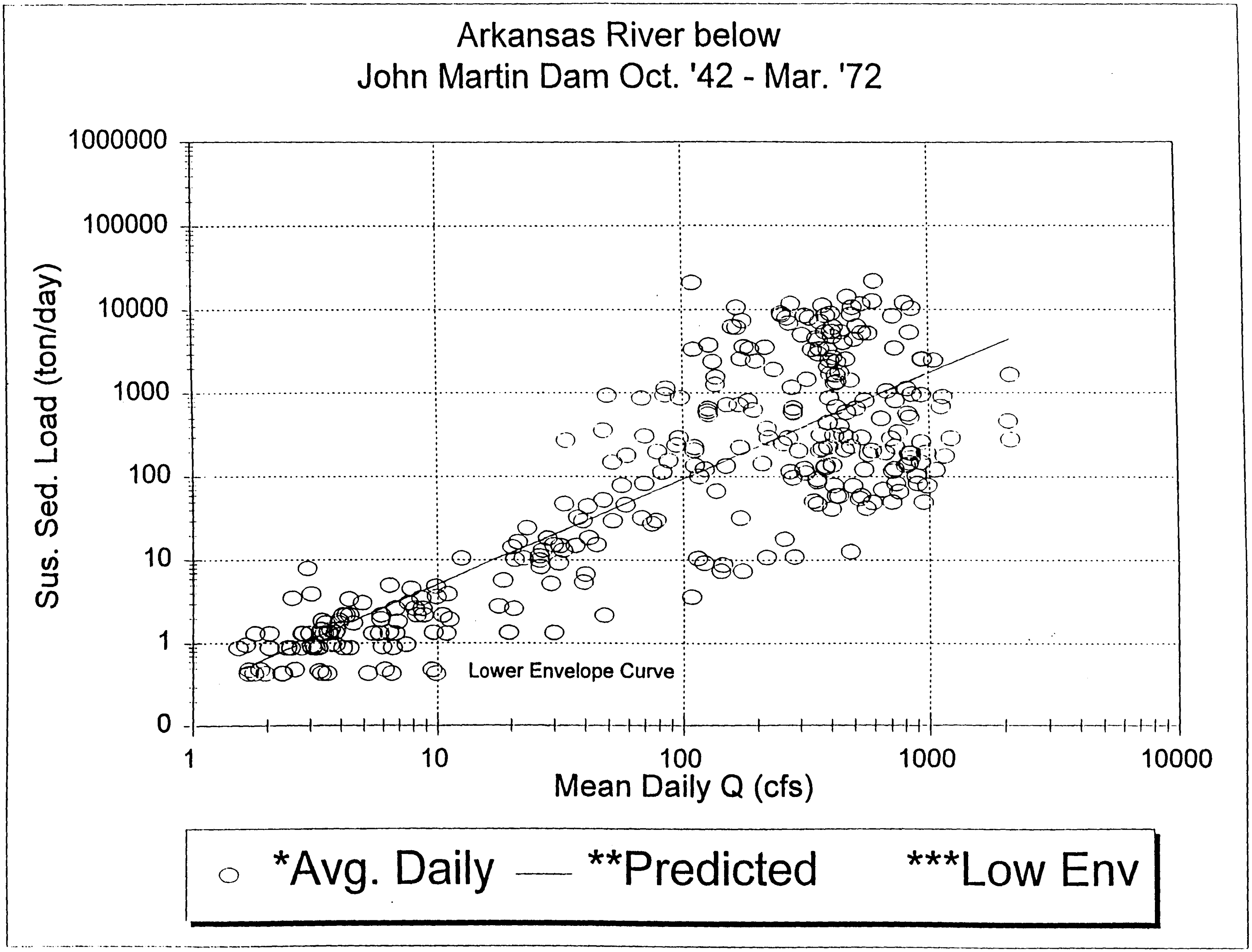
Symbol	Description	Date	Appr.

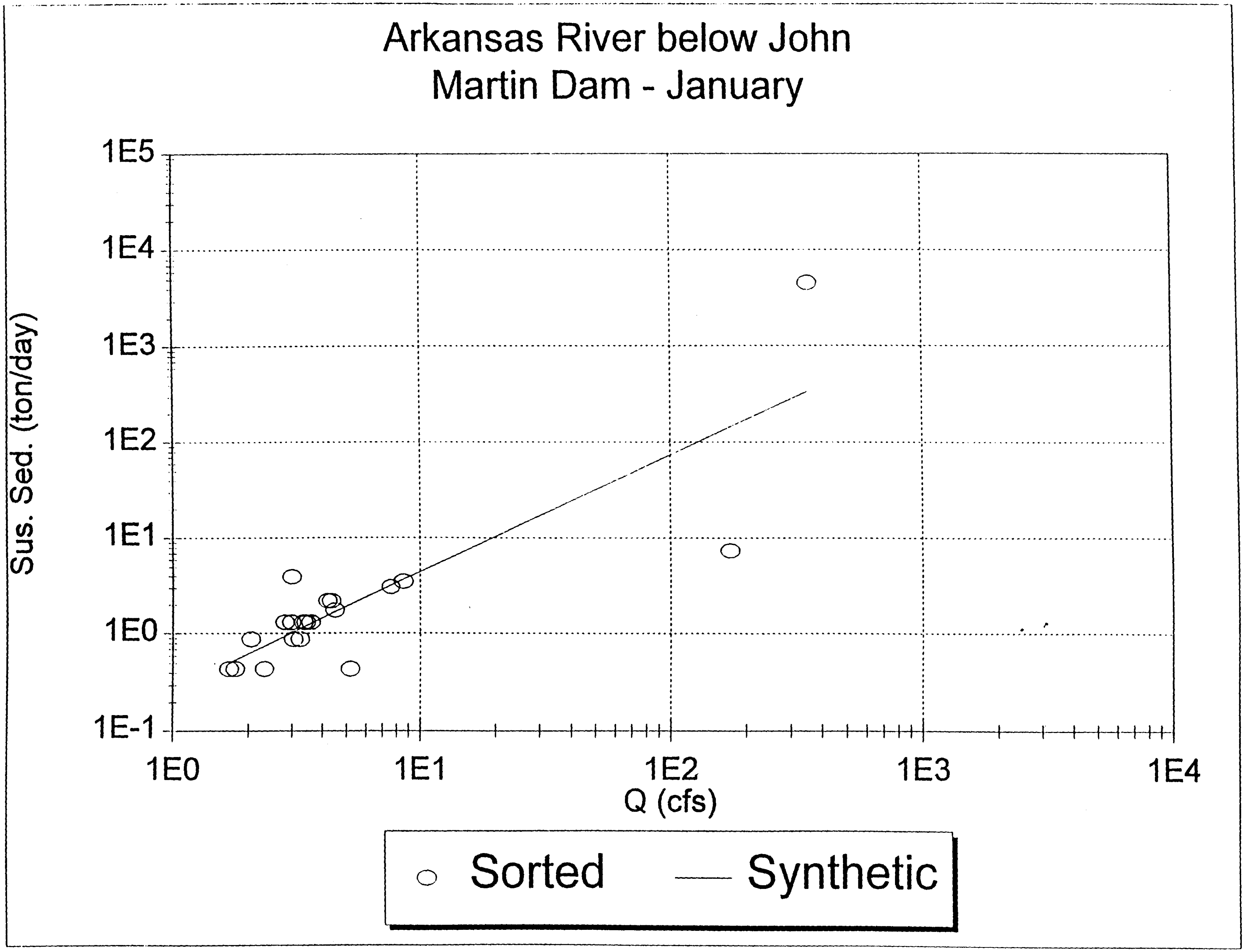
US Army Corps of Engineers
ALBUQUERQUE DISTRICT

APPENDIX A

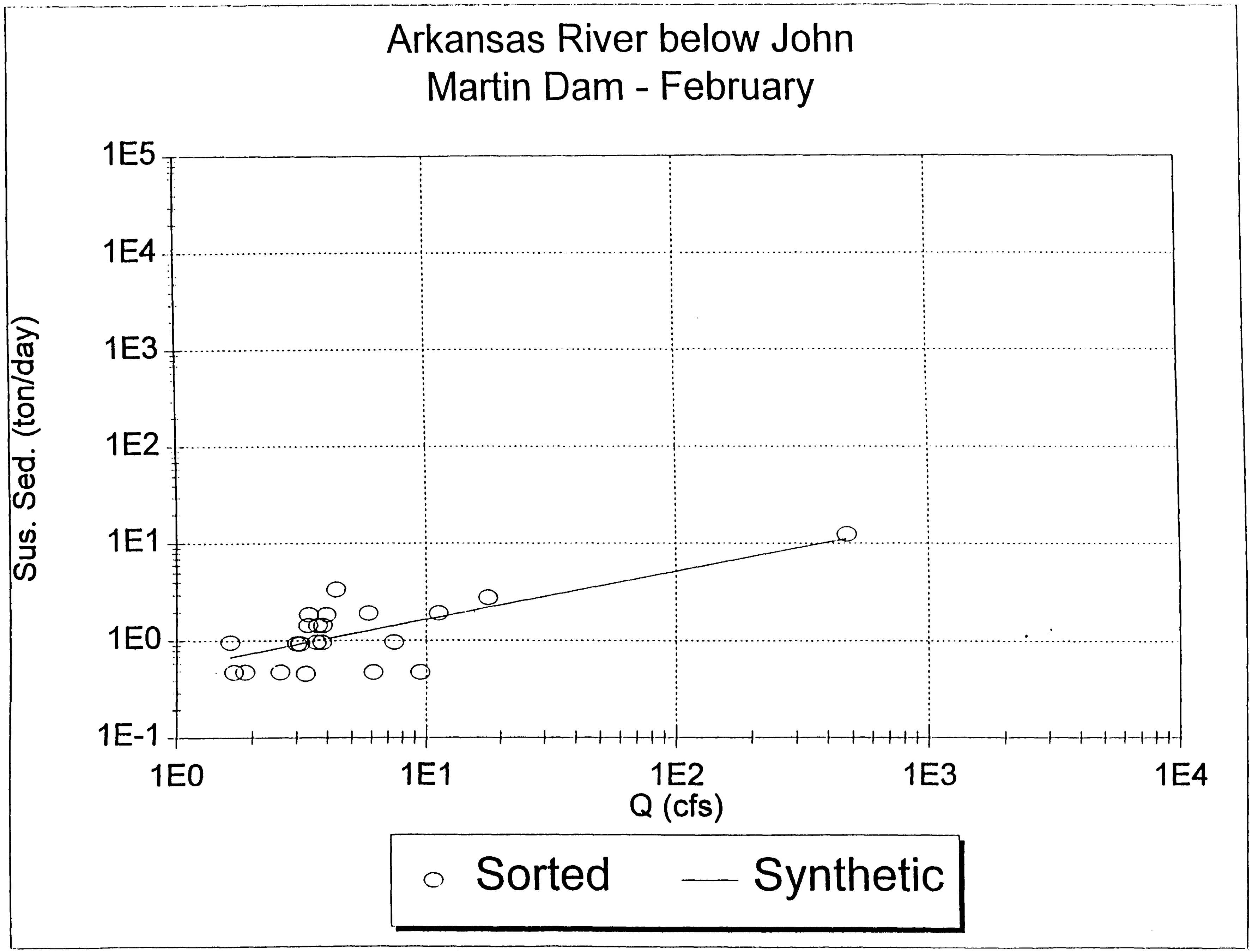
GRAPHICAL SUSPENDED SEDIMENT DATA


Arkansas River below
John Martin Dam
1000000.0
100000.0
10000.0
1000.0
100.0
10.0
1.0
0.1
0.0
Flow (ac. ft.)
Time (YYMM)
Q (ac.ft)
Qss (ac.ft)

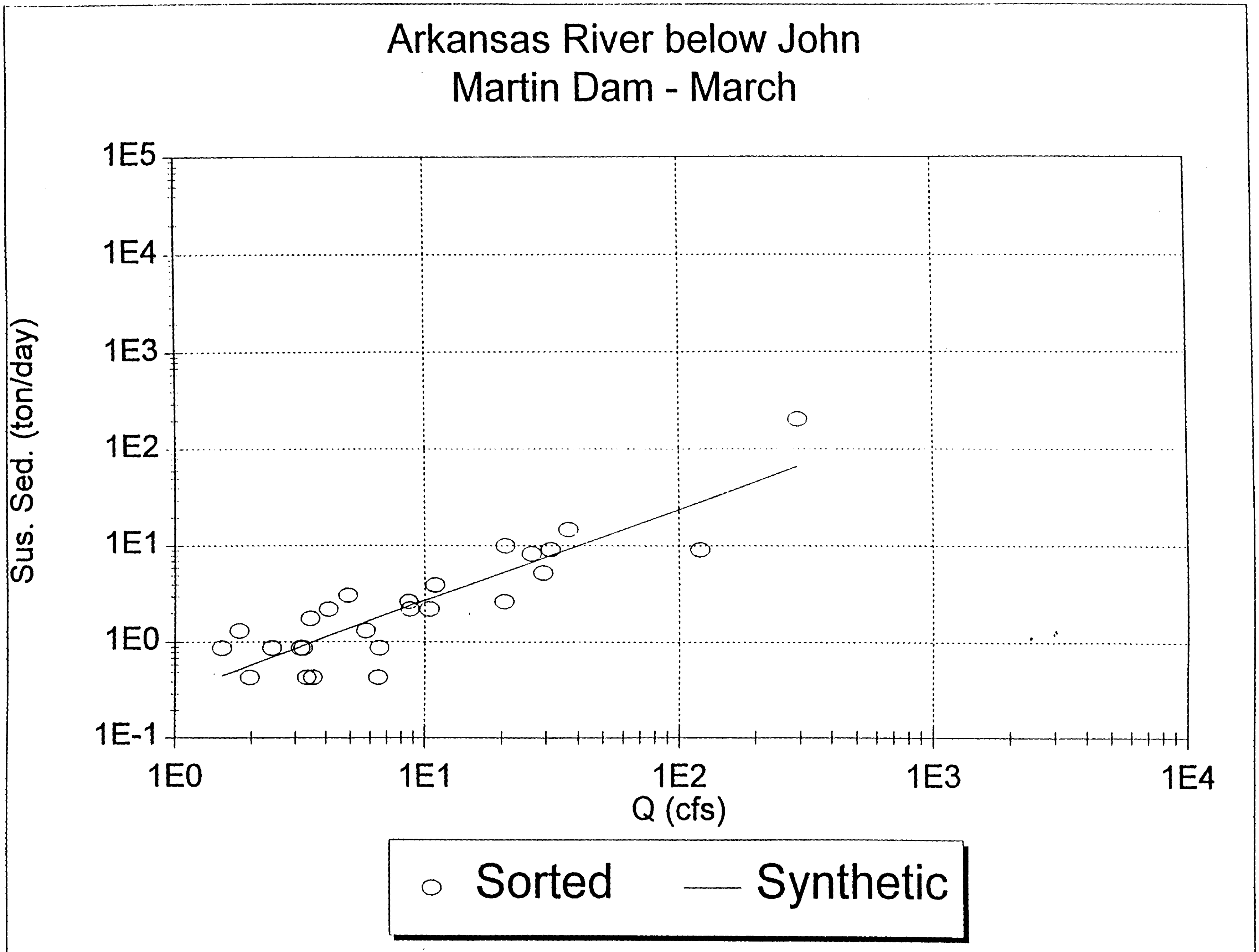

Arkansas River below
John Martin Dam Oct. '42 - Mar. '72
Sus. Sed. Load (ton/day)
1000000
100000
10000
1000
100
10
1
0
1
10
100
1000
10000
Mean Daily Q (cfs)
Lower Envelope Curve
*Avg. Daily
**Predicted
***Low Env



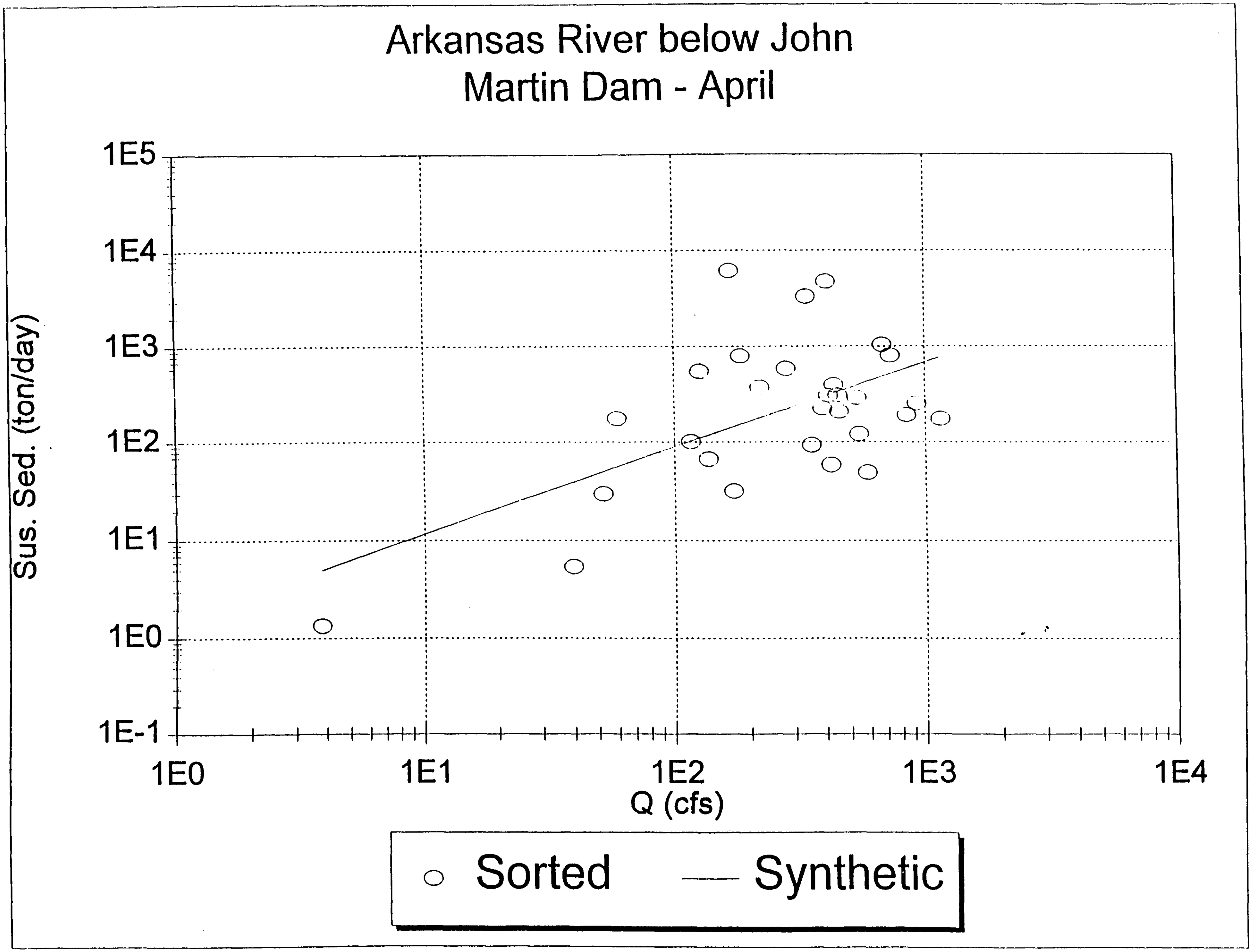
Arkansas River below John
Martin Dam - January
1E5
1E4
1E3
1E2
1E1
1E0
1E-1
Sus. Sed. (ton/day)
1E0
1E1
1E2
1E3
1E4
Q (cfs)
Sorted
Synthetic



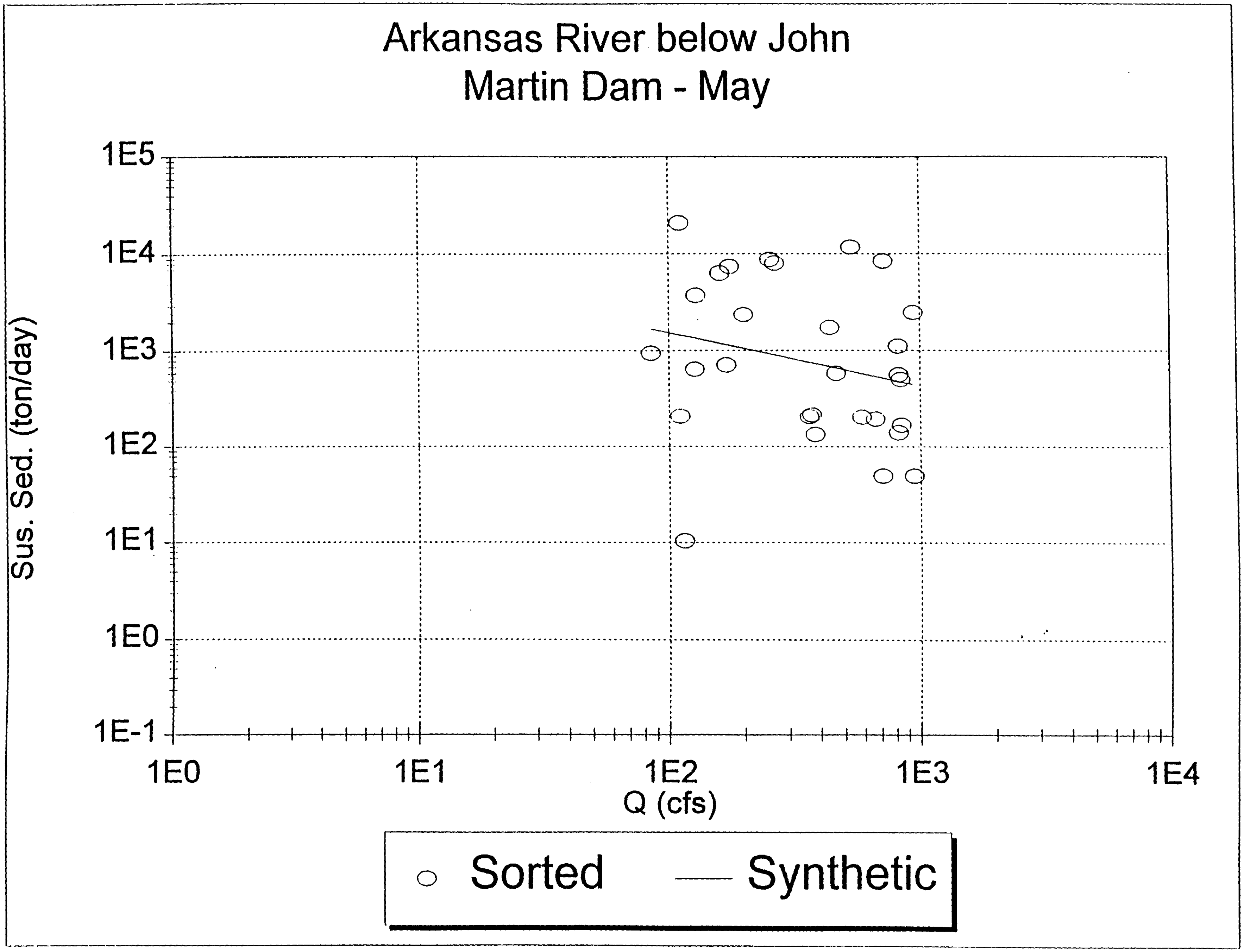
Arkansas River below John
Martin Dam - February
Sus. Sed. (ton/day)
1E5
1E4
1E3
1E2
1E1
1E0
1E-1
1E0
1E1
1E2
1E3
1E4
Q (cfs)
Sorted
Synthetic

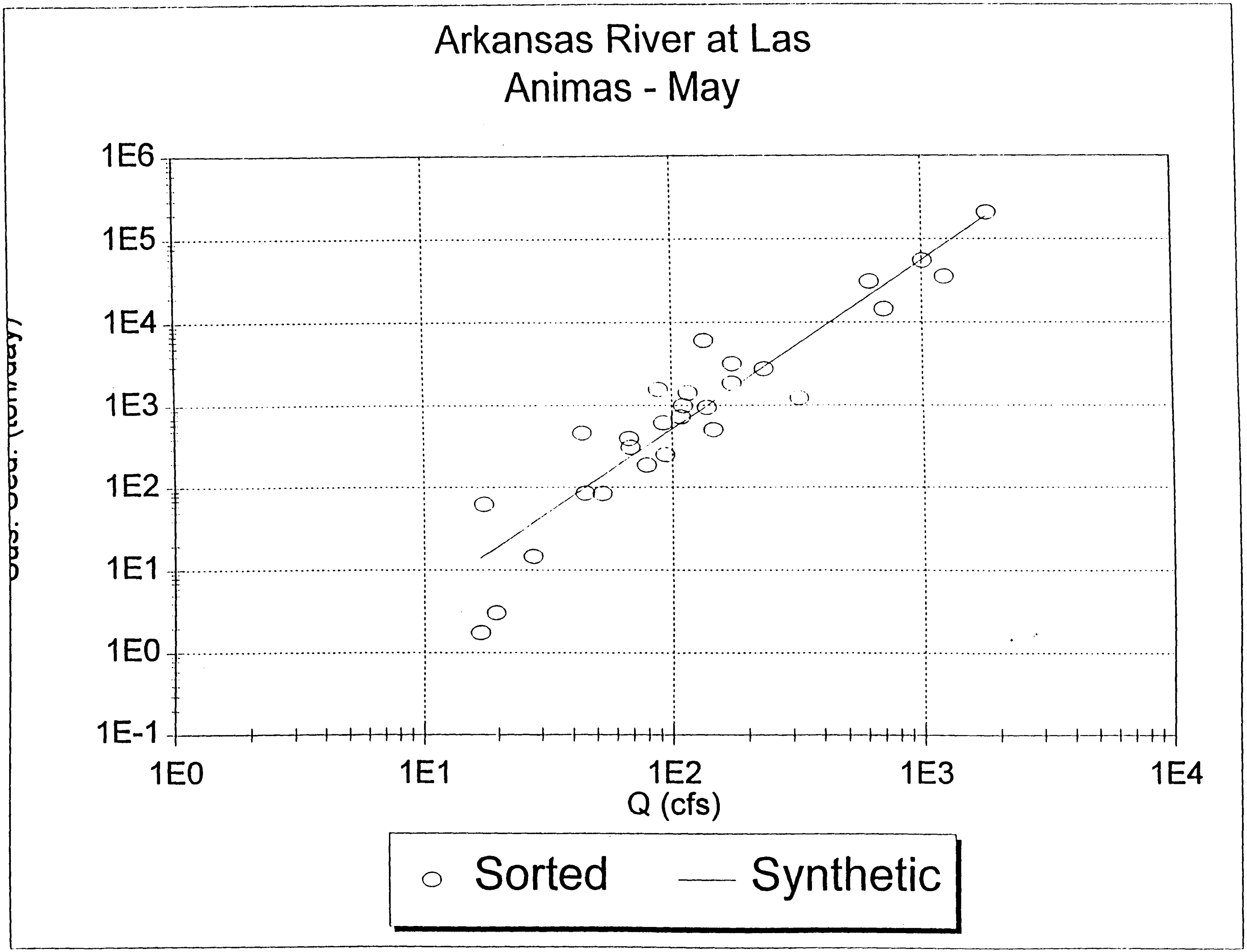


Arkansas River below John
Martin Dam - March
1E5
1E4
1E3
1E2
1E1
1E0
1E-1
Sus. Sed. (ton/day)
1E0
1E1
1E2
1E3
1E4
Q (cfs)
Sorted
Synthetic

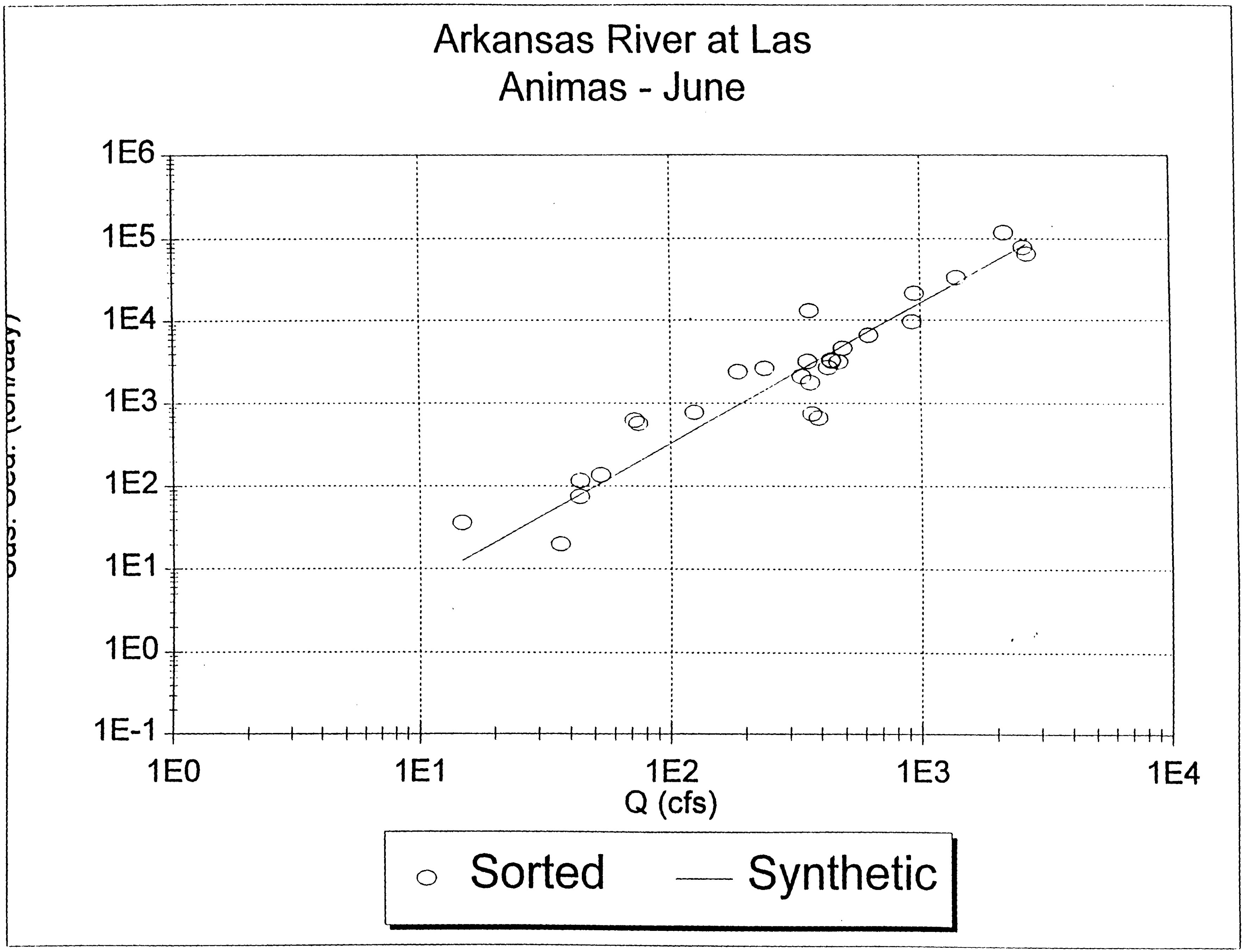


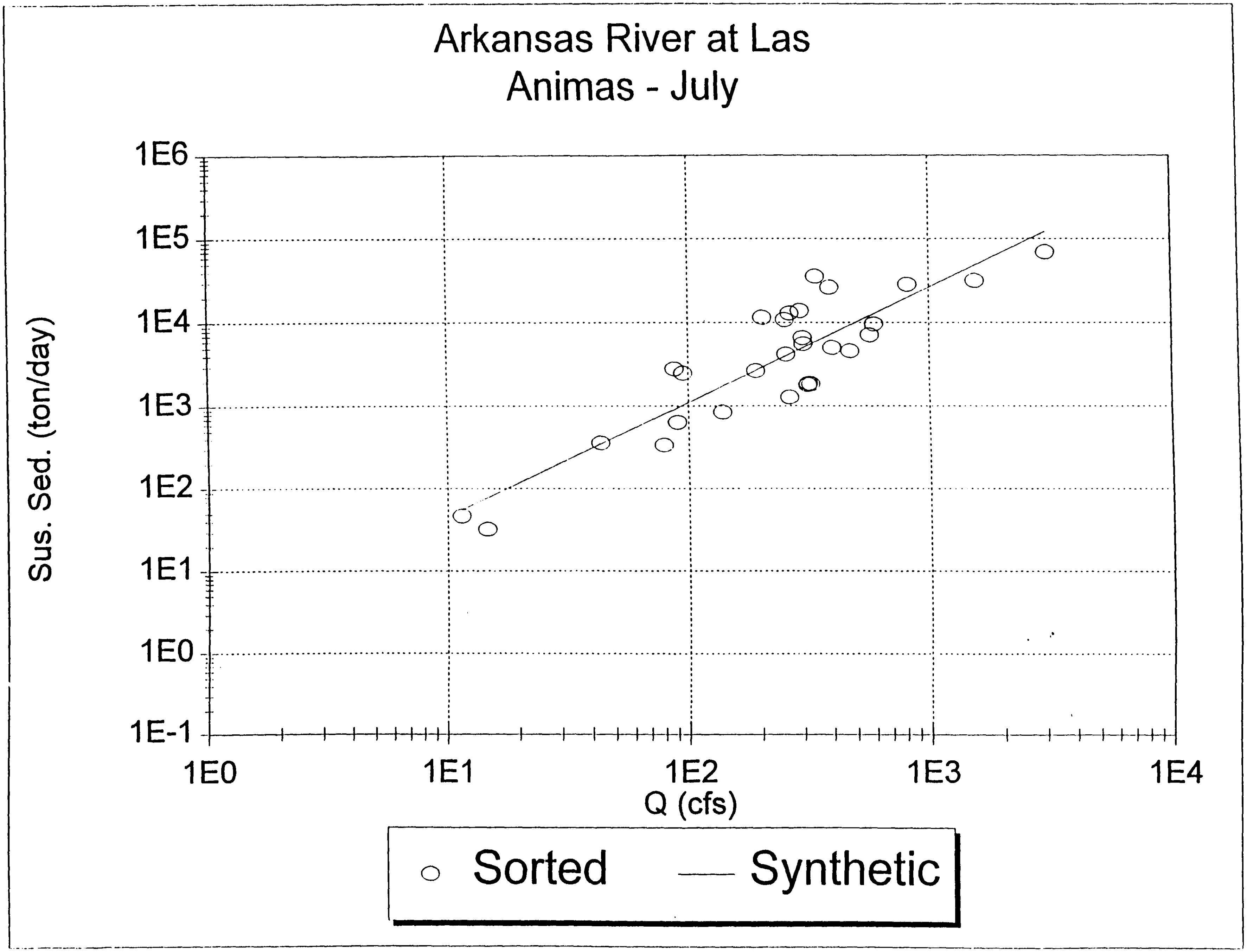
Arkansas River below John
Martin Dam - April
Sus. Sed. (ton/day)
1E5
1E4
1E3
1E2
1E1
1E0
1E-1
1E0
1E1
1E2
1E3
1E4
Q (cfs)
Sorted
Synthetic


Arkansas River below John
Martin Dam - May
Sus. Sed. (ton/day)
1E5
1E4
1E3
1E2
1E1
1E0
1E-1
1E0
1E1
1E2
1E3
1E4
Q (cfs)
Sorted
Synthetic

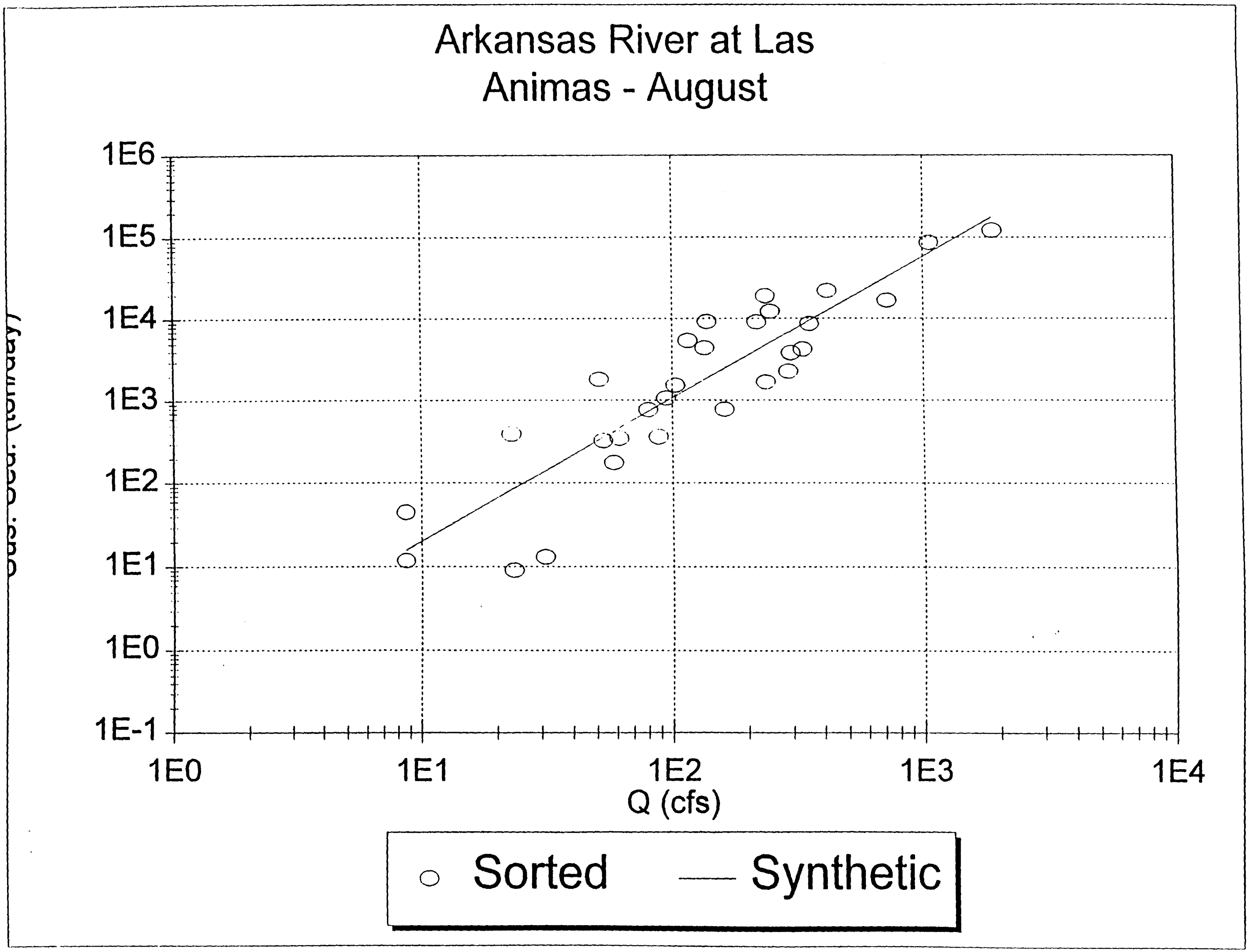


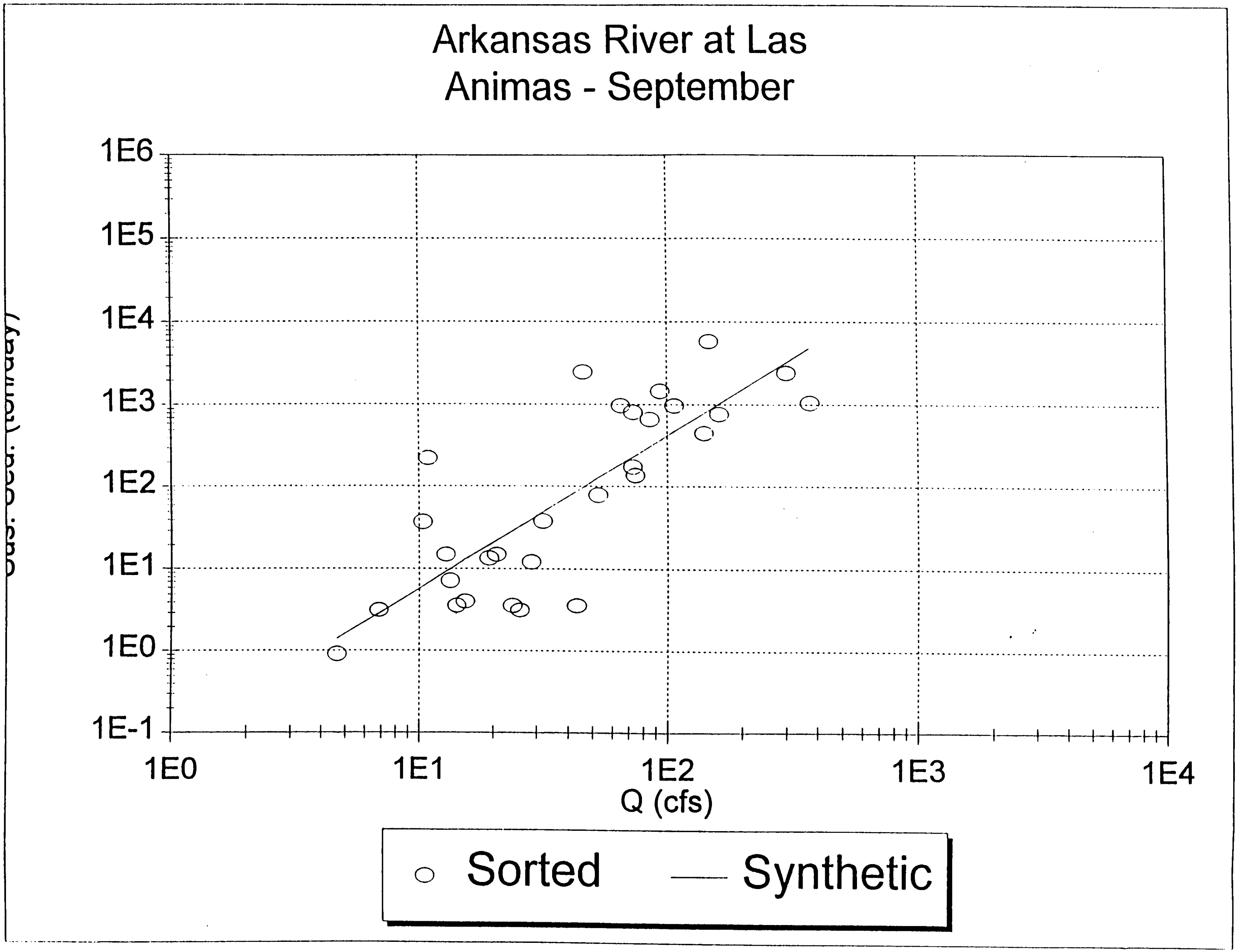
Arkansas River at Las
Animas - May
1E6
1E5
1E4
1E3
1E2
1E1
1E0
1E-1
1E0
1E1
1E2
1E3
1E4
Q (cfs)
Sorted
Synthetic


Arkansas River at Las
Animas - June
1E6
1E5
1E4
1E3
1E2
1E1
1E0
1E-1
1E0
1E1
1E2
1E3
1E4
Q (cfs)
Sorted
Synthetic

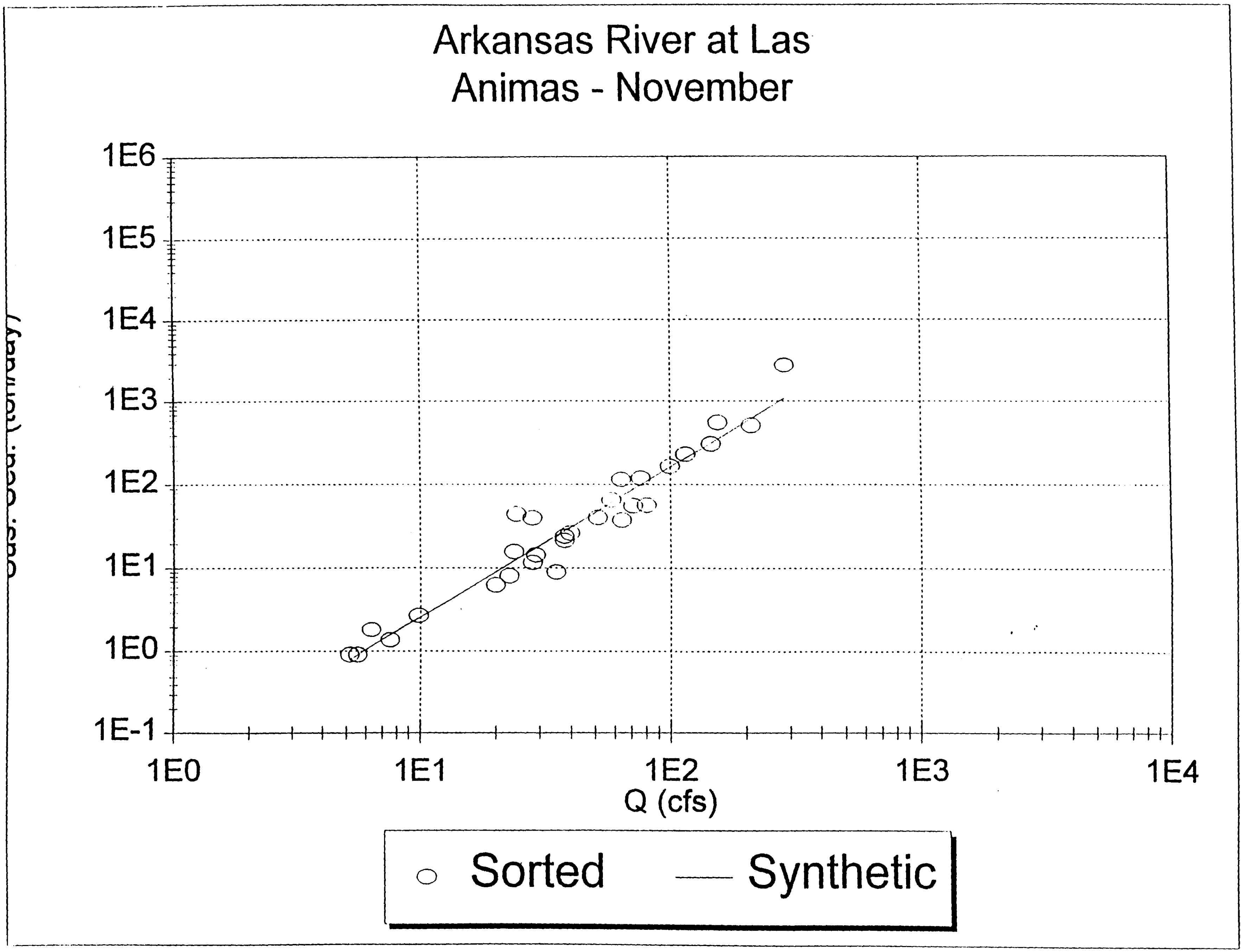


Arkansas River at Las
Animas - July
1E6
1E5
1E4
1E3
1E2
1E1
1E0
1E-1
Sus. Sed. (ton/day)
1E0
1E1
1E2
1E3
1E4
Q (cfs)
Sorted
Synthetic


Arkansas River at Las
Animas - August
1E6
1E5
1E4
1E3
1E2
1E1
1E0
1E-1
1E0
1E1
1E2
1E3
1E4
Q (cfs)
Sorted
Synthetic

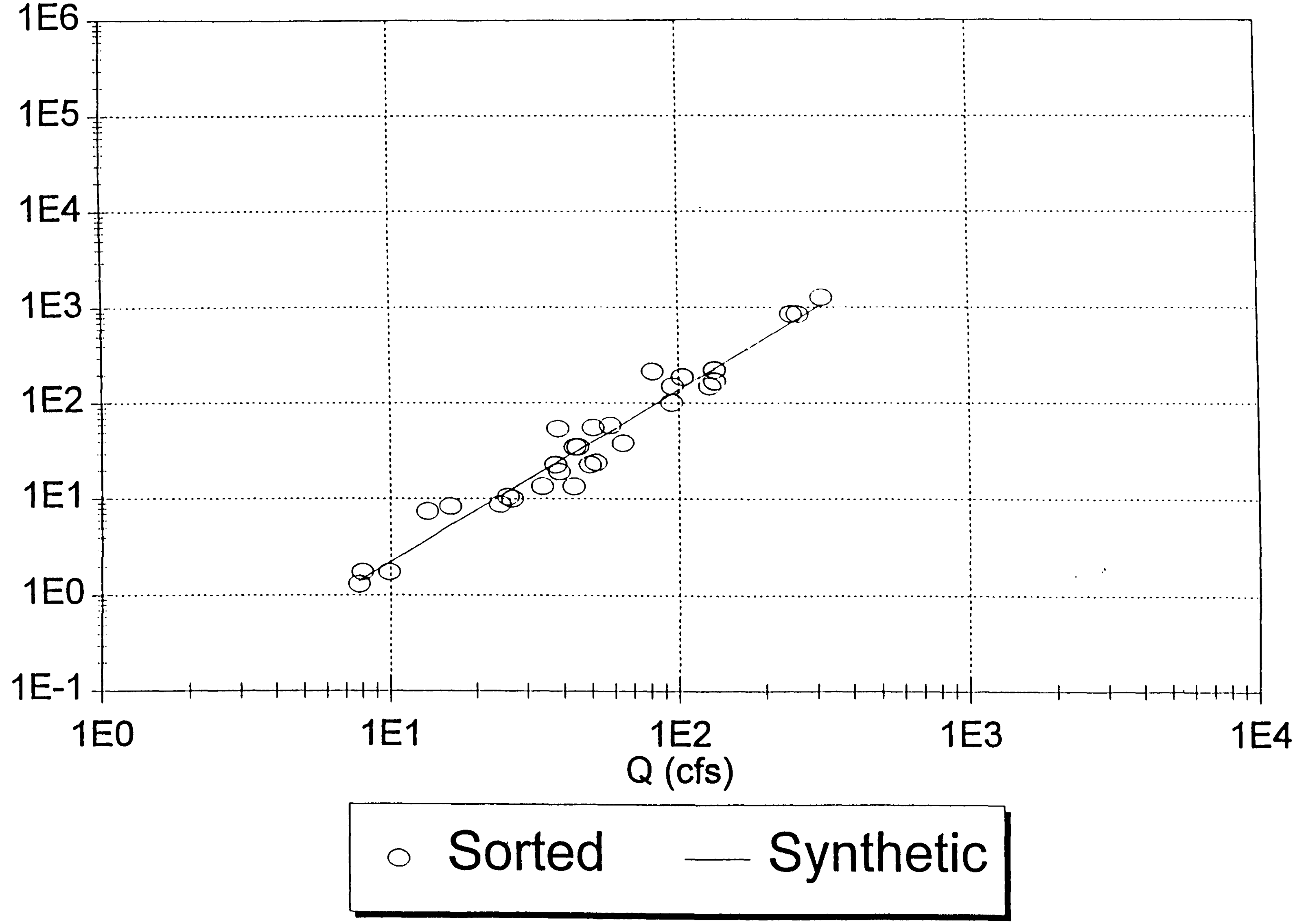


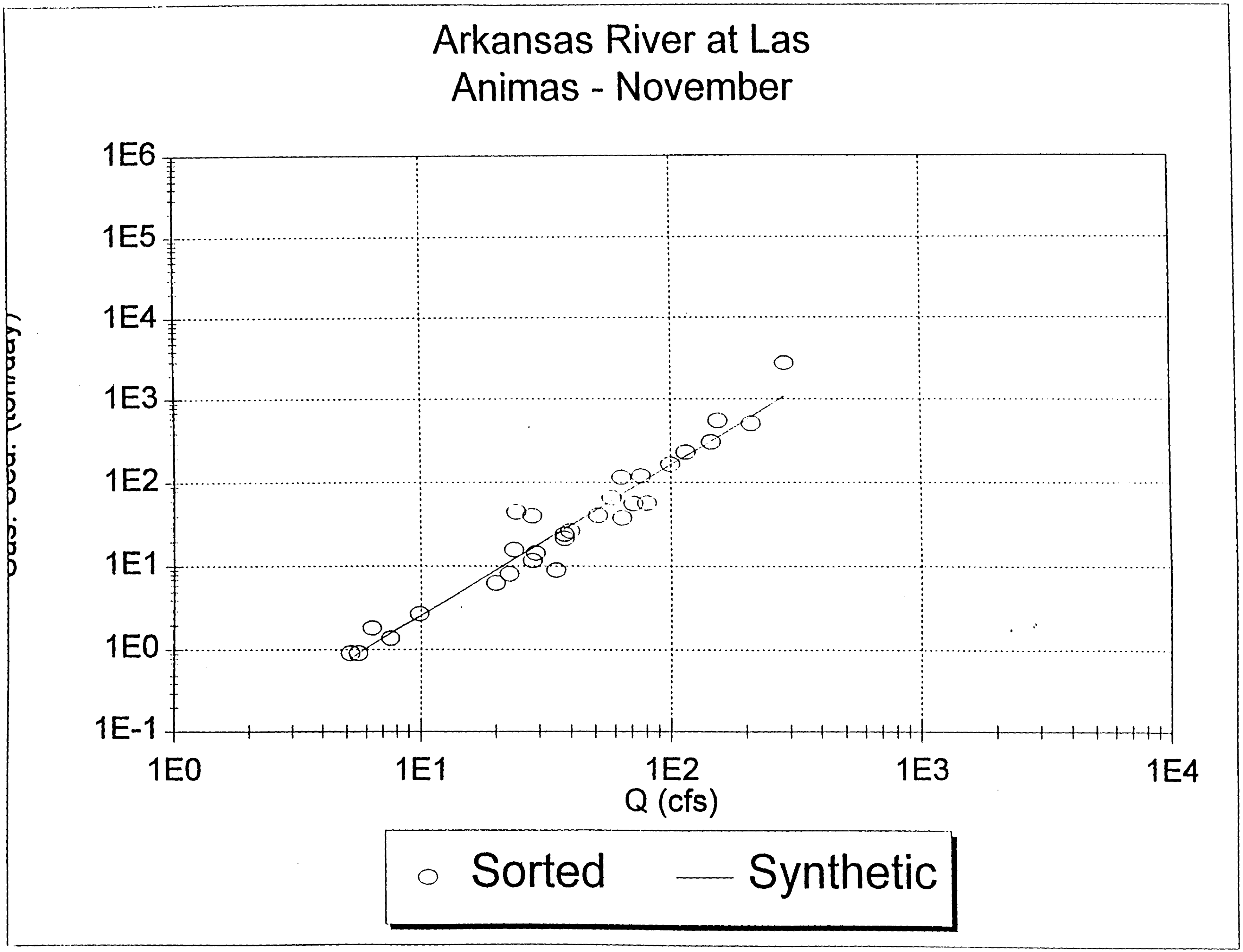
Arkansas River at Las
Animas - September
1E6
1E5
1E4
1E3
1E2
1E1
1E0
1E-1
1E0
1E1
1E2
1E3
1E4
Q (cfs)
Sorted
Synthetic

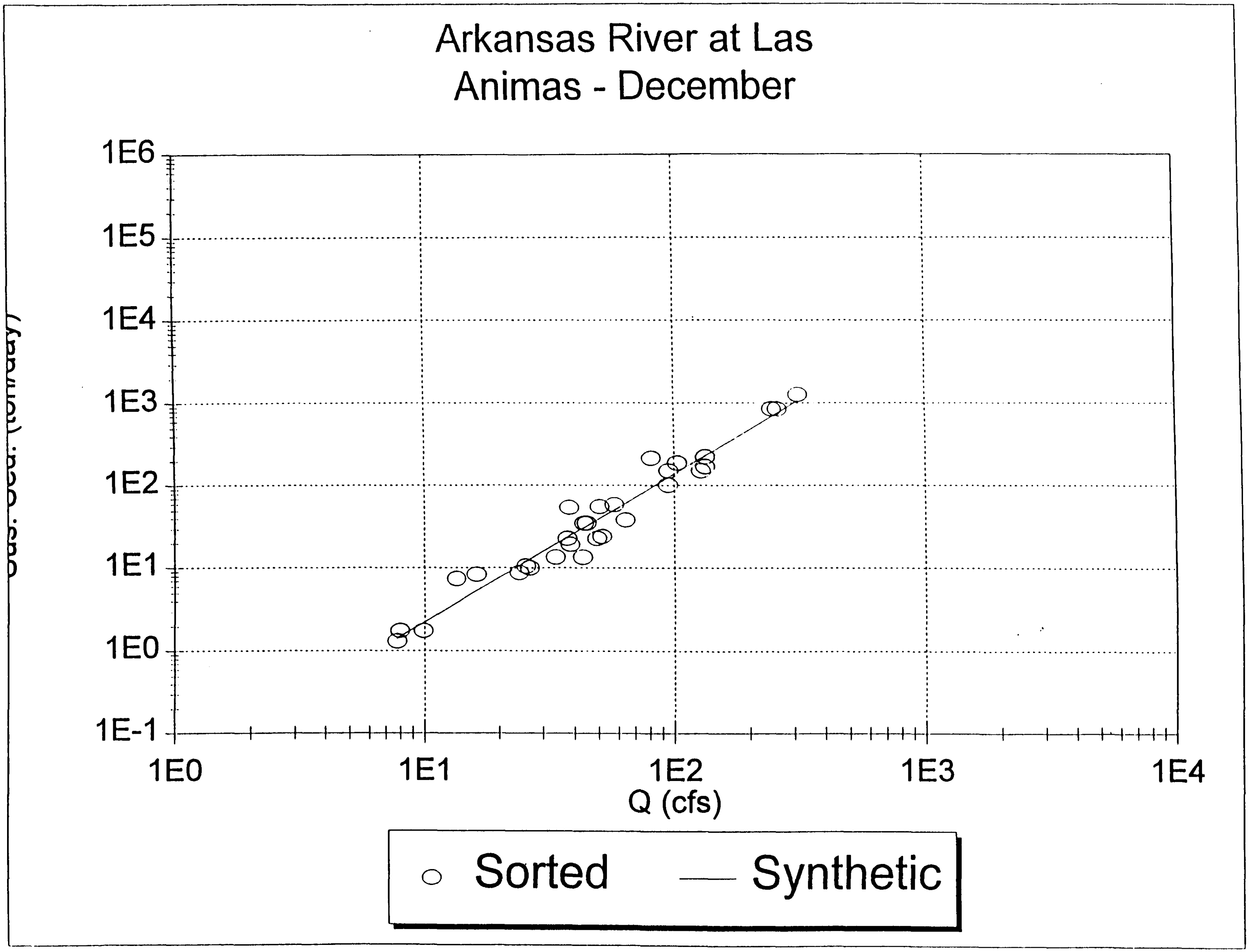


Arkansas River at Las
Animas - November
1E6
1E5
1E4
1E3
1E2
1E1
1E0
1E-1
1E0
1E1
1E2
1E3
1E4
Q (cfs)
Sorted
Synthetic

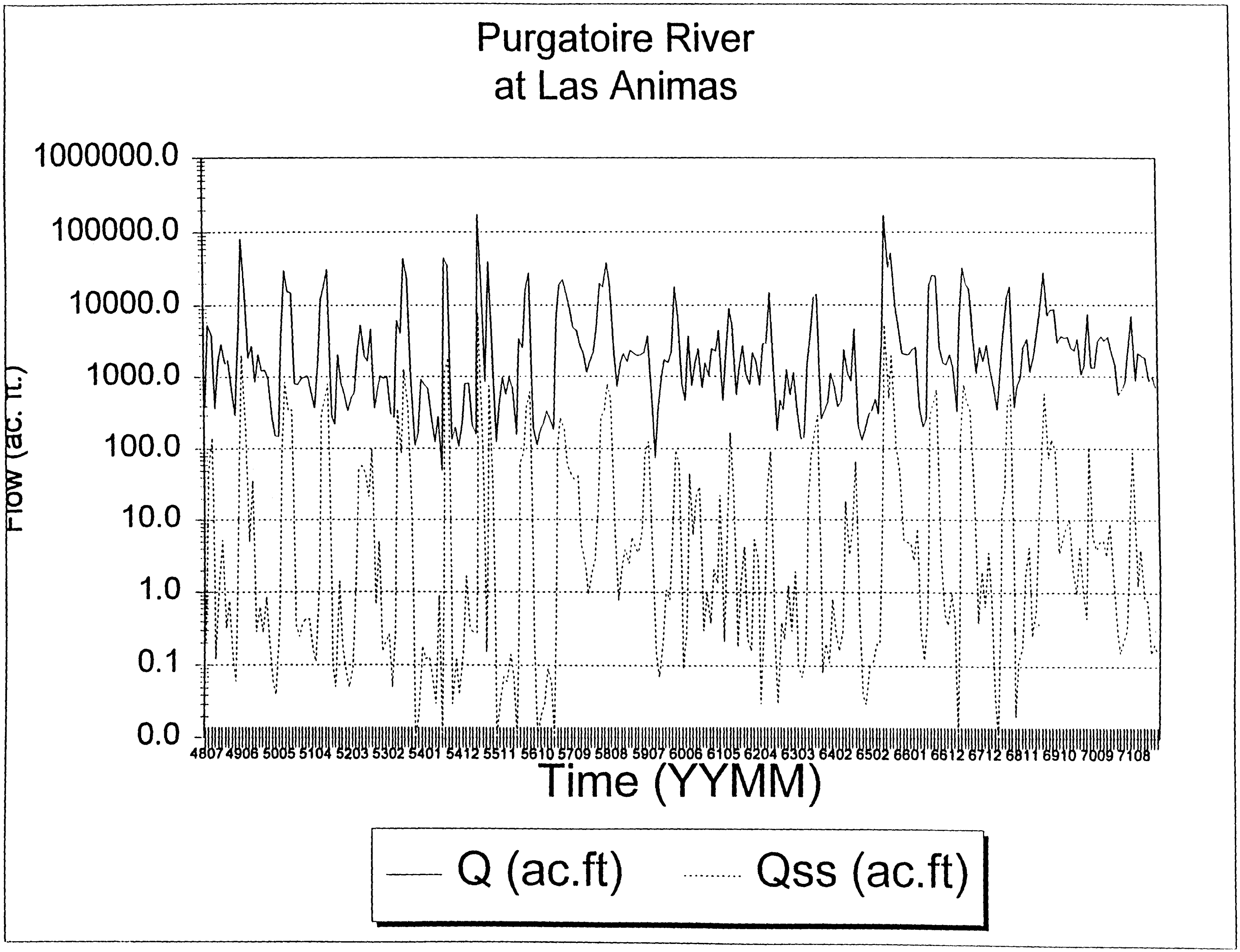
Arkansas River at Las Animas - December

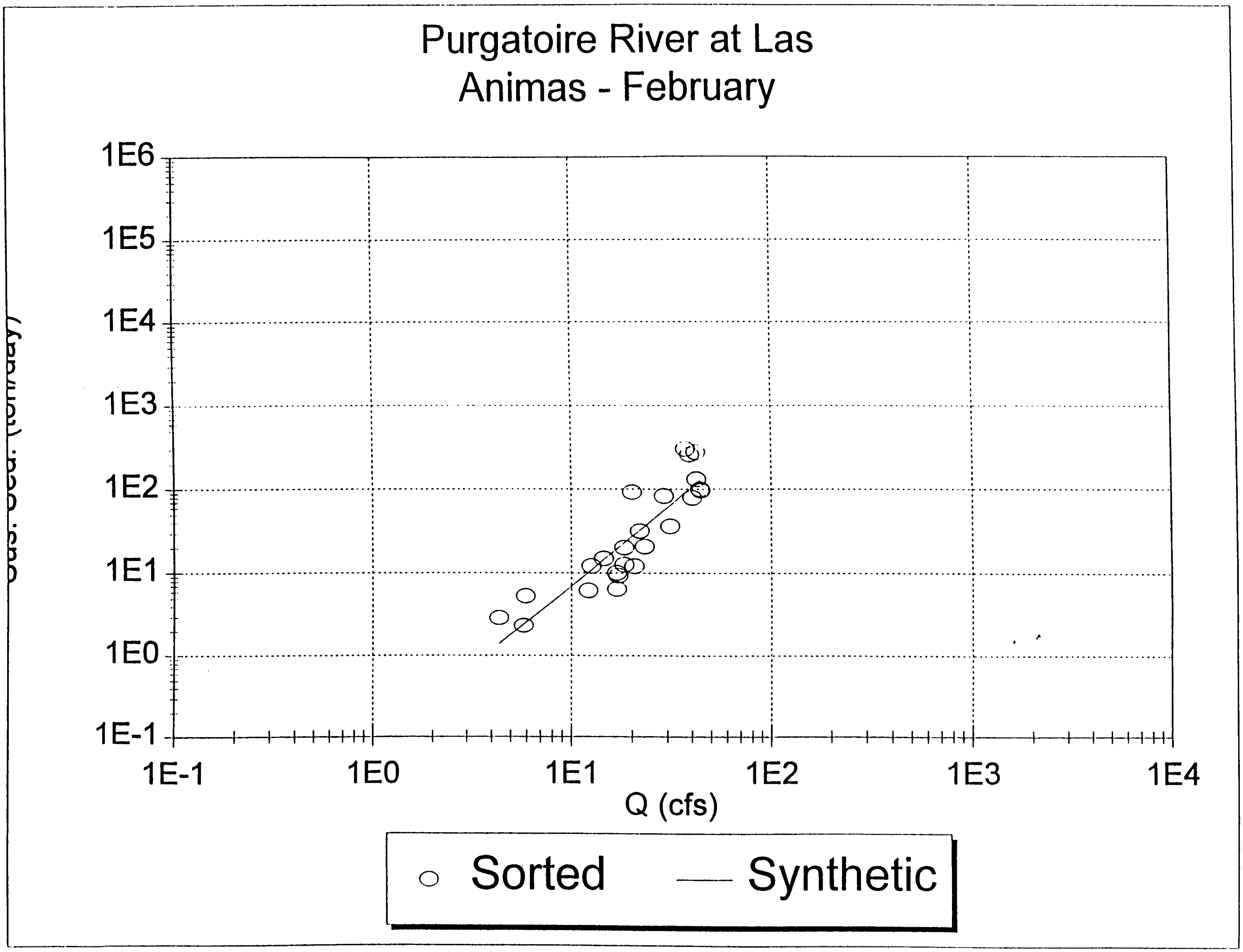



Arkansas River at Las
Animas - November
1E6
1E5
1E4
1E3
1E2
1E1
1E0
1E-1
1E0
1E1
1E2
1E3
1E4
Q (cfs)
Sorted
Synthetic

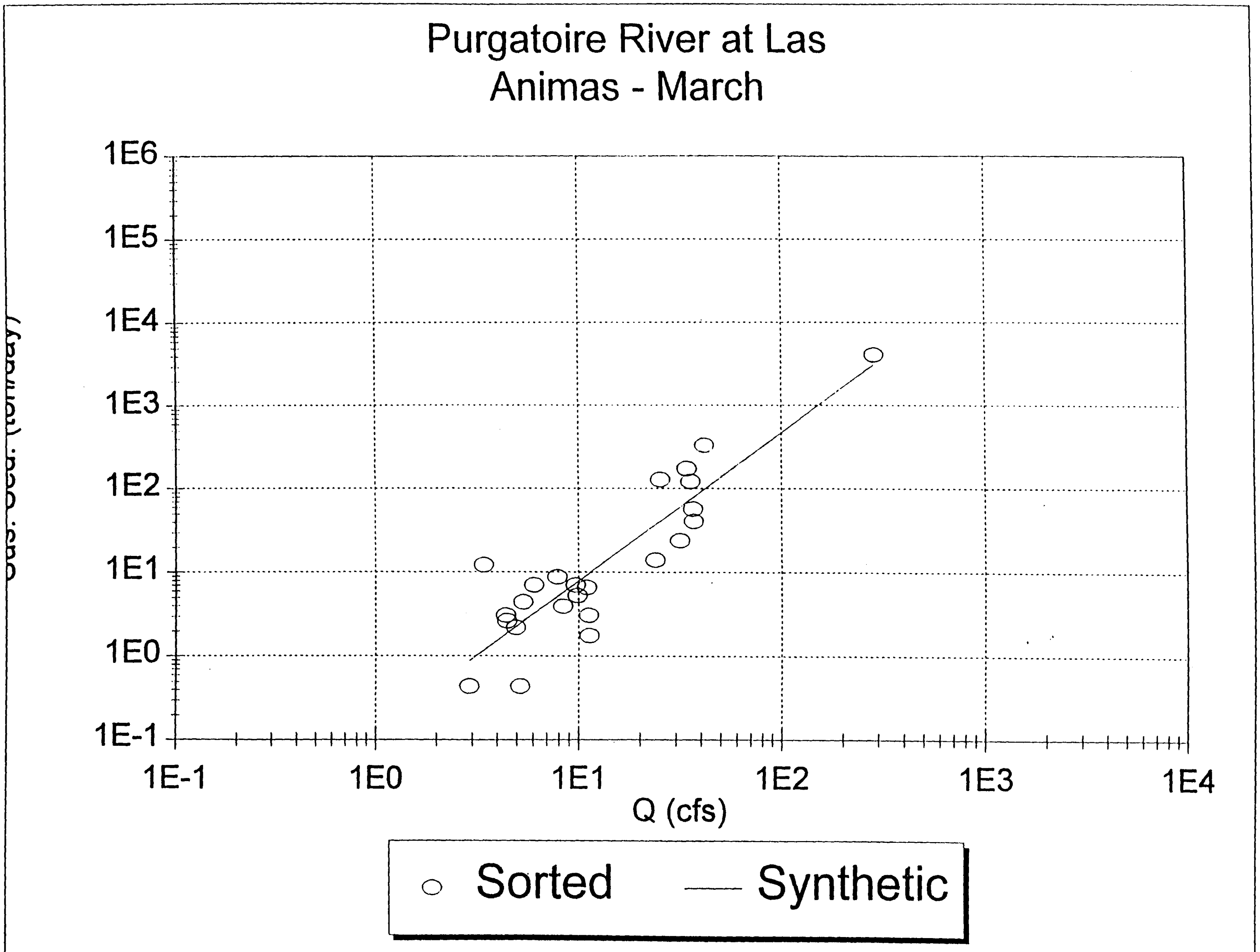


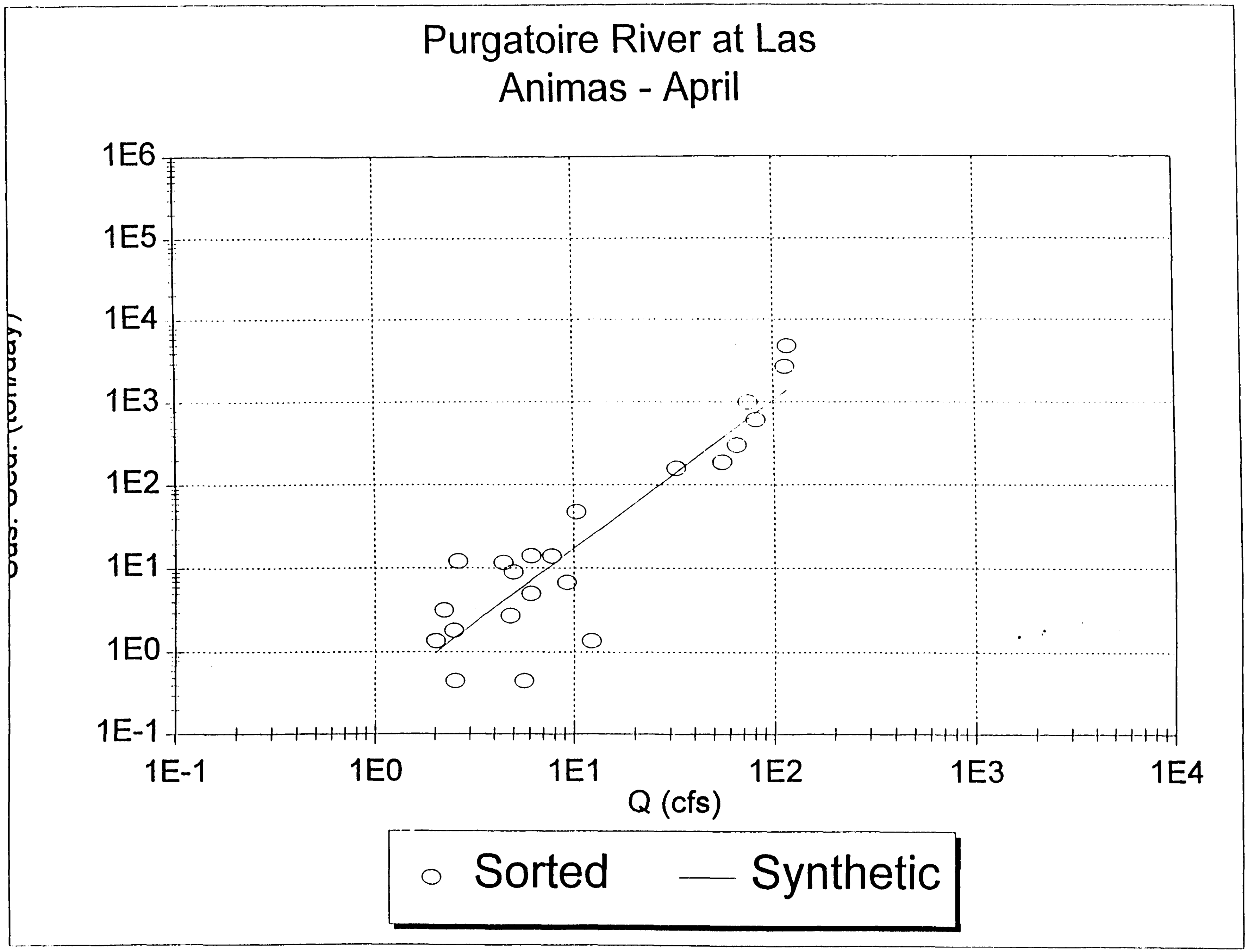
Arkansas River at Las
Animas - December
1E6
1E5
1E4
1E3
1E2
1E1
1E0
1E-1
1E0
1E1
1E2
1E3
1E4
Q (cfs)
Sorted
Synthetic

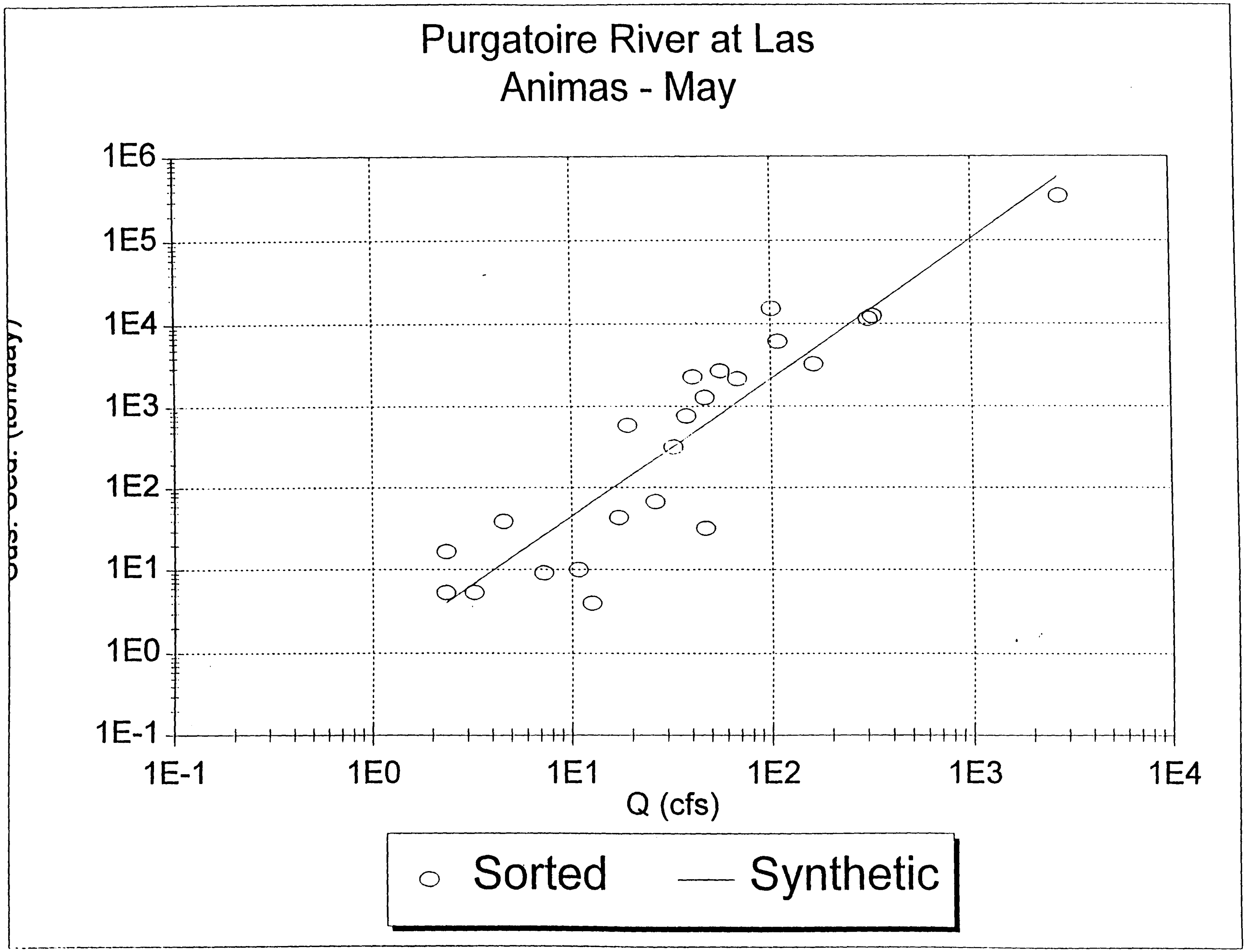

Purgatoire River
at Las Animas
1000000.0
100000.0
10000.0
1000.0
100.0
10.0
1.0
0.1
0.0
Flow (ac. ft.)
4807 4906 5005 5104 5203 5302 5401 5412 5511 5610 5709 5808 5907 6006 6105 6204 6303 6402 6502 6601 6612 6712 6811 6910 7009 7108
Time (YYMM)
Q (ac.ft)
Qss (ac.ft)

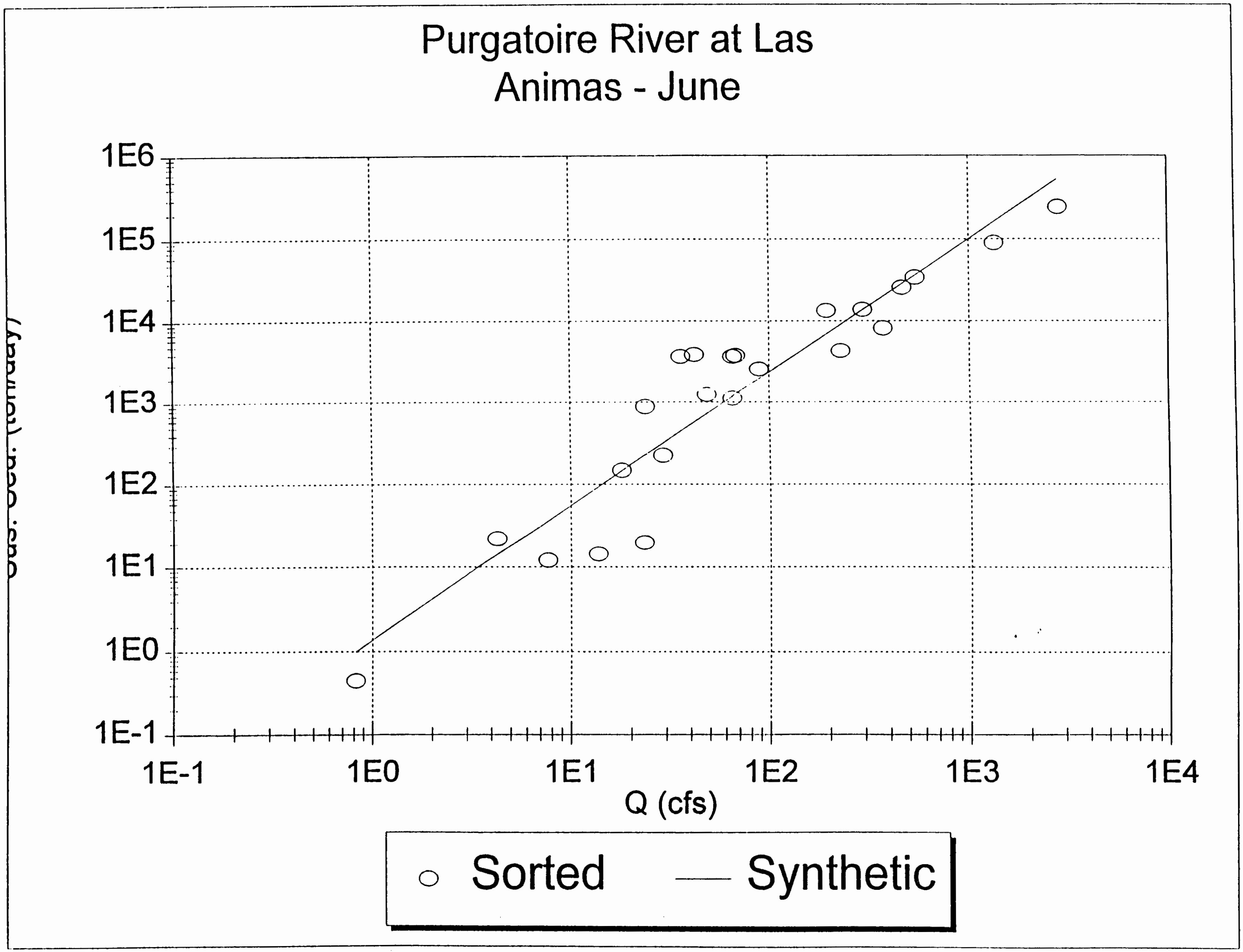


Purgatoire River at Las
Animas - February
1E6
1E5
1E4
1E3
1E2
1E1
1E0
1E-1
1E-1
1E0
1E1
1E2
1E3
1E4
Q (cfs)
Sorted
Synthetic

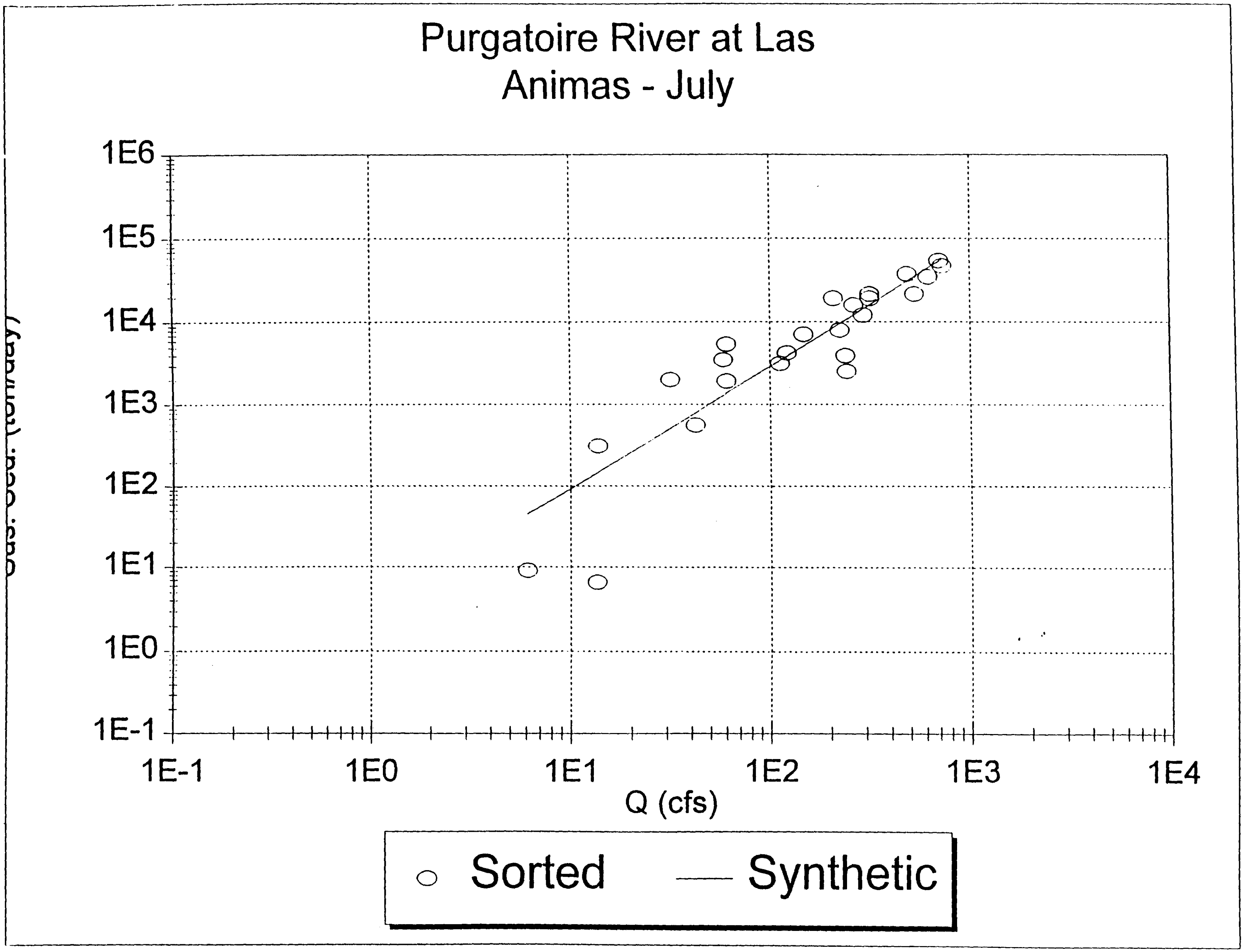

Purgatoire River at Las
Animas - March
1E6
1E5
1E4
1E3
1E2
1E1
1E0
1E-1
1E-1
1E0
1E1
1E2
1E3
1E4
Q (cfs)
Sorted
Synthetic

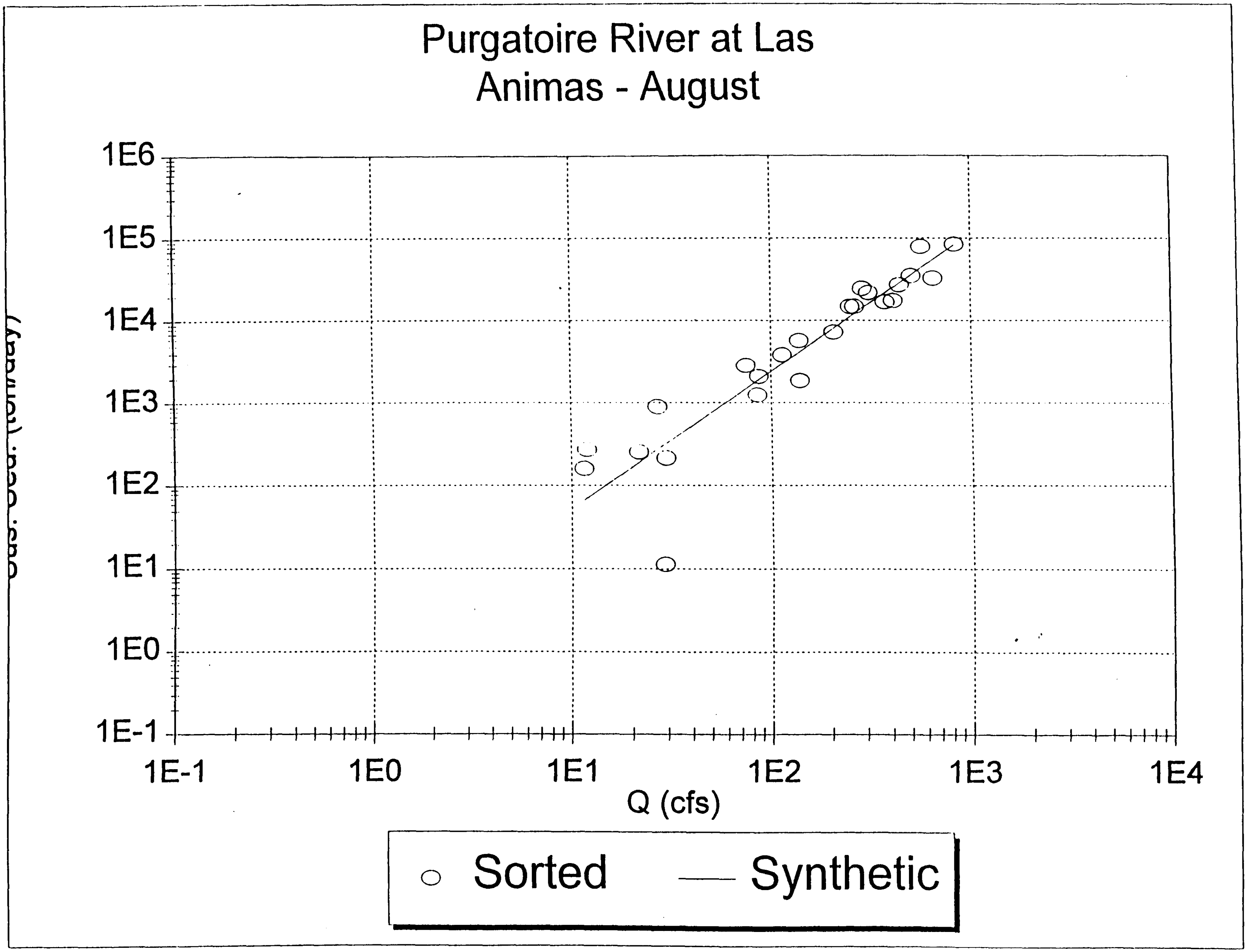

Purgatoire River at Las
Animas - April
1E6
1E5
1E4
1E3
1E2
1E1
1E0
1E-1
1E-1
1E0
1E1
1E2
1E3
1E4
Q (cfs)
Sorted
Synthetic

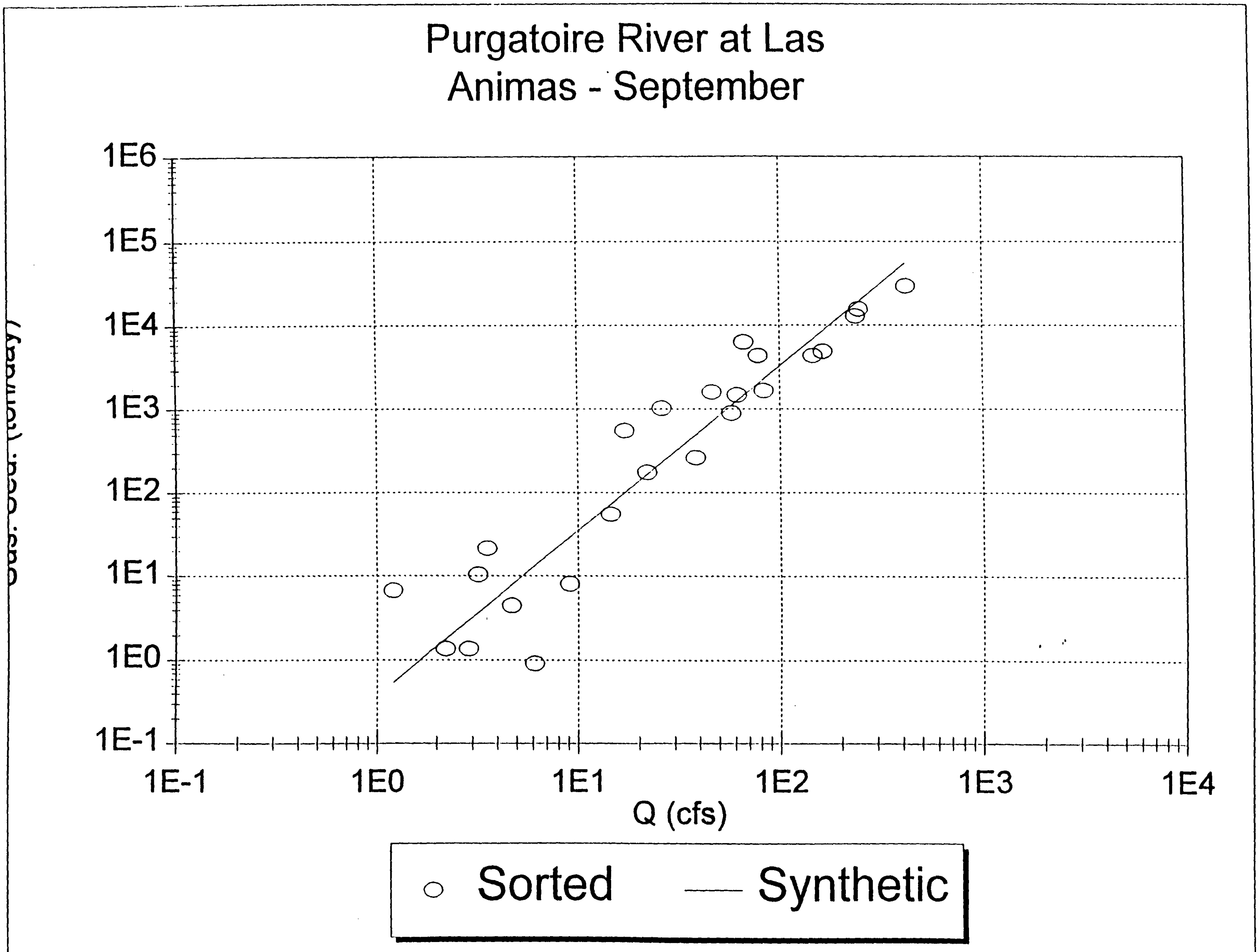

Purgatoire River at Las
Animas - May
1E6
1E5
1E4
1E3
1E2
1E1
1E0
1E-1
1E-1
1E0
1E1
1E2
1E3
1E4
Q (cfs)
Sorted
Synthetic

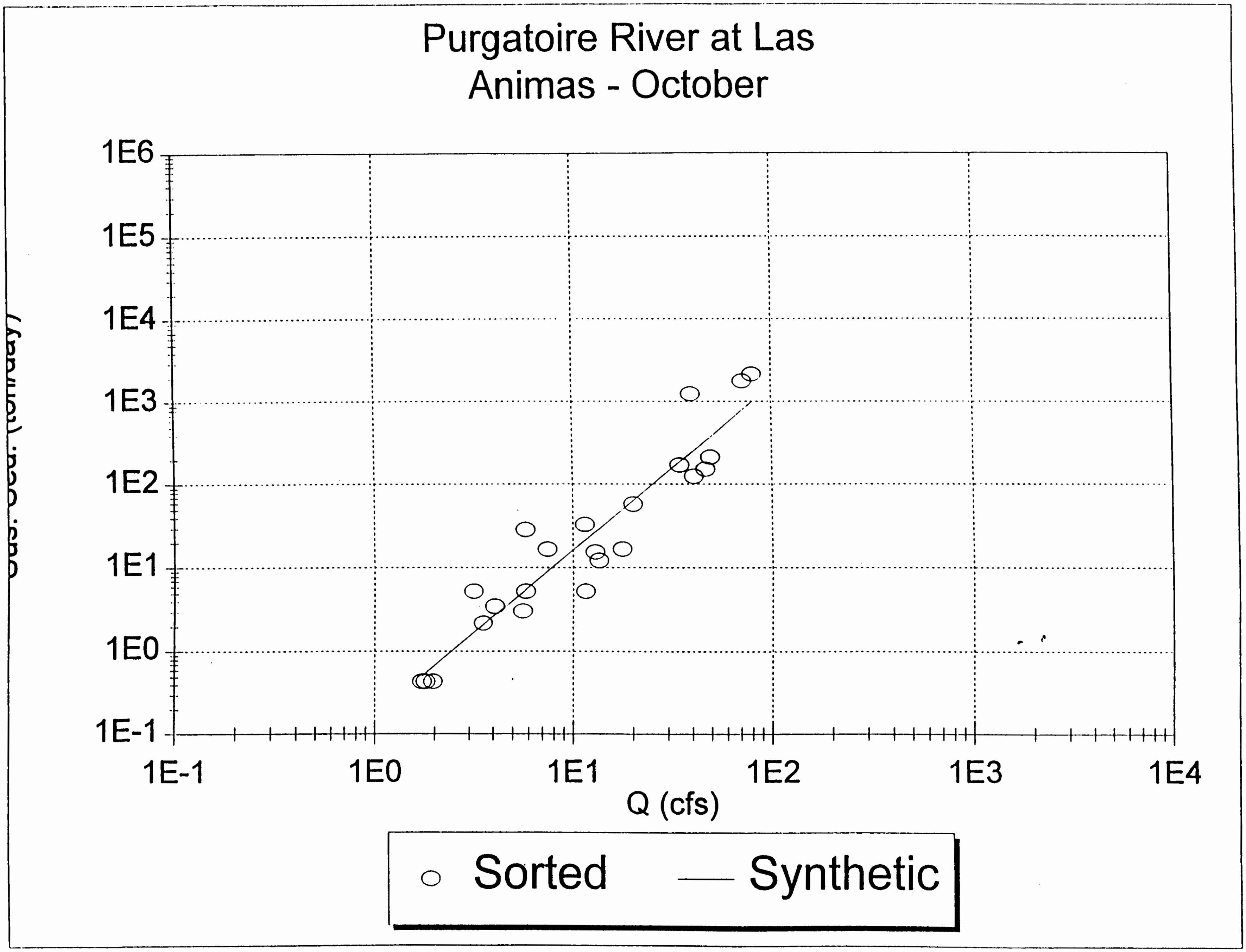


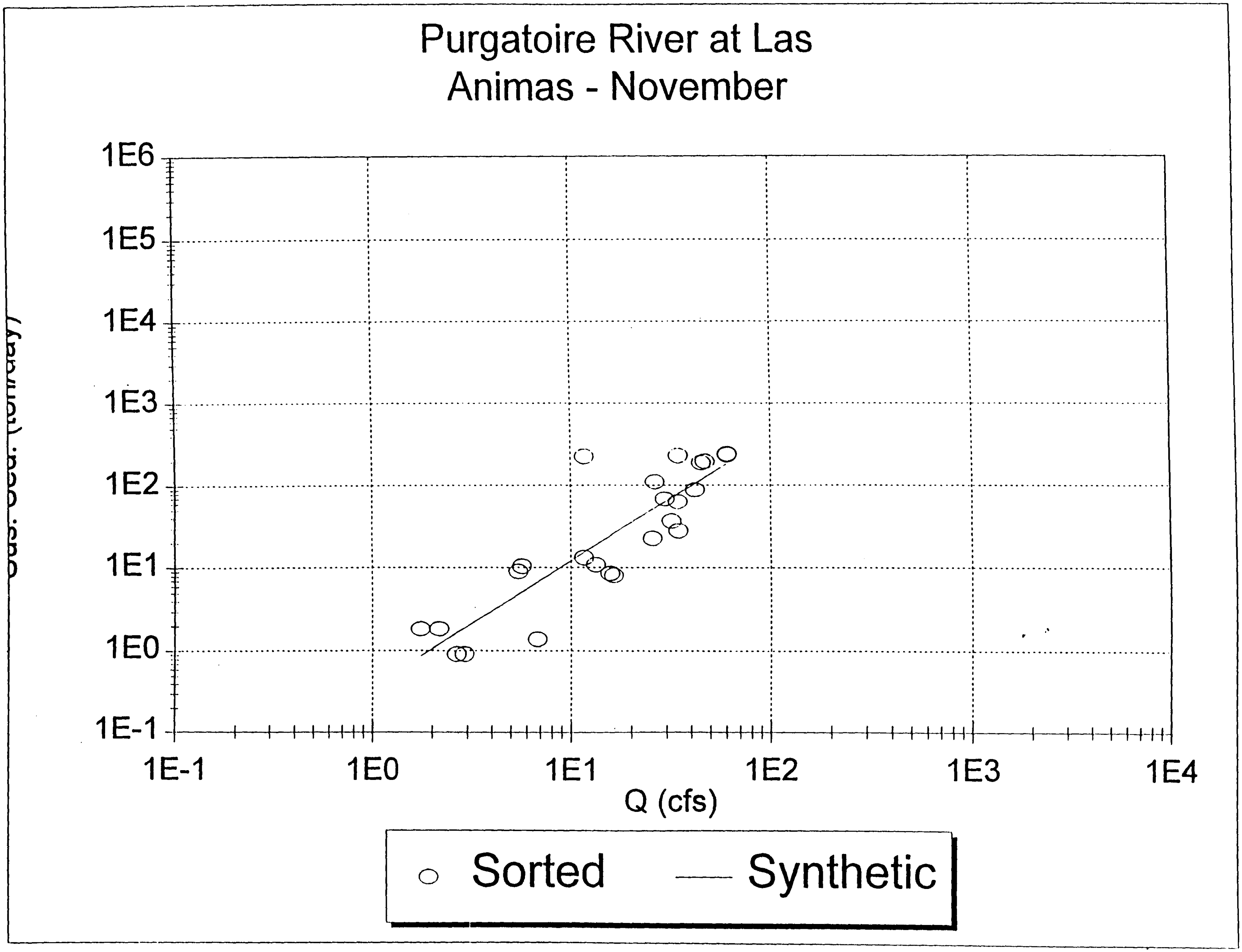
Purgatoire River at Las
Animas - June
1E6
1E5
1E4
1E3
1E2
1E1
1E0
1E-1
1E-1
1E0
1E1
1E2
1E3
1E4
Q (cfs)
Sorted
Synthetic


Purgatoire River at Las
Animas - July
1E6
1E5
1E4
1E3
1E2
1E1
1E0
1E-1
1E-1
1E0
1E1
1E2
1E3
1E4
Q (cfs)
Sorted
Synthetic

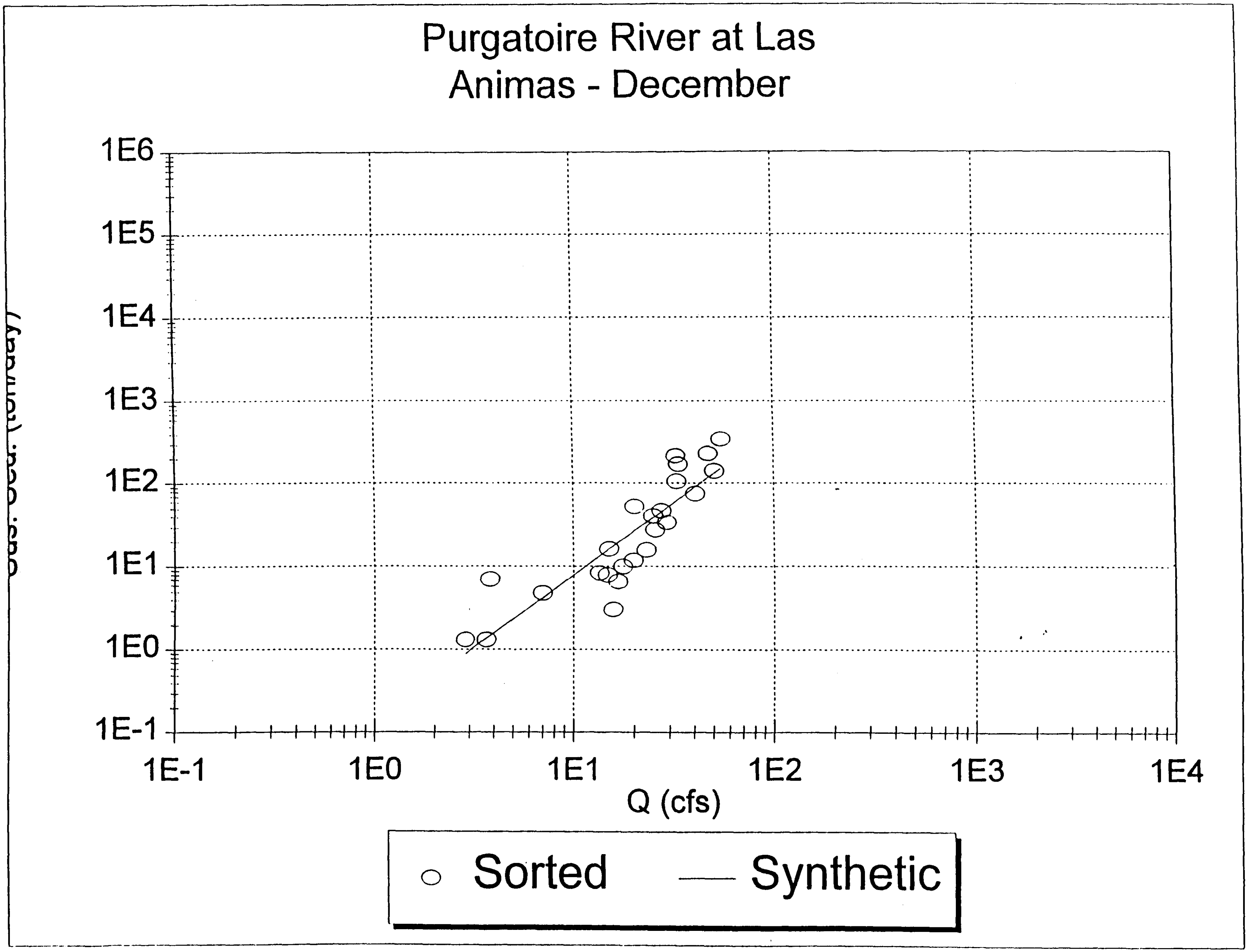

Purgatoire River at Las Animas - August
1E6
1E5
1E4
1E3
1E2
1E1
1E0
1E-1
1E-1
1E0
1E1
1E2
1E3
1E4
Q (cfs)
Sorted
Synthetic


Purgatoire River at Las
Animas - September
1E6
1E5
1E4
1E3
1E2
1E1
1E0
1E-1
1E-1
1E0
1E1
1E2
1E3
1E4
Q (cfs)
Sorted
Synthetic


Purgatoire River at Las
Animas - October
1E6
1E5
1E4
1E3
1E2
1E1
1E0
1E-1
1E-1
1E0
1E1
1E2
1E3
1E4
Q (cfs)
Sorted
Synthetic

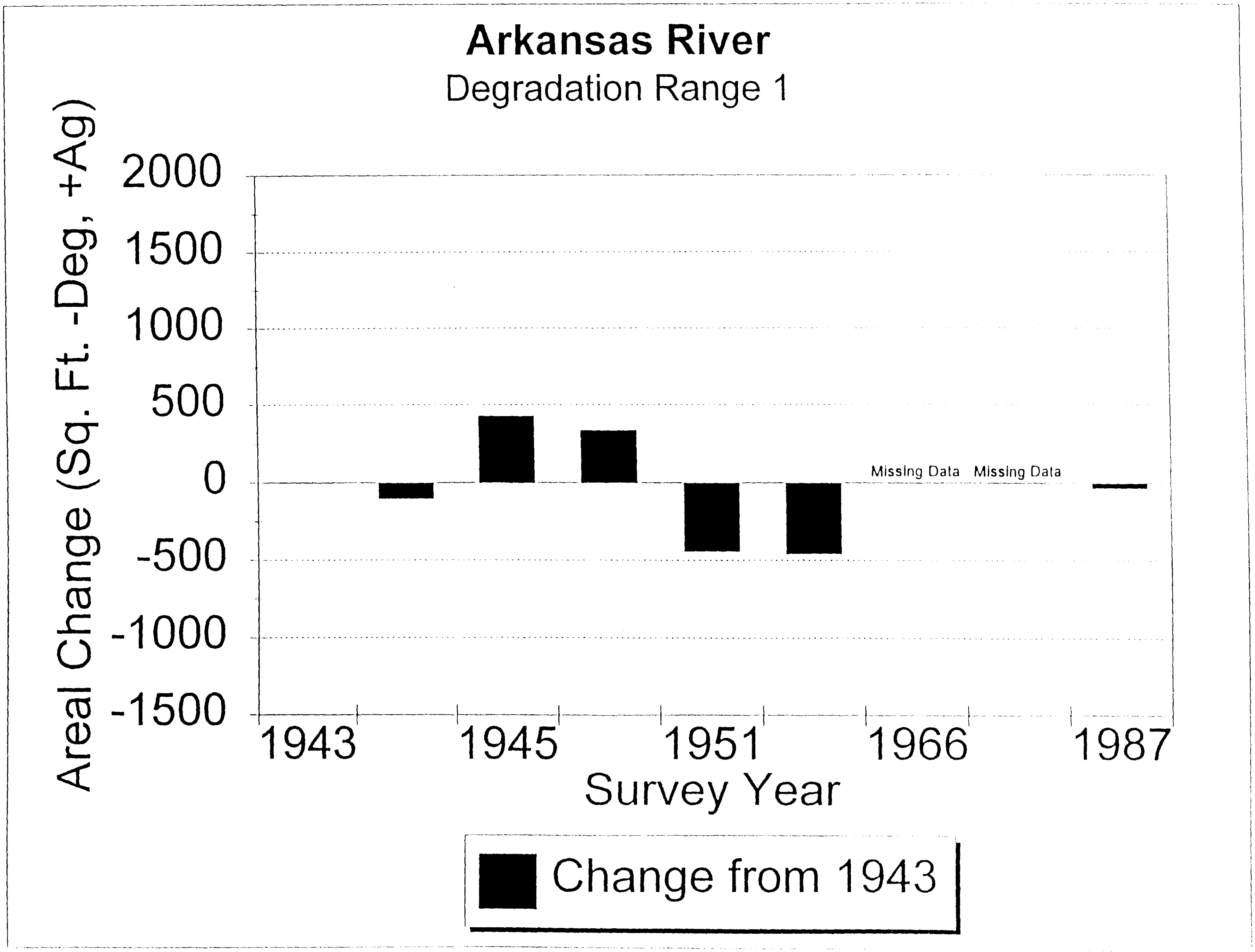


Purgatoire River at Las
Animas - November
1E6
1E5
1E4
1E3
1E2
1E1
1E0
1E-1
1E-1
1E0
1E1
1E2
1E3
1E4
Q (cfs)
Sorted
Synthetic

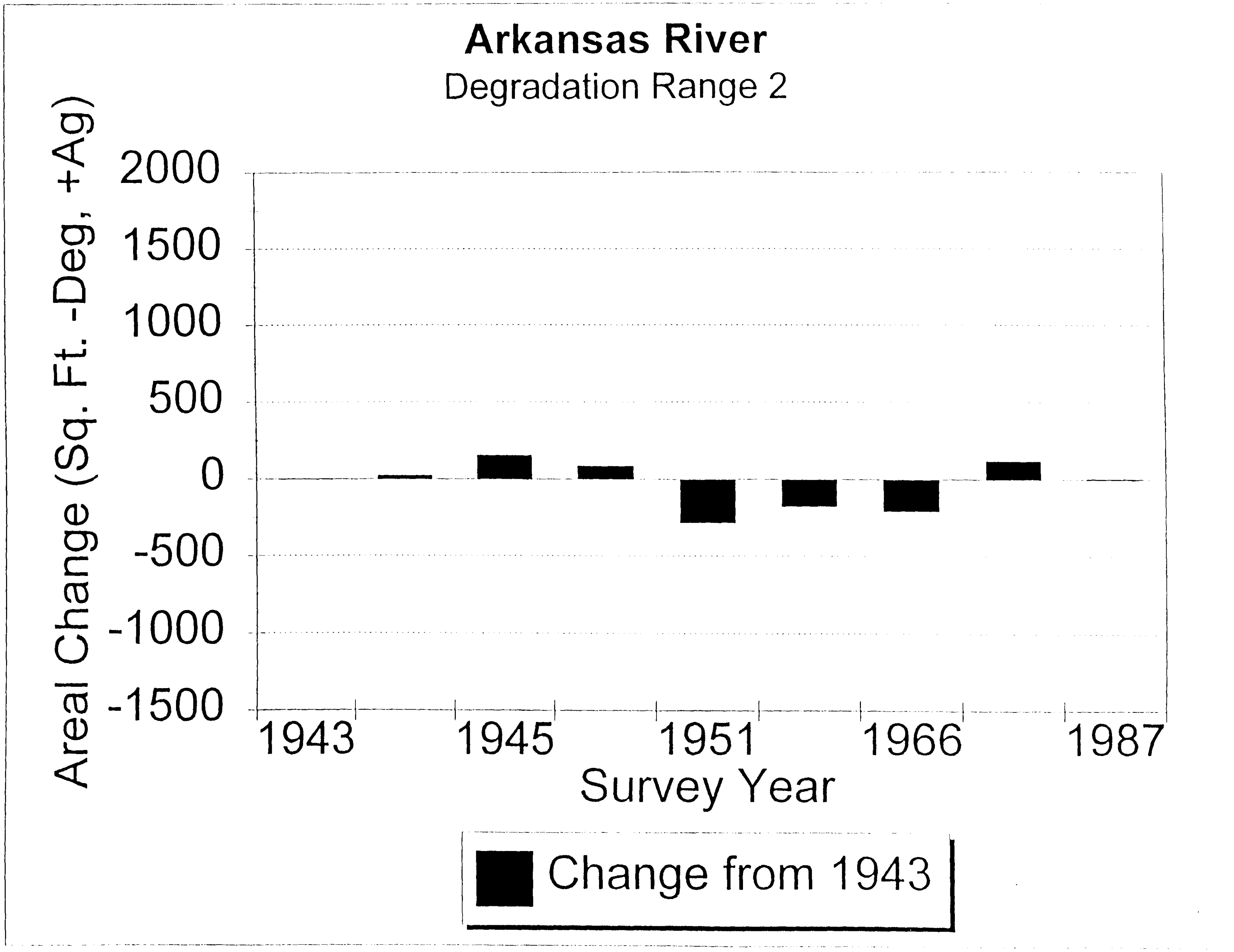

Purgatoire River at Las
Animas - December
1E6
1E5
1E4
1E3
1E2
1E1
1E0
1E-1
1E-1
1E0
1E1
1E2
1E3
1E4
Q (cfs)
Sorted
Synthetic

APPENDIX B

GRAPHICAL DEGRADATION RANGELINE DATA



Arkansas River
Degradation Range 1
Areal Change (Sq. Ft. -Deg, +Ag)
2000
1500
1000
500
0
-500
-1000
-1500
Missing Data
Missing Data
1943
1945
1951
1966
1987
Survey Year
Change from 1943


Arkansas River
Degradation Range 2
Areal Change (Sq. Ft. -Deg, +Ag)
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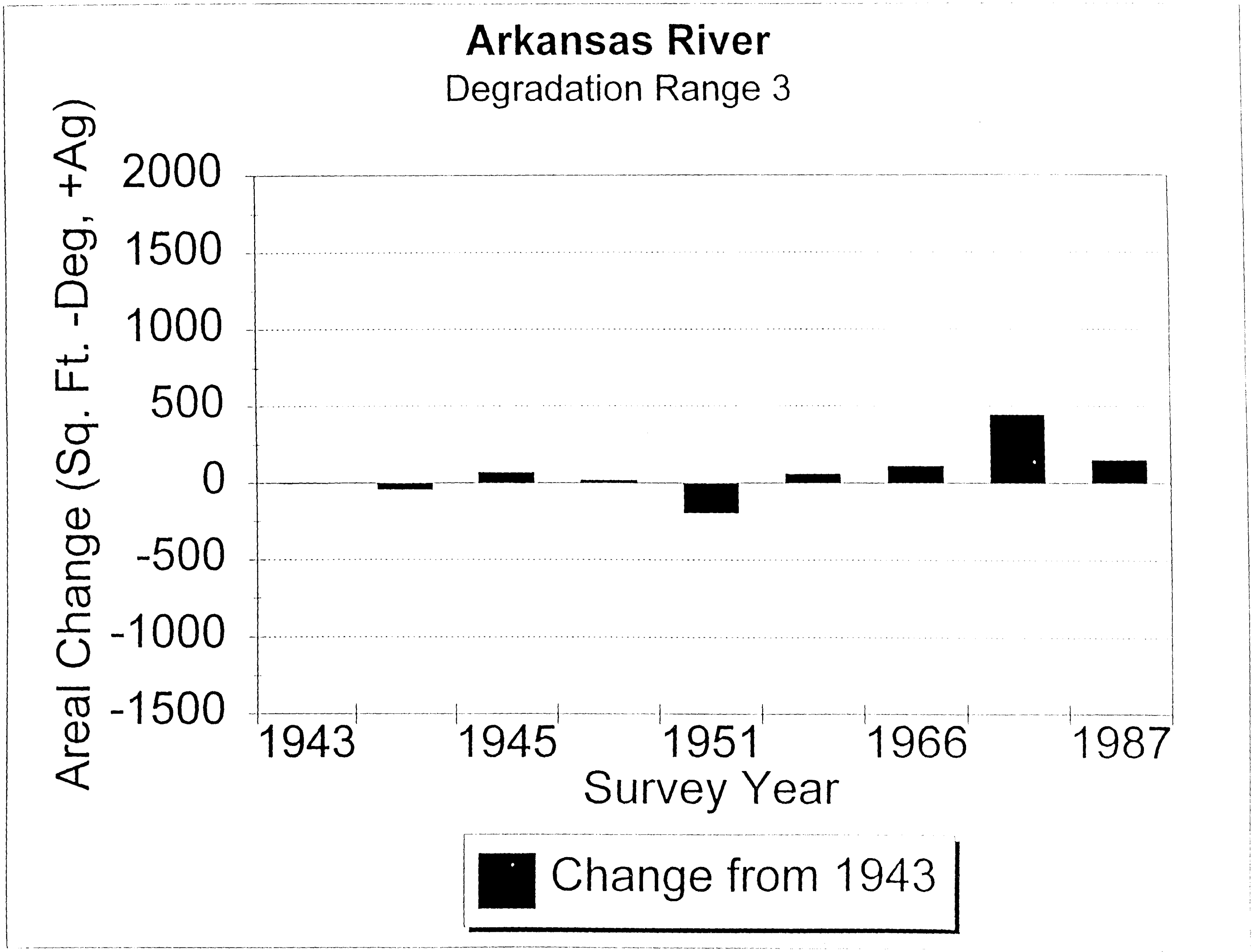
1500
1000
500
0
-500
-1000
-1500
1943
1945
1951
1966
1987
Survey Year
Change from 1943



Arkansas River
Degradation Range 3
Areal Change (Sq. Ft. -Deg, +Ag)
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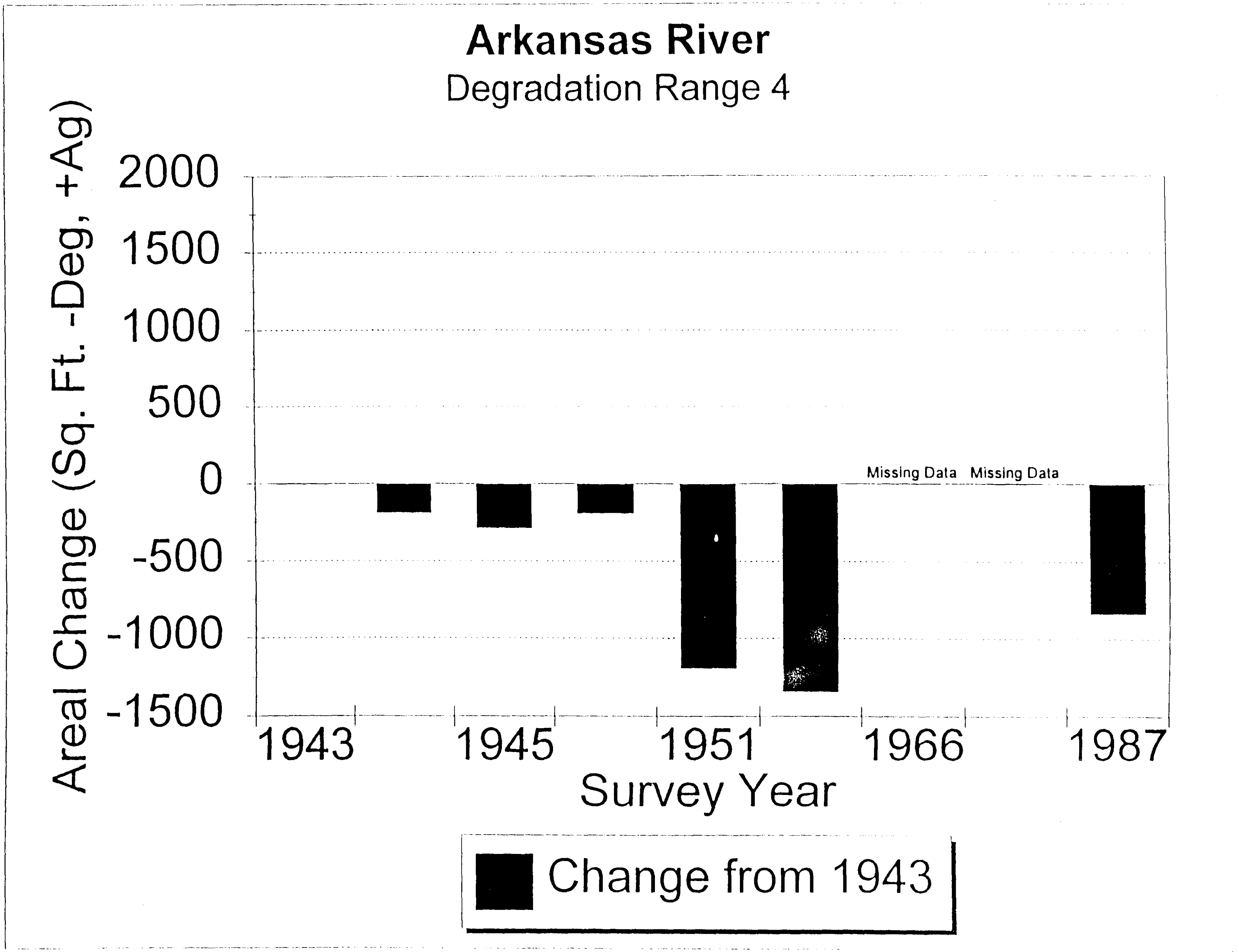
1500
1000
500
0
-500
-1000
-1500
1943
1945
1951
1966
1987
Survey Year
Change from 1943


Arkansas River
Degradation Range 4
Areal Change (Sq. Ft. -Deg, +Ag)
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1500
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0
-500
-1000
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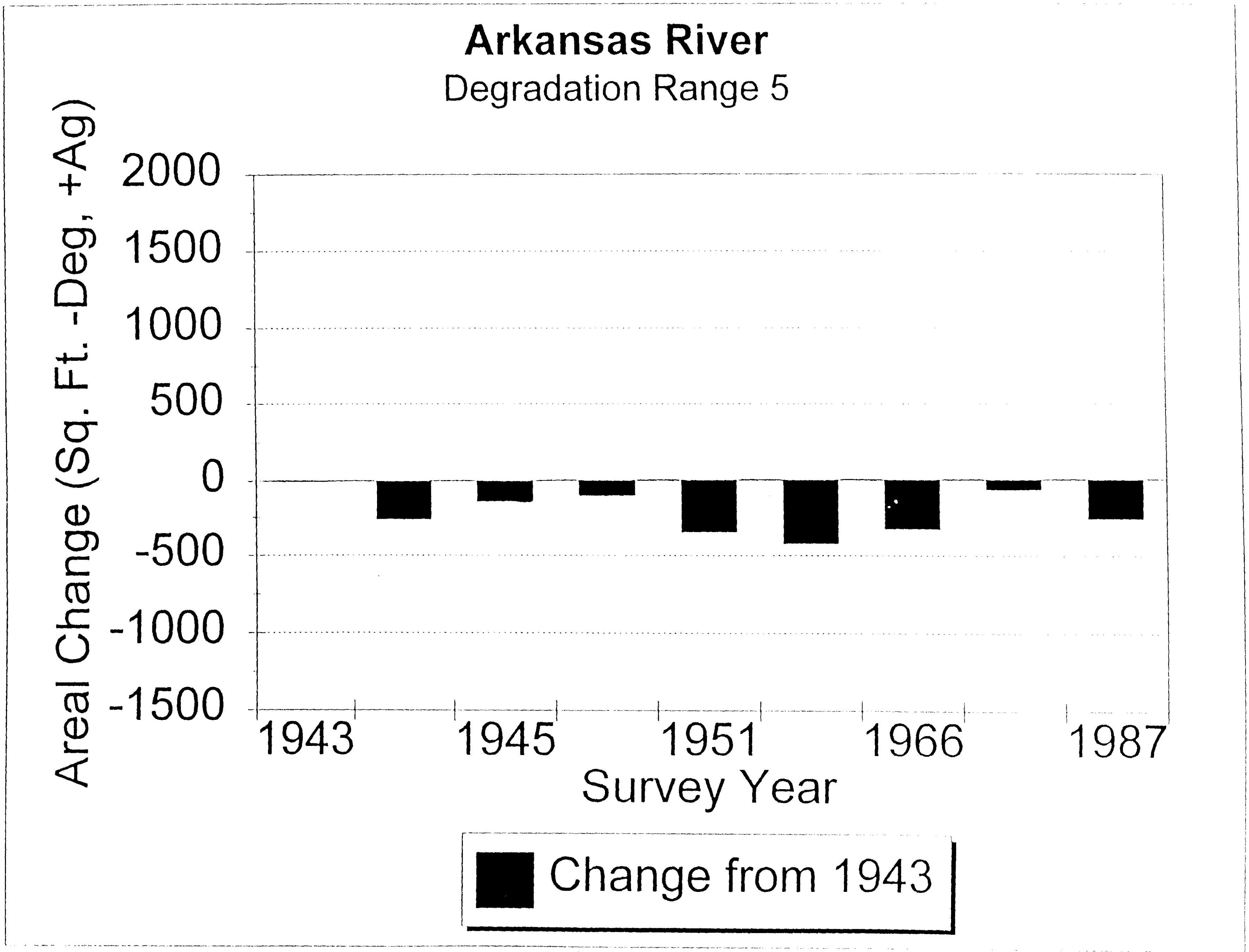
Missing Data
1943
1945
1951
1966
1987
Survey Year
Change from 1943



Arkansas River
Degradation Range 5
Areal Change (Sq. Ft. -Deg, +Ag)
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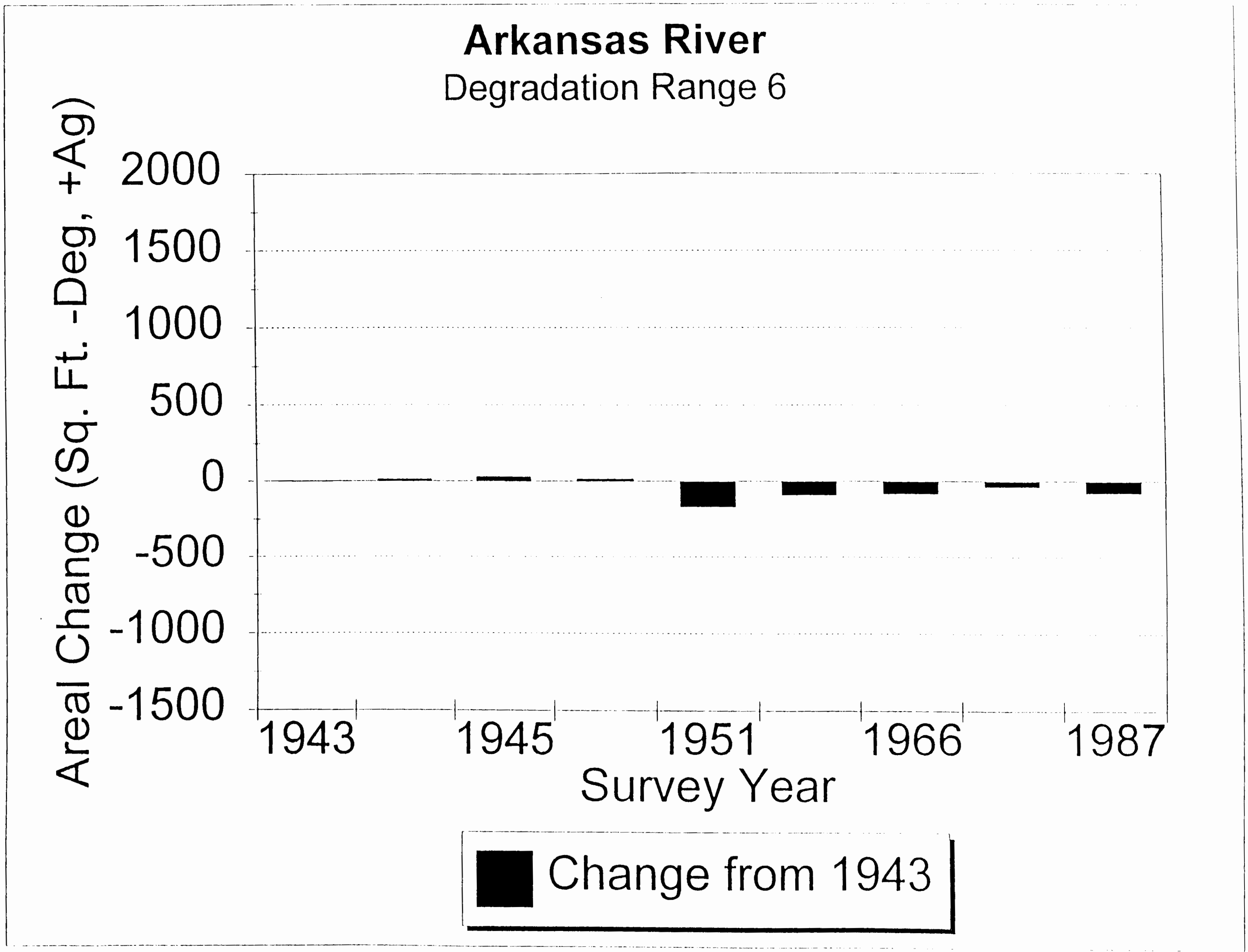
1500
1000
500
0
-500
-1000
-1500
1943
1945
1951
1966
1987
Survey Year
Change from 1943


Arkansas River
Degradation Range 6
Areal Change (Sq. Ft. -Deg, +Ag)
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1000
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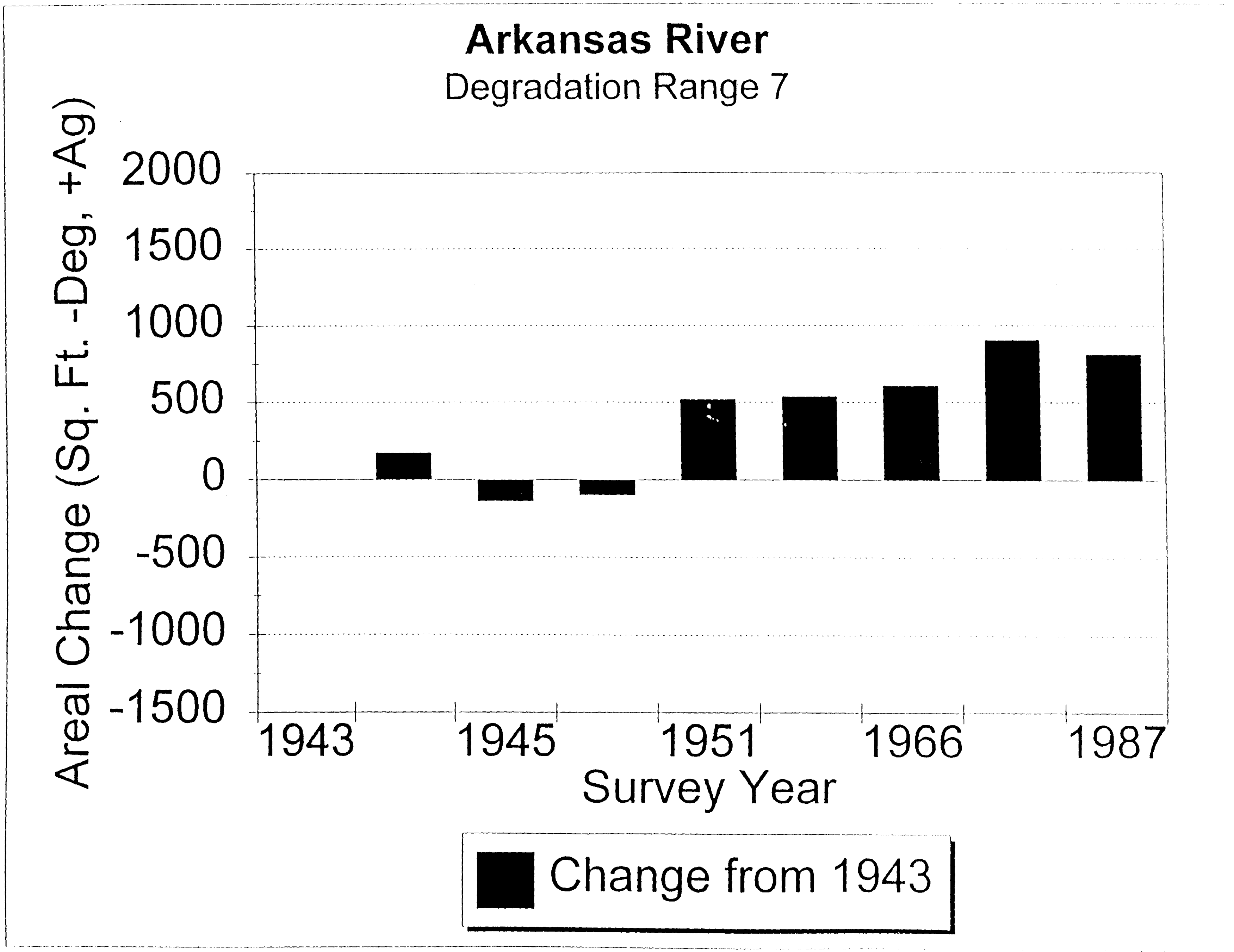
-500
-1000
-1500
1943
1945
1951
1966
1987
Survey Year
Change from 1943



Arkansas River
Degradation Range 7
Areal Change (Sq. Ft. -Deg, +Ag)
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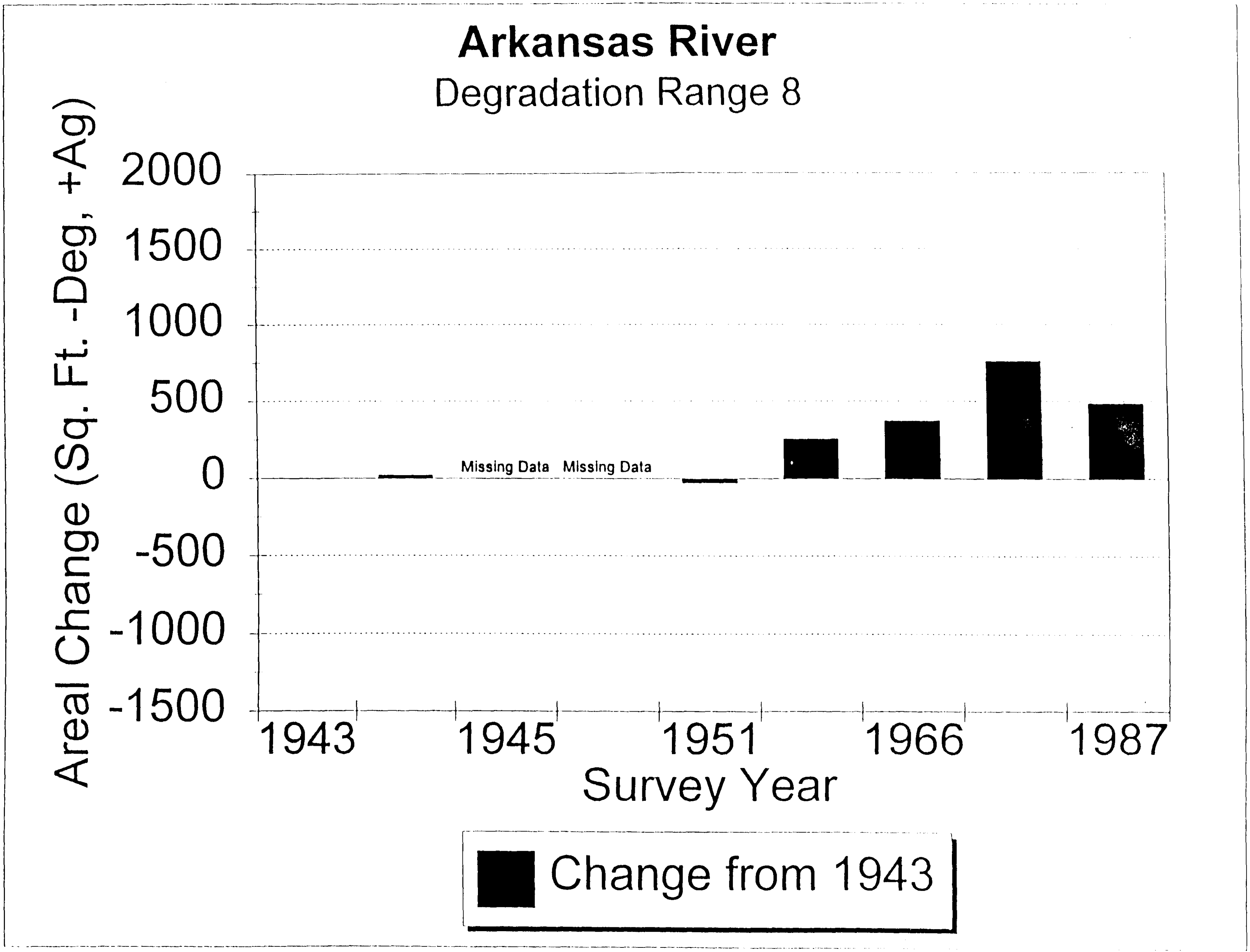
1500
1000
500
0
-500
-1000
-1500
1943
1945
1951
1966
1987
Survey Year
Change from 1943



Arkansas River
Degradation Range 8
Areal Change (Sq. Ft. -Deg, +Ag)
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1000
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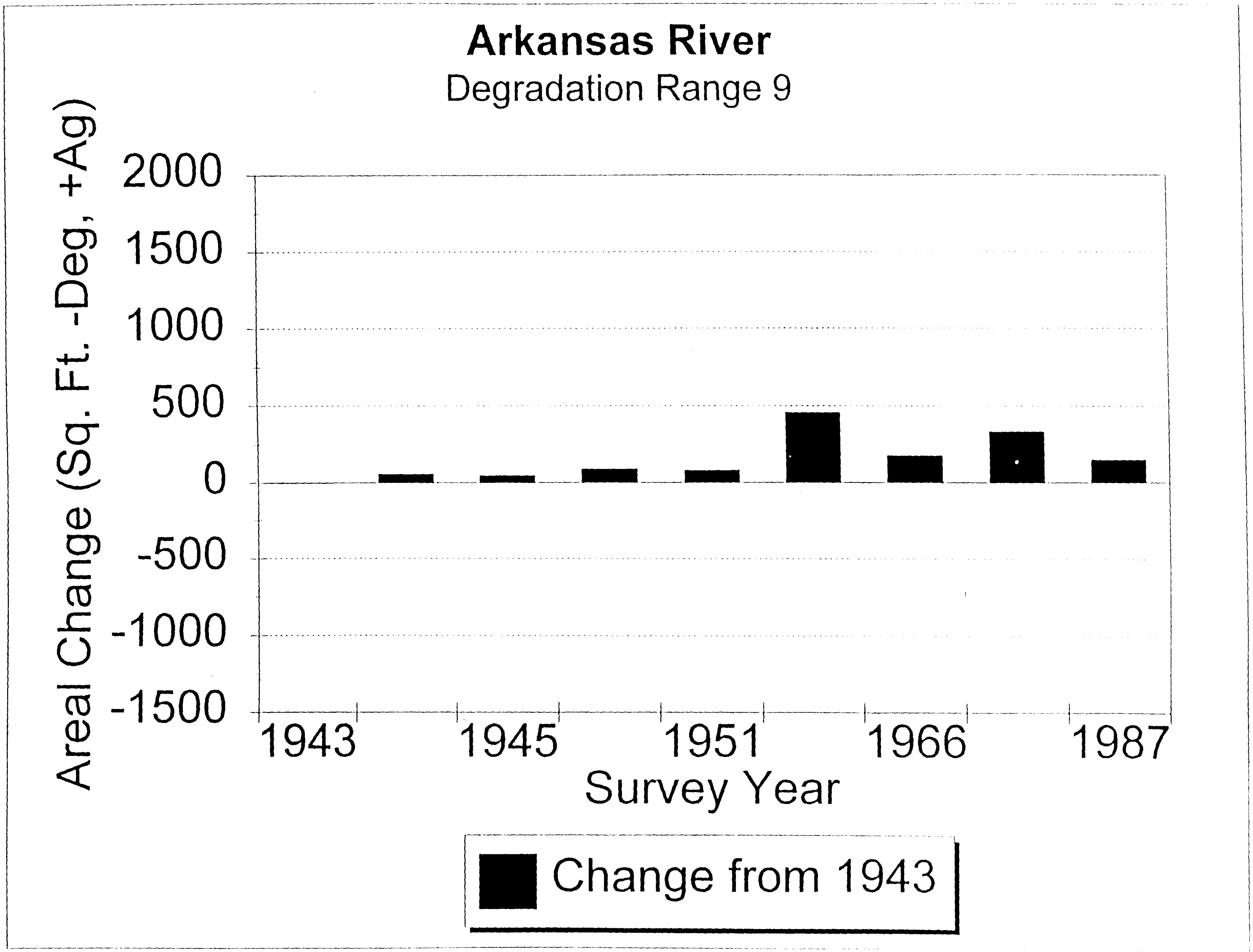
0
-500
-1000
-1500
Missing Data
Missing Data
1943
1945
1951
1966
1987
Survey Year
Change from 1943


Arkansas River
Degradation Range 9
Areal Change (Sq. Ft. -Deg, +Ag)
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1500
1000
500
0
-500
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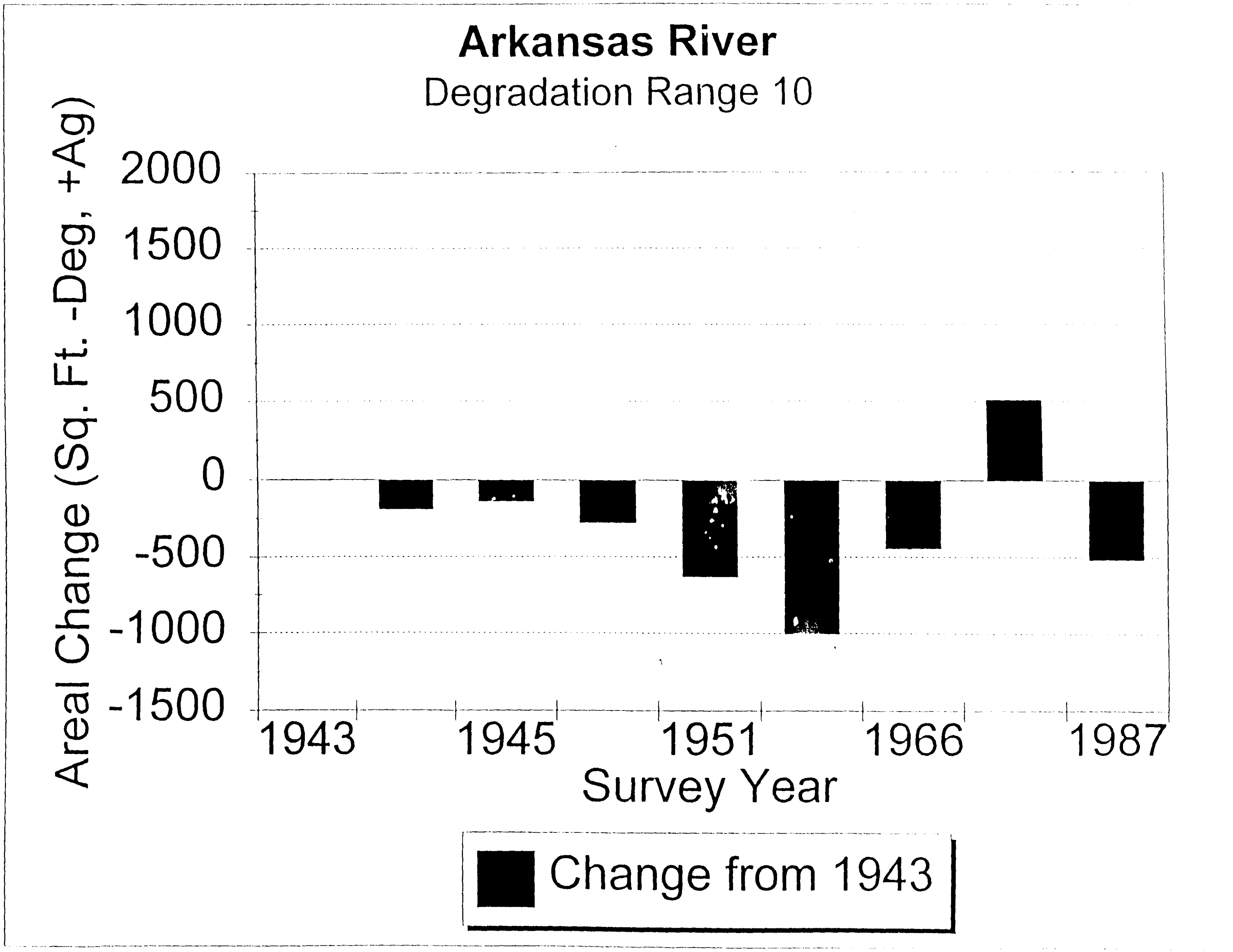
-1500
1943
1945
1951
1966
1987
Survey Year
Change from 1943


Arkansas River
Degradation Range 10
Areal Change (Sq. Ft. -Deg, +Ag)
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1500
1000
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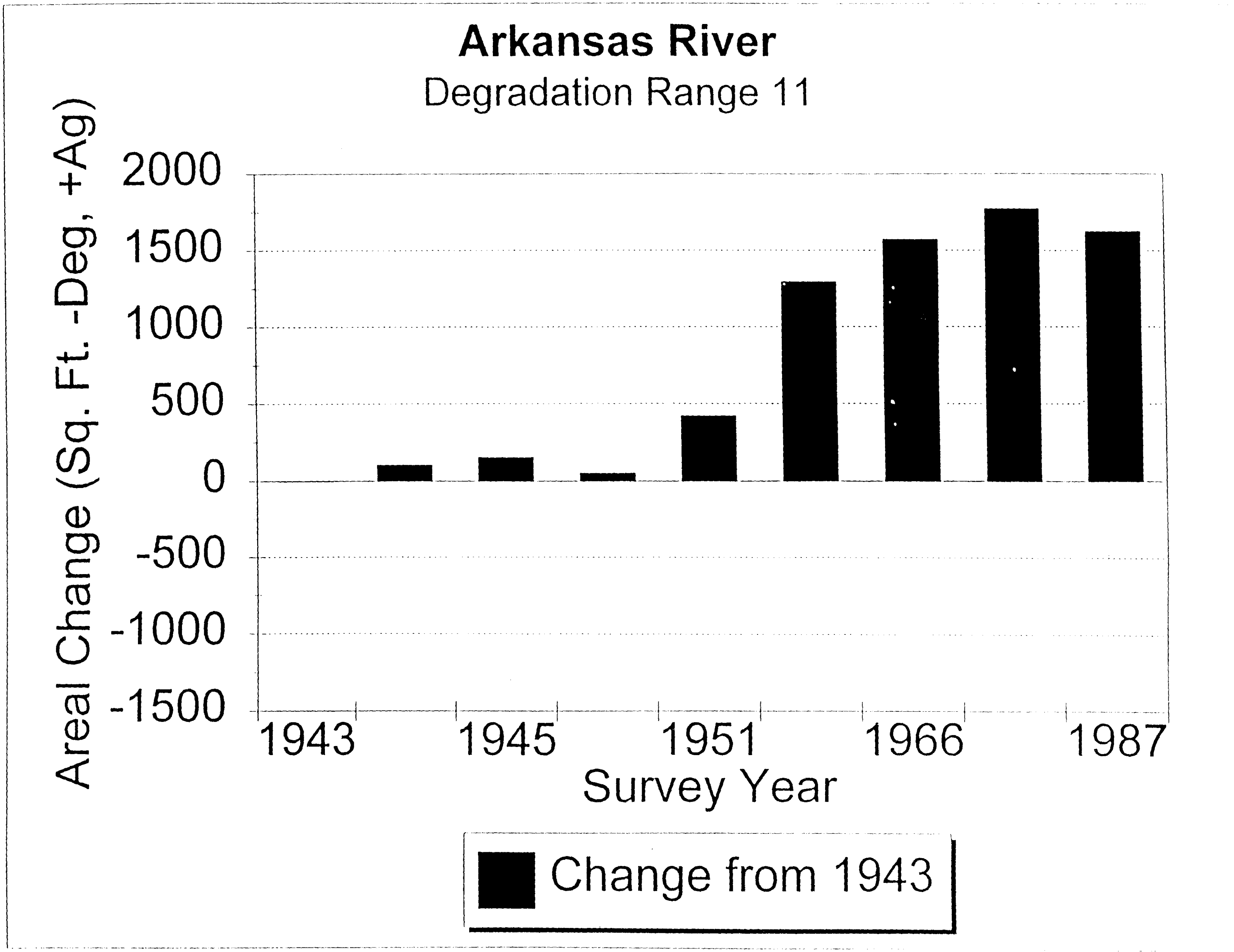
1943
1945
1951
1966
1987
Survey Year
Change from 1943


Arkansas River
Degradation Range 11
Areal Change (Sq. Ft. -Deg, +Ag)
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1000
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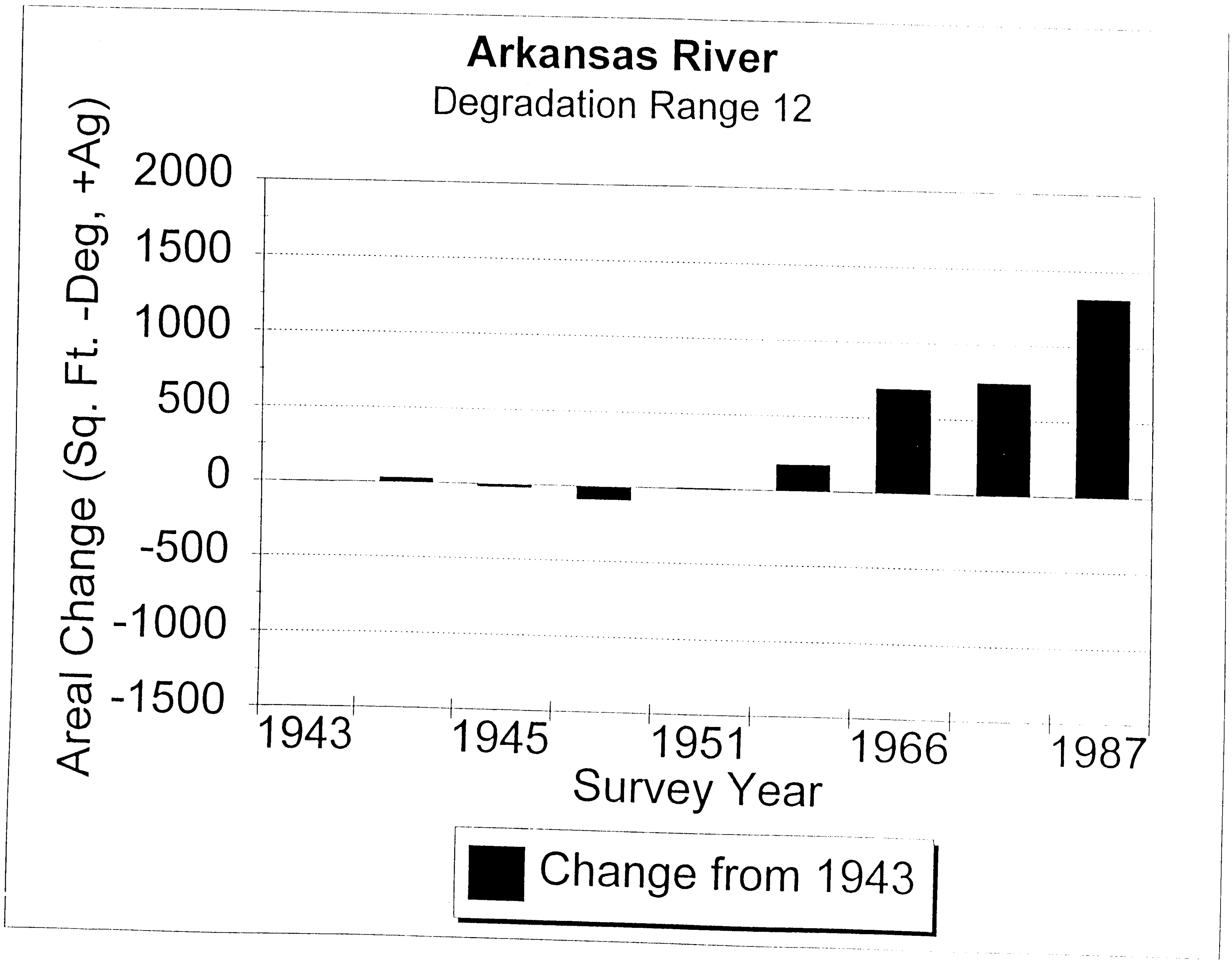
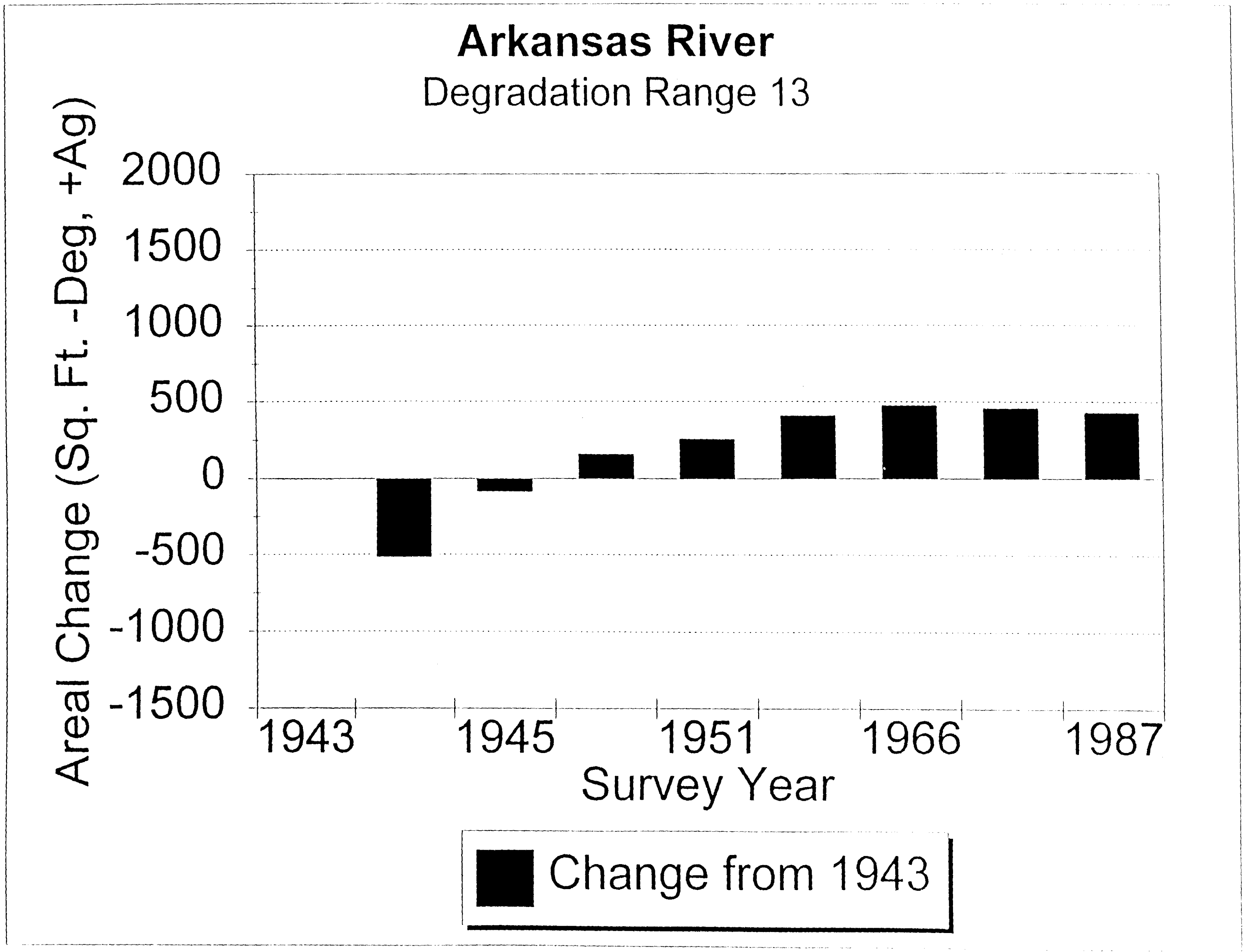
-500
-1000
-1500
1943
1945
1951
1966
1987
Survey Year
Change from 1943



Arkansas River
Degradation Range 12
Areal Change (Sq. Ft. -Deg, +Ag)
2000
1500
1000
500
0
-500
-1000
-1500
1943
1945
1951
1966
1987
Survey Year
Change from 1943


Arkansas River
Degradation Range 13
Areal Change (Sq. Ft. -Deg, +Ag)
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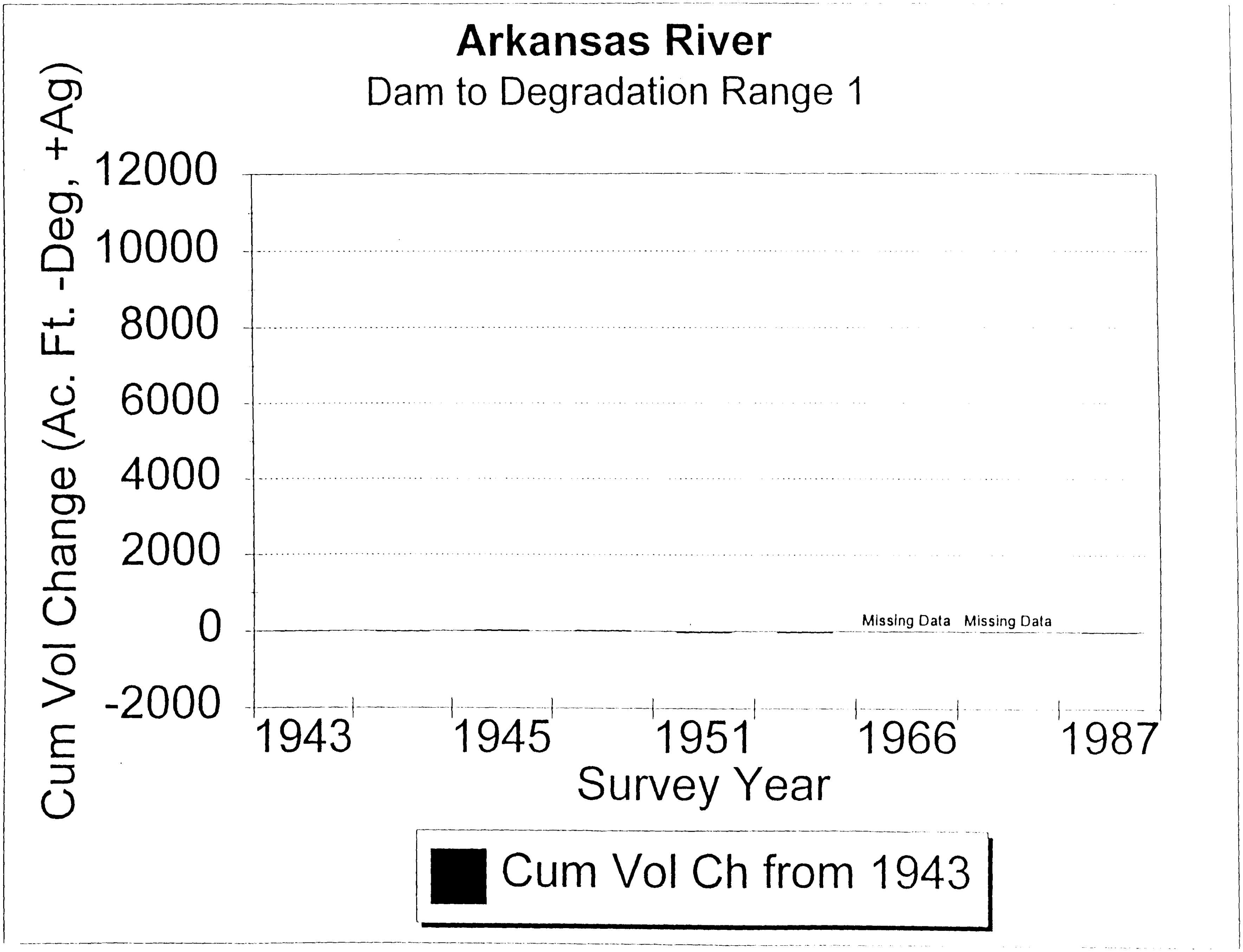
1500
1000
500
0
-500
-1000
-1500
1943
1945
1951
1966
1987
Survey Year
Change from 1943


Arkansas River
Dam to Degradation Range 1
Cum Vol Change (Ac. Ft. -Deg, +Ag)
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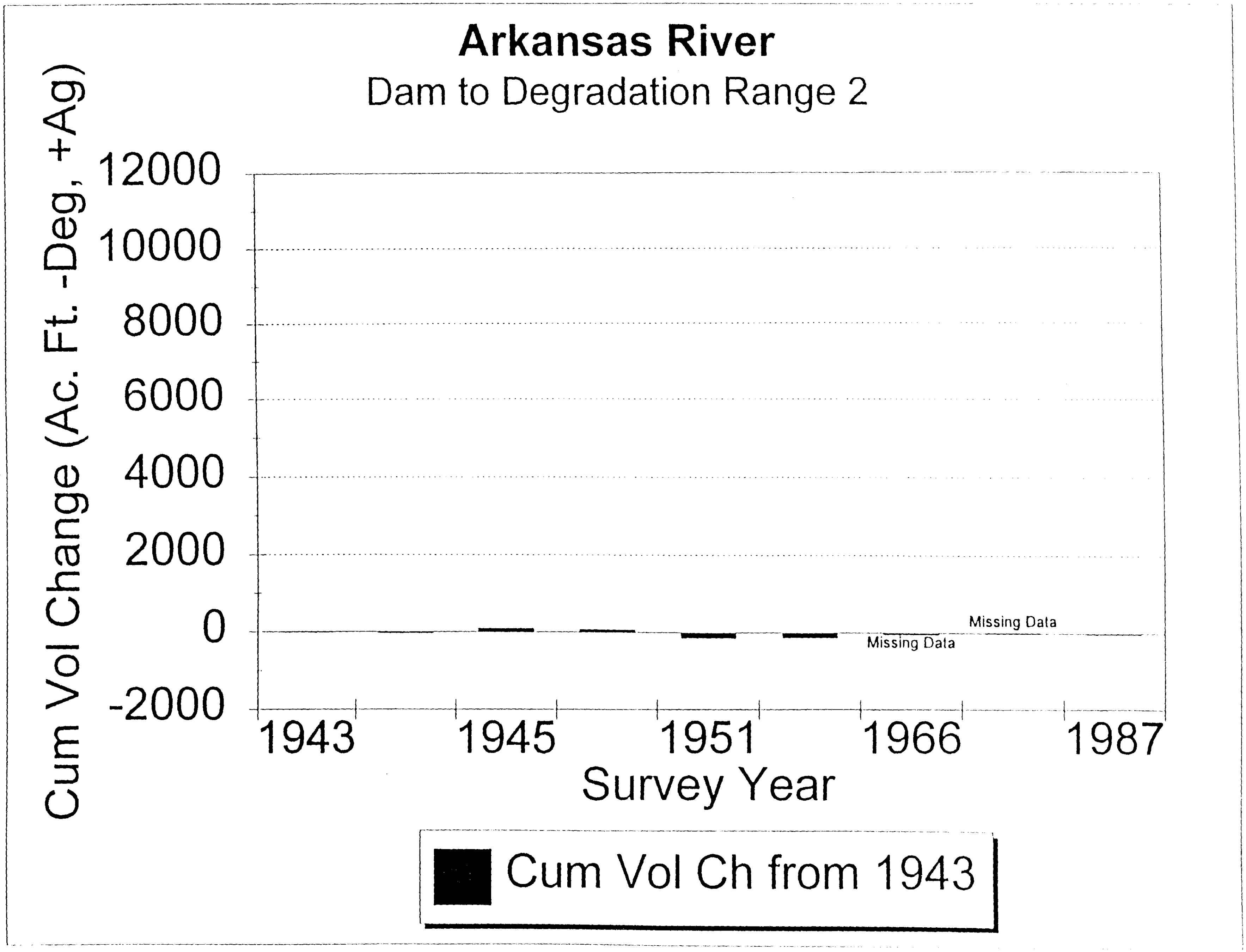
10000
8000
6000
4000
2000
0
-2000
Missing Data
Missing Data
1943
1945
1951
1966
1987
Survey Year
Cum Vol Ch from 1943


Arkansas River
Dam to Degradation Range 2
Cum Vol Change (Ac. Ft. -Deg, +Ag)
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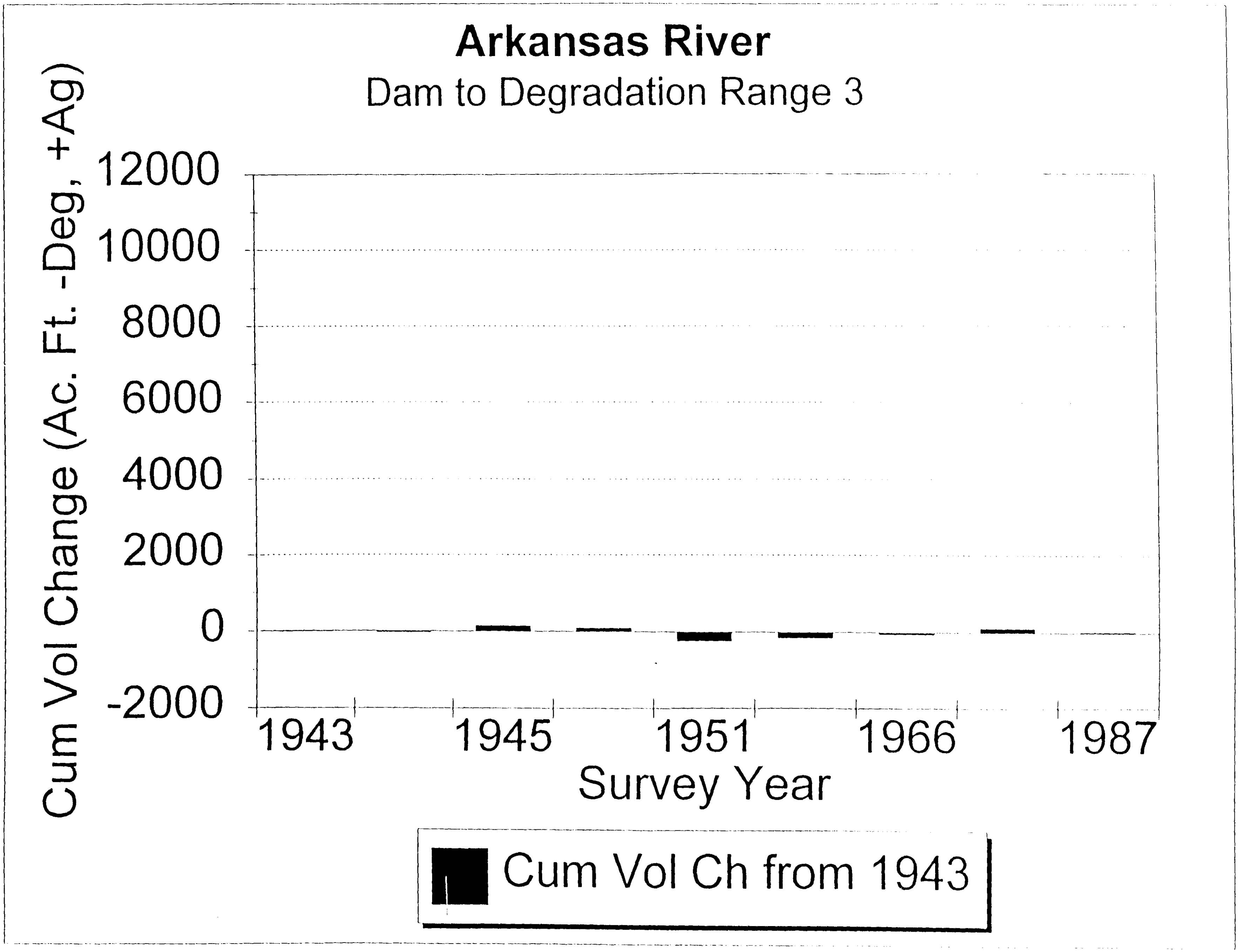
10000
8000
6000
4000
2000
0
-2000
Missing Data
Missing Data
1943
1945
1951
1966
1987
Survey Year
Cum Vol Ch from 1943



Arkansas River
Dam to Degradation Range 3
Cum Vol Change (Ac. Ft. -Deg, +Ag)
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10000
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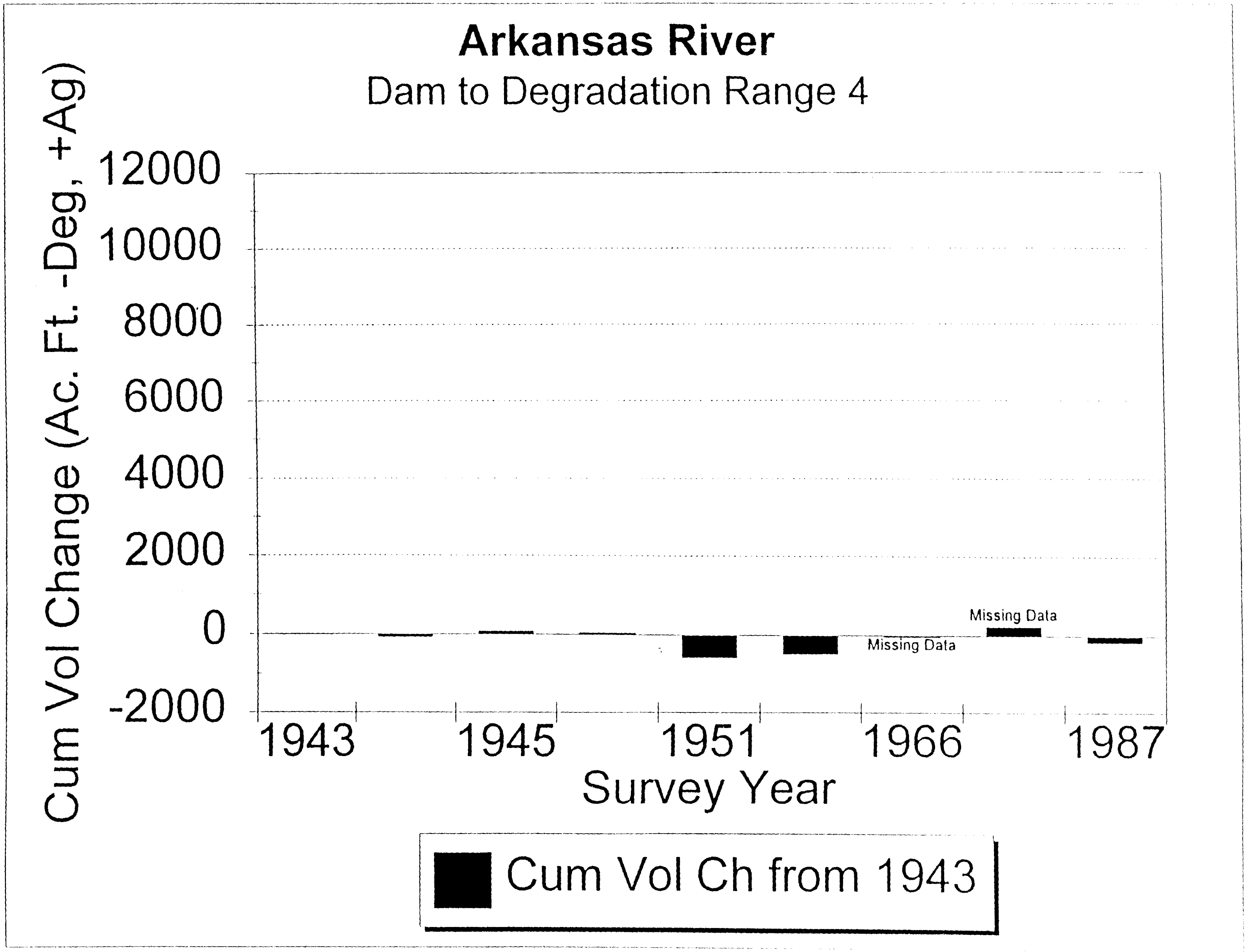
6000
4000
2000
0
-2000
1943
1945
1951
1966
1987
Survey Year
Cum Vol Ch from 1943



Arkansas River
Dam to Degradation Range 4
Cum Vol Change (Ac. Ft. -Deg, +Ag)
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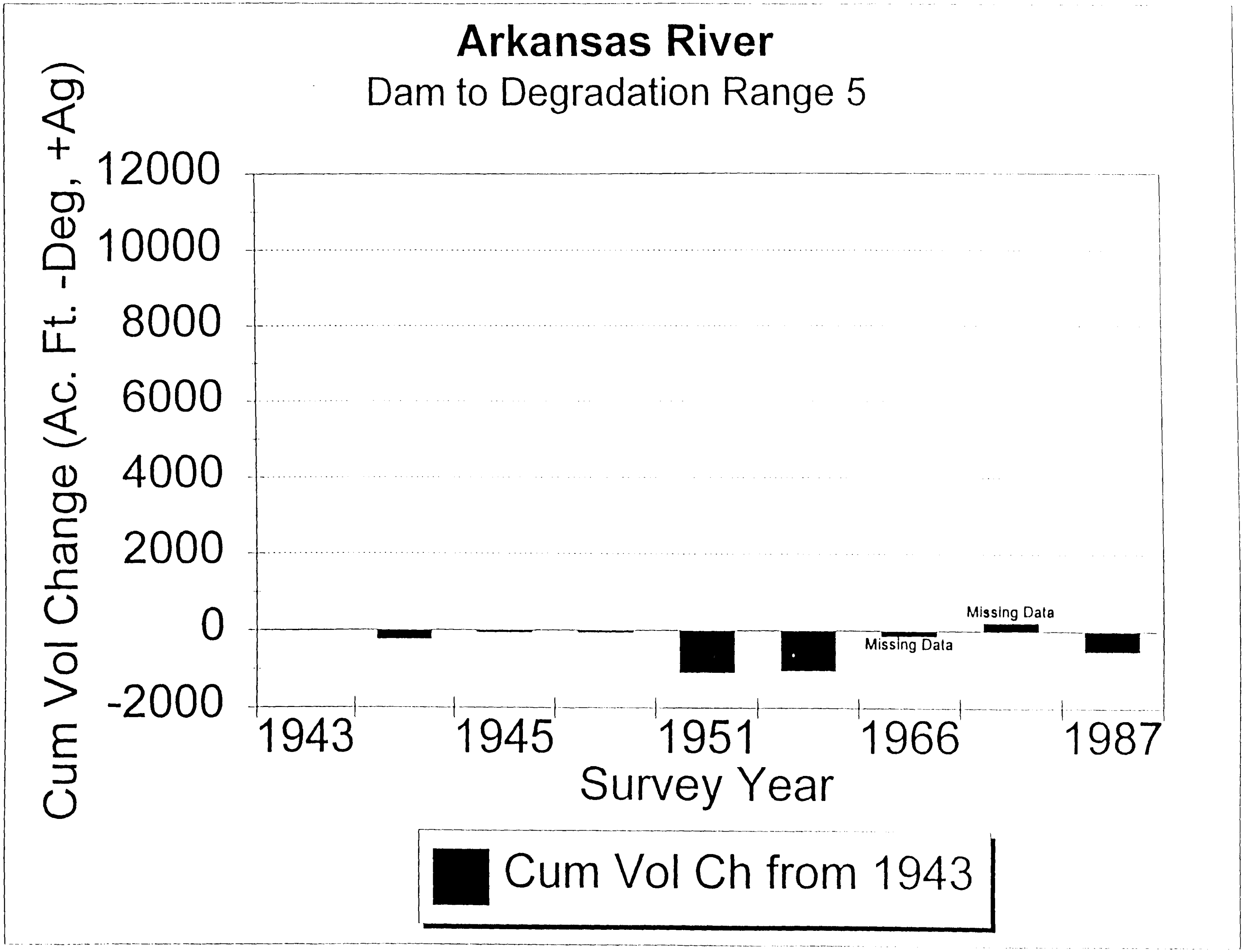
4000
2000
0
-2000
Missing Data
Missing Data
1943
1945
1951
1966
1987
Survey Year
Cum Vol Ch from 1943



Arkansas River
Dam to Degradation Range 5
Cum Vol Change (Ac. Ft. -Deg, +Ag)
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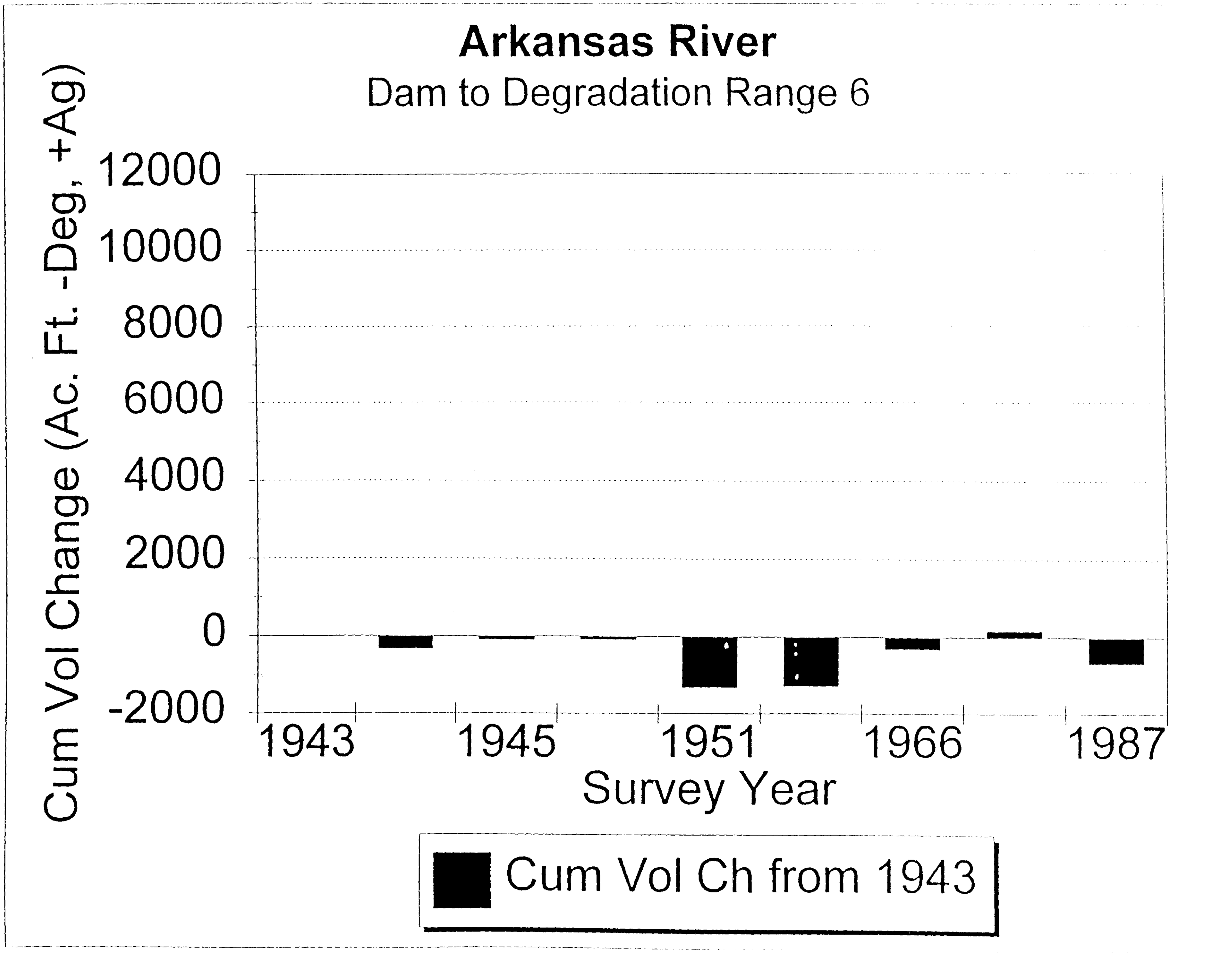
10000
8000
6000
4000
2000
0
-2000
Missing Data
Missing Data
1943
1945
1951
1966
1987
Survey Year
Cum Vol Ch from 1943


Arkansas River
Dam to Degradation Range 6
Cum Vol Change (Ac. Ft. -Deg, +Ag)
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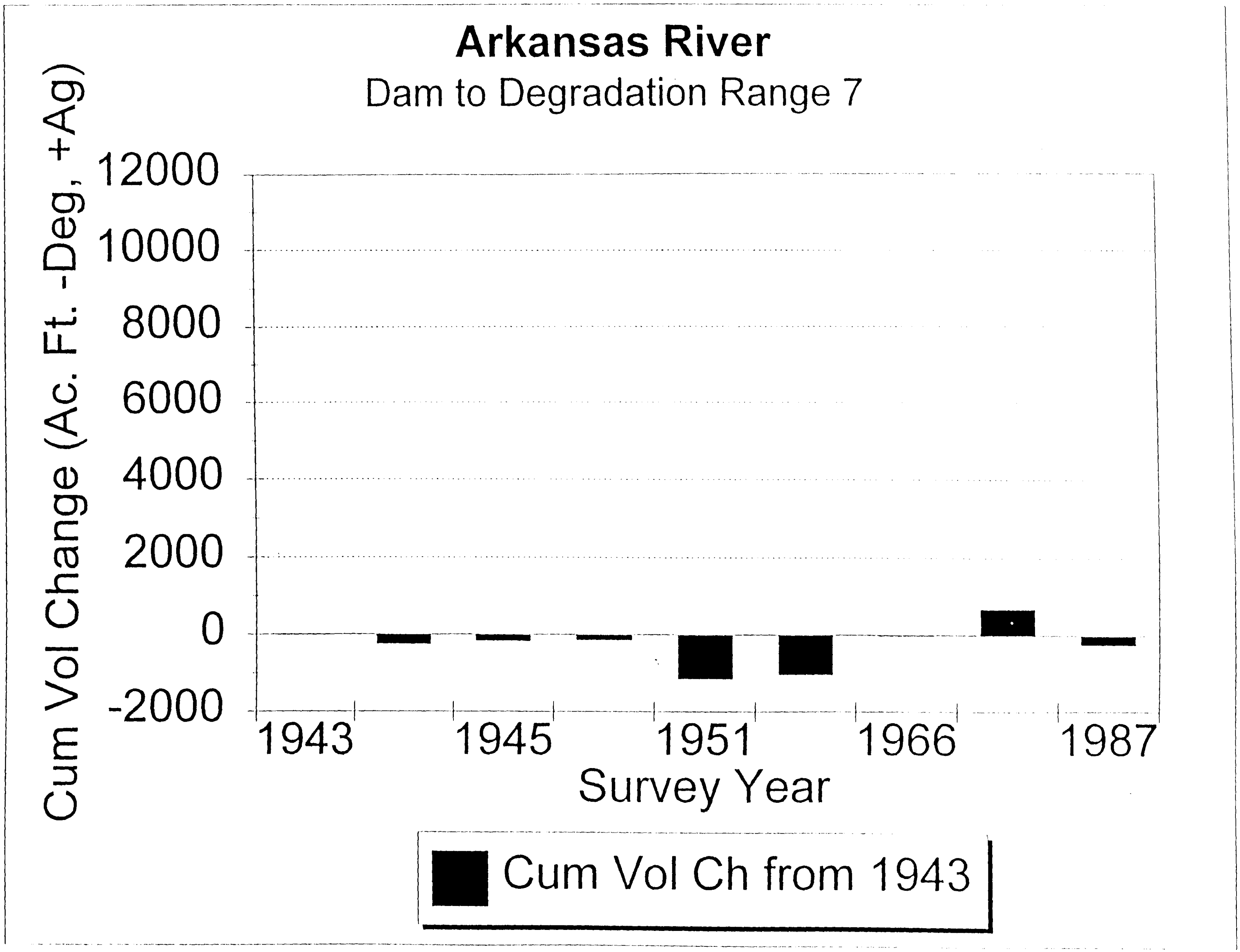
10000
8000
6000
4000
2000
0
-2000
1943
1945
1951
1966
1987
Survey Year
Cum Vol Ch from 1943


Arkansas River
Dam to Degradation Range 7
Cum Vol Change (Ac. Ft. -Deg, +Ag)
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10000
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4000
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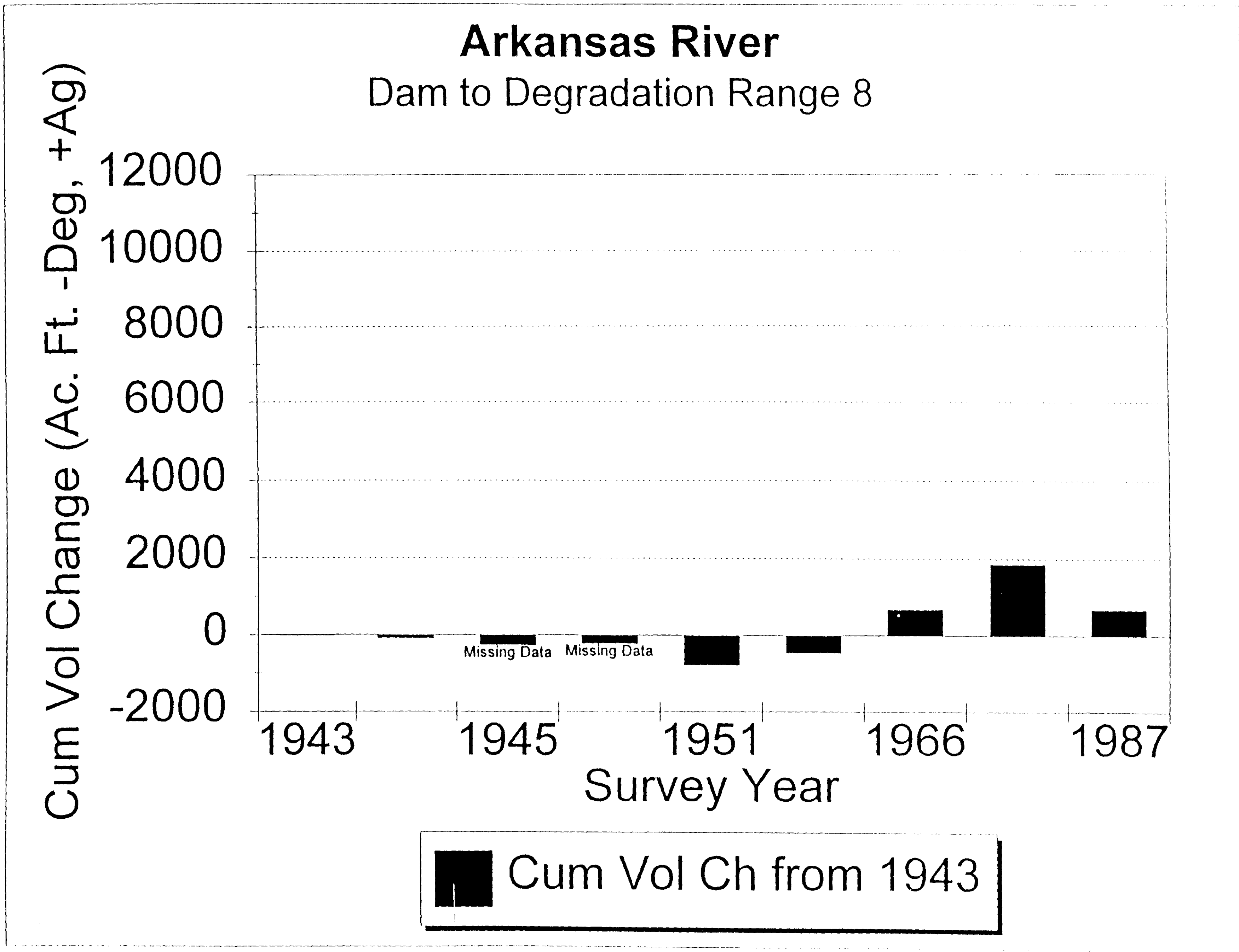
0
-2000
1943
1945
1951
1966
1987
Survey Year
Cum Vol Ch from 1943



Arkansas River
Dam to Degradation Range 8
Cum Vol Change (Ac. Ft. -Deg, +Ag)
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8000
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4000
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0
-2000
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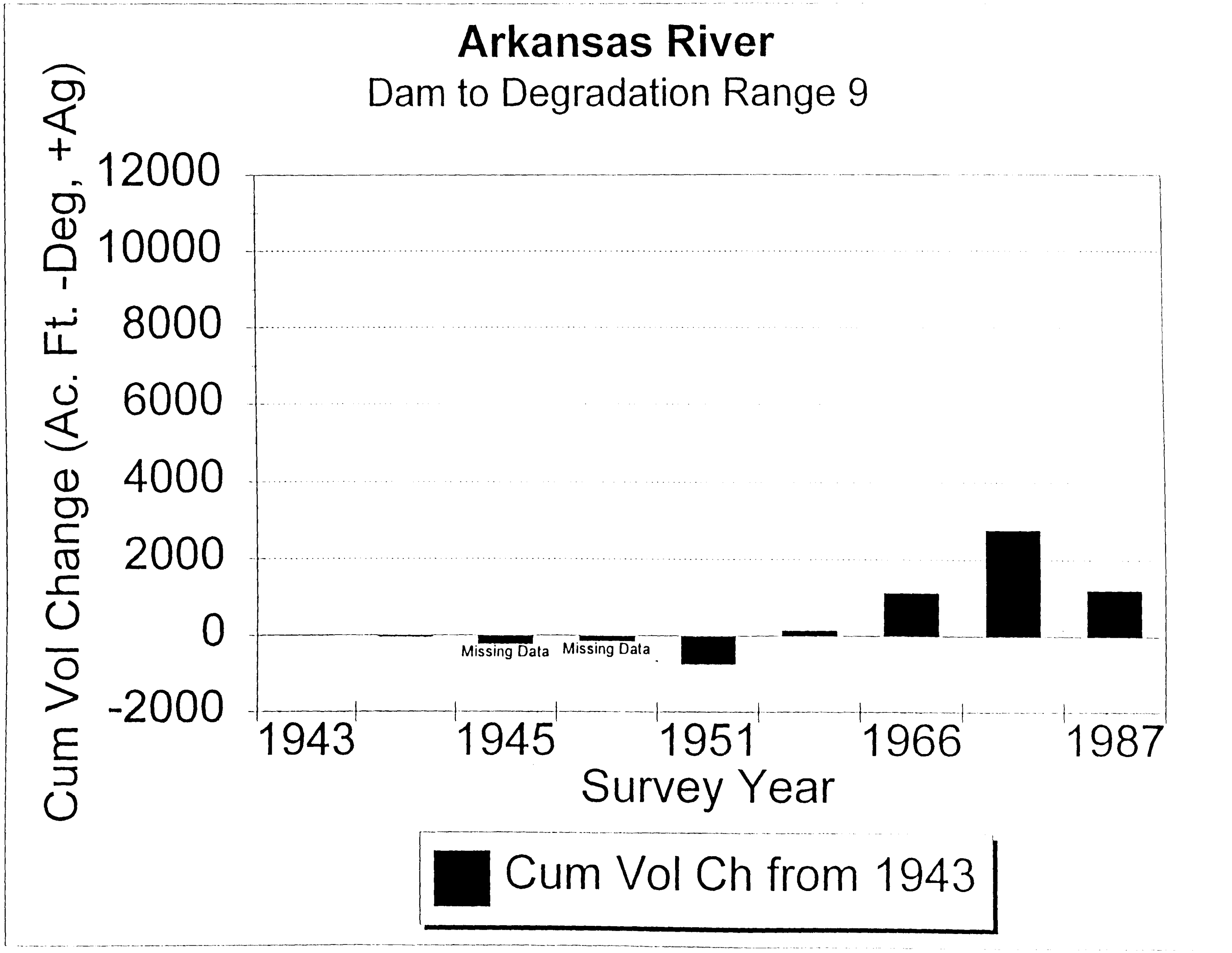
Missing Data
1943
1945
1951
1966
1987
Survey Year
Cum Vol Ch from 1943



Arkansas River
Dam to Degradation Range 9
Cum Vol Change (Ac. Ft. -Deg, +Ag)
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8000
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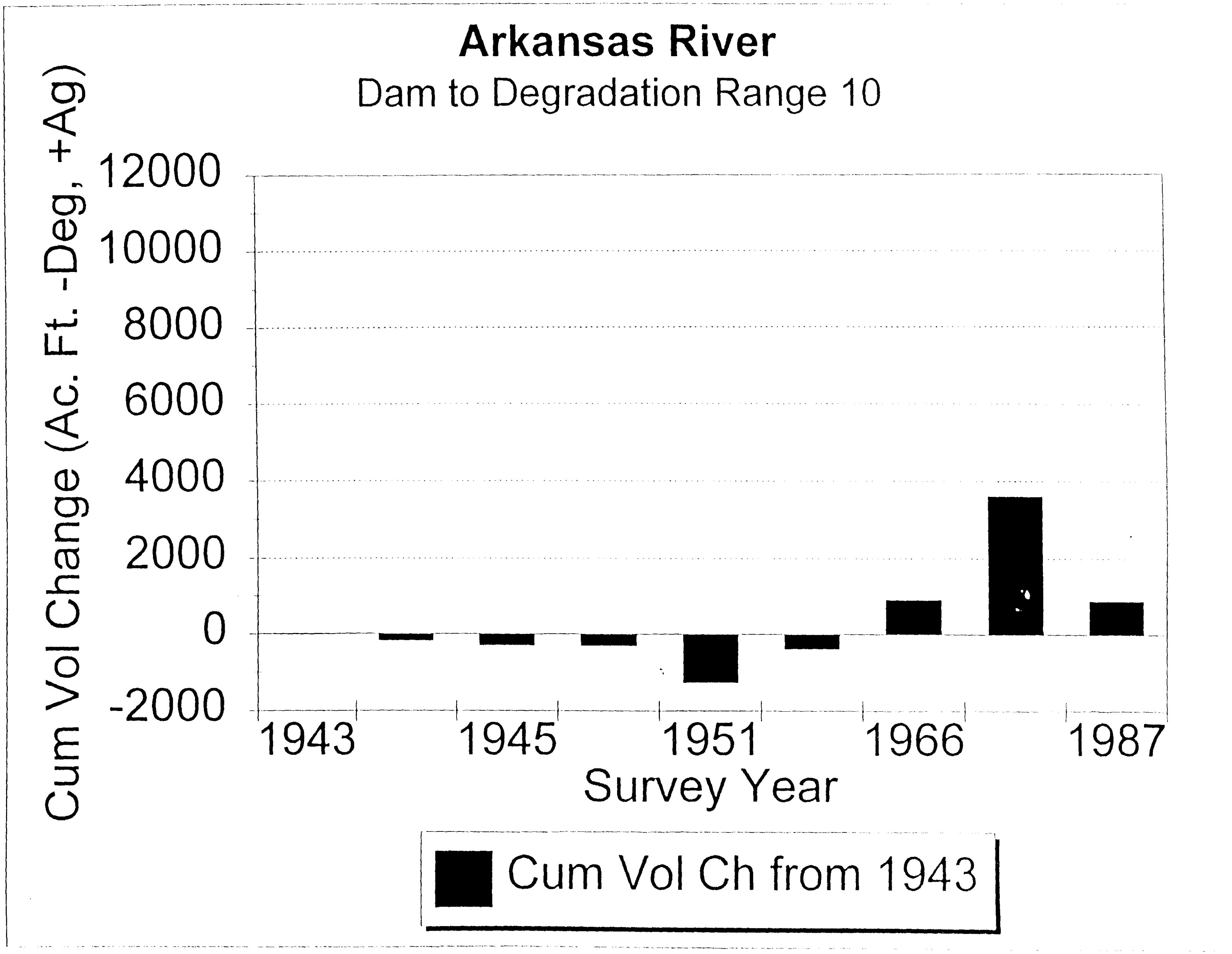
4000
2000
0
-2000
Missing Data
Missing Data
1943
1945
1951
1966
1987
Survey Year
Cum Vol Ch from 1943



Arkansas River
Dam to Degradation Range 10
Cum Vol Change (Ac. Ft. -Deg, +Ag)
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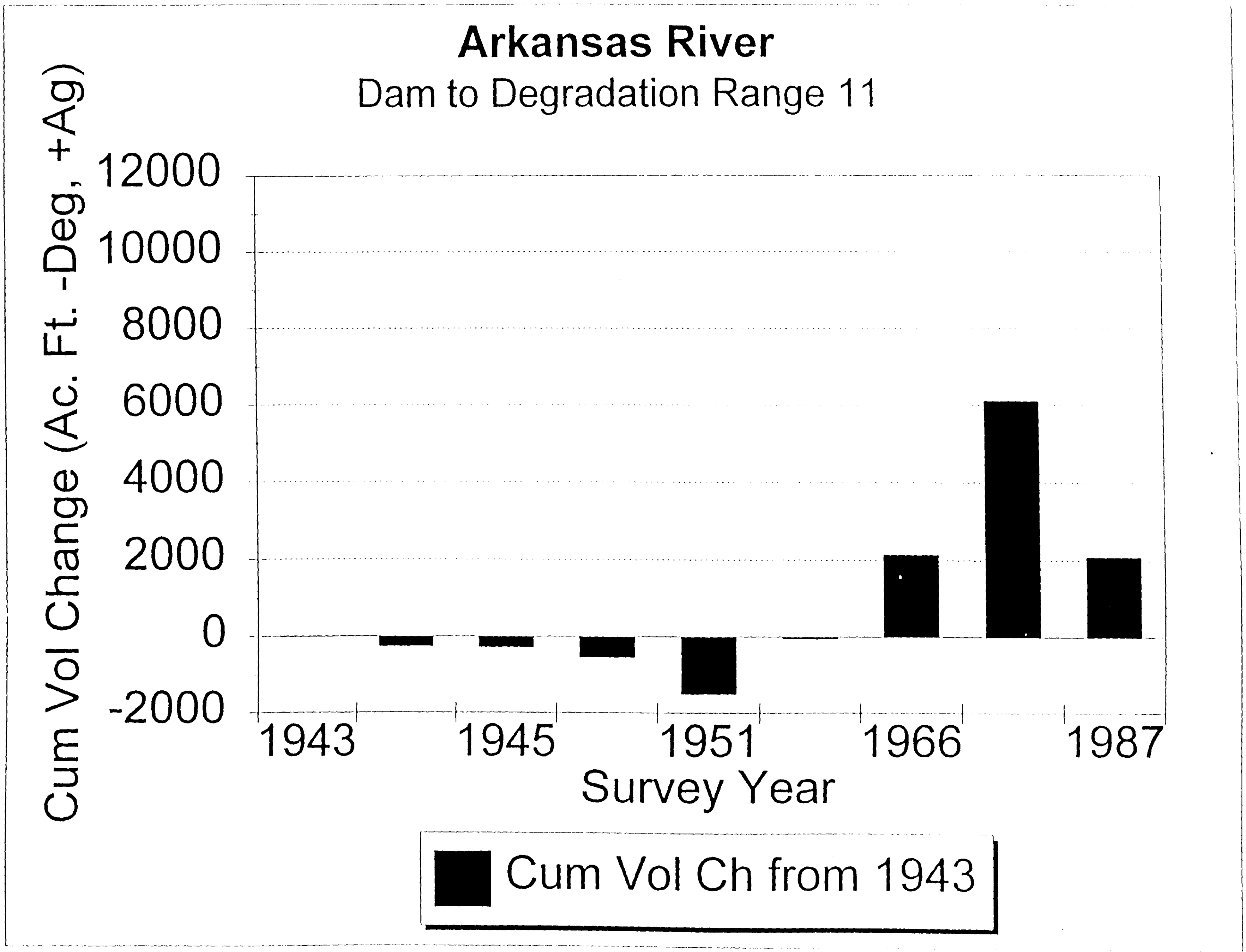
10000
8000
6000
4000
2000
0
-2000
1943
1945
1951
1966
1987
Survey Year
Cum Vol Ch from 1943


Arkansas River
Dam to Degradation Range 11
Cum Vol Change (Ac. Ft. -Deg, +Ag)
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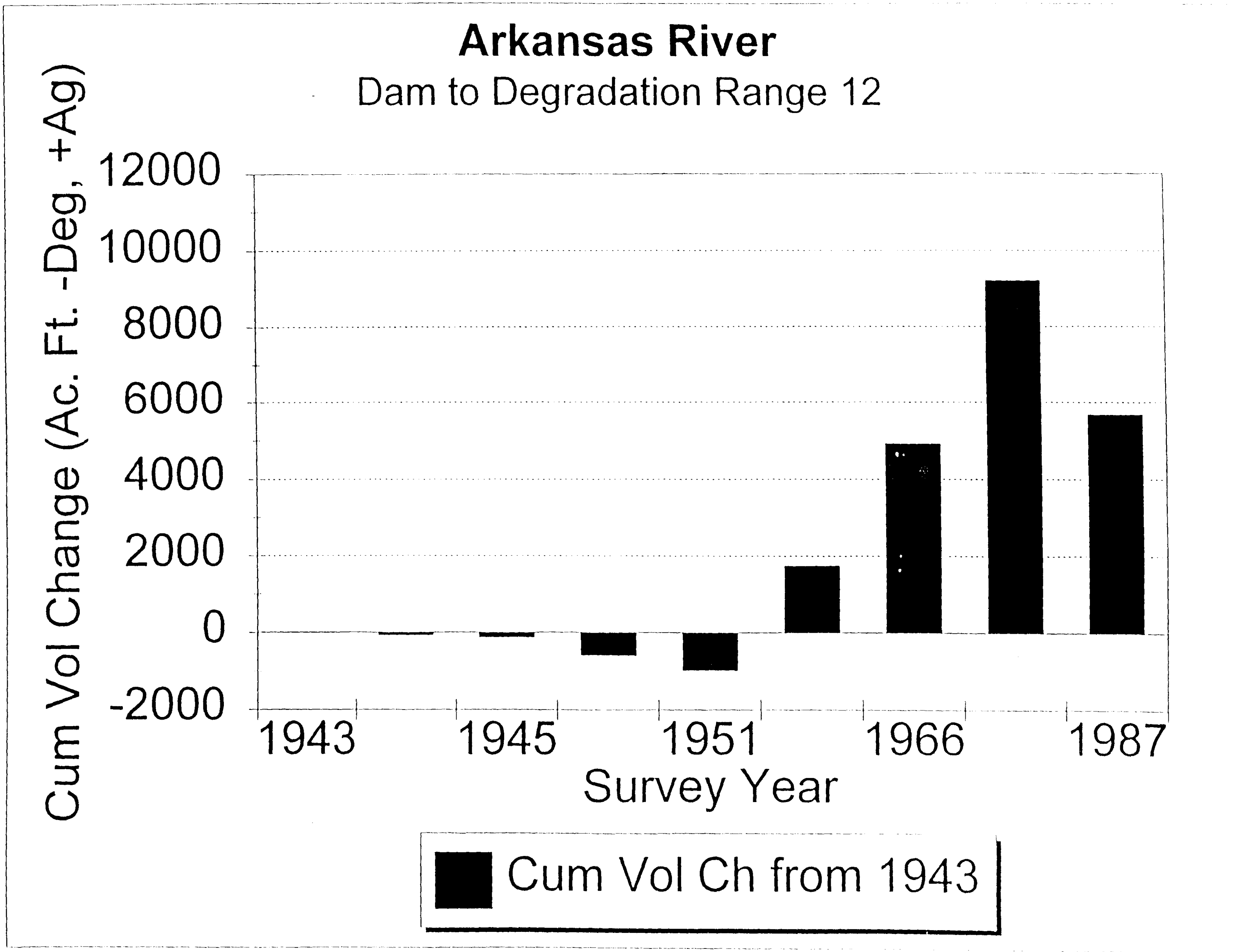
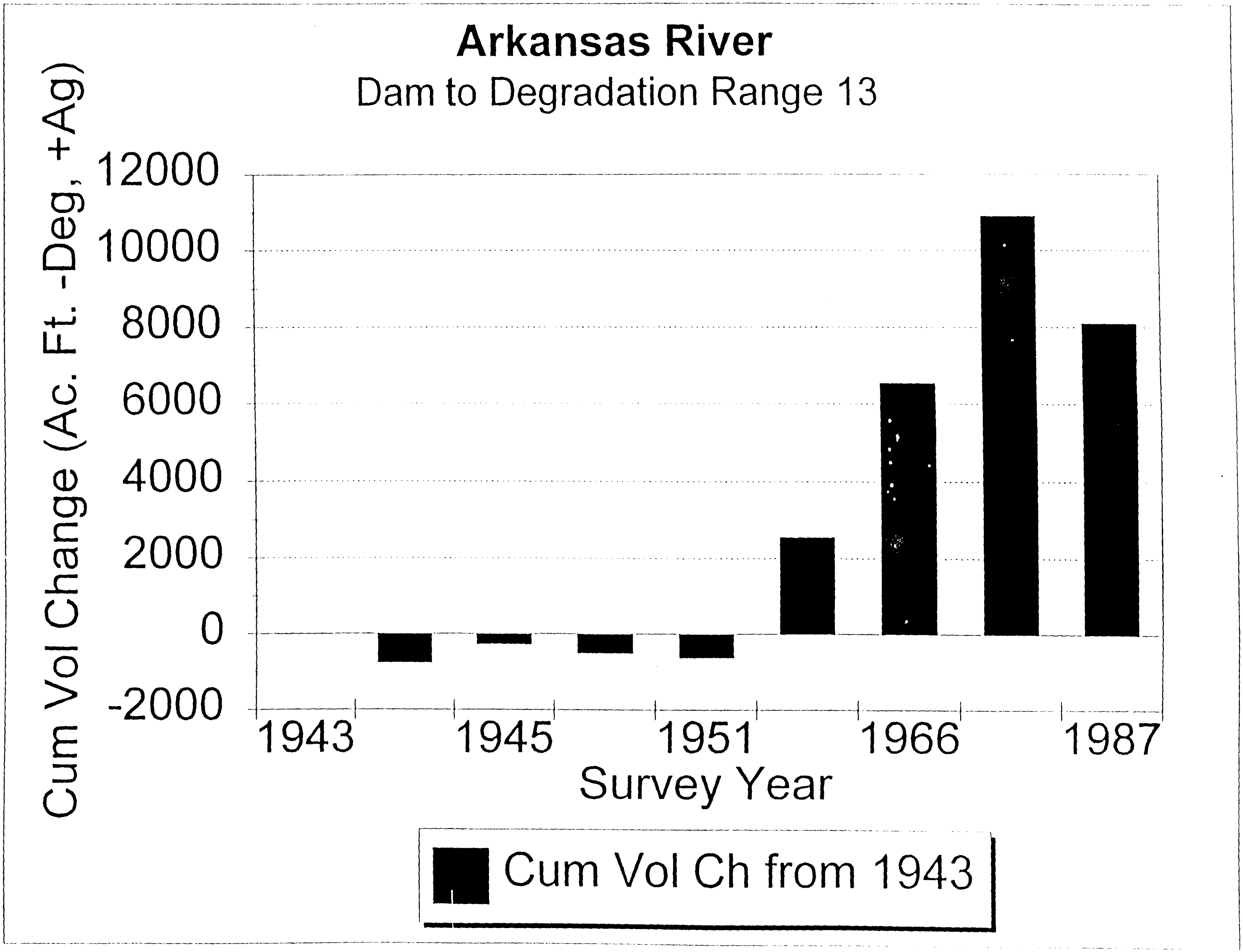
10000
8000
6000
4000
2000
0
-2000
1943
1945
1951
1966
1987
Survey Year
Cum Vol Ch from 1943


Arkansas River
Dam to Degradation Range 12
Cum Vol Change (Ac. Ft. -Deg, +Ag)
12000
10000
8000
6000
4000
2000
0
-2000
1943
1945
1951
1966
1987
Survey Year
Cum Vol Ch from 1943



Arkansas River
Dam to Degradation Range 13
Cum Vol Change (Ac. Ft. -Deg, +Ag)
12000
10000
8000
6000
4000
2000
0
-2000
1943
1945
1951
1966
1987
Survey Year
Cum Vol Ch from 1943

APPENDIX C

GEOMORPHOLOGICAL ASSESSMENT

DEPARTMENT OF THE ARMY
WATERWAYS EXPERIMENT STATION, CORPS OF ENGINEERS
3909 HALLS FERRY ROAD
VICKSBURG, MISSISSIPPI 39180-6199

REPLY TO
ATTENTION OF

CEWES-CE-R (1110-2-1403b) 07 August 1997

MEMORANDUM FOR Commander, U. S. Army Engineer District, Albuquerque ATTN: CESWA-ED-PF (Mr. Darrell Eidson) 4101 Jefferson Plaza, NE, Albuquerque, NM 87109-3435

SUBJECT: Letter Report, Arkansas River Geomorphological Assessment

1. The final letter report for the Arkansas River geomorphological assessment is enclosed. A draft copy of this report was sent to Mr. Darrell Eidson on 30 July 1997. His comments were received by phone on 31 July 1997 and have been incorporated into the final document. This letter completes our formal work on this project.

2. Thank you for the opportunity to work with you on the Arkansas River study. If you have any questions concerning this study, please contact Dr. Ronald R. Copeland at 601-634-2623.

FOR THE DIRECTOR:

James R. Houston

Encl

JAMES R. HOUSTON, PhD
Director
Coastal and Hydraulics Laboratory

ARKANSAS RIVER, COLORADO
GEOMORPHOLOGICAL ASSESSMENT

Purpose of Study

1. The purpose of this study was to identify geomorphological processes that are currently affecting the long-term hydraulic conveyance changes in a 58-mile reach of the Arkansas River downstream from John Martin Dam to the Kansas-Colorado state line. The study will aid the Albuquerque District in conducting a Planning Assistance Study which is currently ongoing with the State of Colorado. Historical documents were reviewed and a field reconnaissance was conducted. Limited hydraulic and sedimentation analyses were conducted using the SAM hydraulic design package. Recommendations are made for more detailed studies appropriate for the Planning Assistance Study.

Watershed Characteristics

2. The Arkansas River originates in the central Rocky Mountains near Leadville, Colorado, and drains about 25,400 square miles in Colorado (Figure 1). There are at least 25 mountain peaks in the upper watershed that exceed 14,000 ft in elevation. The Arkansas River is a torrential mountain stream until it emerges from central Colorado's Royal Gorge Canyon. Downstream from the canyon, at about elevation 5,300 ft, the valley gradually widens and descends through the foothills to reach elevation 4,700 ft at Pueblo, Colorado. From Pueblo to the Kansas state line the river flows across the prairie of eastern Colorado through a broad well-developed irrigated valley. The river then flows across the Great Plains through Kansas, Oklahoma, and Arkansas to the Mississippi River.

3. In addition to discharge regulation at John Martin and Pueblo Dams, natural stream flows are affected by trans-mountain diversions, storage reservoirs, irrigation diversion and return flows, groundwater extraction, and power developments along the river. John Martin Dam, which began storing water in December 1942, greatly reduced the severity and frequency of flooding in the lower Arkansas River valley. However, flooding can still occur from tributaries that enter the Arkansas River below the dam. Such a flood occurred in 1965. About 5,570 square miles of uncontrolled contributing area exists between John Martin Dam

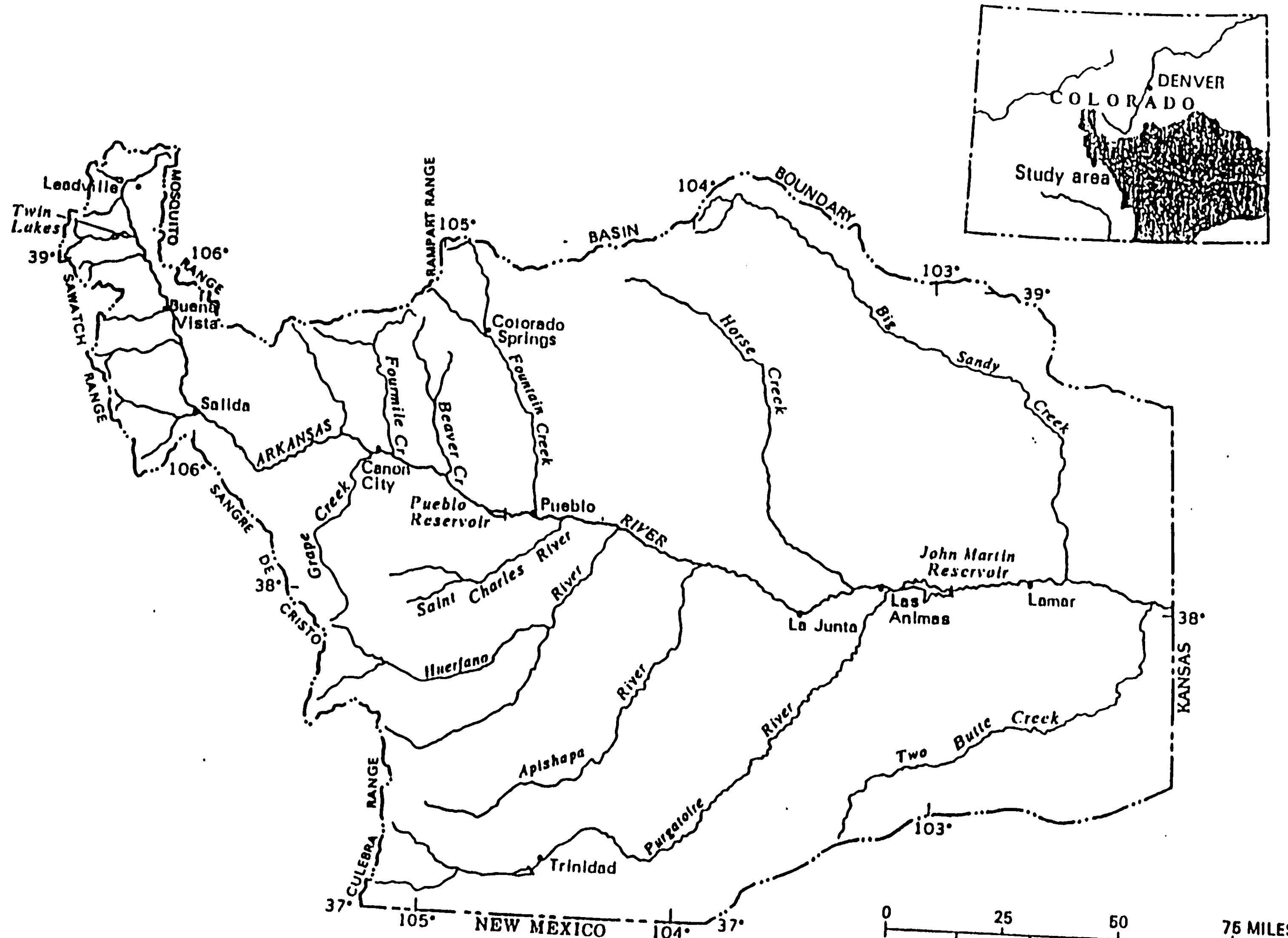


Figure 1. Location Map

and the Kansas state line. Big Sandy Creek has the largest drainage area, 3,426 square miles. However, this drainage area is characterized by significant valley storage, high infiltration, numerous non-contributing areas, and several small Soil Conservation Service flood-retarding structures. Flood peaks from the Big Sandy Creek watershed are not as great as would be expected from its size. Major contributing drainage areas between John Martin Dam and the Kansas state line are located south of the Arkansas River. These include Caddoa Creek, Mud Creek, Clay Creek, Wolf Creek, and Two Butte Creek.

Sediment Accumulation in John Martin Reservoir

4. The reduction in sediment supply to the Arkansas River downstream from John Martin Reservoir can be quantified using reservoir sediment survey data. Twelve surveys have been conducted at variable intervals between 1942 and 1980. Total accumulated sediment volume over the 38 year period is shown in Figure 2. The measured sediment accumulation is compared to annual inflow of water for the same 38 years. The annual inflow is the sum of the annual discharge from the USGS gages *Arkansas River at Las Animas* and *Purgatoire River near Las Animas*. The figure indicates a decline in sediment accumulation after about 1968. This corresponds to a general decrease in annual water runoff volume starting in 1966. This figure can be extended by conducting a new reservoir survey, or by analytical methods. Actual field measurements are preferred. Analytical methods should be verified using the historical data. Extending the sediment accumulation data is recommended for the detailed geomorphological assessment. Extending the sediment accumulation record and comparing the results with annual runoff volumes will help identify long-term trends upstream from the dam. These data can be used to establish a base condition downstream from the dam for comparison purposes.

Historical Changes in the Streambed

5. Geomorphological changes on the Arkansas River between 1870 and 1977 were reported by Nadler (1978). He identified changes in three distinctive reaches using historical mapping through 1952 and measurements in 1977. The first reach was upstream from John Martin Reservoir between La Junta and Las Animas. The second reach was downstream from John Martin Dam, starting six miles upstream from Lamar and extending downstream for about 22 miles. The third reach covered the first 20 miles upstream from the Kansas state line. He compared bankfull widths at specific cross sections over time and calculated averages for each reach. In the first reach, upstream from the reservoir, the average bankfull width

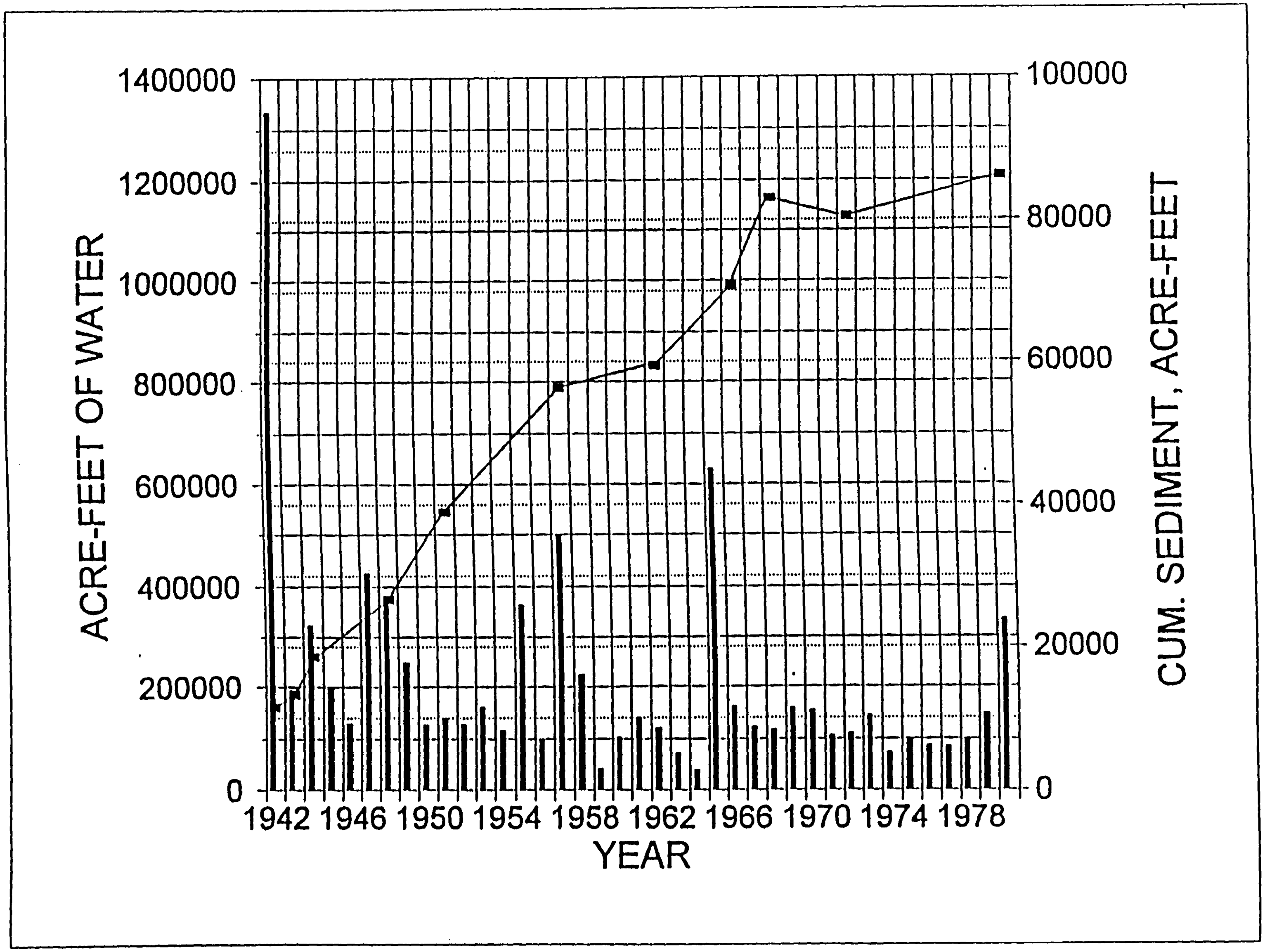


Figure 2. Accumulated sediment deposition and average annual inflow, John Martin Reservoir

increased from about 575 ft to 700 ft (23 percent) between 1870 and 1892. There were considerable deviations from the average at individual cross sections, and widening did not occur at every section. In this first reach the average width remained constant between 1892 and 1926 although changes occurred at individual cross sections. Between 1926 and 1952 the average width decreased significantly to an average of about 150 ft. No clear trend was observed between 1952 and 1977. A similar widening and then narrowing trend was observed in the second reach. Average bankfull width increased from 700 ft to 1160 ft (65 percent) between 1870 and 1892. Significant increases in width occurred at each cross-section. Then between 1892 and 1926 the average bankfull width decreased to 475 ft. Narrowing continued at each cross section through 1952, when the average bankfull width was 180 ft., and through 1977 when the average bankfull width was 100 ft. In the third reach the 1870 average bankfull width was reported to be 1230 ft. A continuous narrowing of the bankfull width was reported for this reach. However, there is an error in the reported bankfull widths for 1892, so that it is uncertain whether the actual average should indicate narrowing or widening. In any event there was a definite narrowing trend continuing through 1926 (850 ft), to 1952 (450 ft), and finally to 1977 (90 ft).

6. In addition to channel width changes, Nadler documented planform changes. In reach 1 the river changed from braided to meandering. In reach 2 the river changed from braided to a narrow straight stream.

7. Nadler attributed changes in the river channel to the following:

a. Irrigation improvements. This includes smoothing of the annual hydrograph due to storage and release of irrigation water, and reduction in sediment load due to abstraction into irrigation canals and due to John Martin Dam. Irrigation improvements caused the river to become a perennial stream instead of an intermittent stream. Annual flow was also increased due to diversions from other watersheds.

b. Introduction of salt cedar into the river basin in 1926, followed by a rapid increase in population of this exotic species between 1936 and 1957. Vegetation along the banks resists erosion and induces deposition.

c. The severe drought that occurred between 1924-1939 caused a decrease in mean annual discharges, allowing the establishment of vegetation along banks and in locations that normally would have been below the mean high water level. At the same time irrigation allowed for perennial flow and sufficient moisture to sustain dense vegetative growth.

8. Thirteen sediment ranges have been established downstream from John Martin Dam by the Corps of Engineers. These ranges extend about 23 miles to Lamar. The ranges have been surveyed at varying intervals between 1944 and 1987. In general, the surveys indicate degradation and narrowing of the river channel. Degradation of the river thalweg averages about 3 feet for the first 16 miles downstream from the dam. Aggradation occurred at ranges located 18 and 20 miles downstream from the dam. This may be related to a cutoff that occurred upstream from these two ranges. Degradation was recorded at the final range which is located 23 miles downstream from the dam. The surveys also indicate a narrowing of the channel caused primarily by deposition in the old channel. The surveys also indicate that this channel adjustment occurred over a period of years, moving steadily downstream. The surreys indicated the following:

a. Through 1951 the first eight miles downstream from the dam adjusted by deposition in a portion of the main channel and degradation in another part of the channel resulting in a narrower and deeper channel. The remaining fifteen miles adjusted primariiy by aggradation on the sides and/or in the middle of the channel. The most downstream ranges adjusted only slightly.

b. Deposition on the sides and/or middle of the channel accompanied by degradation continued through 1962 in the first eight miles downstream from the dam, and the same trend was initiated in the next seven miles. The remaining eight miles adjusted primarily by aggradation.

c. During the next four years, through 1966, trends for deepening and narrowing continued in the first fifteen miles. Downstream for the next eight miles the channel adjusted primarily by aggradation on newly formed bars or along the channel sides resulting in a narrower channel.

d. The 1972 survey indicated a trend reversal at most of the ranges. Aggradation occurred throughout the 23-mile reach. At ranges upstream and downstream from Caddoa Creek (located 2.5 miles downstream from John Martin Dam) the channel aggraded back to pre-dam elevations.

e. The last survey was taken in 1987 and indicated that the 1972 changes were temporary. The channel was generally narrower and deeper than in 1966 for the 17 miles downstream from the dam. The range located about 18 miles downstream from the dam remained an anomaly. It aggraded significantly between 1951 and 1962 and thereafter remained essentially stable, showing no trend for narrowing. The two downstream ranges indicated channel narrowing due to aggradation through 1987 with main channel degradation at the most downstream range and main channel aggradation at the other.

9. The historical survey data clearly demonstrates a trend for channel narrowing. This trend has been documented both upstream and downstream from John Martin Dam. Therefore, narrowing of the river channel between John Martin Dam and the Kansas state line cannot be totally attributed to construction of the flood control reservoir. As suggested by Nadler (1978) increasing vegetation along the banks is probably the most significant factor causing the narrowing. However, the survey ranges downstream from the dam indicate a continuing degradation and narrowing trend after construction the dam through 1987. This trend was not documented in the Nadler study. It is recommended that the ranges reported by Nadler be resurveyed to assess changes through 1997. Further it is recommended that the 13 ranges downstream from John Martin Dam be resurveyed to document recent changes in this reach.

Field Reconnaissance

10. A field reconnaissance of the Arkansas River was conducted 30 April through 1 May 1997. The river channel was observed at several locations upstream and downstream from John Martin Dam. River widths were observed to be highly variable. Based on limited site observations it appeared that generally, existing river widths upstream from John Martin Reservoir were greater than downstream. In most observed cases, the banks were heavily vegetated. Sites where vegetation had been washed out had active bank erosion and were wider. Bank erosion of unprotected banks was observed both upstream and downstream from the dam, indicating that even with the dam in place, it is possible to attain discharges and velocities sufficient to wash out bank vegetation. Figures 3 and 4 show contrasting channel widths at two locations downstream from John Martin Dam. Longitudinal frequency of bank failures upstream and downstream from the dam can be documented by more extensive field work or by inspection of aerial photography.

11. During the field reconnaissance bed-material samples were collected at five sites on the Arkansas River and from two tributaries. The river bed was found to consist primarily of medium to coarse sand. Bed-material gradations are shown in Figure 5. Two samples were collected upstream from John Martin Reservoir -- one at Brent's Old Fort Historical Site and one at the Highway 207 bridge, which is located about 30 miles further upstream. These samples indicated a median grain size of about 0.45 mm. Samples collected downstream from the dam were coarser. The median grain sizes decreased in a downstream direction. Down-

Figure 3. Arkansas River, 1.5 miles upstream from Colorado Highway 385 Bridge, looking downstream, April 1997.

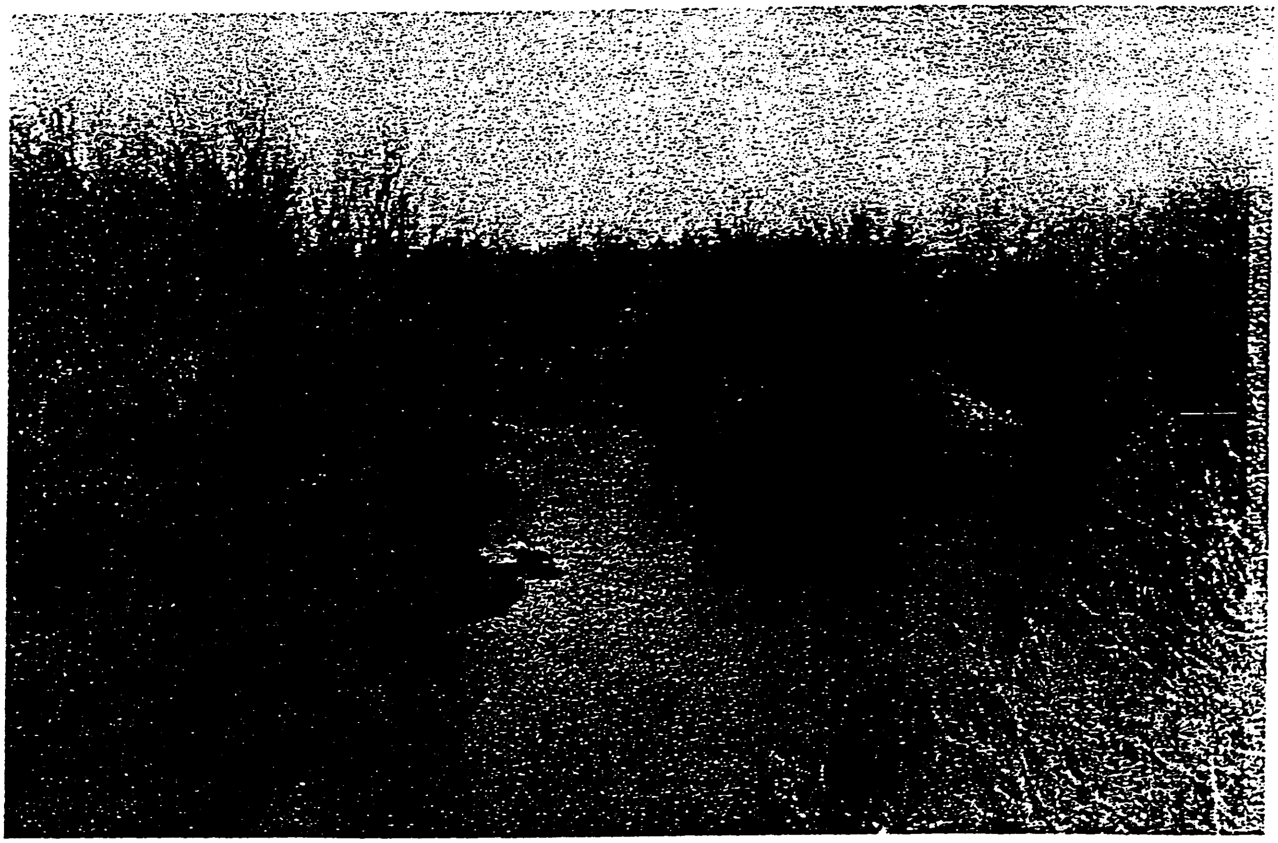


Figure 4. Arkansas River, 4.2 miles downstream from Lamar, Colorado, bridge, looking upstream, April 1997.

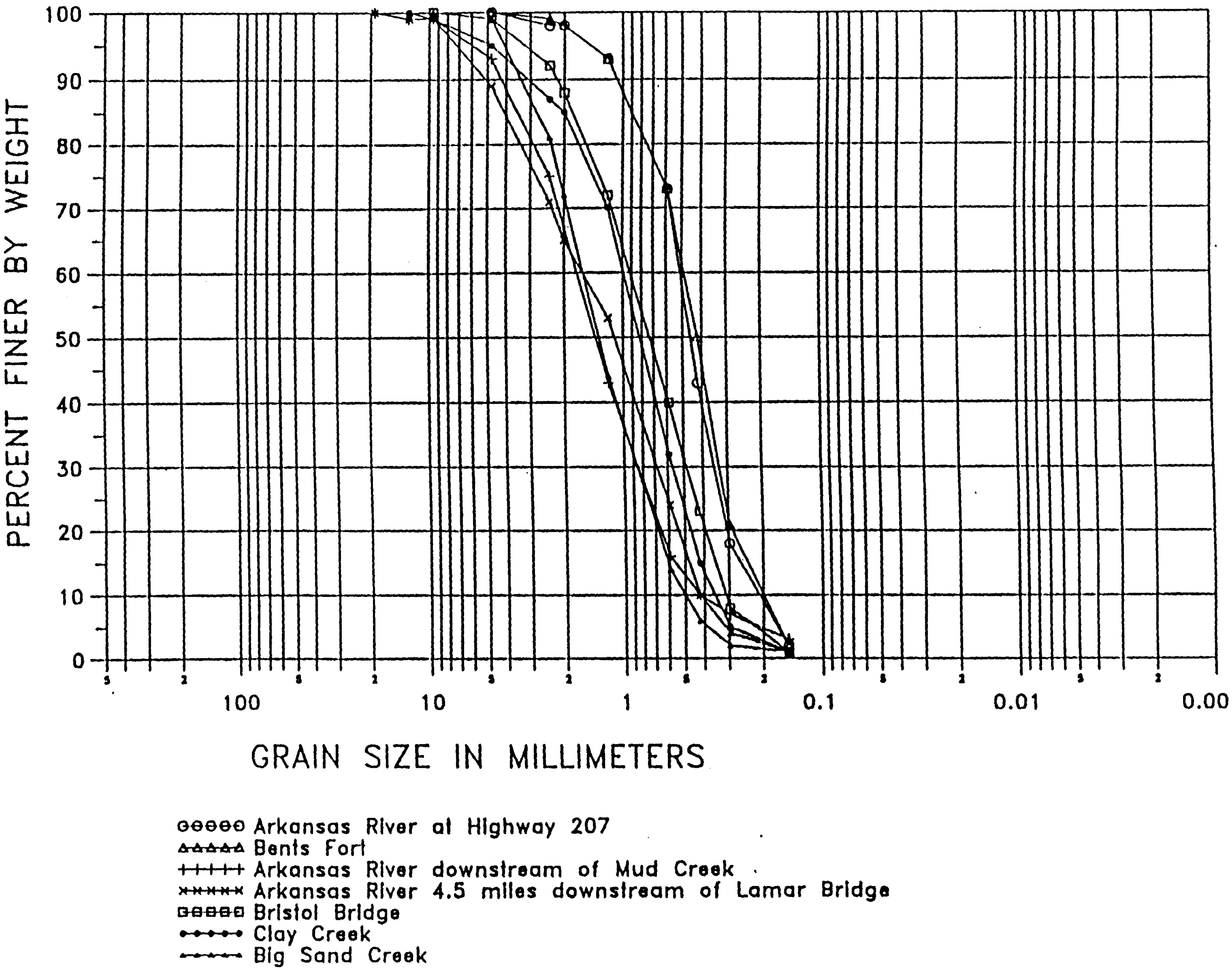


Figure 5. Bed gradations, Arkansas River and tributaries near Lamar, Colorado, April 1997.

stream from the Mud Creek confluence (5 miles downstream from John Martin Dam) the median grain size was about 1.5 mm. Four miles downstream from the Lamar bridge (26 miles below John Martin Dam) the median grain size was about 1.2 mm. At the Highway 385 bridge (44 miles downstream from John Martin Dam) the median grain size was about 0.75 mm. It can be concluded that the bed of the Arkansas River is coarser due to sediment storage in John Martin Dam.

Hydraulic and Sedimentation Analysis

12. Regulation of Arkansas River flows may have significantly effected the channel-forming discharge and thus the stable bankfull width of the channel. The channel-forming discharge can be assumed to be the same as the effective discharge. The effective discharge can be determined by integrating the average-annual flow-duration curve with a bed-material sediment discharge rating curve and then identifying the discharge increment which conveys the most bed-material sediment load.

13. A preliminary analysis was made for this study to assess the significance of changing the channel-forming discharge. The USGS streamgage *Arkansas River at Lamar* was chosen to make the comparison. 83 years of mean daily flow records are available at this gage. Average-annual flow-duration curves were developed from these data for the years 1913 -1943, representing pre-dam conditions, and 1948-1996, representing post-dam flow characteristics. The two flow duration curves are displayed in figure 6. Range 8 which is located about 12 miles downstream from John Martin Dam was chosen as a representative river cross-section for the preliminary analysis. A more detailed analysis would include analyses of additional ranges. Hydraulic parameters were calculated for the surveyed geometries in 1945 and 1987. A roughness coefficient of 0.035 was assigned to the channel. In the 1987 cross-section a roughness coefficient of 0.050 was assigned to the channel berm or bar. The appropriateness of this assumption should be confirmed in the field. Also to be confirmed in the field is whether or not the 1987 berm is capable of transporting sediment or if it is just a sediment deposition feature. In this analysis it was assumed to not transport sediment. Bed-material sediment transport rating curves were developed for 1945 and 1987 conditions using the Yang sediment transport equation. An average bed-material gradation determined from the two samples collected upstream from John Martin Reservoir was used for the 1945 condition. The bed-material gradation taken downstream from the Mud Creek confluence was used for the 1987 condition. The integrated results are shown in Figure 7 and show that significant channel-forming flows have noticeably decreased in magnitude. The preliminary analysis indicates that the channel-forming discharge prior to construction of the

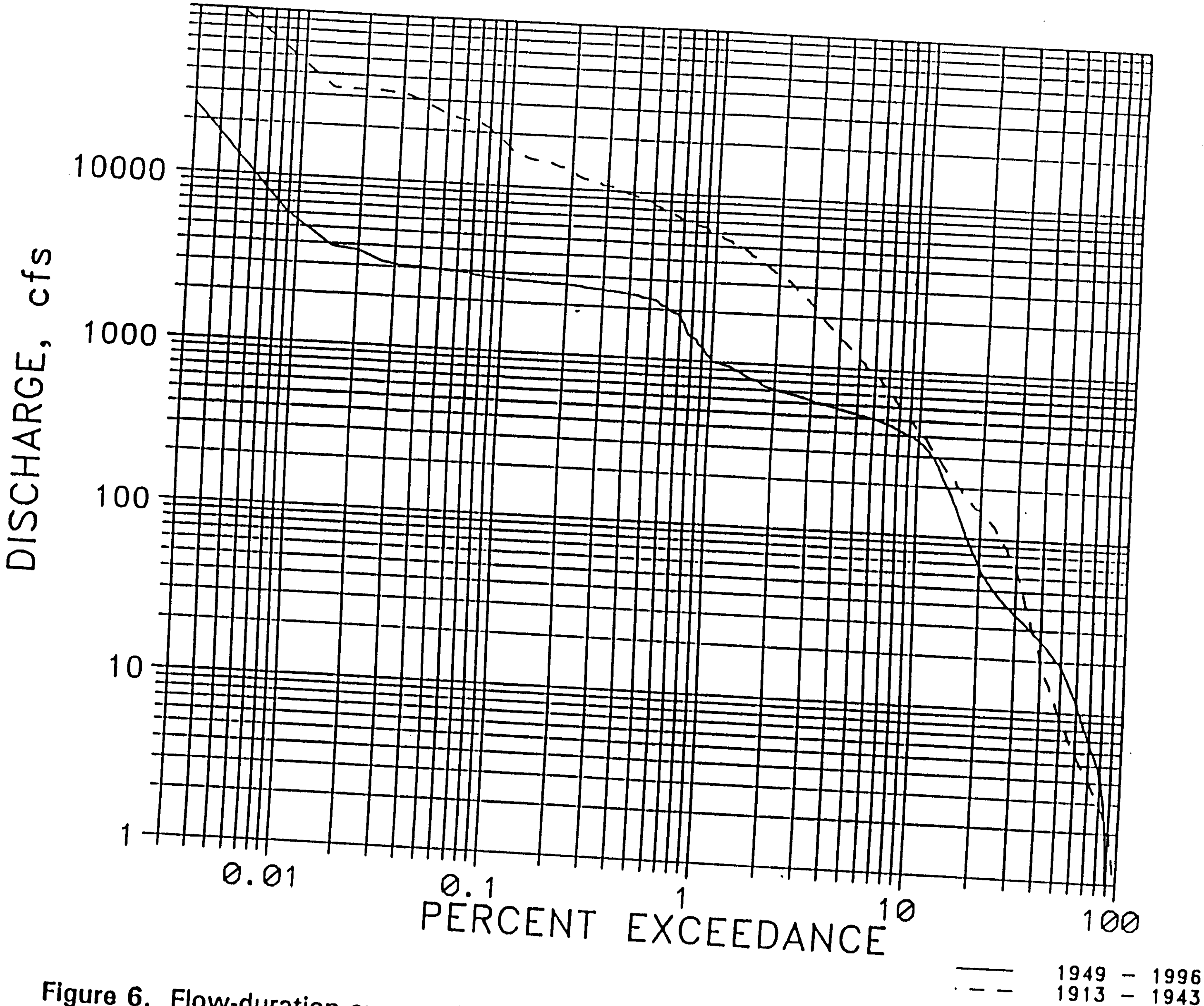


Figure 6. Flow-duration curves, Arkansas River at Lamar, Colorado.

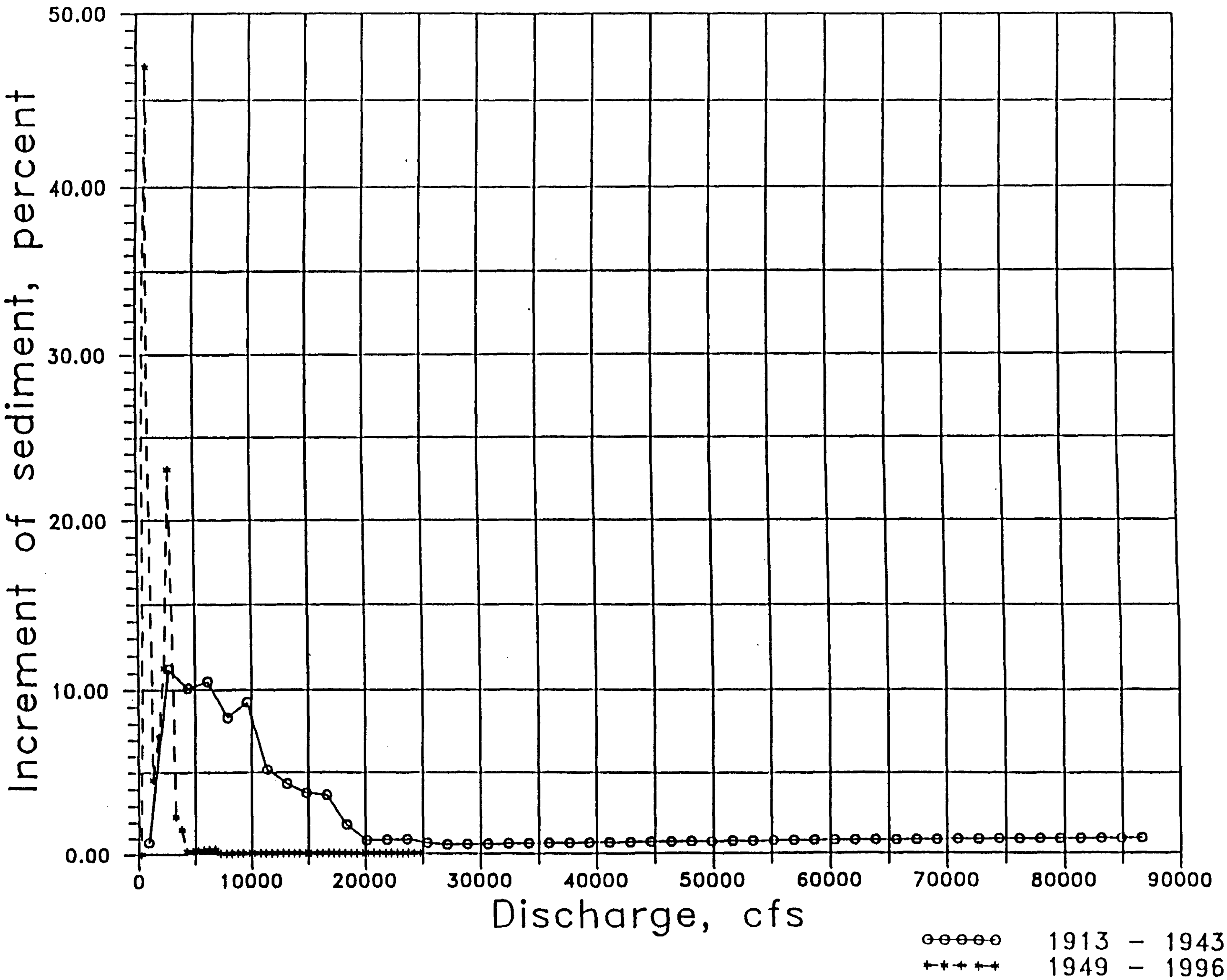


Figure 7. Sediment yield curves, Arkansas River near Lamar, Colorado.

dam was about 3000 cfs. A frequency curve should be checked to see if this is a reasonable value. The analysis suggests that post-dam conditions have produced a much smaller channel-forming discharge of 800 cfs. A second peak in the sediment yield curve occurs at 3000 cfs. This could help explain the formation of the two stage compound channel at Range 8 and at other ranges.

14. Hydraulic geometry theory states that the bankfull width varies directly with the channel- forming discharge according to the following relationship.

$$Width = a\ Q^{0.5}$$

Where a is a coefficient governed by the bank characteristics. Assuming that bank characteristics are not influenced by the dam, the hydraulic geometry relationship indicates that reducing the channel-forming discharge would also result in a reduction in channel width.

15. The formation of a two-stage channel complicates the preceding analysis. If it is determined that sediment transport occurs on the bar of the existing channel then separate hydraulic and sediment transport calculations are needed for the channel and the bar which then need to be combined to obtain a total bed-material sediment discharge rating curve for the cross-section. Bed-material gradation, roughness, and hydraulic parameters will be different for the two sections of the channel.

Recommendations

16. Additional data collection is recommended to update existing information. A new reservoir survey is recommended to determine sediment accumulation behind John Martin Dam since 1980. It is recommended that the survey ranges downstream from John Martin Dam be resurveyed to determine changes since 1987. In addition, an attempt should be made to locate the cross-sections identified by Nadler in his thesis and determine existing channel widths. This is especially important for documenting conditions upstream from John Martin Reservoir and downstream from the Lamar bridge. It is recommended that bed-material gradations be collected when the surveys are conducted to supplement the data collected during the field reconnaissance. It is recommended that bank conditions also be recorded at each surveyed cross-section. This would include a sample of the bank material to determine the percentage of clay and silt in each bank and a visual determination of the quantity and type of vegetative cover in the vicinity.

17. A backwater model (HEC-2 or HEC-RAS) can be developed to determine the effect of cross-section variability on hydraulic parameters. Note that HEC-RAS output files are not compatible with SAM.

18. Suspended-sediment data from gages upstream from John Martin Reservoir on the Arkansas River and the Purgartoire River can be used to help determine which sediment transport equation is appropriate for use in determining the sediment-discharge rating curves. It is important that bed-material gradation at the gages be determined so that the wash load fraction can be established and wash load can be subtracted from the measured suspended sediment data.

19. Using data collected from the new field surveys, the width vs. channel-forming discharge relationship can be used to assess the effect of the dam on stable channel width. Additional analyses, similar to the preliminary analysis conducted for this study, should be conducted for several of the historical ranges to determine possible variability in channel-forming discharge due to cross-section geometry. Discharge variability in the 58-mile reach downstream from John Martin Dam can be determined by developing flow-duration curves from other gages. The coefficient for the hydraulic geometry relationship will vary depending on the bank characteristics. Using field observations, different values for the coefficient can be established for different conditions, e.g. percent silt and clay and/or percent vegetative cover.

20. The channel-forming discharge and the hydraulic geometry relationships can be used to design a stable channel geometry and an appropriate management strategy. Although not part of a geomorphological assessment, a hydraulic analysis should be conducted to insure appropriate conveyance capacity for irrigation delivery and floods.

Conclusions

21. The principle geomorphological processes that seem to be affecting channel development of the Arkansas River downstream from John Martin Dam are increased growth of vegetation along the banks and on channel berms or bars, and a decrease in the channel-forming discharge. The increase in vegetation is supported by several decades of increasing availability of water in the channel due to the increased irrigation supply, of which John Martin Dam is a part. The dam also reduces the occurrence of major flood peaks, flood peaks that would have provided erosive forces sufficient to wash out significant reaches of vegetative encroachment.

22. Recommendations for additional data collection and analyses were made for a more detailed geomorphological assessment. These include new surveys of John Martin Reservoir and established ranges, and documentation of existing bank conditions upstream and downstream from the dam. An analysis to determine the channel-forming discharge should be conducted to determine an appropriate design geometry to establish for maintenance purposes.

References

Nadler, Carl Theodore Jr. 1978. "River Metamorphosis of the South Platte and Arkansas Rivers, Colorado," Masters Thesis, Department of Earth Resources, Colorado State University, Fort Collins, Colorado

APPENDIX D

SECTION 1135 PROGRAM FACT SHEET

PROJECT MODIFICATIONS FOR IMPROVEMENT OF THE ENVIRONMENT (SECTION 1135 PROGRAM)

OBJECTIVE AND SCOPE: Improvement of degraded ecosystem structure, function, and dynamic processes to a less degraded, more natural condition. Eligible areas include Corps-built or Corps-operated water resources projects, and areas where the construction or operation of such projects has contributed to degradation. "Study-only" proposals are not eligible.

ELIGIBLE SPONSORS: Non-Federal public agencies, tribal governments, and non-profit organizations.

COST-SHARING: Planning and design is performed primarily by the Corps as guided by the local sponsor. Section 1135 is a cost-sharing, rather than grant, program. The non-Federal contribution is 25% of the Total Project Cost (*i.e.*, the Feasibility, Plans & Specifications, and Implementation phases) and includes:

- All required lands, easements, rights-of-way, relocations, or water rights
- Work-in-kind (optional, up to 80% of non-Federal share)
- Cash contribution

FUNDING LIMIT: Total Project Cost limit = $6,700,000.

GENERAL PROCESS:
Initial Appraisal (Generally, 6 months) — The Sponsor and the Corps prepare a brief conceptual plan ("Preliminary Restoration Plan") which outlines the problem(s), proposes a potential solution, identifies ecosystem benefits, and estimates costs and scheduling. The Sponsor provides a Letter of Intent to cost-share subsequent phases.

Feasibility Study (Generally, 12 months) — The Corps prepares a feasibility report ("Ecosystem Restoration Report") which includes a 65% design, quantification of ecosystem benefits, cost-effectiveness analysis of alternatives, detailed cost determinations, and requisite environmental compliance. This phase is initially Government funded and is subject to 25% non-Federal cost-sharing after the Project Cooperation Agreement (PCA) is signed.

Plans & Specifications (Generally, 6 months) — Completion of design, specifications, and contract award package. This phase also is initially Government funded and is subject to 25% non-Federal cost-sharing. The Sponsor and Corps execute the PCA prior to award of the implementation contract.

Accelerated process: If the Total Project Cost is estimated to be $400,000 or less, Feasibility and Plans & Specifications can be combined into a single phase.

Implementation — Construction/implementation of the approved plan, after which the project is transferred to the Sponsor. Monitoring of project success for up to 5 years is an optional activity. The Sponsor is responsible for 25% of implementation and monitoring costs, and has the option to perform work-in-kind for up to 80% of their total cost-share amount.

O&M — Operation and maintenance is the responsibility of the Sponsor, except where modification is to lands or structures for which the Corps already holds a real estate interest.

POC: **William DeRagon**, Program Coordinator. Phone: 505-342-3358. FAX: 505-3423199.
e-mail: william.r.deragon@usace.army.mil
U.S. Army Corps of Engineers, 4101 Jefferson Plaza NE, Albuquerque, New Mexico 87109

Exhibit 8

Annual Meeting

December 7, 1999

ANNUAL REPORT

OF THE

OPERATIONS SECRETARY

CONCERNING THE OPERATION

OF

JOHN MARTIN RESERVOIR

1999

SUBMITTED TO THE

OPERATIONS COMMITTEE

ARKANSAS RIVER COMPACT ADMINISTRATION

Exhibit 8

Table of Contents

SECTION 1

ARKANSAS RIVER COMPACT ADMINISTRATION
307 South Fifth Street, Lamar, Colorado 81052
719-336-9696

For Colorado	Chairman and Federal Representative	For Kansas
Peter H. Evans [Acting], Denver	Larry E. Trujillo, Sr.	David L. Pope, Topeka
James G. Rogers, Lamar	Pueblo, Colorado	David A. Brenn, Garden City
Thomas R. Pointon, Las Animas		Randy Hayzlett, Lakin

December 1, 1999

Mr. David Brenn, Chairman
Arkansas River Compact Administration – Operations Committee, 1998-1999

Mr. James Rogers, Member
Arkansas River Compact Administration – Operations Committee, 1998-1999

Gentlemen,

The purposes of this letter report are: 1) to provide you with a summary of accounting of the operation of John Martin Reservoir for the 1998-1999 compact year which is incorporated and made a part hereof; 2) to review the status of Reports of the Operations Secretary previously submitted but not yet approved by the Arkansas River Compact Administration and to describe the status of efforts that have been made to clarify and resolve issues of concern regarding such reports that have been raised by the Assistant Operations Secretary; and 3) to suggest action items to be taken by this committee on December 6, 1999.

Summary of Operations

In accordance with the April 24, 1980 Resolution of the Arkansas River Compact Administration, Concerning an Operating Plan for John Martin Reservoir as amended (1980 Operating Plan), the 1998/1999 "period of winter storage" began at 0000 hours on November 1, 1998. At that time the volume of water in the reservoir was 242,351.00 a.f. distributed as follows: 228,642.45 a.f. in agreement accounts; 9,039.87 a.f. in the permanent recreation pool; and 4,848.68 a.f. in the offset account. Included in agreement accounts were 113,847.46 a.f. in the Kansas Section II account, a total of 104,561.98 a.f. in Colorado Section II accounts, 1,502.99 a.f. in the transit loss account; and 8,730.02 a.f. in the Amity Section III account. Also, from that time, all inflows to John Martin Reservoir (except 299.07 a.f. credited to the offset account during November 1998) were accrued to conservation storage as indicated by increases to the winter compact account.

Beginning on November 15, 1998, pursuant to the provisions of Section III (sometimes referred to as Article III) of the 1980 Operating Plan the storage of certain other water was credited to the winter water account prior to distribution to the specific Section III accounts in accordance with the approved 'Pueblo winter storage plan'. This distribution occurred on March 15, 1999 through a transfer (shown as a release) of the balance remaining in the winter water account to the individual Section (Article) III accounts according to their entitlements and concurrent transfers of 35% of such amounts to the transit loss account and Kansas and Colorado Section II accounts as provided for by Section III D of the 1980 Operating Plan.

On January 11, 1999 a transfer of 165.33 a.f. was made from the offset account to the winter compact account for return flow maintenance considerations. This action resulted in no net increase to reservoir storage.

Similarly, transfers totaling 834.00 a.f. were made from Colorado Section II accounts to the offset account on March 31, 1999. These transfers are shown as releases totaling 800.00 a.f. from Sisson-Stubbs' summer stored water and 1998 winter stored water accounts and a release of 34.00 a.f. from the X-Y summer stored water account with a corresponding inflow to the offset account. The purpose for these transfers was to provide for the annual offset account storage charge and is discussed in a separate report by the Colorado State Engineer.

As of 2400 hours on March 31, 1999, the net increase to storage in accounts (prior to assessment of storage charges) was 93,337.21 a.f. Of this amount, 52,218.75 a.f. went to conservation storage, 41,819.39 a.f. went to the winter water account, and 299.07 a.f. went into the offset account.

Transfer from conservation storage into accounts began pursuant to Sections II A and II D of the 1980 Operating Plan at 0000 hour on April 1, 1999 at the rate of 1250.00 cfs. As explained in last year's report, all accruals of inflow to conservation storage on and after April 1 of each year and prior to the first exhaustion of conservation storage is assigned to an account entitled "Summer Compact Water". Conservation storage was first exhausted at 0744 hour on April 28, 1999. During this interval, an additional 10,691.38 a.f. was added to conservation storage and a total of 61,554.75 a.f. was transferred from conservation storage into Section II accounts.

Although the City of Lamar requested and ultimately received approval to utilize John Martin Reservoir to regulate releases of Fryingpan-Arkansas Project water for municipal use, no such deliveries were made to John Martin Reservoir in 1999. See Section 3 of this report for related documentation.

Conservation storage was resumed at 0900 hour on April 30, 1999 due to inflow conditions at that time. Consistent with the provisions of Section II B (3) of the 1980 Operation Plan transfers from conservation storage into Section II accounts was initiated at 0900 hour on May 2, 1999. This transfer was initiated at the rate of 1250 cfs. and continued at that rate throughout the remainder of the compact year.

At 1500 hour on May 2, 1999, the Corps. of Engineers determined that the reservoir content had reached the level of maximum allowable invasion of the flood pool by the permanent recreation pool and asserted control of operations for flood control purposes. This maximum allowable invasion content was adjusted due to additional permanent pool storage which occurred on May 3 and May 4, 1999 pursuant to the Colorado Division of Wildlife's Muddy Creek Reservoir decree as provided for by the August 14, 1976 resolution of the Arkansas River Compact Administration.

After the reservoir content reached the level of maximum allowable invasion of the flood pool by the permanent recreation pool, inflows continued to accrue to conservation storage (Summer Compact Account) pursuant to Section II B of the 1980 Operating Plan. As conservation storage increased, water in other accounts within the conservation pool were displaced into the flood pool at the rate of computed inflow and according to the order of spill provided in Section II G of the 1980 Operating Plan and as revised by paragraph 13 of the Resolution Concerning An Offset Account in John Martin Reservoir for Colorado Pumping as amended March 30, 1998.

Diversions of stream flows (primarily to storage) upstream of John Martin Reservoir under post-compact water rights occurred beginning on April 29, 1999. The effect of such diversions was to reduce the inflow to John Martin Reservoir and the total volume of water that otherwise would have physically spilled from John Martin Reservoir. In order to compensate for reduced inflow to conservation storage an adjustment was calculated to determine the amount and timing of additional inflow to John Martin Reservoir that would have occurred but for the upstream diversions. See spreadsheet documenting the determination of these adjustments in Section 2 of this report. A release (transfer) equal to this adjustment was then made from the actively spilling account to conservation storage. Thus, accruals to conservation storage occurred at the rate of adjusted inflow until the spill of all accounts was completed on June 4, 1999.

Therefore, as has been done in previous reports of the Operations Secretary and as is described above, the accounting during periods of spill contained in this report reflect the depletion of the actively spilling accounts as being due to the combined effects of inflow and adjustments for upstream, post-compact diversions of stream flow. In this manner 34,244.09 a.f. are shown to have been released from the Section (Article) III account and 5,985.95 a.f. from the offset account as of 1122 hours on May 3, 1999. At that moment of initiation of spill from Section II accounts the content of each was determined, the sum of which established the limit of Section II water that was subject to spill (267,789.10 a.f.). A ratio of the volume controlled by each state to the total volume at that time was also determined to calculate the amount of deduction to be subtracted from each state's account(s). This ratio was determined to be .4849 for Colorado and .5151 for Kansas. The spill of Section II accounts was discontinued on June 3, 1999 when it was determined that 267,789.10 a.f. had spilled. Thereafter, 1665.47 a.f. was spilled from the transit loss account, which was emptied on June 4, 1999.

Throughout the period of spill, the Corps. of Engineers determined and controlled the physical rate of release from the John Martin Reservoir flood pool and the accounting in this report assigns all evaporation charges to the flood pool. All waters in excess of the maximum allowable invasion of the flood pool were evacuated by 0515 hour on July 6, 1999.

Kansas placed a demand for one run of water from its' Section II account during the year. The account release took place from July 8, 1999 to August 2, 1999. No water was available within the transit loss account during the period of this run. See Table XI-A in Section 4 of this report for additional details.

On August 8, 1999 it was again determined that the content of John Martin Reservoir had exceeded the limit of maximum allowable invasion of the flood pool as of 0330 hour on that date. At that time the only accounts containing water that were subject to spill were the offset account and Section II accounts. Using the procedures described above in relation to the first period of spill, it was determined that the 304.82 a.f. contained within the offset account was evacuated by 0502 hours on August 8, 1999. Also, the total content of Section II accounts at that time was determined to be 175,786.25 a.f., of which Colorado's control ratio was .6488 and Kansas' was .3512. However, by the time that the content of the reservoir was reduced to the level of the maximum allowable invasion of the flood pool at approximately 2400 hours on August 25, 1999, only 55,050.07 a.f. had been released/transferred from Section II accounts. Also see spreadsheet documenting adjustments to inflow for upstream post-compact diversions of stream flow during this spill period in Section 2 of this report. It is noteworthy that Table IX shows that the total amount released from the flood pool during both spills was 360,036.82 a.f. whereas the record show that upstream post-compact diversions of streamflow totaled 91,550.92 a.f. or 25.43% of the amount spilled.

During the remainder of the compact year inflow continued to accrue to conservation storage and concurrently transfers of conservation storage were made to Section II accounts. Table VIII shows that an additional delivery of 413.47 a.f. of water which originated from the Colorado River basin was made to the permanent recreation pool during the month of September 1999 as provided for by the April 15, 1980 resolution of the Arkansas River Compact Administration (see Section 3 of this report for additional documentation related to this operation). No transfers of water to the permanent pool pursuant to the June 14, 1999 resolution were made during the year. Various releases of water from Colorado Section II accounts were made as summarized in Table X of Section 4 of this report.

A summary of operations related to the offset account is included in a separate report. However, Table XII included in Section 4 of this report provides an overview of the status of the account throughout the year.

At the close of the compact year, the volume of water in John Martin Reservoir totaled 326,209.82 a.f., distributed as shown in Table XIII, Section 4 herein.

Status of Previous Operations Secretary's Reports and Efforts to Resolve Issues

Reports of the Operations Secretary for some previous years either were not initially accepted, were conditionally approved, or have not been acted upon by the Arkansas River Compact Administration. My understanding of the status of each of these reports is reviewed below.

--1994. By resolution of the Arkansas River Compact Administration dated December 10, 1996 it was determined that "The Annual Reports of the Operations Secretary for the years 1994 and 1996 are accepted subject to inserting the following footnote below the tables showing Colorado Augmentation deliveries:...". At last year's meeting of this Committee, I submitted and distributed copies of a single page document to be inserted in each report which identifies the relevant tables in each report and recites the three footnotes from the resolution verbatim. Subsequently, copies of this insert were distributed to Arkansas River Compact Administration members and others under a memorandum of transmittal dated December 10, 1998. I have verified that these inserts have been incorporated into the copies of the 1994 and 1996 reports that are on file in the Arkansas River Compact Administration office in Lamar, Colorado. This committee has not verified nor caused the record of Arkansas River Compact Administration's proceeding to clearly indicate that the conditions of the December 10, 1996 resolution have been satisfied by these actions.

--1995. A motion offered by Mr. David Pope was passed by the Arkansas River Compact Administration on December 12, 1995 which approved "...the Operations Secretary's report subject to concerns that we would have an opportunity to raise at a later time...".

--1996. See discussion under the sub-heading pertaining to the 1994 report above.

--1997. According to my notes of the December 9, 1997 meeting of the Arkansas River Compact Administration, action concerning acceptance of the 1997 report was to be deferred to a special meeting of the Administration.

--1998. In reliance upon my notes of the December 7, 1998 meeting of this committee and the unedited transcript of the December 8, 1998 meeting of the Arkansas River Compact Administration, I recommended but failed to describe on the record, corrections to Table X of the 1998 report. A corrected replacement page will be submitted to the Operations Committee and distributed to address this problem on December 6 1999.

No action was taken by the Arkansas River Compact Administration concerning acceptance of the 1998 report of the Operations Secretary. However, the Operations Secretary and the Assistant Operations Secretary were directed to meet for the purposes of clarifying and attempting to resolve issues of concern pertaining to the 1995, 1997, and 1998 reports of the Operations Secretary that had been or that may be raised by the Assistant Operations Secretary. Both the Operations Committee and the Engineering Committee were to be involved as deemed appropriate following initial discussions. (It is my understanding that the Engineering Committee's involvement would be for the limited purpose of quantifying injury, if any were to be discovered, pursuant to Section V of the 1980 Operating plan.) Chairman Trujillo requested that a schedule for these proceedings be prepared.

By letter dated December 14, 1998 to the Assistant Operations Secretary, which was copied to the Administration and others, an initial schedule of discussions was proposed. Through subsequent correspondence dated December 18, 1998, January 21, 1999, and February 2, 1999, which were similarly distributed, adoption and revision of this schedule was documented.

During the year, four days of meetings between the Operations Secretary and the Assistant Operations Secretary and their staff members were conducted. These occurred in Pueblo, Colorado on January 14, 1999 and February 25, 1999 and in Garden City, Kansas on April 8 and 9, 1999.

The primary focus of each of these meetings was to understand and respond to the issues of concern preliminarily raised by the Assistant Operations Secretary in his verbal comments to the Operations Committee on December 7, 1998 and to the Arkansas River Compact Administration meeting on December 8, 1998 as revised and extended by the Assistant Operations Secretary Report, dated January 13, 1999. By the end of the April 9, 1999 meeting, it was the intention of the participants to advise the Administration of the status of discussions regarding the various issues through a joint report to the Operations Committee. Although this was not accomplished, this failure was due more to the press of other priorities rather than impasse. In fact, both parties now have a much clearer understanding of the issues and will be able to further narrow those issues with direction from the Operations Committee and/or the Administration.

A brief summary of the status of issues follows:

- The Operations Secretary has agreed and begun to provide the Assistant Operations Secretary additional information, on at least a monthly basis, that will facilitate monitoring and reconciling of differences between reservoir accounting and operations. It is believed that this accommodation has resolved this concern.

- The Assistant Operations Secretary has asserted that the 1980 Operating plan does not provide for the interruption of releases from conservation storage (as was done on November 1, 1997 and on July 25 and 31, 1998 per the Operation Secretary's 1998 report) and therefore, should not occur. The Operations Secretary's position is that the relevant portions of the 1980 Operating Plan (Section II. D, including references to Sections II A and B) are silent concerning such interruptions, but that the practice is consistent with Article V F of the Arkansas River Compact (conservation storage would not have been exhausted during the non-irrigation season) and is suggested by Section II B (3) in relation to the two instances which occurred in July.

  The Operations Secretary will submit to the direction of the Administration on this issue and urges the Operations Committee to make a recommendation to resolve this ambiguity. This is an issue of immediate relevance to Compact Year 2000 accounting.

- The Assistant Operations Secretary has criticized the use of certain accounts on the basis that they are not specifically identified by the 1980 Operating Plan. The underlying rationale for the objections to the use of these accounts are of greater significance than is immediately apparent. In order for the Operations Committee to properly consider the separate issues associated with each set of criticized accounts and to formulate recommendations for consideration by ARCA, it is my recommendation that a special meeting of the Operations Committee be convened in the near future.

- The Operations Secretary does not agree that Section II G of the 1980 Operating Plan requires accounting of spills to be conducted at the rate of physical outflow as suggested by the Assistant Operations Secretary. This does not mean that such a procedure is incorrect, in fact the Operations Secretary has attempted to demonstrate that it makes no difference to account balances at the end of a period of spill whether one accounts for spills from accounts at the rate of outflow or inflow. That being the case, there should be no issue except as to preference. The Operations Secretary prefers to use inflow based accounting which is consistent with procedures used in the past and with those utilized at all other times when spills are not occurring. The Assistant Operations Secretary has not conceded this point.

It has been the practice of the Operations Secretary to assign all evaporation charges to the flood pool during times of spill. The Assistant Operations Secretary has correctly noted that this is not the procedure specified by Section II F of the 1980 Operating Plan, but has suggested an alternative accounting method which the Operations Secretary considers to be incorrect. The Operations Secretary is prepared to demonstrate that the procedure prescribed by Section II F of the 1980 Operating Plan, when correctly applied, produces the same result as that traditionally used. Again, this should not be an issue.

Unless these concerns can be resolved in advance, it is suggested that they be included on the agenda of the previously recommended special meeting of the Operations Committee.

- No substantial amount of time has been devoted to discussion of concerns related to the operation of Pueblo Reservoir, the associated "adjustments" during times of spill, or the resultant differences in date of conservation storage evacuation between the two sets of accounting.

  As reported to the Administration last year, this is the major issue to be addressed, however meaningful discussions on this will be aided by disposing of as many issues of lesser significance as possible. Therefore, it is recommended that the agenda of the previously recommended special meeting of the Operations Committee also include a review briefing of how such operations were treated in the Operations Secretary's accounting for 1998 and 1999 so that the committee can be better informed to direct further proceedings to appropriately address this issue.

- Similarly, little progress has been made toward the identification or resolution of issues that may be of concern to the Assistant Operations Secretary regarding the 1995 and 1997 reports of the Operations Secretary which have not been accepted by Administration. A preliminary alternative accounting of operations for 1995 has been provided by the Assistant Operations Secretary which is believed to show the effect of some of the same propositions that are currently unresolved which have been raised in connection with the 1998 report. It has generally been agreed to defer attention from the 1995 report in the hope that resolution of some of these issues will simplify the process. No specific concerns or criticisms regarding the 1997 Operations Secretary's report have been provided.

Further attention needs to be directed at the staff level to any remaining issues of concern related to these two reports subsequent to the proposed special meeting of the Operations Committee.

- Two emergent issues have resulted from discussions to date. First, what if anything, is to be done if it is determined that accounting done in previous years is in error, to correct those errors. Second, there is an apparent inconsistency between Section IV of the 1980 Operating Plan resolution and the Administration's resolution of August 14, 1976 regarding determination of evaporation from the permanent recreation pool.

  The former is a matter to be addressed by the Operations Committee, or perhaps, referred to the Engineering Committee in the future. The latter has only been preliminarily reviewed by the Operations Secretary and Assistant Operations Secretary and should be the subject of further analysis by them.

Suggested action items to be taken December 6, 1999

1. Determine recommendation to Administration regarding acceptance of the 1999 Operations Secretary's Report.

2. Review Administration's December 10, 1996 resolution and determine to recommend an Administration finding that the conditions of acceptance of the 1994 and 1996 Operations Secretary's Reports have been satisfied.

3. Determine to acknowledge on the record of the December 7, 1999 Administration meeting the receipt of corrected Table X to be inserted in the 1998 Report of the Operations Secretary.

4. Consider issuance of a committee decision affirming that the practice of interrupting releases of conservation storage into accounts in circumstances similar to those that existed in November 1997 and July 1998 are consistent with the intent of the 1980 Operating Plan and are appropriate and determined to report this action into the record of the December 7, 1999 Administration meeting. Alternatively or additionally consider recommendation approving a resolution amending the Administration's Resolution "Concerning An Operating Plan For John Martin Reservoir" dated April 24, 1980, and as subsequently amended, to revise the last sentence of subsection II B (3) to read: "Releases of conservation storage shall be initiated or resumed into the accounts…" and to add a new sub-section II D (4):

    > "In the event that any conservation storage has not been released into accounts as of November 1 of any year, further release shall be suspended until such time as is provided for according to Section II A herein."

5. Determine to schedule a special meeting of the Operations Committee to receive briefing and to consider or direct further action related to, but not necessarily limited to, the following matters:
   - Use of accounts not specifically authorized by the 1980 Operating Plan
   - Spill accounting procedures
   - Upstream diversions during times of spill and related accounting procedures
   - Retroactive correction of accounting errors, if any
   - Assessment of evaporation from the permanent recreation pool

Respectfully submitted,

Steven J. Witte
Arkansas River Compact
Administration Operations Secretary
December 1, 1999

FULL REPORT CAN BE DOWNLOADED ELECTRONICALLY ON THE ARKANSAS RIVER COMPACT ADMINISTRATION WEBSITE

Exhibit 9

Annual Meeting

December 7, 1999

RESOLUTION OF THE ARKANSAS RIVER COMPACT ADMINISTRATION

The Annual Reports of the Operations Secretary for the years 1994 and 1996 are accepted subject to inserting the following footnote below the tables showing Colorado Augmentation deliveries:

1) The State of Kansas reserves its objections a) to the manner in which Kansas release water and Colorado augmentation water have been accounted at the Stateline, b) to the usability of the augmentation deliveries, and c) to the acceptability of the sources of augmentation water.

2) The State of Colorado acknowledges the Kansas objections and agrees to work toward an accounting acceptable to Kansas in this area.

3) Acceptance of this report is without prejudice for either state to endorse a new or different accounting procedure in future years.

Adopted by the Arkansas River Compact Administration at its Annual Meeting on December 10, 1996.

Larry E. Trujillo, Sr.

Chairman Larry E. Trujillo, Sr.

Exhibit 9

Exhibit 10

Annual Meeting

December 7, 1999

7

Assistant Operations Secretary Report

Compact Operations for John Martin Reservoir

Compact Year 1999

This, my second year as Assistant Operations Secretary (AOS) has proven as enlightening as the first. During this compact year (CY), John Martin Reservoir (JMR) content reached a record 456,000 acre feet on May 9, 1999 and water spilled physically over the project's spillway during two separate events. I have again gained valuable insight into the complexities of both accounting for water in John Martin Reservoir (JMR) and in interpreting the various agreements that underlie the accounting. As detailed below, during the year, the Operations Secretary (OS) and I, with additional staff from each state, met three times to better understand the differences in our accounting methodologies and to seek resolution of these differences where possible. Our meetings have been productive, although we have not completed this work. A review of the proposed 1999 OS report reveals that the same disputed operations continue as in prior years. Even so, I remain hopeful that we can build on the work completed to date and resolve at least some of these concerns.

This report will review our meetings and discuss what we have learned regarding the differences between our accounting perspectives. I provided Colorado with alternative accountings for both 1998 and 1995 in January and February, respectively. I am not able to present an alternate accounting for compact year 1999 at this time as it is not yet complete. However, the previous accountings have provided sufficient basis for our discussions to this point.

Attached to this report is the final version of the Compact Year (CY)1998 Assistant Operations Secretary Report. Resolving the accounting issues in CY 1995 and after may affect this accounting for CY 1998.

Meetings Between the Operation and Assistant Operation Secretaries

Our first meeting was held in Pueblo on January 14, 1999. This meeting allowed me to present the Operations Secretary with the final version of the CY 1998 Assistant Operation Secretary's report and provided an opportunity for detailed discussion of many of the issues raised in the report. A second meeting was held in Pueblo on February 25, 1999 to continue these discussions. Prior to the meeting, I provided the Operations Secretary with a preliminary AOS 1995 accounting. At the meeting Colorado provided their reactions to the discussion of our positions of the first meeting. We began exploring the differences in spill accountings in greater detail though conceptual examples and discussed additional data requests by Kansas related to pass-through waters and the JMR administrative account.

A third meeting was held on April 8-9, 1999 in Garden City. At this meeting, the participants reviewed additional data the Operations Secretary proposed to provide on non-reported reservoir operations. We continued to explore impacts of the differences in accounting methods and their consistency with the 1980 Operating Plan. A fourth meeting was planned but was subsequently postponed due to the summer flooding.

Exhibit 10

Review of Issues

The "Pass Through Waters" and "Administration Account"

The AOS report of last year noted that the OS accounting does not report all reservoir inflows and releases. As a result of our discussions, Colorado has agreed to provide Kansas, at least monthly, a spreadsheet(s) showing all releases from JMR including "pass-through" waters as well the daily status of JMR's "administrative account" and its computation. Staff in my office is working to determine if this information is needed more frequently.

Interruption of Releases from Conservation Storage to Section II Accounts

In the accounting review for previous years, the release of summer and winter compact water to accounts was interrupted in the OS accounting on November 1 and in the summer when the reservoir demand below JMR was curtailed. The 1980 Operating Plan provides for release of conservation storage to Section II Accounts, but does not provide for the interruption of these releases once initiated. The 1980 Operating Plan places a prescribed standing call for water by the Section II accounts on conservation storage. I do not believe that call should be interrupted unless specifically provided for by resolution of the ARCA.

Agreement B Sub-accounts

The OS accounting divides each Colorado Ditch's Section II water into summer and winter, and in some cases previous summer, accounts. Similarly, the Operations Secretary's practice is to credit inflows between April 1 to October 31 to *summer* compact water. The purpose of these Colorado accounts is to implement "Agreement B." These sub-accounts are not necessary for the 1980 Operating Plan and are not authorized by ARCA. The AOS accounting does not include the Colorado Section II sub-accounts.

Flood Pool Account

Unlike the OS accounting, the AOS accounting does not include a flood pool account as I see no provision for such an account in the 1980 Operating Plan and it was not necessary for the accounting. In the AOS accounting, forced releases spill the accounts at the rate of physical spill from the reservoir as prescribed by the 1980 Operating Plan. I believe this method was correctly applied in the 1987 spill accounting, based on the minutes from the CY 1987 meeting. The disputed spill accounting in 1995, 1998 and 1999 departs from the previous practice and the 1980 Operating Plan. The Operations Secretary's objection to this method is that account water is temporarily stored in the flood control space of JMR. **The AOS spill accounting simply relies on the physical constraints of the operation of the dam to dictate the forced release of account water under the 1980 Operating Plan.**

Inflow vs. Outflow Spill Accounting

Inflow based forced releases from accounts manipulates the ownership of the stored accounts irrespective of dam operations. Water is transferred from accounts based on artificial inflows into an account that is not recognized by ARCA. This also removes the reliance on the physical spill over the project's spillway as a constraint to the forced release of accounts. Inflow based accounting relies on a specified elevation between conservation storage and the flood control space of JMR.

Outflow based forced releases relies on the measured physical spill over the dam to dictate the forced loss of account water as my reading of the 1980 Operating Plan requires. The outflow is measured below JMR so that the exact water being spilled is a known quantity.

Depletion Credits in Spill Accounting for Out-of-priority Storage

My initial concern with the OS spill accounting, as detailed in the AOS CY 1998 report, was with the practice of adjusting inflows (depletion *debits*) in JMR for upstream post-compact storage in Pueblo during the 1998 spill. These depletion debits accelerated forced releases from accounts to conservation storage. The accounts in JMR again suffered forced releases when Pueblo Reservoir subsequently spilled. I can find nothing within ARCA that would allow for such depletion debits to be applied to inflows to JMR. In our discussions, we could find little hope for resolution of Kansas' concerns regarding post-compact storage during spills and depletion credits at our level.

Evaporation Charges

The Operations Secretary and I discussed two areas of concern related to evaporation charges. One was the evaporation charge during a spill. The AOS accounting uses the method prescribed by the 1980 Operating Plan where all accounts are charged pro rata. The practice of the Operations Secretary has been to charge a flood pool account with all the evaporation.

The second evaporation issue arose out of the discovery that the 1976 resolution authorizing the permanent pool states that its evaporation charge shall be based on incremental area. This is in contrast to the remainder of the accounts which, as stated above, are charged based on the percentage of volume. The OS accountings and the AOS accountings have based the evaporation charge for the permanent pool on percentage of volume. The Operations Committee may want to consider recommending an amendment to the 1976 resolution in this regard or to direct operations accounting to reflect the 1976 resolution.

Winter Water Storage

The 1980 Operating Plan calls for a 35% storage charge on Section III water to be assessed upon delivery to JMR. Under the OS accounting, a winter water account is created to hold Section III water deliveries until March 15 when it is distributed to the individual Section III accounts and the transit loss account. Only then is the 35% charge assessed. Colorado contends that they do not know the exact distribution of the Section III waters until March 15. In the AOS accounting, the Section III accounts were not separated; inflows went directly to a combined Section III account and the 35% charge went to the Kansas transit loss account as delivery of Section III water to JMR occurred.

Deficit Accounting in the Kansas Transit Loss Account

The 1980 Operating Plan provides for a deficit accounting when Kansas calls for water and there is no water available in the Kansas Transit loss account. This circumstance occurred when Kansas called for water in CY 1999. I have been informed that no deficit can be shown on the accounting software used by the Operations Secretary. We will want to include some discussions in the future as to how to operate the transit loss account to meet this requirement under the 1980 Operating Plan.

Comments

Much work by both parties has gone into the discussions conducted thus far on these issues. I believe additional discussions between the Operations Secretary and I would be productive. At some point in the very near future, we should provide a report to the Compact Administration or one of its committees on our findings and recommendations. The report should also indicate differences that we could not resolve. I will provide the AOS accounting for compact year 1999 as soon as it is complete. It may be helpful to include revised accounting for CY's 1995 thru 1998 to assist in resolving the issues that are obstructing the adoption of past years operations reports. Ultimately, I believe all efforts to resolve these issues will serve to build confidence in the operations of the Arkansas River Compact Administration.

Mark E. Rude

Mark E. Rude
Arkansas River Compact Administration
Assistant Operations Secretary

12/6/99

Date

Exhibit 14

Annual Meeting

December 7, 1999

STATE OF COLORADO

WATER DIVISION 2
OFFICE OF THE STATE ENGINEER
310 East Abriendo, Suite B
Pueblo, CO 81004
Phone (719) 542-3368
FAX (719) 544-0800

January 29, 1999

David L. Pope
Kansas Chief Engineer
Kansas Board of Agriculture
901 S. Kansas Avenue, 2nd Floor
Topeka, KS 66612-1283

Ms. Mary Louise Clay
Recording Secretary
Arkansas River Compact Administration
307 South Fifth Street
Lamar, CO 81052

RE: Report of Colorado Pumping and Offset Account Operations by Substitute Water Supply Plans for the Period April 1,1998 to November 30, 1998

Dear Mr. Pope and Ms. Clay:

The purpose of this letter is to provide a report of the operations of five Substitute Water Supply Plans (SWSP) approved by the Colorado State Engineer which have been required to deliver a portion of their replacement water to the Offset Account created by the **Resolution Concerning an Offset Account in John Martin Reservoir for Colorado Pumping As Amended March 30, 1998** ("Resolution"). This requirement is based on the fact that the depletions caused by the operations covered by these plans are estimated to produce depletions to usable Stateline flow during some months of the year. This letter reports the monthly estimated depletions to usable Stateline flow caused by the operations covered by each plan and accounts for the replacement of these estimated depletions by making fully consumable water available to Kansas in the Offset Account.

The following table shows the estimated depletions for each of the SWSPs which the Colorado State Engineer has required be replaced using water delivered to the Offset Account.

Month	Brad Cummings Irrigation	Carder, Inc Gravel Pit	Midwestern Farms Gravel Pit	Prowers County Gravel Pit	Justin Young Wildlife Ponds
April	35	1.99		1.1	
May	42	2.43	3.305	1.3	
June	57	2.73	3.466	1.6	
July	81	2.66	4.269	1.8	
August	111	4.20	4.528	1.7	
September	125	2.32	5.785	1.5	46.09

Exhibit 14

Cc to Ralph, Banfield

October	105	2.33	7.134	1.2	3.82
November	*	*	*	*	*
TOTAL	556	18.66	28.487	10.2	49.91

* No replacements were required by the Colorado State Engineer because there were substantial flows past Garden City during November, 1998 (See Enclosure 7).

Enclosure 1 through Enclosure 3 provide the accounting for three of the SWSPs summarized in the above table. Enclosure 4 and Enclosure 5 provide the stream depletion amounts that were approved for the other two SWSP's which are also summarized in the above table. The total depletions from the above table are 663.257 acre-feet. The replacement of 663.257 acre-feet in the required reaches of the Arkansas River would require a release of 668.4 acre-feet from the Offset Account. These computations are summarized in the table in Enclosure 6. As indicated in Enclosure 6, 668.4 acre-feet of fully consumable water has been made available to Kansas under the provisions of paragraph 5B of the Resolution. Under those provisions, 668.4 acre-feet will be moved from the Colorado Consumable Water subaccount to the Kansas Consumable Water subaccount of the Offset Account 30 days after the date of this notification letter in order that evaporation be charged as provided for by paragraph 5B of the Resolution. As of November 30, 1998, there were 5116.87 acre-feet being stored in the offset account.

Please contact me if you have any questions or require additional information.

Sincerely,

Steven J. Witte
Division Engineer
Colorado Division of Water Resources

7 Enclosures

cc: Mark Rude
John Draper
Dale Book
Hal Simpson
Dennis Montgomery
Bill Howland
Jim Slattery
Larry E. Trujillo, Sr.
Randy Hayzlett
David Brenn
Peter Evans
Thomas R. Pointon
James G. Rogers

Enclosure 1

Water Accounting Form
Brad Cummings - SEO ID Nos. 6705529 & 6705531
Granada, Colorado
Year: 1998

Month	Well ID 6705529				Well ID 6705531		Total	Well Head	Well Head	Stream
	Reading (Kwh)	Usage (Kwh)	PCC (Kwh / ac-ft)	Total (ac-ft)	Reading (ac-ft)	Pumpage (ac-ft)	Pumpage (ac-ft)	Depletion Rate	Depletion (ac-ft)	Depletion (ac-ft)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
April	88229	0	345	0.00	114,487	0.00	0.00	100%	0.00	35
May	8351	20,122	345	58.32	161,050	46.56	104.89	100%	104.89	42
June	46339	37,988	345	110.11	161,050	0.00	110.11	100%	110.11	57
July	74960	66,609	345	193.07	196,138	35.09	228.16	100%	228.16	81
August	84003	75,652	345	219.28	241,594	45.46	264.74	100%	264.74	111
September	41431	57,428	345	166.46	241,594	0.00	166.46	100%	166.46	125
October	41431	0	345	0.00	241,594	0.00	0.00	100%	0.00	105
November	41431	0	345	0.00	249,862	8.27	8.27	100%	8.27	80
December			345	0.00			0.00	100%	0.00	
January			345	0.00			0.00	100%	0.00	
February			345	0.00			0.00	100%	0.00	
March			345	0.00			0.00	100%	0.00	
Total	----		----	747.24	----	135.38	882.62	----	882.62	636

Replacement supply purchased from Colorado Springs and delivered to the Offset Account.

Col 1: Present month.
Col 2: The meter reading at the end of the present month.
Col 3: The total amount of kilowatt hours for the month (Present - Previous month).
Col 4: This column contains the power consumption coefficient to calculate monthly pumping.
Col 5: Col 3 / Col 4
Col 6: Flow meter reading at the end of the present month.
Col 7: Present month's meter reading - previous month.
Col 8: Col 5 + Col 7
Col 9: Well head depletion rate.
Col 10: Col 8 X Col 9
Col 11: Calculated from State's accounting model.

FEB 1 1999

Note: Monthly send copies to:

Dale Straw	Bill Howland	Dan Neuhold	Don Higbee	Brad Cummings	Tom Jagers
CDWR	CDWR	Water Commissioner	LAWMA	24299 Rd 62	4260 Rd MM
PO Box 5728	1640 W. 6th	30240 Co Rd 12	PO Box 1161	Moffat, CO 81143	Lamar, CO 81052
Pueblo, CO 81002	Las Animas, CO 81054	Lamar, CO 81052	Lamar, CO 81052		

Enclosure 2

Water Accounting Form
CARDER, INC
J&S GRAVEL PIT
Lamar, Colorado

Year: 1998

Row	Item	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Annual Total
1	Evap rate, ac-ft/ac	0.38	0.45	0.60	0.62	0.56	0.44	0.31	0.17	0.13	0.12	0.16	0.22	4.15
2	Pit area, ac	3	3	3	3	3	3	3	3					-------
3	Evaporation, ac-ft	1.13	1.36	1.80	1.87	1.67	1.31	0.92	0.50	0.00	0.00	0.00	0.00	10.56
4	Aggregate sales, ton	29,510.09	37,816.70	40,594.56	35,124.83	94,935.90	36,086.14	44,677.92	39,488.14					358,234.28
5	Factor, % by weight	4	4	4	4	4	4	4	4	4	4	4	4	-------
6	Moisture Loss in Material, ac-ft	0.87	1.11	1.20	1.03	2.79	1.06	1.32	1.16	0.00	0.00	0.00	0.00	10.54
7	Aggregate washed, ton	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00					0.00
8	Factor, % by weight	2	2	2	2	2	2	2	2	2	2	2	2	-------
9	Moisture Loss in Washing, ac-ft	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	Water for Dust Suppression, gal	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00					
11	Water for Dust Suppression, ac-ft	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12	Moisture Loss in Material + Moisture Loss in Washing + Water for Dust Suppression, ac-ft	0.87	1.11	1.20	1.03	2.79	1.06	1.32	1.16	0.00	0.00	0.00	0.00	10.54
13	Consumptive Use, ac-ft	2.00	2.47	2.99	2.90	4.47	2.38	2.24	1.66	0.00	0.00	0.00	0.00	21.10
14	Depletion Factor, %	99.2%	98.2%	91.3%	91.5%	94.1%	97.5%	104.3%	113.1%	122.0%	123.7%	114.1%	107.3%	-------
15	Depletion, ac-ft	1.99	2.43	2.73	2.66	4.20	2.32	2.33	1.87	0.00	0.00	0.00	0.00	20.53
16	Year to Date Depletion, ac-ft	1.99	4.41	7.14	9.80	14.00	16.32	18.65	20.53	20.53	20.53	20.53	20.53	-------

Replacement Source: Purchased from Colorado Springs and delivered to the Offset Account.

Row 3: Pond evaporation in acre-feet (Row 1) X (Row 2).
Row 6: Moisture loss in material in acre-feet [(Row 4) X 2000 X {(Row 5)/100} / 62.4] / 43560.
Row 9: Moisture loss in washing aggregate in acre-feet [(Row 7) X 2000 X {(Row 8)/100} / 62.4] / 43560.
Row 10: End of month meter readings for water pumped for dust suppression in gallons (Row 10) -(Previous Row 10).
Row 11: Total gallons pumped for dust suppression in acre-feet (Row 10) / 325851.
Row 12: Totals water consumped in operations (Row 6) + (Row 9) + (Row 11).
Row 13: Total consumptive use (Row 3) + (Row 12).
Row 15: Depletion based on Glover Depletion factors (Row 13) X (Row 14).
Row 16: Year to date depletions (Row 15) + (Previous Row 16).

Note: Monthly send copies to:

Dale Straw	Dan Neuhold	Bill Howland	Don Higbee	Ira Paulin
CDWR	Water Commissioner	CDWR	LAWMA	Carder, Inc.
PO Box 5728	30240 Co Rd 12	1640 W. 6th	PO Box 1161	PO Box 721
Pueblo, CO 81002	Lamar, CO 81052	Las Animas, CO 81054	Lamar, CO 81052	Lamar, CO 81052

Enclosure 3

Water Accounting Form
HOLLY ROCK GRAVEL PIT
Holly, Colorado

Year: 1998

Row	Item	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	Annual Total
1	Evap rate, ac-ft/ac	0.31	0.54	0.71	0.67	0.55	0.38	0.25	0.16	0.13	0.15	0.19	0.29	-------
2	Pit area, ac	9	9	9	9	9	9	9	9					-------
3	Evaporation, ac-ft	2.790	4.860	6.390	6.030	4.950	3.420	2.250	1.440	0.000	0.000	0.000	0.000	32.130
4	Sand & Gravel Sales, tons	48,092	36,200	45,659	33,652	52,912	32,134	34,119	30,854					313,622
5	Factor, % by weight	4	4	4	4	4	4	4	4	4	4	4	4	-------
6	Moisture Loss, ac-ft	1.415	1.065	1.344	0.990	1.557	0.946	1.004	0.908	0.000	0.000	0.000	0.000	9.229
7	Concrete Production, cy	0	0	0	0	0	0	0	0					0
8	Concrete Batching, ac-ft	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
9	Pump meter, gal	0	0	0	0	0	0	0	0					0
10	Total pumped, ac-ft	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
11	Moisture Loss + Concrete Batching + Pump, ac-ft	1.415	1.065	1.344	0.990	1.557	0.946	1.004	0.908	0.000	0.000	0.000	0.000	9.229
12	Consumptive Use, ac ft	4.205	5.925	7.734	7.020	6.507	4.366	3.254	2.348	0.000	0.000	0.000	0.000	41.359
13	Depletion Factor, %	78.6%	58.5%	55.2%	64.5%	88.9%	163.4%	237.7%	259.8%	278.8%	205.2%	154.2%	89.5%	------
14	Depletion, ac-ft	3.305	3.466	4.269	4.528	5.785	7.134	7.735	6.100	0.000	0.000	0.000	0.000	42.322
15	Year to Date Depletion, ac-ft	3.305	6.771	11.040	15.568	21.353	28.487	36.222	42.322	42.322	42.322	42.322	42.322	-------

Replacement Source: Purchased from Colorado Springs and delivered to the Offset Account.

Row 3: Pond evaporation in acre-feet (Row 1) X (Row 2).

Row 6: Moisture loss in material in acre-feet [(Row 4) X 2000 X {(Row 5)/100} / 62.4] / 43560.

Row 8: Water consumed in concrete batching in acre-feet [(Row 7) X 36 / 7.48] / 43560.

Row 9: End of month meter readings for water pumped for dust suppression in gallons (Row 9) -(Previous Row 9).

Row 10: Total gallons pumped for dust suppression in acre-feet (Row 9) / 325851.

Row 11: Totals water consumped in operations (Row 6) + (Row 8) + (Row 10).

Row 12: Total consumptive use (Row 3) + (Row 11).

Row 14: Depletion based on Glover Depletion factors (Row 12) X (Row 13).

Row 15: Year to date depletions (Row 14) + (Previous Row 15).

Note: Monthly send copies to:

Dale Straw	Dan Neuhold	Bill Howland	Don Higbee	Dwayne Turner
CDWR	Water Commissioner	CDWR	LAWMA	Holly Rock
PO Box 5728	30240 Co Rd 12	1640 W. 6th	PO Box 1161	31340 US Highway 50
Pueblo, CO 81002	Lamar, CO 81052	Las Animas, CO 81054	Lamar, CO 81052	Holly, CO 81047

DIV. 2

STATE OF COLORADO

RECEIVED
OFFICE OF THE STATE ENGINEER
Division of Water Resources
Department of Natural Resources JAN - 6 1999
1313 Sherman Street, Room 818 DIVISION ...
Denver, Colorado 80203 PUEBLO ...
Phone (303) 866-3581
FAX (303) 866-3589

December 30 1998

Roy Romer
Governor
James S. Lochhead
Executive Director
Hal D. Simpson
State Engineer

Mr. Frank C. Healy
Helton & Williamsen, P.C.
384 Inverness Drive South, Suite 144
Englewood, Colorado 80112

Re: Prowers County Gravel Pit, Substitute Water Supply Plan
DMG File No. M-97-016
SE¼ NW¼ Section 26, T22S, R46W, 6th P.M.
Water Division 2, Water District 67

Dear Mr. Healy:

We have reviewed your request for renewal of the Prowers County Gravel Pit substitute water supply plan for the plan year April 1, 1998 through March 31, 1999. The required fee of $217 has been paid.

It is anticipated that at the end of mining operations the maximum exposed ground water surface of the gravel pit will be 3 acres. The anticipated maximum annual depletion to the Arkansas River will be 13.58 acre-feet per year, consisting of 12.1 acre-feet of net evaporation from 3 acres of ground water exposure, 0.48 acre-foot of water lost in product, and 1.0 acre-foot of water used for dust suppression. Below is a monthly breakdown of this consumption with lagged depletions to the Arkansas River.

Month	Net Evaporation (af)	Lost in Product (af)	Dust Suppression (af)	Total Consumption (af)	Lagged Depletion (af)
April	1.1	0.04	0.11	1.25	1.1
May	1.3	0.04	0.15	1.49	1.3
June	1.7	0.04	0.18	1.92	1.6
July	1.7	0.04	0.19	1.93	1.8
August	1.6	0.04	0.17	1.81	1.7
September	1.3	0.04	0.12	1.46	1.5
October	0.9	0.04	0.08	1.02	1.2
November	0.5	0.04	0.00	0.54	0.8
December	0.4	0.04	0.00	0.44	0.7
January	0.4	0.04	0.00	0.44	0.6
February	0.5	0.04	0.00	0.54	0.6
March	0.7	0.04	0.00	0.74	0.7
Total	12.1	0.48	1.00	13.58	13.6

This year's source of replacement water is to be administered by LAWMA. LAWMA has contacted with Colorado Springs for 1,677 acre-feet of reusable water for the plan year, 17 acre-feet of which will be dedicated to this plan to cover stream depletions and transit and storage charges. Mr. Jim Rogers, from whom the County is leasing the pit, is paying LAWMA for the

Enclosure 4

subject 17 acre-feet. The water is to be put into the Offset Account in John Martin Reservoir and then regulated on behalf of this plan.

Taek Hui Jensen and Andy Jensen, owners of the pit site, have dedicated 50 shares from the Hyde Ditch as an additional source of long term renewable supply of replacement water. You estimate the yield of these shares to average about 35 acre-feet of consumption annually.

This substitute water supply plan is hereby approved pursuant to Section 37-80-120, C.R.S., subject to the following conditions:

1. The pit's well permit, no. 49444-F, is due to expire on January 30, 1999. Either a statement of beneficial use, a request for extension, or an application for a new permit must be submitted by that date.

2. The total surface area of the groundwater exposed must not exceed 3.0 acres. The combined consumption due to evaporation, pumping for dust suppression, and water lost in product may not exceed 13.6 acre-foot annually.

3. LAWMA shall cause water to be delivered and credited to the Offset Account in John Martin Reservoir (or make releases from its Article II Storage Account in John Martin Reservoir) to replace the gravel pit's current depletions. Releases or deliveries of all water shall be coordinated with and under the direction of the Division Engineer and the Augmentation Coordinator.

4. Adequate accounting of depletions and replacements must be provided to the Water Commissioner and/or Division Engineer on a monthly basis or other interval acceptable to both of them, on forms acceptable to them. The accounting form must show, at a minimum:
   - The three categories of consumption.
   - Total actual monthly lagged depletions to be replaced (monthly and cumulative year-to-date),
   - The amounts of replacement water released to the Arkansas River or credited to the Offset Account in John Martin Reservoir, respectively, to replace the depletions due to the Prowers County Gravel Pit (monthly and cumulative year-to-date).

5. The accounting form shall be sufficient to demonstrate that the net effective replacement equaled or exceeded the total depletion on a monthly basis. All replacement water must be concurrent with depletions in quantity, timing and location, except that credits to the Offset Account may precede the depletions.

6. In accordance with amendments to Section 25-8-202-(7), C.R.S. and "Senate Bill 89-181 Rules and Regulations" adopted on February 4, 1992, the State Engineer shall determine whether or not the substitute supply is of a quality to meet requirements of use to senior appropriators. As such, water quality data or analysis may be requested at any time to determine if the water quality is appropriate for downstream water users.

7. Prowers County must make application to the Water Court for a permanent plan for augmentation within three years before completion of mining, to ensure the permanent replacement of all depletions, including long-term evaporation losses after the gravel mining operations have ceased.

8. This plan is valid through March 31, 1999, unless otherwise revoked or modified. If a plan for augmentation is not obtained in the Water Court by the expiration date, an annual renewal of this plan is required. Any request for renewal of this plan must be submitted with the statutory fee of $217 at least 45 days prior to the date of expiration. Should this substitute water supply plan expire without renewal or be revoked prior to adjudication of a permanent plan for augmentation, all operations at the gravel pit must cease immediately.

9. This substitute water supply plan may be revoked or modified at any time should it be determined that injury to other water rights has or will occur as a result of this plan.

10. Acceptance of these conditions must be made in writing to this office, the Division Engineer (310 E. Abriendo Ave., Suite B, Pueblo, CO 81004), and the Water Commissioner (Dan Neuhold, 30240 County Road 12, Lamar, CO 81052) within two weeks of your receipt of this letter. The name, address, and phone number of a contact person who will be responsible for the operation and accounting of this plan must be provided with the acceptance.

This office does not condone the eradication of native wetland vegetation. Likewise, approval of this plan does not satisfy any federal laws or regulations or liability resulting therefrom. Please contact Keith Vander Horst of this office or Steve Witte, Division Engineer, in Pueblo at (719) 542-3368 if you have any questions concerning this approval.

Sincerely,

Kenneth W. Knox
Assistant State Engineer

cc: Steven J. Witte, Division 2 Engineer
Dan Neuhold, Water Commissioner, Water District 67

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STATE OF COLORADO

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JUL 02 1998

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PUEBLO COLORADO

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Division of Water Resources
Department of Natural Resources
1313 Sherman Street, Room 818
Denver, Colorado 80203
Phone (303) 866-3581
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Roy Romer
Governor
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Executive Director
Hal D. Simpson
State Engineer

June 25, 1998

Frank C. Healy
Helton & Williamsen, P.C.
384 Inverness Dr. South, # 144
Englewood, CO 80112

RE: Justin Young Jr. Substitute Water Supply Plan
Sections 29 & 30, T22S, R44W, 6th P.M.
Water Division 2, Water District 67

Dear Mr. Healy:

We have reviewed your March 30, 1998 request for a substitute water supply plan on behalf of Justin Young Jr. to allow construction and operation of a number of wildlife ponds and "terraces". The structures will consist of one 13.5 acre-feet (9 surface acres) terrace in section 30, and two terraces totaling 3.2 acre-feet (2.31 surface acres) and one pond of 4.13 acre-feet (1.64 surface acres) in section 29. The source of water will be surface flows originating as tail waters from irrigation under the Amity Canal, and the structures will be constructed so as to be drainable. While the pond will contain water year round the terraces will only contain water during the months September through February.

Stream depletions will be caused by filling of all structures in September, and by subsequent surface evaporation. Your estimates of monthly depletions, detailed on Attachment A, also include amounts for saturation of the soil underlying the pond and terraces to a depth of 3 feet. This year's initial operations are estimated to create an annual depletion of about 62 acre-feet. With the pond not having to be filled, subsequent year's depletions are anticipated to be about 55 acre-feet. It is noted that contrary to the note on the proposed accounting form, ice cover of a pond will not reduce the chargeable evaporation.

At the end of February the 3 terraces will be drained. Your submittal stated LAWMA would want credit for this drainage, including "release" of water stored in the soil which is greater than the available water holding capacity. Prior to receiving any credits for soil moisture drainage, additional explanation and documentation of how such storage and drainage is determined and measured must be provided.

Replacement of stream depletions is proposed by use of 74 acre-feet of consumable water Mr. Young has purchased from Colorado Springs Utilities (CSU) via the Lower Arkansas Water Management Association (LAWMA). The 74 acre-feet will cover filling, evaporation, an estimated 20% transit and storage losses, and according to an April 17, 1998 agreement between CSU and LAWMA will be delivered into John Martin Reservoir's Kansas Offset account in June. LAWMA has agreed to provide accounting services for this plan.

Enclosure 5

The State and Division Engineers have reviewed the plan and the adequacy of each source of water provided for use as augmentation water, including, where necessary, the historical consumptive use of each water right, and return flows from diversion of waters imported into the Arkansas River Basin or other fully consumable waters proposed for use as augmentation water. In accordance with Section 25-8-202(7), C.R.S. and Senate Bill 89-181 Rules and Regulations adopted on February 4, 1992, the State Engineer has determined that subject to the terms and conditions below, the replacement supply is of a quality to meet the requirements of use to senior appropriators.

Based on stream depletions determined in accordance with the Amended 1996 Well Use Rules decreed in case no. 95CW211, and consistent with other provisions of the Rules, the State and Division Engineers have determined that, subject to the terms and conditions set forth below, it appears the plan to divert tributary ground water will provide sufficient augmentation water in amount, time, and location to replace out-of-priority depletions to senior surface water rights in Colorado, to the extent required by Rule 11, and all depletions to usable Stateline flow caused by such diversions and may therefore be approved pursuant to Rule 7.

This substitute water supply plan is hereby approved pursuant to Section 37-80-120, C.R.S., subject to the following conditions:

1. Accounting of water in this plan, including diversions into, out of, and storage within the pond and terraces, and replacement water deliveries must be provided to the Water Commissioner and Division Engineer on forms and at times acceptable to them.

2. The 3 storage terraces must be drained of water by the end of February.

3. This approval is of a temporary nature where as the uses approved in this plan are of a permanent nature that will require a court decreed plan for augmentation. Any request for renewal of this plan must include a description of progress made toward obtaining a permanent source of replacement water, and a target date for filing an application for a permanent plan with the water court.

4. Should a request for renewal of this plan be needed, such renewal request must be submitted to this office at least 45 days prior to the expiration date of this plan.

5. This plan shall be valid through August 31, 1999, unless otherwise revoked or modified.

6. This plan may be revoked or modified at any time should it be determined that injury to other vested water rights has or will occur as a result of the operation of this plan.

7. Should this substitute water supply plan expire without renewal or be revoked prior to adjudication of a permanent plan for augmentation, all water must be immediately drained from all structures.

8. In accordance with amendments to Section 25-8-202-(7), C.R.S. and "Senate Bill 89-181 Rules and Regulations" adopted on February 4, 1992, the State Engineer shall determine whether or not the substitute supply is of a quality to meet requirements of use to senior appropriators. As such, water quality data or analysis may be requested at any time to determine if the water quality is appropriate for downstream water users.

9. Acceptance of these conditions must be made in writing to this office, the Division Engineer (310 E. Abriendo, Suite B, Pueblo CO 81004), and the Water Commissioner (Dan Neuhold, 30240 County Road 12, Lamar, CO 81052) within two weeks of your receipt of this letter. The name, address, and phone number of a contact person who will be responsible for the operation and accounting of this plan must be provided with the acceptance.

Should you have any questions, please contact Keith Vander Horst of this office or Steve Witte, Division Engineer, in our Division 2 office in Pueblo at (719) 542-3368.

Sincerely,

Hal D. Simpson
State Engineer

cc: Steve Witte, Division Engineer
Dan Neuhold, Water Commissioner

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Justin Young Jr. Substitute Water Supply Plan

Depletions in Acre-Feet

	West Terrace		South Dam		South Terraces		Total
Month	Fill	Evaporation	Fill	Evaporation	Fill	Evaporation	Depletion
September	27.71	3.77	6.39	0.69	6.64	0.89	46.09
October		2.69		0.49		0.64	3.82
November		1.45		0.26		0.34	2.05
December		1.17		0.21		0.28	1.66
January		1.13		0.21		0.27	1.61
February		1.40		0.26		0.33	1.99
March				0.37			0.37
April				0.62			0.62
May				0.69			0.69
June				0.92			0.92
July				1.01			1.01
August				0.89			0.89
Annual	27.71	11.61	6.39	6.62	6.64	2.75	61.72

West Terrace and South Terraces drained at end of February

Enclosure 6

AUGMENTATION PLAN IMPLEMENTATION SPREADSHEET										
USER	R11	R12	R13	R14	R15	R16	R17	R18	R21	SUM
LAWMA										
TOTAL DEPLETIONS			18.66	10.2		49.91	556	28.487		663.257
REPLACEMENTS										
FRY-ARK RETURN FLOWS										0
COLORADO BEEF										0
FORT BENT DITCH SHARES										0
STUBBS DIRECT FLOW										0
X-Y DIRECT FLOW										0
MANVEL DIRECT FLOW										0
OFFSET ACCOUNT WATER	668.4									668.4
	-668.4	-667.52	-647.99	-636.94	-636.11	-585.36	-28.597	-0.0721		
BALANCE FORWARDED	0	0	0	0	0	0	0	0	0	

River and Ditch Station	Date	Inflows	Outflow	Remarks
Arkansas at Garden City, KS	11/1/98	318		
Arkansas at Garden City, KS	11/2/98	349		
Arkansas at Garden City, KS	11/3/98	354		
Arkansas at Garden City, KS	11/4/98	372		
Arkansas at Garden City, KS	11/5/98	367		
Arkansas at Garden City, KS	11/6/98	386		
Arkansas at Garden City, KS	11/7/98	367		
Arkansas at Garden City, KS	11/8/98	349		
Arkansas at Garden City, KS	11/9/98	367		
Arkansas at Garden City, KS	11/10/98	377		
Arkansas at Garden City, KS	11/11/98	367		
Arkansas at Garden City, KS	11/12/98	363		
Arkansas at Garden City, KS	11/13/98	344		
Arkansas at Garden City, KS	11/14/98	358		
Arkansas at Garden City, KS	11/15/98	354		
Arkansas at Garden City, KS	11/16/98	354		
Arkansas at Garden City, KS	11/17/98	335		
Arkansas at Garden City, KS	11/18/98	322		
Arkansas at Garden City, KS	11/19/98	305		
Arkansas at Garden City, KS	11/20/98	280		
Arkansas at Garden City, KS	11/21/98	292		
Arkansas at Garden City, KS	11/22/98	305		
Arkansas at Garden City, KS	11/23/98	314		
Arkansas at Garden City, KS	11/24/98	314		
Arkansas at Garden City, KS	11/25/98	296		
Arkansas at Garden City, KS	11/26/98	280		
Arkansas at Garden City, KS	11/27/98	280		
Arkansas at Garden City, KS	11/28/98	264		
Arkansas at Garden City, KS	11/29/98	264		
Arkansas at Garden City, KS	11/30/98	245		

Enclosure 7

Exhibit 15

Annual Meeting

December 7, 1999

Comparison of Two Approaches for Determining Ground-Water Discharge and Pumpage in the Lower Arkansas River Basin, Colorado, 1997–98

By Russell G. Dash, Brent M. Troutman, and Patrick Edelmann

U.S. GEOLOGICAL SURVEY

Water-Resources Investigations Report 99–4221

Prepared in cooperation with the
COLORADO DEPARTMENT OF NATURAL RESOURCES,
DIVISION OF WATER RESOURCES,
OFFICE OF THE STATE ENGINEER

Denver, Colorado
1999

Exhibit 15

U.S. DEPARTMENT OF THE INTERIOR
BRUCE BABBITT, Secretary

U.S. GEOLOGICAL SURVEY
Charles G. Groat, Director

For additional information write to:

District Chief
U.S. Geological Survey
Box 25046, Mail Stop 415
Denver Federal Center
Denver, CO 80225–0046

Copies of this report can be purchased from:

U.S. Geological Survey
Information Services
Box 25286
Federal Center
Denver, CO 80225

CONTENTS

FIGURES

TABLES

CONVERSION FACTORS AND ABBREVIATIONS

Multiply	By	To obtain
acre-foot (acre-ft)	1,233	cubic meter
foot (ft)	0.3048	meter
gallons per minute (gal/min)	0.00379	cubic meter per minute
inch (in.)	2.54	centimeter
kilowatthour (kWh)	3,600,000	joule
kilowatthour per acre-foot	2,919	joule per cubic meter

The following terms and abbreviations are used in this report:

Power Conversion Coefficient (PCC)
Totalizing Flowmeter (TFM)
Colorado Division of Water Resources (CDWR)
U.S. Geological Survey (USGS)

Method of Portable Flowmeter:

C (Collins flowmeter)
M (McCrometer flowmeter)
P (Polysonic flowmeter)

Make of Inline Totalizing Flowmeter:

M (new McCrometer TFM)
S (new Signet TFM)
X (existing McCrometer TFM)
B (existing Badger TFM)
R (existing Rockwell TFM)

Type of Discharge Distribution System:

O (open)
L (low-pressure)
S (sprinkler)
C (complex)

Comparison of Two Approaches for Determining Ground-Water Discharge and Pumpage in the Lower Arkansas River Basin, Colorado, 1997–98

By Russell G. Dash, Brent M. Troutman, *and* Patrick Edelmann

Several sections of this report contain detailed mathematical derivations and statistics. To facilitate reading and use of this report, the report is organized in a manner that presents the primary results first, then the detailed mathematical derivations and statistics in the sections that follow titled "Details of Analysis and Results". For those readers who are interested only in the primary results, rather than the derivations and details, they may wish to read the sections titled "Primary Results" and skip the sections titled "Details of Analysis and Results".

EXECUTIVE SUMMARY

Introduction

In March 1994, the Colorado Division of Water Resources (CDWR) adopted "Rules Governing the Measurement of Tributary Ground Water Diversions Located in the Arkansas River Basin" (Office of the State Engineer, 1994); these initial rules were amended in February 1996 (Office of the State Engineer, 1996). The amended rules require users of wells that divert tributary ground water to annually report the water pumped monthly by each well. The rules allow a well owner to report the pumpage measured by a totalizing flowmeter (TFM) or pumpage determined from electrical power data and a power conversion coefficient (PCC) (Hurr and Litke, 1989).

Opinions by representatives of the State of Kansas, presented before the Special Master hearing a court case [State of Kansas v. State of Colorado, No. 105 Original (1996)] concerning post-Compact well pumping, stated that the PCC approach does not provide the same level of accuracy and reliability as a TFM when used to determine pumpage.

In 1997, the U.S. Geological Survey (USGS), in cooperation with the CDWR, began a 2-year study to compare ground-water pumpage estimates made using the TFM and the PCC approaches. The study area was along the Arkansas River between Pueblo, Colorado, and the Colorado-Kansas State line (fig. 1).

The two approaches for estimating ground-water discharge and pumpage were compared for more than 100 wells completed in the alluvial aquifer of the Arkansas River Basin. The TFM approach uses an inline flowmeter to directly measure instantaneous discharge and the total volume of water pumped at a well. The PCC approach uses electrical power consumption records and a power conversion coefficient to estimate the pumpage at ground-water wells.

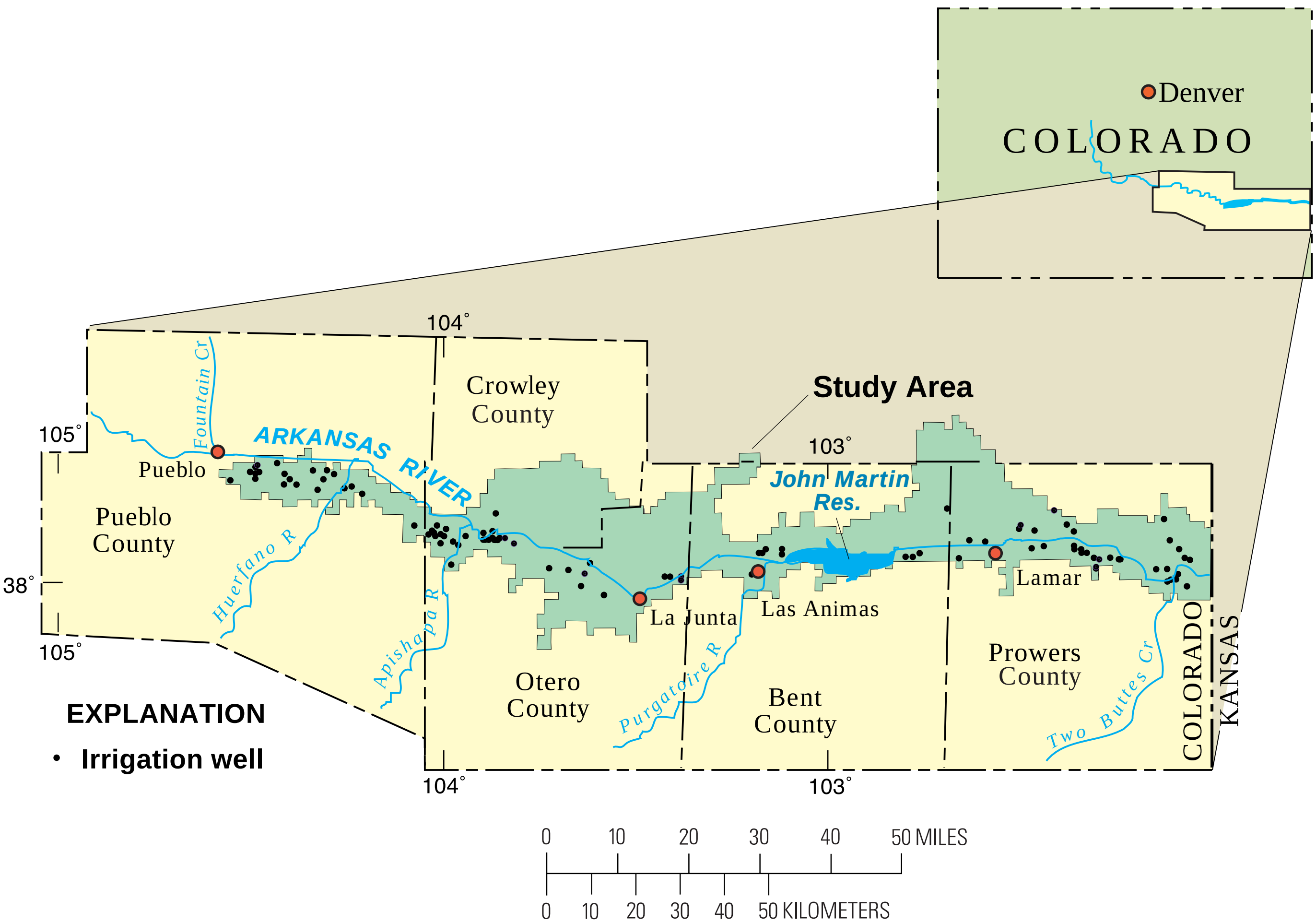

Figure 1. Map showing location of study area and irrigation-wells used in the study, 1997–98.

This executive summary describes the results of the comparison of the two approaches. Specifically, (1) the differences in instantaneous discharge measured with three portable flowmeters and measured with an inline TFM are evaluated, and the statistical differences in paired instantaneous discharge between the two approaches are determined; (2) short- and long-term variations in the PCC's are presented; (3) differences in pumpage between the two approaches are evaluated, and the statistical differences in pumpage between the two approaches are determined; (4) potential sources of discrepancy between pumpage estimates are discussed; and (5) differences in total network pumpage using the two approaches are presented.

During the irrigation seasons of 1997 and 1998, instantaneous discharge and electrical power demand were measured at randomly selected wells to determine PCC's. At more than 100 wells, the PCC's determined during the 1998 season were applied to total electrical power consumption data that was recorded between the initial and final readings at each network well site in 1998 to estimate total ground-water pumpage.

At each site, an inline TFM was installed in a full-flowing, acceptable test section of pipe on the discharge side of the pump where the measurement of discharge was made. Measurements of instantaneous ground-water discharge also were made using three different types of portable flowmeters. The average velocity multiplied by the cross-sectional area of the discharge pipe was used to compute the discharge in gallons per minute. Whenever possible, discharge measurements were made at each network site using all three types of portable flowmeters.

Comparison of Instantaneous Ground-Water Discharge Measurements

Instantaneous discharges measured using portable flowmeters were compared to instantaneous discharges measured using TFM's. The analysis is based on 747 paired measurements taken at 105 wells during a 2-year period. A mixed analysis of variance model with both fixed and random effects was applied. The overall mean difference in discharge measurements between portable flowmeters and TFM's was 0.00 percent, indicating no difference on average between the two approaches for the entire network of wells. More than 80 percent of the differences in the paired discharge measurements were less than 10 percent.

Temporal Variations in Power Conversion Coefficients

Analysis of variations in PCC's measured during the 1998 irrigation season indicated that 58 percent of 104 wells had less than 10-percent change, and 86 percent of 104 wells had less than 20-percent change in the well PCC's. Seasonal variations in PCC's generally were not evident for the measurements made during the 1998 irrigation season. Thirty-seven of the 41 wells with PCC's measurements in 1997 had at least one PCC in the same range as 1998 PCC measurements. The comparison of the 2 years of data indicate that PCC measurements were similar in 1997 and 1998. About 48 percent of available pre-study State-approved PCC's made during 1994–97 were within 10 percent of the 1998 site average PCC's, and about 67 percent of the pre-study State-approved PCC measurements made during 1994–97 were within 20 percent of the 1998 site average PCC's.

Comparison of Ground-Water Pumpage Estimates

Pumpage estimates computed using the PCC approach were compared to pumpage measured by a TFM at network wells. PCC pumpages were computed by applying each PCC obtained during a site visit in 1998 to the total 1998 electrical power consumption. The analysis was based on 553 paired pumpage estimates at 103 wells. The overall mean difference in pumpage between the TFM and PCC approach was 0.01 percent for the entire network of wells, indicating no significant difference on average between pumpage measured by a TFM and pumpage computed by the PCC approach. About 80 percent of the differences in the paired pumpage estimates were less than 10 percent.

Sources of Discrepancy Between Pumpage Estimates

There are several potential sources of discrepancy between pumpage as measured by a TFM and pumpage as computed by the PCC approach. One potential source is temporal variability of the PCC. The analysis indicated that the year-to-year variance component was about nine times the date-within-year variance component and represented a standard deviation of about 15 percent, indicating that the year-to-year variability was a major component of overall variability for this PCC data set.

Estimation of Total Network Pumpage

Differences in the total or aggregated pumpage for a network of wells was estimated by dividing the range of TFM pumpage into equal subdivisions based on the magnitude of TFM total pumpage. Because the correct number of subdivisions (strata) is not known with information now available, the mean and standard deviation of differences in the total pumpage was determined conditionally for several numbers of strata. For a network of 103 wells and a number of strata greater than 10, the resulting mean and standard deviation indicates that, for any given year, there is a 95-percent probability that the difference in aggregated pumpage between the TFM and PCC approaches would be between about –3.41 and 1.59 percent. The analysis indicates that the difference in aggregated pumpage would be expected to be smaller as the total number of wells becomes larger.

INTRODUCTION

Irrigation is the largest use of water in southeastern Colorado, and ground water is a supplemental source for irrigators in the Arkansas River Basin because surface-water supplies in the basin are inadequate to meet irrigation demand. During the past 40 years, ground-water withdrawals were occasionally measured (Luckey, 1972) but were not routinely metered. Some estimates of ground-water withdrawals were reported (Litke and Appel, 1989). However, the accuracy of the ground-water withdrawal estimates were not known.

In March 1994, the Colorado Division of Water Resources (CDWR) adopted “Rules Governing the Measurement of Tributary Ground Water Diversions Located in the Arkansas River Basin” (Office of the State Engineer, 1994); these initial measurement rules were amended in February 1996 (Office of the State Engineer, 1996). The “Amendments to Rules Governing the Measurement of Tributary Ground Water Diversions Located in the Arkansas River Basin” were approved in June 1996 and require that about 1,600 wells that divert tributary ground water must annually report the water pumped monthly by each well. The rules allow a well owner the option of reporting pumpage measured by a totalizing flowmeter (TFM) or estimated using electrical power consumption data and a power conversion coefficient (PCC) (Hurr and Litke, 1989). The inline TFM and the PCC rating must be checked at least once every 4 years by a person approved by the State Engineer. A TFM is an inline flowmeter that directly measures the total volume of water pumped from the well. The PCC approach uses measurements of instantaneous ground-water discharge, hereinafter referred as instantaneous discharge, and instantaneous electrical power demand, hereinafter referred as power demand, to determine the number of kilowatthours of energy required to pump 1 acre-foot of water. Since 1994 when the rules became effective in the river basin, most well owners have chosen to use the PCC approach to determine ground-water pumpage from their irrigation wells.

Opinions by representatives of the State of Kansas, presented before the Special Master of the U.S. Supreme Court hearing a case (State of Kansas v. State of Colorado, No. 105 Original (1996)) concerning well pumping after approval of the Arkansas River Compact of 1948, stated that the PCC approach does not provide the same level of accuracy and reliability as the TFM’s when used to determine annual ground-water pumpage. Thereafter, the Colorado State Engineer proposed a study to determine the comparability of estimates of ground-water pumpage using the TFM and PCC approaches. In 1997, the U.S. Geological Survey (USGS), in cooperation with the Colorado Department of Natural Resources, Division of Water Resources, Office of the State Engineer (CDWR), began a 2-year study to compare ground-water pumpage estimates made using the TFM and PCC approaches. The study area was the Arkansas River alluvial valley between Pueblo, Colorado, and the Colorado-Kansas State line (fig. 1).

Purpose and Scope

This report provides a comparison of two approaches for determining ground-water discharge and pumpage. Specifically, this report:

1. Evaluates differences in instantaneous discharge between TFM’s and three portable flowmeters used with the PCC approach, and determines if differences in instantaneous discharge for the TFM and PCC approach are statistically significant;
2. Evaluates short- and long-term variations in PCC’s, including whether seasonal variations in PCC’s were evident;
3. Evaluates differences in ground-water pumpage estimated with the TFM and PCC approaches, and determines if differences in ground-water pumpage estimated with the TFM and PCC approaches are statistically significant;
4. Evaluates potential sources of discrepancy between pumpage estimates; and
5. Estimates differences in total network pumpage using the two approaches.

One hundred and six irrigation wells that are powered by electric pumps were selected for this study from about 1,300 irrigation wells in the study area. The network of 106 irrigation wells consisted of 11 wells that had TFM’s installed prior to the study and 95 randomly selected wells that had new TFM’s installed during 1997–98. During the irrigation season of 1997, instantaneous discharge was measured at 46 wells (43 of which had TFM’s in 1997) and, during 1998, at 105 wells. One irrigation well was dropped from the network following the 1997 irrigation season because the well owner had reconfigured the discharge distribution system and combined the plumbing of two wells together. This activity created a complex well that was not suitable under the amended rules for Rule 3.6 analyses (Office of the State Engineer, 1996), making the well unacceptable for the continued application of a PCC to determine ground-water pumpage.

During the study, PCC's were calculated each time a portable flowmeter measurement of the instantaneous discharge and power demand were made at a well. At 104 of the wells, PCC's determined during the 1998 irrigation season were applied to the total electrical power consumption recorded between the initial and final readings at the site in 1998 to estimate total ground-water pumpage for the period. The total pumpage estimate derived using the PCC calculation then was compared to the total pumpage measured using the TFM at 104 wells. However, pumpage data from one well were omitted because it was determined that the existing TFM (make R) was not working properly, which resulted in 103 wells that were used for comparison of ground-water pumpage.

Acknowledgments

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METHODS OF INVESTIGATION

Data collection and analysis consisted of several phases: (1) Identification of potential sites; (2) selection of sites for TFM/PCC comparisons; (3) installation of the TFM's; (4) measurement of instantaneous discharges; (5) determination of PCC's; (6) computation of ground-water pumpage using TFM and PCC approaches; and (7) analysis of data.

Initially, the CDWR identified more than 1,300 large-capacity irrigation wells (wells that discharge more than 50 gal/min) in the Arkansas River Valley between Pueblo, Colorado, and the Colorado-Kansas State line for which the PCC approach might be used to determine ground-water pumpage under the amended rules established by the Office of the State Engineer (1996). This initial list of wells was decreased to about 800 potential sites for TFM/PCC consideration based on the following criteria:

1. The well was reported as active and was connected to a power source.
2. The well used an electric motor, as opposed to an internal combustion engine.
3. The well had at least 10 acre-ft of reported annual pumpage at least once since 1994.

A computer program (Scott, 1990) was used to randomly select one primary and four alternative sites for each potential well in the TFM/PCC network. Each primary site was evaluated by CDWR and inventoried to determine its suitability for inclusion in the TFM/PCC study. If a primary site was rejected, a randomly selected alternative site was evaluated and so on down the list of alternatives until a suitable site was found. During 1997, CDWR evaluated 107 wells for potential TFM installation; in 1998, CDWR evaluated 122 wells for additional TFM installations. The most common reasons for rejection and the total number of well sites rejected during 1997–98 were as follows:

1. The site was determined to be a complex system and was found unsuitable for Rule 3.6 analyses, or the site was determined to be a compound system, or the owner indicated future modifications were planned that would make the site unsuitable for continued application of the PCC approach. Compound system means that more than one electrical device is being operated from the same electrical power meter. (38 wells rejected)
2. The discharge pipe was in poor physical condition, the pump surged or was unable to maintain a full pipeline of flow at a measurement section, or

there was inadequate upstream or downstream distances available to correctly install a TFM. (32 wells rejected)

3. The well owner declined to participate in the TFM/PCC study. (19 wells rejected)
4. The well had less than 10 acre-ft of pumpage reported the previous year. (12 wells rejected)
5. The well appeared to be inactive, and the owner indicated it was not used. (9 wells rejected)
6. The discharge pipe was not a correct size for installation of a Signet TFM (one of the brands of TFM used in the study). Pipe was smaller than 8-inch diameter during 1997, or smaller than 6-inch diameter during 1998, or was larger than 12-inch diameter during either year. (24 wells rejected)

In 1997, permission to measure discharge at 46 wells was obtained, including 11 wells that had pre-existing TFM's and 35 wells where new TFM's were planned to be installed during the 1997 irrigation season. During 1997, discharge measurements of installed TFM's were made at 43 of the 46 wells in the monitoring network. One new TFM was not installed until the end of the 1997 irrigation season, and two of the new TFM's were returned to the factory for calibration and were not reinstalled until after the 1997 irrigation season. One pre-existing TFM well was reconfigured to a complex system after the 1997 irrigation season and was dropped from the study. During 1998, permission to install TFM's and measure discharge at 60 additional wells was obtained. The changes resulted in a final monitoring network of 105 wells having TFM's. However, upon evaluation of the data, an electric power meter at one site was found to be malfunctioning, resulting in 104 wells being used for analysis of variations in PCC's; and a TFM was found to be malfunctioning at another site, resulting in 103 wells being used to compare groundwater pumpage.

Each well in the network was visited to identify discharge system characteristics and to confirm that the PCC approach could be properly applied at the well in accordance with the amended rules (Office of the State Engineer, 1996). When possible, well owners and operators were interviewed and information was collected about normal operating conditions, flow ranges and pressures, and number of discharge distribution outlet locations. Well-identifying data were recorded from the motor, pump, and electrical meter nameplates during the visit.

The CDWR made an onsite identification of the type of discharge distribution system at each of the wells in the network, based on a visual observation of the discharge plumbing during the initial visit, which was confirmed before making subsequent field measurements. For this study, four major types of discharge distribution systems were identified. The well network included 65 open-discharge, 18 low-pressure, 10 sprinkler, and 12 complex discharge distribution systems. Hereinafter, the open-discharge distribution system type is referred to as type O, the low-pressure discharge distribution system type is referred to as type L, the sprinkler discharge distribution system type is referred to as type S, and the complex discharge distribution system type is referred to as type C.

According to the CDWR, well sites that are classified as complex systems will vary the total dynamic head (TDH) at the pump during the irrigation season. The change in TDH may result from wells that discharge into a pipeline with multiple outlet locations, multiple wells that discharge into one common pipeline, or wells where the method of water delivery changes between different types of distribution systems, such as open-discharge and sprinkler systems. The complex discharge sites that were included in the study network were sites where the wells discharged into a pipeline with more than one point of discharge (multiple outlet locations). As such, these sites qualified for use of the PCC approach pursuant to Rule 3.6 of the amended rules (Office of the State Engineer, 1996). For such sites, a PCC measurement was determined under the high TDH discharge point and a second PCC measurement determined under the low TDH discharge point; and a system PCC was calculated that was weighted on the basis of the PCC's at the discharge points and the expected crop water demand at each discharge point.

Totalizing Flowmeter Measurements

The accuracy of many factory-calibrated TFM's is reportedly 2 to 3 percent of discharge (M.H. Noffke, Great Plains Meter, Inc., written commun., 1998). To obtain an accuracy of 2 to 3 percent of discharge, a

TFM must be installed correctly, following the manufacturer's specifications. At each selected well, a TFM was installed inline in a full-flowing, acceptable test section of pipe on the discharge side of the pump where the measurement of water velocity was made. The flowmeter location was in a straight, constant-diameter length of pipeline without turbulence-inducing obstructions (elbows, valves, pumps, and changes in pipe diameter) for a certain distance upstream and downstream from the flowmeter installation point. The distances required usually were related to the diameter of the discharge pipe at the measurement location. The desired distance upstream for any flowmeter without a straightening vane installed was 10 pipe diameters and for flowmeters with a straightening vane was 5 pipe diameters. At some wells, slight plumbing modifications, such as adding a pipe elbow, were made to the discharge pipe downstream from the flowmeter measurement location to maintain the required full-flowing condition in the pipe.

Two types of TFM's installed during this study were: (1) the propeller flowmeter manufactured by McCrometer, hereinafter referred to as make M; and (2) the rotating-blade flowmeter manufactured by Signet Scientific Corporation, hereinafter referred to as make S. The pre-existing types of TFM's were: (1) the propeller flowmeter manufactured by McCrometer, hereinafter referred to as make X; (2) the propeller flowmeter manufactured by the Badger Corporation, hereinafter referred to as make B; and (3) the propeller flowmeter manufactured by the Rockwell Corporation, hereinafter referred to as make R.

Twenty of the TFM's installed during this study were a prototype, rotating-blade flow sensor developed by the Signet Scientific Company (Tim Quinlin, George Fischer Inc., oral commun., 1999). Because of design-development limitations, the 10 Signet TFM's installed in 1997 were in irrigation wells that had a discharge pipe with a diameter of 8 in. or more, and the 10 installed in 1998 were in wells that had a discharge pipe with a diameter of 6 in. or more.

The cumulative volume pumped, as indicated by readings of the TFM's, was recorded on an irregular basis. During a site visit, a well discharge measurement was made by reading the register dials of the TFM and timing the index wheel for one complete revolution, then dividing the indicated volume by the elapsed time; the procedure was repeated nine more times; the recorded discharge was the average of the 10 values. The volume of water pumped between site visits was determined by recording the register dials of the TFM at the beginning of each visit. The total volume of water pumped at a study site during 1998 was determined as the difference between TFM readings made at the beginning and the end of the monitoring period.

Portable Flowmeter Measurements

During each site visit, electrical power measurements and other onsite information were recorded, and measurements of instantaneous discharge were made using as many as three different types of portable flowmeters—a manometer, an ultrasonic flowmeter, and a propeller-type meter. These portable flowmeters provided three different methods to determine the average velocity of water flowing through the discharge pipe. The average velocity, multiplied by the cross-sectional area of the discharge pipe, was used to compute the discharge in gallons per minute. Whenever possible for the PCC tests, instantaneous discharge measurements were made using all three portable flowmeters during each site visit. All PCC test measurements were made after the drawdown of the pumping water level had stabilized.

To compute well discharge for two of the three portable flowmeter types (manometer and ultrasonic flow meters), the inside pipe diameter was needed; therefore, throughout the study, inside pipe-dimension measurements were made consistently. The pipe-wall thickness was measured during each site visit using an ultrasonic thickness gage. The outside circumference of the discharge pipe was determined using a thin, flexible metal tape.

The first type of portable flowmeter, a manometer, measures differences in water pressure in an upstream and downstream direction and could be used in all the discharge pipe sizes in this study. A device referred to as a "Collins Meter", hereinafter referred to as method "C", was used to determine the average water-velocity distribution across the inside of the discharge pipe. A pitot tube that had two orifices (one oriented upstream and one oriented downstream) was inserted across the diameter of the discharge pipe and a manometer used to measure the pressure difference between the dynamic (upstream) and static (downstream) orifices at two different points in the pipe's cross section. The measured pressure difference is proportional to the water velocity, and mean water velocity multiplied by the cross-sectional area of the pipe is the instantaneous discharge.

The second type of portable flowmeter was an ultrasonic flowmeter. Typical accuracy of an ultrasonic flowmeter is reportedly 1 to 5 percent (Omega Engineering Inc., 1992). An ultrasonic flowmeter manufactured by Polysonic, hereinafter referred to as method “P”, was used in this study and uses the transit-time method for flow measurement. Two transducers were mounted on the outside of the discharge pipe and functioned alternately as a transmitter and a receiver of ultrasonic signals sent upstream and downstream through the pipe. The time difference between the signals, averaged in the upstream and downstream directions, is proportional to the velocity of water flow. The flowmeter was programmed to process the information and output a discharge value every minute. Generally, 10 or more of the discharge readings were averaged to obtain the instantaneous discharge. Diagnostic menus were used to determine the acceptability during each test. Diagnostic parameters such as signal strength and a difference count were supplied by the equipment and had to be within specified limits to be a valid well discharge measurement.

The third portable flowmeter was a typical propeller-type flowmeter manufactured by McCrometer, hereinafter referred to as method “M”. The propeller-type flowmeter was mounted to the end of a section of plastic pipe with sufficient upstream length and attached with a rubber coupler to the open end of the discharge pipe to make a discharge measurement. During each site visit, well discharge measurements were made with a method M portable flowmeter by reading registers dials of the TFM and timing the index wheel for one complete revolution, and dividing the indicated volume by the elapsed time. Generally, 10 readings were made at each site and the recorded discharge was the average of the 10 values.

Power Conversion Calculations and Computations of Pumpage

The PCC is defined as the number of kilowatthours required to pump 1 acre-ft of water. Electrical power meters contain a disk that revolves as electricity passes through the meter. During a site visit, the meter disk was timed with a stopwatch for 10 complete disk revolutions to measure the rate per revolution. This rate measurement was repeated three times and used to determine the average rate of a disk revolution. Power demand, in kilowatts, was calculated from the equation:

$$\text{power demand} = (\text{rate}) \times (3.6) \times (\text{Kh factor}), \qquad (1)$$

where

rate = average time of disk revolution, in revolutions per second,

3.6 = conversion factor (kilowatt seconds per watthour), and

Kh factor = watthours per revolution (imprinted on the front of power meter).

Determining the PCC combines a concurrent measurement of well discharge (in gallons per minute) with the power demand of the pump (in kilowatts).

The PCC, in kilowatthours per acre-foot, is then calculated from the equation:

$$\text{PCC} = (\text{power demand}) \times (5433)/(\text{well discharge}), \quad (2)$$

where

5433 = conversion factor (in gallon hours per acre-foot minutes), and

well discharge = instantaneous ground-water discharge, in gallons per minute.

A PCC was computed for every instantaneous discharge measurement that was made at a well. The PCC’s derived in 1997 and in 1998 were used to evaluate temporal variations in the PCC data. However, because the majority of PCC’s were measured late in the 1997 irrigation season, only the PCC’s determined from the 1998 measurements were used to compute ground-water pumpage estimates for each well and to compare differences in total pumpage between the TFM and PCC approaches.

Pumpage estimates were calculated using every PCC measurement made at a well during 1998. This was done by dividing the total 1998 power consumed, in kilowatthours, by each unique PCC measurement made at the well during 1998. The number of kilowatthours used between onsite visits was determined by reading the electric meter at the beginning of a site visit. The total electrical power used was determined from readings of the electrical meter at the beginning and end of a monitoring period. The same TFM monitoring period was used with each PCC in 1998 for determining the TFM pumpage at each site.

Quality Control of Data

Data for this study were collected by CDWR personnel and transmitted to the USGS in electronic and paper files for data analysis. Several procedures were used to check the quality of the data. Quality-control checks consisted of developing a form (referred to as a field form) to be completed onsite during each site visit, making periodic site visits with CDWR personnel to observe onsite data collection, reviewing field forms for completeness, and comparing electronic data to written data recorded on the field forms.

Personnel from the USGS visited the sites to ensure that TFM's were installed according to the manufacturer's specifications. In addition, USGS personnel periodically visited selected sites with CDWR personnel to ensure that field techniques were being used correctly. During these visits, USGS personnel checked that (1) site information and essential test information were documented on field forms, (2) multiple water-level measurements were made to confirm that the pumping water level had not changed more than 10 percent in the hour prior to making a well discharge measurement and collecting the PCC data, (3) portable flowmeter discharge measurements were done properly, (4) consistent methods were used in measuring TFM discharge, and (5) electrical power meter measurements were consistently determined.

Field forms were used to document various characteristics of network wells. Site identifier, test date, and test methods used at each well during a PCC measurement also were recorded on field forms. Other data recorded on the field forms included a description of the discharge test procedures used and any type of problem during the measurement, instantaneous discharge (pumping rate), static and pumping water-level measurements, and PCC's determined for each portable flowmeter method used during a site visit. Personnel from the USGS reviewed the field forms for completeness, tabulations, and consistency with established collection procedures. About 10 percent of the electronic data were verified against copies of the original field forms, and all electronic data were scrutinized for anomalous data.

In addition to these quality-control measures, the three types of portable flowmeters used in the study were tested at the Great Plains Meter, Inc., facility in Aurora, Nebraska, before the start of the 1998 irrigation season. The accuracy of the method P portable flowmeter was checked by releasing a known volume of water three times through the test apparatus at the facility, while total elapsed time was measured to calculate an average rate of discharge. The discharge measured by the method P portable flowmeter for each timed release ranged from 99 to 101 percent of the known discharge. The accuracy of the method C portable flowmeter was checked by maintaining a constant flow of water through the test section at the facility. The method C portable flowmeter was installed in a straight length of pipe, and manometer readings were taken at two points in the cross section of the pipe. The instantaneous discharge measured by the method C portable flowmeter ranged from 103 to 104 percent of the discharge measured by a flowmeter installed in the test section at the facility. The test facility did not make any calibration adjustments to either the method P or the method C portable flowmeters. Because the measurements using method P and method C portable flowmeters were within 5 percent of known values, no adjustments were made to the well discharge data collected with these portable flowmeters.

The accuracy of each method M portable flowmeter was checked using a one-point flow test and then calibrated using a three-point flow test. The rate of flow used during these tests ranged from about 100 gal/min for the 4-in. flowmeter, to about 3,000 gal/min for the 10-in. flowmeter. After calibration adjustments, the flows measured by the method M portable flowmeters ranged from 98 to 102 percent of the known flows.

Overview of the Statistics Used for Comparing Discharge and Pumpage

A statistical procedure known as analysis of variance was used to make comparisons of well discharge and pumpage made using the TFM's and the PCC approaches. These comparisons were made by computing the differences in well discharge and pumpage between the two different approaches. The analysis of variance evaluates whether the average or mean difference in values is statistically different and identifies the sources of variation in the data set (Iman and Conover, 1981). A necessary assumption about the analysis of variance model is that the probability distribution of the data is normal. This is a common assumption made when applying statistical models, but it is an assumption that may not be true for many water-resources data sets. One reason a normality assumption is useful is that the normal distribution is characterized by the mean and variance (which is the standard deviation squared). The mean is a measure of central tendency of the random variable, and the variance is a measure of magnitude of random variability. Given the mean and variance, probability statements may be expressed in terms of these parameters; for example, a normally distributed random variable is with probability 0.95 within 1.96 standard deviations of the mean. Another necessary assumption about the analysis of variance model is that the variances are constant.

During data analysis, differences for every well discharge and pumpage estimate initially were computed by subtracting the well discharge or pumpage estimates associated with the PCC approach at each well from the well discharge or pumpage associated with the TFM measured at the same well on the same date. An analysis of the differences computed in this manner indicated that the assumptions of normality and equal variances were not met. Therefore, a transformation of the differences was done by subtracting the natural logarithm of well discharge or pumpage associated with the PCC approach from the natural logarithm of the well discharge or pumpage associated with the TFM. The resulting differences were normally distributed, and the variances were equal for well discharge. However, the differences in pumpage were not normally distributed. Thus, a rank transformation was performed on the differences in pumpage. This consisted of ranking all of the individual differences, and then applying the analysis of variance model to the ranks. The rank transformation for a sample of n observations replaces the smallest observation by the integer 1 (called the rank), the next smallest by rank 2, an so on until the largest observation is replaced by rank n. Using ranks diminishes the influence of the outlying values on the final results. A consequence of doing this is that the final results of the analysis reflect the behavior of the majority of the data points, but the influence of the outlying values has been diminished. An inverse rank transformation (linear approximation) to the results of the analysis of variance was then done, resulting in estimates of the mean or central tendency of the distribution of differences in pumpage. However, data outliers may well have a significant effect in situations for which properties of the probability distribution other than central tendency are important.

The natural logarithmic transformation that was applied to the data has another useful property that makes it appropriate for analyzing this data set. Differences in logarithmically transformed variables are equivalent to relative or fractional differences rather than to absolute differences. Relative differences are an informative way to evaluate differences in well discharge and pumpage. In essence, for small differences, the relative differences, which is the difference in natural log transformed variables, multiplied by 100 times, is nearly equivalent to percent difference. Tornqvist and others (1985) provide a more complete discussion of the advantages of using the log transformation to evaluate relative differences.

During data analysis, various site characteristics, hereinafter called fixed effects (method of discharge measurement, make of TFM, and discharge distribution type) were identified as sources of variation. Additionally, the site, date, and random error, hereinafter called random effects, were identified as sources of variation. Therefore, it was necessary to take these additional sources of variation into consideration when making comparisons of well discharge and pumpage.

COMPARISON OF INSTANTANEOUS GROUND-WATER DISCHARGE MEASUREMENTS

A comparison of the instantaneous discharge measurements using the TFM's to those using the three portable flowmeters was made by evaluating the differences between the measurements and by determining whether the differences are statistically significant. Because it was determined that the method of discharge measurement, make of TFM, discharge distribution type, and the site, date, and random error were identified as sources of variation, an additional level of data analysis was required.

This section of the report presents (1) the magnitude in differences in well discharge; (2) an estimate of the overall mean difference in well discharge and whether the overall mean difference is significantly different from zero; (3) an estimate of the mean differences for each combination of portable flow meter, make of TFM, and discharge distribution type, and whether these mean differences are significantly different from zero; and (4) how much of the variation in the differences is attributable to the site-to-site, date, and random error components. The comparison of ground-water discharge measurements was based on 747 paired measurements taken at 105 wells during a 2-year period.

Primary Results

Analysis of variance was used to evaluate logarithmically transformed differences between instantaneous discharge measured with portable flowmeters and instantaneous discharge measured with a TFM. The analysis was applied to 747 paired discharge measurements made at 105 wells during the 2-year period. More than 80 percent of the differences were less than 10 percent. The overall mean difference was 0.0 percent, indicating no difference on average between portable flowmeter and TFM discharge measurements. For varying site characteristics (the method of portable flowmeter, the make of TFM, and type of discharge distribution system), mean differences range from –4 percent to 4 percent.

Details of Analysis and Results

For each paired discharge measurement, the difference in well discharge (*diffQ*) was computed as:

$$diffQ = \log(\tilde{Q}) - \log(Q), \qquad (3)$$

where $\tilde{Q}$ denotes an instantaneous discharge measurement made using a portable flowmeter at a particular site on a particular date, and Q denotes a corresponding (paired) instantaneous discharge measurement made using a TFM at the same site on the same day. (All logarithms in this report are base e.)

The relation between *diffQ* and Q is shown in figure 2*A*, and the relation between differences in the untransformed discharge, $\tilde{Q} - Q$, and Q is shown in figure 2*B*. There is a marked tendency in figure 2*B* for variability in differences to increase as Q increases. That is, although untransformed differences generally tend to be centered around an average value of zero, the variance of untransformed differences tends to increase with the magnitude of the discharge. In contrast, the differences in log-transformed discharges have variance that is much more nearly constant for the entire range of well discharge values (fig. 2*A*).

As mentioned earlier in the report, the natural logarithmic transformation of the discharges allows *diffQ* to be interpreted as a relative or fractional difference between discharges, and for small differences between $\tilde{Q}$ and Q,

$$diffQ \approx \frac{\tilde{Q} - Q}{Q} \approx \frac{\tilde{Q} - Q}{\tilde{Q}}. \qquad (4)$$

Thus, *diffQ* multiplied by 100 may be interpreted as a percent difference.

Each measurement of Q and $\tilde{Q}$ is made under certain conditions; changes in these conditions may cause the distribution (that is the mean and variance) of *diffQ* to change in a systematic way. Each discharge measurement $\tilde{Q}$ is made with a particular type of flowmeter. There are three portable flowmeters used, resulting in three “levels” associated with this factor. Likewise, the TFM’s made by different manufacturers may affect the distribution of *diffQ*. Finally, each pair of measurements is made on a particular type of discharge distribution system, so any systematic effect of this factor also may be important. Therefore, the effects associated with these three factors: portable flowmeter method, make of the TFM, and type of discharge distribution system were included in the analysis of variance. (These three factors will hereinafter be referred to as simply method, make, and type.)

In addition to method, make, and type, there are two other conditions that can affect *diffQ*; these are site and date. For example, it is important to know whether *diffQ* at a certain site tends to be consistently larger or smaller than values at other sites. Similarly, there may a tendency for *diffQ* to be larger or smaller on certain dates at a given site. In analysis of variance, effects may be treated as either random or fixed. The site and date effects are treated as random, whereas the method, make, and type effects are treated as fixed,

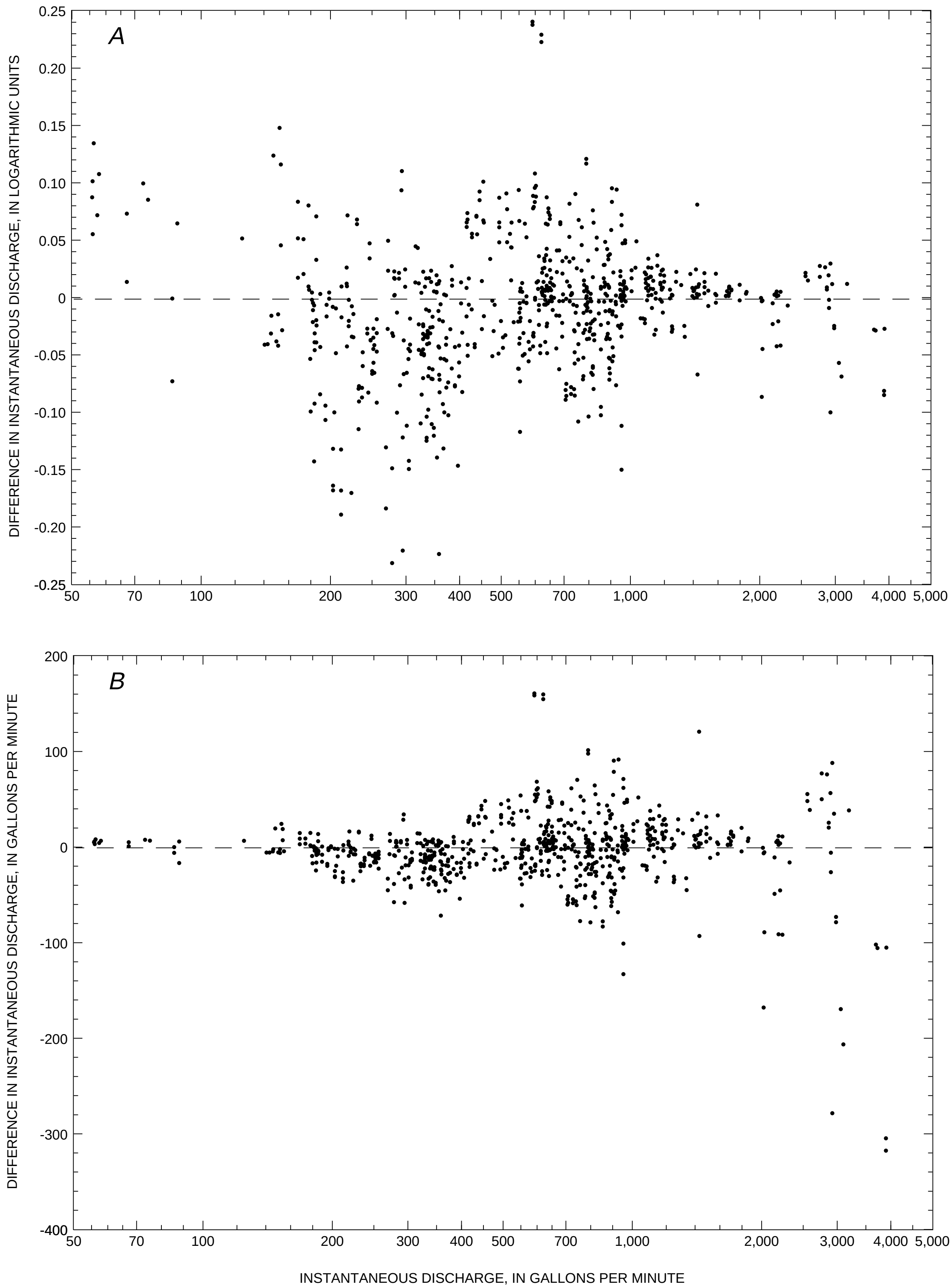

Figure 2. Graphs showing relation of instantaneous discharge measurements from totalizing flowmeter to the differences in instantaneous discharge measurements between portable flowmeters and totalizing flowmeters, expressed (*A*) in logarithmic units and (*B*) in gallons per minute.

and the overall model for *diffQ* is, therefore, known as a mixed model. (See, for example, Snedecor and Cochran (1967) for a more detailed discussion of the distinction between fixed and random effects.) The random effects associated with site and date each have a variance (known as variance components), and the variance of *diffQ* thus is the sum of three constituent terms: the site variance, the date variance, and an error variance, which represents variability (such as measurement error) that is not accounted for by any known factors.

Therefore, a mixed analysis of variance model with both fixed and random effects was applied as follows: The three fixed (nonrandom) effects of interest were: (1) method, with levels P, C, and M; (2) make, with levels M, S, X, and B; and (3) type, with levels O, L, S, and C. The eight values for make R were not included in the analysis because the differences in instantaneous discharge were so much greater in magnitude than all the other values. Boxplots for all the discharge data pooled and for each level of the three fixed effects are shown in figure 3. More than 80 percent of the differences in the paired discharge measurements for the entire network of wells were less than 10 percent, more than 50 percent of the differences were less than 5 percent, and the median difference was less than 1 percent (fig. 3*A*). The distribution of the differences varied among the three fixed effects (method, make, and type) (figs. 3*B*, 3*C*, and 3*D*).

In addition to the fixed effects, two random effects were included in the analysis: (4) site and (5) date. The sites were classified as to make and type; for example, each site was associated with one and only one make and type. Thus, random factor site (4) is said to be nested under fixed effects make (2) and type (3). Likewise, random factor date (5) was nested under fixed factor site (4). The portable flowmeter methods [factor (1)] were applied at all sites, and often two or more methods were applied at the same well on the same date, so there was no nesting used for this factor. This analysis of variance design is referred to as a split-plot design, with “plots” corresponding to a given site on a given day. Snedecor and Cochran (1967) and Helsel and Hirsch (1992) provide more in-depth discussion of fixed and random effects and of nested (or hierarchical) designs.

The mathematical model for *diffQ* may be written as

$$diffQ_{ijkmn} = \mu + \alpha_i + \beta_j + \gamma_k + S_{jkm} + C_{jkmn} + e_{ijkmn}, \qquad (5)$$

where

μ is the intercept term,

α_i is the effect (fixed) for the portable flowmeter method *i*,

β_j is the effect (fixed) for totalizing flowmeter make *j*,

γ_k is the effect (fixed) for distribution system type *k*,

S_{jkm} is the effect (random) for site *m* of wells with make *j* and type *k*,

C_{jkmn} is the effect (random) for make *j* and type *k* on day *n* at site *m*, and

e_{ijkmn} is a random error term.

In this model, the random terms *S*, *C*, and *e* are assumed to be independent and normally distributed with mean 0 and variances σ_S^2, σ_C^2, and σ^2, respectively. The analysis of variance provides estimates of the fixed effects and of the magnitudes of these three variances (known as “variance components” because they constitute a partitioning of the random variability of *diffQ*) as well.

The three fixed effects were included in order to determine if average values of *diffQ* tend to change systematically with method, make, or type. The random effects for site and date were included to account for the correlation among measurements taken at the same site and on the same day. In most cases, more than one portable flowmeter method was used at a given site on the same day. In many cases, the well discharge measurements made at the same site on the same day by portable flowmeters clustered together and exhibited similar deviation from the TFM discharge. This clustering tendency is shown in figure 4, which shows how *diffQ* varies with site. The magnitude of the tendency for differences to cluster is evaluated by the site-and date-variance components. The site variance σ_S^2 is a measure of the tendency for all the measurements made at a well to exhibit a systematic discrepancy between portable

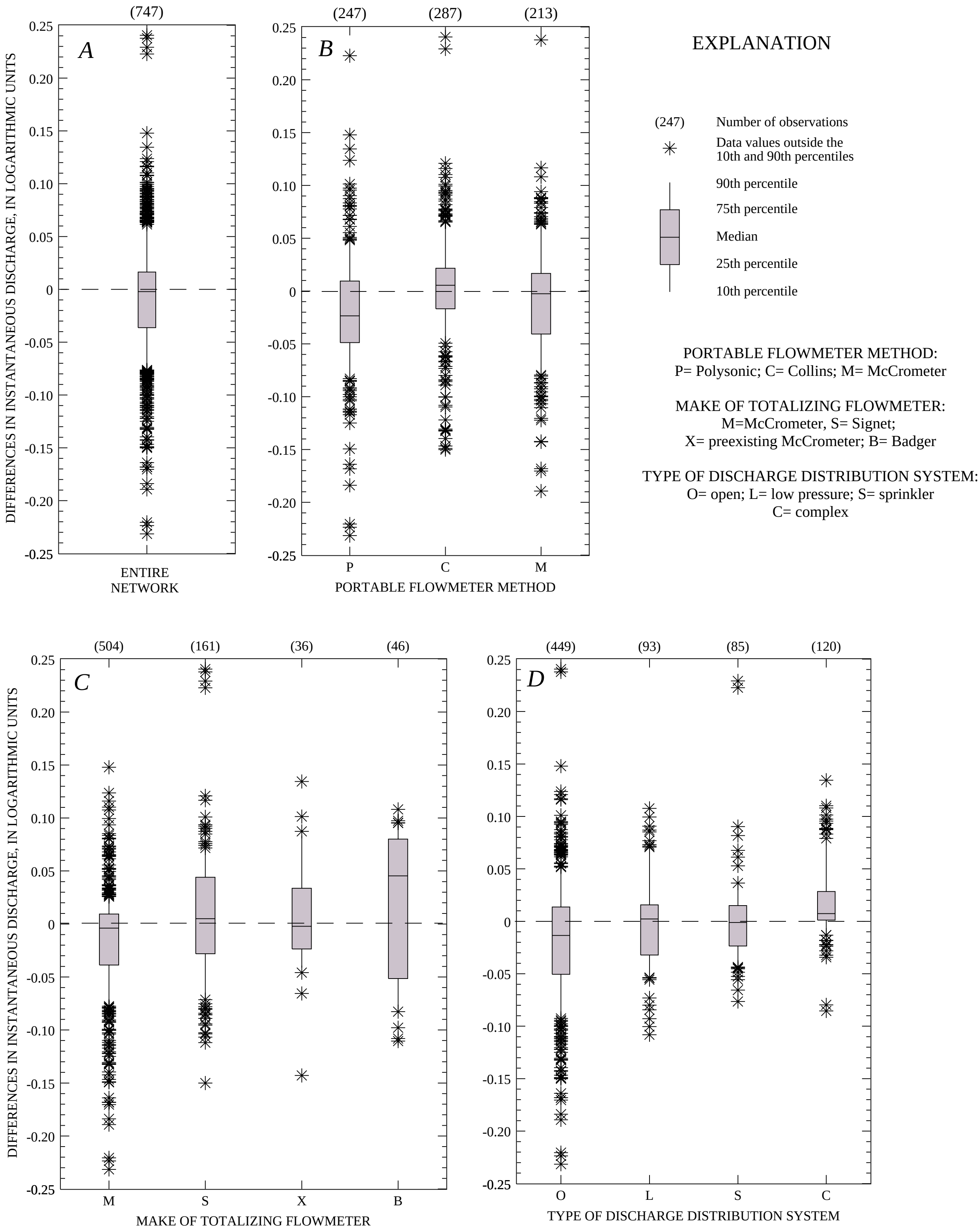

Figure 3. Boxplots showing differences in instantaneous ground-water discharge between portable flowmeters and totalizing flowmeters (*A*) for the entire network, (**B**) by portable flowmeter method, (*C*) by make of totalizing flowmeter, and (*D*) by type of discharge distribution system, 1997–98.

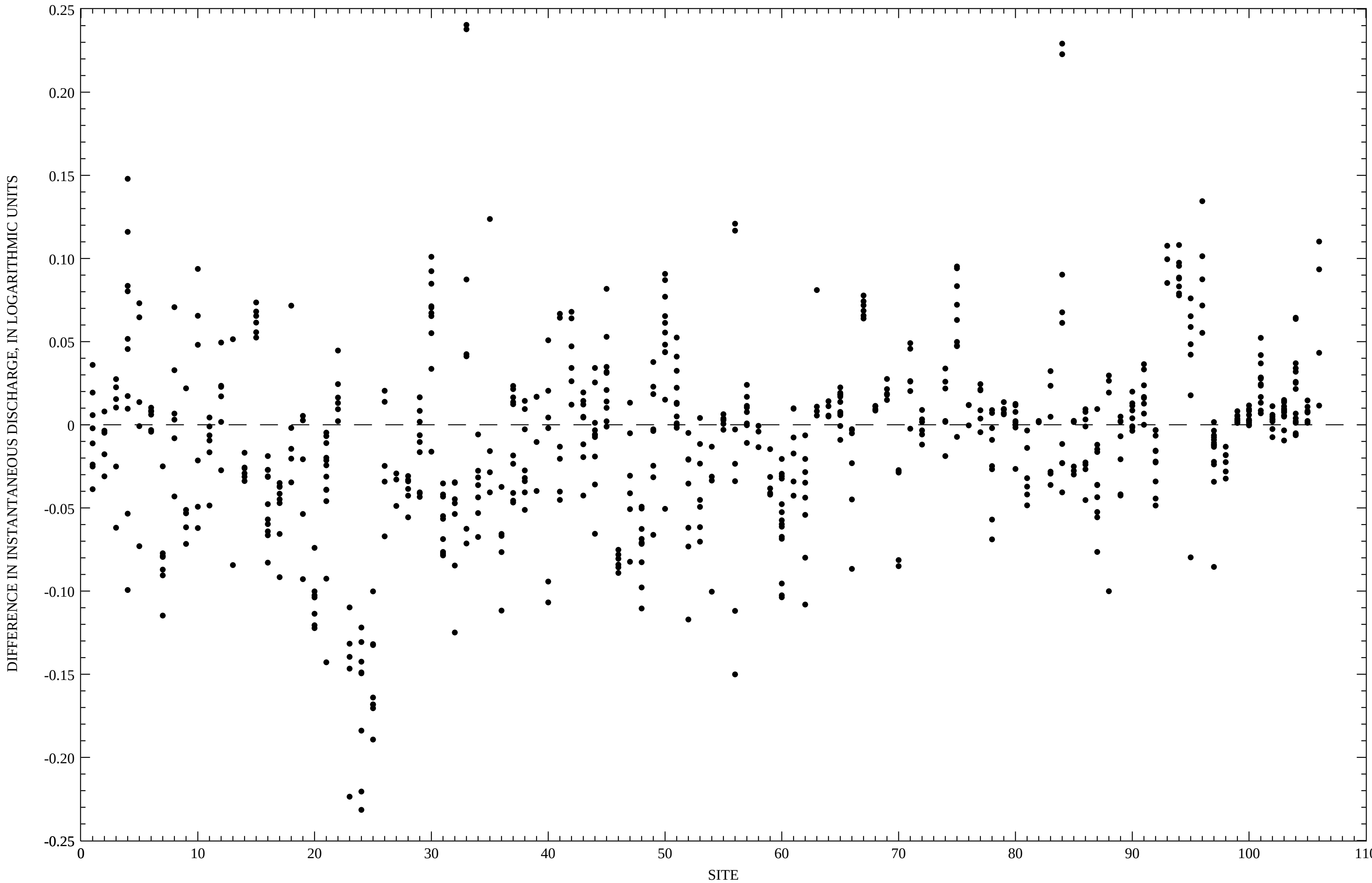

Figure 4. Distribution of differences in instantaneous ground-water discharge between portable flowmeters and totalizing flowmeters for network sites during 1998.

flowmeter and TFM discharge measurements, and the date variance σ_C^2 is a measure of the deviation of TFM discharge from the average of the discharges for portable flowmeters at the same site on the same day. The error variance σ^2 is a measure of the internal consistency of discharge measurements by different portable flowmeters at the same site and same day. If the consistency of measurements among portable flowmeters at the same site on the same day indicates an accurate estimate of true discharge, the magnitudes of the variances σ_S^2 and σ_C^2 may be interpreted as reflecting inaccuracy in the TFM discharge measurement value relative to the true value.

The initial analysis of variance indicated a significant difference (at the 5-percent level) between all pairs of portable flowmeter methods, between makes M and S, and between types O and C. To assess appropriate pooling of the different makes, makes B and X were compared to make M and make S using an estimated difference divided by the standard error of the difference, revealing that the makes B and X data could be pooled with the make S data. This pooling resulted in two levels for the make factor: M and other (B, S, X). Similarly, it was determined that types L and S could be pooled with type C, resulting in two levels of type: O and other (C, L, S). The analysis was redone using the same mathematical model but with only two make levels, M and (B, S, X), and two type levels, O and (C, L, S). Diagnostic plots were examined following the analysis, including a plot of residuals versus fitted and normal quantile-quantile plots for the three random terms in the model. These plots indicated no serious violation of model assumptions that would adversely affect final results.

Final estimates of the means and the differences in means associated with the fixed effects are presented in tables 1–3. [See Graybill (1976) for a discussion of important technical estimability issues associated with these estimates]. A standard error is given for each of the values in these tables, and values that are significantly different from zero (i.e., greater than 2 standard errors from zero) at the (approximately) 5-percent level are noted.

Final estimates of the grand mean (overall average difference of *diffQ*) and fixed effects are listed in table 1. The grand mean is 0.0000; the uncertainty in this number as measured by the standard error is 0.0045 or 0.45 percent. The mean difference for method C is about 1.1 percent, for method M is 0.0 percent, and for method P is about –1.1 percent. The positive sign on the mean for method C indicates that instantaneous discharge measured by portable flowmeters tends to be greater than instantaneous discharge measured by TFM’s, and the opposite holds for method P. The mean differences for each method are very comparable to the differences measured during the quality-control checks done at the Great Plains Meter facility (see “Quality Control of Data” section).

Table 1. Estimates of mean differences in instantaneous ground-water discharge between portable flowmeters and totalizing flowmeters for the grand mean and fixed effects of method, make, and type

[NS, mean is not significantly different from zero at the 5-percent significance level; S, mean is significantly different from zero at the 5-percent significance level; the mean and the standard error can be expressed as a percent difference by multiplying the respective value by 100]

Mean differences	Mean	Standard error	Significance at the 5-percent level
Grand mean	0.0000	0.0045	NS
Method of portable flowmeter (fixed)			
C	.0109	.0047	S
M	.0000	.0048	NS
P	–.0108	.0047	S
Make of totalizing flowmeter (fixed)			
M	–.0152	.0047	S
BSX	.0152	.0075	S
Type of discharge distribution system (fixed)			
O	–.0130	.0054	S
CLS	.0131	.0067	NS

Table 2. Estimates of mean differences in instantaneous ground-water discharge between portable flowmeters and totalizing flowmeters among fixed effects of method, make, and type

[NS, mean is not significantly different from zero at the 5-percent significance level; S, mean is significantly different from zero at the 5-percent significance level; the mean and the standard error can be expressed as a percent difference by multiplying the respective value by 100]

Mean Differences	Mean	Standard error	Significance at the 5-percent level
Method of portable flowmeter			
M–C	–0.0109	0.0026	S
P–C	–.0217	.0025	S
M–P	.0108	.0027	S
Make of totalizing flowmeter			
BSX–M	.0304	.0088	S
Type of discharge distribution system			
CLS–O	.0261	.0082	S

Table 3. Estimates of mean differences in instantaneous ground-water discharge between portable flowmeters and totalizing flowmeters for each combination of fixed effects of method, make, and type

[NS, mean is not significantly different from zero at the 5-percent significance level; S, mean is significantly different from zero at the 5-percent significance level; the mean and the standard error can be expressed as a percent difference by multiplying the respective value by 100]

Method	Mean	Standard error	Significance at the 5-percent level	Method	Mean	Standard error	Significance at the 5-percent level
Discharge distribution type = O Make of totalizing flowmeter = M				Discharge distribution type = O Make of totalizing flowmeter = BSX			
C	–0.0174	0.0060	S	C	0.0130	0.0081	NS
M	–.0283	.0060	S	M	.0021	.0080	NS
P	–.0391	.0060	S	P	–.0087	.0080	NS
Discharge distribution type = CLS Make of totalizing flowmeter = M				Discharge distribution type = CLS Make of totalizing flowmeter = BSX			
C	.0088	.0067	NS	C	.0392	.0093	S
M	–.0022	.0070	NS	M	.0282	.0094	S
P	–.0130	.0068	NS	P	.0174	.0093	NS

Estimates of differences among fixed effects are all less than 5 percent and are listed in table 2. The means in this table may be obtained by computing differences using the means in table 1. All the differences in table 2 are significant at the 5-percent level.

Estimates of combined effects (that is, effects associated with each different combination of levels of the fixed factors) are listed in table 3. For example, for type O distribution systems and make M TFM's, method P portable flowmeters have a mean difference of about –3.9 percent, and mean differences are negative for other methods as well. Differences for make (B, S, X) and type (C, L, S), however, are all positive, with a mean difference for method C portable flowmeters of about 3.9 percent. Overall, for particular combinations of method, make, and type, mean differences range from about –4 percent to 4 percent.

Estimates of the variance components (variances of the site, date, and error random terms) are listed in table 4. The sum of the variance components is 0.002639. The relative magnitude of the three variance components indicates what fraction of the variance of *diffQ* is associated with each of the random terms in equation 5. Site-to-site variability accounts for about 53 percent ($100 \times 0.001399/ 0.002639$) of the sum of the variance components, the date within site variability accounts for about 27 percent of the sum of the variance components, and the random error terms accounts for the remaining 20 percent.

Table 4. Estimates of the variances of the site, date, and error random terms in discharge measurements

Random terms	Variance
Site	0.001399
Date	.000701
Error	.000539
Sum	0.002639

The total variance of *diffQ* around the overall mean (that is, the variance of *diffQ* without a model) is 0.003037, which indicates that the fixed effects account for about 13 percent [equals $100 \times (0.003037 - 0.002639) / 0.003037$] of the variance of *diffQ*. This is a relatively small part of the total variability, but the data set is large enough to result in the statistically significant differences listed in tables 1 through 3. Similarly, the site, date, and error variance components expressed as a percent of the total variance are 46 percent, 23 percent, and 18 percent, respectively. Overall, the largest portion of the variance of *diffQ* is accounted for by site-to-site variability.

The random error variance (0.000539 in table 4) measures the amount of variability among different portable flowmeter measurements applied on the same day at the same site. The error variance can be used to determine the range in expected differences between (logarithmically transformed) instantaneous discharge measured using two different portable flowmeters. The estimated variance of the difference will be 2×0.000539 because the variance of the difference between two independent random variables is the sum of their variances. This translates into a standard deviation of about 3.28 percent. When this measure of the random component of the difference is considered in conjunction with the systematic differences in table 2 for different portable flowmeter methods, an estimate of the total error can be determined. For example, if measurements are made using P and M portable flowmeters, the systematic bias (M–P) is 1.08 percent with a standard deviation of 3.28 percent. If normality is assumed, about 95 percent of the differences between the measurements taken with the two portable flowmeters will be between −5.48 percent and 7.64 percent.

The small size of the random error variance component is indicated by the precision with which differences among portable flowmeters can be estimated in table 2. The standard errors for portable flowmeter differences range from 0.25 to 0.27 percent, which is considerably smaller than standard errors for make differences (0.88 percent) or type differences (0.82 percent). A strength of the design for this data collection was the application of multiple portable flowmeter methods at the same well on the same date during a short period of time.

TEMPORAL VARIATIONS IN POWER CONVERSION COEFFICIENTS

The use of PCC's to estimate ground-water pumpage from wells is most accurate when the relation of well discharge to power consumption remains stable. However, over time, hydrologic and pump operating conditions may change, thus altering the PCC relation to well discharge and power consumption. As examples, depth to ground water may increase after an extended period of pumping or pump efficiency may decrease as the irrigation pump ages. Any well operation that results in significant variations in the PCC over time can result in errors when using the PCC approach to estimate ground-water pumpage.

Short-Term Variations in Power Conversion Coefficients

Multiple PCC measurements repeated at the well sites during 1997 and 1998 are used to indicate the temporal variability in PCC's during one and two irrigation seasons. The range in PCC's at 104 sites during 1998 is shown in figure 5*A*. The PCC's for most sites (86 percent) did not fluctuate more than 20 percent throughout the 1998 irrigation season; however, for unknown reasons, a wide range in PCC's occurred at about 14 percent of the network sites. At some wells, a lower than expected PCC measurement (site 5) or several lower than expected PCC measurements (site 27) resulted in the wide range in PCC's that were measured. The percent difference for the

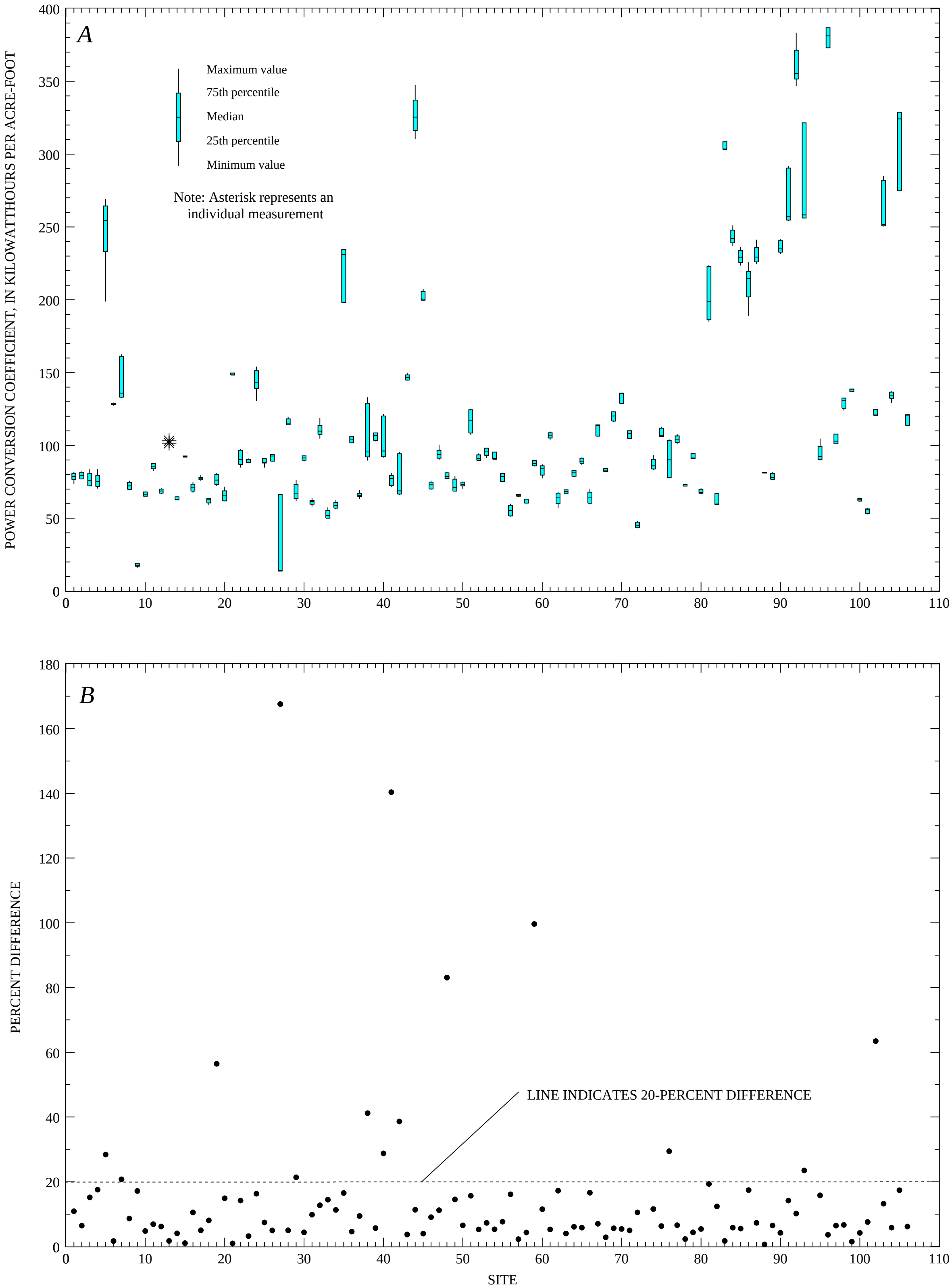

Figure 5. Power conversion coefficients (PCC) determined at network sites during 1998: (*A*) range in PCC and (*B*) percent difference.

total range in PCC's determined during 1998 is shown in figure 5*B*. The equation used to determine percent difference shown in figure 5*B* is:

$$\text{Percent difference} = 100 \times (\text{maximum PCC} - \text{minimum PCC})/\text{site average PCC}. \qquad (6)$$

Percent differences in PCC data at wells ranged from less than 1 percent (sites 21 and 88) to more than 150 percent (site 27). The data indicated that 58 percent of the site comparisons had less than a 10-percent change and 86 percent of the site comparisons had less than a 20-percent change in PCC's throughout the 1998 irrigation season.

The PCC measurements made during the 1998 irrigation season were evaluated for systematic seasonal variations. Figure 6 shows that for the majority of instances, there are no evident seasonal patterns in the PCC measurements made during 1998. Comparisons of PCC's to depth to ground water did not reveal any systematic relation between changes in PCC's and depth to water.

The PCC measurements made at 41 network sites during 1997 were compared to PCC measurements made during 1998 at the same 41 sites (fig. 7) to evaluate temporal variations during two irrigation seasons. Thirty-seven sites (90 percent) had at least one PCC measurement made in 1997 that was less than the range of PCC's made in 1998 (fig. 7); 16 of the sites (39 percent) had all 1997 PCC's less than the range of PCC's made during 1998. Only sites 83 and 87 had a large difference between the 2 years of data. Overall, the 2 years of data indicate that the PCC measurements were similar between 1997 and 1998.

Long-Term Variations in Power Conversion Coefficients

State-approved PCC measurements collected at the network sites during 1994 to 1997 for compliance with State rules (Office of the State Engineer, 1994 and 1996) were used to evaluate temporal variability that occurred in PCC's during the 4-year period. The long-term variability between PCC's for wells in the 1998 network and corresponding State-approved PCC's during 1994–97 is shown in figure 8*A*. Implicit in this comparison is the assumption that the State-approved PCC's determined during 1994–97 are of the same quality as the PCC's determined during this study, including the removal of the cases where the PCC's change under Rule 3.5 (Office of the State Engineer, 1996) due to a change in pump or motor. The equation used to compute the percent differences shown in figure 8*B* is:

$$\text{Percent difference} = 100 \times (\text{State-approved PCC} - \text{site average PCC})/\text{site average PCC}, \qquad (7)$$

where

site average PCC = the arithmetic mean of all PCC's determined at each site in 1998.

Fifty comparisons of 103 PCC measurements (about 48 percent) had less than 10-percent difference between the State-approved PCC's and the site average PCC measured during 1998 and about 67 percent of the State-approved PCC measurements were less than 20 percent of the PCC's during 1998 (table 5). Twenty-one of the 103 site comparisons indicated a positive percent difference of more than 20 percent in PCC's, and 13 site comparisons indicated a negative percent difference of more than 20 percent. A positive percent difference indicated that the 1994–97 State-approved PCC was greater than the site average PCC in 1998.

The percent difference between the State-approved 1994–97 PCC's and the average 1998 PCC ranged from about –57 to 211 (table 5). The largest range in percent difference was between the State-approved PCC's measured in 1995 and the 1998 PCC's. A comparison of the percent differences computed using the State-approved PCC's from 1997 to the average 1998 PCC's indicated that 78 percent of the sites were within 10 percent and 89 percent of the sites were within 20 percent.

During well operation, the PCC is generally constant for a specific discharge pressure and a stable pumping water level. Because the water level in a well often declines rapidly during the initial period of pumping, the PCC also changes rapidly until the pumping water level stabilizes. A potentially important change made in the Colorado amended rules in 1996 (Office of the State Engineer, 1996) required PCC measurements be made only after the pumping water level had not changed more than 10 percent in the hour prior to making the PCC measurement.

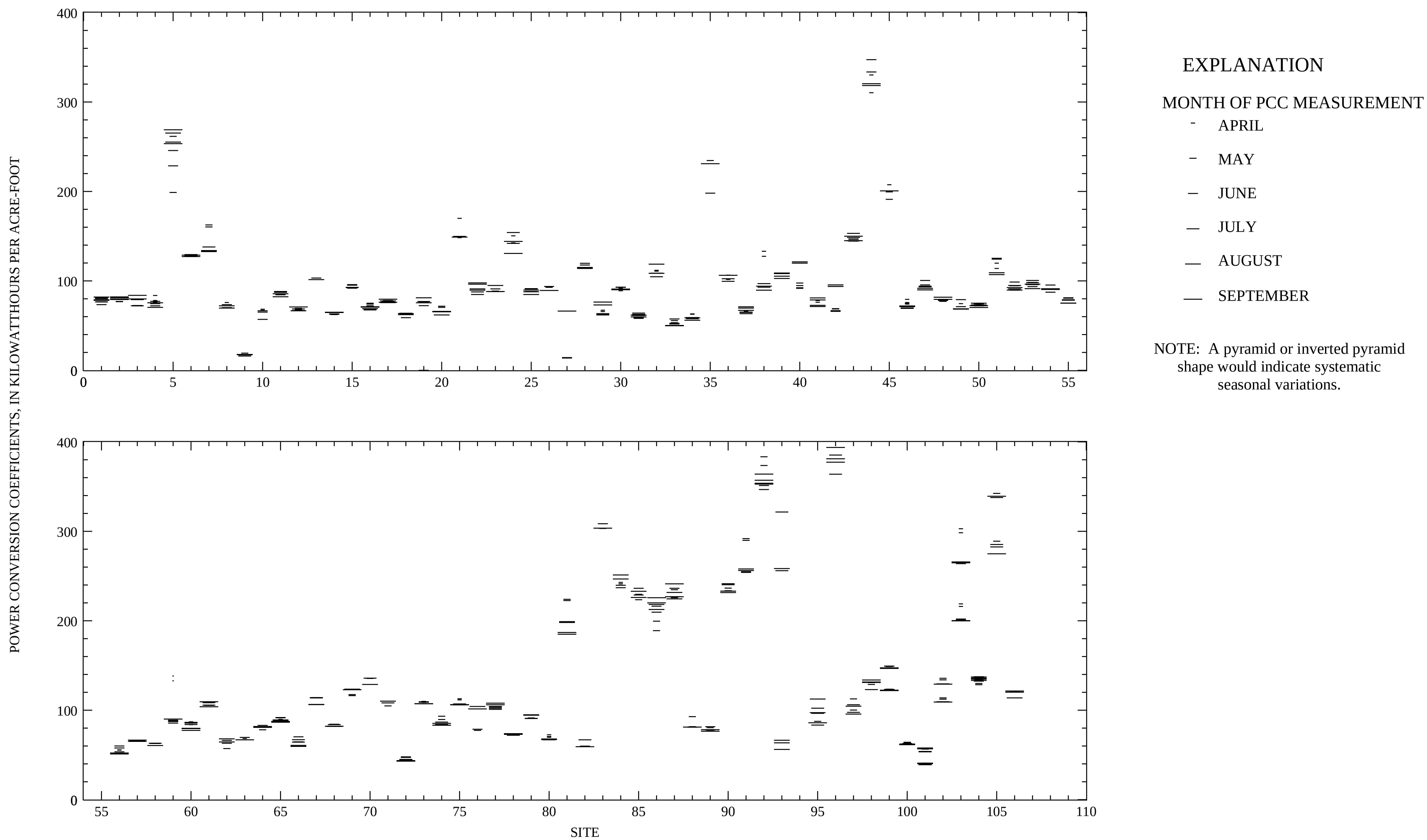

Figure 6. Seasonal distribution of power conversion coefficients (PCC) for network sites during 1998.

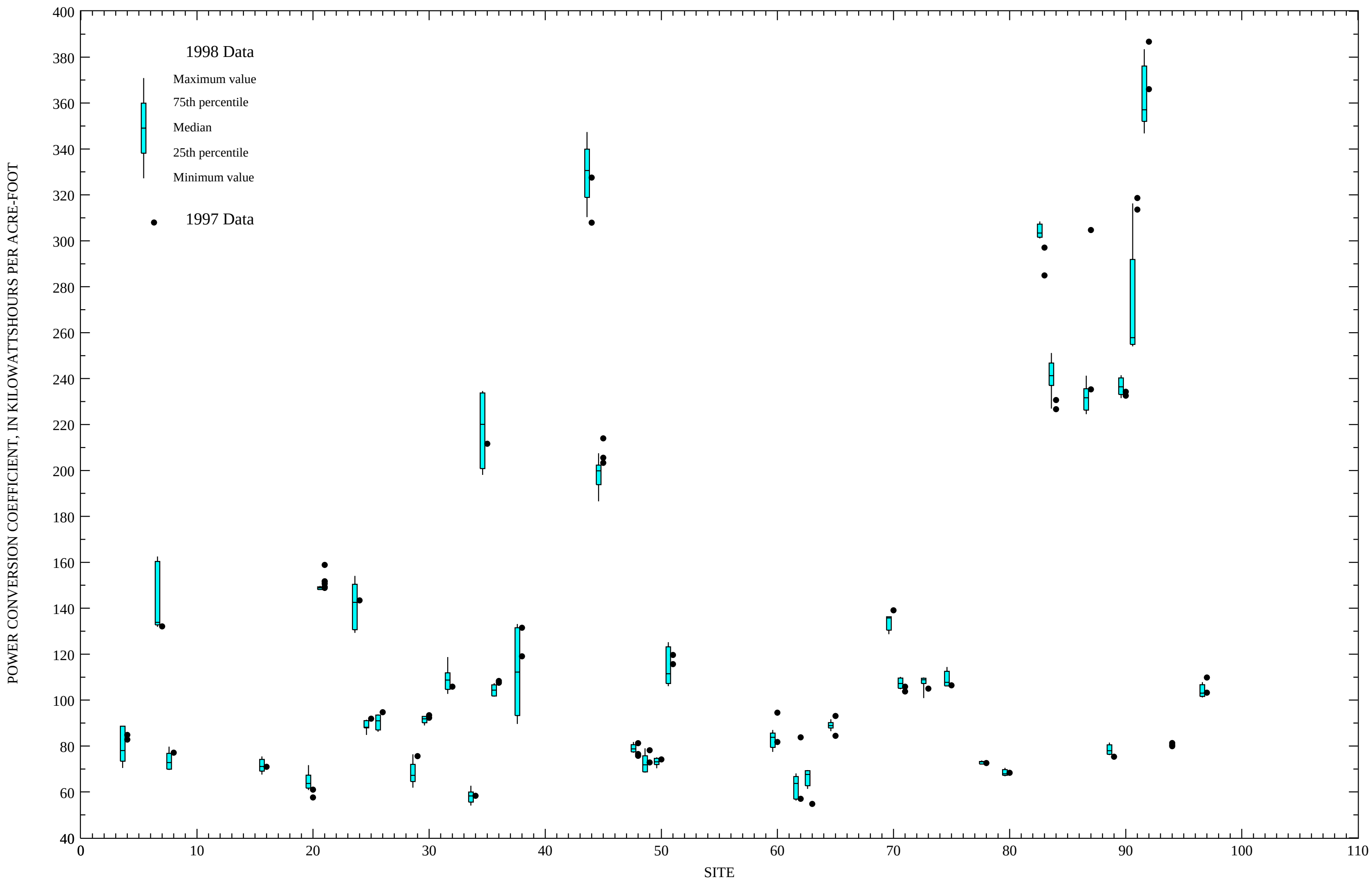

Figure 7. Power conversion coefficients (PCC) determined at selected network sites during 1997 and 1998.

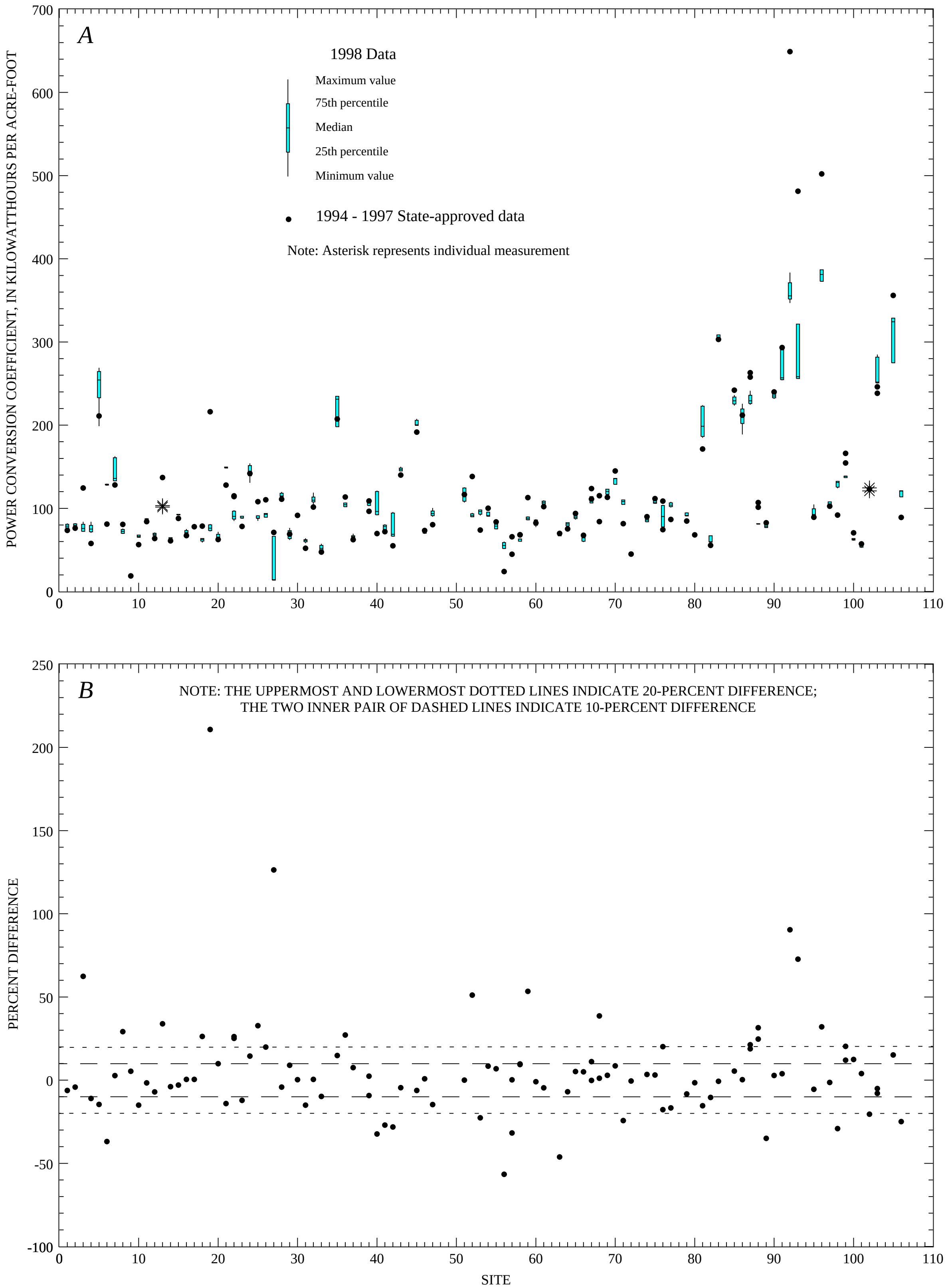

Figure 8. Power conversion coefficients (PCC) at network sites: (*A*) 1994–97 State-approved PCC and 1998 PCC, and (*B*) percent difference between 1994–97 State-approved PCC and 1998 PCC.

Table 5. Comparison of State-approved power conversion coefficient (PCC) measurements (1994–97) to the site average PCC measurements made during 1998

[PCC, power conversion coefficient]

State-approved PCC measurement year	Number of PCC comparisons	Minimum and maximum percent difference	Number of PCC comparisons within 10 percent of 1998 site average PCC		Number of PCC comparisons within 20 percent of 1998 site average PCC	
			Number	Percent	Number	Percent
1994	37	–57 90	18	49	25	68
1995	26	–37 211	8	31	11	42
1996	22	–46 27	10	45	17	77
1997	18	–18 73	14	78	16	89
1994–97	103	–57 211	50	48	69	67

COMPARISON OF GROUND-WATER PUMPAGE ESTIMATES

A comparison of ground-water pumpage measured using TFM's to ground-water pumpage estimates determined by the PCC approach was made by evaluating the differences in pumpage and determining whether the differences are statistically significant. The pumpage estimates were calculated using PCC measurements made at network sites during 1998. This was done by dividing the total 1998 power consumed at each site during the monitoring period, in kilowatthours, by each unique PCC measurement made at that same well site during 1998. The TFM derived pumpage measurement at each well was determined as the difference between TFM readings made at the beginning and the end of the monitoring period. The monitoring period was the same for the TFM and PCC approach. Because it was determined that the method of portable flowmeter, make of TFM, discharge distribution type, and the site, date, and random error were identified as sources of variation, an additional level of data analysis was required.

This section of the report presents (1) the magnitude in differences in ground-water pumpage between TFM and PCC estimates; (2) an estimate of the overall mean difference in pumpage and whether the overall mean difference is significantly different from zero; (3) an estimate of the mean differences for each combination of portable flow meter, make of TFM, and discharge distribution type, and whether these mean differences are significantly different from zero. The comparison of ground-water pumpage was based on 553 paired measurements made at 103 wells during 1998.

Primary Results

The analysis of variance on the differences in pumpage was performed using a rank transformation on 553 paired pumpage measurements made at 103 wells during 1998. About 80 percent of the differences in pumpage between the TFM and PCC approach were less than 10 percent. The overall mean difference in pumpage was 0.01 percent, indicating no significant difference on average between pumpage as measured by TFM and pumpage as computed by the PCC approach. For varying site characteristics (the method of portable flowmeter, the make of TFM, and type of discharge distribution system), mean differences in pumpage were generally less than ±3 percent and, for most instances, the mean differences in total pumpage were not significantly different from zero at the 5-percent level.

Details of Analysis and Results

For each paired pumpage measurement made at a well, the difference in ground-water pumpage, *diffP*, was computed as:

$$diffP = \log(\tilde{V}) - \log(V), \tag{8}$$

where $\tilde{V}$ denotes estimated pumpage as calculated by the PCC approach, and *V* denotes a corresponding total pumpage as measured by a TFM. As with instantaneous discharge measurements, a log transformation was used, so that the variable of interest is the difference between the log-transformed values.

Because *diffP* is a random variable like *diffQ*, the probability distribution must be characterized. However, as mentioned earlier in the report, unlike *diffQ*, the distribution for *diffP* deviated significantly from normality. There are a number of data values found outside the range of the majority of data values, and such a deviation from normality can cause serious problems with analysis of variance. Therefore, a rank transformation was performed on the data before performing the analysis, and an inverse rank transformation (linear approximation) to the results of the analysis of variance provided estimates of the central tendency of the distribution of *diffP*. Use of the rank transformation in analysis of variance is discussed by Iman and Conover (1981), Helsel and Hirsch (1992), Kepner and Wackerly (1996) and Hora and Iman (1988). Rank transformation does not render the test truly nonparametric, but asymptotic normal theory should be more applicable than would be the case if using untransformed data. Rank transformation minimizes the influence of very large outliers so that the analysis better reflects the central tendency of the data. Evaluating the data without the influence of extreme outliers was essential in understanding the data, and the results of this analysis indicated the types of errors in estimation of pumpage expected at a typical site under typical circumstances. Because a typical-site analysis is inadequate when analyzing aggregated pumpage for a number of wells, a separate analysis of this problem is discussed later in the report in the section titled “Estimation of Total Network Pumpage”.

The overall pattern of differences between *V* and $\tilde{V}$ are illustrated in figure 9*A*, which is a plot of *diffP* versus *V*, and in figure 9*B*, which is a plot of the difference in untransformed pumpage versus *V*. These plots are analogous to the plots in figure 2*A* and 2*B* for discharge. Variability about the mean tends to be more nearly constant in figure 9*A* than in figure 9*B* for most of the data, so making a logarithmic transformation on the variables is reasonable. These plots also show clearly that there is a small proportion of the differences for which *diffP* tends to be outside the range of the majority of the data.

Boxplots of *diffP* for all the data pooled and for each level of method, make, and type are shown in figure 10. About 80 percent of the differences in pumpage estimates between the TFM and PCC approach were less than 10 percent, more than 50 percent of the differences were less than 6 percent, and the median difference was about 1 percent (fig. 10*A*). The distribution of the differences varied somewhat depending on method, make, and type (figs. 10*B*, 10*C*, and 10*D*).

The analysis of variance model was first applied using all levels of each of the fixed factors: method, make, and type. Significant differences occurred between all pairs of methods, but not between different makes or types. However, pooling the pumpage data in the same manner as the discharge data allows direct comparisons between results of the two analyses. Such comparisons are useful and can be used to determine how errors in instantaneous discharge measurements affect errors in pumpage calculations. Thus, the analysis was redone using the same pooling described in the “Comparison of Instantaneous Ground-Water Discharge Measurements” section. Diagnostic plots again indicated satisfactory adherence to the analysis of variance assumptions.

Final results of the analysis of variance are listed in tables 6 through 8 and are analogous to the results for the instantaneous discharge data presented in tables 1 through 3. As stated earlier, results from the analysis of variance is in terms of ranks, so a linear approximation to the rank-transformation curve near the median was used to back-transform and obtain results in terms of *diffP*. Differences in estimates of the mean differences listed in tables 6 through 8 that are more than 2 standard errors from zero again are indicated as being statistically significant.

The overall grand mean difference for all possible pairs of pumpage in table 6 is 0.0001 (0.01 percent), again almost zero. The estimates for the portable flowmeter method effects were: for method C, 0.73 percent; for method M, 0.22 percent; and for method P, –0.93 percent. These effects are comparable in magnitude to portable flowmeter method effects for the well discharge data in table 1. Similarly, signs of the make and type effects are the

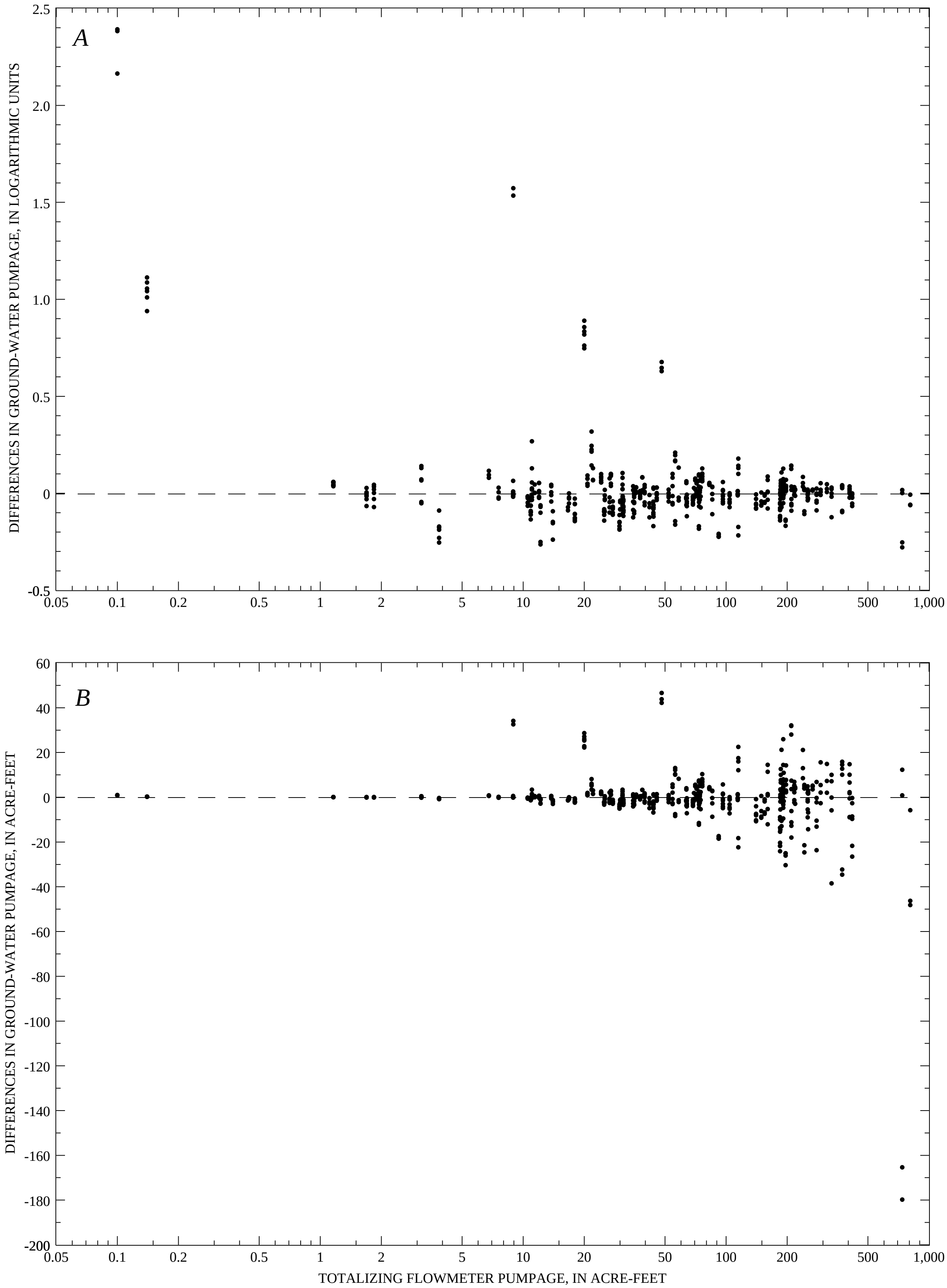

Figure 9. Relation of ground-water pumpage from inline totalizing flowmeter to the differences in pumpage estimates between power conversion coefficient approach and totalizing flowmeters, expressed (*A*) in logarithmic units and (*B*) in acre-feet.

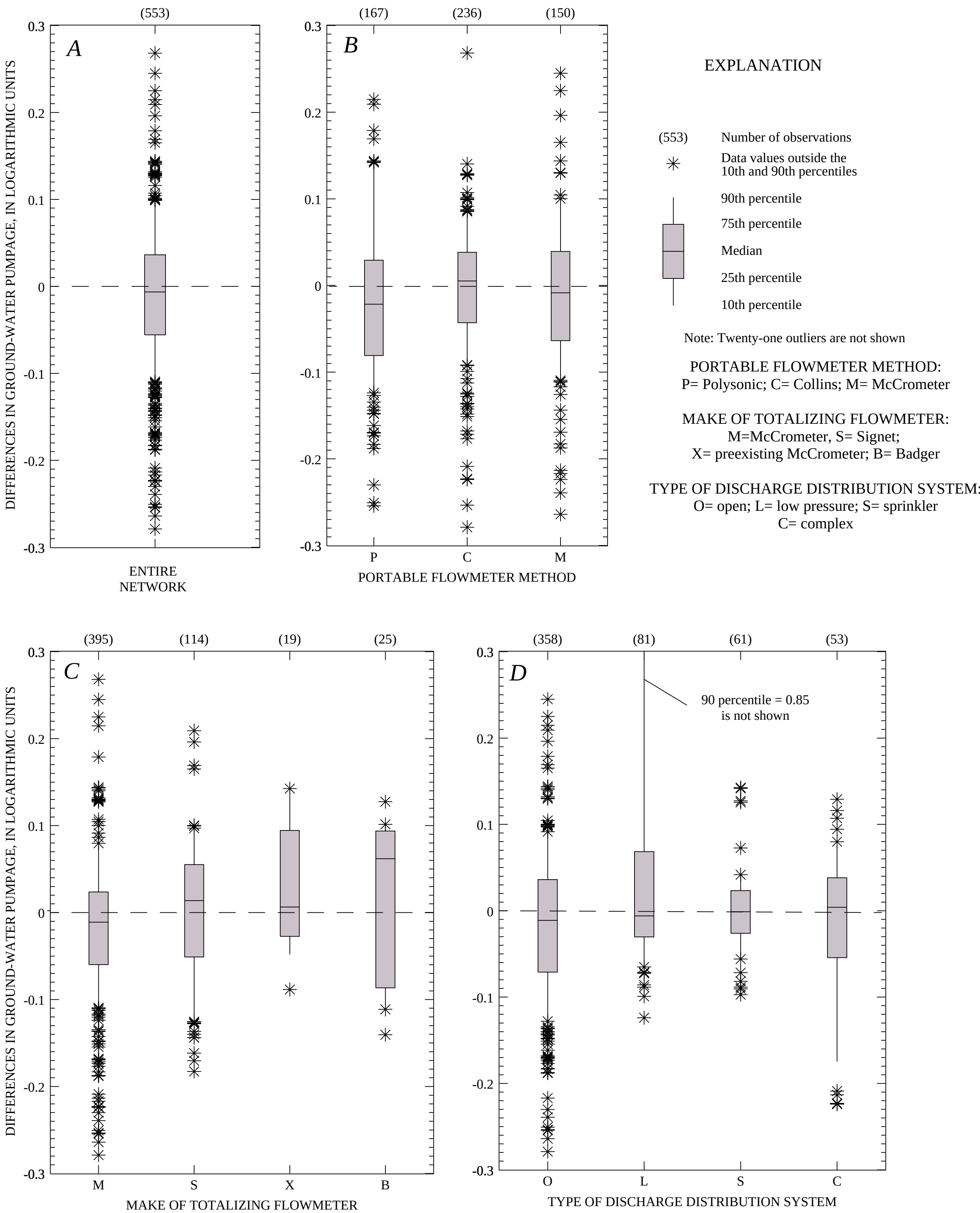

Figure 10. Boxplots showing differences in ground-water pumpage estimates between power conversion coefficient approach and totalizing flowmeters (*A*) for the entire network, (*B*) by portable flowmeter method, (*C*) by make of totalizing flowmeter, and (*D*) by type of discharge distribution system, 1998.

same as for the discharge analysis, but the magnitude of the effects for pumpage estimates is somewhat smaller. Most of the differences shown in table 6 are not statistically significant.

In table 7, estimates of mean differences among the three fixed effects are less than ±2.04 percent. The small standard errors for these differences reflect the increase in precision due to use of more than one portable flowmeter method at the same well on the same day.

The largest positive value for the combined effects (table 8) is 2.44 percent for type (CLS), make (BSX), and method C. The most negative value in table 8 is −2.63 percent for type O, make M, and method P. Both of these extreme values are statistically significant, but most other combined effects in table 8 are not.

A linear approximation for the back-transformation from ranks provided good results for the estimated mean values in tables 6 through 8 because these values were all near zero. However, such a linearization technique applied to variances is questionable because of increasing effects of nonlinearity for errors far from zero. Therefore, estimates of the variance components for the pumpage analysis are not presented.

Table 6. Estimates of mean differences in pumpage between power conversion coefficient approach and totalizing flowmeter for the grand mean and fixed effects of method, make, and type

[NS, mean is not significantly different from zero at the 5-percent significance level; S, mean is significantly different from zero at the 5-percent significance level; the mean and the standard error can be expressed as a percent difference by multiplying the respective value by 100

Mean differences	Mean	Standard error	Significance at the 5-percent level
Grand mean	0.0001	0.0046	NS
Method of portable flowmeter (fixed)			
C	.0073	.0047	NS
M	.0022	.0048	NS
P	–.0093	.0047	NS
Make of totalizing flowmeter (fixed)			
M	–.0101	.0048	S
BSX	.0103	.0077	NS
Type of discharge distribution system (fixed)			
O	–.0068	.0053	NS
CLS	.0070	.0069	NS

Table 7. Estimates of mean differences in pumpage between power conversion coefficient approach and totalizing flowmeter among fixed effects of method, make, and type

[NS, mean is not significantly different from zero at the 5-percent significance level; S, mean is significantly different from zero at the 5-percent significance level; the mean and the standard error can be expressed as a percent difference by multiplying the respective value by 100]

Mean differences	Mean	Standard error	Significance at the 5-percent level
Method of portable flowmeter			
M–C	–0.0052	0.0021	S
P–C	–.0166	.0020	S
M–P	.0114	.0023	S
Make of totalizing flowmeter			
BSX–M	.0204	.0089	S
Type of discharge distribution system			
CLS–O	.0138	.0082	NS

Table 8. Estimates of mean differences in pumpage between power conversion coefficient approach and totalizing flowmeter for each combination of fixed effects of method, make, and type

[NS, mean is not significantly different from zero at the 5-percent significance level; S, mean is significantly different from zero at the 5-percent significance level; the mean and the standard error can be expressed as a percent difference by multiplying the respective value by 100]

Method	Mean	Standard error	Significance at the 5-percent level	Method	Mean	Standard error	Significance at the 5-percent level
Discharge distribution type = O Make of totalizing flowmeter = M				Discharge distribution type = O Make of totalizing flowmeter = BSX			
C	–0.0097	0.0058	NS	C	0.0106	0.0080	NS
M	–.0149	.0059	S	M	.0055	.0080	NS
P	–.0263	.0059	S	P	–.0060	.0080	NS
Discharge distribution type = CLS Make of totalizing flowmeter = M				Discharge distribution type = CLS Make of totalizing flowmeter = BSX			
C	.0040	.0068	NS	C	.0244	.0094	S
M	–.0011	.0070	NS	M	.0192	.0096	NS
P	–.0126	.0069	NS	P	.0078	.0095	NS

SOURCES OF DISCREPANCY BETWEEN PUMPAGE ESTIMATES

The analysis of variance procedures applied to instantaneous discharge and pumpage data provided information on the mean differences in well discharge (*diffQ*) and pumpage (*diffP*) and on the variance of *diffQ*. It is clear, however, that these analyses are not independent of each other. Part of the discrepancy between total pumpage computed by the PCC approach and pumpage measured by the TFM comes from differences between measurements made by portable flowmeters and TFM's and differences between these meters are reflected in differences between the paired instantaneous discharge measurements. In other words, one would expect that part of the variability in *diffP* is being caused by variability in *diffQ*. However, there are other possible sources of discrepancy between total pumpage obtained by the two approaches. The following section of the report enumerates several possible sources of discrepancy. For most of these sources, data are not available to estimate exactly how much of the discrepancy is coming from each source. Nevertheless, it is important to explicitly discuss what the possible sources of error are, possibly providing guidance for future data-collection efforts. One important source of potential discrepancy that is discussed in some detail is temporal variability of the PCC. Some data are available to obtain an estimate of the contribution of this component to the difference between pumpage by the two approaches.

Specifically, this section of the report discusses (1) possible sources of discrepancy that result in differences between ground-water pumpage as measured by a TFM and ground-water pumpage as obtained by the PCC approach; and (2) with available data, how might the temporal variability of PCC's effect the differences in pumpage.

Primary Results

There are several potential sources of discrepancy between pumpage as measured by a TFM and pumpage as computed by the PCC approach. These include errors in instantaneous discharge as measured by a TFM and a portable flowmeter, TFM pumpage errors, errors in the electrical power meter, and temporal variability of the PCC. Each may account for a portion of the discrepancy between pumpage as measured by a TFM and pumpage as computed by the PCC approach. It is not possible with data currently available to give reliable estimates of the magnitude of each of the components of pumpage error. Additional data and evaluation of these data are needed to define long-term temporal variations in PCC's and TFM's, as well as defining other sources of discrepancy in pumpage estimates.

Limited data are available to provide an estimate of errors caused by temporal variability of PCC's. The standard deviation associated with year-to-year variability of these PCC's was estimated to be about

15 percent, and the year-to-year variance was about nine times the date-within-year variance. This indicates that year-to-year variability of the PCC may make a significant contribution to errors in the PCC approach for estimating pumpage. The conclusions based on this analysis are based on an assumption that the State-approved PCC's made from 1994–97 are of the same quality as the 1998 study PCC's.

Details of Analysis and Results

To determine total pumpage for some specified period of time, such as one pumping season, at a given well, the following terms are used:

V_T = true total pumpage volume for the monitoring period,

V = pumpage volume as measured by a TFM,

$\tilde{V}$ = pumpage volume as estimated by the PCC approach,

A_T = true electrical power consumption for the period,

A = total electrical power consumption as measured by a meter,

p_T = true PCC for the period, and

$\tilde{p}$ = estimated PCC

True values in these definitions cannot be measured directly, but are still assumed to exist. Total pumpage estimated by the PCC approach ($\tilde{V}$) is computed using metered power consumption (A) and the estimated PCC ($\tilde{p}$) from the equation

$$\tilde{V} = \frac{A}{\tilde{p}} . \tag{9}$$

(The conversion factor to account for different units of measure will for simplicity be taken to be unity in this section.)

At this point, no assumption is made about how $\tilde{p}$ is obtained. The true PCC (p_T) is the value that, by definition, yields a correct value for total pumpage when divided into true power consumption, or

$$p_T = \frac{A_T}{V_T} ; \tag{10}$$

however, the true values A_T and V_T are generally unknown, so p_T also is unknown.

Again, logarithmic transformations are used to express all errors; that is, an error is the difference between a log-transformed quantity that is measured or estimated and the log transform of the corresponding true value. Hence the errors are defined as:

$U_1 = \log(V) - \log(V_T)$ = TFM pumpage error,

$U_2 = \log(A) - \log(A_T)$ = electrical power meter error,

$U_3 = \log(\tilde{p}) - \log(p_T)$ = error in the estimated PCC.

One relation of interest is the error in the PCC approach, given by

$$\log(\tilde{V}) - \log(V_T) = U_2 - U_3 , \tag{11}$$

the difference between power meter error and PCC error. This relation is derived using the definitions and equations 9 and 10.

If the estimated PCC is obtained using a measured instantaneous discharge, as in the data set analyzed in the section "Comparison of Ground-Water Pumpage Estimates", and if measurements are made at some single time, *t*, the following can be defined:

$Q_T(t)$ = true instantaneous discharge at time *t*,

$Q(t)$ = instantaneous discharge as measured by a TFM,

$\tilde{Q}(t)$ = instantaneous discharge as measured by a portable flowmeter,

$a_T(t)$ = true instantaneous electrical power consumption at time *t*,

$a(t)$ = instantaneous electrical power consumption determined from a power meter,

$p_T(t)$ = true instantaneous PCC, and

$\hat{p}$ = PCC estimated with one instantaneous discharge measurement.

Thus, $\hat{p}$ is calculated by

$$\hat{p} = \frac{a(t)}{\tilde{Q}(t)} \tag{12}$$

and total pumpage estimated by the PCC approach is equation 9 with $\hat{p}$ used for $\tilde{p}$. The true instantaneous PCC is defined to be

$$p_T(t) = \frac{a_T(t)}{Q_T(t)} . \quad (13)$$

Using instantaneous measurements introduces four new errors:

$U_4 = \log[Q(t)] - \log[Q_T(t)]$ = error in instantaneous discharge measured with TFM,

$U_5 = \log[\tilde{Q}(t)] - \log[Q_T(t)]$ = error in instantaneous discharge measured with a portable flowmeter,

$U_6 = \log[a(t)] - \log[a_T(t)]$ = error in instantaneous power meter reading,

$U_7 = \log[p_T(t)] - \log(p_T)$ = error in instantaneous PCC, or the difference between true instantaneous PCC, and true PCC for the period.

Therefore, when the PCC is estimated using equation 12, the PCC error U_3 may be broken down into three components,

$$U_3 = U_6 - U_5 + U_7 , \quad (14)$$

which again is shown using the definitions of the various errors. Combining equations 11 and 14 gives the final expression for the error in total pumpage as estimated by the PCC approach,

$$\log(\tilde{V}) - \log(V_T) = U_2 - U_6 + U_5 - U_7 . \quad (15)$$

The difference in log-transformed instantaneous discharge (*diffQ*) as measured by a portable flowmeter and a TFM may be expressed as the difference of two errors,

$$diffQ = \log[\tilde{Q}(t)] - \log[Q(t)] = U_5 - U_4 . \quad (16)$$

Similarly, the difference between log-transformed pumpage computed by the PCC approach and TFM approach (*diffP*) may be computed by subtracting the TFM error (U_1) from both sides of equation 15 to yield

$$\begin{aligned} diffP &= \log(\tilde{V}) - \log(V) \\ &= U_2 - U_6 + U_5 - U_7 - U_1 . \end{aligned} \quad (17)$$

The expression for *diffP* in equation 17 has one additional component, namely U_1, that is not contained in the actual error for the PCC approach (that is, the error relative to true total pumpage) given by equation 15. That is, TFM errors in an actual application of the PCC approach would not be observed.

The differing signs in these expressions indicate that some of the errors can be compensating. A positive error in one term may cancel a negative error in another, giving a smaller overall error. While such cancellation may hold for certain pairs of terms, other pairs of errors may be independent of each other. For example, U_5, the error in instantaneous discharge measured with a portable flowmeter, would not be expected to be related to U_6, the error in instantaneous power meter reading. For variables that are uncorrelated, the signs make no difference in the contribution to total variance, because the variance of a difference of two uncorrelated random variables is the same as the variance of the sum.

The errors U_4 (error in instantaneous discharge measured with a TFM) and U_5 (error in instantaneous discharge measured with a portable flowmeter) represent deviations of instantaneous discharge from true discharge. Because true discharge is unknown, there is no estimate of size of these component errors. Data are available only for *diffQ*, which, in equation 16, is the difference between these two individual errors. The values in table 4 indicate bounds on the variance of U_5 under different conditions. If consistency between two (or more) portable flowmeter methods is an indication that the methods are both accurate, in the sense of being a good estimate of the true instantaneous discharge, then the error variance (0.000539) from table 4 would be a good estimate of the variance of U_5. In this case, the site- and date-variance components in table 4 would be mostly attributable to error in the TFM, U_4. However, an upper bound for the variance of U_5 would be the sum of variance components in table 4, or 0.002639. Use of this value as an estimate of the variance of U_5 would assume that the TFM is error-free.

The error U_7 (error in instantaneous PCC) in equation 17 represents deviation of the instantaneous PCC from some long-term true value, which is assumed to be constant. Thus, the average magnitude of U_7 depends on how much temporal variability exists in the time series $\{p_T(t)\}$. An in-depth study of temporal variability of the PCC, including trends, seasonality, and magnitude of serial correlation, would need detailed data on $\{p_T(t)\}$, which are not available for any of the sites. Therefore, a simpler approach was used to obtain an idea of the short- and long-term variabilities in PCC. This approach uses the State-approved PCC's made from 1994–97 together with the PCC's made in 1998 as part of this study. One potential fallacy in this approach is the implicit assumption that the quality of the State-approved PCC's made from 1994–97 is the same as the quality of the PCC's made during this study. If this assumption is accepted, then the temporal variability in PCC can be evaluated. If the PCC data are not of the same quality, then errors not associated with temporal variability could be attributed to the errors in temporal variability in the following analyses, resulting in an inflated estimate of the year-to-year variability.

A nested variance-components analysis using random terms for site, year within site, and date within year and site, was performed using all the log-transformed PCC values, including the 1998 values and 106 State-approved PCC's from 1994–97. Once again, fixed effects (method, make, and type) were not included in the analysis. Such a nested model that has terms representing variability at different time scales is one way of modeling temporal correlation. The estimate of the variance for the year component was 0.02297, for the date-within-year component was 0.00254, and for the residual variance was 0.00077. The year component represents about a 15-percent standard deviation (obtained by taking the square root of the variance and multiplying by 100). This indicates that the year-to-year variability could be a major component of variability for this PCC data set; the year variance component is about nine times the variance of date-within-year component. The PCC values used in this analysis contained uncertainty due to errors in instantaneous discharge as measured by the portable flowmeter as well as errors in instantaneous power meter reading (see eq. 14). This means that an estimate of the variance of U_7 (error in instantaneous PCC) using this analysis is inflated somewhat. Based on the estimates given in the preceding paragraph, however, errors in discharge as measured by a portable flowmeter would not account for much of the year-to-year variability in the PCC (fig. 8*B*). To accurately quantify the temporal variability in the PCC, long-term time series PCC data are needed.

Errors U_1 (TFM pumpage error) and U_2 (electrical power meter error) represent errors in the long-term integrated values of discharge and power consumption, respectively. The first error (U_1) would result from a TFM that is malfunctioning and providing consistently biased readings, and the second error (U_2) would result from a malfunctioning electrical meter. Although no data are available for evaluating the magnitude of these errors, one or both may be at least partly responsible for the extreme differences in pumpage (*diffP*) seen in figure 9*A*. Component U_1 (TFM pumpage error) would not be present when comparing PCC-estimated pumpage to true pumpage (eq. 15). Finally, errors U_2 and U_6, integrated and instantaneous power meter error, may somewhat compensate for each other if the errors result from a malfunctioning power meter.

ESTIMATION OF TOTAL NETWORK PUMPAGE

The analysis presented earlier in the report, in the "Comparison of Ground-Water Pumpage Estimates" section, provided estimates of the mean or average differences between the log-transformed PCC-estimated total pumpage and TFM-measured total pumpage, *diffP*, at a well. However, it also is important to quantify the differences in the total or aggregated pumpage for a network of wells.

Primary Results

An analysis of the pumpage data was done to determine differences in the total or aggregated pumpage between the TFM and PCC approach for a network of wells. The difference in pumpage between the TFM and PCC approach varied with the volume of water pumped during the 1998 monitoring period. Some wells that recorded small pumpage exhibited larger percent differences than wells with larger pumpage. Because of these unequal differences with respect to total pumpage, it was necessary to group or stratify the data based on the magnitude of total pumpage for the 1998 monitoring period. Because the correct number of groupings, or strata, is not known with the information available, the mean and standard deviation of differences in the total pumpage was determined conditionally for several numbers of strata. For a network of 103 wells and a number of strata greater than 10, the resulting mean and standard deviation leads to a conclusion that, for any given year, there is a 95-percent probability that the difference in aggregated pumpage between the TFM and PCC approach would be between about –3.41 and 1.59 percent. The analysis indicates that the difference in aggregated pumpage would be expected to be smaller as the number of wells becomes larger. Assuming the distribution of total TFM pumpage is the same for 1998 data set, there is a 95-percent probability that the difference in aggregated pumpage between the TFM and the PCC approach for any given year for a network of 1,000 wells would be between –1.71 and –0.11 percent. This assumes that the large differences in pumpage are confined to wells with smaller pumpage. It also is important to emphasize that only 1998 pumpage data were used for this analysis, so the effect of temporal variations (over a period greater than 1 year) of PCC's on total network pumpage is not known.

Details of Analysis and Results

The difference in total pumpage between the PCC and TFM approaches for *n* wells, D_n, is denoted as,

$$D_n = \sum_{i=1}^{n} \tilde{V}_i - \sum_{i=1}^{n} V_i = \sum_{i=1}^{n} (\tilde{V}_i - V_i) \quad . \qquad (18)$$

where $\tilde{V}_i$ denotes the PCC-estimated total pumpage at well *i* ($i = 1, 2, ..., n$), and V_i is the corresponding value of TFM-measured total pumpage at well *i*.

To determine the difference in total pumpage for *n* wells, D_n, it may be assumed that D_n is approximately normally distributed. Once the mean of D_n and the standard deviation of D_n are defined, probability statements may be made on the likely magnitude of network differences from year to year. It is assumed that TFM-measured pumpage values V_i are fixed (non-random), and the mean of D_n and the standard deviation of D_n are expressed relative to total network TFM-measured pumpage.

Complications arise in computing the mean and standard deviation of D_n primarily because of the nonnormality of the individual well differences, *diffP*, and the fact that these differences appear to have a tendency to vary in magnitude depending on how large ground-water pumpage, *V*, is. This variation necessitates using a stratification scheme. The effect of using the logarithmic transformation also must be considered. Specifically, analysis of how the errors (differences) at individual wells is propagated to total network errors (differences) requires that three relevant issues be considered in some detail: the effect of the logarithmic transformation, the effect of changes of the distribution of differences depending on volume pumped at a well, and the effect of nonnormality of the distribution of differences between (logarithmically transformed) TFM and PCC pumpage volumes.The effect of the logarithmic transformation becomes an issue because, when computing total network pumpage for a number of wells, it is the untransformed values that need to summed. Thus, results from analyses using logarithmically transformed data first need to be back transformed. This back-transformation results in a so-called transformation bias. If the differences between the log-transformed pumpage volumes were identically and normally distributed, then estimating the magnitude of this bias would be straightforward. However, as shown in figure 9*A*, there is indication of a tendency of the distribution of differences to change depending on total pumpage and of nonnormality. Therefore, stratification is used to account for changes in the distribution of differences, and a parameter-estimation procedure that does not rely on an assumption of normality is used.

Much of the problem is associated with the relatively few number of paired measurements that have a much larger difference in pumpage than most of the data (fig. 9*A*). The rank transformation that was used in the analysis of variance down-weighted the effect of these differences and, therefore, produced results that are representative of the central tendency of the data. However, when summing volumes over all wells in a network, the small number of data that have large differences will be included; therefore, the potential effect of these data cannot be ignored. The data associated with the large differences were examined, and a valid reason for deleting them from the analysis was not found. In addition, the nature of the data did not lend itself to fitting a common probability distribution or to description of the exact pattern of the non-uniform variations in the distribution with respect to pumpage. Thus, the approach taken below is essentially nonparametric and should be viewed as an attempt to explore the sensitivity of total network pumpage to these large errors (differences).

Even though it is not assumed that the differences at individual sites, $\tilde{V}_i - V_i$, have any particular distribution, the network difference (D_n), which is the sum of a number of independent random variables, will, under some general conditions, be approximately normally distributed. This follows from central limit theory, and, because of the stratification that is applied below, central limit results for random variables that are not identically distributed need to be used. Experiments at randomly selecting values from the stratified population of total well pumpage to estimate network pumpage indicate that normality is a good approximation for total network pumpage. Given that D_n has an approximately normal distribution, only the mean and variance (or standard deviation) need evaluation. The main purpose of the analysis that follows is to obtain expressions for the mean and standard deviation.

Assume that the V_i are a set of fixed (nonrandom) values, and that the deviation of $\tilde{V}_i$ from V_i is described by a random error. The difference between log-transformed PCC-estimated pumpage and log-transformed TFM-measured pumpage at well *i* is

$$diffP_i = \log(\tilde{V}_i) - \log(V_i) \,. \qquad (19)$$

These errors are all assumed to be associated with different wells, so they will be assumed throughout to be independent.

Exponentiating both sides of equation 19 gives the relation

$$\tilde{V}_i = V_i e^{diffP_i} \qquad (20)$$

between the untransformed variables. The additive error on the log-transformed variables becomes a multiplicative error on the untransformed variables. The mean difference between the PCC and the TFM pumpage volume for well *i* is

$$\begin{aligned} E(\tilde{V}_i - V_i) &= V_i E e^{diffP_i} - V_i \\ &= V_i E(e^{diffP_i} - 1) . \end{aligned} \qquad (21)$$

where *E* denotes mathematical expectation, or mean, and V_i is assumed to be fixed. If the mean deviation is expressed as a fraction of TFM pumpage V_i, it is

$$\frac{E(\tilde{V}_i - V_i)}{V_i} = E(e^{diffP_i} - 1) \,. \qquad (22)$$

If $E diffP_i = 0$, then it may be shown that $E e^{diffP_i} > 1$, or $E(e^{diffP_i} - 1) > 0$. Thus, even if the errors in the log-transformed variables have mean zero, there is a positive bias when looking at untransformed variables. This is important because, when looking at network-wide aggregates, the untransformed variables need to be summed, so the absence of bias in the log-transformed variables does not automatically translate into a lack of bias for network-wide aggregates. Bias in the present situation, however, is not limited to bias caused by the logarithmic transformation. Additional bias is introduced by large positive errors that reflect nonnormality of $diffP_i$ (fig. 9*A*), and the variance of these errors changes with V_i, which motivates the need for the stratification that follows.

The mean, or expected, difference (also referred to as bias) is given by

$$ED_n = \sum_{i=1}^{n} V_i E(e^{diffP_i} - 1) \,, \qquad (23)$$

and the variance is given by

$$Var(D_n) = \sum_{i=1}^{n} V_i^2 Var(e^{diffP_i}) \,. \qquad (24)$$

To deal with the error distribution dependence on total pumpage, the population of wells is stratified with respect to the magnitude of total pumpage at a well, V_i, and it is assumed that the errors within each stratum are identically distributed. Equation 23 leads to

$$ED_n = \sum_{k=1}^{K} B_k \mu_k \qquad (25)$$

where *K* is the number of strata, B_k is the sum of the V_i for all wells in the *k*th stratum, and $\mu_k = E(e^{diffP_i} - 1)$ for each well *i* in the *k*th stratum. Likewise, equation 24 yields

$$Var(D_n) = \sum_{k=1}^{K} T_k \sigma_k^2 \qquad (26)$$

where T_k is the sum of the V_i^2 for all wells in the *k*th stratum and $\sigma_k^2 = Var(e^{diffP_i})$ for each well *i* in the *k*th stratum.

If the number of strata *K*=1, that is, if the assumption of identical distribution holds, equation 25 gives

$$\frac{ED_n}{\sum_{i=1}^{n} V_i} = E(e^{diffP} - 1) \ . \qquad (27)$$

The important implication in this equation is that, if the differences have the same distribution, bias in the difference in total network pumpage relative to the magnitude of total (TFM) network pumpage is the same magnitude as relative bias for an individual well given in equation 22. For example, a 5-percent bias per well translates into a 5-percent bias for the total network. If *K* is greater than 1, then according to equation 25, network relative bias is a pumpage-weighted average of the individual stratum biases $\mu_1, \mu_2, \ldots, \mu_K$.

Likewise, if *K*=1, the standard deviation of total network error as a fraction of total network pumpage is given by

$$\frac{SD(D_n)}{\sum_{i=1}^{n} V_i} = \frac{\sqrt{\sum_{i=1}^{n} V_i^2}}{\sum_{i=1}^{n} V_i} SD(e^{diffP}) \ . \qquad (28)$$

In this equation, the ratio involving V_i on the right-hand side tends to decrease as the number of wells (*n*) increases. The rate of decrease is in proportion to $1/\sqrt{n}$. Thus, the random component of difference in total network pumpage tends to decrease and become less important compared to the bias component, represented in equation 25, which does not diminish with number of wells, *n.* If *K*>1, it may be shown that the standard deviation of D_n , computed from equation 26, relative to total network pumpage, will still tend to grow smaller as number of wells (*n)* increases, again roughly in proportion to $1/\sqrt{n}$.

Use of equations 25 and 26 requires estimates of the parameters μ_k and σ_k . Let n_k be the number of measurements from the *k*th stratum, and denote these measurements by $diffP_{k1}, diffP_{k2}, \ldots, diffP_{kn_k}$. If it can be assumed that these observations are normally distributed, there are special widely used techniques based on this assumption that can be used to estimate the parameters. Because the normal assumption is not a good one, however, the parameters are estimated by

$$\hat{\mu}_k = \frac{1}{n_k} \sum_{j=1}^{n_k} (e^{diffP_{kj}} - 1) \ . \qquad (29)$$

and

$$\hat{\sigma}_k = \sqrt{\frac{1}{n_k} \sum_{j=1}^{n_k} (e^{diffP_{kj}} - 1 - \hat{\mu}_k)^2} \ . \qquad (30)$$

Equations 29 and 30 are the ordinary sample mean and sample standard deviation of the $e^{diffP} - 1$ values in the *k*th stratum. These estimates are essentially the "smearing estimates" for nonparametric retransformation discussed by Duan (1983) in the context of regression.

The *K* strata for this analysis are formed by dividing the range of $\log(V_i)$ values for the 553 paired-pumpage measurements for 1998 into *K* equal intervals. The number of wells was *n* = 103. The $diffP_{kj}$ used for estimating the mean and the standard deviation in equations 29 and 30 consist of the differences $\log(\tilde{V}_i) - \log(V_i)$ for all the $\log(V_i)$ in the *k*th stratum. The correct or most appropriate value of *K* is not known, so computations in equations 25 and 26 were done using parameter estimates from equations 29 and 30, for *K* ranging from 1 to 50. As *K* increases, the outcome of this analysis is essentially equivalent to randomly selecting a PCC-estimated value at each well for computing pumpage at that site. Results are shown in figure 11. When *K* = 1, the tendency for error magnitude to diminish for larger pumpage is ignored, so that large pumpage could conceivably have errors as large as 239 percent (the maximum value in the data set; see fig. 9*A*), an error that, in the actual data set, is associated with a well that contributes little to total network pumpage. The results of permitting large errors to be associated with wells having large pumpage are severe, yielding a mean of about 9.3 percent and standard deviation of about 11.9 percent for $K = 1$ (fig. 11). For $K = 2$, the mean decreases to 2.70 percent; for $K = 3$, it decreases to 0.77 percent; for K = 4, it decreases to less than 0 percent; for *K* greater than about 10, the mean tends to level off at approximately –0.91 percent. Likewise, the standard deviation levels off for *K* greater than 4 at about 1.25 percent. The fact that the mean becomes negative when *K* is greater than 4 indicates that the large positive errors at a small number of wells have little effect on total network pumpage; it is instead the influence of negative errors for large-pumpage wells (see figure 9) that is causing the mean to become negative as *K* increases. Imposing the restriction that number of strata *K* be larger than 4 prevents the few very large positive errors from being associated with wells that have large pumpage.

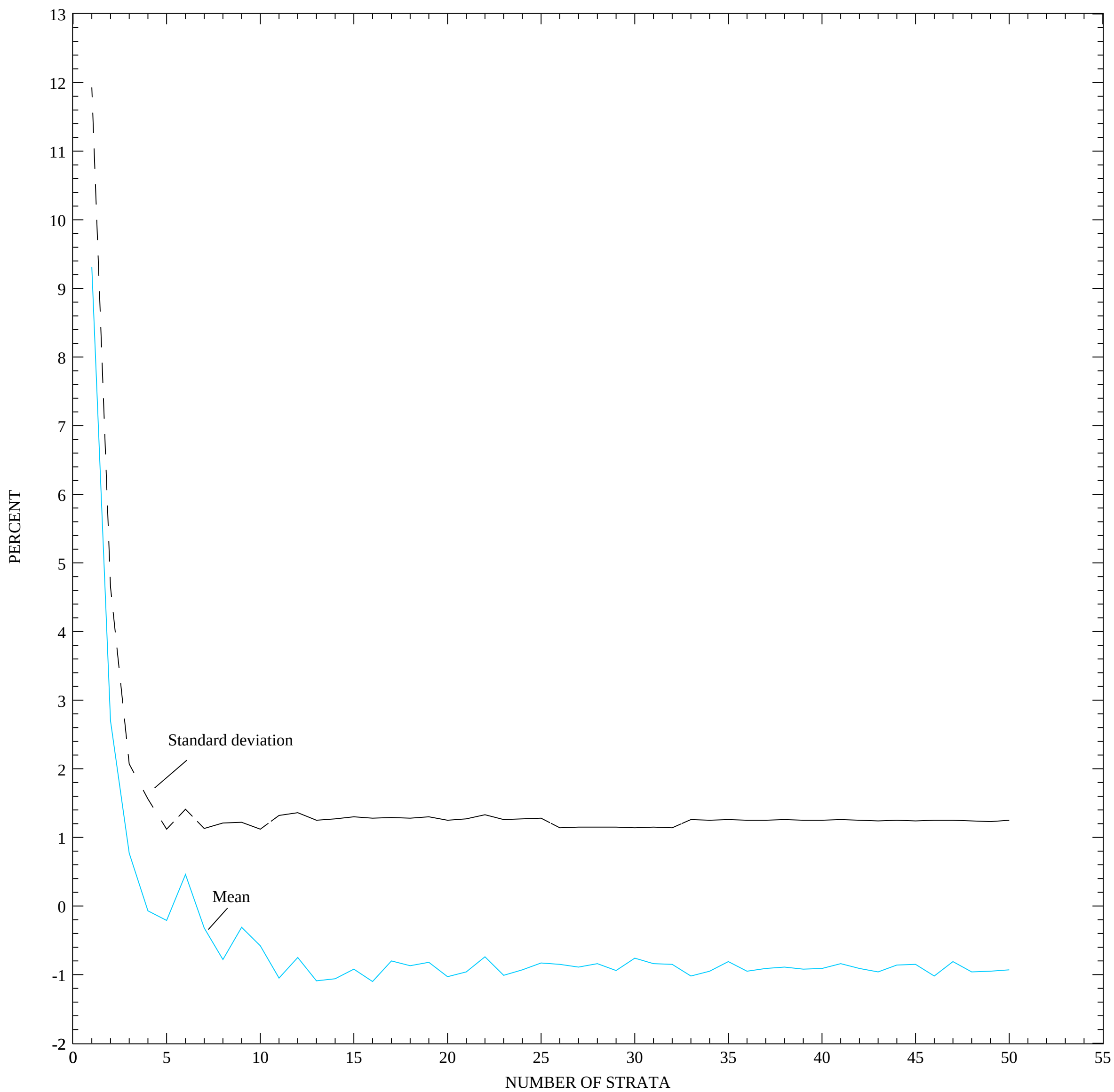

Figure 11. Graph showing relation of the mean and standard deviation of total network pumpage, in percent, to the number of strata.

The approximate normality of the difference in network-aggregated pumpage D_n can be used with the mean and the standard deviation to make probability statements about likely differences in total network pumpage obtained by TFM and PCC approach. Using a mean of –0.91 percent and a standard deviation of 1.25 percent, for example, results in a conclusion that, for any given year, there is a 95-percent probability that the difference in aggregated pumpage between the TFM and PCC approach would be between about –3.41 and 1.59 percent for a network of 103 wells.

To predict the difference in aggregated pumpage for a larger network, the distribution of total TFM pumpage (the values of V_i) will be assumed to be the same, the estimate of the mean remains the same (–0.91 percent), but the standard deviation decreases in proportion to the square root of the ratio of numbers of wells. For n = 1,000 wells, the 1.25 percent standard deviation for 103 wells decreases by a factor of $\sqrt{\frac{103}{1000}}$, resulting in an estimated standard deviation of 0.40 percent. Therefore, for a network of 1,000 wells, there is a 95-percent probability that the difference in aggregated pumpage between the TFM and the PCC approach for any given year would be between –1.71 and –0.11 percent.

CONCLUSIONS

This report compares two approaches for determining instantaneous ground-water discharge and pumpage. The data collected and analyzed as part of this study included (1) logarithmically transformed differences of well discharge computed from 747 paired discharge measurements made at 105 wells during 1997 and 1998; (2) power conversion coefficients (PCC's) derived for 104 wells during 1997 and 1998; (3) ranked, logarithmically transformed differences of pumpage computed from 553 paired pumpage comparisons made at 103 wells during 1998, and (4) State-approved PCC's that were made from 1994–97.

Given the data analysis presented in this report, the main conclusions are:

1. More than 80 percent of the differences in well discharge were less than 10 percent. The overall mean difference in well discharge for all sites was 0.0 percent, indicating no difference on average between TFM's and portable flowmeter instantaneous discharge measurements. For varying site characteristics, mean differences in well discharge range from a –4 percent to 4 percent.
2. Variations in PCC's measured during the 1998 irrigation season indicated that 58 percent of the wells had less than 10-percent change, and 86 percent of the wells had less than 20-percent change. Systematic seasonal variations in PCC's generally were not evident for the measurements made during the 1998 irrigation season.
3. Ninety percent of the sites had at least one PCC measured during 1997 that was less than the range of PCC's measured in 1998, indicating the range in PCC's measured at majority of sites between 1997 and 1998 were similar.
4. About 48 percent of the State-approved PCC's made between 1994 through 1997 were within 10 percent of the 1998 site average PCC's and about 67 percent of the State-approved PCC measurements made between 1994 through 1997 were within 20 percent of the 1998 site average PCC's.
5. About 80 percent of the differences in pumpage between the TFM and PCC approaches were less than 10 percent. The overall mean difference in pumpage was 0.01 percent, indicating no significant difference on average between pumpage as measured by TFM's and pumpage as computed by the PCC approach. For varying site characteristics, mean differences in pumpage were generally less than ±3 percent and, for most instances, the mean differences in pumpage were not significantly different from zero at the 5-percent significance level.
6. There are several potential sources of discrepancy between pumpage as measured by a TFM and pumpage as computed by the PCC approach. With data currently available, it is not possible to give reliable estimates of the magnitude of each of the potential sources of pumpage error. However, using available data, an estimate of errors caused by temporal variability of PCC's can be made. The year-to-year variance was about nine times the date-within-year variance, indicating that year-to-year variability of the PCC's may make a significant contribution to error in the PCC approach for estimating pumpage. This conclusion is based on an assumption that the State-approved PCC's from 1994–97 are of the same quality as the 1998 PCC's.

7. For a network of 103 wells and a number of strata (logarithms of TFM total pumpage divided into equal subdivisions) greater than 10, the resulting mean and standard deviation indicates that, for any given year, there is a 95-percent probability that the difference in aggregated pumpage between the TFM and PCC approach would be between about –3.41 and 1.59 percent.
8. The difference in aggregated pumpage would be expected to be smaller as the number of well sites becomes larger. Assuming the distribution of total TFM pumpage is the same for 1998 data set, there is a 95-percent probability that the difference in aggregated pumpage between the TFM and the PCC approach, for any given year, for a network of 1,000 wells would be between –1.71 and –0.11 percent. This assumes that the large differences in pumpage are confined to wells with smaller pumpage. It also is important to emphasize that only 1998 pumpage data were used for this analysis, so the effect of temporal variations of PCC's on total network pumpage is not known.

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Exhibit 16

Annual Meeting

December 7, 1999

RESOLUTION
OF THE
ARKANSAS RIVER COMPACT ADMINISTRATION
CONCERNING
AN AMENDMENT TO THE OPERATING PRINCIPLES FOR THE TRINIDAD DAM AND RESERVOIR PROJECT RECOGNIZING THE ENLARGED PERMANENT POOL

WHEREAS, Article IV-D of the Arkansas River Compact provides: "This Compact is not intended to impede or prevent the future beneficial development of the Arkansas river basin in Colorado and Kansas by federal or state agencies, by private enterprise, or by combinations thereof, which may involve construction of dams, reservoirs and other works for the purposes of water utilization and control, as well as the improved or prolonged functioning of existing works: Provided, that the waters of the Arkansas river, as defined in Article III, shall not be materially depleted in usable quantity or availability for use to the water users in Colorado and Kansas under this compact by such future development or construction;" and

WHEREAS, Article III of the Compact specifically excludes "waters brought into the Arkansas River basin from other river basins" from the definition of "waters of the Arkansas river;" and

WHEREAS, in P.L. 85-500, dated July 3, 1958, Congress authorized the Trinidad Project "substantially in accordance with the recommendations" in a Review Report by the U.S. Army Corps of Engineers ("Army Corps") dated June 30, 1953, published as House Document No. 325, 84th Congress; and

WHEREAS, Kansas by letter from Gov. William H. Avery dated December 30, 1966 approved proposed Operating Principles for the Trinidad Project subject to five additional conditions; and

WHEREAS, the Arkansas River Compact Administration (the "Administration") reviewed and approved the Trinidad Project Operating Principles, including the Five Kansas Conditions, by resolution dated June 6, 1967; and

WHEREAS, the U.S. Bureau of Reclamation ("Reclamation") and the Purgatoire River Conservancy District ("PRWCD") approved the Operating Principles, including the additional five Kansas Conditions; and

WHEREAS, the 1964 Irrigation Report for the Trinidad Project, prepared by Reclamation, states that the project will serve the functions of flood control, irrigation, and fish and wildlife with an initial space allocation of 4,500 acre-feet from the total reservoir volume of 114,500 acre-feet to the fish and recreation pool. The 1964 report further states that "water stored in the permanent fishery pool is to be furnished by the State of Colorado;" and

WHEREAS, the Trinidad Project was constructed by the Army Corps and was substantially completed by January 1, 1977; and

WHEREAS, a 1986 resurvey of the as-constructed reservoir determined that it in fact contained a total of 125,967 acre-feet of capacity with an additional 11,467 acre-feet of space that was not allocated to any use or purpose by existing agreements, contracts, or the Operating Principles, and

WHEREAS, the State of Colorado owns and operates Trinidad Lake State Park at Trinidad Reservoir and is vitally interested in the preservation and enhancement of the permanent fishery and recreation pool at Trinidad Reservoir; and

WHEREAS, the Army Corps conducted an Environmental Assessment ("EA") of the proposed reallocation of the excess space consistent with the requirements of the national environmental Policy Act ("NEPA"); and

WHEREAS, following the NEPA review, the Army Corps assigned the unallocated space to the permanent fishery pool, thereby increasing the pool to 15,967 acre-feet, as set out in the Final EA, dated September 1994; and

WHEREAS, the Operating Principles, as currently approved, define the capacity of the permanent fishery pool as being 4,500 acre-feet of a total reservoir capacity of 114,500 acre-feet; and

WHEREAS, Kansas Condition No. 2 of the Operating Principles states: "Any subsequent amendment of the Operating Principles should be subject to the review and approval of the same interests as provided for in the original procedure;" and

NOW, THEREFORE, BE IT RESOLVED that the Administration hereby approves, subject to the approvals provided for below, the proposed amendment to the Operating Principles for the Trinidad Dam and Reservoir Project, as set forth in the attached Exhibit "A," increasing the size of the permanent fishery pool to 15,967 acre-feet.

Entered this 26th day of January, 1996, at a special telephonic meeting of the Arkansas River Compact Administration.

Larry E. Trujillo, Sr. Chairman	2-14-96 DATE
State of Colorado	3/20/96 DATE
State of Kansas	5/30/96 DATE
U.S. Bureau of Reclamation	4/4/96 DATE
Purgatoire River Water Conservancy District	3/14/1996 DATE
U.S. Army Corps of Engineers	22 Mar 96 DATE

EXHIBIT "A"

TO RESOLUTION OF THE ARKANSAS RIVER COMPACT ADMINISTRATION

DATED JANUARY 26, 1996

AND AMENDMENT TO THE OPERATING PRINCIPLES FOR THE TRINIDAD RESERVOIR PROJECT RECOGNIZING THE ENLARGED PERMANENT POOL

1. On page 2, Article I - OBJECTIVES, number 4: change the capacity of the Permanent Fishery Pool from "~~4,500~~" to "15,967" acre-feet.

2. On page 2, Article I - OBJECTIVES, number 4: change the "~~Total Capacity 114,500~~" to "Total Allocated Capacity 125,967" acre-feet.

3. On page 3, Article II - DEFINITION OF TERMS, number 5: change "4,500" to "15,967" acre-feet.

4. On page 11, Article V - FISHERY AND RECREATION, number 1: revise to read as follows:

> Water for the initial filling and for replacing evaporation and seepage losses will be acquired by the State of Colorado without interference to the District water supply and without interference to usable Stateline flows, or without additional cost to the District or the United States for the Trinidad Project as envisioned in House Document No. 325. In the specific case of the 11,467 acre-feet allocated to the permanent fishery pool pursuant to the Final Environmental Assessment for Revision of the Water Control Manual to Allocate Excess Storage in Trinidad Lake, Las Animas County, Colorado, U.S. Army Corps of Engineers, dated September 1994, the initial filling shall only be made using waters imported into the Arkansas River basin from other river basins, either by direct importation or by exchange pursuant to the laws of Colorado. The initial filling and the replacement of evaporation and seepage shall be made according to the following procedures:
>
> 1. All water rights on the Purgatoire River downstream of Trinidad Reservoir will be satisfied during the period of any exchange;
>
> 2. Prior to any exchange, the specific source of imported or native water, as limited by the Operating Principles for Trinidad Dam and Reservoir Project, as amended, will be verified by the Colorado State Engineer;
>
> 3. For each acre-foot of native water stored in Trinidad Reservoir by exchange, the Colorado Division of Parks will deliver an acre-foot of identifiable imported water, or native water whose consumptive use has been determined by final decree of the Colorado Water Court, to the Arkansas River at Las Animas gaging station;

4. Transit losses between the source of supply for an exchange and the Las Animas gage will be determined and assessed by the Colorado State Engineer, using the "Livingston method" or other suitable means, to assure that a "one for one" exchange is accomplished.

The Colorado State Engineer will report and account contemporaneously and annually to the Arkansas River Compact Administration on the initial filling and replacement of evaporation and seepage in the permanent fishery pool.

5. On p. 11, Article V - FISHERY AND RECREATION, number 3: revise to read as follows:

> There shall never be any release or transfer of water from the permanent fishery pool excepting by necessity of dam safety or flood emergency operations as determined by the Corps of Engineers, District Engineer.

Exhibit 18

Annual Meeting

December 7, 1999

Report of Civil Works Activities by the

U.S. Army Corps of Engineers, Albuquerque District

in the Arkansas River Basin

During Calendar Year 1999

Exhibit 18

1. **General.** During 1999, activities of the U.S. Army Corps of Engineers, Albuquerque District (Corps), in the Arkansas River Basin consisted of reservoir regulation, flood-control related studies, flood plain management services, regulation under Section 404 of the Clean Water Act, and emergency assistance.

2. **Flood Control Operations.** Major flooding occurred on the Arkansas River and virtually all it's tributaries between Pueblo and John Martin Reservoir including Fountain Creek, St Charles, Huerfano, and Purgatoire Rivers in late April and early May. In the Fountain Creek drainage, minor flooding began on the morning of April 29th and escalated throughout the day reaching peaks in excess of 20,000 cfs. The Arkansas River began to flood on April 30th and reached a peak in excess of 30,000 cfs before reaching John Martin Dam. Reservoir operations during this event were as follows:

Pueblo Reservoir – On April 30th, the release from Pueblo was cut to 100 cfs and the reservoir began to capture inflow. A peak reservoir inflow of 10, 600 cfs was recorded on April 30th.

The project had been operating under a deviation while structural modifications were made below the dam to address dam safety concerns. On May 2nd, with the modifications about 90% complete, the Bureau of Reclamation requested a change to the existing deviation. This request recognized that there was a significant reduction in dam safety risk and thus the potential for additional irrigation storage. The Corps approved this change on May 3rd allowing the project to store to the full capacity of the conservation pool.
On May 8th, the lake elevation reached the top of the conservation pool and releases to pass inflow began.

Trinidad Lake – The reservoir began to see a significant increase in inflow by midmorning on April 30th and began to store inflow. A peak reservoir inflow of 3,000 cfs was recorded on May 3rd. On June 20th the top of the conservation pool was reached for the first time and releases were adjusted to pass inflow. On August 8th, a new record pool elevation of 6230.35 was recorded as a result of a localized thunderstorm above the project.

John Martin Reservoir – The reservoir began to see a significant increase in inflow on the morning of May 2nd as the flood waters reached the reservoir. Flood releases began when the conservation pool was topped off on May 2nd. A maximum inflow of 30,600 cfs was recorded on May 3rd. The reservoir elevation continued to rise and reached a new record peak on May 9th of 3860.45, filling 43% of the flood space. The previous record peak elevation was 3856.80, which occurred on May 31, 1987. As per flood release criteria, flows from the dam were regulated to not exceed 3,000 cfs at the Coolidge, KS river gage. Releases were adjusted up or down to accommodate intervening downstream flow and irrigation demand. Flood releases from John Martin Dam continued throughout the months of May, June and into early July until all the flood water was evacuated.

3. <u>Other Construction activities at John Martin Reservoir related to the flood events:</u>

<u>Railroad Embankment:</u> During a field inspection of the reservoir on May 6, John Martin Project Office personnel discovered a slide on the Burlington Northern – Santa Fe railway embankment within the reservoir area. Railroad officials were notified of this problem and on a subsequent inspection on May 11, it was noted that the problem was getting worse. In response to this situation, railroad officials placed a speed limit on all train traffic and took action to make the necessary repairs. The railroad placed approximately 69 train cars of riprap at this site to stabilize the slide and protect the embankment.

<u>Fort Lyons Levee</u>: On May 12th, sand boils were reported along a 1,200-foot long section of the Fort Lyon VA Hospital levee. It was determined that the situation posed no threat, but as a prudent precaution a contract was issued to build a stabilizing berm on the hospital side of the levee. The berm was constructed along the existing road embankment that had been placed by the VA. The amount of fill required varied from 4 to 10 feet thick. This repair work consisted of placing material to establish a working base, and placement of filter material; then building an earthfill embankment 10 to 15 feet wide and 1,500 feet long. A subsequent modification was issued to install manholes for the sub-drains and additional material for a new wing dike south of the National Cemetery.

<u>South Wing Dam</u>: Seepage was also noted along the toe of the south wing dam on May 12th. It was determined that the seepage was passing through the rock foundation under the embankment and that there was no threat to the integrity of the dam. To manage the seepage, the Corps contracted to construct a seepage control berm at the toe of this wing dam. This berm also serves to provide access in this area for monitoring purposes.

4. <u>Damages Prevented from Flood Control Operations.</u> The Corps estimates that there was $63 million in damages prevented due to flood control operations in the basin.

5. <u>Hydrographic Surveys.</u> Hydrographic surveys of the sediment ranges at Trinidad Lake and John Martin Reservoir were completed in June, 1999. New elevation area-capacity tables for both projects were implemented on November 1, 1999.

6. **Planning Assistance to States (Section 22) Program.** Under authority of Section 22 of the Water Resources Development Act of 1974, the Corps is authorized to assist non-Federal entities in the preparation of comprehensive plans for the development, use, and conservation of water and related land resources.

In August 1996, the Corps, in cooperation with the Colorado Water Conservation Board (CWCB), initiated the Section 22 study entitled, "Channel Capacity and Riverine Habitat Planning, Arkansas River Below John Martin Dam." The study was completed in August 1999. The Corps determined the existing channel capacity and sediment transport capability in five problem reaches, as well as riparian and aquatic habitat values which have degraded since the construction of John Martin Dam. The report recommends small-scale channel modification and riparian restoration features which are cost-effective and environmentally acceptable. Improvements can be pursued by local authorities and/or through the Corps' Section 1135 program.

7. **Section 1135.** The 1986 Water Resources Development Act authorized the review of completed water resources projects to implement modifications that improve the quality of the environment. Albuquerque District is currently pursuing two Section 1135 projects in the Arkansas River Basin.

The Lake Hasty aquatic habitat restoration feasibility study was completed in August 1998. The recommended plan would route 5-8 cfs through Lake Hasty when irrigation releases are being made from John Martin Dam to improve aquatic habitat conditions in the Lake. The Corps completed detailed plans for the project in November 1999. The potential project sponsor, the Colorado Division of Wildlife, anticipates cost-sharing funds to be available in July 2001, and construction is expected to occur during the winter 2001-2002 months.

A feasibility study is being conducted in the Fountain Creek floodway at Pueblo, CO, to determine the extent of riparian and wet meadow habitat that may be restored. The feasibility study will be completed in January 2000 and the potential local sponsor is the City of Pueblo. Those having a need for this program should contact the U.S. Army Corps of Engineers, Environmental Branch, 4101 Jefferson Plaza NE. , Albuquerque, New Mexico 87109, telephone (505) 342-3358.

8. **Section 206.** The 1996 Water Resource Development Act of provided authority for aquatic ecosystem restoration projects in areas unrelated to existing Corps water projects. The Albuquerque District is currently conducting a feasibility study for improving fish and riparian habitat along 9 miles of the Arkansas River downstream of Pueblo Dam. Scoping meetings will be held in

November 1999 and a final feasibility report is to be completed in December of 2000.

9. **Continuing Authorities Program.** Under Section 14 of the 1946 Flood Control Act, as amended, the Corps provides emergency streambank protection works to prevent damage to public facilities. Up to $500,000 in Federal funds can be spent for each project. Under our Section 205 authority, small flood control projects may be constructed with a maximum Federal contribution of $7,000,000.

The non-federal sponsor, under both of these authorities, must contribute 35% of the cost for these projects. This program is available to communities, flood control organizations, and other governing entities. Those having a need for this program should contact the U.S. Army Corps of Engineers, Formulation Section, 4101 Jefferson Plaza NE. , Albuquerque, New Mexico 87109, telephone (505) 342-3201.
To date, no studies have been requested in the Arkansas Basin for 1999.

10. **Flood Plain Management Services.** The objective of the Flood Plain Management Services Program is to support comprehensive flood plain management planning with technical services and planning guidance at all appropriate governmental levels. Section 321 of the Water Resources Development Act of 1990 requires recovering the costs of services provided to Federal Agencies, private persons and organizations. A fee schedule has been established. These services are provided to state and local governments at no cost.

Services available include: help in interpretation and evaluation of basic flood-hazard data; guidance in preparation of flood plain regulations; advice on use of data regarding possible alternative developments in flood-prone areas; guidance on structural and nonstructural measures which might be employed to reduce flood hazard; and, in some cases, development of basic flood-hazard data. Governmental agencies or persons having a need for these services should contact the U.S. Army Corps of Engineers, Hydrology and Hydraulics Section, 4101 Jefferson Plaza, Northeast, Albuquerque, New Mexico 87109-3435, telephone (505) 342-3461, or check out our FPMS web page at: "http://www.spa-wc.usace.army.mil/fpms/."

In 1999, the Federal Emergency Management Agency selected the Albuquerque District as Study Contractor to produce a Flood Insurance Study for Oak Creek through the city of Florence, Colorado. The study is ongoing and will be completed in 2000. In addition, the Albuquerque District received two requests for technical services at specific sites within the Arkansas River Basin.

11. <u>404 Permits.</u> Section 404 of the Clean Water Act prohibits discharges of dredged or fill materials into waters of the United States, including wetlands, without a permit from the Corps. Persons or agencies who are planning to do filling or excavation activities in any waterway should contact the Corps office in Pueblo, Colorado.

In 1999, 8 individual permits were issued in the Arkansas River Basin. An additional 182 activities in the Basin were reviewed during the period and most were covered under nationwide permits. Persons or agencies who are planning to conduct fill or excavation activities in any waterway are advised to contact the Southern Colorado Project Office, 720 North Main, Suite 205, Pueblo, Colorado 81003, (719) 543-9459. Information, including all public notices, is also available on our web home page at: "http://www.swp.usace.army.mil/reg/".

12. <u>Emergency Management Coordination.</u> Public Law 84-99 gives the Corps of Engineers the authority to assist state and local governments before, during and after flood events. The Corps, using the PL 84-99 authority, will repair three flood control works damaged during in the May 99 flood. These rehabilitation projects are located in Pueblo on Fountain Creek, and on the Arkansas River at La Junta and Las Animas.

The La Junta Channel Improvement project was built in 1956 to increase channel conveyance capability with the dredged material used to construct a spoil bank levee. After forty years of service and river sedimentation, the project currently provides an 8-year level of protection. The May 1999 flood event overtopped and breached this levee, resulting in significant damage to the North La Junta area. The Corps has requested approval to repair this damaged levee at Federal cost.

The Las Animas levee project was built by the Corps in 1979 and provides a 200-year level of protection. The levee did incur some slope protection damage during the flood which the Corps has requested approval to repair at Federal cost.

The Pueblo levee project was built by the Corps in 1990 and provides a 200-year level of protection. This levee also incurred some slope protection damage during the flood which the Corps has requested approval to repair at Federal cost.

The Corps' Emergency Management Branch works with Local governments to inspect numerous flood control projects throughout the Arkansas Basin to insure that these facilities are in proper operational condition for the next flood season. During years with high snow pack, the Corps works with the Flood Control Section of the Colorado Water Conservation Board to prepare for flood fight activities that may be required.

During the past year, the Emergency Management Branch received 22 contacts from local governments and private citizens in the Arkansas River Basin requesting information or assistance regarding flood related activities.

Exhibit 19

Annual Meeting

December 7, 1999

Report of U.S. Geological Survey Water-Resources Activities in the Arkansas River Basin of Colorado

to the

Arkansas River Compact Administration

December 7, 1999

Items of Direct Interest to the Administration

The USGS again received small decreases in funding for the Federal Collection of Basic Records Program in 1999, and additional cuts are expected through 2000 as part of the agreement to balance the Federal budget. This program provides basic station funding for 6 of the stations operated in support of the Compact (4 in Colorado and 2 in Kansas). Although funding for Compact stations was not affected in 1999, continued decreases in funding could affect these stations in the future.

During 1999, the USGS in cooperation with the Colorado State Engineer completed a study to compare the power conversion coefficient (PCC) method to totalizing flow meters (TFM) for estimating ground-water pumpage in the lower Arkansas River valley alluvial aquifer of Colorado. The report is WRIR 99-4221 'Comparison of two approaches for determining ground-water discharge and pumpage in the lower Arkansas River basin, Colorado, 1997-98.'

Items of General Interest

During 1999, the USGS will operate continuous-recording stream gages at about 55 sites in the basin, continuous-recording gages at 3 reservoirs, continuous recording water-quality stations at 13 sites. The USGS will conduct sediment data collection at about 15 sites, periodic water-quality measurements on Pueblo Reservoir, biological sampling at about 5 sites, and periodic water-quality sampling at about 35 surface-water sites and 165 wells (including about 150 wells at the U.S. Army's Pueblo Chemical Depot and 15 wells near Colorado Springs). Several networks of ground-water level measurements are operated in the basin, including 70 wells measured twice a year between Pueblo and the state line, 40 wells measured twice a year between Leadville and Pueblo, 40 wells measured twice a year in the alluvial aquifer south of Colorado Springs, 30 wells measured every other month in the Upper Black Squirrel Creek Basin and 130 wells measured annually in El Paso County. Much of the continuous-recording streamflow and water-quality data are available on the World Wide Web at http://co.water.usgs.gov/

The cooperative program between the USGS, U.S. Army, Agriculture Research Service, and Natural Resource Conservation Service of monitoring precipitation, streamflow, water quality, and suspended sediment at the U.S. Army's Pinon Canyon Maneuver Site along the Purgatoire

River between La Junta and Trinidad and on Fort Carson Military Reservation is continuing to be developed to provide improved information to make land-use decisions.

The USGS continued water-quality monitoring for the lower Arkansas River between Pueblo and John Martin Reservoir.

A draft report was prepared by the USGS in cooperation with the Colorado Water Conservation Board to 1) determine the extent of high water-table conditions near La Junta, Colorado; 2) evaluate trends in ground-water levels, diversions, and streamflow; and 3) evaluate changes in stream channel elevations. The draft report is being revised subsequent to cooperator and technical review and is expected to be published in spring 2000.

Exhibit 20

Annual Meeting

December 7, 1999

STATE OF COLORADO

OFFICE OF THE STATE ENGINEER
Division of Water Resources
Department of Natural Resources
1313 Sherman Street, Room 818
Denver, Colorado 80203
Phone: (303) 866-3581
FAX: (303) 866-3589
http://water.state.co.us/default.htm

December 3, 1999

Bill Owens
Governor

Greg E. Walcher
Executive Director

Hal D. Simpson, P.E.
State Engineer

Mr. A. Jack Garner, Area Manager
Eastern Colorado Area Office, U.S. Bureau of Reclamation
11056 West County Road 18E
Loveland, CO 80537

Lt. Col Thomas Fallin, District Engineer
Albuquerque District, U.S. Army Corps of Engineers
4101 Jefferson Plaza NE
Albuquerque, NM 87103

Mr. Larry E. Trujillo, Chairman
Arkansas River Compact Administration
1525 Sherman Street, Suite 200
Denver, CO 80203

Mr. David Pope, Chief Engineer - Director
Kansas Division of Water Resources
109 SW 9th Street, Second Floor
Topeka, KS 66612

Mr. Eugene Aiello, President
Purgatoire River Water Conservancy District
314 West Main Street
Trinidad, CO 81082

Re: Temporary Detention and Release of Flood Flows at Trinidad Reservoir

Gentlemen:

I am aware that there have been discussions of the temporary detention of flood flows at Trinidad Reservoir during the current review of the Operating Principles for the Project, and also of concerns related to those operations expressed by downstream water users.

Article III of the Operating Principles Trinidad Dam and Reservoir Project pertains to flood control

Exhibit 20

Pope, Barfield, Rolfs, Rude, Draper, Book and states that "Trinidad Reservoir shall be operated for flood control benefits in accordance with regulations prescribed by the Secretary of the Army and the following operating principles." In particular, Paragraph 3 of Article III states:

> 3. Any inflow, other than that stored for irrigation use, temporarily retained below the bottom of the flood control capacity for flood control purposes, shall be released by the operating agency at such rate, time, and quantity as may be ordered by the Colorado State Engineer, but within nondamaging flow in the channels below the reservoir.

I am directing this correspondence to you, as signatories to the Operating Principles, to document how the Colorado State Engineer makes the necessary determinations required by Paragraph 3. Accordingly, and until further notice, I will continue to utilize the attached:

> **CRITERIA FOR TEMPORARY DETENTION AND SUBSEQUENT RELEASE OF FLOOD FLOWS STORED IN THE TRINIDAD RESERVOIR BELOW FLOOD CONTROL CAPACITY AND FOR DISTRIBUTION OF RELEASED FLOOD FLOWS GENERALLY.**

In addition, I hereby offer to provide suitable reports and accounting of any hydrologic events that require administration of the Purgatoire River pursuant to this criteria.

Sincerely,

Hal Simpson, Colorado State Engineer

cc Aurelio Sisneros
Wendy Weiss
Steve Witte
Peter Evans
James Rogers
Tom Pointon
Don Steerman
John Lefferdink

CRITERIA FOR TEMPORARY DETENTION AND SUBSEQUENT RELEASE OF FLOOD FLOWS STORED IN THE TRINIDAD RESERVOIR BELOW FLOOD CONTROL CAPACITY AND FOR DISTRIBUTION OF RELEASED FLOOD FLOWS GENERALLY

Criteria for temporary detention of flood flows

The Division Engineer temporarily detains flood flows to limit releases from Trinidad Dam so as to cause the flow measured at the Trinidad gage to not exceed 3,000 cfs. This is in accord with a letter from Gary L. Gamel of the Corps of Engineers dated April 16, 1993, which states:

> The Water Control Plan for the flood control operation of Trinidad Lake calls for releases of 5000 cfs, as measured at the Trinidad gage ... Until the Water Control Plan can officially be revised, any releases from Trinidad Dam in excess of 3000 cfs should not be made without consultation with this office.

Because this lower rate is based upon hydraulic analysis performed below Trinidad, Colorado this is interpreted to mean that releases from Trinidad Dam should be limited so as to cause the flow measured at the Trinidad gage not to exceed 3000 cfs without consultation with appropriate personnel of the Albuquerque District, Corps of Engineers.

Criteria for subsequent release

The Division Engineer begins releasing water temporarily detained after 8:00 a.m. of the following day as soon as channel capacity is available. Channel capacity is available when such releases will not cause the flow at the Trinidad gage to exceed 3,000 cfs.

Water temporarily detained is released at the maximum rate, taking into account bypasses of reservoir inflow to satisfy current district demands and downstream senior rights, that will not cause the flow at the Trinidad gage to exceed 3,000 cfs. However, the Corps of Engineers may direct releases greater than 3,000 cfs, but not to exceed 5,000 cfs at the Trinidad gage, if channel conditions permit.

Criteria for distribution of released flood flows

The Division Engineer distributes the released waters ensuring that the project ditches are not diverting any flood flows temporarily stored in Trinidad Reservoir either below or in the Flood Control Capacity, unless John Martin Reservoir is spilling, or unless otherwise lawfully entitled to do so pursuant to a Colorado water right, an exchange or substitute supply plan administered by the Division Engineer, or a decreed plan for augmentation.

Exhibit 21

Annual Meeting

December 7, 1999

ARKANSAS RIVER COMPACT ADMINISTRATION
307 SOUTH FIFTH STREET, LAMAR, COLORADO 81052
719-336-9696

FOR COLORADO
PETER H. EVANS [ACTING], DENVER
JAMES G. ROGERS, LAMAR
THOMAS R. POINTON, LAS ANIMAS

CHAIRMAN AND FEDERAL REPRESENTATIVE
LARRY E. TRUJILLO, SR.
PUEBLO, COLORADO

FOR KANSAS
DAVID L. POPE, TOPEKA
DAVID A. BRENN, GARDEN CITY
RANDY HAYZLETT, LAKIN

RESOLUTION
OF THE
ARKANSAS RIVER COMPACT ADMINISTRATION
CONCERNING
AN AMENDMENT TO THE OPERATING PRINCIPLES FOR THE TRINIDAD DAM AND RESERVOIR PROJECT REGARDING STOCK WATERING DURING THE NON-IRRIGATION SEASON

WHEREAS, in P.L. 85-500, dated July 3, 1958, Congress authorized the Trinidad Project "substantially in accordance with the recommendations" in a Review Report by the U.S. Army Corps of Engineers dated June 30, 1953, published as House Document No. 325, 84th Congress; and

WHEREAS, the Arkansas River Compact Administration reviewed and approved the Operating Principles Trinidad Dam and Reservoir Project, including the Five Kansas Conditions, by resolution dated June 6, 1967; and

WHEREAS, the Trinidad Project was constructed by the U.S. Army Corps of Engineers and was substantially completed by January 1, 1977; and

WHEREAS, the Purgatoire River Water Conservancy District distributes the irrigation water supplies of the Trinidad Project and has requested that Article IV. D., Paragraph 2(a) of the Operating Principles be amended to allow the more efficient distribution of water for livestock watering during the non-irrigation season on a volumetric basis; and

WHEREAS, the U.S. Bureau of Reclamation concluded in a study dated December 1996, "Trinidad Lake Project Colorado Review of Operating Principles and Project Operations - Final Report", that the change in stock watering procedures was more efficient and caused no additional depletions to downstream water users; and

WHEREAS, the Colorado State Engineer has agreed to provide an accounting of stock water releases at the end of each non-irrigation season; and

WHEREAS, Kansas Condition No. 2 of the Operating Principles states: "Any subsequent amendment of the Operating Principles should be subject to the review and approval of the same interests as provided for in the original procedure"; and

WHEREAS, the U.S. Bureau of Reclamation, after conferring with the parties to the Operating Principles, has recommended that the Operating Principles be amended by replacing the existing language of Article IV. D., Paragraph 2(a) with the provision set forth in the attached Exhibit "A".

NOW, THEREFORE, BE IT RESOLVED that the Arkansas River Compact Administration hereby approves the proposed amendment to the Operating Principles for the Trinidad Dam and Reservoir Project, as set forth in the attached Exhibit "A," providing for the delivery of stock water during the non-irrigation season on a volumetric basis, and further authorizes the Chairman of the Administration to sign Exhibit A, indicating the Administration's approval of the amendment.

Entered this 7th day of December, 1999, at the Annual Meeting of the Arkansas River Compact Administration.

____

Aurelio Sisneros, Chairman
Arkansas River Compact Administration

EXHIBIT "A" TO DECEMBER 7, 1999 RESOLUTION OF THE ARKANSAS RIVER COMPACT ADMINISTRATION
[CONCERNING AN AMENDMENT TO THE OPERATING PRINCIPLES FOR THE TRINIDAD DAM AND RESERVOIR PROJECT REGARDING STOCK WATERING DURING THE NON-IRRIGATION]

Paragraph 2(a) of Article IV. D. of the Operating Principles Trinidad Dam and Reservoir Project is hereby amended to read as follows:

2. District Operation, Non-Irrigation Season

(a) During each non-irrigation season, the District will provide an allowance for stock watering purposes of not more than 1,200 acre-feet measured at the headgates of the ditches diverting water for stock watering purposes. If the stream gains below the Trinidad Dam are insufficient to fulfill the allowance, an equivalent volume of reservoir inflow may be released to satisfy stock water demands within the allowance; provided, the stock water allowance shall not be used for irrigation purposes. The maximum daily quantity released may be up to, but shall not exceed, the total reservoir inflow on the previous day and shall not count as water stored under the District Storage Right. No other diversions by Project ditches shall be allowed prior to April 1 of each year.

An annual report of reservoir releases and diversions for stock watering operations by the Colorado State Engineer will be provided within 30 days of the end of the non-irrigation season of each year, and upon request, reports on specific operations, to the Water Commissioner of the Garden City field office of the Division of Water Resources, Kansas Department of Agriculture.

Chairman, Arkansas River Compact Administration	Date	Purgatoire River Water Conservancy District	Date
U.S. Bureau of Reclamation	Date	State of Kansas	Date
U.S. Army Corps of Engineers	Date		

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printed:December 6, 1999

Exhibit 22

Annual Meeting

December 7, 1999

STATE OF KANSAS

BILL GRAVES, GOVERNOR
Mary Jane Stattelman, Acting Secretary of Agriculture

DIVISION OF WATER RESOURCES
David L. Pope, Chief Engineer
109 S.W. 9th Street, 2nd Floor
Topeka, Kansas 66612-1283
(785) 296-3717 FAX (785) 296-1176

KANSAS DEPARTMENT OF AGRICULTURE

August 13, 1999

Mr. A. Jack Garner, Area Manager
United States Department of the Interior
Bureau of Reclamation
Eastern Colorado Area Office
11056 West County Rd 18E
Loveland, CO. 80537-9711

Re: Criteria for Temporary Detention and Subsequent Release of Flood Flows Stored in the Trinidad Reservoir Conservation Pool

Dear Mr. Garner:

At the July 12, 1999 meeting in Denver called by you for purposes of discussing Dam and Reservoir Project issues related to the Trinidad Operating Principles, Kansas agreed to submit comments on the Colorado Division Engineer's Criteria for Temporary Detention and Subsequent Release of Flood Flows Stored in the Trinidad Reservoir Conservation Pool, submitted to you by letter dated December 2, 1998 from Mr. Steve Witte, the Colorado Division 2 Engineer ("Criteria").

As a result of the discussion at the meeting and subsequent consideration, Kansas would propose that the Criteria be modified as follows:

1. Title: Modify the title of the Criteria to read as follows: "Criteria for Temporary Detention and Subsequent Release of Flood Flows Stored in the Trinidad Reservoir <u>Below Flood Control Capacity and for Distribution of Released Flood Flows Generally</u>".

2. The second-to-last paragraph of the Criteria should be supplemented by adding the sentence: "However, the Corps of Engineers may direct releases greater than 3,000 cfs, but not to exceed 5,000 cfs at the Trinidad gage, if channel conditions permit." This is in accordance with the suggestion by the Corps of Engineers in their letter to you of February 10, 1999.

3. New subheading before the last paragraph of the Criteria: "Criteria for Distribution of Released Flood Flows".

Exhibit 22

4. The last paragraph of the Criteria, the only paragraph under the new subheading suggested above, should be modified to read as follows:

> "The Division Engineer distributes the released waters ensuring that the project ditches are not <u>diverting any flood flows temporarily stored in the Trinidad Reservoir, either below or in the Flood Control Capacity, unless John Martin Reservoir is spilling"</u>.

5. The Criteria should be incorporated into the Operating Principles by amending Article III, Paragraph 3 of the Operating Principles by adding at the end of paragraph 3 the following sentence: The Colorado State Engineer shall comply with "The Criteria for Temporary Detention and Subsequent Release of Flood Flows Stored in the Trinidad Reservoir Below Flood Control Capacity and for Distribution of Released Flood Flows Generally" dated ____________, appended to these Operating Principles.

The reason for the suggested changes regarding distribution of released flood flows are (1) to clarify that the Criteria apply not only to flood flows temporarily detained below the Flood Control Capacity, but also to flood flows temporarily stored in the Flood Control Capacity; and (2) to eliminate the implication of the previous wording that project ditches may have an entitlement to divert flood flows temporarily detained or stored in Trinidad Reservoir.

For convenience, a copy of the amended criteria, as proposed, is attached.

Sincerely yours,

David L. Pope

David L. Pope, P.E.
Chief Engineer

DLP:dr
pc: See attached distribution list (As used with Jack Garner letter dated July 8, 1999)

Criteria for Temporary Detention and Subsequent Release of Flood Flows Stored in the Trinidad Reservoir Below Flood Control Capacity and for Distribution of Released Flood Flows Generally

Criteria for Temporary Detention of Flood Flows

The Division Engineer temporarily detains flood flows to limit releases from Trinidad Dam so as to cause the flow measured at the Trinidad gage not to exceed 3,000 cfs. This is in accord with a letter from Gary L. Gamel of the Corps of Engineers dated April 16, 1993, which states:

> The Water Control Plan for the flood control operation of Trinidad Lake calls for releases of 5000 cfs, as measured at the Trinidad gage. . . Until the Water Control Plan can officially be revised, any releases from Trinidad Dam in excess of 3000 cfs should not be made without consultation with this office.

Because this lower rate is based upon hydraulic analysis performed below Trinidad, Colorado, this is interpreted to mean that releases from Trinidad Dam should be limited so as to cause the flow measured at the Trinidad gage not to exceed 3000 cfs without consultation with appropriate personnel of the Albuquerque District, Corps of Engineers.

Criteria for Subsequent Release

The Division Engineer begins releasing water temporarily detained after 8:00 a.m. of the following day as soon as channel capacity is available. Channel capacity is available when such releases will not cause the flow at the Trinidad gage to exceed 3,000 cfs.

Water temporarily detained is released at the maximum rate, taking into account bypasses of reservoir inflow to satisfy current district demands and downstream senior rights, that will not cause the flow at the Trinidad gage to exceed 3,000 cfs. However, the Corps of Engineers may direct releases greater than 3,000 cfs, but not to exceed 5,000 cfs at the Trinidad gage, if channel conditions permit.

Criteria for Distribution of Released Flood Flows

The Division Engineer distributes the released waters ensuring that the project ditches are not diverting any flood flows temporarily stored in the Trinidad Reservoir either below or in the Flood Control Capacity, unless John Martin Reservoir is spilling

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KANSAS DEPARTMENT OF AGRICULTURE

August 13, 1999

Mr. A Jack Garner, Area Manager
United States Department of the Interior
Bureau of Reclamation
Eastern Colorado Area Office
11056 West County Road 18E
Loveland, CO 80537-9711

RE: Trinidad Operating Principles: Stock watering releases

Dear Mr. Garner:

Enclosed is a draft of Kansas' proposed amendments to Article IV, D, 2 (a) of the Operating Principles, Trinidad Dam and Reservoir Project, regarding stock water releases in the non-irrigation season, in both "strike-type" and "clean" versions.

The primary changes to the current language, as amended effective April 30, 1998, are:

1) Instead of being limited to a 5 cubic feet per second release rate, the stock water releases are limited to 1,200 acre-feet during each non-irrigation season, and each day to no more than the previous days' inflow to Trinidad Reservoir.

2) The releases will be measured at the headgates of the ditches diverting water for stock watering purposes, not at a gage on the Purgatoire River above the Baca ditch headgate.

3) A report of the releases and diversions shall be furnished to the State of Kansas in April each year, or upon request of the State of Kansas.

Sincerely yours,

David L. Pope, P.E.
Chief Engineer

DLP:dr

pc: See attached distribution list (As used with Jack Garner letter dated July 8, 1999)

Proposed Amendment to the Operating Principles
Trinidad Dam and Reservoir Project
Strike-type version
August 12, 1999

Delete: Article IV, D, 2 (a)
Substitute the following language:

During ~~the~~ each non-irrigation season, the District will provide an allowance for stock watering purposes of not more than ~~a daily mean flow of five second feet or its volume equivalent~~ 1,200 acre-feet measured at ~~a gage to be located near and above the Baca River headgate~~ the headgates of the ditches diverting water for stock watering purposes. If the stream gains ~~from the Trinidad dam to said gage~~ below the Trinidad Dam are insufficient to fulfill the allowance, an equivalent volume of reservoir inflow ~~will~~ may be released to satisfy stock water demands within the allowance; provided the stock water allowance shall not be used for irrigation purposes. The maximum daily quantity released may be up to, but shall not exceed, the total reservoir inflow on the previous day and shall not count as water stored under the District Storage right. No other diversions by Project ditches shall be allowed during the non-irrigation season.

An annual report of reservoir releases and diversions for stock watering operations shall be provided by the State of Colorado in April of each year, and upon request, reports on specific operations, to the Water Commissioner of the Garden City field office of the Division of Water Resources, Kansas Department of Agriculture.

Proposed Amendment to the Operating Principles
Trinidad Dam and Reservoir Project
Cleaned up version
August 12, 1999

Delete: Article IV, D, 2 (a)
Substitute the following language:

During each non-irrigation season, the District will provide an allowance for stock watering purposes of not more than 1,200 acre-feet measured at the headgates of the ditches diverting water for stock watering purposes. If the stream gains below the Trinidad Dam are insufficient to fulfill the allowance, an equivalent volume of reservoir inflow may be released to satisfy stock water demands within the allowance; provided, the stock water allowance shall not be used for irrigation purposes. The maximum daily quantity released may be up to, but shall not exceed, the total reservoir inflow on the previous day and shall not count as water stored under the District Storage Right. No other diversions by Project ditches shall be allowed during the non-irrigation season.

An annual report of reservoir releases and diversions for stock watering operations shall be provided by the State of Colorado in April of each year, and upon request, reports on specific operations, to the Water Commissioner of the Garden City field office of the Division of Water Resources, Kansas Department of Agriculture.

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KANSAS DEPARTMENT OF AGRICULTURE

October 13, 1999

Mr. Peter Evans, Director
Colorado Water Conservation Board
721 State Centennial Building
1313 Sherman Street
Denver, CO 80203

RE: Trinidad Project; City of Trinidad Transfer

Dear Peter:

The amendment to the Trinidad Project Operating Principles adopted by ARCA in December, 1997 to allow the City of Trinidad to store water in Trinidad Reservoir in lieu of irrigating some of the lands located in the District irrigable area, provided for advance notice to ARCA of the designation of such lands. Notice was received by a letter from the City's consultant to ARCA, dated April 16, 1999. This letter provided notice that 123.7 acres under the Model Ditch would be dried up and the water consumptively used on this tract would be stored in Trinidad Reservoir. The amended Operating Principles also provide that any dry-up for the City of Trinidad shall reduce the number of acres allowed to be irrigated from the District Water Supply. (Article IV.B.3.(c) of the Amended Principles).

The City of Trinidad received approval from the Colorado State Engineer to dry-up 948 acres under the Johns Flood Ditch and 373.7 acres under the Model Ditch in the 1997 amendment. They are proposing to store water in Trinidad Reservoir corresponding to 123.7 acres under the Model Ditch for 1999. The tract claimed for dry-up has not been irrigated for a number of years and was not included as irrigated in the two studies of project irrigated area undertaken by Reclamation in 1985 and 1994.

The position currently taken by the District, and consented to by Reclamation and Colorado, is that the acreage irrigated by the Project water supply can be shifted from year to year. We understand that the combined total of contracted acreages exceed the project limit and also that lands other than those originally intended to be irrigated with project supply have been irrigated. For these reasons it is necessary to monitor acreage year to year to insure the project limit is not exceeded.

Reclamation's Final Report on the latest review of the Operating Principles dated December, 1996 (1996 Report) made several findings relevant to this situation. The total irrigated area with project supply in 1994 was determined by Reclamation to be **<u>19,458 acres</u>**. This was slightly less than the 19,499 acres, which should be considered the limit on project acreage, since 218 acres are irrigated with non-project supply. In addition, 367 acres were identified by Reclamation as "intended to be irrigated". These totals did not include the City's claimed tract for dry-up under the Model Ditch.

While Kansas believes it is not adequate to have to rely on data from 1994 for assessing current compliance with the acreage limit, this data is apparently the best information available. Based on this information, the total irrigated acreage in the project exceeds the limit under the Operating Principles, when the City's 124 acre tract is included. The tract claimed by the City has not been irrigated for many years, if at all. It would therefore be necessary to discontinue some other acreage being irrigated with project water supply in order for the project to remain under the acreage limit.

Kansas requested that the mapping and notice provision be included in the 1997 amendment to allow verification that the project limitation was not being exceeded when considering the City's tracts in combination with the remaining irrigated land. We were frankly surprised when the first tract claimed under the provisions of the 1997 amendment had not been irrigated for many years, if ever, and believe this situation leads to potential compliance difficulties with the acreage limitation for the project. Kansas has maintained in the discussions over possible further amendments to the Operating Principles that procedures need to be implemented to insure that the acreage limit is adhered to. The present claim by the City for dry-up of unirrigated land further demonstrates this need.

Based on the documentation provided in the 1996 report, the total project irrigated acreage is not being limited to the allowable acreage in apparent violation of the Trinidad Operating Principles. Kansas requests that further documentation be provided to identify the tract(s) irrigated with project water supply in 1994, which are not being irrigated in 1999, to insure that the acreage limit is not being exceeded when the City's tract is included. Kansas also requests an updated map identifying the 1999 irrigated acreage with project water supply.

The use of water for augmentation purposes is also inconsistent with the intent of the Operating Principles. To clarify this, I have attached a proposed amendment to the definition section in the Operating Principles.

Sincerely yours,

David L. Pope, P.E.
Chief Engineer

DLP:dr
Attachments
pc: Attached Distribution List

Draft Amendment to Trinidad Operating Principles
October 13, 1999

The following definition is hereby added to Article II of the Operating Principles, Trinidad Dam and Reservoir Project, as paragraph 19.

19. "Municipal and Industrial Use (M&I Use)" means the use made of water delivered, or to be delivered, directly to an incorporated municipality and distributed through a common distribution system operated by the municipality to be applied directly to beneficial uses within the corporate limits of the municipality, including the use of water in connection with the manufacture, production, transport, or storage of products, and the use of water in connection with providing commercial services.

Municipal and Industrial Use does not include the use of water for augmentation for any purpose.

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Exhibit 23

Annual Meeting

December 7, 1999

STATE OF KANSAS

BILL GRAVES, GOVERNOR
Jamie Clover Adams, Secretary of Agriculture

DIVISION OF WATER RESOURCES
David L. Pope, Chief Engineer
109 S.W. 9th Street, 2nd Floor
Topeka, Kansas 66612-1283
(785) 296-3717 FAX (785) 296-1176

KANSAS DEPARTMENT OF AGRICULTURE

October 13, 1999

Mr. A. Jack Garner, Area Manager
United States Department of the Interior
Bureau of Reclamation
Eastern Colorado Area Office
11056 West County Road 18E
Loveland, CO 80537-9711

RE: Trinidad Project Operating Principles: Irrigated Acres

Dear Jack:

At the meeting with Reclamation, the Purgatoire River Water Conservancy District (District), the State of Colorado and others on July 12, 1999 in Denver, Reclamation requested that Kansas prepare a proposed amendment to the Trinidad Operating Principles to address the issue of compliance with the limitation on irrigated area served by the Trinidad Dam and Reservoir Project. This request was made in response to Kansas' concerns about the District's suggestion in their letter to you dated May 1, 1998 that current practices by the District adequately address the issue.

Kansas believes that the District's response is inadequate. While the District has submitted a procedure, it appears that the District has merely summarized its procedures which were in effect at the time of the meeting in February, 1998. At that meeting, both Reclamation and Kansas requested that additional procedures be proposed by the District to address deficiencies in enforcement and verification of acreage limits. Kansas requested that the procedure provide that by April 1 each year the District report to Kansas which tracts will be irrigated that year and that no changes in irrigated land be allowed during the remainder of the calendar year. The Kansas request was reaffirmed in Recommendation E of my letter to you dated March 18, 1998. The May 1, 1998 letter failed to include the requested provisions. Therefore, Kansas continues to believe that the monitoring procedure currently being used by the District, as described in its letter of May 1, 1998 and at the July 12 meeting is inadequate.

Reclamation, in the 1988 review of the Operating Principles, concluded that the District should implement procedures for positive verification that no more than the maximum irrigated acreage is actually irrigated. Reclamation recognized in its report that the limitation on the amount of lands irrigated is a critical element in the protection of downstream water rights. The procedures

Exhibit 23

need to include annual documentation of lands receiving water, verification that only lands so identified were actually irrigated, and provisions for enforcement. The procedures should be sufficient to allow other water users and officials to determine whether the acreage limitation is being complied with from the documentation provided by the District.

Attached is recommended language for inclusion in the Operating Principles to address this issue. This provision should be added to Article IV.B.1 of the current Operating Principles.

Kansas requests that this provision be included in any amendment that shall hereafter be adopted to the Operating Principles. It is imperative that the District implement substantive procedures to verify, on an ongoing basis, that no more than the maximum project acreage is irrigated.

Sincerely yours,

David L. Pope, P.E.
Chief Engineer

DLP:dr
Attachments
pc: Attached Distribution List

October 13, 1999

AMENDMENT TO ARTICLE IV.B.1
OF THE
TRINIDAD OPERATING PRINCIPLES

The District shall provide notice each year of the particular tracts to be irrigated and the particular tracts to be removed from irrigation pursuant to Article IV.B.3(c), with a map and tabulation identifying those tracts, prior to April 1 each year. The notice shall be provided to the State of Kansas and the Bureau of Reclamation. The map shall identify the acreage of each tract potentially irrigable with District Water Supply, each tract to be irrigated that year, and each tract to be removed from irrigation pursuant to Article IV.B.3(c). The tabulation shall list the tracts by ditch, the acreage for each tract, and whether each tract will be irrigated or removed from irrigation pursuant to Article IV.B.3(c), that year. The tracts so identified shall not be changed at any time during the irrigation season. The District shall not deliver any water to any tract not identified to be irrigated on the map provided prior to April 1 of that year. The District shall prepare a verification report each year in which it shall positively verify, through delivery records, field inspection reports, or other method approved in writing by the Bureau of Reclamation and Kansas, that irrigation has been limited to the tracts identified prior to April 1 that year. The District shall provide the verification report to the Bureau of Reclamation and Kansas prior to February 1 of the following year. The Bureau of Reclamation shall monitor compliance with the notice and confirm to Kansas by April 1 the accuracy of the verification report. The District shall cooperate with representatives of Kansas for the purpose of their conducting field inspections.

MR. EUGENE AIELLO
PURGATOIRE RIVER WATER CONSERVANCY DIST.
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TRINIDAD CO 81082

MR. DAVID BRINN
THE GARDEN CITY COMPANY
P O BOX 597
GARDEN CITY KS 67846

MR. JOHN DRAPER
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P O BOX 2307
SANTA FE NM 87504-2307

MR. DENNIS GARCIA
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KANSAS JUDICIAL CENTER
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LAMAR, CO 81052

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ARKANSAS RIVER COMPACT ADMINISTRATION
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LAMAR CO 81052

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1313 SHERMAN STREET
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TROUT AND RALEY
1775 SHERMAN, SUITE 1300
DENVER CO 80203-4313

MR. DALE BOOK
SPRONK WATER ENGINEERS
1000 LOGAN STREET
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MR. TOM SIMPSON
SOUTHEASTERN COLORADO WATER CONS. DIST.
P O BOX 440
PUEBLO, CO 81002

0/13/99

STATE OF KANSAS

BILL GRAVES, GOVERNOR
Jamie Clover Adams, Secretary of Agriculture

DIVISION OF WATER RESOURCES
David L. Pope, Chief Engineer
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(785) 296-3717 FAX (785) 296-1176

KANSAS DEPARTMENT OF AGRICULTURE

October 13, 1999

Mr. A. Jack Garner, Area Manager
United States Department of the Interior
Bureau of Reclamation
Eastern Colorado Area Office
11056 West County Road 18E
Loveland, CO 80537-9711

RE: Trinidad Project Operating Principles; Ideal Headgate Requirements

Dear Jack:

At the meeting in Denver on July 12, 1999, it was agreed that Kansas would review information provided by Reclamation and the Purgatoire River Conservancy District (District) concerning the Ideal Headgate Requirement for diversions by the project ditches. This letter provides Kansas' comments on the information provided and positions stated by Reclamation and the District, with a recommendation for an amendment to the Operating Principles to correct deficiencies in administration of the Trinidad Project as related to delivery limitations.

Background

In your letter of July 8, 1999, you point out the difference in language between the recommendations in the 1988 report relating to "ideal irrigation requirement" and the Operating Principles limiting deliveries to irrigation requirements at the farm headgate, with allowance for canal and lateral losses. Kansas does not understand this distinction to be material; the Operating Principles contain the provision to limit deliveries to irrigation requirements in Paragraph IV.B.2. The issue currently being addressed is how to implement this provision. The 1961 study referred to the limitation of headgate diversions to "ideal crop requirements". The limitation in the Operating Principles is intended to prevent diversions and deliveries in excess of irrigation requirements, on a reasonable time interval, with adequate estimates of irrigation demand made ahead of time so that the provision can be effectively enforced.

The issue of excess diversions was addressed in the 1988 Reclamation Report on the first review of the Operating Principles. In that Report, Reclamation concluded that the District had made no effort to limit the headgate diversions to that necessary to meet irrigation requirements and excess diversions had in fact occurred. The Report went on to describe general effects of this practice to reduce inflows to John Martin

Reservoir. The Report included a recommendation to implement procedures for limiting diversions to the "ideal irrigation requirement".

The issue was revisited in the 1996 Reclamation Report on the second review of the Operating Principles. Reclamation found that the District had not developed a methodology for determining a "current real time irrigation requirement". This conclusion was supported by Reclamation's finding that excess diversions had occurred in seven out of the ten years of the review period. Again Reclamation recommended that the District should develop (and strictly administer) a methodology for determining a current real time irrigation requirement. However, unlike the 1988 report (and the 1961 Study), the 1996 Report fails to point out the depletive effect of excess diversions to downstream water rights.

The excess diversions do have depletive effects on downstream water users. The 1964 Irrigation Report describes the water supply for the Project as follows:

> "Any improvement in water supply conditions must be accomplished by increasing the irrigation efficiency of existing supplies. This type of development is imperative because there are no substantial new water supplies available to be developed. The dominant aspect of future project operations are, therefore, concerned with improving water use efficiency." (Pg 17)

Obviously the anticipated benefits of the Project were re-regulation of the existing supplies to improve the timing of deliveries to times when the water would be more usable in supplying crop consumptive demands. The low efficiencies historically prevalent in the project were to be increased by improved timing of deliveries and eliminating excess deliveries. Also obvious was the requirement that project depletions not be increased beyond the historical depletions to prevent impacts on downstream water users. In order for this to be possible, an accounting of the pre-project return flows was made and the depletive effects of return flows from excess diversions were estimated and included in the analysis. In concept, this is the only way it would be possible for the Project water supply to be improved to increase crop consumption while not exceeding historical depletions in the project area.

Contrary to assertions presently being made by the District, excess diversions do not occur without some loss before returning to the stream. Reclamation's analysis in the 1988 report showing increased Project depletions with excess diversions demonstrates this. This is also intuitive when considering the benefit of project storage to re-regulate the available water supply to provide water to the crops at times more beneficial to increase crop consumption relative to no-project conditions. Excess diversions have the effect of maintaining pre-project losses on nonbeneficial diversions while also allowing for increased crop consumptive use. Therefore, as concluded in the original Project studies, the limitation on deliveries to meet irrigation requirements is a necessary condition for project operation in order to prevent effects on downstream water users. The ideal irrigation requirement was not a meaningless limitation when the parties incorporated it in the operating principals in 1967, and no analysis since the original studies has shown this limitation to be unnecessary.

Need for Amendment to Operating Principles

The information and descriptions of current administrative practices in the District lead us to conclude that there have been no changes to limit deliveries to the irrigation requirements. The District has interpreted the Operating Principles to mean that the allocations it makes to the ditches, however they are determined, are sufficient to satisfy the requirement of Paragraph IV.B.2. The District further asserts that it is not possible to anticipate the irrigation requirement during the season and therefore not practical to implement any limitation on diversions beyond whatever allocation the District has made. This statement is clearly incorrect, especially given the findings of Reclamation in both the 1988 and 1996 Reports and, if accepted, would effectively eliminate the limitation of deliveries to irrigation requirements as a constraint on the irrigation operations of the District, to the detriment of downstream water users.

In response to Kansas' requests for documentation on the District's efforts to enforce this limitation, Reclamation has described a cooperative program between Reclamation, a local soil conservation district and NRCS to study alternatives to improve irrigation efficiencies in a portion of the Project service area. However, there is no indication that the District is participating in this program. Further, Reclamation stated that the District is exploring an agreement with Reclamation to do a transit loss study. However, again, there is no indication that any action has occurred on this front.

These actions are not responsive to the issue of limiting deliveries to irrigation requirements. The studies of the NRCS to improve irrigation efficiencies do not address determination of requirements and control of deliveries. The limitations included in the Operating Principles are to apply to existing efficiencies. Reclamation estimated such requirements in the Irrigation Studies and concluded in the review reports that actual diversions exceeded the requirements for efficiencies with the existing systems. Any improvements in irrigation efficiencies should be accounted for by reducing the ideal irrigation requirement. It should be noted that increased irrigation efficiencies serve to reduce return flows and increase consumptive uses, which should be accounted for when assessing whether Project depletions have exceeded historical no-project depletions.

Any study of transit loss, if it occurs, would be only the first step in implementing the limitation set out in the Operating Principles.

The provisions of the Operating Principles limiting water deliveries to irrigation requirements should be implemented. An amendment to the Operating Principles is necessary to provide specific guidelines to determine the diversion limits. Paragraph IV.B.2 should be amended by adding the attached language to the existing provision.

Sincerely yours,

David L. Pope, P.E.
Chief Engineer

DLP:dr
Attachments
pc: See Attached Distribution List

October 13, 1999

Proposed Amendment to Paragraph IV.B.2. of the Operating Principles

The irrigation requirement will be established by the District each year for each ditch system based on the number of acres and types of crops to be irrigated during the season, as follows:

(a) The consumptive use requirement for crops will be determined by calculating the consumptive use for each ditch based on the crop distribution irrigated under that ditch. The average crop distribution from the previous five years shall be used, unless a Ditch provides a commitment to grow different during the current year, in which case the latter crop mix shall be used. The method used to calculate consumptive use shall be approved by the Bureau of Reclamation and shall will incorporate climate data for the previous five years to calculate the monthly consumptive use requirement of crops.

(b) The effective precipitation will be determined using records of actual precipitation collected within the project area. Precipitation from the current irrigation season will be used to calculate effective precipitation on a monthly basis, using a method approved by the Bureau of Reclamation, and the consumptive irrigation demand will be updated throughout the season using this data.

(c) The farm delivery requirement will be calculated assuming farm losses of no more than 35%.

(d) Canal and lateral losses will be determined by the Bureau of Reclamation for each ditch system. The losses will be added to the farm delivery requirement to determine the river headgate requirement for each ditch system.

(e) Diversions for each ditch will be limited during the current irrigation season to the calculated river headquate requirement, as updated throughout the irrigation season for effective precipitation. The District will maintain ongoing records of updated river headgate requirements and the actual river headqart diversions for each ditch for the purpose of providing notice of limits and enforcing the diversion limits.

(f) The District will provide Reclamation and the State of Kansas by December 1 each year with a summary of the calculated river headgate requirements and actual river headgate diversions on a monthly basis for that year.

Exhibit 24

Annual Meeting

December 7, 1999

11/19/99

United States Department of the Interior

BUREAU OF RECLAMATION
Eastern Colorado Area Office
11056 West County RD 18E
Loveland, Colorado 80537-9711

IN REPLY
REFER TO:
E.C.-1300 (JOHNS)

RECEIVED
NOV 23 1999
LEGAL SECTION
KS DEPT. AGRICULTURE

NOV 19 1999

To: Distribution List

Subject: Amendments to the Operating Principles, Trinidad Dam and Reservoir Project: Update to Action Items as a result of October 19, 1999, Technical Meeting in Denver, Colorado

On October 19, 1999, a technical meeting to continue discussion of issues relating to the Trinidad dam and Reservoir Operating Principles was held at the Marriott Courtyard near Denver International Airport (list of attenders enclosed). An draft agenda, faxed to most of the parties in attendance prior to the meeting, was finalized at the meeting. The final agenda is enclosed. Listed below are action items resulting from the meeting.

Action Items related to permanent stock water amendment:

During a break from the meeting, Peter Evans and David Pope agreed to a modification (enclosed) of the language to the stock water amendment proposed in Kansas' August 13, 1999, letter. The following action items relate to the language as modified on October 19, 1999.

1. The Purgatoire River Conservancy District (District) was concerned that the statement in the amendment as modified which reads "No other diversions by Project ditches shall be allowed prior to April 1 of each year." creates a potential conflict with local court decrees. Provide to Kansas copies of the two court decrees where this potential exists. Responsible Party: District. Target Date: Completed (On November 1, 1999, Jeris Danielson, General Manager for the District reported that these had been provided to Kansas following the October 19 meeting.).

2. Examine decrees provided by the District and take a closer look at the District's concern. Responsible Party: Kansas. Target Date: December 6, 1999 (prior to annual meeting of the Arkansas River Compact Administration (ARCA)).

3. Because Colorado is not a signatory to the Operating Principles, it is unclear how they could they be bound by this amendment to provide an annual report of reservoir releases and diversion for stock water operations. In consultation with Kansas, determine and implement appropriate

Exhibit 24

3. In consultation with Kansas, determine and implement appropriate mechanism (possibly a letter to Kansas) to document Colorado's agreement to supply an annual report. (Because Colorado is not a signatory to the Operating Principles, it is unclear how they could they be bound by this amendment to provide an annual report of reservoir releases and diversion for stock water operations.) Responsible party: Colorado. Target Date: December 6, 1999 (prior to annual ARCA meeting).

Action Items Related to storage and release of flood flows: Concern was expressed by several of the parties that it would not be appropriate to amend the Operating Principles to incorporate the "Criteria for Temporary Detention and Subsequent Release of Flood Flows Stored in the Trinidad Reservoir Conservation Pool" as proposed by Kansas. And again, because they are not a signatory, it is unclear how Colorado could be bound by such an amendment.

4. Discuss internally (Colorado Water Conservation Board and State Engineer's Office), develop the appropriate document (for example, a letter, statement, or agreement of some sort) to more formally set forth the flood flow criteria, and report results. Responsible Party: Colorado. Target Date: December 7, 1999, ARCA meeting.

Action Items Related to "Ideal Headgate Requirement":

5. Meet to discuss possible response to Kansas' October 13, 1999, letter concerning ideal headgate requirements. Responsible Parties: Reclamation, District, and Colorado. Target Date: Completed (November 1, 1999).

6. Report results of meeting. Responsible Party: Reclamation. Target Date: December 7, 1999, ARCA meeting.

Action Items Related to Irrigated Acreage: The District proposed that the acreage allowed to be irrigated be the original acreage contracted between the District and the ditch companies, and that it is the District's obligation to ensure that the sum of the acreage not exceed the annual acreage cap, currently proposed at 19,499 acres.

7. Meet to discuss possible response to Kansas' October 13, 1999, letter concerning irrigated acres and assistance to the District in developing a process for verifying irrigated acreage on an annual basis. Responsible Parties: District, Colorado, and Reclamation. Target Date: Completed (November 1, 1999).

8. Report results of meeting. Responsible party: Reclamation. Target date: December 7, 1999, ARCA meeting.

Action Items related to City of Trinidad--Review of Kansas' concerns and discussion: No specific action items were identified. (Concerns relate to irrigated acreage, discussed above.)

Action Items related to Storage of Winter Water: At a technical meeting on July 12, 1999, Bruce Kroeker, (Ted Zorich & Associates, Inc., [TZA]), if authorized to do so by clients (Fort Lyon Canal Company and District 67 Irrigating Canals Association), agreed to develop a proposed work plan for evaluating the effects of the proposed storage of winter water outside the 20,000 acre-foot Model right upon downstream water rights, including specific technical recommendations to improve the existing Reclamation model.

TZA responded in an October 18, 1999, letter (enclosed), concluding it is not necessary to perform additional modeling studies for reasons described in the letter. The letter states that "...the 1988 Bureau Report concluded that these practices were a departure from the intent of the Operating Principles." The District pointed out that Reclamation's 1996 report concluded that the practices were not a departure from the Operating Principles. Reclamation commented that it should probably review this conclusion from the 1996 report. There was little time remaining for discussion at the October 19, 1999, meeting and specific actions items were not identified. An action item is offered below.

1. Review conclusion in Reclamation's 1996 Report that storage of winter water outside the model right is not a departure of the Operating Principles and document findings. Responsible Party: Reclamation. Target Date: December 2000.

If you have any questions or require further information on these items please call Alice Johns at (970) 962-4338 or Malcolm Wilson at (970) 962-4362.

Sincerely,

Elizabeth M. Boaz

for Gerald Kelso
Acting Area Manager

Enclosures (4)

Proposed Amendment to the Operating Principles, Trinidad Dam and Reservoir Project, enclosed with an August 13, 1999, letter from David L. Pope; and as further modified on October 19, 1999, following discussions between Kansas (David Pope) and Colorado (Peter Evans). Modifications from October 19, 1999, meeting are shown in redline and strikeout.

Delete: Article IV, D, 2 (a)
Substitute the following language:

During each non-irrigation season, the District will provide an allowance for stock watering purposes of not more than 1,200 acre-feet measured at the headgates of the ditches diverting water for stock watering purposes. If the stream gains below the Trinidad Dam are insufficient to fulfill the allowance, an equivalent volume of reservoir inflow may be released to satisfy stock water demands within the allowance; provided, the stock water allowance shall not be used for irrigation purposes. The maximum daily quantity released may be up to, but shall not exceed, the total reservoir inflow on the previous day and shall not count as water stored under the District Storage Right. No other diversions by Project ditches shall be allowed ~~during the non-irrigation season~~ prior to April 1 of each year.

An annual report of reservoir releases and diversions for stock watering operations by the State of Colorado will ~~shall~~ be provided ~~by the State of Colorado in April~~ within 30 days of the end of the non-irrigation season of each year, and upon request, reports on specific operations, to the Water Commissioner of the Garden City field office of the Division of Water Resources, Kansas Department of Agriculture.

(Enclosure 2)

Exhibit 26

Annual Meeting

December 7, 1999

9/14/98 KWC SECWCD

United States Department of the Interior

U.S. GEOLOGICAL SURVEY
Water Resources Division
Norwest Bank Bldg., Suite 200
201 W. 8th St.
Pueblo CO 81003-3031
Phone and FAX (719) 544-7155

SEP 16 1998

Mr. James Rodgers, Secretary/Treasurer
Arkansas River Compact Administration
307 S. 5th Street
Lamar, CO 81052

Dear Jim,

To formalize the cooperative program between the Arkansas River Compact Administration (ARCA) and the U.S. Geological Survey (USGS), Colorado District, I am submitting two originals of the Joint Funding Agreement (JFA) for fiscal year 1999 (October 1, 19978through September 30, 1999) for the operation and maintenance of the streamflow-gaging stations in Colorado that support the Compact. I know that the Compact will not formally act on our program until the December meeting, and if there are changes in the program resulting from discussions at the meeting, the JFA could be amended at that time.

As the attached summary table indicates, funding for the Cooperative (USGS/ARCA) portion of the stream-gaging program is $51,100, of which $25,550 is repay funds from the Administration and $25,550 is federal matching funds from the USGS. For future planning purposes, funding for the Administration's share of the FY00 stream-gaging program should be about $26,800.

If the JFA is satisfactory, please sign both originals; keep one for your records; return one to the address shown below, by October 1, 1998, if possible. Work performed with funds from this agreement will be conducted on a fixed-price basis and billing will be made quarterly.

U.S.G.S.-WRD
Mail Stop 415, Box 25046
Denver Federal Center
Lakewood, CO 80225

If you have any questions, please don't hesitate to call me at (719) 544-7155, ext. 130. We are appreciative of your continuing involvement in these important efforts.

Sincerely yours,

Doug Cain
Subdistrict Chief

copy to Lytle, Rolfs, Rude

WATER RESOURCES RECEIVED
SEP 14 1998
KS DEPT OF AGRICULTURE

Enclosure

Copy to: District Chief, WRD, Lakewood, CO
District Chief, WRD, Lawrence, KS
Larry Trujillo, ARCA, Pueblo, CO
David Pope, KDWR, Topeka, KS
Peter Evans, CWCB, Denver, CO
Steve Miller, CWCB, Denver, CO
Steve Witte, CDWR, Pueblo, CO
Ron Steger, WRD, Pueblo, CO

SUMMARY OF PROGRAM

U.S. Geological Survey (Colorado District)/
Arkansas River Compact Administration

Station number	Station name	Notes[1]	Funding[2] in FY1999
07119500	Apishapa R. nr. Fowler	A	$ 8,900
07124000	Arkansas R. at Las Animas	B	2,850
07128500	Purgatoire R. nr. Las Animas	B	2,850
07130500	Arkansas R. blw. John Martin Res.	B	2,850
07133000	Arkansas R. at Lamar	B	2,850
07134100	Big Sandy Creek	C	10,150
07134500	Arkansas R. at Granada	A D	8,900 2,850
07134990	Wild Horse Creek	E	4,450
07135000	Two Buttes Creek	E	4,450
	TOTALS:		$ 51,100

[1]Activities included are explained as follows:

Note A Funding for basic station O&M.
Note B Funding for about six supplemental measurements per year (April-November); basic station O&M funded by USGS.
Note C Funding for basic station O&M, and for crest-stage gage on Big Sandy Creek upstream from Amity Canal.
Note D Funding for about six supplemental measurements per year (April - November)
Note E Funding for seasonal (April-October) O&M.

[2]Based on Federal fiscal years, October 1 through September 30.

Form 9-1366
(May 1996)

U.S. Department of the Interior
U.S. Geological Survey
Joint Funding Agreement
FOR
Water Resources Investigations

Agreement No. CO98019
Customer No. CO008
TIN - 84-00811823

THIS AGREEMENT is entered into as of the **1st** day of **October** 1998 by the U.S. GEOLOGICAL SURVEY, UNITED STATES DEPARTMENT OF THE INTERIOR, party of the first part, and the **Arkansas River Compact Administration**, party of the second part.

1. The parties hereto agree that subject to the availability of appropriations and in accordance with their respective authorities there shall be maintained in cooperation **operation and maintenance of gaging stations in support of the Compact,** hereinafter called the program.

2. The following amounts shall be contributed to cover all of the cost of the necessary field and analytical work directly related to this program.

   (a) **$25,550.00** by the party of the first part during the period **October 1, 1998** to **September 30, 1999**

   (b) **$25,550.00** by the party of the second part during the period **October 1, 1998** to **September 30, 1999**

   (c) Additional or reduced amounts by each party during the above period or succeeding periods as may be determined by mutual agreement and set forth in an exchange of letters between the parties.

3. The costs of this program may be paid by either party in conformity with the laws and regulations respectively governing each party.

4. The field and analytical work pertaining to this program shall be under the direction of or subject to periodic review by an authorized representative of the party of the first part.

5. The areas to be included in the program shall be determined by mutual agreement between the parties hereto or their authorized representatives. The methods employed in the field and office shall be those adopted by the party of the first part to insure the required standards of accuracy subject to modification by mutual agreement.

6. During the course of this program, all field and analytical work of either party pertaining to this program shall be open to the inspection of the other party, and if the work is not being carried on in a mutually satisfactory manner, either party may terminate this agreement upon 60 days written notice to the other party.

7. The original records resulting from this program will be deposited in the office of origin of those records. Upon request, copies of the original records will be provided to the office of the other party.

8. The maps, records or reports resulting from this program shall be made available to the public as promptly as possible. The maps, records or reports normally will be published by the party of the first part. However, the party of the second part reserves the right to publish the results of this program and, if already published by the party of the first part shall, upon request, be furnished by the party of the first part, at cost, impressions suitable for purposes of reproduction similar to that for which the original copy was prepared. The maps, records or reports published by either party shall contain a statement of the cooperative relations between the parties.

9. Billing for this agreement will be rendered **quarterly**. Payments of bills are due within 60 days after the billing date. If not paid by the due date, interest will be charged at the current Treasury rate for each 30 day period, or portion thereof, that the payment is delayed beyond the due date. (31 USC 3717; Comptroller General File B-212222, August 23, 1983.).

U.S. GEOLOGICAL SURVEY
UNITED STATES
DEPARTMENT OF THE INTERIOR

By W K Hand
(SIGNATURE & TITLE)
District Chief, Colorado District

Arkansas River Compact Administration

By ______________________________

By ______________________________

By ______________________________

(USE REVERSE SIDE IF ADDITIONAL SIGNATURES ARE REQUIRED)

Exhibit 28

Annual Meeting

December 7, 1999

Purgatoire River Water Conservancy District

Trinidad, Colorado

Report to the

Arkansas River Compact Administration

December 7, 1999

Exhibit 28

Introduction:

The Purgatoire River Water Conservancy District was formed pursuant to Colorado Revised Statutes, Title 37, Article 45, paragraph 101, et.seq, on December 2, 1960. The purpose for the formation of the District was to provide a legal entity capable of contracting with the United States for repayment of the irrigation component assigned to the Trinidad Project and to provide a management entity to oversee and operate the irrigation facilities associated with the Project.

On February 10, 1967, the District executed a repayment contract with the United States whereby it assumed a debt of $ 6,465,600, which is to be repaid over a 70 year period. The annual repayment installments vary from $ 118,000 to $ 238,000 depending upon the available water supply for the irrigation season.

The District is governed by a Board consisting of nine members appointed by the Senior District Judge for Las Animas County. The District Board is responsible for, among other things, determining the start and end of the irrigation season, the equitable allocation of water to each of the participating ditches, and declaration of the time when the reservoir is considered to be empty, allowing diversions of natural stream flow to proceed under the Colorado Priority System.

Day to day matters are administered by the District Water Coordinator and the General Manager. The District provides accounting for all irrigation, stockwater and municipal and industrial water releases and diversions utilizing a sophisticated computer model that provides daily accounting of reservoir releases, ditch diversions, and storage accounts.

Project Description:

The main feature of the Trinidad Project is Trinidad Dam which is located several miles west of the City of Trinidad on the Purgatoire River in Las Animas County, Colorado. The dam, which was constructed by the Army Corps of Engineers, is of the earth fill type of construction, having a crest length of approximately 5,930 feet, a height of 208 feet above the stream bed, and a crest elevation of 6,298 feet above mean sea level.

The reservoir created by the dam has a total capacity of 125,967 acre feet, which is allocated to the following uses:

Flood Control:	51,000	acre-feet
Irrigation and M&I:	20,000	acre-feet
Permanent Recreation and Fishery:	15,967	acre-feet
Joint Use and Sediment Pool:	39,000	acre-feet

The irrigation and joint use pools are utilized to provide storage for the irrigation, by eleven project ditches, of up to 19,499 acres in the project service area, and for municipal use by the City of Trinidad. Each of the participating ditches have repayment contracts with the District whereby annual payments are made based upon available water during the year.

The Colorado Division of Parks and Outdoor Recreation operates Trinidad State Park at the reservoir site which provides a wide array of recreational opportunities.

Operations During the 1999 Irrigation Season:

Operations of the Trinidad Project during the 1999 irrigation season began with predictions of runoff as late as May of only 23% of normal. Late snowfall and higher than average rainfall during the growing season provided the opportunity to provide a full irrigation supply to all of the project ditches, except for the Model Land and Irrigation Company, and actually resulted in the filling of the reservoir to the bottom of the flood pool during the period when John Martin Reservoir was spilling.

The Model Land and Irrigation Company was unable to divert during most of the irrigation season due to the rendering of it's canal inoperable as a result of severe rains and was granted permission by the Secretary of the Interior to irrigate past the traditional end of season date of October 15 in order to salvage some economic benefit. The Model Company irrigated up to and including October 19, 1999.

The Project ditches diverted 612 acre-feet of stock water during the calendar year 1999. A composite summary of diversions by each project ditch is appended to this report.

The Corps of Engineers conducted a sedimentation survey during the latter part of the irrigation season which indicated that 1,227 acre-feet of silt had been deposited in the reservoir since the last sediment survey was conducted.

A composite hydrograph of reservoir storage and releases is appended to this report.

Future Activities:

The District has embarked on two projects designed to enhance the monitoring, allocation, and reporting functions related to the operation of the Trinidad Project:

1. **Determination of Canal Efficiencies**

    The District has executed a three year contract with the United States Bureau of Reclamation which is designed to determine canal losses and efficiencies on each of the eleven project ditches. This project is jointly funded by the United States Bureau of Reclamation ($125,000), and the District ($50,000) and will provide invaluable information required by the District to refine its water allocation responsibility.

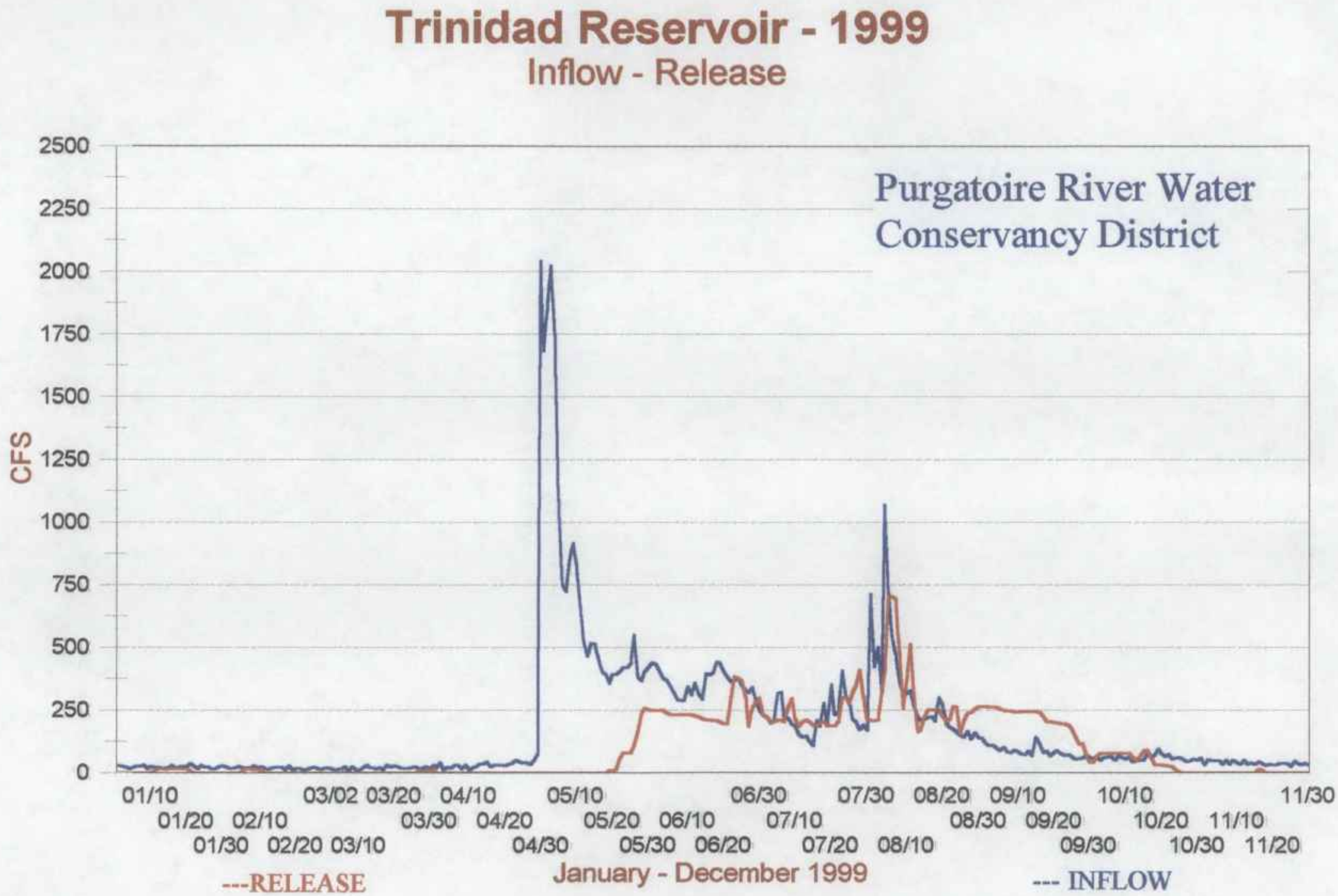
2. **Verification of Irrigated Acreage**

    The District is committed to develop, in cooperation with the Colorado Water Conservation Board and the United States Bureau of Reclamation, a methodology for identifying and verifying, on an annual basis, lands to be irrigated within the Project. This verification procedure is necessary to ensure that irrigated lands do not exceed, in any year, the 19,499 acres allowed by the Project authorization. Contracts to implement the acreage verification program are currently being negotiated.

Purgatoire River Water Conservancy District
Composite Report

Composite Year to date: 1999

Ditch:	Share of Inflow - AF	Demand AF	Computed Acct. Withdrawal- AF	Computed Acct. Bal.-AF	Additional Allocation - AF	Diversion AF	Actual Acct. Withdrawal - AF	Actual Acct. Bal.-AF	Cumulative Use AF per Acre	Stock Water AF
Baca:	1106.51	1001.67	284.57	33.26	76.50	1083.27	283.13	37.45	3.48	56.81
Chilili:	1078.73	840.01	259.87	47.63	74.64	1125.89	406.66	-93.14	3.75	0.00
El Moro:	825.94	414.55	171.52	-14.25	37.93	343.48	43.64	113.65	2.22	9.48
Enl Southside:	19868.79	19735.83	7294.25	-406.87	1369.39	21327.58	7914.05	-814.13	3.86	306.41
Hoehne:	4306.16	3919.40	1257.34	427.86	0.00	4831.29	1554.71	519.62	4.03	0.00
John Flood:	7631.99	6265.88	1581.06	396.36	323.07	6344.98	1541.57	436.06	2.99	91.76
Model:	22142.35	4849.66	1741.90	6000.00	0.00	4984.06	1661.40	5964.69	0.81	0.00
Picketwire:	8677.01	6743.90	1604.07	890.16	591.54	6703.67	1332.61	1051.27	2.78	146.96
River Canyon:	2090.03	1111.06	98.59	375.19	153.22	1515.10	624.74	16.85	1.63	0.00
Total Diversion:						48259.33				



Spady Consulting 1999

Purgatoire River Water Conservancy District
Trinidad Reservoir Monthly Report

April 1999
Content as of Midnight on First of month: 22,392.00 AF

1 Date:	2 Computed Inflow: CFS	3 Computed Inflow: AF	4 Evaporation: AF	5 Release: AF	6 Release: CFS	7 Amount Stored: AF	8 Current Content: AF
01-Apr-99	21.08	41.82	13.50	0.32	0.16	41.50	22420.00
02-Apr-99	43.22	85.73	0.41	0.32	0.16	85.41	22505.00
03-Apr-99	13.23	26.24	4.92	0.32	0.16	25.92	22526.00
04-Apr-99	22.78	45.19	2.87	0.32	0.16	44.87	22568.00
05-Apr-99	18.42	36.53	8.21	0.32	0.16	36.21	22596.00
06-Apr-99	33.23	65.92	15.62	0.30	0.15	65.62	22646.00
07-Apr-99	31.90	63.27	20.99	0.28	0.14	62.99	22688.00
08-Apr-99	17.74	35.19	14.00	0.19	0.10	35.00	22709.00
09-Apr-99	31.14	61.77	18.55	0.22	0.11	61.55	22752.00
10-Apr-99	13.41	26.60	12.37	0.23	0.12	26.37	22766.00
11-Apr-99	20.89	41.44	13.20	0.24	0.12	41.20	22794.00
12-Apr-99	25.47	50.51	15.27	0.24	0.12	50.27	22829.00
13-Apr-99	35.72	70.85	6.61	0.24	0.12	70.61	22893.00
14-Apr-99	36.12	71.65	0.41	0.24	0.12	71.41	22964.00
15-Apr-99	44.34	87.94	8.70	0.24	0.12	87.70	23043.00
16-Apr-99	24.44	48.47	6.23	0.24	0.12	48.23	23085.00
17-Apr-99	32.42	64.31	7.07	0.24	0.12	64.07	23142.00
18-Apr-99	32.22	63.90	6.66	0.24	0.12	63.66	23199.00
19-Apr-99	30.82	61.13	10.84	0.29	0.15	60.84	23249.00
20-Apr-99	29.21	57.93	14.61	0.32	0.16	57.61	23292.00
21-Apr-99	35.46	70.34	5.02	0.32	0.16	70.02	23357.00
22-Apr-99	38.84	77.03	4.60	0.43	0.22	76.60	23429.00
23-Apr-99	50.64	100.44	0.00	0.44	0.22	100.00	23529.00
24-Apr-99	44.62	88.50	2.10	0.40	0.20	88.10	23615.00
25-Apr-99	41.01	81.35	8.00	0.35	0.18	81.00	23688.00
26-Apr-99	41.35	82.01	9.69	0.32	0.16	81.69	23760.00
27-Apr-99	34.49	68.41	10.13	0.28	0.14	68.13	23818.00
28-Apr-99	47.40	94.01	6.77	0.24	0.12	93.77	23905.00
29-Apr-99	75.15	149.06	3.82	0.24	0.12	148.82	24050.00
30-Apr-99	2041.84	4049.98	6.68	0.30	0.15	4049.68	28093.00
	0.00				0.00		
end of month:		5967.52	257.85	8.67		5958.85	28093.00

Purgatoire River Water Conservancy District
Trinidad Reservoir Monthly Report

May 1999
Content as of Midnight on First of month: 28,093.00 AF

1 Date:	2 Computed Inflow: CFS	3 Computed Inflow: AF	4 Evaporation: AF	5 Release: AF	6 Release: CFS	7 Amount Stored: AF	8 Current Content: AF
01-May-99	1684.14	3340.50	2.40	0.10	0.05	3340.40	31431.00
02-May-99	1847.93	3665.37	15.29	0.08	0.04	3665.29	35081.00
03-May-99	2023.68	4013.96	18.91	0.05	0.03	4013.91	39076.00
04-May-99	1748.93	3469.00	15.96	0.04	0.02	3468.96	42529.00
05-May-99	1086.88	2155.83	4.77	0.06	0.03	2155.77	44680.00
06-May-99	749.89	1487.40	14.32	0.08	0.04	1487.32	46153.00
07-May-99	723.48	1435.02	17.95	0.07	0.04	1434.95	47570.00
08-May-99	859.43	1704.67	21.59	0.08	0.04	1704.59	49253.00
09-May-99	917.14	1819.14	32.10	0.04	0.02	1819.10	51040.00
10-May-99	829.18	1644.67	26.66	0.01	0.01	1644.66	52658.00
11-May-99	659.77	1308.66	7.66	0.00	0.00	1308.66	53959.00
12-May-99	522.43	1036.23	23.23	0.00	0.00	1036.23	54972.00
13-May-99	464.52	921.37	33.37	0.00	0.00	921.37	55860.00
14-May-99	517.73	1026.92	32.92	0.00	0.00	1026.92	56854.00
15-May-99	515.12	1021.75	31.75	0.00	0.00	1021.75	57844.00
16-May-99	457.32	907.09	21.09	0.00	0.00	907.09	58730.00
17-May-99	403.24	799.82	19.82	0.00	0.00	799.82	59510.00
18-May-99	392.43	778.38	33.43	18.95	9.55	759.43	60236.00
19-May-99	356.11	706.35	32.24	19.11	9.63	687.24	60891.00
20-May-99	392.76	779.04	15.86	24.18	12.19	754.86	61630.00
21-May-99	391.63	776.79	27.36	111.43	56.18	665.36	62268.00
22-May-99	403.98	801.30	25.23	160.07	80.70	641.23	62884.00
23-May-99	421.47	835.98	16.91	160.07	80.70	675.91	63543.00
24-May-99	420.82	834.70	11.60	160.10	80.72	674.60	64206.00
25-May-99	439.07	870.90	7.00	223.90	112.88	647.00	64846.00
26-May-99	550.99	1092.89	8.61	332.28	167.52	760.61	65598.00
27-May-99	383.21	760.09	14.93	476.16	240.06	283.93	65867.00
28-May-99	367.17	728.28	17.32	508.96	256.60	219.32	66069.00
29-May-99	403.08	799.51	15.77	499.74	251.95	299.77	66353.00
30-May-99	421.23	835.50	27.66	495.84	249.98	339.66	66665.00
31-May-99	439.98	872.71	37.25	495.46	249.79	377.25	67005.00
end of month:		43229.82	630.96	3686.86		39542.96	67005.00

Purgatoire River Water Conservancy District
Trinidad Reservoir Monthly Report

June 1999
Content as of Midnight on First of month: 67,005.00 AF

1 Date:	2 Computed Inflow: CFS	3 Computed Inflow: AF	4 Evaporation: AF	5 Release: AF	6 Release: CFS	7 Amount Stored: AF	8 Current Content: AF
01-Jun-99	431.89	856.66	34.15	496.51	250.32	360.15	67331.00
02-Jun-99	408.16	809.59	39.80	496.79	250.46	312.80	67604.00
03-Jun-99	378.21	750.17	44.66	473.51	238.72	276.66	67836.00
04-Jun-99	369.18	732.26	51.11	461.15	232.49	271.11	68056.00
05-Jun-99	344.23	682.78	42.39	462.39	233.12	220.39	68234.00
06-Jun-99	318.22	631.18	31.22	462.96	233.41	168.22	68371.00
07-Jun-99	290.82	576.84	46.45	462.39	233.12	114.45	68439.00
08-Jun-99	290.22	575.65	44.07	462.58	233.21	113.07	68508.00
09-Jun-99	287.68	570.61	25.66	462.95	233.40	107.66	68590.00
10-Jun-99	344.87	684.05	28.09	462.96	233.41	221.09	68783.00
11-Jun-99	311.88	618.61	18.48	448.13	225.93	170.48	68935.00
12-Jun-99	359.70	713.46	10.46	441.00	222.33	272.46	69197.00
13-Jun-99	315.72	626.23	20.15	426.08	214.81	200.15	69377.00
14-Jun-99	293.67	582.50	24.22	420.28	211.89	162.22	69515.00
15-Jun-99	396.99	787.43	8.90	417.53	210.50	369.90	69876.00
16-Jun-99	390.76	775.08	9.74	417.34	210.41	357.74	70224.00
17-Jun-99	402.45	798.26	17.92	417.34	210.41	380.92	70587.00
18-Jun-99	441.34	875.40	24.53	401.87	202.61	473.53	71036.00
19-Jun-99	440.81	874.35	22.16	388.19	195.71	486.16	71500.00
20-Jun-99	405.37	804.05	32.13	389.92	196.58	414.13	71882.00
21-Jun-99	382.38	758.46	21.48	609.98	307.53	148.48	72009.00
22-Jun-99	363.47	720.94	30.57	761.37	383.85	-40.43	71938.00
23-Jun-99	371.00	735.88	35.51	742.37	374.27	-6.49	71896.00
24-Jun-99	378.31	750.38	28.06	722.32	364.16	28.06	71896.00
25-Jun-99	345.19	684.68	28.91	585.77	295.32	98.91	71966.00
26-Jun-99	327.82	650.24	41.37	366.87	184.96	283.37	72208.00
27-Jun-99	318.68	632.10	47.23	513.87	259.07	118.23	72279.00
28-Jun-99	341.58	677.52	29.86	562.66	283.67	114.86	72364.00
29-Jun-99	284.65	564.60	44.81	590.79	297.85	-26.19	72293.00
30-Jun-99	249.40	494.69	37.33	457.36	230.58	37.33	72293.00
	0.00				0.00		
end of month:		20994.65	921.42	14785.23		6209.42	72293.00

Purgatoire River Water Conservancy District
Trinidad Reservoir Monthly Report

July 1999
Content as of Midnight on First of month: 72,293.00 AF

1 **Date:**	2 **Computed Inflow:** **CFS**	3 **Computed Inflow:** **AF**	4 **Evaporation:** **AF**	5 **Release:** **AF**	6 **Release:** **CFS**	7 **Amount Stored:** **AF**	8 **Current Content:** **AF**
01-Jul-99	230.02	456.24	37.33	390.91	197.08	65.33	72321.00
02-Jul-99	220.94	438.24	29.86	408.38	205.89	29.86	72321.00
03-Jul-99	203.54	403.72	28.19	417.53	210.50	-13.81	72279.00
04-Jul-99	205.63	407.86	32.33	417.53	210.50	-9.67	72237.00
05-Jul-99	317.91	630.57	39.83	405.74	204.56	224.83	72422.00
06-Jul-99	323.00	640.68	21.61	520.07	262.20	120.61	72521.00
07-Jul-99	220.70	437.76	22.44	586.32	295.60	-148.56	72350.00
08-Jul-99	218.74	433.87	20.74	427.13	215.34	6.74	72336.00
09-Jul-99	193.86	384.52	4.98	365.54	184.29	18.98	72350.00
10-Jul-99	189.12	375.11	25.72	406.39	204.89	-31.28	72293.00
11-Jul-99	153.86	305.18	26.52	420.66	212.08	-115.48	72151.00
12-Jul-99	142.63	282.90	25.64	399.26	201.29	-116.36	72009.00
13-Jul-99	146.56	290.71	24.78	378.93	191.04	-88.22	71896.00
14-Jul-99	124.91	247.75	28.87	374.88	189.00	-127.13	71740.00
15-Jul-99	109.04	216.29	17.30	396.99	200.15	-180.70	71542.00
16-Jul-99	210.26	417.05	11.52	405.53	204.45	11.52	71542.00
17-Jul-99	186.42	369.76	11.52	372.24	187.67	-2.48	71528.00
18-Jul-99	276.24	547.92	19.77	372.15	187.62	175.77	71684.00
19-Jul-99	198.39	393.51	20.61	372.90	188.00	20.61	71684.00
20-Jul-99	352.05	698.29	21.45	408.84	206.12	289.45	71952.00
21-Jul-99	232.31	460.79	18.16	597.63	301.30	-136.84	71797.00
22-Jul-99	239.40	474.84	17.31	599.53	302.26	-124.69	71655.00
23-Jul-99	408.26	809.79	18.96	549.83	277.20	259.96	71896.00
24-Jul-99	299.57	594.20	11.56	639.64	322.48	-45.44	71839.00
25-Jul-99	289.98	575.17	23.92	693.25	349.51	-118.08	71697.00
26-Jul-99	212.69	421.88	17.28	813.60	410.18	-391.72	71288.00
27-Jul-99	205.51	407.62	19.69	598.93	301.96	-191.31	71077.00
28-Jul-99	173.53	344.19	18.02	424.17	213.85	-79.98	70979.00
29-Jul-99	192.19	381.20	21.29	415.91	209.68	-34.71	70923.00
30-Jul-99	170.80	338.79	19.64	417.15	210.31	-78.36	70825.00
31-Jul-99	712.34	1412.93	9.03	417.90	210.69	995.03	71811.00
end of month:		14599.33	665.87	14415.46		183.87	71811.00

Purgatoire River Water Conservancy District
Trinidad Reservoir Monthly Report

August 1999
Content as of Midnight on First of month: 71,811.00 AF

1 Date:	2 Computed Inflow: CFS	3 Computed Inflow: AF	4 Evaporation: AF	5 Release: AF	6 Release: CFS	7 Amount Stored: AF	8 Current Content: AF
01-Aug-99	423.85	840.70	9.91	660.79	333.14	179.91	71981.00
02-Aug-99	501.89	995.49	11.58	799.91	403.28	195.58	72165.00
03-Aug-99	323.38	641.43	8.25	1397.18	704.40	-755.75	71401.00
04-Aug-99	1070.37	2123.07	10.72	1390.35	700.96	732.72	72123.00
05-Aug-99	716.07	1420.32	16.56	1375.76	693.60	44.56	72151.00
06-Aug-99	532.21	1055.63	17.40	939.23	473.52	116.40	72250.00
07-Aug-99	474.67	941.51	19.12	508.39	256.31	433.12	72664.00
08-Aug-99	361.95	717.92	15.83	759.09	382.70	-41.17	72607.00
09-Aug-99	313.06	620.95	16.61	1017.34	512.90	-396.39	72194.00
10-Aug-99	317.06	628.89	22.36	592.53	298.73	36.36	72208.00
11-Aug-99	327.89	650.37	28.22	323.15	162.92	327.22	72507.00
12-Aug-99	263.40	522.46	21.65	343.81	173.34	178.65	72664.00
13-Aug-99	222.70	441.73	27.50	443.23	223.46	-1.50	72635.00
14-Aug-99	210.14	416.82	30.80	500.02	252.09	-83.20	72521.00
15-Aug-99	215.82	428.07	27.43	499.64	251.90	-71.57	72422.00
16-Aug-99	221.38	439.11	24.90	500.21	252.19	-61.10	72336.00
17-Aug-99	222.30	440.93	26.53	500.40	252.28	-59.47	72250.00
18-Aug-99	207.19	410.97	12.43	440.54	222.10	-29.57	72208.00
19-Aug-99	300.77	596.57	17.41	409.16	206.28	187.41	72378.00
20-Aug-99	268.56	532.68	16.61	430.07	216.82	102.61	72464.00
21-Aug-99	195.25	387.27	17.44	526.83	265.61	-139.56	72307.00
22-Aug-99	180.76	358.53	19.06	523.47	263.91	-164.94	72123.00
23-Aug-99	174.44	346.00	23.18	308.82	155.69	37.18	72137.00
24-Aug-99	163.23	323.77	31.43	420.34	211.92	-96.57	72009.00
25-Aug-99	151.02	299.55	23.95	473.60	238.77	-174.05	71811.00
26-Aug-99	141.89	281.44	18.13	475.31	239.63	-193.87	71599.00
27-Aug-99	166.76	330.76	20.56	508.20	256.21	-177.44	71401.00
28-Aug-99	134.19	266.16	20.52	526.64	265.51	-260.48	71120.00
29-Aug-99	158.97	315.31	13.10	527.21	265.80	-211.90	70895.00
30-Aug-99	140.21	278.11	16.34	527.77	266.08	-249.66	70629.00
31-Aug-99	137.35	272.44	31.79	520.65	262.49	-248.21	70349.00
end of month:		18324.96	617.32	19169.64		-844.68	70349.00

Purgatoire River Water Conservancy District
Trinidad Reservoir Monthly Report

September 1999
Content as of Midnight on First of month: 70,349.00 AF

1 Date:	2 Computed Inflow: CFS	3 Computed Inflow: AF	4 Evaporation: AF	5 Release: AF	6 Release: CFS	7 Amount Stored: AF	8 Current Content: AF
01-Sep-99	117.88	233.81	36.58	517.23	260.77	-283.42	70029.00
02-Sep-99	109.69	217.58	20.26	517.32	260.81	-299.74	69709.00
03-Sep-99	110.93	220.02	21.82	502.20	253.19	-282.18	69405.00
04-Sep-99	100.08	198.50	22.57	493.93	249.02	-295.43	69087.00
05-Sep-99	90.95	180.39	18.49	492.90	248.50	-312.51	68756.00
06-Sep-99	101.47	201.27	25.67	492.60	248.35	-291.33	68439.00
07-Sep-99	82.99	164.61	26.40	481.21	242.61	-316.60	68096.00
08-Sep-99	81.15	160.97	19.96	483.01	243.51	-322.04	67754.00
09-Sep-99	91.39	181.27	21.51	487.76	245.91	-306.49	67426.00
10-Sep-99	83.10	164.83	16.69	488.14	246.10	-323.31	67086.00
11-Sep-99	77.04	152.80	18.23	487.57	245.81	-334.77	66733.00
12-Sep-99	72.17	143.15	7.91	488.24	246.15	-345.09	66380.00
13-Sep-99	86.14	170.86	21.29	487.57	245.81	-316.71	66042.00
14-Sep-99	67.65	134.18	9.44	474.74	239.34	-340.56	65692.00
15-Sep-99	142.31	282.27	3.93	440.34	222.00	-158.07	65530.00
16-Sep-99	117.56	233.19	13.33	407.86	205.63	-174.67	65342.00
17-Sep-99	80.36	159.39	10.17	404.22	203.79	-244.83	65087.00
18-Sep-99	86.51	171.60	17.96	394.64	198.96	-223.04	64846.00
19-Sep-99	67.53	133.95	6.23	394.72	199.00	-260.77	64579.00
20-Sep-99	82.22	163.08	1.56	388.52	195.88	-225.44	64352.00
21-Sep-99	89.96	178.43	17.07	387.36	195.29	-208.93	64126.00
22-Sep-99	77.82	154.35	17.81	375.54	189.33	-221.19	63887.00
23-Sep-99	71.83	142.47	16.23	351.24	177.08	-208.77	63662.00
24-Sep-99	72.66	144.13	18.52	284.61	143.49	-140.48	63503.00
25-Sep-99	66.11	131.13	20.04	230.09	116.00	-98.96	63384.00
26-Sep-99	56.46	111.98	13.09	230.89	116.41	-118.91	63252.00
27-Sep-99	58.24	115.52	10.77	143.75	72.47	-28.23	63213.00
28-Sep-99	60.08	119.16	8.46	84.70	42.70	34.46	63239.00
29-Sep-99	72.18	143.17	18.47	84.70	42.70	58.47	63279.00
30-Sep-99	62.11	123.20	20.00	130.20	65.64	-7.00	63252.00
	0.00				0.00		
end of month:		5031.26	500.46	11627.80		-6596.54	63252.00

Purgatoire River Water Conservancy District
Trinidad Reservoir Monthly Report

October 1999
Content as of Midnight on First of month: 63,252.00 AF

1 **Date:**	2 **Computed Inflow: CFS**	3 **Computed Inflow: AF**	4 **Evaporation: AF**	5 **Release: AF**	6 **Release: CFS**	7 **Amount Stored: AF**	8 **Current Content: AF**
01-Oct-99	57.33	113.71	21.54	157.17	79.24	-43.46	63187.00
02-Oct-99	63.53	126.01	21.52	157.49	79.40	-31.48	63134.00
03-Oct-99	50.00	99.17	7.68	157.49	79.40	-58.32	63068.00
04-Oct-99	61.32	121.62	16.13	157.49	79.40	-35.87	63016.00
05-Oct-99	63.90	126.74	22.25	157.49	79.40	-30.75	62963.00
06-Oct-99	65.44	129.80	25.31	157.49	79.40	-27.69	62910.00
07-Oct-99	51.92	102.99	11.50	157.49	79.40	-54.50	62844.00
08-Oct-99	67.85	134.58	16.09	157.49	79.40	-22.91	62805.00
09-Oct-99	62.07	123.11	17.62	157.49	79.40	-34.38	62753.00
10-Oct-99	55.71	110.51	16.84	120.67	60.84	-10.16	62726.00
11-Oct-99	62.81	124.58	26.79	97.79	49.30	26.79	62726.00
12-Oct-99	43.35	85.98	22.96	128.02	64.54	-42.04	62661.00
13-Oct-99	48.38	95.96	17.59	170.37	85.89	-74.41	62569.00
14-Oct-99	51.09	101.34	22.92	183.42	92.47	-82.08	62464.00
15-Oct-99	49.53	98.24	14.51	122.73	61.88	-24.49	62425.00
16-Oct-99	76.19	151.12	12.22	59.90	30.20	91.22	62504.00
17-Oct-99	62.58	124.13	12.23	59.90	30.20	64.23	62556.00
18-Oct-99	73.68	146.15	7.64	59.51	30.00	86.64	62635.00
19-Oct-99	96.46	191.33	5.36	55.97	28.22	135.36	62765.00
20-Oct-99	78.11	154.93	9.96	51.97	26.20	102.96	62858.00
21-Oct-99	66.26	131.43	17.64	48.79	24.60	82.64	62923.00
22-Oct-99	74.24	147.26	11.51	17.75	8.95	129.51	63041.00
23-Oct-99	55.24	109.57	14.59	1.98	1.00	107.59	63134.00
24-Oct-99	60.46	119.93	13.07	1.86	0.94	118.07	63239.00
25-Oct-99	61.30	121.58	13.85	1.73	0.87	119.85	63345.00
26-Oct-99	54.64	108.37	14.64	1.73	0.87	106.64	63437.00
27-Oct-99	43.36	86.00	18.50	1.50	0.76	84.50	63503.00
28-Oct-99	48.78	96.76	15.43	1.33	0.67	95.43	63583.00
29-Oct-99	54.89	108.87	1.54	1.33	0.67	107.54	63689.00
30-Oct-99	51.34	101.83	8.50	1.33	0.67	100.50	63781.00
31-Oct-99	59.96	118.93	11.60	1.33	0.67	117.60	63887.00
end of month:		3712.53	469.53	2608.00		1104.53	63887.00

Purgatoire River Water Conservancy District
Trinidad Reservoir Monthly Report

November 1999
Content as of Midnight on First of month: 62,637.00 AF

1 Date:	2 Computed Inflow: CFS	3 Computed Inflow: AF	4 Evaporation: AF	5 Release: AF	6 Release: CFS	7 Amount Stored: AF	8 Current Content: AF
01-Nov-99	31.69	62.85	8.52	1.33	0.67	61.52	62690.00
02-Nov-99	53.37	105.85	11.63	1.22	0.62	104.63	62783.00
03-Nov-99	47.56	94.34	13.19	1.15	0.58	93.19	62863.00
04-Nov-99	47.18	93.58	12.43	1.15	0.58	92.43	62943.00
05-Nov-99	47.18	93.59	12.44	1.15	0.58	92.44	63023.00
06-Nov-99	34.36	68.15	14.00	1.15	0.58	67.00	63076.00
07-Nov-99	49.55	98.28	17.13	1.15	0.58	97.13	63156.00
08-Nov-99	35.27	69.95	14.80	1.15	0.58	68.80	63210.00
09-Nov-99	49.55	98.29	17.14	1.15	0.58	97.14	63290.00
10-Nov-99	41.43	82.18	14.03	1.15	0.58	81.03	63357.00
11-Nov-99	34.73	68.88	14.82	1.06	0.53	67.82	63410.00
12-Nov-99	51.58	102.31	20.30	1.01	0.51	101.30	63491.00
13-Nov-99	35.10	69.63	15.62	1.01	0.51	68.62	63544.00
14-Nov-99	39.80	78.95	10.94	1.01	0.51	77.94	63611.00
15-Nov-99	34.43	68.30	13.29	1.01	0.51	67.29	63665.00
16-Nov-99	43.26	85.80	15.65	30.15	15.20	55.65	63705.00
17-Nov-99	39.39	78.13	20.35	17.78	8.96	60.35	63745.00
18-Nov-99	28.04	55.62	14.09	1.53	0.77	54.09	63785.00
19-Nov-99	35.50	70.41	14.88	1.53	0.77	68.88	63839.00
20-Nov-99	32.64	64.75	9.40	1.35	0.68	63.40	63893.00
21-Nov-99	32.14	63.74	9.41	1.33	0.67	62.41	63946.00
22-Nov-99	39.30	77.96	8.63	1.33	0.67	76.63	64014.00
23-Nov-99	38.80	76.96	8.63	1.33	0.67	75.63	64081.00
24-Nov-99	38.81	76.97	8.64	1.33	0.67	75.64	64148.00
25-Nov-99	25.70	50.97	8.64	1.33	0.67	49.64	64189.00
26-Nov-99	45.87	90.99	8.65	1.34	0.68	89.65	64270.00
27-Nov-99	38.81	76.98	8.65	1.33	0.67	75.65	64337.00
28-Nov-99	32.26	63.99	8.66	1.33	0.67	62.66	64391.00
29-Nov-99	38.74	76.84	8.66	1.18	0.59	75.66	64458.00
30-Nov-99	32.10	63.67	8.66	1.01	0.51	62.66	64512.00
	0.00				0.00		
end of month:		2328.91	371.88	82.03		2246.88	64512.00

Exhibit 29

Annual Meeting

December 7, 1999

United States Department of the Interior

BUREAU OF RECLAMATION
Eastern Colorado Area Office
11056 West County RD 18E
Loveland, Colorado 80537-9711

IN REPLY
REFER TO:
EC-1300 (AJohns)

AUG 09 1999

To: Distribution List

Subject: Amendments to the Operating Principles, Trinidad Dam and Reservoir Project: Update to Action Items as a Result of July 12, 1999, Technical Meeting in Denver, Colorado

Dear Interested Party:

On July 12, 1999, a technical meeting to discuss issues relating to the Trinidad Dam and Reservoir Operating Principles was held at the Marriott Courtyard near Denver International Airport (list of attenders enclosed). A draft agenda, distributed July 7, 1999, by FAX to most of the parties in attendance (also enclosed), was followed in the meeting. Listed below are action items resulting from the meeting.

Action Items related to permanent stock water amendment:

1. Review April 26, 1999, letter and report on stock watering at Trinidad Reservoir from Steve Witte, Colorado Division 2 Engineer, to Mark Rude, Kansas State Board of Agriculture; proposed language from Purgatoire River Water Conservancy District (District) for permanent stock water amendment; and provide written comments on language for the permanent stock water amendment. Responsible Party: Kansas. Target Date: August 12, 1999.

Action Items related to storage and release of flood flows:

2. Review Colorado's proposed criteria and comments from the Army Corps of Engineers in their February 10, 1999, letter and provide written comments. Responsible Party: Kansas. Target Date: August 12, 1999.

Action Items related to "ideal headgate requirement":

3. Review definitions provided at the meeting by Reclamation for crop irrigation requirements and related terms from the technical literature. Responsible Party: Kansas. Target Date: September 15, 1999.

4. The District's General Manager reported that he is discussing with Reclamation an agreement for a transit loss study. When finalized, provide a copy of the agreement. Responsible Party: Reclamation. Target Date: When agreement is finalized.

Irrigated Acreage:

5. Review the District's proposal to list acreage by contract and ditch in the operating principles, along with an acreage cap to allow farmers, ditches and the District to adjust acreage from one ditch to another without going over the cap. Responsible Parties: Kansas, Colorado, and Reclamation. Target Date: October 15, 1999.

6. Propose a method to verify irrigated acreage on an annual basis. Responsible Parties: Kansas and Colorado. Target Date: October 15, 1999.

7. Provide a listing of acreage by contract and ditch. Responsible Party: Purgatoire River Water Conservancy District. Target Date: Completed (July 15, 1999, Letter to David Pope).

Storage of Winter Water:

8. If authorized to do so by clients (Fort Lyon Canal Company and District 67 Irrigating Canals Association) develop a proposed work plan for evaluating the effects of the proposed storage of winter water upon downstream water rights. Include as part of that work plan specific technical recommendations to improve the existing Reclamation model. Responsible Party: Bruce Kroeker, Ted Zorich & Associates, Inc. (TZA). Target Date: September 15, 1999.

9. Identify technical representatives (for example hydrologists, engineers) for a team which will recommend an approach to address remaining technical concerns relating to the storage of winter water. Responsible Parties: Kansas, Colorado, Army Corps of Engineers, Purgatoire River Water Conservancy District, Reclamation. Target Date: September 15, 1999.

10. Review TZA's proposed workplan and specific technical recommendations (if provided), the existing Reclamation model, and Kansas proposed modeling approach (particularly monitoring concerns). Responsible Party: Technical team. Target Date: October 19, 1999.

11. Send out confirmation of, and a draft agenda for, the next meeting to discuss issues relating to the Trinidad Dam and Operating Principles, scheduled to begin at 10:30 a.m. on October 19, 1999, near Denver International Airport. Responsible Party: Reclamation.
Target Date: October 1, 1999.

If you have any questions, please contact Alice Johns at (970) 962-4338.

Sincerely,

A. Jack Garner
Area Manager

Enclosure 1 - List of Attendees at July 12, 1999, meeting
Enclosure 2 - Draft Agenda
Enclosure 3 - Definitions for Crop Irrigation Requirements and related terms

7-1654 (11-94)
Bureau of Reclamation

COMPUTATION SHEET

BY	DATE 7/12/99	PROJECT	SHEET ___ OF ___
CHKD BY	DATE	FEATURE	
DETAILS Technical Meeting on Trinidad Op. Princ.			

Attendance

Name	Representing
Malcolm Wilson	Bureau of Reclamation Loveland.
JULIE SWANDA	" "
Julianne Woldridge	Purgatoire River WCD
EUGENE AIELLO	" " "
JERIS DANIELSON	PRWCD - Gen. Mgr.
Thelma Lujan	Purgatoire River Water Cons. Dist.
DANIEL E. GARCIA	CORPS OF ENGINEERS - ALB. DIST.
Tom Pointon	A.R.C.A.
Peter Evans	CWCB
Wendy Weiss	Colo AG
Steve Miller	CWCB Denver
Randy Seaholm	CWCB Denver
Bruce Kroeker	District 67/14 Lyons
DONALD STEEEMAN	District 67
John S. Leffendink	Fort Lyon Canal Co.
Randy Hayzlett	ARCA KANSAS
Dale Book	State of Kansas
KEVIN L. SALTER	KS Div of WATER RES.
Leland E. Rolfs	KS Dept of Agric
JOHN DRAPER	State of Kansas

ENCLOSURE 1

Name	Representing
Donald L. Pitts	Ks. A.G.
David L. Pope	KS DWR / ARCA
David A. Brown	ARCA, KA
Robert Trout	Trout + Raley for Model Land + Irrigation Co.
LISA VEHMAS	DOI Solicitor's Office, Denver
JACK Garner	BOR – ECAO - Loveland
ALice Johns	BOR – Loveland

DRAFT AGENDA

Technical Meeting on Trinidad Dam and Reservoir Operating Principles
July 12, 1999, 10:30 a.m. to 3:30 p.m.
Marriott Courtyard by Denver International Airport
6901 Tower Rd., Denver, CO.

Purpose: Reach agreement on needed amendments and other actions to resolve outstanding issues relating to Trinidad Dam and Reservoir Operating Principles prior to the next meeting of the Arkansas River Compact Administration (may take subsequent meeting(s) to achieve).

1. Introductions.

2. Permanent Stock water amendment--proposed language from Purgatoire River Water Conservancy District (District)(enclosed).

3. Temporary storage and release of flood flows--Colorado's proposed criteria (enclosed) and comments from the Army Corps of Engineers in their February 10, 1999 letter (enclosed).

4. "Ideal headgate requirement"
   --Kansas' request for Reclamation to define, provide a copy of an August 20, 1998 letter, and describe discussions at Nov. 1998 District board meeting.

5. Irrigated acreage
   --District's proposal to list acreage by ditch in the operating principles, along with an acreage cap to allow farmers, ditches and the District to adjust acreage from one ditch to another without going over the cap.
   --additional concerns, including verifying irrigated acreage annually.
   --agreement on process to resolve irrigated acreage concerns.

6. Storage of winter water
   --Modeling approach proposed by Kansas in a December 23, 1998, letter
   --Discussion of potential modifications and alternatives to proposed approach
   --agreement on process to resolve concerns relating to storage of winter water

7. Distribution list for mailings, various copies of operating principles
   --distribution list to be updated by Reclamation on ongoing basis
   --District's proposal that two versions of the operating principles be used in future discussions: (1) version currently in effect with signatures from early 1998, and (2) a redlined version with any proposed amendments, clean-up changes, and notation identifying the party proposing the changes.

8. Additional action items, schedule for next meeting (if needed).

ENCLOSURE 2

Amendment to the Operating Principles
Trinidad Dam & Reservoir Project
Amended 1997

Delete: Article IV, D,2,(a)

Substitute the following:

Article IV D,2,(a)

During the non-irrigation season, the District will provide an allowance for stock watering purposes of not more than 1,200 acre-feet measured at the ditch headgates. If the stream gains below the Trinidad Dam are insufficient to fulfill the allowance, an equivalent volume of reservoir inflow may be released to satisfy stock water demands within the allowance; provided the stock water allowance shall not be used for irrigation purposes. The maximum daily rate of release may be up to but may not exceed the corresponding daily rate of reservoir inflow and will not count as stored water. No other diversion by Project ditches will be allowed prior to April 1 of any year.

An annual report of reservoir releases and diversion for stock water operations will be provided in April of each year to the Kansas Division of Water Resources in Garden City, Kansas by the State of Colorado.

STATE OF COLORADO

WATER DIVISION 2
OFFICE OF THE STATE ENGINEER
310 East Abriendo, Suite B
Pueblo, CO 81004
Phone (719) 542-3368
FAX (719) 544-0800

Roy Romer
Governor

James S. Lochhead
Executive Director

Hal D. Simpson
State Engineer

Steven J. Witte, P.E.
Division Engineer

December 2, 1998

DEC - 7 1998

Mr. A. Jack Garner, Area Manager
United States Department of the Interior
Bureau of Reclamation
Eastern Colorado Area Office
11056 West County RD 18E
Loveland. CO 80537-9711

100
1314

1300, 1320, 1320

Dear. Mr. Garner,

Please find enclosed the Division Engineer's present operating criteria for temporary storage and release of flood flows not stored in the flood pool pertaining to Trinidad Reservoir.

Sincerely,

Steven J. Witte
Division Engineer - Division 2
Colorado Division of Water Resources

Enclosure

cc: Mr. David Pope, Chief Engineer
Division of Water Resources
Kansas Department of Agriculture
901 S. Kansas Avenue
Topeka, KS 66612

Mr. Hal Simpson, State Engineer
Colorado Division of Water Resources
Room 818, Centennial Building
1313 Sherman Street
Denver. CO 80203

Enclosure to Mr. A. Jack Garner letter, dated December 2, 1998

CRITERIA FOR TEMPORARY DETENTION AND SUBSEQUENT RELEASE OF FLOOD FLOWS STORED IN THE TRINIDAD RESERVOIR CONSERVATION POOL

Criteria for temporary detention of flood flows

The Division Engineer temporarily detains flood flows to limit releases from Trinidad Dam so as to cause the flow measured at the Trinidad gage to not exceed 3,000 cfs. This is in accord with a letter from Gary L. Gamel of the Corps of Engineers dated April 16, 1993, which states:

> The Water Control Plan for the flood control operation of Trinidad Lake calls for releases of 5000 cfs, as measured at the Trinidad gage... Until the Water Control Plan can officially be revised, any releases from Trinidad Dam in excess of 3000 cfs should not be made without consultation with this office.

Because this lower rate is based upon hydraulic analysis performed below Trinidad, Colorado this is interpreted to mean that releases from Trinidad Dam should be limited so as to cause the flow measured at the Trinidad gage not to exceed 3000 cfs without consultation with appropriate personnel of the Albuquerque District, Corps of Engineers.

Criteria for subsequent release

The Division Engineer begins releasing water temporarily detained after 8:00 a.m. of the following day as soon as channel capacity is available. Channel capacity is available when such releases will not cause the flow at the Trinidad gage to exceed 3,000 cfs.

Water temporarily detained is released at the maximum rate, taking into account bypasses of reservoir inflow to satisfy current district demands and downstream senior rights, that will not cause the flow at the Trinidad gage to exceed 3,000 cfs.

The Division Engineer distributes the released waters ensuring that the project ditches are not exceeding their entitlements and that downstream rights are not diverting out of priority or beyond their entitlements.

DEPARTMENT OF THE ARMY
ALBUQUERQUE DISTRICT, CORPS OF ENGINEERS
4101 JEFFERSON PLAZA, NE
ALBUQUERQUE, NEW MEXICO 87109-3435
FAX (505) 342-3199

Reply to Attention of:

COPY

February 10, 1999

Operations Division
Reservoir Control Branch

Mr. Jack Garner
Area Manager
Eastern Colorado Area Office
Bureau of Reclamation
11056 West County Road 18E
Loveland, Colorado 80537-97111

Dear Mr. Garner,

Based upon our review of the "CRITERIA FOR TEMPORARY DETENTION AND SUBSEQUENT RELEASE OF FLOOD FLOWS STORED IN THE TRINIDAD RESERVOIR CONSERVATION POOL", as provided by Mr. Steve Witte, to you, in a letter dated December 2, 1998, the following comments are provided for clarification regarding the flood releases from Trinidad Dam.

In 1992, the U.S. Army Corps of Engineers (Corps) completed a hydraulic analysis of the Purgatoire River below Trinidad, Colorado. This study showed the existing channel capacity below Trinidad to be 3,000 cfs. As a result, the Corps advised Mr. Steve Witte of the significance of the findings in a letter dated April 16, 1993. The letter states in part "...any releases from Trinidad Dam in excess of 3,000 cfs should not be made without consultation with this office." In other words, Corps personnel will make the call on releases above 3,000 cfs while river conditions are monitored. We did not feel that it was appropriate to place the responsibility on Colorado officials for calling for releases above 3,000 cfs when we had a study that indicated there could likely be flood problems.

The second to the last paragraph of Mr. Witte's letter states in part "...that will not cause the flow at the Trinidad gage to exceed 3,000 cfs." For clarification, we suggest that this sentence be added: "However, the Corps of Engineers may direct releases greater that 3,000 cfs, but not to exceed 5,000 cfs at the Trinidad gage, if channel conditions permit."

If you have any questions on the information provided, please contact Mr. Dick Kreiner, at (505) 342-3383.

Sincerely,

for D. E. Gronewold
Chief, Operations Division

ESTIMATING IRRIGATION WATER REQUIREMENTS

Technical Guideline

Abridged Foreign Edition

(Metric Units)

UNITED STATES DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
DENVER OFFICE
EARTH SCIENCES DIVISION
SURFACE WATER BRANCH
WATER RESOURCE SECTION

DENVER, COLORADO
September 1990

ENCLOSURE 3

3. - Crop Irrigation Requirements

The crop irrigation requirement, sometimes referred to as the net irrigation requirement, represents the amount of water that must be applied to the crop by irrigation. Usually, the crop irrigation requirement is estimated by deducting effective precipitation and stored carryover soil moisture from the estimated crop evapotranspiration. The crop irrigation requirement as used in U.S. Bureau of Reclamation (Reclamation) planning does not include an additional amount for leaching of salts. It may also include water requirements for germination, frost protection, wind erosion, or plant cooling. In isolated cases, the crop irrigation requirement may be partially met from a high ground-water table. See figure 3-1 for a schematic disposition of water on a typical irrigated field.

The following sections discuss effective precipitation, carryover soil moisture, and water requirements for other beneficial uses.

3.1 Effective Precipitation

The irrigation water supply must be planned to complement precipitation. Effective precipitation is the precipitation that neither runs off on the surface, nor percolates below the root zone. Further, it is the portion of a precipitation event that contributes to meeting the evapotranspiration needs of the crop or vegetation. The effectiveness may depend upon several factors, including total precipitation, intensity of precipitation, intake rate of soil, water holding capacity of soil, antecedent soil moisture conditions, land slope, and vegetative cover.

Effective precipitation may be insignificant in an extremely arid area, contrasted to a humid area where it may supply most or even all of the crop evapotranspiration. In arid or semiarid areas, effective precipitation is small enough that even large errors in estimates would have little effect on irrigation requirements. In subhumid areas, however, the effect of errors in effective precipitation estimates has a significant impact. Since most of the conterminous Western United States is considered to be arid or semiarid, simple techniques are adequate for estimating effective precipitation for planning purposes. A number of simple methods to calculate effective precipitation are suitable for use in arid or semiarid areas. The Reclamation and Soil Conservation Service methods are two simple empirically determined methods that may be used in project planning.

3.1.1 - Reclamation Method

This method has been developed by Reclamation for use in arid or semiarid areas. Although the Reclamation method was intended to be applied to growing season precipitation data covering the driest 5 consecutive years, these restrictions can be ignored. The

5. Conveyance Losses and Operational Waste

Conveyance losses are water losses in transit from the source of supply to the point of service, whether in natural or artificial channels such as canals, ditches, and laterals. They comprise evaporation from the water surfaces, seepage, and incidental transpiration by vegetation growing in the water or along the banks of natural channels, canals, and laterals. Operational wastes are losses due to lack of efficiency in management and breaks in the conduits. In estimating diversion requirements, all conveyance losses and waste usually are included in a single estimate.

Usually evaporation from canals and laterals is negligible in comparison with seepage losses. Evaporation seldom is computed separately.

Vegetation, growing in or along canals and natural channels, usually consumes a small amount of water. If losses due to this vegetation are expected to be significant, methods of estimating consumptive use can be employed.

For general planning purposes, canal seepage loss and operational waste are considered as a percentage of the diversion quantity. This is because only conceptual system plans are available. Table 5-1 displays typical ranges of combined seepage loss and operational waste for several types of distribution systems.

A reliable basis for estimating conveyance losses is a reference to losses experienced on operating canals of similar size, under similar conditions, and under anticipated similar method of operation. When the conveyance system is better defined as in the design stage, a more accurate estimate of seepage rates can be made using unit loss rates and the physical configuration. Additional data, such as permeability rates or ponding tests, are required to determine expected loss rates from unlined channels. Field tests determined the following seepage rates for lined channels:

Lining	Seepage rate
Concrete & all types of membrane linings	2 $cm/m^2/day$
Compacted Earth	3 $cm/m^2/day$

Generally, channels having free-drainage seepage rates greater than 15 $cm/m^2/day$ are lined. Usually, seepage from canals follows the laws of percolation through a porous medium under free-draining conditions. If conditions are not free-draining, appropriate relationships should be employed to estimate seepage rates.

Operational wastes, including releases to wasteways and leakage past gates, generally are related to the degree of care exercised in

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IN REPLY REFER TO:
EC-1300(AJohns)

July 8, 1999

JUL 1 1999

To: Distribution List

Subject: Amendments to the Operation Principles, Trinidad Dam and Reservoir Project: Status of and Responses to Action Items in the December 30, 1998, Letter

By letter of June 24, 1998, I confirmed a July 12, 1998 technical meeting in Denver, Colorado. On July 7, 1999, my staff distributed, by FAX, a draft agenda for the meeting (also enclosed). This letter reviews the status of and responses to action items included in my December 30, 1998, letter.

Status of Action Items and Reclamation's Responses

Action Items Relating to Irrigated Acreage:

Action Item 7: (Review and provide written comment on information submitted by the District in a May 1, 1998 letter, which addresses irrigated acreage tracking and allocation, including transportation losses and irrigation requirements.) has not been responded to by Colorado or Reclamation. Kansas (by letter of January 29, 1999 from Leland Rolfs to Alice Johns) suggested that item 7 be separated into two subitems and that their response would be based upon additional information they requested as follows:

Action Item 7A: "In Recommendation D attached to Jack Garner's letter of October 15, 1998, it states 'Reclamation agreed to define what was meant by "current real time irrigation requirements" as referenced in the Operating Principles.' This should be set out as a separate action item for Reclamation to complete. The other parties should be given a reasonable time to review the definition after they receive it."

Action Item 7B: "Kansas is also requesting Reclamation to furnish Kansas with: a) a copy of a letter dated August 20, 1998, relating to its cooperative agreement with NRCS and the Spanish Peaks/Purgatoire River Soil Conservation District, Trinidad Lake Project, and a report on what occurred at the Purgatoire River Water Conservancy District's November 5, 1998, Board meeting concerning ideal headgate requirements. Kansas needs a reasonable amount of time to review this information once it is received. This should also be a separate action item."

Action Item 8: (Draft an amendment to the Operating Principles to address concerns relating to irrigated acreage.) Reclamation has not received a response from Kansas yet.

Reclamation's response:

Action Item 7: In its January 29, 1999, letter, the District commented on the irrigated acres listed by ditch in the Operating Principles. The District proposed listing the numbers from the contracts, and identifying them as such, but including a 19,499 acre cap on total irrigated acres. "This would allow the farmers, ditches, and District to adjust acreage from one ditch to another, without going over the total cap, while still being within the original intent of the Operating Principles."

Reclamation agrees with this approach in concept, and suggests the approach be discussed at the July meeting. Reclamation requests that the District continue to pursue a procedure for identifying and verifying the actual acres to be irrigated each season as described in the attachment to Reclamation's October 15, 1998, letter.

The District's May 1, 1998, letter mentions a proposal to reduce acres under the Model and the Salas Ditches and to increase the acres under the Lewelling and McCormick Ditch. Enclosed is a March 23, 1999, letter from M.E. MacDougall containing a copy of an Agreement between River Canyon Ranch, Inc., and Model land and Irrigation Company reflecting this change.

Action Item 7A: Reclamation has reviewed the Operating Principles and finds that "current real time irrigation requirements" is not referenced in the Operating Principles. Per the Operating Principles Article IV.B.2. water deliveries "...will be limited during the irrigation season to the irrigation requirements at the farm headgate as determined by the District. Allowance for canal and lateral losses on the individual ditch systems will also be determined by the District." Per Article IV.C.2., "The District water supply will be allocated by the District to the ditches within the District to provide each acre of the District irrigable area an equitable share of the District water supply after allowance has been made for individual ditch transportation losses, provided such allocation will not exceed the irrigation requirements at the farm headgate."

Reclamation's December 1988 Review of Operating Principles and Project Operations Final Report recommends the District "Develop and implement procedure for limiting the diversion to the ideal irrigation requirement." This term and the terms "current real time irrigation requirement" and "ideal headgate requirement" are directed towards allocation of the District's water supply at each of the river headgates to assure that (1) on-farm irrigation requirements are not exceeded, considering crop consumptive use and farm losses, (2) transit losses in individual ditches are appropriately factored into the calculations, and (3) reasonable actions are taken to conserve the available supply for all ditches served by the Project. Reclamation has researched these terms and will bring definitions of them for discussion to the July 12 meeting.

Action Item 7B: At the District's November 5, 1998, Board meeting, Reclamation provided information on its Water Conservation Field Services Program and offered financial assistance to the District under this program. The FSP is designed to encourage water conservation; assist water agencies to develop and implement effective water management and conservation plans; and generally foster improved water management on a regional, statewide, and watershed basis. Along with discussing the FSP, Reclamation and a NRCS representative, discussed work conducted under a cooperative agreement between Reclamation and the NRCS (Demonstration of Improved Irrigation Practices, Purgatoire River Hydrologic Unit). This agreement is the subject of our August 20, 1998, letter (enclosed). Reclamation representatives did not define the term "ideal headgate requirement" at the board meeting but did encourage the Board to utilize the FSP, to the extent that the goals of the FSP coincide, to address issues related to the Trinidad Operating Principles which may be of concern to Kansas.

Action Item 9. Relating to Kansas' Proposed Modeling Approach

Written comments were received from the District, the Colorado State Engineer, and the Fort Lyon Canal Company / District 67 Irrigating Canals Association on Action Item 9 (Examine "Modeling Approach for Analysis of Trinidad Project Operations" submitted by Kansas in a December 23, 1998, letter.) The focus of the proposed modeling was to assess effect of storage of senior direct flow rights of the Project ditches outside the transferred 20,000 acre-feet Model storage right during the nonirrigation season. This practice is referred to as the storage of winter water. Written comments have not been provided by Reclamation or the CWCB. CWCB has discussed the criteria with Reclamation representatives in several telephone discussions. Likewise, Reclamation has discussed the criteria with representatives of Kansas and the District.

The Colorado State Engineer questioned the feasibility of meeting Kansas' criteria due to limited pre-project streamflow data, lack of data for model calibration, and difficulty in reaching agreements on model refinements. Also, Colorado indicated it was not clear why such a model needs to be developed to the state line. Further, the State Engineer noted that even if the model were feasible, it could only determine long term averages, which have already been addressed by Reclamation in prior studies. The District asserts that Reclamation has already conducted sufficient studies to show there is no impact upon water available to Kansas.

Fort Lyon Canal Company and District 67 Irrigating Canals Association (the canal companies), in their April 7, 1999, letter, suggested that the parties review their February 27, 1998, letter and a February 13, 1998, letter from Bruce Kroeker of Ted Zorich & Associates Inc. (TZA) to Donald L. Steerman, Esq., and John S. Lefferdink, Esq. The canal companies assert that the operating principles are intended to protect all downstream Colorado water rights as well as useable flows for Kansas and that additional modeling needs to be done to determine effects of proposed amendments on the river and on downstream ditches. They suggest meetings by parties and interested groups to determine the best and most cost effective way of analyzing the effect of the proposed amendments. In their February 27, 1998, letter, the canal companies pointed out that the evaluation by Reclamation is based on average annual impacts. They requested an analysis to determine depletions on a short term basis so that the downstream ditches can determine not only the amount of water which may be reduced by winter storage but also which ditch or ditches may be injured. These concerns are described in more detail in TZA's February 13, 1998 letter.

In telephone conversations with Kansas, the District, and CWCB, Kansas' proposed modeling approach and some of the above-mentioned concerns have been discussed. As an alternative to modeling, the possibility of the parties agreeing to some sort of augmentation plan which, with a reasonable margin of safety, would ensure non-injury to Kansas and the canal companies was initially explored. An advantage would be that it would largely avoid the substantial contention, and commitment of time and resources to come to agreement on a feasible model, develop it and interpret the results in a manner which would satisfy Kansas' current criteria. A disadvantage is the risk of augmenting more than what is actually needed. The possibility of further exploring this option has not been dismissed by any of the parties. However, several parties noted that some degree of study would be needed to develop the plan. CWCB also recommended that the canal companies attend the next technical meeting so they would be afforded an opportunity to express their concerns and discuss the best and most cost effective way of analyzing the effect of the proposed amendment on their systems.

Reclamation's response:

Reclamation has studied the hydrology of project operations with the best available data using accepted techniques. The studies show that annual inflows to John Martin Reservoir are enhanced over pre-project conditions. We believe there is a lack of data to construct a model sufficient to satisfy Kansas' requirements or to calibrate such a model. We do not agree with extending the scope of such a model downstream from John Martin Reservoir. Such an extension would, in our view, bring Reclamation into the realm of river administration (which is the purview of the Colorado State Engineer) or flood control (which is the purview of the Army Corps of Engineers).

We agree with CWCB that the canal companies are invited to attend the July technical meeting to present their concerns and engage in technical discussions with the parties on reasonable approaches to addressing concerns about depletions to water yield resulting from storage of winter water.

Reclamation is willing to consider alternate approaches to addressing Kansas' and the canal companies' concerns, however we suggest Colorado assume the lead role in any study which concerns the normal (non-flood) operations of John Martin Reservoir and river administration.

Action Items Relating to a Stock Water Amendment:

Action Items 1. & 2. As addressed in Leland Rolfs' January 29, 1999, letter to Alice Johns, Action Item 1. (Sign the temporary stock water amendment approved by the Arkansas River Compact Administration (ARCA) on December 8, 1998), and 2. (Contact the Division Engineer, Water Division 2, Colorado, and inform him that the temporary stock water amendment has been approved and is ready to be implemented), have been completed.

Action Item 6. (Review and provide written comments on language for a permanent stock water amendment, submitted by the District on December 7, 1998), has not been completed. This was an action for Kansas, Colorado, and Reclamation. The District's proposed language for a permanent stock water amendment, discussed at an informal meeting held in Lamar on the afternoon of December 7, 1998, and titled "Amendment to the Operating Principles, Trinidad Dam & Reservoir Project, Amended 1997" was enclosed with the draft agenda for the July 12, 1999, meeting (enclosed). (This was also an enclosure to the District's January 29, 1999, letter Re: Amendments to the Operating Principles). As noted in the District's January 29, 1999, letter, it differs from the temporary amendment that was ultimately signed.

Per Leland Rolfs' January 29, 1999, letter, Kansas requested a target date of June 30, 1999, to comment on a permanent amendment, to allow 60 days for Kansas to review Colorado's report on stock watering at Trinidad Reservoir, which was required by the temporary amendment to the Operating Principles. By letter of April 26, 1999, Steve Witte, Colorado Division 2 Engineer, sent a report on reservoir releases and diversions for stock water to Mark Rude, Kansas State Board of Agriculture.

Reclamation's response:

We appreciate the efforts of all the parties to reach agreement on the temporary amendment, to comply with its terms, and to obtain signatures in a timely fashion, particularly considering that much of this work occurred during the winter holiday season. The District's proposed language for a permanent amendment is acceptable to Reclamation and we hope the parties can reach agreement on this amendment at the July 12 meeting.

Action Item 4. Relating to Temporary Storage and Release of Flood Flows:

(Review and provide written comment on "Criteria for Temporary Detention and subsequent Release of Flood Flows Stored in the Trinidad Reservoir Conservation Pool, submitted by Colorado in December, 1998, prior to the ARCA meeting) has been completed by the Army Corps of Engineers and the District. The District found the criteria to be acceptable. The Corps, in a February 10, 1999, letter, suggested adding to the second to the last paragraph, a sentence which reads "However, the Corps of Engineers may direct releases greater than 3,000 cfs, but not to exceed 5,000 cfs at the Trinidad gage, if channel conditions permit."

Reclamation's response:

The criteria and the proposed additional sentence from the Corps are acceptable.

Action Item 3. Regarding the Distribution List:

(Review attached distribution list for completeness, accuracy and unnecessary entries and provide comments to Reclamation), comments have been received from various parties and changes made.

Reclamation's response:

Reclamation will continue to update the list on an ongoing basis as comments are received.

Action Item 5. on Various Copies of the Operating Principles:

(Check the 'cleaned up' versions of the Trinidad Dam and Reservoir Project Operating Principles, distributed by Reclamation at the December 7-8, 1998, ARCA meeting, and transmitted December 14, 1999, by letter. Provide comments on grammar, punctuation, and format.), comments were received from the District and from Kansas. Kansas suggests concentrating on more substantive matters first. The District provided comments on errors and discrepancies in the cleaned up versions. The District also suggested using two versions in future discussions: "1) the first being that version that is currently in effect, with signatures from early 1998, supplemented with the temporary stock water amendment..., and 2) a redlined version with any proposed amendments and clean-up changes. Because there is more than one party requesting amendments, the redlined version should have some legend or other notation identifying who proposed substantive changes."

Reclamation's response:

We agree with Kansas that we should focus on more substantive matters first, and also with the District that we limit ourselves to two versions for future discussions. We suggest that Reclamation produce the redlined version with notations following the July meeting.

If you have any questions concerning this information, please contact Alice Johns at (970) 962-4338 or Malcolm Wilson at (970) 962-4362.

Sincerely,

Alice E. Johns

for A. Jack Garner
Area Manager

Enclosures (3)

Enclosure 1 -- Draft agenda
Enclosure 2 -- August 20, 1998, letter
Enclosure 3 -- River Canyon agreement

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NOV 19

To: Distribution List

Subject: Amendments to the Operating Principles, Trinidad Dam and Reservoir Project: Update to Action Items as a result of October 19, 1999, Technical Meeting in Denver, Colorado

On October 19, 1999, a technical meeting to continue discussion of issues relating to the Trinidad dam and Reservoir Operating Principles was held at the Marriott Courtyard near Denver International Airport (list of attenders enclosed). An draft agenda, faxed to most of the parties in attendance prior to the meeting, was finalized at the meeting. The final agenda is enclosed. Listed below are action items resulting from the meeting.

Action Items related to permanent stock water amendment:

During a break from the meeting, Peter Evans and David Pope agreed to a modification (enclosed) of the language to the stock water amendment proposed in Kansas' August 13, 1999, letter. The following action items relate to the language as modified on October 19, 1999.

1. The Purgatoire River Conservancy District (District) was concerned that the statement in the amendment as modified which reads "No other diversions by Project ditches shall be allowed prior to April 1 of each year." creates a potential conflict with local court decrees. Provide to Kansas copies of the two court decrees where this potential exists. Responsible Party: District. Target Date: Completed (On November 1, 1999, Jeris Danielson, General Manager for the District reported that these had been provided to Kansas following the October 19 meeting.).

2. Examine decrees provided by the District and take a closer look at the District's concern. Responsible Party: Kansas. Target Date: December 6, 1999 (prior to annual meeting of the Arkansas River Compact Administration (ARCA)).

3. Because Colorado is not a signatory to the Operating Principles, it is unclear how they could they be bound by this amendment to provide an annual report of reservoir releases and diversion for stock water operations. In consultation with Kansas, determine and implement appropriate

3. In consultation with Kansas, determine and implement appropriate mechanism (possibly a letter to Kansas) to document Colorado's agreement to supply an annual report. (Because Colorado is not a signatory to the Operating Principles, it is unclear how they could they be bound by this amendment to provide an annual report of reservoir releases and diversion for stock water operations.) Responsible party: Colorado. Target Date: December 6, 1999 (prior to annual ARCA meeting).

Action Items Related to storage and release of flood flows: Concern was expressed by several of the parties that it would not be appropriate to amend the Operating Principles to incorporate the "Criteria for Temporary Detention and Subsequent Release of Flood Flows Stored in the Trinidad Reservoir Conservation Pool" as proposed by Kansas. And again, because they are not a signatory, it is unclear how Colorado could be bound by such an amendment.

4. Discuss internally (Colorado Water Conservation Board and State Engineer's Office), develop the appropriate document (for example, a letter, statement, or agreement of some sort) to more formally set forth the flood flow criteria, and report results. Responsible Party: Colorado. Target Date: December 7, 1999, ARCA meeting.

Action Items Related to "Ideal Headgate Requirement":

5. Meet to discuss possible response to Kansas' October 13, 1999, letter concerning ideal headgate requirements. Responsible Parties: Reclamation, District, and Colorado. Target Date: Completed (November 1, 1999).

6. Report results of meeting. Responsible Party: Reclamation. Target Date: December 7, 1999, ARCA meeting.

Action Items Related to Irrigated Acreage: The District proposed that the acreage allowed to be irrigated be the original acreage contracted between the District and the ditch companies, and that it is the District's obligation to ensure that the sum of the acreage not exceed the annual acreage cap, currently proposed at 19,499 acres.

7. Meet to discuss possible response to Kansas' October 13, 1999, letter concerning irrigated acres and assistance to the District in developing a process for verifying irrigated acreage on an annual basis. Responsible Parties: District, Colorado, and Reclamation. Target Date: Completed (November 1, 1999).

8. Report results of meeting. Responsible party: Reclamation. Target date: December 7, 1999, ARCA meeting.

Action Items related to City of Trinidad--Review of Kansas' concerns and discussion: No specific action items were identified. (Concerns relate to irrigated acreage, discussed above.)

Action Items related to Storage of Winter Water: At a technical meeting on July 12, 1999, Bruce Kroeker, (Ted Zorich & Associates, Inc., [TZA]), if authorized to do so by clients (Fort Lyon Canal Company and District 67 Irrigating Canals Association), agreed to develop a proposed work plan for evaluating the effects of the proposed storage of winter water outside the 20,000 acre-foot Model right upon downstream water rights, including specific technical recommendations to improve the existing Reclamation model.

TZA responded in an October 18, 1999, letter (enclosed), concluding it is not necessary to perform additional modeling studies for reasons described in the letter. The letter states that "...the 1988 Bureau Report concluded that these practices were a departure from the intent of the Operating Principles." The District pointed out that Reclamation's 1996 report concluded that the practices were not a departure from the Operating Principles. Reclamation commented that it should probably review this conclusion from the 1996 report. There was little time remaining for discussion at the October 19, 1999, meeting and specific actions items were not identified. An action item is offered below.

1. Review conclusion in Reclamation's 1996 Report that storage of winter water outside the model right is not a departure of the Operating Principles and document findings. Responsible Party: Reclamation. Target Date: December 2000.

If you have any questions or require further information on these items please call Alice Johns at (970) 962-4338 or Malcolm Wilson at (970) 962-4362.

Sincerely,

Elizabeth M. Boar

for Gerald Kelso
Acting Area Manager

Enclosures (4)

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Colorado Springs, CO 80903-1418

AGENDA

Technical Meeting on Trinidad Dam and Reservoir Operating Principles
October 19, 1999, 10:30 a.m. to 3:30 p.m.
Marriott Courtyard by Denver International Airport
6901 Tower Rd., Denver, CO.

Purpose: Reach agreement on needed amendments and other actions to resolve outstanding issues relating to Trinidad Dam and Reservoir Operating Principles prior to the next meeting of the Arkansas River Compact Administration.

1. Introductions.

2. Brief status of action items outlined in Reclamation's August 9, 1999, letter.

3. Permanent Stock water amendment--Language proposed by Kansas in an August 13, 1999, letter, RE: Trinidad Operating Principles: Stock watering releases.

4. Temporary storage and release of flood flows--Proposed modifications to criteria proposed by Kansas in an August 13, 1999, letter, RE: Criteria for Temporary Detention and Subsequent Release of Flood Flows Stored in the Trinidad Reservoir Conservation Pool.

5. Ideal headgate requirement--Process to address Kansas comments and proposed amendments.

6. Irrigated acreage--Purgatoire River Water Conservancy District's proposal to list acreage by contract and ditch in the operating principles, along with an acreage cap to allow farmers, ditches and the District to adjust acreage from one ditch to another without going over the cap.

7. City of Trinidad--Review of Kansas' concerns and discussion.

8. Irrigated acreage--Information provided by Reclamation and progress by Colorado and Kansas in proposing a method to verify irrigated acreage on an annual basis.

9. Storage of winter water--Discussion of Ted Zorich and Associates, Inc., proposed workplan and specific technical recommendations, the existing Reclamation model, and Kansas proposed modeling approach (particularly monitoring concerns).

(Enclosure 1)

Proposed Amendment to the Operating Principles, Trinidad Dam and Reservoir Project, enclosed with an August 13, 1999, letter from David L. Pope; and as further modified on October 19, 1999, following discussions between Kansas (David Pope) and Colorado (Peter Evans). Modifications from October 19, 1999, meeting are shown in redline and strikeout.

Delete: Article IV, D, 2 (a)
Substitute the following language:

During each non-irrigation season, the District will provide an allowance for stock watering purposes of not more than 1,200 acre-feet measured at the headgates of the ditches diverting water for stock watering purposes. If the stream gains below the Trinidad Dam are insufficient to fulfill the allowance, an equivalent volume of reservoir inflow may be released to satisfy stock water demands within the allowance; provided, the stock water allowance shall not be used for irrigation purposes. The maximum daily quantity released may be up to, but shall not exceed, the total reservoir inflow on the previous day and shall not count as water stored under the District Storage Right. No other diversions by Project ditches shall be allowed ~~during the non-irrigation season~~ prior to April 1 of each year.

An annual report of reservoir releases and diversions for stock watering operations by the State of Colorado will ~~shall~~ be provided ~~by the State of Colorado in April~~ within 30 days of the end of the non-irrigation season of each year, and upon request, reports on specific operations, to the Water Commissioner of the Garden City field office of the Division of Water Resources, Kansas Department of Agriculture.

(Enclosure 2)

ENCLOSURE 3)

7-1654 (11-94)
Bureau of Reclamation

COMPUTATION SHEET

BY	DATE 10/19/99	PROJECT TRINIDAD	SHEET ___ OF ___
CHKD BY	DATE	FEATURE	
DETAILS	ATTENDANCE		

Name	Representing	Phone
Malcolm Wilson	BOR - Loveland	(970)-962-4362
DENNIS E. GARCIA	US ARMY CORPS	(505) 342-3380
JERIS A. DANIELSON	PRWCD	303-237-5146
Julianne Woldridge	PRWCD	719 520 9288
Jeffrey J Kahn	City of Trinidad	(303) 776-9900
Bruce Kroeker	District 67/Ft Lyon	303-971-0030
John S. Leffendink	Ft Lyon Canal	719-336-7411
Tom Pointon	ARCA Colo	719 456 0413
Donald Steerman	District 67	719-336-4313
Peter Evans	Colo Water Conservation	303-866-3441
Randy Seaholm	Colorado Water Conservation Bd.	303-866-3441
Wendy Weiss	Colo AGO	303-866-5008
Steve Miller	Colo Water Cons Bd	3038663441
Steve Witte	Colo Div Water Resources	(719) 542-3368
Dale Book	Spronk Water Engineers	(303) 861-8700
JOHN DRAPER	Counsel, State of Kansas	(505) 986-2525
David L Pope	Kansas Chief Engineer/ARCA	785-296-3710
David A. Brenn	ARCA State of KS	316-276-3246
Randy L. Hayzlett	ARCA State of KS	316-355-7499
David Barfield	Kansas Div. of Water Resources	785-296-3830
Dan Pitts	Kansas AG Office	785-296-2215
MARK RUDE	KS. DWR - GARDEN CITY	316-276-2901

(ENCLOSURE 3 CONTINUED)

Bob Trout	Model Land + Reservoir Co.	303-861-1963
Lisa Vehmas	DOI Solicitor's Office	303/231-5353 x287.

(ENCLOSURE 4)

TZA TED ZORICH & ASSOCIATES, INC.
CONSULTING ENGINEERS IN WATER RESOURCES

TEL (303) 971-0030
FAX (303) 971-0077
9200 W. CROSS DR. • SUITE 308
LITTLETON, COLORADO 80123

October 18, 1999

Donald L. Steerman, Esq.
Shinn, Steerman & Shinn
P.O. Box 390
Lamar, CO 81052

John S. Lefferdink, Esq.
Lefferdink Law Office, LLC
Drawer 110
Lamar, CO 81052-0110

Re: Amendments to Operating Principles for Trinidad Dam and Reservoir Project

Gentlemen:

As you know, the Purgatoire River Water Conservancy District (District) is proposing to amend the Operating Principles for the Trinidad Project. Proposed changes to several portions of the Operating Principles would allow storage of the direct flow priorities during the non-irrigation season without such storage being charged against or deducted from the 20,000 acre-feet that can be stored under the Model storage right. Various interested parties have different opinions about the need to evaluate the effects of the proposed amendments with additional modeling studies.

The State of Kansas submitted a letter to the Bureau of Reclamation (Bureau) dated December 28, 1998 in which they describe their beliefs about proper criteria for modeling the potential impacts of the proposed amendments. Kansas suggested a detailed modeling approach that would result in a model that would extend to the stateline and could be used to determine Trinidad Project impacts on usable stateline flow. The District responded in a letter dated January 29, 1999 that it could not undertake the modeling study proposed by Kansas and that it was unnecessary to do so.

On behalf of the District 67 Ditch Association and Fort Lyon Canal Company, we have been asked to develop a suitable technical approach for evaluating the effects of the proposed amendments on downstream Colorado water rights. In order to properly do so, it is necessary to consider the terms and conditions in the decree that changed the Model storage right to Trinidad Reservoir and documented information about the intentions of the parties to that decree. Accordingly, we have reviewed the decree in Civil Action No. 19793 (hereinafter "1965 Model transfer decree"), two Colorado Supreme Court rulings regarding the Model transfer decree, information contained in the Bureau of Reclamation report titled "Review of Operating Principles, Final Report", dated December, 1988 (hereinafter "the 1988 Bureau Report"), and other background information. After doing so, it is our conclusion that it is <u>not</u> necessary to perform additional modeling studies to determine the effect of the proposed amendments upon downstream Colorado water rights. Our reasoning in reaching this conclusion is described below.

The transfer of the Model storage right to Trinidad Reservoir was required by House Document 325 as a condition precedent to the construction of the Trinidad Project. The District requested approval of that transfer from the Las Animas County District Court in Civil Action No. 19793. A consent decree was entered in that matter on April 15, 1965, after several years of negotiations between the District and objectors to the case, including the Fort Lyon Canal Company, Amity Mutual Irrigation Company, and the Arkansas Valley Ditch Association. The Project then proceeded to construction.

The 1965 Model transfer decree changed the entire 20,000 acre-feet decreed to the Model storage right, although a survey in 1946 had determined that the usable capacity of the reservoir was only 6,200 acre-feet at that time. The Colorado Supreme Court later ruled that the 1965 Model transfer decree had made the changes set forth in House Document 325 and the Operating Principles, which included storage of Project's direct flow rights during the non-irrigation season, even though such storage may not have been explicitly described in the 1965 decree.

Paragraph 10 of the findings in the 1965 Model transfer decree states in part:

> "The protestants hereto have consented to the issuance of this Decree changing the location of the place of storage of the Model Reservoir Right from the Model Reservoir to the Trinidad Reservoir upon the representation and assurance of the Petitioners, *based upon engineering studies made by the United States Bureau of Reclamation* that with the imposition of the following enumerated conditions, the exercise of the Model Storage Right of 20,000 acre feet at the Trinidad Reservoir as part of the Trinidad Dam and Reservoir Project will not injure or impair the vested water rights of any of the parties to this proceeding or their beneficiaries." (emphasis added)

The decree then specified seven conditions upon which the parties had consented to the entry of the decree, one of which reads in part as follows:

> "e. That the Petitioners' storage of water in the Trinidad Reservoir under the Model Reservoir Right shall be regulated in such a manner that the quantity of water occurring in the Las Animas or Purgatoire River at a gauging station on said river below Van Bremmer Arroya shall remain and be the same, as determined by the State Engineer, during any period of ten consecutive years reckoned in continuing progressive series beginning with January 1, 1954 as it would have been had the Model Reservoir Right not been transferred to the Trinidad Reservoir."

Inclusion of this term and condition was a key element in the negotiations that resulted in entry of the consent decree. Representations had been made, based upon the engineering studies conducted by the Bureau, that operation of the project as planned would not reduce flows available to downstream water rights. This decree condition provided the means to test the accuracy of that representation on an on-going basis after project completion.

The 1965 Model transfer decree and operation of the Trinidad Project have been the subject of two appeals before the Colorado Supreme Court. It is of interest that in both of the decisions resulting from those cases the Supreme Court chose to recite and emphasize that this decree condition (e) provided protection for downstream Colorado water rights (see Purgatoire District v. Highland, 194 Colo. 510, 574 P.2d 83 (Colo. 1978) and Purgatoire District v. Kuiper, 197 Colo. 200, 593 P.2d 333 (Colo. 1979)).

To our knowledge, the State Engineer has never made the annual determination required by condition (e) of the consent decree nor regulated the reservoir in accordance therewith. As a consequence, the information that would result from those determinations is not available to assist in determining whether operations according to the *existing* Operating Principles have been in compliance with the 1965 Model transfer decree or resulted in injury to downstream Colorado water rights.

An additional condition of the consent decree states in part:

> "g. That the storage of water in Trinidad Reservoir under the transferred Model Reservoir Right shall at all times be conducted in accordance with, subject to, and governed by . . . . The conditions of operation of the Trinidad Dam and Reservoir Project prescribed by House Document 325 . . . . as implemented by Article IV of the 'Operating Principles – Trinidad Dam and Reservoir Project which is appended to Volume I of the United States Bureau of Reclamation Irrigation Report on said project (Revised September, 1964) . . . ."

The representations of non-injury made during the negotiation of the consent decree in the 1965 Model transfer case were based upon the planning studies conducted by the Bureau. The Bureau studies were premised upon the assumption that the winter water would be stored under the Model storage right and credited against the 20,000 acre-foot allowed under that right (page 11, 1988 Bureau Report). The objectors in the 1965 case believed that was the operation they were consenting to, and condition (g) of the decree appears to require such operation.

The 1988 Bureau Report includes the following statement on page 11:

> "From a review of House Document No. 325 and the 1961 and 1964 studies, there is little doubt the Bureau of Reclamation personnel formulating the irrigation components of the project did not intend that water stored under the Model Right be transferred out of the Model Right or that winter water be stored under any right but the Model right."

Accordingly, the 1988 Bureau Report concluded that these practices were a departure from the intent of the Operating Principles. They also appear to be a departure from the intent of the 1965 Model transfer decree.

In our opinion, any water stored under the Model storage right (including winter direct flow water) in excess of 20,000 acre-feet is water that should be passed downstream for the benefit of downstream users under the intent of the 1965 Model transfer decree (except at times when John Martin Reservoir is spilling or expected to spill). It is not necessary to use a model to determine the effect of the District's proposed amendments to the Operating Principles. If the District stores more water than it is entitled to, some downstream water user receives less.

The District got a good deal in the 1965 Model transfer decree. It changed a 6,200 acre-foot off-channel reservoir into a 20,000 acre-foot on-channel reservoir and received the right to store winter direct flow water in that reservoir. It is not fair to the downstream Colorado water users to now change the method of operation they consented to in 1965.

For the reasons described above, we do not believe that the Arkansas River Compact Administration should consider any amendments related to the storage of winter water.

Please call if you have any questions or wish to discuss this matter.

Sincerely,

Bruce E Kroeker

Bruce E. Kroeker, P.E.

cc: Parties at meeting on 10/19/1999

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Exhibit 31

Annual Meeting

December 7, 1999

29

ARKANSAS RIVER COMPACT ADMINISTRATION

Audited Financial Statements

June 30, 1999

Exhibit 31

ARKANSAS RIVER COMPACT ADMINISTRATION
TABLE OF CONTENTS
June 30, 1999

ANDERSON & COMPANY P.C.

Members
NSPA
PASC

Certified Public Accountants

Ronald D. Anderson, P.A.
Gary L. Anderson, C.P.A.
Cynthia S. Anderson, A.B.A.

INDEPENDENT AUDITOR'S REPORT

November 3, 1999

To the Representatives of
Arkansas River Compact Administration
Lamar, Colorado 81052

We have audited the accompanying statements of assets, liabilities and equity - cash basis - of the Arkansas River Compact Administration as of June 30, 1999, and the related statements of revenue collected and expenses paid for the year then ended. These financial statements are the responsibility of the Administration's management. Our responsibility is to express an opinion on these financial statements based on our audit.

Our examination was made in accordance with generally accepted auditing standards and accordingly, included such tests of the accounting records and such other auditing procedures as we considered necessary in the circumstances.

As described in Note 1a, these financial statements were prepared on the basis of cash receipts and disbursements, which is a comprehensive basis of accounting other than generally accepted accounting principles.

In our opinion, the financial statements referred to above present fairly, in all material respects, the assets and liabilities - cash basis - of the Arkansas River Compact Administration as of June 30, 1999 and its revenue collected and expenses paid during the year then ended, on the basis of accounting described in Note 1a.

Anderson & Company, P.C.

Gary L. Anderson

4th & Parmenter ■ (719) 336-7785 ■ P. O. Box 1077 ■ FAX: (719) 336-7786 ■ Lamar, Colorado 81052

ARKANSAS RIVER COMPACT ADMINISTRATION

STATEMENT OF ASSETS AND LIABILITIES - CASH BASIS

	June 30, 1999	June 30, 1998
ASSETS		
Cash	$ 64,563	$ 55,363
TOTAL ASSETS	$ 64,563	$ 55,363
CASH BASIS EQUITY		
Unexpended	64,563	55,353
TOTAL CASH BASIS EQUITY	$ 64,563	$ 55,363

See Accountant's Audit Report.

ARKANSAS RIVER COMPACT ADMINISTRATION

STATEMENT OF REVENUES and EXPENSES
with BUDGET COMPARISON
For the Budget Year July 1, 1998 to June 30, 1999

	ACTUAL	BUDGET	OVER(UNDER)
REVENUES			
Revenues from Assessments			
Colorado - 60%	$ 37,200	$ 37,200	$ 0
Kansas - 40%	24,800	24,800	0
Interest	2,019	1,000	1,019
Miscellaneous	82	0	82
TOTAL REVENUES	64,101	63,000	1,101
EXPENSES			
U. S. Geological Survey-Colorado District	$ 24,475	$ 24,700	$(225)
U. S. Geological Survey - Kansas District	6,915	7,060	(145)
Satellite Access Fee-State of Colorado	8,400	8,400	0
Operation Secretary	6,100	6,100	0
Treasurer Bond	0	100	(100)
Telephone	1,136	1,200	(64)
Court Reporter, Annual Meeting	1,360	1,000	360
Recording Secretary	2,000	2,000	0
Treasurer	2,000	2,000	0
Meeting Expense	816	500	316
Auditor Fee	350	400	(50)
Incidental Office Expense	499	400	99
Other Miscellaneous Office Expense	250	300	(50)
Printing Annual Reports	0	2,000	(2,000)
Office Rent	600	600	0
Legal Fees	0	0	0
Contingency	0	2,000	(2,000)
TOTAL EXPENSES	54,901	58,760	(3,859)
BUDGET SURPLUS (DEFICIT)	$ 9,200	4,240	$ 4,960

See Accountant's Audit Report.

ARKANSAS RIVER COMPACT ADMINISTRATION

CHANGES IN CASH BALANCE
STATEMENT OF RECEIPTS AND DISBURSEMENTS
For the Year Ended June 30, 1999

CASH BALANCE - July 1, 1998		$ 55,363
RECEIPTS		
Revenues from Assessments		
Colorado	$ 37,200	
Kansas	24,800	
Interest	2,019	
Miscellaneous	82	
TOTAL RECEIPTS		64,101
DISBURSEMENTS		
Geological Survey - Gaging Stations	$ 31,390	
Satellite Access Fee - Gaging Stations	8,400	
Operations Secretary	6,100	
Office Rent	600	
Auditor Fee	350	
Court Reporter Fee	1,360	
Office Expense	749	
Meeting Expense	816	
Telephone	1,136	
Recording Secretary	2,000	
Treasurer	2,000	
TOTAL DISBURSEMENTS		(54,901)
RECEIPTS IN EXCESS OF DISBURSEMENTS		9,200
CASH BALANCE - June 30, 1999		$ 64,563

See Accountant's Audit Report.

ARKANSAS RIVER COMPACT ADMINISTRATION

NOTES TO FINANCIAL STATEMENTS
June 30, 1999

NOTE 1 - Summary of significant accounting policies:

a. The Administration maintains financial records using the cash basis of accounting. By using the cash basis of accounting, certain revenues are recognized when received rather than when earned, and certain expenses and purchases of assets are recognized when cash is disbursed rather than when the obligation is incurred.

b. The *Statement of Receipts and Disbursements* is shown only to reconcile the beginning and ending cash balances. It is not intended to reflect *income* and *expense* recognition. Income and expenses are reflected in the *Statement of Revenues and Expenses with Budget Comparison.*

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AUDITS	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	ARCA$DAT.WB2:AUDITS															
2	Dec 6, 1999		ARCA AUDIT SUMMARY AND BUDGET RECONCILIATION													
3																
4																
5	ARCA	DATES	ARCA	JULY 1	EXPENSES		OVER/	INCOME				CALCULATE	REPORTED	6/30 CASH BALANCE		BALANCE
6	FY	COVERED	APPROVAL	BALANCE	EST.	ACTUAL	UNDER [1]	ASSESS	INTEREST	MISC.	TOTAL	SURPLUS [2]	SURPLUS	CALC [3]	REPORTED	DIFFER
7	87-88	7/1/87-6/30/88	12/13/88	$57,824	$35,490	$29,896	$5,594	$20,000	$3,197	$169	$23,366	($6,530)	($6,530)	$51,294	$51,294	$0
8	88-89	7/1/88-6/30/89	12/12/89	$51,294	$38,395	$28,793	$9,602	$20,000	$4,184	$0	$24,184	($4,609)	($4,609)	$46,685	$46,685	$0
9	89-90	7/1/89-6/30/90	12/11/90	$46,685	$38,525	$34,870	$3,655	$20,000	$3,075	$0	$23,075	($11,795)	($11,795)	$34,890	$34,890	$0
10	90-91	7/1/90-6/30/91	12/10/91	$34,890	$40,780	$32,758	$8,022	$25,000	$2,302	$515	$27,817	($4,941)	($4,941)	$29,949	$29,949	$0
11	91-92	7/1/91-6/30/92	12/8/92	$29,949	$40,550	$35,533	$5,017	$26,250	$1,716	$0	$27,966	($7,567)	($7,567)	$22,382	$22,382	$0
12	92-93	7/1/92-6/30/93	12/14/93	$22,382	$47,625	$32,997	$14,628	$44,200	$1,398	$0	$45,598	$12,601	$12,601	$34,983	$34,983	$0
13	93-94	7/1/93-6/30/94	12/13/94	$34,983	$57,200	$44,573	$12,627	$47,800	$1,128	$0	$48,928	$4,355	$4,355	$39,338	$39,338	$0
14	94-95	7/1/94-6/30/95	12/12/95	$39,338	$52,050	$38,316	$13,734	$50,000	$1,698	$0	$51,698	$13,382	$13,482	$52,720	$52,820	($100)
15	95-96	7/1/95-6/30/96	12/10/96	$52,820	$78,180	$68,861	$9,319	$50,000	$977	$0	$50,977	($17,884)	($17,884)	$34,936	$34,936	$0
16	96-97	7/1/96-6/30/97	12/09/97	$34,936	$59,425	$53,305	$6,120	$62,000	$1,094	$0	$63,094	$9,789	$9,789	$44,725	$44,725	$0
17	97-98	7/1/97-6/30/98	12/08/98	$44,725	$59,260	$53,210	$6,050	$62,000	$1,848	$0	$63,848	$10,638	$10,638	$55,363	$55,363	$0
18	98-99	7/1/98-6/30/99		$55,363	$58,760	$54,901	$3,859	$62,000	$2,019	$82	$64,101	$9,200	$9,200	$64,563	$64,563	$0
19																
20																
21																
22																
23		NOTES	[1] CALCULATED = ESTIMATED EXPENSES - ACTUAL EXPENSES													
24			[2] CALCULATED = TOTAL INCOME - ACTUAL EXPENSES													
25			[3] CALCULATED = JULY 1 BALANCE + CALCULATED SURPLUS													
26			[4] $100 DIFFERENCE IN FY 94-95 SURPLUS IS FROM PREPAYMENT OF 1995 TREASURER BOND FEE IN FY93-94													

BUDSUM	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1	ARKANSAS RIVER COMPACT ADMINISTRATION															
2	BUDGET AND ASSESSMENT SUMMARY 1989 - 1998															
3	DGET ITEM			ACTUAL EXPENDITURES FROM AUDITS										CURRENT BUDGETS		
4				FY89-90	FY90-91	FY91-92	FY92-93	FY93-94	FY94-95	FY95-96	FY96-97	FY97-98	FY98-99	FY99-00	FY00-01	FY01-02
5																proposed 12/7/99
6	EXPENDITURES															
7	A.	PROFESSIONAL SERVICE CONTRACTS														
8		1	Treasurer	$1,000	$1,750	$2,000	$2,000	$2,000	$2,000	$2,000	$2,000	$2,000	$2,000	$2,000	$2,000	$2,000
9		2	Recording Secretary	$1,000	$1,750	$2,000	$2,000	$2,000	$2,000	$2,000	$2,000	$2,000	$2,000	$2,000	$2,000	$2,000
10		3	Operations Secretary	$6,501	$3,602	$7,509	$4,350	$5,437	$6,060	$6,087	$6,100	$6,100	$6,100	$6,100	$6,100	$6,100
11		4	Auditor's Fees	$700	$350	$350	$350	$350	$350	$350	$350	$350	$350	$400	$400	$400
12		5	Court Reporter's Fees	$453	$643	$468	$0	$1,553	$1,058	$847	$0	$1,751	$1,360	$1,000	$1,000	$1,000
13			**subtotal services**	**$9,654**	**$8,095**	**$12,327**	**$8,700**	**$11,340**	**$11,468**	**$11,284**	**$10,450**	**$12,201**	**$11,810**	**$11,500**	**$11,500**	**$11,500**
14	B.	GAGING STATIONS & STUDIES														
15		1	U.S.G.S. Colorado Dist. Joint Funding fed. FY	$11,370	$11,830	$12,425	$13,225	$14,300	$9,665	$30,530	$23,350	$23,535	$24,475	$25,700	$26,800	28000
16		2	U.S.G.S. Kansas Dist. Joint Funding fed. FY	W/COLO	W/COLO	W/COLO	W/COLO	W/COLO	$5,375	$5,650	$6,175	$6,725	$6,915	$7,200	$7,550	8000
17		3	State of Colorado Satellite System	$8,000	$8,000	$8,000	$8,000	$8,000	$8,000	$8,400	$8,400	$8,400	$8,400	$10,500	$10,500	10500
18			**subtotal gaging**	**$19,370**	**$19,830**	**$20,425**	**$21,225**	**$22,300**	**$23,040**	**$44,580**	**$37,925**	**$38,660**	**$39,790**	**$43,400**	**$44,850**	
19	C.	OPERATING EXPENSES														
20		1	Treasurer's Bond	$100	$100	$100	$100	$200	$0	$200	$0	$0	$0	$100	$100	$100
21		2	Annual Reports Printing	$3,678	$2,557	$0	$0	$2,465	$1,000	$9,620	$0	$0	$0	$2,000	$1,000	$1,000
22		3	Telephone	$749	$1,071	$1,087	$1,597	$1,013	$934	$1,057	$822	$905	$1,136	$1,200	$1,200	$1,200
23		4	Miscellaneous Office Expense	$159	$174	$155	$195	$478	$418	$9	$103	$0	$499	$300	$300	$300
24		5	Postage/Copying/Supplies	$321	$132	$252	$243	$0	$0	$400	$400	$400	$250	$400	$400	$400
25		6	Meetings	$239	$199	$330	$387	$3,079	$144	$589	$1,623	$444	$816	$500	$500	$500
26		7	Travel	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
27		8	Rent	$600	$600	$600	$550	$600	$600	$600	$600	$600	$600	$600	$600	$600
28			**subtotal operating**	**$5,846**	**$4,833**	**$2,524**	**$3,072**	**$7,835**	**$3,096**	**$12,475**	**$3,548**	**$2,349**	**$3,301**	**$5,100**	**$4,100**	**$4,100**
29	D.	EQUIPMENT		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
30	E.	CONTINGENCY		$0	$0	$257	$0	$0	$0	$0	$0	$0	$0	$2,000	$2,000	$2,000
31	F.	LITIGATION		N/A	N/A	N/A	N/A	$3,126	$612	$522	$1,382	$0	$0	$0	$0	$0
32			**TOTAL ALL EXPENDITURES**	**$34,870**	**$32,758**	**$35,533**	**$32,997**	**$44,601**	**$38,216**	**$68,861**	**$53,305**	**$53,210**	**$54,901**	**$62,000**	**$62,450**	~~**$17,600**~~
33	INCOME															
34	A.	ASSESSMENTS														
35		1	Colorado (60%)	$12,000	$15,000	$15,750	$23,400	$31,800	$30,000	$30,000	$37,200	$37,200	$37,200	$40,800	$40,800	$40,800
36		2	Kansas (40%)	$8,000	$10,000	$10,500	$20,800	$16,000	$20,000	$20,000	$24,800	$24,800	$24,800	$27,200	$27,200	$27,200
37			subtotal	$20,000	$25,000	$26,250	$44,200	$47,800	$50,000	$50,000	$62,000	$62,000	$62,000	$68,000	$68,000	$68,000
38	C.	INTEREST EARNINGS		$3,075	$2,302	$1,716	$1,398	$1,128	$1,698	$977	$1,094	$1,848	$2,019	$1,000	$1,000	$1,000
39	D.	MISCELLANEOUS		$0	$515	$0	$0	$0	$0	$0	$0	$0	$82	$0	$0	$0
40			**TOTAL ALL INCOME**	**$23,075**	**$27,817**	**$27,966**	**$45,598**	**$48,928**	**$51,698**	**$50,977**	**$63,094**	**$63,848**	**$64,101**	**$69,000**	**$69,000**	**$69,000**
41	CASH SURPLUS ACCOUNT															
42	A.	EXPENDITURES FROM SURPLUS		**($11,795)**	**($4,941)**	**($7,567)**				**($17,884)**						
43	B.	ADDITION TO SURPLUS					**$12,601**	**$4,327**	**$13,482**		**$9,789**	**$10,638**	**$9,200**	**$7,000**	**$6,550**	
44		NOTES														

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SURPLUS	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	ARKANSAS RIVER COMPACT ADMINISTRATION															
2	ANALYSIS OF ARCA SURPLUS ACCOUNT															
3																
4		ACTUAL	ACTUAL	ACTUAL	ACTUAL	ACTUAL	ACTUAL	ACTUAL	ACTUAL	ACTUAL	ACTUAL	ACTUAL	ACTUAL	EST.	EST.	EST.
5		FY87-88	FY88-89	FY89-90	FY90-91	FY91-92	FY92-93	FY93-94	FY94-95	FY95-96	FY96-97	FY97-98	FY98-99	FY99-00	FY00-01	FY01-02
6	**OPEN CASH BALANCE**	$57,800	$51,300	$46,700	$34,890	$29,949	$22,382	$34,983	$39,338	$52,820	$34,936	$44,725	$55,363	$64,563	~~$64,563~~	~~$70,733~~
7	**INCOME**														70733	77283
8	REG. ASSESS COLORADO	$12,000	$12,000	$12,000	$15,000	$15,750	$23,400	$24,000	$24,000	$30,000	$37,200	$37,200	$37,200	$40,800	$40,800	$40,800
9	REG. ASSESS KANSAS	$8,000	$8,000	$8,000	$10,000	$10,500	$15,600	$16,000	$16,000	$20,000	$24,800	$24,800	$24,800	$27,200	$27,200	$27,200
10	SPEC. ASSESS COLORAD(	$0	$0	$0	$0	$0	$0	$7,800	$6,000	$0	$0	$0	$0	$0	$0	$0
11	SPEC. ASSESS KANSAS	$0	$0	$0	$0	$0	$5,200	$0	$4,000	$0	$0	$0	$0	$0	$0	$0
12	INTEREST	$3,400	$4,200	$3,100	$2,817	$1,716	$1,398	$1,128	$1,698	$977	$1,094	$1,848	$2,019	$1,000	$1,000	$1,000
13	MISC.	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$82	$0	$0	$0
14	**TOTAL INCOME**	$23,400	$24,200	$23,100	$27,817	$27,966	$45,598	$48,928	$51,698	$50,977	$63,094	$63,848	$64,101	$69,000	$69,000	$69,000
15																
16	**EXPENSES**	$29,900	$28,800	$34,900	$32,758	$35,533	$32,997	$44,573	$38,216	$68,861	$53,305	$53,210	$54,901	$62,830	$62,450	
17																
18	**OVER/(UNDER)**	($6,500)	($4,600)	($11,800)	($4,941)	($7,567)	$12,601	$4,355	$13,482	($17,884)	$9,789	$10,638	$9,200	$6,170	$6,550	~~$69,000~~
19																
20	**CLOSE CASH BALANCE**	$51,300	$46,700	$34,900	$29,949	$22,382	$34,983	$39,338	$52,820	$34,936	$44,725	$55,363	$64,563	$70,733	~~$71,113~~	
21																
22	FY1996-97 Actual figures are based on FY 96-7 Audit approved by ARCA at 12/9/97 Annual Meeting.														77283	
23	FY1997-98 Actual figures are based on FY 97-8 Audit pending approved by ARCA at 12/8/98 Annual Meeting.															
24	FY1998-99 Actual figures are based on FY 98-9 Audit pending approved by ARCA at 12/7/99 Annual Meeting.															
25	Estimated surplus for FY99-00 and FY00-01based on previously adopted budgets reviewed and/or adopted at 12/8/98 Annual Meeting.															
26	Estimated surplus for FY00-01based on proposed budget to be adopted at 12/7/99 Annual Meeting.															

ARKANSAS RIVER COMPACT ADMINISTRATION
307 SOUTH FIFTH STREET, LAMAR, COLORADO 81052
719-336-9696

FOR COLORADO
DARIES C. LILE, DENVER
THOMAS R. POINTON, LAS ANIMAS
JAMES G. ROGERS, LAMAR

CHAIRMAN AND FEDERAL REPRESENTATIVE
LARRY E. TRUJILLO, SR.
PUEBLO, COLORADO

FOR KANSAS
DAVID L. POPE, TOPEKA
ROBERT BUERKLE, HOLCOMB
EUGENE OVERTON, SYRACUSE

ARKANSAS RIVER COMPACT ADMINISTRATION
FY 1999 - 2000 BUDGET
(July 1, 1999 - June 30, 2000)

I. EXPENDITURES

A. PROFESSIONAL SERVICE CONTRACTS		
1. Treasurer		$2,000
2. Recording Secretary		$2,000
3. Operations Secretary		$6,100
4. Auditor Fee		$400
5. Court Reporter Fee		$1,000
	subtotal services	**$11,500**
B. GAGING STATIONS & STUDIES		
1. U.S.G.S. Colorado District Joint Funding fed. FY98-99		$25,700
2. U.S.G.S. Kansas District Joint Funding fed. FY98-99		$7,200
3. State of Colorado Satellite System		$10,500
	subtotal gaging	**$43,400**
C. OPERATING EXPENSES		
1. Treasurer Bond		$100
2. Annual Report Printing (CY1998)		$2,000
3. Telephone		$1,200
4. Miscellaneous Office Expense		$300
5. Postage/Copying/Supplies		$400
6. Meetings		$500
7. Travel		$0
8. Rent		$600
	subtotal operating	**$5,100**
D. OTHER		
1. Equipment		$0
2. Contingency		$2,000
3. Litigation		$0
	subtotal other	**$2,000**
	TOTAL ALL EXPENDITURES	**$62,000**

II. INCOME

A. ASSESSMENTS		
1. Colorado (60%)		$40,800
2. Kansas (40%)		$27,200
	subtotal assessments	**$68,000**
B. OTHER		
1. Interest Earnings		$1,000
2. Miscellaneous		$0
	subtotal other	**$1,000**
	TOTAL ALL INCOME	**$69,000**

III. CASH SURPLUS ACCOUNT

A. EXPENDITURES FROM SURPLUS	
B. ADDITION TO SURPLUS	**$7,000**

Adopted by the Arkansas River Compact Administration at its December 9, 1997 Annual Meeting.

James Rogers, Treasurer

Date

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ARKANSAS RIVER COMPACT ADMINISTRATION
307 South Fifth Street, Lamar, Colorado 81052
719-336-9696

For Colorado
Peter H. Evans [acting], Denver
James G. Rogers, Lamar
Thomas R. Pointon, Las Animas

Chairman and Federal Representative
Larry E. Trujillo, Sr.
Pueblo, Colorado

For Kansas
David L. Pope, Topeka
David A. Brenn, Garden City
Randy Hayzlett, Lakin

FY 2000 - 2001 BUDGET

(July 1, 2000 - June 30, 2001)

I. EXPENDITURES

A. PROFESSIONAL SERVICE CONTRACTS	
1. Treasurer	$2,000
2. Recording Secretary	$2,000
3. Operations Secretary	$6,100
4. Auditor Fee	$400
5. Court Reporter Fee	$1,000
subtotal services	**$11,500**
B. GAGING STATIONS & STUDIES	
1. U.S.G.S. Colorado District Joint Funding fed. FY99-00	$26,800
2. U.S.G.S. Kansas District Joint Funding fed. FY99-00	$7,550
3. State of Colorado Satellite System	$10,500
subtotal gaging	**$44,850**
C. OPERATING EXPENSES	
1. Treasurer Bond	$100
2. Annual Report Printing	$1,000
3. Telephone	$1,200
4. Miscellaneous Office Expense	$300
5. Postage/Copying/Supplies	$400
6. Meetings	$500
7. Travel	$0
8. Rent	$600
subtotal operating	**$4,100**
D. OTHER	
1. Equipment	$0
2. Contingency	$2,000
3. Litigation	$0
subtotal other	**$2,000**
TOTAL ALL EXPENDITURES	**$62,450**

II. INCOME

A. ASSESSMENTS	
1. Colorado (60%)	$40,800
2. Kansas (40%)	$27,200
subtotal assessments	**$68,000**
B. OTHER	
1. Interest Earnings	$1,000
2. Miscellaneous	$0
subtotal other	**$1,000**
TOTAL ALL INCOME	**$69,000**

III. CASH SURPLUS ACCOUNT

A. EXPENDITURES FROM SURPLUS	**$0**
B. ADDITION TO SURPLUS	**$6,550**

Adopted by the Arkansas River Compact Administration at its December 8, 1998 Annual Meeting.

James Rogers, Treasurer

Date

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ARKANSAS RIVER COMPACT ADMINISTRATION
307 South Fifth Street, Lamar, Colorado 81052
719-336-9696

For Colorado
Peter H. Evans [Acting], Denver
James G. Rogers, Lamar
Thomas R. Pointon, Las Animas

Chairman and Federal Representative
Larry E. Trujillo, Sr.
Pueblo, Colorado

For Kansas
David L. Pope, Topeka
David A. Brenn, Garden City
Randy Hayzlett, Lakin

PROPOSED FY 2001 - 2002 BUDGET

(July 1, 2001 - June 30, 2000)

I. EXPENDITURES

A. PROFESSIONAL SERVICE CONTRACTS	
1. Treasurer	$2,000
2. Recording Secretary	$2,000
3. Operations Secretary	$6,100
4. Auditor Fee	$400
5. Court Reporter Fee	$1,000
subtotal services	**$11,500**
B. GAGING STATIONS & STUDIES	
1. U.S.G.S. Colorado District Joint Funding fed. FY99-00	28000 $
2. U.S.G.S. Kansas District Joint Funding fed. FY99-00	8000 $
3. State of Colorado Satellite System	10500 $
subtotal gaging	**$0**
C. OPERATING EXPENSES	
1. Treasurer Bond	$100
2. Annual Report Printing	$1,000
3. Telephone	$1,200
4. Miscellaneous Office Expense	$300
5. Postage/Copying/Supplies	$400
6. Meetings	$500
7. Travel	$0
8. Rent	$600
subtotal operating	**$4,100**
D. OTHER	
1. Equipment	$0
2. Contingency	$2,000
3. Litigation	$0
subtotal other	**$2,000**
TOTAL ALL EXPENDITURES	64,100 **$**

II. INCOME

A. ASSESSMENTS	
1. Colorado (60%)	$40,800
2. Kansas (40%)	$27,200
subtotal assessments	**$68,000**
B. OTHER	
1. Interest Earnings	$1,000
2. Miscellaneous	$0
subtotal other	**$1,000**
TOTAL ALL INCOME	**$69,000**

III. CASH SURPLUS ACCOUNT

A. EXPENDITURES FROM SURPLUS	**$0**
B. ADDITION TO SURPLUS	4900 **$**

Adopted by the Arkansas River Compact Administration at its December 7, 1999 Annual Meeting.

PROPOSED DRAFT — 12-6-99

James Rogers, Treasurer — Date

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Exhibit 32

Annual Meeting

December 7, 1999

ARKANSAS RIVER COMPACT ADMINISTRATION
307 South Fifth Street, Lamar, Colorado 81052
719-336-9696

For Colorado
Peter H. Evans, Denver
James G. Rogers, Lamar
Thomas R. Pointon, Las Animas

Chairman and Federal Representative
Aurelio Sisneros
Pueblo, Colorado

For Kansas
David L. Pope, Topeka
David A. Brenn, Garden City
Randy Hayzlett, Lakin

FY 2001 - 2002 BUDGET
(July 1, 2001 - June 30, 2002)

I. EXPENDITURES

A. PROFESSIONAL SERVICE CONTRACTS		
1. Treasurer		$2,000
2. Recording Secretary		$2,000
3. Operations Secretary		$6,100
4. Auditor Fee		$400
5. Court Reporter Fee		$1,000
	subtotal services	**$11,500**
B. GAGING STATIONS & STUDIES		
1. U.S.G.S. Colorado District Joint Funding [calender year 2001]		$28,000
2. U.S.G.S. Kansas District Joint Funding [calender year 2001]		$8,000
3. State of Colorado Satellite System		$10,500
	subtotal gaging	**$46,500**
C. OPERATING EXPENSES		
1. Treasurer Bond		$100
2. Annual Report Printing		$1,000
3. Telephone		$1,200
4. Miscellaneous Office Expense		$300
5. Postage/Copying/Supplies		$400
6. Meetings		$500
7. Travel		$0
8. Rent		$600
	subtotal operating	**$4,100**
D. OTHER		
1. Equipment		$0
2. Contingency		$2,000
3. Litigation		$0
	subtotal other	**$2,000**
	TOTAL ALL EXPENDITURES	**$64,100**

II. INCOME

A. ASSESSMENTS		
1. Colorado (60%)		$40,800
2. Kansas (40%)		$27,200
	subtotal assessments	**$68,000**
B. OTHER		
1. Interest Earnings		$1,000
2. Miscellaneous		$0
	subtotal other	**$1,000**
	TOTAL ALL INCOME	**$69,000**

III. CASH SURPLUS ACCOUNT

A. ESTIMATED BALANCE JULY 1, 2001	**$77,300**
B. EXPENDITURES FROM SURPLUS	**$0**
C. ADDITION TO SURPLUS	**$4,900**
D. PROJECTED BALANCE JUNE 30, 2002	**$82,200**

Adopted by the Arkansas River Compact Administration at its December 7, 1999 Annual Meeting.

James G. Rogers

James Rogers, Treasurer

12/22/99

Date

Exhibit 32

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