SJ-3
ALP

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Comments
Of
Thomas C. Turney
On
Animas La Plata Repayment Contract
Before
San Juan Water Commission
February 27, 2002
Farmington, NM

Good morning. I have invited myself here this morning to discuss an Associated Press news article that appeared last Friday in the Albuquerque Journal. I am here because I am deeply concerned about the future water supply of this region. The article indicated that there were concerns over the amount of water communities would get and one of the SJWC's member entities, the City of Aztec, had voted against the Amendatory Repayment Contract.

The Four Corners region of New Mexico is lucky. Through it flows the State's largest supply of surface water. To make efficient use of the water, though, the flows must be managed. Spring runoff from the nearby San Juan mountains must be stored so that it can be released during the hot summer months when it is needed for irrigation and municipal and industrial use. Navajo Dam was built on the San Juan river to capture spring flows. The Animas River flow is unregulated.

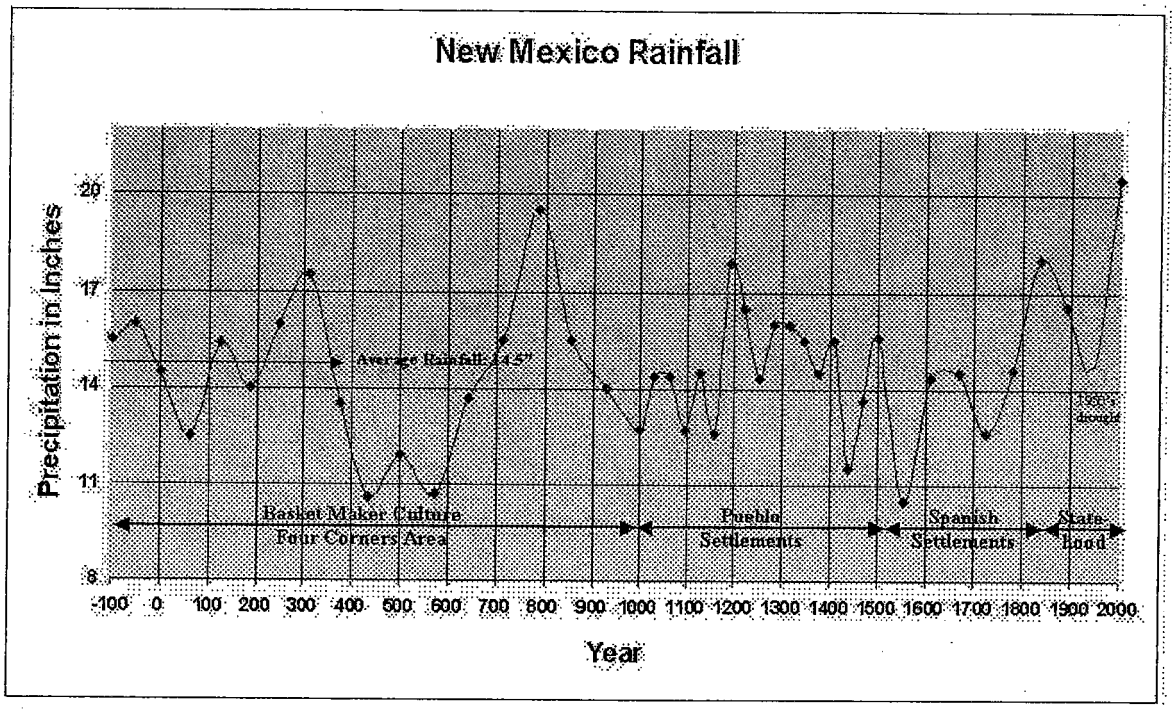
The proposed Animas La Plata project has been the subject of discussion in San Juan County for many decades. The purpose of the project has evolved. Where it was once envisioned to provide agricultural irrigation water for the La Plata valley, the Project's purpose in New Mexico is to now provide municipal and industrial water

for the cities of Farmington, Aztec, Bloomfield, and rural development in San Juan County. Additionally, the project will supply water for the Navajo community of Shiprock.

Ridges Basin, in Colorado, will store peak flows in the Animas River for future release during dry summer months. About 95% of the time, natural flows of water in the Animas River will supply water for NM communities. The remainder of the time, water released from storage will provide a dependable year round water supply. At first blush, this 5% may not seem like much. But over the course of a dry year, or a series of dry years, this storage can mean the difference between a good supply or a severely rationed supply to this valley. Having a city run out of water for even a day is scary. A week or more without water and the consequences may be catastrophic.

Every summer, I deal with irrigators and communities who run out of water. It is a frightening and sobering experience. Tempers flare. Police and security issues escalate. People ask me to provide them water. But although there are many powers my office has, there is one thing we can't do--and that is to make additional water. The only method I know to provide a dependable water supply is to make sure that one has early water rights and a good historic supply of water. Storage must be provided to get through the dry spells. The Animas River dries up. Twice in the past 20 years, I have been able to cross the river without getting my boots wet.

I am going to distribute a graph that shows precipitation in New Mexico over the last two thousand years. Precipitation has been far from constant. In fact, it is very cyclical. NM routinely experiences drought cycles. If you look at the graph, the 1950's are very interesting. The droughts of the 1950's are often used today to illustrate worst case scenarios for water supply projects. Yet, if you look in the broader two thousand year term, the drought experienced in the 1950's is actually representative of the average precipitation of the state over the last two thousand years.



NM has been in a wet cycle for the last two decades. The precipitation pattern over the last two thousand years says that that this wet cycle will not continue. There will be another drought cycle. Snow pack in the San Juan Mountains now sits at 35% of average. To provide a dependable water supply during the next drought cycle is the very reason that storage is an absolute necessity and why the Animas La Plata Project is of such vital necessity to municipalities in this area.

The idea of building storage on the Animas River has been discussed for decades. In the early 1980's, the Bureau of Reclamation approached communities in the San Juan Basin, inviting them to enter into contracts for ALP project water. The cost of this water to an individual community was high—for some communities the hundreds of thousands of dollars of cost were very prohibitive. As I recall, the attitude of the communities to the project was generally negative—there was simply no way the project could be afforded without raising their municipality's water rates dangerously high.

To address the cost of the project, in 1986 the San Juan Water Commission was born. The Commission, created by a joint powers agreement between basin municipalities and the county, has the ability to implement a mill levy upon all real estate and personal property in the County. This is beneficial to all members of the commission as much of the higher valued property in the County belongs to entities who have high capital cost facilities and whose products are marketed outside of the

San Juan Basin. This mill levy has provided municipalities and the county with a vehicle to obtain an affordable water supply. Without the ability to pay for the project, I doubt the smaller municipalities and rural water associations in the County would be in a position today to afford the project.

I am here this morning to tell you what I see can happen if the SJWC member entities choose to not participate in the revised Animas La Plata Project. I believe that the consequences will be major.

I suppose that one option for not signing the contract is to try to dissolve the Commission and then for each community to enter into a separate repayment contract with the Bureau of Reclamation. This option leaves member entities with the question on how they will pay for the project. Individual cities will no longer have a county mill levy to pay for the project. Instead they will have to provide additional funds from their own taxing and rate setting authority. I believe it is safe to forecast that cities who go on their own are going to have to raise their water rates significantly. As an example, I want to cite the City of Aztec. I do this because Aztec, as I understand from the newspaper, has voted against the proposed Repayment Contract. Aztec is getting about 10% of the projects' water, while they only contribute about 5% of the assessable tax base. If Aztec chooses to enter into a separate contract with the Bureau and they continue to want 10% of the project water, then they will have to pay about double the cost they are now paying.

Another option is for an individual community to choose is to not participate in the project—thereby diminishing their community's ability to grow. Many communities are already using Animas La Plata Project water and they will have to cease use of this water until they can acquire other water rights from willing sellers. Or if a City wants to continue development and they cannot find willing sellers, they can move into uncharted territory—specifically a municipality, under state law, has the authority to condemn water rights both within and without its corporate boundaries.

If all the New Mexico entities choose to opt out of the ALP Project, the assurances provided by the Animas La Plata Project Compact, a compact negotiated between Colorado and New Mexico, will go away. New Mexico can lose parity on this water supply to Colorado.

If any member entity or the county chooses to not want their water, I sincerely doubt if the ALP project will go away. I strongly suspect the Navajo Nation will want the water and be glad to enter into a contract for the water—the depletions associated

with the project will provide about half of the supply the Navajos need for the Navajo Gallup pipeline.

It has been suggested for years that NM should build its own raw water storage somewhere in New Mexico. The cost of providing raw water storage in New Mexico is going to be more expensive than in Colorado. I have seen test holes dug in many desirable water storage sites in New Mexico. Yet when I have seen these same test holes filled with water— the water will soak into the ground within minutes. Unfortunately, the valley alluvium does not lend itself to storing water.

I have heard that the Cities could go to Navajo Dam for a water supply. Yes, one could do this--but it will be in direct competition with the Navajo Nation. I can guarantee that the Navajos will not willingly forgo their Navajo Dam storage. Further, to get water from Navajo Dam will require a new Section 7 consultation. In recent years, we have learned the extraordinary value of a Section 7 consultation. A Section 7 consultation has already been completed on the Animas La Plata Project. There is no assurance today that a non-jeopardy opinion could be secured for a Navajo Dam Water Supply contract.

I erred when I spoke with the SJWC last August. I said that to make the request to the Secretary of Interior on assigning Project Water to project beneficiaries, the State Engineer needed to know more specifically how the 10,400 afy of Project Water is to be divided up. We recently re-reviewed the Joint Powers agreement, dated March 6th, 1986, which created the SJWC. This Agreement is very clear on how the water is to be divided up. Any diminishment of the 30,800 afy of project water originally contemplated will result in a proportional decrease based upon the percentage of the 30,800 afy allocated in the Joint Powers Agreement. This language makes it very easy for us to compute the new diversions and depletions resulting from the revised Animas La Plata Project.

We have discussed the importance of ensuring that Project Water be protected so that it arrives undiminished at the NM State Line. I have discussed this issue with my counterpart in Colorado twice. We will develop an operating manual to insure state line flows. This operating manual will take time to develop but New Mexico and Colorado do have recent experience in this area. We have just completed development and initiation of a similar operating manual on another interstate river New Mexico and Colorado share.

This operating manual will not be able to be prepared quickly. It must be done carefully. On the development of the Costilla Creek operating manual, public

hearings were held during development of the manual. The States prepared an initial draft that was then circulated. Based on widespread public input, the manual was extensively written two times. The end result is a draft that has been tentatively adopted for trial administration during this past irrigation season. I would envision that a similar process would be followed here on the Animas River.

I should note that the existing permits for diversion of project water by the member entities of the SJWC by my office in 1995 refer to the old water supply contract. These permits will need to be revisited to reflect the actual Project water supply allocation per the new contract. I am researching whether this process can be expedited.

It is my recommendation that the SJWC and its member entities approve the Amendatory Repayment Contract. We are aware that there are different viewpoints of the ALP among SJWC member entities. However, I believe it is important that member entities act on what is the greater good for all the municipalities and rural development in the San Juan Basin. The General Counsel for the Interstate Stream Commission and the New Mexico Commissioner for the Upper Colorado River have reviewed the Contract. We have no hesitancy in recommending that this Contract be executed.

The importance of the value of getting a wet water supply cannot be understated. Cities all over New Mexico are starting to wake up to the fact that they will need water for their future. Unfortunately, there is generally no free or unappropriated water available anywhere in the State. I can assure you that many cities throughout New Mexico would wish they had the type of problem now facing member entities of the SJWC. Sign a contract and get wet water. Don't sign it and you put this basin's future municipal water supply in potential jeopardy. To me, the answer should be very clear.

Thank you.

File San Juan-3 ALP

John Whipple

From: scone
Sent: Thursday, January 24, 2002 10:05 PM
To: sjwc
Cc: liztaylor; bstandley; mfischer; rassam; troberts; whall; jburnham; rbc; bhudson; pmartin; jschmitz; cobmanager; Eaune; tjonsanjuan; bliesner; jwhipple; waterjm32; tturney; lindon.wiebe
Subject: New Mexico Inspection of Public Records Act request

January 25, 2002
"electors Concerned about Animas Water" -- CAW
1217 Chaco Avenue
Farmington, NM 97401

Randy Kirkpatrick, Executive Director
San Juan Water Commission
Farmington City Hall
Farmington, New Mexico 87401

ATTENTION: New Mexico Inspection of Public Records Act -- request

Dear Mr. Kirkpatrick:

On January 8, 2002, in a Tri-City Meeting at the Farmington Civic Center, the issue of contracting impropriety was raised relative to the San Juan Water Commission's recent execution of an Animas-La Plata Project "Escrow Agreement" with the U.S. Bureau of Reclamation/Department of the Interior.

As Executive Director of the San Juan Water Commission you are, no doubt, intimately familiar with the articles of the Commission's 1986 Joint Powers Agreement (agreement) as approved by the secretary of finance and administration pursuant to the New Mexico Joint Powers Agreements Act [11-1-1 to 11-1-7 NMSA 1978] (Act). According to the Act, the San Juan Water Commission, as administering agency,

> ". . . shall possess the common power specified in the agreement and may exercise it in the manner or according to the method provided in the agreement" [11-1-5(C) NMSA 1978].

Thus, in accordance with New Mexico State law, the agreement provides a strict definition of the San Juan Water Commission's express authority to enter into any and all contracts with the Bureau of Reclamation at page nine (9), Article X, Section A, as follows:

> **CONTRACTS WITH BOR**
> **ARTICLE X**
> **A. It is expressly understood and agreed that the matter of contracts which may be entered into with the BOR pertaining to the ALP is of great importance to the Cities and the parties. The Commission shall not enter into any contract pertaining to the ALP unless the contract or contracts with the BOR contain the signatures of the members and unless such contract or contracts are entered into with the unanimous agreement of all parties. [emphasis added]**

A cursory review of the San Juan Water Commission's 15-year history of contracting with Reclamation would seem to suggest that irregularities and violations have been the rule rather than the exception. The records sought in this request may serve to substantiate allegations that the San Juan Water Commission has habitually failed to comply with the terms of its Joint Powers Agreement in contracting activity with the BOR since the Commission's inception in 1986. It is necessary to establish the degree to which the San Juan Water Commission has overstepped its authority and failed to comply with the JPA, in the consummation of contracts with the Bureau of Reclamation.

To this end, CAW requests access to the following public records:

All contracts from 1986 to date involving the San Juan Water Commission and the U.S. Bureau of Reclamation/Department of the Interior in which compliance with the Joint Powers Agreement Article X, Section A, is evidenced by the signatures of each and every member of the San Juan Water Commission.
NOTE: The contracts in question include, but are not necessarily limited to, any and all memoranda of understanding, cost-sharing agreements, escrow agreements, agreements in principle, schedules, amendments and repayment contracts to which the San Juan Water Commission and U.S. Bureau of Reclamation/Department of the Interior are signatory parties.

By virtue of its status as a public entity, the Commission is subject to New Mexico's Inspection of Public Records Act (NMSA 1978, Chapter 14, Article 2). Section 14-2-1 of this Act states that every person has a right to inspect any public records of this State save those which are specifically excepted. Section 14-2-8 sets forth the requirements for a written request to view such records and the requirement that the custodian of those records permit the inspection within fifteen (15) days or explain in writing, within three (3) business days after receipt of the request, when that request will be acted upon.

Your timely written reply is required in compliance with provisions of the New Mexico Inspection of Public Records Act as stated above.

Sincerely,

Steve Cone, Director
(505) 327-0743

Verna Forbes Willson
(505) 326-2417
Secretary Treasurer

parital cc list:

Farmington Mayor Bill Standley
Farmington Councilor Mary Fischer
Farmington Councilor Hormuzd Rassam
Farmington Councilor Tommy Roberts

Farmington Councilor William Hall
Farmington City Attorney Jay Burnham
Richard Cole
Farmington City Manager Bob Hudson
Farmington City Engineer, Paul Martin
Farmington Director of Community Development, Joe Schmitz
State Engineer Tom Turney
City Manager, City of Bloomfield, Bob Campbell
Tim Jimerson, San Juan River Watch
Elizabeth Newlin Taylor
Aztec City Planner, Eric J. Aune
Ron Bliesner
New Mexico Secretary of Finance and Administration
U.S. Representative Tom Udall
U.S. Senator Pete Domenici
U.S. Senator Jeff Bingaman
Department of the Interior Solicitor John Bezdek
Office of Management and Budget Rick Mertens
Secretary of the Interior, Gale Norton
Bureau of Reclamation, Upper Colorado Regional Director Rick Gold
Bureau of Reclamation, Mike Loring
Bureau of Reclamation, Pat Schumacher
Jim Dunlap

RESOLUTION

of the

UPPER COLORADO RIVER COMMISSION

Re: Proposed "Hydrologic Determination, 1987--Water Availability from Navajo Reservoir and the Upper Colorado River Basin for Use in New Mexico"

WHEREAS, the Upper Colorado River Commission supports water resource development in the Upper Colorado River Basin to enable the Upper Division States to fully develop their compact apportionments of Colorado River water while meeting their compact water delivery requirements at Lee Ferry; and

WHEREAS, it is the position of the Upper Colorado River Commission and the Upper Division States that, with the delivery at Lee Ferry of 75 million acre-feet of water in each period of ten consecutive years, the water supply available in the Colorado River System below Lee Ferry is sufficient to meet the apportionments to the Lower Basin provided for in Article III (a) and (b) of the Colorado River Compact and the entire Mexican Treaty delivery obligation; and

WHEREAS, it is the understanding and expectation of the Upper Colorado River Commission and the Upper Division States that appropriate authorities will take all actions necessary to ensure that all States have access to their respective apportionments as specified in the Upper Colorado River Basin Compact; and

WHEREAS, the Commission resolved at its Special Meeting in Denver, Colorado on June 2, 1987 that it ". . . would not object to a determination by the Bureau [of Reclamation] that the Upper Basin yield is at least 6.0 million acre feet annually, rather than 5.8 million acre feet as previously determined":

NOW, THEREFORE, BE IT RESOLVED by the Upper Colorado River Commission at its Adjourned Annual Meeting in Denver, Colorado, on October 22, 1987, that while the Commission does not endorse the projected Upper Basin depletions, study assumptions, or analytical methodologies set forth in the proposed "Hydrologic Determination, 1987--Water Availability from Navajo Reservoir and the Upper Colorado River Basin for Use in New Mexico," and while it specifically disagrees with the assumption of a minimum Upper Basin delivery of 8.23 million acre-feet annually at Lee Ferry, the Commission does not object to a determination by the Secretary of the Interior that 94,500 acre-feet annually, in addition to the amount to be contracted for the San Juan-Chama Project, the Hammond Project, and the Navajo Indian Irrigation Project, are reasonably likely to be available for contract from the Navajo Reservoir supply for use in New Mexico without causing New Mexico to exceed its compact apportionment of Colorado River System water.

BE IT FURTHER RESOLVED, that the Commission asks that all long-term municipal and industrial water service contracts for water in Navajo Reservoir entered into upon the basis of the subject determination: (1) extend no later than through the year 2039, (2) specify that in the event curtailment of use of water by the States of the Upper Division shall become necessary at any time in order that the flow at Lee Ferry will not be depleted below that required by Article III of the Colorado River Compact, such curtailment shall be determined as specified in Article IV of the Upper Colorado River Basin Compact, and (3) specify that such contracts will be treated in accordance with New Mexico's doctrine of prior appropriation and are subject to the Upper Colorado River Basin Compact.

BE IT FURTHER RESOLVED that the Commission reaches no conclusion at this time on the interpretation and application of Article III(b)(3) of the Upper Colorado River Basin Compact because the Commission believes that New Mexico will be within its compact entitlement based on the position set forth in the second "WHEREAS" clause hereof.

BE IT FURTHER RESOLVED, that this resolution be transmitted to the Regional Director, Upper Colorado Region, Bureau of Reclamation, Salt Lake City, Utah, and, as appropriate, to other Federal, State, and Congressional officials who may consider this "Hydrologic Determination."

CERTIFICATE

I, GERALD R. ZIMMERMAN, Executive Director and Secretary of the Upper Colorado River Commission, do hereby certify that the above Resolution was adopted by the Upper Colorado River Commission at an Adjourned Annual Meeting held in Denver, Colorado on October 22, 1987.

WITNESS my hand this 23rd day of October, 1987.

Gerald R. Zimmerman

GERALD R. ZIMMERMAN
Executive Director and Secretary

RESOLUTION
OF
UPPER COLORADO RIVER COMMISSION

RE: "UPPER COLORADO RIVER BASIN YIELD STUDY--HYDROLOGIC DETERMINATION"

WHEREAS, the Upper Colorado River Commission supports water resource development in the Upper Colorado River Basin to enable the Upper Division States to fully develop their compact apportionments of Colorado River water while meeting their compact water delivery requirements at Lee Ferry; and

WHEREAS, it is the position of the Upper Colorado River Commission and the Upper Division States that with the delivery at Lee Ferry of 75 million acre-feet of water in each period of ten consecutive years, the water supply available in the Colorado River System below Lee Ferry is sufficient to meet the apportionments to the Lower Basin provided for in Article III (a) and (b) of the Colorado River Compact and the entire Mexican Water Treaty delivery obligation; and

WHEREAS, the Upper Colorado River Commission and the Upper Division States will call upon appropriate authorities to take all actions necessary to ensure that all States have access to their respective apportionments as specified in the Upper Colorado River Basin Compact:

NOW, THEREFORE, BE IT RESOLVED by the Upper Colorado River Commission at its Special Meeting in Denver, Colorado, on June 2, 1987, that while the Commission does not endorse the projections of depletions, the study assumptions or the analytical methodologies, particularly the assumption of a minimum Upper Basin delivery of 8.23 million acre-feet annually at Lees Ferry, contained in the "Upper Colorado River Basin Yield Study--Hydrologic Determination" as transmitted by letter dated March 9, 1987, from the Upper Colorado Region of the Bureau of Reclamation, the Commission would not object to a determination by the Bureau that the Upper Basin yield is at least 6.0 million acre-feet annually, rather than 5.8 million acre-feet as previously determined.

BE IT FURTHER RESOLVED that the Commission encourages the Bureau of Reclamation to redetermine the amount of water available for contract from the Navajo Reservoir supply based on an Upper Basin yield of 6.0 million acre-feet annually.

BE IT FURTHER RESOLVED that the Commission is not, at this time, taking any position on the amount of water which is reasonably likely to be available from any given Federal reservoir for long-term water service contracts without causing an Upper Division State to exceed its compact apportionment based upon a determination by the Bureau of Reclamation that the Upper Basin yield is at least 6.0 million acre-feet annually.

BE IT FURTHER RESOLVED that this resolution be transmitted to the Regional Director, Upper Colorado Region, Bureau of Reclamation, Salt Lake City, Utah, and, as appropriate, to other Federal, State, and congressional officials who may consider the "Upper Colorado River Basin Yield Study--Hydrologic Determination."

CERTIFICATE

I, GERALD R. ZIMMERMAN, Executive Director and Secretary of the Upper Colorado River Commission, do hereby certify that the above Resolution was adopted by the Upper Colorado River Commission at the Special Meeting held in Denver, Colorado on June 2, 1987.

WITNESS my hand this 4th day of June, 1987.

Gerald R. Zimmerman
Executive Director and Secretary

HYDROLOGIC DETERMINATION
1988

Water Availability from Navajo Reservoir and
the Upper Colorado River Basin for Use in New Mexico

FEB 02 1988
Date

Acting Secretary of the Interior

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I. Executive Summary

Determination as to the availability of water under long-term service contracts for municipal and industrial (M&I) uses from Navajo Reservoir involves a projection into the future of estimated water uses and water supplies. On the basis of this hydrologic investigation, water depletions for the Upper Basin of the Colorado River can be reasonably allowed to rise to 6 million acre-feet (MAF) annually. This determination certifies the availability of 94,500 acre-feet of water annually for marketing from Navajo Reservoir. Of this amount, 3,000 acre-feet annually has been reserved for use in perpetuity by the Jicarilla Apache Tribe, 69,000 acre-feet per year, previously identified by the 1984 hydrologic investigation, is available for marketing through the year 2039, and an additional 22,500 acre-feet per year is available for marketing from Navajo Reservoir in perpetuity. This depletion level can be achieved under the same shortage criteria upon which the allowable annual depletion level of 5.8 MAF was determined in the 1984 hydrologic investigation, without significant increase in the level of risk.

To avoid a critical compact interpretation, we assume that the Upper Basin will be obligated to deliver 75 MAF of water every 10 years at Lee Ferry, plus 750,000 acre-feet annually toward Mexican Treaty deliveries. This would require an average annual water delivery at Lee Ferry of at least 8.25 MAF. It must be noted here that the Upper Colorado River Commission, comprised of representatives of the Upper Basin States, does not agree with delivery of the 750,000 acre-feet annually toward the Mexican Treaty obligation.

The change in maximum depletion levels for the Upper Basin States under the previously mentioned assumptions, and as a result of this investigation is as follows:

	Depletion Levels (Acre-feet/year)	
State	1984 Investigation	1988 Investigation
Arizona	50,000	50,000
Colorado	2,976,000	3,079,500
New Mexico	647,000	669,500
Utah	1,322,000	1,368,000
Wyoming	805,000	833,000

The Upper Basin States have previously stated disagreement with some of the assumptions in the 1984 hydrologic investigation. Therefore, it should be stated that results from this 1988 hydrologic investigation are for Bureau planning purposes only.

II. Introduction

The Act of June 13, 1962 (76 Stat. 96, Public Law 87-483), authorizing the Navajo Indian Irrigation Project and the San Juan-Chama Project, provides in Section 11 that the Secretary of Interior shall not enter into long-term contracts for the delivery of water from Navajo Reservoir until he has made certain hydrologic determinations as to water availability, has submitted such determinations to the Congress, and the Congress has approved such contracts. The act also authorized the Secretary to market water from Navajo Reservoir for other municipal and industrial uses in New Mexico if he determines on the basis of hydrologic investigation that such water is reasonably likely to be available.

By November 1967, the first determination which made 100,000 acre-feet of water available for marketing was submitted to the Congress, and on March 22, 1968, Senate Joint Resolution 123 (Public Law 90-272) was adopted, approving three long-term contracts with a total estimated annual depletion of 51,550 acre-feet. However, by the early 1980's it became impractical to sell water to meet long-term demands from the Navajo Reservoir supply under the Secretary of the Interior's 1963 determination. Under that determination, any contracts must terminate in the year 2005, which did not allow enough time for potential contractors to develop a project and recover investments.

In December 1984, the Secretary of Interior signed an updated hydrologic determination for the Upper Colorado River Basin by the Bureau of Reclamation (Reclamation). A principal conclusion of the 1984 determination was the estimation that there was enough runoff in the Upper Basin to support a depletion level of at least 5.8 million acre-feet (MAF). This determination also certified the availability of 69,000 acre-feet per year of water for marketing from Navajo Reservoir through the year 2039. Although there was some indication, dependent upon assumptions and study conditions, that utilization of the Colorado River Simulation System (CRSS) might have resulted in somewhat greater yield estimations for the Upper

Basin, consensus on the appropriate procedure for employing the CRSS model limited further investigation into this possibility at that time.

On July 10, 1985, the Secretary of the New Mexico Interstate Stream Commission formally requested that Reclamation continue to pursue a review based on the CRSS of water availability in the Upper Colorado River Basin with the focus toward a re-determination of the water supply available for use in New Mexico. This investigation is a result of that request and will further examine the use of the CRSS data base for Upper Basin yield estimations.

III. Hydrologic Investigation

The Department of Interior's past position on water availability in the Upper Basin assumed that up to 5.8 MAF of water could be safely depleted annually in the Upper Basin. This number was derived from an annual virgin flow data base and developed with three assumptions: (1) the lowest 34-year period of natural runoff; (2) assigned tolerable shortages to irrigated agriculture; and (3) delivery of half the Mexican Treaty commitment from the Upper Basin.

Throughout the hydrologic investigation, and as demonstrated in the attached tables, present Colorado River Storage Project (CRSP) operating policy, along with required Upper Basin water deliveries, combine to form the underlying assumptions that are integral to a hydrologic determination of water availability from Navajo Reservoir and the Upper Colorado River Basin for use in New Mexico. To determine required water deliveries for the Upper Basin, the then current depletion projections were employed by the Bureau in a "demand data base" for the 1984 hydrologic investigation. This depletion schedule for the Colorado River System is periodically updated and the current version can be found in the Bureau publication, Quality of Water - Colorado River Basin Progress Report No.13 - January 1987. The report updates depletion projections for the river system through year 2010. These projections were then extended through year 2040 to serve in the demand data base for this 1988 investigation and can be found in Appendix I of the report.

The extended depletion schedule is based on the hypothesis that the Upper Basin level of depletions will reach 5.8 MAF in the year 2040. The examin-

ation of the effects of demands exceeding 5.8 MAF was accomplished by simply increasing the depletions in the year 2040, with no attempt to prorate the increased amount back over several years or decades. For relatively large increases, such as from 5.8 MAF to 6.3 MAF, the increase was distributed throughout the Upper Basin and among the States by their approximate percentage share of Colorado River water. For small increases, such as from 5.8 MAF to 5.87 MAF, the increase was lumped at one demand point near the bottom of the system.

As to water use in the Upper Basin, subsection (b) of Article III of the Upper Colorado River Basin Compact permits New Mexico or any other Upper Basin State to use waters in excess of its percentage allotment, provided such excess use does not prohibit any of the remaining States from utilizing its respective allotment. This excess of allotted use for New Mexico is demonstrated in Appendix I as projected negative values by year 2000. Thus the availability of Navajo Reservoir water for municipal and industrial purposes in New Mexico beyond the year 2005 depends upon the extent of water use in the entire Upper Basin beyond year 2005 as well as upon the physical availability of water in Navajo Reservoir.

A. Study Approach and Results

1. Hydrology

The basis for the current hydrologic determination is the hydrology data base used for the CRSS. This data base consists of computed monthly natural flows at key points throughout the Colorado River Basin and is complete from 1906-1980. The data have been extended to include the years 1981-1986. The years 1981, 1982, and 1983 were estimated utilizing recorded flows and reservoir operations in so far as possible, with estimated consumptive use. The years 1984, 1985, and 1986 were estimated using estimated consumptive use and basin runoff values in conjunction with stochastically generated flows which were disaggregated throughout the Upper Basin. The hydrology data base is currently scheduled to be updated through 1985 and the provisional data thus eliminated. Updates to the hydrology data base are planned every five years following publication of the Colorado River System Consumptive Uses and Losses Report. The report is prepared every five years pursuant to the Colorado River Basin Project Act of 1968, (P.L. 90-537).

Use of the CRSS hydrology data base with system storage results in a critical drawdown period of 25 years beginning in 1953. This is contrasted to the virgin flow data base used in previous hydrologic determinations which produced a critical period of 34 years beginning in 1931. The virgin flow data base was limited to annual flow values at Lee Ferry. The basis of computing virgin flow was changed several times during the period of record and for this reason, it is felt that the CRSS hydrology is more consistent.

2. Use of The Colorado River Simulation System (CRSS)

The CRSS model was used to determine available system storage and was not directly used to determine basin yield. However the hydrologic data from the model were used for this purpose. The model provided an 81 year sequence of hydrologic data based on historic records from 1906 to 1986. These data were then used to create 81 possible hydrologic cycles for the period from 1986 to 2066. Each of the 81 years functioned as the starting point for a sequence with the preceding years added to the end of the cycle. The same data were used in this investigation as were employed in verification runs for the 1984 hydrologic investigation. However using the data in this way generated 81 possible permutations of the projected hydrology to the year 2066 upon which current demands could be superimposed, (for a more complete explanation see Appendix II). When demands were superimposed on these series of hydrologic projections, a critical storage value of 24.762 MAF was derived for use in the mass balance analysis.

3. Mass Balance Analysis

The yield of the basin above Lee Ferry was determined from a simple mass balance procedure. Although the method was computerized, the basic equation was the following:

$$\text{Yield} = \frac{\frac{[Q + S(1+B)]}{n} - Rm}{1-s}$$

where Q = streamflow for the critical period
S = surface storage available
B = bank storage coefficient
Rm = minimum release to the Lower Basin
s = percent basin-wide shortage
n = number of years in the critical period.

The CRSS model, as explained above and in Appendix II, was used to determine the quantity S(1+B) for use in the mass balance analysis. Although the CRSS model could have been used to determine yield, it is an unwieldy tool for shortage and probability analyses and would have required considerable trial and error work at considerable expense.

The values input to the mass balance program are the annual natural flows at Lees Ferry for 1906-1986 (see Hydrology section, above), the amount of storage available, bank storage coefficient, percent shortage and minimum release. The program provides output values for yield, defines the critical period and computes the probability of meeting various demands higher than the firm yield, given the input constraints.

The critical period is determined by examining all possible average flows and their associated period up to 50 years, over the period of record, in conjunction with the input storage value.

The storage value of 24.762 MAF determined from the CRSS data was based on a monthly operation. Since the mass balance procedure uses only annual data, it was necessary to make an adjustment to the storage value for use with the mass balance program. Adjustments were made for both the differences in the amount of streamflow over 25 years and seven months

compared to 25 years of annual streamflow as well as the difference in the amount of storage used in the monthly study as opposed to that which would be used in just 25 years. Both of these adjustments were then applied to the storage value used in the mass balance program. The adjustments were as follows:

Storage Adjustment

a) 25 year 7 month storage = 24.762 MAF

b) Adjusted amount for 25 years = 24.762 x 25/25.5833 = 24.197 MAF

Streamflow Adjustment

a) 25 year critical period average streamflow = 12.97 MAF

b) 25 year 7 month critical period average streamflow = 12.81 MAF

difference = 0.16

for 25 years: 0.16 x 25 = 4.00

Total Adjustment

24.197 - 4.00 = 20.197 MAF of "adjusted" storage.

The adjusted storage includes the effects of sedimentation and bank storage. Use of this value along with the annual natural flow record at Lees Ferry and a minimum delivery to the Lower Basin from Lake Powell of 8.25 MAF produced a firm yield for the Upper Basin of 5.55 MAF. The yield varied from 5.55 MAF with no shortages to the Upper Basin to 6.03 MAF with an eight percent overall shortage as shown in Table 1.

The liklihood and magnitude of other shortages or "calls on the river" are discussed in Section 5.

4. Probability Analysis

In addition to calculating the firm yield of the Upper Basin, the mass balance model also calculated the probabilities of various higher yields for given levels of shortages. These probabilities are simple plotting positions or percent frequency and were determined by dividing the number of times an interval of critical period length produced at least the specified yield, divided by the total number of times an interval of critical period length could occur in the total record (from 1906 to 1986). The results are tabulated in Table 1 which also indicates the length of the

critical period associated with each probability. These data were used to prepare the curves of Figure 1 which indicate the yield available from the system for a desired probability and a given shortage. Since the data are limited it should be understood that these curves are only approximate and give only an indication as to the probabilities involved.

TABLE 1

Relationships Between
Yield - Probability - Shortage

Shortage	Firm Yield	Percent Probability of Greater Yield					
(Percent)	(MAF)	5.8	5.9	6.0	6.1	6.2	6.3
0	5.55	93.94	87.50	80.85	73.81	65.85	55.26
	(25)1/	(49)	(50)	(35)	(40)	(41)	(44)
2	5.66	98.08	93.94	87.50	80.85	73.91	65.85
	(25)	(30)	(49)	(50)	(35)	(36)	(41)
4	5.78	98.25	98.11	96.23	90.63	84.38	76.09
	(25)	(25)	(29)	(29)	(50)	(50)	(36)
6	5.90			98.11	96.49	90.91	84.85
	(25)			(29)	(25)	(49)	(49)
8	6.03				98.11	96.49	93.94
	(25)				(29)	(25)	(49)

1/ Figures in parentheses indicate the associated critical period length in years.

5. Calls on the River - Site Specific Shortage Analysis

A "call on the river" occurs when the Upper Division is unable to make the required delivery to the Lower Division from Upper Basin storage and must curtail its own uses to meet the delivery from river flows. An analysis of calls was made using the CRSS model. A nominal demand level of 6.1 MAF was used with the 81 hydrologic sequences to analyze the effects and frequency of calls. The hydrologic record was wrapped around so that each sequence was extended to the year 2040 when Upper Basin demands are expected to

reach maximum. The CRSS model does not model the call situation but rathe it indicates the quantity of the call by the amount it shorts the Lower Basin delivery. Appendix III shows the results of the analysis. Using these data, a frequency analysis was made which demonstrates both severity and frequency of a call on the river at a demand level of 6.1 MAF.

The results indicate that the frequency of a call of 100,000 acre feet or less is about 0.75 percent while that of a call over 2 MAF is less than 0.3 percent. This is shown on an incremental basis in Figure 2 and on a cumulative basis in Figure 3. A general conclusion of this analysis is that calls on the river are likely to occur only very rarely even at a 6.1 MAF demand level, but their effects could have significant impact to the Upper Basin and their magnitude could range to over 100 percent of Upper Basin depletion. Cursory examination of demands less than 6.1 MAF indicates that both frequency and magnitude of calls on the river diminish rapidly below this demand level.

6. Other Considerations - Changes in Assumptions

To obtain a wider range of yield analysis results, various changes in basic assumptions were made and the corresponding results arrayed with previous work. In particular, the use of inactive storage pools and a change in minimum delivery to the Lower Basin were examined in regards to the effects on Upper Basin yield. In the mass balance analysis discussed above, the total amount of system storage used during the drawdown period as determined from the use of CRSS was 24.762 MAF. There remained in inactive storage and minimum power pools another 3.012 MAF. If it is assumed that this entire amount is available for use and that the length of the drawdown period would be the same as previously determined, the amount of storage adjusted for use in a mass balance analysis using annual data would be:

$$[(24.762 + 3.012)x25/25.5833] - 4.00 = 23.141 \text{ MAF}.$$

Utilizing this value in the mass balance procedure along with a minimum release of 8.23 MAF at Glen Canyon produces a firm yield (no shortages) of 5.67 MAF for the Upper Basin. The results of additional analysis which relate yield to basin wide shortages and the probability of meeting a yield given a particular shortage are shown in Figure 4. Because the data are somewhat limited, it should be understood that these curves are only approximate and only give an indication as to the probabilities involved.

Additional analyses were made at the request of the Upper Basin States with minimum releases set at 7.5 MAF annually. The difference between releases can be translated directly into increased yield to the Upper Basin. Mass balance analyses similar to those described above were made using both 20.197 MAF of storage ("empty" at top of inactive pools) and 23.141 MAF ("empty" at bottom of inactive pools). The firm yields for the basin (no shortages) were calculated at 6.28 MAF and 6.40 MAF respectively. Figures 5 and 6 show the relationships between yield, shortages and probabilities. As indicated in the earlier examples, these should be considered approximate relationships.

B. Conclusions and Recommendations

Table 2 shows a summary of the results of this investigation.

TABLE 2

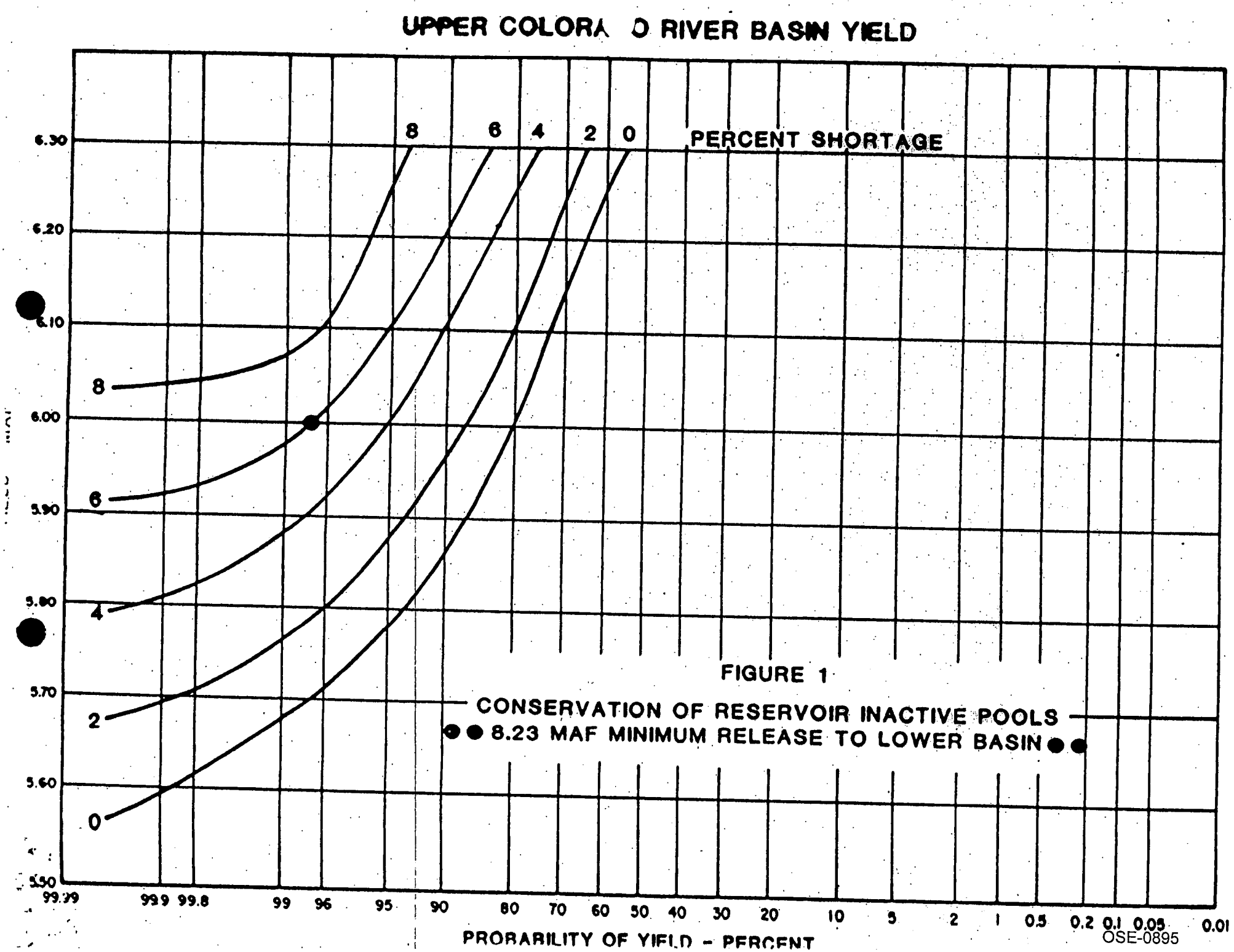
Summary Results

Study	Hydrology	Storage (MAF)	Min. Release (MAF)	Yield Without Shortages (MAF)	Yield With Tolerable Shortages 1/ (MAF)
1967 Study	Virgin Flow	26.232	8.25	5.45	5.80
Current Studies					
Maintain					
Min. Pools	CRSS Nat'l	20.197	8.23	5.55	6.00
	CRSS Nat'l	20.197	7.5	6.28	6.77
Use					
Min. Pools	CRSS Nat'l	23.141	8.23	5.67	6.09
	CRSS Nat'l	23.141	7.50	6.40	6.88

1/ Yield has approximately a 98.5% probability of being sustained with about a 6% shortage.

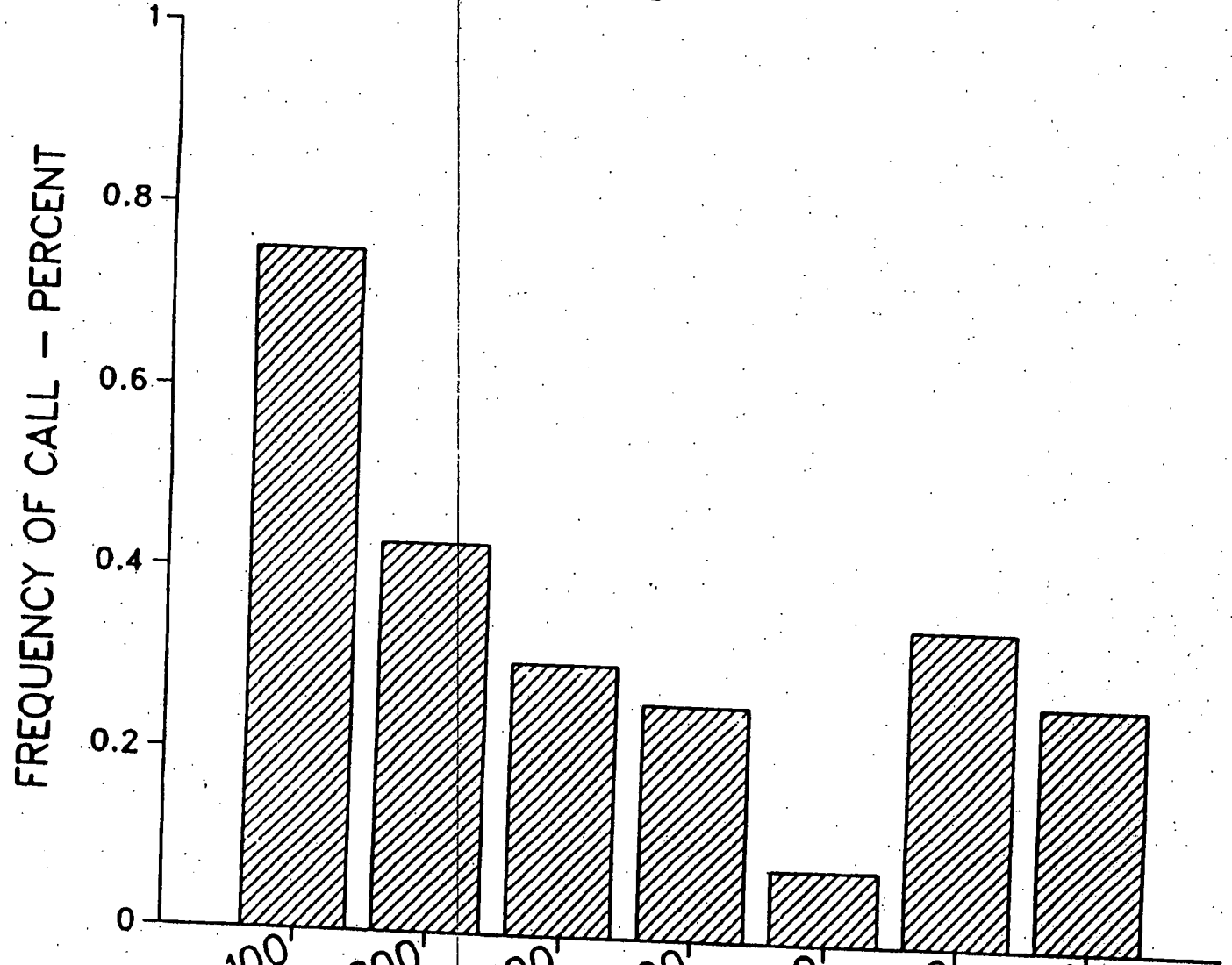
Use of the CRSS hydrology data base and system storage availability as determined from the use of CRSS indicate that the Upper Basin firm yield, without acceptable shortages, is about 100,000 acre-feet greater than was

previously thought, based on other similar assumptions. At the previous estimate of firm yield at 5.45 MAF, the application of risk and shortage criteria resulted in a reasonable depletion level of 5.8 MAF. Applying similar risk and shortage criteria to the present hydrologic determination as those applied to earlier determinations, the increase of Upper Basin firm yield to 5.55 MAF will result in a reasonable depletion level of 6.0 MAF. This has been discussed with the Basin States and the magnitude and consequences of such risk and shortages are understood. Therefore, based on an allowable over-all basin shortage of six percent and a probability of meeting the demands about 98.5 percent of the time (see Figure 1), it is recommended that the Secretary certify that 6.0 million acre feet is reasonably available in the Upper Basin for beneficial consumptive use. This figure takes into account the above risk and shortage criteria as well as provides for a minimum operational release of 8.23 MAF at Lees Ferry.


UPPER COLORADO RIVER BASIN YIELD
8
6
4
2
0
PERCENT SHORTAGE
6.30
6.20
6.10
6.00
5.90
5.80
5.70
5.60
5.50
8
6
4
2
0
99.99
99.9
99.8
99
96
95
90
80
70
60
50
40
30
20
10
5
2
1
0.5
0.2
0.1
0.05
0.01
PROBABILITY OF YIELD - PERCENT
FIGURE 1
CONSERVATION OF RESERVOIR INACTIVE POOLS
8.23 MAF MINIMUM RELEASE TO LOWER BASIN
OSE-0895

Figur 2

FREQUENCY OF CALLS – COLORADO RIVER
Call Range in 1000 AF



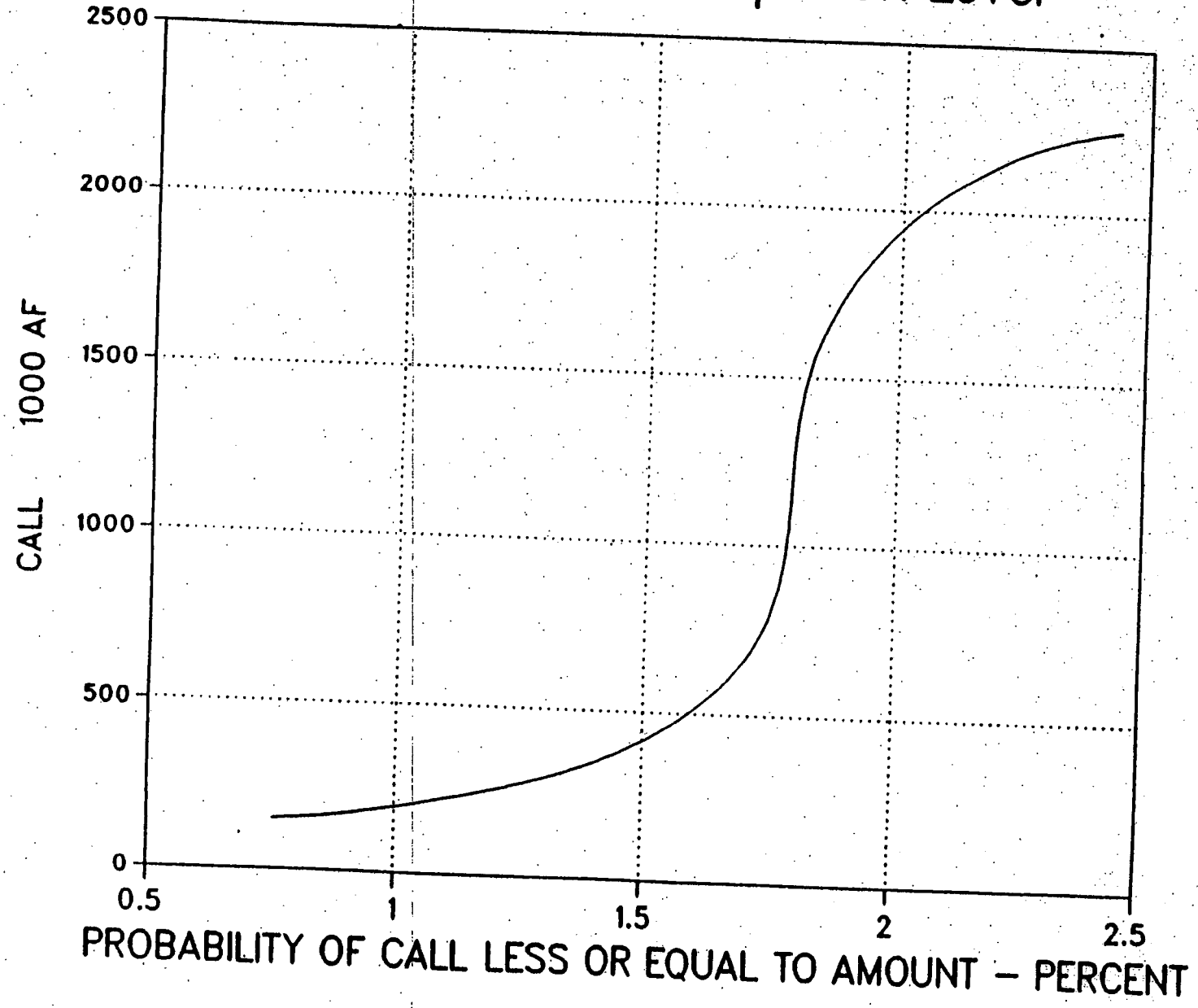
6.1 MAF Nominal Depletion Level

OSE-0896

13

Figur 3

CALL ANALYSIS – COLORADO RIVER
6.1 MAF Nominal Depletion Level



81 YEAR, 81–TRACE ANALYSIS

OSE-0897

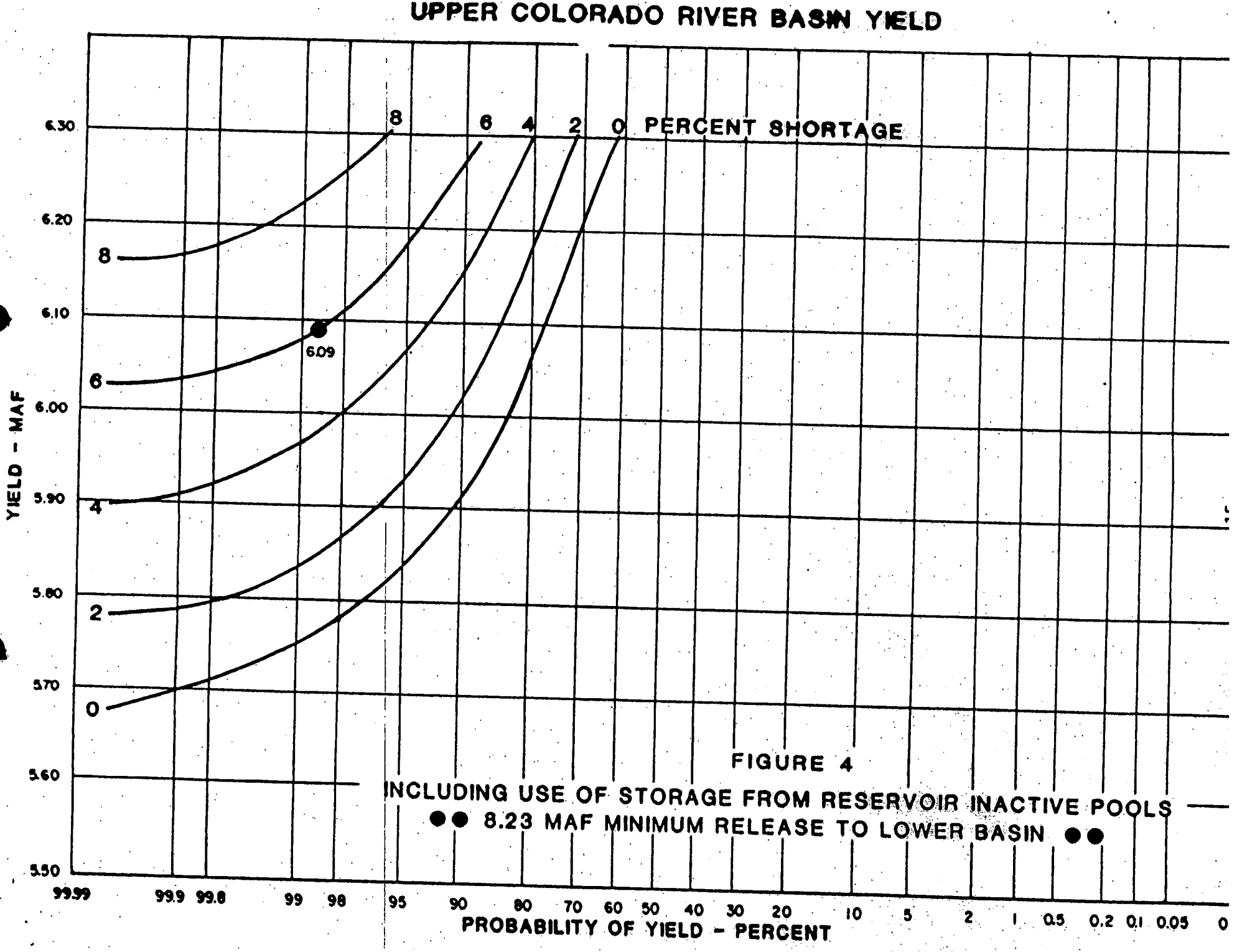
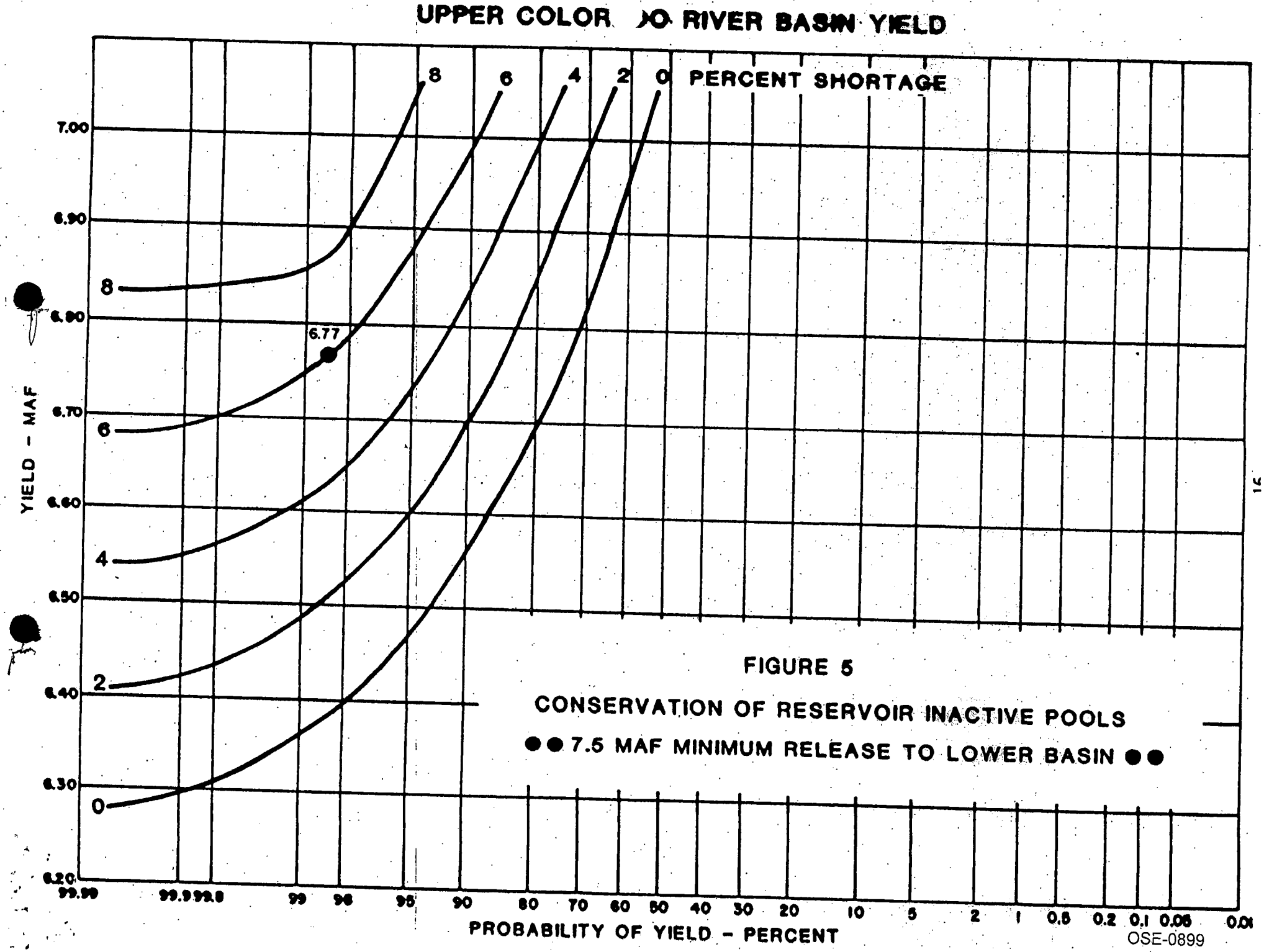


FIGURE 4

OSE-0898


UPPER COLORADO RIVER BASIN YIELD
PERCENT SHORTAGE
8
6
4
2
0
7.00
6.90
6.80
6.70
6.60
6.50
6.40
6.30
6.20
YIELD - MAF
6.77
99.99
99.9
99.8
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
0.5
0.2
0.1
0.05
0.01
PROBABILITY OF YIELD - PERCENT
FIGURE 5
CONSERVATION OF RESERVOIR INACTIVE POOLS
●● 7.5 MAF MINIMUM RELEASE TO LOWER BASIN ●●
OSE-0899

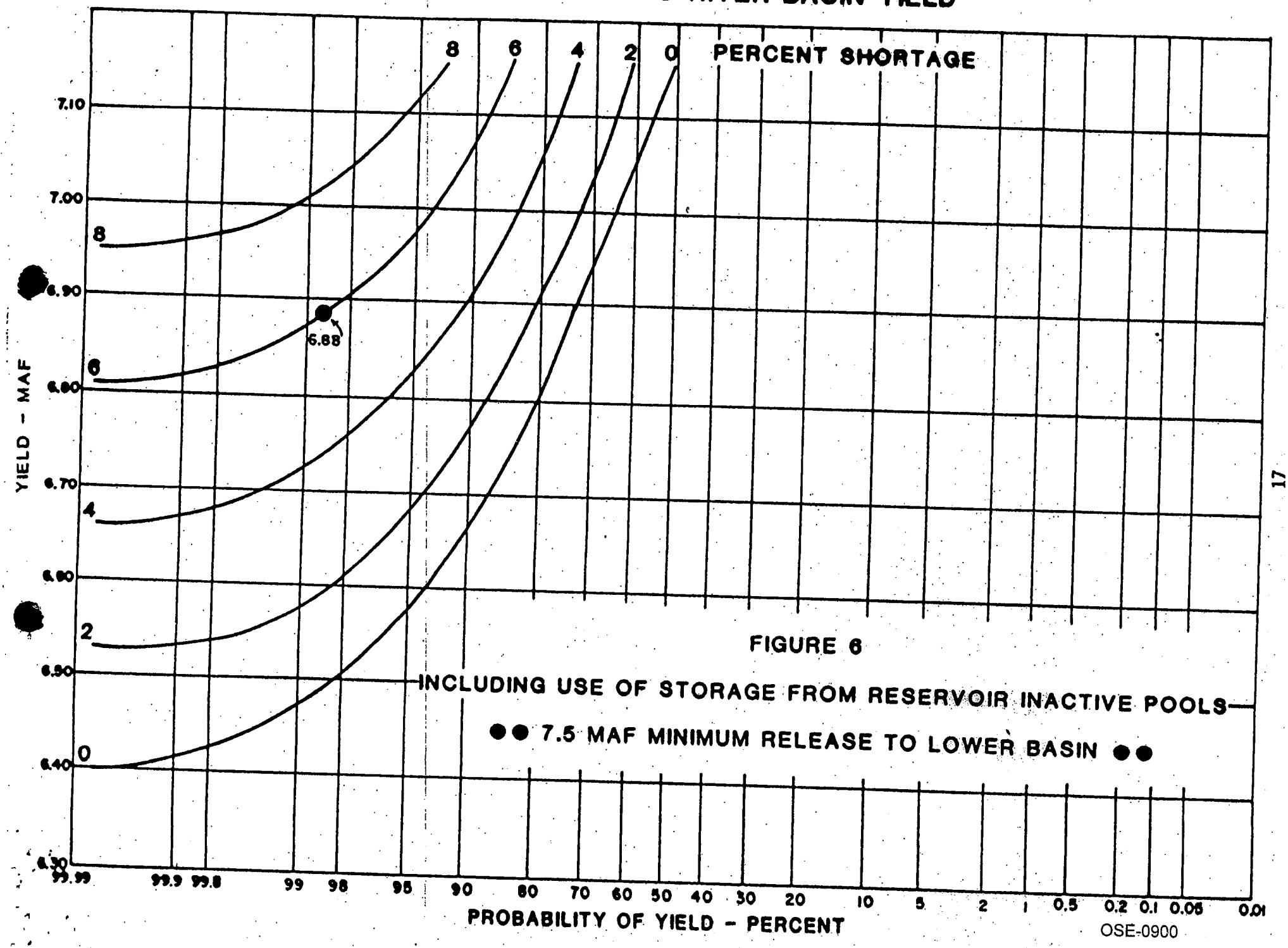

UPPER COLORADO RIVER BASIN YIELD
PERCENT SHORTAGE
8
6
4
2
0
YIELD - MAF
7.10
7.00
6.90
6.80
6.70
6.60
6.50
6.40
6.30
6.88
99.99
99.9
99.8
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
0.5
0.2
0.1
0.05
0.01
PROBABILITY OF YIELD - PERCENT
INCLUDING USE OF STORAGE FROM RESERVOIR INACTIVE POOLS
●● 7.5 MAF MINIMUM RELEASE TO LOWER BASIN ●●
OSE-0900

FIGURE 6

IV. Current Water Service at Navajo Reservoir

The 1984 hydrologic investigation identified an annual 69,000 acre-feet of water available for water service contracts until the year 2040. Table 3 is a list of water service contracts which are currently in effect for Navajo Reservoir:

TABLE 3

Navajo Reservoir Water Service Contracts

Contractor	Expiration Date	Annual Depletion or Diversion (Acre-feet)
Public Service Co. of New Mexico	2005	16,200 depletion 20,200 diversion
Utah International Inc.	2022	35,300 depletion 44,000 diversion
Farmington Elks Lodge 1/	1989	20
Sunterra Gas Processing Co. 2/	2005	50
Long-term subtotal	=	51,570
San Juan Basin Water Haulers Association	1988	500
Bloomfield Refining Co.	1988	340
Amoco Production Co.	1990	200
Earl Hickman	1988	150
Douglas Lee	1990	80
Bloomfield Water & Sanitation	1988	40
Burnett Construction	1988	40
Meridian Oil	1990	50
Nielson Inc.	1987	9
Short-term subtotal	=	1,409

1/ Long-term contract is currently under negotiation.

2/ Formerly known as Southern Union Gas Company, an amendatory contract to extend the expiration date is currently under negotiation.

OSE-0901

V. Additional Requests for Water from Navajo Reservoir

ong-term water service contracts for municipal and industrial uses from Navajo Reservoir involve a projection into the future of estimated water uses and water supplies. The Bureau projection of water supply and depletions from the Navajo Reservoir through the year 2039 is formulated with the consultation of the State of New Mexico. The remaining block of Navajo Reservoir water supply, as identified in the 1984 determination, will still be marketed by the United States and will still be allocated in consultation with the New Mexico Interstate Stream Commission. New individual long-term water service contracts would also need the approval of the Congress.

With an increase in the consumptive use of the Upper Basin to 6.0 MAF, the proportionate share for the State of New Mexico of that increase will be 22,500 acre-feet per year of depletion. The following is a list of additional water service requests submitted to the Bureau of Reclamation for Navajo Reservoir water when it becomes available.

TABLE 4

Additional Requests for Navajo Reservoir Water Service and/or Contract Extensions

Request	Amount (Acre-feet) 1/	Contract Length
Jicarilla Apache Tribe	40,000	perpetuity
Gallup-Navajo Project	24,000	until 2039
Paragon Resources	17,000	40 years
Public Service Company of New Mexico	16,200	until 2025
Bloomfield Refining	340	until 2025
Southern Union Refining Co.	50	40 years
Farmington Elks Lodge	20	40 years

1/ Diversion or depletion not specified.

VI. Determination

ecognizing the status of water use in the Upper Colorado River Basin, the physical availability, and institutional constraints, it is determined through hydrologic investigation that sufficient water is reasonably likely to be available under the provision of Section 11(a) of Public Law 87-483, to fulfill contracts that involve additional Navajo Reservoir water depletions up to 94,500 acre-feet annually. Of this amount, 3,000 acre-feet annually has been reserved for use in perpetuity by the Jicarilla Apache Tribe, 69,000 acre-feet annually is available for marketing through the year 2039, and an additional 22,500 acre-feet of water annually is reasonably likely to be available for depletion from Navajo Reservoir in perpetuity.

Extensive hydrologic data analyses, present Colorado River Storage Project operating policies, and required and projected Upper Basin water deliveries, support the Upper Basin depletion limit of 6.0 MAF. This 6.0 MAF yield from the Upper Colorado River Basin is recognized by the Bureau and the Department as an estimate which takes into account risk and shortage criteria as well as providing for the minimum operational release of 8.23 MAF at Lees Ferry. The 6.0 MAF figure is an estimate to be used for planning purposes only and is not intended to be an interpretation of the Upper Basin entitlement according to the provisions of the Colorado River Compacts and other law of the river.

Therefore, we conclude that the projection of water uses now envisioned in the Upper Basin by year 2040 can reach a 6.0 MAF depletion level without impairment of the Upper Basin's ability to meet its water delivery obligation to the Lower Basin and the Republic of Mexico.

APPENDIX I

This appendix summarizes the extension of project depletions published by the Department of the Interior in the Quality of Water - Colorado River Basin Progress Report No. 13 - January 1987. The projections for the years 1985 through 2010 which appear in the report, represent the best estimate by the Bureau of Reclamation of how water use will be developed over the next 25 years. The projections were made after consultation with individual States within the Colorado River Basin; however, the States do not necessarily concur, but do not object, with the projections adopted by the Bureau for planning purposes. The projections after 2010 were developed in order to extend depletion levels to their previously assumed maximums at year 2040. The state shares of the Upper Basin yield and the remaining water available after use have been adjusted to reflect the revised 6.0 MAF total yield. Upon the approval of this hydrologic determination, the consumptive use projections will be updated accordingly.

June 1987

Bureau of Reclamation
Upper Colorado Region
Projected Water Supply and Depletions
Upper Colorado River Basin

Upper Basin projects	Present and Projected Depletions (Unit--1,000 acre-feet/year) 1985	1990	2000	2010	2020	2030	2040
Arizona							
Comprehensive Framework Study	10	10	10	10	10	10	10
Miscellaneous additional depletions							
Irrigation	6	6	6	6	6	6	6
Municipal and domestic	6	8	10	12	12	12	12
Navajo Poverplant	22	22	22	22	22	22	22
Gallup-Navajo Indian Water Supply Project (temporary)	0	(5)	(7)	(7)	(7)	(7)	(7)
Total depletions	44	46	48	50	50	50	50
Compact Apportionment	50	50	50	50	50	50	50
Remaining Water Available	6	4	2	0	0	0	0
Wyoming							
Comprehensive Framework Study	282	282	282	282	282	282	282
Miscellaneous additional depletions							
Irrigation and livestock	6	8	26	32	41	45	47
Municipal	6	8	11	13	14	17	20
Reclamation projects							
Seedskadee	6	17	20	20	20	20	20
Lyman	10	10	10	10	10	10	10
Savery-Pot Hook	0	0	0	0	0	0	11
La Barge	0	0	0	0	0	0	4
Transmountain diversions	11	19	39	50	50	50	50
Industrial uses							
Thermal electric	29	41	51	71	71	71	71
Mineral	30	40	56	62	62	63	65
Coal gasification	0	0	19	50	52	70	88
Oil shale	0	0	4	10	24	40	58
Proposed reservoir evaporation	0	0	6	6	6	6	6
Total depletions	380	425	524	606	632	674	732
Evaporation, storage units	73	73	73	73	73	73	73
Total	453	498	597	679	705	747	805
State Share of 6.0 Million Acre-Foot Yield	833	833	833	833	833	833	833
Remaining Water Available	380	335	236	154	128	86	28

Upper Basin projects	Present and Projected Depletions (Unit--1,000 acre-feet/year) 1985	1990	2000	2010	2020	2030	2040
Colorado							
Comprehensive Framework Study	1,707	1,707	1,707	1,707	1,707	1,707	1,707
Misc. additional depletions							
Irrigation	24	24	24	24	24	24	24
Municipal and industrial	5	6	7	10	11	12	13
Fish and wildlife	1	1	1	1	1	1	1
Minerals	1	1	1	1	1	1	1
Exports							
Denver Expansion	48	70	100	130	160	180	200
Homestake Expansion	28	28	48	48	48	48	48
Independence Pass Expansion	7	7	7	7	7	7	7
Pueblo Expansion	3	3	3	3	3	3	3	3
Colorado Springs Expansion	0	0	5	5	5	5	5
Englewood	10	10	10	10	10	10	10
Fryingpan-Arkansas	69	69	69	69	69	69	69
Windy Gap	2	54	54	54	54	54	54
Reclamation projects							
Animas-La Plata	0	0	20	121	121	121	121
Lostwick Park	4	4	4	4	4	4	4
Dallas Creek	0	9	10	17	17	17	17
Dolores	7	36	80	81	81	81	81
Fruitland Mesa	0	0	0	0	0	0	21
San Miguel	0	0	0	0	0	0	25
Savery-Pot Hook	0	0	0	0	0	0	12
Upper Gunnison River Basin	1	5	10	15	20	25	35
West Divide	0	0	0	0	0	0	38
Municipal, Industrial, and Domestic							
Taylor Draw Reservoir	2	2	4	7	7	7	7
Stagecoach Project	0	2	4	4	4	4	4
Ruedi contracts	0	0	0	16	49	49	49
Blue Mesa contracts	0	5	10	10	10	10	10
Oil shale	0	0	2	8	25	34	43
Rock Creek	0	15	15	15	15	15	15
Bluestone	0	4	4	4	4	4	4
Green Mountain	0	2	2	2	2	2	2
Thermal-electric powerplants							
Craig-Hayden	17	18	18	18	18	18	18
Colorado Ute-Southwest Project	0	0	5	5	9	9	9
Unidentified	0	0	0	0	0	0	50
Total depletions	1,936	2,082	2,224	2,396	2,486	2,521	2,707
Evaporation, storage units	269	269	269	269	269	269	269
Total	2,205	2,351	2,493	2,665	2,755	2,790	2,976
State Share of 6.0 Million Acre-foot Yield	3,079.5	3,079.5	3,079.5	3,079.5	3,079.5	3,079.5	3,079.5
Remaining Water Available	874.5	728.5	586.5	414.5	324.5	289.5	103.5

Present and Projected Depletions (Unit--1,000 acre-feet/year)

Upper Basin projects	1985	1990	2000	2010	2020	2030	2040
New Mexico							
Adjusted Comprehensive Framework Study 1/	89	89	89	89	89	89	78
Misc. additional depletions	12	12	12	12	12	12	12
Reclamation projects							
Navajo Reservoir evaporation	26	26	26	26	26	26	26
Animas-La Plata	0	0	10	34	34	34	34
San Juan-Chama	110	110	110	110	110	110	110
Navajo Indian irrigation 2/	132	134	267	267	267	267	267
Hammond	10	10	10	10	10	10	10
Hogback Extension	7	10	10	10	10	10	10
Jicarilla Apache 3/	0	3	3	3	3	3	3
Utah International, Inc. (private right)	27	39	39	39	39	39	39
Navajo Reservoir contracts (temporary)							
Public Service Company of New Mexico	16	16	16	0	0	0	0
Utah International, Inc.	0	35	35	35	35	35	0
Gallup-Navajo India Water Supply Project	0	10	14	18	24	24	0
Not identified	0	10	10	10	10	10	0
Total depletions	429	504	651	663	669	669	589
Evaporation, storage units	58	58	58	58	58	58	58
Total	487	562	709	721	727	727	647
State Share of 6.0 Million Acre-foot Yield	669.5	669.5	669.5	669.5	669.5	669.5	669.5
Remaining Water Available	182.5	107.5	-39.5	-51.5	-57.5	-57.5	22.5

1/ Assumes the buy-out of 11,000 acre-feet of private rights.

2/ The ultimate depletion level of 267,000 acre-feet is an estimated figure derived from a 1980 Solicitor's opinion based solely on the project's productive acreage. The 267,000 acre-foot figure is yet to be evaluated for technical accuracy.

3/ This figure may be increased subject to ongoing Indian water rights settlement.

OSE-0907

Present and Projected Depletions (Unit--1,000 acre-feet/year)

Upper Basin projects	1985	1990	2000	2010	2020	2030	2040
Utah							
Comprehensive Framework Study	664	664	664	664	664	664	664
Miscellaneous additional depletions							
Irrigation and stock	1	1	1	1	1	1	1
Municipal	2	3	5	7	9	11	13
Minerals	1	1	1	1	1	1	1
Reclamation projects							
Central Utah Project							
Bonneville Unit	53	136	166	166	166	166	166
Upalco Unit	0	0	12	12	12	12	12
Jensen Unit	3	15	15	15	15	15	15
Uintah Unit	0	0	28	28	28	28	28
Emery County	10	10	10	10	9	9	9
Ute Indian lands	4	4	84	84	84	84	84
Division of Water Resources projects	15	16	20	24	28	32	36
Thermal electric powerplants							
Emery County	30	30	30	30	36	36	36
Conversion of irrigation to power	-9	-9	-9	-9	-10	-10	-10
Other Utah Power & Light Company plants	0	0	2	6	24	30	36
Deseret Generation Co-op	0	6	12	12	12	12	12
Municipal and industrial							
White River Dam	0	0	0	6	6	6	6
Oil shale	0	0	1	20	40	45	51
Tar sands	0	0	6	18	42	42	42
Total depletions	774	877	1,048	1,095	1,167	1,184	1,202
Evaporation, storage units	120	120	120	120	120	120	120
Total	894	997	1,168	1,215	1,287	1,304	1,322
State Share of 6.0 Million Acre-foot Yield	1,368	1,368	1,368	1,368	1,368	1,368	1,368
Remaining Water Available	474	371	200	153	81	64	46
Upper Colorado River Basin totals							
Total depletions	3,563	3,934	4,495	4,810	5,004	5,098	5,280
Evaporation, storage units	520	520	520	520	520	520	520
Total	4,083	4,454	5,015	5,330	5,524	5,618	5,800

DISCLAIMER

The Upper Colorado River Basin Compact provides that the States of Arizona Colorado, New Mexico, Utah, and Wyoming will share in the consumptive use of water available in the Upper basin in the following constant and proportions:

Arizona	50,000 acre-feet
Colorado	51.75 percent of the remainder
New Mexico	11.25 percent of the remainder
Utah	23.00 percent of the remainder
Wyoming	14.00 percent of the remainder

To be conservative in making its estimate of water supply and depletions in the Upper Basin, the Department of Interior has assumed that the riverflow will be 75 MAF every 10 years at Lee Ferry, plus 750,000 acre-feet annually for Mexican Treaty deliveries. This would require an average annual water delivery at Lee Ferry of 8.25 MAF. Using this assumption, the Department of the Interior estimates that the long-term dependable yield of water available in the Upper Basin for consumptive use by man is 6.0 MAF per year. this assumption is not to be considered an interpretation of the obligation of the Upper Basin States for water delivery at Lee Ferry under the Colorado River Compact, nor is it in accord with the view of the Upper Basin States. It is the position of the Upper Colorado River Commission and the Upper Basin States that, with the delivery at Lee Ferry of 75 MAF of water in each period of 10 consecutive years, the water supply available in the Colorado River System below Lee Ferry is sufficient to meet the apportionments to the Lower Basin provided for in Article III (a) and (b) of the Colorado River Compact and the entire Mexican Treaty delivery. The Upper Basin States submit that the long-term dependable yield of water available in the Upper Basin would be at least 6.3 MAF.

The values of 'State Share' and 'Remaining Water Available' which appear in the depletion tables are based on the Department of the Interior's assumed dependable yield of 6.0 MAF of water available for consumptive use in the

Upper Basin. The negative values of remaining water which appear in the New Mexico projections represent uses of water above that available under the Department's conservative, assumed water supply and are assumed by the Department to be permitted under the Upper Colorado River Basin Compact.

Nothing in this report is intended to interpret the provisions of the Colorado River Compact (45 Stat. 1057), the Upper Colorado River Basin Compact (63 Stat. 31), the Water Treaty of 1944 with the United Mexican States (Treaty Series 994, 59 Stat. 1219), the decree entered by the Supreme Court of the United States in Arizona vs. California, et. al. (376 U.S. 340), the Boulder Canyon Project Act (45 Stat. 1057), the Boulder Canyon Project Adjustment Act (54 Stat. 774; 43 U.S. Code 618a), the Colorado River Storage Project Act (70 Stat. 105; 43 U.S. Code 620), or the Colorado River Basin Project Act (82 Stat. 885; 43 U.S. Code 1501).

APPENDIX II

USE OF
THE COLORADO RIVER SIMULATION SYSTEM (CRSS)
TO DETERMINE AVAILABLE STORAGE

Documentation of the CRSS model is found in the following publications, all published by the Bureau of Reclamation:

Colorado River Simulation System - An Executive Summary
Colorado River Simulation System - System Overview
CRSM User Manual

The model accounts for sedimentation in four reservoirs: Navajo, Flaming Gorge, Lake Powell, and Lake Mead. Sedimentation is assumed to be a constant annual amount that varies seasonally for each reservoir, but the distribution of sediment between active and dead storage pools is a function of the individual reservoir operation. The model continually updates the elevation-capacity relationships for each of the four reservoirs. Sedimentation is important in yield determination since over the 81 year period of record used in modeling, total Upper Basin system storage is decreased by over 5 MAF as a result of sediment.

Shortages are calculated locally in the model at individual demand points and summed for the entire basin. The model output indicates total annual shortages. It is recognized that inaccuracies in shortages are generated by the model. This is due to modeling limitations such as not modeling local storage facilities, as well as not recognizing water right priorities. In some instances shortages are generated due to inadequacy of hydrologic information in localized areas.

In current runs of the CRSS model, consideration of bank storage is given to two reservoirs in the Upper Basin. The change in storage of Lake Powell is modified by a bank storage factor of 0.08 and in Flaming Gorge the change in storage is modified by a factor of 0.033. No consideration for

bank storage is given for any of the other Upper Basin reservoirs.

A number of different model runs were made to determine the amount of storage that would be available during a critical drawdown period of the Upper Colorado system. To get some idea of the stress placed on the system under current modeling conditions, i.e. using the current demand schedule that indicates development to 5.8 million acre-feet by the year 2040, an 81 year (1986 to 2066), 81-trace run was performed. Traces are modeling simulation runs with a fixed sequence of hydrology. The initial trace began with the initial hydrology year of 1906 set at the initial modeling year of 1986. The hydrology was then shifted one year for each trace until each of the 81 years of record had been used as the initial modeling year, (see Table 1 for an alignment of hydrology and trace years).

This run indicated that the 5.8 MAF level of demands was not great enough to completely utilize all of the system storage. Since sediment accumulation continually changes reservoir characteristics, and because all upstream reservoirs in the CRSS model are forced down as Lake Powell empties, the elevation of Lake Powell was used as an index to determine the storage state of the system. The maximum drawdown in Lake Powell occurred in trace 75 in March 2065 with Powell elevation at 3530 or some 40 feet above minimum power pool and corresponded to a total system storage remaining of about 5.6 MAF.

Another 81-trace run was performed that set the demands to a 6.3 MAF level at the year 2040. At that level of demand, the system is over stressed. This is apparent in that not only is the entire Upper Basin system storage utilized, but the system remains drawn down to minimum levels for a relatively high number of months. Of the 81 traces, there were 28 traces in which Lake Powell was empty (at minimum power pool) from 3 to 31 months. From Table 2 it can be seen that trace 75 is the critical trace in that it reflects the greatest stress on the system. It should be noted that trace 75 not only produces the greatest number of months of complete drawdown, but is also the trace in which the greatest amount of water in storage is available and used. Because of this, additional analysis was focused on trace 75.

To determine the amount of storage that could reasonably be available in a critical drawdown period, several single-trace runs of trace 75 were made until a level of demands was found that produced a drawdown in which the system just emptied, i.e. reached minimum power pools or inactive storage levels for one month. This occurred when the nominal demands reached a level of 5.87 MAF in 2040. The run produced a drawdown that started with the reservoirs full near the beginning of 2040 and just emptied in February 2065. This indicated a drawdown period of 25 years and 7 months. The sediment-modified storage amount utilized from full system to empty system was 24.762 MAF. The actual depletions for the drawdown period including evaporation and adjustment for shortages amounting to 4.45 percent, averaged 5.805 MAF.

Additional CRSS model runs were made to answer specific questions or allow further analysis of some situations. A 100-year run of trace 75 was made with the 81-year hydrologic record being "wrapped around" to verify system recovery. The run was identical to the previously discussed run through the year 2066. The additional years of operation indicated that the system would refill in June of 2072.

A trace 75 run was made with the surplus strategy turned-off. The surplus strategy provides for the release of water early in a wet (above average) year which would not normally be released until the flood runoff period. The purpose of this strategy is to make better use of water in these higher runoff years with the effect of drawing or keeping down reservoirs earlier in the year. A run made with the surplus strategy turned-off was done to answer questions regarding the effects of the surplus strategy. Although the operation during the early years of the run varied somewhat, the system filled and emptied in the same respective months as in the previous run. Because the pattern of sediment deposition was changed somewhat, the amount of water between full and empty states varied by about 15,000 acre feet. When considered over the more than 25-year drawdown period this was felt to be insignificant.

TABLE 1
CRSS TRACES AND HYDROLOGIES

Trace	Initial Year Hydrology	Ending Year Hydrology	Hydrology Year @2040 Run Year
1	1906	1986	1960
2	1907	1906	1961
3	1908	1907	1962
4	1909	1908	1963
5	1910	1909	1964
6	1911	1910	1965
7	1912	1911	1966
8	1913	1912	1967
9	1914	1913	1968
10	1915	1914	1969
11	1916	1915	1970
12	1917	1916	1971
13	1918	1917	1972
14	1919	1918	1973
15	1920	1919	1974
16	1921	1920	1975
17	1922	1921	1976
18	1923	1922	1977
19	1924	1923	1978
20	1925	1924	1979
21	1926	1925	1980
22	1927	1926	1981
23	1928	1927	1982
24	1929	1928	1983
25	1930	1929	1984
26	1931	1930	1985
27	1932	1931	1986
28	1933	1932	1906
29	1934	1933	1907
30	1935	1934	1908
31	1936	1935	1909
32	1937	1936	1910
33	1938	1937	1911
34	1939	1938	1912
35	1940	1939	1913
36	1941	1940	1914
37	1942	1941	1915
38	1943	1942	1916
39	1944	1943	1917
40	1945	1944	1918
41	1946	1945	1919
42	1947	1946	1920
43	1948	1947	1921
44	1949	1948	1922
5	1950	1949	1923
46	1951	1950	1924

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TABLE 2

	TRACE	MONTHS EMPTY	UPPER BASIN STORAGE AT YEAR 2040	AVG. ANNUAL SHORTAGE FOR THE TRACE-ACRE FEET
1.	1	16	19.8	151,630
2.	2	14	18.3	151,530
3.	3	9	14.5	148,510
4.	4	8	18.2	148,218
5.	5	7	14.3	144,699
6.	6	5	11.8	141,409
7.	7	3	16.5	142,033
8.	8	0	14.9	140,383
9.	61	6	22.1	133,500
10.	62	6	20.2	134,645
11.	63	4	16.4	133,458
12.	64	9	20.6	132,660
13.	65	14	25.8	131,766
14.	66	18	25.6	131,757
15.	67	18	26.9	133,150
16.	68	18	27.0	136,135
17.	69	18	24.5	134,591
18.	70	17	26.3	137,205
19.	71	16	27.5	137,488
20.	72	16	27.7	137,466
21.	73	19	27.0	151,470
22.	74	26	25.7	152,337
23.	75	31	27.7	234,479
24.	76	27	20.3	152,835
25.	77	22	16.7	158,273
26.	78	23	13.6	155,634
27.	79	20	11.9	153,892
28.	80	18	16.6	153,600
29.	81	17	19.0	152,549

APPENDIX III

COLORADO RIVER - CALL ANALYSIS
6.1 MAF DEPLETION LEVEL
(Units--1,000 acre-feet)

Trace	Release	Year of Call	Call	EVAP	CU	Depletion	Call as Percent of Remaining Depletion
33	8,216	2097	14	276	5,503	5,779	0.24%
23	8,214	2103	16	299	5,238	5,537	0.29%
23	8,196	2117	34	299	5.271	5,570	0.61%
24	8,195	2116	35	299	5,271	5,570	0.63%
25	8,195	2115	35	298	5,272	5,570	0.63%
41	8,195	2099	35	288	5,279	5,567	0.63%
22	8,194	2104	36	299	5,238	5,537	0.65%
29	8,194	2097	36	303	5,238	5,541	0.65%
42	8,194	2098	36	287	5,279	5,566	0.65%
43	8,194	2097	36	286	5,279	5,565	0.65%
26	8,193	2114	37	298	5,273	5,571	0.67%
27	8,193	2113	37	298	5,274	5,572	0.67%
44	8,193	2096	37	285	5,279	5,564	0.67%
28	8,192	2112	38	297	5,275	5,572	0.69%
45	8,192	2095	38	286	5,279	5,565	0.69%
29	8,191	2111	39	297	5,276	5,573	0.70%
46	8,191	2094	39	285	5,279	5,564	0.71%
30	8,190	2110	40	297	5,277	5,574	0.72%
52	8,190	2088	40	284	5,281	5,565	0.72%
53	8,190	2087	40	284	5,281	5,565	0.72%
54	8,190	2086	40	284	5,281	5,565	0.72%
31	8,189	2109	41	295	5,278	5,573	0.74%
32	8,189	2108	41	295	5,279	5,574	0.74%
47	8,189	2093	41	285	5,279	5,564	0.74%
48	8,189	2092	41	285	5,279	5,564	0.74%
51	8,189	2089	41	285	5,280	5,565	0.74%
33	8,188	2107	42	295	5,279	5,574	0.76%
49	8,188	2091	42	285	5,279	5,564	0.76%
34	8,187	2106	43	295	5,279	5,574	0.78%
50	8,187	2090	43	285	5,280	5,565	0.78%
35	8,186	2105	44	294	5,279	5,573	0.80%
36	8,186	2104	44	294	5,279	5,573	0.80%
37	8,185	2103	45	294	5,279	5,573	0.81%
38	8,183	2102	47	294	5,279	5,573	0.85%
39	8,182	2101	48	293	5,279	5,572	0.87%
40	8,182	2100	48	293	5,279	5,572	0.87%
32	8,178	2098	52	276	5,503	5,779	0.91%
28	8,164	2098	66	303	5,238	5,541	1.21%
21	8,155	2105	75	298	5,238	5,536	1.37%
23	8,153	2106	77	294	5,422	5,716	1.37%
31	8,146	2099	84	276	5,503	5,779	1.47%
21	8,145	2108	85	295	5,422	5,717	1.51%
19	8,142	2110	88	297	5,422	5,719	1.56%
20	8,142	2109	88	295	5,422	5,717	1.56%
22	8,142	2107	88	295	5,422	5,717	1.56%

Trace	Release	Year of Call	Call	EVAP	CU	Depletion	Call as Percent of Remaining Depletion
76	8,142	2063	88	354	4,081	4,435	2.02%
17	8,135	2112	95	294	5,426	5,720	1.69%
27	8,135	2099	95	301	5,238	5,539	1.75%
18	8,131	2111	99	297	5,422	5,719	1.76%
20	8,116	2106	114	298	5,238	5,536	2.10%
26	8,116	2100	114	299	5,238	5.537	2.10%
30	8,115	2100	115	276	5,503	5,779	2.03%
29	8,111	2101	119	276	5,503	5,779	2.10%
28	8,100	2102	130	281	5,503	5,784	2.30%
27	8,097	2103	133	281	5,503	5,784	2.35%
25	8,083	2103	147	400	5,213	5,613	2.69%
25	8,080	2105	150	282	5,503	5,785	2.66%
19	8,079	2107	151	298	5,238	5,536	2.80%
16	8,077	2110	153	294	5,238	5,532	2.84%
24	8,076	2106	154	282	5,503	5,785	2.75%
25	8,074	2101	156	299	5,238	5,537	2.90%
26	8,064	2117	166	381	4,988	5.369	3.19%
25	8,060	2118	170	383	4,987	5,370	3.27%
24	8,059	2119	171	384	4,987	5,371	3.29%
16	8,058	2113	172	295	5,422	5,717	3.10%
14	8,056	2115	174	295	5,422	5,717	3.14%
15	8,055	2114	175	295	5,422	5,717	3.16%
23	8,055	2120	175	384	4,986	5,370	3.37%
15	8,052	2111	178	294	5,238	5,532	3.32%
18	8,050	2108	180	297	5,238	5,535	3.36%
13	8,049	2116	181	294	5,426	5,720	3.27%
12	8,047	2117	183	294	5,426	5,720	3.31%
11	8,046	2118	184	294	5,426	5,720	3.32%
10	8,040	2119	190	295	5,426	5,721	3.44%
24	8,040	2102	190	300	5,238	5,538	3.55%
9	8,037	2120	193	295	5,426	5,721	3.49%
14	8,030	2112	200	294	5,238	5,532	3.75%
17	8,017	2109	213	297	5,238	5,535	4.00%
13	8,004	2113	226	293	5,238	5,531	4.26%
12	7,977	2114	253	293	5,238	5,531	4.79%
71	7,973	2068	257	346	4,100	4,446	6.14%
22	7,950	2108	280	282	5,503	5,785	5.09%
23	7,950	2107	280	281	5,503	5,784	5.09%
20	7,949	2110	281	282	5,503	5,785	5.11%
21	7,949	2109	281	282	5,503	5,785	5.11%
18	7,948	2112	282	283	5,503	5,786	5.12%
19	7,948	2111	282	282	5,503	5,785	5.12%
16	7,947	2114	283	283	5,503	5,786	5.14%
17	7,947	2113	283	283	5,503	5,786	5.14%
15	7,946	2115	284	283	5,503	5,786	5.16%
11	7,945	2115	285	293	5,238	5,531	5.43%
14	7,945	2116	285	284	5,503	5,787	5.18%
11	7,944	2119	286	284	5,503	5,787	5.20%
12	7,944	2118	286	284	5,503	5,787	5.20%
13	7,944	2117	286	284	5,503	5,787	5.20%
70	7,944	2069	286	346	4,100	4,446	6.88%

Trace	Release	Year of Call	Call	EVAP	CU	Depletion	Call as Percent of Remaining Depletion
10	7,943	2120	287	284	5,503	5,787	5.22%
69	7,923	2070	307	346	4,100	4,446	7.42%
75	7,914	2064	316	348	4,069	4,417	7.71%
10	7,903	2116	327	293	5,238	5,531	6.28%
68	7,893	2071	337	345	4,100	4,445	8.20%
74	7,884	2065	346	348	4,068	4,416	8.50%
9	7,867	2117	363	293	5,238	5,531	7.02%
67	7,862	2072	368	345	4,100	4,445	9.03%
73	7,860	2066	370	348	4,068	4,416	9.14%
20	7,838	2120	392	302	5,268	5,570	7.57%
21	7,836	2119	394	301	5,269	5,570	7.61%
22	7,835	2118	395	301	5,270	5,571	7.63%
72	7,832	2067	398	347	4,068	4,415	9.91%
8	7,825	2118	405	291	5,238	5,529	7.90%
66	7,814	2073	416	344	4,100	4,444	10.33%
7	7,795	2119	435	291	5,238	5,529	8.54%
65	7,758	2074	472	343	4,100	4,443	11.89%
6	7,757	2120	473	291	5,238	5,529	9.36%
64	7,709	2075	521	343	4,100	4,443	13.28%
63	7,663	2076	567	342	4,100	4,442	14.63%
62	7,628	2077	602	341	4,100	4,441	15.68%
61	7,570	2078	660	340	4,100	4,440	17.46%
60	7,342	2079	888	336	4,100	4,436	25.03%
59	7,129	2080	1,101	332	4,096	4,428	33.09%
58	7,016	2081	1,214	329	4,096	4,425	37.81%
57	6,929	2082	1,301	328	4,071	4,399	41.99%
56	6,921	2083	1,309	328	4,071	4,399	42.36%
55	6,882	2084	1,348	328	4,070	4,398	44.20%
54	6,826	2085	1,404	323	4,058	4,381	47.16%
53	6,709	2086	1,521	321	4,058	4,379	53.22%
52	6,679	2087	1,551	321	4,058	4,379	54.84%
51	6,661	2088	1,569	321	4,058	4,379	55.84%
50	6,633	2089	1,597	321	4,058	4,379	57.40%
49	6,631	2090	1,599	321	4,058	4,379	57.52%
48	6,606	2091	1,624	321	4,058	4,379	58.95%
47	6,578	2092	1,652	321	4,058	4,379	60.58%
46	6,530	2093	1,700	319	4,058	4,377	63.50%
45	6,496	2094	1,734	319	4,058	4,377	65.61%
44	6,469	2095	1,761	319	4,058	4,377	67.32%
43	6,429	2096	1,801	318	4,058	4,376	69.94%
42	6,400	2097	1,830	318	4,058	4,376	71.88%
41	6,376	2098	1,863	318	4,057	4,375	74.16%
40	6,359	2099	1,871	319	4,049	4,368	74.93%
39	6,318	2100	1,912	318	4,049	4,367	77.88%
38	6,278	2101	1,952	318	4,049	4,367	80.83%
37	6,243	2102	1,987	318	4,049	4,367	83.49%
36	6,199	2103	2,031	317	4,049	4,366	86.98%
34	6,168	2105	2,062	317	4,049	4,366	89.50%
30	6,165	2109	2,065	319	4,049	4,368	89.67%
35	6,162	2104	2,068	316	4,049	4,365	90.03%
32	6,146	2107	2,084	318	4,049	4,367	91.28%

Trace	Release	Year of Call	Call	EVAP	CU	Depletion	Call as Percent of Remaining Depletion
33	6,141	2106	2,089	317	4,049	4,366	91.74%
31	6,129	2108	2,101	318	4,049	4,367	92.72%
28	6,076	2111	2,154	318	4,049	4,367	97.33%
29	6,075	2110	2,155	318	4,049	4,367	97.42%
27	6,060	2112	2,170	318	4,049	4,367	98.77%
26	6,028	2113	2,202	318	4,049	4,367	101.71%
25	6,023	2114	2,207	318	4,048	4,366	102.22%
24	6,018	2115	2,212	318	4,048	4,366	102.69%
23	6,010	2116	2,220	318	4,049	4,367	103.40%
22	6,004	2117	2,226	318	4,049	4,367	103.97%
21	5,996	2118	2,234	318	4,049	4,367	104.74%
20	5,984	2119	2,246	319	4,049	4,368	105.84%
19	5,975	2120	2,255	319	4,048	4,367	106.77%

Average Call:
(81 years, 81 traces) 15

FREQUENCY OF CALLS

Call Range (1,000 acre-feet)	Number of Occurrences	Frequency (Percent)	Accumulative Frequency of Calls (Percent)
0	6401	97.56	
1-100	49	0.75	0.75
101-200	28	0.43	1.18
201-300	20	0.30	1.48
301-500	17	0.26	1.74
501-1000	5	0.08	1.82
1001-2000	23	0.35	2.17
2001-2255	18	0.27	2.44
81 years, 81 traces	6561	100.00	