Draft

MEMORANDUM
November 14, 2005

To: Engineering Advisory Committee of the Upper Colorado River Commission

From: John Whipple, Engineering Advisor for New Mexico

Subject: Impacts Of Depletions On Lee Ferry Flows

BACKGROUND

Article III(d) of the Colorado River Compact requires that the Upper Basin not deplete the flow at Lee Ferry below 75 million acre-feet in any period of ten consecutive years. Thus, the depletion under Article III(d) must be measured at the point of delivery (i.e., Lee Ferry). Further, Article VI of the Upper Colorado River Basin Compact provides for the use of the inflow-outflow method to account historic consumptive uses in the Upper Basin. The inflow-outflow method would account for the net of all impacts of man's activities on streamflow, including salvage, by measuring the net effect of depletions at the downstream point (i.e., the delivery point at Lee Ferry) after actual depletions and new losses.

The process for estimating the man-made depletion of the flow of the Colorado River at Lee Ferry by developments in each of the Upper Basin States requires the following steps (Letter from Royce J. Tipton, Chairman of the Committee on Depletion, to Members of the Committee on Depletion of the Engineering Advisory Committee to the Upper Colorado River Compact Commission, January 26, 1948): (1) estimation of total rate of depletions by irrigated crops at the point of use with a full water supply; (2) estimation of incidental depletions due to irrigation; (3) estimation of the depletion that was being caused by natural processes on the now irrigated lands before man came into the picture; (4) estimation of the reduction in the depletion at the point of use due to inadequate water supplies; (5) estimation of the salvage of stream flow losses between the point of depletions and the main river gaging stations (Green River at Green River, Utah; Colorado River at Cisco, Utah; and the San Juan River at Bluff, Utah); (6) estimation of the salvage of water between the above main stream gaging stations and Lee Ferry; and (7) estimation of the man-made depletion at Lee Ferry by deducting the sum of items 4, 5 and 6 from the sum of items 1 and 2.

A. 1948 Engineering Advisory Committee Report.

Salvage by use was included in the 1948 Engineering Advisory Committee (EAC) report to the Upper Colorado River Basin Compact Commission, whereby stream depletions at sites of use were reduced for reductions in channel losses resulting from the use of water.

The following is a summary of the procedure used to determine salvage by use described at pages 42-55 of the 1948 EAC report.

To determine channel loss rates: (1) river bottom areas exposed to evaporation were measured and estimated from available aerial photography and mapping for reaches of stream from Lee Ferry to the headwater areas; (2) water surface evaporation rates were estimated as a function of elevation for the Colorado, Green and San Juan rivers based on available pan evaporation and other meteorologic data; and (3) average channel losses were then estimated for the period 1914-1945 with allowance made for the effect of turbulence on evaporation rates. As a check on the method, channel losses for several years also were estimated using the hydrometric method for the San Juan River between Rosa and Bluff and for the Colorado River and tributaries between Green River, Cisco and Bluff and Lee Ferry. The hydrometric method compares daily inflow and outflow hydrographs for the reaches and evaluates losses under varying conditions of rising, steady or falling flows and of wet or dry channel conditions, and considering any intervening tributary runoff and base inflows and any known man-made depletions. Channel losses estimated using the hydrometric method include both channel evaporation losses and consumptive use of water by riparian streamside vegetation, and thus are greater than those estimated from the channel surface using the evaporation rate method. The EAC report at page 46 indicates that the results obtained from the evaporation rate method are minimum channel loss estimates, and consequently, the losses estimated using the evaporation rate method were used to reflect the average historic channel loss to be more conservative.

However, for both the San Juan River reach between Rosa and Bluff and the Colorado River and tributaries reach between Green River, Cisco and Bluff and Lee Ferry, the annual channel losses computed using the hydrometric method were related to the annual inflows to the reaches with both losses and inflows expressed as percentage of mean (see curves used to estimate channel loss increase, average historic to average virgin conditions, at page 54 of the EAC report). The resulting relationships were applied to these and other river reaches in the Upper Colorado River Basin based on channel similarities, such that channel losses in percent of mean for each reach could be determined from the inflows to each reach also in percent of mean. The annual channel loss amounts for all reaches in the Upper Basin were then estimated for the 1914-1945 period using the inflows to each reach and the mean channel surface evaporation loss amounts for each reach determined using the elevations for the reaches and the average evaporation rates for the given elevations (from the elevation-evaporation curve at page 47 of the EAC report adjusted for a turbulence factor). Estimated historic man-made depletions within each reach and the loss curves were then used to determine what additional channel losses would have occurred under virgin flow conditions for the 1914-1945 period. The difference between the indicated channel losses under virgin conditions and the historic channel loss amounts was considered the amount of water salvaged due to historic uses. Similarly, the difference between channel losses derived using the same approach under reductions in streamflow from the 1914-1945 average can be determined.

Using this approach and routing of flows through stream reaches, the 1948 EAC report estimated that salvage in the Upper Basin by historic uses during the 1914-1945 period amounted to about 73,300 acre-feet, which equated to a basin-wide average of about 3.8 percent of average at-site depletions for the period. Of this amount, the report found that salvage by use in New Mexico between sites of use and Lee Ferry amounted to about 2,700 acre-feet per year, on average, for the 1914-1945 period. Depletions at Lee Ferry resulting from use in New Mexico and other states were thus reduced from at-site depletions accordingly. The salvage associated with uses in New Mexico of 2,700 acre-feet equated to about 3.7 percent of on-site depletions for the period.

B. 1965 Tipton and Kalmbach Report.

Tipton and Kalmbach in 1965 prepared a report for the Upper Colorado River Commission on water supplies available for use by the Upper Division States that included the Department of the Interior's July 1965 projections of depletions at Lee Ferry that were reduced for salvage estimated to be about 4 percent of on-site depletions by projects in the Upper Basin (see Water Supplies of the Colorado River Available for Use by the States of the Upper Division and for Use from the Main Stem by the States of Arizona, California and Nevada in the Lower Basin, Tipton and Kalmbach, Inc., July 1965, Table A-2). Interior's projections allowed 101,000 acre-feet for salvage by use in the Upper Basin as of 1965 conditions, which equated to an average of about 3.50 percent of on-site depletions basin-wide as of 1965. Interior's projections also allowed 164,000 acre-feet of estimated salvage in the Upper Basin under 2030 conditions, which equated to a basin-wide average of about 3.44 percent of projected 2030 on-site depletions. The Tipton and Kalmbach report did not segregate the quantities of salvage by state.

C. 1968 Colorado River Basin Projects Act.

Hydrologic studies prepared by the Bureau of Reclamation for consideration of the Colorado River Basin Projects Act included salvage by uses in the Upper Basin in its projections of the flow at Lee Ferry available to the Lower Basin (see Hearing before the Subcommittee on Irrigation and Reclamation of the Committee on Interior and Insular Affairs, House of Representatives, 89th Congress, First Session, on H.R. 4671 and similar bills, Lower Colorado River Basin Project, August 23-September 1, 1965, Serial No. 17, pages 229-230 and 463-464). The Secretary of the Interior and the Commissioner of Reclamation provided Congress tabulations showing estimated depletions by the Upper Basin that Reclamation used as the basis of its forecast of Colorado River water supply available to the Lower Basin. The tabulation reduced the total depletion at sites of use in the Upper Basin for salvage to determine depletion at Lee Ferry. Reclamation estimated salvage to be 4 percent of on-site uses.

D. 1970 Colorado River Reservoirs Long-Range Operating Criteria.

The Bureau of Reclamation in the preparation of long-range operating criteria for the Colorado River pursuant to Public Law 90-537, including development of the 602(a) storage algorithm, in 1969 included salvage by uses in the Upper Basin in its projections of the flow at Lee Ferry (see: (1) Meeting of Federal and State Representatives for Review of Basic Data Pertinent to the Preparation of Operating Criteria for the Colorado River Pursuant to Section 602 of Public Law 90-537, US Department of the Interior, Bureau of Reclamation, July 25, 1969, table entitled "Upper Colorado River Water Uses with Projected Depletions at Lee Ferry"; (2) Upper Basin Depletions, report of Task Force on long-range reservoir operating criteria, August 1969; and (3) Report of the Committee on Probabilities and Test Studies to the Task Force on Operating Criteria for the Colorado River, Bureau of Reclamation, October 30, 1969, page 12). Reclamation in its Colorado River Storage Project studies allowed 115,000 acre-feet for salvage by use in the Upper Basin as of 1968, which equated to an average of about 4 percent of on-site depletions basin-wide as of 1968. Reclamation also allowed 191,000 acre-feet of estimated salvage in the Upper Basin under 2030 conditions, which equated to a basin-wide average of about 4 percent of projected 2030 on-site depletions. Of these amounts, the salvage associated with uses in New Mexico was estimated at 5,000 acre-feet (or 3.45 percent of on-site depletions) in 1968 and projected to be 21,000 acre-feet (or 3.57 percent of on-site depletions) in 2030.

E. 1971 Upper Colorado Region Comprehensive Framework Study.

The 1971 Upper Colorado Region Comprehensive Framework Study (CFS) at pages 39 and 48 notes that the on-site depletions used therein in schedules of depletion for the Upper Basin for planning purposes are not to be construed as depletions charged to the states under the provisions of the Colorado River and Upper Colorado River Basin compacts because they do not necessarily reflect direct relationships to streamflow diminishment at Lee Ferry. Carrying the CFS on-site depletions forward in subsequent evaluations of depletions should not be construed as altering that preface. The depletion of flow at Lee Ferry is less than the depletion of the flow at the place of use because a portion of the streamflow used would have been lost to evaporation or evapotranspiration had the water remained in the stream. The savings in river channel losses above Lee Ferry resulting from putting the water to use in the Upper Basin constitutes salvage by use. Only depletion of the flow at Lee Ferry is chargeable against a state's apportionment of the yield available to the Upper Basin at Lee Ferry under Article III of the Colorado River Compact.

While the 1971 CFS made no attempt to account for changes or differences in natural river channel losses that are referred to as salvage by use, it did account for a considerable amount of such salvage water within reservoir areas in the computation of net reservoir losses in mainstem reservoirs which include Lake Powell, Flaming Gorge Reservoir and the three reservoirs comprising the Aspinall Unit (see the 1971 CFS at pages 46 and 52).

F. Colorado River System Consumptive Uses and Losses Reports.

Public Law 90-537 does not specify how the Bureau of Reclamation's Colorado River System consumptive uses and losses (CU&L) reports are to be prepared. Reclamation in said reports includes on-site consumptive uses and does not include salvage. Minutes of the Upper Colorado River Commission's Subcommittee on Consumptive Use meeting of April 7-8, 1976, state that the report should document that the on-site consumptive uses should not be construed as consumptive use at Lee Ferry. In its comments to Reclamation on the CU&L report for 1971-1975, the Upper Colorado River Commission noted that the report states that no attempt was made to deal with the question of channel losses and salvage by use, and that Reclamation, to be consistent with Article VI of the Upper Colorado River Basin Compact, should report the consumptive use by Upper Basin States as depletion of the virgin flow at Lee Ferry (see Ival Goslin's January 28, 1977, letter to Commissioner Gilbert Stamm). In its response, Reclamation recognized the value of reporting consumptive use by the Upper Basin as depletion at Lee Ferry, and stated that Reclamation intends prior to issuing the subsequent CU&L report to conduct studies of channel losses and salvage that would permit conversion of the on-site uses to depletions at Lee Ferry (see Commissioner Keith Higginson's April 11, 1977, letter to Ival Goslin).

In comments on a proposed plan of study for the 1976-1980 CU&L report, the Upper Colorado River Commission noted that Reclamation did not plan to attempt to account for possible channel-loss salvage, and pointed out that consumptive uses in the Upper Basin must be determined in terms of man-made depletions of the virgin flow at Lee Ferry for compact purposes, that salvage is an important factor in the determination of consumptive uses, and that future CU&L reports will need to consider salvage by use as the use of water in the Upper Basin approaches the limit of the apportionment (see Paul Billhymer's December 7, 1981, letter to Clifford Barrett). In its response, Reclamation agreed that the value of the CU&L report would be enhanced by inclusion of channel-loss salvage, but felt that salvage will have to be addressed in future CU&L reports because insufficient data were available at that time to confidently estimate salvage (see Clifford Barrett's February 2, 1982, letter to Paul Billhymer). In comments on the draft CU&L report for 1976-1980, the Commission reiterated its earlier comments on the plan of study, stated that future Reclamation reports must consider the compact provisions, and suggested that Reclamation work with the Commission staff and the states so that salvage can be considered in the next CU&L report (see Paul Billhymer's May 23, 1983, letter to Clifford Barrett). In addition, Wyoming and New Mexico submitted comments indicating that salvage by use is a compact consideration that becomes more important as uses increase and it should be included in the next CU&L report (see John Buyok's May 31, 1983, and Philip Mutz' June 6, 1983, letters to Clifford Barrett). Subsequent CU&L reports did not address salvage by use.

Nevertheless, net evaporation rates used to compute reservoir evaporation losses for inclusion in the CU&L reports, and consequently, for use in determining natural flows at Lee Ferry, were determined from estimated gross evaporation rates, taking into account also precipitation on the lake surface and runoff salvage from within the reservoir pool area (see the first CU&L report for 1971-1975 at pages 11-12). Mainstem reservoir evaporation is computed based on average monthly lake surface areas and predetermined average monthly net evaporation rates, and evaporation from other reservoirs in the CU&L reports are computed based on average annual lake surface areas and average annual net evaporation rates. Allowing for salvage by use of river channel losses outside of reservoir areas would be consistent with allowing for salvage by inundation of river channel losses within reservoir areas. A consistent approach should be used to evaluate net depletions at Lee Ferry for comparison against the yield available to the Upper Basin at that point on the river. Only the depletion effects of uses on the flow at Lee Ferry should be accounted in the depletion schedules that are compared a state's apportionment of the yield available at Lee Ferry.

G. Hydrologic Determinations Pursuant to Public Law 87-483.

The Bureau of Reclamation in the 1984 Hydrologic Determination prepared for contracting water from Navajo Reservoir did not include salvage by uses in the Upper Basin. In commenting to Reclamation on the December 1983 draft of the Hydrologic Determination, New Mexico noted that the draft takes no account of salvage by use (see Steve Reynolds' January 18, 1984, letter to Cliff Barrett). The Upper Colorado River Commission's Resolution of March 20, 1984, stated that the Commission does not endorse the projections of depletions in the Upper Basin or the study assumptions set forth in the December 1983 draft. The Bureau of Reclamation in the 1988 Hydrologic Determination largely used the same depletion schedules used in the 1984 Hydrologic Determination, with only minor variations, and did not include salvage by use. The Upper Colorado River Commission's Resolutions of June 2, 1987, and October 22, 1987, stated that the Commission does not endorse the projections of depletions, the study assumptions or the analytical methodologies that are contained in drafts of the Hydrologic Determination.

H. States' Depletion Schedules for Colorado River Basin Planning Studies.

After the 1988 Hydrologic Determination, the Commission has not objected to the use for planning and water supply studies in the Colorado River Basin of depletion schedules that the Upper Division States prepared in 1994 and updated in 1999, which schedules are of on-site depletions and do not include or consider salvage. These later two schedules include a qualifying note that the depletion schedules do not attempt to interpret the Colorado River Compact, the Upper Colorado River Basin Compact or any other element of the "Law of the River," and that the schedules should not be construed as an acceptance of any assumption that limits the Upper Colorado River Basin's depletion (see the Commission's July 13, 1994, Resolution regarding the July 1994 States' Depletion Tables and the associated depletion schedule dated July 1994, and the Commission's December 15, 1999, Resolution regarding the January 2000 States' Depletion Tables and the associated depletion schedule dated January 2000).

I. Administration of Uses.

The reverse of salvage by use (decreasing evaporation losses with reductions in flow and river surface area) is incremental channel loss (increasing evaporation losses with increases in flow and river surface area). If the Upper Colorado River Commission pursuant to Article IV were to require curtailments of use in order to increase the flow at Lee Ferry by a defined amount, the Commission and the Upper Division States must necessarily consider incremental channel losses in determining how much on-site use must be curtailed to deliver the defined quantity at Lee Ferry.

J. Potential Amount of Allocable Salvage.

If the salvage by use in New Mexico amounts to about 3.5 percent of at-site uses, then at-site depletions in New Mexico of about 611,400 acre-feet per year should salvage about 21,400 acre-feet per year compared to virgin or natural flow conditions. Under the 1988 Hydrologic Determination, the yield available to the Upper Basin at Lee Ferry is at least 6,000,000 acre-feet, of which New Mexico's apportioned share is at least 611,400 acre-feet. Thus, New Mexico could deplete about 632,800 acre-feet at sites of use and remain within her apportioned share of the yield at Lee Ferry if the yield does not factor in any salvage. If the yield does not factor in any salvage and salvage is not allowed for in projecting uses in the Upper Basin, New Mexico would not develop her share of the yield because on-site uses of 611,400 acre-feet would result in a depletion of flow at Lee Ferry of only about 590,000 acre-feet. The amount of salvage would be increased if the yield to the Upper Basin, and New Mexico's apportionment, were increased relative to the 1988 Hydrologic Determination. For example, if the Upper Basin yield is 6.3 MAF, New Mexico's apportioned share of the yield would be about 703,100 acre-feet measured at Lee Ferry and 727,700 acre-feet of on-site depletion after allowing for about 24,600 acre-feet of salvage.

In addition, although water uses from perennial streams in the Upper Basin may have a full impact on the flow of the stream adjacent to the site of use, water uses from other sources may not. For example, consumptive uses from ground water may have a delayed impact on streamflow over time if the ground water is tributary to Upper Basin streams such as the San Juan, Upper Colorado or Green rivers, and may have no impact on these streams or the flow at Lee Ferry if the ground water in non-tributary. Also, uses of surface water on ephemeral tributaries do not have a full impact on the perennial tributaries. For example, uses on washes tributary to the ephemeral Chaco River do not have a full impact on San Juan River flows in New Mexico because much of the water if not used would be lost in transit due to evaporation, evapotranspiration and seepage losses into dry channels (i.e., water also is salvaged in the ephemeral channels). Salvage on ephemeral tributary channels in the Chaco River drainage would be in addition to salvage on the San Juan River computed above for uses on perennial tributaries.

However, to the extent that historic salvage was not accounted in quantifying the natural flows at Lee Ferry, the annual natural flows are overestimated because at-site depletions that were added to the gaged flows were not reduced for salvage. To that extent only, the average annual salvage occurring historically during the critical water supply period should not be allowed or allocated in the depletion schedules. Historic salvage that was accounted in the historic natural flow calculations for the critical period and additional salvage resulting from increased depletions occurring after the critical period should be accounted in the depletion schedules.

The natural flows used in the yield study are the Colorado River System Simulation (CRSS) model flows. The CRSS natural flows at Lee Ferry for the 1953-1977 critical period of record were developed by adding historic irrigation and other depletions to the gaged flows. The historic depletions were not reduced for salvage by use; except, that irrigation consumptive use was reduced for effective precipitation (which apparently was considered consumed by natural vegetation prior to irrigation). Thus, to the extent that man-made depletions salvaged channel losses during the critical period, the gaged and natural flows reflect the actual salvage and reduced losses occurring during that period. Consequently, the yield to the Upper Basin estimated using the CRSS natural flows includes the average annual amount of salvage that occurred historically during the critical period. To compare depletions associated with anticipated water development in the Upper Basin against the yield at Lee Ferry, the total amount of depletion in the States' depletion estimates should be reduced only for the amount of difference between the amount of salvage under full development conditions and the average amount of salvage during the critical period.

EVALUATION OF ALLOCABLE SALVAGE

The following evaluation of the amounts of salvage that might be allocable to the Upper Division States in general, and the State of New Mexico in particular, is divided into two parts: (1) salvage of natural channel losses by reservoir inundation; (2) salvage of river channel losses by use in main reaches of the Upper Colorado, Green and San Juan rivers and their tributaries that are identified at pages 46-48 of the 1948 EAC report, excluding reaches inundated by reservoirs; and (3) salvage of channel losses on ephemeral tributaries.

Salvage by Reservoir Inundation

A general algebraic expression of flow at a dam site may be represented as:

$$Q = I + P - L$$

where Q = flow at the dam site,

I = inflow to the reservoir basin (the basin area within the maximum operating level of the reservoir referred to as the control area),

P = precipitation volume on the control area, and

L = losses or depletions within the control area.

Losses or depletions within the control area may be expressed as:

$$L = E_{lake} + L_{river} + L_{riparian} + L_{terrace} + L_{upland} + D$$

where E_{lake} = gross evaporation from the lake water surface,

L_{river} = gross evaporation from the river channel water surface,

$L_{riparian}$ = consumptive use by riparian streamside vegetation rooted within the water table,

$L_{terrace}$ = consumptive use by vegetation on floodplain terraces that has access to capillary ground water,

L_{upland} = consumptive use by upland hillside vegetation that depends on precipitation for water, including areas considered barren, and

D = man-made depletions (for example, irrigation).

The net depletion of stream flow at the dam site resulting from filling and operating the reservoir can be determined as the difference between the total losses and depletions within the control area (L) under pre-reservoir and post-reservoir conditions. The difference thus incorporates salvage of pre-reservoir losses. The Bureau of Reclamation employs this general procedure for determining the impacts of post-1929 reservoirs on stream flows in the Rio Chama and Rio Grande in New Mexico, and Reclamation's results are used for San Juan-Chama Project water accounting and Rio Grande Compact administration (see Bureau of Reclamation San Juan-Chama Accounting Computer Program Enhancement, undated; Upper Rio Grande Water Operations Model Physical Accounting, Abiquiu Reservoir Accounting Example, June 2002 draft; Albuquerque Area Office Annual Water Accounting Reports). However, whereas Reclamation for Rio Grande reservoirs classifies reservoir basin areas in terms of lake area, river channel area, irrigated area, meadow area and barren area, pre-reservoir vegetation surveys for Colorado River Storage Project reservoir basins conducted by the University of Utah in the late 1950s and early 1960s suggest using the area classifications indicated by the above definitions for Colorado River Basin reservoirs. Also, for purposes of accounting man-made depletions of the natural stream flow at the dam site, pre-reservoir depletions (D) that are removed from the stream system in anticipation of inundation due to filling of the reservoir should not be included in the analysis or otherwise considered as salvaged losses. Areas classified in the pre-reservoir vegetation surveys as current or recently abandoned irrigated farmland on floodplain terraces should be lumped with the terrace areas to determine natural losses.

The acreages of lake water surface, river channel, riparian vegetation, terrace and upland hillside areas within the reservoir control area vary over time with reservoir storage. The lake evaporation rate may be computed as pan evaporation times a pan coefficient of 0.7 for large reservoirs, with reductions in proportions to percentage ice cover during winter months. The river channel evaporation rate may be computed as either: (1) the lake evaporation rate, which is the assumption used by the Bureau of Reclamation in the Rio Grande Basin water accounting; (2) pan evaporation times a pan coefficient of 0.8 for shallow water bodies, which coefficient value accounts for greater heating of shallow water as compared to lakes; or (3) the lake evaporation rate times a turbulence factor that reflects the increased exposure of surface area to the atmosphere caused by turbulence, which is the approach used by the 1948 EAC report. Consumptive use rates for the vegetative areas that include use of precipitation can be estimated from the 1948 Engineering Advisory Committee report to the Upper Colorado River Basin Compact Commission (see Appendix B, Consumptive Use of Water Rates in the Upper Colorado River Basin, Harry Blaney and Wayne Criddle, pages 25-28, table 2 at page 10 and figure 1 following page 2). Estimated average loss rates for the various areas within the control area are provided in Table 1.

To determine the actual net depletion of stream flow by man as a result of reservoir inundation, taking into account salvage of pre-reservoir losses, the evaporation losses and vegetation consumptive uses within the control area of the reservoir should be determined monthly for pre-reservoir and current conditions based on reservoir storage and meteorological data when available. For the purpose of evaluating the possible magnitude of salvaged losses by Colorado River Storage Project (CRSP) reservoirs, an analysis is made using the average annual evaporation and consumptive use rates presented in Table 1 and the pre-reservoir condition river surface acreage, streamside riparian acreage, terrace acreage (including farmlands), and upland hillside and barren acreage within the reservoir control areas shown in Table 2. The size of the reservoir control areas reflects the reservoir surface area at live capacity (for example, spillway crest) as obtained from Glen Canyon Environmental Studies, Final Report, US Department of the Interior, January 1988, page D-11, Table D-1.

Compare 1948 EAC rates w/ met. data USBR

Estimated average pre-reservoir natural losses within the control areas of the CRSP reservoirs are shown in Table 3, and represent the maximum potential salvage by inundation if the reservoirs were always full. Also shown in Table 3 are the estimated average evaporation losses from the reservoirs if full throughout the year. The difference between the gross lake evaporation when full and the pre-reservoir natural losses within the control area indicates the maximum potential annual depletion of stream flow at the dam sites. Each with 70% full?

For Lake Powell, the Bureau of Reclamation uses this procedure, except that the post and pre-reservoir losses are based on monthly average net lake evap. coefficients (or rates gross lake evap-precip), as opposed to current year meteorologic data. Reclamation also assumes that river channel evap. is the same as the net lake evap. rate, and that the rate of net effective precip in the upland hillside areas (all vegetation) is [.95 x precip → 86 ... or precip → '93 ...] ?

post $Q_P = I - (E_G - P) = I - E_N$

pre $Q_b = I - [(E_G - P)_R + (CU_R - P)_R + (CU_T - P)_T + (CU_u - P)_u]$

$= I - [(E_N)_R + (NCU)_R + (NCU)_T]$

$CU_u - P = P_{eff} - P = 0$

net evap loss $= Q_b - Q_p = (E_N)_L - (E_N)_R - (NCU)_R - (NCU)_T$

same rate diff. area

Computed monthly: monthly avg E_N applied to A_{lake} & A_{river}, A_{rip} & A_T also vary monthly

For other CRSP units, average $Q_b - Q_p$ rate determined and applied to monthly A_{lake} (A_{river}, A_{rip}, A_T built into avg net evap coeff. & not varied monthly) - okay where ratio between areas does not vary substantially w/ elevation

Table 1. Estimated Average Loss Rates within Reservoir Control Areas

Reservoir	Consumptive Use Rates, including Precip (feet)					Precip
	Lake	River	Riparian	Terrace	Upland	(feet)
Lake Powell [1]	5.25	6.00	3.88	2.59	0.41	0.50
Flaming Gorge Reservoir [2]	2.67	3.05	2.20	1.30	0.48	0.97
Aspinall Unit [3]	2.92	3.34	1.46	0.98	0.53	0.79
Navajo Reservoir [4]	3.58	4.09	3.00	1.78	0.67	1.05

[1] Lake evaporation for Lake Powell is based on measured Class A pan evaporation at Lees Ferry for the period 1922-1938, as reported in the 1948 EAC report, Appendix A, at page 5, times a pan coefficient of 0.7 (see also the elevation-evaporation data and curves in the 1948 EAC report at page 47). For evaporation from river channels, application of a turbulence factor of 1.3 to the free water surface evaporation for lakes would give a river channel evaporation rate of 6.82 feet, as compared to a rate of 6.00 feet computed using a pan coefficient of 0.8. The precipitation rate is based on the 1916-2004 average measured precipitation rate at Lees Ferry published by the US Weather Bureau.

A pre-reservoir survey of the Glen Canyon Reservoir basin indicated that 82 percent of the streamside riparian area had vegetative cover, which included large cottonwood, willow and tamarix (see Survey of Vegetation in the Navajo Reservoir Basin, University of Utah Department of Anthropology, Anthropological Papers Number 51, Upper Colorado Series Number 4, June 1961, page 39). Terrace areas, excluding farmlands, had 51 percent vegetative cover, and upland hillside areas had 18 percent vegetative cover. The consumptive use rates for the Lake Powell basin are based on the normal rates shown in table 8 of the 1948 EAC report for the Moab area of Utah for dense and light native vegetation and for the Green River area of Utah for sparse vegetation, respectively.

[2] Lake evaporation for Flaming Gorge Reservoir is based on the elevation-evaporation curve for the Green River in the 1948 EAC report at page 47. For evaporation from river channels, application of a turbulence factor of 1.3 to the free water surface evaporation for lakes would give a river channel evaporation rate of 3.47 feet, as compared to a rate of 3.05 feet computed using a pan coefficient of 0.8. The precipitation rate is based on the 1957-2004 average measured precipitation rate at Flaming Gorge, Utah, published by the US Weather Bureau.

A pre-reservoir survey of the Flaming Gorge Reservoir basin indicated that 86 percent of the streamside riparian area had vegetative cover, which included cottonwood (see Survey of Vegetation in the Navajo Reservoir Basin, University of Utah Department of Anthropology, Anthropological Papers Number 51, Upper Colorado Series Number 4, June 1961, page 39). Terrace areas, excluding farmlands, had 51 percent vegetative cover, and upland hillside areas had 21 percent vegetative cover. The consumptive use rates for the Flaming Gorge Reservoir basin are based on the normal rates shown in table 8 of the 1948 EAC report for the Henry's Fork area of Wyoming for very dense, light and sparse native vegetation, respectively.

[3] Lake evaporation for the Blue Mesa, Crystal and Morrow Point reservoirs is based on the elevation-evaporation curve for the Colorado River in the 1948 EAC report at page 47, and has not been reduced for ice cover during the winter months. For evaporation from river channels, application of a turbulence factor of 1.3 to the free water surface evaporation for lakes would give a river channel evaporation rate of 3.80 feet, as compared to a rate of 3.34 feet computed using a pan coefficient of 0.8. The precipitation rate is based on the 1967-2004 average measured precipitation rate at Blue Mesa Lake published by the US Weather Bureau.

The consumptive use rates for the Blue Mesa, Crystal and Morrow Point reservoir basins are based on the normal rates shown in table 8 of the 1948 EAC report for the Upper Gunnison area of Colorado for dense, light and sparse native vegetation, respectively.

[4] Lake evaporation for Navajo Reservoir is based on the mean pan evaporation at El Vado Dam for the period 1931-1960 as determined by Class A pan evaporation measurements and reported in New Mexico State Engineer Technical Report 31 at page 18 (figure 5), times a pan coefficient of 0.7. The resultant lake evaporation rate of 3.58 feet is somewhat greater than a lake evaporation rate of 3.17 feet obtained from the elevation-evaporation curve for the San Juan River in the 1948 EAC report at page 47, but somewhat less than a lake evaporation rate of about 4.05 feet estimated using a combination of available Navajo Dam and Farmington pan evaporation data for the period 1981-1994. US Weather Bureau pan evaporation data for Arboles, Colorado, for the period 1958-1964 is consistent with the El Vado Dam mean pan evaporation rate. For evaporation from river channels, the 1948 EAC report adjusted the free water surface evaporation for lakes to allow for the effect of turbulence on evaporation rates (page 46). A turbulence factor of 1.3 was used for stream segments in the San Juan River Basin above Bluff, Utah (see Memorandum from the Hydrology Division, Bureau of Reclamation, to the EAC dated November 12, 1947). Application of a turbulence factor of 1.3 to a lake evaporation rate of 3.17 feet would give a river channel evaporation rate of 4.12 feet, as compared to a rate of 4.09 feet computed using the mean El Vado Dam pan evaporation and a pan coefficient of 0.8. The 1948 EAC report found that channel loss computed using the pan evaporation method was conservatively low as compared to channel loss computed using a mass balance approach for the Rosa to Bluff reach of the San Juan River (pages 50-52). The precipitation rate is based on the 1963-2004 average measured precipitation rate at Navajo Dam published by the US Weather Bureau.

The pre-reservoir survey of the Navajo Reservoir basin indicates 80 percent of the streamside riparian area had vegetative cover, of which 86 percent of the vegetated area had a cover density of 75 percent or more (see Survey of Vegetation in the Navajo Reservoir Basin, University of Utah Department of Anthropology, Anthropological Papers Number 51, Upper Colorado Series Number 4, June 1961, page 32). Streamside vegetation consisted primarily of large cottonwoods, willows and understory shrubs (page 36). Terrace areas, excluding farmlands, had 72 percent vegetative cover, of which 70 percent of the vegetated area had a cover density of 75 percent or more. Terrace vegetation consisted primarily of large cottonwoods with tree and shrub understories, brush and herbaceous vegetation. Upland hillside areas had 22 percent vegetative cover, almost all of which had a cover density of between 10 and 50 percent. Upland hillside vegetation consisted primarily of sagebrush, juniper and pinyon pine. Therefore, the consumptive use rates for the Navajo Reservoir basin are based on the average of the normal rates shown in table 8 of the 1948 EAC report for the Dulce and the Bloomfield-Shiprock areas of New Mexico for very dense, light and sparse native vegetation, respectively.

[5] The 1948 EAC report computed the consumptive use rate on upland hillside areas, which includes interspersed vegetation and barren areas, based on precipitation during the frost-free period plus 5 percent of winter precipitation not to exceed 3 inches. The Bureau of Reclamation in its Rio Grande Basin reservoir water accounting also limits its estimates of consumptive use on barren areas to a measure of effective precipitation. Reclamation uses as effective precipitation: (1) the average of high and low range values presented in the Bureau of Reclamation Manual Volume IV, 4.1.12B, which gives declining percentages of effective precipitation with each one-inch increment of monthly precipitation, for Heron, Jemez and Cochiti reservoirs; (2) the first 3 inches of monthly precipitation plus one-half of monthly precipitation in excess of 3 inches for El Vado and Abiquiu reservoirs; and (3) the measured precipitation for Elephant Butte Reservoir.

Table 2. Pre-Reservoir Condition Acreages within Reservoir Control Areas

Reservoir	Control Acres	Pre-Reservoir Condition Areas (acres) River	Riparian	Terrace	Upland
Lake Powell [1]	161,390	9,680	13,660	36,410	101,640
Flaming Gorge Reservoir [2]	42,020	2,520	1,980	9,480	28,040
Aspinall Unit [3]	10,300	620	510	2,270	6,900
Navajo Reservoir [4]	15,610	940	1,090	3,900	9,680

[1] It is assumed that the pre-reservoir river channel surface area within the Lake Powell basin amounted to about 6 percent of the total basin area. The pre-reservoir survey of the Lake Powell basin indicates that of the assumed 94 percent of the total basin area that was not river channel water surface, about 9 percent was streamside riparian area, 24 percent was terrace area including farmland, and 67 percent was upland hillside area (see Survey of Vegetation in the Navajo Reservoir Basin, University of Utah Department of Anthropology, Anthropological Papers Number 51, Upper Colorado Series Number 4, June 1961, page 39, and divide vegetative coverage acreage by percentage coverage to determine land area of each classification). Only about 17 percent of the control area within the reservoir basin was surveyed due to the inaccessibility of the area (page 37), and the survey results are extrapolated to the remainder of the control area.

[2] It is assumed that the pre-reservoir river channel surface area within the Flaming Gorge Reservoir basin amounted to about 6 percent of the total basin area. The pre-reservoir survey of the Flaming Gorge Reservoir basin indicates that of the assumed 94 percent of the total basin area that was not river channel water surface, about 5 percent was streamside riparian area, 24 percent was terrace area including farmland, and 71 percent was upland hillside area (see Survey of Vegetation in the Navajo Reservoir Basin, University of Utah Department of Anthropology, Anthropological Papers Number 51, Upper Colorado Series Number 4, June 1961, page 39, and divide vegetative coverage acreage by percentage coverage to determine land area of each classification). About 95 percent of the control area within the reservoir basin was surveyed and mapped (page 37).

[3] It is assumed that under pre-reservoir conditions within the Blue Mesa, Morrow Point and Crystal reservoir basins, the control area was comprised of about 6 percent river channel water surface, 5 percent was streamside riparian area, 22 percent was terrace area including farmland, and 67 percent was upland hillside area.

[4] The pre-reservoir survey of the Navajo Reservoir basin indicates that of the total basin area, about 6 percent was river channel surface area, 7 percent was streamside riparian area, 25 percent was terrace area including farmland, and 62 percent was upland hillside area (see Survey of Vegetation in the Navajo Reservoir Basin, University of Utah Department of Anthropology, Anthropological Papers Number 51, Upper Colorado Series Number 4, June 1961, page 92). Practically all of the control area within the reservoir basin was surveyed and mapped, and portions of the basin above the control area also were surveyed (pages 37 and 39).

Table 3. Average Annual Loss Amounts from Reservoir Control Areas
(Units: acre-feet per year)

Reservoir	Pre-Reservoir Condition Losses	Gross Lake Evaporation if Full	Potential Depletion of Flow at Dam	Long-Term Average Depletion of Flow at Dam [5]
Lake Powell [1]	247,060	847,300	600,240	400,000
Flaming Gorge Reservoir [2]	37,830	112,190	74,360	60,000
Aspinall Unit [3]	8,700	30,080	21,380	15,000
Navajo Reservoir [4]	20,540	55,880	35,340	25,000

[1] The pre-reservoir losses in the Lake Powell basin from the river channel surface area averaged about 58,080 acre-feet based on the data in Tables 1 and 2. Lake Powell when full inundates approximately 190 miles of the Colorado River, including about 125 miles above its confluence with the San Juan River, and 65 miles of the San Juan River (Colorado River Storage Project, Hearings on H.R. 4449, H.R. 4443 and H.R. 4463, January 1954, page 108, River Profile showing Main Stem Developments). The 1948 EAC report estimated the annual river channel losses from channel area evaporation during the 1914-1945 period to average 417 acre-feet per mile from the Colorado River in the reach between the Green River confluence and the San Juan River confluence, 477 acre-feet per mile from the Colorado River in the reach between the San Juan River confluence and Lee Ferry, and 266 acre-feet per mile for the reach of the San Juan River from Bluff to its confluence with the Colorado River (pages 46-48). Based on the 1948 EAC report channel loss rates and assuming uniform distribution of losses within each reach, the reservoir if at full operating level for a year would salvage up to about 100,420 acre-feet of river channel losses on the Colorado and San Juan rivers alone, excluding salvage of losses from vegetation consumptive uses. *The difference may be explained by a turbulence factor of 1.5 v. 1.14 ratio of 8 to 7 pan coeff.*

[2] The pre-reservoir losses in the Flaming Gorge Reservoir basin from the river channel surface area averaged about 7,690 acre-feet based on the data in Tables 1 and 2. Flaming Gorge Reservoir when full inundates approximately 80 miles of the Green River, a portion of which is downstream from Linwood (Colorado River Storage Project, Hearings on H.R. 4449, H.R. 4443 and H.R. 4463, January 1954, page 108, River Profile showing Main Stem Developments). The 1948 EAC report estimated the annual river channel losses from channel area evaporation during the 1914-1945 period to average 317 acre-feet per mile for the reach of the Green River from Green River, Wyoming, to Linwood (page 48). The loss rate for the Green River was estimated at 422 acre-feet per mile for the reach of the Green River between Linwood and Green River, Utah. Based on the 1948 EAC report channel loss rates, the reservoir if at full operating level for a year would salvage more than about 25,360 acre-feet of river channel losses on the Green River alone, excluding salvage of losses from vegetation consumptive uses.

[3] The pre-reservoir losses in the Blue Mesa, Morrow Point and Crystal reservoir basins from the river channel surface area averaged about 2,070 acre-feet based on the data in Tables 1 and 2. Blue Mesa, Morrow Point and Crystal reservoirs when full inundate

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approximately 30-plus miles of the Gunnison River (Colorado River Storage Project, Hearings on H.R. 4449, H.R. 4443 and H.R. 4463, January 1954, page 108, River Profile showing Main Stem Developments). The 1948 EAC report estimated the annual river channel losses from channel area evaporation during the 1914-1945 period to average 122 acre-feet per mile for the reach of the Gunnison River from the Tomichi Creek confluence to its mouth (page 46). Based on the 1948 EAC report channel loss rates, the reservoirs if at full operating level for a year would salvage more than about 3,660 acre-feet of river channel losses on the Gunnison River, excluding salvage of losses from vegetation consumptive uses.

[4] The 1948 EAC report estimated the annual river channel losses during the 1914-1945 period to average 426 acre-feet per mile for the Rosa to Blanco reach of the San Juan River and 371 acre-feet per mile for the Ignacio to mouth reach of the Pine River (page 48). Navajo Reservoir inundates, when full to the spillway crest elevation of 6085 feet, about 35 miles of the San Juan River and about 14 miles of the Pine River. Based on the 1948 EAC report channel loss rates, the reservoir if at full operating level for a year would salvage up to about 20,100 acre-feet of river channel losses on the San Juan and Pine rivers alone, excluding salvage of losses from vegetation consumptive uses. The reservoir when full also inundates about 5 miles of the Piedra River, several miles of Sambrito Creek, and lower portions of several ephemeral tributaries. The pre-reservoir losses in the Navajo Reservoir basin from the river channel surface area averaged about 3,840 acre-feet based on the data in Tables 1 and 2. could be doubled with Miller (usgs and topo data) acres?

[5] The long-term average storage for expected operations is 70% of capacity – assume same proportion of surface area and uniform distribution of areas within control

Table 3. Average Annual Loss Amounts from Reservoir Control Areas

Reservoir	Pre-Reservoir Condition Losses (af)	Gross Lake Evaporation if Full (af)	Potential Depletion of Flow at Dam (af)
Lake Powell [1]	247,060	847,300	600,240
Flaming Gorge Reservoir [2]	37,830	112,190	74,360
Aspinall Unit [3]	8,700	30,080	21,380
Navajo Reservoir [4]	20,540	55,880	35,340

[1] The pre-reservoir losses in the Lake Powell basin from the river channel surface area, including also losses from the river surface and flooded streamside vegetation within the high water mark during the April through July snowmelt runoff period, averaged about 111,080 acre-feet (see Appendix A). The pre-reservoir losses in Table 3 include all riparian streamside vegetation losses and also vegetation consumptive uses from the terrace and upland hillside areas.

[2] The pre-reservoir losses in the Flaming Gorge Reservoir basin from the river channel surface area averaged about 7,690 acre-feet based on the data in Tables 1 and 2. Flaming Gorge Reservoir when full inundates approximately 80 miles of the Green River, a portion of which is downstream from Linwood (Colorado River Storage Project, Hearings on H.R. 4449, H.R. 4443 and H.R. 4463, January 1954, page 108, River Profile showing Main Stem Developments). The 1948 EAC report estimated the annual river channel losses from channel area evaporation during the 1914-1945 period to average 317 acre-feet per mile for the reach of the Green River from Green River, Wyoming, to Linwood (page 48). The loss rate for the Green River was estimated at 422 acre-feet per mile for the reach of the Green River between Linwood and Green River, Utah. Based on the 1948 EAC report channel loss rates, the reservoir if at full operating level for a year would salvage more than about 25,360 acre-feet of river channel losses on the Green River alone, excluding salvage of losses from vegetation consumptive uses.

[3] The pre-reservoir losses in the Blue Mesa, Morrow Point and Crystal reservoir basins from the river channel surface area averaged about 2,070 acre-feet based on the data in Tables 1 and 2. Blue Mesa, Morrow Point and Crystal reservoirs when full inundate approximately 30-plus miles of the Gunnison River (Colorado River Storage Project, Hearings on H.R. 4449, H.R. 4443 and H.R. 4463, January 1954, page 108, River Profile showing Main Stem Developments). The 1948 EAC report estimated the annual river channel losses from channel area evaporation during the 1914-1945 period to average 122 acre-feet per mile for the reach of the Gunnison River from the Tomichi Creek confluence to its mouth (page 46). Based on the 1948 EAC report channel loss rates, the reservoirs if at full operating level for a year would salvage more than about 3,660 acre-feet of river channel losses on the Gunnison River, excluding salvage of losses from vegetation consumptive uses.

[4] The 1948 EAC report estimated the annual river channel losses during the 1914-1945 period to average 426 acre-feet per mile for the Rosa to Blanco reach of the San Juan River and 371 acre-feet per mile for the Ignacio to mouth reach of the Pine River (page

Table 1. Estimated Average Loss Rates within Reservoir Control Areas

	Consumptive Use Rates, including Precip (feet)					Precip
Reservoir	Lake	River	Riparian	Terrace	Upland [5]	(feet)
Lake Powell [1]	4.9-5.3	5.6-6.4	3.88	2.59	0.41	0.50
Flaming Gorge Reservoir [2]	2.67	3.05	2.20	1.30	0.48	0.97
Aspinall Unit [3]	2.92	3.34	1.46	0.98	0.53	0.79
Navajo Reservoir [4]	3.58	4.09	3.00	1.78	0.67	1.05

[1] Gross lake evaporation for Lake Powell based on measured Class A pan evaporation at Lees Ferry for the period 1922-1938, as reported in the 1948 EAC report, Appendix A, at page 5, times a pan coefficient of 0.7 would be about 5.25 feet. However, adjusting the gross lake evaporation rate for elevation of the lake water surface using the elevation-evaporation data and curves in the 1948 EAC report at page 47 gives an evaporation rate of between about 4.9 feet at the maximum water level elevation 3700 feet and 5.3 feet at the dead pool elevation 3370 feet. The precipitation rate is based on the 1916-2004 average measured precipitation rate at Lees Ferry published by the US Weather Bureau.

Lake Powell when full to elevation 3700 feet inundates approximately 195 miles of the Colorado River, including about 124 miles above its confluence with the San Juan River, and about 68 miles of the San Juan River (see Evaporation Study of Upper Colorado River and Tributaries, Colorado Water Conservation Board, 1948, Tables 3a and 3b). For evaporation from river channels within the inundated reaches, the 1948 EAC report adjusted the free water surface evaporation for lakes using a turbulence factor of 1.1 for 157 miles of the Colorado River, 1.2 for 23 miles of the Colorado River and 66 miles of the San Juan River, and larger factors for short reaches of the rivers, resulting in a range of river channel evaporation loss rates of 5.6 to 6.4 feet depending on reach of river. Detailed river channel evaporation rates by inundated reach are shown in Appendix A. Using the pan evaporation data and a pan coefficient of 0.8 would give an average river channel loss rate of about 6.0 feet.

A pre-reservoir survey of the Glen Canyon Reservoir basin indicated that 82 percent of the streamside riparian area had vegetative cover, which included large cottonwood, willow and tamarix (see Survey of Vegetation in the Navajo Reservoir Basin, University of Utah Department of Anthropology, Anthropological Papers Number 51, Upper Colorado Series Number 4, June 1961, page 39). Terrace areas, excluding farmlands, had 51 percent vegetative cover, and upland hillside areas had 18 percent vegetative cover. The consumptive use rates for the Lake Powell basin are based on the normal rates shown in table 8 of the 1948 EAC report for the Moab area of Utah for dense and light native vegetation and for the Green River area of Utah for sparse vegetation, respectively.

[2] Lake evaporation for Flaming Gorge Reservoir is based on the elevation-evaporation curve for the Green River in the 1948 EAC report at page 47. For evaporation from river channels, application of a turbulence factor of 1.3 to the free water surface evaporation for lakes would give a river channel evaporation rate of 3.47 feet, as compared to a rate of 3.05 feet computed using a pan coefficient of 0.8. The

Table 2. Pre-Reservoir Condition Acreages within Reservoir Control Areas

Reservoir	Control Acres	Pre-Reservoir Condition Areas (acres) River	Riparian	Terrace	Upland
Lake Powell [1]	161,390	9,680	13,660	36,410	101,640
Flaming Gorge Reservoir [2]	42,020	2,520	1,980	9,480	28,040
Aspinall Unit [3]	10,300	620	510	2,270	6,900
Navajo Reservoir [4]	15,610	940	1,090	3,900	9,680

[1] It is assumed that the pre-reservoir river channel surface area within the Lake Powell basin amounted to about 12,080 acres, or 7 percent of the total basin area (see Appendix A). The pre-reservoir survey of the Lake Powell basin indicates that of the remaining 93 percent of the total basin area that was not river channel water surface, about 9 percent was streamside riparian area, 24 percent was terrace area including farmland, and 67 percent was upland hillside area (see Survey of Vegetation in the Navajo Reservoir Basin, University of Utah Department of Anthropology, Anthropological Papers Number 51, Upper Colorado Series Number 4, June 1961, page 39, and divide vegetative coverage acreage by percentage coverage to determine land area of each classification). Only about 17 percent of the control area within the reservoir basin was surveyed due to the inaccessibility of the area (page 37), and the survey results are extrapolated to the remainder of the control area.

[2] It is assumed that the pre-reservoir river channel surface area within the Flaming Gorge Reservoir basin amounted to about 6 percent of the total basin area. The pre-reservoir survey of the Flaming Gorge Reservoir basin indicates that of the assumed 94 percent of the total basin area that was not river channel water surface, about 5 percent was streamside riparian area, 24 percent was terrace area including farmland, and 71 percent was upland hillside area (see Survey of Vegetation in the Navajo Reservoir Basin, University of Utah Department of Anthropology, Anthropological Papers Number 51, Upper Colorado Series Number 4, June 1961, page 39, and divide vegetative coverage acreage by percentage coverage to determine land area of each classification). About 95 percent of the control area within the reservoir basin was surveyed and mapped (page 37).

[3] It is assumed that under pre-reservoir conditions within the Blue Mesa, Morrow Point and Crystal reservoir basins, the control area was comprised of about 6 percent river channel water surface, 5 percent was streamside riparian area, 22 percent was terrace area including farmland, and 67 percent was upland hillside area.

[4] The pre-reservoir survey of the Navajo Reservoir basin indicates that of the total basin area, about 6 percent was river channel surface area, 7 percent was streamside riparian area, 25 percent was terrace area including farmland, and 62 percent was upland hillside area (see Survey of Vegetation in the Navajo Reservoir Basin, University of Utah Department of Anthropology, Anthropological Papers Number 51, Upper Colorado Series Number 4, June 1961, page 92). Practically all of the control area within the reservoir basin was surveyed and mapped, and portions of the basin above the control area also were surveyed (pages 37 and 39).

SUPPLEMENT TO OCTOBER 2005
IMPACTS OF DEPLETIONS ON LEE FERRY FLOWS

The process for estimating the man-made depletion of the flow of the Colorado River at Lee Ferry by developments in each of the Upper Basin States requires the following steps (Letter from Royce J. Tipton, Chairman of the Committee on Depletion, to Members of the Committee on Depletion of the Engineering Advisory Committee to the Upper Colorado River Compact Commission, January 26, 1948):

(1) estimation of total rate of depletions by irrigated crops at the point of use with a full water supply;
(2) estimation of incidental depletions due to irrigation;
(3) estimation of the depletion that was being caused by natural processes on the now irrigated lands before man came into the picture;
(4) estimation of the reduction in the depletion at the point of use due to inadequate water supplies;
(5) estimation of the salvage of stream flow losses between the point of depletions and the main river gaging stations (Green River at Green River, Utah; Colorado River at Cisco, Utah; and the San Juan River at Bluff, Utah);
(6) estimation of the salvage of water between the above main stream gaging stations and Lee Ferry; and
(7) estimation of the man-made depletion at Lee Ferry by deducting the sum of items 4, 5 and 6 from the sum of items 1 and 2.

CRSS natural flows at Lee Ferry for the 1953-1977 critical period of record were developed by adding historic irrigation and other depletions to the gaged flows. The historic depletions were not reduced for salvage by use; except, that irrigation consumptive use was reduced for effective precipitation (which apparently was considered consumed by natural vegetation prior to irrigation). Thus, to the extent that man-made depletions salvaged channel losses during the critical period, the gaged and natural flows reflect the actual salvage and reduced losses occurring during that period. Consequently, the yield to the Upper Basin estimated using the CRSS natural flows includes the average annual amount of salvage that occurred historically during the critical period. To compare depletions associated with anticipated water development in the Upper Basin against the yield at Lee Ferry, the total amount of depletion in the States' depletion estimates should be reduced only for the amount of difference between the amount of salvage under full development conditions and the average amount of salvage during the critical period.

Salvage by Reservoir Inundation

A general algebraic expression of flow at a dam site may be represented as:

$$Q = I + P - L$$

where Q = flow at the dam site,
I = inflow to the reservoir basin (the basin area within the maximum operating level of the reservoir referred to as the control area),
P = precipitation volume on the control area, and
L = losses or depletions within the control area.

Losses or depletions within the control area may be expressed as:

$$L = E_{lake} + L_{river} + L_{riparian} + L_{terrace} + L_{upland} + D$$

where E_{lake} = gross evaporation from the lake water surface,
L_{river} = gross evaporation from the river channel water surface,
$L_{riparian}$ = consumptive use by riparian streamside vegetation rooted within the water table,
$L_{terrace}$ = consumptive use by vegetation on floodplain terraces that has access to capillary water,
L_{upland} = consumptive use by upland hillside vegetation that depends on precipitation for water, including areas considered barren, and
D = man-made depletions (for example, irrigation).

The net depletion of stream flow at the dam site resulting from filling and operating the reservoir can be determined as the difference between the total losses and depletions within the control area (L) under pre-reservoir and post-reservoir conditions. The difference thus incorporates salvage of pre-reservoir losses. The Bureau of Reclamation employs this general procedure for determining the impacts of post-1929 reservoirs on stream flows in the Rio Chama and Rio Grande in New Mexico, and Reclamation's results are used for San Juan-Chama Project water accounting and Rio Grande Compact administration (see Bureau of Reclamation San Juan-Chama Accounting Computer Program Enhancement, undated; Upper Rio Grande Water Operations Model Physical Accounting, Abiquiu Reservoir Accounting Example, June 2002 draft; Albuquerque Area Office Annual Water Accounting Reports). However, whereas Reclamation for Rio Grande reservoirs classifies reservoir basin areas in terms of lake area, river channel area, irrigated area, meadow area and barren area, pre-reservoir vegetation surveys for Colorado River Storage Project reservoir basins conducted by the University of Utah in the late 1950s and early 1960s suggest using the area classifications indicated by the above definitions for Colorado River Basin reservoirs. Also, for purposes of accounting man-made depletions of the natural stream flow at the dam site, pre-reservoir depletions (D) that are removed from the stream system in anticipation of inundation due to filling of the reservoir should not be included in the analysis or otherwise considered as salvaged losses. Areas classified in the pre-reservoir vegetation surveys as current or recently abandoned irrigated farmland on floodplain terraces should be lumped with the terrace areas to determine natural losses.

The acreages of lake water surface, river channel, riparian vegetation, terrace and upland hillside areas within the reservoir control area vary over time with reservoir storage. The lake evaporation rate may be computed as pan evaporation times a pan coefficient of 0.7 for large reservoirs, with reductions in proportions to percentage ice cover during winter months. The river channel evaporation rate may be computed as either: (1) the lake evaporation rate, which is the assumption used by the Bureau of Reclamation in the Rio Grande Basin water accounting; (2) pan evaporation times a pan coefficient of 0.8 for shallow water bodies, which coefficient value accounts for greater heating of shallow water as compared to lakes; or (3) the lake evaporation rate times a turbulence factor that reflects the increased exposure of surface area to the atmosphere caused by turbulence, which is the approach used by the 1948 EAC report. Consumptive use rates for the vegetative areas that include use of precipitation can be estimated from the 1948 Engineering Advisory Committee report to the Upper Colorado River Basin Compact Commission (see Appendix B, Consumptive Use of Water Rates in the Upper Colorado River Basin, Harry Blaney and Wayne Criddle, pages 25-28, table 2 at page 10 and figure 1 following page 2). Estimated average loss rates for the various areas within the control area are provided in Table 1.

Table 1

	Consumptive Use Rates, including Precip (feet)					Precip
Reservoir	Lake	River	Riparian	Terrace	Upland [5]	(feet)
Lake Powell [1]	5.25	6.00	3.88	2.59	0.41	0.50
Flaming Gorge Reservoir [2]	2.67	3.05	2.20	1.30	0.48	0.97
Aspinall Unit [3]	2.92	3.34	1.46	0.98	0.53	0.79
Navajo Reservoir [4]	3.58	4.09	3.00	1.78	0.67	1.05

[1] Lake evaporation for Lake Powell is based on measured Class A pan evaporation at Lees Ferry for the period 1922-1938, as reported in the 1948 EAC report, Appendix A, at page 5, times a pan coefficient of 0.7 (see also the elevation-evaporation data and curves in the 1948 EAC report at page 47). For evaporation from river channels, application of a turbulence factor of 1.3 to the free water surface evaporation for lakes would give a river channel evaporation rate of 6.82 feet, as compared to a rate of 6.00 feet computed using a pan coefficient of 0.8. The precipitation rate is based on the 1916-2004 average measured precipitation rate at Lees Ferry published by the US Weather Bureau.

A pre-reservoir survey of the Glen Canyon Reservoir basin indicated that 82 percent of the streamside riparian area had vegetative cover, which included large cottonwood, willow and tamarix (see Survey of Vegetation in the Navajo Reservoir Basin, University of Utah Department of Anthropology, Anthropological Papers Number 51, Upper Colorado Series Number 4, June 1961, page 39). Terrace areas, excluding farmlands, had 51 percent vegetative cover, and upland hillside areas had 18 percent vegetative cover. The consumptive use rates for the Lake Powell basin are based on the normal rates shown in table 8 of the 1948 EAC report for the Moab area of Utah for dense and light native vegetation and for the Green River area of Utah for sparse vegetation, respectively.

[2] Lake evaporation for Flaming Gorge Reservoir is based on the elevation-evaporation curve for the Green River in the 1948 EAC report at page 47. For

evaporation from river channels, application of a turbulence factor of 1.3 to the free water surface evaporation for lakes would give a river channel evaporation rate of 3.47 feet, as compared to a rate of 3.05 feet computed using a pan coefficient of 0.8. The precipitation rate is based on the 1957-2004 average measured precipitation rate at Flaming Gorge, Utah, published by the US Weather Bureau.

A pre-reservoir survey of the Flaming Gorge Reservoir basin indicated that 86 percent of the streamside riparian area had vegetative cover, which included cottonwood (see Survey of Vegetation in the Navajo Reservoir Basin, University of Utah Department of Anthropology, Anthropological Papers Number 51, Upper Colorado Series Number 4, June 1961, page 39). Terrace areas, excluding farmlands, had 51 percent vegetative cover, and upland hillside areas had 21 percent vegetative cover. The consumptive use rates for the Flaming Gorge Reservoir basin are based on the normal rates shown in table 8 of the 1948 EAC report for the Henry's Fork area of Wyoming for very dense, light and sparse native vegetation, respectively.

[3] Lake evaporation for the Blue Mesa, Crystal and Morrow Point reservoirs is based on the elevation-evaporation curve for the Colorado River in the 1948 EAC report at page 47, and has not been reduced for ice cover during the winter months. For evaporation from river channels, application of a turbulence factor of 1.3 to the free water surface evaporation for lakes would give a river channel evaporation rate of 3.80 feet, as compared to a rate of 3.34 feet computed using a pan coefficient of 0.8. The precipitation rate is based on the 1967-2004 average measured precipitation rate at Blue Mesa Lake published by the US Weather Bureau.

The consumptive use rates for the Blue Mesa, Crystal and Morrow Point reservoir basins are based on the normal rates shown in table 8 of the 1948 EAC report for the Upper Gunnison area of Colorado for dense, light and sparse native vegetation, respectively.

[4] Lake evaporation for Navajo Reservoir is based on the mean pan evaporation at El Vado Dam for the period 1931-1960 as determined by Class A pan evaporation measurements and reported in New Mexico State Engineer Technical Report 31 at page 18 (figure 5), times a pan coefficient of 0.7. The resultant lake evaporation rate of 3.58 feet is somewhat greater than a lake evaporation rate of 3.17 feet obtained from the elevation-evaporation curve for the San Juan River in the 1948 EAC report at page 47, but somewhat less than a lake evaporation rate of about 4.05 feet estimated using a combination of available Navajo Dam and Farmington pan evaporation data for the period 1981-1994. US Weather Bureau pan evaporation data for Arboles, Colorado, for the period 1958-1964 is consistent with the El Vado Dam mean pan evaporation rate. For evaporation from river channels, the 1948 EAC report adjusted the free water surface evaporation for lakes to allow for the effect of turbulence on evaporation rates (page 46). A turbulence factor of 1.3 was used for stream segments in the San Juan River Basin above Bluff, Utah (see Memorandum from the Hydrology Division, Bureau of Reclamation, to the EAC dated November 12, 1947). Application of a turbulence factor of 1.3 to a lake evaporation rate of 3.17 feet would give a river channel evaporation rate of 4.12 feet, as compared to a rate of 4.09 feet computed using the mean El Vado Dam pan

evaporation and a pan coefficient of 0.8. The 1948 EAC report found that channel loss computed using the pan evaporation method was conservatively low as compared to channel loss computed using a mass balance approach for the Rosa to Bluff reach of the San Juan River (pages 50-52). The precipitation rate is based on the 1963-2004 average measured precipitation rate at Navajo Dam published by the US Weather Bureau.

The pre-reservoir survey of the Navajo Reservoir basin indicates 80 percent of the streamside riparian area had vegetative cover, of which 86 percent of the vegetated area had a cover density of 75 percent or more (see Survey of Vegetation in the Navajo Reservoir Basin, University of Utah Department of Anthropology, Anthropological Papers Number 51, Upper Colorado Series Number 4, June 1961, page 32). Streamside vegetation consisted primarily of large cottonwoods, willows and understory shrubs (page 36). Terrace areas, excluding farmlands, had 72 percent vegetative cover, of which 70 percent of the vegetated area had a cover density of 75 percent or more. Terrace vegetation consisted primarily of large cottonwoods with tree and shrub understories, brush and herbaceous vegetation. Upland hillside areas had 22 percent vegetative cover, almost all of which had a cover density of between 10 and 50 percent. Upland hillside vegetation consisted primarily of sagebrush, juniper and pinyon pine. Therefore, the consumptive use rates for the Navajo Reservoir basin are based on the average of the normal rates shown in table 8 of the 1948 EAC report for the Dulce and the Bloomfield-Shiprock areas of New Mexico for very dense, light and sparse native vegetation, respectively.

[5] The 1948 EAC report computed the consumptive use rate on upland hillside areas, which includes interspersed vegetation and barren areas, based on precipitation during the frost-free period plus 5 percent of winter precipitation not to exceed 3 inches. The Bureau of Reclamation in its Rio Grande Basin reservoir water accounting also limits its estimates of consumptive use on barren areas to a measure of effective precipitation. Reclamation uses as effective precipitation: (1) the average of high and low range values presented in the Bureau of Reclamation Manual Volume IV, 4.1.12B, which gives declining percentages of effective precipitation with each one-inch increment of monthly precipitation, for Heron, Jemez and Cochiti reservoirs; (2) the first 3 inches of monthly precipitation plus one-half of monthly precipitation in excess of 3 inches for El Vado and Abiquiu reservoirs; and (3) the measured precipitation for Elephant Butte Reservoir.

To determine the actual net depletion of stream flow by man as a result of reservoir inundation, taking into account salvage of pre-reservoir losses, the evaporation losses and vegetation consumptive uses within the control area of the reservoir should be determined monthly for pre-reservoir and current conditions based on reservoir storage and meteorological data when available. For the purpose of evaluating the possible magnitude of salvaged losses by Colorado River Storage Project reservoirs, an analysis is made using the average annual evaporation and consumptive use rates presented ~~above~~ in Table 1 and the ~~following~~ pre-reservoir condition river surface acreage, streamside riparian acreage, terrace acreage (including farmlands), and upland hillside and barren acreage within the reservoir control areas shown in Table 2. The size of the reservoir control areas reflects the reservoir surface area at live capacity (for example, spillway crest) as obtained from Glen Canyon Environmental Studies, Final Report, US Department of the Interior, January 1988, page D-11, Table D-1.

Table 2

Reservoir	Control Acres	Pre-Reservoir Condition Areas (acres) River	Riparian	Terrace	Upland
Lake Powell[1]	161,390	9,680	13,660	36,410	101,640
Flaming Gorge Reservoir[2]	42,020	2,520	1,980	9,480	28,040
Aspinall Unit[3]	10,300	620	510	2,270	6,900
Navajo Reservoir[4]	15,610	940	1,090	3,900	9,680

1/ It is assumed that the pre-reservoir river channel surface area within the Lake Powell basin amounted to about 6 percent of the total basin area. The pre-reservoir survey of the Lake Powell basin indicates that of the assumed 94 percent of the total basin area that was not river channel water surface, about 9 percent was streamside riparian area, 24 percent was terrace area including farmland, and 67 percent was upland hillside area (see Survey of Vegetation in the Navajo Reservoir Basin, University of Utah Department of Anthropology, Anthropological Papers Number 51, Upper Colorado Series Number 4, June 1961, page 39, and divide vegetative coverage acreage by percentage coverage to determine land area of each classification). Only about 17 percent of the control area within the reservoir basin was surveyed due to the inaccessibility of the area (page 37), and the survey results are extrapolated to the remainder of the control area.

2/ It is assumed that the pre-reservoir river channel surface area within the Flaming Gorge Reservoir basin amounted to about 6 percent of the total basin area. The pre-reservoir survey of the Flaming Gorge Reservoir basin indicates that of the assumed 94 percent of the total basin area that was not river channel water surface, about 5 percent was streamside riparian area, 24 percent was terrace area including farmland, and 71 percent was upland hillside area (see Survey of Vegetation in the Navajo Reservoir Basin, University of Utah Department of Anthropology, Anthropological Papers Number 51, Upper Colorado Series Number 4, June 1961, page 39, and divide vegetative coverage acreage by percentage coverage to determine land area of each classification). About 95 percent of the control area within the reservoir basin was surveyed and mapped (page 37).

3/ It is assumed that under pre-reservoir conditions within the Blue Mesa, Morrow Point and Crystal reservoir basins, the control area was comprised of about 6 percent river channel water surface, 5 percent was streamside riparian area, 22 percent was terrace area including farmland, and 67 percent was upland hillside area.

4/ The pre-reservoir survey of the Navajo Reservoir basin indicates that of the total basin area, about 6 percent was river channel surface area, 7 percent was streamside riparian area, 25 percent was terrace area including farmland, and 62 percent was upland hillside area (see Survey of Vegetation in the Navajo Reservoir Basin, University of Utah Department of Anthropology, Anthropological Papers Number 51, Upper Colorado Series Number 4, June 1961, page 92). Practically all of the control area within the reservoir basin was surveyed and mapped, and portions of the basin above the control area also were surveyed (pages 37 and 39).

The 1948 EAC report ~~to the UCRBCC~~ estimated the annual river channel losses during the 1914-1945 period to average ~~15,800 acre-feet, or~~ 426 acre-feet per mile for the Rosa to Blanco reach of the San Juan River and ~~to average 10,000 acre-feet, or~~ 371 acre-feet per mile for the Ignacio to mouth reach of the Pine River (page 48). Navajo Reservoir inundates, when full to ~~a target elevation of 6082 feet~~ (spillway crest elevation ~~is~~ 6085 feet), about ~~34.5~~ miles of the San Juan River and about ~~13.9~~ miles of the Pine River. Based on the 1948 EAC report channel loss rates, the reservoir if at full operating level for a year would salvage up to about ~~19,850~~ acre-feet of river channel losses on the San Juan and Pine rivers alone. The reservoir also inundates about ~~4.8~~ miles of the Piedra River, several miles of Sambrito Creek, lower portions of several ephemeral tributaries ~~and approximately 15,000 acres of upland vegetation when full.~~

Lake Powell when full inundates approximately 190 miles of the Colorado River, including about 125 miles above its confluence with the San Juan River, and 65 miles of the San Juan River (Colorado River Storage Project, Hearings on H.R. 4449, H.R. 4443 and H.R. 4463, January 1954, page 108, River Profile showing Main Stem Developments). The 1948 EAC report ~~to the UCRBCC~~ estimated the annual river channel losses during the 1914-1945 period to average ~~57,700 acre-feet, or~~ 417 acre-feet per mile from the Colorado River in the reach between the Green River confluence and the San Juan River confluence, ~~and to average 37,200 acre-feet, or~~ 477 acre-feet per mile from the Colorado River in the reach between the San Juan River confluence and Lee Ferry, and ~~to average 30,600 acre-feet, or~~ 266 acre-feet per mile for the reach of the San Juan River from Bluff to its confluence with the Colorado River (pages 46-48). Based on the 1948 EAC report channel loss rates, the reservoir if at full operating level for a year would salvage up to about 100,420 acre-feet of river channel losses on the Colorado and San Juan rivers alone. Salvage of losses from upland ~~vegetation is not included.~~

Flaming Gorge when full inundates approximately 80 miles of the Green River, a portion of which is downstream from Linwood (Colorado River Storage Project, Hearings on H.R. 4449, H.R. 4443 and H.R. 4463, January 1954, page 108, River Profile showing Main Stem Developments). The 1948 EAC report ~~to the UCRBCC~~ estimated the annual river channel losses during the 1914-1945 period to average ~~21,500 acre-feet, or~~ 317 acre-feet per mile for the reach of the Green River from Green River, Wyoming, to Linwood (page 48). The loss rate for the Green River was estimated at 422 acre-feet per mile for the reach of the Green River between Linwood and Green River, Utah. Based on the 1948 EAC report channel loss rates, the reservoir if at full operating level for a year would salvage more than about 25,~~680~~ acre-feet of river channel losses on the Green River alone. Salvage of losses from upland ~~vegetation is not included.~~

Blue Mesa and Crystal when full inundate approximately 30 miles of the Gunnison River (Colorado River Storage Project, Hearings on H.R. 4449, H.R. 4443 and H.R. 4463, January 1954, page 108, River Profile showing Main Stem Developments). The 1948

EAC report to the UCRBCC estimated the annual river channel losses during the 1914-1945 period to average 18,100 acre-feet, or 122 acre-feet per mile for the reach of the Gunnison River from the Tomichi Creek confluence to its mouth (page 46). Based on the 1948 EAC report channel loss rates, the reservoirs if at full operating level for a year would salvage more than about 3,660 acre-feet of river channel losses on the Gunnison River. Salvage of losses from upland vegetation is not included.

APPENDIX A

On-Site Depletions
for
Upper Colorado River Basin

Table A-1. On-Site Depletions in the Upper Colorado River Basin by State and Subregion during the Critical Period

State	Subregion	Year	Reservoir Evaporation	Irrigation	Stockpond Evaporation & Livestock	Mineral Resources	Thermal Electric Power	Municipal & Industrial Other	Fish & Wildlife, Recreation	Export Outside System	Export Within System	Total
Arizona	San Juan-Colorado	1914-45	0	3790	0	0	0	200	0	0		3990
		1965	2000	4900	1100	0	0	1500	600	0		10100
		1965 adj.										10498
		1971	3000	2500	1100	0	0	2900	1600	0		11100
		1972	2900	2900	1100	0	0	3600	1700	0		12200
		1973	2400	4000	900	0	0	3200	900	0		11400
		1974	3000	4300	1200	0	5300	3700	1700	0		19200
		1975	2500	5100	900	0	12400	2900	1400	0		25200
		1976	3900	2700	1000	0	19900	2900	0	0		30400
		1977	4200	3800	1100	0	21800	3100	0	0		34000
		1953-77										13405
Colorado	Green River	1914-45	0	98113	0	0	0	1010	0	0	0	99123
		1965 adj.										140196
		1971	2100	130000	6100	4600	4900	1900	3700	0	0	153300
		1972	1600	108800	5100	4600	4900	2000	2800	0	0	129800
		1973	1500	95200	4900	4700	4900	2100	2600	0	0	115900
		1974	1700	112600	5600	4700	2900	2200	3100	0	0	132800
		1975	1600	100200	5200	4700	3200	2200	2800	0	0	119900
		1976	5100	101200	3100	4800	4900	1500	0	0	0	120600
		1977	6700	89300	3300	4800	7100	1600	0	0	0	112800
		1953-77										135359
	Upper Main Stem	1914-45	0	729237	0	0	0	53828	0	0	100000	883065
		1953-70								379300		
		1965 adj.										1572731
		1971	20300	889700	11100	11200	300	13300	2700	412800	142600	1504000
		1972	18100	891100	12000	11300	300	13600	2500	488800	128400	1566100
		1973	19000	732300	12500	11400	800	13900	2700	439100	106600	1338300
		1974	20200	946900	12900	11600	800	14200	2800	500800	119900	1630100
		1975	16500	826100	10700	11700	800	14500	2300	559800	120300	1562700
		1976	31500	839900	6900	11800	800	9800	0	491800	135500	1528000
		1977	39900	769700	7000	11900	800	10200	0	523100	61900	1424500
		1953-77										1531991
	San Juan-Colorado	1914-45	0	172690	0	0	0	7875	0	0	-100000	80565
		1953-70								5050		
		1965 adj.										98248
		1971	7900	164300	5300	2100	0	3000	900	2200	-142600	43100
		1972	7500	187000	5600	2200	0	3100	900	1700	-128400	79600
		1973	5600	169100	3700	2200	0	3300	700	4000	-106600	82000
		1974	7600	191800	4900	2200	0	3400	900	1200	-119900	92100
		1975	5700	196300	3800	2200	0	3600	700	2800	-120300	94800
		1976	4900	149200	3800	2300	0	2500	0	3000	-135500	30200
		1977	4800	118600	3800	2300	0	2500	0	300	-61900	70400
		1953-77										85314
	Total	1914-45	0	1000040	0	0	0	62713	0	0		1062753
		1953-70								384350		
		1965	27100	1190000	20700	16900	3200	15900	3400	429400		1706600
		1965 adj.										1811174
		1971	30300	1184000	22500	17900	5200	18200	7300	415000		1700400
		1972	27200	1186900	22700	18100	5200	18700	6200	490500		1775500
		1973	26100	996600	21100	18300	5700	19300	6000	443100		1536200
		1974	29500	1251300	23400	18500	3700	19800	6800	502000		1855000
		1975	23800	1122600	19700	18600	4000	20300	5800	562600		1777400
		1976	41500	1090300	13800	18900	5700	13800	0	494800		1678800
		1977	51400	977600	14100	19000	7900	14300	0	523400		1607700
		1953-77										1752664
New Mexico	San Juan-Colorado	1914-45	0	71167	0	0	0	1000	0	0		72167
		1965	31700	91000	2400	1600	15300	2400	500	0		144900
		1965 adj.										139569
		1971	18900	80900	2800	2400	15700	3900	600	54400		179600
		1972	18000	93300	2900	2600	20800	4100	700	41100		183500
		1973	26800	87800	2300	2700	20300	4300	500	174900		319600
		1974	20000	96500	3000	2900	24600	4500	700	47700		199900
		1975	23600	89000	2400	3000	21900	4800	500	145200		290400
		1976	21100	141400	1200	3100	22900	5100	0	84400		279200
		1977	20000	131900	1100	3300	27600	5300	0	19400		208600
		1953-77										159452

Table A-1. On-Site Depletions in the Upper Colorado River Basin by State and Subregion during the Critical Period (continued)

State	Subregion	Year	Reservoir Evaporation	Irrigation	Stockpond Evaporation & Livestock	Mineral Resources	Thermal Electric Power	Municipal & Industrial Other	Fish & Wildlife, Recreation	Export Outside System	Export Within System	Total
Utah	Green River	1914-45	0	406676	0	0	0	95500	0	0	0	502176
		1953-70								104740		
												616449
		1971	25500	500400	4200	7200	1900	4200	6900	111800	0	662100
		1972	25600	504000	4300	7300	1700	4300	7100	130600	0	684900
		1973	24100	502100	3600	7300	1900	4300	6200	106800	0	656300
		1974	31800	524500	4800	7400	1800	4300	9200	127000	0	710800
		1975	24000	393800	4500	7400	7000	4400	6600	107200	0	554900
		1976	32500	416500	3300	7400	5100	3800	0	113600	0	582200
		1977	35100	228000	3300	7500	7300	4000	0	80200	0	365400
		1953-77										619498
	Upper Main Stem	1914-45	0	9971	0	0	0	0	0	0	0	9971
												12181
		1971	100	9600	500	1400	0	800	0	0	0	12400
		1972	100	8900	400	1400	0	800	0	0	0	11600
		1973	100	9100	400	1400	0	900	0	0	0	11900
		1974	100	9900	500	1400	0	900	0	0	0	12800
		1975	100	8700	400	1400	0	900	0	0	0	11500
		1976	300	10400	100	1400	0	600	0	0	0	12800
		1977	400	4000	100	1500	0	600	0	0	0	6600
		1953-77										11940
	San Juan-Colorado	1914-45	0	48397	0	0	0	0	0	-4000	0	44397
		1953-70								-2300		
												57297
		1971	14700	39200	1900	1200	0	1300	900	-4200	0	55000
		1972	15600	34400	2000	1100	0	1400	1000	-3400	0	52100
		1973	14400	48200	1600	1200	0	1500	900	-6000	0	61800
		1974	18800	41000	2000	1100	0	1600	1100	-4100	0	61500
		1975	12600	36900	1700	1200	0	1600	800	-6100	0	48700
		1976	5100	38200	2600	1200	0	900	0	-5000	0	43000
		1977	5300	15900	2400	1200	0	900	0	-1000	0	24700
		1953-77										55134
	Total	1914-45	0	465044	0	0	0	95500	0	-4000		556544
		1953-70								102440		
		1965	30200	485400	6200	9400	1300	5000	8200	118300		664000
		1965 adj.										685927
		1971	40300	549200	6600	9800	1900	6300	7800	107600		729500
		1972	41300	547300	6700	9800	1700	6500	8100	127200		748600
		1973	38600	559400	5600	9900	1900	6700	7100	100800		730000
		1974	50700	575400	7300	9900	1800	6800	10300	122900		785100
		1975	36700	439400	6600	10000	7000	6900	7400	101100		615100
		1976	37900	465100	6000	10000	5100	5300	0	108600		638000
		1977	40800	247900	5800	10200	7300	5500	0	79200		396700
		1953-77										686572
Wyoming	Green River	1914-45	0	224370	0	0	0	3300	0	0		227670
		1965	23900	241600	4500	5800	3400	2600	300	0		282100
		1965 adj.										298687
		1971	27200	275200	5000	11100	5700	3300	200	6000		333700
		1972	31700	238200	4900	12000	4500	3400	200	8700		303600
		1973	30800	235300	4700	12800	7600	3500	200	8700		303600
		1974	33400	288500	5200	13700	10100	3700	200	8700		363500
		1975	28100	207100	4900	14600	12900	3800	200	6600		278200
		1976	26100	204000	3900	15500	20400	3100	0	9200		282200
		1977	27700	133100	4200	16400	28800	3400	0	5300		218900
		1953-77										300186

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Table A-1. On-Site Depletions in the Upper Colorado River Basin by State and Subregion during the Critical Period (continued)

State	Subregion	Year	Reservoir Evaporation	Irrigation	Stockpond Evaporation & Livestock	Mineral Resources	Thermal Electric Power	Municipal & Industrial Other	Fish & Wildlife, Recreation	Export Outside System	Export Within System	Total
Upper Basin	Green River	1914-45	0	729159	0	0	0	99810	0	0	0	828969
		1953-65								106250		932150
		1953-70								104740		
		1965	42400	776000	13300	17200	6300	7900	8500	120900	0	992500
		1965 adj.										1030090
		1971	54800	905600	15300	22900	12500	9400	10800	117800	0	1149100
		1972	58900	851000	14300	23900	11100	9700	10100	139300	0	1118300
		1973	56400	832600	13200	24800	14400	9900	9000	115500	0	1075800
		1974	66900	925600	15600	25800	14800	10200	12500	135700	0	1207100
		1975	53700	701100	14600	26700	23100	10400	9600	113800	0	953000
		1976	63700	721700	10300	27700	30400	8400	0	122800	0	985000
		1977	69500	450400	10800	28700	43200	9000	0	85500	0	697100
		1953-77										1029981
	Upper Main Stem	1914-45	0	739208	0	0	0	53828	0	0	100000	893036
		1953-65								370080		1280580
		1953-70								379300		
		1965	16900	914700	11200	11900	1600	12300	1800	426900	100000	1497300
		1965 adj.										1597050
		1971	20400	899300	11600	12600	300	14100	2700	412800	142600	1516400
		1972	18200	900000	12400	12700	300	14400	2500	488800	128400	1577700
		1973	19100	741400	12900	12800	800	14800	2700	439100	106600	1350200
		1974	20300	956800	13400	13000	800	15100	2800	500800	119900	1642900
		1975	16600	834800	11100	13100	800	15400	2300	559800	120300	1574200
		1976	31800	850300	7000	13200	800	10400	0	491800	135500	1540800
		1977	40300	773700	7100	13400	800	10800	0	523100	61900	1431100
		1953-77										1454711
	San Juan-Colorado	1914-45	0	296044	0	0	0	9075	0	-4000	-100000	201119
		1953-65								1080		363880
		1953-70								2750		
		1965	55600	322200	10400	4600	15300	7200	2700	-100	-100000	317900
		1965 adj.										318710
		1971	44500	286900	11100	5700	15700	11100	4000	52400	-142600	288800
		1972	44000	317600	11600	5900	20800	12200	4300	39400	-128400	327400
		1973	49200	309100	8500	6100	20300	12300	3000	172900	-106600	474800
		1974	49400	333600	11100	6200	29900	13200	4400	44800	-119900	372700
		1975	44400	327300	8800	6400	34300	12900	3400	141900	-120300	459100
		1976	35000	331500	8600	6600	42800	11400	0	82400	-135500	382800
		1977	34300	270200	8400	6800	49400	11800	0	18700	-61900	337700
		1953-77										384725
	Total	1914-45	0	1764411	0	0	0	162713	0	-4000		1923124
		1953-65								477410		2576610
		1953-70								486790		
		1965	114900	2012900	34900	33700	23200	27400	13000	547700		2807700
		1965 adj.										2945850
		1971	119700	2091800	38000	41200	28500	34600	17500	583000		2954300
		1972	121100	2068600	38300	42500	32200	36300	16900	667500		3023400
		1973	124700	1883100	34600	43700	35500	37000	14700	727500		2900800
		1974	136600	2216000	40100	45000	45500	38500	19700	681300		3222700
		1975	114700	1863200	34500	46200	58200	38700	15300	815500		2986300
		1976	130500	1903500	25900	47500	74000	30200	0	697000		2908600
		1977	144100	1494300	26300	48900	93400	31600	0	627300		2465900
		1953-77										2869416

Notes:

(1) Upper Basin reservoir evaporation amounts shown in this table do not include evaporation from Lake Powell, Flaming Gorge Reservoir or the Apsinall Unit reservoirs.

(2) Other municipal and industrial uses include urban, rural and other industrial uses. Municipal and industrial uses and export uses may include evaporation from related reservoirs, as is explicitly the case for Colorado and Utah exports outside system for 1965.

(3) Average depletions for 1914-1945 are from the 1948 Engineering Advisory Committee report. Irrigation depletions for about 1946 are from Estimate of Unit Rates of Depletion for Irrigation, Upper Colorado River Basin, undated (see files of the NMISC), and include evaporation from small irrigation reservoirs. Average exports for 1953-1970 are based on the data shown in Table A-2. Average nominal depletions under 1965 development conditions are from the 1971 Comprehensive Framework Study. Annual depletions for 1971-1977 are from the Bureau of Reclamation's Colorado River System Consumptive Uses and Losses reports for 1971-1975 and 1976-1980. Crop consumptive uses were computed using the original Blaney-Criddle method until 1970, after which crop consumptive uses were computed using the modified Blaney-Criddle method. Data for scattered livestock uses and small lakes and ponds in ephemeral tributary areas apparently were not incorporated into the average depletions for the period 1914-1945.

(4) Fish and wildlife and recreation uses are included in reservoir evaporation amounts beginning 1976.

Table A-1. On-Site Depletions in the Upper Colorado River Basin by State and Subregion during the Critical Period (continued)

Notes (continued):

(5) The nominal average annual crop consumptive use in Arizona under 1965 development conditions was 4,400 af per year based on the CFS, excluding incidental irrigation depletions. It is assumed that the consumptive use would have been estimated at about 13 percent, or 570 af, greater using the modified Blaney-Criddle method.

(6) For the period 1914-1945, average depletions of 63,153 af per year for McElmo Creek above and below Cortez, CO, were supplied by diversions of about 100,000 af per year from the Dolores River above Dolores, CO (see the 1948 Engineering Advisory Committee report, pages 22 and 43-44).

(7) Average municipal depletions in Colorado for the period 1914-1945 for the Upper Main Stem and San Juan-Colorado basins include about 42,810 af and 520 af of exports, respectively (see Table A-2). The nominal average annual crop consumptive use in Colorado under 1965 development conditions was 991,300 af per year based on the CFS, excluding incidental irrigation depletions. It is assumed that the consumptive use would have been estimated at about 13 percent, or 128,870 af, greater using the modified Blaney-Criddle method. Total average depletions in Colorado were distributed to each subregion based on the historic percentage distribution between subregions for the period 1971-1977 (7.4 percent Green River, 88.5 percent Upper Main Stem, and 4.1 percent San Juan-Colorado) and the subregion totals shown in Table A-2.

(8) Irrigation uses in New Mexico under the Hammond Irrigation Project began in 1962, and an average of about 2000 acres were irrigated from 1964-1973 (see Irrigated Acreage in the San Juan Basin in New Mexico, NMISC memorandum to file dated June 11, 1997). Thus, irrigation depletions for 1964-1970 averaged about 5,000 af per year more than the pre-1962 irrigation depletions. Irrigation on the Navajo Indian Irrigation Project began in 1976. Uses at the Four Corners Power Plant began in December 1961 and at the San Juan Generating Station begin in April 1973. New Mexico estimates that the power depletions averaged about 17,000 af per year for the period 1961-1970 and 24,200 af per year for the period 1961-1977 (see Historic Depletions from the San Juan River in New Mexico for Power Generation, NMISC memorandum to file dated August 8, 2003). Navajo Reservoir began storage in December 1962, and Navajo reservoir evaporation for 1965 is not reduced for salvage within the reservoir basin. Beginning 1971, Navajo Reservoir evaporation is net after salvage. Evaporation from other reservoirs in New Mexico amounts to about 1,200 af per year. The nominal average annual crop consumptive use in New Mexico under 1965 development conditions was 76,000 af per year based on the CFS, excluding incidental irrigation depletions. New Mexico has computed that the consumptive use would have been estimated at about 13 percent, or 9,880 af, greater using the modified Blaney-Criddle method. Based on the water development history in New Mexico, the average total depletions in New Mexico adjusted for application of the modified Blaney-Criddle method was about 158,000 af per year for 1953-1977 (see Table B-2, note 2). This compares to 159,000 af obtained from the distribution of depletions set forth in note 11 below.

(9) Average municipal and industrial depletions for the Green River Basin in Utah for the period 1914-1945 include about 66,670 af of exports (see Table A-2). The nominal average annual crop consumptive use in Utah under 1965 development conditions was 404,400 af per year based on the CFS, excluding incidental irrigation depletions. It is assumed that the consumptive use would have been estimated at about 13 percent, or 52,570 af, greater using the modified Blaney-Criddle method. Total average depletions in Utah were distributed to each subregion based on the historic percentage distribution between subregions for the period 1971-1977 (90.8 percent Green River, 1.7 percent Upper Main Stem, and 7.5 percent San Juan-Colorado) and the subregion totals shown in Table A-2.

(10) The nominal average annual crop consumptive use in Wyoming under 1965 development conditions was 221,200 af per year based on the CFS, excluding incidental irrigation depletions. It is assumed that the consumptive use would have been estimated at about 13 percent, or 28,760 af, greater using the modified Blaney-Criddle method.

(11) The depletions shown in this table by subregion for 1965 are nominal average depletions from the CFS, Main Report, Part III, Table 2. Depletion amounts for 1965 for recent Reclamation projects, non-CRSP reservoir evaporation, and other depletions (except exports) that the CFS used to compute natural flows are shown in Table A-2. The following shows a comparison of total nominal depletions to 1965 depletion amounts for the subregions (excluding export diversions and CRSP reservoir evaporation, but including Upper Basin reservoir evaporation associated with export projects) and adjustments to 1965 depletions to reflect water uses attained as of 1965. Average Navajo Reservoir evaporation is from Historic Storage and Evaporation at CRSP Reservoirs from the November 22, 2005, preliminary draft yield study prepared by NMISC and USBR. Distribution of subregion depletions between states is based on average distributions between states for the 1971-1977 period of depletions less export diversions outside system.

					Adjustments - 1965 Attained Uses			1965
					1966-70	1966-70	Modified	Adjusted
	Nominal	1965		1965	Export	Navajo	B-C	Nominal
	Depletion	Depletion	Difference	Depletion	Diversions	Res. Evap	Application	Depletions
Subregion	(af)	(af)	(af)	(af)	(af)	(af)	(af)	(af)
Green River	883000	844000	39000	844000	99990	0	86100	1030090
Upper Main Stem	982700	971000	11700	971000	403300	0	97200	1471500
San Juan-Colorado	387500	380000	7500	380000	9400	17460	37400	444260
Total	2253200	2195000	58200	2195000	512690	17460	220700	2945850

State	Subregion	Nominal Depletion (excluding export div.) (af)	Share of State Total (%)	Distributed Nominal Depletion (no export) (af)	Share of Subregion Total (%)	Reduction for 1965 Depletion Difference (af)	Adjustments - 1965 Attained Uses: 1966-70 Export Diversions (af)	1966-70 Navajo Res. Evap (af)	Modified B-C Application (af)	1965 Adjusted Nominal Depletions (af)
Arizona	San Juan-Colorado	10100	100.00	10100	2.61	-203	0	0	600	10498
Colorado	Green River		10.41	134281	15.21	-5768	0	0	11683	140196
	Upper Main Stem		74.38	959175	97.61	-11563	403300	0	96268	1447181
	San Juan-Colorado		15.20	196044	50.59	-3927	9400	0	22281	223798
	Subtotal	1289500	100.00	1289500		-21258	412700	0	128900	1811174
New Mexico	San Juan-Colorado	114400	100.00	114400	29.52	-2291	0	17460	10000	139569
Utah	Green River		88.29	491860	55.70	-21119	99990	0	45718	616449
	Upper Main Stem		2.04	11383	1.16	-137	0	0	935	12181
	San Juan-Colorado		9.67	53857	13.90	-1079	0	0	4519	57297
	Subtotal	557100	100.00	557100		-22335	99990	0	52500	685927
Wyoming	Green River	282100	100.00	282100	31.95	-12113	0	0	28700	298687
Total		2253200		2253200		-58200	512690	17460	220700	2945854

(Shares of subregion totals add to 102.86% for Green River, 98.77% for Upper Main Stem and 96.62% for San Juan-Colorado, with differences from 100% resulting from applying 1971-1977 depletion distributions to 1965 subregion nominal depletions. Reductions for 1965 depletion differences were adjusted slightly from percentage shares of subregion total to balance results consistent with subregion depletion difference totals. The modified Blaney-Criddle application adjustment was distributed to subregions within states by applying the same distribution principles to the irrigation depletions only. Exports from the Green River Basin in Wyoming are assumed included within other depletion categories.)

(12) Average annual total depletions by subregion and state are based on the 1965 adjusted total depletions with correction for 1953-1965 average annual export diversions applied for 1953-1965 (New Mexico pre-1965 depletions also adjusted for the difference between actual Navajo Reservoir evaporation for that period and 1966-1970 reservoir evaporation), the 1966-1970 average total depletions computed as the average of the 1965 adjusted total depletions and the 1971-1975 average total depletions (except that New Mexico exports beginning 1971 and Page Power Plant uses are not considered in the averaging to represent 1966-1970 conditions), and the 1971-1977 total depletions. See Table B-2, Note 1, for a discussion of the differences between the aggregate Upper Basin total depletions for each subregion and the subregion totals for the states, which do not sum to the subregion totals for the Upper Basin shown in this table.

Table A-2. Pre-1971 Average Upper Colorado River Basin Depletions by Subregion

Diversion	1914-45	1953-65	Period 1966-70	1953-70	1965
Green River Subregion:					
Transmountain Diversions (UT)					
Duchesne River Drainage-					
Strawberry Tunnel	57880	63420	62920		
Hobble Creek Ditch	910	920			
Strawberry River Ditch	2400	2420			
Duchesne Tunnel	0	29530	22040		
Subtotal	61190	96290		90730	
San Rafael River Drainage-					
Cedar Creek Tunnel	360	280			
Black Canyon Ditch	310	250			
Candland Ditch	200	180			
Larson Tunnel	280	870			
Twin Creek Tunnel	220	210			
Spring City Tunnel	490	2070	1720		
Reeder Ditch	150	290			
Madsen Ditch	40	30			
John August Ditch	190	210			
Fairview Ditch	1350	1230	0		
Fairview Tunnel			2190		
Horseshoe Tunnel	600	570			
Coal Fork Ditch	260	250			
Ephraim Tunnel	1030	3520	4640		
Subtotal	5480	9960		10440	
Total	66670	106250		101170	
Recent Reclamation Projects	3200	18900			25000
Reservoir Evaporation	13300	21000			21000
All Other Depletions	746000	786000			798000
Total	829170	932150			
Upper Main Stem Subregion:					
Transmountain Diversions (CO)					
Upper Colorado River Drainage-					
Roberts Tunnel	0	4400	36880		
Eureka Ditch	20	950	100		
Alva Adams Tunnel	0	238300	215320		
Berthoud Pass Ditch	630	620	590		
Moffat Water Tunnel	8450	47910	50130		
August Gumlick Tunnel	1200	5120			
Columbine Ditch	500	1170	1670		
Ewing Ditch	1190	990	980		
Wurtz Ditch	860	2020	2290		
Homestake Tunnel			15710		
Twin Lakes Tunnel	11370	37820	49700		
Busk-Ivanhoe Tunnel	2970	4880	6100		
Grand River Ditch	14510	17160	14130		
Hoosier Pass Tunnel	0	7660	8340		
Fremont Pass Ditch	580	0	0		
Boreas Pass Ditch	60	180	10		
Subtotal	42340	369180	401950	378280	
Gunnison River Drainage-					
Larkspur Ditch	50	110	240		
Tabor Ditch	90	470	690		
Tarbell Ditch	330	320	420		
Subtotal	470	900	1350	1020	
Total	42810	370080	403300	379300	
Recent Reclamation Projects	0	8100			16000
Reservoir Evaporation	500	4400			6000
All Other Depletions	770000	898000			949000
Total	813310	1280580			
San Juan-Colorado Subregion:					
Transmountain Diversions (CO)					
San Juan River Drainage-					
Raber-Lohr Ditch	250	2180	8440		
Piedra Pass Ditch	20	100	20		
Squaw Pass Ditch	40	200	120		
Fuchs Ditch	100	730	540		
Treasure Pass Ditch	110	170	260		
Total	520	3380	9380	5050	
Transmountain Diversions (UT)					
Paria River Drainage-					
Tropic & East Fork Canal	-2600	-2300			
Recent Reclamation Projects	0	1300			5000
Reservoir Evaporation	400	3500			4000
All Other Depletions	298000	358000			371000
Total	296320	363880			
Upper Basin Total	1938800	2576610			

Notes:

(1) Transmountain diversion data for 1953-1965 are from the 1971 Upper Colorado Region Comprehensive Framework Study, Appendix V, Water Resources, Part IX, Table 7. Diversion data for water years 1966-1970 are from USGS Water Supply Paper 2125. Strawberry Tunnel and Duchesne Tunnel averages for 1966-1970 are based on 1966-1968 USGS data and the 1969-1970 USBR CU&L Technical Appendix data. Fairview Tunnel is for 1968-1970 only because diversion records for 1966 are not available and for 1967 are not continuous. Fairview Ditch and Fairview Tunnel divert water from both the Price River and San Rafael River drainages, and all flow for 1966-1967 was diverted through the tunnel.

(2) Other data are from the 1971 Upper Colorado Region Comprehensive Framework Study, Appendix V, Water Resources, Part X, Table 8. The 1914-1945 period average annual total depletion for the Upper Basin used in the CFS was 1,938,800 af, as compared to 1,923,120 af used in the 1948 Engineering Advisory Committee report. Reservoir evaporation amounts shown in this table exclude evaporation from Lake Powell, Flaming Gorge Reservoir and Navajo Reservoir.

Table A-3. Current On-Site Depletions in the Upper Colorado River Basin

State	Reporting Area	Year	Reservoir Evaporation	Irrigation	Stockpond Evaporation & Livestock	Mineral Resources	Thermal Electric Power	Municipal & Industrial Other	Fish & Wildlife, Recreation	Export Outside System	Export Within System	Total
Arizona	San Juan-Colorado	1996	4000	800	900	0	21400	4300	0	0		31400
		1997	3300	700	1200	0	22400	3800	0	0		31400
		1998	3800	800	1000	0	25000	3500	0	0		34100
		1999	3600	700	900	0	26700	3800	0	0		35700
		2000	3500	900	900	0	28700	4100	0	0		38100
		1996-00										34140
Colorado	Green River	1996	5600	168200	3200	700	16900	2800	0	0	2000	199400
		1997	4300	131400	3000	600	17500	2900	0	0	2200	161900
		1998	7000	162300	3500	600	19600	3000	0	0	4500	200500
		1999	7800	150800	3400	500	18700	3100	0	0	1600	185900
		2000	7700	190500	3500	500	14100	3200	0	0	1800	221300
		1996-00										193800
	Upper Main Stem	1996	64900	963100	7900	3200	1600	24200	0	484000	168300	1717200
		1997	65800	835400	7900	3100	1500	25100	0	520600	142100	1601500
		1998	73100	964500	8200	3100	1300	26000	0	402100	160400	1638700
		1999	72900	815400	7800	3100	1500	26900	0	403400	147900	1478900
		2000	73800	1080500	7700	3100	1400	27800	0	584900	174900	1954100
		1996-00										1678080
	San Juan-Colorado	1996	9100	321600	5200	100	0	5100	0	300	-170300	171100
		1997	8900	325300	4600	200	0	5200	0	2900	-144300	202800
		1998	9800	335700	5100	200	0	5400	0	1300	-164900	192600
		1999	9700	311900	5200	200	0	5500	0	5600	-149500	188600
		2000	9300	362900	5300	200	0	5700	0	500	-176700	207200
		1996-00										192460
	Total	1996	79600	1452900	16300	4000	18500	32100	0	484300		2087700
		1997	79000	1292100	15500	3900	19000	33200	0	523500		1966200
		1998	89900	1462500	16800	3900	20900	34400	0	403400		2031800
		1999	90400	1278100	16400	3800	20200	35500	0	409000		1853400
		2000	90800	1633900	16500	3800	15500	36700	0	585400		2382600
		1996-00										2064340
New Mexico	San Juan-Colorado	1996	46200	208200	4400	1200	43500	14500	0	58500		376500
		1997	35800	183500	4400	600	45900	13400	0	142300		425900
		1998	41000	194100	4500	400	42600	17300	0	96700		396600
		1999	35200	155600	4500	600	45000	16300	0	118900		376100
		2000	45700	181100	4500	800	44400	17900	0	42700		337100
		1996-00										382440
Utah	Green River	1996	42600	443900	4900	2600	37800	11000	0	131300	0	674100
		1997	39400	442800	4500	2400	33800	11100	0	137100	0	671100
		1998	44400	516300	4700	2300	35700	11100	0	131400	0	745900
		1999	45100	523700	4600	2100	35300	11100	0	145700	0	767600
		2000	43600	429200	4600	2000	34800	11100	0	150400	0	675700
		1996-00										706880
	Upper Main Stem	1996	1400	12800	200	900	0	1500	0	0	0	16800
		1997	1300	19900	300	900	0	1500	0	0	0	23900
		1998	1400	19100	200	900	0	1500	0	0	0	23100
		1999	1300	17700	200	800	0	1600	0	0	0	21600
		2000	1300	13900	200	800	0	1600	0	0	0	17800
		1996-00										20640
	San Juan-Colorado	1996	6700	65000	3900	1800	0	3600	0	-4500	0	76500
		1997	6700	62700	3700	1900	0	3600	0	-5500	0	73100
		1998	6700	70900	3800	1900	0	3700	0	-6900	0	80100
		1999	6700	59500	3800	2000	0	3700	0	-6700	0	69000
		2000	6700	70200	3800	2000	0	3700	0	-5700	0	80700
		1996-00										75880
	Total	1996	50700	521700	9000	5300	37800	16100	0	126800		767400
		1997	47400	525400	8500	5200	33800	16200	0	131600		768100
		1998	52500	606300	8700	5100	35700	16300	0	124500		849100
		1999	53100	600900	8600	4900	35300	16400	0	139000		858200
		2000	51600	513300	8600	4800	34800	16400	0	144700		774200
		1996-00										803400
Wyoming	Green River	1996	33100	391700	4400	2800	39300	5400	0	18800		495500
		1997	34500	339600	4400	2300	40100	5300	0	15900		442100
		1998	34300	281300	4200	1800	46800	5300	0	16700		390400
		1999	34900	311700	4300	1300	42700	5200	0	15000		415100
		2000	31300	322400	4300	700	40000	5200	0	17200		421100
		1996-00										432840

Note: Annual depletions for 1996-2000 are from the Bureau of Reclamation's Colorado River System Consumptive Uses and Losses report for 1996-2000.

Table A-4. Distribution of Consumptive Uses in the Upper Colorado River Basin

River Reach	Colorado (af)	Colorado (% of State Total for Subregion)	New Mexico (af)	New Mexico (% of State Total for Subregion)	Utah (af)	Utah (% of State Total for Subregion)	Wyoming (af)	Wyoming (% of State Total for Subregion)
	1914-1945 Distribution of Total Depletions							
Green River:								
Above Green River, WY	0	0.0	0	0.0	0	0.0	132100	58.0
Green River, WY, to Linwood, UT	0	0.0	0	0.0	11338	2.3	76390	33.6
Linwood, UT, to Yampa River confluence	1138	1.1	0	0.0	0	0.0	0	0.0
Little Snake River: Above WY-CO State Line	11245	11.3	0	0.0	0	0.0	19180	8.4
Little Snake River: WY-CO State Line to Lily, CO	0	0.0	0	0.0	0	0.0	0	0.0
Yampa River: Above Craig, CO	53021	53.5	0	0.0	0	0.0	0	0.0
Yampa River: Craig, CO, to Green River confluence	0	0.0	0	0.0	0	0.0	0	0.0
Yampa River to Brush Creek confluence	0	0.0	0	0.0	0	0.0	0	0.0
Brush Creek to Ashley Creek confluence	0	0.0	0	0.0	45999	9.2	0	0.0
Ashley Creek to Duchesne River confluence	0	0.0	0	0.0	337525	67.2	0	0.0
Duchesne River to White River confluence	0	0.0	0	0.0	0	0.0	0	0.0
White River: Above Watson, UT	33719	34.0	0	0.0	0	0.0	0	0.0
White River: Watson, UT, to Green River confluence	0	0.0	0	0.0	0	0.0	0	0.0
White River to Price River confluence	0	0.0	0	0.0	0	0.0	0	0.0
Price River: Above Heiner, UT	0	0.0	0	0.0	31457	6.3	0	0.0
Price River: Heiner, UT, to Green River confluence	0	0.0	0	0.0	0	0.0	0	0.0
Price River to Green River, UT	0	0.0	0	0.0	8767	1.7	0	0.0
Green River, UT, to Colorado River confluence	0	0.0	0	0.0	67090	13.4	0	0.0
Green River Subregion Total	99123	100.0	0	0.0	502176	100.0	227670	100.0
San Juan River:								
Above Rosa, NM	13527	7.5	371	0.5	0	0.0	0	0.0
Pine River: Above Ignacio, CO	41766	23.1	0	0.0	0	0.0	0	0.0
Pine River: Ignacio, CO, to San Juan River conf.	0	0.0	1208	1.7	0	0.0	0	0.0
Rosa, NM, to Blanco, NM	0	0.0	0	0.0	0	0.0	0	0.0
Animas River: Above Cedar Hill, NM	30057	16.6	0	0.0	0	0.0	0	0.0
Animas River: Cedar Hill, NM, to Farmington, NM	0	0.0	0	0.0	0	0.0	0	0.0
Blanco, NM, to Farmington, NM	0	0.0	59490	82.4	0	0.0	0	0.0
La Plata River: Above CO-NM State Line	20361	11.3	0	0.0	0	0.0	0	0.0
La Plata River: CO-NM State Line to Farmington	0	0.0	6179	8.6	0	0.0	0	0.0
Farmington, NM, to Shiprock, NM	0	0.0	0	0.0	0	0.0	0	0.0
Shiprock, NM, to Mancos River confluence	0	0.0	4919	6.8	0	0.0	0	0.0
Mancos River: Above Towaoc, CO	11701	6.5	0	0.0	0	0.0	0	0.0
Mancos River: Towaoc, CO, to San Juan River conf.	0	0.0	0	0.0	0	0.0	0	0.0
Mancos River to McElmo Creek confluence	0	0.0	0	0.0	0	0.0	0	0.0
McElmo Creek: Above Cortez, CO	63153	35.0	0	0.0	0	0.0	0	0.0
McElmo Creek: Cortez, CO, to San Juan River conf.	0	0.0	0	0.0	0	0.0	0	0.0
McElmo Creek to Chinle Creek confluence	0	0.0	0	0.0	8970	20.2	0	0.0
Chinle Creek to Bluff, UT	0	0.0	0	0.0	0	0.0	0	0.0
Bluff, UT, to Colorado River confluence	0	0.0	0	0.0	0	0.0	0	0.0
San Juan-Colorado Subregion Total (excluding within system imports)	180565	100.0	72167	100.0	44397	100.0	0	0.0
Colorado River:								
Above Glenwood Springs, CO	102406	13.1	0	0.0	0	0.0	0	0.0
Glenwood Springs, CO, to Cameo, CO	132256	16.9	0	0.0	0	0.0	0	0.0
Gunnison River: Above Delta, CO	351613	44.9	0	0.0	0	0.0	0	0.0
Gunnison River: Delta, CO, to Grand Junction, CO	0	0.0	0	0.0	0	0.0	0	0.0
Dolores River: Above Dolores, CO	5164	0.7	0	0.0	0	0.0	0	0.0
Dolores River: Dolores, CO, to Colorado River conf.	38027	4.9	0	0.0	0	0.0	0	0.0
Cameo, CO, to Cisco, UT	153599	19.6	0	0.0	0	0.0	0	0.0
Cisco, UT, to Green River confluence	0	0.0	0	0.0	9971	100.0	0	0.0
Upper Main Stem Subregion Total (excluding within system exports)	783065	100.0	0	0.0	9971	100.0	0	0.0
Green River confluence to San Juan River confluence	0	0.0	0	0.0	35193	79.3	0	0.0
San Juan River confluence to Lee Ferry, AZ	0	0.0	0	0.0	234	0.5	0	0.0
Total	1062753		72167		556544		227670	

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Table A-4. Distribution of Consumptive Uses in the Upper Colorado River Basin
(continued)

River Reach	Colorado (af)	Colorado (% of State Total for Subregion)	New Mexico (af)	New Mexico (% of State Total for Subregion)	Utah (af)	Utah (% of State Total for Subregion)	Wyoming (af)	Wyoming (% of State Total for Subregion)
	Distribution of 1976-1980 Irrigation Depletions Plus 1953-1977 Export Diversions							
Green River:								
Above Green River, WY	0	0.0	0	0.0	0	0.0	141170	63.4
Green River, WY, to Linwood, UT	0	0.0	0	0.0	8900	1.8	70060	31.5
Linwood, UT, to Yampa River confluence	4040	3.7	0	0.0	0	0.0	0	0.0
Little Snake River: Above WY-CO State Line	9080	8.3	0	0.0	0	0.0	11320	5.1
Little Snake River: WY-CO State Line to Lily, CO	0	0.0	0	0.0	0	0.0	0	0.0
Yampa River: Above Craig, CO	62100	56.7	0	0.0	0	0.0	0	0.0
Yampa River: Craig, CO, to Green River confluence	0	0.0	0	0.0	0	0.0	0	0.0
Yampa River to Brush Creek confluence	0	0.0	0	0.0	0	0.0	0	0.0
Brush Creek to Ashley Creek confluence	0	0.0	0	0.0	47240	9.6	0	0.0
Ashley Creek to Duchesne River confluence	0	0.0	0	0.0	330290	67.4	0	0.0
Duchesne River to White River confluence	0	0.0	0	0.0	0	0.0	0	0.0
White River: Above Watson, UT	34380	31.4	0	0.0	0	0.0	0	0.0
White River: Watson, UT, to Green River confluence	0	0.0	0	0.0	0	0.0	0	0.0
White River to Price River confluence	0	0.0	0	0.0	0	0.0	0	0.0
Price River: Above Heiner, UT	0	0.0	0	0.0	44500	9.1	0	0.0
Price River: Heiner, UT, to Green River confluence	0	0.0	0	0.0	0	0.0	0	0.0
Price River to Green River, UT	0	0.0	0	0.0	4440	0.9	0	0.0
Green River, UT, to Colorado River confluence	0	0.0	0	0.0	54730	11.2	0	0.0
Green River Subregion Total	109600	100.0	0	0.0	490100	100.0	222550	100.0
San Juan River:								
Above Rosa, NM	10940	7.2	22680	12.3	0	0.0	0	0.0
Pine River: Above Ignacio, CO	44780	29.4	0	0.0	0	0.0	0	0.0
Pine River: Ignacio, CO, to San Juan River conf.	0	0.0	2740	1.5	0	0.0	0	0.0
Navajo Indian Irrigation Project	0	0.0	51900	28.1	0	0.0	0	0.0
Navajo Dam to Farmington, NM	0	0.0	54760	29.7	0	0.0	0	0.0
Animas River: Above Cedar Hill, NM	31460	20.7	0	0.0	0	0.0	0	0.0
Animas River: Cedar Hill, NM, to Farmington, NM	0	0.0	38860	21.0	0	0.0	0	0.0
La Plata River: Above CO-NM State Line	14300	9.4	0	0.0	0	0.0	0	0.0
La Plata River: CO-NM State Line to Farmington	0	0.0	0	0.0	0	0.0	0	0.0
Farmington, NM, to Shiprock, NM	0	0.0	0	0.0	0	0.0	0	0.0
Chaco River	0	0.0	2080	1.1	0	0.0	0	0.0
Shiprock, NM, to Mancos River confluence	0	0.0	11660	6.3	0	0.0	0	0.0
Mancos River: Above Towaoc, CO	10060	6.6	0	0.0	0	0.0	0	0.0
Mancos River: Towaoc, CO, to San Juan River conf.	0	0.0	0	0.0	0	0.0	0	0.0
Mancos River to McElmo Creek confluence	0	0.0	0	0.0	0	0.0	0	0.0
McElmo Creek: Above Cortez, CO	40640	26.7	0	0.0	0	0.0	0	0.0
McElmo Creek: Cortez, CO, to San Juan River conf.	0	0.0	0	0.0	0	0.0	0	0.0
McElmo Creek to Chinle Creek confluence	0	0.0	0	0.0	5420	14.6	0	0.0
Chinle Creek to Bluff, UT	0	0.0	0	0.0	0	0.0	0	0.0
Bluff, UT, to Colorado River confluence	0	0.0	0	0.0	0	0.0	0	0.0
San Juan-Colorado Subregion Total (excluding within system imports)	152180	100.0	184680	100.0	37150	100.0	0	0.0
Colorado River:								
Above Glenwood Springs, CO	516570	40.3	0	0.0	0	0.0	0	0.0
Glenwood Springs, CO, to Cameo, CO	108080	8.4	0	0.0	0	0.0	0	0.0
Gunnison River: Above Delta, CO	417030	32.6	0	0.0	0	0.0	0	0.0
Gunnison River: Delta, CO, to Grand Junction, CO	11840	0.9	0	0.0	0	0.0	0	0.0
Dolores River: Above Dolores, CO	4300	0.3	0	0.0	0	0.0	0	0.0
Dolores River: Dolores, CO, to Colorado River conf.	33100	2.6	0	0.0	0	0.0	0	0.0
Cameo, CO, to Cisco, UT	190240	14.8	0	0.0	0	0.0	0	0.0
Cisco, UT, to Green River confluence	0	0.0	0	0.0	10720	100.0	0	0.0
Upper Main Stem Subregion Total (excluding within system exports)	1281160	100.0	0	0.0	10720	100.0	0	0.0
Green River confluence to San Juan River confluence	0	0.0	0	0.0	31660	85.2	0	0.0
San Juan River confluence to Lee Ferry, AZ	0	0.0	0	0.0	70	0.2	0	0.0
Total	1542940		184680		537970		222550	

Table A-4. Distribution of Consumptive Uses in the Upper Colorado River Basin
(continued)

River Reach	Distribution of 1996-2000 Irrigation Depletions Plus 1991-2001 Export Diversions							
	Colorado		New Mexico		Utah		Wyoming	
	(af)	(% of State Total for Subregion)	(af)	(% of State Total for Subregion)	(af)	(% of State Total for Subregion)	(af)	(% of State Total for Subregion)
Green River:								
Above Green River, WY	0	0.0			0	0.0	196820	56.6
Green River, WY, to Linwood, UT	0	0.0			17060	3.0	126520	36.4
Linwood, UT, to Yampa River confluence	3590	2.2			0	0.0	0	0.0
Little Snake River: Above WY-CO State Line	63560	39.0			0	0.0	24640	7.1
Little Snake River: WY-CO State Line to Lily, CO	0	0.0			0	0.0	0	0.0
Yampa River: Above Craig, CO	54760	33.6			0	0.0	0	0.0
Yampa River: Craig, CO, to Green River confluence	0	0.0			0	0.0	0	0.0
Yampa River to Brush Creek confluence	0	0.0			0	0.0	0	0.0
Brush Creek to Ashley Creek confluence	0	0.0			50200	8.8	0	0.0
Ashley Creek to Duchesne River confluence	0	0.0			402170	70.2	0	0.0
Duchesne River to White River confluence	0	0.0			0	0.0	0	0.0
White River: Above Watson, UT	40890	25.1			1620	0.3	0	0.0
White River: Watson, UT, to Green River confluence	0	0.0			0	0.0	0	0.0
White River to Price River confluence	0	0.0			12490	2.2	0	0.0
Price River: Above Heiner, UT	0	0.0			35950	6.3	0	0.0
Price River: Heiner, UT, to Green River confluence	0	0.0			0	0.0	0	0.0
Price River to Green River, UT	0	0.0			8510	1.5	0	0.0
Green River, UT, to Colorado River confluence	0	0.0			44820	7.8	0	0.0
Green River Subregion Total	162800	100.0			572820	100.0	347980	100.0
San Juan River:								
Above Rosa, NM	0	0.0			0	0.0	0	0.0
Pine River: Above Ignacio, CO	0	0.0			0	0.0	0	0.0
Pine River: Ignacio, CO, to San Juan River conf.	0	0.0			0	0.0	0	0.0
Navajo Indian Irrigation Project	0	0.0			0	0.0	0	0.0
Above Navajo Dam (excluding NIIP)	62790	20.2			0	0.0	0	0.0
Navajo Dam to Farmington, NM	0	0.0			0	0.0	0	0.0
Animas River: Above Cedar Hill, NM	35820	11.5			0	0.0	0	0.0
Animas River: Cedar Hill, NM, to Farmington, NM	0	0.0			0	0.0	0	0.0
La Plata River: Above CO-NM State Line	21610	7.0			0	0.0	0	0.0
La Plata River: CO-NM State Line to Farmington	0	0.0			0	0.0	0	0.0
Farmington, NM, to Shiprock, NM	0	0.0			0	0.0	0	0.0
Chaco River	0	0.0			0	0.0	0	0.0
Shiprock, NM, to Mancos River confluence	0	0.0			0	0.0	0	0.0
Mancos River: Above Towaoc, CO	41960	13.5			0	0.0	0	0.0
Mancos River: Towaoc, CO, to San Juan River conf.	0	0.0			0	0.0	0	0.0
Mancos River to McElmo Creek confluence	0	0.0			0	0.0	0	0.0
McElmo Creek: Above Cortez, CO	97930	31.5			0	0.0	0	0.0
McElmo Creek: Cortez, CO, to San Juan River conf.	0	0.0			0	0.0	0	0.0
McElmo Creek to Chinle Creek confluence	50540	16.3			11860	19.5	0	0.0
Chinle Creek to Bluff, UT	0	0.0			0	0.0	0	0.0
Bluff, UT, to Colorado River confluence	0	0.0			0	0.0	0	0.0
San Juan-Colorado Subregion Total (excluding within system imports)	310650	100.0			60910	100.0	0	0.0
Colorado River:								
Above Glenwood Springs, CO	601970	42.5			0	0.0	0	0.0
Glenwood Springs, CO, to Cameo, CO	115650	8.2			0	0.0	0	0.0
Gunnison River: Above Delta, CO	404042	28.5			0	0.0	0	0.0
Gunnison River: Delta, CO, to Grand Junction, CO	25790	1.8			0	0.0	0	0.0
Dolores River: Above Dolores, CO	0	0.0			0	0.0	0	0.0
Dolores River: Dolores, CO, to Colorado River conf.	78360	5.5			0	0.0	0	0.0
Cameo, CO, to Cisco, UT	190000	13.4			0	0.0	0	0.0
Cisco, UT, to Green River confluence	0	0.0			16660	100.0	0	0.0
Upper Main Stem Subregion Total (excluding within system exports)	1415812	100.0			16660	100.0	0	0.0
Green River confluence to San Juan River confluence	0	0.0			49050	80.5	0	0.0
San Juan River confluence to Lee Ferry, AZ	0	0.0			0	0.0	0	0.0
Total	1889262				650390		347980	

Notes:

(1) See notes in Table B-1 for explanations of the distribution of 1914-1945 period average depletions.

(2) San Juan-Colorado Subregion includes San Juan River drainage area and the drainage of the Colorado River below the Green River confluence.

(3) For the period 1914-1945, average depletions of 63,153 af per year for McElmo Creek above and below Cortez, CO, were supplied by diversions of about 100,000 af per year from the Dolores River near Dolores, CO. For the period 1976-1980, average depletions of 40,640 af for McElmo Creek were supplied by diversions of 113,320 af per year from the Dolores River. For the period 1996-2000, depletions of 41,960 af for the Mancos River above Towaoc, 97,930 af for McElmo Creek and 50,540 af for the area tributary to the San Juan River between McElmo Creek and Chinle Wash (190,430 af total) were supplied primarily from diversions of 161,140 af per year from the Dolores River, including the Dolores Project. The computed net depletion for the area in the San Juan River drainage is 29,290 af for 1996-2000. The September 2005 Navajo-Gallup Water Supply Project Biological Assessment indicates that return flows resulting from Dolores River diversions to the San Juan River Basin under current conditions amount to about 11,800 af per year. The within-system export of water from the Dolores River drainage to the San Juan River drainage in Colorado is not included in this table, and the net gain in San Juan River flows resulting from the diversions is not distributed in this table.

(4) Utah depletions for the San Juan River confluence to Lee Ferry reach are net depletions after imports to the Paria River drainage.

(5) 1976-1980 irrigation depletion and export diversion data from Bureau of Reclamation Consumptive Uses and Losses Report Technical Appendix (irrigation depletions reported by defined evaluation areas). Other depletions assumed to have a similar spatial distribution, on average. Critical period distribution of depletions to river reaches is based primarily on average percentage distributions for the 1976-1980 period for each state and subregion as it reflects the distribution of non-irrigation development that was largely in place by the early part of the critical period, except that the New Mexico depletion distribution for the critical period reflects also the history of individual project development.

(6) Net NIIP depletion assumed at Navajo Dam, though project return flows accrue to San Juan River below the dam between Bloomfield and Shiprock.

(7) New Mexico depletions shown in this table for 1976-1980 for the San Juan River between Navajo Dam and Farmington include depletions in the reach of river between Farmington and Shiprock. New Mexico depletions for 1976-1980 for the Animas River include New Mexico depletions for the La Plata River. New Mexico depletions for the Chaco River include a small amount of depletion in the Chinle Wash drainage near Crystal.

(8) Exports for 1953-1977 are as follows: (1) Colorado - 404,110 af from Colorado River drainage above Glenwood, 1,090 af from Gunnison River drainage, 3,740 af from Pine River drainage, 600 af from San Juan River drainage above Navajo Dam; (2) New Mexico - 22,680 af San Juan-Chama Project; (3) Utah - 89,710 af from Duchesne River drainage, 10,390 af from San Rafael River drainage; (4) Wyoming - 7,608 af from Green River drainage (1971-1977 average included for above Green River, WY). Exports for Wyoming are from Bureau of Reclamation CU&L Technical Appendix and UCRC data.

(9) 1996-2000 irrigation depletion data from Bureau of Reclamation Consumptive Uses and Losses Report Technical Appendix (irrigation depletions for Colorado, Utah and Wyoming were reported by defined hydrologic units). 1991-2001 export diversion data from UCRC annual reports. Other depletions are assumed to have a similar spatial distribution, on average, as the combined depletions for irrigation plus export uses. The distribution of depletions to river reaches under full Upper Basin development is based on the average percentage distribution for the 1990s for each state and subregion, except that the New Mexico depletion distribution under full development conditions is based on its revised depletion schedule that incorporates the San Juan River Basin in New Mexico Navajo Nation Water Rights Settlement Agreement (see Revised Upper Colorado River Basin Depletion Schedule for New Mexico, memorandum dated April 22, 2005). Future depletions and return flows for the Mancos River, McElmo Creek and the San Juan River tributary area between McElmo Creek and Chinle Wash are assumed to be the same as for current conditions (see note 3 of this table).

(10) Colorado depletions above Navajo Dam for the 1990s include San Juan River, Piedra River and Pine River depletions. Gunnison River depletions for 1996-2000 were distributed above and below Delta based on the depletions in the associated hydrologic unit reported by county. Irrigation depletions for 1996-2000 for the Dolores River below Dolores include those in the Dolores River drainage above Dolores. 1996-2000 irrigation depletions for the Colorado River between Cameo and Cisco include Plateau Valley and depletions for other evaluation areas previously included in the Glenwood to Cameo reach total depletions.

(11) Utah irrigation depletions for the San Juan River drainage between McElmo Creek and Chinle Wash for 1996-2000 may include depletions of water imported via the Dolores Project. Imports into the Paria River drainage in Utah exceeded irrigation depletions in the drainage by about 660 af per year during 1996-2000.

(12) Exports for 1991-2001 are as follows: (1) Colorado - 472,340 af from Colorado River drainage above Glenwood, 1,560 af from Gunnison River drainage, 1,930 af from San Juan River drainage above Navajo Dam (including Pine River); (2) Utah - 89,670 af from Duchesne River drainage, 9,940 af from San Rafael River drainage; (4) Wyoming - 15,350 af from Green River drainage (included for above Green River, WY).

APPENDIX B

River Channel Losses

Table B-1. Channel Losses by River Reach, Virgin Conditions and 1914-1945 Average Loss Conditions

River Reach	1914-1945 Average Depletions within Reach (af) Colorado	New Mexico	Utah	Wyoming	Upper Basin	Upper Basin Depletions Above Reach (af)	Net Depletions Above Reach Adjusted for Salvage (af)	Channel Losses within Reach (af) Virgin Conditions	1914-1945 Average	Salvage by Use (af)	(% of use above reach)
Green River:											
Above Green River, WY	0	0	0	132100	132100						
Green River, WY, to Linwood, UT	0	0	11338	76390	87728	132100	132100	22800	21500	1300	0.98
Linwood, UT, to Yampa River confluence	1138	0	0	0	1138	219828	218528	29000	26400	2600	1.19
Little Snake River: Above WY-CO State Line	11245	0	0	19180	30425						
Little Snake River: WY-CO State Line to Lily, CO	0	0	0	0	0	30425	30425	8600	8300	300	0.99
Yampa River: Above Craig, CO	53021	0	0	0	53021						
Yampa River: Craig, CO, to Green River confluence	0	0	0	0	0	53021	53021	30100	29300	800	1.51
Yampa River to Brush Creek confluence	0	0	0	0	0	304412	299412	12600	11900	700	0.23
Brush Creek to Ashley Creek confluence	0	0	45999	0	45999	304412	298712	2600	2500	100	0.03
Ashley Creek to Duchesne River confluence	0	0	337525	0	337525	350411	344611	38400	35600	2800	0.81
Duchesne River to White River confluence	0	0	0	0	0	687936	679336	800	800	0	0.00
White River: Above Watson, UT	33719	0	0	0	33719						
White River: Watson, UT, to Green River confluence	0	0	0	0	0	33719	33719	18600	18000	600	1.78
White River to Price River confluence	0	0	0	0	0	721655	712455	48600	43500	5100	0.72
Price River: Above Heiner, UT	0	0	31457	0	31457						
Price River: Heiner, UT, to Green River confluence	0	0	0	0	0	31457	31457	5000	5000	0	0.00
Price River to Green River, UT	0	0	8767	0	8767	753112	738812	16100	14400	1700	0.23
Green River, UT, to Colorado River confluence	0	0	67090	0	67090	761879	745879	59600	52600	7000	0.94
San Juan River:											
Above Rosa, NM	13527	371	0	0	13898						
Pine River: Above Ignacio, CO	41766	0	0	0	41766						
Pine River: Ignacio, CO, to San Juan River conf.	0	1208	0	0	1208	41766	41766	10600	10000	600	1.44
Rosa, NM, to Blanco, NM	0	0	0	0	0	13898	13898	15900	15800	100	0.72
Animas River: Above Cedar Hill, NM	30057	0	0	0	30057						
Animas River: Cedar Hill, NM, to Farmington, NM	0	0	0	0	0	30057	30057	11300	11100	200	0.67
Blanco, NM, to Farmington, NM	0	59490	0	0	59490	56872	56172	20000	19600	400	0.71
La Plata River: Above CO-NM State Line	20361	0	0	0	20361						
La Plata River: CO-NM State Line to Farmington	0	6179	0	0	6179	20361	20361	6700	5000	1700	8.35
Farmington, NM, to Shiprock, NM	0	0	0	0	0	172959	169959	26900	25900	1000	0.59
Shiprock, NM, to Mancos River confluence	0	4919	0	0	4919	172959	168959	21300	20400	900	0.53
Mancos River: Above Towaoc, CO	11701	0	0	0	11701						
Mancos River: Towaoc, CO, to San Juan River conf.	0	0	0	0	0	11701	11701	4000	3600	400	3.42
Mancos River to McElmo Creek confluence	0	0	0	0	0	189579	184279	28900	27600	1300	0.71
McElmo Creek: Above Cortez, CO	-36847	0	0	0	-36847						
McElmo Creek: Cortez, CO, to San Juan River conf.	0	0	0	0	0	-36847	-36847	4500	7600	-3100	8.41
McElmo Creek to Chinle Creek confluence	0	0	8970	0	8970	152732	149232	20200	19600	600	0.40
Chinle Creek to Bluff, UT	0	0	0	0	0	161702	157602	14500	14100	400	0.25
Bluff, UT, to Colorado River confluence	0	0	0	0	0	161702	157202	32200	30600	1600	1.02
Colorado River:											
Above Glenwood Springs, CO	102406	0	0	0	102406						
Glenwood Springs, CO, to Cameo, CO	132256	0	0	0	132256	102406	102406	15600	15000	600	0.59
Gunnison River: Above Delta, CO	351613	0	0	0	351613						
Gunnison River: Delta, CO, to Grand Junction, CO	0	0	0	0	0	351613	351613	8300	7200	1100	0.31
Dolores River: Above Dolores, CO	105164	0	0	0	105164						
Dolores River: Dolores, CO, to Colorado River conf.	38027	0	0	0	38027	105164	105164	32200	27300	4900	4.66
Cameo, CO, to Cisco, UT	153599	0	0	0	153599	729466	722866	253700	230400	23300	3.22
Cisco, UT, to Green River confluence	0	0	9971	0	9971	883065	853165	38900	35200	3700	0.43
Green River confluence to San Juan River confluence	0	0	35193	0	35193	1722005	1665405	64100	57700	6400	0.38
San Juan River confluence to Lee Ferry, AZ	0	0	234	0	234	1918900	1849800	41400	37200	4200	0.23
Total	1062753	72167	556544	227670	1919134			964000	890700	73300	

Notes:

(1) 1914-1945 average annual stream depletions at sites of use from 1948 Engineering Advisory Committee Report (pages 43-45; see also Appendix B at Figure I following page 2). Irrigation uses computed using original Blaney-Criddle method. Upper Basin total in this table excludes uses in Arizona.

(2) Channel losses from 1948 Engineering Advisory Committee Report (page 53).

(3) For the period 1914-1945, average depletions of 63,153 af per year for McElmo Creek above and below Cortez, CO, were supplied by diversions of about 100,000 af per year from the Dolores River above Dolores, CO (see the 1948 Engineering Advisory Committee report, pages 22 and 43-44). The negative salvage value for McElmo Creek above Cortez reflects the channel loss on water imported into McElmo Creek via return flows of 36,847 af per year resulting from the trans-drainage diversions.

(4) Florida Project return flows are assumed to Animas River only; Pine River Project return flows are assumed to Pine River only (return flows to San Juan River below Rosa, NM, are assumed insignificant for purposes of this analysis).

(5) Depletions of 59,490 af per year for the Animas and San Juan rivers in New Mexico assumed to occur at or above Farmington and are not segregated between the Animas and San Juan rivers or between above and below Farmington.

(6) Ouray, UT, area depletions 10,099 af per year lumped in the Duchesne River confluence to White River confluence reach of the Green River (most of the depletion impact occurs near or above the White River confluence). Price River depletions assumed near Heiner for purposes of evaluating losses. Huntington-Castle Dale-Ferron area depletions in Utah are not segregated by drainage (most of the depletion for the area occurs in the San Rafael River drainage which is tributary to the Green River below Green River, UT, and some of the depletions occurs in the Price River drainage below Heiner).

(7) The 1948 Engineering Advisory Committee report did not reduce on-site uses on ephemeral tributaries for losses between the places of use and the designated river reaches.

(8) The channel loss for the Cameo, CO, to Cisco, UT, reach of the Colorado River was determined by water budget using as inflow flows of the Colorado River at Cameo, the Gunnison River near Grand Junction, Plateau Creek near Cameo and the Dolores River near Gateway (see the 1948 Engineering Advisory Committee report, page 46). The Dolores River flows were adjusted for estimated losses from Gateway to the Colorado River confluence (see page 48). Therefore, depletions of the Gunnison and Dolores rivers are assumed to be above the Cameo to Cisco reach for purposes of this analysis.

(9) The 1948 Engineering Advisory Committee report distributed the salvage amount of 73,300 af per year for the 1914-1945 period among the Upper Basin States as follows:

State	On-Site Depletion (af)	Salvage by Use (af)	(% of on-site use)
Arizona	3990	0	0.00
Colorado	1062753	46700	4.39
New Mexico	72167	2700	3.74
Utah	556544	12200	2.19
Wyoming	227670	11700	5.14
Upper Basin	1923124	73300	3.81

Table B-2. Channel Loss Salvage by River Reach and State for the Critical Period

River Reach	Salvage by Use (% of use above reach)	Colorado: Depletions in Reach (% of State Total for Subregion)	Colorado: Depletions in Reach (af)	Colorado: Depletions above Reach (af)	Colorado: Depletions above Reach, Adjusted for Salvage (af)	Colorado: Depletions above Reach, Salvage by Use (af)	New Mexico: Depletions in Reach (% of State Total for Subregion)	New Mexico: Depletions in Reach (af)	New Mexico: Depletions above Reach (af)	New Mexico: Depletions above Reach, Adjusted for Salvage (af)	New Mexico: Depletions above Reach, Salvage by Use (af)
Green River:											
Above Green River, WY		0.0									
Green River, WY, to Linwood, UT	0.50	0.0									
Linwood, UT, to Yampa River confluence	1.04	3.7	5010	0	0	0					
Little Snake River: Above WY-CO State Line		8.3	11238								
Little Snake River: WY-CO State Line to Lily, CO	0.99	0.0		11238	11238	111					
Yampa River: Above Craig, CO		56.7	76772								
Yampa River: Craig, CO, to Green River confluence	1.51	0.0		76772	76772	1159					
Yampa River to Brush Creek confluence	0.23	0.0		93020	91749	211					
Brush Creek to Ashley Creek confluence	0.03	0.0		93020	91538	27					
Ashley Creek to Duchesne River confluence	0.81	0.0		93020	91511	741					
Duchesne River to White River confluence	0.00	0.0		93020	90770	0					
White River: Above Watson, UT		31.3	42380								
White River: Watson, UT, to Green River confluence	1.78	0.0		42380	42380	754					
White River to Price River confluence	0.72	0.0		135400	132395	953					
Price River: Above Heiner, UT		0.0									
Price River: Heiner, UT, to Green River confluence	0.00	0.0									
Price River to Green River, UT	0.23	0.0		135400	131442	302					
Green River, UT, to Colorado River confluence	0.94	0.0		135400	131140	1233					
Green River Total		100.0	135400		129907	5493	0.0	0		0	0
San Juan River:											
Above Rosa, NM		7.2	15185					23800			
Pine River: Above Ignacio, CO		29.4	62005								
Pine River: Ignacio, CO, to San Juan River conf.	1.10	0.0		62005	62005	681		1700			
Rosa, NM, to Blanco, NM	0.38	0.0		15185	15185	58			23800	23800	92
Navajo Reservoir depletions (Evap., direct diversions)		0.0						14100			
Animas River: Above Cedar Hill, NM		20.7	43656								
Animas River: Cedar Hill, NM, to Farmington, NM	0.67	0.0		43656	43656	292		39700			
Blanco, NM, to Farmington, NM	0.71			77189	76450	543		23000	39600	39508	281
La Plata River: Above CO-NM State Line		9.4	19825								
La Plata River: CO-NM State Line to Farmington	8.35	0.0		19825	19825	1655		6000			
Farmington, NM, to Shiprock, NM	0.59	0.0		140670	137440	811		42400	108300	107928	637
Chaco River		0.0						7300			
Shiprock, NM, to Mancos River confluence	0.53	0.0		140670	136629	724		0	158000	156991	832
Mancos River: Above Towaoc, CO		6.6	13919								
Mancos River: Towaoc, CO, to San Juan River conf.	3.42	0.0		13919	13919	476					
Mancos River to McElmo Creek confluence	0.71	0.0		154590	149349	1060			158000	156159	1109
McElmo Creek: Above Cortez, CO		26.7	-69240								
McElmo Creek: Cortez, CO, to San Juan River conf.	8.41	0.0		-69240	-69240	-5823					
McElmo Creek to Chinle Creek confluence	0.40	0.0		85350	84872	339			158000	155050	620
Chinle Creek to Bluff, UT	0.25	0.0		85350	84532	211			158000	154430	386
Bluff, UT, to Colorado River confluence	0.66	0.0		85350	84321	560			158000	154044	1023
San Juan River Total		100.0	85350		83761	1589	100.0	158000		153021	4979
Upper Colorado River Main Stem:											
Above Glenwood Springs, CO		40.3	566779								
Glenwood Springs, CO, to Cameo, CO	0.59	8.4	118138	566779	566779	3344					
Gunnison River: Above Delta, CO		32.6	458486								
Gunnison River: Delta, CO, to Grand Junction, CO	0.31	0.9	12658	458486	458486	1421					
Dolores River: Above Dolores, CO		0.3	129769								
Dolores River: Dolores, CO, to Colorado River conf.	4.66	2.6	36566	129769	129769	6047					
Cameo, CO, to Cisco, UT	3.22	14.9	209554	1322396	1311584	42233					
Cisco, UT, to Green River confluence	0.43	0.0		1531950	1478904	6359					
Upper Colorado River Main Stem Total		100.0	1531950		1472545	59405	0.0	0		0	0
Colorado River:											
Green River confluence to San Juan River confluence	0.17	0.0		1667350	1602452	2744			0	0	0
San Juan River confluence to Lee Ferry, AZ	0.12	0.0		1752700	1683470	2031			158000	153021	185
Colorado River Total		0.0	0			4775	0.0	0			185
Total			1752700			71262		158000			5164

Table B-2. Channel Loss Salvage by River Reach and State for the Critical Period
(continued)

River Reach	Salvage by Use (% of use above reach)	Utah: Depletions in Reach (% of State Total for Subregion)	Utah: Depletions in Reach (af)	Utah: Depletions above Reach (af)	Utah: Depletions above Reach Adjusted for Salvage (af)	Utah: Salvage by Use (af)	Wyoming: Depletions in Reach (% of State Total for Subregion)	Wyoming: Depletions in Reach (af)	Wyoming: Depletions above Reach (af)	Wyoming: Depletions above Reach Adjusted for Salvage (af)	Wyoming: Salvage by Use (af)
Green River:											
Above Green River, WY		0.0					63.4	190327			
Green River, WY, to Linwood, UT	0.50	1.8	11151				31.5	94563	190327	190327	950
Linwood, UT, to Yampa River confluence	1.04	0.0		11151	11151	116	0.0		284890	283940	2947
Little Snake River: Above WY-CO State Line		0.0					5.1	15310			
Little Snake River: WY-CO State Line to Lily, CO	0.99	0.0					0.0		15310	15310	152
Yampa River: Above Craig, CO		0.0					0.0				
Yampa River: Craig, CO, to Green River confluence	1.51	0.0					0.0				
Yampa River to Brush Creek confluence	0.23	0.0		11151	11035	25	0.0		300200	296152	681
Brush Creek to Ashley Creek confluence	0.03	9.6	59472	11151	11010	3	0.0		300200	295470	89
Ashley Creek to Duchesne River confluence	0.81	67.4	417543	70623	70479	571	0.0		300200	295382	2393
Duchesne River to White River confluence	0.00	0.0		488166	487451	0	0.0		300200	292989	0
White River: Above Watson, UT		0.0					0.0				
White River: Watson, UT, to Green River confluence	1.78	0.0					0.0				
White River to Price River confluence	0.72	0.0		488166	487451	3510	0.0		300200	292989	2110
Price River: Above Heiner, UT		9.1	56375				0.0				
Price River: Heiner, UT, to Green River confluence	0.00	0.0		56375	56375	0	0.0				
Price River to Green River, UT	0.23	0.9	5576	544541	540316	1243	0.0		300200	290880	669
Green River, UT, to Colorado River confluence	0.94	11.2	69384	550116	544648	5120	0.0		300200	290211	2728
Green River Total		100.0	619500		539529	10587	100.0	300200		287483	12717
San Juan River:											
Above Rosa, NM		0.0					0.0				
Pine River: Above Ignacio, CO		0.0					0.0				
Pine River: Ignacio, CO, to San Juan River conf.	1.10	0.0					0.0				
Rosa, NM, to Blanco, NM	0.38	0.0					0.0				
Navajo Reservoir depletions (Evap., direct diversions)		0.0					0.0				
Animas River: Above Cedar Hill, NM		0.0					0.0				
Animas River: Cedar Hill, NM, to Farmington, NM	0.67	0.0					0.0				
Blanco, NM, to Farmington, NM	0.71	0.0					0.0				
La Plata River: Above CO-NM State Line		0.0					0.0				
La Plata River: CO-NM State Line to Farmington	8.35	0.0					0.0				
Farmington, NM, to Shiprock, NM	0.59	0.0					0.0				
Chaco River		0.0					0.0				
Shiprock, NM, to Mancos River confluence	0.53	0.0					0.0				
Mancos River: Above Towaoc, CO		0.0					0.0				
Mancos River: Towaoc, CO, to San Juan River conf.	3.42	0.0					0.0				
Mancos River to McElmo Creek confluence	0.71	0.0					0.0				
McElmo Creek: Above Cortez, CO		0.0					0.0				
McElmo Creek: Cortez, CO, to San Juan River conf.	8.41	0.0					0.0				
McElmo Creek to Chinle Creek confluence	0.40	14.6	8045				0.0				
Chinle Creek to Bluff, UT	0.25	0.0		8045	8045	20	0.0				
Bluff, UT, to Colorado River confluence	0.66	0.0		8045	8024	53	0.0				
San Juan River Total		14.6	8045		7971	73	0.0	0		0	0
Upper Colorado River Main Stem:											
Above Glenwood Springs, CO		0.0					0.0				
Glenwood Springs, CO, to Cameo, CO	0.59	0.0					0.0				
Gunnison River: Above Delta, CO		0.0					0.0				
Gunnison River: Delta, CO, to Grand Junction, CO	0.31	0.0					0.0				
Dolores River: Above Dolores, CO		0.0					0.0				
Dolores River: Dolores, CO, to Colorado River conf.	4.66	0.0					0.0				
Cameo, CO, to Cisco, UT	3.22	0.0					0.0				
Cisco, UT, to Green River confluence	0.43	100.0	12000	0			0.0				
Upper Colorado River Main Stem Total		100.0	12000		0	0	0.0	0		0	0
Colorado River:											
Green River confluence to San Juan River confluence	0.17	85.2	46945	631500	620913	1063	0.0		300200	287483	492
San Juan River confluence to Lee Ferry, AZ	0.12	0.2	110	686490	674766	814	0.0		300200	286991	346
Colorado River Total		85.4	47055			1877	0.0	0			838
Total			686600			12538		300200			13556

Table B-2. Channel Loss Salvage by River Reach and State for the Critical Period
(continued)

River Reach	Salvage by Use (% of use above reach)	Upper Division States Shared CRSP Evaporation: Depletions in Reach (% of State Total for Subregion)	Upper Division States Shared CRSP Evaporation: Depletions in Reach (af)	Upper Division States Shared CRSP Evaporation: Depletions above Reach (af)	Upper Division States Shared CRSP Evaporation: Depletions above Reach Adjusted for Salvage (af)	Upper Division States Shared CRSP Evaporation: Depletions above Reach Salvage by Use (af)	Arizona: Depletions in Reach (% of State Total for Subregion)	Arizona: Depletions in Reach (af)	Arizona: Depletions above Reach (af)	Arizona: Depletions above Reach Adjusted for Salvage (af)	Arizona: Depletions above Reach Salvage by Use (af)
Green River:											
Above Green River, WY											
Green River, WY, to Linwood, UT	0.50		37850								
Linwood, UT, to Yampa River confluence	1.04			37850	37850	393					
Little Snake River: Above WY-CO State Line											
Little Snake River: WY-CO State Line to Lily, CO	0.99										
Yampa River: Above Craig, CO											
Yampa River: Craig, CO, to Green River confluence	1.51										
Yampa River to Brush Creek confluence	0.23			37850	37457	86					
Brush Creek to Ashley Creek confluence	0.03			37850	37371	11					
Ashley Creek to Duchesne River confluence	0.81			37850	37360	303					
Duchesne River to White River confluence	0.00			37850	37057	0					
White River: Above Watson, UT											
White River: Watson, UT, to Green River confluence	1.78										
White River to Price River confluence	0.72			37850	37057	267					
Price River: Above Heiner, UT											
Price River: Heiner, UT, to Green River confluence	0.00										
Price River to Green River, UT	0.23			37850	36790	85					
Green River, UT, to Colorado River confluence	0.94			37850	36706	345					
Green River Total			37850		36361	1489		0		0	0
San Juan River:											
Above Rosa, NM											
Pine River: Above Ignacio, CO											
Pine River: Ignacio, CO, to San Juan River conf.	1.10										
Rosa, NM, to Blanco, NM	0.38										
Navajo Reservoir depletions (Evap., direct diversions)											
Animas River: Above Cedar Hill, NM											
Animas River: Cedar Hill, NM, to Farmington, NM	0.67										
Blanco, NM, to Farmington, NM	0.71										
La Plata River: Above CO-NM State Line											
La Plata River: CO-NM State Line to Farmington	8.35										
Farmington, NM, to Shiprock, NM	0.59										
Chaco River											
Shiprock, NM, to Mancos River confluence	0.53										
Mancos River: Above Towaoc, CO											
Mancos River: Towaoc, CO, to San Juan River conf.	3.42										
Mancos River to McElmo Creek confluence	0.71										
McElmo Creek: Above Cortez, CO											
McElmo Creek: Cortez, CO, to San Juan River conf.	8.41										
McElmo Creek to Chinle Creek confluence	0.40							200			
Chinle Creek to Bluff, UT	0.25							9800	200	200	1
Bluff, UT, to Colorado River confluence	0.66							200	10000	10000	66
San Juan River Total			0		0	0		10200		9933	67
Upper Colorado River Main Stem:											
Above Glenwood Springs, CO											
Glenwood Springs, CO, to Cameo, CO	0.59										
Gunnison River: Above Delta, CO			3540								
Gunnison River: Delta, CO, to Grand Junction, CO	0.31			3540	3540	11					
Dolores River: Above Dolores, CO											
Dolores River: Dolores, CO, to Colorado River conf.	4.66										
Cameo, CO, to Cisco, UT	3.22			3540	3529	114					
Cisco, UT, to Green River confluence	0.43			3540	3415	15					
Upper Colorado River Main Stem Total			3540		3401	139		0		0	0
Colorado River:											
Green River confluence to San Juan River confluence	0.17		0	41390	39761	68					
San Juan River confluence to Lee Ferry, AZ	0.12		179850	41390	39693	48		3200	10200	10133	12
Colorado River Total			179850			116		3200			12
Total			221240			1745		13400			79

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Table B-2. Channel Loss Salvage by River Reach and State for the Critical Period (continued)

Notes:

(1) The following depletions in af for the 1953-1977 critical period by subregion and state are from Table A-1. Differences between the sum of the subregion depletions for the states and the subregion depletions for the Upper Basin are due to how each is computed. For the states, pre-1965 depletions for each subregion were determined from the 1965 adjusted depletions. For the Upper Basin in the aggregate, pre-1965 depletions were determined from the annual depletions used to compute natural flows in the 1971 Comprehensive Framework Study (see Appendix V, Water Resources, Part X, Table 8). The aggregate Upper Basin depletions for each subregion used to compute natural flows were distributed from 1914 to 1965 by linear interpolation between the end points for all types of use other than export diversions, recent Reclamation projects and reservoir evaporation. The depletions shown by state are conservatively high for the Green River and Upper Main Stem subregions for the purpose of computing the amount of channel loss salvage already included in the gage record for the critical period (considering also within-system exports). For the San Juan-Colorado subregion, review of the available data for each state does not indicate that the states' estimated depletions for the period are unreasonable. It is not clear if the CFS adequately accounted for the export of Dolores River water from the Upper Main Stem subregion to the San Juan-Colorado subregion. The subregion amounts shown below for each state are used in this table, except that 125,600 af per year (1971-1976 average) of within-system export from the Dolores River drainage to the San Juan River drainage in Colorado is accounted after the percentage distribution of depletions.

Subregion	Arizona	Colorado	New Mexico	Utah	Wyoming	Total	Table A-1 Total	Difference
Green River	0	135400	0	619500	300200	1055100	1030000	25100
Upper Main Stem	0	1406400	0	12000	0	1418400	1454700	-36300
San Juan-Colorado	13400	210900	158000	55100	0	437400	384700	52700
Total	13400	1752700	158000	686600	300200	2910900	2869400	41500

(2) The distribution of depletions by river reach are based primarily on the percentage distributions of depletions in the Upper Basin from 1976-1980 shown in Table A-4. Adjustment was made for depletions in the areas of Towaoc and Cortez, Colorado. Navajo Reservoir evaporation is included in the New Mexico depletions, and other Colorado River Storage Project reservoirs are included under Upper Division States Shared CRSP Evaporation. Reservoir evaporation for CRSP reservoirs is net evaporation after salvage of pre-reservoir losses within reservoir basins by inundation (ie, the net depletion of flow due to storage). New Mexico's total depletions and depletions distribution is based on the water development history in New Mexico, which includes removal of about 1200 acres of irrigation from the San Juan and Pine rivers by 1961 in connection with construction of Navajo Reservoir, Navajo Reservoir evaporation beginning with initiation of storage 1962, irrigation on the Hammond Irrigation Project beginning 1961 (which averaged about 2000 acres irrigated for the critical period), diversions to the Four Corners Power Plant beginning 1961 and to the San Juan Generating Station beginning 1973, and San Juan-Chama Project diversions beginning 1971. See Table A-1, note 8.

(3) Reservoir evaporation shared among the Upper Division states for the Colorado River Storage Project units (Lake Powell, Flaming Gorge Reservoir and the Aspinall Unit) is from the Bureau of Reclamation historic reservoir evaporation data for the CRSP unit reservoirs (see Historic Storage and Evaporation at CRSP Reservoirs from the November 22, 2005, preliminary draft yield study prepared by NMISC and USBR). The evaporation data for 1962-1977 were averaged over the 1953-1977 critical period.

(4) Salvage rates for river reaches partially inundated by Colorado River Storage Project reservoirs are adjusted for the fraction of losses within the reach that were salvaged, on average, during the critical period as follows. Data on channel losses for 1914-1945 flow conditions for the indicated river sections within the reservoir basins for Flaming Gorge Reservoir and Lake Powell are from Evaporation Study of Upper Colorado River and Tributaries, Colorado Water Conservation Board, 1948, Tables 3a-3c. Losses for the 12-mile Green River section 66 were prorated to the 10-mile subreach below Linwood and the 2-mile subreach above Linwood, and losses for the 14-mile Colorado River section 8 were prorated to the 5-mile subreach below the San Juan River confluence and the 9-mile subreach above the confluence. For Navajo Reservoir, about 29 miles of the San Juan River were inundated, on average, during 1962-1977, of which 27 miles were in the 37-mile Rosa to Blanco reach and 2 miles were above Rosa, and about 10 miles of the Pine River were inundated, on average, during 1962-1977 within the 27-mile Ignacio to San Juan River confluence reach. Channel loss rates per mile for the San Juan River and Pine River reaches within the Navajo Reservoir basin for 1914-1945 are from the 1948 Engineering Advisory Committee report, page 48. Average channel losses within river reaches inundated by CRSP reservoirs during part of the 1953-1977 critical period are from Tables C-1 through C-4.

Reservoir	River Reaches	Total 1914-1945 Channel Loss in Reach from Table B-1 (af)	River Section Numbers for Sections Partially or Fully Inundated	Average Channel Loss within Inundated Sections for Period Inundated (af)	Period Inundated	Channel Loss within Inundated Sections Averaged over Critical Period (af)	Remaining River Channel Loss with Reservoir in Place (af)	Remaining River Channel Loss with Reservoir in Place (% of Total Loss for Reach)	Salvage by Use: Table B-1 (% of use above reach)	Salvage by Use: Adjusted (% of use above reach)
Flaming Gorge	Green River: Linwood, UT-Yampa River conf.	26400	61-66	5275	1962-1977	3376	23024	87.2	1.19	1.04
	Green River: Green River, WY-Linwood, UT	21500	66-72	16483	1962-1977	10549	10951	50.9	0.98	0.50
	Total	47900		21758		13925	33975			
Navajo Reservoir	San Juan River: Rosa, NM-Blanco, NM	15800		11502	1962-1977	7361	8439	53.4	0.72	0.38
	Pine River: Ignacio, CO-San Juan River conf.	10000		3710	1962-1977	2374	7626	76.3	1.44	1.10
	Total	25800		15212		9736	16064			
Lake Powell	Colorado River: San Juan River-Lee Ferry, AZ	37200	2- 8	29476	1963-1977	17686	19514	52.5	0.23	0.12
	Colorado River: Green River-San Juan River	57700	8-24	52839	1963-1977	31703	25997	45.1	0.38	0.17
	San Juan River: Bluff, UT-Colorado River conf.	30600	1-14	17788	1963-1977	10673	19927	65.1	1.02	0.66
		125500		100103		60062	65438			

(5) The following summarizes the historic average amounts of salvage by use for each state during the critical period as estimated in this table.

State	On-Site Depletion (af)	Salvage by State Uses (af)	Salvage by State Uses (% of on-site use)	Downstream Losses Salvaged by Shared CRSP Reservoirs (% share)	Downstream Losses Salvaged by Shared CRSP Reservoirs (af)	Total Salvage by Use (af)
Arizona	13400	79	0.59	0.00	0	79
Colorado	1752700	71262	4.07	51.75	903	72164
New Mexico	158000	5164	3.27	11.25	196	5360
Utah	686600	12538	1.83	23.00	401	12939
Wyoming	300200	13556	4.52	14.00	244	13800
Upper Basin	2910900	102598	3.52	100.00	1745	104343

Table B-3. Channel Loss Salvage by River Reach and State for Full Development Conditions

River Reach	Salvage by Use (% of use above reach)	Colorado: Depletions in Reach (% of State Total for Subregion)	Colorado: Depletions in Reach (af)	Colorado: Depletions above Reach (af)	Colorado: Depletions above Reach, Adjusted for Salvage (af)	Colorado: Depletions above Reach, Salvage by Use (af)	New Mexico: Depletions in Reach (% of State Total for Subregion)	New Mexico: Depletions in Reach (af)	New Mexico: Depletions above Reach (af)	New Mexico: Depletions above Reach, Adjusted for Salvage (af)	New Mexico: Depletions above Reach, Salvage by Use (af)
Green River:											
Above Green River, WY		0.0									
Green River, WY, to Linwood, UT	0.18	0.0									
Linwood, UT, to Yampa River confluence	0.95	2.2	6118	0	0	0					
Little Snake River: Above WY-CO State Line		39.0	108448								
Little Snake River: WY-CO State Line to Lily, CO	0.99	0.0		108448	108448	1074					
Yampa River: Above Craig, CO		33.6	93432								
Yampa River: Craig, CO, to Green River confluence	1.51	0.0		93432	93432	1411					
Yampa River to Brush Creek confluence	0.23	0.0		207998	205513	473					
Brush Creek to Ashley Creek confluence	0.03	0.0		207998	205041	62					
Ashley Creek to Duchesne River confluence	0.81	0.0		207998	204979	1660					
Duchesne River to White River confluence	0.00	0.0		207998	203319	0					
White River: Above Watson, UT		25.2	72474								
White River: Watson, UT, to Green River confluence	1.78	0.0		72474	72474	1290					
White River to Price River confluence	0.72	0.0		280472	274503	1976					
Price River: Above Heiner, UT		0.0									
Price River: Heiner, UT, to Green River confluence	0.00	0.0									
Price River to Green River, UT	0.23	0.0		280472	272526	627					
Green River, UT, to Colorado River confluence	0.94	0.0		280472	271899	2556					
Green River Total		100.0	280472		269344	11128	0.0	0		0	0
San Juan River:											
Above Rosa, NM		4.4	19000					107700			
Pine River: Above Ignacio, CO		17.8	77000								
Pine River: Ignacio, CO, to San Juan River conf.	0.75	0.0		77000	77000	574		0			
Rosa, NM, to Blanco, NM	0.20	0.0		19000	19000	37		10400	107700	107700	211
Navajo Reservoir depletions (Evap., direct diversions)		0.0						302600			
Animas River: Above Cedar Hill, NM		21.8	94300					100			
Animas River: Cedar Hill, NM, to Farmington, NM	0.67	0.0		94300	94300	632		57700	100	100	1
Blanco, NM, to Farmington, NM	0.71	0.0		96000	95389	677		24800	420700	420489	2985
La Plata River: Above CO-NM State Line		6.2	27000								
La Plata River: CO-NM State Line to Farmington	8.35	0.0		27000	27000	2255		6000			
Farmington, NM, to Shiprock, NM	0.59	0.0		217300	213125	1257		114500	509300	506103	2986
Chaco River		0.0						9300			
Shiprock, NM, to Mancos River confluence	0.53	0.0		217300	211868	1123		0	633100	626917	3323
Mancos River: Above Towaoc, CO		12.0	51960								
Mancos River: Towaoc, CO, to San Juan River conf.	3.42	0.0		51960	51960	1777					
Mancos River to McElmo Creek confluence	0.71	0.0		269260	260928	1853			633100	623594	4428
McElmo Creek: Above Cortez, CO		24.9	-11800								
McElmo Creek: Cortez, CO, to San Juan River conf.	8.41	0.0		-11800	-11800	-992					
McElmo Creek to Chinle Creek confluence	0.40	12.8	14130	257460	248268	993			633100	619167	2477
Chinle Creek to Bluff, UT	0.25	0.0		271590	261405	654			633100	616690	1542
Bluff, UT, to Colorado River confluence	0.28	0.0		271590	260751	724			633100	615148	1709
San Juan River Total		100.0	271590		260027	11563	100.0	633100		613439	19661
Upper Colorado River Main Stem:											
Above Glenwood Springs, CO		42.6	938360								
Glenwood Springs, CO, to Cameo, CO	0.59	8.2	180623	938360	938360	5536					
Gunnison River: Above Delta, CO		28.5	627776								
Gunnison River: Delta, CO, to Grand Junction, CO	0.31	1.8	39649	627776	627776	1946					
Dolores River: Above Dolores, CO		0.0	161140								
Dolores River: Dolores, CO, to Colorado River conf.	4.66	5.5	121150	161140	161140	7509					
Cameo, CO, to Cisco, UT	3.22	13.4	292765	2068698	2053707	66129					
Cisco, UT, to Green River confluence	0.43	0.0		2361463	2280342	9805					
Upper Colorado River Main Stem Total		100.0	2361463		2270537	90926	0.0	0		0	0
Colorado River:											
Green River confluence to San Juan River confluence	0.03	0.0		2641935	2539881	682					
San Juan River confluence to Lee Ferry, AZ	0.05	0.0		2913525	2799225	1337			633100	613439	293
Colorado River Total		0.0	0			2019	0.0	0			293
Total			2913525			115637		633100			19954

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Table B-3. Channel Loss Salvage by River Reach and State for Full Development Conditions
(continued)

River Reach	Salvage by Use (% of use above reach)	Utah: Depletions in Reach (% of State Total for Subregion)	Utah: Depletions in Reach (af)	Utah: Depletions above Reach (af)	Utah: Depletions above Reach Adjusted for Salvage (af)	Utah: Salvage by Use (af)	Wyoming: Depletions in Reach (% of State Total for Subregion)	Wyoming: Depletions in Reach (af)	Wyoming: Depletions above Reach (af)	Wyoming: Depletions above Reach Adjusted for Salvage (af)	Wyoming: Salvage by Use (af)
Green River:											
Above Green River, WY		0.0					56.6	446121			
Green River, WY, to Linwood, UT	0.18	3.0	31048				36.4	286905	446121	446121	815
Linwood, UT, to Yampa River confluence	0.95	0.0		31048	31048	296	0.0		733026	732211	6972
Little Snake River: Above WY-CO State Line		0.0					7.0	55174			
Little Snake River: WY-CO State Line to Lily, CO	0.99	0.0					0.0		55174	55174	546
Yampa River: Above Craig, CO		0.0					0.0				
Yampa River: Craig, CO, to Green River confluence	1.51	0.0					0.0				
Yampa River to Brush Creek confluence	0.23	0.0		31048	30752	71	0.0		788200	779867	1794
Brush Creek to Ashley Creek confluence	0.03	8.8	91074	31048	30682	9	0.0		788200	778073	233
Ashley Creek to Duchesne River confluence	0.81	70.2	726526	122123	121747	986	0.0		788200	777840	6301
Duchesne River to White River confluence	0.00	0.0		848648	847286	0	0.0		788200	771539	0
White River: Above Watson, UT		0.2	2070				0.0				
White River: Watson, UT, to Green River confluence	1.78	0.0		2070	2070	37	0.0				
White River to Price River confluence	0.72	2.2	22769	850718	849319	6115	0.0	-	788200	771539	5555
Price River: Above Heiner, UT		6.3	65201				0.0				
Price River: Heiner, UT, to Green River confluence	0.00	0.0		65201	65201	0	0.0				
Price River to Green River, UT	0.23	1.5	15524	938688	931174	2142	0.0		788200	765984	1762
Green River, UT, to Colorado River confluence	0.94	7.8	80725	954212	944556	8879	0.0		788200	764222	7184
Green River Total		100.0	1034937		935677	18534	100.0	788200		757039	31161
San Juan River:											
Above Rosa, NM		0.0					0.0				
Pine River: Above Ignacio, CO		0.0					0.0				
Pine River: Ignacio, CO, to San Juan River conf.	0.75	0.0					0.0				
Rosa, NM, to Blanco, NM	0.20	0.0					0.0				
Navajo Reservoir depletions (Evap., direct diversions)		0.0					0.0				
Animas River: Above Cedar Hill, NM		0.0					0.0				
Animas River: Cedar Hill, NM, to Farmington, NM	0.67	0.0					0.0				
Blanco, NM, to Farmington, NM	0.71	0.0					0.0				
La Plata River: Above CO-NM State Line		0.0					0.0				
La Plata River: CO-NM State Line to Farmington	8.35	0.0					0.0				
Farmington, NM, to Shiprock, NM	0.59	0.0					0.0				
Chaco River		0.0					0.0				
Shiprock, NM, to Mancos River confluence	0.53	0.0					0.0				
Mancos River: Above Towaoc, CO		0.0					0.0				
Mancos River: Towaoc, CO, to San Juan River conf.	3.42	0.0					0.0				
Mancos River to McElmo Creek confluence	0.71	0.0					0.0				
McElmo Creek: Above Cortez, CO		0.0					0.0				
McElmo Creek: Cortez, CO, to San Juan River conf.	8.41	0.0					0.0				
McElmo Creek to Chinle Creek confluence	0.40	7.3	16721				0.0				
Chinle Creek to Bluff, UT	0.25	10.9	25000	16721	16721	42	0.0				
Bluff, UT, to Colorado River confluence	0.28	10.9	25000	41721	41679	116	0.0				
San Juan River Total		29.0	66721		41563	158	0.0	0		0	0
Upper Colorado River Main Stem:											
Above Glenwood Springs, CO		0.0					0.0				
Glenwood Springs, CO, to Cameo, CO	0.59	0.0					0.0				
Gunnison River: Above Delta, CO		0.0					0.0				
Gunnison River: Delta, CO, to Grand Junction, CO	0.31	0.0					0.0				
Dolores River: Above Dolores, CO		0.0					0.0				
Dolores River: Dolores, CO, to Colorado River conf.	4.66	0.0					0.0				
Cameo, CO, to Cisco, UT	3.22	0.0					0.0				
Cisco, UT, to Green River confluence	0.43	100.0	30083	0			0.0				
Upper Colorado River Main Stem Total		100.0	30083		0	0	0.0	0		0	0
Colorado River:											
Green River confluence to San Juan River confluence	0.03	30.1	69159	1065020	1046486	281	0.0		788200	757039	203
San Juan River confluence to Lee Ferry, AZ	0.05	40.9	94000	1200900	1181927	564	0.0		788200	756835	361
Colorado River Total		71.0	163159			846	0.0	0			565
Total			1294900			19537		788200			31726

Table B-3. Channel Loss Salvage by River Reach and State for Full Development Conditions
(continued)

River Reach	Salvage by Use (% of use above reach)	Upper Division States Shared CRSP Evaporation: Depletions in Reach (% of State Total for Subregion)	Depletions in Reach (af)	Depletions above Reach (af)	Depletions above Reach: Adjusted for Salvage (af)	Salvage by Use (af)	Arizona: Depletions in Reach (% of State Total for Subregion)	Depletions in Reach (af)	Depletions above Reach (af)	Depletions above Reach: Adjusted for Salvage (af)	Salvage by Use (af)
Green River:											
Above Green River, WY											
Green River, WY, to Linwood, UT	0.18		68000								
Linwood, UT, to Yampa River confluence	0.95			68000	68000	648					
Little Snake River: Above WY-CO State Line											
Little Snake River: WY-CO State Line to Lily, CO	0.99										
Yampa River: Above Craig, CO											
Yampa River: Craig, CO, to Green River confluence	1.51										
Yampa River to Brush Creek confluence	0.23			68000	67352	155					
Brush Creek to Ashley Creek confluence	0.03			68000	67198	20					
Ashley Creek to Duchesne River confluence	0.81			68000	67177	544					
Duchesne River to White River confluence	0.00			68000	66633	0					
White River: Above Watson, UT											
White River: Watson, UT, to Green River confluence	1.78										
White River to Price River confluence	0.72			68000	66633	480		–			
Price River: Above Heiner, UT											
Price River: Heiner, UT, to Green River confluence	0.00										
Price River to Green River, UT	0.23			68000	66154	152					
Green River, UT, to Colorado River confluence	0.94			68000	66001	620					
Green River Total			68000		65381	2619		0		0	0
San Juan River:											
Above Rosa, NM											
Pine River: Above Ignacio, CO											
Pine River: Ignacio, CO, to San Juan River conf.	0.75										
Rosa, NM, to Blanco, NM	0.20							200			
Navajo Reservoir depletions (Evap., direct diversions)											
Animas River: Above Cedar Hill, NM											
Animas River: Cedar Hill, NM, to Farmington, NM	0.67										
Blanco, NM, to Farmington, NM	0.71								200	200	1
La Plata River: Above CO-NM State Line											
La Plata River: CO-NM State Line to Farmington	8.35										
Farmington, NM, to Shiprock, NM	0.59							6400	200	199	1
Chaco River											
Shiprock, NM, to Mancos River confluence	0.53								6600	6597	35
Mancos River: Above Towaoc, CO											
Mancos River: Towaoc, CO, to San Juan River conf.	3.42										
Mancos River to McElmo Creek confluence	0.71								6600	6562	47
McElmo Creek: Above Cortez, CO											
McElmo Creek: Cortez, CO, to San Juan River conf.	8.41										
McElmo Creek to Chinle Creek confluence	0.40							500	6600	6516	26
Chinle Creek to Bluff, UT	0.25							8900	7100	6990	17
Bluff, UT, to Colorado River confluence	0.28							3000	16000	15872	44
San Juan River Total			0		0	0		19000		15828	172
Upper Colorado River Main Stem:											
Above Glenwood Springs, CO											
Glenwood Springs, CO, to Cameo, CO	0.59										
Gunnison River: Above Delta, CO			9000								
Gunnison River: Delta, CO, to Grand Junction, CO	0.31			9000	9000	28					
Dolores River: Above Dolores, CO											
Dolores River: Dolores, CO, to Colorado River conf.	4.66										
Cameo, CO, to Cisco, UT	3.22			9000	8972	289					
Cisco, UT, to Green River confluence	0.43			9000	8683	37					
Upper Colorado River Main Stem Total			9000		8646	354		0		0	0
Colorado River:											
Green River confluence to San Juan River confluence	0.03		0	77000	74027	20					
San Juan River confluence to Lee Ferry, AZ	0.05		445000	77000	74007	35		31000	19000	18828	9
Colorado River Total			445000			55		31000			9
Total			522000			3028		50000			181

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Table B-3. Channel Loss Salvage by River Reach and State for Full Development Conditions
(continued)

Notes:

(1) The following on-site depletions in af by subregion and state assume a yield to the Upper Basin at Lee Ferry of 6.2 maf per year and full development of the yield. Each states' depletions were distributed generally to each subregion and river reach based on the distribution of depletions for the 1990s (see Table A-4) with adjustment for authorized and planned uses as indicated. The total yield to the Upper Basin is reduced 0.52 maf per year for shared CRSP evaporation at Lake Powell, Flaming Gorge Reservoir and the Aspinall Unit, thus reducing the yield available for uses within states to 5.68 maf per year, excluding salvage by use (see the November 22, 2005, preliminary draft yield study summary prepared by NMISC and USBR). The subregion amounts shown below for each state are used in this table, except that 161,100 af per year (1996-2000 average) of within-system export from the Dolores River drainage to the San Juan River drainage and 2,400 af of average export from the White River drainage to the Upper Colorado River drainage in Colorado is accounted after the percentage distribution of depletions. Depletions between subregions in Colorado are adjusted for a lesser rate of increase in depletions in the San Juan-Colorado subregion, relative to the other subregions (see note 4).

Subregion	Arizona	Colorado	New Mexico	Utah	Wyoming	Total	Colorado Adjusted	Utah Adjusted
Green River	0	270666	0	1140418	788200	2199285	278072	1034937
Upper Main Stem	0	2144063	0	33149	0	2177212	2202723	30083
San Juan-Colorado	50000	498795	633375	121332	0	1303503	432730	229880
Total	50000	2913525	633375	1294900	788200	5680000	2913525	1294900

(2) The distribution of depletions by river reach are based primarily on the percentage distributions of depletions in the Upper Basin from 1996-2000 shown in Table A-4. Adjustment was made for depletions in the areas of Towaoc and Cortez, Colorado. Navajo Reservoir evaporation is included in the New Mexico depletions, and other Colorado River Storage Project reservoirs are included under Upper Division States Shared CRSP Evaporation. Reservoir evaporation for CRSP reservoirs is net evaporation after salvage of pre-reservoir losses within reservoir basins by inundation (ie, the net depletion of flow due to storage). For the Aspinall Unit, future reservoir operations and evaporation were assumed to be the same as historic: 7,900 af at Blue Mesa Reservoir for 1968-2004; 800 af at Morrow Point Reservoir for 1968-2004; and 300 af at Crystal Reservoir for 1978-2004. For Flaming Gorge Reservoir, the assumed average storage under full development conditions was 70 percent of active capacity or 2,468,800 af. Based on the historic storage and evaporation data, the average evaporation at Flaming Gorge Reservoir under full development is estimated at about 68,000 af. For Lake Powell, future operations under full development conditions were assumed to result in an average active storage of 11,432,600 af and live storage of 15,429,600 af. Based on the current area-capacity relationship, the future average evaporation from Lake Powell is thus estimated at about 445,000 af. Total CRSP shared evaporation is assumed to be 522,000 af. These evaporation assumptions are based on the November 22, 2005, preliminary draft yield study prepared by NMISC and USBR (assuming use of CRSP active storage capacity and all other Upper Basin live storage capacity, with Lake Powell capacity reduced for sedimentation through 2060 and a couple years of shortage).

(3) Salvage rates for river reaches partially inundated by Colorado River Storage Project reservoirs are adjusted for the fraction of losses within the reach that are salvaged, on average, under full development conditions. Data on channel losses for 1914-1945 flow conditions for the indicated river sections within the reservoir basins for Flaming Gorge Reservoir and Lake Powell are from Evaporation Study of Upper Colorado River and Tributaries, Colorado Water Conservation Board, 1948, Tables 3a-3c. Losses for the 12-mile Green River section 66 were prorated to the 10-mile subreach below Linwood and the 2-mile subreach above Linwood, and losses for the 14-mile Colorado River section 8 were prorated to the 5-mile subreach below the San Juan River confluence and the 9-mile subreach above the confluence. For Navajo Reservoir, about 32 miles of the San Juan River are inundated, on average, under full development, of which 27 miles are in the 37-mile Rosa to Blanco reach and 5 miles are above Rosa, and about 13 miles of the Pine River are inundated, on average, under full development within the 27-mile Ignacio to San Juan River confluence reach. Channel loss rates per mile for the San Juan River and Pine River reaches within the Navajo Reservoir basin for 1914-1945 are from the 1948 Engineering Advisory Committee report, page 48. Average channel losses within river reaches inundated by CRSP reservoirs under full Upper Basin development conditions are from Tables C-1 through C-4.

Reservoir	River Reach	Total 1914-1945 Channel Loss in Reach from Table B-1 (af)	River Section Numbers for Sections Partially or Fully Inundated	Average Channel Loss within Inundated Portions under Full Develop. (af)	Remaining River Channel Loss with Reservoir in Place (af)	Remaining River Channel Loss with Reservoir in Place (% of Total Loss for Reach)	Salvage by Use: Table B-1 (% of use above reach)	Salvage by Use: Adjusted (% of use above reach)
Flaming Gorge	Green River: Linwood, UT-Yampa River conf.	26400	61-66	5275	21125	80.0	1.19	0.95
	Green River: Green River, WY-Linwood, UT	21500	66-72	17494	4006	18.6	0.98	0.18
	Total	47900		22769	25131			
Navajo Reservoir	San Juan River: Rosa, NM-Blanco, NM	15800		11502	4298	27.2	0.72	0.20
	Pine River: Ignacio, CO-San Juan River conf.	10000		4823	5177	51.8	1.44	0.75
	Total	25800		16325	9475			
Lake Powell	Colorado River: San Juan River-Lee Ferry, AZ	37200	2- 8	29476	7724	20.8	0.23	0.05
	Colorado River: Green River-San Juan River	57700	8-24	53621	4079	7.1	0.38	0.03
	San Juan River: Bluff, UT-Colorado River conf.	30600	1-14	22265	8335	27.2	1.02	0.28
		125500		105362	20138			

(4) Colorado's depletions on the Animas River were based on the average of 35,800 af for 1996-2000 irrigation and export uses, plus 43,500 af for the Animas-La Plata Project, plus an assumed 15,000 af for other uses, including unused Indian rights (94,300 af total). It is assumed that no return flows from the Animas-La Plata Project uses in Colorado re-enter the San Juan River through the La Plata River. For the Mancos River, McElmo Creek and the San Juan River drainage between McElmo Creek and Chinle Wash, depletions were assumed to equal historic irrigaiton and export depletions for 1996-2000 (see Table A-4) plus 10,000 af, 10,000 af and 5,000 af, respectively, for other uses. The resultant total depletion assumed for the latter three areas combined of 215,430 af under full development conditions, including depletions under the Dolores Project, is about 7.4 percent of total Colorado depletions (current irrigation depletions for the three areas combined average 10.1 percent of current total irrigation plus export depletions in the Upper Basin in Colorado based on the data in Table A-4). For the La Plata River, future depletions were assumed to be 21,600 af for existing irrigation uses, plus 1,500 af for the Long Hollow Reservoir Project, plus 900 af for Red Mesa, plus 3,000 af for other uses (27,000 af). Consequently, under full development conditions, the Animas River is assumed to have a larger percentage of the San Juan-Colorado subregion total depletion and the other four areas are assumed to have a smaller percentage of the subregion total depletion as compared to the distribution of irrigation plus export depletions for the 1990s shown in Table A-4. The development from the Animas River is assumed to be about the same as the amount of development in Colorado above Navajo Dam. Colorado's depletion above Navajo Dam was distributed to the San Juan River and Pine River drainages based on the 1976-1980 relative distribution between drainages. The remainder of Colorado's depletions under full development were distributed to the other subregions in the proportions that their 1990s irrigation plus export depletions beared to one another. Imports of 161,100 af (1996-2000 average) from the Dolores River to the San Juan-Colorado subregion were applied to the depletions in the McElmo Creek and San Juan River drainage below McElmo Creek, leaving return flows of 11,800 af from the Dolores Project to the San Juan River as per the hydrology used in the 2005 Biological Assessment for the Navajo-Gallup Water Supply Project.

Table B-3. Channel Loss Salvage by River Reach and State for Full Development Conditions
(continued)

Notes (continued):

(5) New Mexico's total depletions and depletions distribution is based on the historic and anticipated water development in New Mexico, which includes completion of the Navajo Indian Irrigation Project, the Animas-La Plata Project and the Navajo-Gallup Water Supply Project. New Mexico irrigation depletions differ from those in the April 2005 revised New Mexico Depletions Schedule to include full use of NIIP and crop consumptive uses computed using the modified Blaney-Criddle method (which is consistent with the irrigation depletion assumptions used by the Bureau of Reclamation in the Biological Assessment). Navajo Reservoir evaporation under full development is about 27,700 af per year based on the September 2005 Biological Assessment for the Navajo-Gallup Water Supply Project. Of this amount of evaporation, 15,500 af results from maintenance of the minimum operating level for the NIIP intake at elevation 5990 feet (7400 acres x 2.101 ft average annual evaporation rate from Historical Inflows, Colorado River Storage Project (CRSP), Tom Ryan, October 1993). The remaining 12,200 af of evaporation is chargeable to all states in proportion to their uses from the reservoir, which are: 431,900 af in New Mexico (105,200 af San Juan-Chama Project by exchange; 270,000 af NIIP; 20,800 af Navajo Nation uses under the Navajo-Gallup Water Supply Project; 25,500 af for uses under the Jicarilla Apache Nation Settlement Contract; and 10,400 af under the Hammond Project); 6,400 af in Arizona by Navajo Nation uses under the Navajo-Gallup Project; and 1,000 af in Colorado (Colorado State Parks and Town of Arboles). Thus, 27,500 af of Navajo Reservoir evaporation is charged to New Mexico and 200 af is charged to Arizona. Colorado may be charged with a portion of the Navajo Reservoir evaporation if reoperation of the reservoir to meet the flow recommendations for endangered fish habitat in the San Juan River causes increased reservoir evaporation losses (federal water projects in New Mexico and Colorado both benefit by the Endangered Species Act compliance resulting from said reoperation of Navajo Reservoir). Irrigation depletions greater than those shown in this table for New Mexico can be assumed if one were to account for evaporation losses from sprinkler spray and for possible adjudication of the Navajo Nation's water rights for the Hogback and Fruitland projects based on the modified Blaney-Criddle method. Depletions for the Blanco to Farmington reach of the San Juan River include Citizens Ditch and the Hammond Irrigation Project, depletions for the Animas River include Farmers Mutual Ditch and the City of Farmington, and depletions for the Farmington to Shiprock reach include the Hogback and Fruitland projects, Jewett Valley Ditch, the power plants and most of the Navajo-Gallup Water Supply Project.

(6) Utah's depletions in the San Juan-Colorado subregion were based on the average of 75,880 af of total depletion for 1996-2000 (distributed by river reach according to the distribution of irrigation and export uses for 1996-2000 shown in Table A-4), plus 94,000 af for the St. George-Cedar City Pipeline Project diversion from Lake Powell, plus 50,000 af for assumed Navajo Nation uses (reflecting a possibility of a Utah-Navajo water rights settlement from the San Juan River), plus an assumed 10,000 af for other uses (229,880 af total assumed under full development conditions). Consequently, under full development conditions, the San Juan-Colorado subregion is assumed to have a larger percentage af total assumed under full development conditions). The remainder of Utah's depletions under full development were distributed to the other subregions in the proportions that their 1990s irrigation plus export depletions beared to one another. Of the 50,000 af assumed for a Navajo settlement, half are assumed above Bluff and half below.

(7) Wyoming's depletions under full development conditions were distributed based solely on the distribution of its 1990s irrigation plus export depletions (see Table A-4).

(8) Arizona's depletions include 31,000 af at Lake Powell (Navajo Power Plant and City of Page), 6,400 af of Navajo-Gallup Project uses supplied by diversions from the San Juan River in New Mexico near Kirtland, 12,400 af of ephemeral tributary uses, and 200 af of Navajo Reservoir evaporation.

(9) The following summarizes the average amounts of salvage by use for each state under full development conditions as estimated in this table.

State	On-Site Depletion (af)	Salvage by State Uses (af)	Salvage by State Uses (% of on-site use)	Downstream Losses Salvaged by Shared CRSP Reservoirs (% share)	Downstream Losses Salvaged by Shared CRSP Reservoirs (af)	Total Salvage by Use (af)
Arizona	50000	181	0.36	0.00	0	181
Colorado	2913525	115637	3.97	51.75	1567	117204
New Mexico	633375	19954	3.15	11.25	341	20294
Utah	1294900	19537	1.51	23.00	697	20234
Wyoming	788200	31726	4.03	14.00	424	32150
Upper Basin	5680000	187035	3.29	100.00	3028	190063

(10) Salvage by use in this table excludes salvage on ephemeral tributaries. To the extent that historic on-site depletions for uses on ephemeral tributaries were included in the computation of natural flows without reduction for salvage of channel losses on the ephemeral tributaries, such salvage should not be considered in future use projections. Salvage of losses on ephemeral tributaries could be considered to the extent that future uses exceed historic uses in ephemeral drainages. Based on the San Juan River Basin in New Mexico Navajo Nation Water Rights Settlement Agreement which would define the Navajo Nation's rights in ephemeral drainages in New Mexico by historic use, future uses are not expected to significantly exceed uses that occurred during the critical period at least for New Mexico.

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Table B-4. Allocation of Channel Losses Salvaged by Use

State	Upper Basin Depletion (af)	Total Channel Loss Salvage by Use: Full Development Conditions San Juan River (af)	Full Development Conditions Other Rivers (af)	Full Development Conditions Total (af)	Critical Period San Juan River (af)	Critical Period Other Rivers (af)	Critical Period Total (af)	Allocable Salvage by Use San Juan River (af)	Allocable Salvage by Use Other Rivers (af)	Allocable Salvage by Use Total (af)	On-Site Depletion Allocation with Salvage (af)
Arizona	50000	172	9	181	67	12	79	105	-3	102	50102
Colorado	2913525	11563	105641	117204	1589	70575	72164	9974	35066	45040	2958565
New Mexico	633375	19661	634	20294	4979	381	5360	14682	253	14934	648309
Utah	1294900	158	20076	20234	73	12866	12939	84	7211	7295	1302195
Wyoming	788200	0	32150	32150	0	13800	13800	0	18350	18350	806550
Upper Basin	5680000	31554	158510	190063	6709	97634	104343	24845	60876	85721	5765721

Notes:

(1) Assumes yield for development available to the Upper Basin of 6.2 maf, including Colorado River Storage Project reservoir evaporation, measured at Lee Ferry.

(2) Excludes salvage of channel losses on ephemeral tributaries by historic uses.

(3) Assumes river channel surface area evaporation rates are equal to lake evaporation rates times turbulence factors averaging about 1.15 for the Colorado River between Grand Junction and Lake Powell, 1.12 for the Green River between Flaming Gorge Dam and Lake Powell, and 1.30 for the Juan River. The turbulence factors were based on the consensus of a group of engineers representing Colorado, Utah and the Bureau of Reclamation due to a lack of factual data (see Evaporation Study of Upper Colorado River and Tributaries, Colorado Water Conservation Board, section 5). If a pan coefficient of 0.8 commonly used for estimating free water surface evaporation from small shallow water bodies is applied to determine river channel evaporation rates, which would account for greater heating of the water in the streams during the summer months as compared to large lakes, such rates would average about 1.14 times lake evaporation rates determined using a typical pan coefficient of 0.7 for large deep reservoirs. Using a pan coefficient of 0.8 instead of a turbulence factor of 1.3 for the San Juan River would reduce the amount of allocable salvage from the San Juan River by about 12 percent, resulting in the following allocable salvage amounts.

State	Upper Basin Depletion (af)	Allocable Salvage by Use San Juan River (af)	Allocable Salvage by Use Other Rivers (af)	Allocable Salvage by Use Total (af)	On-Site Depletion Allocation with Salvage (af)
Arizona	50000	92	-3	89	50089
Colorado	2913525	8747	35066	43812	2957337
New Mexico	633375	12875	253	13127	646502
Utah	1294900	74	7211	7284	1302184
Wyoming	788200	0	18350	18350	806550
Upper Basin	5680000	21787	60876	82663	5762663

(4) NMISC is reviewing USGS stream gage discharge measurements to evaluate minimum changes in water surface widths as a function of changes in flows under current (1980-2000) conditions. The stream gaging sites are generally more entrenched and stable than are other locations on the rivers.