APPENDIX F

San Juan River Salvage with Future Conditions

Table F-1. San Juan River Streamflow Gage Hydrograph and Channel Width Data under Pre-Navajo Dam, Critical Period and Future Conditions

Gaging Station	January	February	March	April	May	June	July	August	September	October	November	December
San Juan River at Archuleta												
Average Flows (cfs):												
Blanco Gage Flow (1929-45)	275	434	1124	3406	4863	4178	1386	831	781	755	395	289
Pre-Navajo Dam - Archuleta	275	434	1124	3456	4988	4303	1511	956	906	855	395	289
Critical Period (1955-77)	795	913	935	1467	1938	1949	1134	982	832	833	768	775
Future (NGWSP BA)	322	307	722	1360	2067	1899	417	504	489	409	338	396
Change from Pre-Dam	47	-127	-402	-2096	-2921	-2404	-1094	-452	-417	-446	-57	107
Change from Critical Period	-473	-606	-213	-107	129	-50	-717	-478	-343	-424	-430	-379
Average River Widths (ft):												
Pre-Navajo Dam	158	168	187	210	217	214	193	184	183	181	166	159
Critical Period	180	183	183	192	198	198	187	184	181	181	179	179
Future	162	161	178	191	199	198	167	171	170	166	163	166
Change from Pre-Dam	3	-7	-9	-19	-18	-17	-26	-13	-13	-15	-3	6
Change from Critical Period	-18	-22	-5	-2	1	-1	-20	-14	-11	-14	-17	-14
San Juan River at Farmington												
Average Flows (cfs):												
Pre-Navajo Dam (1914-45)	639	976	1987	4764	8358	8472	3277	1808	1602	1499	884	673
Critical Period (1953-77)	1076	1193	1364	2135	3736	4117	1881	1355	1098	1180	1037	1063
Future (NGWSP BA)	589	604	1128	2114	3981	4350	1164	693	687	717	654	670
Change from Pre-Dam	-50	-372	-859	-2650	-4377	-4122	-2113	-1115	-915	-782	-230	-3
Change from Critical Period	-487	-589	-236	-21	245	233	-717	-662	-411	-463	-383	-393
Average River Widths (ft):												
Pre-Navajo Dam	161	174	195	221	238	239	210	192	189	187	171	163
Critical Period	177	180	184	197	214	217	194	184	178	180	176	177
Future	159	160	178	197	216	219	179	164	164	165	162	163
Change from Pre-Dam	-2	-14	-17	-24	-22	-20	-31	-29	-25	-22	-9	0
Change from Critical Period	-18	-20	-6	0	2	2	-14	-20	-14	-15	-14	-14
San Juan River at Shiprock												
Average Flows (cfs):												
Pre-Navajo Dam (1916-45)	724	1203	2488	5164	8517	8290	3210	2298	1781	1711	955	733
Critical Period (1953-77)	1091	1241	1407	2115	3586	4005	1845	1374	1076	1196	1085	1107
Future (NGWSP BA)	565	600	1103	2124	3930	4274	1114	654	641	713	674	649
Change from Pre-Dam	-159	-603	-1385	-3040	-4587	-4016	-2096	-1644	-1140	-998	-281	-84
Change from Critical Period	-526	-641	-304	9	344	269	-731	-720	-435	-483	-411	-458
Average River Widths (ft):												
Pre-Navajo Dam	188	196	207	218	226	226	211	206	202	201	192	188
Critical Period	194	196	198	204	213	214	202	198	194	196	194	194
Future	184	185	194	204	214	215	195	186	186	188	187	186
Change from Pre-Dam	-4	-11	-13	-14	-12	-10	-16	-19	-16	-14	-5	-2
Change from Critical Period	-10	-11	-4	0	1	1	-8	-11	-8	-8	-7	-8
San Juan River near Bluff												
Average Flows (cfs):												
Pre-Navajo Dam (1914-45)	766	1457	2124	4843	8330	8241	3576	2306	2222	1916	1065	831
Critical Period (1953-77)	1157	1387	1547	2289	3603	4005	1977	1633	1318	1546	1258	1188
Future (NGWSP BA)	702	920	1325	2209	3841	4311	1446	1092	968	992	805	774
Change from Pre-Dam	-64	-537	-799	-2634	-4489	-3930	-2130	-1214	-1254	-924	-260	-57
Change from Critical Period	-455	-467	-222	-80	238	306	-531	-541	-350	-554	-453	-414
Average River Widths (ft):												
Pre-Navajo Dam	145	156	163	177	187	187	172	164	164	161	151	146
Critical Period	152	155	157	164	172	174	162	158	154	157	154	152
Future	143	148	154	164	173	175	156	151	149	149	146	145
Change from Pre-Dam	-2	-8	-8	-14	-14	-12	-16	-13	-15	-12	-5	-1
Change from Critical Period	-9	-7	-3	-1	1	1	-6	-7	-5	-8	-8	-8

Table F-1. San Juan River Streamflow Gage Hydrograph and Channel Width Data under Pre-Navajo Dam, Critical Period and Future Conditions (continued)

Notes:

(1) The pre-Navajo Dam hydrographs are based on data available for water years 1914-1945 published in the 1948 Engineering Advisory Committee report, during which period little water development occurred in New Mexico (the Pine River Project in Colorado was implemented near the end of the period). Differences between pre-Dam flows and 1953-1977 critical period flows reflects regulation by Navajo Reservoir beginning the end of 1962, increases in depletions during the critical period (see Table A-1, note 8), and different hydrologic conditions. Monthly flows during the irrigation season at Archuleta for the 1914-1945 period are estimated based on the mean monthly flows at Blanco for the 1929-1945 period plus 100 cfs for half of April and October and 125 cfs for May-September for assumed irrigation diversions and depletions occuring between the two gage sites. The diversions between Blanco and Archuleta are based on the metered diversions of the Citizens Ditch for 1938 (New Mexico State Engineer Report on Hydrographic Survey of the San Juan River Basin prepared for the Echo Ditch Adjudication), assuming La Pumpa wasteway discharges above the Blanco gage offset irrigation depletions between the gages.

(2) The future flow hydrographs are based on full compact development in New Mexico with projects as currently planned through implementation of the San Juan River Basin in New Mexico Navajo Nation Water Rights Settlement Agreement, including re-regulation of river flows at Navajo Reservoir to meet the San Juan River Basin Recovery Implementation Program's flow recommendations for endangered fish habitat in the San Juan River as necessary to provide Endangered Species Act compliance for existing and future uses in New Mexico and Colorado. The future flow hydrographs include the impacts of: (1) completion of the NIIP with an average depletion of 270,000 af/yr (New Mexico's depletion schedule includes 256,500 af for the NIIP); (2) the Navajo-Gallup Water Supply Project in New Mexico and Arizona; (3) the Animas-La Plata Project in Colorado and New Mexico; and (4) existing and environmental baseline uses in Colorado, New Mexico, Utah and Arizona. Also included in the baseline for Colorado are Red Mesa, Long Hollow and Stevens reservoirs, but not all future development that might occur within Colorado's Upper Basin apportionment. Rehabilitation of the Hogback and Fruitland irrigation projects in New Mexico is not considered, although it could be considered covered by the difference between the depletion for NIIP in New Mexico's depletion schedule and the depletion used in the environmental baseline for ESA purposes. The future flow hydrographs were derived from the Bureau of Reclamation's San Juan River Basin hydrology model as reported in the August 2005 Biological Assessment for the Navajo-Gallup Water Supply Project prepared for Reclamation, Appendix A, Tables A13-A17 (NGWSP+Baseline configuration), and reflect average hydrologic conditions for the period 1929-2000 with future development. The differences in monthly average flows may reflect differences in hydrology between the 1914-1945 period and the 1929-2000 period, as well as differences in depletions between the 1914-1945 period and the future modeled condition. Attached is one figure illustrating the typical future release pattern for Navajo Dam and another figure from the US Fish and Wildlife Service's January 5, 2006, Final Biological Opinion for Navajo Reservoir Operations, Colorado River Storage Project, that graphically illustrates the effects of water development and Navajo Reservoir operations on San Juan River flows near Bluff (the illustration is generally applicable to flows in the San Juan River downstream from the Animas River confluence at Farmington).

(3) The average river widths were estimated from the flow rating measurements provided in Appendix E. Any changes in channel configurations since operation of Navajo Dam began is not considered. Although operation of the dam may have reduced overbank flooding in some stretches of the river and possibly contributed to increased channel entrenchment: (1) overbank flooding likely was not extensive during the critical period due to drought during 1953-1962 and flow regulation by the dam beginning the end of 1962; and (2) data to document changes in width versus flow relationships are not readily available. River cross-section data at several transects on the river were collected by the San Juan River Basin Recovery Implementation Program, all of which indicate variable width versus flow relations at base flows and steady width versus flow relations at high or bank-to-bank flows. Variability in the width to flow relation at low flows when the river is not bank-to-bank appears to be caused by cycles of scour and deposition of sand and cobble substrate (see attached sample transect cross-section data from the San Juan River Basin Recovery Implementation Program's May 1999 Flow Recommendations for the San Juan River), such that there is uncertainty in the estimation of channel widths at low flows even though the widths theoretically will decrease as flows decrease (all else being equal). No post-critical period salvage is estimated to occur in response to reductions in overbank flooding caused by Navajo Reservoir (overbank flows already reduced during critical period due to the reservoir) or in response to geomorphic changes that might have occurred after the critical period as a result of the reservoir in combination with other water development. Infestations of salt cedar and Russian olive along the river banks and on the floodplains below Farmington after the critical period have increased total channel losses from the river, but such infestations and increased evapotranspiration losses likely would have occurred with or without flow regulation by Navajo Dam (increased evapotranspiration losses could offset reduced river water surface evaporation losses in so far as the water physically available at Lake Powell is concerned).

(4) The flow rating measurements for the San Juan River gages are for the period 1985-2004. At the Archuleta gage, the reported channel widths at high flows were about 40-50 feet greater during the late 1980s and early 1990s compared to later years, but the slope of the relation between channel width and flow was similar for both subperiods. Similarly, the channel widths at the Farmington gage at high flows are about 30-40 feet greater prior to the late 1990s, though the slope of the width-flow relation did not change. The slopes of the linear relations of channel widths to flows shown in Table D-1 reflect constancy in the relations despite shifts up or down in widths caused by cycles of deposition and scour within the river channel. For the analysis in this table, average river channel widths are based on log functions averaged for all flow rating measurements as shown below. Use of the log functions fit through all the flow rating measurement data gives a conservatively high sensitivity of width to flow at high flows, recognizes scatter in the data at low flows, and provides for transition in the width to flow relations near the flow level at which the river comes into contact with both banks (such transition is evident in the data such as is illustrated by the figures in Appendix E but is not reflected in the summary information provided in Table D-1). Changes in flows in some instances occur within or across such transitions.

Gaging Station	Log Function	
Archuleta	$w = 20.279 \ln(x) + 44.512$	w = channel width
Farmington	$w = 29.892 \ln(x) - 31.694$	x = flow
Shiprock	$w = 15.464 \ln(x) + 86.021$	
Bluff	$w = 17.795 \ln(x) + 26.499$	

(5) Critical period flows are used to determine Upper Basin yield and already include salvage occuring, on average, through that period. Therefore, estimates of salvage to compare depletion impacts against the yield include only salvage accruing after the critical period. For this analysis, changes in flows and channel widths reflect future flow conditions as compared to 1953-1977 average conditions. Note that considerable reductions in flows and channel widths are shown in this table for the winter months of November-February as compared to the critical period, which is a result of future Navajo Reservoir operations to mimic the natural hydrograph in the San Juan River below Farmington with low winter flows as compared to historic reservoir operations to make relatively uniform dam releases with relatively high releases during the winter. Future river flows during the winter months will be similar to pre-Navajo Dam winter flows (that is, no net salvage of river channel losses during the winter months as compared to pre-Navajo Dam conditions).

Table F-2. Anticipated Channel Loss Salvage in the San Juan River after Post-Critical Period Water Development from Navajo Reservoir and Reservoir Reoperation

River Reach	January	February	March	April	May	June	July	August	September	October	November	December	Annual
Navajo Dam-Farmington (47 mi):													
Change in Channel Width (ft)	-18.2	-21.2	-5.5	-0.9	1.6	0.6	-17.3	-16.8	-12.4	-14.7	-15.2	-13.7	
Change in Surface Area (ac)	-103.5	-120.9	-31.1	-5.2	9.1	3.2	-98.7	-95.6	-70.6	-83.5	-86.7	-78.1	
River Evap Rate (ft)	0.12	0.12	0.25	0.45	0.56	0.64	0.61	0.54	0.40	0.26	0.12	0.04	4.10
Change in Evap Losses (af)	-13	-15	-8	-2	5	2	-60	-51	-28	-21	-10	-3	-205
Farmington-Shiprock (37 mi):													
Change in Channel Width (ft)	-14.1	-15.8	-4.7	-0.1	1.7	1.3	-11.1	-15.8	-11.0	-11.4	-10.6	-11.0	
Change in Surface Area (ac)	-63.2	-70.8	-21.2	-0.5	7.4	5.9	-49.7	-70.7	-49.4	-51.3	-47.4	-49.5	
River Evap Rate (ft)	0.13	0.13	0.27	0.48	0.60	0.70	0.66	0.58	0.43	0.28	0.13	0.05	4.45
Change in Evap Losses (af)	-8	-9	-6	0	4	4	-33	-41	-21	-14	-6	-2	-133
Shiprock-Bluff (105 mi):													
Change in Channel Width (ft)	-9.5	-9.3	-3.3	-0.3	1.3	1.2	-6.7	-9.3	-6.8	-7.9	-7.7	-7.9	
Change in Surface Area (ac)	-121.3	-118.0	-41.5	-3.6	16.3	14.7	-85.1	-118.6	-85.9	-101.1	-97.4	-101.1	
River Evap Rate (ft)	0.15	0.15	0.31	0.54	0.68	0.78	0.75	0.66	0.48	0.31	0.14	0.05	5.00
Change in Evap Losses (af)	-18	-18	-13	-2	11	12	-63	-78	-42	-32	-14	-5	-261
Bluff-Lake Powell (52 mi):													
Change in Channel Width (ft)	-8.9	-7.3	-2.8	-0.6	1.1	1.3	-5.6	-7.2	-5.5	-7.9	-7.9	-7.6	
Change in Surface Area (ac)	-56.0	-46.0	-17.4	-4.0	7.2	8.3	-35.1	-45.1	-34.6	-49.8	-50.1	-48.1	
River Evap Rate (ft)	0.17	0.17	0.34	0.61	0.76	0.88	0.83	0.73	0.54	0.35	0.16	0.06	5.60
Change in Evap Losses (af)	-9	-8	-6	-2	5	7	-29	-33	-19	-17	-8	-3	-122
Total, Navajo Dam-Lake Powell:													
Change in Evap Losses (af)	-48	-49	-32	-7	26	25	-186	-204	-110	-85	-38	-14	-722

Notes:

(1) This table estimates anticipated salvage of channel evaporation losses in the San Juan River as a result of full compact development in New Mexico, including re-regulation of river flows at Navajo Reservoir to meet the San Juan River Basin Recovery Implementation Program's flow recommendations for endangered fish habitat as necessary to provide Endangered Species Act compliance for existing and future uses in New Mexico and Colorado. Salvage of pre-reservoir losses within Navajo Reservoir is not included (see Table F-3).

(2) Changes in river channel widths from the 1914-1945 period to future conditions are averaged for gages at the top and bottom of each river reach from the data in Table F-1.

(3) The annual river evaporation rates for each reach are from Table D-3 (see Table D-3, note 2). The annual evaporation rates were distributed monthly based on the following mean monthly pan evaporation rates at Farmington given in New Mexico State Engineer Technical Report 31 (Figure 5). About 55 percent of the river evaporation rate is assumed to occur during April-July.

	January	February	March	April	May	June	July	August	September	October	November	December	Annual
Pan Evaporation (in)	2.00	2.00	4.10	7.30	9.10	10.50	10.00	8.80	6.50	4.20	1.90	0.70	67.10
River Evap (pan x 0.8)	1.60	1.60	3.28	5.84	7.28	8.40	8.00	7.04	5.20	3.36	1.52	0.56	53.68
Evap Rate (ft)	0.13	0.13	0.27	0.49	0.61	0.70	0.67	0.59	0.43	0.28	0.13	0.05	4.47
Evap Rate (%)	2.98	2.98	6.11	10.88	13.56	15.65	14.90	13.11	9.69	6.26	2.83	1.04	100.00

(4) The San Juan River between the Bluff gage and Lake Powell is within a canyon-bound reach, and is channelized between Navajo Dam and Shiprock. Relatively few sections of the river are braided with side channels. An attached figure from the San Juan River Basin Recovery Implementation Program's May 1999 Flow Recommendations shows relationships of backwater areas in the river from above Shiprock at the Hogback Project diversion dam to Lake Powell (reaches 1-5) under varied conditions with side channels having been flushed by high spring runoff flows or non-flushed of sediment deposits accruing from ephemeral tributaries during the summer thunderstorm season. The attached figure indicates that the total area of backwaters below the Hogback diversion dam ranges from about 12 acres at flows between 1500 cfs and 3000 cfs to about 30 acres at either low base flows or flows above about 4000 cfs. The small amount of backwater area suggests that the river is fairly well channelized, and this in combination with the San Juan River transect data of the Recovery Implementation Program suggest that the flow rating measurements at the gage station may be reasonably used to represent the sensitivity of river surface area to flow generally for purposes of this salvage analysis (particularly when Table F-1 uses the log functions relating channel width to flow, which functions give conservatively high sensitivity of width to flow for high flows).

(5) The total annual reduction in river channel evaporation losses indicated in this table is an estimate of the losses salvaged by use under the future condition modeled in the Bureau of Reclamation's August 2005 Biological Assessment for the Navajo-Gallup Water Supply Project. The salvage amount is distributed to Arizona, Colorado and New Mexico based on the difference between the future depletions modeled and the average total depletion in each state that occurred historically during the 1953-1977 critical period. While the post-critical period increase in depletions above each river reach might be segregated and accounted separately by state for determining salvage by each state within each reach, assuming the increases in depletions all occur at Navajo Reservoir is adequate for this evaluation of the magnitude of salvage creditable to each state. The bulk of the post-critical period water development is supported either directly from the Navajo Reservoir water supply (uses from the San Juan River in New Mexico and Arizona) or indirectly through flow regulation at Navajo Reservoir to offset federal water development (uses in Colorado and New Mexico from San Juan River tributaries).

	Depletions (af)			State %	State
	Critical			Share of Depletion	Share of Salvage
State	Period	Future	Change	Increase	(af)
Arizona	0	6600	6600	1.06	8
Colorado	85300	222100	136800	22.02	159
New Mexico	159500	637300	477800	76.92	555
Total			621200		722

Notes:

(a) Arizona depletions only for Navajo-Gallup Water Supply Project and associated share of Navajo Reservoir evaporation (see Table B-3, note 5).
(b) Critical period depletions for Colorado and New Mexico are the average depletions for the San Juan-Colorado subregion for 1953-77 (see Table A-1).
(c) Future depletions for Colorado and New Mexico are from the August 2005 Navajo-Gallup Project Biological Assessment, Table A3, with adjustments for each state's share of Animas-La Plata Project depletions and unspecified minor depletions.

Table F-2a. Anticipated Channel Loss Salvage in the San Juan River after Pre-Dam Period Water Development from Navajo Reservoir and Reservoir Reoperation

River Reach	January	February	March	April	May	June	July	August	September	October	November	December	Annual
Navajo Dam-Farmington (47 mi):													
Change in Channel Width (ft)	0.4	-10.7	-13.0	-21.6	-20.0	-18.3	-28.5	-20.8	-18.9	-18.5	-6.1	3.1	
Change in Surface Area (ac)	2.2	-60.9	-73.8	-123.1	-114.0	-104.0	-162.5	-118.6	-107.7	-105.4	-34.7	17.8	
River Evap Rate (ft)	0.12	0.12	0.25	0.45	0.56	0.64	0.61	0.54	0.40	0.26	0.12	0.04	4.10
Change in Evap Losses (af)	0	-7	-18	-55	-63	-67	-99	-64	-43	-27	-4	1	-447
Farmington-Shiprock (37 mi):													
Change in Channel Width (ft)	-3.1	-12.6	-14.8	-19.0	-17.1	-15.1	-23.7	-24.0	-20.6	-17.8	-7.2	-1.0	
Change in Surface Area (ac)	-14.1	-56.3	-66.2	-85.3	-76.5	-67.7	-106.1	-107.9	-92.2	-79.8	-32.3	-4.5	
River Evap Rate (ft)	0.13	0.13	0.27	0.48	0.60	0.70	0.66	0.58	0.43	0.28	0.13	0.05	4.45
Change in Evap Losses (af)	-2	-7	-18	-41	-46	-47	-70	-63	-40	-22	-4	0	-361
Shiprock-Bluff (105 mi):													
Change in Channel Width (ft)	-2.7	-9.5	-10.5	-13.9	-12.9	-10.9	-16.2	-16.4	-15.3	-12.6	-5.2	-1.6	
Change in Surface Area (ac)	-34.3	-120.5	-133.5	-176.3	-163.8	-138.6	-206.7	-208.3	-194.7	-160.7	-66.0	-20.0	
River Evap Rate (ft)	0.15	0.15	0.31	0.54	0.68	0.78	0.75	0.66	0.48	0.31	0.14	0.05	5.00
Change in Evap Losses (af)	-5	-18	-41	-96	-111	-108	-154	-137	-94	-50	-9	-1	-825
Bluff-Lake Powell (52 mi):													
Change in Channel Width (ft)	-1.6	-8.2	-8.4	-14.0	-13.8	-11.5	-16.1	-13.3	-14.8	-11.7	-5.0	-1.3	
Change in Surface Area (ac)	-9.8	-51.6	-52.9	-88.0	-86.8	-72.7	-101.6	-83.8	-93.2	-73.8	-31.4	-8.0	
River Evap Rate (ft)	0.17	0.17	0.34	0.61	0.76	0.88	0.83	0.73	0.54	0.35	0.16	0.06	5.60
Change in Evap Losses (af)	-2	-9	-18	-54	-66	-64	-85	-62	-51	-26	-5	0	-440
Total, Navajo Dam-Lake Powell:													
Change in Evap Losses (af)	-8	-41	-95	-246	-287	-286	-408	-325	-227	-125	-22	-1	-2073

Notes:

(1) This table estimates anticipated salvage of channel evaporation losses in the San Juan River as a result of full compact development in New Mexico, including re-regulation of river flows at Navajo Reservoir to meet the San Juan River Basin Recovery Implementation Program's flow recommendations for endangered fish habitat as necessary to provide Endangered Species Act compliance for existing and future uses in New Mexico and Colorado. Salvage of pre-reservoir losses within Navajo Reservoir is not included (see Table F-3).

(2) Changes in river channel widths from the 1914-1945 period to future conditions are averaged for gages at the top and bottom of each river reach from the data in Table F-1.

(3) The annual river evaporation rates for each reach are from Table D-3 (see Table D-3, note 2). The annual evaporation rates were distributed monthly based on the following mean monthly pan evaporation rates at Farmington given in New Mexico State Engineer Technical Report 31 (Figure 5). About 55 percent of the river evaporation rate is assumed to occur during April-July.

	January	February	March	April	May	June	July	August	September	October	November	December	Annual
Pan Evaporation (in)	2.00	2.00	4.10	7.30	9.10	10.50	10.00	8.80	6.50	4.20	1.90	0.70	67.10
River Evap (pan x 0.8)	1.60	1.60	3.28	5.84	7.28	8.40	8.00	7.04	5.20	3.36	1.52	0.56	53.68
Evap Rate (ft)	0.13	0.13	0.27	0.49	0.61	0.70	0.67	0.59	0.43	0.28	0.13	0.05	4.47
Evap Rate (%)	2.98	2.98	6.11	10.88	13.56	15.65	14.90	13.11	9.69	6.26	2.83	1.04	100.00

(4) The San Juan River between the Bluff gage and Lake Powell is within a canyon-bound reach, and is channelized between Navajo Dam and Shiprock. Relatively few sections of the river are braided with side channels. An attached figure from the San Juan River Basin Recovery Implementation Program's May 1999 Flow Recommendations shows relationships of backwater areas in the river from above Shiprock at the Hogback Project diversion dam to Lake Powell (reaches 1-5) under varied conditions with side channels having been flushed by high spring runoff flows or non-flushed of sediment deposits accruing from ephemeral tributaries during the summer thunderstorm season. The attached figure indicates that the total area of backwaters below the Hogback diversion dam ranges from about 12 acres at flows between 1500 cfs and 3000 cfs to about 30 acres at either low base flows or flows above about 4000 cfs. The small amount of backwater area suggests that the river is fairly well channelized, and this in combination with the San Juan River transect data of the Recovery Implementation Program suggest that the flow rating measurements at the gage station may be reasonably used to represent the sensitivity of river surface area to flow generally for purposes of this salvage analysis (particularly when Table F-1 uses the log functions relating channel width to flow, which functions give conservatively high sensitivity of width to flow for high flows).

(5) The total annual reduction in river channel evaporation losses indicated in this table is an estimate of the losses salvaged by use under the future condition modeled in the Bureau of Reclamation's August 2005 Biological Assessment for the Navajo-Gallup Water Supply Project. The salvage amount is distributed to Arizona, Colorado and New Mexico based on the difference between the future depletions modeled and the average total depletion in each state that occurred historically during the 1953-1977 critical period. While the post-dam period increase in depletions above each river reach might be segregated and accounted separately by state for determining salvage by each state within each reach, assuming the increases in depletions all occur at Navajo Reservoir is adequate for this evaluation of the magnitude of salvage creditable to each state. The bulk of the post-critical period water development is supported either directly from the Navajo Reservoir water supply (uses from the San Juan River in New Mexico and Arizona) or indirectly through flow regulation at Navajo Reservoir to offset federal water development (uses in Colorado and New Mexico from San Juan River tributaries).

State	Depletions (af) 1914-45 Period	Future	Change	State % Share of Depletion Increase	State Share of Salvage (af)
Arizona	0	6600	6600	0.93	19
Colorado	80600	222100	141500	19.84	411
New Mexico	72200	637300	565100	79.23	1642
Total			713200		2073

Notes:

(a) Arizona depletions only for Navajo-Gallup Water Supply Project and associated share of Navajo Reservoir evaporation (see Table B-3, note 5).

(b) Pre-dam period depletions for Colorado and New Mexico are the average depletions for the San Juan-Colorado subregion for 1914-45 (see Table A-1).

(c) Future depletions for Colorado and New Mexico are from the August 2005 Navajo-Gallup Project Biological Assessment, Table A3, with adjustments for each state's share of Animas-La Plata Project depletions and unspecified minor depletions.

Table F-3. Anticipated Salvage of Pre-Reservoir Losses within the Navajo Reservoir Basin in Excess of Salvage Occurring during the Critical Period

Evaluation A:

During the period 1962-1977, Navajo Reservoir by inundation of the San Juan River and the Pine River reduced total river channel losses by about 16,100 af per year (see Table C-4). Based on this estimate, the amount of channel loss reduction within the reservoir basin due to inundation averaged about 10,300 af per year over the length of the 1953-1977 critical period. Under full development conditions, the total reduction in river channel losses within the reservoir basin is anticipated to be about 18,500 af per year (see Table C-4). Thus, the amount of channel loss reduction due to inundation within Navajo Reservoir that would be creditable as the average amount of water salvaged after the critical period would be about 8,200 af, the bulk of which would be creditable to New Mexico (as is the bulk of Navajo Reservoir evaporation). However, because the Bureau of Reclamation uses average monthly evaporation factors to account net evaporation at Colorado River Storage Project reservoirs that are already reduced for salvage of pre-reservoir losses, no additional salvage can be credited towards other depletions. Reclamation's monthly evaporation factors amount to a lake evaporation rate of 2.15 feet, which is net of gross evaporation less precipitation and salvage of pre-reservoir losses (see Historical Inflows, Colorado River Storage Project, Bureau of Reclamation, October 1993). Estimates of the annual gross lake evaporation rate at Navajo Dam range from about 3.35 feet (see Evaporation Study of Upper Colorado River and Tributaries, Colorado Water Conservation Board, 1948) to about 3.58 feet (see New Mexico State Engineer Technical Report 31, Figure 5 mean pan evaporation for El Vado times a pan coefficient of 0.7). Using a gross evaporation rate of 3.58 feet and mean annual precipitation of 10 inches (see Technical Report 31, Figure 2), the net evaporation rate without consideration of salvage of pre-reservoir losses is about 2.74 feet, on average. The amount of credit provided New Mexico for salvage of pre-reservoir losses as a result of Reclamation using its monthly evaporation factors is estimated as follows (average water surface elevations for Navajo Reservoir are based on Table C-4, and average surface areas are based on the latest available area-capacity tables for the reservoir dated September 2000):

Condition	Average Elevation (ft)	Average Surface Area (ac)	Net Lake Evap at 2.74 ft (af)	Evap Reduced for Salvage at 2.15 ft (af)	Salvage (af)	Comments
1962-1977 Average	6006	8390	22989	18039	4950	Amounts would be greater if average end-of-month contents used instead of end-of-year.
Critical Period					3168	Reflects the 1962-77 period salvage amount spread over the 1953-77 critical period.
Full Development	6059	12605	34538	27101	7437	NGWSP Biological Assessment gives 27,900 af net evap under future conditions using Reclamation evap factors (the difference is due to the Assessment using end-of-month contents and due to the non-linearity of the elevation-area relation for the reservoir).
Increase after Critical Period					4269	Creditable amount of salvage by inundation after the critical period.

Based on this evaluation, the Bureau of Reclamation's Navajo Reservoir evaporation calculations reduce the amount of evaporation from Navajo Reservoir by 7,400 af per year for salvage by inundation even though about 3,200 af of this salvage amount (or about 42 percent) was already included within the gaged flows and Upper Basin yield for the critical period. These salvage amounts would be greater if lake evaporation were not reduced for precipitation, but the alternative reporting of Navajo Reservoir evaporation by the Interstate Stream Commission to Reclamation for use in the Colorado River System Consumptive Uses and Losses reports have in the past used net evaporation rates. This evaluation indicates the difference in evaporation calculations between past ISC reporting and use of Reclamation's evaporation factors.

Evaluation B:

Losses within the Navajo Reservoir basin are the sum of gross evaporation losses from the lake water surface and the river water surface, plus consumptive uses by riparian streamside vegetation rooted within the water table, vegetation on floodplain terraces that has access to capillary ground water, and upland hillside vegetation that depends on precipitation for water (including areas considered barren). A pre-reservoir survey of the basin indicates that of the total basin area, about 6 percent was river channel 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). It is assumed for this evaluation that the relative amounts of river and vegetative area did not vary significantly with elevation. To compute lake evaporation, a gross lake evaporation rate of 3.58 ft per year is used (see Evaluation A). To compute river evaporation losses, a gross river evaporation rate of 4.09 ft per year is used (that is, the lake evaporation rate adjusted for a pan coefficient of 0.8 instead of 0.7). For riparian, terrace and upland areas, vegetation consumptive uses are computed using the average of the normal consumptive use rates, including precipitation, shown in Table 8 of the 1948 Engineering Advisory Committee report for the Dulce and Bloomfield-Shiprock areas of New Mexico for very dense, light and sparse native vegetation, respectively. The results of this evaluation are as follows using the average lake surface area under the full development condition as the basin area (see Evaluation A):

	Lake Evaporation (3.58 af/ac)		River Evaporation (4.09 af/ac)		Riparian Use (3.00 af/ac)		Terrace Use (1.78 af/ac)		Upland Use (0.67 af/ac)			
Condition	Average Lake Surface Area (ac)	Gross Lake Evap (af)	Average River Surface Area (ac)	Gross River Evap (af)	Average Riparian Area (ac)	Riparian Area CU (af)	Average Terrace Area (ac)	Terrace Area CU (af)	Average Upland Area (ac)	Upland Area CU (af)	Total Losses (af)	Total Losses Excluding Lake Evap (af)
Pre-Reservoir	0	0	756	3093	882	2647	3151	5609	7815	5236	16586	16586
1962-1977 Average	8390	30036	253	1034	295	885	1054	1876	2613	1751	35582	5546
Full Development	12605	45126	0	0	0	0	0	0	0	0	45126	0

The total losses under full development conditions are estimated to be 28,500 af per year greater than under pre-reservoir conditions, which is comparable to the average future Navajo Reservoir evaporation of 27,900 af per year determined by the August 2005 Biological Assessment for the Navajo-Gallup Water Supply Project. This result suggests that use of Reclamation's evaporation coefficients for Navajo Reservoir reflects full salvage of pre-reservoir losses and results in reservoir evaporation amounts that on average are nearly equivalent to the reduction in streamflow at the damsite caused by storage of water in the reservoir. The anticipated future Navajo Reservoir evaporation amount used in New Mexico's depletion schedule is 27,900 af.

Also, this evaluation suggests that pre-reservoir losses during the period 1953-1961 averaged 16,600 af and that losses within the same reservoir area during the period 1962-1977 averaged 5,500 af, excluding reservoir evaporation. Thus, for the control area used for this evaluation, the total losses excluding reservoir evaporation averaged about 9,500 af during the 1953-1977 critical period. Based on this evaluation, the Navajo Reservoir evaporation calculations reduce the amount of evaporation from the reservoir by 16,600 af per year for salvage by inundation under future or full development conditions even though about 7,100 af of this salvage amount (or about 43 percent) occurred during the critical period and is reflected in the gaged flows used to determine the Upper Basin yield. If the lake evaporation rate is used for the river and upland use is not considered (similar to Reclamation's evaporation analyses for Lake Powell, see Table F-4), then the pre-reservoir losses are estimated at 11,000 af, the losses during the 1962-1977 period averaged 3,700 af excluding lake evaporation, and the losses during the critical period averaged 6,300 af excluding lake evaporation.

Table F-4. Anticipated Salvage of Pre-Reservoir Losses within the Basins of CRSP Reservoirs in Excess of Salvage Occurring during the Critical Period

Lake Powell:

Losses within the Lake Powell basin are the sum of gross evaporation losses from the lake water surface and the river water surface, plus consumptive uses by riparian streamside vegetation rooted within the water table, vegetation on floodplain terraces that has access to capillary ground water, and upland hillside vegetation that depends on precipitation for water (including areas considered barren). The pre-reservoir survey of the Lake Powell basin indicates that of the total basin area, about 12 percent was river channel surface area, 2 percent was streamside riparian area, 4 percent was terrace area (including farmland), and 82 percent was upland hillside area (see Survey of Vegetation in the Glen Canyon Reservoir Basin, University of Utah Department of Anthropology, Anthropological Papers Number 36, Glen Canyon Series Number 5, January 1959, page 28). The relationships between pre-reservoir river and vegetative areas and elevations within the basin used here, however, are provided in Lake Powell Evaporation, Bureau of Reclamation, August 1986, Figures 4-6. To compute lake water surface evaporation, a gross evaporation rate of 5.79 ft per year is used (see Lake Powell Evaporation, Bureau of Reclamation, August 1986, Table 4 and page 14). To compute river evaporation losses, a gross evaporation rate of 6.62 ft per year is used (the lake evaporation rate adjusted for a pan coefficient of 0.8 instead of 0.7). For riparian, terrace and upland areas, vegetation consumptive uses are computed using the normal consumptive use rates, including precipitation, shown in Table 8 of the 1948 Engineering Advisory Committee 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. The results of this evaluation are as follows using the average lake surface area under the full development condition as the basin area (average lake elevations are from Table C-1, notes 4 and 5, and average lake areas are from the 1963 Lake Powell area-capacity tables):

		Lake Evaporation (5.79 af/ac)		River Evaporation (6.62 af/ac)		Riparian Use (3.88 af/ac)		Terrace Use (2.59 af/ac)		Upland Use (0.41 af/ac)			
Condition	Average Lake Surface Elev (ft)	Average Lake Surface Area (ac)	Gross Lake Evap (af)	Average River Surface Area (ac)	Gross River Evap (af)	Average Riparian Area (ac)	Riparian Area CU (af)	Average Terrace Area (ac)	Terrace Area CU (af)	Average Upland Area (ac)	Upland Area CU (af)	Total Losses (af)	Total Losses Excluding Lake Evap (af)
Pre-Reservoir		0	0	18340	121411	28380	110114	6100	15799	59190	24268	271592	271592
1963-1977 Average	3589	92670	536559	880	5826	280	1086	70	181	18110	7425	551078	14518
Full Development	3624	112010	648538	0	0	0	0	0	0	0	0	648538	0

The following alternate evaluation assumes that the river evaporation rate is the same as the lake evaporation rate, and that effective water surface evaporation, streamside use and terrace use coefficients are as provided in Historical Inflows, Colorado River Storage Project, Bureau of Reclamation, October 1993, last page (no losses are accounted for upland uses). The lake and river evaporation rate of 5.24 ft is described as effective evaporation (gross evaporation minus precipitation).

		Lake Evaporation (5.24 af/ac)		River Evaporation (5.24 af/ac)		Riparian Use (2.79 af/ac)		Terrace Use (2.34 af/ac)		Upland Use (0.00 af/ac)			
Condition	Average Lake Surface Elev (ft)	Average Lake Surface Area (ac)	Gross Lake Evap (af)	Average River Surface Area (ac)	Gross River Evap (af)	Average Riparian Area (ac)	Riparian Area CU (af)	Average Terrace Area (ac)	Terrace Area CU (af)	Average Upland Area (ac)	Upland Area CU (af)	Total Losses (af)	Total Losses Excluding Lake Evap (af)
Pre-Reservoir		0	0	18340	96102	28380	79180	6100	14274	59190	0	189556	189556
1963-1977 Average	3589	92670	485591	880	4611	280	781	70	164	18110	0	491147	5556
Full Development	3624	112010	586932	0	0	0	0	0	0	0	0	586932	0

Adjusting the alternate evaluation above to use gross lake evaporation (which treats precipitation is an inflow) gives:

		Lake Evaporation (5.79 af/ac)		River Evaporation (5.79 af/ac)		Riparian Use (2.79 af/ac)		Terrace Use (2.34 af/ac)		Upland Use (0.00 af/ac)			
Condition	Average Lake Surface Elev (ft)	Average Lake Surface Area (ac)	Gross Lake Evap (af)	Average River Surface Area (ac)	Gross River Evap (af)	Average Riparian Area (ac)	Riparian Area CU (af)	Average Terrace Area (ac)	Terrace Area CU (af)	Average Upland Area (ac)	Upland Area CU (af)	Total Losses (af)	Total Losses Excluding Lake Evap (af)
Pre-Reservoir		0	0	18340	106189	28380	79180	6100	14274	59190	0	199643	199643
1963-1977 Average	3589	92670	536559	880	5095	280	781	70	164	18110	0	542600	6040
Full Development	3624	112010	648538	0	0	0	0	0	0	0	0	648538	0

Using Reclamation's methodology and vegetation consumptive use coefficients, but with an adjustment to use gross water surface evaporation losses to determine total losses, the total losses under full development conditions are estimated to be about 449,000 af per year greater than under pre-reservoir conditions, which is comparable to the average future Lake Powell net evaporation of 445,000 af per year determined as described in Table B-3, note 2. This result suggests that use of Reclamation's evaporation coefficients for Lake Powell, which were used to develop the evaporation assumptions for historic and future reservoir operations, reflects full salvage of pre-reservoir losses and results in reservoir evaporation amounts that on average are nearly equivalent to the reduction in streamflow at the damsite caused by storage of water in the reservoir (using Reclamation loss analyses instead of the 1948 EAC report loss and consumptive use rates).

Also, this evaluation suggests that pre-reservoir losses during the period 1953-1962 averaged about 200,000 af and that losses within the same reservoir area during the period 1963-1977 averaged 6,000 af, excluding reservoir evaporation. Thus, for the control area used for this evaluation, the total losses excluding reservoir evaporation averaged about 83,600 af during the 1953-1977 critical period. Based on this evaluation, the Lake Powell evaporation calculations reduce the amount of evaporation from the reservoir by 200,000 af per year for salvage by inundation under future or full development conditions even though about 116,400 af of this salvage amount (or about 58 percent) occurred during the critical period and is reflected in the gaged flows used to determine the Upper Basin yield. Under the first evaluation that uses higher evaporation and consumptive use rates, the estimated amount of salvage would be greater but Reclamation's evaporation calculations would not credit the additional amount of estimated salvage to the Upper Basin states.

Flaming Gorge Reservoir:

Losses within the Flaming Gorge Reservoir basin are the sum of gross evaporation losses from the lake water surface and the river water surface, plus consumptive uses by riparian streamside vegetation rooted within the water table, vegetation on floodplain terraces that has access to capillary ground water, and upland hillside vegetation that depends on precipitation for water (including areas considered barren). It is assumed that the pre-reservoir river channel surface area within the 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 remainder of the total basin area, 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). It is assumed for this evaluation that the relative amounts of river and vegetative area did not vary significantly with elevation. To compute lake evaporation, a gross lake evaporation rate of 2.67 ft per year is used (based on the elevation-evaporation curve for the Green River in the 1948 Engineering Advisory Committee report at page 47). To compute river evaporation losses, a gross river evaporation rate of 3.05 ft per year is used (the lake evaporation rate adjusted for a pan coefficient of 0.8 instead of 0.7). For riparian, terrace and upland areas, vegetation consumptive uses are based on the normal consumptive use rates, including precipitation, shown in Table 8 of the 1948 Engineering Advisory Committee report for the Henry's Fork area of Wyoming for very dense, light and sparse native vegetation, respectively. The results of this evaluation are as follows using the average lake surface area under the full development condition as the basin area (average lake elevations are from Table C-2, notes 4 and 5, and average lake areas are derived from historic storage-evaporation data provided in Reclamation's November 22, 2005, draft Upper Basin yield study, Colorado River Storage Project evaporation data, with linear interpolation on reservoir contents to surface areas):

		Lake Evaporation (2.67 af/ac)		River Evaporation (3.05 af/ac)		Riparian Use (2.20 af/ac)		Terrace Use (1.30 af/ac)		Upland Use (0.48 af/ac)			
Condition	Average Lake Surface Elev (ft)	Average Lake Surface Area (ac)	Gross Lake Evap (af)	Average River Surface Area (ac)	Gross River Evap (af)	Average Riparian Area (ac)	Riparian Area CU (af)	Average Terrace Area (ac)	Terrace Area CU (af)	Average Upland Area (ac)	Upland Area CU (af)	Total Losses (af)	Total Losses Excluding Lake Evap (af)
Pre-Reservoir		0	0	1943	5926	1522	3348	7305	9496	21610	10373	29143	29143
1962-1977 Average	5985	26000	69420	383	1168	300	660	1439	1871	4258	2044	75162	5742
Full Development	6003	32380	86455	0	0	0	0	0	0	0	0	86455	0

The total losses under full development conditions are estimated to be 57,300 af per year greater than under pre-reservoir conditions, which is comparable to an average future Flaming Gorge Reservoir net evaporation of 68,000 af per year computed using the estimated average lake surface area and Reclamation's net effective evaporation factor of 2.10 ft for the reservoir provided in Historical Inflows, CRSP, Reclamation, October 1993. There would be little difference between the two estimates if the evaluation did not include a higher evaporation rate for the river surface or pre-reservoir losses in upland hillside areas. The result suggests that use of Reclamation's evaporation factors for Flaming Gorge Reservoir reflects salvage of pre-reservoir losses and results in reservoir evaporation amounts that on average are similar to the reduction in streamflow at the damsite caused by storage of water in the reservoir.

Also, this evaluation suggests that pre-reservoir losses during the period 1953-1961 averaged 29,100 af and that losses within the same reservoir area during the period 1962-1977 averaged 5,700 af, excluding reservoir evaporation. Thus, for the control area used for this evaluation, the total losses excluding reservoir evaporation averaged about 14,100 af during the 1953-1977 critical period. Based on this evaluation, the Navajo Reservoir evaporation calculations reduce the amount of evaporation from the reservoir by 29,100 af per year for salvage by inundation under future or full development conditions even though about 15,000 af of this salvage amount (or about 52 percent) occurred during the critical period and is reflected in the gaged flows used to determine the Upper Basin yield. If the lake evaporation rate is used for the river and upland use is not considered (similar to Reclamation's evaporation analyses for Lake Powell), then the pre-reservoir losses are estimated at 18,000 af, the losses during the 1962-1977 period averaged 3,550 af excluding lake evaporation, and the losses during the critical period averaged 8,750 af excluding lake evaporation.

Aspinall Unit:

No similar evaluation of pre-reservoir evaporation losses, vegetation consumptive use and salvage by inundation is made for the Aspinall Unit because detailed vegetation data are lacking. Based on Table C-3, average river channel losses salvaged under full development conditions is about 4,600 af, and the salvage that occurred on average during the critical period amounted to roughly half that amount (2,300 af). This compares to Aspinall Unit evaporation of about 9,000 af per year under normal operating conditions (see Reclamation's November 22, 2005, draft Upper Basin Yield Study, Historic Storage and Evaporation at Colorado River Storage Project Reservoirs). The river channel salvage figures for the Apsinall Unit do not include pre-reservoir upland hillside losses, which may be significant within the Blue Mesa Reservoir basin.

Allocation of Post-Critical Period Salvage to States:

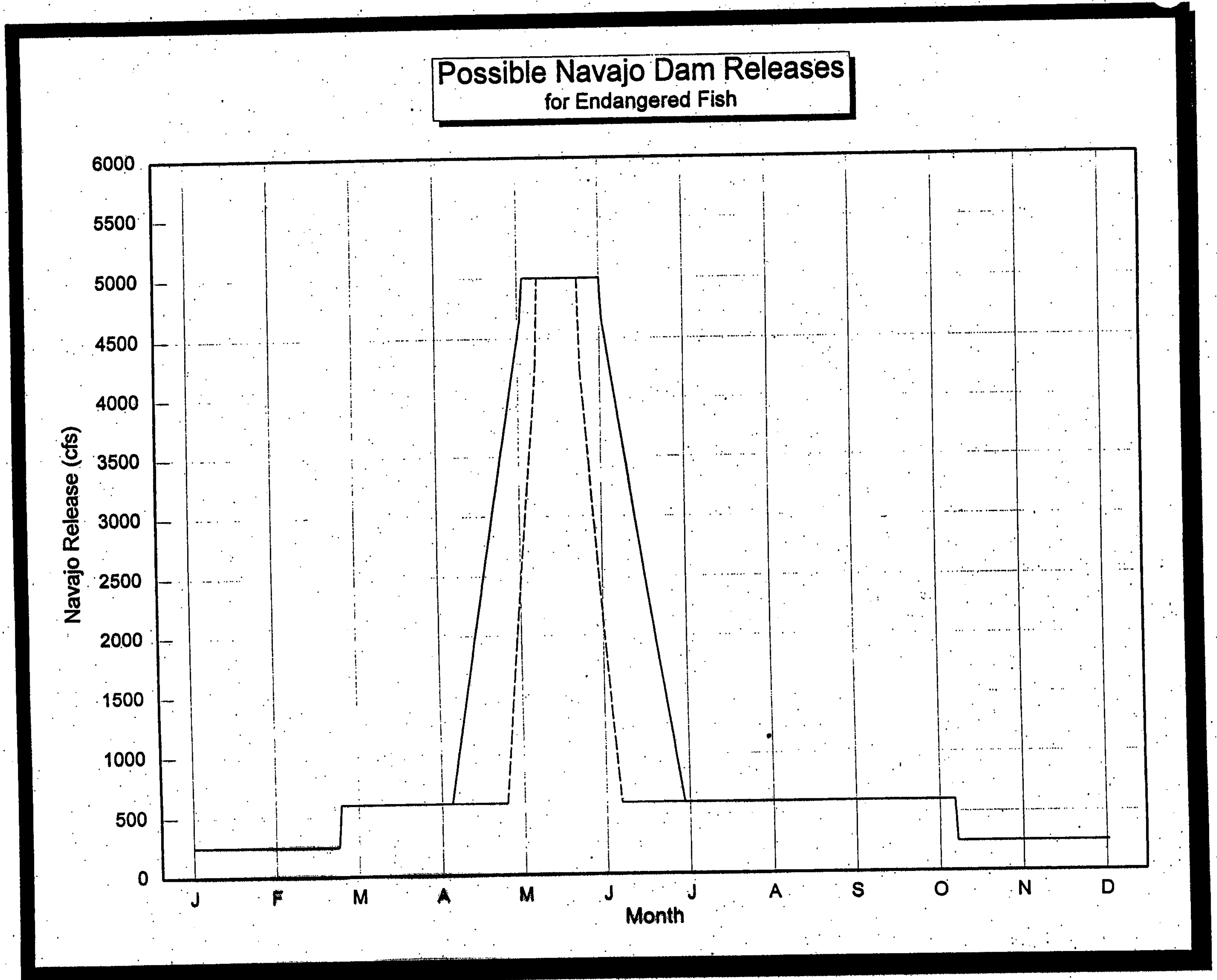
The following allocations are based on the CRSP salvage by inundation evaluations in Tables F-3 and F-4, and on distributing shared CRSP evaporation and salvage in accordance with the Upper Colorado River Basin Compact Article III(a) apportionment percentages for the Upper Division States. The minimum salvage amounts based on the Bureau of Reclamation approach to pre-reservoir losses are used to reflect salvage credited using Reclamation's evaporation factors for CRSP reservoirs.

	Salvage with Full Development (af)					Salvage after Critical Period (af)					
State	Lake Powell	Flaming Gorge Reservoir	Aspinall Unit	Navajo Reservoir	Total	Lake Powell	Flaming Gorge Reservoir	Aspinall Unit	Navajo Reservoir	Total	Total Salvage before Critical Period (af)
Arizona	0	0	0	77	77	0	0	0	44	44	33
Colorado	103500	9315	2381	0	115196	43263	4528	1190	0	48981	66214
New Mexico	22500	2025	518	10923	35966	9405	984	259	6256	16904	19061
Utah	46000	4140	1058	0	51198	19228	2013	529	0	21770	29429
Wyoming	28000	2520	644	0	31164	11704	1225	322	0	13251	17913
Total	200000	18000	4600	11000	233600	83600	8750	2300	6300	100950	132650

Assuming Reclamation's evaporation factors for CRSP reservoirs were used to determine reservoir evaporation and natural flows for the critical period, the Upper Basin yield reflects a measure of impact on streamflow that storage in CRSP reservoirs had during the critical period. Continued use of Reclamation's evaporation factors is necessary for consistency in evaluating water supply and demand, and provides further credit to the Upper Basin for salvage by inundation accruing after the critical period. The following compares salvage credited through use of the Reclamation evaporation factors for CRSP reservoirs and the salvage by use amounts allocated by the Secretary of the Interior in hydrologic studies prepared for evaluation of water supplies to support the Colorado River Basin Projects Act (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 HR 4671 and similar bills, Lower Colorado River Basin Project, August 23-September 1, 1965, Serial No. 17, pages 229-230 and 463-464) and the 1970 Colorado River Reservoirs Long-Range Operating Criteria pursuant to said Act (see 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"). The DOI/USBR salvage amounts were based on 4 percent salvage of river losses by use for Upper Basin projects but account for less than a full development condition (as compared to salvage by inundation within CRSP reservoir basins).

	DOI/USBR Salvage by Use Estimates with Future Development (af)		Credited Salvage by Storage in CRSP under Full Use with USBR Evap (af)		Maximum Salvage by Storage in CRSP under Full Use with EAC Report Evap and CU Rates (af)	
State	CRBPA	LROC	Total	After Critical Period	Total	After Critical Period
Arizona		0	77	44	100	60
Colorado		121000	115196	48981	157993	69242
New Mexico		21000	35966	16904	50846	24493
Utah		18000	51198	21770	70219	30774
Wyoming		31000	31164	13251	42742	18732
Total	164000	191000	233600	100950	321900	143300

Note: New Mexico's historic position based on the 1948 EAC report and the 1965 Tipton-Kalmbach Study is that New Mexico be apportioned 24,000 af for salvage by use under full development.


Possible Navajo Dam Releases
for Endangered Fish
Navajo Release (cfs)
6000
5500
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
J
F
M
A
M
J
J
A
S
O
N
D
Month

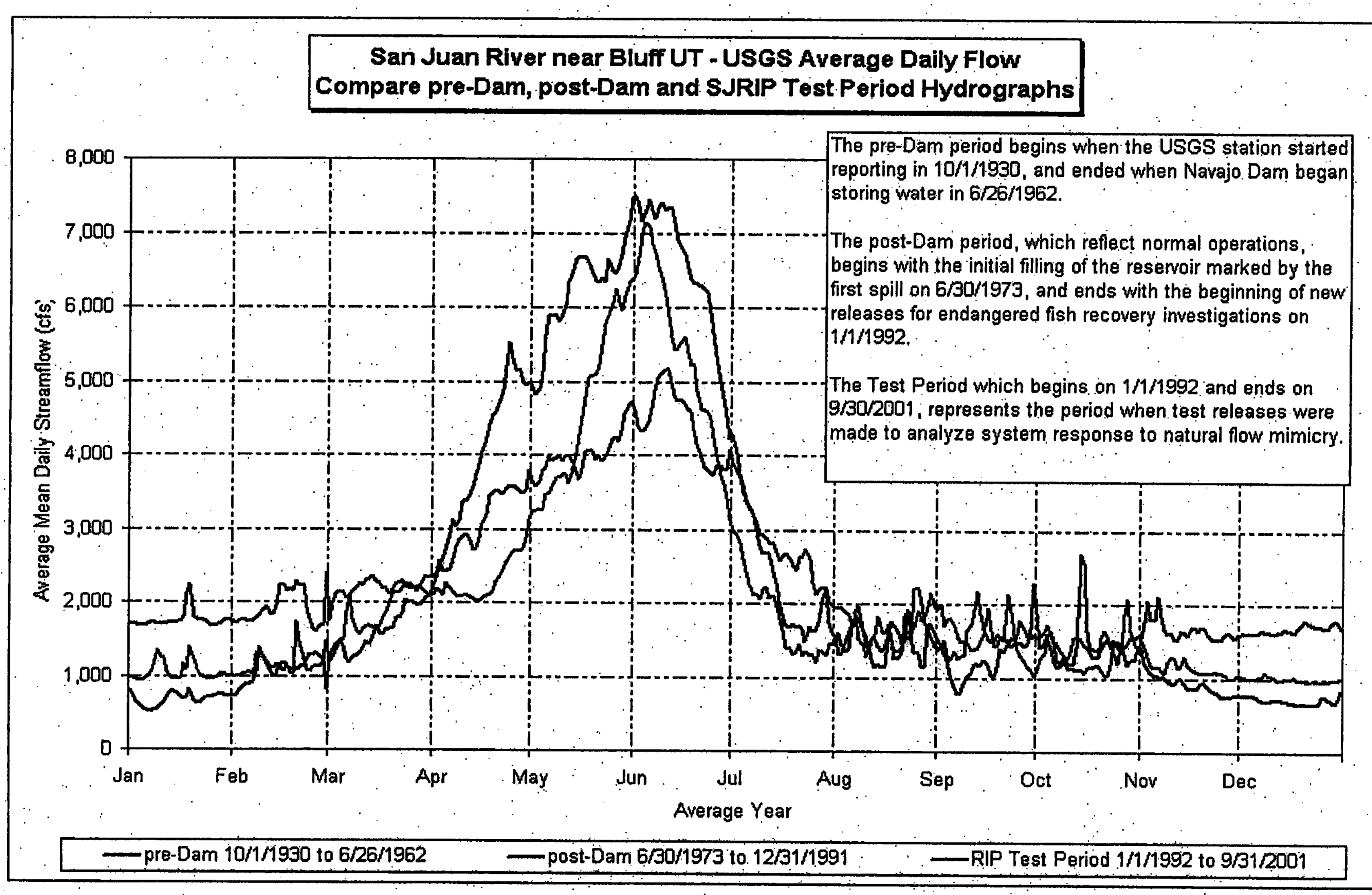


Figure 2. . Graph comparing pre-Navajo Dam, post-Navajo Dam (pre-Flow Recommendations), and proposed action flow of San Juan River past the Bluff gage.

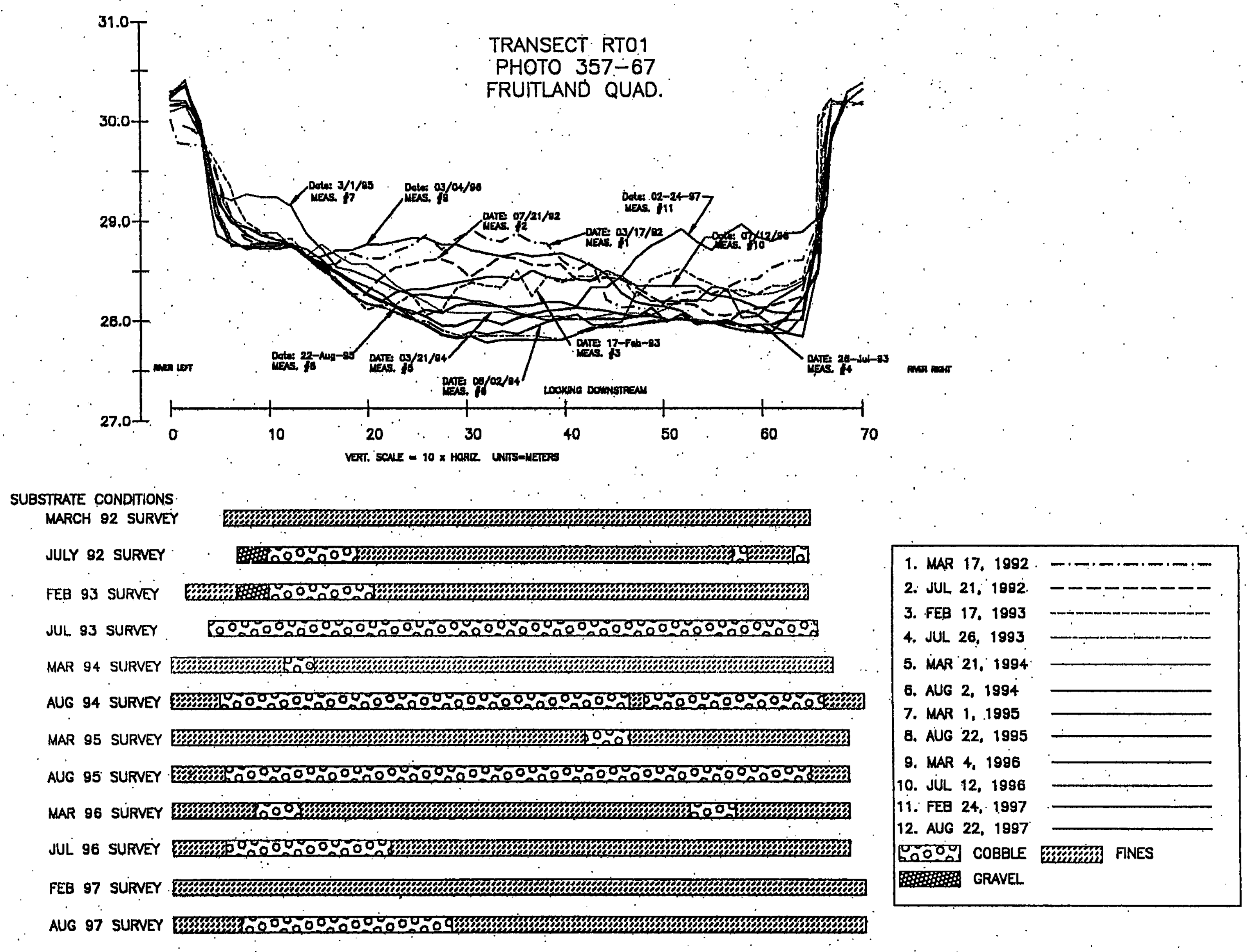


Figure 4.1. Cross-section surveys of the San Juan River at River Transect (RT) 01 for the period 1992 to 1997.

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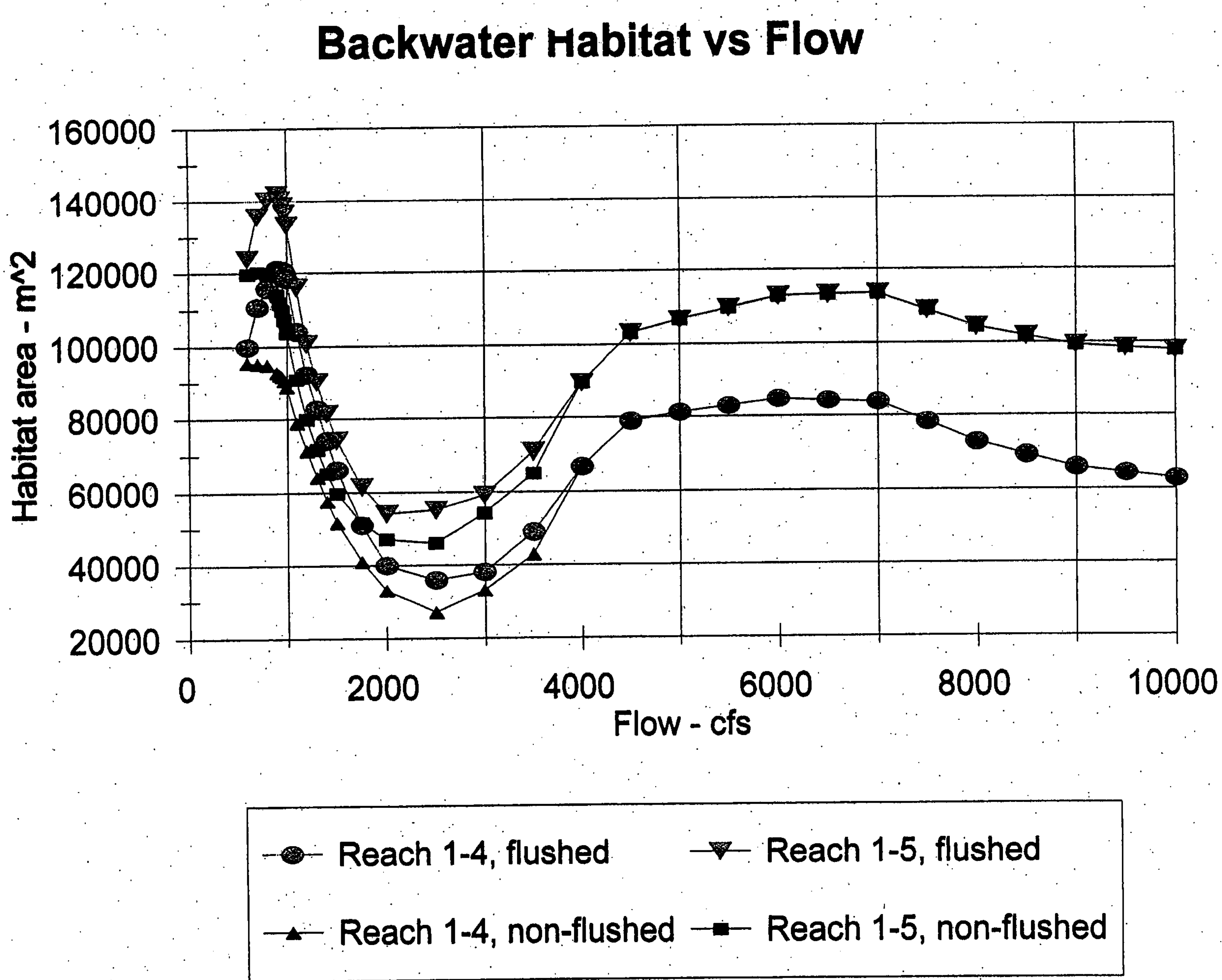


Figure 7.3. **Flow/backwater habitat model for Reaches 1 to 4 and 1 to 5 based on flushed and nonflushed conditions.**

OSE-0501

1 KILOMETERS MILES

RS =
FREQUENCY = 349
SUM-LENGTHKM = ~~549.403892~~ ~~341~~ NA

2
RS = Navajo D am to Animas & San Juan confluence
FREQUENCY = 84
SUM-LENGTHKM = 71.874909 45

3
RS = Animas & San Juan confluence to Shiprock gage
FREQUENCY = 58
SUM-LENGTHKM = 58.844095 37

4
RS = Shiprock gage to Mancos River confluence
FREQUENCY = 21
SUM-LENGTHKM = 41.81067 26

5
RS = Mancos R iver confluence to McElmo Creek confluence
FREQUENCY = 18
SUM-LENGTHKM = 40.444647 25

6
RS = McElmo C reek confluence to Bluff gage
FREQUENCY = 23
SUM-LENGTHKM = 87.217323 54

7
RS = Bluff ga ge to head Lake Powell
FREQUENCY = 29
SUM-LENGTHKM = 88.873039 55 52 adj.

8
RS = Head Lak e Powell to Green & Colorado confluence
FREQUENCY = 13
SUM-LENGTHKM = 39.733894 25

9
RS = Green & Colorado confluence to Dolores confluence
FREQUENCY = 38
SUM-LENGTHKM = 156.878056 97

10
RS = Green & Colorado confluence to Green R. UT gage
FREQUENCY = 30
SUM-LENGTHKM = 193.133795 120

11
RS = Green R. UT gage to Price & Green confluence
FREQUENCY = 13

SUM-LENGTHKM = 29.904463 19

12

RS = Price & Green confluence to Price nr Heiner gage
FREQUENCY = 72
SUM-LENGTHKM = 179.848695 112

13

RS = Price & Green confluence to White & Green confluen
FREQUENCY = 51
SUM-LENGTHKM = 174.665173 108

14

RS = White & Green confluence to Duchesne nr Randlett g
FREQUENCY = 55
SUM-LENGTHKM = 25.931747 16

15

RS = Duchesne nr Randlett gage to at Myton gage
FREQUENCY = 76
SUM-LENGTHKM = 39.355903 24

16

RS = White & Green confluence to White nr Watson gage
FREQUENCY = 119
SUM-LENGTHKM = 106.48563 66

17

RS = White nr Watson gage to White & Piceace confluence
FREQUENCY = 131
SUM-LENGTHKM = 124.641067 77

18

RS = White & Green confluence to Green nr Jensen gage
FREQUENCY = 58
SUM-LENGTHKM = 114.931993 71

19

RS = Green nr Jensen gage to Green & Yampa confluence
FREQUENCY = 16
SUM-LENGTHKM = 45.179143 28

20

RS = Green & Yampa confluence to Flaming Gorge Dam
FREQUENCY = 36
SUM-LENGTHKM = 105.843808 66

21

RS = Green & Yampa to Little Snake & Yampa confluence
FREQUENCY = 76
SUM-LENGTHKM = 81.831121 51

22

RS = Colorado & Dolores confluence to CO-UT State Line

FREQUENCY = 12
SUM-LENGTHKM = 61.672032 38
23
RS = CO-UT State Line to Gunnison & Colorado confluence
FREQUENCY = 32
SUM-LENGTHKM = 57.157675 35
24
RS = Gunnison & Colorado confluence to Colorado nr Cameo
FREQUENCY = 20
SUM-LENGTHKM = 46.26749 29
25
RS = Colorado nr Cameo gage to bl Glenwood gage
FREQUENCY = 66
SUM-LENGTHKM = 108.913342 68
26
RS = Gunnison & Colorado confluence to Gunnison at Delta
FREQUENCY = 32
SUM-LENGTHKM = 91.977305 57
27
RS = Little Snake & Yampa confluence to Yampa nr Maybel
FREQUENCY = 26
SUM-LENGTHKM = 59.264491 37
28
RS = Yampa nr Maybell to bl Craig gage
FREQUENCY = 29
SUM-LENGTHKM = 82.628954 51
29
RS = La Plata & San Juan confluence to La Plata at CO-NM
FREQUENCY = 75
SUM-LENGTHKM = 40.769247 25
30
RS = Mancos & San Juan confluence to Mancos nr Tawaoc gage
FREQUENCY = 19
SUM-LENGTHKM = 40.246256 25
31
RS = San Juan & McElmo Creek confluence to McElmo nr Cortez gage
FREQUENCY = 27
SUM-LENGTHKM = 71.850703 45
32
RS = Colorado & Dolores confluence to McPhee Dam.
FREQUENCY = 154
SUM-LENGTHKM = 295.02046 183
33

RS = Gunnison at Delta gage to Blue Mesa Dam
FREQUENCY = 53
SUM-LENGTHKM = 106.060356 66

34

RS = San Juan & Animas confluence to Cedar Hill gage
FREQUENCY = 55
SUM-LENGTHKM = 63.177406 39

35

RS = Animas R iver above Cedar Hill gage
FREQUENCY = 78
SUM-LENGTHKM = 139.777576 87

36

RS = Colorado River above Glenwood Springs gage
FREQUENCY = 212
SUM-LENGTHKM = 290.772786 181

37

RS = Colorado River in Lake Powell
FREQUENCY = 309
SUM-LENGTHKM = 430.867363 268

38

RS = Dolores River in McPhee Reservoir
FREQUENCY = 11
SUM-LENGTHKM = 18.344274 11

39

RS = Duchesne River above Myton
FREQUENCY = 126
SUM-LENGTHKM = 150.64559 94

40

RS = Green Ri ver in Flaming Gorge Reservoir
FREQUENCY = 134
SUM-LENGTHKM = 119.959803 74

41

RS = Green Ri ver above Flaming Gorge Reservoir
FREQUENCY = 344
SUM-LENGTHKM = 436.105601 271

42

RS = Flaming Gorge Reservoir tributaries
FREQUENCY = 150
SUM-LENGTHKM = 181.044269 112

43

RS = Dolores River above McPhee Reservoir
FREQUENCY = 59
SUM-LENGTHKM = 88.202832 55

44

RS = Blue Mes a Reservoir tributaries
FREQUENCY = 42
SUM-LENGTHKM = 54.146641 34

45

RS = Gunnison River above Blue Mesa Reservoir
FREQUENCY = 24
SUM-LENGTHKM = 25.965506 16

46

RS = Gunnison River in Blue Mesa Reservoir
FREQUENCY = 35
SUM-LENGTHKM = 36.938466 23

47

RS = Little S nake & Yampa confluence to CO-WY State Lin
FREQUENCY = 104
SUM-LENGTHKM = 123.355891 77

48

RS = Little S nake on CO-WY State Line
FREQUENCY = 69
SUM-LENGTHKM = 155.073373 96

49

RS = White Ri ver above Piceance confluence
FREQUENCY = 76
SUM-LENGTHKM = 77.741775 48

50

RS = Price Ri ver above Heiner
FREQUENCY = 16
SUM-LENGTHKM = 39.551056 25

51

RS = Price Ri ver in Scofield Reservoir
FREQUENCY = 13
SUM-LENGTHKM = 16.061033 10

52

RS = Mancos n r Tawoac gage to Mancos, CO
FREQUENCY = 36
SUM-LENGTHKM = 78.241845 49

53

RS = Mancos R iver above Mancos, CO
FREQUENCY = 7
SUM-LENGTHKM = 24.014971 15

54

RS = McElmo C reek above Cortez gage
FREQUENCY = 19

SUM-LENGTHKM = 38.158989 24

55

RS = La Plata River above NM-CO State Line

FREQUENCY = 23

SUM-LENGTHKM = 65.979699 41

56

RS = San Juan River tributaries in Lake Powell

FREQUENCY = 66

SUM-LENGTHKM = 69.724371 43

57

RS = Piedra River in Navajo Reservoir

FREQUENCY = 32

SUM-LENGTHKM = 91.929193 57

58

RS = Los Pinos River in Navajo Reservoir

FREQUENCY = 17

SUM-LENGTHKM = 23.091056 14

59

RS = San Juan River tributaries in Navajo Reservoir

FREQUENCY = 29

SUM-LENGTHKM = 53.432605 33

60

RS = San Juan River in Lake Powell

FREQUENCY = 95

SUM-LENGTHKM = 90.591157 56

61

RS = San Juan River in Navajo Reservoir

FREQUENCY = 23

SUM-LENGTHKM = 46.150337 29

62

RS = San Juan River above Navajo Reservoir

FREQUENCY = 57

SUM-LENGTHKM = 107.642765 67

63

RS = Yampa River above Craig gage

FREQUENCY = 127

SUM-LENGTHKM = 162.132917 101

1

NAME = Little S nake River

FREQUENCY = 175

SUM-LENGTHKM = 279.075524 173

2

NAME = Strawber ry River

FREQUENCY = 141

SUM-LENGTHKM = 172.611555 107

3

NAME = San Rafa el River

FREQUENCY = 45

SUM-LENGTHKM = 170.367076 106

4

NAME = Escalant e River

FREQUENCY = 161

SUM-LENGTHKM = 205.779001 128

5

NAME = San Juan River

FREQUENCY = 521

SUM-LENGTHKM = 785.182405 488

6

NAME = Colorado River

FREQUENCY = 702

SUM-LENGTHKM = 192.262639 119

7

NAME = Green Ri ver

FREQUENCY = 834

SUM-LENGTHKM = 400.886138 249

8

NAME = Price Ri ver

FREQUENCY = 101

SUM-LENGTHKM = 235.460783 146

9

NAME = Duchesne River

FREQUENCY = 257

SUM-LENGTHKM = 215.93324 134

10

NAME = White Ri ver

FREQUENCY = 324

SUM-LENGTHKM = 308.750382 192

11

NAME = Yampa Ri ver

FREQUENCY = 258

SUM-LENGTHKM = 385.857484 240

12

NAME = Gunnison River
FREQUENCY = 186
SUM-LENGTHKM = 315.088274 196

13

NAME = Plata River, La
FREQUENCY = 98
SUM-LENGTHKM = 106.748946 66

14

NAME = Mancos River
FREQUENCY = 62
SUM-LENGTHKM = 142.503072 88

15

NAME = McElmo Creek
FREQUENCY = 46
SUM-LENGTHKM = 110.009692 68

16

NAME = Dolores River
FREQUENCY = 224
SUM-LENGTHKM = 401.567566 249

17

NAME = Animas River
FREQUENCY = 133
SUM-LENGTHKM = 202.954982 126

18

NAME = Piedra River
FREQUENCY = 31
SUM-LENGTHKM = 86.443763 54

pre-d : $Q_{D1} = I + P - L_1$ [30] — salvage

post-dam $Q_{D2} = I + P - E_G$

$I - [(E_G - P) - L_1]$ (salv.)

$E_N = 58{,}900 - (16500 \times .83)$ ~13,700

$= 45{,}200$ 8,200

6,800

$\frac{\text{Loss}}{\text{mean loss}} = c_1 + b_1 * \frac{\text{inflow}}{\text{mean inflow}}$

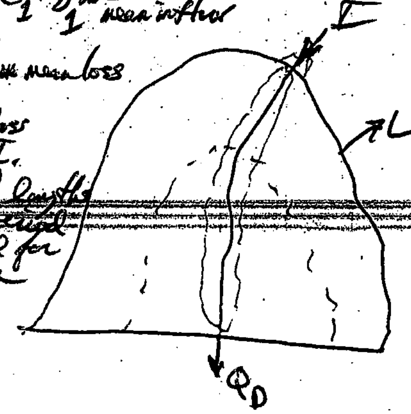
$\text{Loss} = [c_1 + b_1 \frac{\text{inf}}{\text{mean inf}}] * \text{mean loss}$

$\Delta \text{Loss} = b_1 \frac{\Delta \text{inf}}{\text{mean inf}} * \text{mean loss}$

~~prorated to stream lengths~~

~~reflects by crit. period~~

salvage, reduced for CO use salvage



$b_1 = .51$ SJ_{Ro-BL}

$= .77$ SJ/CO

BL-LF

Net riverdep $= E_G - L_1 = 58{,}900 - 15{,}800$

$= 43{,}100$

$L_1 = A_{River} * E_{RG} + A_{Rip} * CU_{Rip} + A_u * P_{eff}$ $[+ A_L * (PE * .7)]$

(Pan EV. * .8)

$= 1000 \times (5.1 \times .8) + 1200 \times 1.4 + 14300 \times .7$

500 600 7100

$= 15{,}800$

7850

Rio Grande – P_{eff} = 1. USBR manual

2. Total P

3. 100% 1st 3" plus 50% rest

$L_1 > P$ by 1-2,000 AF

Δ ave. salvage critical period 1953-77 ≅ ½ of diff. = 500-1000 AF

filled in mid 1960s

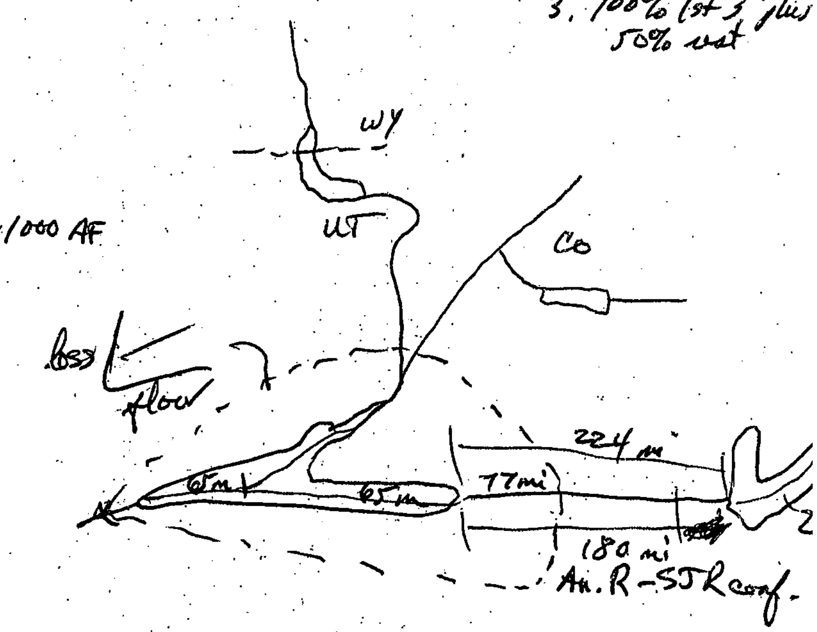
-30 L_1 $(I - (E_G - L_1)) = N_a$

+50 E_L $N_b = I - (E_L + L_1)$ N_a comp. 50 → 20

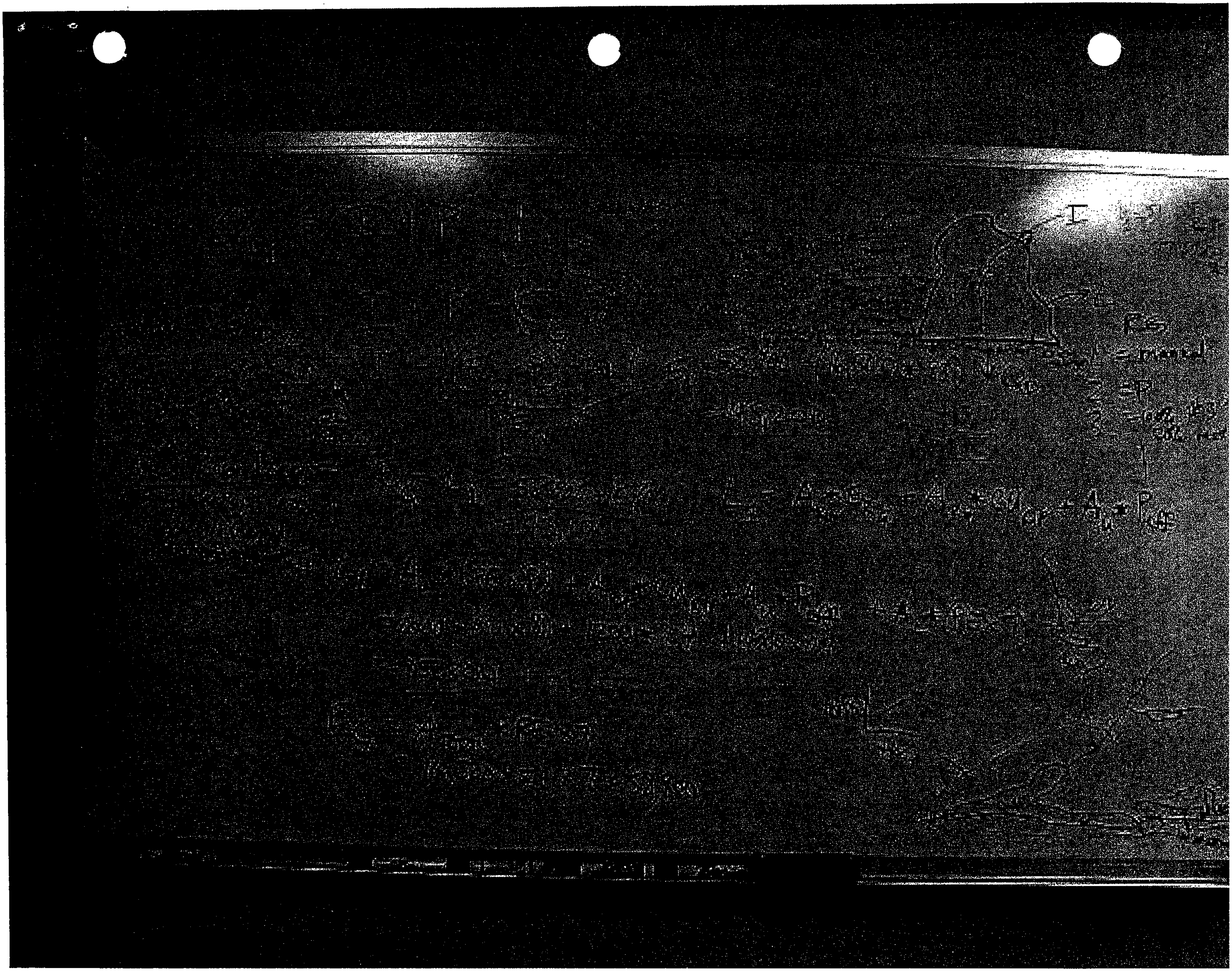
G_b -30

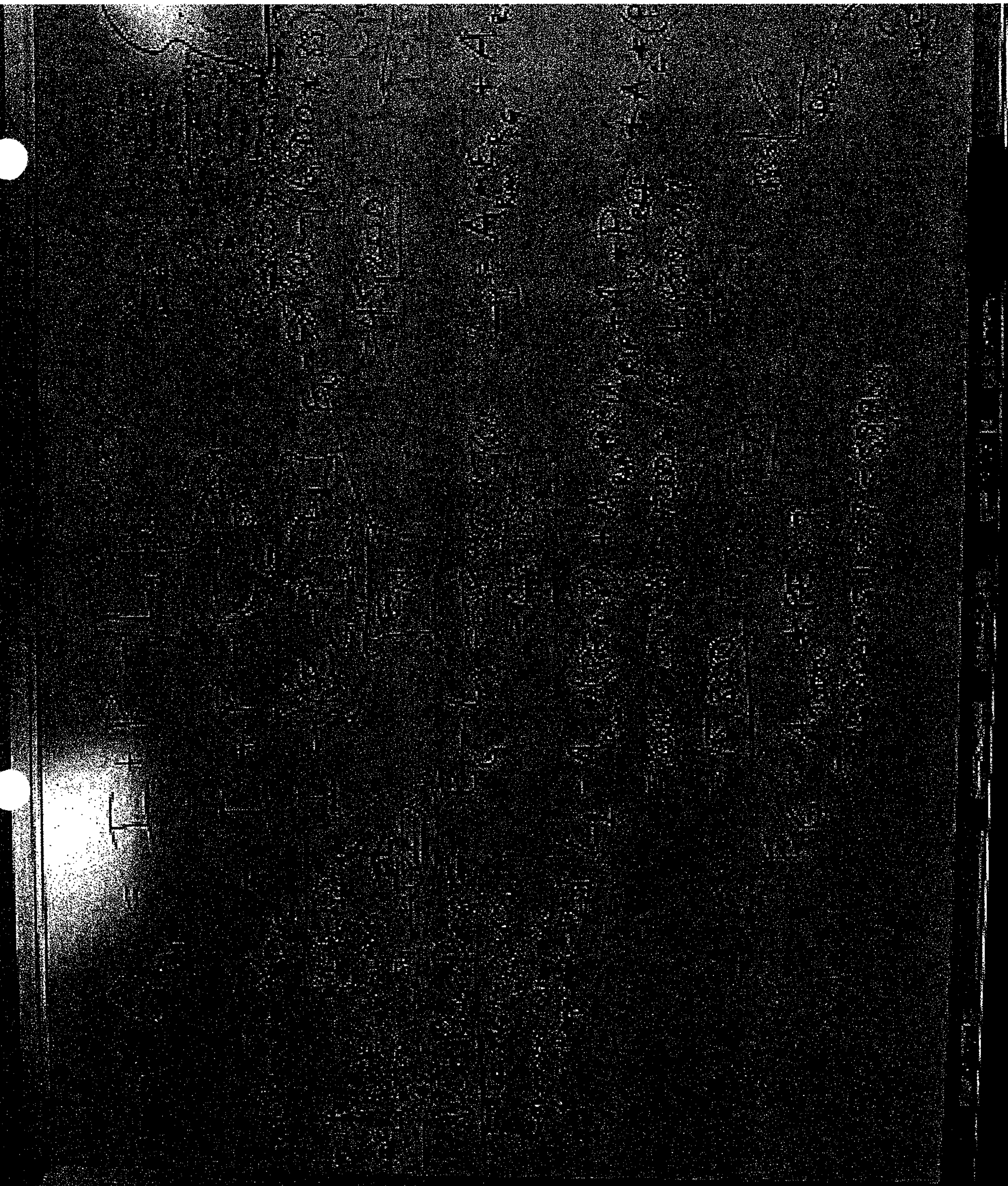
$I_{UP} = R + \Delta S_N + (E_G - P - L_1)_N + \Delta S_{UP}$

↳ regress to snowpack forecast – op study → 20



OSE-0510





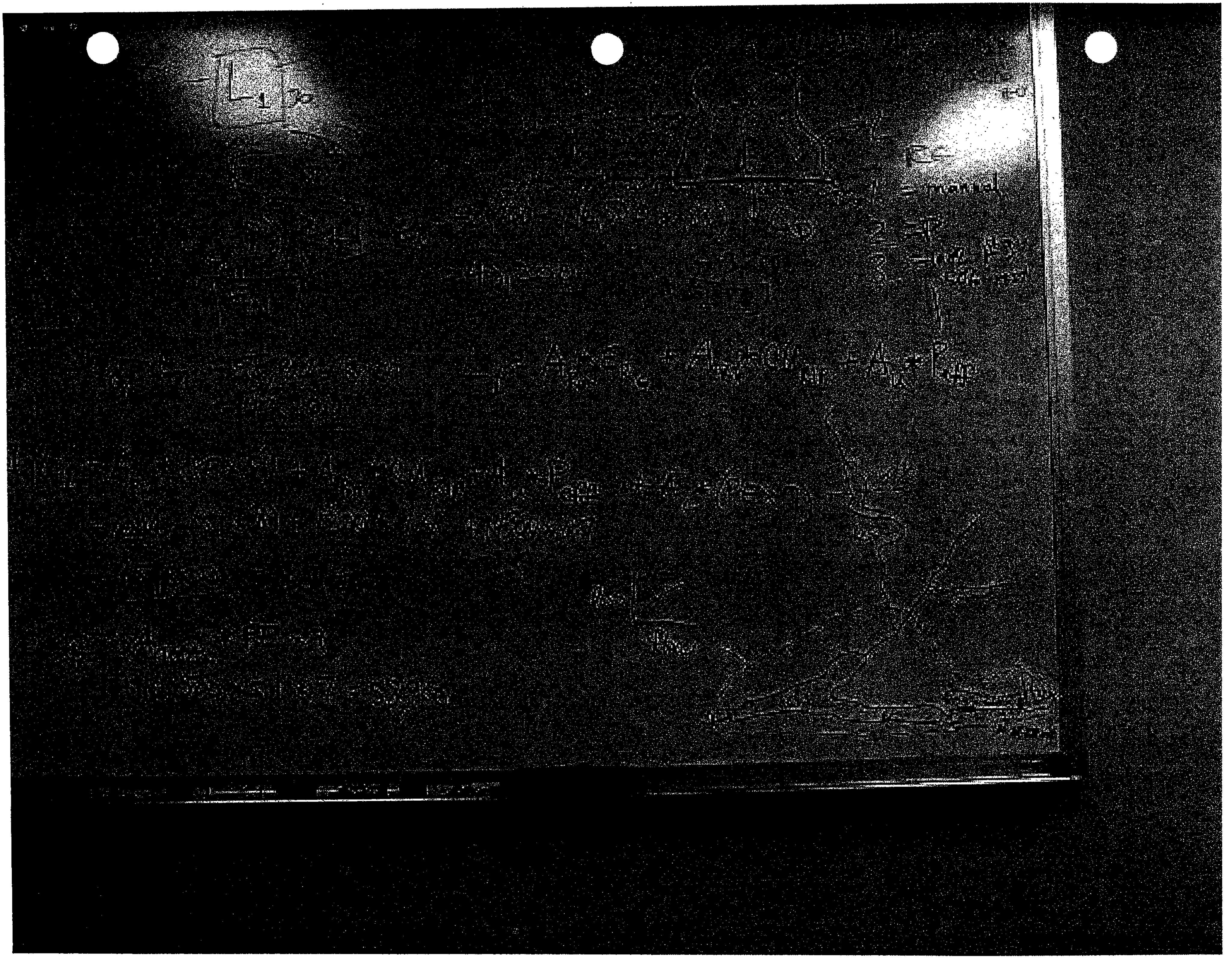


Table A-1. Channel Losses by River Reach, Virgin Conditions and 1914-1945 Average Loss Conditions

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).

(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 depletion 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

53-70 ~~[illegible]~~
1200 ~~[illegible]~~ 2.400 1.600 98.1
80. ~~98.1~~
+10 for MBC

53-61	1.2	80.0	2.4	1.6	0.0	2.4	0.5
62-70	18.7 ~~21.2~~	+10 95.0	2.4	1.6	17.5	3.5	0.5

Crit period. 139.2 ~~131.7~~ +237.2
237.3
71-77
151.9 ~~144.7~~
pre-71 →
Nav Res.
+ Hammond
+ 4-C

Assu... On-si...

...tions —
...ge
...bles for (a) shared CRSP
...B-3 (cont.)
...at FG, Albuit, L Powell;
...Arizona

historic critical period
(Yield study evap data)
62-77 avg.
53-77 avg.

...Juan River, Farmington-Shiprock

31,000 at Colo. R., SJ conf. to Lee Ferry
(Page[3] & Page/Navajo PP[28])
12,400 San Juan River, 3/4 Chinle Cr.
1/4 Bluff-Colo R.
200 Nav. Res Evap (note next pg.)

50,000

1st crit period...

2. Shared CRSP evap - FG - Green R. ab. Linwood
Asp. - Gunnison ab. Delta
Powell - Colo R, SJR-Lee F.

Aspinall - Table C-3, note 3
future operations assumed same as historic, on average. → 11/22/05 Yield study, Evap. sheet, avg. hist. evap
Blue Mesa = 7,900 af (1968-04)
Morrow Pt. = 800 (—"—).
Crystal = 300 (1978-04)
9,000.

FG - Table C-2, note 5 -
future assumed 18 ft. lower than hist, on av.
11/22/05 Yield study Evap. sheet
FG evap = 74,600 af (1968-04) → 2,924,260 af stor

at assumed 70% active capacity 468,760 af
Evap linearly interp.
~68,000 af

OSE-0515

Nav EV = 27.7
EV. @ 5990' = 15.5 min. op. level for NIIP – charge NM
Δ = 12.2 allocable evap to all states by use

(Historical Inflows, CRSP (CRSP)
Tom Ryan, 10/1993.

Powell – Table C-1, note 5
future long-term avg. assumed
11,432,600 af active storage
15,429,600 af live
Evap ≈ 445,000 af   from yield study, 11/22/05 Ev. Sheet

of Δ caused by evap (share NM 431.9 fraction & CO ≈200? fraction fed. project depl.'s provided ESA coverage) and not dist.

Total = 517,000 ≈ 522,000 from CRSP act. + UB stor. w/2 yrs. shortage

Nav. Res. uses – NM	105.2		
SJCP by exchange	270.0		
NIIP	20.8		
NGWSP-NM	25.5		
Jicarilla	10.4		
Hammond	431.9	(98.3%)	
AZ (NGP)	6.4	(1.5%)	
CO (Parks/Animas)	1.0	(0.2%)	

633,400 w/ MBC. (yield 5.68 w/o shared ev., 6.2 w/ .52)
MBC = 1.13 × OBC

3. NM –
Depletion schedule –

		Irr.+PP	Stock	M&I	Res EV
107.7	above Rosa (inc. Pine)	1.9/0.5		+.6/.6	+105.2 SJCP 22.7
0.0	Pine			~~+0.5 Jic (25.5 9.5 Gallup 16.2 SC~~)	
302.6	Nav. Res – NIIP	270.0/2.6		+5.0 NGP +0.1 small contracts +27.9 Nav. Res. Evap. 11.5 NRes EV.	
10.4	Rosa – Blanco	9.3 +1.0			
24.8	Blanco – Farm.	20.3/19.1 +1.0 +3.4/3.4 inc. FMD + HP			
0.1 ab CH / 57.7 b/l CH	Animas < ab. CHill / b/l CHill	0.1 R Basin evap; 35.8/35.8		+1.3/1.3 +4.4 +13.5 ALP	
6.0	La Plata	5.8/5.8		+.2/.2	29.3 Dep. M&I 28.3
114.5	Farm – Shiprock	24.5/0 NGP + 87.7/40.1	+2.3/2.3	HB + FP + JV + SJGS + 4CPP + SR M&I 56.2; 3.2/3.2	
9.3	Chaco	4.6/4.6 +2.1/2.1		+.6/.6 +2.0 gw /0	
0.0	Shiprock – Mancos				
633.1					

note – Nav. Res. EV. appt. to NM – some to AZ (2.2) for NGP

in nat. flow calc's this on-site use reduc. for salv. for hist. uses (future use at > hist.)

better distribute crit. period w/

2.6 avg 53-77

NIIP 76 77 33.8 31.8

Revised Draft Memo – Historic Dep.'s. from the SJR in NM for Power Generation

OSE-0516

redo dist. for critical period & 1990s w/no Dolores-McElmo transfer, then put in transfer at end - same for full development

4. CO

5.68 → 2,913,500 . ~~total~~

	1990s	Future	Total
Linwood-Yampa		803.7 dist. in 1990s proportions.	
Little Snake			
Yampa			
White			
Green ~~total~~	193.8		
Ab Navajo Dam		0.5 Stephens	
Animas	30.1	43.5 ALP	
La Plata		~~1.5 Long Hollow~~	
SJ ~~total~~ (exc. McElmo)	1,678.1		
Ab. Glenwood			
Glen-Cameo			
Gunnison [ab Delta / b/e Delta]			
Dolores [ab Dolores / b/e Dolores]			
Cameo-Cisco			
UMS total	192.5		
Total	2,064.3		2,913.5
	%		

check McElmo assumptions.

Do 3 projects separately, then apply 1990s avg. CO % for other areas to remaining Δ.

5. WY

		Future	
ab Green R. WY		distr in same proportions 355,360.	
GR-Linwood			
Little Snake			
total	432,840		788,200

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6. UT 1,294,900.

current (Table A-3)

		to Price R. & north in 1990s proposal
GR	706,880	→ 441,500
UMS	20,640	∅
SJ-C	75,880	NN-50,00
Total	803,400	Δ=491,50

Total salvage net →
full devel. - crit. period to states.

same if use no turb. factor
& if use 0.8 pan coeff.
(equiv. to 1.14 turb. factor,

avg. turb. factors -
1.30 SJ River
1.13 Colo. River
1.13 Green River
(Table 3d - EAC report).

Upper Basin-wide
Post May - eval. cross sections at GS stations, SJRIP data for est. of river widths/areas relation to flows (all reaches)