McKAY RESERVOIR
1993 SEDIMENTATION SURVEY

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16. ABSTRACT

The Bureau of Reclamation surveyed the underwater area of McKay Reservoir in May 1993 to compile field data for developing a reservoir topographic map and computing a present storage-elevation relationship. The data were also used to calculate the volume of sediment that has accumulated in the reservoir since dam closure in December 1927. The 1993 bathymetric survey used sonic depth recording equipment interfaced with an automated microwave positioning system that gave continuous depth and sounding positions throughout the reservoir. The underwater topography was developed by a computer graphics program using the collected data. The above-water reservoir area was measured from aerial photography obtained in October 1991. The new reservoir contour map is a combination of the 1991 aerial and 1993 underwater topography.

As of May 1993, at reservoir elevation (feet) 1322.0, the surface area was 1,283 acres, and the total capacity was 71,534 acre-feet. Since the reservoir's initial filling in December 1927, it is estimated that 1,909 acre-feet of sediment have been trapped in McKay Reservoir, resulting in a 2.6-percent loss in reservoir capacity. The average annual rate of sediment accumulation since 1927 is 29.1 acre-feet.

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McKAY RESERVOIR

1993 SEDIMENTATION SURVEY

by

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U.S. Department of the Interior
Mission Statement

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally-owned public lands and natural resources. This includes fostering sound use of our land and water resources; protecting our fish, wildlife, and biological diversity; preserving the environmental and cultural values of our national parks and historical places; and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The Department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

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INTRODUCTION

McKay Dam and Reservoir, major features of the Umatilla Project, are located on McKay Creek of the Umatilla River basin. The dam, located in Umatilla County is 6 miles south of Pendleton, Oregon (fig. 1).

On December 3, 1905, the east and west divisions of the Umatilla Project were authorized under provisions of the original Reclamation Act, section 4, (32 Stat. 388). Recommendations from the Board of Engineers with respect to construction of McKay Dam were approved by the Director of the Reclamation Service on March 3, 1923. Modification of McKay Dam was authorized by Public Law 94-228, dated March 11, 1976. McKay Reservoir is operated by the Bureau of Reclamation. The McKay Reservoir area is a national wildlife refuge that is heavily used by migrating waterfowl.

Construction of McKay Dam and Reservoir began in 1923 and was completed in 1927. McKay is a homogeneous, rolled sand and gravel embankment. A continuous slab of reinforced concrete paving on the upstream slope provides the water barrier. The embankment was placed by spreading material in 8-inch layers and compacting with four passes of an 11-ton traction engine. The embankment material was described as a well-graded gravel, and the voids were filled with earth, sand, and a small percentage of clay. The upstream concrete slab terminates at a 2.5-foot-high parapet wall at the crest and is joined to a cutoff wall along the upstream toe of the structure. At dam crest elevation (feet) 1330.0, McKay Dam (fig. 2) has:

- a structural height* of 165 feet
- a hydraulic height of 156 feet
- a top crest width of 23.5 feet
- a crest length of 2,700 feet

The dam has a side-channel spillway located on the right abutment. Releases are controlled by six 20- by 10-foot radial gates and a two-barrel siphon. Releases are made into a partially concrete lined spillway chute which conveys the flow to the outlet channel and then into Mckay Creek below the dam. The spillway crest design elevation was 1312.0 feet. The spillway and chute were modified in 1978-79 to increase the discharge capacity to safely pass the inflow design flood. The spillway capacity is 27,000 cubic feet per second at water surface elevation 1322.0 feet.

The river outlet works, with a discharge capacity of 1,500 cubic feet per second at reservoir elevation 1322.0, is located on the right abutment and consists of:

- rectangular intake structure with trashracks
- 10-foot diameter concrete lined horseshoe intake tunnel
- emergency gate chamber with two 4- by 4-foot hydraulically operated gates
- downstream concrete-lined horseshoe tunnel, 14 feet in diameter, containing two 54-inch-diameter steel and one 12-inch-diameter steel outlet pipes
- valve house containing two 48-inch and one 10-inch balanced needle valves. The larger valves discharge into a rock lined plunge pool, and the small valve discharges into a closed conduit leading to the Marion Jack Ditch

* The definition of terms such as "structural height," "hydraulic height," etc., may be found in manuals such as Reclamation's *Design of Small Dams* and *Guide for Preparation of Standing Operating Procedures for Dams and Reservoirs*, or ASCE's *Nomenclature for Hydraulics*.

Closure of the dam and first reservoir storage began in December 1927. At elevation 1322.0, the reservoir extends 3.5 miles up McKay Creek and has an average width of 0.6 mile.

The 1993 reservoir survey measured a total storage capacity of 71,534 acre-feet and a surface area of 1,909 acres at reservoir elevation 1322.0.

SUMMARY AND CONCLUSIONS

This report presents the 1993 results of the first extensive sedimentation survey of McKay Reservoir by the Bureau of Reclamation since construction of McKay Dam. The primary objectives of the survey were to:

- gather data needed for developing new reservoir topography
- compute area-capacity relationships
- estimate storage depletion caused by sediment deposition since closure of McKay Dam.

Standard land surveying methods were used to establish horizontal and vertical control points for the aerial and hydrographic surveys. A horizontal grid system was established for both surveys using monumented control points located in the reservoir area. The bathymetric survey was run using sonic depth recording equipment interfaced with an automated survey system consisting of a line-of-sight microwave positioning unit capable of determining sounding locations within the reservoir. The system continuously recorded reservoir depth and horizontal coordinates as the survey boat was navigated along close spaced gridlines covering the reservoir area. The positioning system provided information to allow the boat operator to maintain course along these gridlines. Water surface elevations measured by the land surveyors at the time of data collection were used to convert the sonic depth measurements to true lake bottom elevations.

The 1993 underwater surface areas at predetermined 5-foot contour intervals were generated by a computer graphics program using the collected data. The above-water reservoir area was measured from aerial photography obtained in October 1991. The new reservoir contour map is a combination of the 1991 aerial and 1993 underwater topography (fig. 3). The revised area and capacity tables were produced by a computer program that uses measured contour surface areas and a curve-fitting technique to compute area and capacity at prescribed elevation increments.

Table 1 contains a summary of reservoir watershed characteristics and sediment data for the 1993 survey. The 1993 survey determined that the reservoir has a storage capacity of 71,534 acre-feet and a surface area of 1,283 acres at reservoir elevation 1322.0. Since closure in 1927, the reservoir has accumulated a volume of 1,909 acre-feet of sediment below reservoir elevation 1322. This volume represents a 2.60-percent loss in total capacity and an average annual loss of 29.1 acre-feet. For sediment calculation purposes, the difference between the original and 1993 capacity was used, but some question exists as to the accuracy of the original area-capacity. Because of the low sediment production in the drainage area, a future resurvey of McKay Reservoir should not be necessary unless major sediment inflow occurs in the future.

DESCRIPTION OF WATERSHED

McKay Reservoir watershed has a drainage area of 186 square miles with elevations ranging from 1182 feet at the outlet works to 4700 feet along the southeastern divide. Below elevation 2000, the basin has gentle rolling slopes and is predominantly used for agriculture. The soil is a silt loam and ranges in depths from 12 to 24 inches. The basin, between elevation 2000 and 4000, tends to be V-shaped with steep side slopes and numerous rock outcrops. The vegetative cover in the bottom of the draws is comprised of scrub brush and some deciduous trees. The steep side slopes are open and covered with native grass. The basin above elevation 4000 has gentle slopes and is heavily forested with very little under brush on the forest floor. The soils are shallow, reddish in nature, and contain a large amount of clay compared with the lower part of the basin.

RESERVOIR OPERATIONS

The reservoir is a multiuse facility having (following values are from May 1993 area-capacity tables):

- 7,460 acre-feet of surcharge flood storage between elevations 1322.0 and 1327.6
- 6,068 acre-feet of exclusive flood control storage between elevations 1317.1 and 1322.0
- 65,466 acre-feet of exclusive conservation storage between elevations 1182.0 and 1317.1
- 0 acre-feet of dead storage below elevation 1182.0

Records for McKay Reservoir show an average unregulated inflow of 77,720 acre-feet per year. The estimated mean annual runoff from the basin is 7.8 inches. McKay Reservoir operation ranged from no usable contents in September 1966 to above elevation 1322.0 in May 1991. The inflow and end-of-month stage records in table 1 show the very extreme annual fluctuation of the reservoir. The reservoir elevation commonly fluctuates over 100 feet annually. The table only presents the 1948 through 1993 records that were readily available. Records are available from the U.S. Geological Survey that could be used to calculate the 1927 through 1947 operation years.

SURVEY METHOD AND EQUIPMENT

The McKay Reservoir hydrographic survey was completed using the contour method as outlined by Blanton (1982). The procedure involved collecting adequate coordinate data for developing a reliable contour map by photogrammetric and bathymetric survey methods. Standard land surveying methods were used by Columbia Basin Project Office personnel to establish horizontal and vertical control points for both survey methods. A horizontal grid system was established for both surveys using monumented points, with state plane coordinates, located in the reservoir area. The vertical control for the study was based on the Bureau of Reclamation vertical datum. The above water data were collected by aerial photography obtained on October 20, 1991, at reservoir elevation 1246.2. The field survey work for the bathymetric survey involved establishing a triangulation network around the reservoir to provide horizontal and vertical control for all required grid lines and shore stations. No previously established range lines existed on the lake and no permanent range lines were established during this survey. Because of the size and shape of the reservoir, any future survey would also employ the contour method; therefore, permanent range line end markers were not necessary.

The hydrographic survey was run on May 19 and 20, 1993, with the reservoir at water surface elevation 1316.98 and 1317.08, respectively. The bathymetric survey was run using sonic depth recording equipment interfaced with an automated survey system consisting of a line-of-sight microwave positioning unit capable of determining sounding locations within the reservoir. This positioning system transmitted line-of-sight microwave signals to fixed shore stations and converted the reply time to range distances, which were used by the system data logger to compute the coordinate position of the sounding boat. The survey system continuously recorded reservoir depth and horizontal coordinates as the survey boat moved across close-spaced gridlines covering the reservoir area. Grid spacing of 200 feet was selected to produce adequate data for developing contours of McKay Reservoir. The system gave directions to the boat operator to assist in maintaining course along the close-spaced gridlines. During each run, the depth and position data were recorded on a floppy disk for subsequent processing by Denver Office personnel. A graph plotter was used in the field to track the boat and ensure adequate coverage during the collection process. Water surface elevations surveyed at the time of collection were used to convert the sonic depth measurements to true lake bottom elevations.

RESERVOIR AREA AND CAPACITY

Original Capacity

The original total capacity of McKay Reservoir was reported as 73,800 acre-feet at reservoir elevation 1322.0. For determining change in reservoir storage, the original storage-elevation relationship was recomputed using 5-foot surface area values projected from an area curve dated September 23, 1937, drawing number 30-100-2. Some questions exist as to the accuracy of this method, but the recomputed capacity at elevation 1322.0 compared fairly well with the original. Results of the original area and capacity computations are listed in table 1 and in columns (2) and (3) of table 2.

Development of 1993 Contour Areas

The 1993 contour surface areas for McKay Reservoir were measured from the generated contour maps from the collected aerial and underwater coordinate data. Five-foot contour intervals, for reservoir elevations 1250.0 through 1330.0, were created of the reservoir area by a contractor from aerial photography obtained on October 20, 1991, at reservoir elevation 1246.2. The Denver Office measured the surface areas by digitizing the five-foot contours. Five-foot contour intervals of the underwater reservoir data, from elevations 1190.0 through 1245.0, were created by computer graphics software program SURFACE II (Kansas Geological Survey, 1978). A modification of this program by the Denver Office calculated the closed contour surface areas of the generated map. The final reservoir map shown on figure 3 was prepared by the Denver Office Computer Drafting Unit of the Drafting Section. The map has a scale of one inch equals 300 feet and a contour interval of five feet.

1993 Revised Storage Capacity

The storage-elevation relationships based on the aerial and underwater survey data were developed using the area-capacity computer program ACAP85 (Reclamation, 1985). Surface areas at 5-foot contour intervals computed from the aerial and underwater survey data were used as the control parameters for computing reservoir capacity. The program computes an area at elevation increments of 0.01 to 1.0 foot by linear interpolation between the 5-foot

contour intervals. The program begins by testing the initial capacity equation over successive intervals to ensure that the equation fits within an allowable error limit, which was set at 0.000001 for McKay Reservoir. This capacity equation is then used over the full range of intervals fitting within this allowable error limit. For the first interval at which the initial allowable error limit is exceeded, a new capacity equation (integrated from the basic area curve over that interval) tests the fit until it also exceeds the error limit. Thus, the capacity curve is defined by a series of curves, each fitting a certain region of data. Final area equations are derived by differentiating the capacity equations, which are of second order polynomial form:

$$y = a + a_2x + a_3x^2$$

where:

y = capacity,
x = elevation above a reference base,
a = intercept, and
a_2 and a_3 = coefficients

Results of the 1993 McKay Reservoir area and capacity computations are listed in table 1 and columns (4) and (5) of table 2. Listed in columns (2) and (3) of table 2 are the original surface areas and recomputed capacity values. A separate set of 1993 area and capacity tables has been published for the 0.01-, 0.1-, and 1-foot elevation increments (Reclamation, 1993). A description of the computations and coefficients output from the ACAP85 program is included with these tables. Both the original and 1993 area-capacity curves are plotted on figure 4. As of May 1993, at reservoir elevation 1322.0, the surface area was 1,283 acres with a total capacity of 71,534 acre-feet.

SEDIMENT ANALYSES

Sediments have accumulated in McKay Reservoir to a total volume of 1,909 acre-feet since dam closure in December 1927. The total sediment accumulation of 1,909 acre-feet has deposited in the conservation pool below elevation 1317.1. The average annual rate of sediment deposition between closure and May 1993 (65.5 years) was 29.1 acre-feet per year, or 0.16 acre-foot per square mile from the sediment contributing drainage area. The storage loss in terms of percent of original storage capacity was 2.60 percent. Tables 1 and 2 contain the McKay Reservoir sediment accumulation and water storage data based on the 1993 resurvey.

The 1993 study based its sediment calculations on the difference between the original and 1993 measured reservoir capacities. This method would account for all sediment accumulation during the 65.5 years of reservoir operation, but the calculations are only as accurate as the original reservoir areas. For sediment calculation purposes the difference between the original and 1993 capacity was used, but as noted, a question exists as to the accuracy of the original area-capacity. A resurvey of McKay Reservoir should be considered in the future if major sediment inflow events occur.

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American Society of Civil Engineers, *Nomenclature for Hydraulics*, ASCE Headquarters, New York, 1962.

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RESERVOIR SEDIMENT
DATA SUMMARY

McKay Reservoir
NAME OF RESERVOIR

1
DATA SHEET NO.

DAM	1. OWNER Bureau of Reclamation	2. STREAM McKay Creek	3. STATE Oregon
	4. SEC. 34 TWP. 2N RANGE 32E	5. NEAREST P.O. Pendleton	6. COUNTY Umatilla
	7. LAT 45° 36′ 28″ LONG 118° 47′ 30″	8. TOP OF DAM ELEVATION 1330.0	9. SPILLWAY CREST 1312.0[1]

RESERVOIR	10. STORAGE ALLOCATION	11. ELEVATION TOP OF POOL	12. ORIGINAL SURFACE AREA, Ac	13. ORIGINAL CAPACITY, AF	14. GROSS STORAGE ACRE- FEET	15. DATE STORAGE BEGAN
	a. SURCHARGE	1327.6		7,280	81,080	
	b. FLOOD CONTROL	1322.0	1290	6,000	73,800	12/1927
	c. POWER					
	d. WATER SUPPLY					16. DATE NORMAL OPERATION BEGAN
	e. IRRIGATION					
	f. CONSERVATION	1317.1	1200	67,800	67,800	
	g. INACTIVE	1182.0	0	0	. 0	12/1927

	17. LENGTH OF RESERVOIR	3.5 MILES	AVG. WIDTH OF RESERVOIR	0.6	MILES
BASIN	18. TOTAL DRAINAGE AREA	186 SQUARE MILES	22. MEAN ANNUAL PRECIPITATION	8.2[2]	INCHES
	19. NET SEDIMENT CONTRIBUTING AREA	186 SQUARE MILES	23. MEAN ANNUAL RUNOFF	7.8[3]	INCHES
	20. LENGTH MILES	AV. WIDTH MILES	24. MEAN ANNUAL RUNOFF	77,720[4]	ACRE-FEET
	21. MAX. ELEVATION 4,700	MIN. ELEVATION 1182.0	25. ANNUAL TEMP. MEAN 53°F RANGE -11°F to 108°F[2]		

SURVEY DATA

26. DATE OF SURVEY	27. PER. YRS.	28. ACCL. YRS.	29. TYPE OF SURVEY	30. NO. OF RANGES OR INTERVAL	31. SURFACE AREA, AC.	32. CAPACITY ACRE-FEET	33. C/I RATIO AF/AF
12/1927			Contour(R)		1282[5]	73,443[6]	0.94
5/19/93	65.5	65.5	Contour(D)	5 ft	1283.0	71,534	0.92

26. DATE OF SURVEY	34. PERIOD ANNUAL PRECIP.	35. PERIOD WATER INFLOW, ACRE FEET			WATER INFLOW TO DATE, AF	
		a. MEAN ANN.	b. MAX. ANN.	c. TOTAL	a. MEAN ANN.	b. TOTAL
5/19/93	8.2	77,720[4]	134,800[4]	-	77,720[4]	-

26. DATE OF SURVEY	37. PERIOD CAPACITY LOSS, ACRE-FEET			38. TOTAL SEDIMENT DEPOSITS TO DATE, AF		
	a. TOTAL	b. AV. ANN.	c. /MI.^{2}-YR.	a. TOTAL	b. AV. ANNUAL	c. /MI.^{2}-YR.
5/19/93	1,909[7]	29.1	0.16	1,909	29.1	0.16

26. DATE OF SURVEY	39. AV. DRY WT. (#/FT^3)	40. SED. DEP. TONS/MI.^{2}-YR.		41. STORAGE LOSS, PCT.		42. SEDIMENT INFLOW, PPM	
		a. PERIOD	b. TOTAL TO DATE	a. AV. ANNUAL	b. TOTAL TO DATE	a. PER.	b. TOT.
5/19/93				0.04[8]	2.60[8]		

26. DATE OF SURVEY	43. DEPTH DESIGNATION RANGE IN FEET BELOW, AND ABOVE, SPILLWAY CREST ELEVATION											
	132.5-112.0	112.0-92.0	92.0-82.0	82.0-72.0	72.0-62.0	62.0-52.0	52.0-42.0	42.0-32.0	32.0-22.0	22.0-12.0	12.0-Crest	Crest +10.0
	PERCENT OF TOTAL SEDIMENT LOCATED WITHIN DEPTH DESIGNATION											
5/93	3.6	8.5	11.2	11.9	13.4	9.5	5.4	3.1	9.0	14.0	10.0	0.4

26. DATE OF SURVEY	44. REACH DESIGNATION PERCENT OF TOTAL ORIGINAL LENGTH OF RESERVOIR													
	0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100	100-105	105-110	110-115	115-120	120-125
	PERCENT OF TOTAL SEDIMENT LOCATED WITHIN REACH DESIGNATION													
	N/A													

Table 1. - Reservoir sediment data summary (page 1 of 2).

45. RANGE IN RESERVOIR OPERATION

WATER YEAR	MAX. ELEV.	MIN. ELEV.	INFLOW, AF	WATER YEAR	MAX. ELEV.	MIN. ELEV.	INFLOW, AF
1948	1320.5[9]	1237.5[9]	134,800[4]	1949	1316.9	1238.1	67,000
1950	1320.0	1238.5	93,400	1951	1318.7	1245.8	88,800
1952	1314.5	1236.1	52,400	1953	1320.4	1235.3	95,300
1954	1303.8	1225.5	45,300	1955	1311.4	1226.4	57,300
1956	1320.4	1227.3	97,300	1957	1320.6	1226.7	74,900
1958	1320.6	1224.5	112,700	1959	1319.5	1224.6	87,400
1960	1317.0	1219.0	64,900	1961	1317.4	1197.5	65,900
1962	1305.7	1190.4	56,700	1963	1313.3	1203.1	67,700
1964	1287.9	1209.2	40,200	1965	1320.9	1214.7	119,200
1966	1290.8	1192.0	20,800	1967	1307.0	1194.4	57,900
1968	1284.0	1205.0	32,900	1969	1319.7	1206.8	94,000
1970	1319.6	1249.6	82,800	1971	1316.4	1250.3	55,900
1972	1317.0	1235.5	122,300	1973	1278.5	1193.2	25,400
1974	1317.6	1194.6	124,800	1975	1317.0	1239.4	91,000
1976	1317.2	1243.1	91,000	1977	1276.4	1209.2	21,600
1978	1317.7	1212.3	75,300	1979	1317.4	1238.1	99,100
1980	1317.2	1238.8	77,300	1981	1317.1	1253.5	78,800
1982	1317.2	1253.8	114,200	1983	1317.2	1251.5	121,700
1984	1317.5	1252.1	128,390	1985	1318.0	1241.5	66,010
1986	1317.4	1236.8	-	1987	1318.6	1226.8	66,760
1988	1290.1	1214.2	39,270	1989	1320.9	1213.6	113,890
1990	1298.3	1232.2	41,810	1991	1320.4	1232.1	-
1992	1305.5	1220.5	-	1993	1316.6	1220.8	-

46. ELEVATION - AREA - CAPACITY DATA FOR **1993 TOTAL CAPACITY** [10]

ELEV.	AREA	CAP.	ELEV.	AREA	CAP.	ELEV.	AREA	CAP.
1186.5	0	0	1190	13.2	23	1195	31.3	134
1200	63.0	370	1205	95.3	766	1210	134.7	1,341
1215	183.4	2,136	1220	254.2	3,230	1225	312.4	4,647
1230	349.3	6,301	1235	376.1	8,114	1240	399.0	10,052
1245	429.0	12,122	1246.2	442.9	12,645	1250	466.2	14,373
1255	506.6	16,805	1260	544.5	19,432	1265	584.4	22,255
1270	624.3	25,276	1275	663.5	28,496	1280	697.0	31,897
1285	734.3	35,475	1290	779.8	39,261	1295	831.0	43,288
1300	898.2	47,611	1305	976.7	52,298	1310	1074.6	57,426
1315	1155.0	63,000	1320	1246.8	69,005	1322	(1283)	71,534
1325	1336.1	75,462	1330	1422.9	82,359			

47. REMARKS AND REFERENCES

[1] Spillway overflow controlled by radial gates and siphon. Normal water surface elevation 1322.0.

[2] Bureau of Reclamation *Project Data Book* of Umatilla Project, 1966 - 80.

[3] Calculated using mean annual runoff value of 77,720 acre-feet, (Item 24).

[4] Calculated unregulated monthly inflows for reservoir operation period 1948 through 1993. Missing records for water years 1986 and 1991 though 1993. Possible to calculate additional records, 1928 - 1947, using available USGS records.

[5] Surface area at reservoir elevation 1322.0. Original areas projected from the 1937 area curve.

[6] Capacity at elevation 1322.0. Computed by Reclamation's ACAP program using original surface areas. Some question as to the accuracy of the original surface areas caused by projecting from area curve.

[7] Total capacity loss calculated by comparing recomputed capacity (see remark #6) and 1993 capacity at reservoir elevation 1322.0. Original areas projected from the 1937 area curve.

[8] Average annual and total sediment deposits of 29.1 acre-feet and 1,909 acre-feet, respectively, divided by 73,443 acre-feet. Capacity at El. 1322.0 computed by ACAP using original surface area data.

[9] End-of-month maximum and minimum reservoir elevations.

[10] 1993 total capacity computed by ACAP using 1991 and 1993 measured areas. Area in ( ) calculated by ACAP. Areas below elevation 1246.2 measured from 5/93 hydrographic survey data. Areas at elevation 1246.2 and above measured from 10/91 aerial photography.

48. AGENCY MAKING SURVEY Bureau of Reclamation

49. AGENCY SUPPLYING DATA Bureau of Reclamation | DATE March 1994

Table 1. - Reservoir sediment data summary (page 2 of 2).

(1) Elevation (feet)	(2) Original Area (acres)	(3) Original Total Capacity (acre-feet)	(4) 1993 Area (acres)	(5) 1993 Capacity (acre-feet)	(6) Measured Sediment Volume (acre-feet)	(7) Percent Measured Sediment	(8) Percent Reservoir Depth
1330	-	-	1,422.9	82,359	-	-	-
1327.6	-	-	(1,381)	78,994	-	-	-
1322	1,282	73,443	(1,283)	71,534	1,909	100.0	100.0
1320	1,246	70,914	1,246.8	69,005	1,909	100.0	98.6
1317.1	1,194	67,375	(1,194)	65,466	1,909	100.0	96.6
1312	1,108	61,508	(1,107)	59,607	1,901	99.6	93.0
1310	1,076	59,324	1,074.6	57,426	1,898	99.4	91.6
1300	925	49,321	898.2	47,611	1,710	89.6	84.6
1290	808	40,704	779.8	39,261	1,443	75.6	77.5
1280	704	33,169	697.0	31,897	1,272	66.6	70.5
1270	630	26,489	624.3	25,276	1,213	63.5	63.5
1260	559	20,541	544.5	19,432	1,109	58.1	56.5
1250	488	15,300	466.2	14,373	927	48.6	49.5
1240	425	10,724	399.0	10,052	672	35.2	42.4
1230	366	6,746	349.3	6,301	445	23.3	35.4
1220	284	3,461	254.2	3,230	231	12.1	28.4
1200	55	439	63.0	370	69	3.6	14.4
1190	19	102	13.2	23	79	4.1	7.4
1186.5	13	45	0	0	45	2.4	4.9
1179.5	0	0	0	0	0	0.0	0.0

(1) Elevation of reservoir water surface.
(2) Original reservoir surface area values projected from September 23, 1937, area curve.
(3) Original reservoir capacity recomputed using ACAP85 from original surface areas from column two.
(4) Reservoir surface area from 1991 aerial and 1993 hydrographic surveys. Areas in ( ) computed by ACAP85.
(5) 1993 reservoir capacity computed by ACAP85 using areas from column four.
(6) Measured sediment volume = column (3) - column (5).
(7) Measured sediment expressed in percentage of total sediment 1,909 acre-feet at spillway crest elevation 1322.0.
(8) Depth of reservoir in percentage of total depth of 142.5 feet, from spillway crest elevation 1322.0 and river channel elevation 1179.5.

Table 2. - Summary of 1993 survey results.

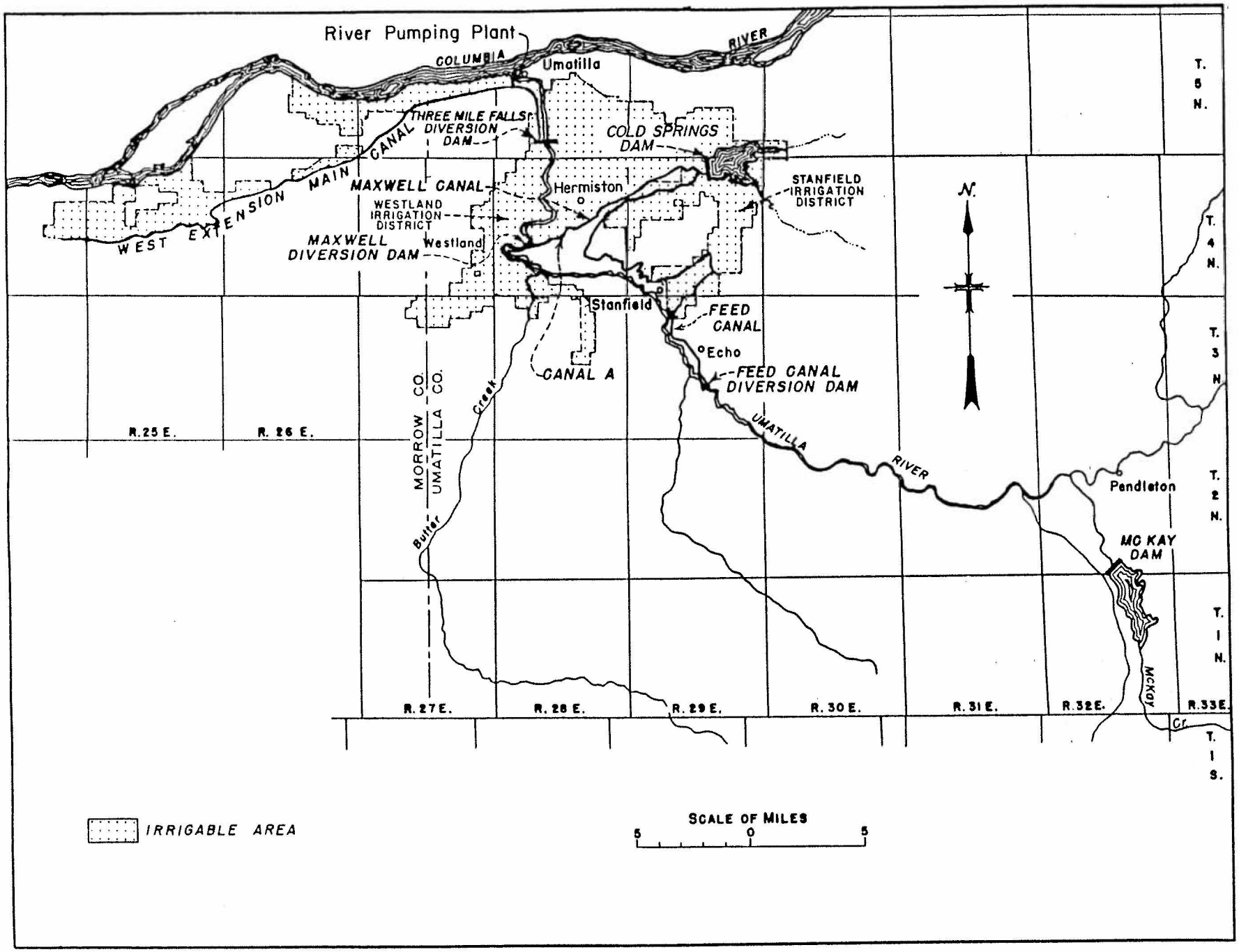

Figure 1. - McKay Reservoir location map.

Space intentionally left blank due to security concerns

30-D-396

E 8640000
E 8641250
E 8642500
E 8643750
N 712500
N 711250
N 710000
N 708750
N 707500

MCKAY RESERVOIR
W.L. 1246.2
10-20-91

N

300 0 300 600 900
SCALE OF FEET

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UNITED STATES
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BUREAU OF RECLAMATION
UMATILLA PROJECT

MCKAY RESERVOIR

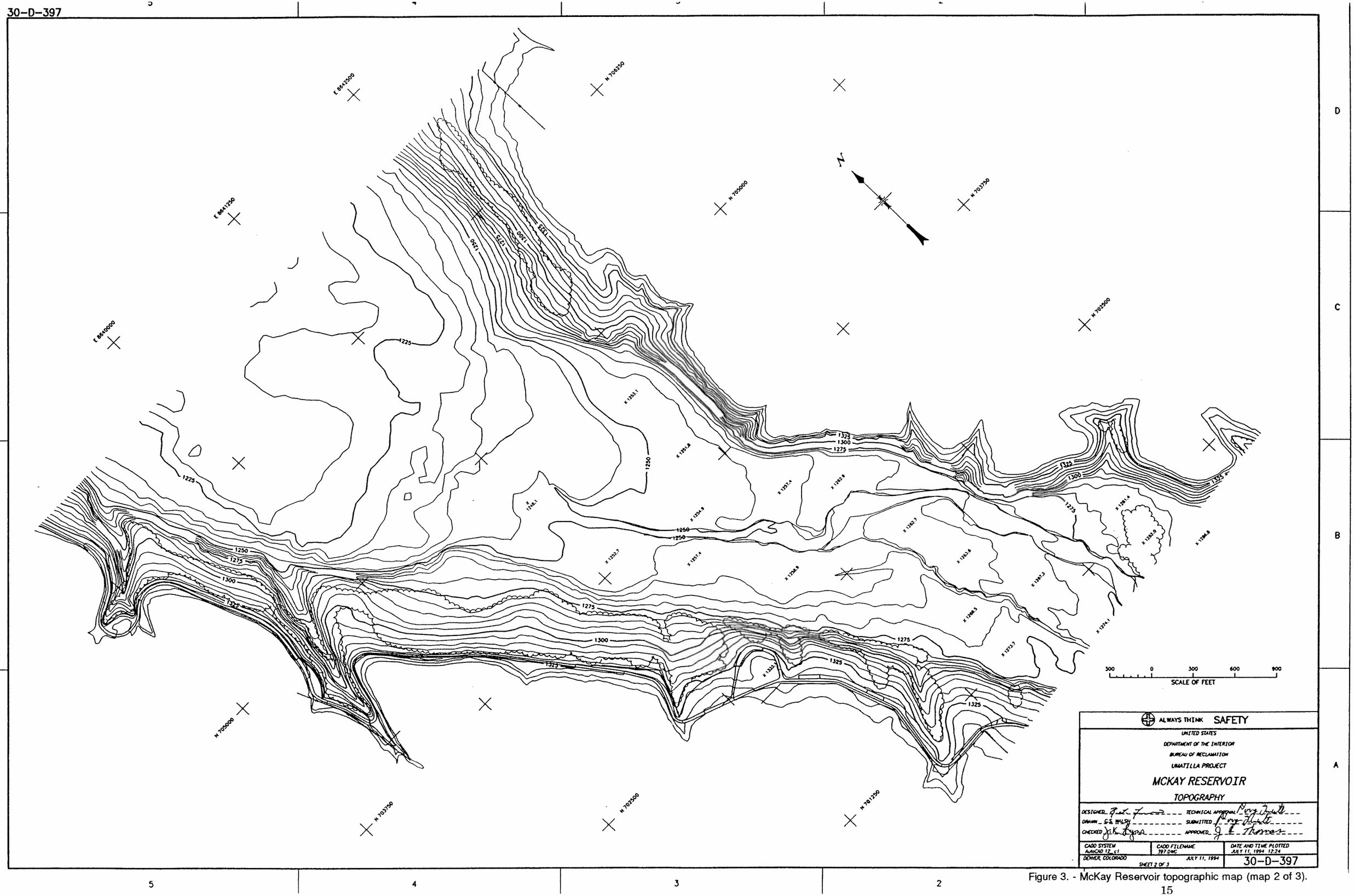
TOPOGRAPHY

DESIGNED J. K. Isaacs	TECHNICAL APPROVAL Don Dodd
DRAWN GS WALSH	SUBMITTED D. M. Dodd
CHECKED J. K. Isaacs	APPROVED D. L. Thomas

CADD SYSTEM	CADD FILENAME	DATE AND TIME PLOTTED
AutoCAD 12_c1	396.DWG	JULY 11, 1994 11:26
DENVER, COLORADO	JULY 11, 1994	30-D-396
SHEET 1 OF 3		

Figure 3. - McKay Reservoir topographic map (map 1 of 3).

30-D-397



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AutoCAD 12_c1	397.DWG	JULY 11, 1994 12:24
DENVER, COLORADO	JULY 11, 1994	30-D-397

SHEET 2 OF 3

Figure 3. - McKay Reservoir topographic map (map 2 of 3).

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CADD SYSTEM	CADD FILENAME	DATE AND TIME PLOTTED
AutoCAD 12 c1	398.DWG	JULY 11, 1994 12:29
DENVER, COLORADO	JULY 11, 1994	30-D-398
	SHEET 3 OF 3	

Figure 3. - McKay Reservoir topographic map (map 3 of 3).

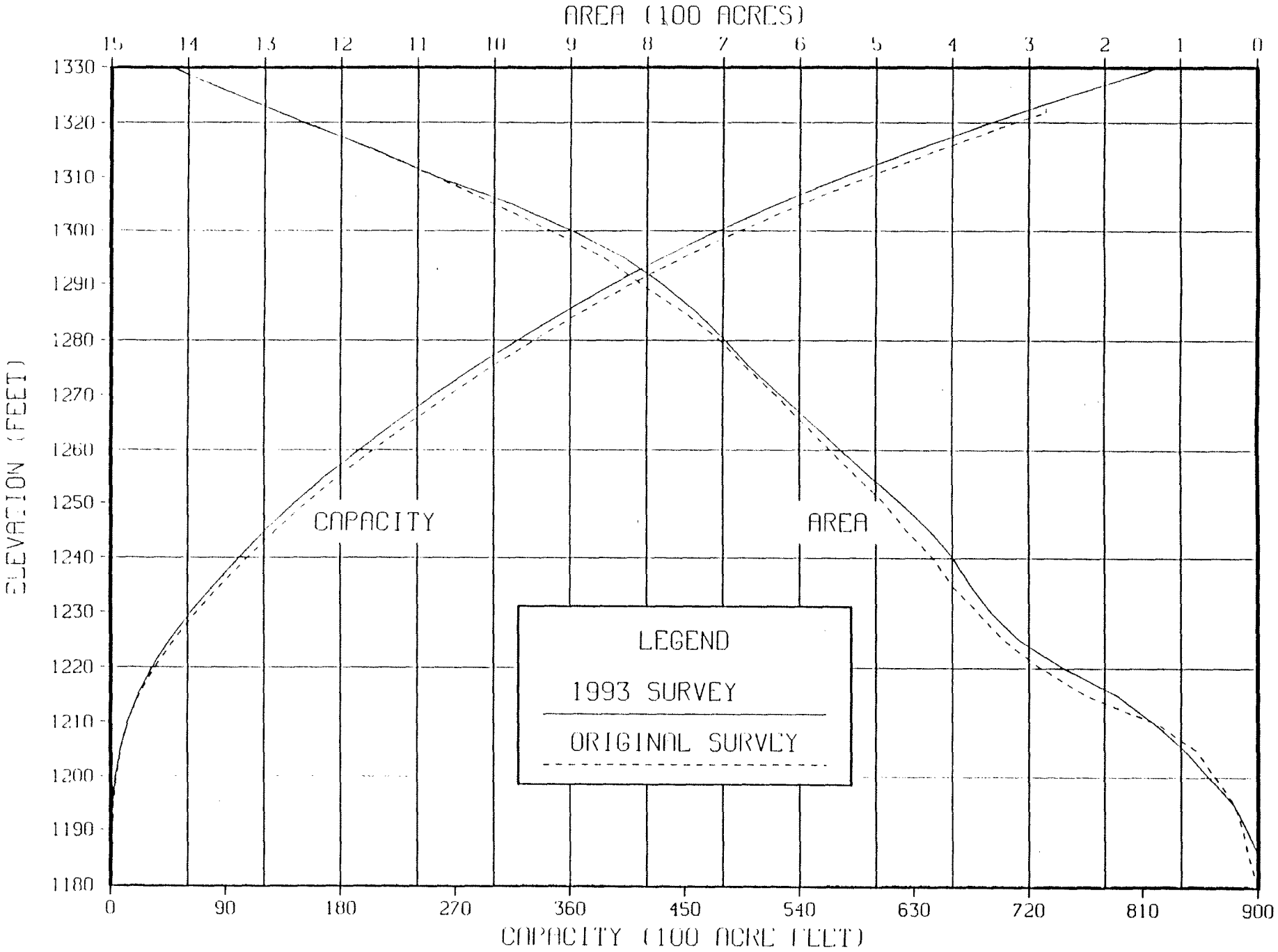

Figure 4. - Area and capacity curves — McKay Reservoir.

Mission

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