DEADWOOD RESERVOIR
2002 SURVEY

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13. ABSTRACT *(Maximum 200 words)*

The Bureau of Reclamation (Reclamation) surveyed Deadwood Reservoir in July 2002 to develop a topographic map and compute the present storage-elevation relationship (area-capacity tables). The data was used to generate current reservoir capacity since dam closure on November second of 1930. The underwater survey was conducted in July of 2002 near reservoir elevation 5,325 feet (project datum). The underwater survey used sonic depth recording equipment interfaced with a global positioning system (GPS) that gave continuous sounding positions throughout the underwater portions of the reservoir covered by the survey vessel. The above water survey was conducted on August 24, 2002 near reservoir elevation 5,299.6 feet. The above-water topography was determined by a GPS controlled LiDAR (light distance and ranging) method to developed reservoir contours from elevation 5,300 and above. The new topographic map of Deadwood Reservoir was developed from the combined 2002 underwater and above water-measured topography.

As of July 2002, at top of conservation water surface elevation (feet) 5,334.0, the surface area was 3,115 acres with a total capacity of 153,992 acre-feet.

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Deadwood Reservoir

2002 Survey

by

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Sedimentation and River Hydraulics Group
Water Resources Services
Technical Service Center
Denver, Colorado

July 2003

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The Bureau of Reclamation's (Reclamation) Sedimentation and River Hydraulics Group of the Technical Service Center (TSC) prepared and published this report. Ronald Ferrari and Sharon Nuanes of the TSC conducted the hydrographic survey. Horizons, Inc., under contract with the Pacific Northwest Regional Office, conducted the above water survey. Ronald Ferrari completed the data processing to generate the new topographic map and area-capacity tables. Sharon Nuanes of the TSC completed the final map development. Kent Collins of the TSC performed the technical peer review of this documentation.

Mission Statements

The mission of the Department of the Interior is to protect and provide access to our Nation's natural and cultural heritage and honor our trust responsibilities to Indian Tribes and our commitments to island communities.

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.

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INTRODUCTION

Deadwood Dam and reservoir, features of the Boise Project, are located in Valley County about 25 miles southeast of the town of Cascade and 53 miles northeast of Boise, Idaho (fig. 1). The dam and reservoir are located on the Deadwood River that is a tributary of the south fork of the Payette River. Deadwood Reservoir is the primary storage facility for the Emmett Irrigation District, and in conjunction with Cascade Reservoir on the North Fork of the Payette River, provides irrigation water for lands in the Payette Division of the Boise Project. The dam and reservoir are operated and maintained by the Bureau of Reclamation's Snake River Area Office West Unit - Black Canyon Dam Field Branch.

Deadwood Dam was completed in 1931 with closure on November 2, 1930. The dam is a concrete arch structure whose dimensions are (fig. 2):

Hydraulic height[1]	137	feet[2]	Structural height	165	feet
Top width	9	feet	Crest length	749	feet
Crest of Dam elevation	5,340.0	feet	Parapet wall elevation	5,343.5	feet

An overflow spillway occupies 100 feet of the central portion of the dam and two outlets are provided near the bottom right of the spillway. The spillway is an uncontrolled overflow type with a crest elevation of 5,334.0 and capacity of 11,300 cfs (cubic feet per second) at reservoir water surface elevation 5,343.5 (top of parapet walls). The outlet works consist of a trashracked intake structure, two 66-inch inside diameter conduits through base of the dam and a valve house containing two 4.5 foot by 4.5 foot pressure emergency gates. Capacity of outlet works is 1,980 cfs at reservoir water surface elevation 5,334.0. A stilling basin is utilized by the spillway and outlet works.

The total drainage area above Deadwood Dam is 112 square miles. Deadwood Reservoir has an average width of 0.8 miles with a length of around 3.9 miles at reservoir elevation 5,334.0.

[1]The definition of such terms as hydraulic height, structural height, and 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*.

[2]Elevation levels are shown in feet. All elevations shown in this report are based on the original project datum established by U.S. Bureau of Reclamation that was found by this study to be around 18.6 feet greater than the NAVD88.

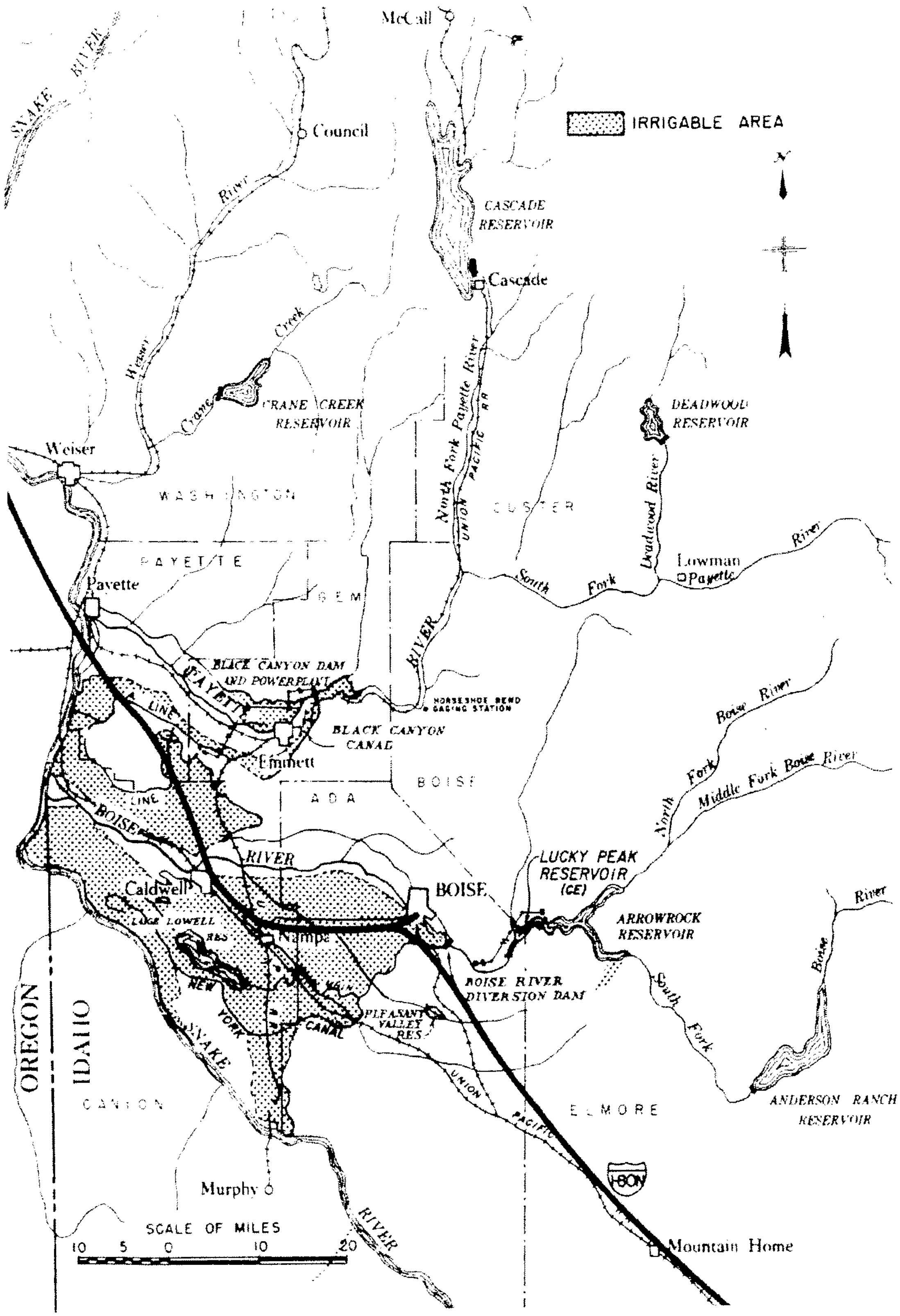

Figure 1. – Deadwood Reservoir location map.

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SUMMARY AND CONCLUSIONS

This Reclamation report presents the 2002 results of the survey of Deadwood Reservoir. The primary objectives of the survey were to gather data needed to:

- develop reservoir topography
- compute area-capacity relationships

A GPS control and aerial collection survey was contracted by the Pacific Northwest Regional Office to establish the study area control and measure the above water portions of the reservoir area. The survey established horizontal and vertical control on existing Reclamation monuments located on the left (east) and right (west) abutments of the dam. The horizontal control was established in the Idaho west state plane coordinate zone of the North American Datum of 1983 (NAD83) and the vertical control was tied to the North American Vertical Datum of 1988 (NAVD88) and the Reclamation project datum. All elevations in this report are referenced to the Reclamation project or construction datum that was found to be around 18.6 feet greater than the NAVD88.

Due to the rapidly dropping reservoir water surface levels, the underwater survey was conducted in July of 2002 near reservoir water surface elevation 5,325 prior to the contracted GPS control survey. Prior to the underwater data collection, the hydrographic survey crew measured an absolute position on the Reclamation monument located on the west abutment of the dam. Using Real-time Kinematic (RTK) GPS, measurements were taken on the east monument, a temporary control point, and the reservoir water surface during the underwater survey. During post processing these measurements were shifted to match the horizontal and vertical control established by the GPS control survey. The bathymetric survey determined sounding locations throughout the reservoir using sonic depth recording equipment interfaced with RTK GPS. The bathymetric system continuously recorded depth and horizontal coordinates of the survey boat as it was navigated along grid lines covering Deadwood Reservoir. The positioning system provided information to allow the boat operator to maintain a course along these predetermined grid lines. Water surface elevations measured by the reservoir gauge (tied to the Reclamation vertical datum) and the RTK GPS were recorded during the time of collection and used to convert the sonic depth measurements to true reservoir bottom elevations.

The above water topography was measured on August 24 of 2002 near reservoir water surface elevation 5,299.6 by a contract aerial survey. The aerial survey was conducted using a LiDAR (Light Detection and Ranging) acquisition method that utilized GPS for control. The LiDAR instrument transmits light to measure the ground elevations below the aircraft. The airborne GPS data was processed as a kinematic survey and resulted in detailed x,y,z data sets and 2-foot reservoir topography from elevation 5300 and above (Horizon's Inc.).

The 2002 Deadwood Reservoir topographic map is a combination of the 2002 aerial and underwater survey data. The 2002 reservoir surface areas at predetermined contour intervals were generated by a computer graphics program using the collected reservoir data. The 2002 area and capacity tables were produced by a computer program that used the measured contour surface areas and a curve-fitting technique to compute the reservoir's area and capacity at prescribed elevation increments (Bureau of Reclamation, 1985).

Tables 1 and 2 contain summaries of the Deadwood Reservoir sedimentation and watershed characteristics for the 2002 survey. The 2002 survey determined that the reservoir has a total storage capacity of 153,992 acre-feet and a surface area of 3,115 acres at active conservation reservoir elevation 5,334.0.

RESERVOIR OPERATIONS

Deadwood Dam operates to provide regulation flows for the Black Canyon Dam powerplant and supply water for irrigation for the Payette Division and Emmett Irrigation District. The July 2002 area-capacity tables show 184,682 acre-feet of total storage at maximum water surface elevation 5,343.5. The 2002 survey measured a minimum bottom elevation of 5,195.0. The following values are from the July 2002 area-capacity tables:

- 30,690 acre-feet of surcharge between elevation 5,334.0 and 5,343.5.
- 153,992 acre-feet of conservation use between elevation 5,202.75 and 5,334.0.
- No measurable capacity below elevation 5,202.75.

The Deadwood Reservoir inflow and end-of-month stage records in table 1, for the operation period of water years 1931 through 2002, show the measured annual outflow and reservoir fluctuation since dam closure. These values were obtained from USGS and Reclamation records. The outflow data, that is regulated by the reservoir, was measured at the USGS gage located just downstream of the dam and is called "Deadwood River below Deadwood Reservoir near Lowman, Idaho." Reclamation has monthly computed inflow data for all years of record, but for the purpose of this study time wasn't taken to compute the annual values of all of this data. The outflow values don't account for the annual runoff during initial filling of the reservoir and the years of total drawdown of the reservoir for repairs, but the measured outflow does provide an estimated total amount of runoff that has occurred since dam closure in November of 1930. Since initial filling, the extreme storage fluctuations of Deadwood Reservoir ranged from elevation 5,205 in 1951, 1952, 1973, and 1974 to the maximum-recorded elevation of 5,337.4 in 1974 and 1982. The elevation 5,205 measurements indicate total draining of the reservoir for repairs.

HYDROGRAPHIC SURVEY EQUIPMENT AND METHOD

The hydrographic survey equipment was mounted in the cabin of a 24-foot trihull aluminum vessel equipped with twin in-board motors (fig. 3). The hydrographic system contained on the survey vessel consisted of a GPS receiver with a built-in radio and an omnidirectional antenna, depth sounders, a helmsman display for navigation, computers, and hydrographic system software for collecting and processing the underwater data. An on-board generator supplied power to the equipment.

Figure 3. – Hydrographic survey vessel

The shore equipment included a second GPS receiver with an external radio and an omnidirectional antenna. The GPS receiver and antenna were mounted on a survey tripod over a known datum point that had a clear line-of-sight to the survey boat over the vast majority of the reservoir. 12-volt batteries provided power for the shore unit.

The Sedimentation and River Hydraulics Group conducts their bathymetric surveys using Real-time Kinematic (RTK) GPS. The major benefit of RTK versus differential GPS (DGPS) is that precise heights can be measured in real time for monitoring water surface elevation changes. The basic outputs from a RTK receiver are precise 3D coordinates in latitude, longitude, and height with accuracies on the order of 2 centimeters horizontally and 3 centimeters vertically. The output was in the GPS datum of WGS-84 that the hydrographic collection software converted into state plane coordinates.

In 2001 the Sedimentation and River Hydraulics Group began utilizing an integrated multibeam hydrographic survey system. The system consists of a single transducer mounted on the center bow or forward portion of the boat. From the single transducer a fan array of narrow beams generate a detailed cross section of bottom geometry as the survey vessel passes over the areas to be mapped. The system transmits 80 separate 1-1/2 degree slant beams resulting in a 120-degree swath from the transducer. The 200 kHz high-resolution multibeam echosounder system measures the relative water depth across the wide swath perpendicular to the vessel's track. Figure 4 illuminates the swath of the sea floor that is about 3.5 times the water depth below the transducer.

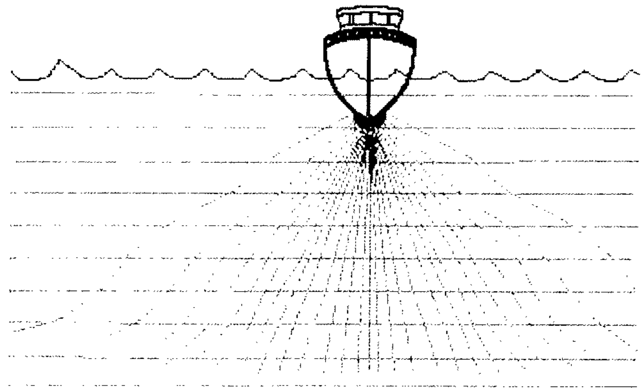

Figure 4. – Multibeam collection system

The multibeam system is composed of several instruments that are all in constant communication with a central on-board notebook computer. The components include the RTK GPS for positioning; a motion reference unit to measure the heave, pitch, and roll of the survey vessel; a gyro to measure the yaw or vessel attitude; and a velocity meter to measure the speed of sound through the vertical profile of the reservoir water. With the proper calibration, the data processing software utilizes all the incoming information to provide an accurate detailed x,y,z data set of the lake bottom.

The Deadwood Reservoir bathymetric survey collection was conducted from July 11 through July 14 of 2002 between water surface elevation 5,324.1 and 5,325.2 (Reclamation project datum). The survey was run using the instrumentation described above where the survey system software continuously recorded reservoir depths and horizontal coordinates as the survey vessel moved across close-spaced grid lines covering the reservoir area. Most transects (grid lines) were run in a north or south direction of the reservoir where the multibeam swaths in the deeper portions of the reservoir overlapped. Even though the multibeam system could have provided full bottom coverage, time and budget didn't allow for this to occur in the shallow portions of the reservoir. Detailed information along the face of the dam was collected with the multibeam collection system, but power surges during the time of collection at the dam along with positioning and depth-sounding anomalies affected the detail of the mapping along the face of the dam. The loss of this additional data didn't have a significant impact on the area computations since it only occurred near the face of the dam.

The above water topography was measured on August 24 of 2002 near reservoir water surface elevation 5,299.6 by a contract aerial survey. The aerial survey was conducted using a LiDAR acquisition method that utilized GPS for control and the LiDAR instrument that transmits light to measure ground elevations below the aircraft. The methodology of the multibeam and LiDAR systems are very similar. The airborne GPS data was processed as a kinematic survey and resulted in detailed x,y,z data sets and 2-foot reservoir topography from elevation 5300 and above. Figure 5 provides an orthophoto mosaic of the reservoir area covered by the LiDAR survey.

Deadwood Reservoir Datums

A GPS survey was contracted by the Pacific Northwest Regional Office to establish the study area control at Deadwood Dam on existing Reclamation monuments located on the west and east abutments of the reservoir. The horizontal control was established in the Idaho west state plane coordinate zone of NAD83. The vertical control was tied to the NAVD88 and the Reclamation project vertical datum. All elevations in this report are referenced to the Reclamation project or construction datum that was found to be around 18.6 feet greater than the NAVD88. Following are the results from the control survey.

Name	Latitude (NAD83)	Longitude (NAD83)	Ellipsoid Height	Idaho West (North)	NAD83 (West)	NAVD88 Elevation	BOR* Elevation	BOR NAVD88 +
East	44°17'37.55909"	115°38'41.51389	5273.95	957467.40	2652193.53	5322.06	5340.622	18.56
West	44°17'34.40889"	115°38'47.92204"	5273.86	957147.82	2651727.87	5322.00	5340.609	18.61

* The Reclamation elevations are from a previous level survey.

Due to the rapidly dropping reservoir water surface levels, the underwater survey was conducted prior to the contracted control survey. In order to tie all survey data together the hydrographic survey crew measured an absolute position on the Reclamation monument located on the dam's west abutment. Using Real-time Kinematic (RTK) GPS, measurements were taken on the east monument and a temporary control point used for the GPS base station during the underwater survey. During post processing all the bathymetric measurements were shifted slightly to match the horizontal control established by the GPS control survey and vertical control established by a previous Reclamation level survey. The shift was determined to be (+) 2.35 feet to the north coordinates and (+) 0.97 feet to the west coordinates. All underwater measurements were tied to the Reclamation's reservoir water surface gage readings recorded at the time of the underwater survey.

RESERVOIR AREA AND CAPACITY

Topography Development

Using ARC/INFO the topography of the reservoir was developed from the combined underwater and above water data (ESRI 1992). ARC/INFO is a software package for development and analysis of geographic information system (GIS) layers and development of interactive GIS applications. The underwater collected data was processed using the hydrographic system software that was also used for the onboard data collection. The analysis included applying all measurements such as vessel location and corrections for the roll, pitch, and yaw effects. The other corrections included applying the sound velocity of the reservoir water column and converting all depth data points to elevations using the measured water surface elevation at the

Figure 5 – Deadwood Reservoir LiDAR Coverage

time of collection. Due to the massive amount of data, the multibeam data was filtered by taking the measured maximum depth and location for each 5-foot cell or grid of the reservoir area surveyed. The resulting data set was in x,y,z format and contained over two million data points.

The contractor provided the above water LiDAR data in several formats consisting of AutoCAD drawing files and the x,y,z data sets used to generate the drawing contours. The x,y,z data sets were used for the final analysis due to the large size of the drawing files and since the reservoir surface areas needed to be computed for the entire reservoir area. The x,y,z data was labeled 3D-"edited surface" and represented the final bare earth LiDAR measurements. The resulting data set was in x,y,z format and contained nearly two million data points.

Using the APPEND option in ARC/INFO, the two data sets where merged resulting in a x,y,z data set of just over four million data points. Using ARCEDIT, a clip of the 2002 Deadwood Reservoir data was developed such that interpolation was not allowed to occur outside of this boundary. Contours for the reservoir area inside this clip were computed from the combined 2002 data sets using the triangular irregular network (TIN) surface-modeling package within ARC/INFO. A TIN is a set of adjacent, non-overlapping triangles computed from irregularly spaced points with x,y coordinates and z values. The TIN method was designed to deal with continuous data such as elevations. The TIN software uses a method known as Delaunay's criteria for triangulation where triangles are formed among all data points within the polygon clip. The method requires that a circle drawn through the three nodes of a triangle will contain no other point, meaning that sample points are connected to their nearest neighbors to form triangles using all collected data. Elevation contours are then interpolated along the triangle elements. The linear interpolation option of the ARC/INFO TINCONTOUR command was used to interpolate contours from the Deadwood Reservoir TIN. The surface areas at 1-foot increments were also computed from the developed TIN from elevation 5,195.0 to 5,350.0. The contour topography at 2-foot intervals is presented on figures 6, 7, and 8.

Development of 2002 Contour Areas

The 2002 contour surface areas for Deadwood Reservoir were computed at 1-foot increments, from elevation 5,196.0 to 5,350.0, using the Deadwood Reservoir TIN discussed above. The 2002 survey measured a minimum reservoir bottom elevation of 5,195.0. These calculations were performed using the ARC/INFO VOLUME command. This command computes areas at user specified elevations directly from the TIN and takes into consideration all regions of equal elevation.

2002 Storage Capacity

The storage-elevation relationships based on the measured surface areas were developed using the area-capacity computer program ACAP85 (Bureau of Reclamation, 1985). Computed surface areas from the developed TIN, at 2-foot contour intervals, from reservoir elevation 5,196.0 to elevation 5,350.0 were used as the control parameters for computing the Deadwood Reservoir capacity. The program can compute an area and capacity at elevation increments 0.01- to 1.0-foot by linear interpolation between the given contour surface areas. The program begins by testing the initial capacity equation over successive intervals to ensure that the equation fits within an allowable error limit. The error limit was set at 0.000001 for Deadwood Reservoir. The 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 basic area curve over that interval) is utilized until it exceeds the error limit. Thus, the capacity curve is defined by a series of curves, each fitting a certain region of data. Differentiating the capacity equations, which are of second order polynomial form, derives final area equations:

$$y = a_1 + a_2x + a_3x^2$$

where:

y = capacity
x = elevation above a reference base
a_1 = intercept
a_2 and a_3 = coefficients

Results of the 2002 Deadwood Reservoir area and capacity computations are listed in table 1 and columns 4 and 5 of table 2. On table 2, columns 2 and 3 list the original surface areas and capacities projected from the area and capacity curve dated 1935. A separate set of 2002 area and capacity tables has been published for the 0.01, 0.1 and 1-foot elevation increments (Bureau of Reclamation 2003). A description of the computations and coefficients output from the ACAP85 program is included with these tables. Both the original and 2002 area-capacity curves are plotted on figure 8. As of July 2002, at maximum reservoir water surface elevation 5,343.5, the surface area was 3,343 acres with a total capacity of 184,682 acre-feet.

RESERVOIR ANALYSES

Figure 8 is a plot of Deadwood Reservoir's original area and capacity data versus the 2002 measured area and capacity. The surface area curves illustrate the difference between the original survey of unknown origin and the very detailed 2002 survey of the Deadwood Reservoir area. The original surface areas and capacity values were projected from curves on a 1935 drawing labeled X-D-767 while the 2002 curves were developed from the 2002 survey results.

The 2002 study assumes the difference between the two surveys is due to the detail of collection and not loss of surface area and resulting capacity due to sediment inflow. It is assumed the original survey was conducted by a plane table type survey prior to construction and clearing of the reservoir area where the detail of collection would have been affected by the forested terrain. The 2002 aerial survey was conducted near the Reclamation recorded gage reservoir elevation 5,299.4 which is over forty feet lower than the maximum reservoir water surface elevation of 5,343.5. This forty vertical feet of reservoir area is fairly clear of thick vegetation that would have impeded true ground measurements during the original survey. Another explanation could be a possible datum shift between the original and 2002 surveys. The 2002 underwater survey was processed utilizing the Reclamation gage measurements recorded at the time of the survey. Spot check of the x,y,z aerial data set found good elevation comparisons between the measured 2002 underwater data set and the Reclamation gage readings recorded at the time of aerial collection. Column 6 and 7 on table 2 list the differences between the two surveys with the conclusion that the difference is due primarily to the variation in the levels of detail and accuracy between the two surveys.

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RESERVOIR SEDIMENT
DATA SUMMARY

Deadwood Reservoir
NAME OF RESERVOIR

1
DATA SHEET NO.

DAM	1. OWNER Bureau of Reclamation	2. STREAM Deadwood River	3. STATE Idaho
	4. SEC. 8 TWP. 11 N RANGE 7 E	5. NEAREST P.O. Lowman	6. COUNTY Valley
	7. LAT 44° 17' 38" LONG 115° 38' 41"	8. TOP OF DAM ELEVATION 5,340.0[1]	9. SPILLWAY CREST EL 5,334.0[2]

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	5,343.5[1]		29,600	193,600	11/30
	b. FLOOD CONTROL					
	c. POWER					
	d. JOINT USE					16. DATE NORMAL OPERATION BEGAN
	e. CONSERVATION	5,334.0		164,000	164,000[3]	11/30
	f. INACTIVE					
	g. DEAD	5,202.75				
	17. LENGTH OF RESERVOIR	3.9		AVG. WIDTH OF RESERVOIR	0.8	

BASIN	18. TOTAL DRAINAGE AREA 112 SQUARE		22. MEAN ANNUAL PRECIPITATION 11.7[4]
	19. NET SEDIMENT CONTRIBUTING AREA 112 SQUARE		23. MEAN ANNUAL RUNOFF 28.0[5]
	20. LENGTH MILES	AV. WIDTH	24. MEAN ANNUAL RUNOFF 167,200[6] ACRE-
	21. MAX. ELEVATION	MIN. ELEVATION	25. ANNUAL TEMP. MEAN 52 °F RANGE -23 °F to 108 °F[4]

SURVEY DATA

26. DATE OF SURVEY	27. PER. YRS.	28. ACCL.	29. TYPE OF SURVEY	30. NO. OF RANGES OR INTERVAL	31. SURFACE AREA, AC.	32. CAPACITY ACRE-FEET	33. C/I RATIO AF/AF
11/30			Contour (R)	5-ft	3,146[3]	164,000[3]	0.98
7/02	71.7	71.7	Contour (D)	1-ft	3,115[7]	153,992[7]	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
7/02		167,200	319,400[8]	11,985,600	167,200	11,985,600

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.
7/02	[9]					

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.
7/02				[9]	[9]		

26. DATE OF SURVEY	43. DEPTH DESIGNATION RANGE BY RESERVOIR ELEVATION											
		-	-	-	-	-	-	-				
	PERCENT OF TOTAL SEDIMENT LOCATED WITHIN DEPTH DESIGNATION											

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														

Table 1. - Reservoir sediment data summary (page 1 of 3).

45. RANGE IN RESERVOIR OPERATION[8]							
YEAR	MAX. ELEV.	MIN. ELEV.	INFLOW, AF	YEAR	MAX. ELEV.	MIN. ELEV.	INFLOW, AF
1930				1931	-	-	71,300
1932	-	-	104,000	1933	-	-	152,000
1934	-	-	182,500	1935	-	-	115,800
1936	5,331.5	5,260.1	109,900	1937	5,323.6	5,286.7	113,200
1938	5,336.6	5,282.8	132,700	1939	5,334.8	5,292.6	172,900
1940	5,335.6	5,291.9	120,800	1941	5,335.6	5,305.5	90,340
1942	5,336.0	5,308.8	195,600	1943	5,337.1	5,305.7	208,100
1944	5,334.7	5,291.6	166,200	1945	5,335.1	5,287.0	115,900
1946	5,335.2	5,303.1	189,300	1947	5,336.4	5,291.0	217,900
1948	5,336.6	5,290.5	155,700	1949	5,334.6	5,298.6	138,500
1950	5,335.6	5,305.0	150,100	1951	5,334.7	5,205.0[6]	319,400
1952	5,335.7	5,205.0[6]	149,600	1953	5,336.4	5,285.4	191,900
1954	5,336.0	5,288.2	213,960	1955	5,334.3	5,288.1	127,200
1956	5,336.4	5,284.7	259,700	1957	5,336.2	5,284.8	173,200
1958	5,336.3	5,275.5	198,900	1959	5,335.6	5,282.8	190,400
1960	5,335.3	5,289.1	145,500	1961	5,327.5	5,278.7	147,500
1962	5,335.8	5,280.5	143,400	1963	5,336.4	5,287.6	188,600
1964	5,336.1	5,293.4	160,300	1965	5,336.8	5,294.2	245,700
1966	5,335.5	5,294.4	139,900	1967	5,336.2	5,282.9	180,900
1968	5,335.4	5,287.2	147,900	1969	5,335.4	5,289.5	193,700
1970	5,336.8	5,294.5	201,700	1971	5,337.3	5,295.9	293,400
1972	5,334.8	5,294.9	208,200	1973	5,329.3	5,205 [6]	192,600
1974	5,337.4	5,205 [6]	241,000	1975	5,334.6	5,297.3	173,500
1976	5,335.6	5,296.6	188,200	1977	5,312.2	5,273.5	91,410
1978	5,335.2	5,275.0	174,700	1979	5,332.3	5,280.7	131,900
1980	5,335.9	5,281.6	145,800	1981	5,336.3	5,301.0	175,900
1982	5,337.4	5,296.1	253,700	1983	5,337.1	5,298.2	243,500
1984	5,333.1	5,299.4	201,400	1985	5,335.7	5,292.4	166,700
1986	5,337.1	5,295.6	207,400	1987	5,328.2	5,289.6	106,200
1988	5,324.8	5,283.4	101,500	1989	5,334.6	5,285.4	108,300
1990	5,335.0	5,297.6	118,100	1991	5,328.5	5,294.8	97,700
1992	5,315.2	5,282.2	111,700	1993	5,335.8	5,282.7	134,700
1994	5,327.4	5,290.2	124,900	1995	5,336.2	5,289.9	143,000
1996	5,336.9	5,318.6	255,900	1997	5,335.8	5,319.3	247,600
1998	5,335.4	5,318.4	181,100	1999	5,335.4	5,303.8	214,600
2000	5,335.2	5,308.8	153,700	2001	5,320.2	5,289.7	111,200
2002	5,326.5	5,289.4	64,000				

46. ELEVATION - AREA - CAPACITY DATA FOR **2002 CAPACITY**[10]								
ELEVATION	AREA	CAPACITY	ELEVATION	AREA	CAPACITY	ELEVATION	AREA	CAPACITY
5,195	0	0	5,210	5	17	5,215	22	72
5,220	57	270	5,225	92	639	5,230	140	1,216
5,235	202	2,065	5,240	280	3,264	5,245	372	4,890
5,250	474	7,001	5,255	591	9,655	5,260	729	12,954
5,265	868	19,944	5,270	1,017	21,651	5,275	1,177	27,126
5,280	1,343	33,432	5,285	1,500	40,538	5,290	1,649	48,412
5,295	1,798	57,020	5,300	1,992	66,457	5,305	2,166	76,859
5,310	2,342	88,127	5,315	2,515	100,272	5,320	2,685	113,272
5,325	2,850	127,113	5,330	3,003	141,754	5,334	3,115	153,992
5,335	3,140	157,119	5,340	3,260	173,127	5,343.5	3,343	184,682
5,345	3,378	189,723	5,350	3,498	206,908			

Table 1. - Reservoir sediment data summary (page 2 of 3).

47. REMARKS AND REFERENCES

1 Top of parapet wall, elevation of 5,343.5, forms a continuous water barrier. All elevations are in feet and based on the original project datum established by Reclamation that were found by the 2002 study to be around 18.6 feet greater then the NAVD88.

2 Uncontrolled overflow spillway.

3 Capacity projected from area and capacity curves, dated 3/8/35, and from reservoir capacity allocation table.

4 Bureau of Reclamation Project Data Book, 1981. Values for Boise Project.

5 Calculated using mean annual runoff value of 167,200 AF, item 24, 11/30 through 7/02. (See remark #6).

6 USGS discharges just downstream of dam by water year, from 11/30 through 7/02, at gage "Deadwood River Below Deadwood Reservoir, Near Lowman, ID." Provides total inflow information. Values affected by years of filling and years of total drawdown for dam construction (1951, 1952, 1973 & 1974).

7 Surface area & capacity at elevation 5,334.0 computed by ACAP program.

8 NOT INFLOW VALUES. Values are measured USGS discharges just downstream of dam by water year, from 11/30 through 7/02, at gage "Deadwood River Below Deadwood Reservoir, Near Lowman, ID." Provides total inflow information. Values affected by years of filling and years of total drawdown for dam construction (1951, 1952, 1973 & 1974). Maximum and minimum elevations from available USGS published records. Information provided to USGS by Reclamation. Reservoir drained in 1951, 1952, 1973 and 1974 for repairs.

9 No computed sediment volumes due to unknown accuracy of 1930 surface area and capacity values.

10 Capacities computed by Reclamation's ACAP computer program.

48. AGENCY MAKING SURVEY Bureau of Reclamation

49. AGENCY SUPPLYING DATA Bureau of Reclamation | DATE April 2003

Table 1. - Reservoir sediment data summary (page 3 of 3).

1	2	3	4	5	6	7	8
					2002	2002	Percent of
Elevations	Original	Original	2002	2002	Volume	Percent of	Reservoir
	Survey	Capacity	Survey	Survey	Difference	Difference	Depth
(feet)	(acres)	(acre-feet)	(acres)	(acre-feet)			
5,350.0			3,498	206,908			
5,345.0			3,378	189,723			
5,343.5			3,343	184,682			100.0
5,340.0			3,260	173,127			97.6
5,335.0			3,140	157,119			94.3
5,334.0	3,146	164,000	3,115	153,992	10,008	100.0	93.6
5,330.0	3,046	146,250	3,003	141,754	4,496	44.9	90.9
5,325.0	2,923	131,220	2,850	127,113	4,107	41.0	87.5
5,320.0	2,754	117,210	2,685	113,272	3,938	39.3	84.2
5,315.0	2,581	104,150	2,515	100,272	3,878	38.7	80.8
5,310.0	2,400	91,710	2,342	88,127	3,583	35.8	77.4
5,305.0	2,238	80,730	2,166	76,859	3,871	38.7	74.1
5,300.0	2,062	70,000	1,992	66,457	3,543	35.4	70.7
5,295.0	1,900	60,000	1,798	57,020	2,980	29.8	67.3
5,290.0	1,723	50,475	1,649	48,412	2,063	20.6	64.0
5,285.0	1,554	42,195	1,500	40,538	1,657	16.6	60.6
5,280.0	1,400	34,524	1,343	33,432	1,092	10.9	57.2
5,275.0	1,246	28,095	1,177	27,126	969	9.7	53.9
5,270.0	1,100	22,380	1,017	21,651	729	7.3	50.5
5,265.0	931	17,317	868	16,944	373	3.7	47.1
5,260.0	762	13,170	729	12,954	216	2.2	43.8
5,255.0	623	10,000	591	9,655	345	3.4	40.4
5,250.0	500	7,317	474	7,001	316	3.2	37.0
5,245.0	400	5,122	372	4,890	232	2.3	33.7
5,240.0	292	3,170	280	3,264	-94	-0.9	30.3
5,235.0	200	1,950	202	2,065	-115	-1.1	26.9
5,230.0	131	1,220	140	1,216	4	0.0	23.6
5,225.0	85	700	92	639	61	0.6	20.2
5,220.0	46	240	57	270	-30	-0.3	16.8
5,215.0	25	10	22	72	-62	-0.6	13.5
5,210.0	15	5	5	17	-12	-0.1	10.1
5,195.0	0	0	0	0	0	0.0	0.0

1	Elevation of reservoir water surface.
2	Original reservoir surface area projected from 1935 curve.
3	Original reservoir capacity projected from 1935 curve.
4	Reservoir surface area from 2002 survey.
5	Reservoir capacity computed from 2002 surface areas using ACAP.
6	Measured volume difference = column (3) - column (5).
7	Measured difference expressed in percentage of total 10,008 at elevation 5,334.0.
8	Depth of reservoir expressed in percentage of total depth of 148.5 feet.

Table 2. - Summary of 2002 survey results

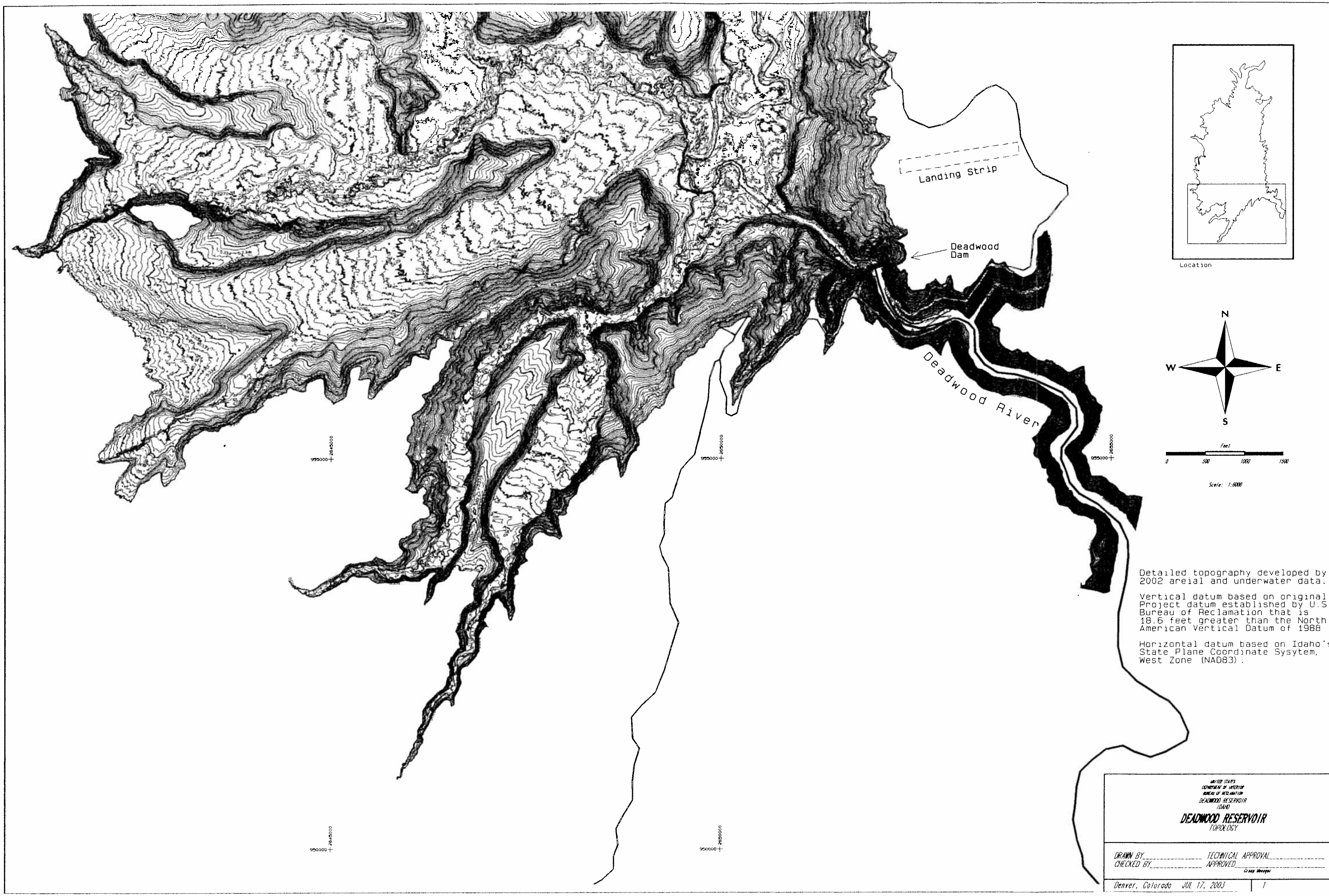

Figure 6. - Deadwood Reservoir topographic map.

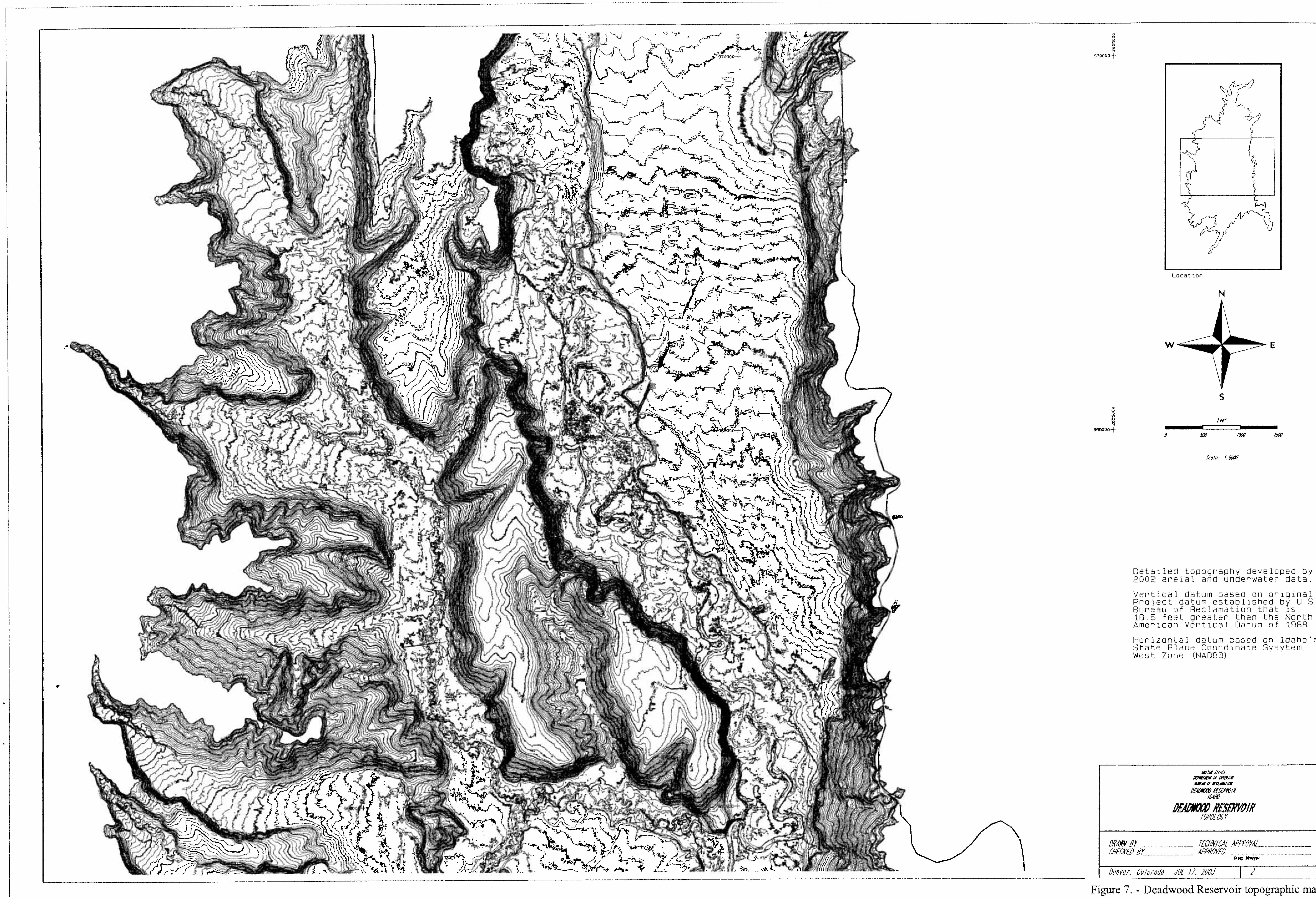

Figure 7. - Deadwood Reservoir topographic map.

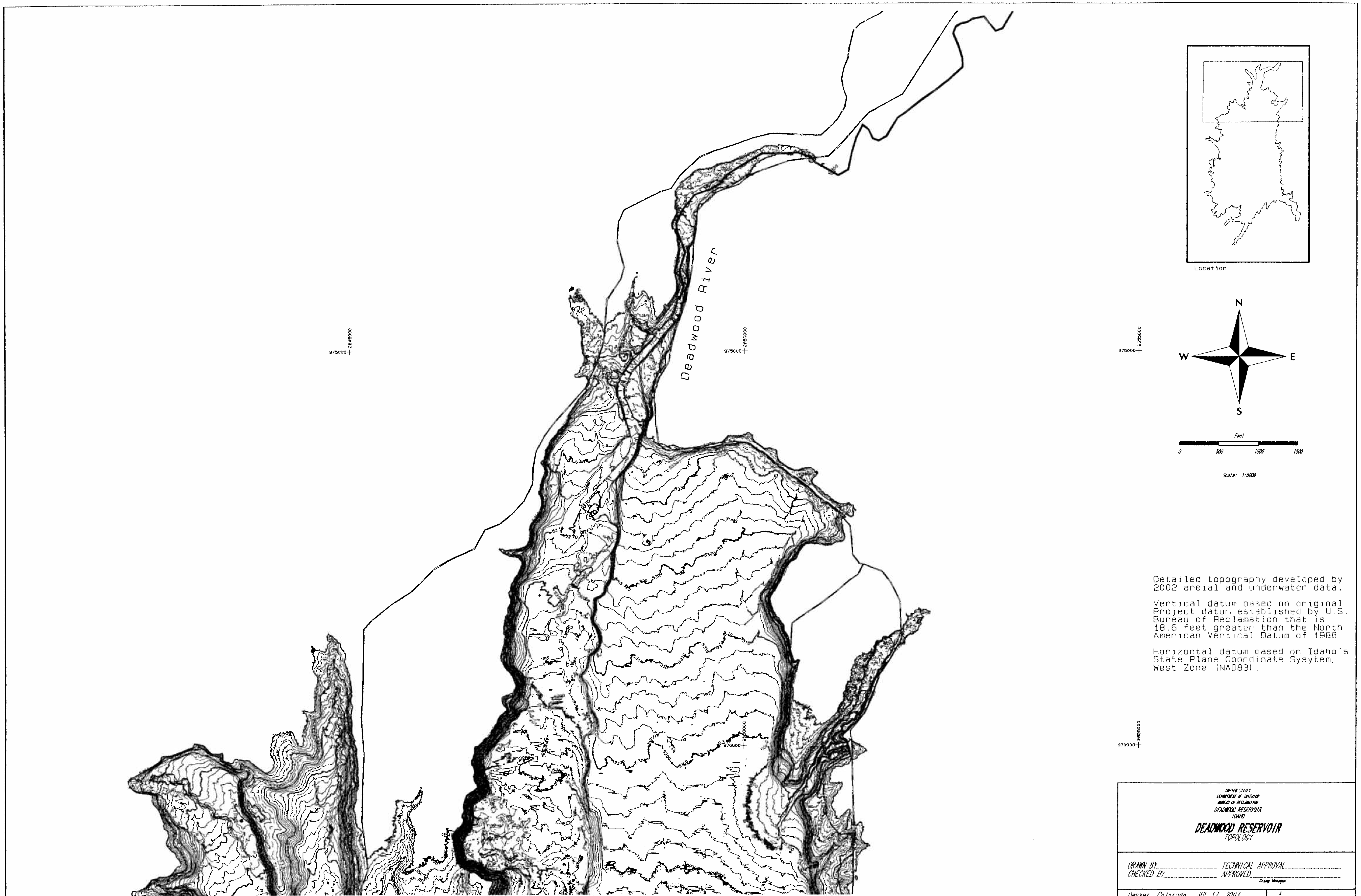

Figure 8. - Deadwood Reservoir topographic map.

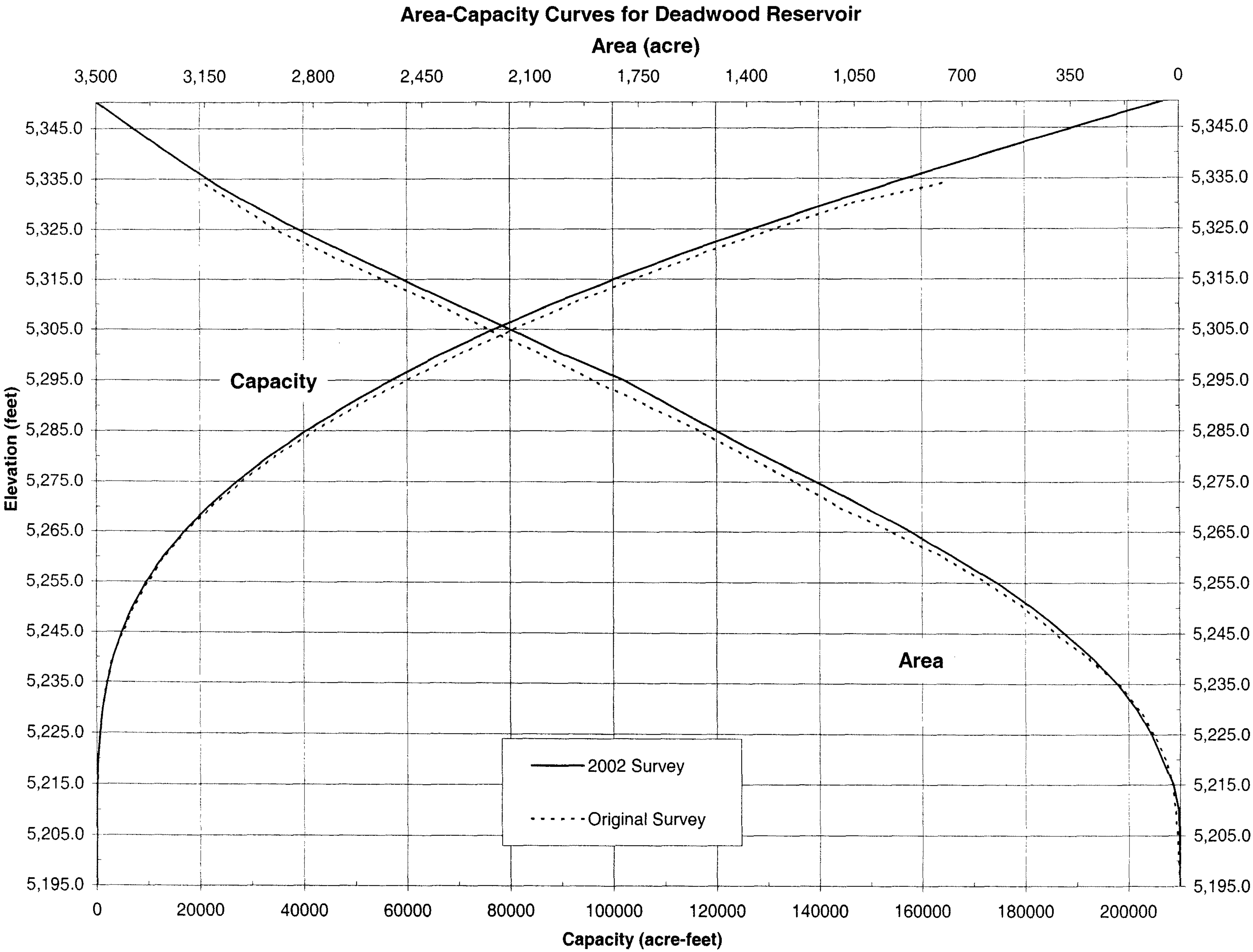

Figure 9. - 2002 area and capacity curves