YELLOWTAIL AFTERBAY
2000 SURVEY

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Ronald L. Ferrari

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13. ABSTRACT *(Maximum 200 words)*

The Bureau of Reclamation (Reclamation) surveyed Yellowtail Afterbay on June 14th of 2000 to develop a topographic map and compute a present storage-elevation relationship (area-capacity tables). The underwater survey was conducted near water surface elevation 3,186 feet (NGVD29). 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 topography was determined from elevation 3190.0 and above from an aerial survey conducted in the fall of 1997. The new topographic map of Yellowtail Afterbay was developed from the combined 1997 aerial and 2000 underwater measured topography. The 2000 underwater survey was conducted using a flat bottom raft that allowed collection in the shallow portions of the reservoir, but did not have the power to collect any closer then 1,400 feet downstream of the dam. As part of the analysis, underwater contours in this portion of the underwater area were projected.

As of June 2000, at water surface elevation (feet) 3,192.0, the surface area was 176 acres with a projected total capacity of 2,877 acre-feet.

14. SUBJECT TERMS

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Yellowtail Afterbay

2000 Survey

By

Ronald L. Ferrari

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

July 2003

ACKNOWLEDGMENTS

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 Stephanie Schwinghammer of the TSC conducted the hydrographic survey. Ronald Ferrari completed the data processing needed to generate the new topographic map and area-capacity tables. Sharon Nuanes of the TSC completed the final map development. Kent Collins of 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.

CONTENTS

TABLES

Table

FIGURES

Figure

INTRODUCTION

Yellowtail Afterbay Dam and Reservoir are located 2.2 miles below Yellowtail Dam near Fort Smith, Montana. The Yellowtail Afterbay Dam and Reservoir are used to smooth out fluctuating discharges from the Yellowtail Powerplant and as a diversion structure to the Bighorn Canal. The original reported storage for the reservoir was around 3,130 acre-feet at elevation 3,192.0 feet[1].

The primary objectives of the June 2000 survey were to gather data needed to develop reservoir topography and compute area-capacity relationships for the Yellowtail Afterbay reservoir. Prior to the underwater survey, a 1997 ground and aerial photography survey was conducted at the Fort Smith government camp. The survey covered the Yellowtail Afterbay at water surface elevation 3,190.0 and above. The 1997 established global positioning system (GPS) control points were used as the control network for the 2000 underwater survey. The horizontal control was established in a local coordinate system that was tied to Montana State plane coordinates in the North American Datum of 1983 (NAD83). The vertical control was in the National Geodetic Vertical Datum of 1929 (NGVD29). The detailed contours were developed with the local horizontal coordinates that required a shifting of the 2000 underwater survey data points to match the 1997 survey.

The bathymetric survey was run using sonic depth recording equipment interfaced with a differential GPS capable of determining sounding locations within the reservoir. The system continuously recorded depth and horizontal coordinates of the survey vessel as it was navigated around Yellowtail Afterbay. Water surface elevations recorded by a Reclamation gauge during the time of collection and measured by the GPS system were used to convert the sonic depth measurements to true reservoir bottom elevations.

Table 1 contains a summary of the 2000 Yellowtail Afterbay Reservoir survey. The 2000 survey determined that the reservoir has a total storage capacity of 2,877 acre-feet and a surface area of around 176 acres at reservoir elevation 3,192.0.

HYDROGRAPHIC SURVEY EQUIPMENT AND METHOD

The hydrographic survey equipment was mounted on an 18-foot raft with an outboard motor (figure1). The hydrographic system included a GPS receiver with a built-in radio, a depth sounder, a helmsman display for navigation, a computer, and hydrographic system software for collecting the underwater data. On-board batteries supplied power to all the equipment. The shore equipment included a second GPS receiver with an external radio. The GPS receiver and antenna were mounted on a survey tripod over a known datum point and a 12-volt battery provided the power for the shore unit.

[1] Elevation levels are shown in feet and are based on the National Geodetic Vertical Datum of 1929 (NGVD29).

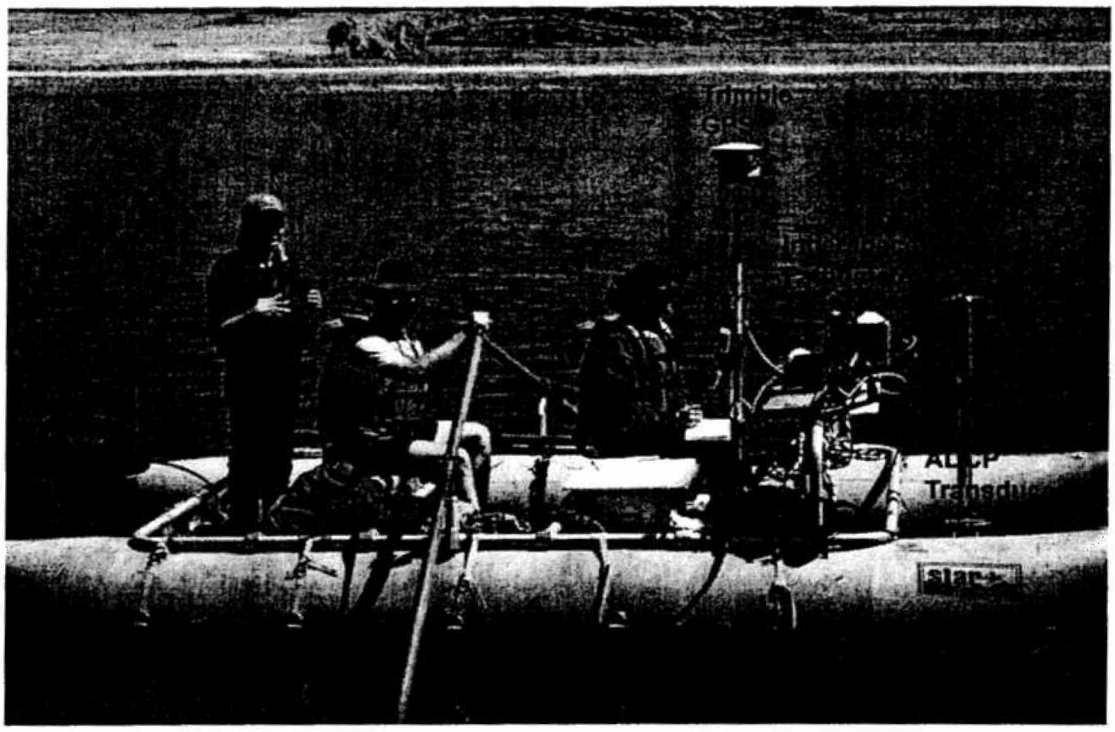

Figure 1 - Survey vessel with mounted hydrographic equipment

The Sedimentation and River Hydraulics Group uses Real-time Kinematic (RTK) GPS with the major benefit being the ability to measure precise heights in real time to monitor the water surface elevation changes. The basic outputs from an RTK receiver are precise 3D coordinates in latitude, longitude, and height with accuracies in the order of 2 centimeters horizontally and 3 centimeters vertically. This output was on the GPS datum of WGS-84 that the hydrographic collection software converted into Montana's NAD83 state plane coordinate system. The RTK GPS system employs two receivers that track the same satellites simultaneously just like with differential GPS. The shore base unit was placed over the 1997 aerial survey point labeled "12" located upstream of the left abutment of the afterbay dam with the following coordinates:

Montana's State Plane in NAD1983 (Grid North)

North 119,826.22 meters
East 723,625.27 meters

Local Ground Feet (True North)

North 393,147.00
East 2,374,873.78
Elevation 3,204.27

The bearings were referenced to True North based on GPS observations and rotated about (+) 1.1403 degrees from the grid bearings.

The underwater data were collected by a depth sounder that was calibrated by lowering a 25-foot survey rod below the sounders transducer. This was accomplished by tying the survey vessel at several locations along the buoy line just upstream of the dam. The depth sounder was calibrated by adjusting the speed of sound, which can vary with density, salinity, temperature, turbidity, and other conditions to match the known bottom depth. The collected data were digitally transmitted to the computer collection system via a RS-232 port. The depth sounder also produced an analog hard-copy chart of the measured depths. These graphed analog charts were printed for all survey lines as the data were collected and recorded by the computer. The charts were analyzed during post-processing, and when the analog charted depths indicated a difference from the recorded computer bottom depths, the computer data files were modified. The water surface elevations at the dam recorded by a Reclamation gage at 15-minute intervals and the RTK GPS elevation measurements were used to convert the sonic depth measurements to true lake-bottom elevations. These vertical measurements were absolutely critical for this study since the water surface fluctuated continuously throughout the survey.

The small flat bottom survey vessel allowed collection in the shallow portions of the reservoir, but due to limited power of the survey vessel and underwater turbulence conditions the collection ended about 1,400 feet below Yellowtail Dam. Even if the vessel could have progressed safely further upstream, the dam would have eventually hindered the collection of the GPS measurements and the underwater turbulence from the power releases would have prevented the depth sounder from obtaining good bottom depth readings.

RESERVOIR AREA AND CAPACITY

Using ARC/INFO the topography of Yellowtail Afterbay was developed from the 1997 aerial data and the 2000 underwater data set. ARC/INFO is a software package for development and analysis of geographic information system (GIS) layers and development of interactive GIS applications that provided a means of organizing and interpreting these data sets. The 1997 data was provided in a digital format, but the contour of the reservoir water surface, elevation 3,190.0, was not a complete contour and did not provide all the island details as illustrated on the hard copy maps. For the purpose of this study, the 3190 contour was digitized from the several maps that represented the reservoir. The aerial contours were projected to a local coordinate system that had ties to Montana's NAD 1983 state plane coordinates. The resulting enclosed 3,190.0 contour provided a surface area at this elevation and was also used to provide a clip or boundary around the edge of the underwater data set such that interpolation was not allowed to occur outside of this boundary. This clip was performed using the hardclip option of the ARC/INFO CREATETIN command. This clip was selected because it was the closest available contour elevation to the reservoir water surface during the underwater collection that was conducted near reservoir elevation 3,186.

Using the ARCEDIT command the underwater data and the digitized 3190 contour layers were plotted. Since the underwater data were in Montana's state plane coordinates they needed to be shifted to match the local coordinated system of the aerial contour data. Shifting the underwater data points 17.2 feet north and 779.9 feet east and rotating the data set, using point 12 as the pivot point, 1.1403 degrees, completed this. A plot of the adjusted underwater data set found all points within the 3190 contour boundary along the banks and around the islands.

Contours for elevations 3,190.0 and below were computed from the 2000 underwater data set using the triangular irregular network (TIN) surface-modeling package within ARC/INFO. The 2000 contour surface areas for Yellowtail Afterbay were computed at 1-foot increments, from elevation 3,144.0 to 3,190.0, using the developed TIN. The 2000 survey measured the minimum reservoir elevation at 3,143.3. These calculations were performed using the ARC/INFO VOLUME command that computes areas at specified elevations directly from the TIN taking into consideration all regions of equal elevation.

Due to the lack of 2000 underwater data points from the dam to about 1400 feet downstream, some judgment was used to add points in this area to develop contours and resulting surface areas in this portion of the reservoir. These points were added using the 3190 clip and the 2000 upper data points as a guide. The surface areas and resulting capacity from the 2000 survey data and the modified data set are listed on table 1. The contour topography at 2-foot intervals is presented on figure 2.

2000 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). The 2000 measured surface areas at 1-foot contour intervals from minimum reservoir elevation 3,145.0 (no area reported at this elevation) to elevation 3,186.0 and the surface areas of aerial data from elevation 3,190.0 to elevation 3,210.0 were used as the control parameters for computing the 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 that was set at 0.000001. The initial capacity equation is 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 a 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. Final area equations are derived by differentiating the capacity equations, which are of second order polynomial form:

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

where:

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

Results of the 2000 Yellowtail Afterbay Reservoir area and capacity computations are listed in table 1 and 2 and the area-capacity curves plotted on figure 3. As of June 2000, at elevation 3,197.5, crest elevation of embankments, the surface area was 202 acres with a total capacity of 3,902 acre-feet.

REFERENCES

Bureau of Reclamation, 1981. ***Project Data***, Denver Office, Denver CO.

Bureau of Reclamation, 1985. Surface Water Branch, ***ACAP85 User's Manual***, Technical Service Center, Denver CO.

Environmental Systems Research Institute , Inc. (ESRI), 1992. ***ARC Command References***.

Elevations (feet)	2000 Survey Adjusted Area (acres)	2000 Survey Adjusted Capacity (acre-feet)
3,210.0	258.4	6,813
3,200.0	218.4	4,429
3,198.0	206.7	4,004
3,197.5	202.0	3,902
3,196.0	189.7	3,608
3,194.0	182.3	3,236
3,192.0	176.4	2,877
3,190.0	167.2	2,533
3,186.0	149.7	1,899
3,184.0	144.4	1,605
3,182.0	138.8	1,322
3,180.0	132.0	1,051
3,178.0	120.3	799
3,176.0	103.5	575
3,174.0	82.9	389
3,172.0	56.8	249
3,170.0	39.7	153
3,168.0	28.8	84
3,166.0	16.4	39
3,164.0	6.9	16
3,162.0	2.1	6
3,160.0	1.1	3
3,158.0	0.4	2
3,156.0	0.3	1
3,154.0	0.2	1
3,152.0	0.1	0
3,150.0	0.1	0
3,148.0	0.0	0
3,146.0	0.0	0
3,145.0	0.0	0

Table 1 - Summary of 2000 survey results

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
GREAT PLAINS REGION

YELLOWTAIL UNIT
YELLOWTAIL AFTERBAY
WYOMING

AREA AND CAPACITY TABLES

U.S. Department of the Interior
Bureau of Reclamation

June 2000

EQUATIONS --> $AREA = A2 + X*(A3 + A3)$

$CAPACITY = A3*X^2 + A2*X + A1$

WHERE X = THE DIFFERENCE BETWEEN THE BASE ELEVATION AND A GIVEN ELEVATION. AREA IS IN ACRES AND CAPACITY IS IN ACRE-FEET

YELLOWTAIL AFTERBAY - MONTANA
2000 AREA-CAPACITY TABLES

EQUATION NUMBER	ELEVATION BASE	CAPACITY BASE	COEFFICIENT A1(INTERCEPT)	COEFFICIENT A2(1ST TERM)	COEFFICIENT A3(2ND TERM)
1	3145.00	0	.0000	.0000	.0050
2	3146.00	0	.0050	.0100	.0050
3	3148.00	0	.0450	.0300	.0075
4	3150.00	0	.1350	.0600	.0150
5	3152.00	0	.3150	.1200	.0225
6	3156.00	1	1.1550	.3000	.0275
7	3158.00	1	1.8650	.4100	.1625
8	3160.00	3	3.3350	1.0600	.2600
9	3162.00	6	6.4950	2.1000	1.2050
10	3164.00	15	15.5150	6.9200	2.3650
11	3166.00	38	38.8150	16.3800	3.1100
12	3168.00	84	84.0150	28.8200	2.7300
13	3170.00	152	152.5750	39.7400	4.2600
14	3172.00	249	249.0950	56.7800	6.5400
15	3174.00	388	388.8150	82.9400	5.1400
16	3176.00	575	575.2550	103.5000	4.1900
17	3178.00	799	799.0150	120.2600	2.9350
18	3180.00	1051	1051.2750	132.0000	1.6925
19	3182.00	1322	1322.0450	138.7700	1.4175
20	3184.00	1605	1605.2550	144.4399	1.3250
21	3186.00	1899	1899.4351	149.7400	2.1825
22	3190.00	2533	2533.3149	167.2000	2.3000
23	3192.00	2876	2876.9151	176.3999	1.4750
24	3194.00	3235	3235.6150	182.3000	1.8500
25	3196.00	3607	3607.6150	189.7001	4.2499
26	3198.00	4004	4004.0149	206.7001	2.9250
27	3200.00	4429	4429.1147	218.4000	2.0000

YELLOWTAIL AFTERBAY - MONTANA

2000 AREA-CAPACITY TABLES

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THE AREA TABLE IS IN ACRES

THE ELEVATION INCREMENT IS IN ONE TENTH FOOT

ELEV. FEET	0	.1	.2	.3	.4	.5	.6	.7	.8	.9
3145	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
3146	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
3147	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
3148	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
3149	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
3150	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
3151	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
3152	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
3153	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
3154	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
3155	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
3156	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
3157	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
3158	0.	0.	0.	1.	1.	1.	1.	1.	1.	1.
3159	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.
3160	1.	1.	1.	1.	1.	1.	1.	1.	1.	2.
3161	2.	2.	2.	2.	2.	2.	2.	2.	2.	2.
3162	2.	2.	3.	3.	3.	3.	4.	4.	4.	4.
3163	5.	5.	5.	5.	5.	6.	6.	6.	6.	7.
3164	7.	7.	8.	8.	9.	9.	10.	10.	11.	11.
3165	12.	12.	13.	13.	14.	14.	14.	15.	15.	16.
3166	16.	17.	18.	18.	19.	19.	20.	21.	21.	22.
3167	23.	23.	24.	24.	25.	26.	26.	27.	28.	28.
3168	29.	29.	30.	30.	31.	32.	32.	33.	33.	34.
3169	34.	35.	35.	36.	36.	37.	38.	38.	39.	39.
3170	40.	41.	41.	42.	43.	44.	45.	46.	47.	47.
3171	48.	49.	50.	51.	52.	53.	53.	54.	55.	56.
3172	57.	58.	59.	61.	62.	63.	65.	66.	67.	69.
3173	70.	71.	72.	74.	75.	76.	78.	79.	80.	82.
3174	83.	84.	85.	86.	87.	88.	89.	90.	91.	92.
3175	93.	94.	95.	96.	97.	98.	99.	100.	101.	102.
3176	104.	104.	105.	106.	107.	108.	109.	109.	110.	111.
3177	112.	113.	114.	114.	115.	116.	117.	118.	119.	119.
3178	120.	121.	121.	122.	123.	123.	124.	124.	125.	126.
3179	126.	127.	127.	128.	128.	129.	130.	130.	131.	131.
3180	132.	132.	133.	133.	133.	134.	134.	134.	135.	135.
3181	135.	136.	136.	136.	137.	137.	137.	138.	138.	138.
3182	139.	139.	139.	140.	140.	140.	140.	141.	141.	141.
3183	142.	142.	142.	142.	143.	143.	143.	144.	144.	144.
3184	144.	145.	145.	145.	145.	146.	146.	146.	147.	147.

YELLOWTAIL AFTERBAY - MONTANA (ACAP92) COMPUTED
4/ 8/2003
2000 AREA-CAPACITY TABLES 10:25:28

THE AREA TABLE IS IN ACRES THE ELEVATION INCREMENT IS IN ONE TENTH FOOT

ELEV. FEET	0	.1	.2	.3	.4	.5	.6	.7	.8	.9
3185	147.	147.	148.	148.	148.	148.	149.	149.	149.	149.
3186	150.	150.	151.	151.	151.	152.	152.	153.	153.	154.
3187	154.	155.	155.	155.	156.	156.	157.	157.	158.	158.
3188	158.	159.	159.	160.	160.	161.	161.	162.	162.	162.
3189	163.	163.	164.	164.	165.	165.	165.	166.	166.	167.
3190	167.	168.	168.	169.	169.	170.	170.	170.	171.	171.
3191	172.	172.	173.	173.	174.	174.	175.	175.	175.	176.
3192	176.	177.	177.	177.	178.	178.	178.	178.	179.	179.
3193	179.	180.	180.	180.	181.	181.	181.	181.	182.	182.
3194	182.	183.	183.	183.	184.	184.	185.	185.	185.	186.
3195	186.	186.	187.	187.	187.	188.	188.	189.	189.	189.
3196	190.	191.	191.	192.	193.	194.	195.	196.	196.	197.
3197	198.	199.	200.	201.	202.	202.	203.	204.	205.	206.
3198	207.	207.	208.	208.	209.	210.	210.	211.	211.	212.
3199	213.	213.	214.	214.	215.	215.	216.	217.	217.	218.
3200	218.	219.	219.	220.	220.	220.	221.	221.	222.	222.
3201	222.	223.	223.	224.	224.	224.	225.	225.	226.	226.
3202	226.	227.	227.	228.	228.	228.	229.	229.	230.	230.
3203	230.	231.	231.	232.	232.	232.	233.	233.	234.	234.
3204	234.	235.	235.	236.	236.	236.	237.	237.	238.	238.
3205	238.	239.	239.	240.	240.	240.	241.	241.	242.	242.
3206	242.	243.	243.	244.	244.	244.	245.	245.	246.	246.
3207	246.	247.	247.	248.	248.	248.	249.	249.	250.	250.
3208	250.	251.	251.	252.	252.	252.	253.	253.	254.	254.
3209	254.	255.	255.	256.	256.	256.	257.	257.	258.	258.
3210	258.									

YELLOWTAIL AFTERBAY - MONTANA

2000 AREA-CAPACITY TABLES

(ACAP92) COMPUTED
4/ 8/2003
10:25:28

THE CAPACITY TABLE IS IN ACRE FEET

THE ELEVATION INCREMENT IS ONE TENTH FOOT

ELEV. FEET	0	.1	.2	.3	.4	.5	.6	.7	.8	.9
3145	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
3146	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
3147	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
3148	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
3149	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
3150	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
3151	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
3152	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
3153	0.	0.	0.	1.	1.	1.	1.	1.	1.	1.
3154	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.
3155	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.
3156	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.
3157	1.	2.	2.	2.	2.	2.	2.	2.	2.	2.
3158	2.	2.	2.	2.	2.	2.	2.	2.	2.	2.
3159	2.	3.	3.	3.	3.	3.	3.	3.	3.	3.
3160	3.	3.	4.	4.	4.	4.	4.	4.	4.	4.
3161	5.	5.	5.	5.	5.	6.	6.	6.	6.	6.
3162	6.	7.	7.	7.	8.	8.	8.	9.	9.	9.
3163	10.	10.	11.	11.	12.	12.	13.	14.	14.	15.
3164	16.	16.	17.	18.	19.	20.	21.	22.	23.	24.
3165	25.	26.	27.	29.	30.	31.	33.	34.	36.	37.
3166	39.	40.	42.	44.	46.	48.	50.	52.	54.	56.
3167	58.	61.	63.	65.	68.	70.	73.	76.	78.	81.
3168	84.	87.	90.	93.	96.	99.	102.	106.	109.	112.
3169	116.	119.	123.	126.	130.	133.	137.	141.	145.	149.
3170	153.	157.	161.	165.	169.	174.	178.	182.	187.	192.
3171	197.	201.	206.	211.	217.	222.	227.	232.	238.	243.
3172	249.	255.	261.	267.	273.	279.	286.	292.	299.	305.
3173	312.	319.	327.	334.	341.	349.	357.	365.	372.	381.
3174	389.	397.	406.	414.	423.	432.	440.	449.	458.	468.
3175	477.	486.	496.	505.	515.	525.	535.	545.	555.	565.
3176	575.	586.	596.	607.	617.	628.	639.	650.	661.	672.
3177	683.	694.	705.	717.	728.	740.	752.	763.	775.	787.
3178	799.	811.	823.	835.	848.	860.	872.	885.	897.	910.
3179	922.	935.	948.	960.	973.	986.	999.	1012.	1025.	1038.
3180	1051.	1064.	1078.	1091.	1104.	1118.	1131.	1145.	1158.	1171.
3181	1185.	1199.	1212.	1226.	1239.	1253.	1267.	1281.	1294.	1308.
3182	1322.	1336.	1350.	1364.	1378.	1392.	1406.	1420.	1434.	1448.
3183	1462.	1476.	1491.	1505.	1519.	1533.	1548.	1562.	1576.	1591.
3184	1605.	1620.	1634.	1649.	1663.	1678.	1692.	1707.	1722.	1736.

YELLOWTAIL AFTERBAY - MONTANA

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2000 AREA-CAPACITY TABLES

THE CAPACITY TABLE IS IN ACRE FEET

THE ELEVATION INCREMENT IS ONE TENTH FOOT

ELEV. FEET	0	.1	.2	.3	.4	.5	.6	.7	.8	.9
3185	1751.	1766.	1780.	1795.	1810.	1825.	1840.	1855.	1870.	1884.
3186	1899.	1914.	1929.	1945.	1960.	1975.	1990.	2005.	2021.	2036.
3187	2051.	2067.	2082.	2098.	2113.	2129.	2145.	2160.	2176.	2192.
3188	2208.	2224.	2239.	2255.	2271.	2287.	2304.	2320.	2336.	2352.
3189	2368.	2385.	2401.	2417.	2434.	2450.	2467.	2483.	2500.	2517.
3190	2533.	2550.	2567.	2584.	2601.	2617.	2634.	2651.	2669.	2686.
3191	2703.	2720.	2737.	2755.	2772.	2789.	2807.	2824.	2842.	2859.
3192	2877.	2895.	2912.	2930.	2948.	2965.	2983.	3001.	3019.	3037.
3193	3055.	3073.	3091.	3109.	3127.	3145.	3163.	3181.	3199.	3217.
3194	3236.	3254.	3272.	3290.	3309.	3327.	3346.	3364.	3383.	3401.
3195	3420.	3438.	3457.	3476.	3494.	3513.	3532.	3551.	3570.	3589.
3196	3608.	3627.	3646.	3665.	3684.	3704.	3723.	3742.	3762.	3782.
3197	3802.	3821.	3841.	3861.	3882.	3902.	3922.	3942.	3963.	3983.
3198	4004.	4025.	4045.	4066.	4087.	4108.	4129.	4150.	4171.	4192.
3199	4214.	4235.	4256.	4278.	4299.	4321.	4342.	4364.	4386.	4407.
3200	4429.	4451.	4473.	4495.	4517.	4539.	4561.	4583.	4605.	4627.
3201	4650.	4672.	4694.	4716.	4739.	4761.	4784.	4806.	4829.	4851.
3202	4874.	4897.	4919.	4942.	4965.	4988.	5010.	5033.	5056.	5079.
3203	5102.	5125.	5148.	5172.	5195.	5218.	5241.	5265.	5288.	5311.
3204	5335.	5358.	5382.	5405.	5429.	5452.	5476.	5500.	5524.	5547.
3205	5571.	5595.	5619.	5643.	5667.	5691.	5715.	5739.	5763.	5787.
3206	5812.	5836.	5860.	5884.	5909.	5933.	5958.	5982.	6007.	6031.
3207	6056.	6081.	6105.	6130.	6155.	6180.	6204.	6229.	6254.	6279.
3208	6304.	6329.	6354.	6380.	6405.	6430.	6455.	6481.	6506.	6531.
3209	6557.	6582.	6608.	6633.	6659.	6684.	6710.	6736.	6762.	6787.
3210	6813.									

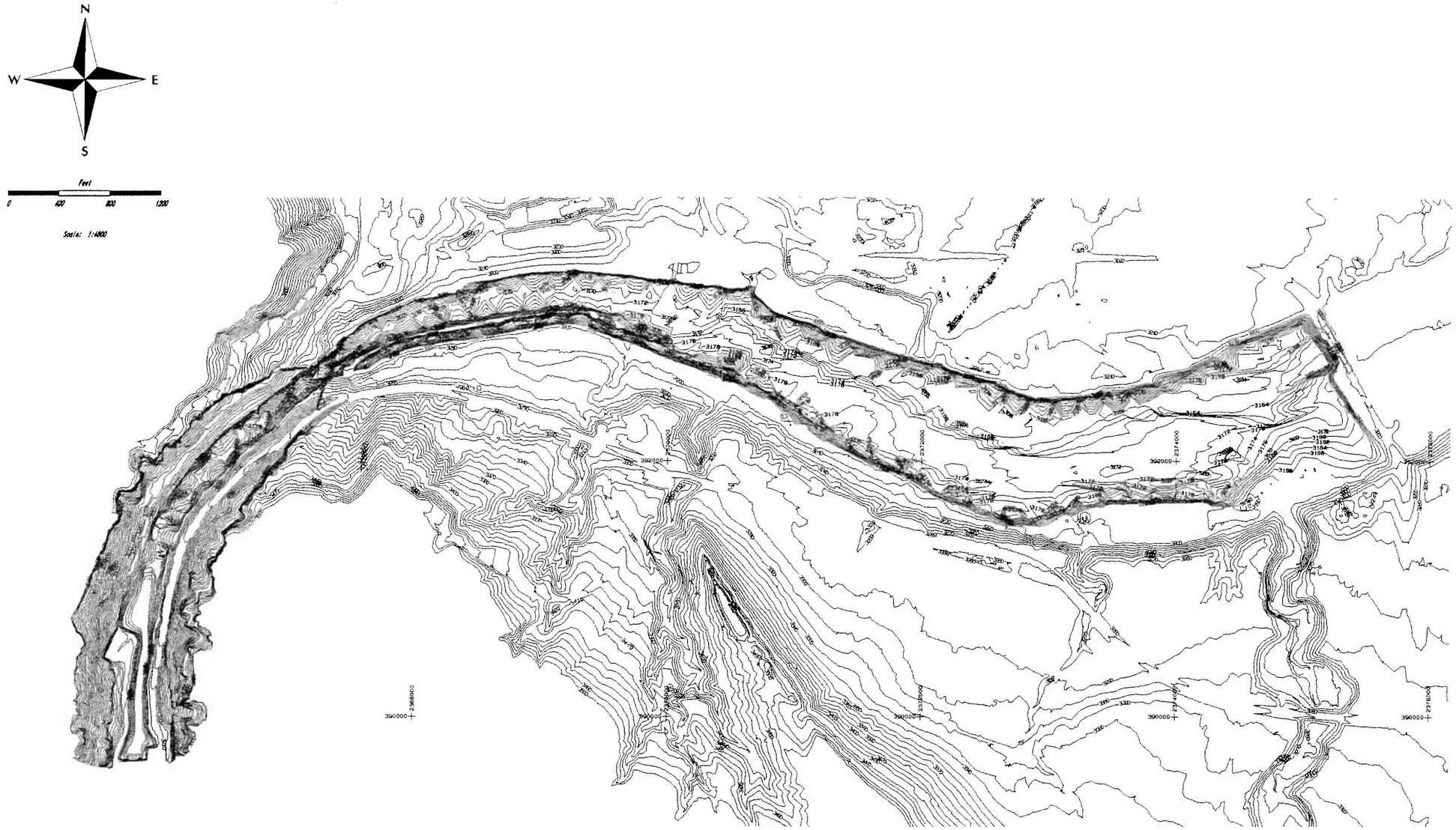

Figure 2 – Yellowtail Afterbay topographic map

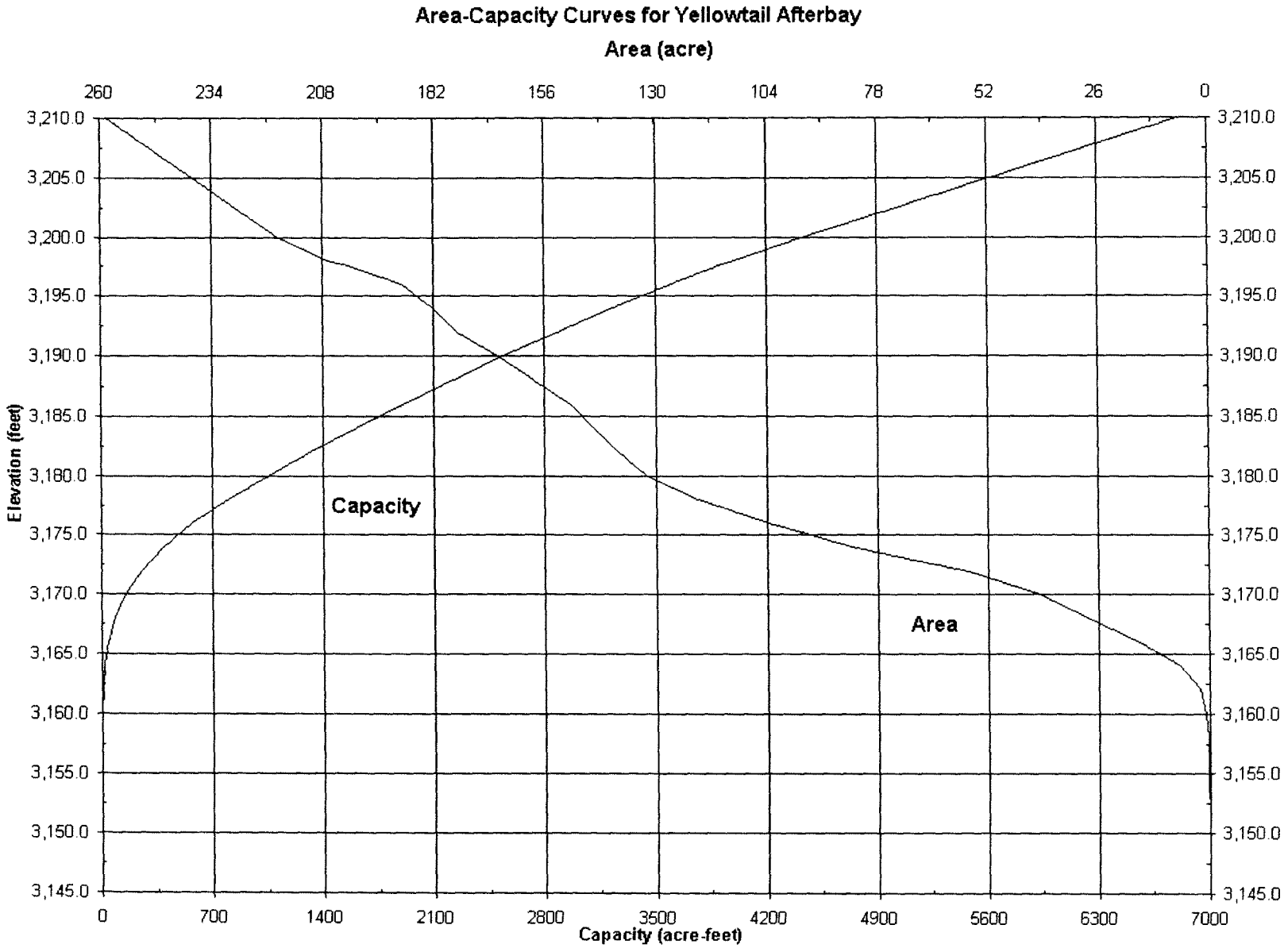

Figure 2 - 2000 area and capacity curves