CITY OF
RANCHO PALOS VERDES

U.S. ARMY CORPS OF
ENGINEERS

PORTUGUESE BEND SHORE PROTECTION FEASIBILITY STUDY

ANALYSIS OF LANDSLIDE MATERIAL LOSS

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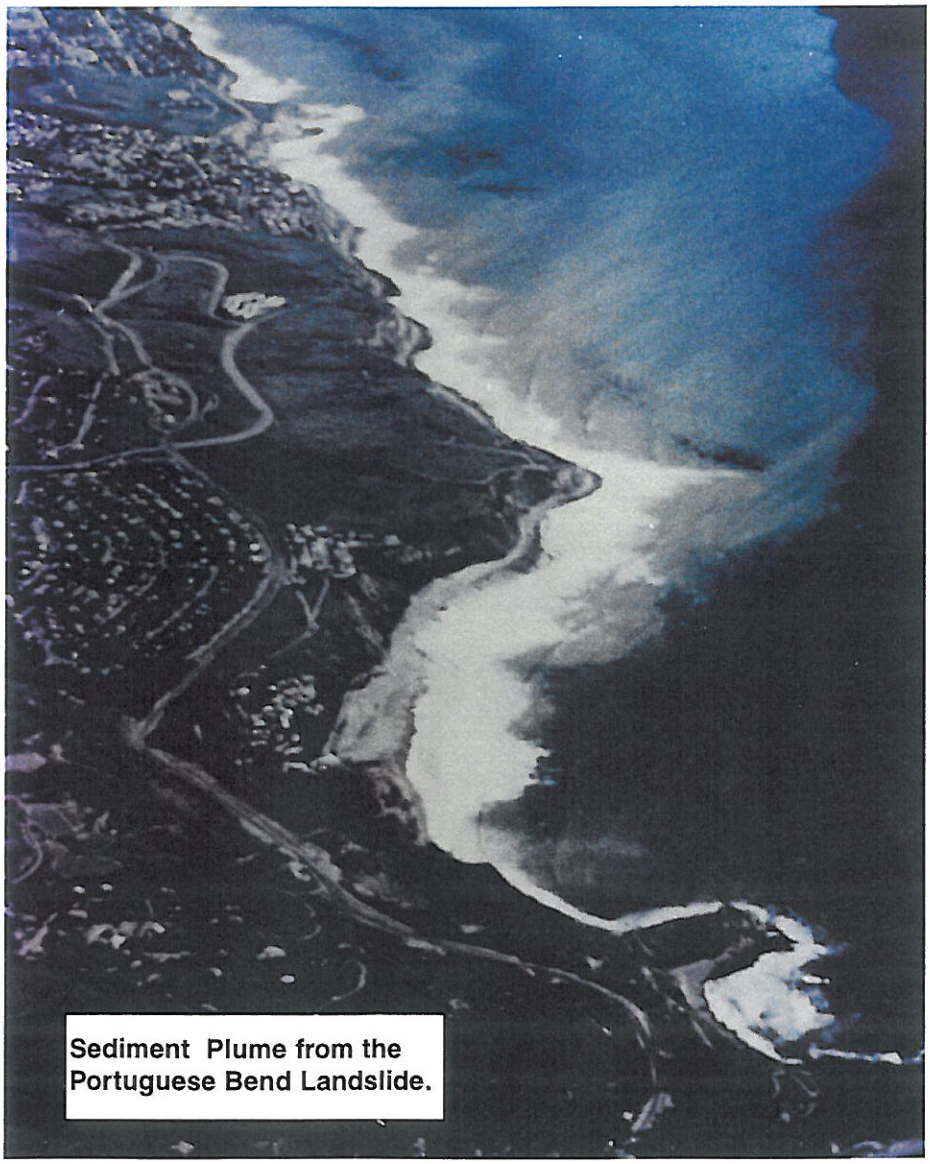
LANDSLIDE MATERIAL LOSS

BACKGROUND

The Portuguese Bend Landslide has moved continuously over the past forty years. Vonder Linden (1972), attributes this continued movement partly to a notable rise in the ground water table between 1957 and 1968 and the continued erosion of the toe by wave action. The rate of movement varies considerably in response to variation in ground water levels (Vonder Linden, 1972). In 1978, above average rainfall caused a large increase in the rate of movement in the Portuguese Bend Landslide. The high rates of movement continued until 1986 when the Rancho Palos Verdes Redevelopment Agency performed remedial grading. For example, one survey monument, R-1, (see Figure 1) which is located in the east central part of the landslide, moved 382 feet horizontally in the ten year period from October 1976 to October 1986 whereas it had moved 237 feet during the twenty year period from October 1956 to October 1976 (Ehlig 1991). Near the coast, the correlation of offset features indicates displacements of more than 800 feet since the start of landsliding.



Sediment Plume from the Portuguese Bend Landslide.

A sediment plume has been visible in the ocean since the start of movement in 1956 . Landslide sediments have been identified 2.5 nautical miles to the south of the landslide and 1.5 nautical miles off-shore

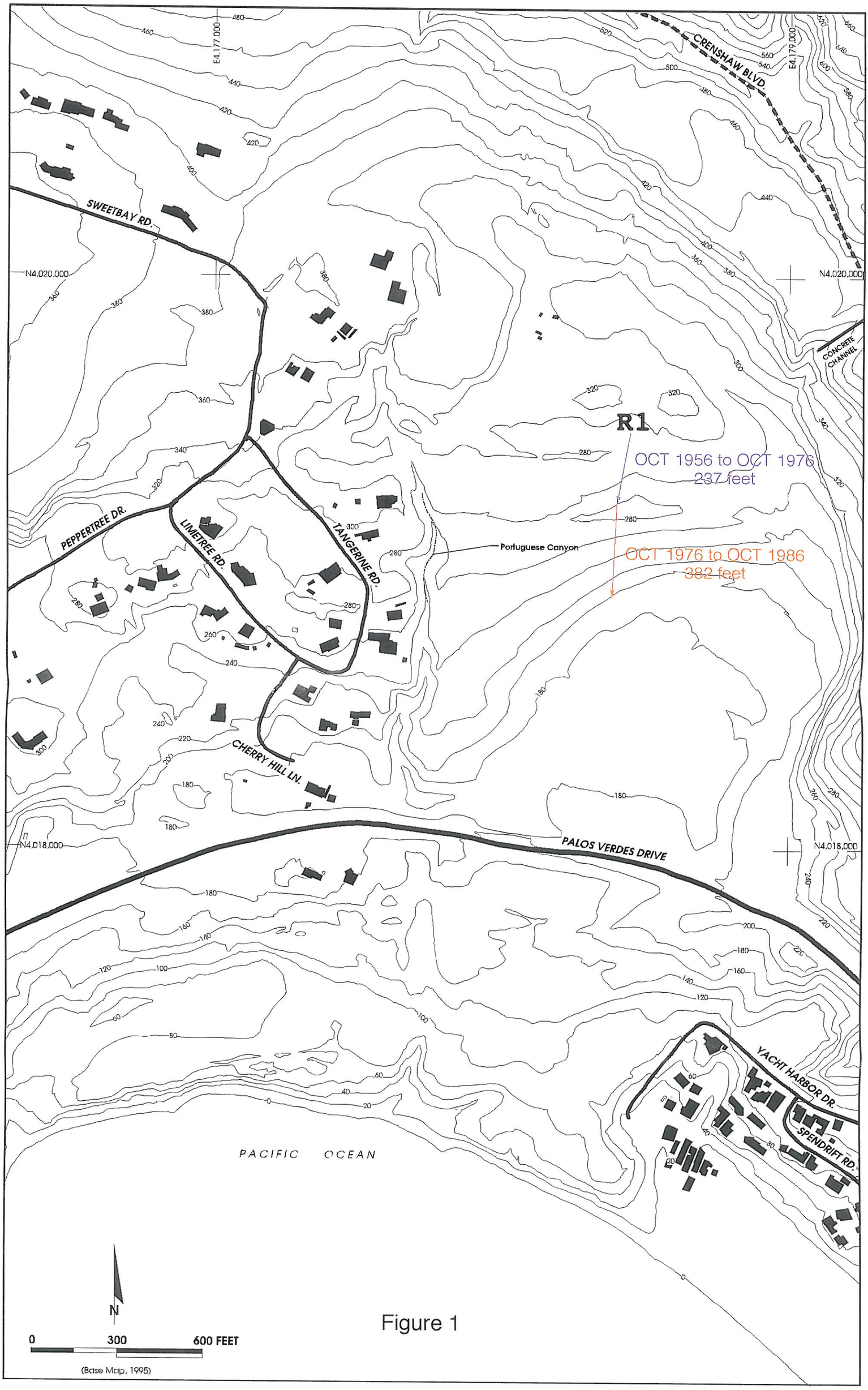

E4,177,000
E4,179,000
CRENSHAW BLVD.
SWEETBAY RD.
N4,020,000
CONCRETE CHANNEL
R1
OCT 1956 to OCT 1976
237 feet
OCT 1976 to OCT 1986
382 feet
PEPPERTREE DR.
LIMETREE RD.
TANGERINE RD.
Portuguese Canyon
CHERRY HILL LN.
N4,018,000
PALOS VERDES DRIVE
YACHT HARBOR DR.
SPENDRIFT RD.
PACIFIC OCEAN
N
0
300
600 FEET
(Base Map, 1995)

Figure 1

(Stevens, 1990). It is estimated that sediment from the Portuguese Bend Landslide affects the marine environment in an area of approximately 771 hectares in size (Stevens, 1990). The photograph on the previous page shows the sediment plume from the Portuguese Bend Landslide in 1980.

ANALYSIS

In determining the amount of landslide material that has been lost, cross-sections were drawn using topographic maps of the area from 1955, 1976, 1984, 1987, 1988 and 1995. By comparing the area between cross-sections on the first map, dated August 1955 (prior to the start of landsliding), and cross sections taken at the same location on subsequent topographic maps, a difference of the upslope removal and the downslope fill can be computed. However, in this situation where the entire landslide mass is translating downslope in a non-uniform manner, the typical approach to calculating the difference between removals and fills does not explain how parts of a mass can translate up to 800 feet without that part of the entire mass being dispersed into the ocean. Therefore, the difference in density of the material in slide mass before landsliding began, and in 1995, must be taken into account after the typical difference between removals and fills are calculated.

In order to calculate the difference between the removals and fills created by the landslide, a total of eight (8) cross-sections were computed between the easterly edge of the landslide and Inspiration Point for each topographic map. The location of the cross-sections are shown on Figure 2. The various cross-sections are included in Attachment A. Adequate maps are not available to determine the amount of land movement in the area between Inspiration Point and Portuguese Point. Therefore we did not take cross-sections in this area.

Volume of displaced earth was determined by using the average end area method. Volume calculations were broken down into three portions. Portion 1, the removal, included the material between the location of the bluff in 1955 or limit of landslide and the top of the landslide. Portion 2 included the material between the 1955 shoreline and the location of the bluff in 1955 which is part of the fill area. Portion 3 included the material between the 1955 shoreline and the shoreline in later years and represents the part that the landslide has encroached into the ocean. Figure 3 shows the general location of the three portions used in our calculations.

Based on this volume analysis, we estimate that the amount of material that has entered the ocean due to landsliding is approximately 3,584,000 cubic yards.

However, as stated earlier, this does not account for the total amount of material dispersed into the ocean. Because of the loss of density of the moving material in the slide mass, another significant amount of material has been moved into the ocean. Once the


E4,177,000
E4,179,000
CRENSHAW BLVD.
SWEETBAY RD.
N4,020,000
CONCRETE CHANNEL
PEPPERTREE DR.
LIMETREE RD.
TANGERINE RD.
Portuguese Canyon
CHERRY HILL LN.
N4,018,000
PALOS VERDES DRIVE
YACHT HARBOR DR.
SPENDRIFT RD.
PACIFIC OCEAN
1
2
3
4
5
6
7
8
N
0
300
600 FEET
(Base Map, 1995)

Figure 2

CROSS-SECTION
E 4,178,000

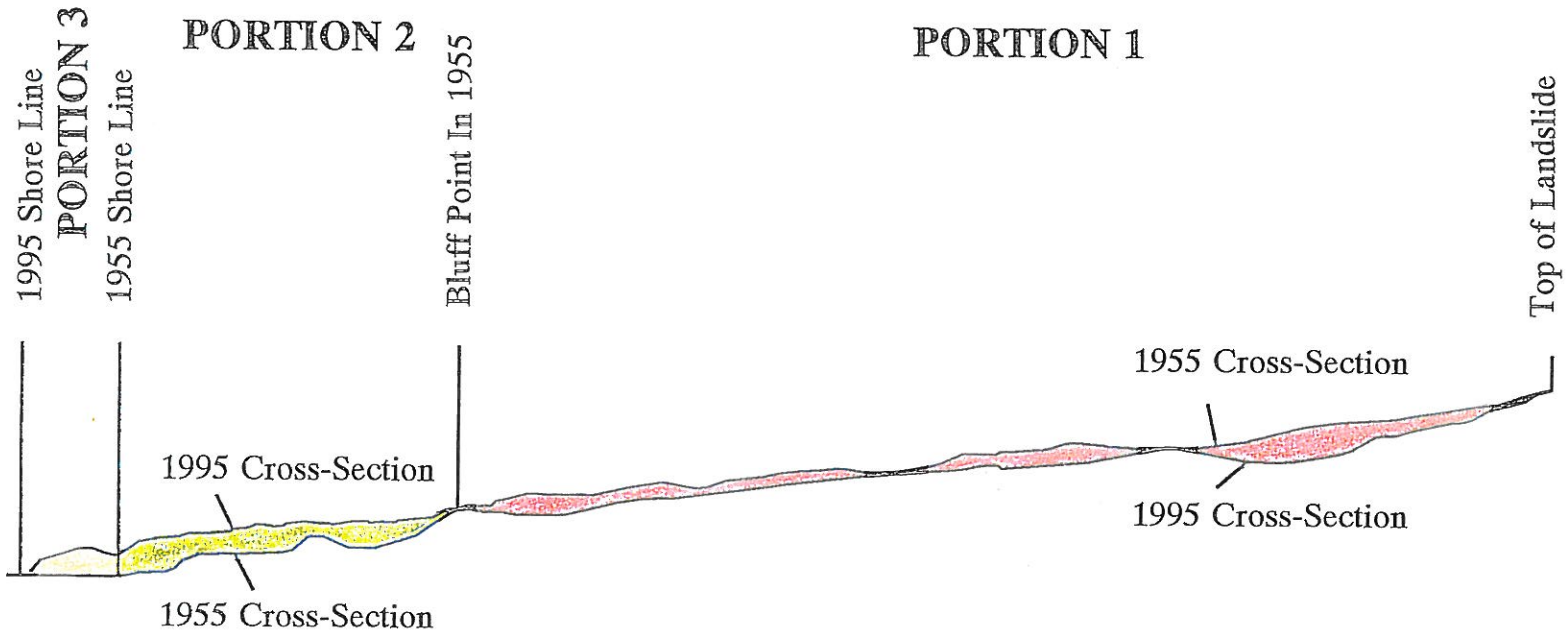


Figure 3

mass began moving downslope, a number of factors have affected the speed of the landslide mass. These factors include: 1) the height of ground water above the slide plane, 2) the depth of the slide mass, 3) the slope of the slide plane, 4) the friction of the material at the slide plane, 5) the amount of support, particularly at the bluff and 6) the rate at which the ocean removes material along the shoreline. These factors vary throughout the landslide. Survey data indicates that the most rapid movement has occurred within the oceanward part of the landslide south of Palos Verdes Drive South. Because the downslope portion of the landslide has a higher rate of movement than other sections of the landslide, grabens and voids are created within the landslide mass causing a significant reduction in the density of the original slide mass. For the purposes of this report, we have assumed that the loss in density is 10%. This assumption is based on our experience in mass earthwork construction where materials such as soils and rock that are loosened, typically show a 10%-15% decrease in density. The translation of the material occurs at a much faster rate in the coastal zone (Palos Verdes Drive South to the ocean) than in the inland areas. Therefore, pull aparts, grabens, and fissures are commonplace in the areas moving. Thus, the faster moving areas separate from the slower moving areas creating these void spaces and less dense material.

From our cross-sections and calculations, we estimate the mass of the original landslide to be 22,480,000 cubic yards. Assuming a loss of 10% in density, the additional dispersement of material into the ocean is 2,250,000 cubic yards. This brings the total amount of material loss due to landsliding to 5,834,000 cubic yards since the landslide began moving in 1956.

Figures 4 and 5 on the following page show the cumulative amount of material loss and the average yearly loss for various periods between 1956 and 1995. As shown in Figure 5, the average yearly loss of material was 85, 633 cubic yards for the period from 1955 through 1976 and 207,795 cubic yards for the period from 1987 through 1995.

CONCLUSION

Two factors must be considered in determining the amount of landslide material loss; 1) the actual amount of earth that has moved into the ocean which can be verified using photographs and topographic maps, and 2)the estimated loss of density that has occurred as a result of land movement. Our calculations using verifiable information indicate that approximately 3, 589,000 cubic yards of earth entered into the ocean as a result of landsliding. In addition, based on our experience, we have estimated that the landslide mass has experienced a minimum 10% reduction in density as a result of land movement. This translates into an additional 2,250,000 cubic yards of earth that has been dispersed in the ocean. Therefore, the total landslide material loss is estimated to be 5,834,000 cubic yards.

CUMMULATIVE LANDSLIDE MATERIAL LOSS

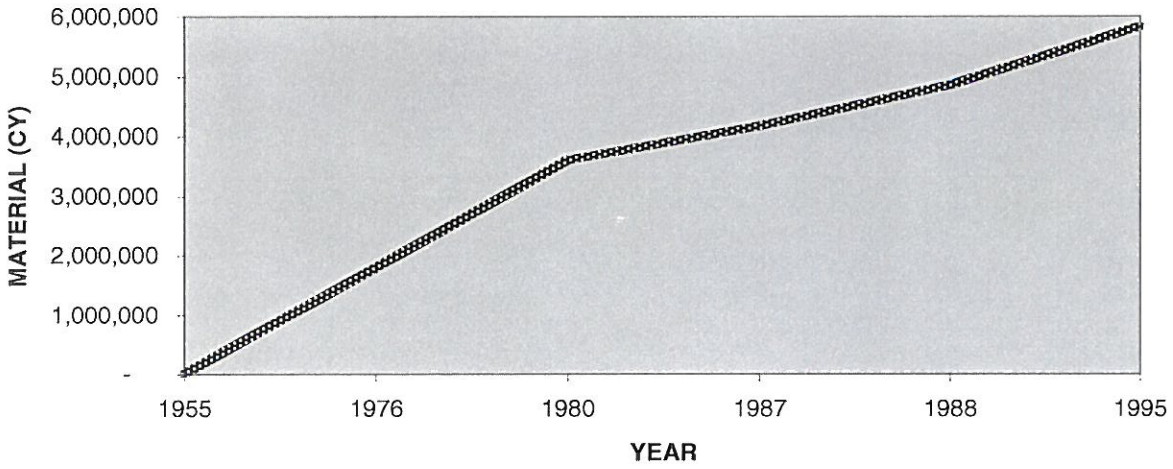


FIGURE 4

Year	Cummlative Erosion (CY)
1955	-
1976	1,798,291
1980	3,606,855
1987	4,171,713
1988	4,853,645
1995	5,834,076

AVERAGE YEARLY LOSS FOR PERIOD

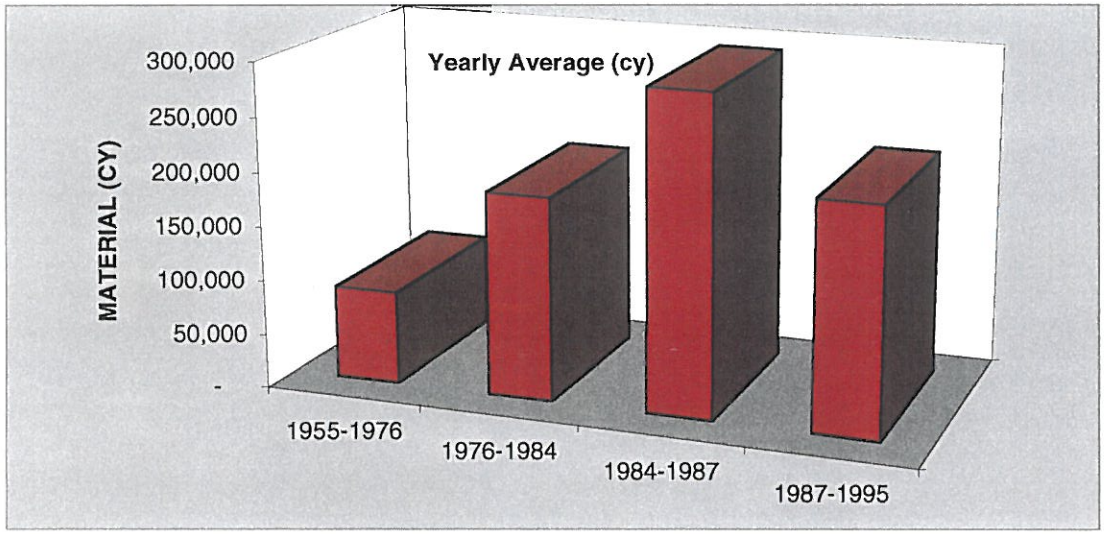


FIGURE 5

Period Years	Total for Period (CY)	Yearly Average (CY)
1955-1976	1,798,291	85,633
1976-1984	1,498,072	187,259
1984-1987	875,440	291,813
1987-1995	1,662,363	207,795

ATTACHMENT A

CHANGE FROM 1955

YEAR	1976	1980	1984	1987	1988	1995
SUBSIDENCE	2,040,411	3,956,207	4,671,553	5,465,636	5,950,297	6,396,982
INFILL	1,994,248	2,060,989	2,819,481	2,742,001	2,630,278	2,250,303
BEYOND SHORELINE	497,963	538,364	805,798	801,922	716,374	562,603
X-SECTION BALANCE	(451,799)	1,356,855	1,046,273	1,921,713	2,603,645	3,584,076
10% BULKING OF 22,480,000 C.Y. SLIDE	2,250,000	2,250,000	2,250,000	2,250,000	2,250,000	2,250,000
EROSION	1,798,201	3,606,855	3,296,273	4,171,713	4,853,645	5,834,076

1955 to 1976
EARTH MOVEMENT CALCULATIONS
PORTION 1
SUBSIDENCE NORTH OF 1955 BLUFF

X-Section	North of Bluff Square Feet	Average End Area Square Feet	Distance Feet	Volume Cubic Yards
6,050	8,000.00			
		9,700.63	450	161,677
6,500	11,401.25			
		12,730.35	600	282,897
7,100	14,059.45			
		18,086.33	300	200,959
7,400	22,113.20			
		22,265.80	300	247,398
7,700	22,418.40			
		25,102.83	300	278,920
8,000	27,787.25			
		27,625.00	300	306,944
8,300	27,462.75			
		27,606.33	300	306,737
8,600	27,749.90			
		16,896.33	300	187,737
8,900	6,042.75			
		3,021.38	600	67,142
9,500	0.00			
				2,040,411

PORTION 2
INFILL BETWEEN 1955 SHORE LINE & 1955 BLUFF

X-Section	1955 Shore to Bluff Square Feet	Average End Area Square Feet	Distance Feet	Volume Cubic Yards
6,300	6,000.00			
		8,506.90	200	63,014
6,500	11,013.80			
		15,300.23	600	340,005
7,100	19,586.65			
		18,751.55	300	208,351
7,400	17,916.45			
		21,535.18	300	239,280
7,700	25,153.90			
		32,777.83	300	364,198
8,000	40,401.75			
		37,584.13	300	417,601
8,300	34,766.50			
		26,490.45	300	294,338
8,600	18,214.40			
		9,107.20	200	67,461
8,800	0.00			
		0.00	400	0
9,200	0.00			
				1,994,248

PORTION 3
INFILL BETWEEN 1955 SHORE LINE & 1976 SHORE LINE

X-Section	South of 1955 Shore Square Feet	Average End Area Square Feet	Distance Feet	Volume Cubic Yards
6,300	3,000.00			
		3,440.80	200	25,487
6,500	3,881.60			
		4,942.30	600	109,829
7,100	574.00			
		6,451.88	300	71,688
7,400	6,900.75			
		7,978.75	300	88,653
7,700	9,056.75			
		9,240.88	300	102,676
8,000	9,425.00			
		6,343.75	300	70,486
8,300	3,262.50			
		2,226.25	300	24,736
8,600	1,190.00			
		595.00	200	4,407
8,800	0.00			
		0.00	400	0
9,200	0.00			
				497,963

1955 to 1980±
EARTH MOVEMENT CALCULATIONS
PORTION 1
SUBSIDENCE NORTH OF 1955 BLUFF

X-Section	North of Bluff Square Feet	Average End Area Square Feet	Distance Feet	Volume Cubic Yards
6,050	7,000.00			
		13,143.13	450	219,052
6,500	19,286.25			
		16,106.63	600	357,925
7,100	12,927.00			
		27,174.50	300	301,939
7,400	41,422.00			
		36,282.00	300	403,133
7,700	31,142.00			
		40,506.00	300	450,067
8,000	49,870.00			
		68,511.94	300	761,244
8,300	87,153.88			
		68,843.74	300	764,930
8,600	50,533.60			
		37,782.05	300	419,801
8,900	25,030.50			
		12,515.25	600	278,117
9,500	0.00			
				3,956,207

PORTION 2
INFILL BETWEEN 1955 SHORE LINE & 1955 BLUFF

X-Section	1955 Shore to Bluff Square Feet	Average End Area Square Feet	Distance Feet	Volume Cubic Yards
6,300	6,000.00			
		9,926.00	200	73,526
6,500	13,852.00			
		8,446.50	600	187,700
7,100	3,041.00			
		11,128.50	300	123,650
7,400	19,216.00			
		23,271.50	300	258,572
7,700	27,327.00			
		38,941.50	300	432,683
8,000	50,556.00			
		48,355.19	300	537,280
8,300	46,154.38			
		33,400.07	300	371,112
8,600	20,645.75			
		10,322.88	200	76,466
8,800	0.00			
		0.00	400	0
9,200	0.00			
				2,060,989

PORTION 3
INFILL BETWEEN 1955 SHORE LINE & 1980 SHORE LINE

X-Section	South of 1955 Shore Square Feet	Average End Area Square Feet	Distance Feet	Volume Cubic Yards
6,300	3,000.00			
		3,668.00	200	27,170
6,500	4,336.00			
		2,255.50	600	50,122
7,100	175.00			
		7,153.75	300	79,486
7,400	14,132.50			
		10,431.00	300	115,900
7,700	6,729.50			
		9,740.00	300	108,222
8,000	12,750.50			
		9,611.38	300	106,793
8,300	6,472.25			
		4,030.63	300	44,785
8,600	1,589.00			
		794.50	200	5,885
8,800	0.00			
		0.00	400	0
9,200	0.00			
				538,364

1955 to 1984
EARTH MOVEMENT CALCULATIONS
PORTION 1
SUBSIDENCE NORTH OF 1955 BLUFF

X-Section	North of Bluff Square Feet	Average End Area Square Feet	Distance Feet	Volume Cubic Yards
6,050	8,000.00			
		14,706.63	450	245,110
6,500	21,413.25			
		25,904.73	600	575,661
7,100	30,396.20			
		39,839.60	300	442,662
7,400	49,283.00			
		46,267.80	300	514,087
7,700	43,252.60			
		51,740.58	300	574,895
8,000	60,228.55			
		60,696.33	300	674,404
8,300	61,164.10			
		61,556.30	300	683,959
8,600	61,948.50			
		49,472.75	300	549,697
8,900	36,997.00			
		18,498.50	600	411,078
9,500	0.00			
				4,671,553

PORTION 2
INFILL BETWEEN 1955 SHORE LINE & 1955 BLUFF

X-Section	1955 Shore to Bluff Square Feet	Average End Area Square Feet	Distance Feet	Volume Cubic Yards
6,300	6,000.00			
		10,426.38	200	77,232
6,500	14,852.75			
		21,634.60	600	480,769
7,100	28,416.45			
		27,364.80	300	304,053
7,400	27,120.75			
		29,789.78	300	330,998
7,700	33,266.40			
		45,084.85	300	500,943
8,000	56,903.30			
		56,529.03	300	628,100
8,300	56,154.75			
		38,089.78	300	423,220
8,600	20,024.80			
		10,012.40	200	74,166
8,800	0.00			
		0.00	400	0
9,200	0.00			
				2,819,481

PORTION 3
INFILL BETWEEN 1955 SHORE LINE & 1984 SHORE LINE

X-Section	South of 1955 Shore Square Feet	Average End Area Square Feet	Distance Feet	Volume Cubic Yards
6,300	3,000.00			
		4,256.63	200	31,531
6,500	5,513.25			
		5,758.13	600	127,958
7,100	6,003.00			
		10,663.58	300	118,484
7,400	15,324.15			
		16,287.08	300	180,968
7,700	17,250.00			
		15,799.60	300	175,551
8,000	14,349.20			
		10,237.60	300	113,751
8,300	6,126.00			
		4,333.20	300	48,147
8,600	2,540.40			
		1,270.20	200	9,409
8,800	0.00			
		0.00	400	0
9,200	0.00			
				805,798

1955 to 1987
EARTH MOVEMENT CALCULATIONS
PORTION 1
SUBSIDENCE NORTH OF 1955 BLUFF

X-Section	North of Bluff Square Feet	Average End Area Square Feet	Distance Feet	Volume Cubic Yards
6,050	8,000.00			
		16,069.50	450	267,825
6,500	24,139.00			
		28,311.25	600	629,139
7,100	32,483.50			
		42,512.15	300	472,357
7,400	52,540.80			
		56,544.85	300	628,276
7,700	60,548.90			
		68,168.25	300	757,425
8,000	75,787.60			
		71,660.43	300	796,227
8,300	67,533.25			
		68,096.85	300	756,632
8,600	68,660.45			
		57,619.48	300	640,216
8,900	46,578.50			
		23,289.25	600	517,539
9,500	0.00			
				5,465,636

PORTION 2
INFILL BETWEEN 1955 SHORE LINE & 1955 BLUFF

X-Section	1955 Shore to Bluff Square Feet	Average End Area Square Feet	Distance Feet	Volume Cubic Yards
6,300	6,000.00			
		10,721.13	200	79,416
6,500	15,442.25			
		20,540.25	600	456,450
7,100	25,638.25			
		25,975.70	300	288,619
7,400	26,313.15			
		30,564.53	300	339,606
7,700	34,815.90			
		46,165.25	300	512,947
8,000	57,514.60			
		55,528.05	300	616,978
8,300	53,541.50			
		34,899.50	300	387,772
8,600	16,257.50			
		8,128.75	200	60,213
8,800	0.00			
		0.00	400	0
9,200	0.00			
				2,742,001

PORTION 3
INFILL BETWEEN 1955 SHORE LINE & 1987 SHORE LINE

X-Section	South of 1955 Shore Square Feet	Average End Area Square Feet	Distance Feet	Volume Cubic Yards
6,300	3,000.00			
		4,934.00	200	36,548
6,500	6,868.00			
		5,006.50	600	111,256
7,100	3,145.00			
		9,234.58	300	102,606
7,400	15,324.15			
		16,121.08	300	179,123
7,700	16,918.00			
		15,848.75	300	176,097
8,000	14,779.50			
		11,099.88	300	123,332
8,300	7,420.25			
		5,423.88	300	60,265
8,600	3,427.50			
		1,713.75	200	12,694
8,800	0.00			
		0.00	400	0
9,200	0.00			
				801,922

1955 to 1988
EARTH MOVEMENT CALCULATIONS
PORTION 1
SUBSIDENCE NORTH OF 1955 BLUFF

X-Section	North of Bluff Square Feet	Average End Area Square Feet	Distance Feet	Volume Cubic Yards
6,050	8,000.00			
		15,284.88	450	254,748
6,500	22,569.75			
		27,824.78	600	618,328
7,100	33,079.80			
		44,265.50	300	491,839
7,400	55,451.20			
		56,327.05	300	625,856
7,700	57,202.90			
		71,417.25	300	793,525
8,000	85,631.60			
		86,856.55	300	965,073
8,300	88,081.50			
		85,307.75	300	947,864
8,600	82,534.00			
		65,103.25	300	723,369
8,900	47,672.50			
		23,836.25	600	529,694
9,500	0.00			
				5,950,297

PORTION 2
INFILL BETWEEN 1955 SHORE LINE & 1955 BLUFF

X-Section	1955 Shore to Bluff Square Feet	Average End Area Square Feet	Distance Feet	Volume Cubic Yards
6,300	6,000.00			
		10,290.50	200	76,226
6,500	14,581.00			
		27,529.28	600	611,762
7,100	40,477.55			
		34,710.33	300	385,670
7,400	28,943.10			
		30,654.25	300	340,603
7,700	32,365.40			
		34,723.10	300	385,812
8,000	37,080.80			
		41,617.15	300	462,413
8,300	46,153.50			
		29,091.50	300	323,239
8,600	12,029.50			
		6,014.75	200	44,554
8,800	0.00			
		0.00	400	0
9,200	0.00			
				2,630,278

PORTION 3
INFILL BETWEEN 1955 SHORE LINE & 1988 SHORE LINE

X-Section	South of 1955 Shore Square Feet	Average End Area Square Feet	Distance Feet	Volume Cubic Yards
6,300	3,000.00			
		4,781.75	200	35,420
6,500	6,563.50			
		4,499.28	600	99,984
7,100	2,435.05			
		7,784.03	300	86,489
7,400	13,133.00			
		14,443.50	300	160,483
7,700	15,754.00			
		14,408.50	300	160,094
8,000	13,063.00			
		9,767.63	300	108,529
8,300	6,472.25			
		4,824.63	300	53,607
8,600	3,177.00			
		1,588.50	200	11,767
8,800	0.00			
		0.00	400	0
9,200	0.00			
				716,374

1955 to 1995
EARTH MOVEMENT CALCULATIONS
PORTION 1
SUBSIDENCE NORTH OF 1955 BLUFF

X-Section	North of Bluff Square Feet	Average End Area Square Feet	Distance Feet	Volume Cubic Yards
6,050	10,000.00			
		18,635.25	450	310,588
6,500	27,270.50			
		33,253.00	600	738,956
7,100	39,235.50			
		49,942.25	300	554,914
7,400	60,649.00			
		60,705.50	300	674,506
7,700	60,762.00			
		78,123.75	300	868,042
8,000	95,485.50			
		94,068.63	300	1,045,207
8,300	92,651.75			
		88,653.88	300	985,043
8,600	84,656.00			
		64,810.50	300	720,117
8,900	44,965.00			
		22,482.50	600	499,611
9,500	0.00			
				6,396,982

PORTION 2
INFILL BETWEEN 1955 SHORE LINE & 1955 BLUFF

X-Section	1955 Shore to Bluff Square Feet	Average End Area Square Feet	Distance Feet	Volume Cubic Yards
6,300	6,000.00			
		9,115.75	200	67,524
6,500	12,231.50			
		21,427.88	600	476,175
7,100	30,624.25			
		24,920.13	300	276,890
7,400	19,216.00			
		23,271.50	300	258,572
7,700	27,327.00			
		38,941.50	300	432,683
8,000	50,556.00			
		42,531.50	300	472,572
8,300	34,507.00			
		21,259.25	300	236,214
8,600	8,011.50			
		4,005.75	200	29,672
8,800	0.00			
		0.00	400	0
9,200	0.00			
				2,250,303

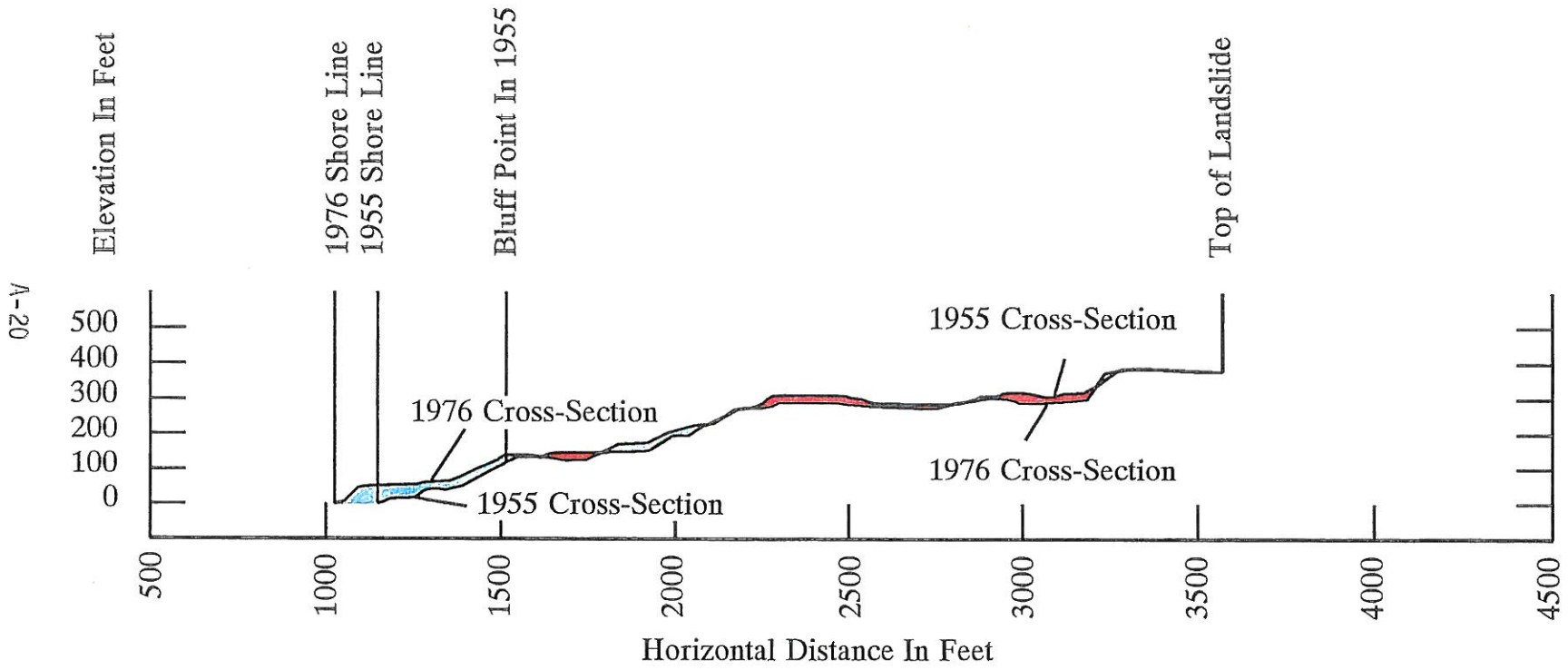
PORTION 3
INFILL BETWEEN 1955 SHORE LINE & 1995 SHORE LINE

X-Section	South of 1955 Shore Square Feet	Average End Area Square Feet	Distance Feet	Volume Cubic Yards
6,300	3,000.00			
		4,312.50	200	31,944
6,500	5,625.00			
		2,900.00	600	64,444
7,100	175.00			
		7,153.75	300	79,486
7,400	14,132.50			
		10,431.00	300	115,900
7,700	6,729.50			
		9,740.00	300	108,222
8,000	12,750.50			
		9,446.75	300	104,964
8,300	6,143.00			
		4,341.25	300	48,236
8,600	2,539.50			
		1,269.75	200	9,406
8,800	0.00			
		0.00	400	0
9,200	0.00			
				562,603

CROSS-SECTION

E 4,176,500

08/55 and 03/76



1976 Cross-section above 1955 cross-section

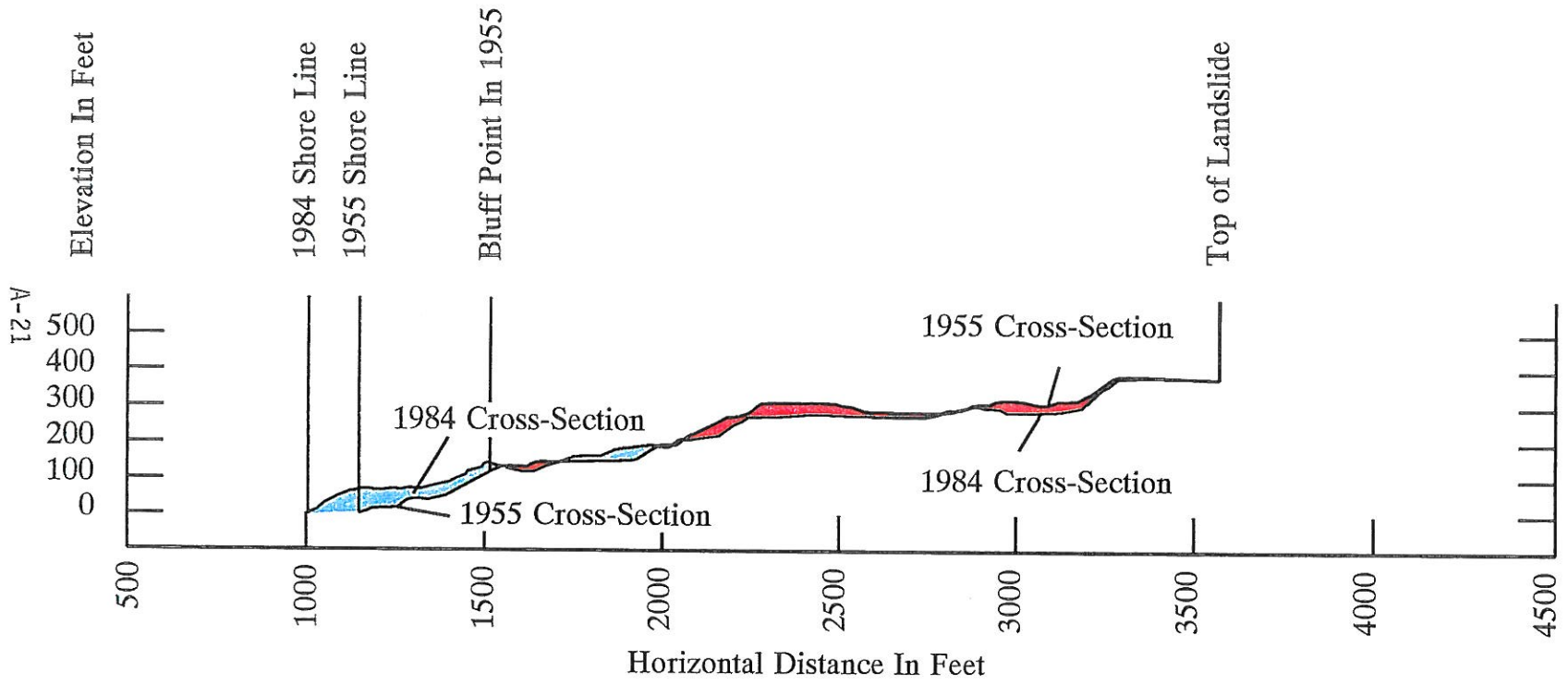
1955 Cross-section above 1976 cross-section

L

CROSS-SECTION

E 4,176,500

08/55 and 09/84



1984 Cross-section above 1955 cross-section

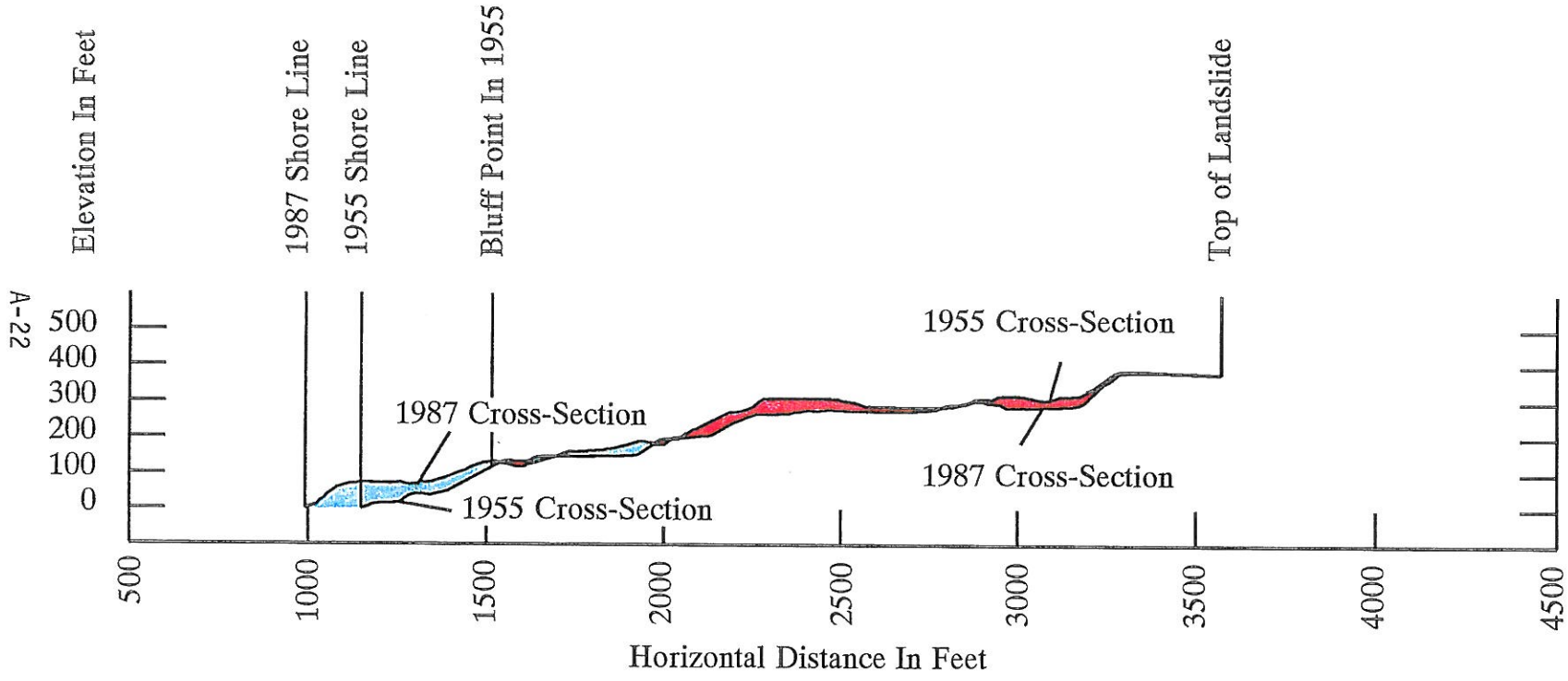
1955 Cross-section above 1984 cross-section

1

CROSS-SECTION

E 4,176,500

08/55 and 01/87



1987 Cross-section above 1955 cross-section

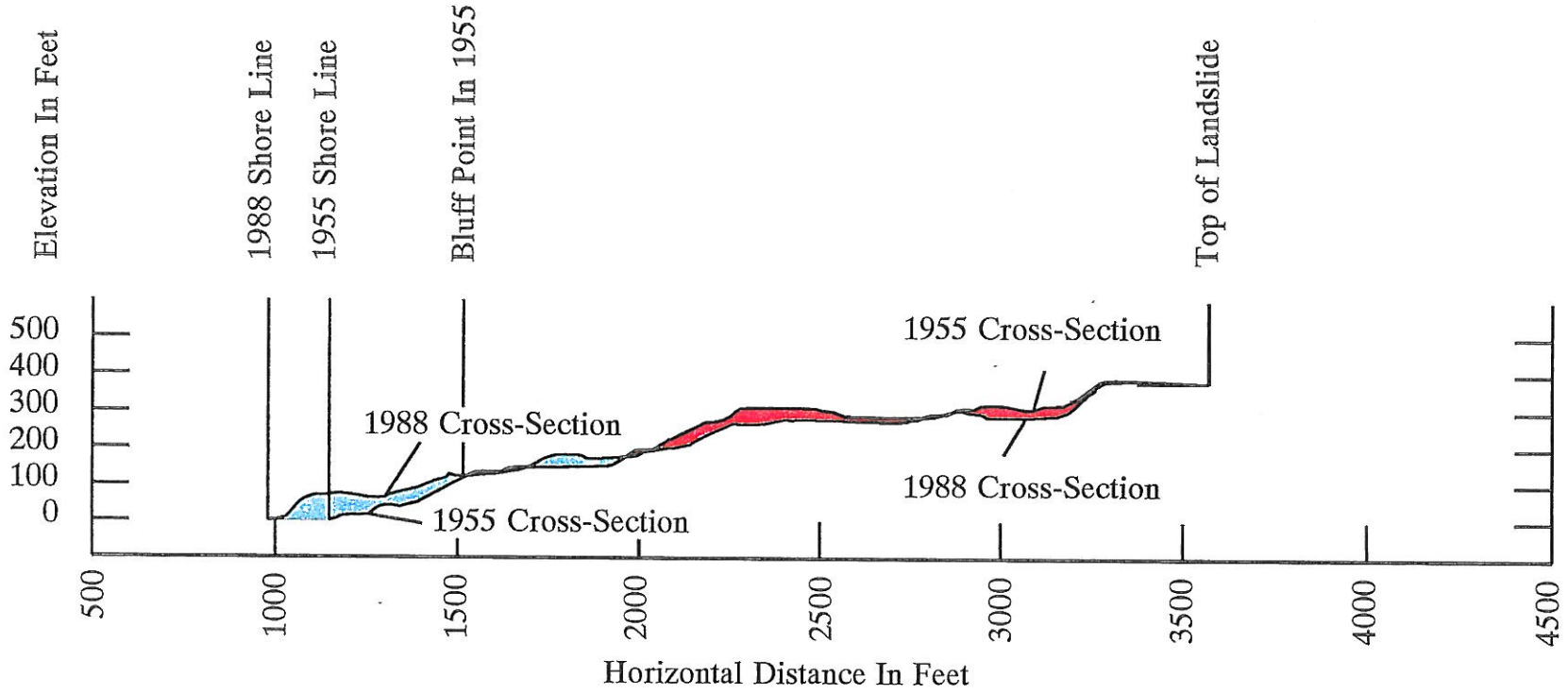
1955 Cross-section above 1987 cross-section

L

CROSS-SECTION

E 4,176,500

08/55 and 03/88



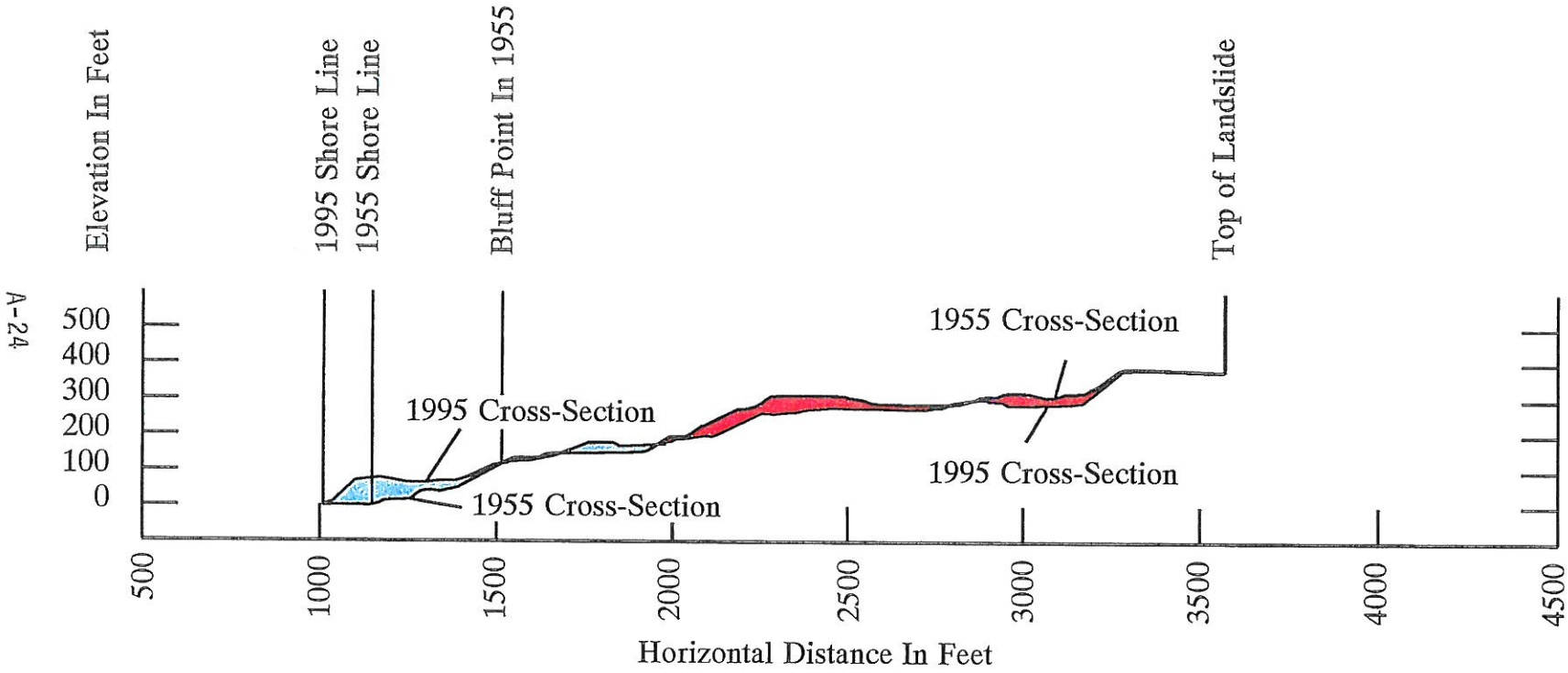
1988 Cross-section above 1955 cross-section

1955 Cross-section above 1988 cross-section

CROSS-SECTION

E 4,176,500

08/55 and 08/95



1995 Cross-section above 1955 cross-section

1955 Cross-section above 1995 cross-section

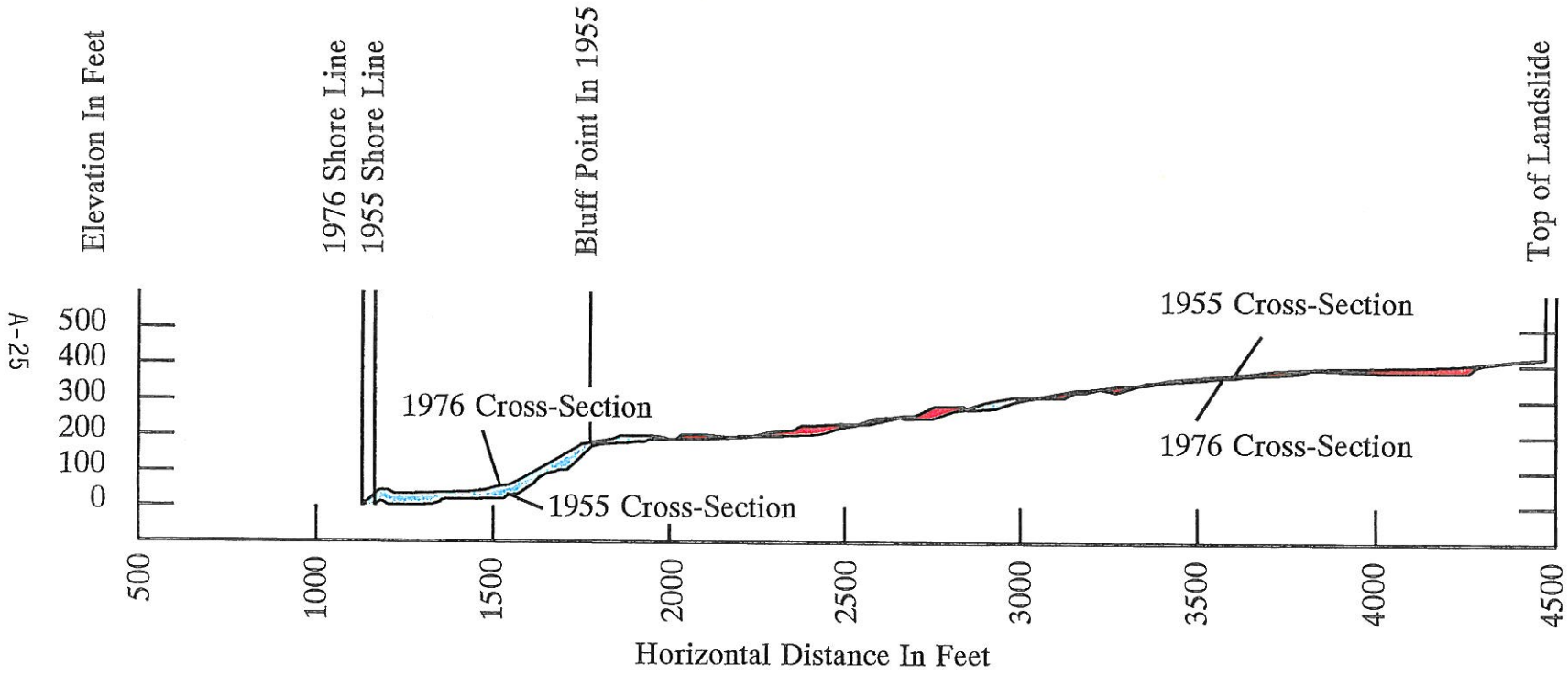
A-24

1

CROSS-SECTION

E 4,177,100

08/55 and 03/76



1976 Cross-section above 1955 cross-section

1955 Cross-section above 1976 cross-section

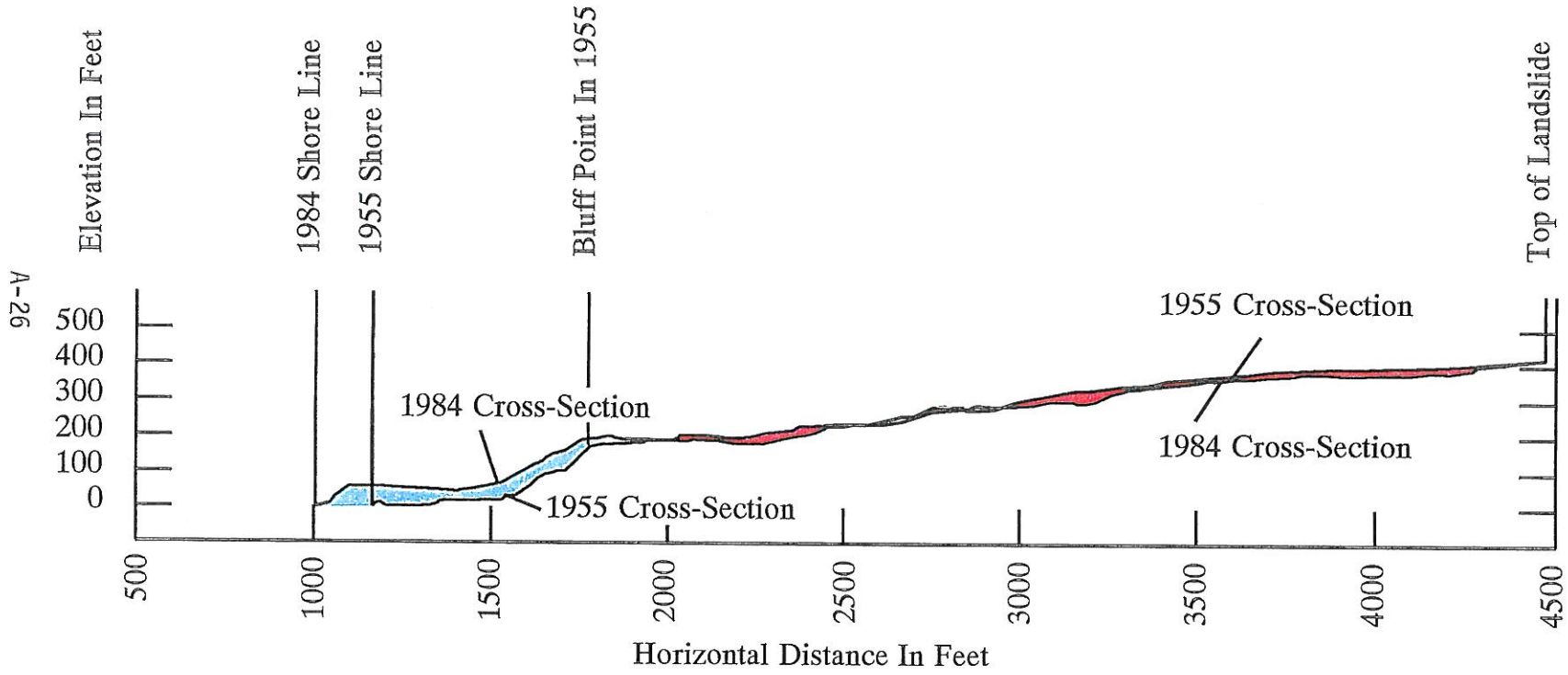
A-25

2

CROSS-SECTION

E 4,177,100

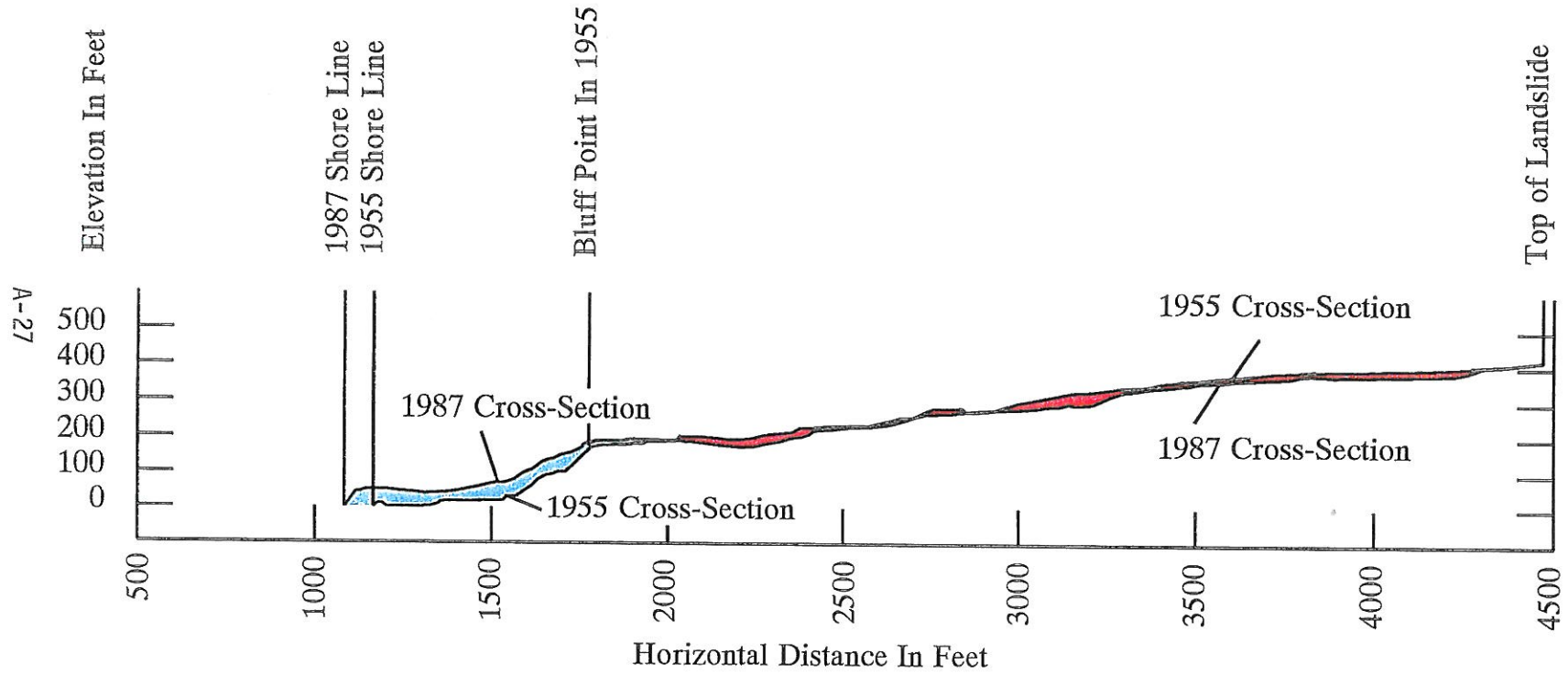
08/55 and 09/84



CROSS-SECTION

E 4,177,100

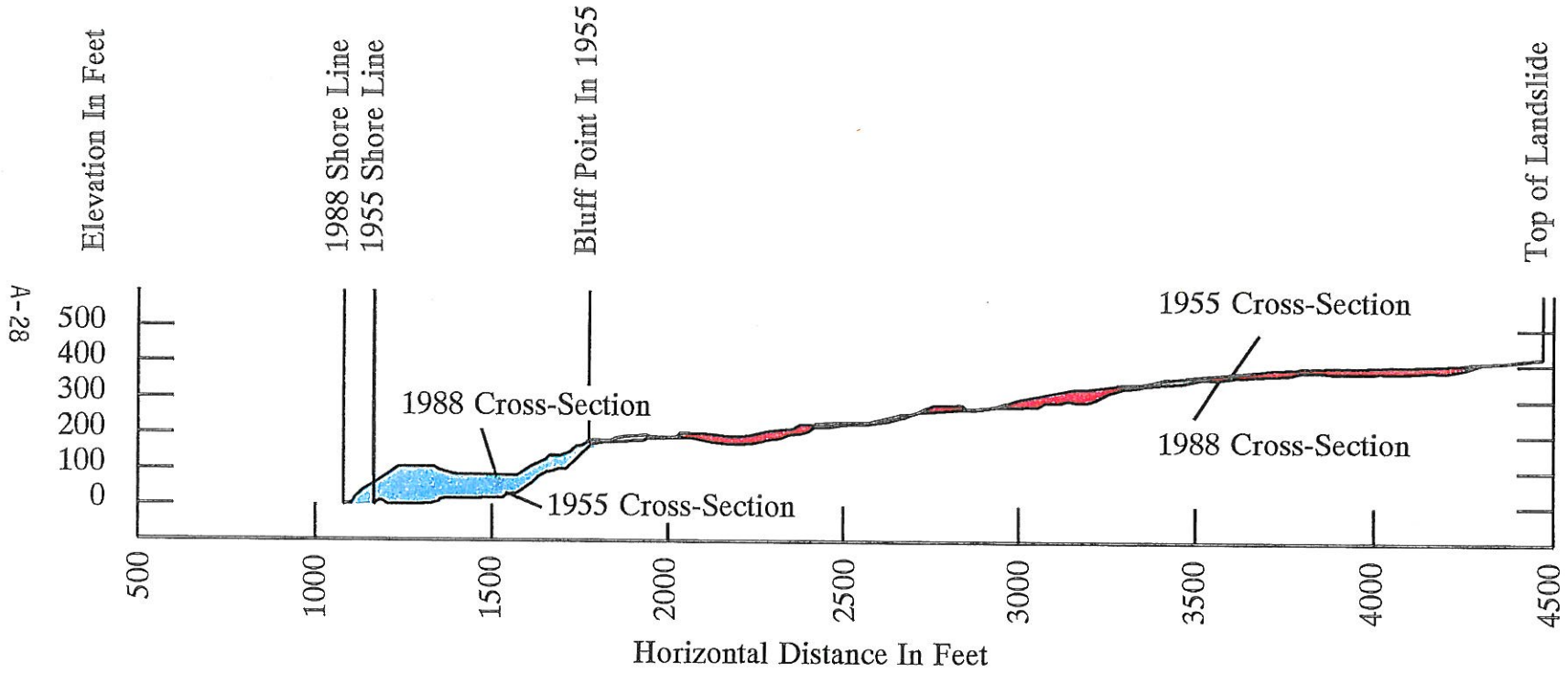
08/55 and 01/87



CROSS-SECTION

E 4,177,100

08/55 and 03/88



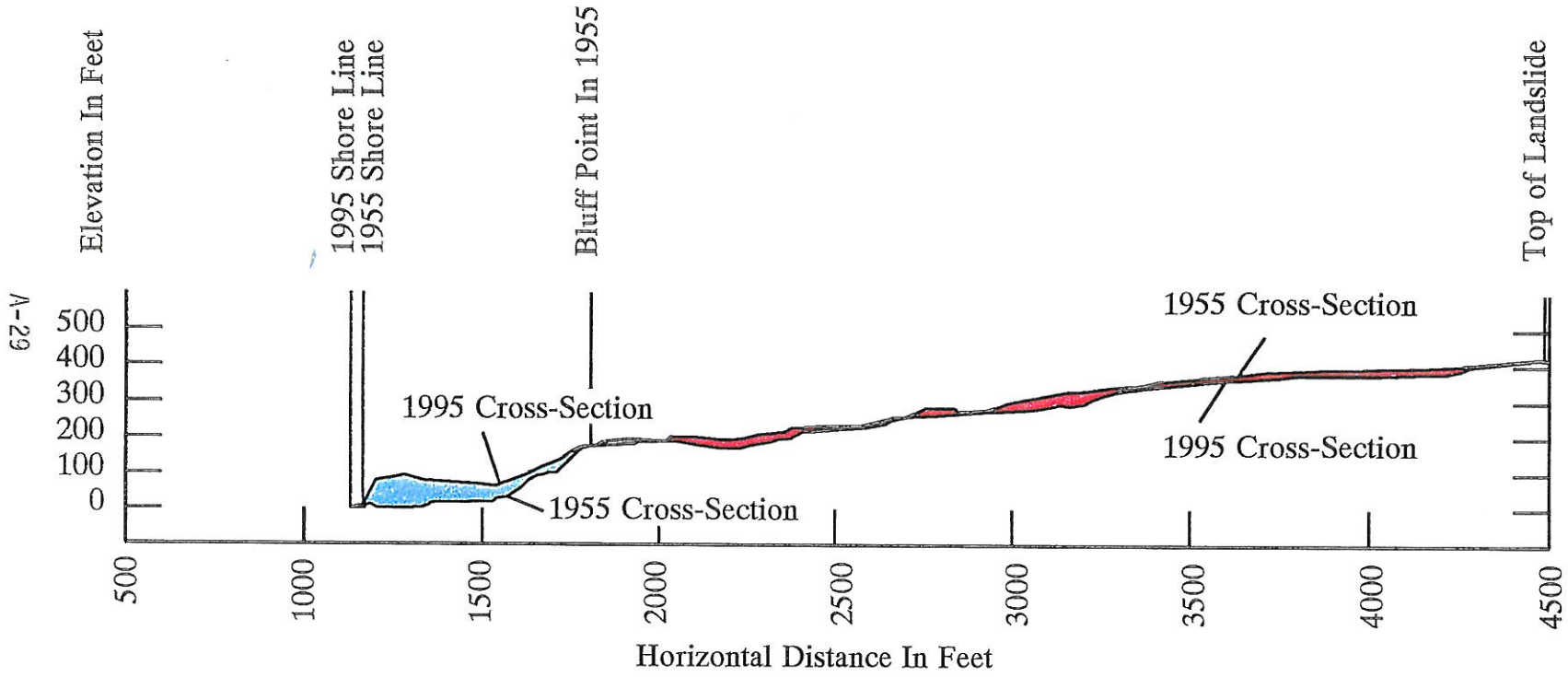
1988 Cross-section above 1955 cross-section

1955 Cross-section above 1988 cross-section

CROSS-SECTION

E 4,177,100

08/55 and 08/95



1995 Cross-section above 1955 cross-section

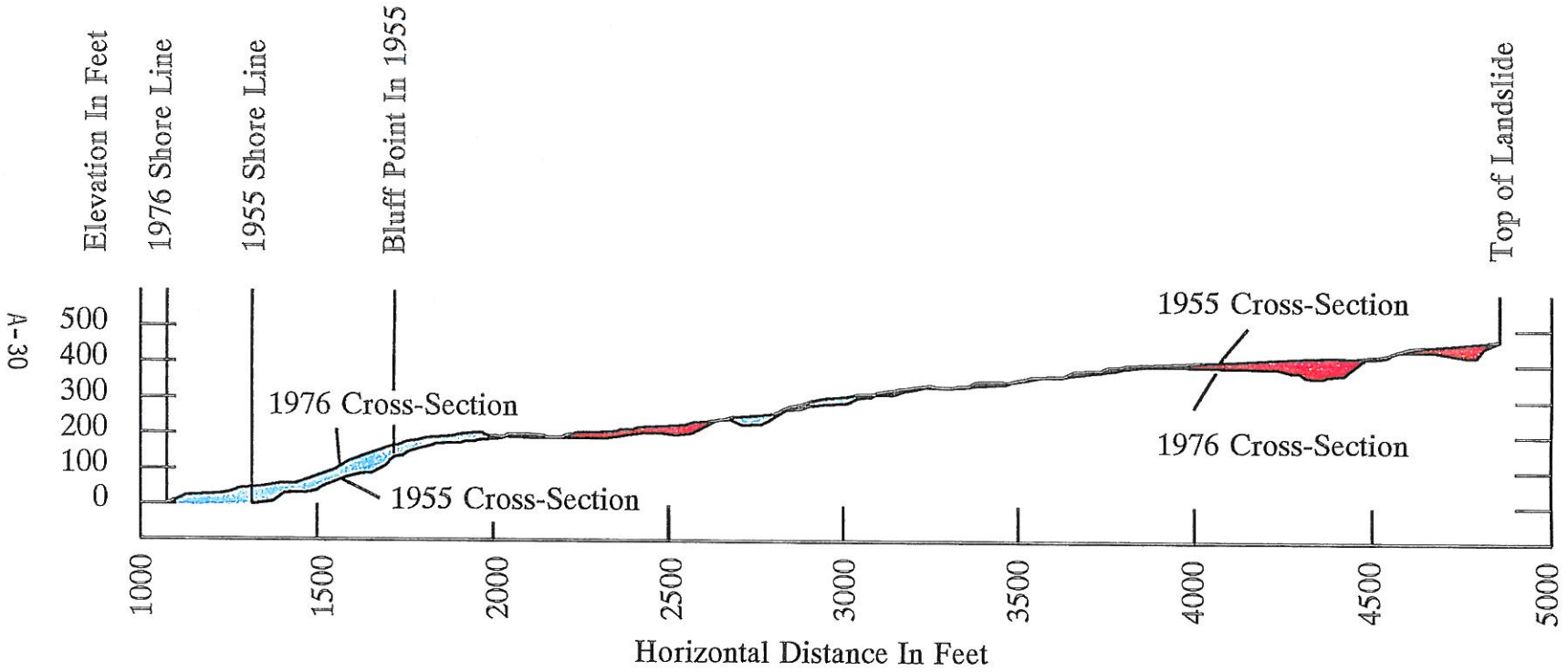
1955 Cross-section above 1995 cross-section

2

CROSS-SECTION

E 4,177,400

08/55 and 03/76



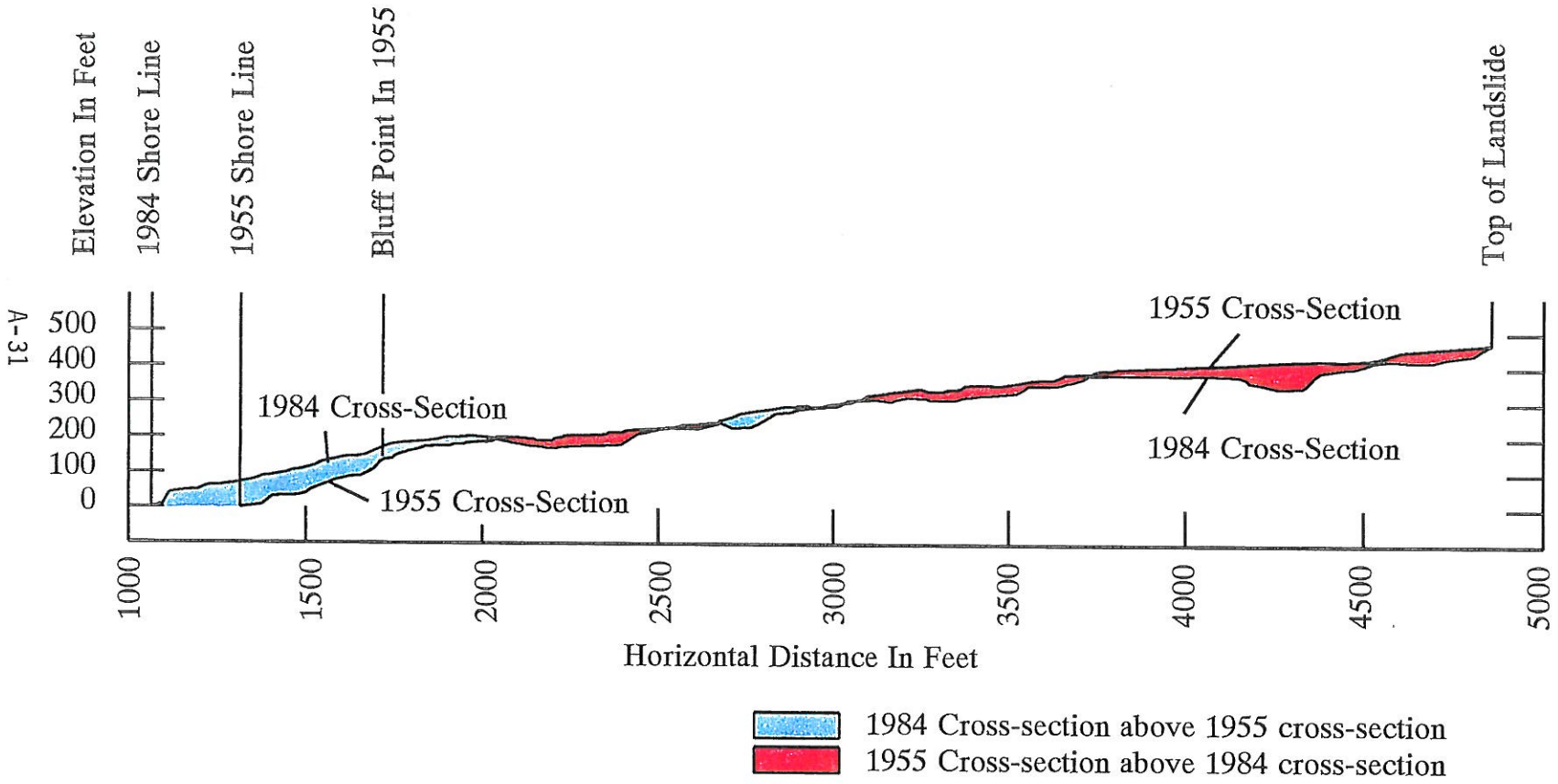
1976 Cross-section above 1955 cross-section

1955 Cross-section above 1976 cross-section

CROSS-SECTION

E 4,177,400

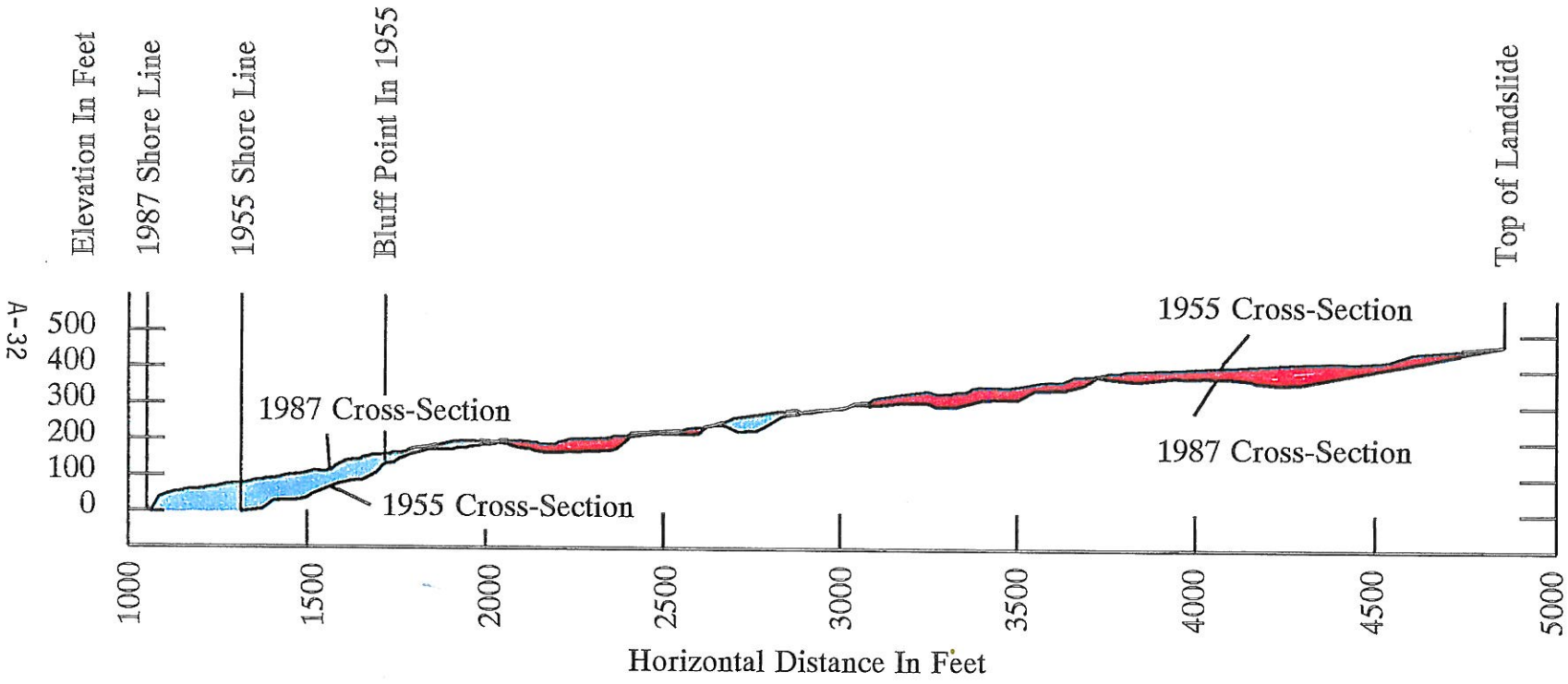
08/55 and 09/84



CROSS-SECTION

E 4,177,400

08/55 and 01/87



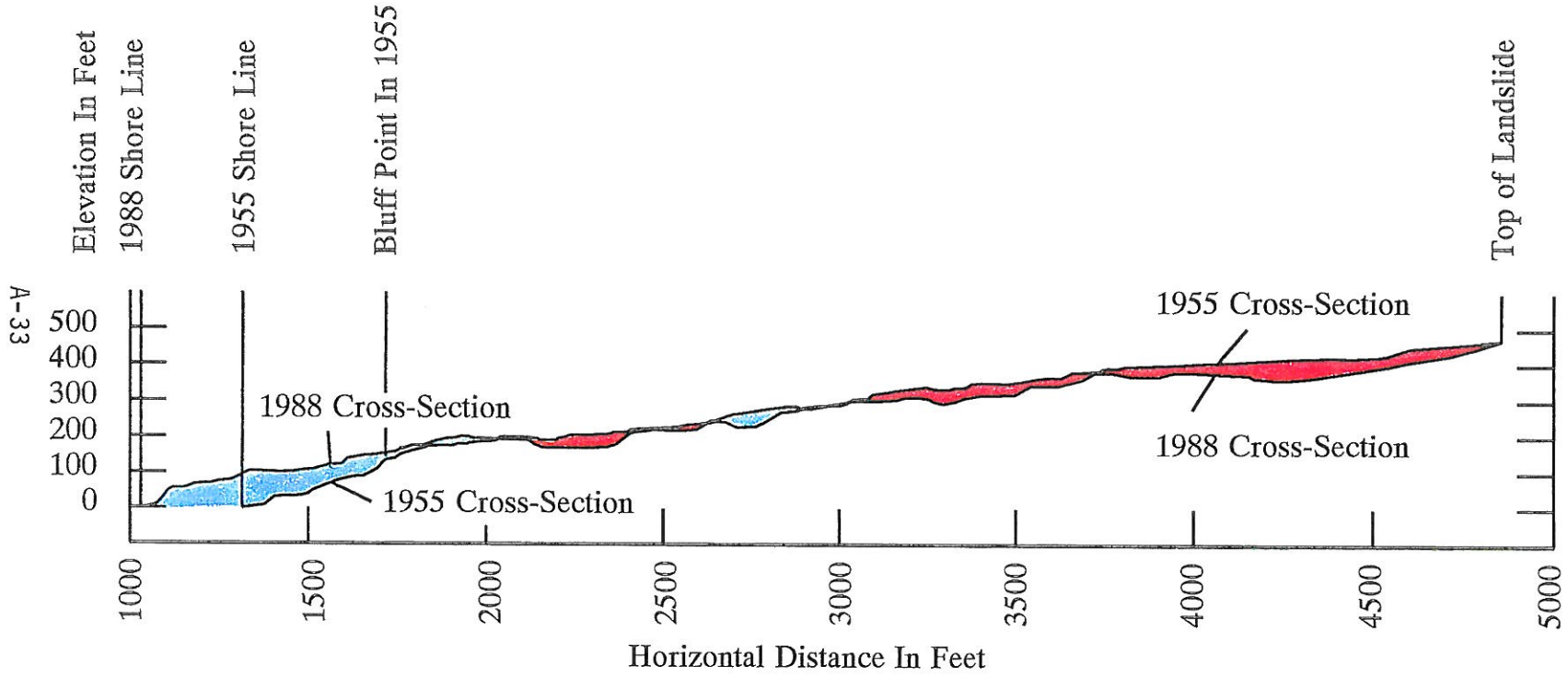
1987 Cross-section above 1955 cross-section

1955 Cross-section above 1987 cross-section

CROSS-SECTION

E 4,177,400

08/55 and 03/88



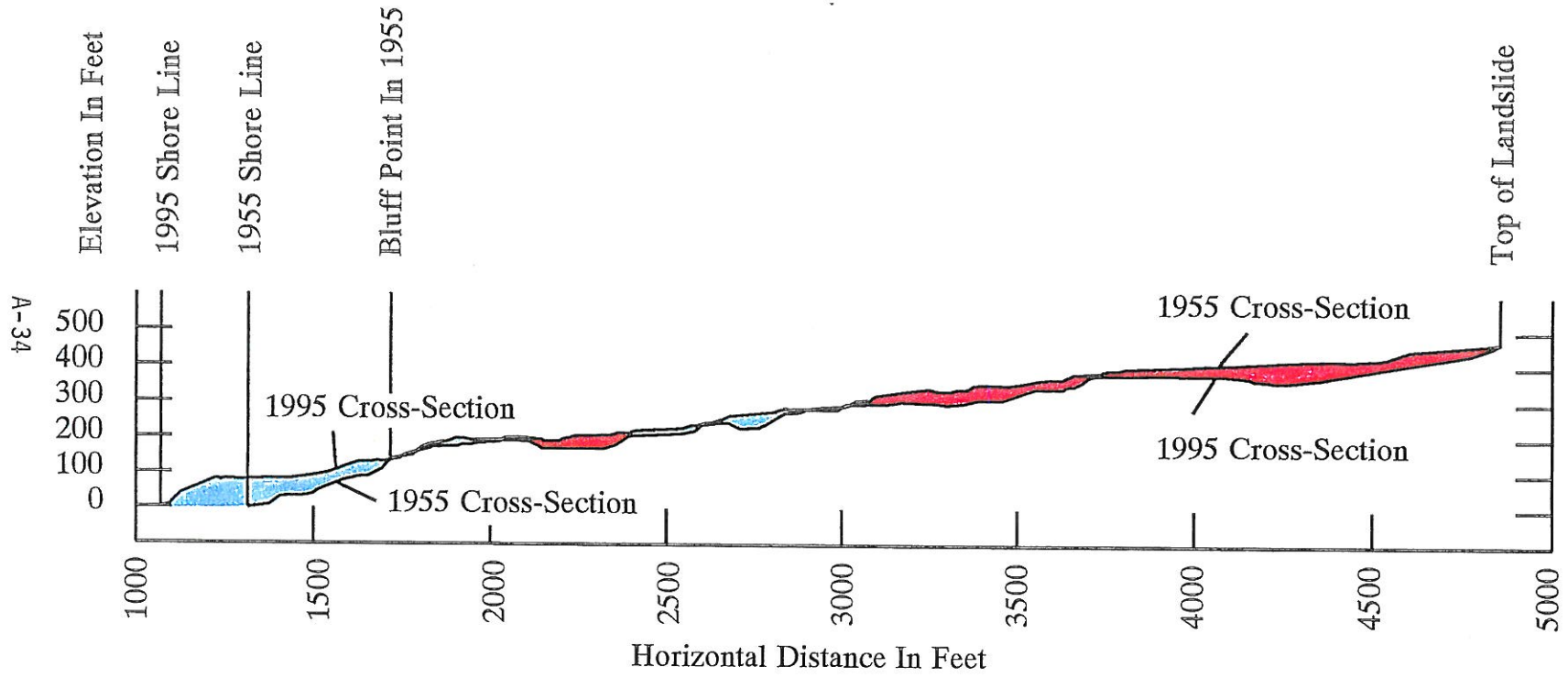
1988 Cross-section above 1955 cross-section

1955 Cross-section above 1988 cross-section

CROSS-SECTION

E 4,177,400

08/55 and 08/95



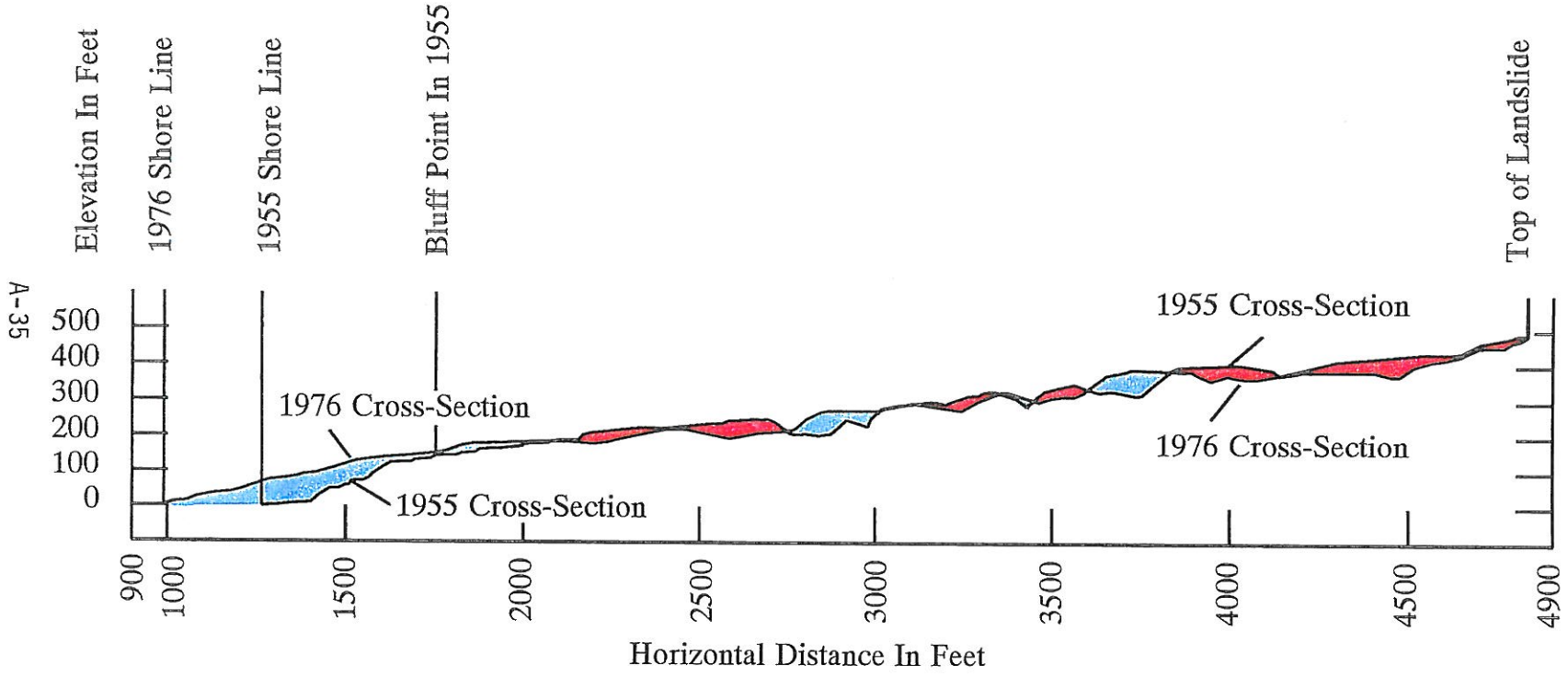
1995 Cross-section above 1955 cross-section

1955 Cross-section above 1995 cross-section

CROSS-SECTION

E 4,177,700

08/55 and 03/76



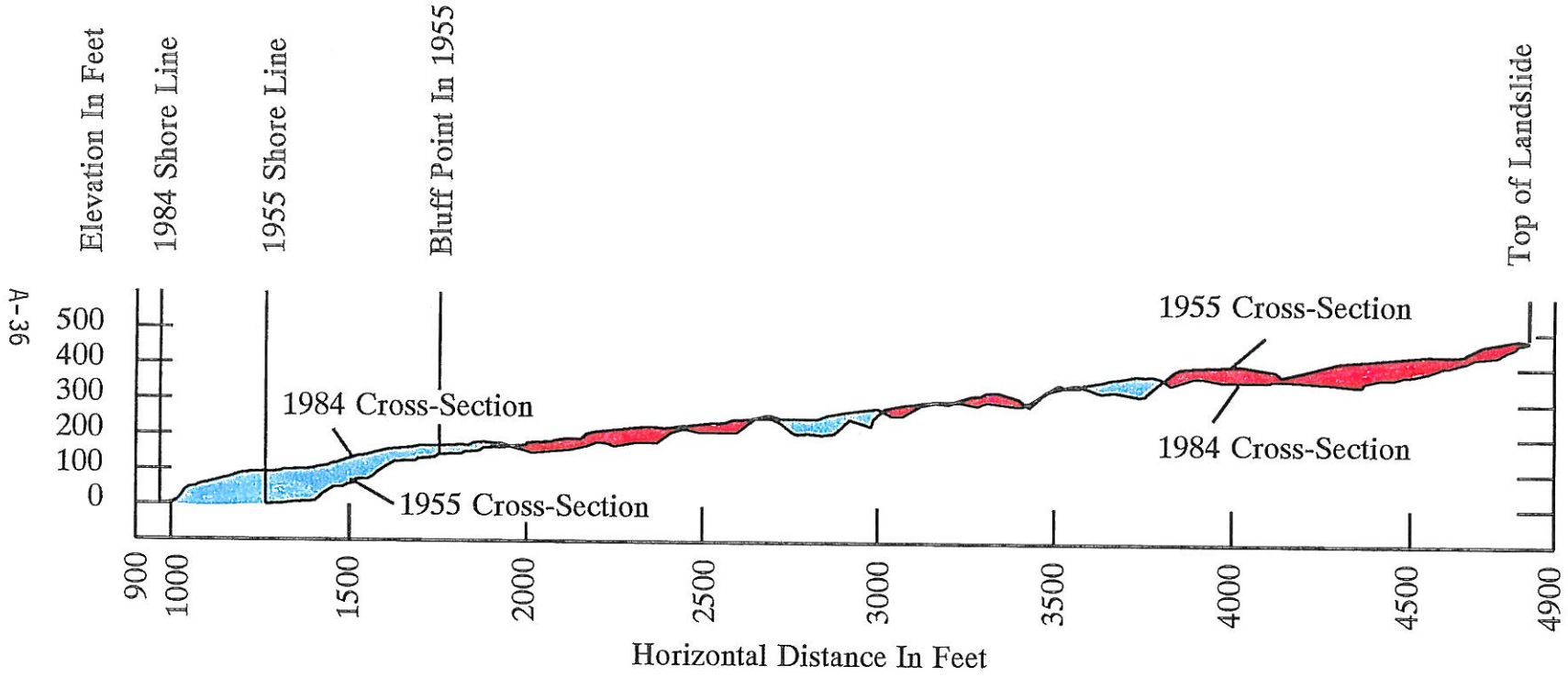
1976 Cross-section above 1955 cross-section

1955 Cross-section above 1976 cross-section

CROSS-SECTION

E 4,177,700

08/55 and 09/84



1984 Cross-section above 1955 cross-section

1955 Cross-section above 1984 cross-section

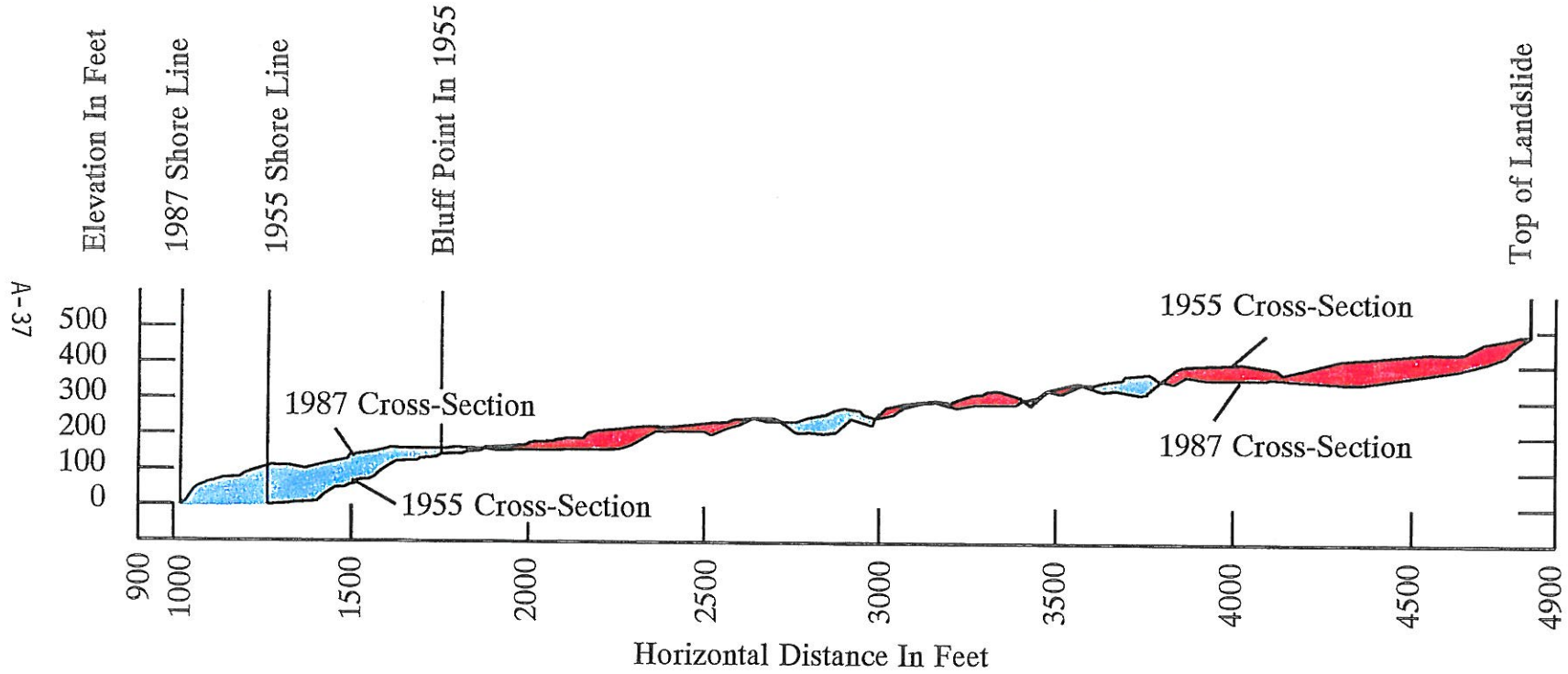
A-36

4

CROSS-SECTION

E 4,177,700

08/55 and 01/87



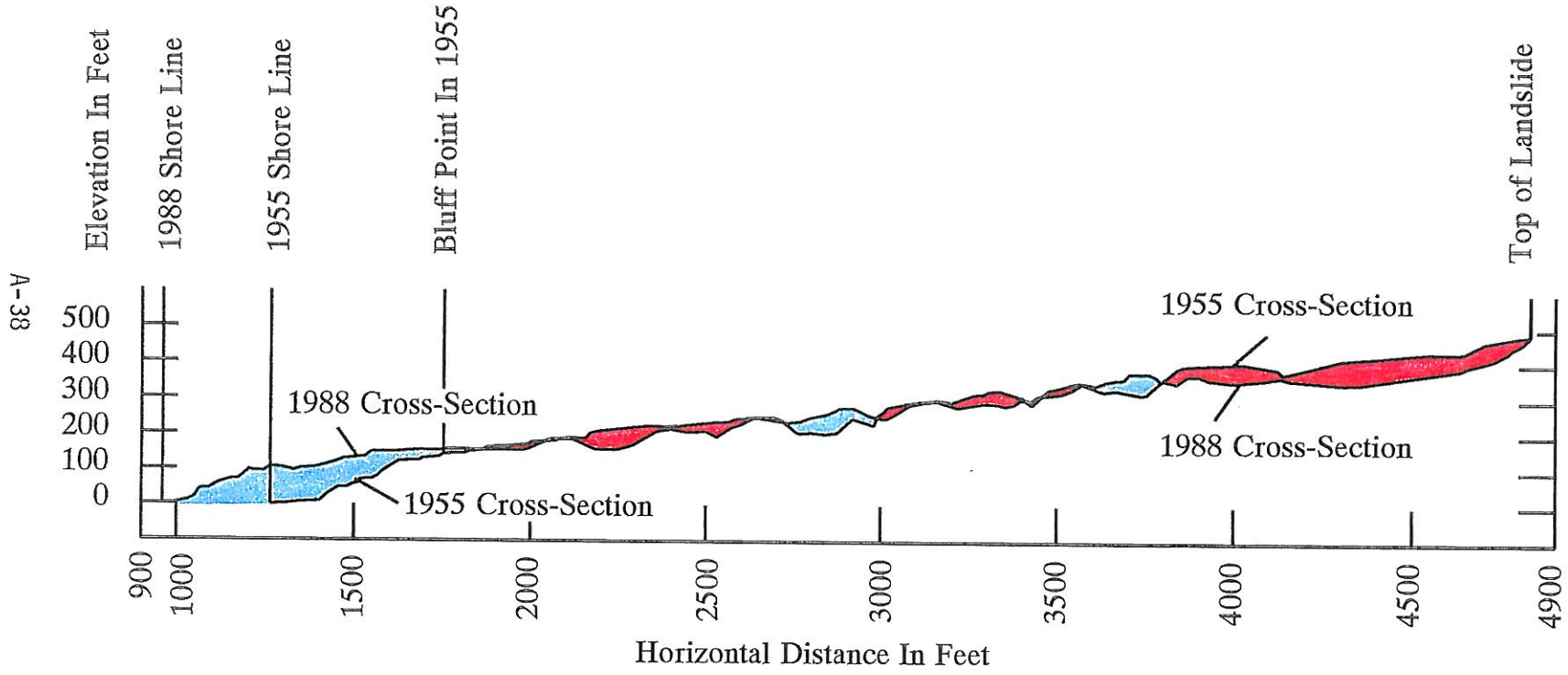
1987 Cross-section above 1955 cross-section

1955 Cross-section above 1987 cross-section

CROSS-SECTION

E 4,177,700

08/55 and 03/88



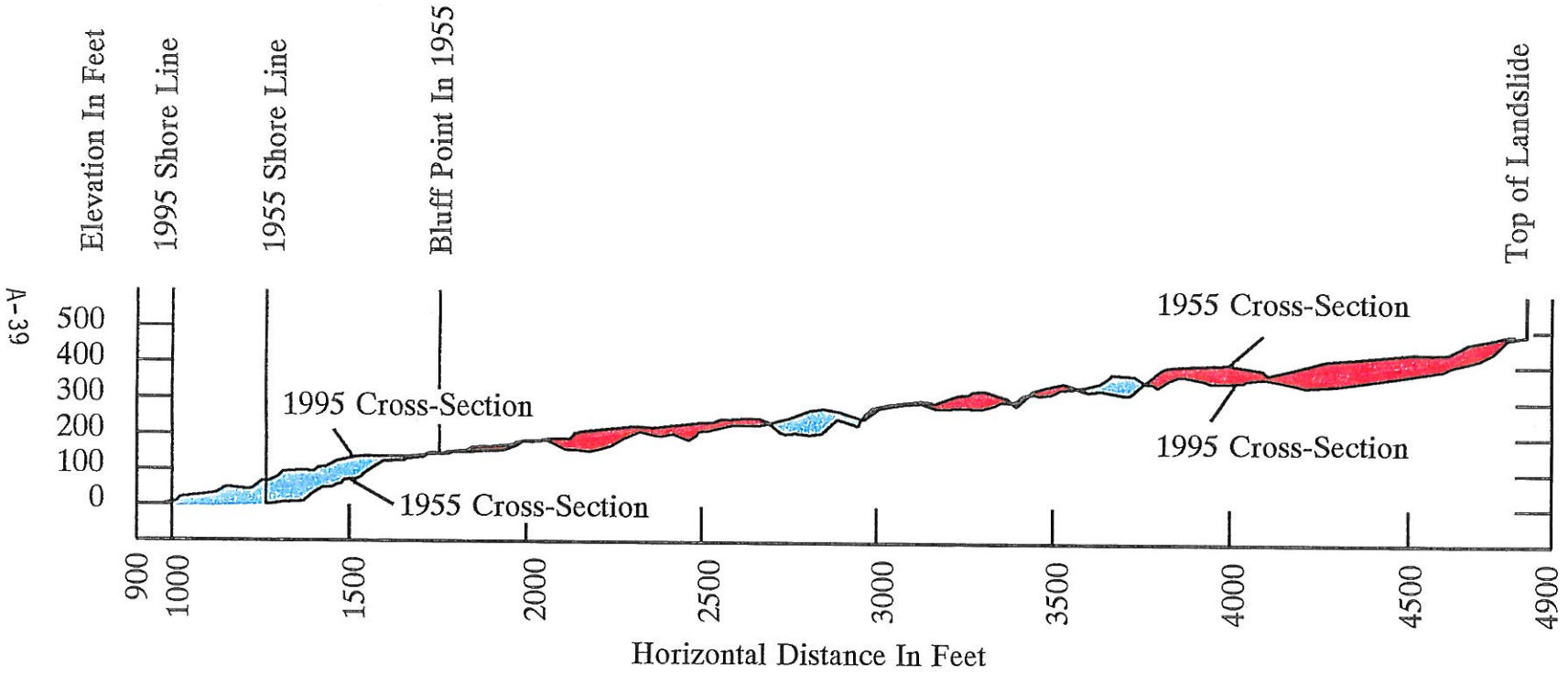
1988 Cross-section above 1955 cross-section

1955 Cross-section above 1988 cross-section

CROSS-SECTION

E 4,177,700

08/55 and 08/95



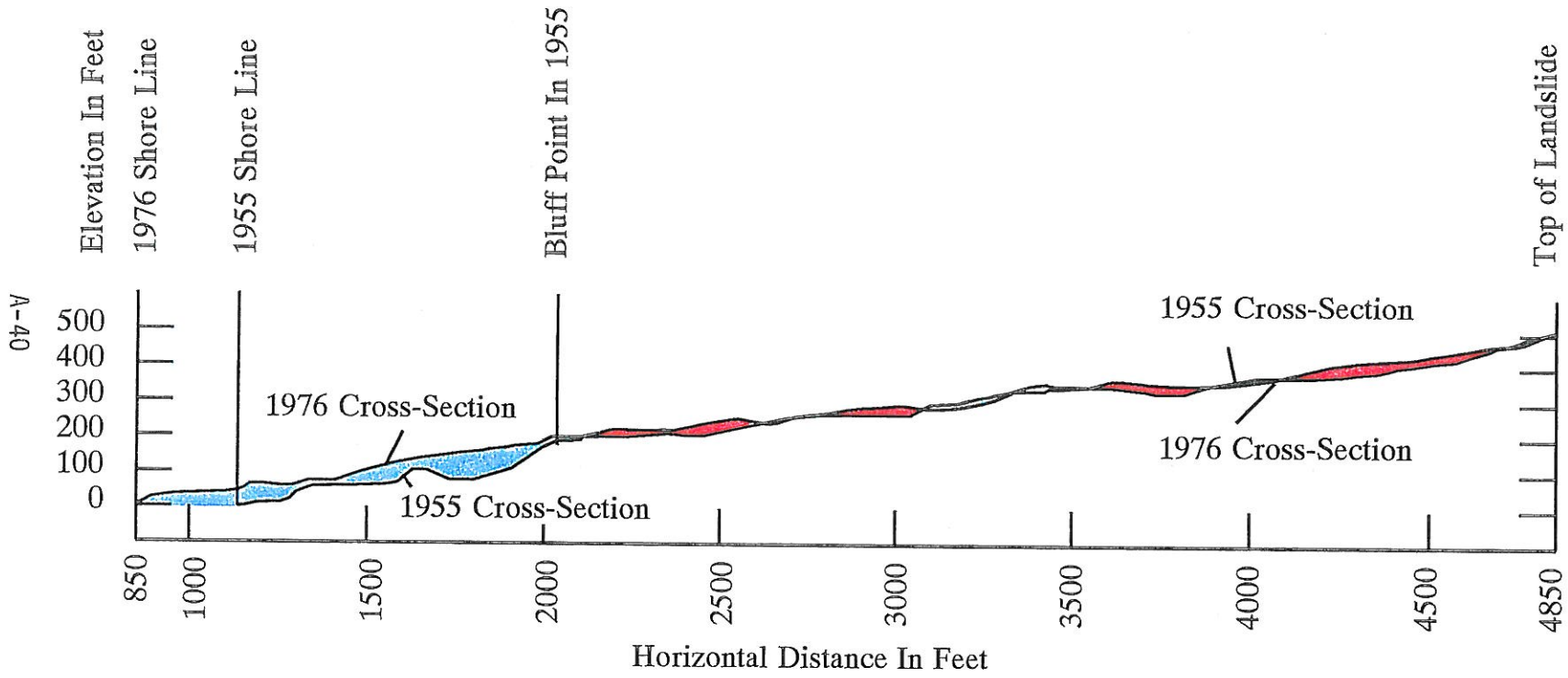
1995 Cross-section above 1955 cross-section

1955 Cross-section above 1995 cross-section

CROSS-SECTION

E 4,178,000

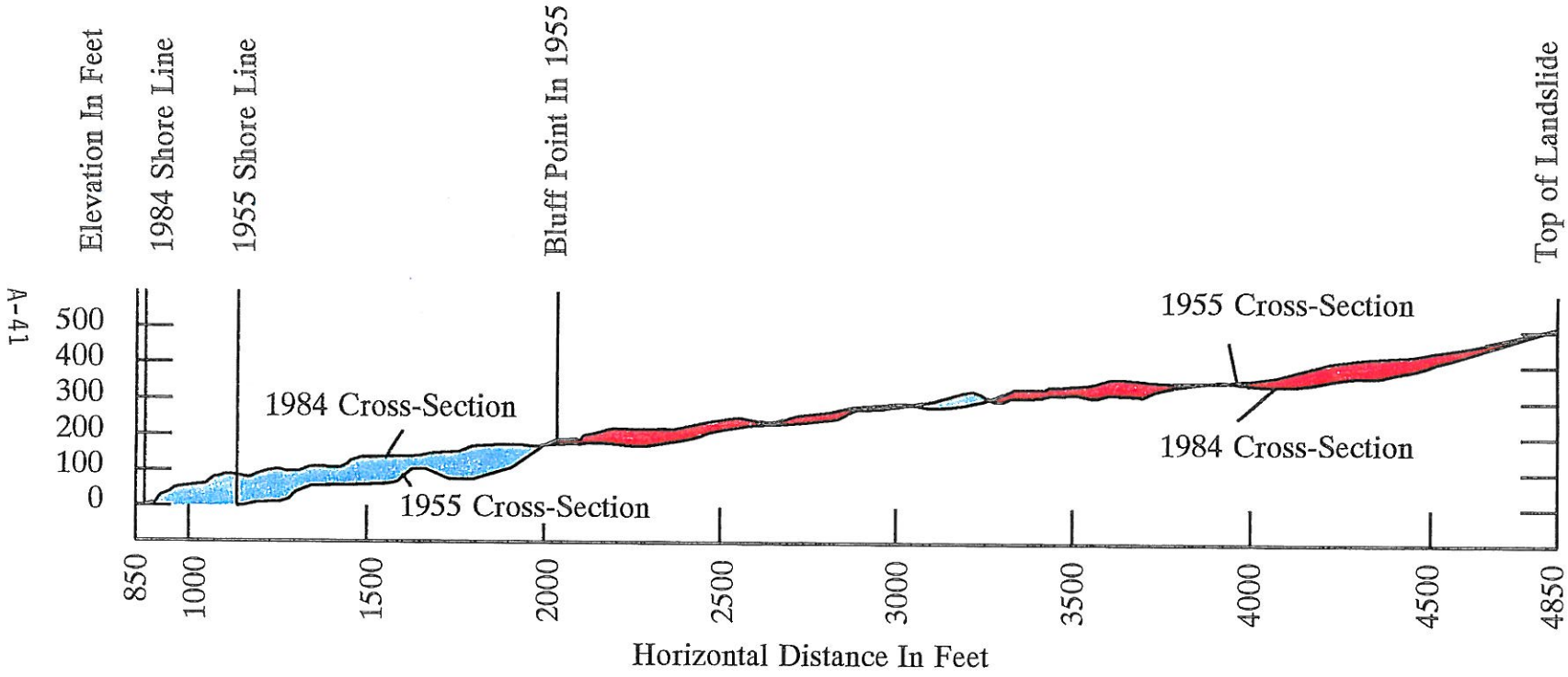
08/55 and 03/76



CROSS-SECTION

E 4,178,000

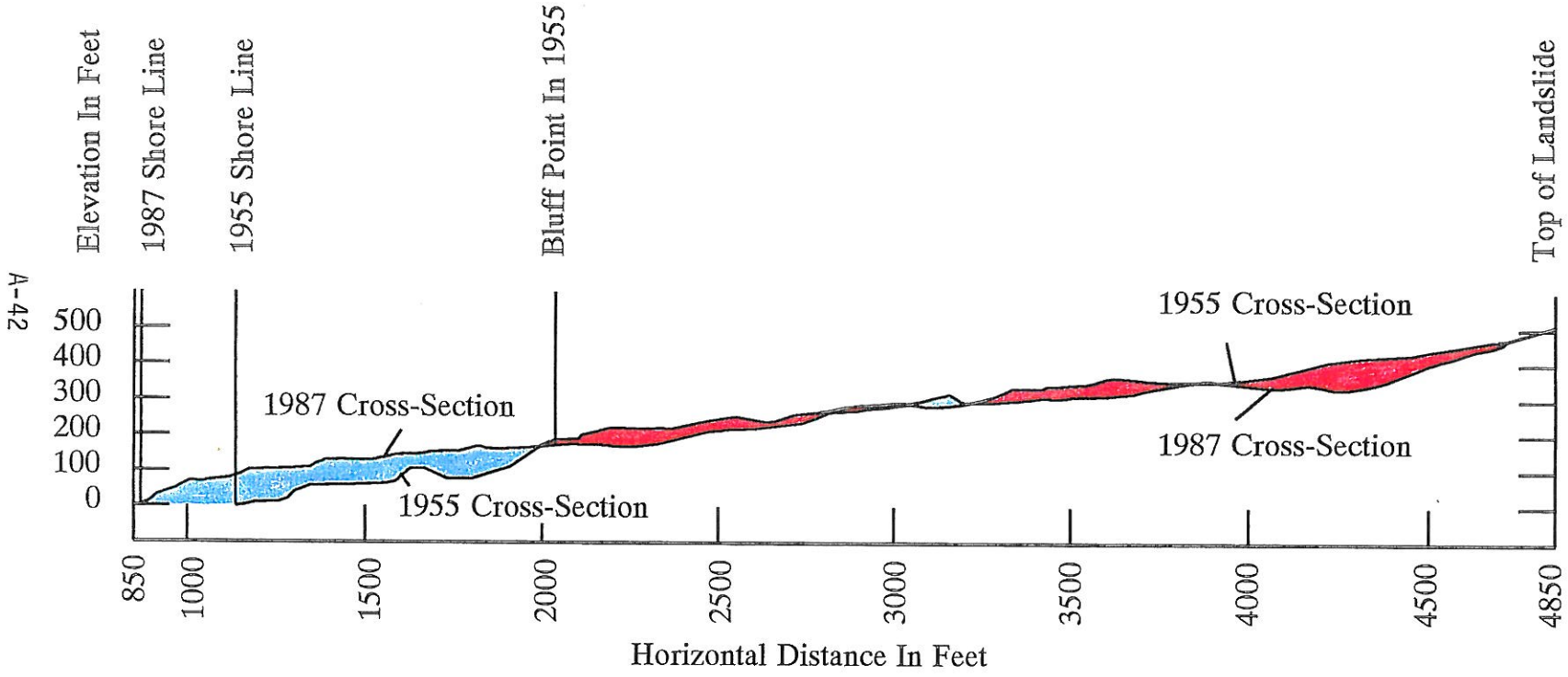
08/55 and 09/84



CROSS-SECTION

E 4,178,000

08/55 and 01/87



1987 Cross-section above 1955 cross-section

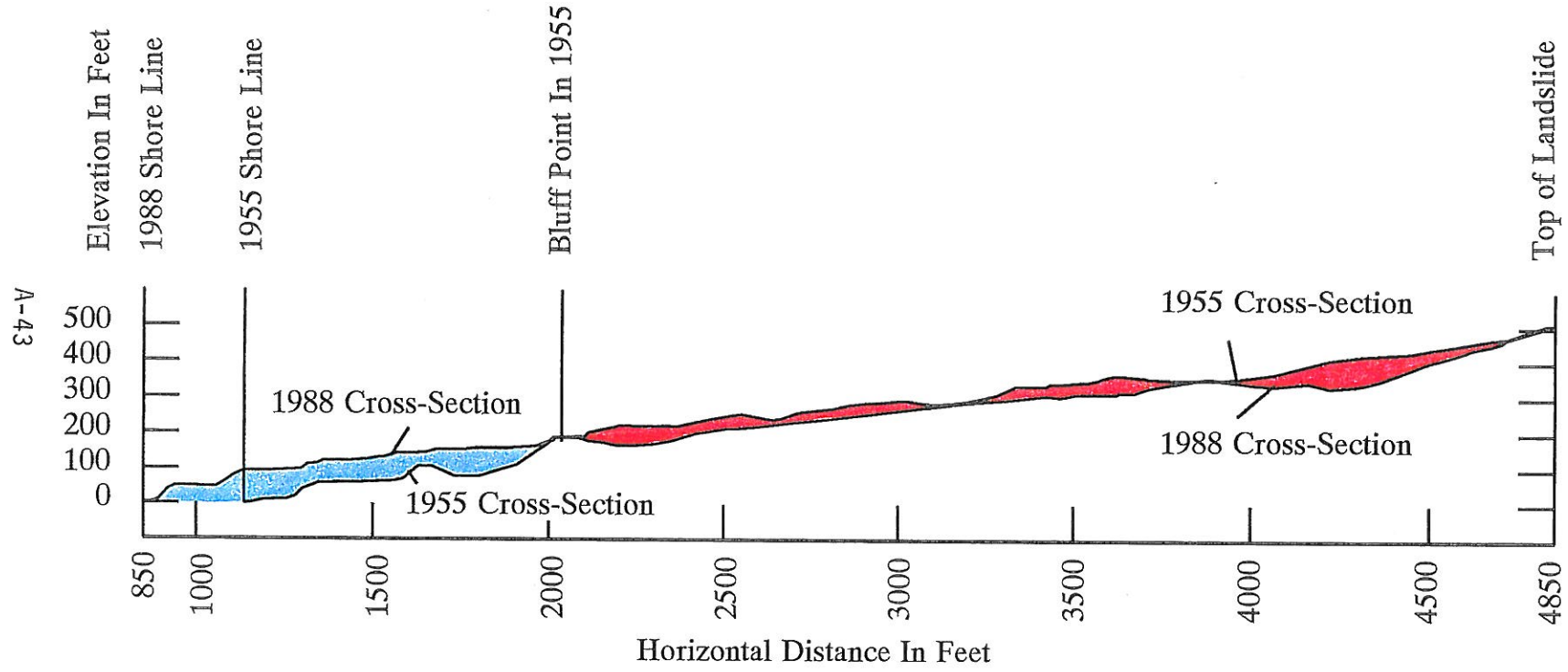
1955 Cross-section above 1987 cross-section

5

CROSS-SECTION

E 4,178,000

08/55 and 03/88



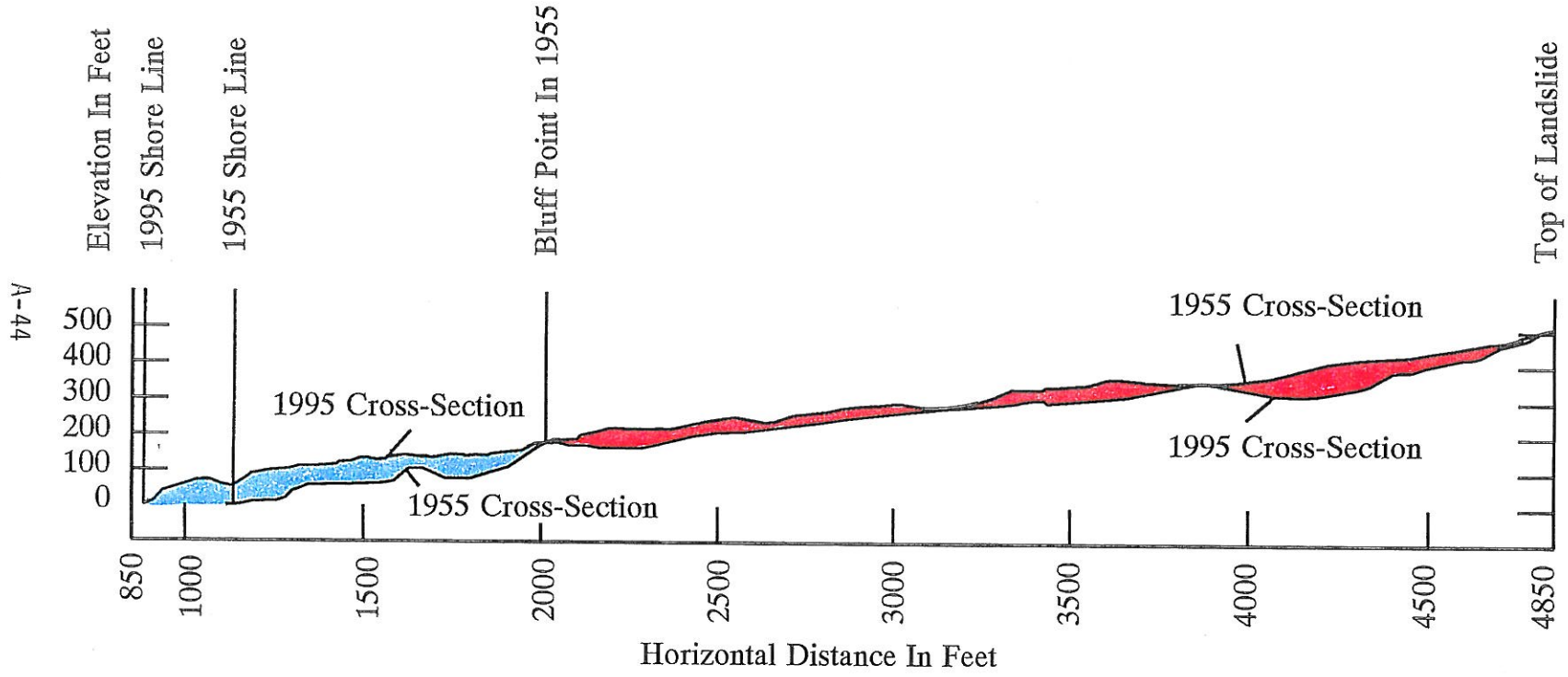
1988 Cross-section above 1955 cross-section

1955 Cross-section above 1988 cross-section

CROSS-SECTION

E 4,178,000

08/55 and 08/95



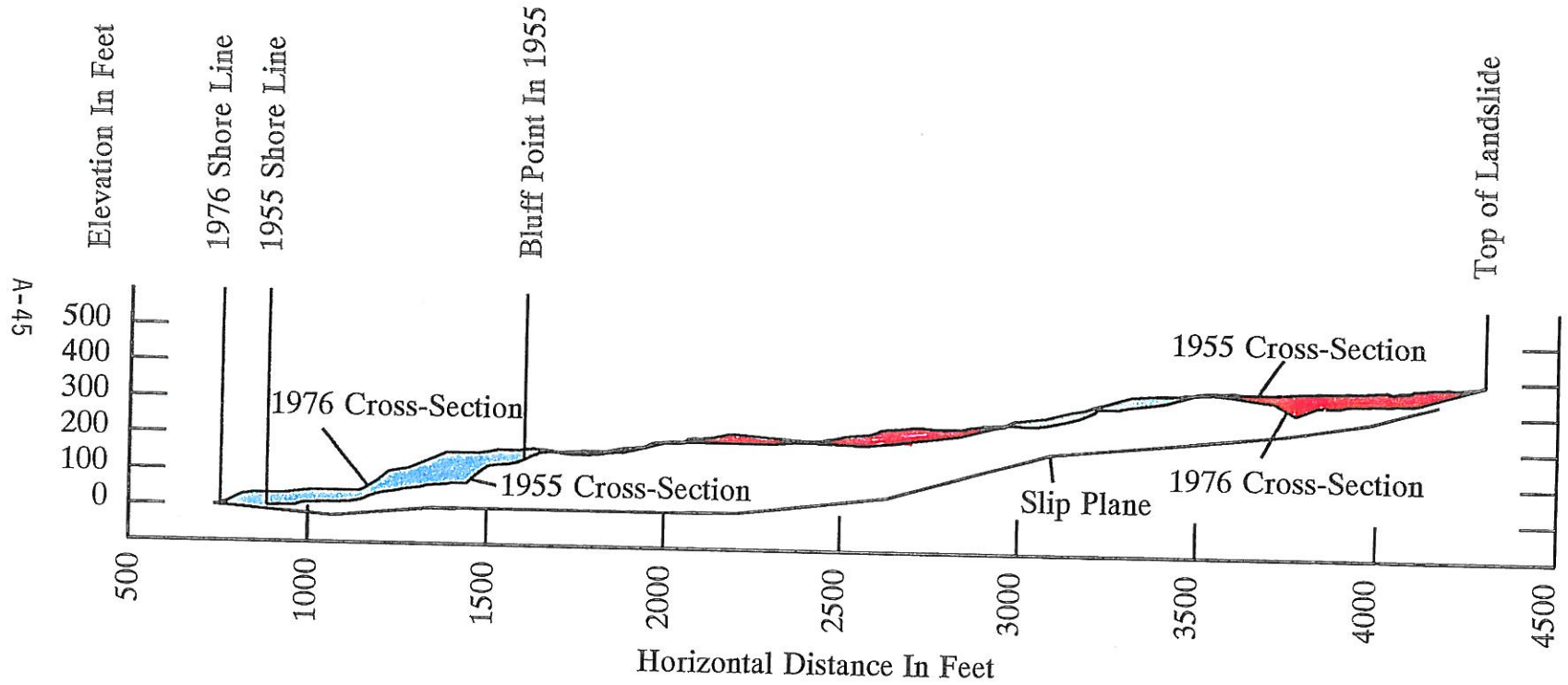
1995 Cross-section above 1955 cross-section

1955 Cross-section above 1995 cross-section

CROSS-SECTION

E 4,178,300

08/55 and 03/76



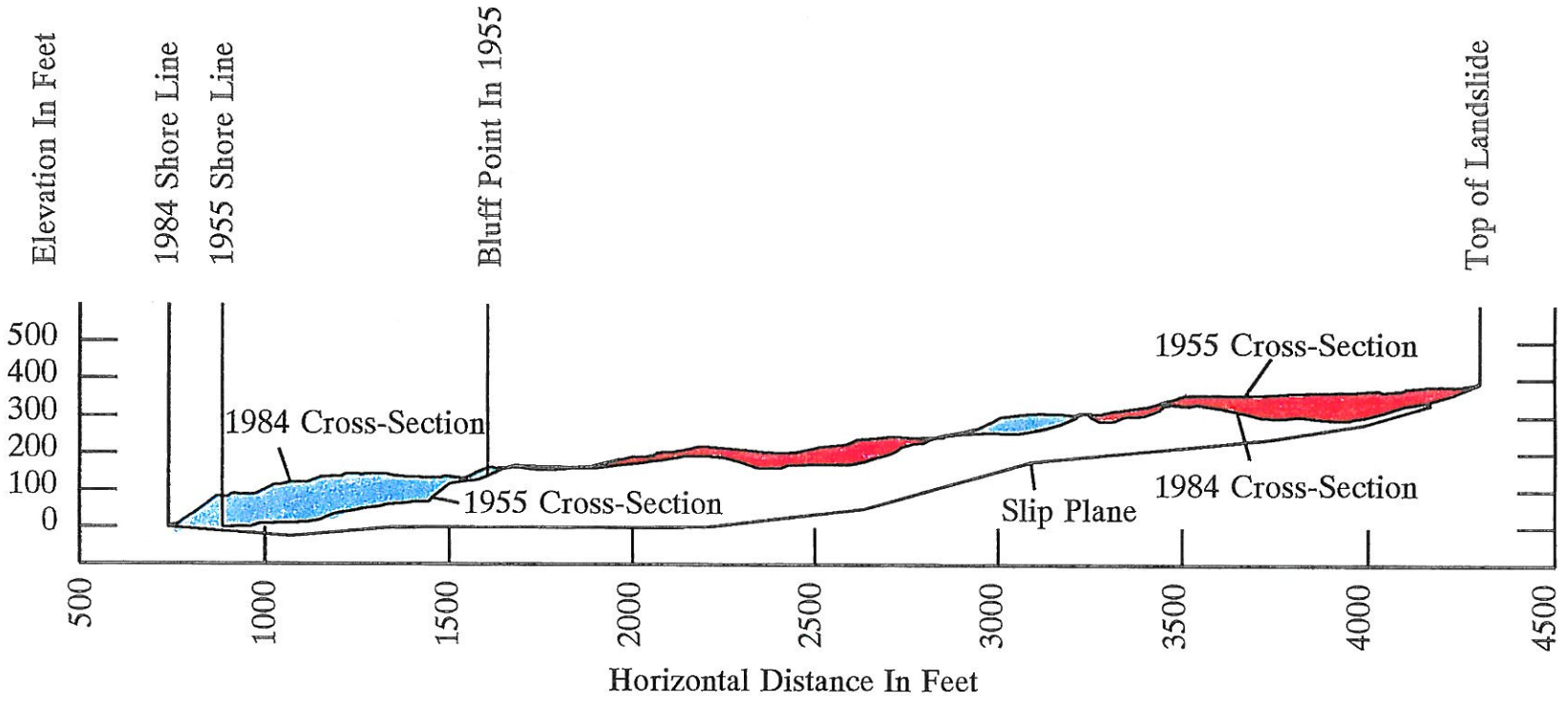
1976 Cross-section above 1955 cross-section

1955 Cross-section above 1976 cross-section

CROSS-SECTION

E 4,178,300

08/55 and 09/84



1984 Cross-section above 1955 cross-section

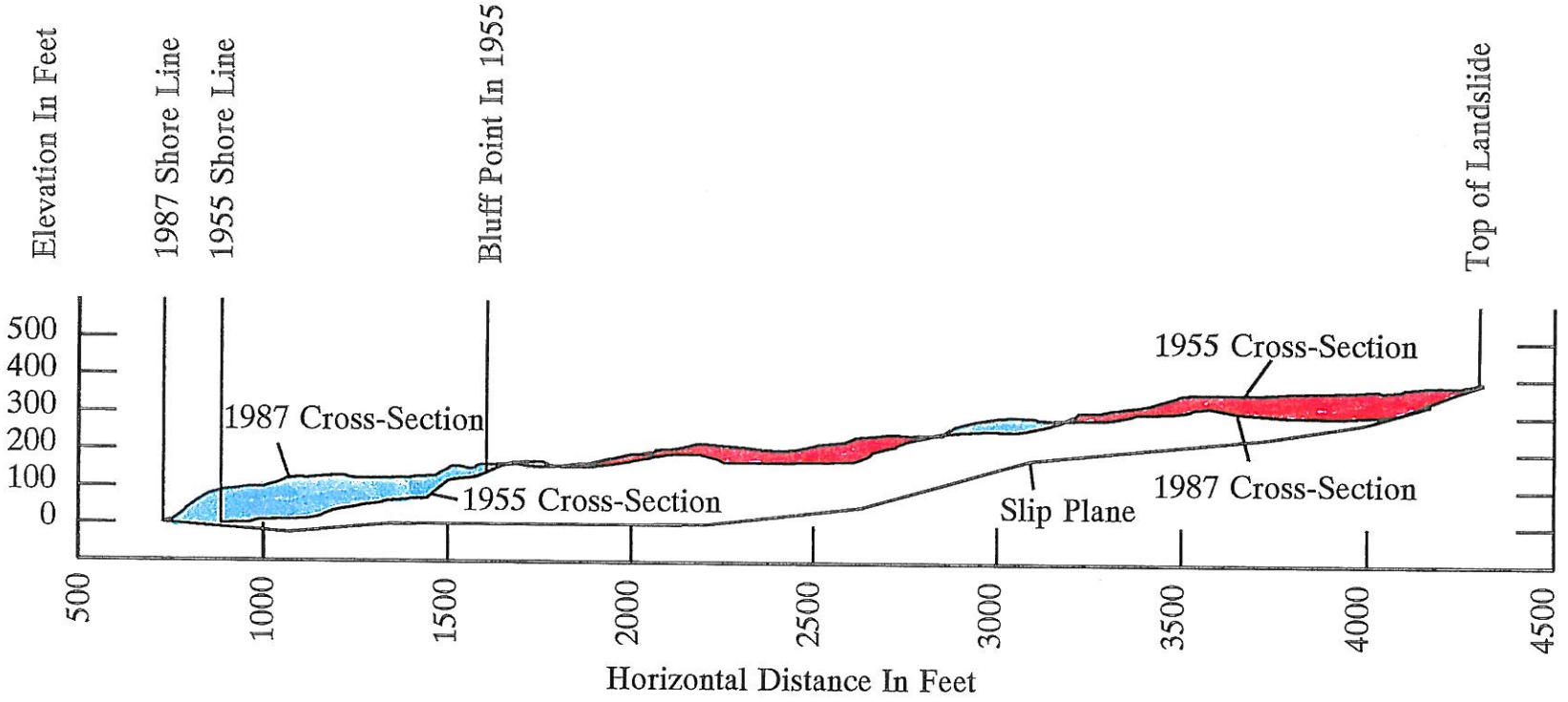
1955 Cross-section above 1984 cross-section

A-46

CROSS-SECTION

E 4,178,300

08/55 and 01/87



1987 Cross-section above 1955 cross-section

1955 Cross-section above 1987 cross-section

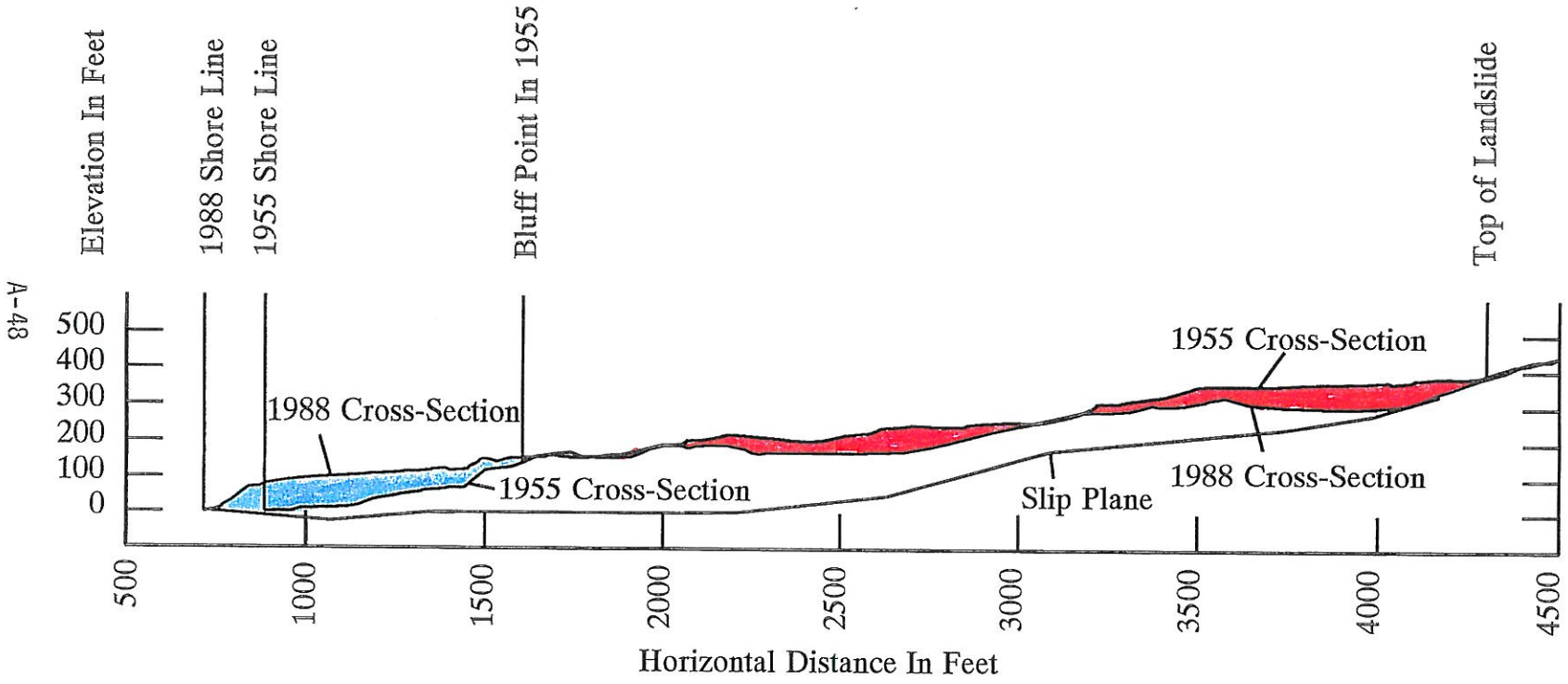
A-47

9

CROSS-SECTION

E 4,178,300

08/55 and 03/88



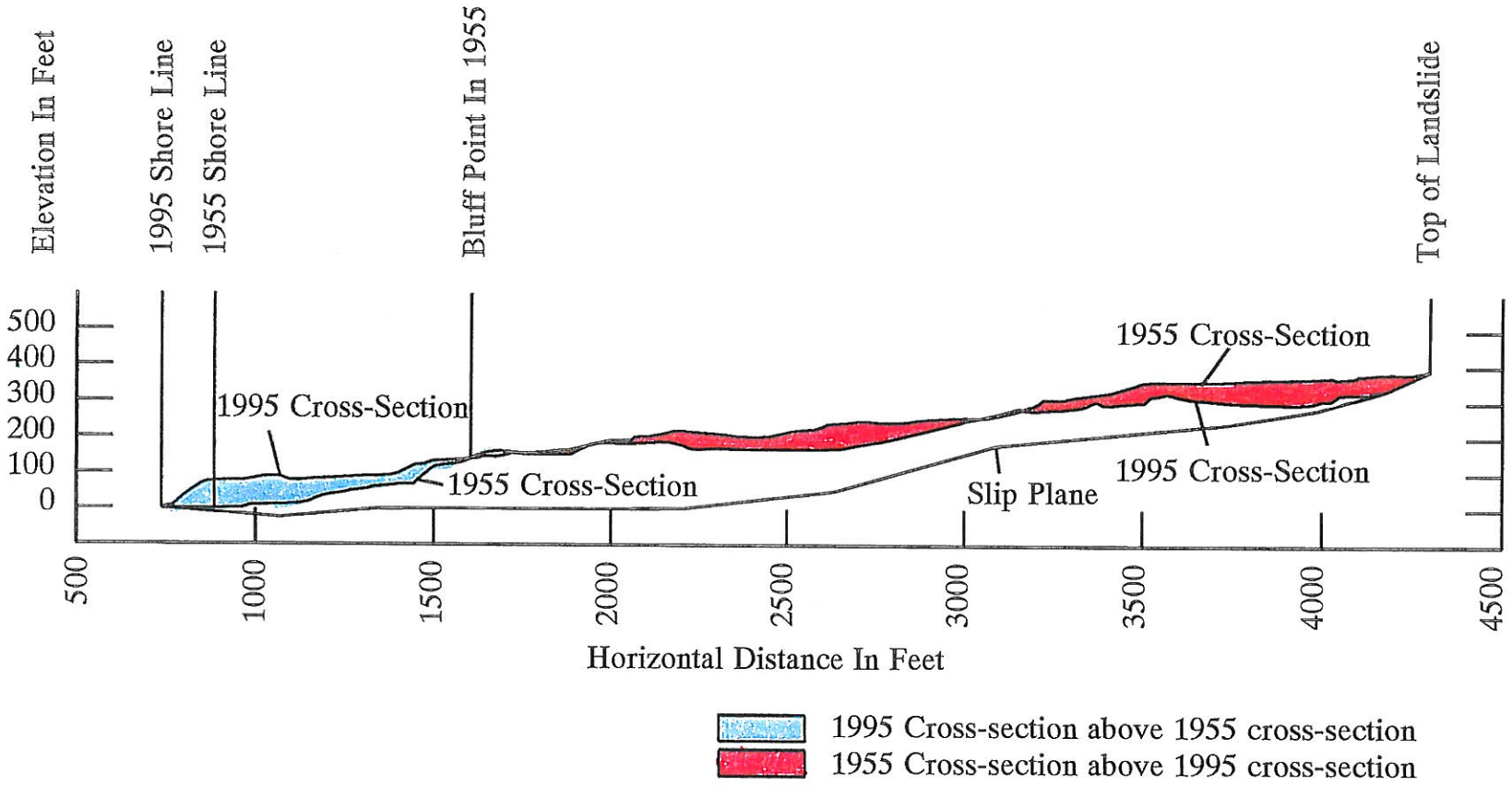
1988 Cross-section above 1955 cross-section

1955 Cross-section above 1988 cross-section

CROSS-SECTION

E 4,178,300

08/55 and 08/95



1995 Cross-section above 1955 cross-section

1955 Cross-section above 1995 cross-section

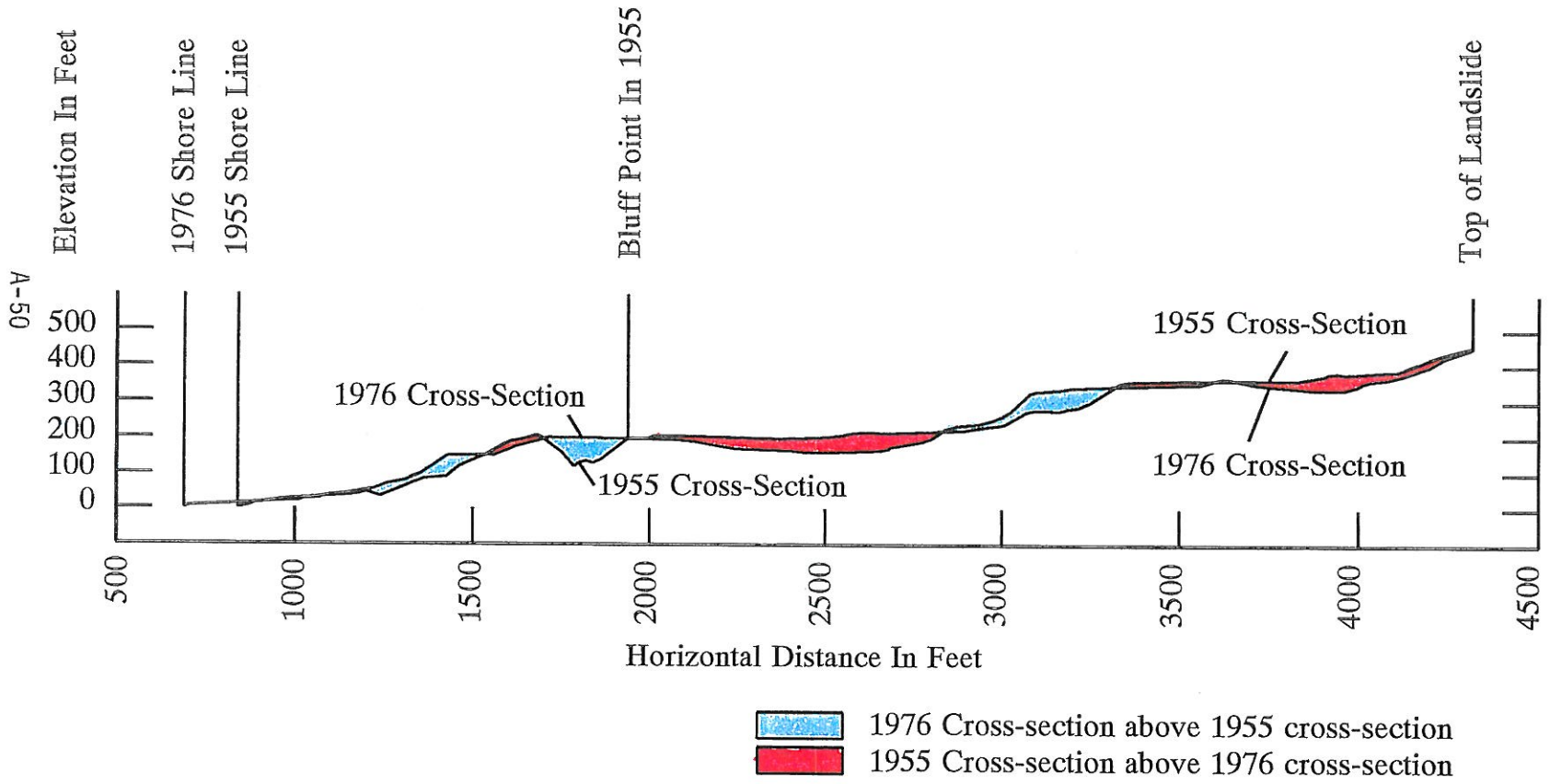
A-49

6

CROSS-SECTION

E 4,178,600

08/55 and 03/76

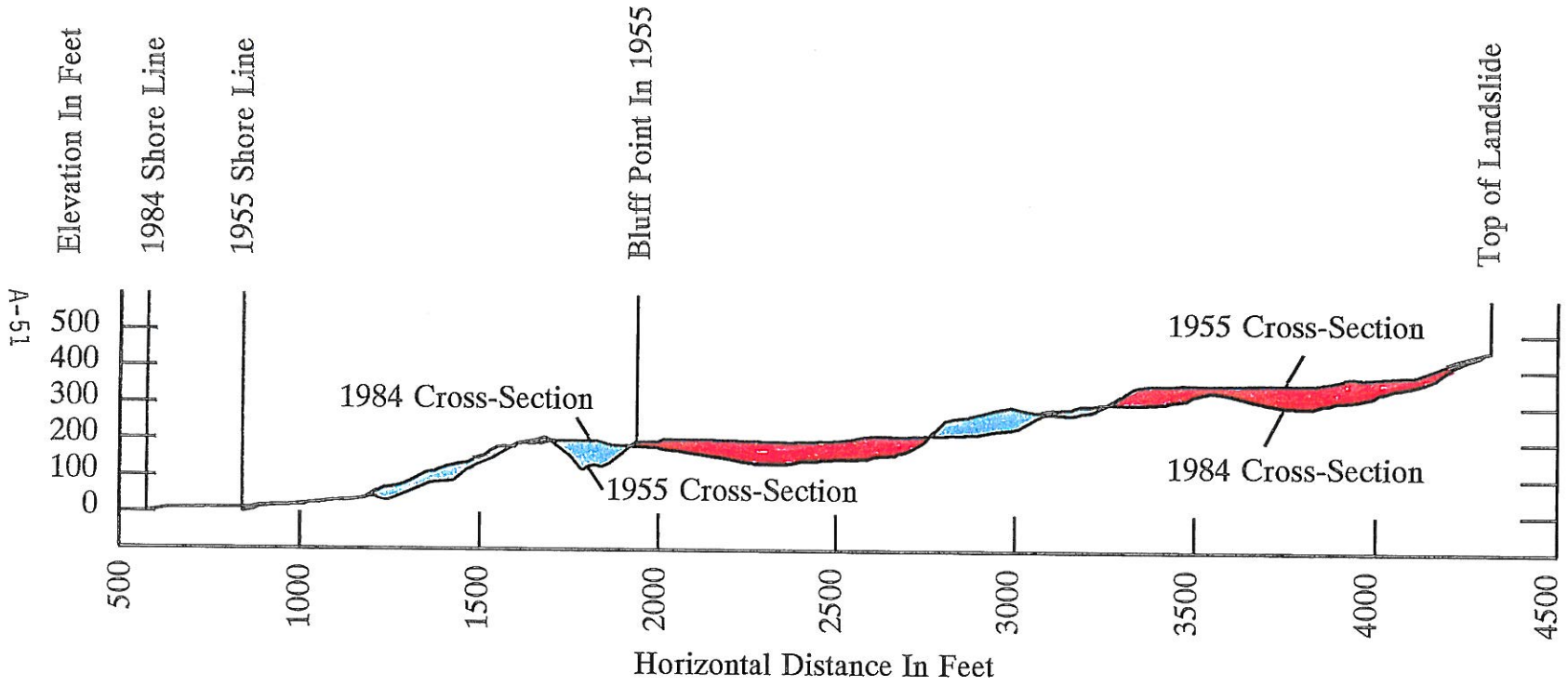


7

CROSS-SECTION

E 4,178,600

08/55 and 08/84



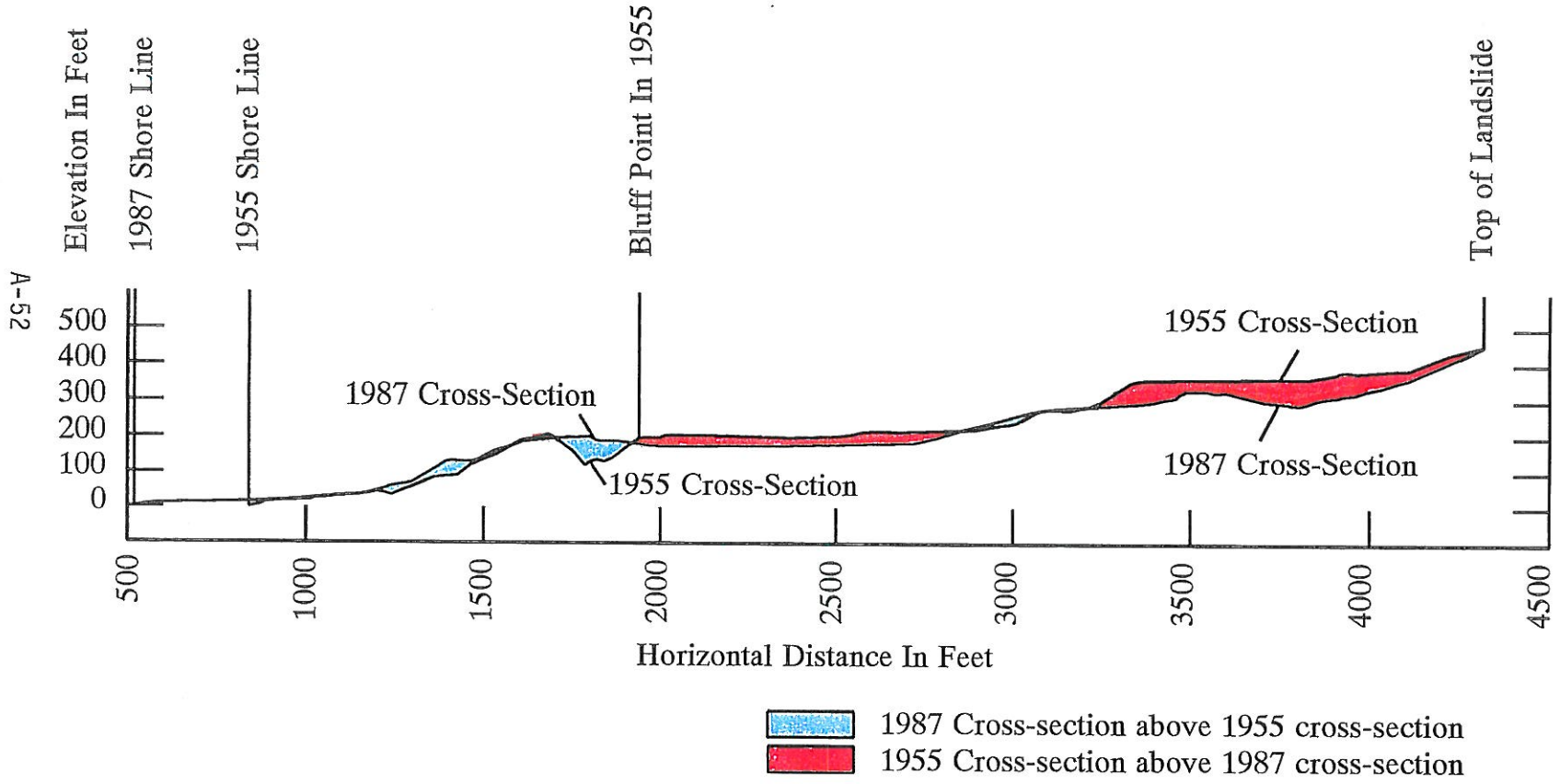
1984 Cross-section above 1955 cross-section

1955 Cross-section above 1984 cross-section

CROSS-SECTION

E 4,178,600

08/55 and 08/87

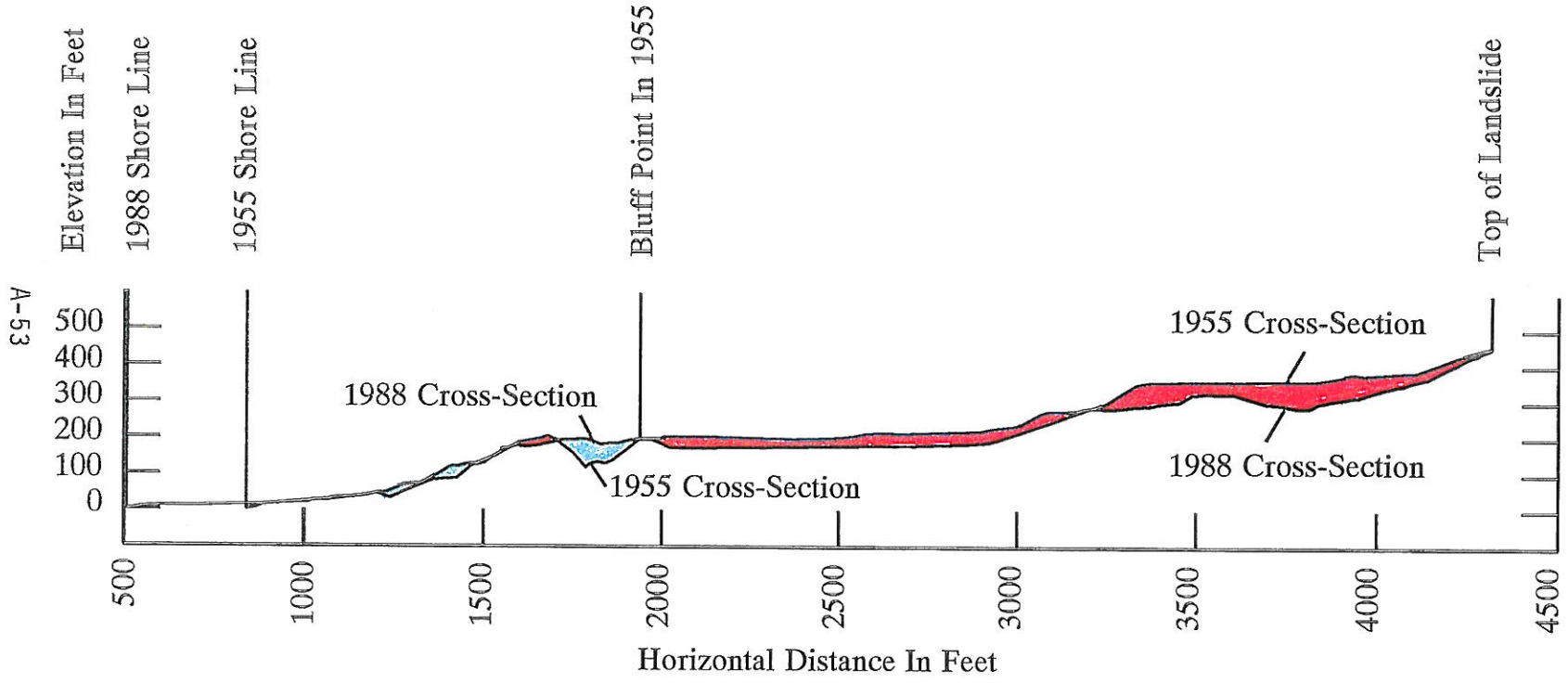


7

CROSS-SECTION

E 4,178,600

08/55 and 08/88



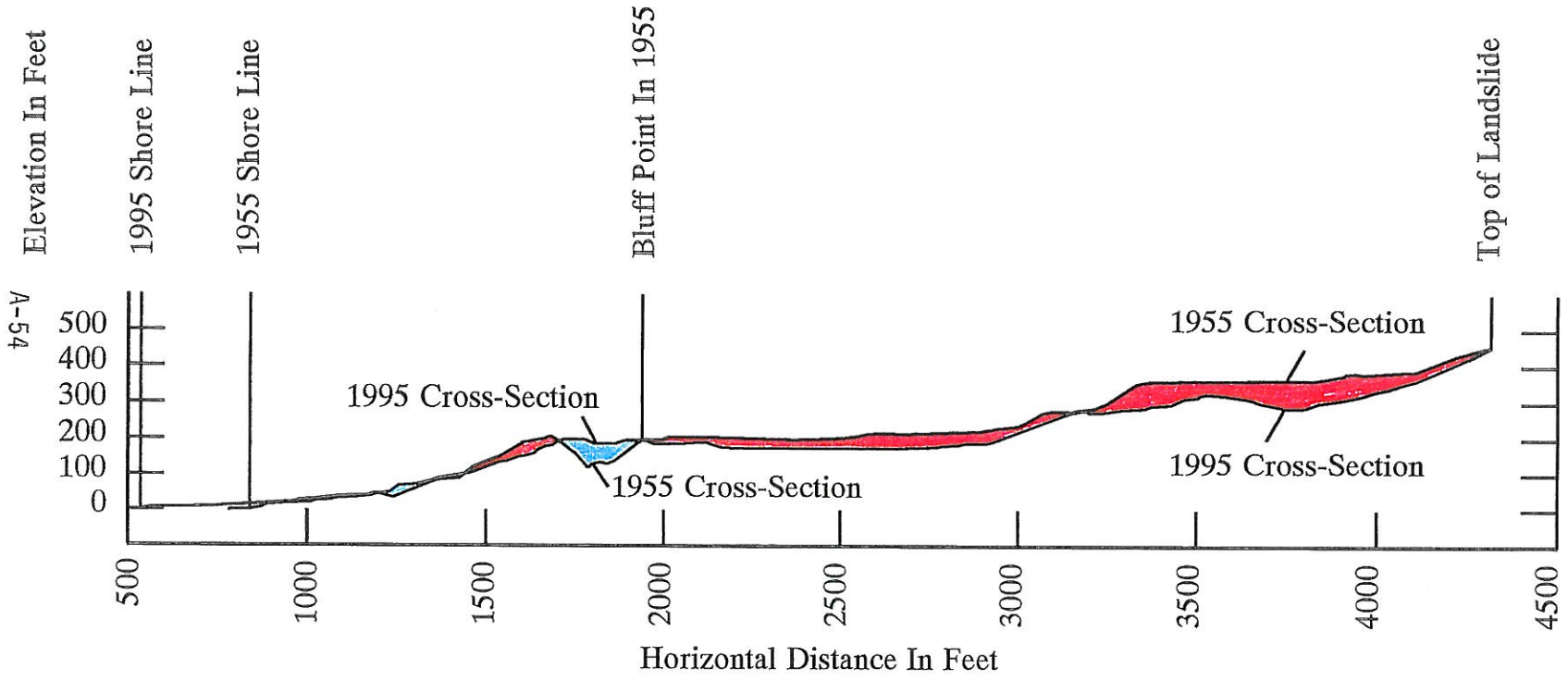
1988 Cross-section above 1955 cross-section

1955 Cross-section above 1988 cross-section

CROSS-SECTION

E 4,178,600

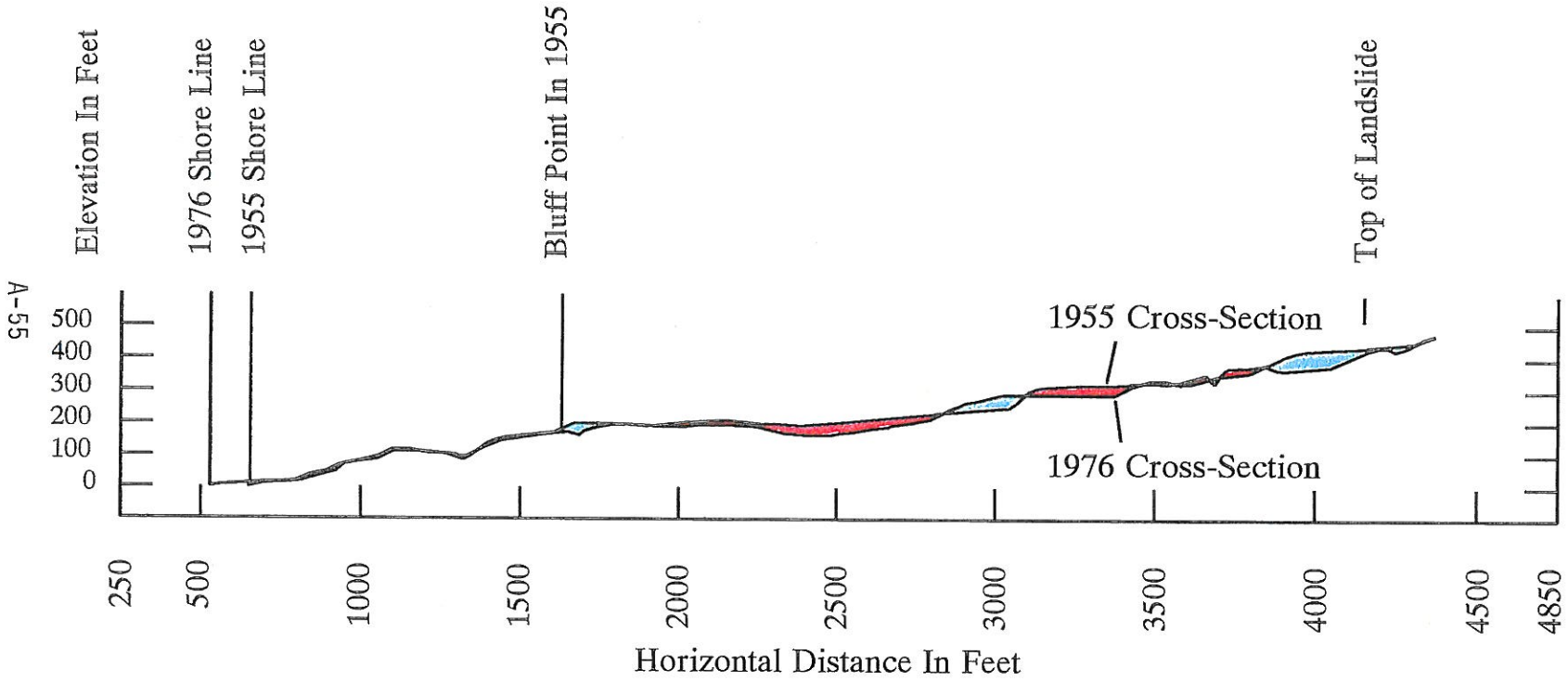
08/55 and 08/95



CROSS-SECTION

E 4,178,900

08/55 and 03/76



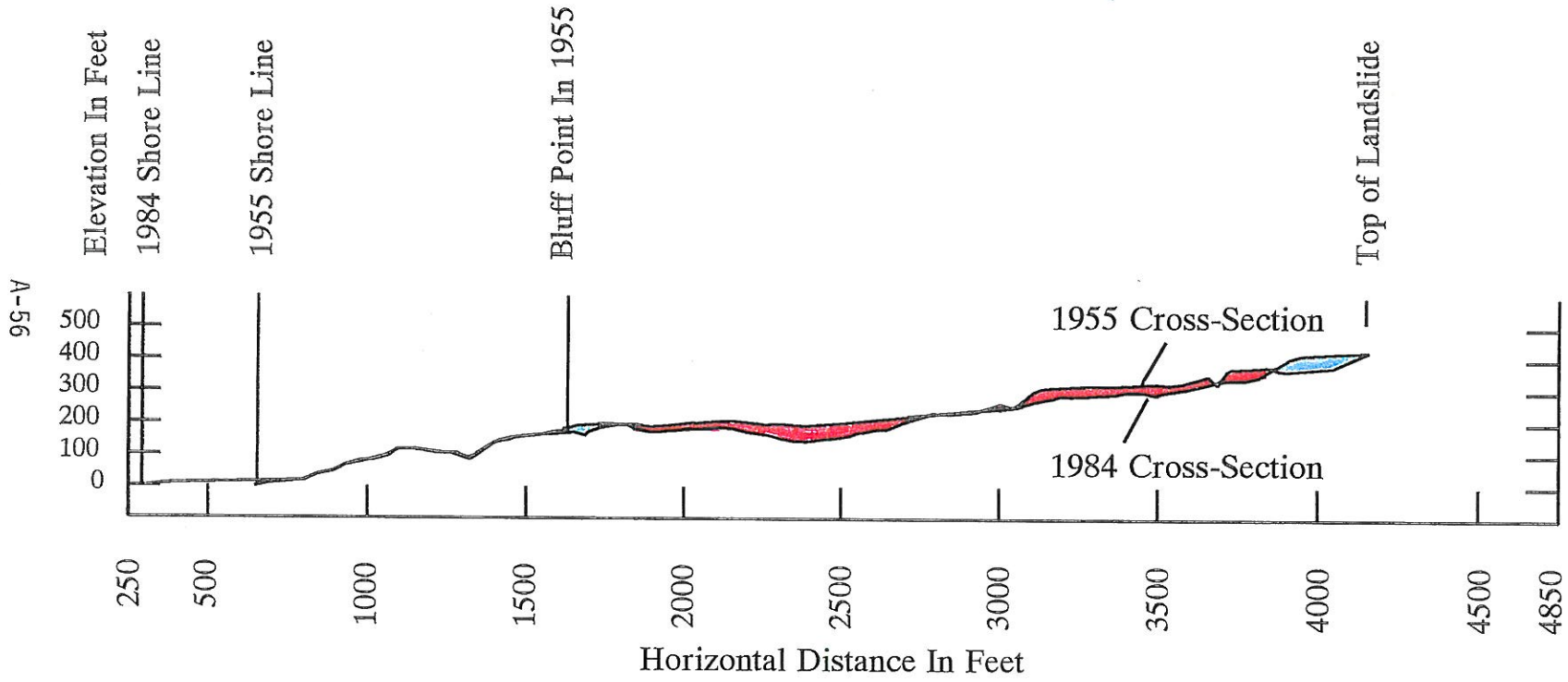
1976 Cross-section above 1955 cross-section

1955 Cross-section above 1976 cross-section

CROSS-SECTION

E 4,178,900

08/55 and 09/84



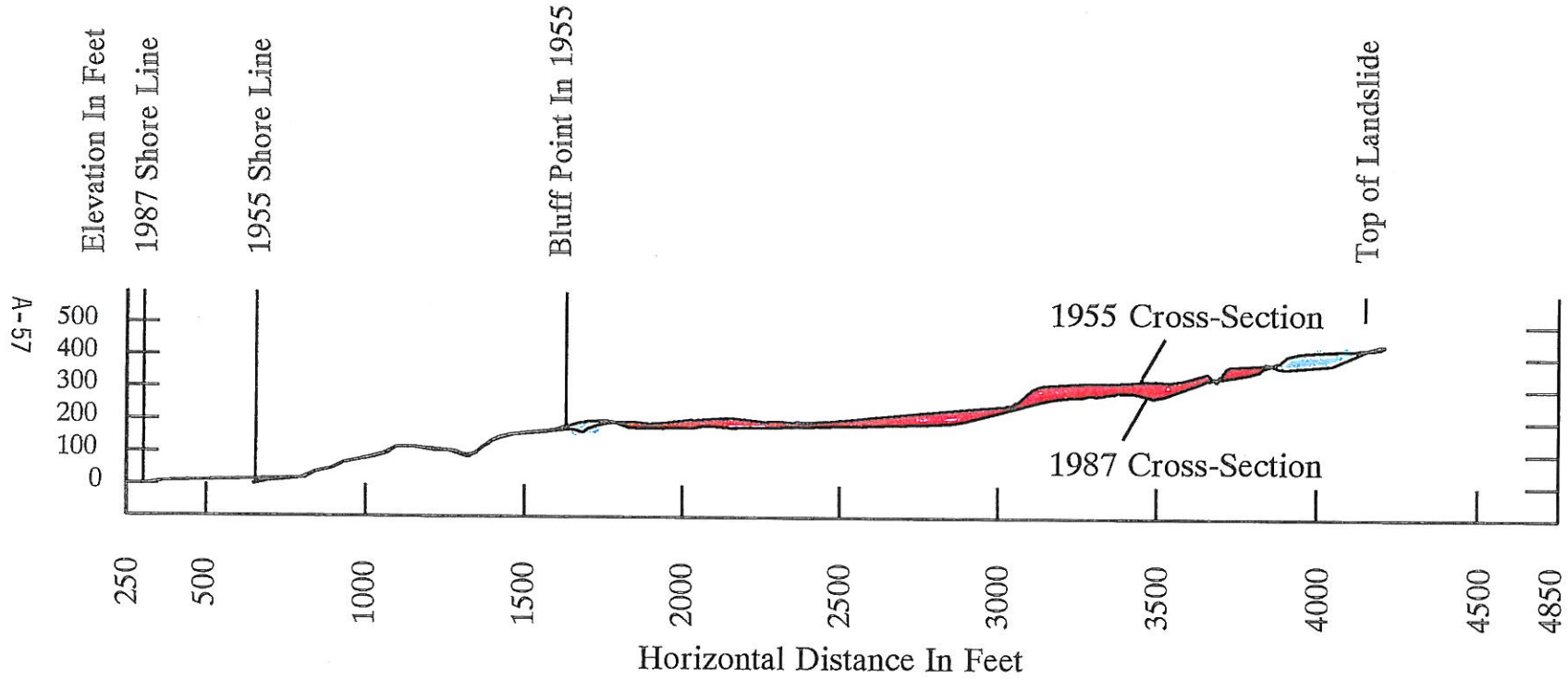
1984 Cross-section above 1955 cross-section

1955 Cross-section above 1984 cross-section

CROSS-SECTION

E 4,178,900

08/55 and 01//87



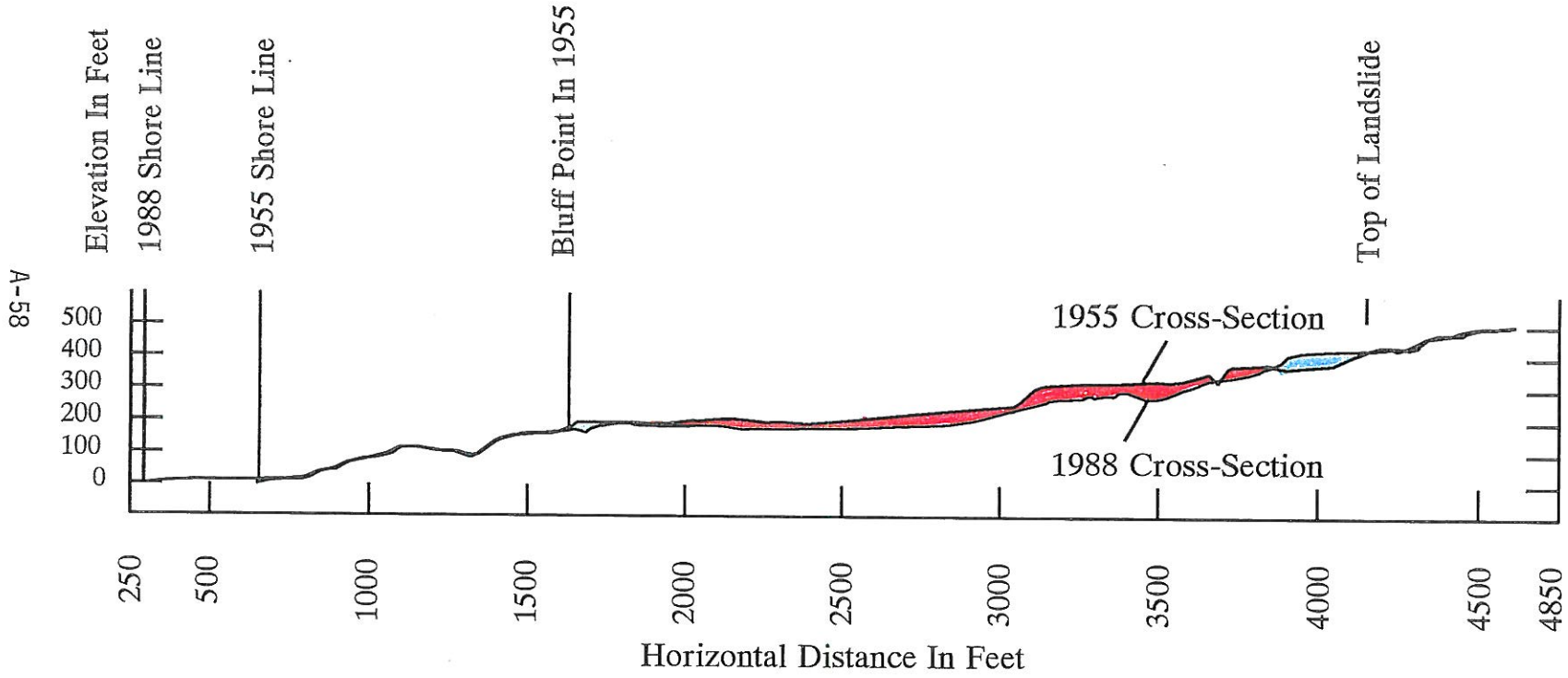
1987 Cross-section above 1955 cross-section

1955 Cross-section above 1987 cross-section

CROSS-SECTION

E 4,178,900

08/55 and 03/88



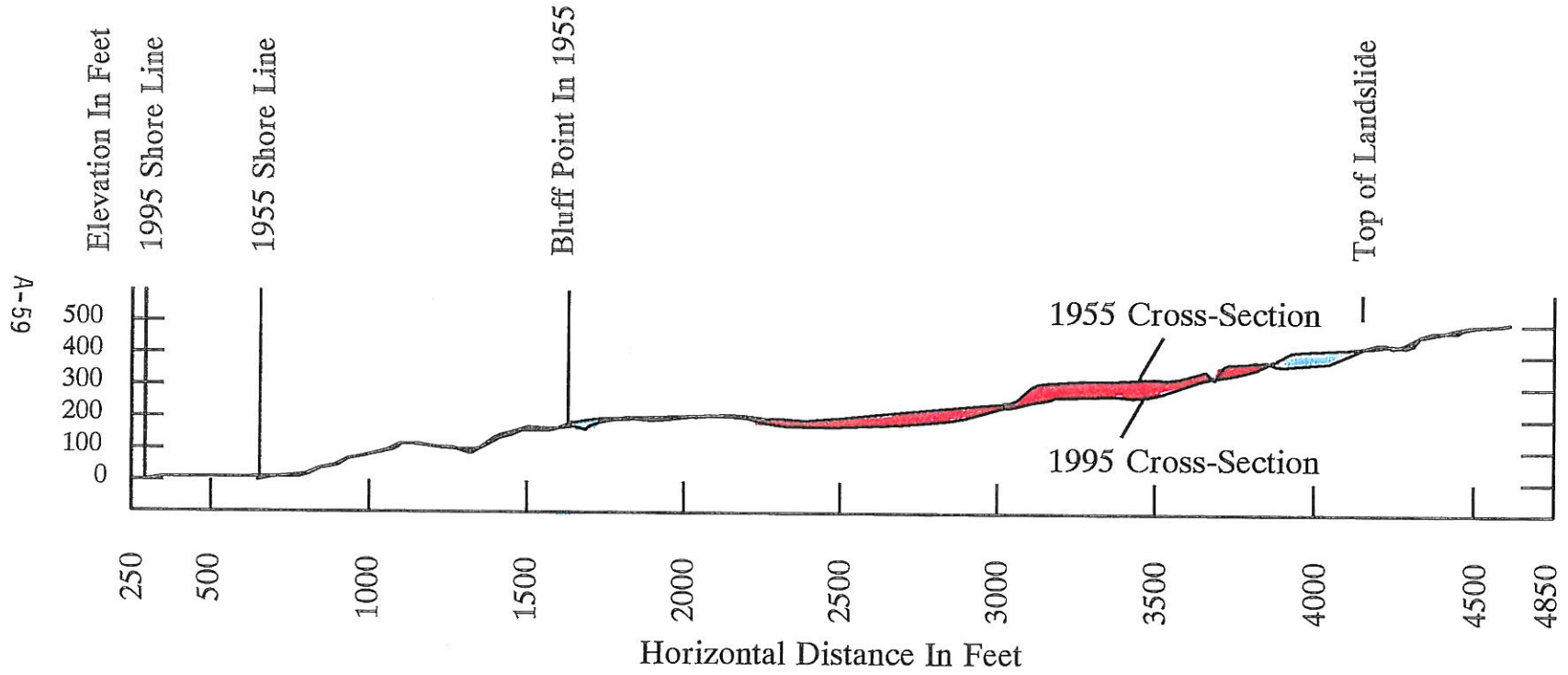
1988 Cross-section above 1955 cross-section

1955 Cross-section above 1988 cross-section

CROSS-SECTION

E 4,178,900

08/55 and 08/95



1995 Cross-section above 1955 cross-section

1955 Cross-section above 1995 cross-section