BING YEN & ASSOCIATES, INC.
Geotechnical Consultants, Established 1979

September 11, 1992

BYA Project No. 54-247

Mr. Allen Collett
City of Rancho Palos Verdes
30940 Hawthorne Blvd.
Rancho Palos Verdes, CA 90274

SUBJECT: Abalone Cove Landslide Monitoring Results.

Dear Mr. Collett,

As requested, we completed rounds of monitoring the slope inclinometers and piezometers at the Abalone Cove Landslide during May and August of 1992. This letter presents the results of that monitoring.

At the present time, five of the seven slope inclinometers which have been installed at the site remain functional (ACL-1, 3, 4, 7B, & 8). Two of the inclinometers (ACL-2 and ACL-6) have become inoperative due to excessive distortion of their casings from landslide movement. A third inclinometer (ACL-4) was inadvertently filled with dirt by the Los Angeles County Sanitation District in June of this year. This dirt was successfully flushed from the casing on September 10 and the inclinometer is now functional. Of the 32 piezometers which have been installed at the site, 19 remain functional while the remainder have been destroyed by landslide movement.

Plots illustrating the deformation recorded by the four functional slope inclinometers from the May and August of 1992 readings are included in Appendix A. From these results, a single, progressively enlarging offset can be seen in each inclinometer. The offset depth, elevation, total displacement, direction of movement, and inclinometer status (i.e. functional or destroyed) is summarized for each installation in Table. 1. The direction of movement which has been recorded at each inclinometer installation is also shown graphically in Figure 1.

The most recent inclinometer data indicates that the landslide slowed to an average rate of movement of ≈0.6 inches per year between May and August of 1992. The average rate of movement between February and May of 1992 was ≈1.1 inches per year. The variation in the rate of landslide movement over the last 3½ years -based upon the slope inclinometer data - is shown graphically in Figure 2. As shown in this figure, the landslide has apparently been moving continuously during this period at an **overall average** rate of approximately 0.5 inches per year. The monthly and daily rainfall recorded at the nearby Los Angeles County Flood Control District Station 43D since late 1988 has been plotted in Figures 3 and 4, respectively. Comparison of the landslide movement rate with the rainfall record indicates

Agenda Item 10 11B

39 Musick Avenue, Irvine, CA 92718 Tel. (714) 583-1919 Fax: (714) 583-1763

21" at 1011B

that the landslide has gradually slowed during periods of little or no precipitation, and accelerated relatively rapidly following even short periods of moderate to high rainfall. The ≈19 inches of rainfall which occurred over the past winter was sufficient to accelerate the failure to a average displacement rate of approximately 1.3 inches per year.

The results from the piezometers have been summarized graphically in the plots presented in Appendix B. In these figures, the bottom of the vertical arrows represent the elevation of the specified piezometers, while the tip of the arrows represent the recorded piezometric elevations. One of two reduced scale cross sections through the landslide has been inset on each of these figures. The alignment of these cross sections is shown in Figure 1. The locations of the borings in which the piezometers have been installed are shown and labeled on these cross sections. The tip and groundwater elevations for each individual piezometer which was installed in a given boring is shown graphically immediately to the right of that boring (the small circles represent the tip elevations while the inverted triangles represent the recorded groundwater elevations). An arrow on each cross section identifies the piezometer tip associated with each figure.

As requested by the technical panel, multiple readings of the piezometers installed in ACL-7B were taken over a 10 hour period in order to assess the impact of tidal fluctuations on the recorded response. The results of these measurements are illustrated in Figure 5 along with the tidal level during the day the measurements were taken. A shown, only very minor variations in the piezometric levels were recorded while the tide level varied by several feet. These results would tend to indicate that the permeability of the bedrock in the area of ACL-7B is to low for the localized groundwater level to respond to the relatively short-term tidal fluctuations.

I hope this information is helpful to the City and the members of the Technical Panel. Please feel free to contact me if you have any questions or comments.

Sincerely,
BING YEN & ASSOCIATES, INC.

Glenn D. Tofani

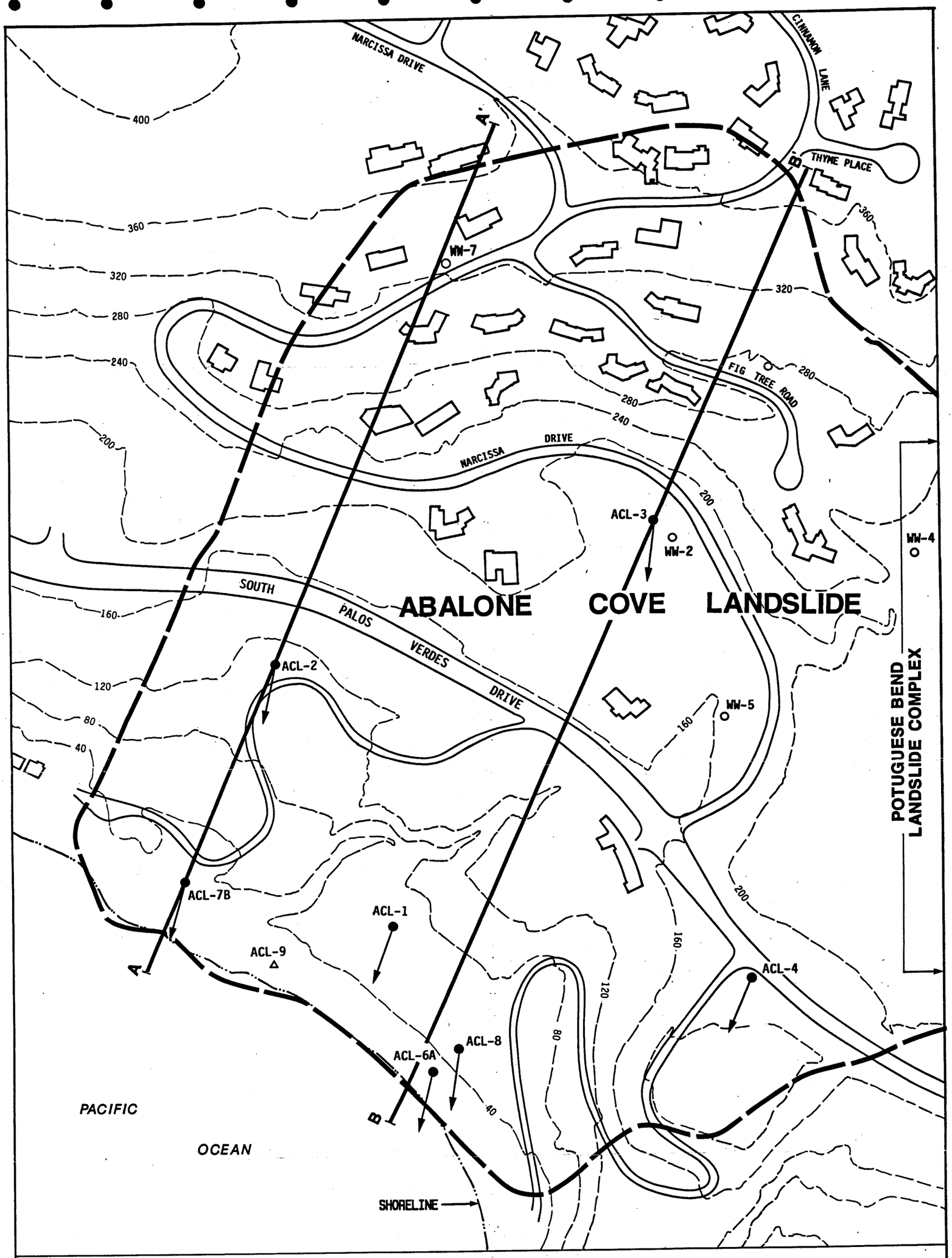
Glenn D. Tofani, RCE/REA
Vice President

attachments.

TABLE 1. STATUS OF ABALONE COVE SLOPE INCLINOMETERS - AS OF SEPTEMBER 1992.

SLOPE INCLINOMETER	DEPTH TO OFFSET	ELEVATION OF OFFSET	TOTAL DISPLACEMENT	DIRECTION OF MOVEMENT	STATUS[1]
ACL-1	150 FT.	-85 FT.	2.5 INCHES	S20°W	FUNCT.
ACL-2	55 FT.	50 FT.	1.7 INCHES	S10°W	DEST.
ACL-3	170 FT.	0 FT.	1.5 INCHES	S10°W	FUNCT.
ACL-4	235 FT.	-55 FT.	2.2 INCHES	S20°W	FUNCT.
ACL-6A	70 FT.	-55 FT.	0.6 INCHES	S10°W	DEST.
ACL-7B	80 FT.	-48 FT.	0.3 INCHES	S10°W	FUNCT.
ACL-8	165 FT.	-90 FT.	1.0 INCHES	S10°W	FUNCT.

[1] Functional or Destroyed.



EXPLANATION

ACL-8	APPROXIMATE LOCATION OF SLOPE INCLINOMETER/PIEZOMETER, ARROW INDICATES DIRECTION OF RECORDED MOVEMENT
ACL-9 △	APPROXIMATE LOCATION OF PIEZOMETER
WW-2 ○	APPROXIMATE LOCATION OF DEWATERING OR MONITORING WELL
	RESIDENCE OR OTHER STRUCTURE
	POSSIBLE BOUNDARY OF ACTIVE ABALONE COVE LANDSLIDE
A — A'	LOCATION OF CROSS SECTION

N

0 200 400 FEET

BING YEN & ASSOCIATES

PROJECT NAME: ABALONE COVE LANDSLIDE

PROJECT NO.: 54-[illegible] DATE: SEPTEMBER 1[illegible]

LOCATIONS OF SLOPE INCLINOMETER/PIEZOMETERS AND DIRECTION OF RECORDED MOVEMENT

E 1

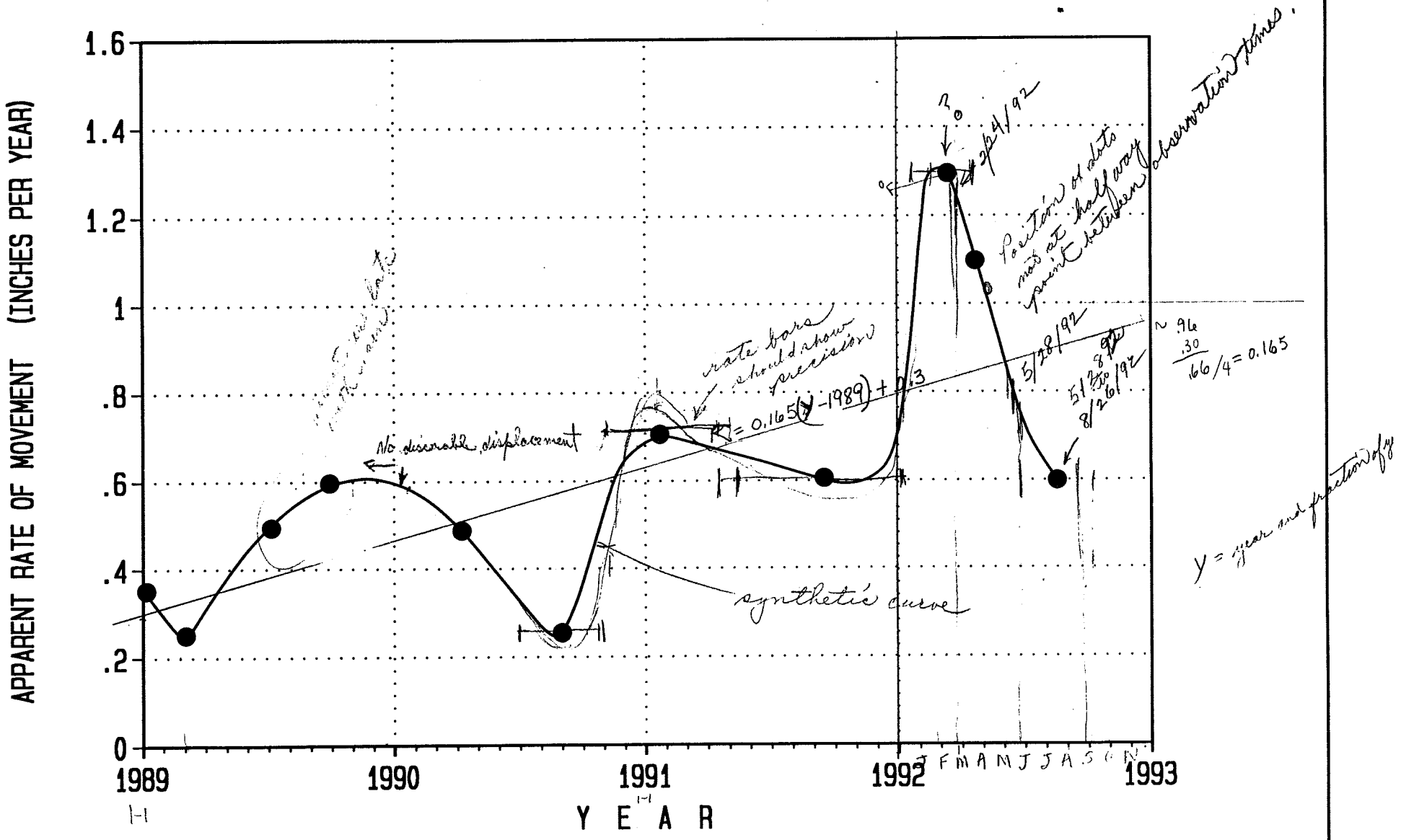


FIGURE 2

PROJECT NO. 54-247	APPARENT RATE OF LANDSLIDE MOVEMENT FROM INCLINOMETER DATA.	BING YEN & ASSOC.

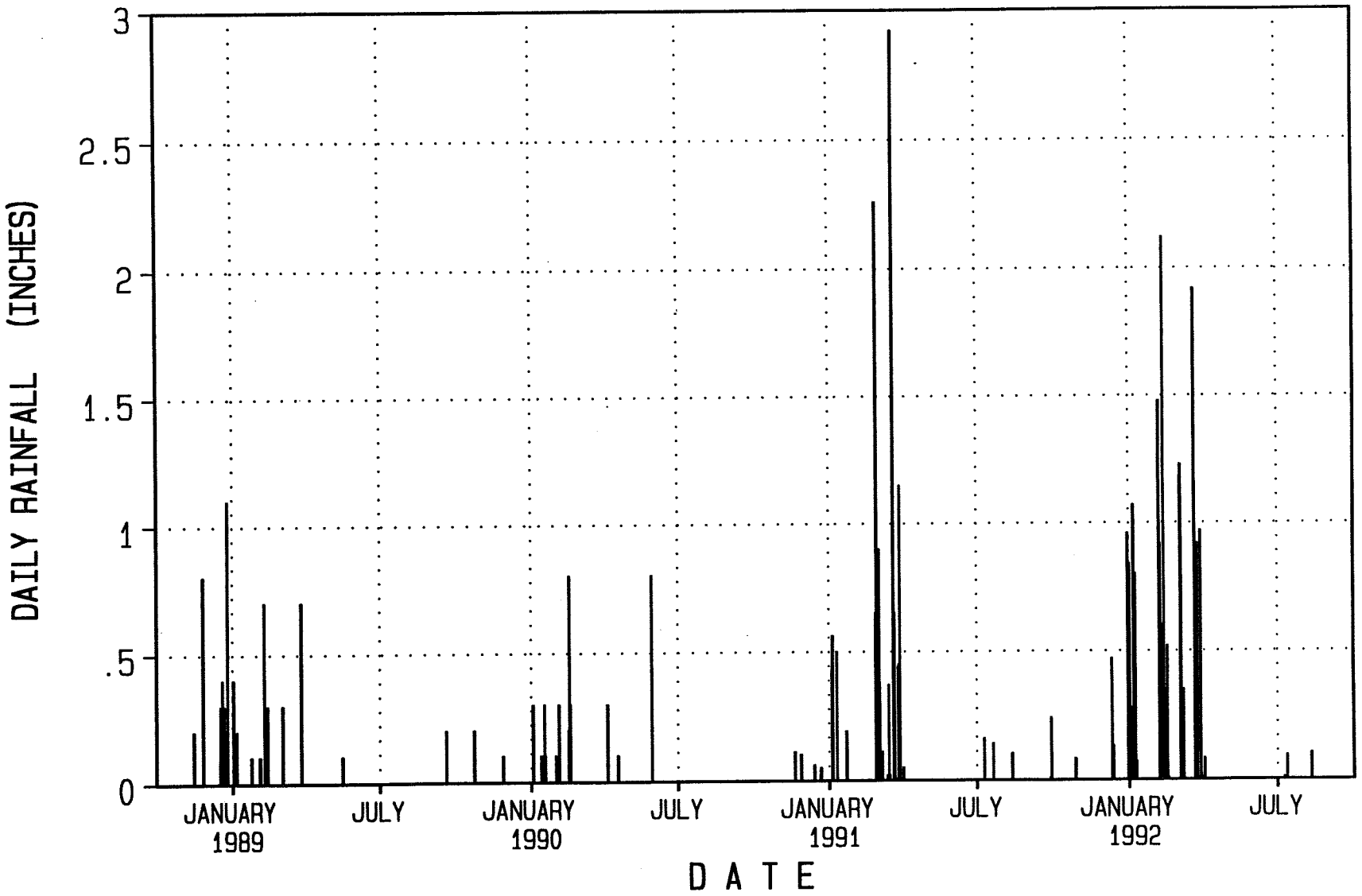


FIGURE 3

PROJECT # 54-247	DAILY RAINFALL RECORD FOR LACFCD STATION 43D.	BING YEN & ASSOC.

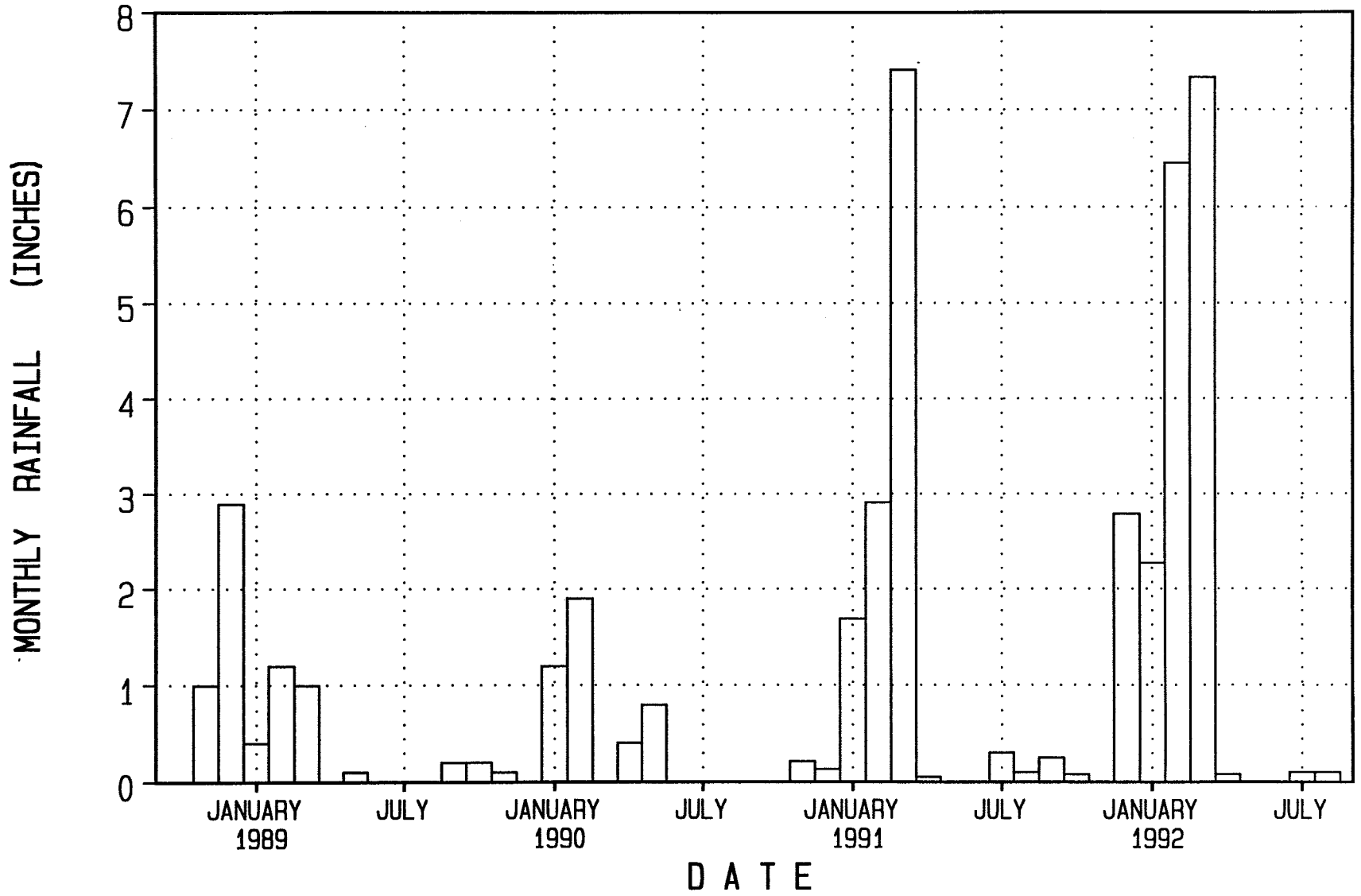


FIGURE 4

PROJECT # 54-247	MONTHLY RAINFALL RECORD FOR LACFCD STATION 43D.	BING YEN & ASSOC.

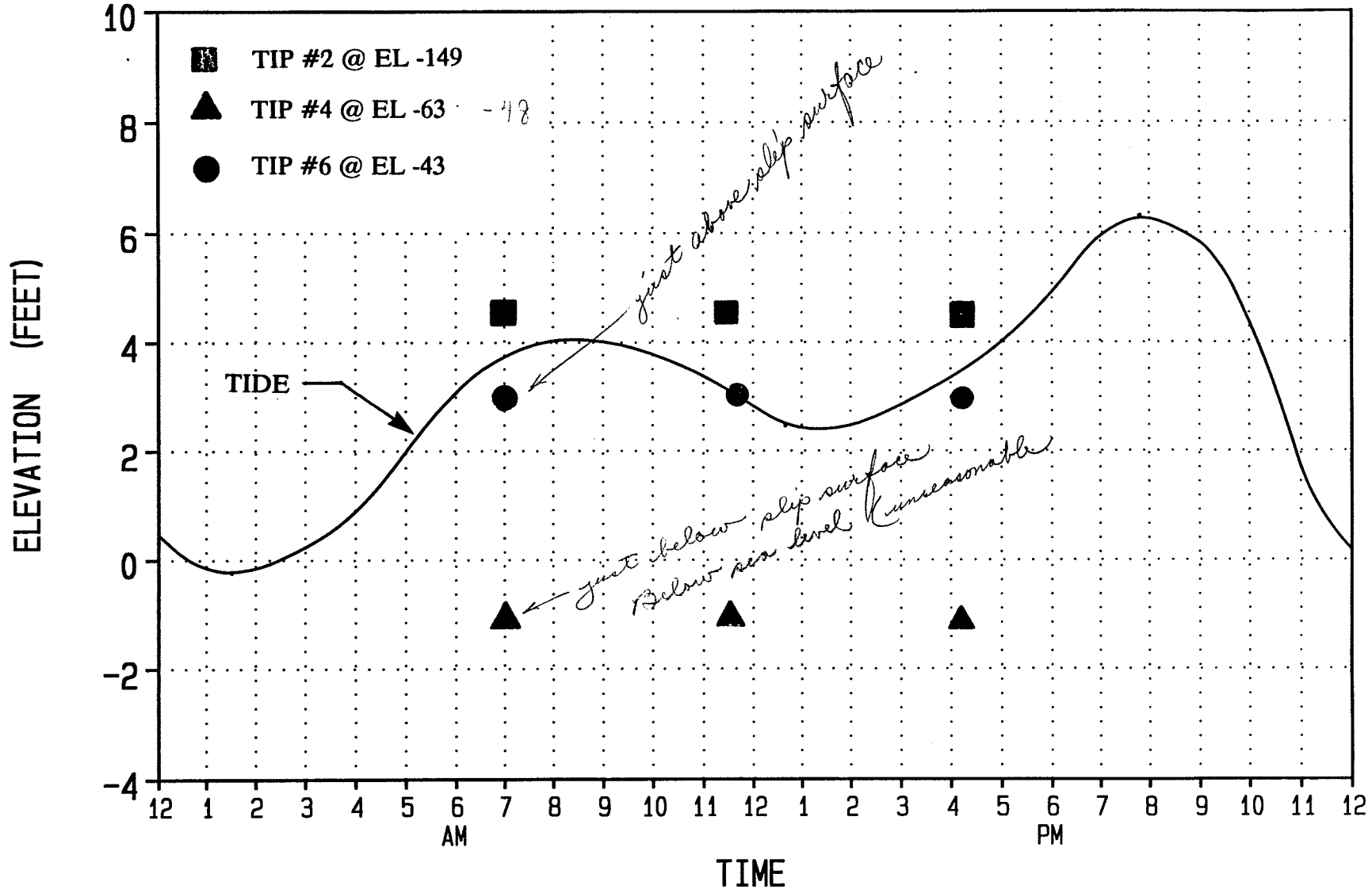
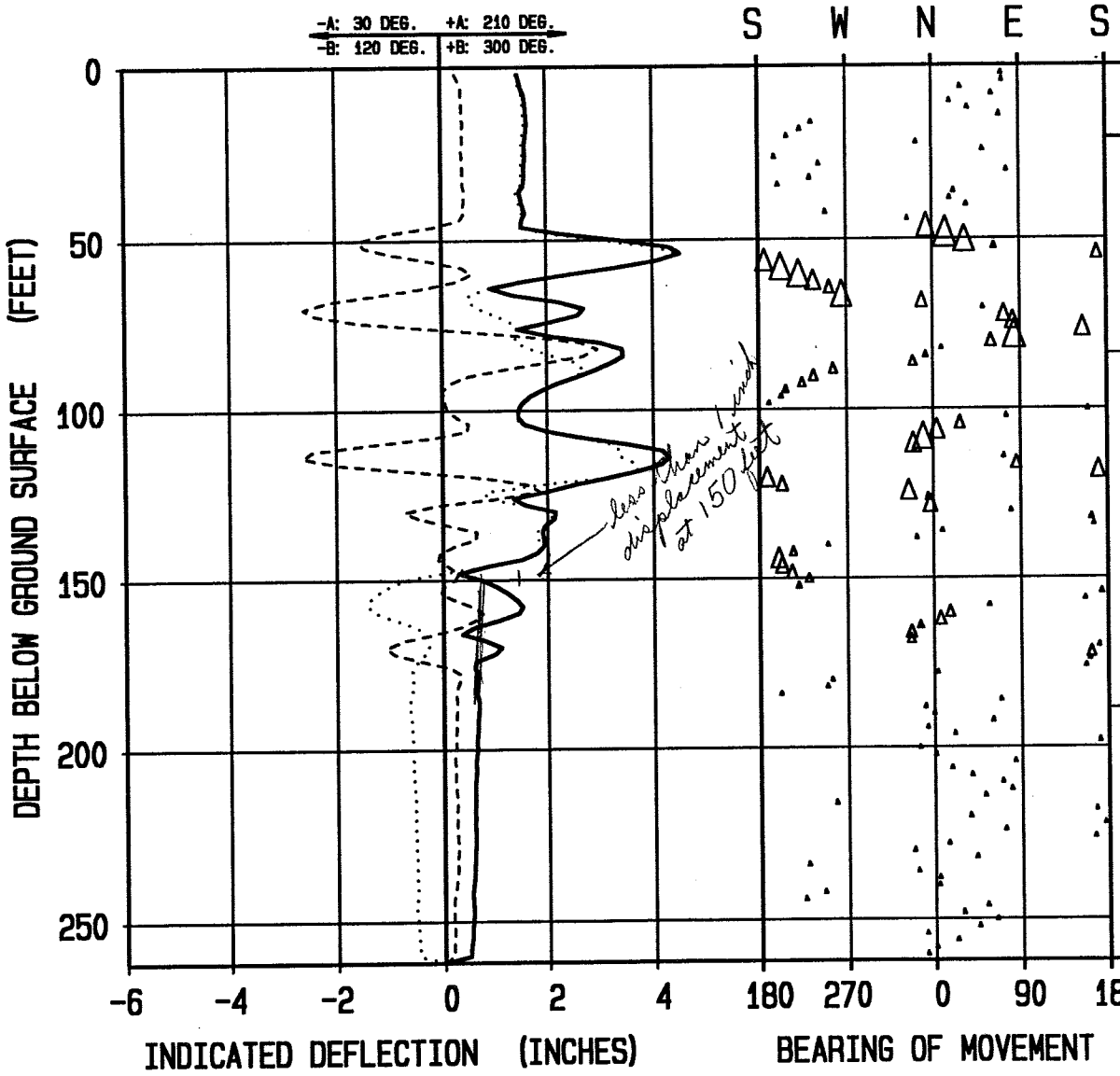


FIGURE 5

PROJECT # 54-247	INFLUENCE OF TIDE ON PIEZOMETER ACL-7B - AUGUST 24 1992.	BING YEN & ASSOC.

APPENDIX A

(Slope Indicator Results)



EXPLANATION

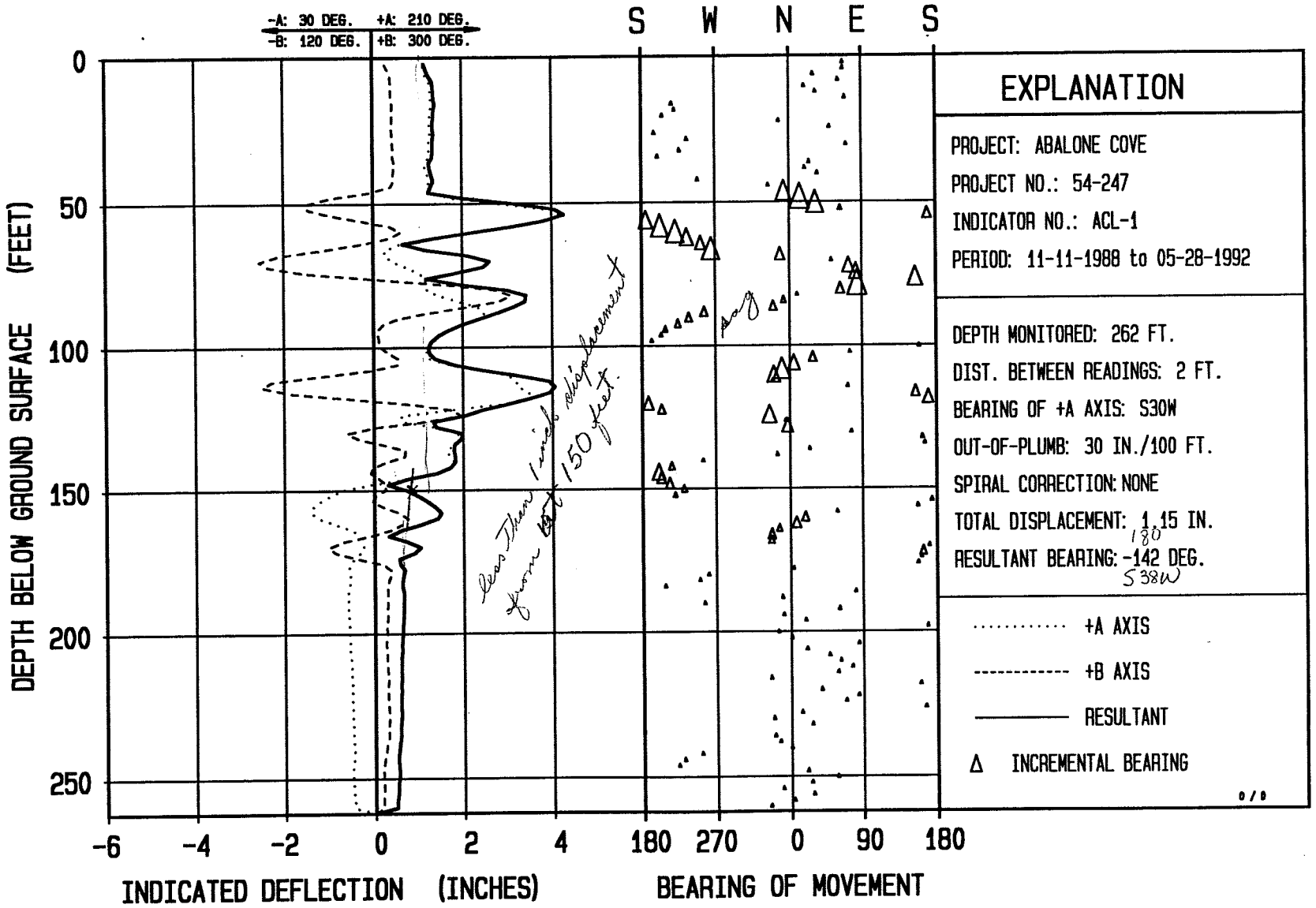
PROJECT: ABALONE COVE
PROJECT NO.: 54-247
INDICATOR NO.: ACL-1
PERIOD: 11-11-1988 to 08-26-1992

DEPTH MONITORED: 262 FT.
DIST. BETWEEN READINGS: 2 FT.
BEARING OF +A AXIS: S30W 85 + 30 = 115°
OUT-OF-PLUMB: 30 IN./100 FT.
SPIRAL CORRECTION: NONE
TOTAL DISPLACEMENT: 1.46 IN.
RESULTANT BEARING: -144 DEG. S36W

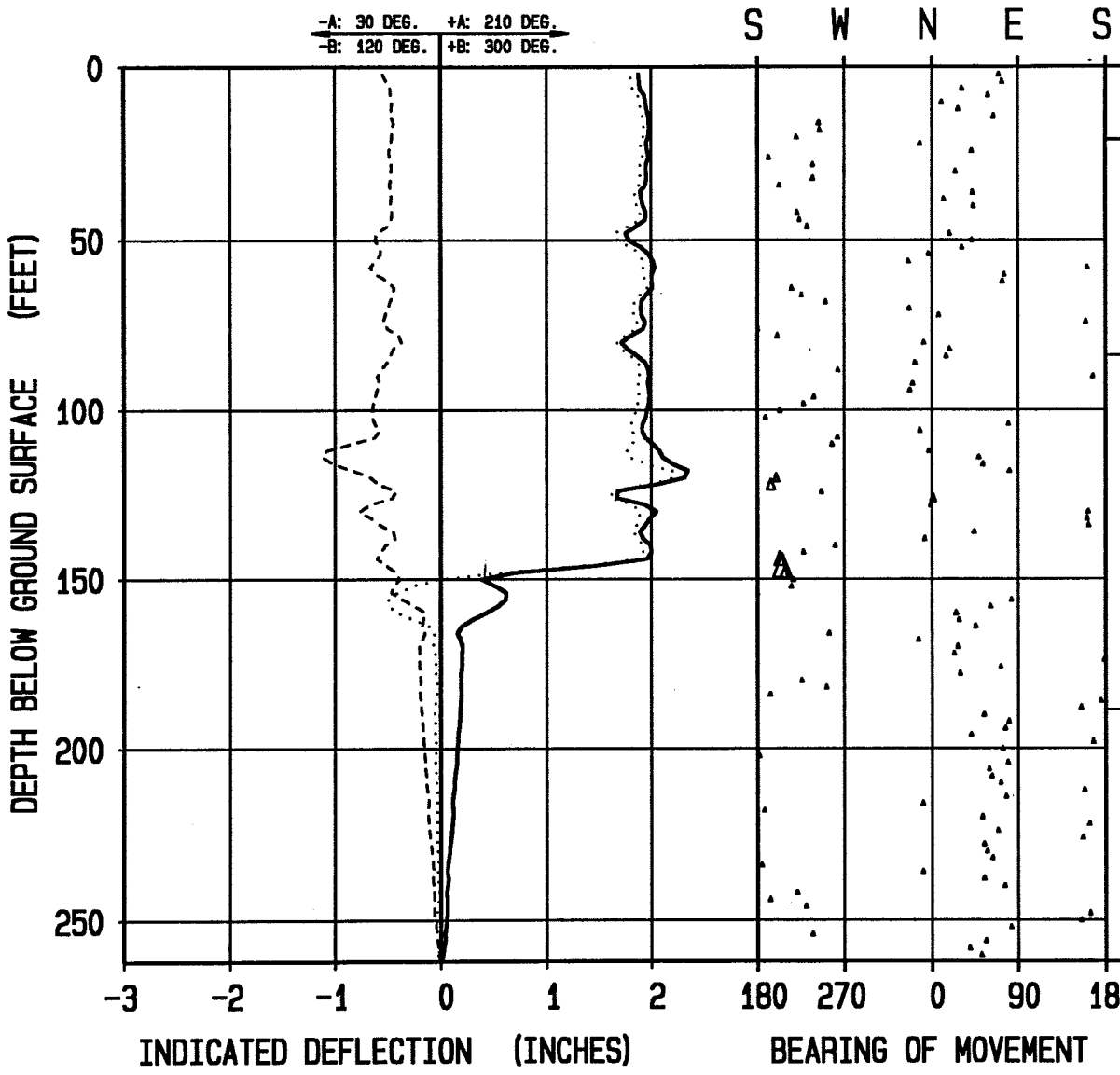
..... +A AXIS
---------- +B AXIS
———— RESULTANT
Δ INCREMENTAL BEARING

PROJECT # 54-247	ABALONE COVE LANDSLIDE SLOPE INDICATOR RESULTS.	BING YEN & ASSOC.

#15



PROJECT # 54-247	ABALONE COVE LANDSLIDE SLOPE INDICATOR RESULTS.	BING YEN & ASSOC.



EXPLANATION

PROJECT: ABALONE COVE

PROJECT NO.: 54-247

INDICATOR NO.: ACL-1

PERIOD: 01-04-1990 to 08-26-1992

DEPTH MONITORED: 262 FT.

DIST. BETWEEN READINGS: 2 FT.

BEARING OF +A AXIS: S5W

OUT-OF-PLUMB: 39 IN./100 FT.

SPIRAL CORRECTION: NONE

TOTAL DISPLACEMENT: 1.87 IN.

RESULTANT BEARING: ~~-161~~ 180 DEG. S19W

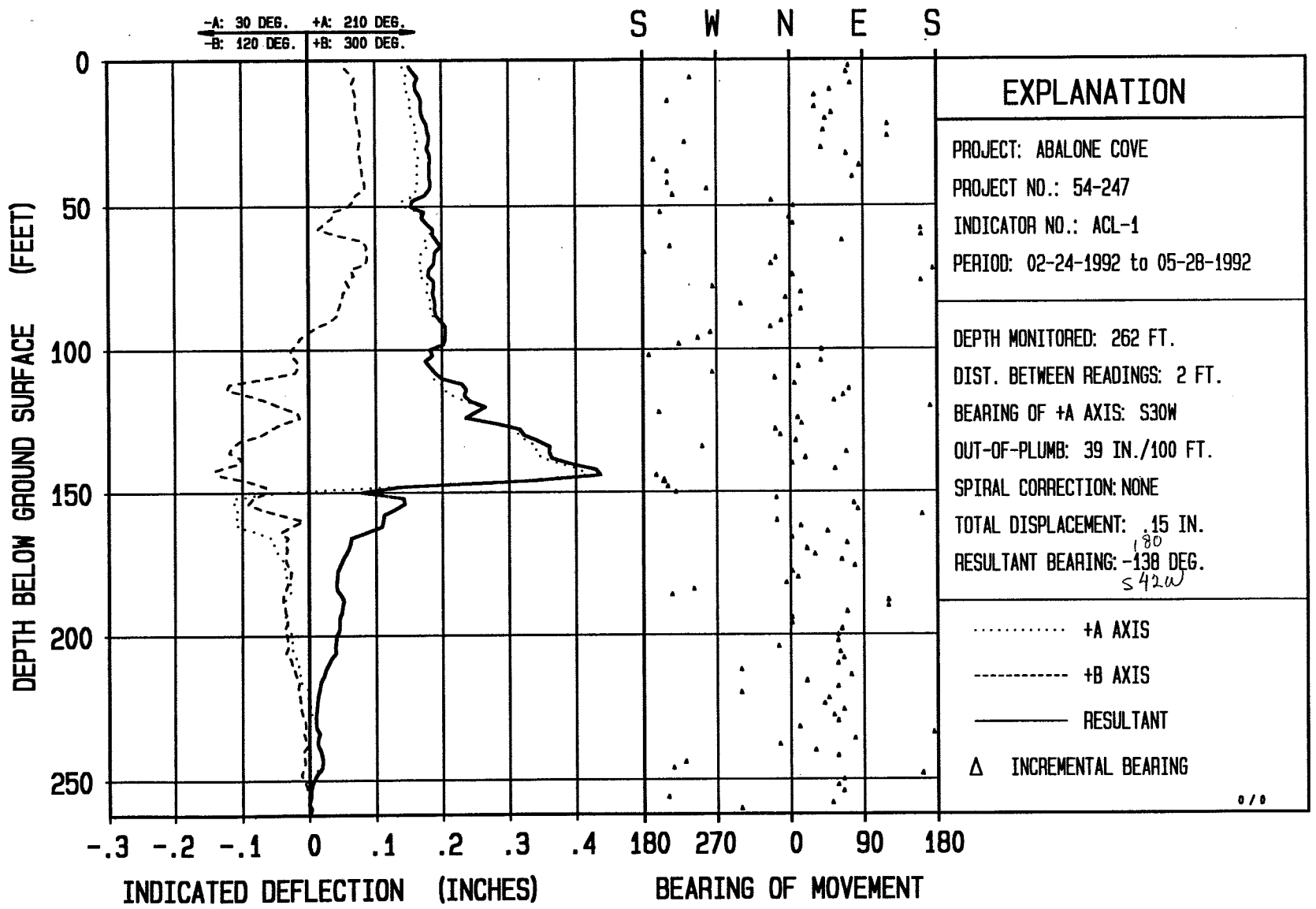
..... +A AXIS

---------- +B AXIS

———— RESULTANT

Δ INCREMENTAL BEARING

PROJECT # 54-247	ABALONE COVE LANDSLIDE SLOPE INDICATOR RESULTS.	BING YEN & ASSOC.



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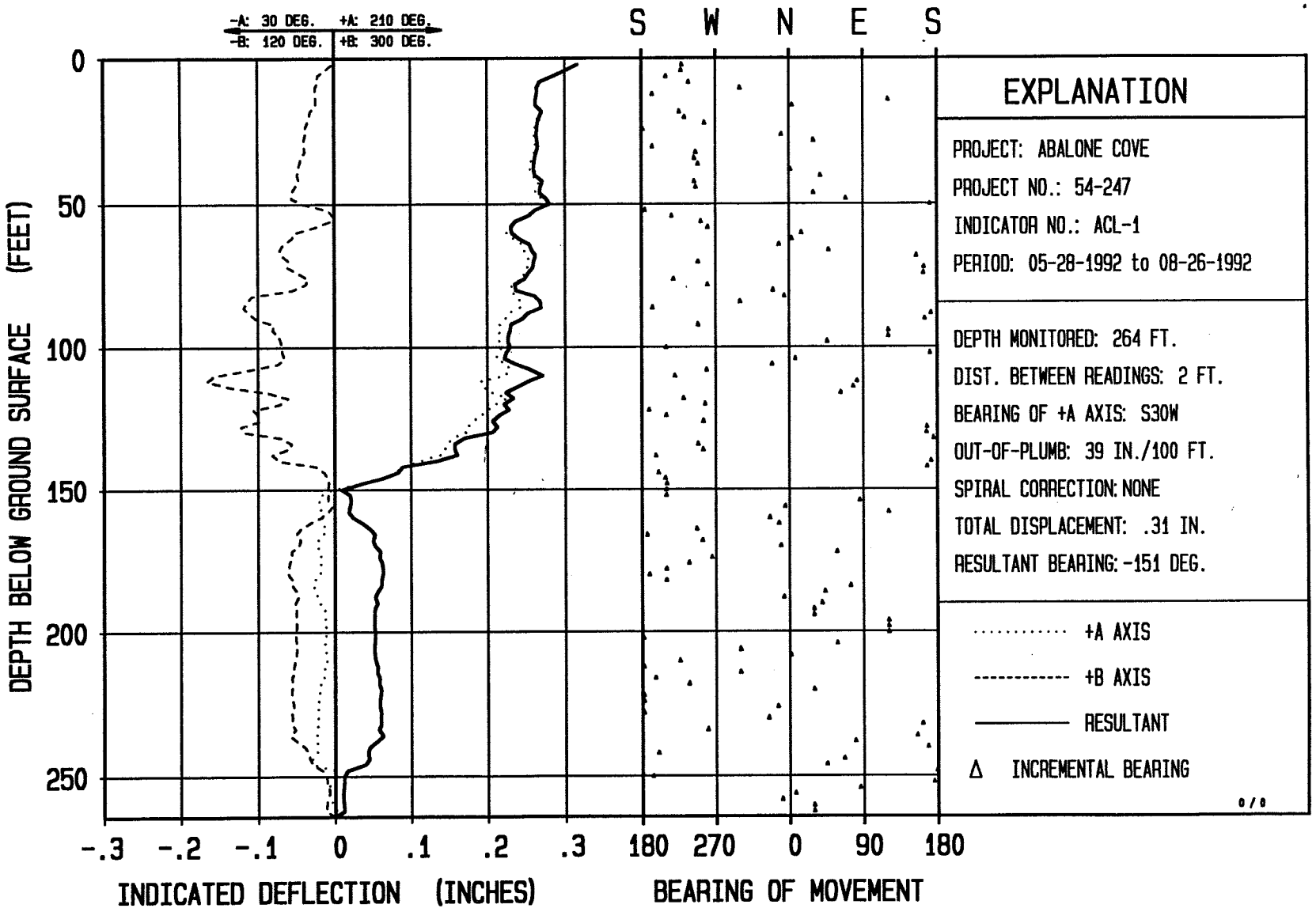

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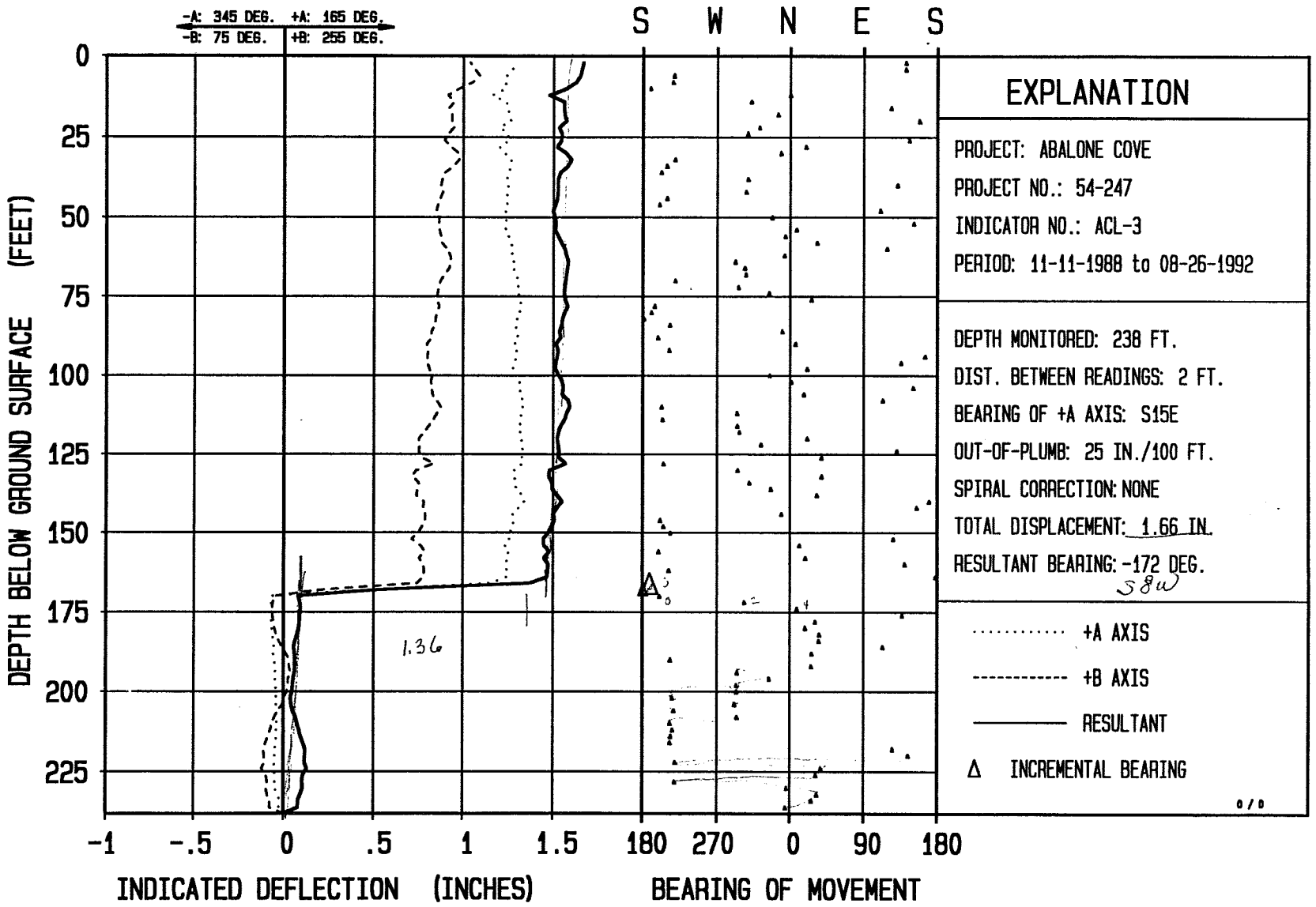
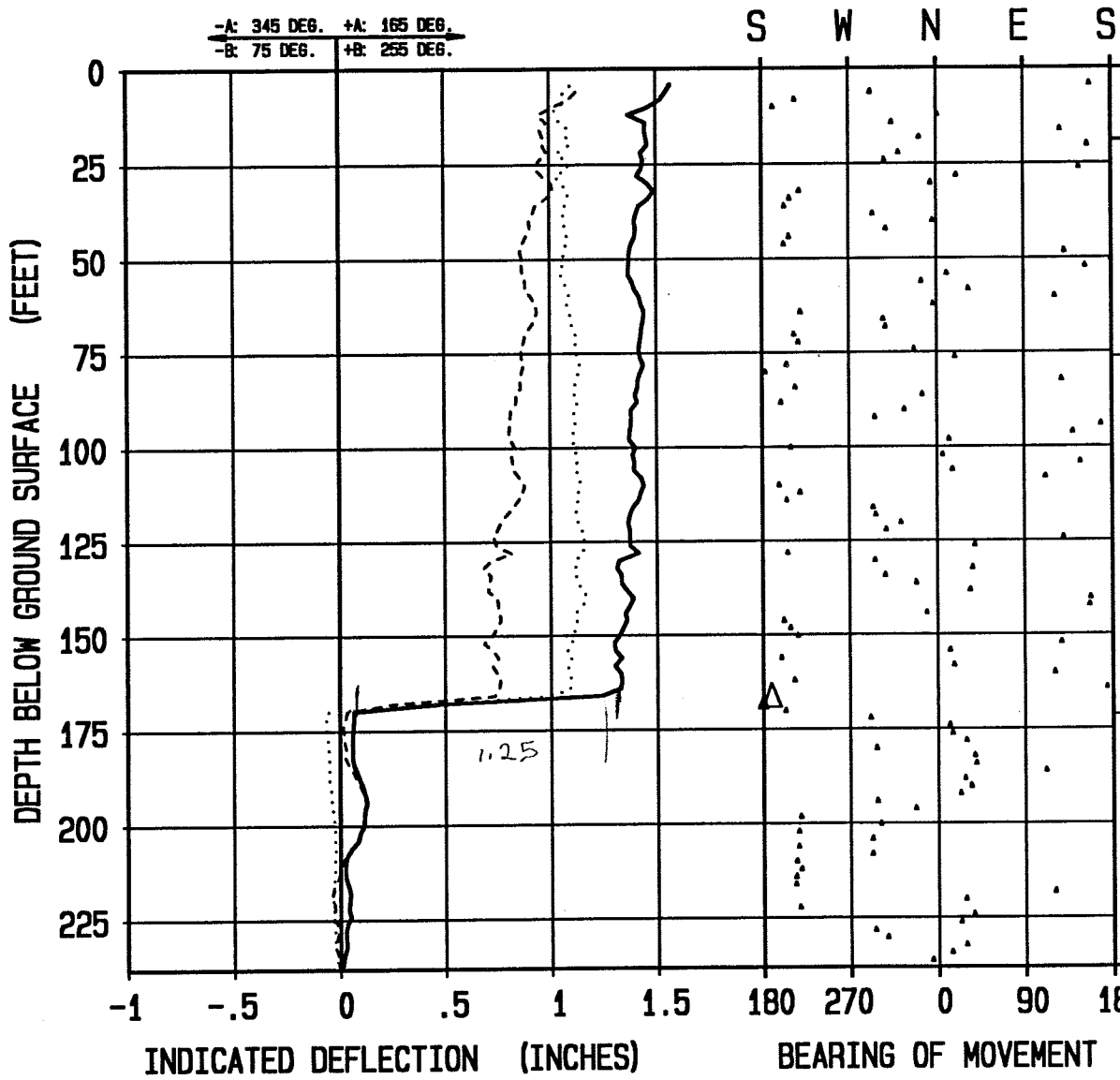


PROJECT # 54-247	ABALONE COVE LANDSLIDE SLOPE INDICATOR RESULTS.	BING YEN & ASSOC.

4 / 5



EXPLANATION

PROJECT: ABALONE COVE LANDSLIDE

PROJECT NO.: 54-247

INDICATOR NO.: ACL-3

PERIOD: 11-11-1988 to 05-28-1992

DEPTH MONITORED: 238 FT.

DIST. BETWEEN READINGS: 2 FT.

BEARING OF +A AXIS: S15E

OUT-OF-PLUMB: 25 IN./100 FT.

SPIRAL CORRECTION: NONE

TOTAL DISPLACEMENT: 1.57 IN. 1.09 5-28-92 7/26

RESULTANT BEARING: -168 DEG. S12W

..... +A AXIS

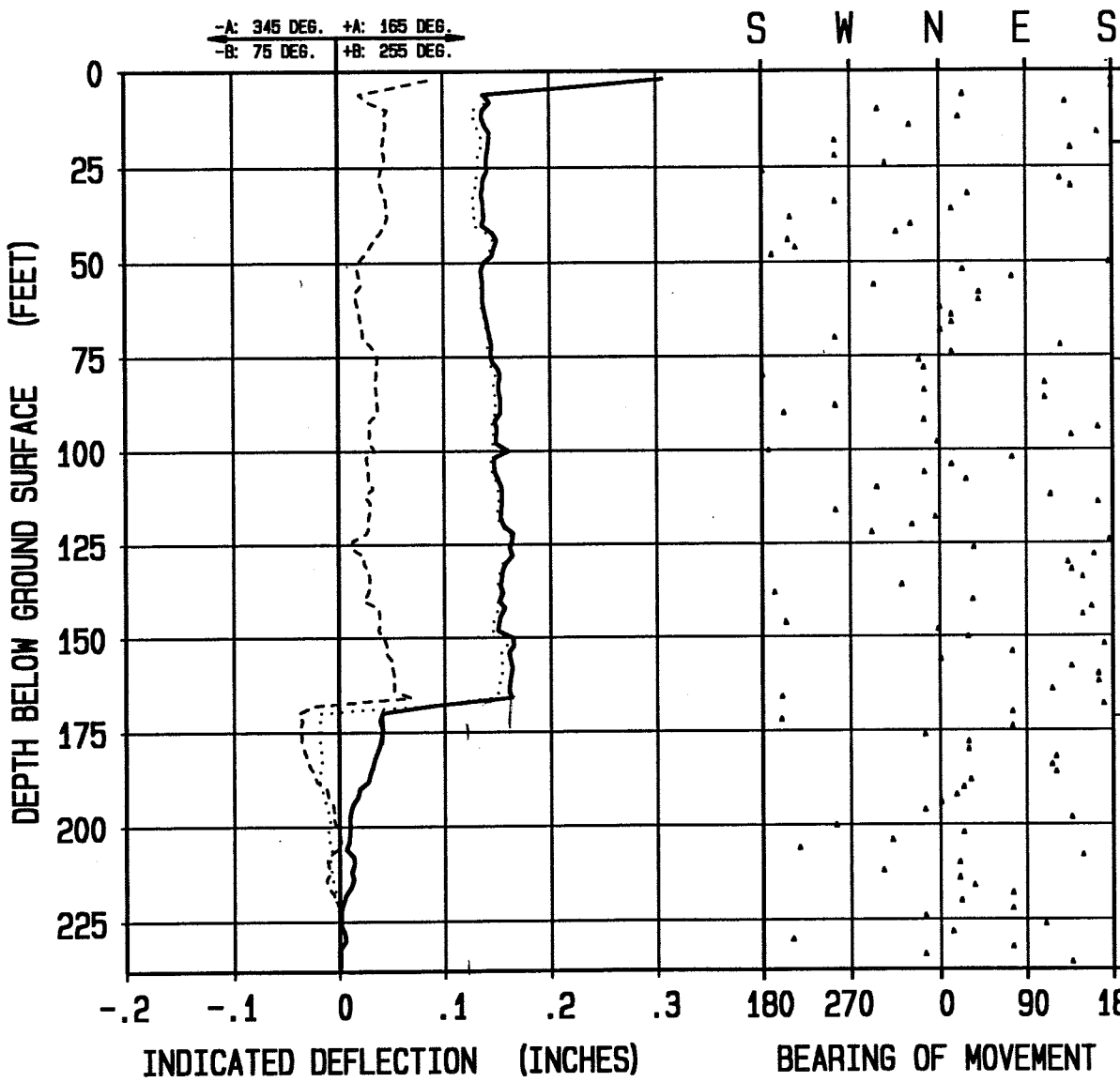
---------- +B AXIS

———— RESULTANT

Δ INCREMENTAL BEARING

PROJECT # 54-247	ABALONE COVE LANDSLIDE - SLOPE INDICATOR RESULTS	BING YEN & ASSOC.

#14



EXPLANATION

PROJECT: ABALONE COVE

PROJECT NO.: 54-247

INDICATOR NO.: ACL-3

PERIOD: 02-24-1992 to 05-28-1992

don't have

DEPTH MONITORED: 238 FT.

DIST. BETWEEN READINGS: 2 FT.

BEARING OF +A AXIS: S10E

OUT-OF-PLUMB: 26 IN./100 FT.

SPIRAL CORRECTION: NONE

TOTAL DISPLACEMENT: .3 IN.

RESULTANT BEARING: 175 DEG.

S5E

..... +A AXIS

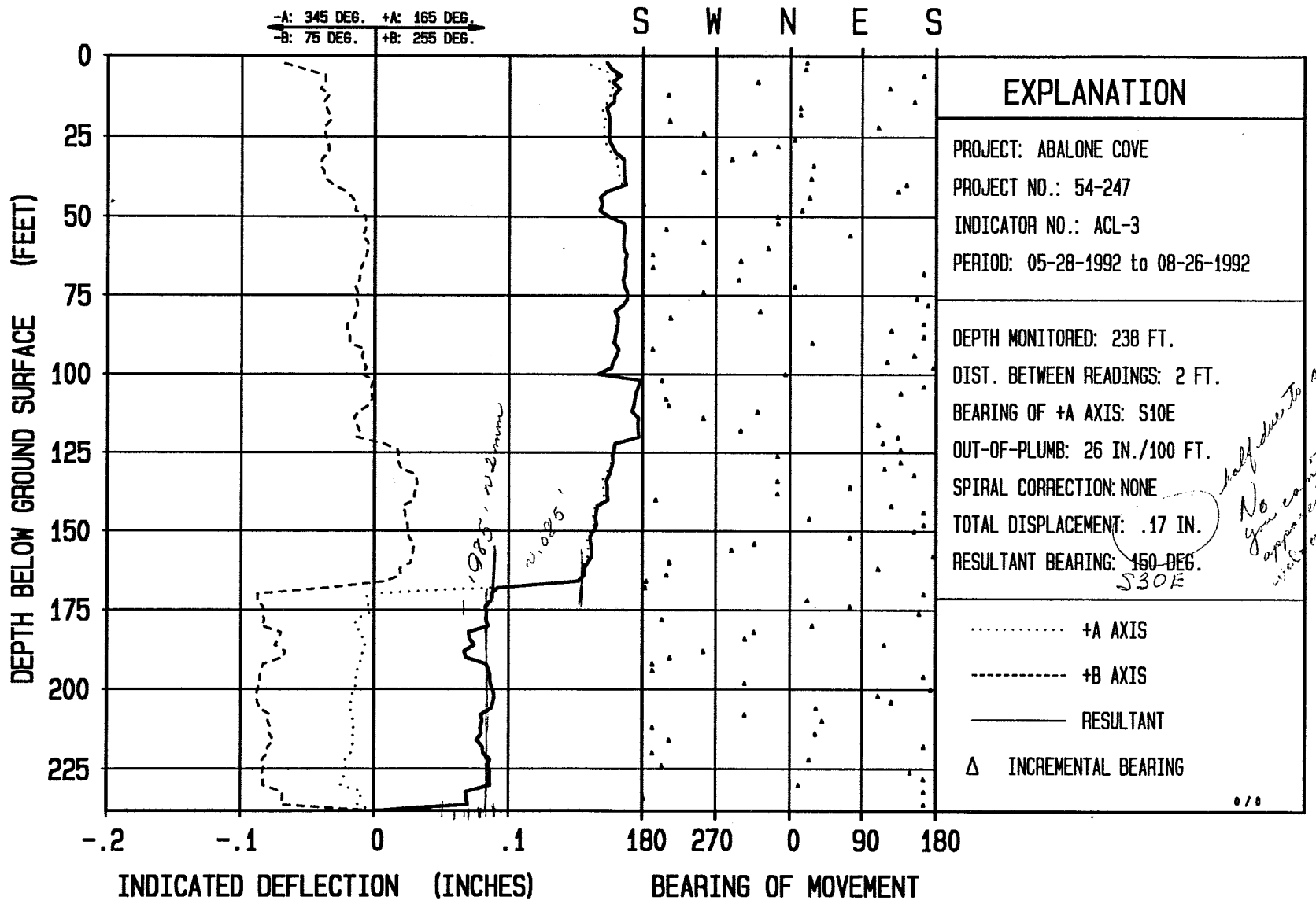
---------- +B AXIS

———— RESULTANT

Δ INCREMENTAL BEARING

0/0

PROJECT # 54-247	ABALONE COVE LANDSLIDE SLOPE INDICATOR RESULTS.	BING YEN & ASSOC.

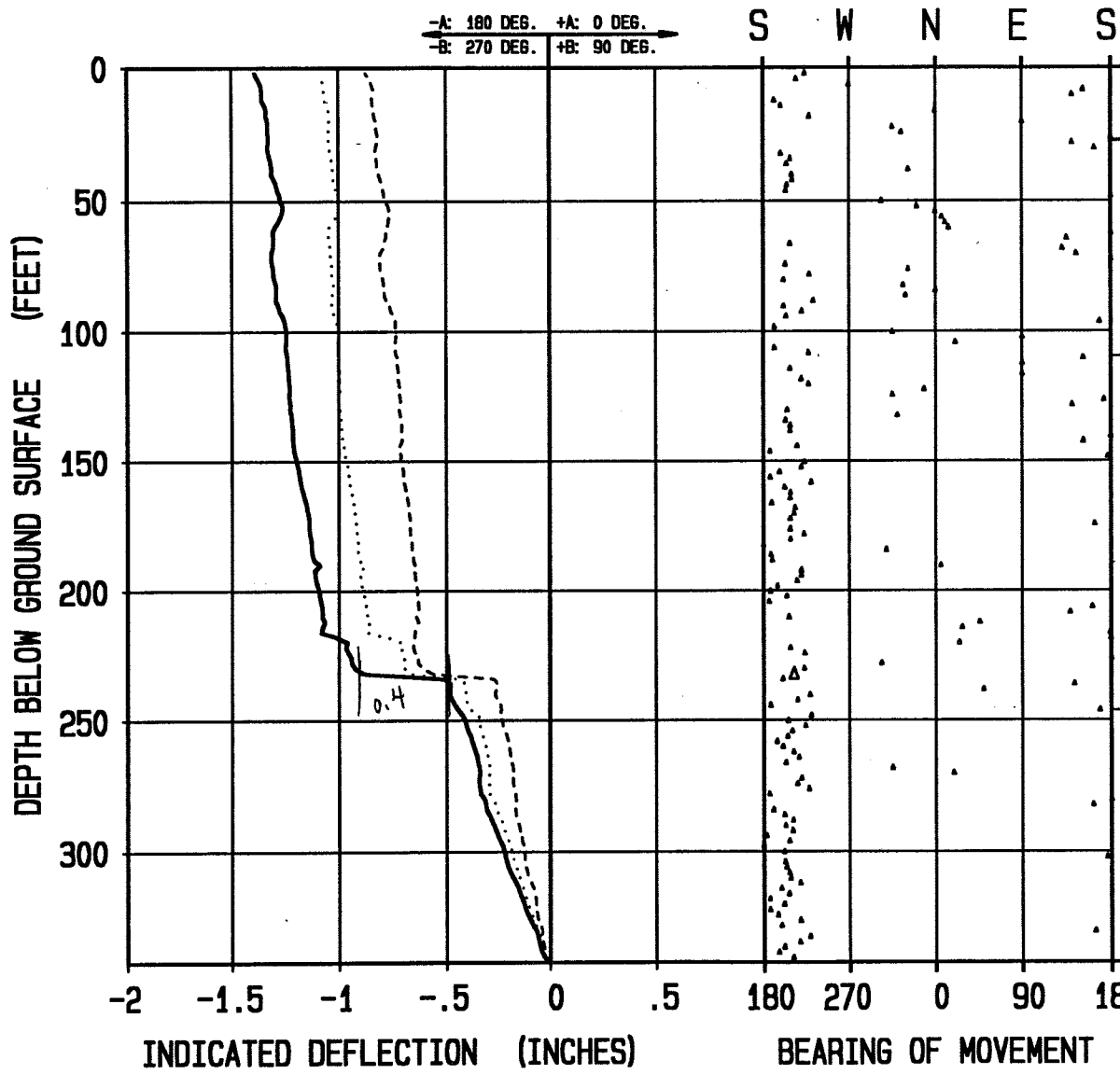


show not true scale

half due to pitch at bottom.

No, you can't count apparent displacement with no vertical plane.

PROJECT # 54-247	ABALONE COVE LANDSLIDE SLOPE INDICATOR RESULTS.	BING YEN & ASSOC.



EXPLANATION

PROJECT: ABALONE COVE

PROJECT NO.: 54-247

INDICATOR NO.: ACL-4

PERIOD: 05-05-1991 to 02-24-1992

DEPTH MONITORED: 342 FT.

DIST. BETWEEN READINGS: 2 FT.

BEARING OF +A AXIS: NOOW

OUT-OF-PLUMB: 75 IN./100 FT.

SPIRAL CORRECTION: NONE

TOTAL DISPLACEMENT: 1.39 IN. about .4 at slip surface.

RESULTANT BEARING: -157 DEG. S23W

+1

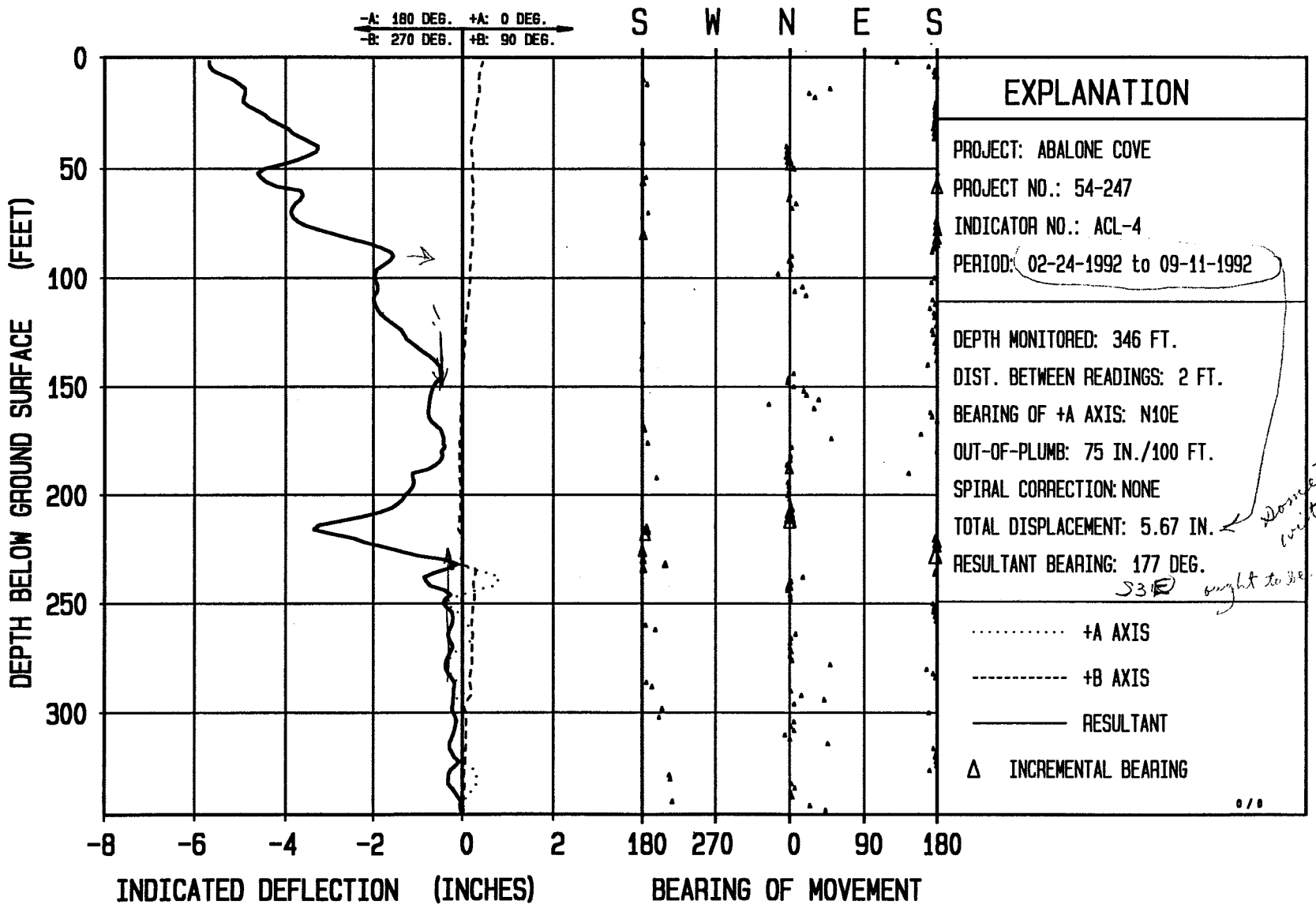
..... +A AXIS

---------- +B AXIS

———— RESULTANT

Δ INCREMENTAL BEARING

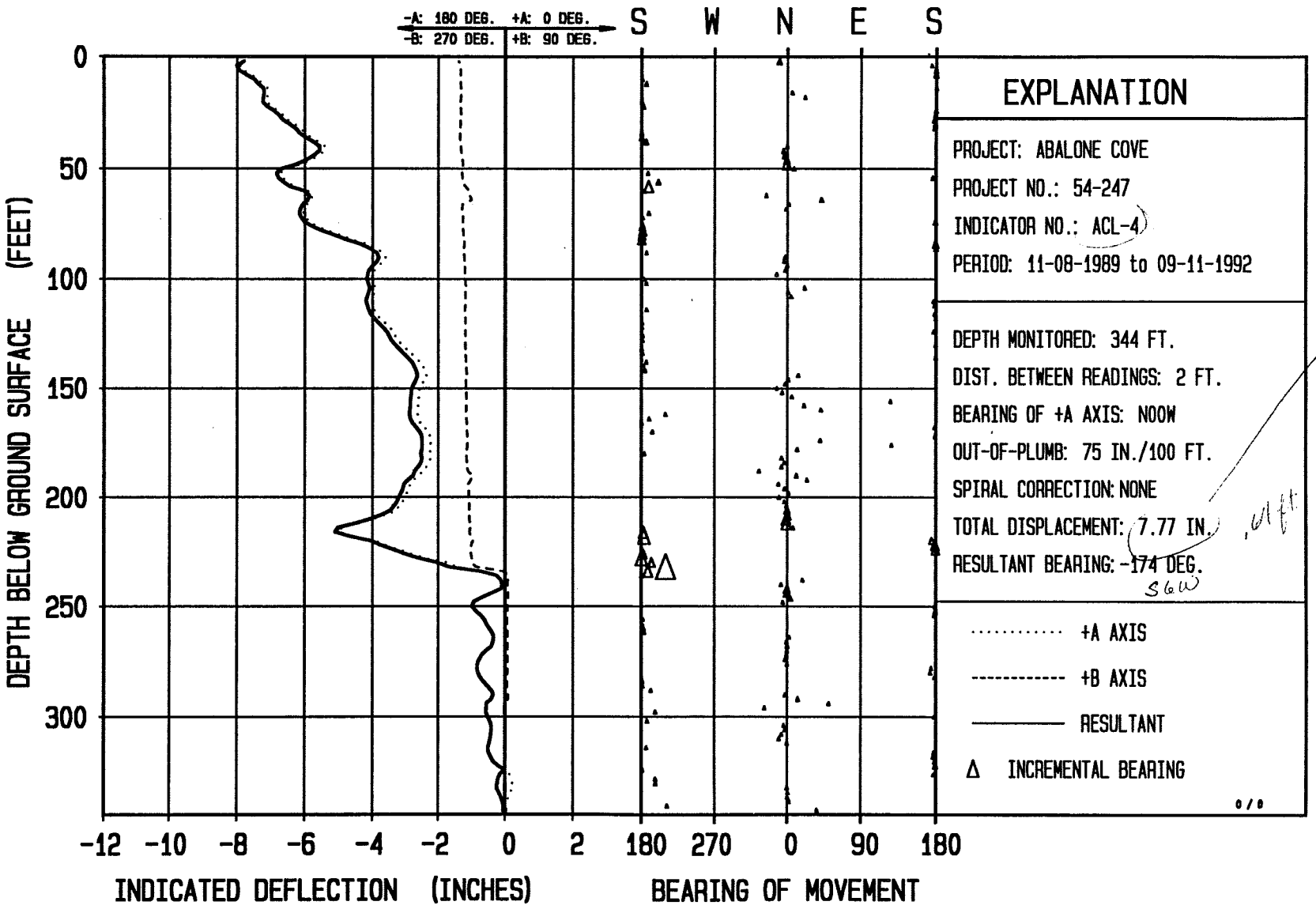
PROJECT # 54-247	ABALONE COVE LANDSLIDE SLOPE INCLINOMETER RESULTS.	BING YEN & ASSOC.



Something is wrong with measurement.

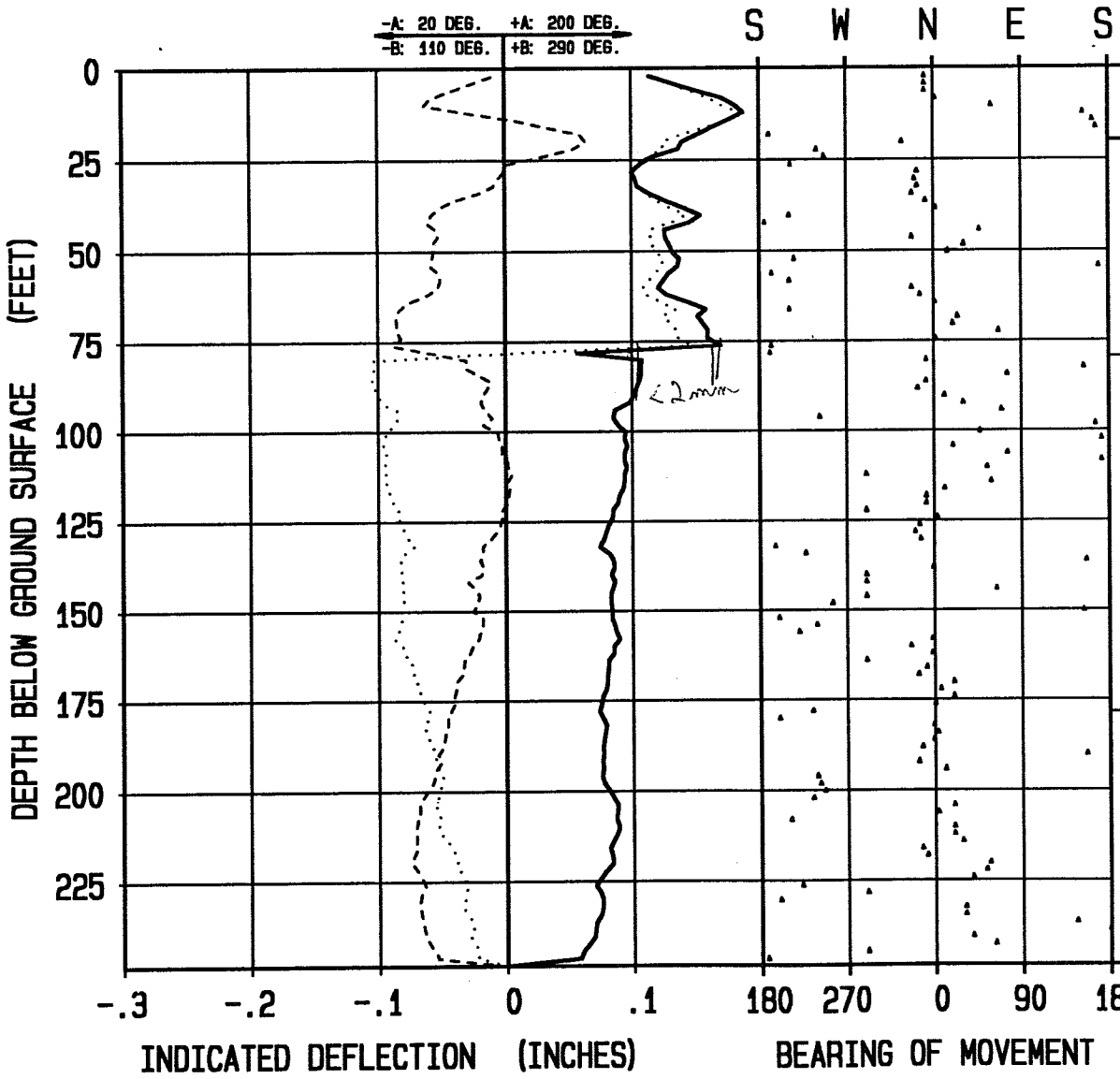
ought to be about S68W

PROJECT # 54-247	ABALONE COVE LANDSLIDE SLOPE INCLINOMETER RESULTS.	BING YEN & ASSOC.



Not possible even with cleaning & lt. is either instrument or operator error. Something wrong with data.

PROJECT # 54-247	ABALONE COVE LANDSLIDE SLOPE INCLINOMETER RESULTS.	BING YEN & ASSOC.



EXPLANATION

PROJECT: ABALONE COVE

PROJECT NO.: 54-247

INDICATOR NO.: ACL-7B

PERIOD: 04-08-1992 to 08-26-1992

DEPTH MONITORED: 248 FT.

DIST. BETWEEN READINGS: 2 FT.

BEARING OF +A AXIS: S20W

OUT-OF-PLUMB: 52 IN./100 FT.

SPIRAL CORRECTION: NONE

TOTAL DISPLACEMENT: .11 IN.

RESULTANT BEARING: -163 DEG.

S17W

not valid should not be read from bottom to top of hole. grain of sand may deflect bottom read. Take difference between 76 and 82.

..... +A AXIS

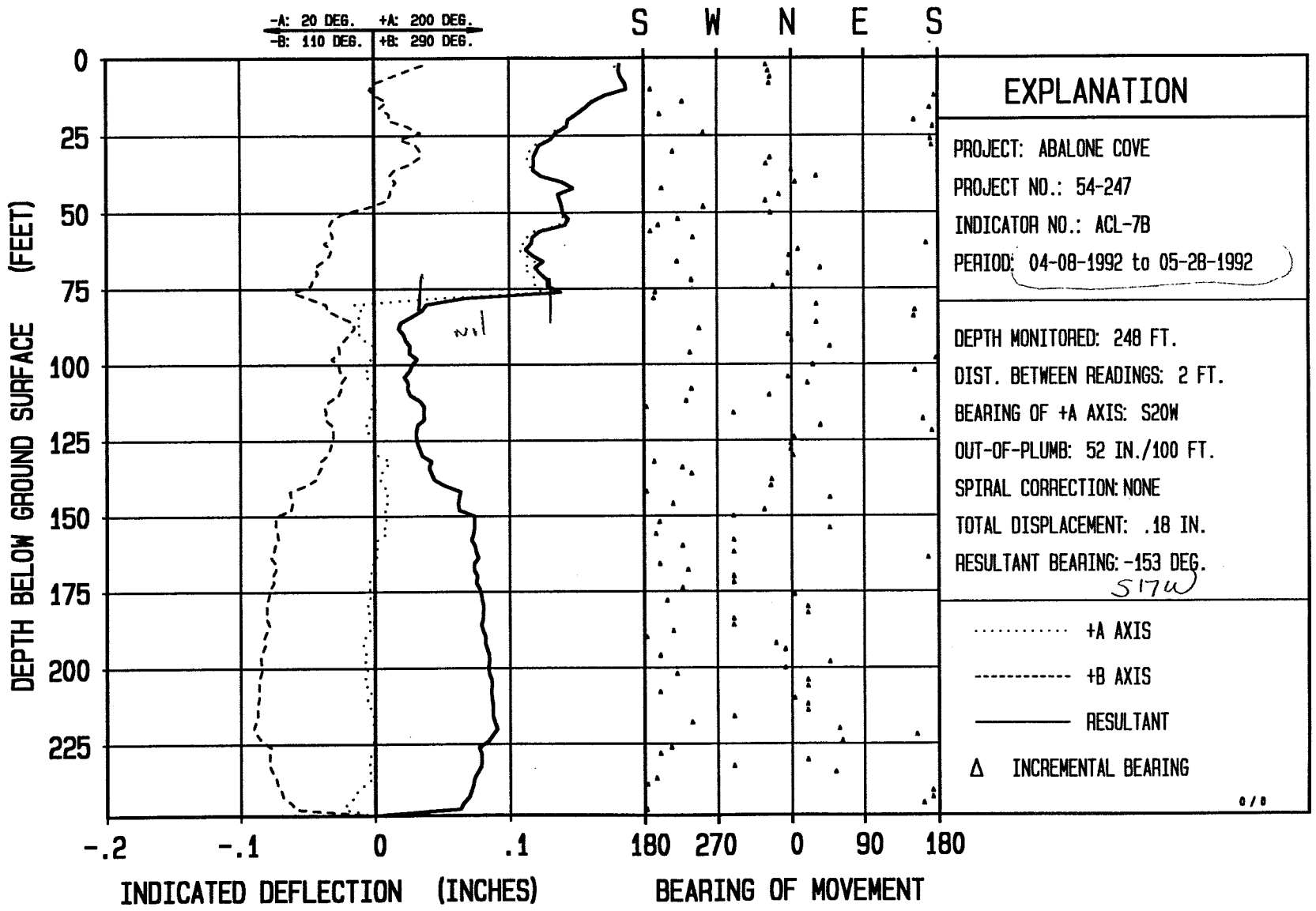
---------- +B AXIS

———— RESULTANT

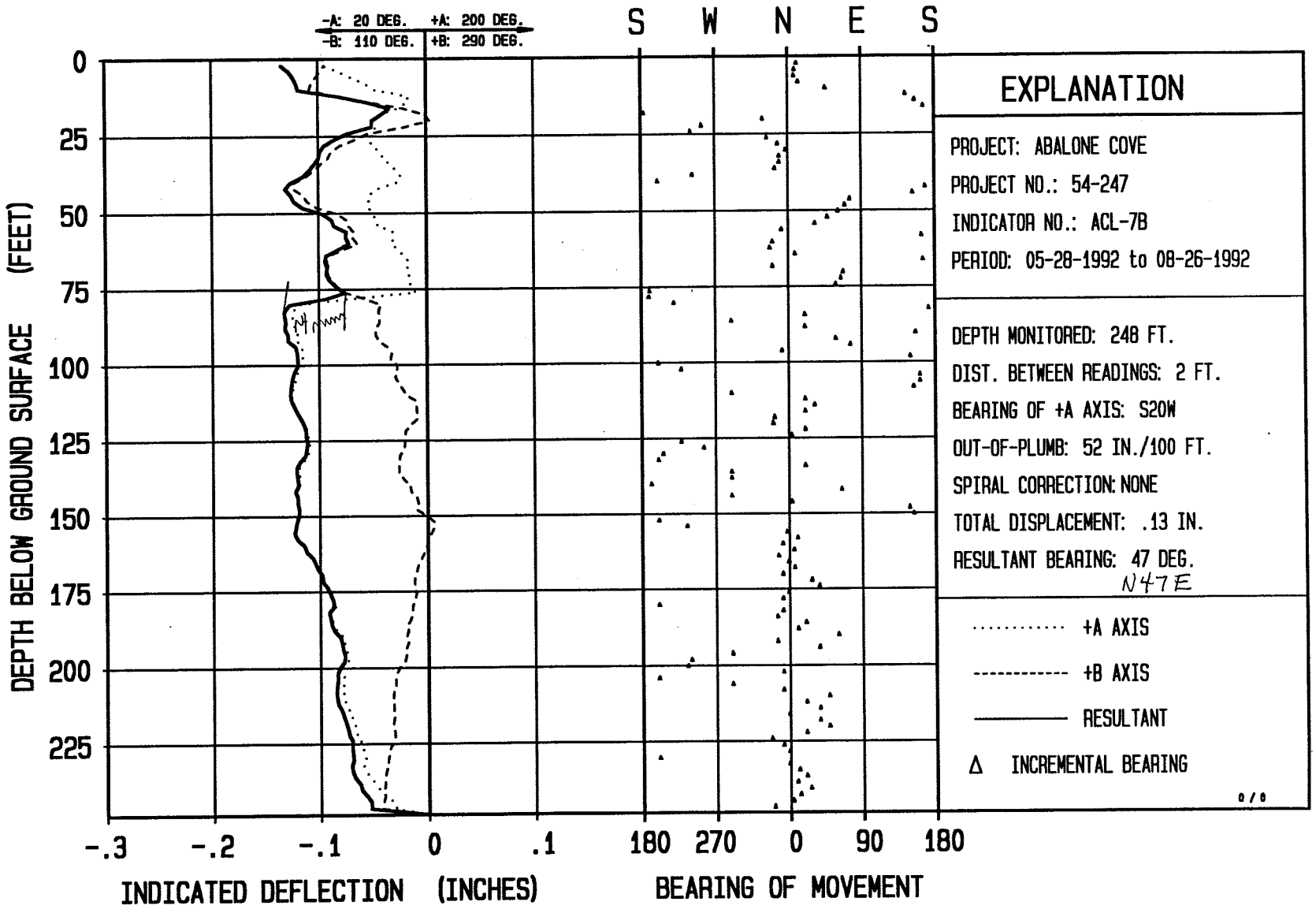
Δ INCREMENTAL BEARING

0/0

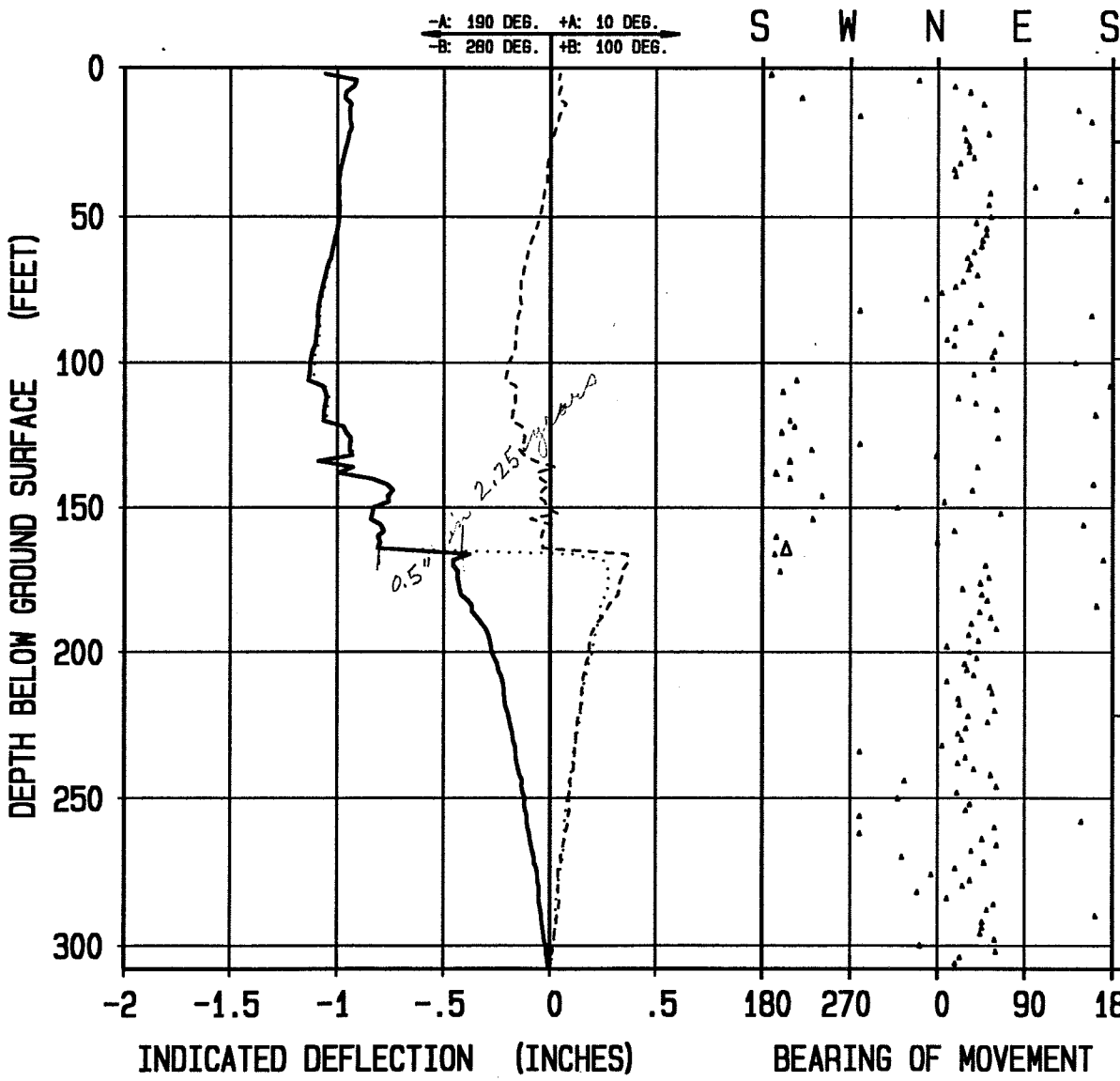
PROJECT # 54-247	ABALONE COVE LANDSLIDE SLOPE INDICATOR RESULTS.	BING YEN & ASSOC.



PROJECT # 54-247	ABALONE COVE LANDSLIDE SLOPE INDICATOR RESULTS.	BING YEN & ASSOC.



PROJECT # 54-247	ABALONE COVE LANDSLIDE SLOPE INDICATOR RESULTS.	BING YEN & ASSOC.



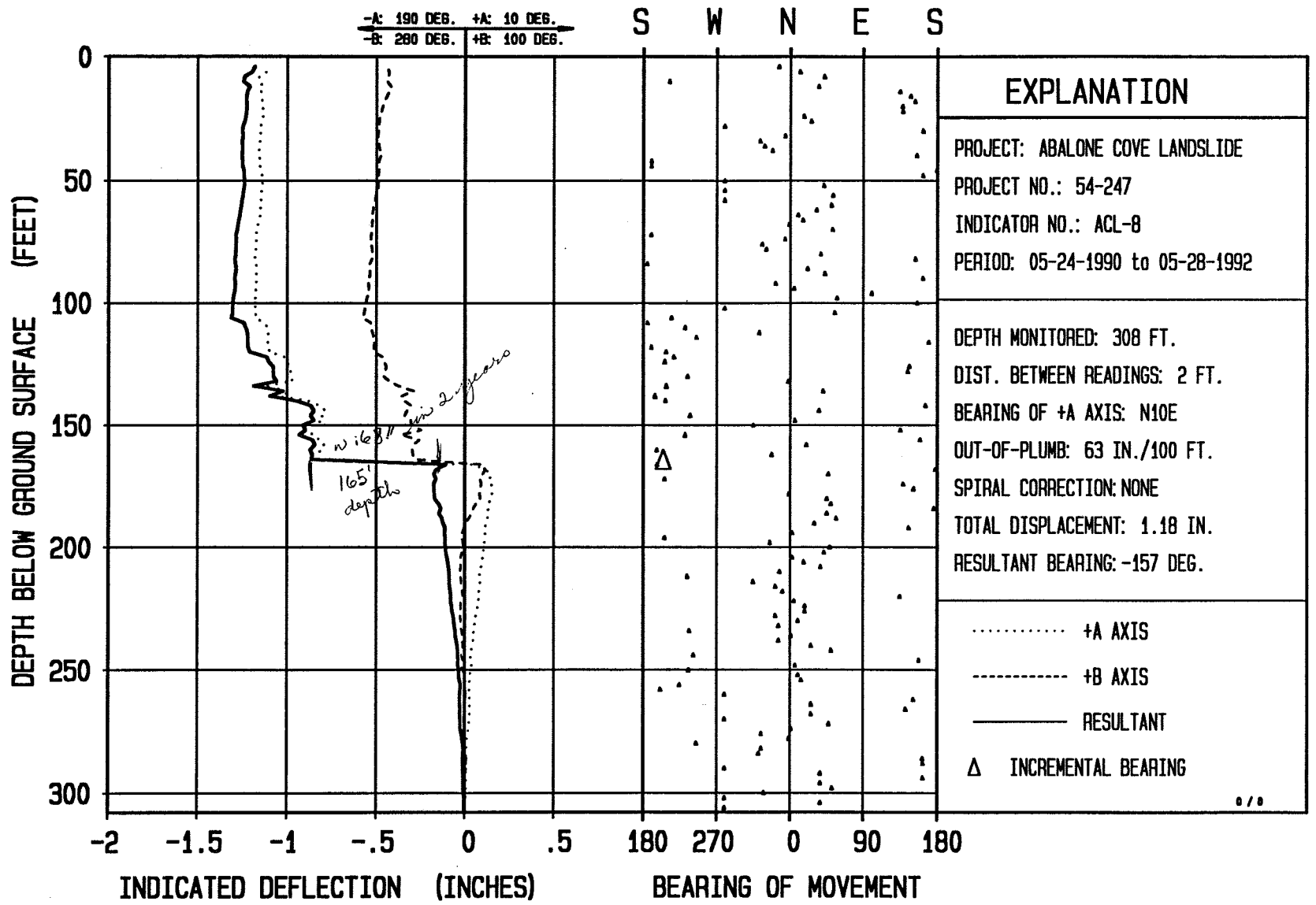
EXPLANATION

PROJECT: ABALONE COVE
PROJECT NO.: 54-247
INDICATOR NO.: ACL-8
PERIOD: 05-24-1990 to 08-26-1992

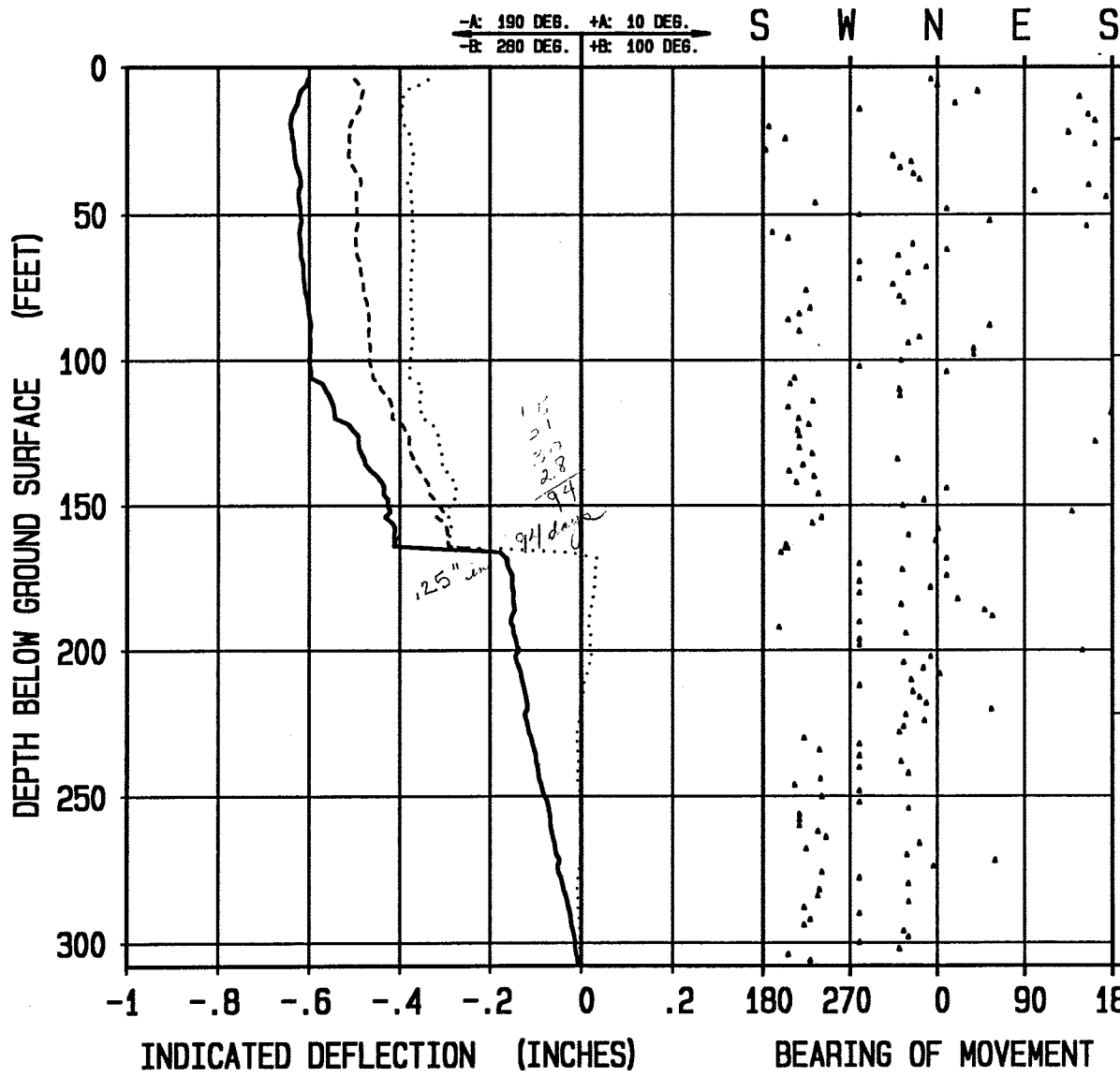
DEPTH MONITORED: 308 FT.
DIST. BETWEEN READINGS: 2 FT.
BEARING OF +A AXIS: N10E
OUT-OF-PLUMB: 63 IN./100 FT.
SPIRAL CORRECTION: NONE
TOTAL DISPLACEMENT: 1.05 IN.
RESULTANT BEARING: -172 DEG.
S8W

..... +A AXIS
---------- +B AXIS
———— RESULTANT
Δ INCREMENTAL BEARING

PROJECT # 54-247	ABALONE COVE LANDSLIDE SLOPE INDICATOR RESULTS.	BING YEN & ASSOC.



PROJECT # 54-247	ABALONE COVE LANDSLIDE - SLOPE INDICATOR RESULTS	BING YEN & ASSOC.



EXPLANATION

PROJECT: ABALONE COVE LANDSLIDE

PROJECT NO.: 54-247

INDICATOR NO.: ACL-8

PERIOD: 02-24-1992 to 05-28-1992

DEPTH MONITORED: 308 FT.

DIST. BETWEEN READINGS: 2 FT.

BEARING OF +A AXIS: N25E

OUT-OF-PLUMB: 62 IN./100 FT.

SPIRAL CORRECTION: NONE

TOTAL DISPLACEMENT: .6 IN.

RESULTANT BEARING: -136 DEG.

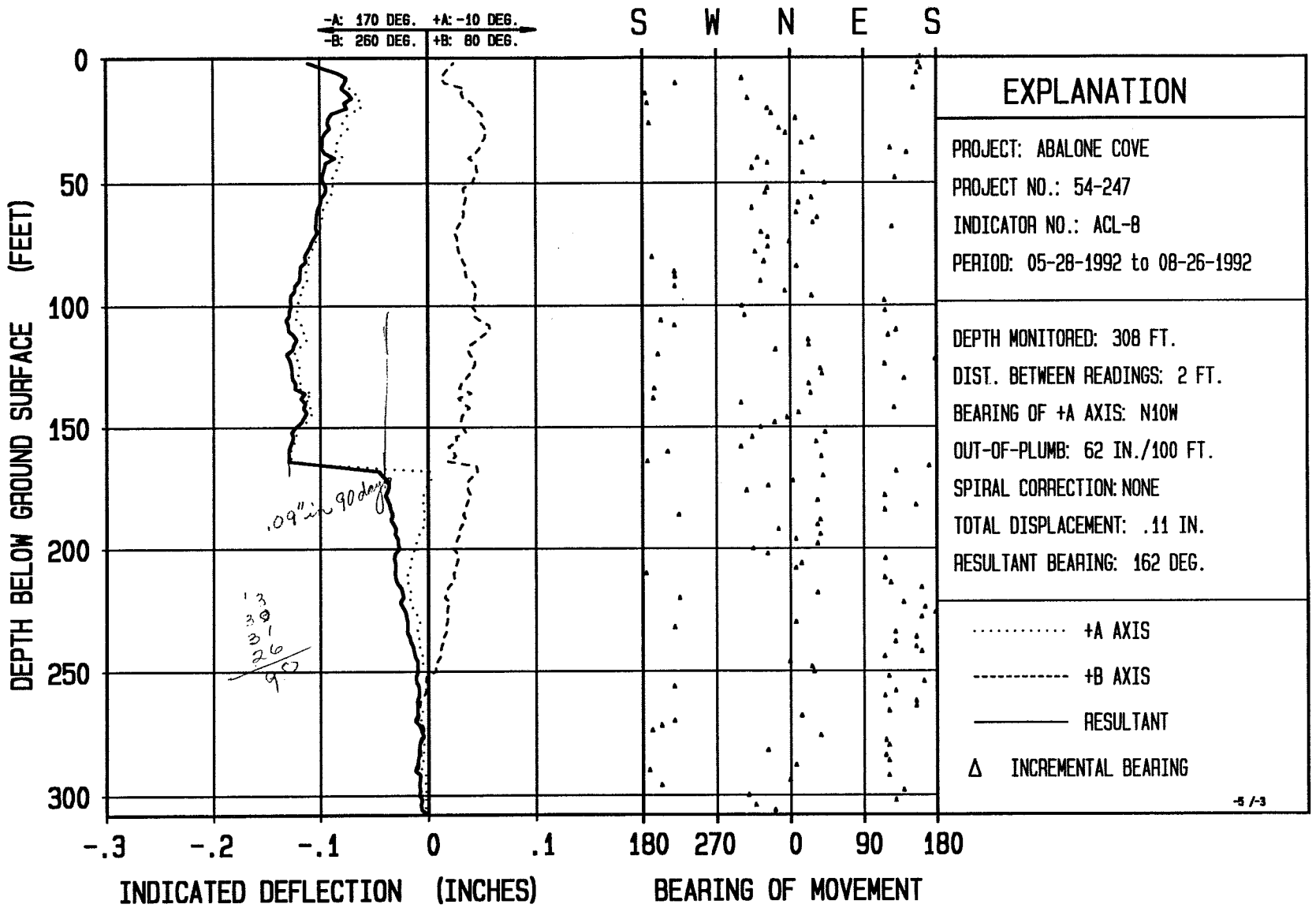
+A AXIS

+B AXIS

RESULTANT

Δ INCREMENTAL BEARING

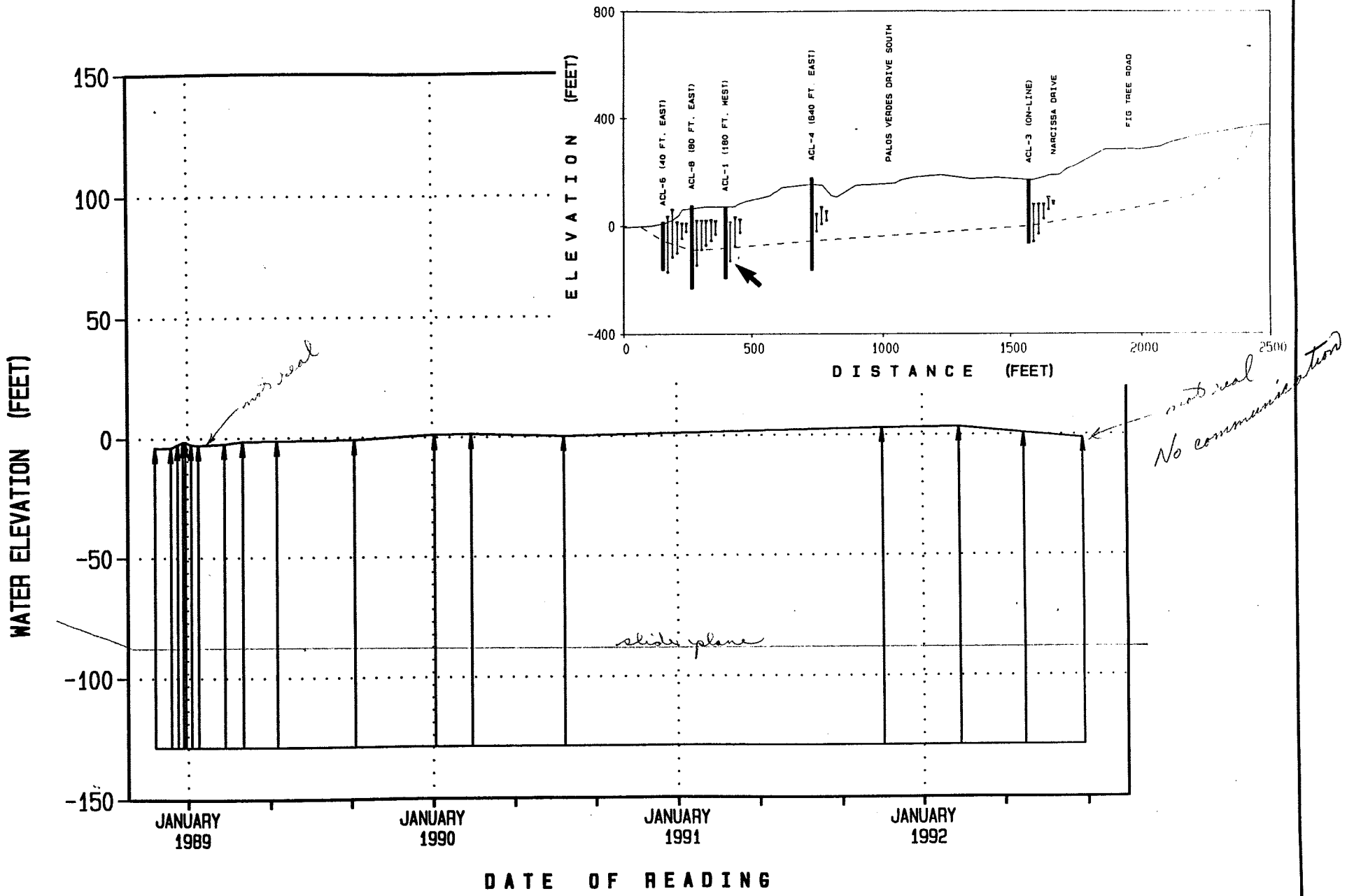
PROJECT # 54-247	ABALONE COVE LANDSLIDE - SLOPE INDICATOR RESULTS	BING YEN & ASSOC.



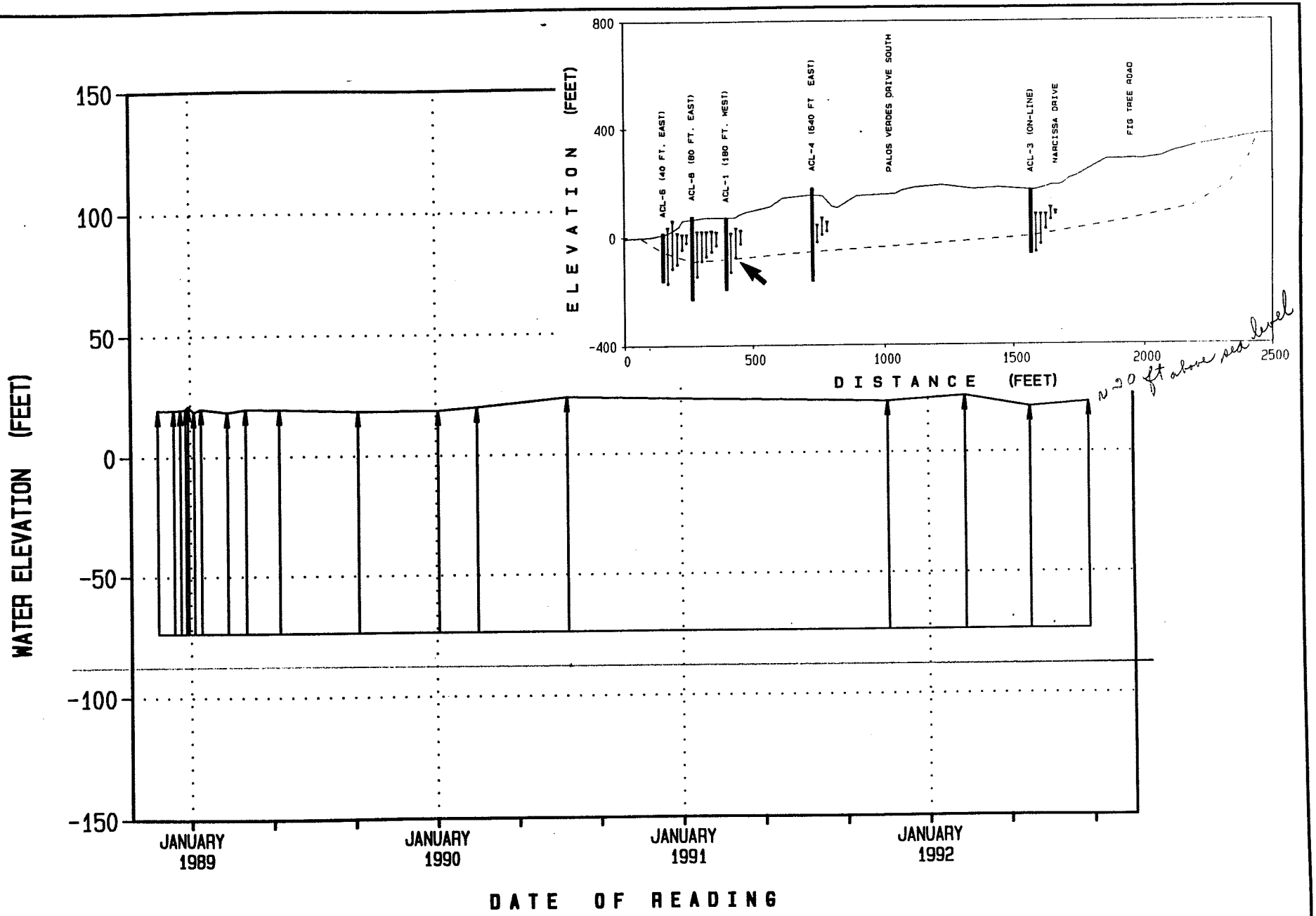
PROJECT # 54-247	ABALONE COVE LANDSLIDE SLOPE INDICATOR RESULTS.	BING YEN & ASSOC.

APPENDIX B

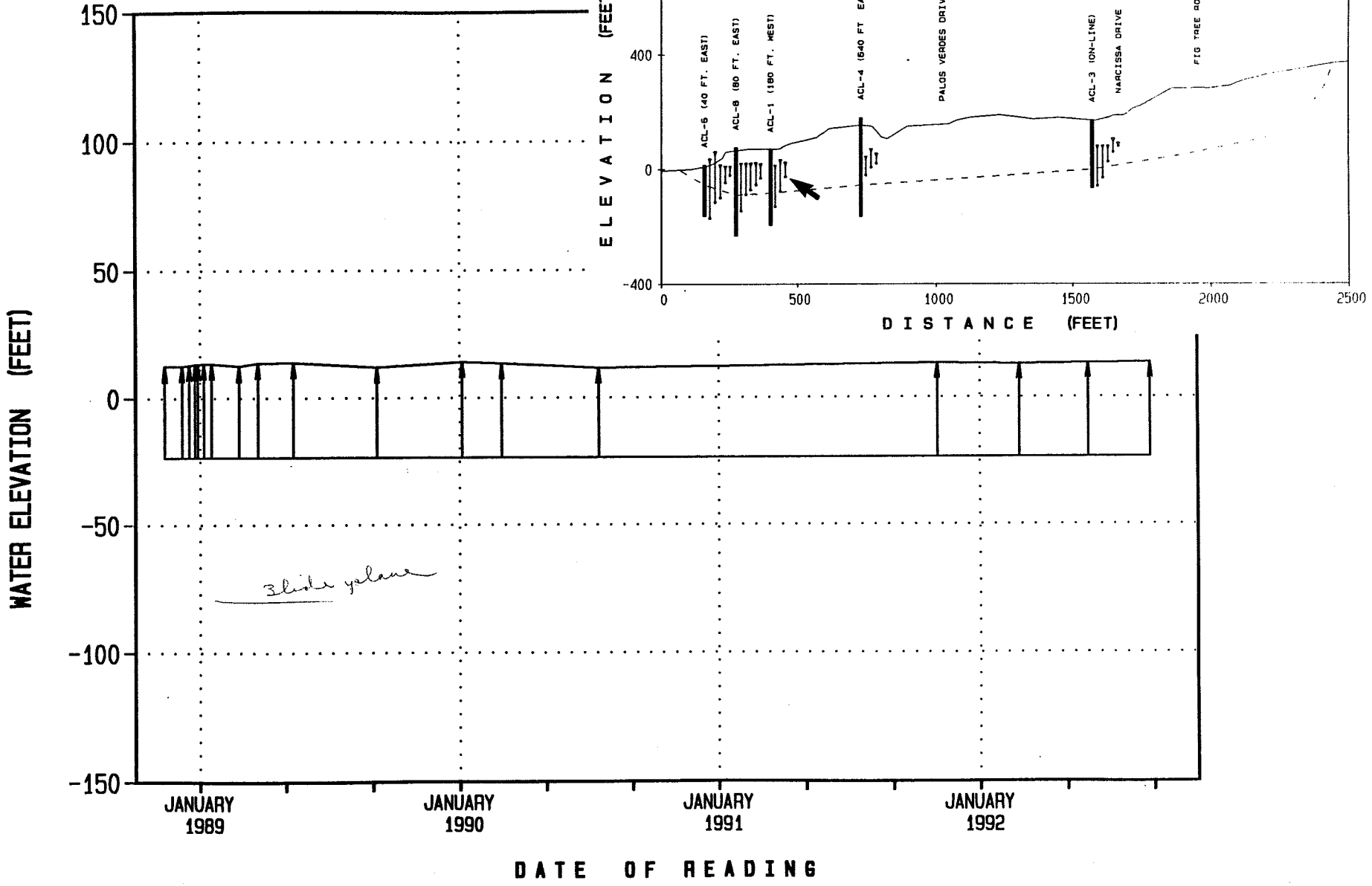
(Piezometer Results)



PROJECT # 54-247	ABALONE COVE PIEZOMETRIC LEVELS - ACL-1/TIP #1.	BING YEN & ASSOC.



PROJECT # 54-247	ABALONE COVE PIEZOMETRIC LEVELS - ACL-1/TIP #2.	BING YEN & ASSOC.



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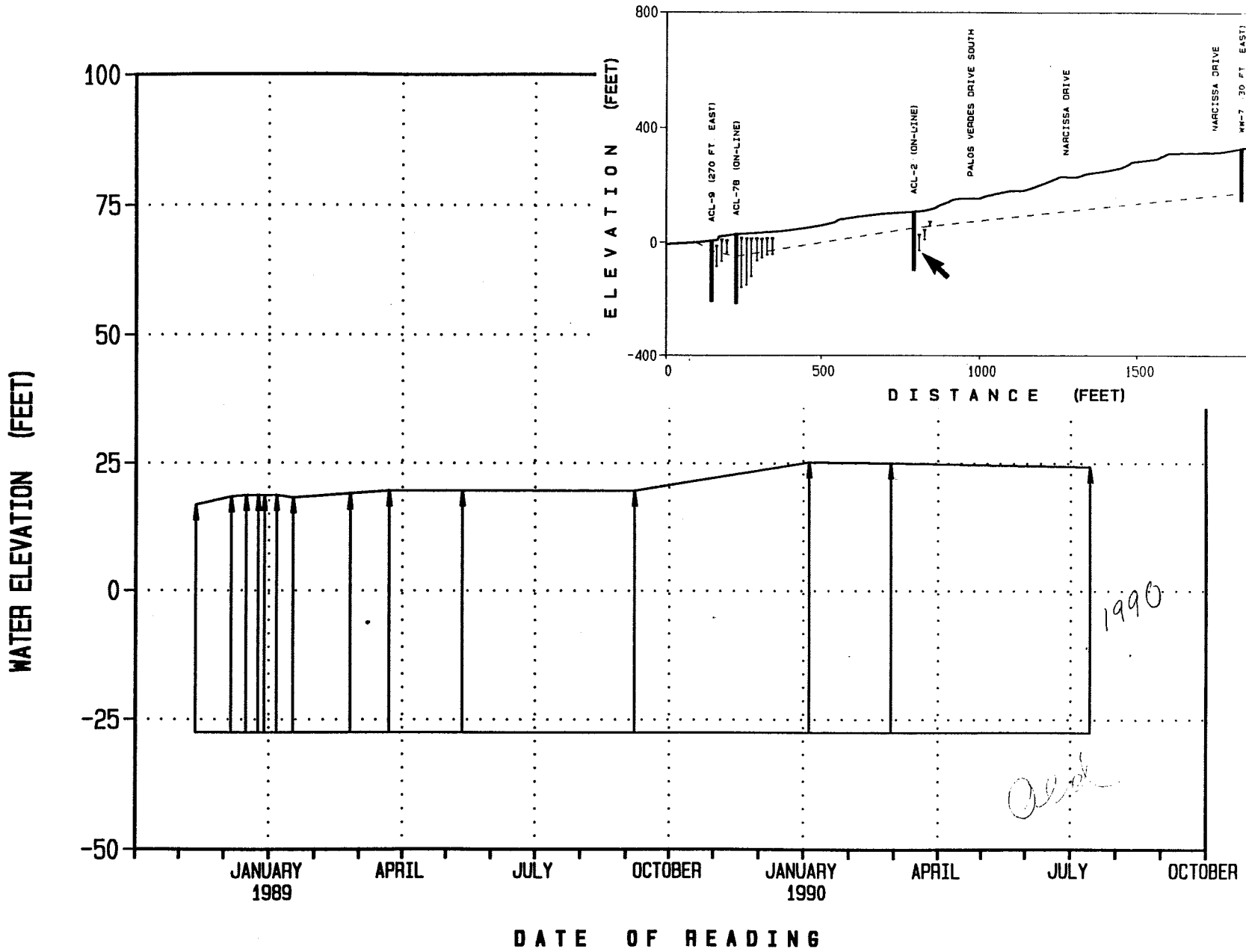

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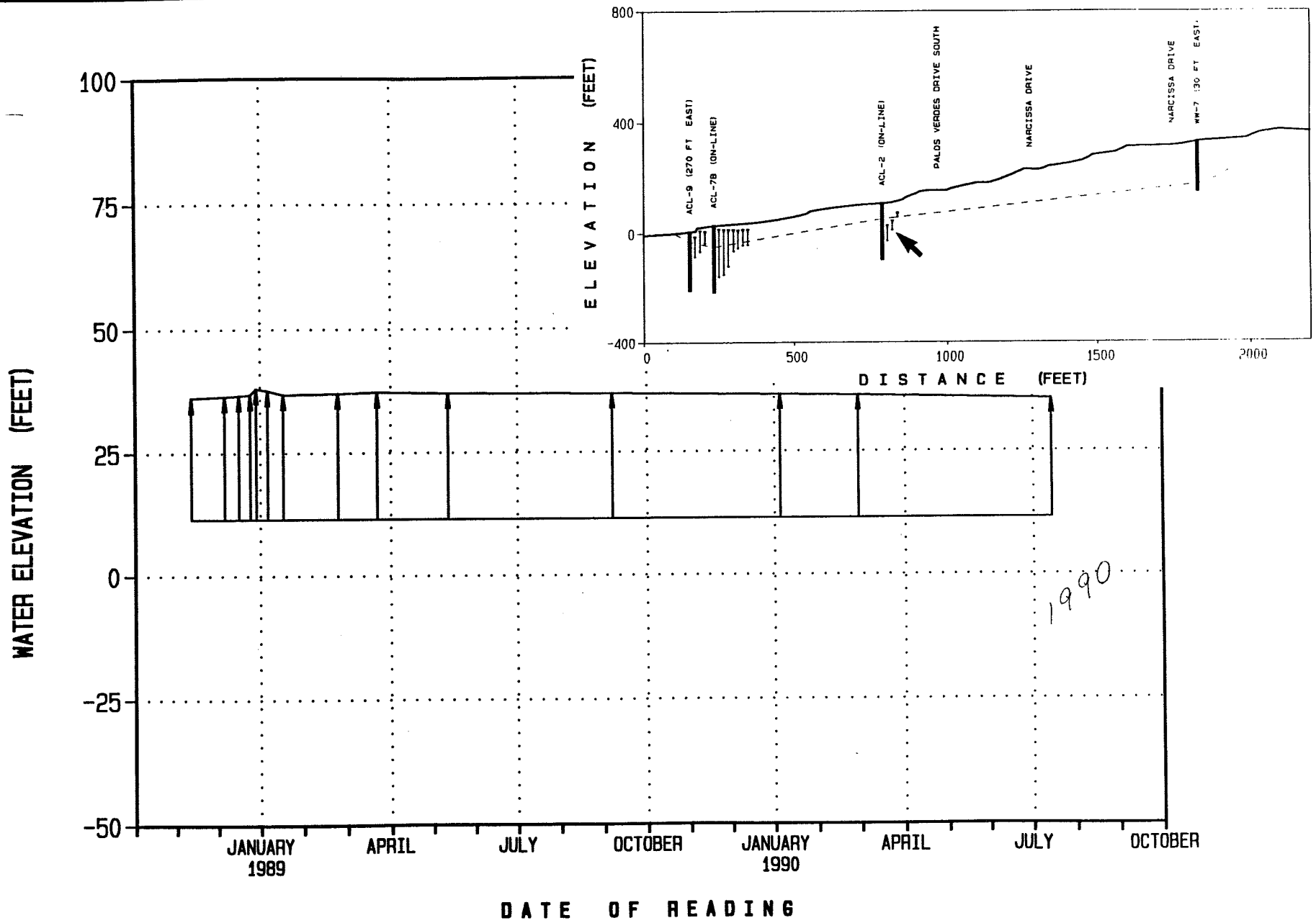
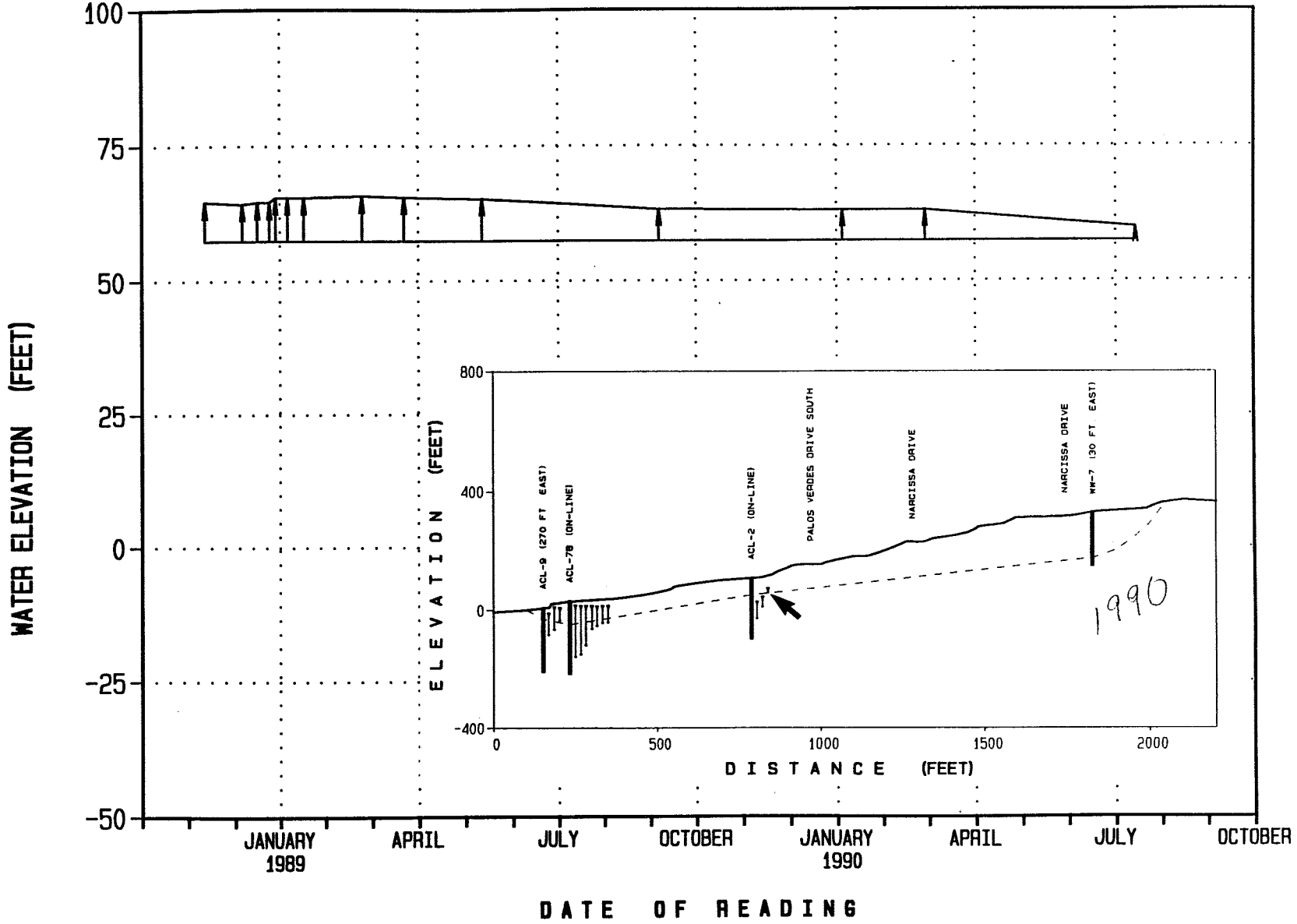
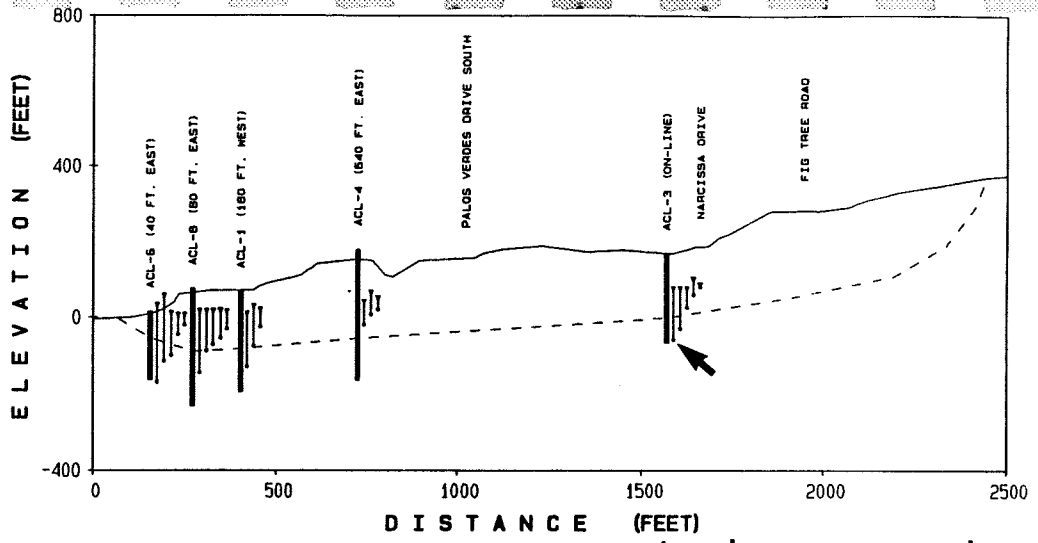
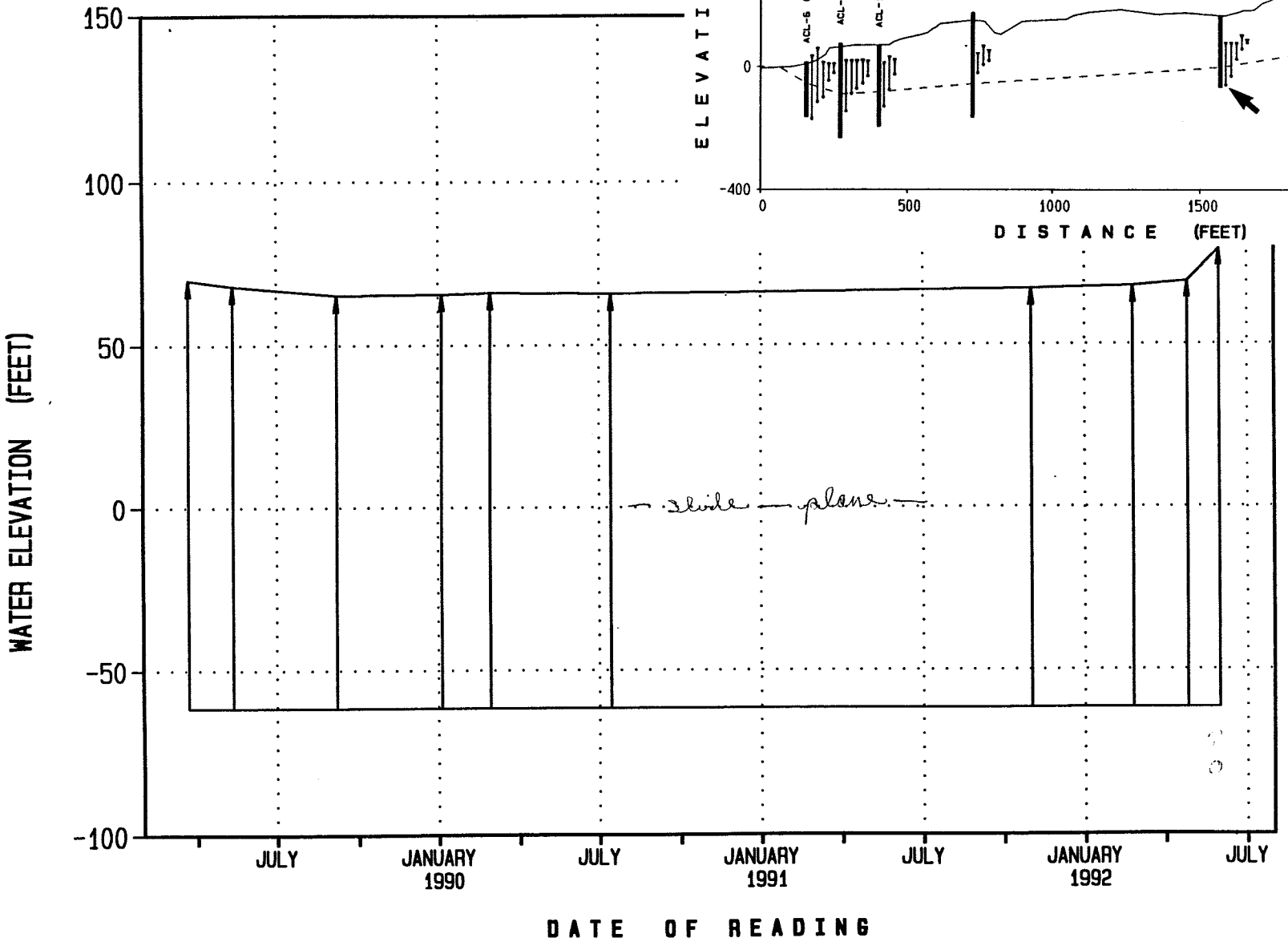


PROJECT # 54-247	ABALONE COVE PIEZOMETRIC LEVELS - ACL-2/TIP #2.	BING YEN & ASSOC.

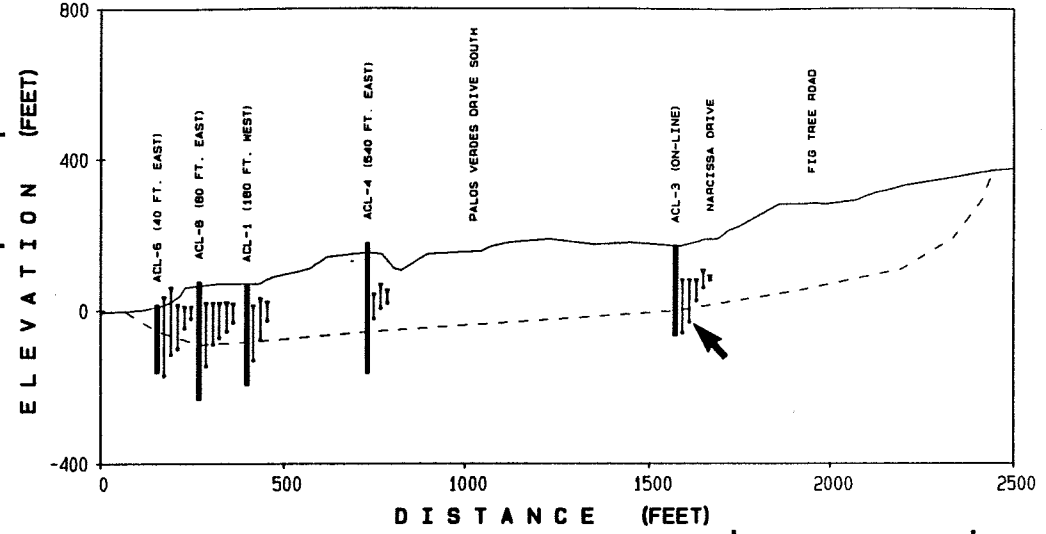


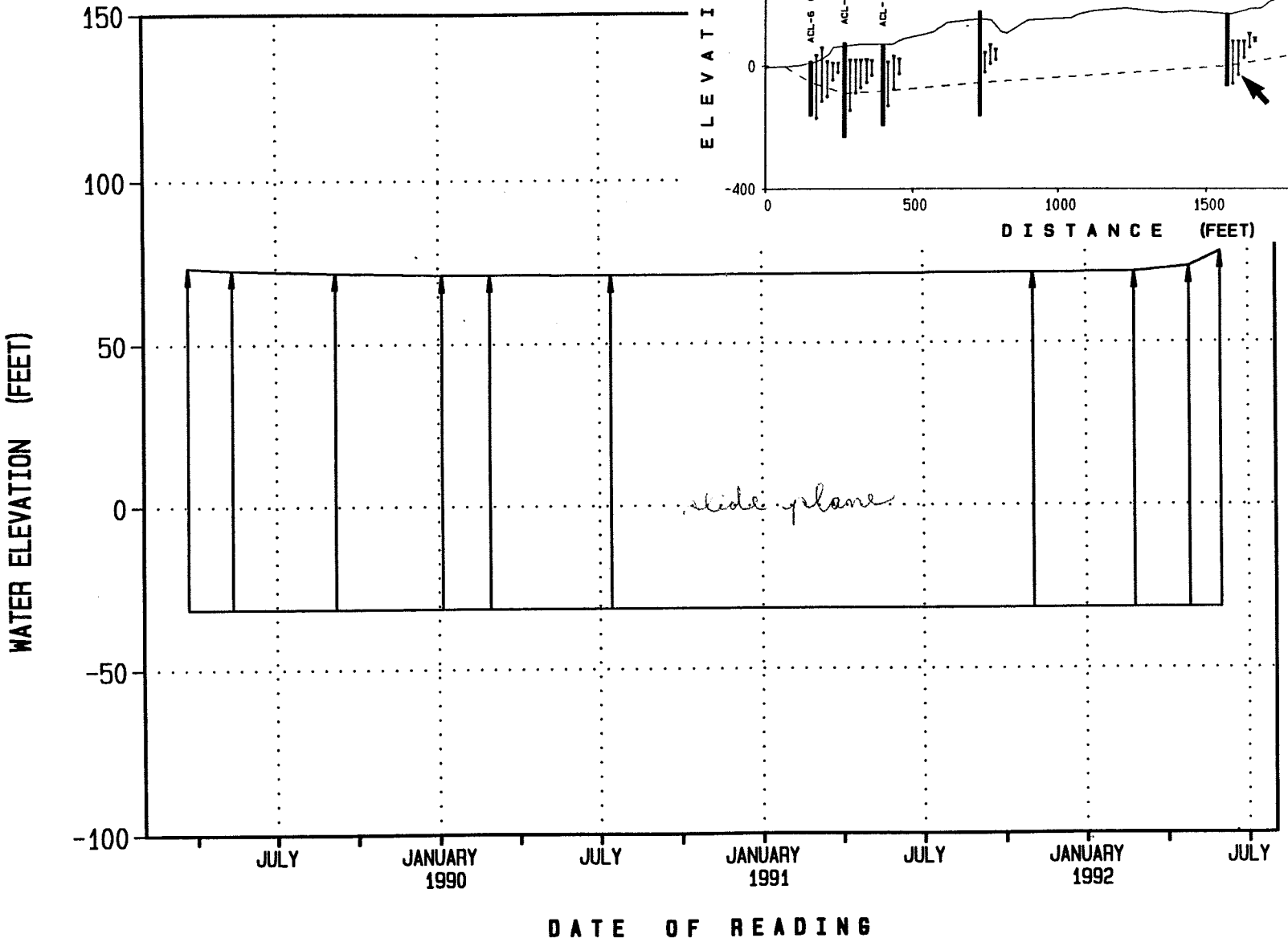
PROJECT # 54-247	ABALONE COVE PIEZOMETRIC LEVELS - ACL-2/TIP #3.	BING YEN & ASSOC.



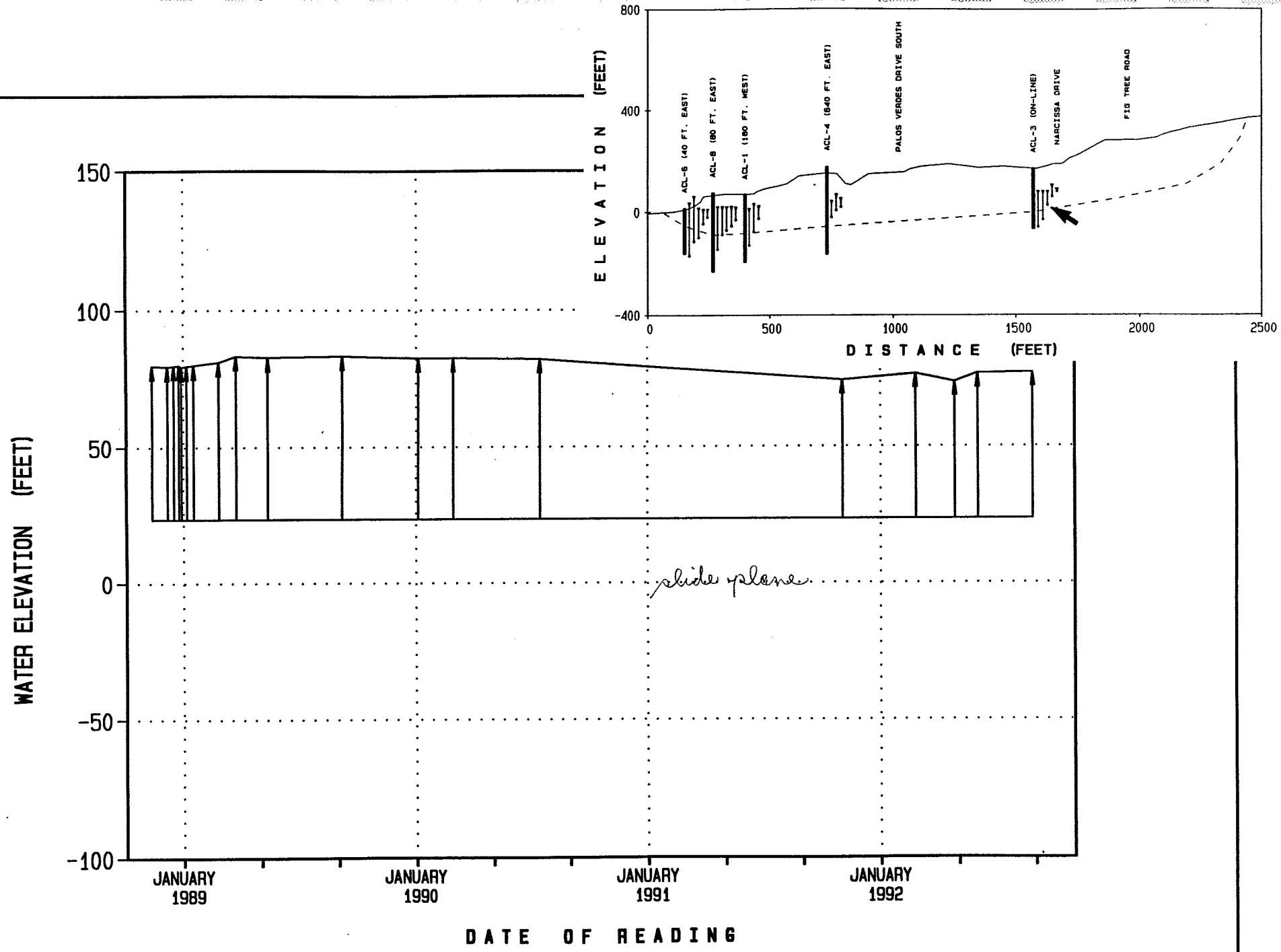


PROJECT # 54-247	ABALONE COVE PIEZOMETRIC LEVELS - ACL-3/TIP #1.	BING YEN & ASSOC.

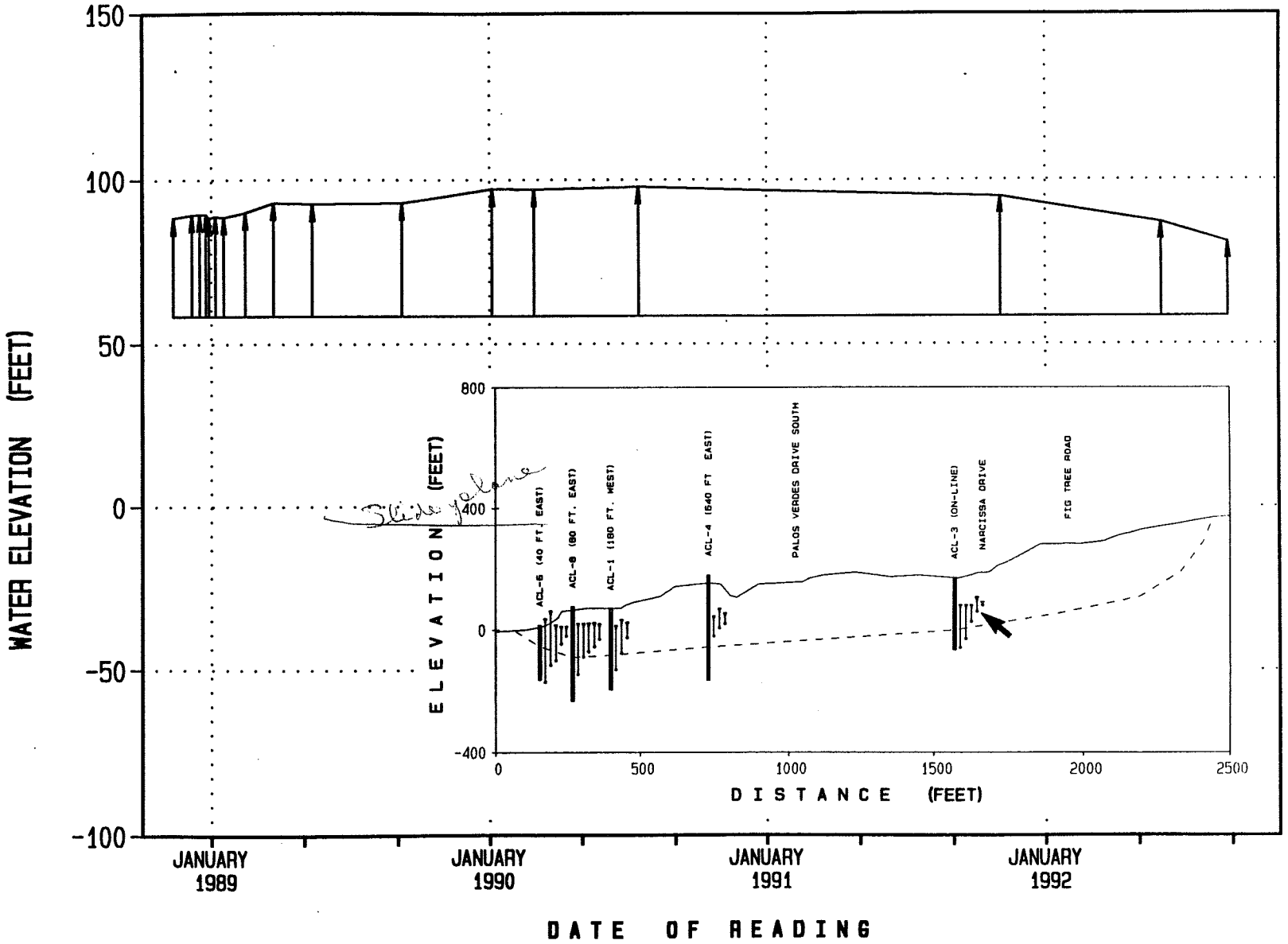




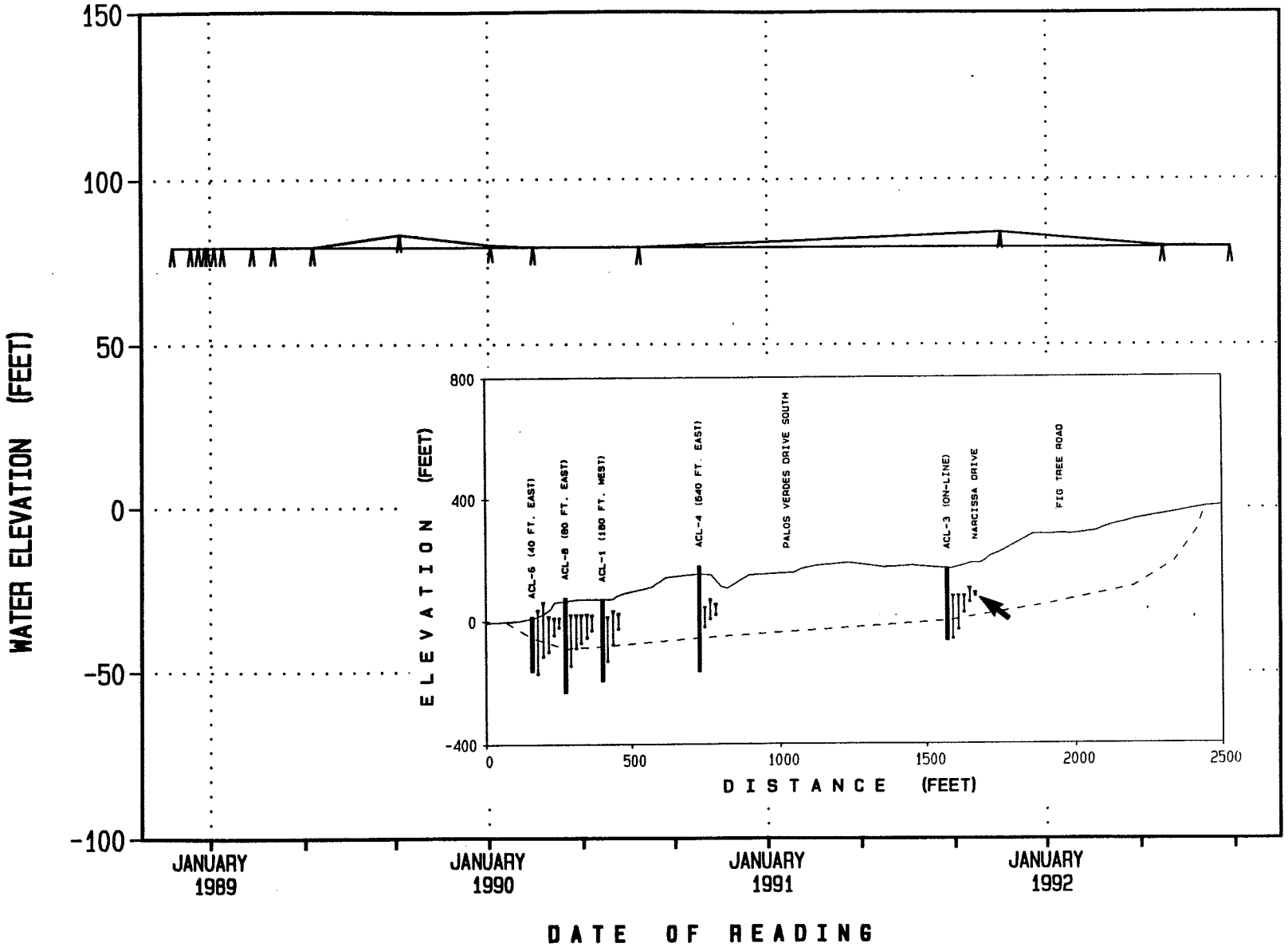
PROJECT # 54-247	ABALONE COVE PIEZOMETRIC LEVELS - ACL-3/TIP #2.	BING YEN & ASSOC.



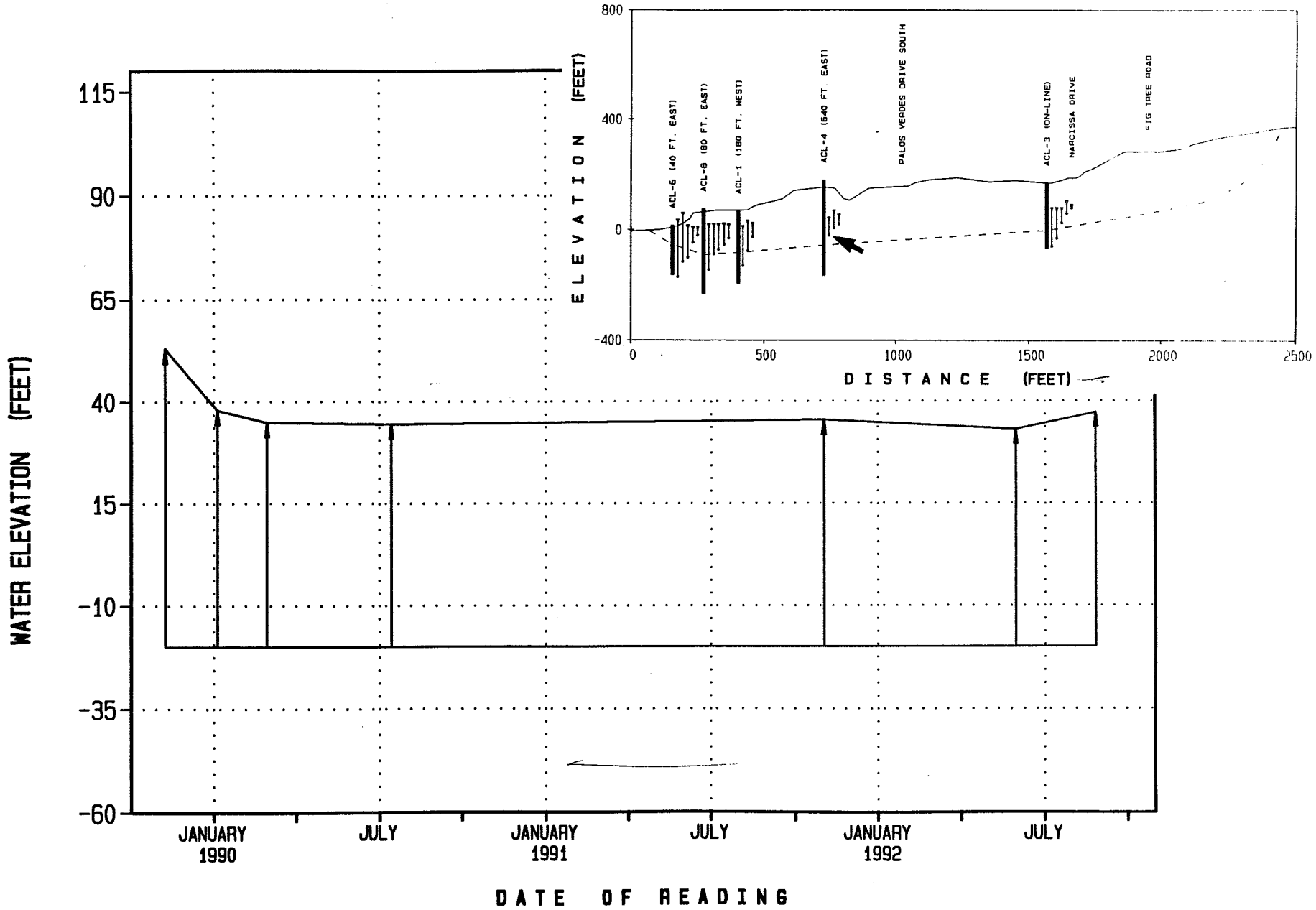
PROJECT # 54-247	ABALONE COVE PIEZOMETRIC LEVELS - ACL-3/TIP #3.	BING YEN & ASSOC.



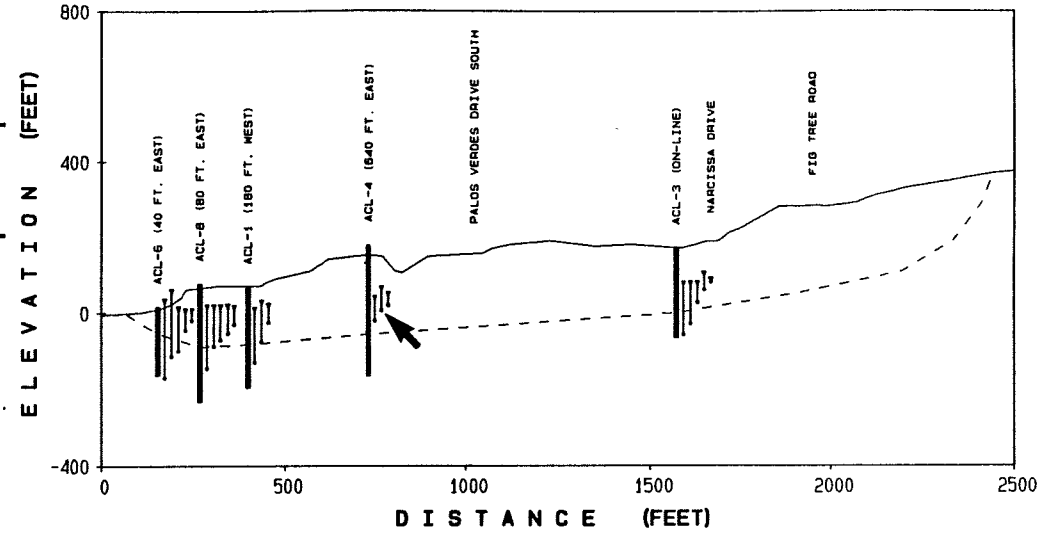
PROJECT # 54-247	ABALONE COVE PIEZOMETRIC LEVELS - ACL-3/TP #4.	BING YEN & ASSOC.

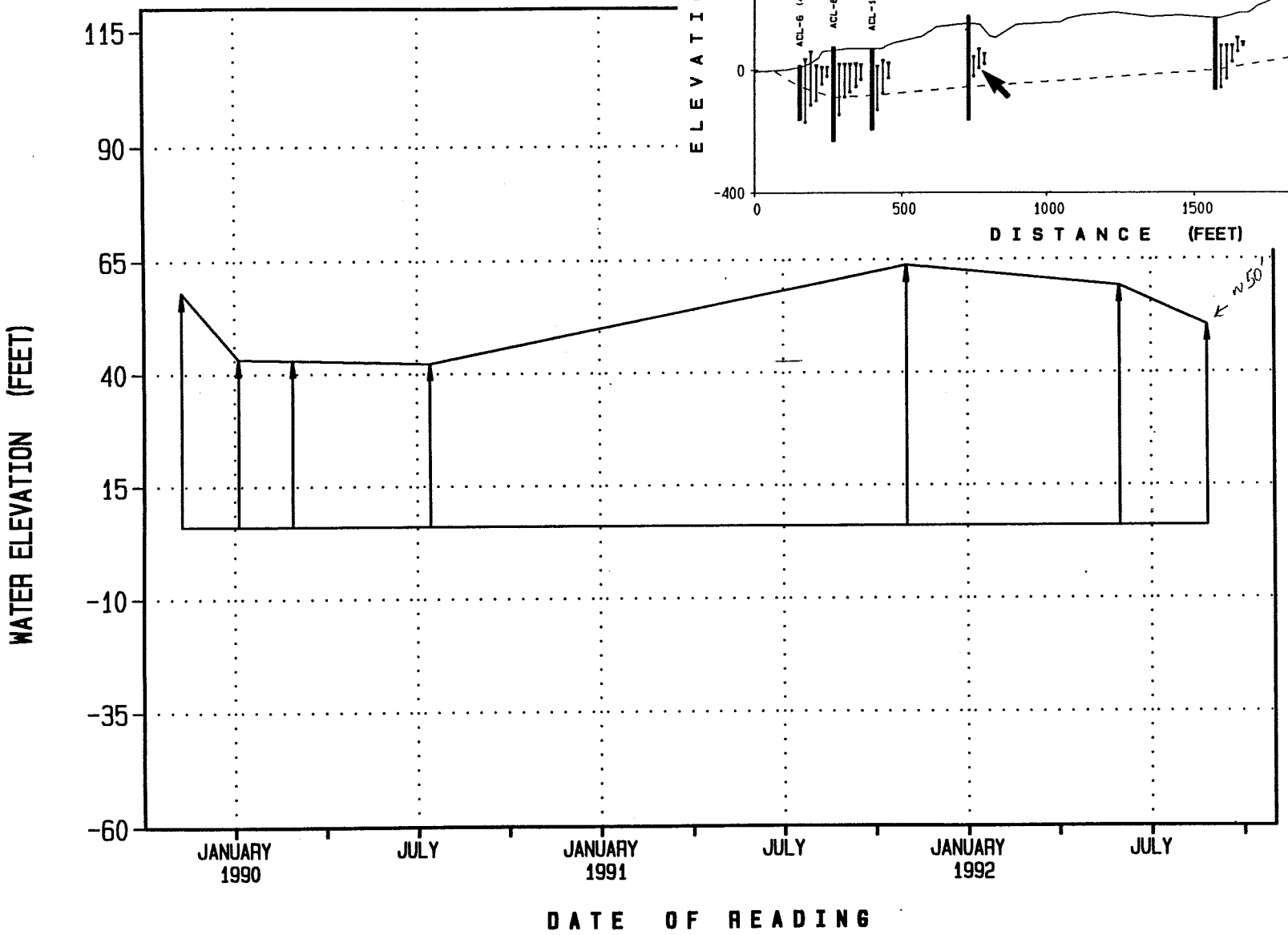


PROJECT # 54-247	ABALONE COVE PIEZOMETRIC LEVELS - ACL-3/TIP #5.	BING YEN & ASSOC.

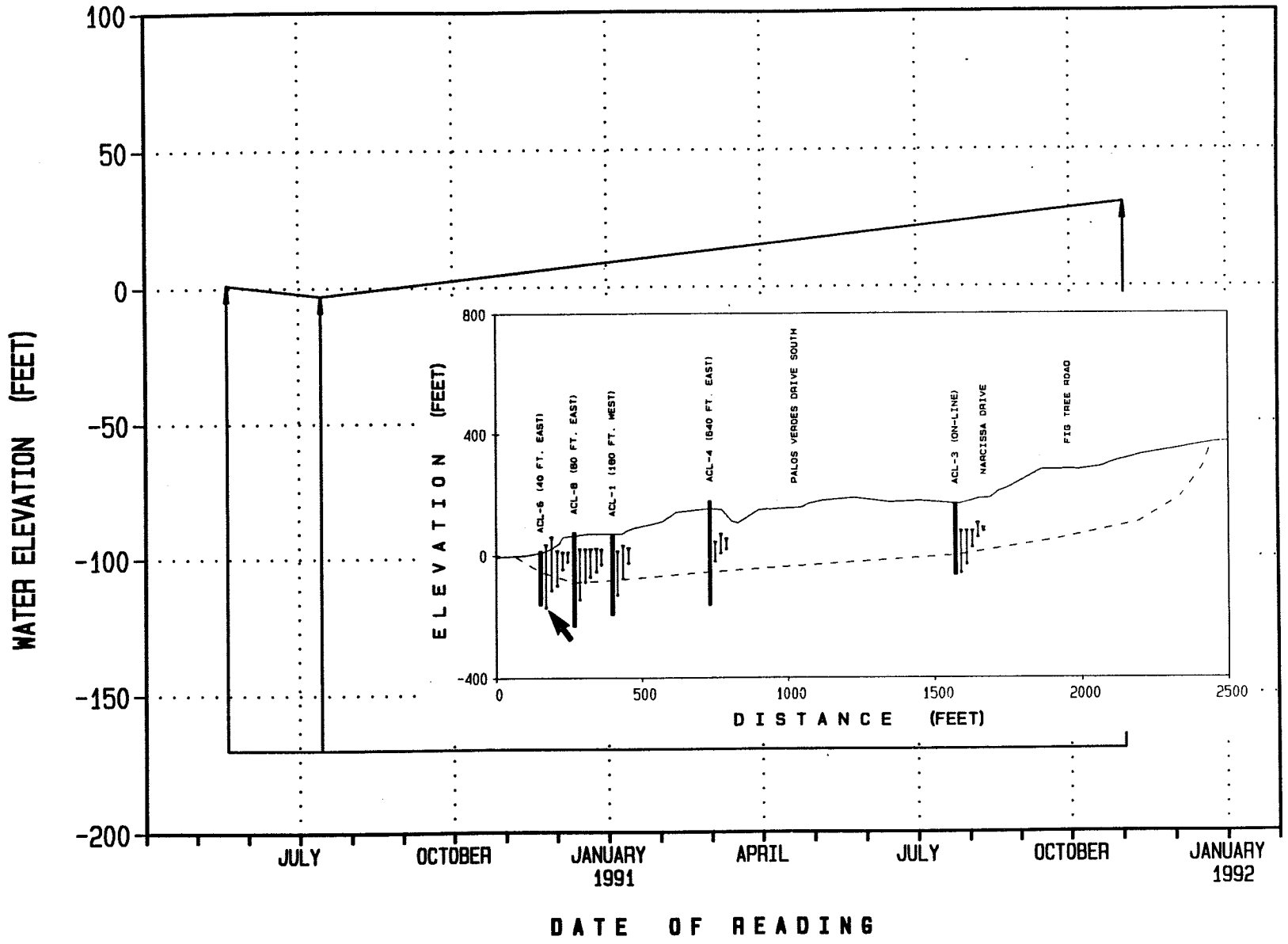


PROJECT # 54-247	ABALONE COVE PIEZOMETRIC LEVELS - ACL-4/TIP #4.	BING YEN & ASSOC.

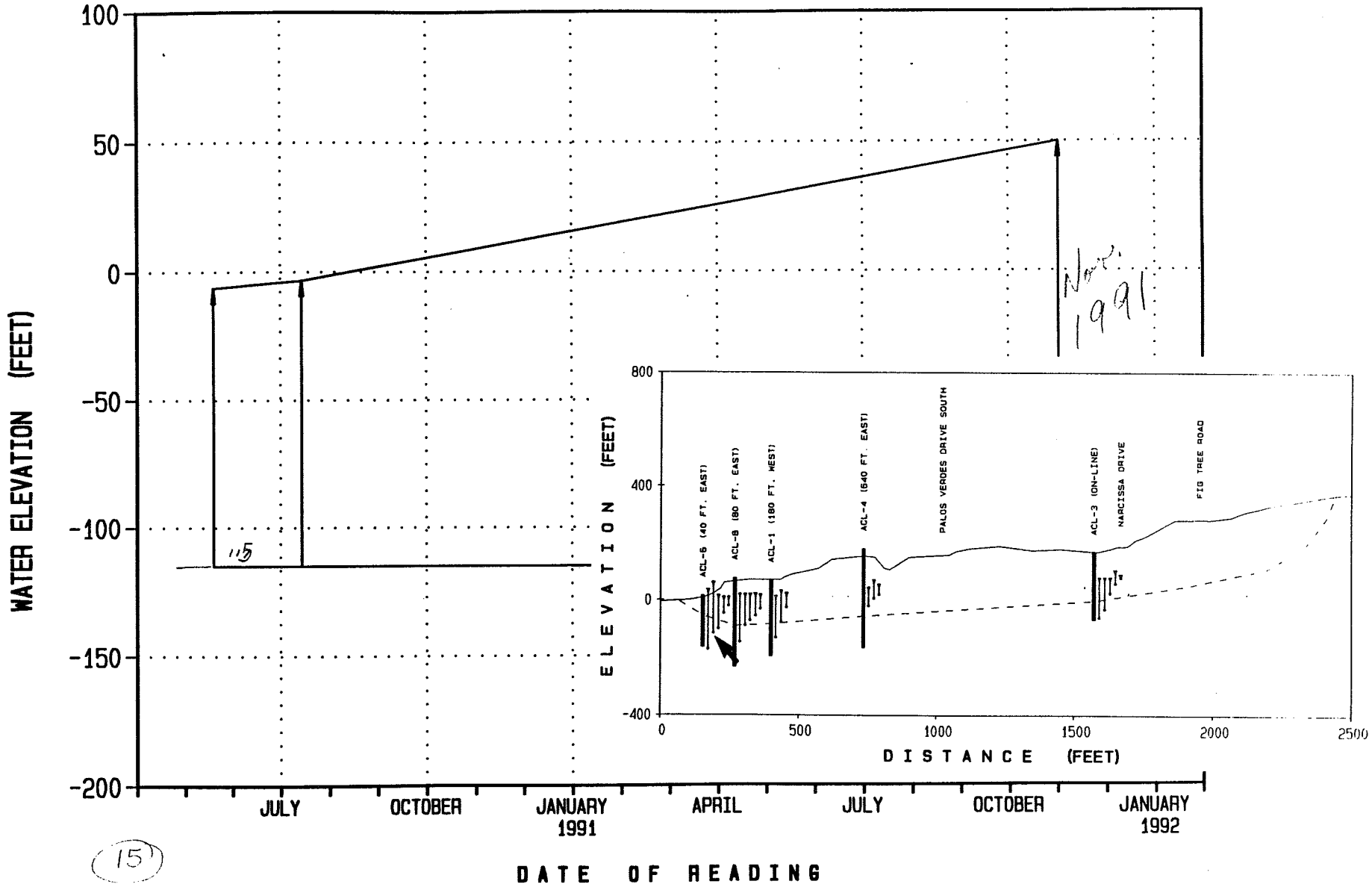




PROJECT # 54-247	ABALONE COVE PIEZOMETRIC LEVELS - ACL-4/TIP #5.	BING YEN & ASSOC.



PROJECT # 54-247	ABALONE COVE PIEZOMETRIC LEVELS - ACL-6A/TIP #1.	BING YEN & ASSOC.



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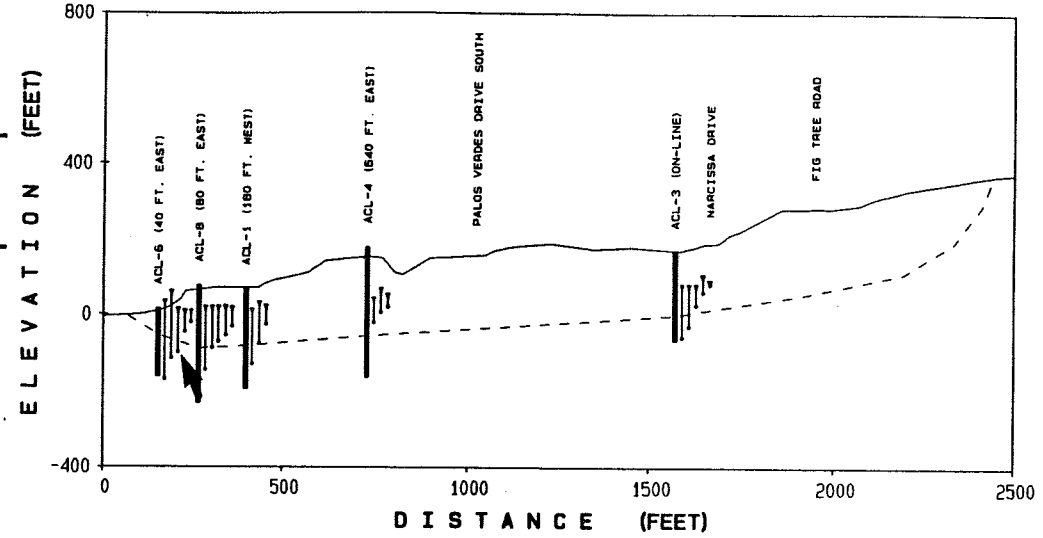
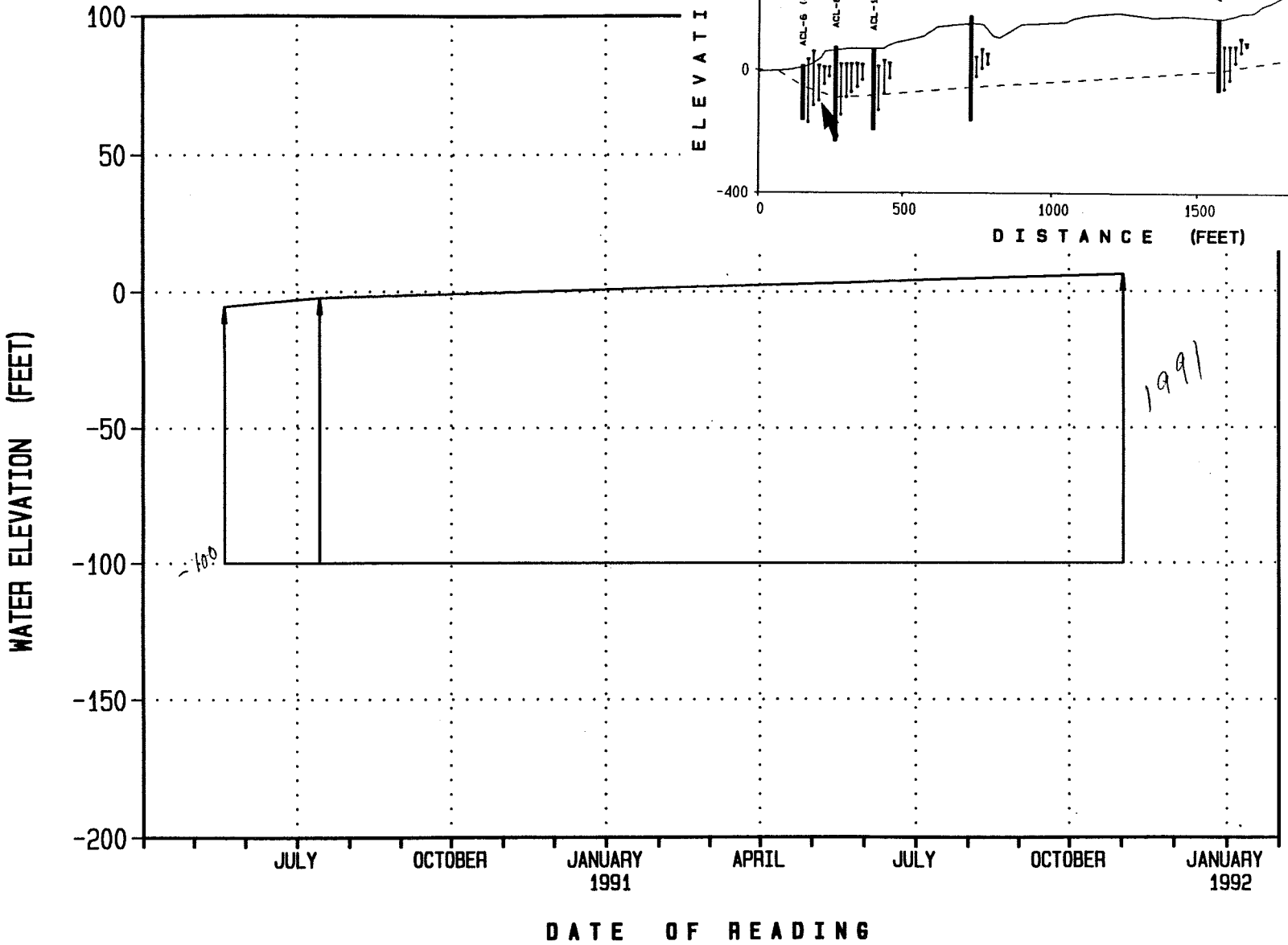
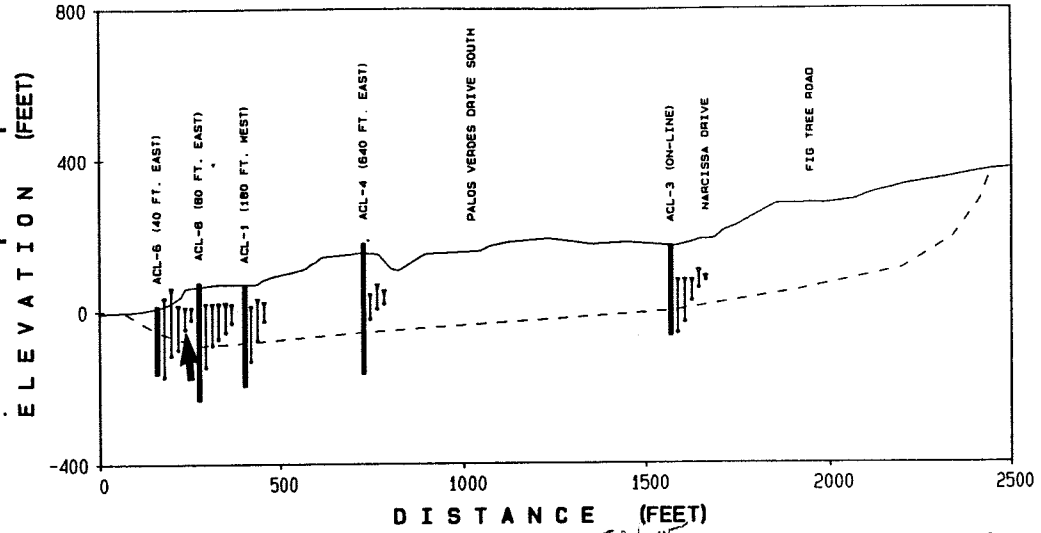
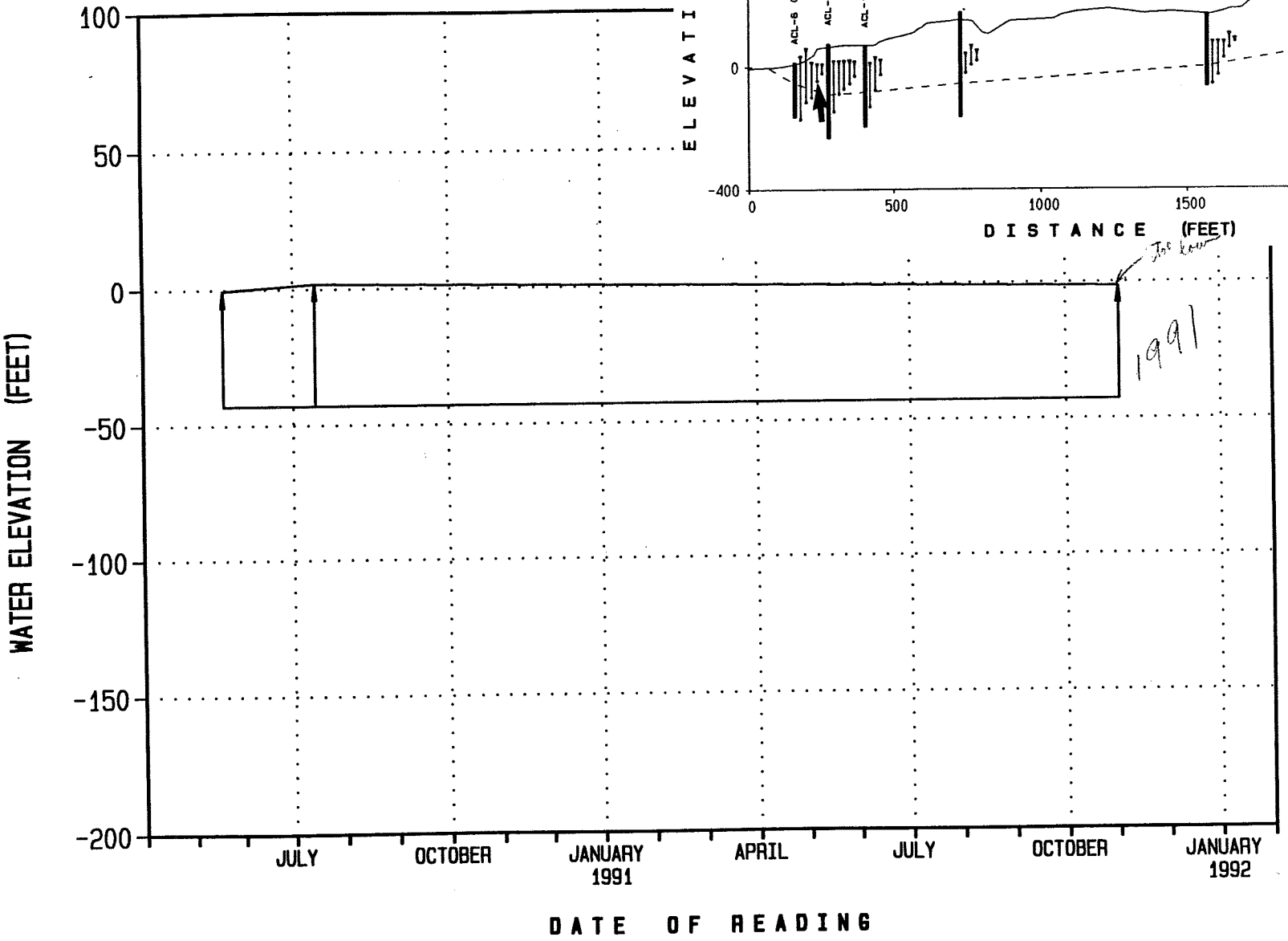
PROJECT # 54-247	ABALONE COVE PIEZOMETRIC LEVELS - ACL-6A/TIP #2.	BING YEN & ASSOC.



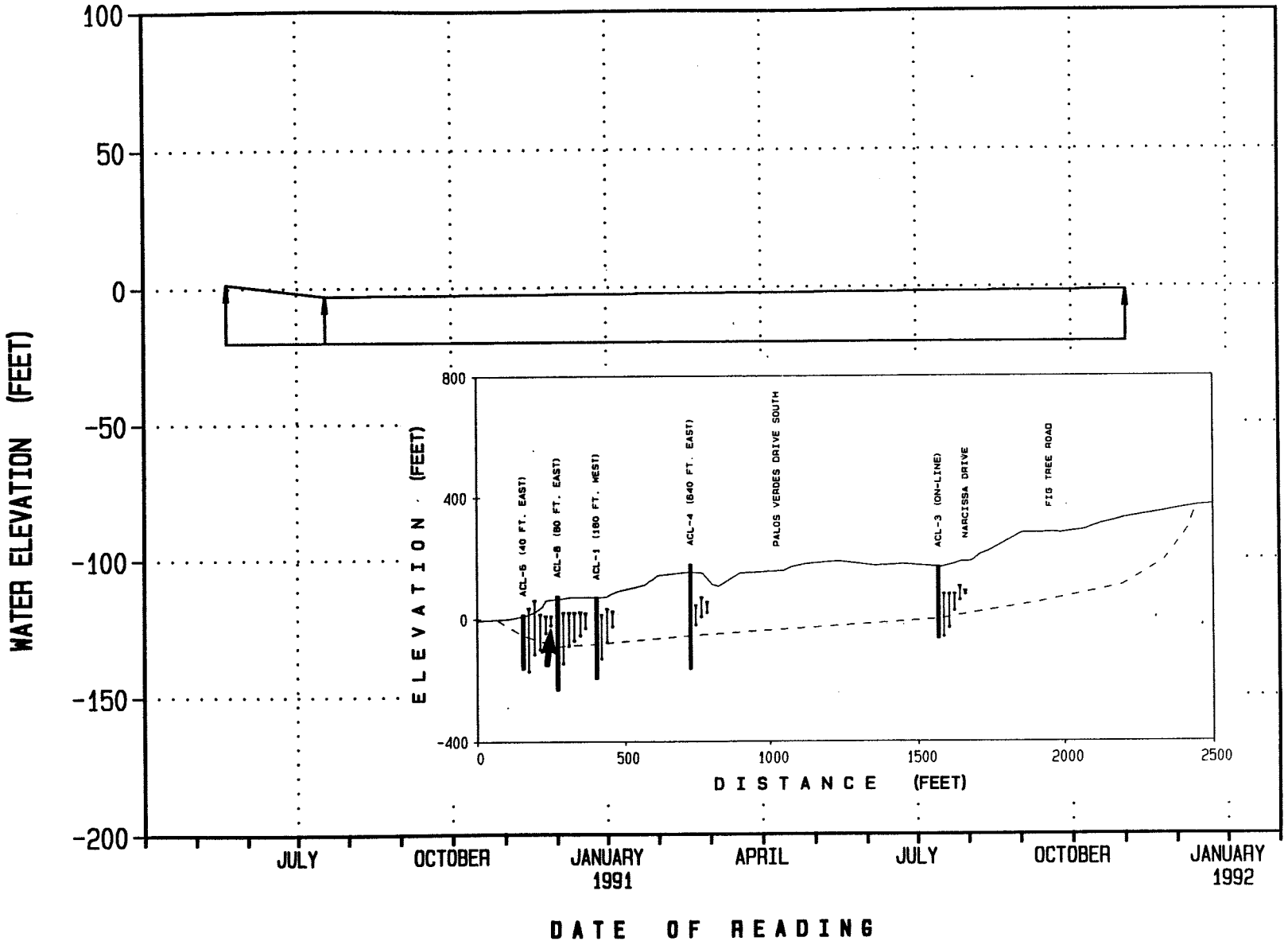


PROJECT # 54-247	ABALONE COVE PIEZOMETRIC LEVELS - ACL-6A/TIP #3.	BING YEN & ASSOC.

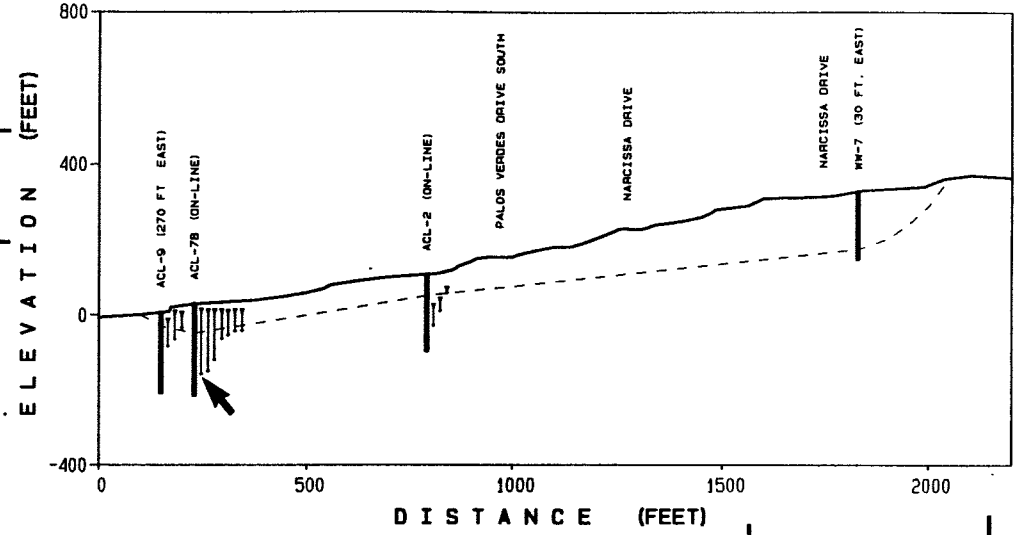


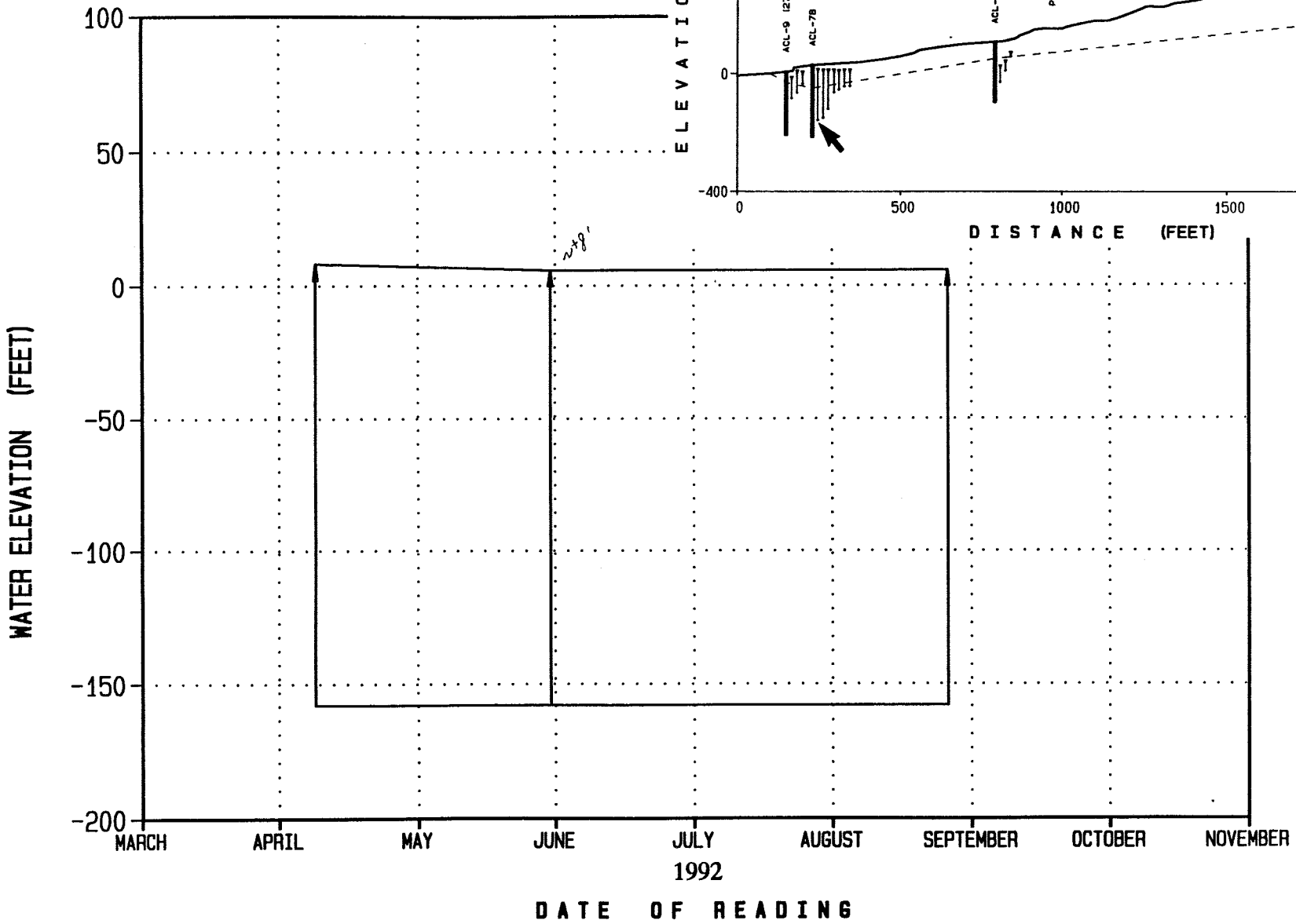


PROJECT # 54-247	ABALONE COVE PIEZOMETRIC LEVELS - ACL-6A/TIP #4.	BING YEN & ASSOC.

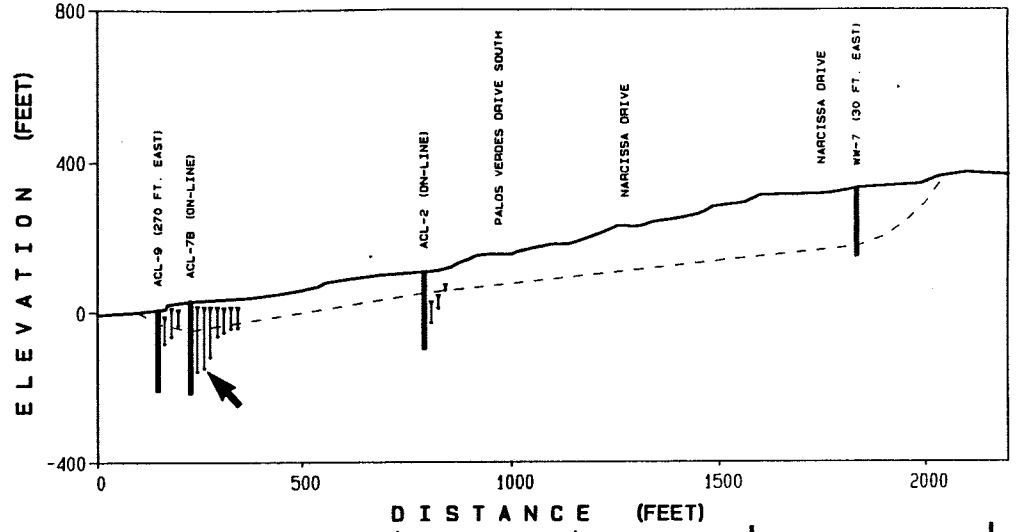


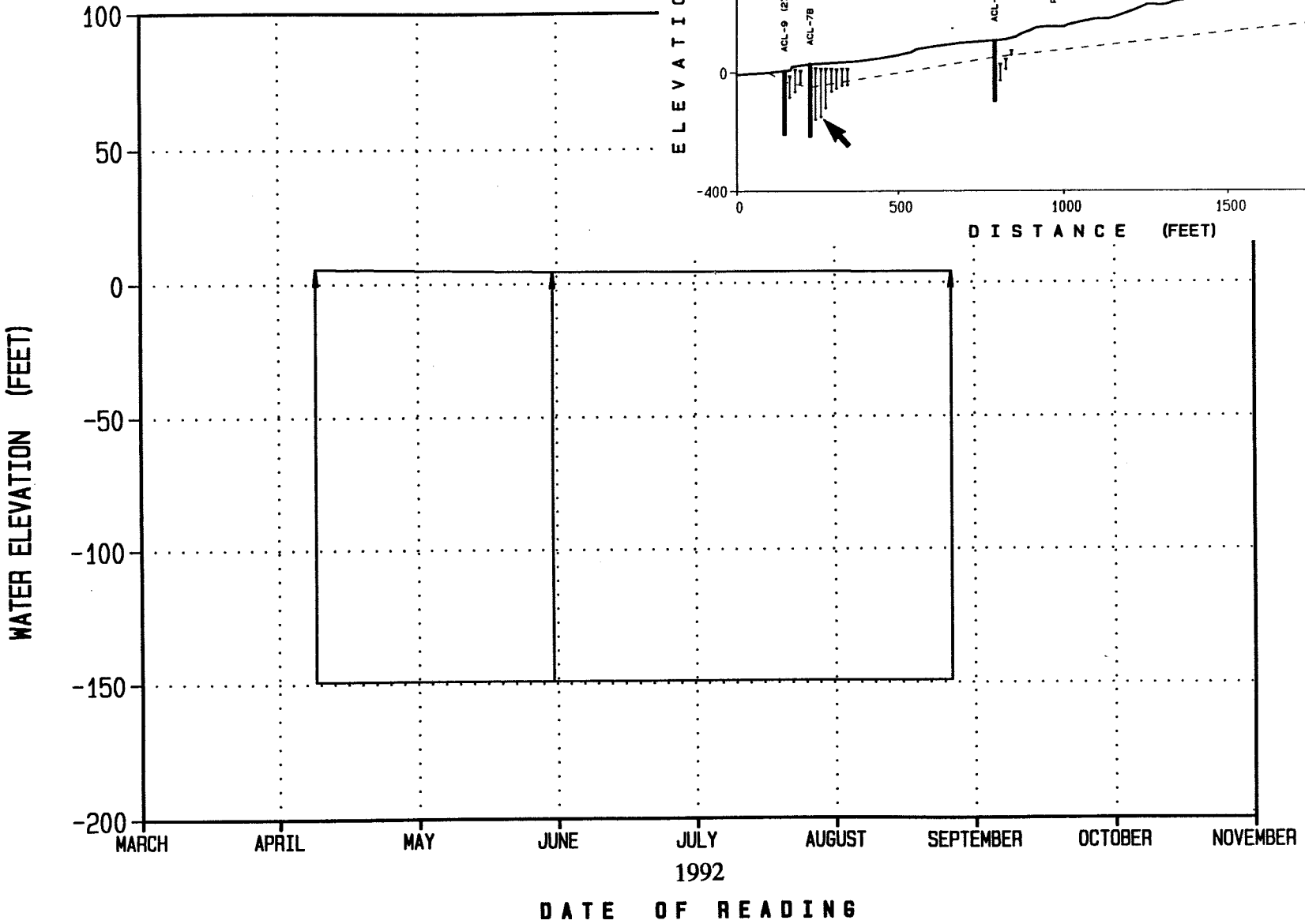
PROJECT # 54-247	ABALONE COVE PIEZOMETRIC LEVELS - ACL-6A/TIP #5.	BING YEN & ASSOC.



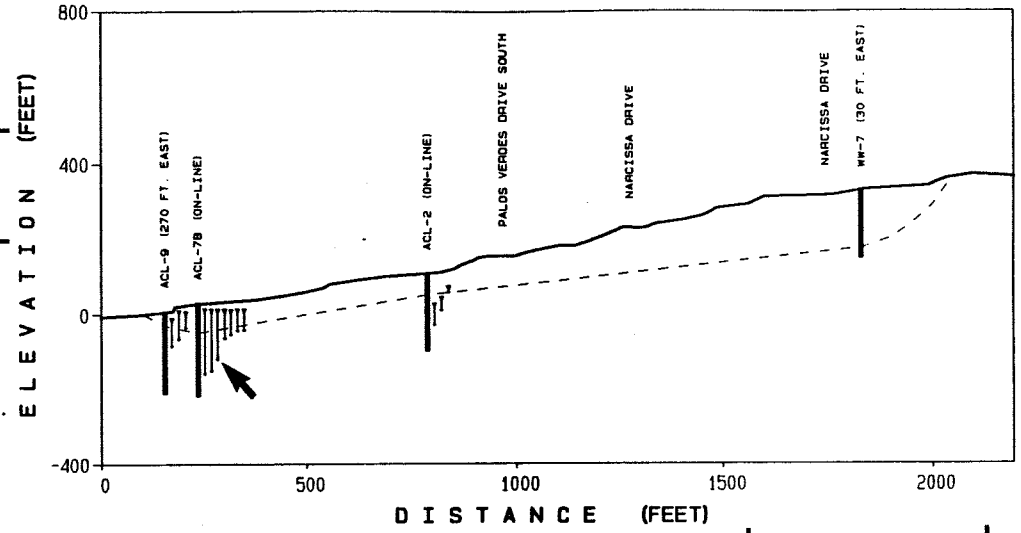


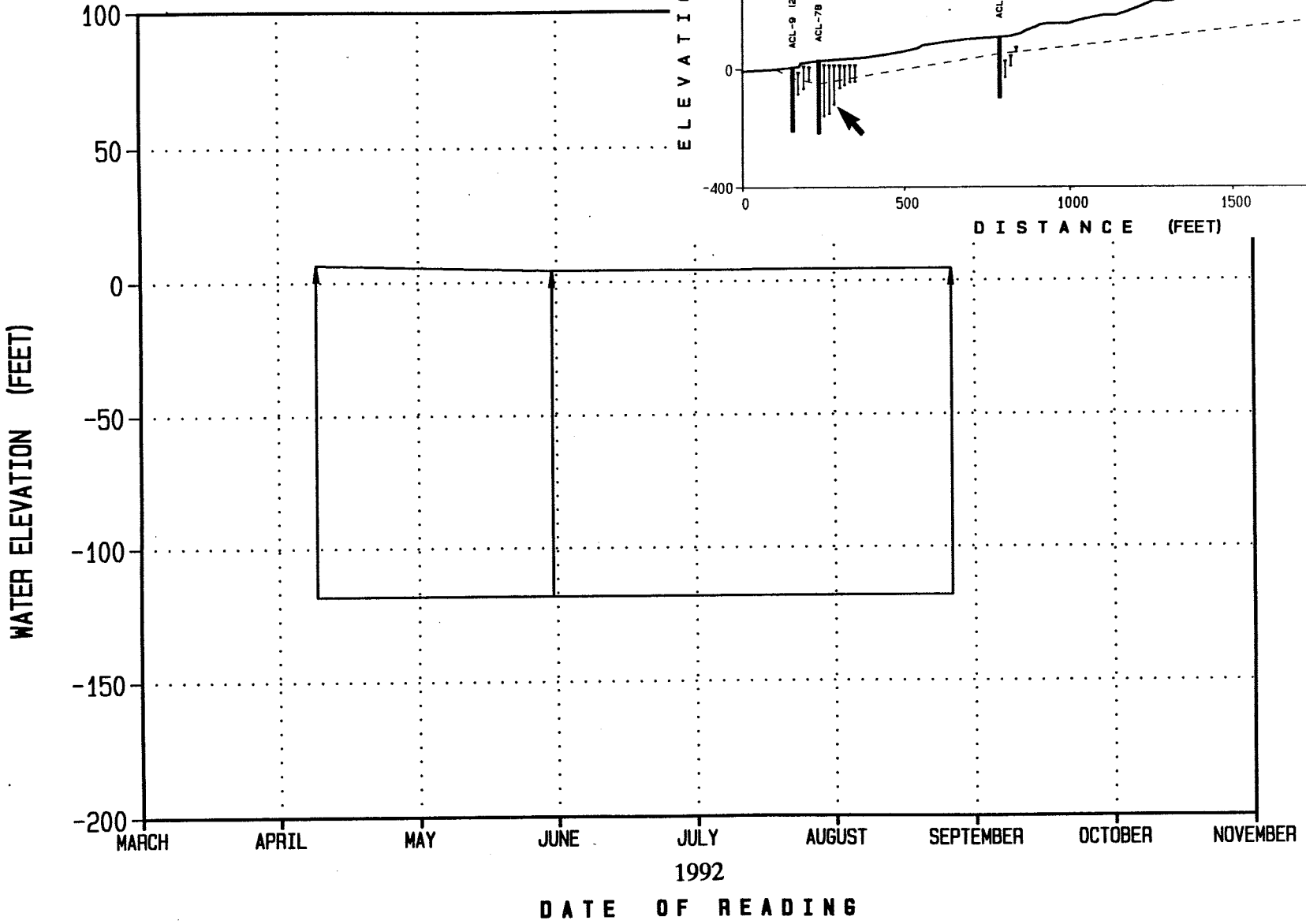
PROJECT # 54-247	ABALONE COVE PIEZOMETRIC LEVELS - ACL-7B/TIP #1.	BING YEN & ASSOC.



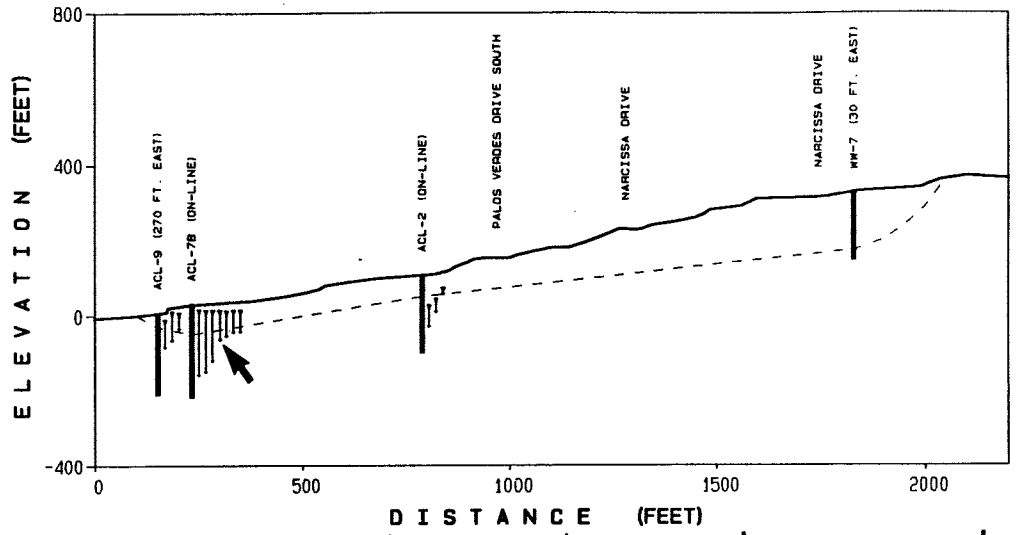


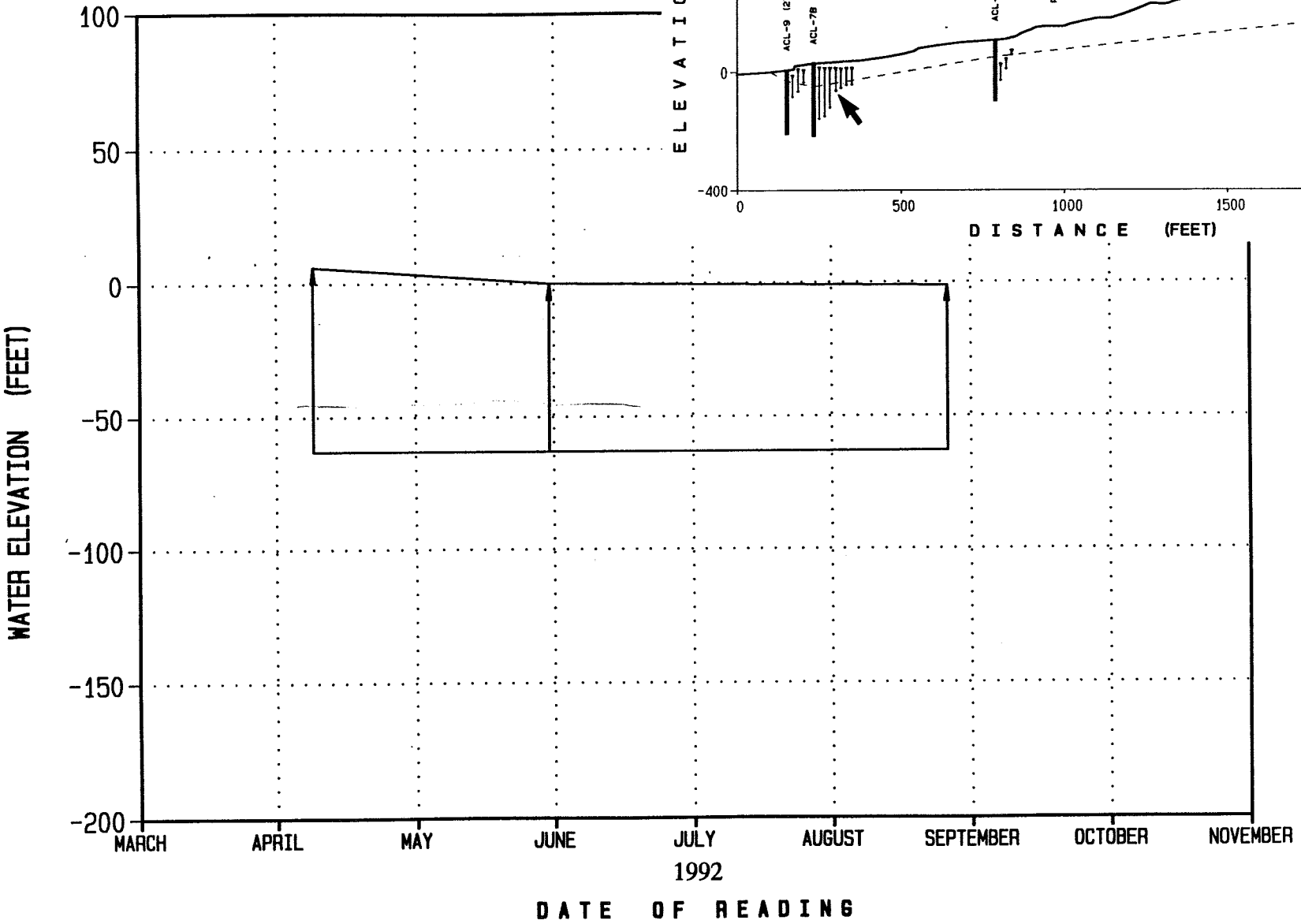
PROJECT # 54-247	ABALONE COVE PIEZOMETRIC LEVELS - ACL-7B/TIP #2.	BING YEN & ASSOC.



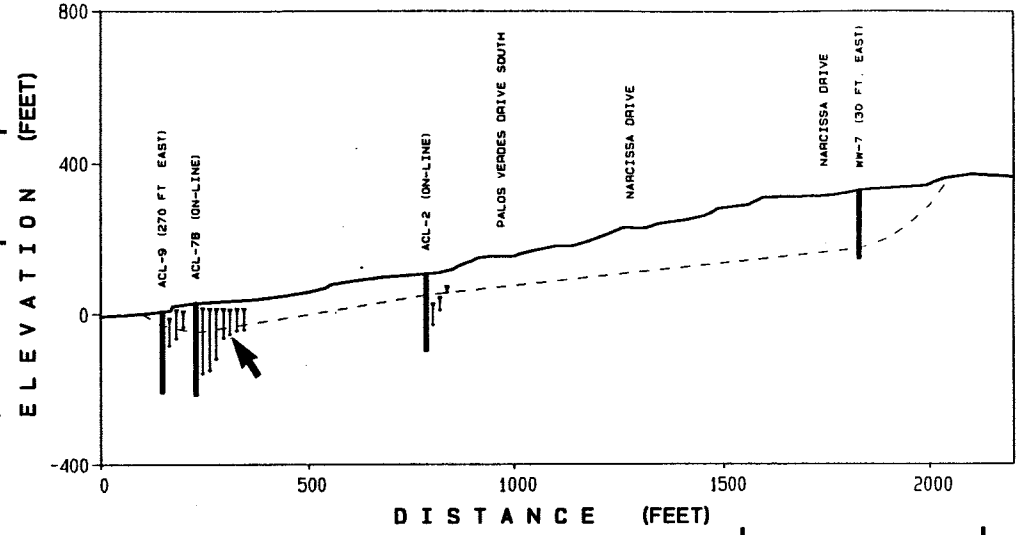


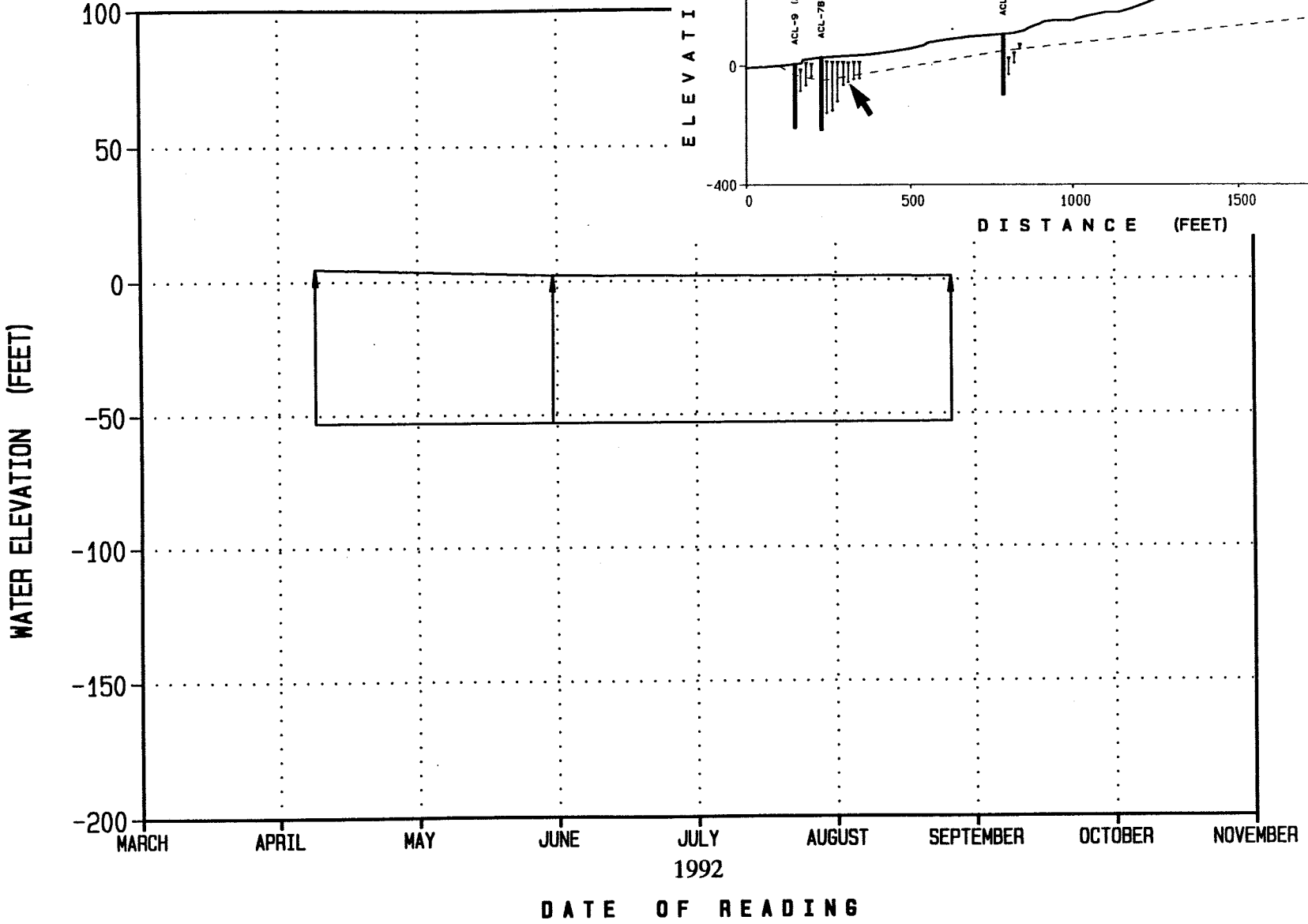
PROJECT # 54-247	ABALONE COVE PIEZOMETRIC LEVELS - ACL-7B/TIP #3.	BING YEN & ASSOC.





PROJECT # 54-247	ABALONE COVE PIEZOMETRIC LEVELS - ACL-7B/TIP #4.	BING YEN & ASSOC.





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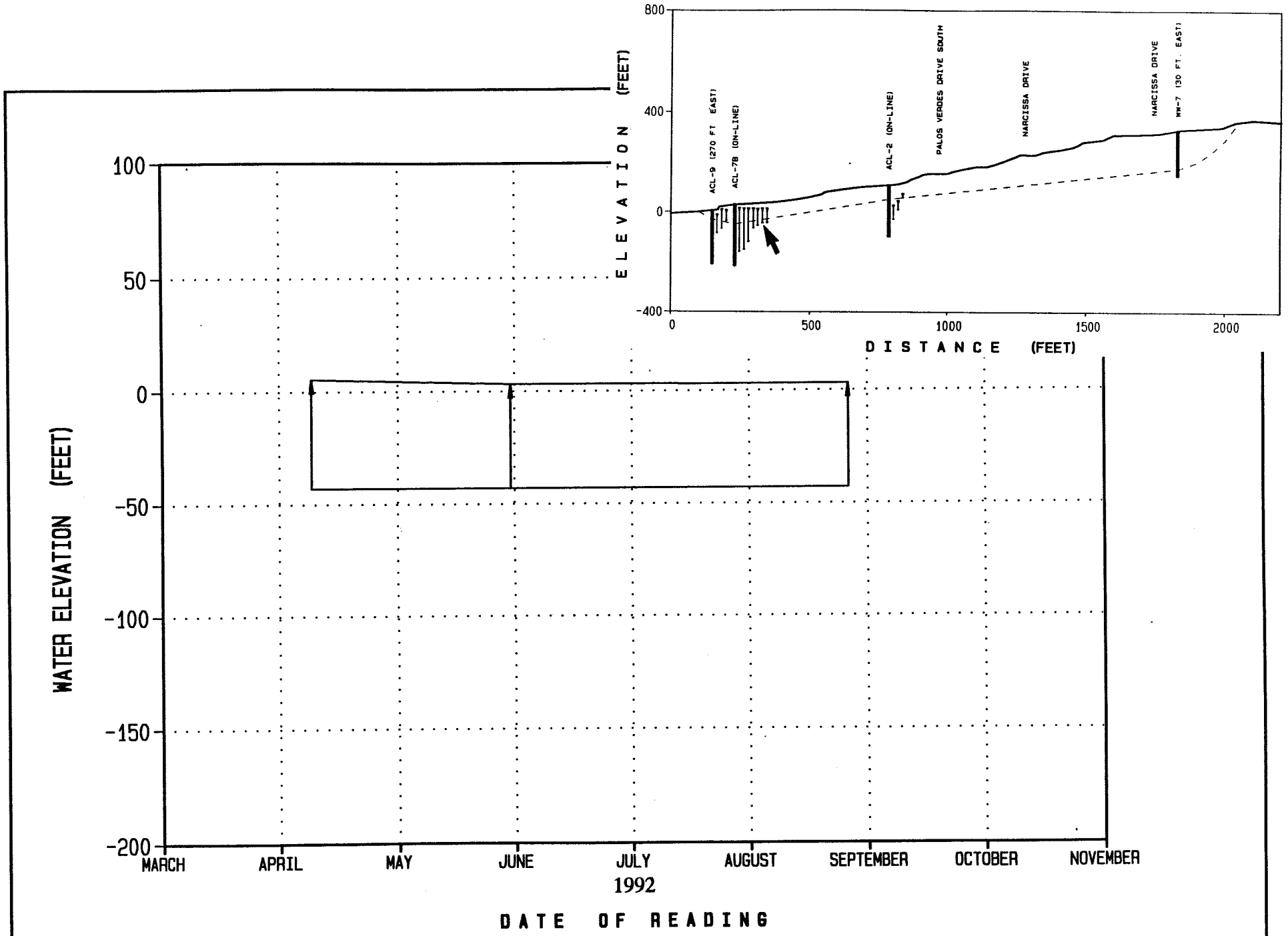
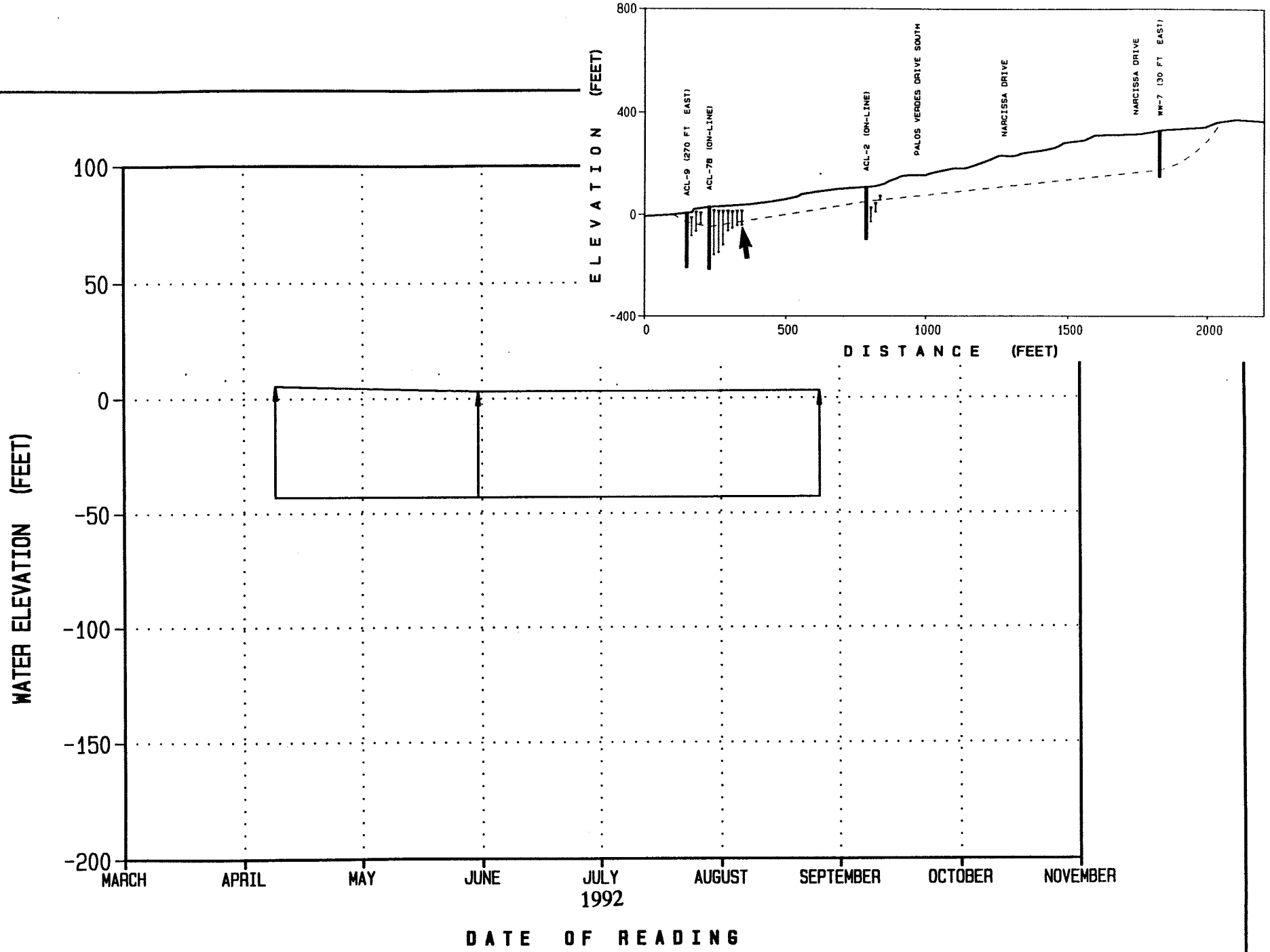
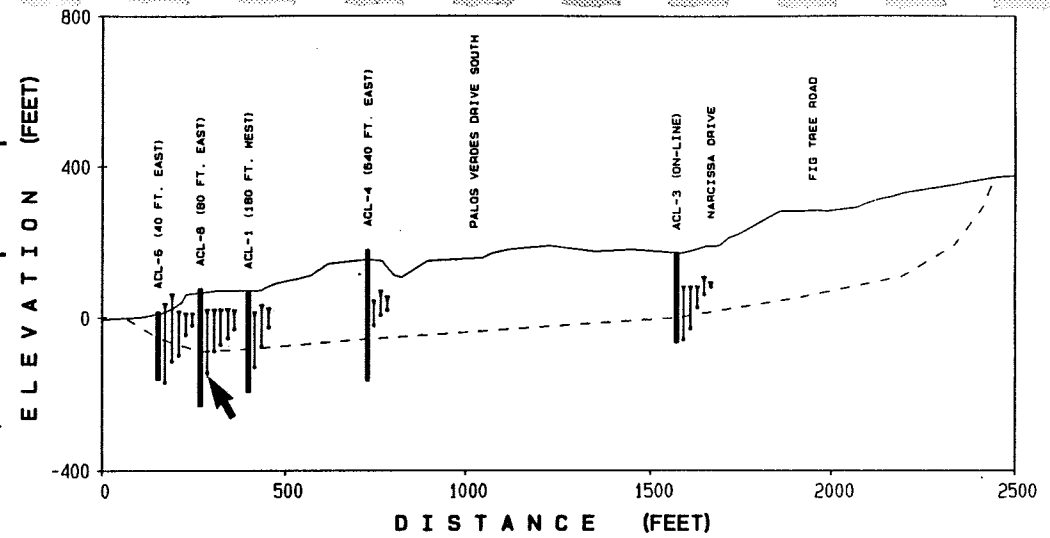
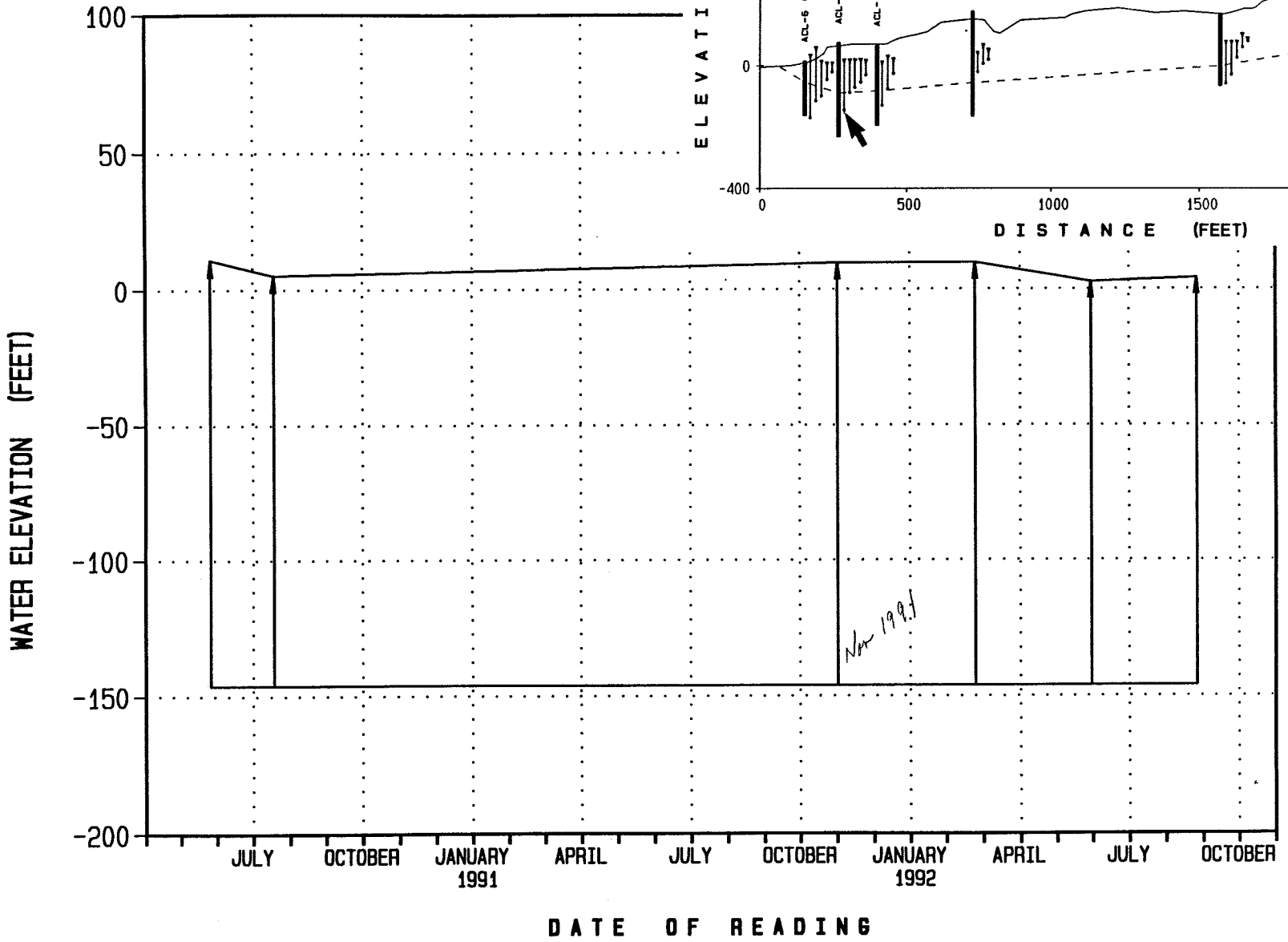


PROJECT # 54-247	ABALONE COVE PIEZOMETRIC LEVELS - ACL-7B/TIP#6.	BING YEN & ASSOC.

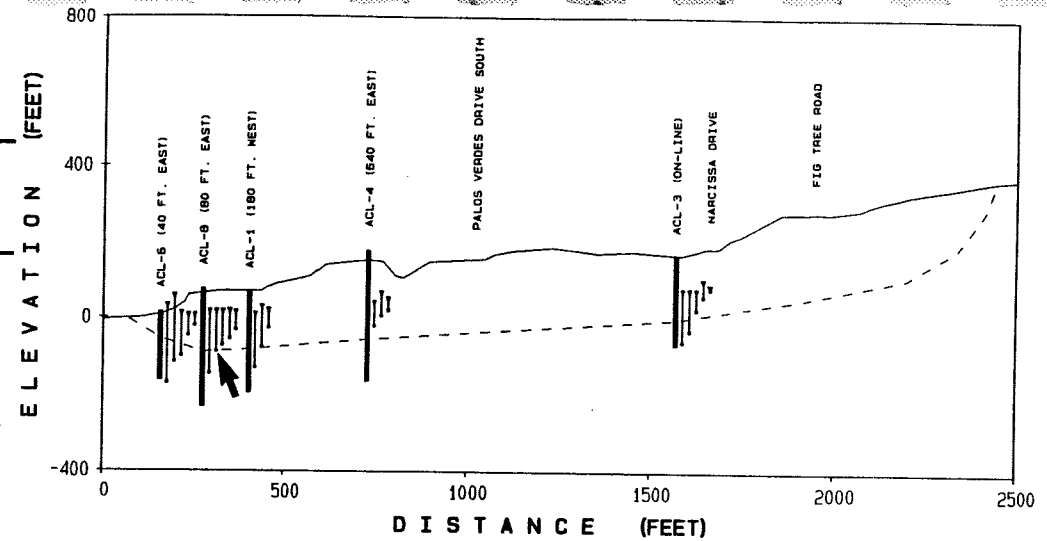


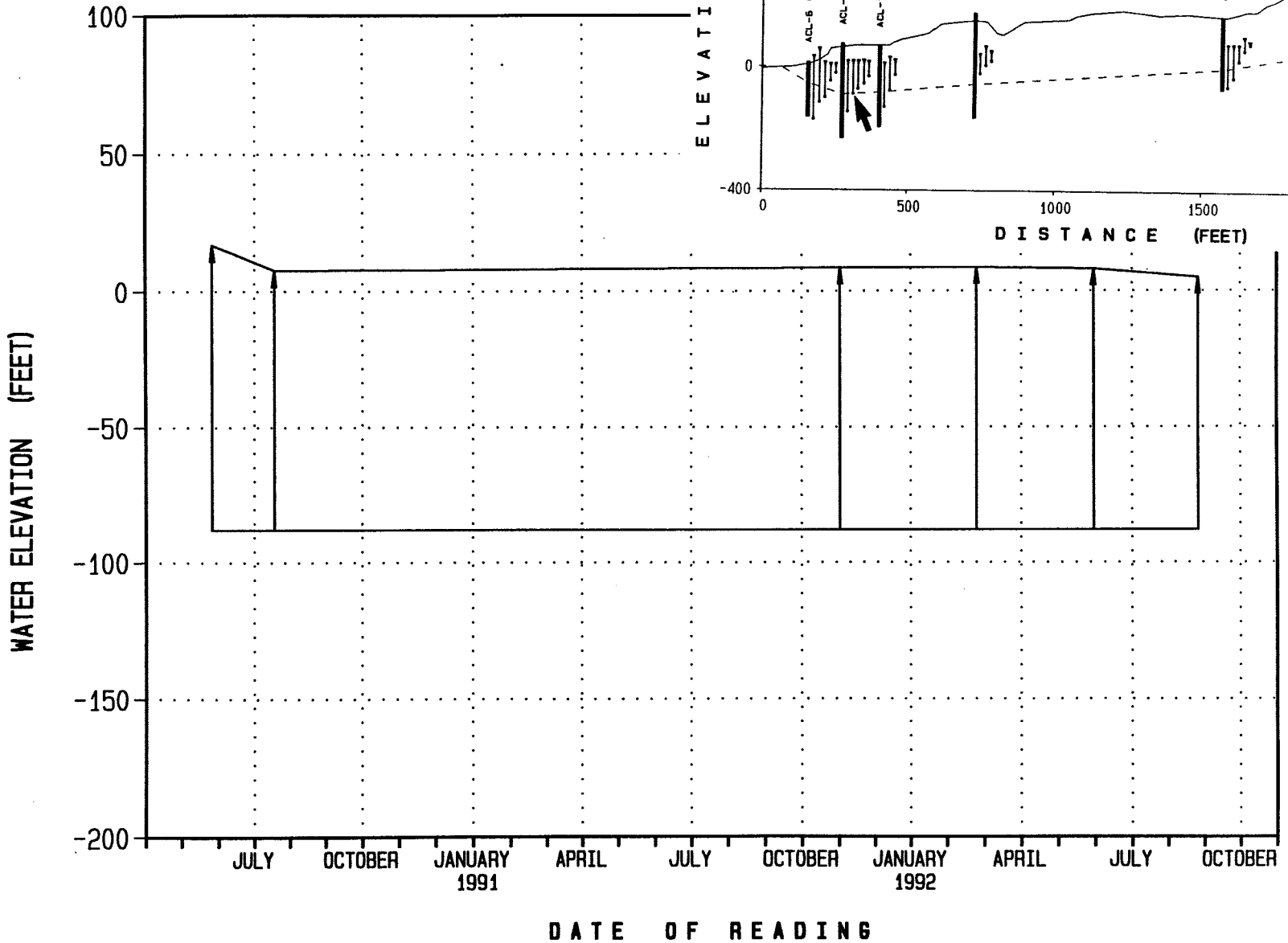
PROJECT # 54-247	ABALONE COVE PIEZOMETRIC LEVELS - ACL-7B/STANDPIPE.	BING YEN & ASSOC.



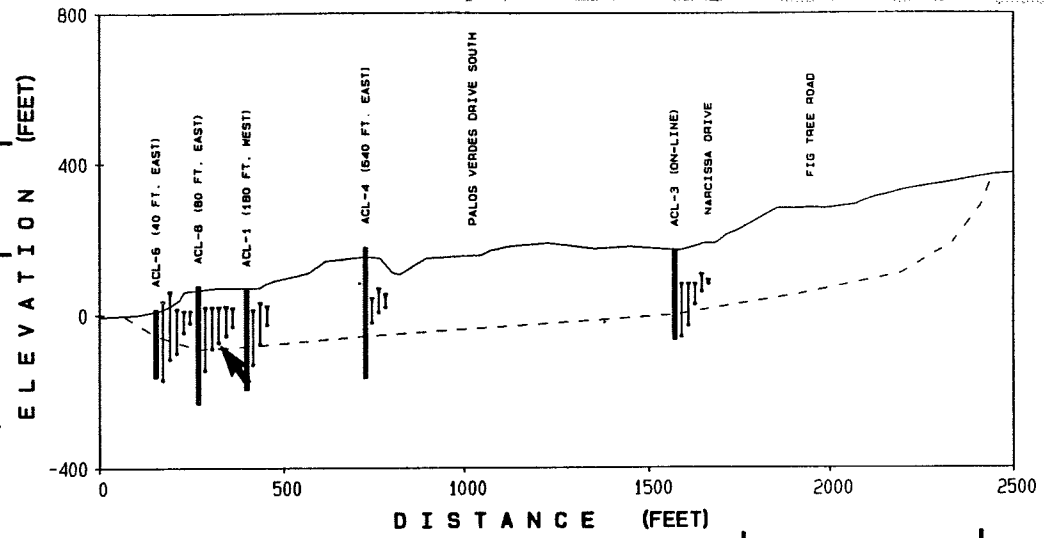


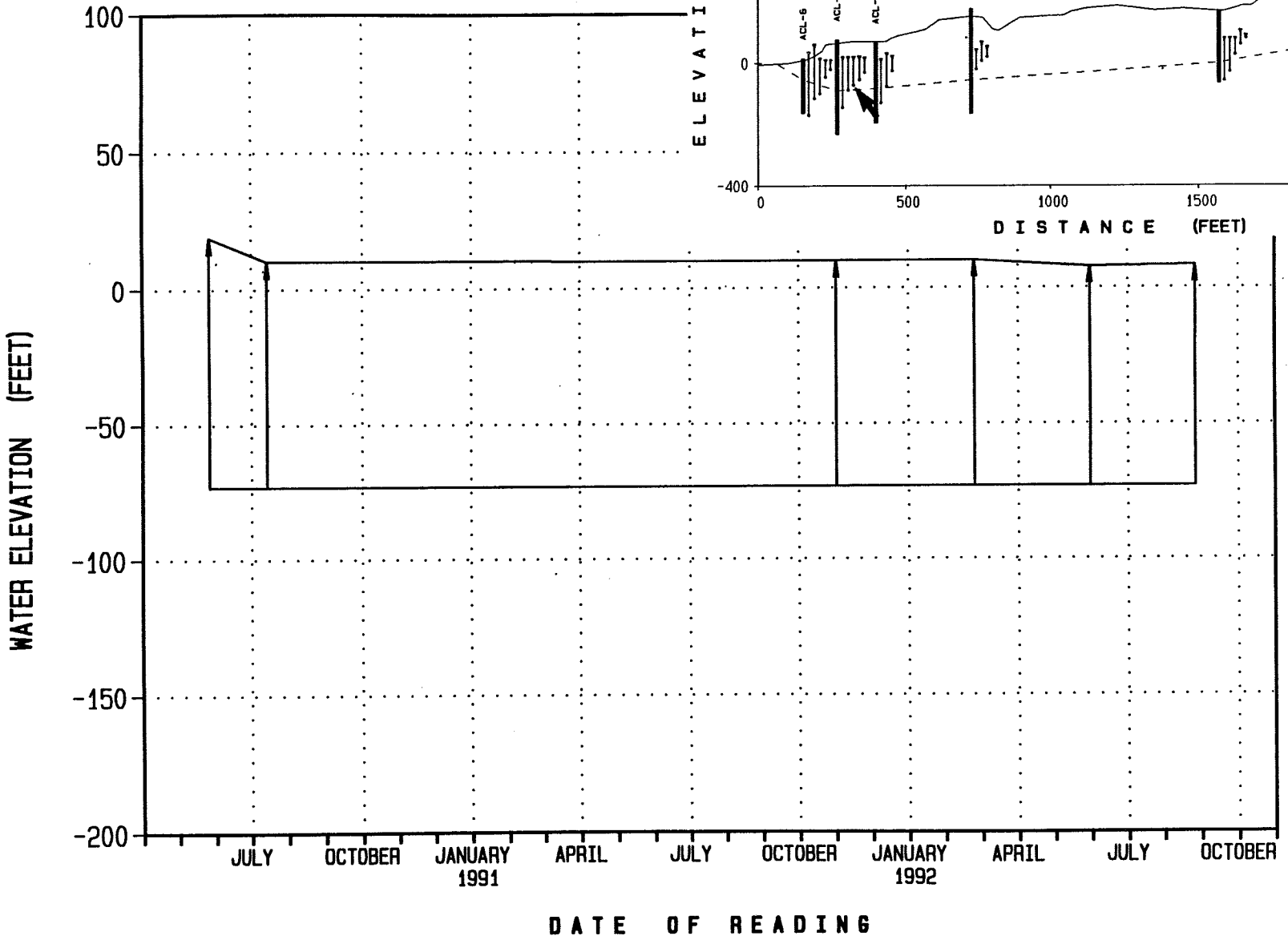
PROJECT # 54-247	ABALONE COVE PIEZOMETRIC LEVELS - ACL-8/TIP #1.	BING YEN & ASSOC.



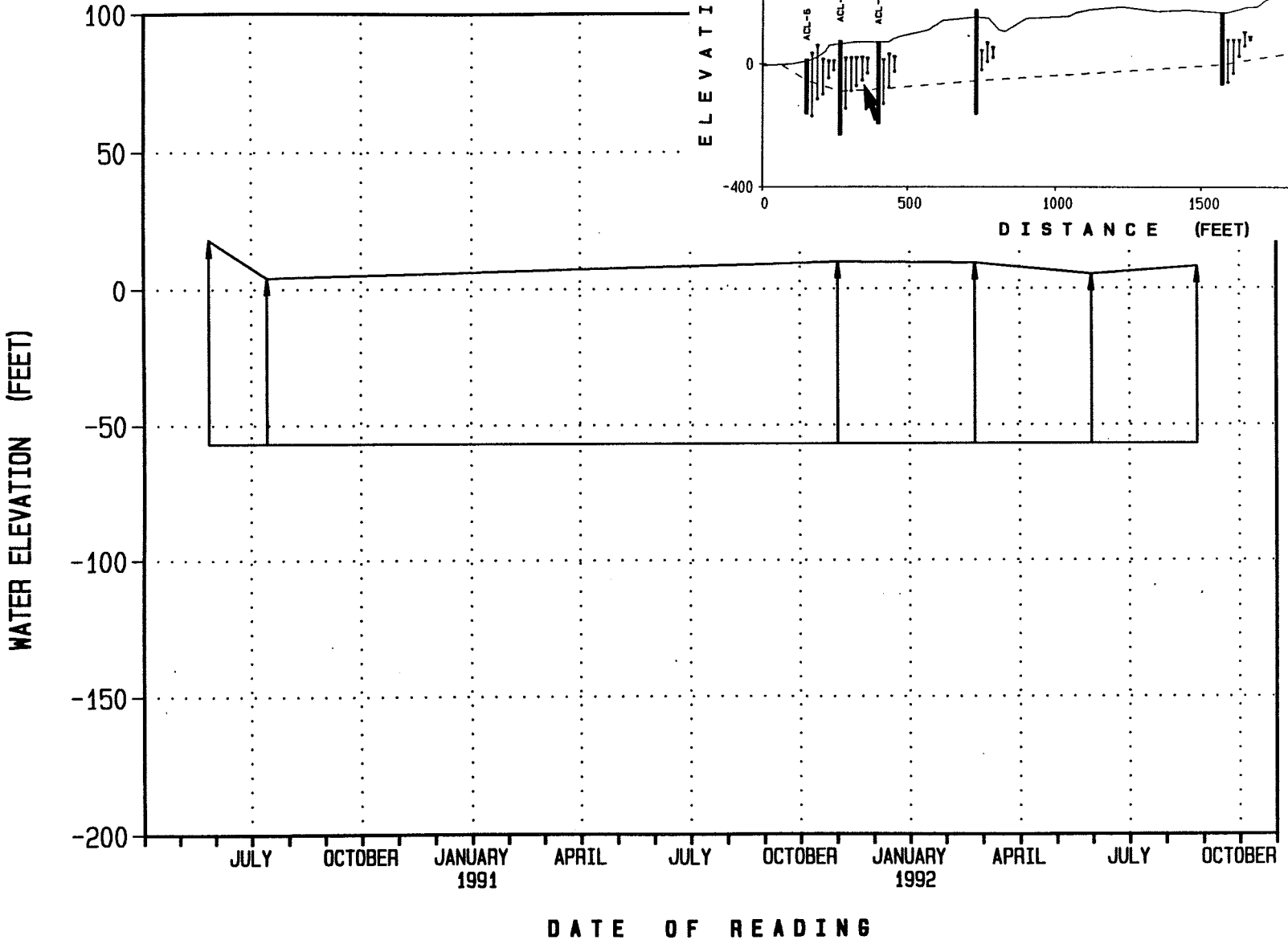


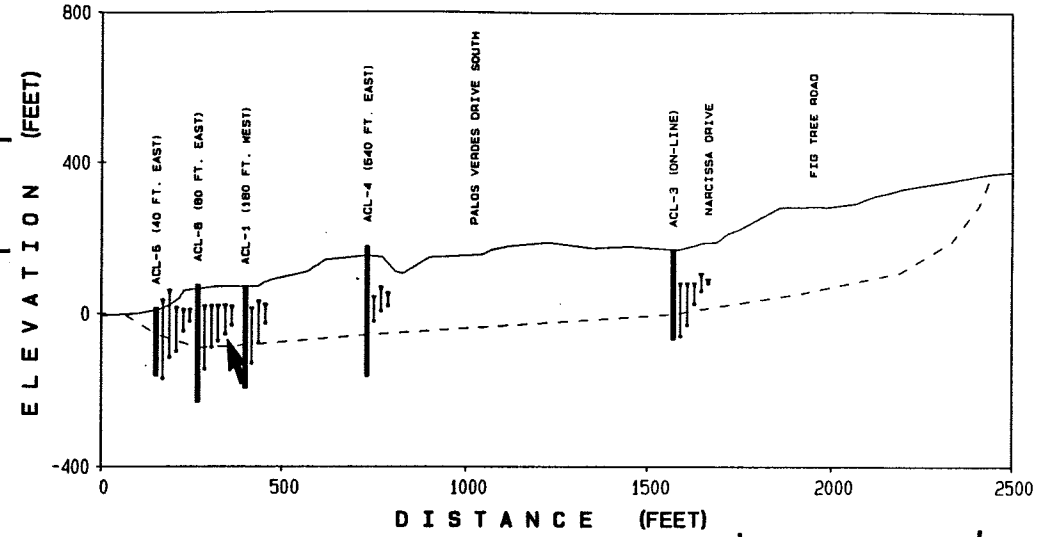
PROJECT # 54-247	ABALONE COVE PIEZOMETRIC LEVELS - ACL-8/TIP #2.	BING YEN & ASSOC.



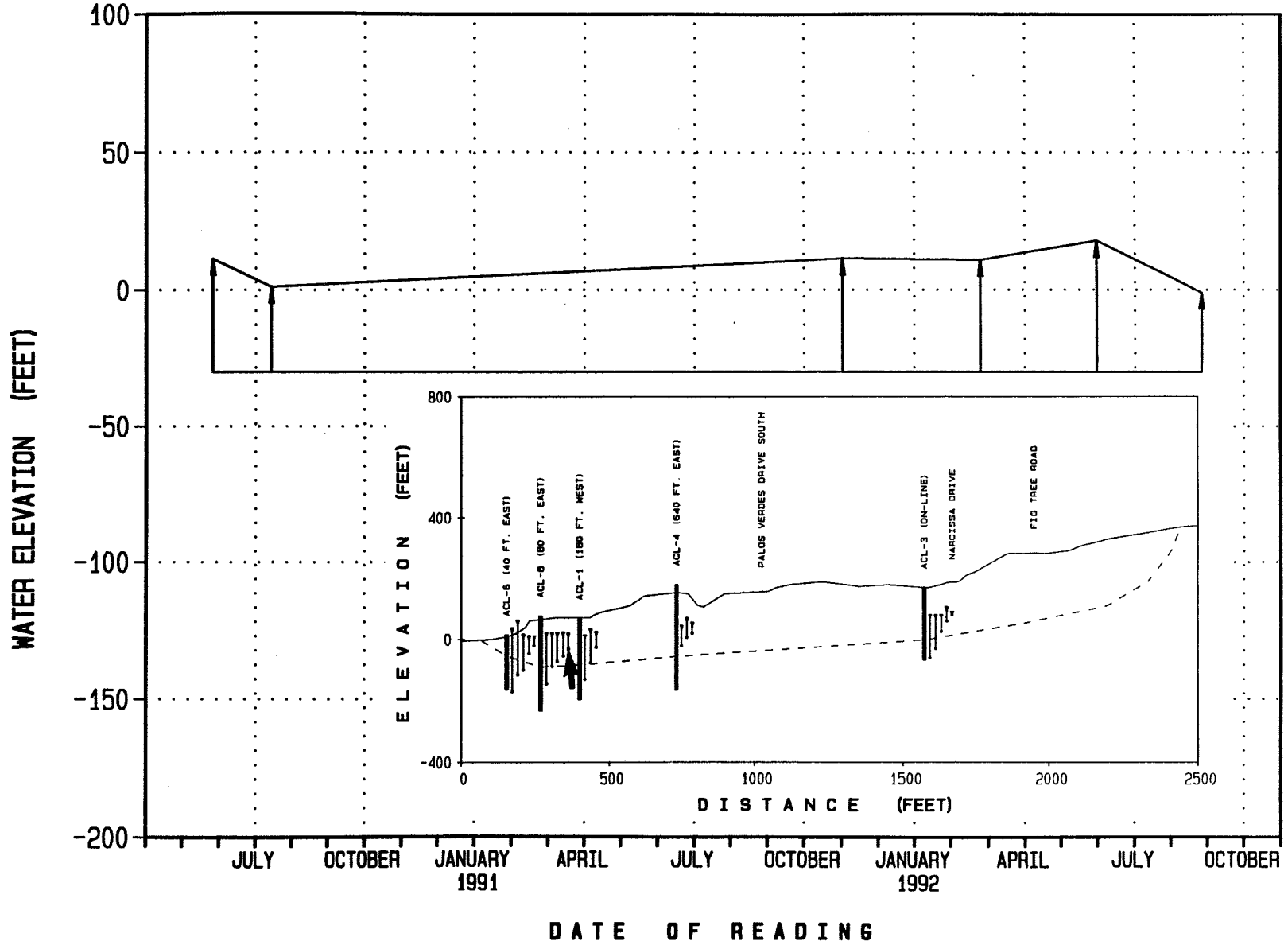


PROJECT # 54-247	ABALONE COVE PIEZOMETRIC LEVELS - ACL-8/TIP #3.	BING YEN & ASSOC.

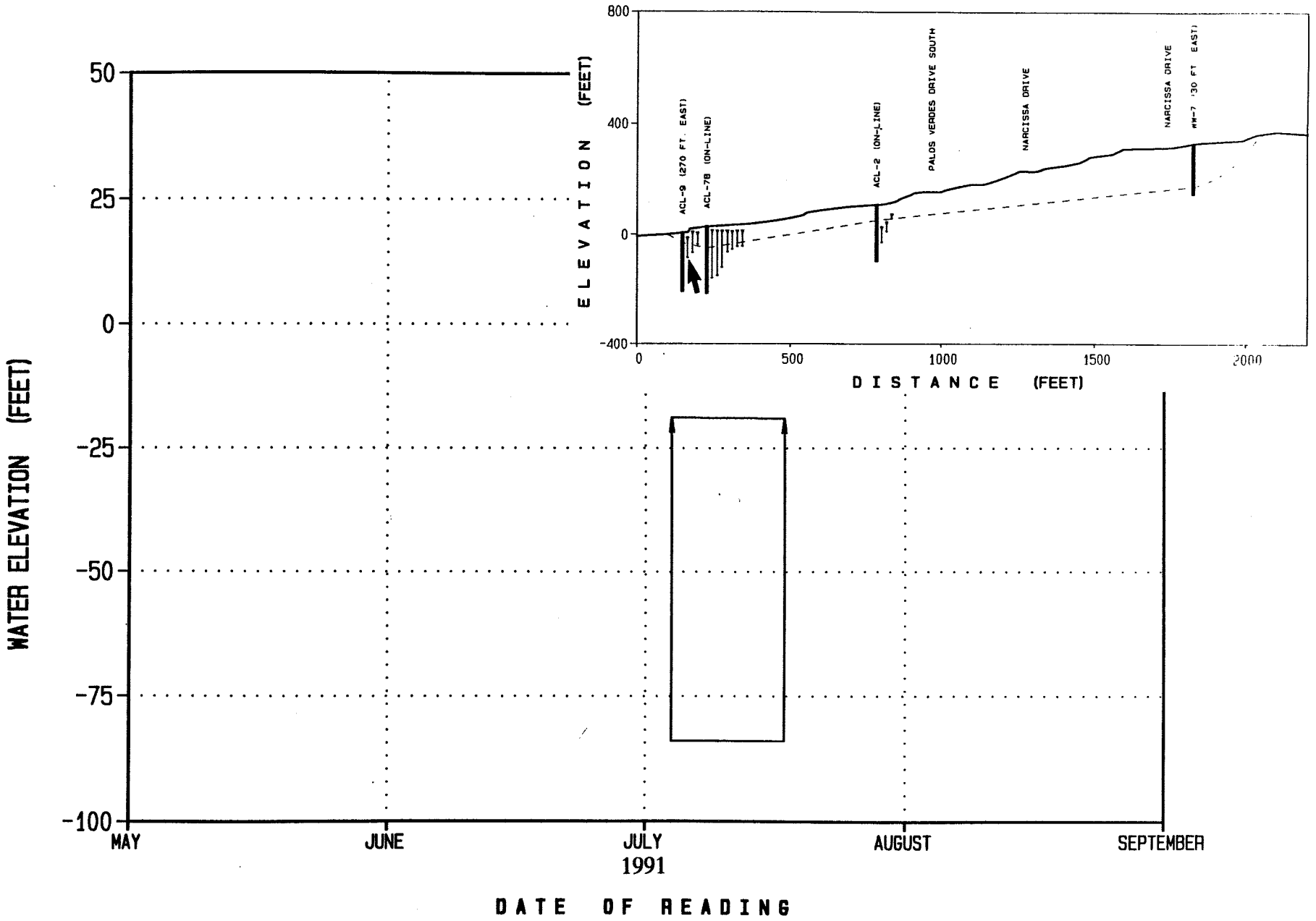




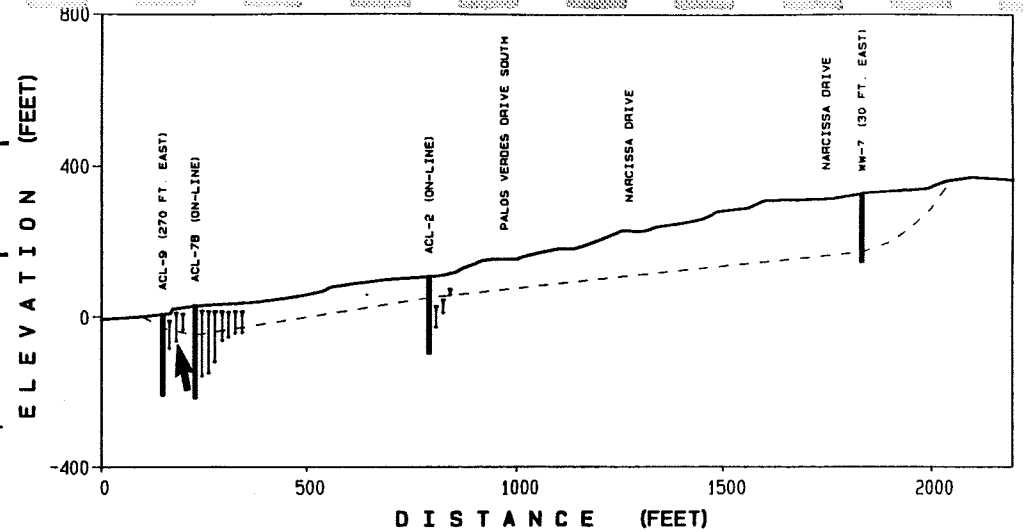
PROJECT # 54-247	ABALONE COVE PIEZOMETRIC LEVELS - ACL-8/TIP #4.	BING YEN & ASSOC.

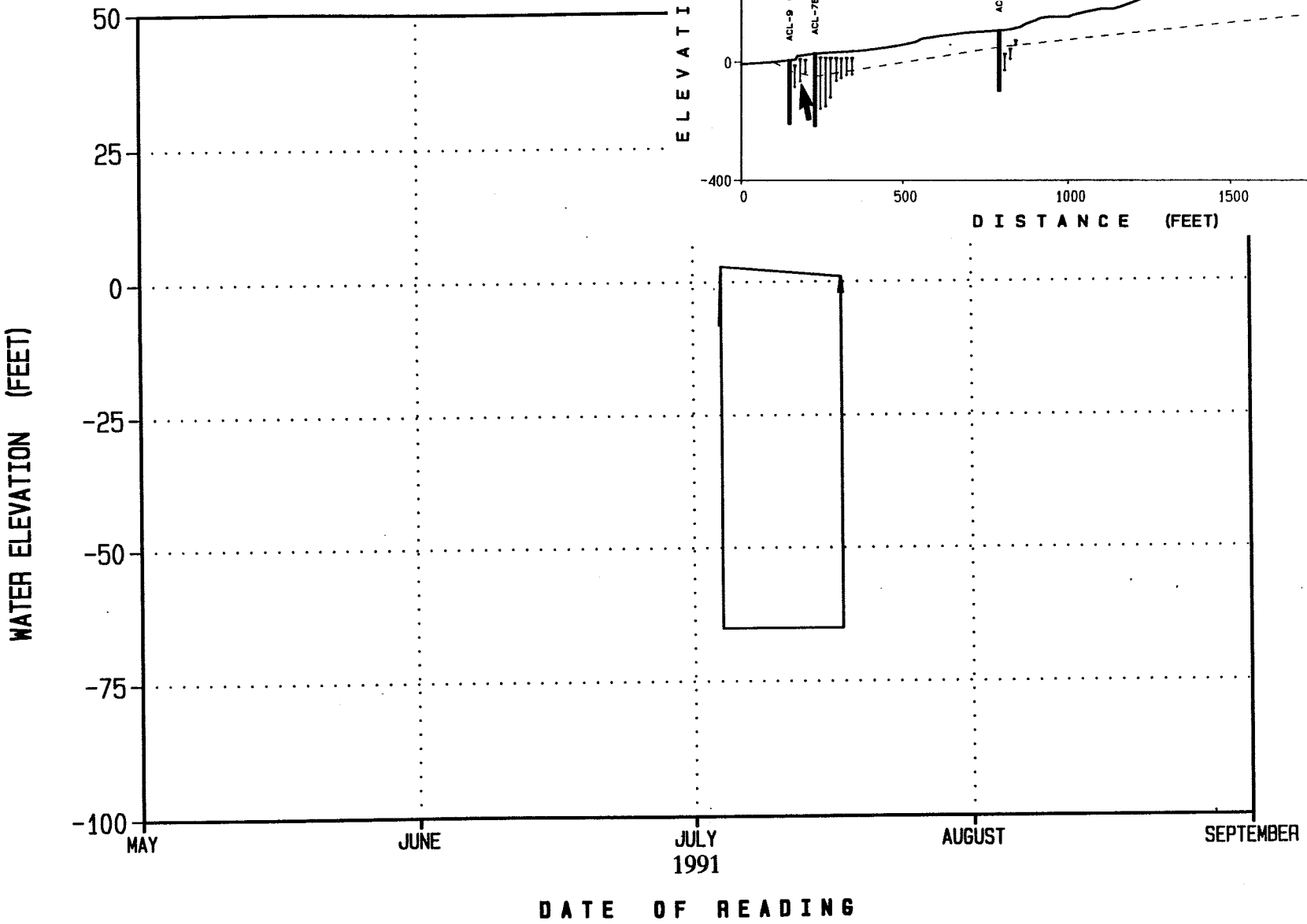


PROJECT # 54-247	ABALONE COVE PIEZOMETRIC LEVELS - ACL-8/TIP #5.	BING YEN & ASSOC.

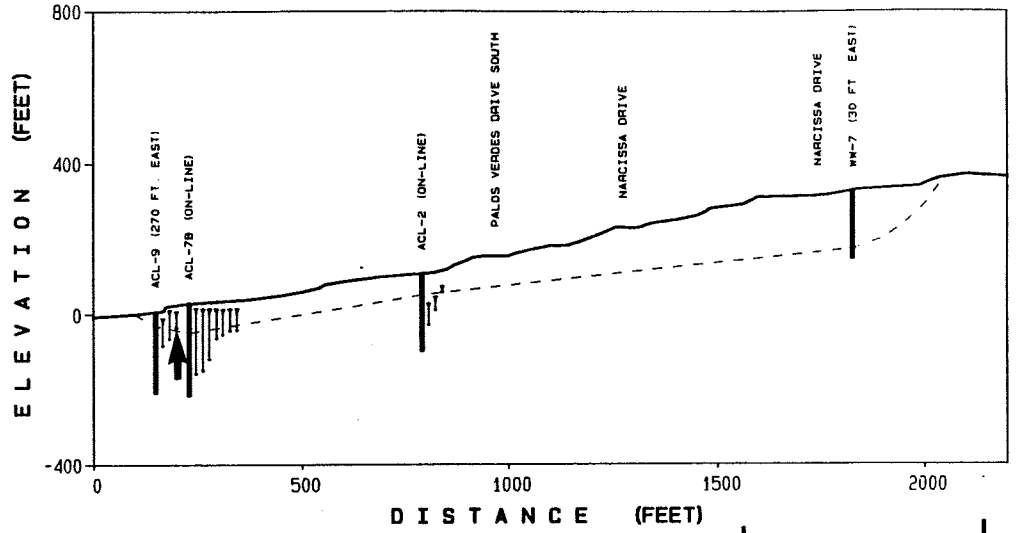


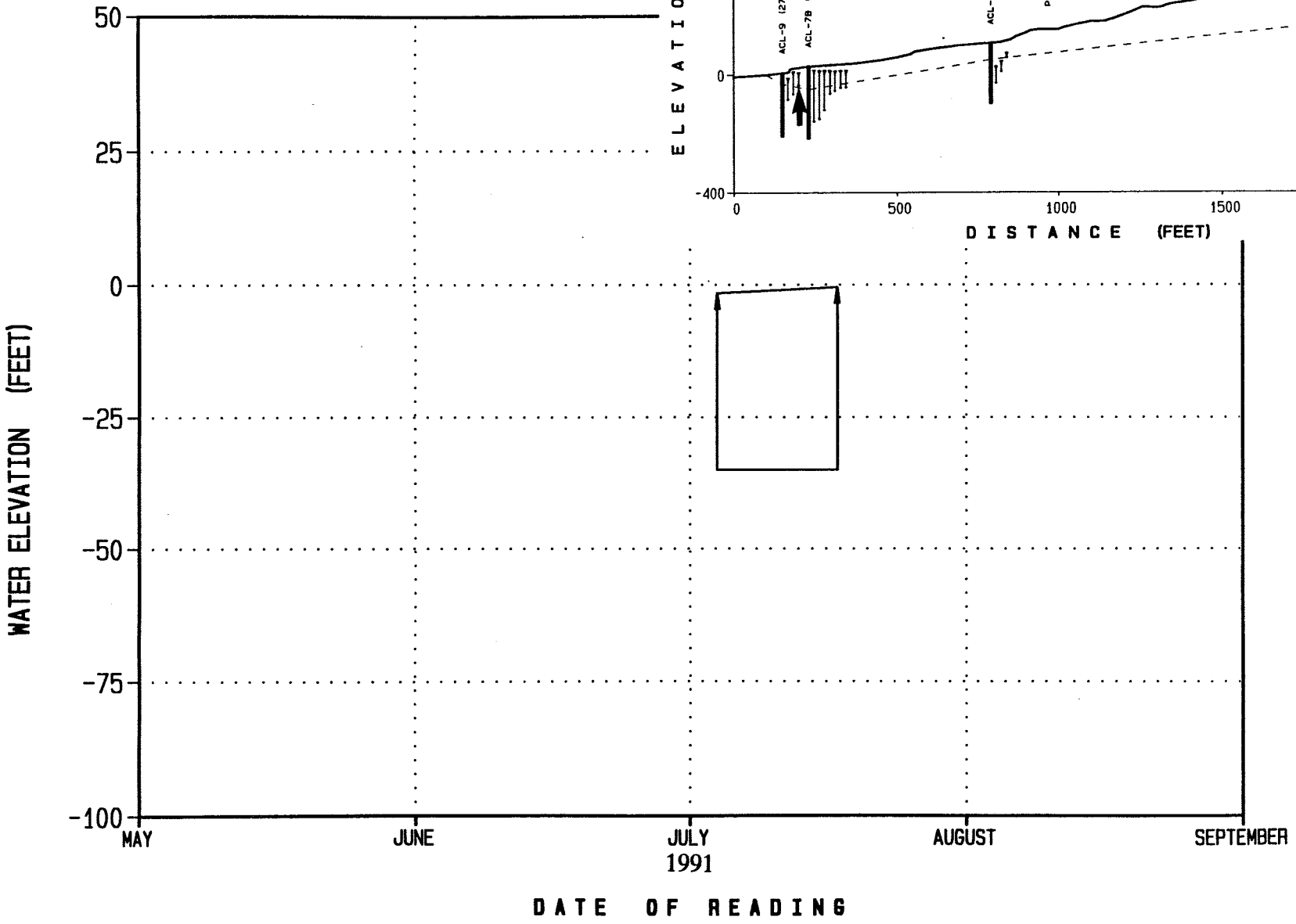
PROJECT # 54-247	ABALONE COVE PIEZOMETRIC LEVELS - ACL-9/TIP #1.	BING YEN & ASSOC.





PROJECT # 54-247	ABALONE COVE PIEZOMETRIC LEVELS - ACL-9/TIP #2.	BING YEN & ASSOC.





PROJECT # 54-247	ABALONE COVE PIEZOMETRIC LEVELS - ACL-9/TIP #3.	BING YEN & ASSOC.