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CASE HISTORY OF AN OPEN PIT COAL MINE SLOPE FAILURE AT LUSCAR, ALBERTA

by

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Submitted To The Faculty of Graduate Studies and Research
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ABSTRACT

The case history of a major open pit coal mine slope failure is described. The site is Cardinal River Coals Ltd. near Hinton, Alberta. The magnitude of the failure was approximately one million cubic yards (one million cubic metres). A substantial amount of piezometric and slope displacement data was collected before and after failure. The slope instability was detected from surface displacement measurements more than 100 days before any visual signs of failure appeared. The slope displacements were monitored on a continuous basis, permitting safe mining operations up to several hours before failure. The slope was ultimately stabilized by a rock fill toe buttress, to permit future mining in front of the failure. Analysis of slope displacements provided insight into the detailed mechanics of the failure. Stability analyses, combined with slope displacements, provided further insight into the nature of the failure.

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1.0 INTRODUCTION

This report describes the case history of a major open pit mine slope failure which occurred at Cardinal River Coals Ltd. pit 51-B-2 on November 10, 1979.

This case history is of particular interest because:

- the magnitude of the failure volume was relatively large, in the order of one million cubic yards (one million cubic metres);

- piezometric and slope displacement data was collected before and after failure, providing some insight into the details of the mechanics of failure;

- the slope instability was detected from displacement measurements long before any visible signs of failure were apparent;

- the slope displacements were monitored on a continuous basis through failure, permitting safe mining operations up to several hours before failure;

- the slope was ultimately stabilized by a rock fill buttress to permit future mining in front of the failure.

1.1 Units of Measurement

Since Cardinal River Coals Ltd. use the Imperial system of measurement for base maps and sections, the primary units utilized in the figures, text and tables of this report are Imperial for consistency. Wherever practical, metric units are provided in figures and text (in brackets). Raw data in tables is presented in the original units of the measuring instrument.

2.0 REGIONAL DESCRIPTION

2.1 Location and Access

Cardinal River Coals Ltd. is located in west-central Alberta approximately 25 miles (40 kilometres) south of Hinton and 200 miles (320 kilometres) west of Edmonton, on Alberta Highway 40 (Figure A.1, Appendix A). The mine occupies the site of the former town of Luscar.

Pit 51-B-2 is located mainly in Section 27, Township 47, Range 24 West of the Fifth Meridian.

2.2 Topography and Surface Drainage

The mine is situated along the southwestern limits of the Rocky Mountain Foothills, adjacent to the Front Ranges of the Rocky Mountains (Figure A.1).

Approximately 3 miles (5 kilometres) to the southwest, Luscar Mountain rises to 8500 feet (2590 metres) elevation. The ground surface slopes regionally to the northeast, falling to approximately 5000 feet (1525 metres) elevation at the northern edge of the mine site.

Within the mine site, natural ground elevations range from approximately 5000 to 6100 feet (1525 to 1860 metres) elevation.

Open pit coal mining extends down to approximately 5000 feet (1525 metres) elevation.

Surface drainage from the site flows west to Cabin Creek, east to Luscar Creek and north to Mary Gregg Creek, which all flow to the McLeod River.

2.3 Surficial Soils and Vegetation

Surficial soil cover across the site is typically thin, in the order of 10 feet (3 metres) or less except along stream valleys. Soils are predominantly colluvium and cordilleran till, which both strongly reflect the composition of underlying sedimentary bedrock. Constituent grain sizes consist predominantly of sand, with lesser amounts of clay and silt. The soils are generally very stony and well-drained.

Along stream valleys, soil thickness can exceed 10 feet (3 metres), and concentrations of coarser and finer-grained soils are formed by fluvial processes.

Prior to mining, the area was covered with trees, predominantly spruce and lodge pine.

2.4 Climate

The Hinton area has a continental subhumid climate, with long, cold winters modified by short periods of chinook conditions and short, cool summers. The mean annual temperature is approximately 34.3° F. (1.3° C.). Mean total precipitation is approximately 20 inches (510 mm), and evapotranspiration is approximately 14.5 inches (370 mm).

2.5 Land Use

Land uses include forestry, recreation and coal mining.

Mining at the Cardinal River Coals site was started in 1921 by Luscar Coal Ltd. Mining at Luscar continued by open pit and underground methods until 1956.

Mining was recommenced by Cardinal River Coals Ltd. in 1970. In 1979, Cardinal River produced 2.7 million clean short tons (2.5 million tonnes) of bituminous coal from three open pits including Pit 51-B-2. The coal was exported for consumption by the Japanese steel industry.

2.6 Regional Structural Geology

Tectonic forces from the southwest have produced major regional folding and faulting which trends northwest - southeast. The Lower Cretaceous strata of the Luscar area lie in two large folds, the Cadomin Synclinorium and the Luscar Anticlinorium, as mapped by Hill (1980) in Figure A.2. Major faults are the Nikanassin Thrust, which outcrops along the Front Ranges to the southwest and the Luscar Thrust, which outcrops between the axes of the two folds discussed above.

The Nikanassin Thrust dips steeply to the southwest at approximately 70°, with a dip direction of approximately 210°. Fault displacement is substantial, in places thrusting Upper Devonian Limestones over Cretaceous sediments. The Luscar Thrust outcrops at the south limit of Pit 51-B-2. Displacement along this fault is approximately 2400 feet (730 metres). The fault dips to the southwest at approximately 30° in the mine area, flattening to the southeast and steepening to the northwest. Associated with the Luscar Thrust are numerous small faults which displace the Jewel coal seam by several tens of feet. It has been inferred that the Luscar Thrust and associated minor faults were folded after faulting.

Pit 51-B-2 lies within the south limb of the Luscar Anticlinorium and is defined by a flat-bottomed syncline. The apical angle of the syncline is 140°, and the apical angle of the anticlinorium is 90°. The syncline apical angle decreases to the northwest, and the syncline is distorted into a "W" shape at the western limit of Pit 51-B-2.

Folding tends to cause thickening of the coal at the axes of the folds, which makes mining more economically attractive in these zones.

2.7 Regional Stratigraphy

Hill (1980) summarized the stratigraphic column for the Luscar area as shown in Table 2.1.

Table 2.1 - Stratigraphic Column for the Luscar Area.

Paleocene		Brazeau Formation
	Upper	Wapiabi Formation Cardium Formation Blackstone Formation
Cretaceous	Lower	Mountain Park Formation Luscar Formation Cadomin Formation Nikanassin Formation
Jurassic		Fernie Group
Triassic		Spray River Group
Paleozoic		Undivided

The mineable coal is confined to the Lower Cretaceous Luscar Formation. The stratigraphy of the Luscar Formation is depicted in Figure A.3, and is described further below.

Hill divided the Luscar Formation into A, B, C and D members. The Luscar Formation conformably overlies the Cadomin Formation and grades into the overlying Mountain Park Formation. Total thickness of the Luscar Formation is estimated to be 1400 feet (425 metres).

Member A

Member A at the base of the Luscar Formation, consists of thin, interbedded sandstones, siltstones and shales with thin coal seams. A coarsening upward sequence is prevalent, with coal or carbonaceous shale at the base and sandstone at the top. Total thickness is estimated to be approximately 413 feet (126 metres).

The sandstones are fine to medium-grained and light to dark grey, weathering to brown, orange and buff. They are predominantly calcareous although occasionally iron-rich, and frequently contain fossils.

The siltstones are typically fissile, dark grey or black weathering to green, brown and buff.

The shales are dark grey or black and frequently carbonaceous, grading into coal seams.

Member B

Member B consists mainly of shales, coarsening near the top into interbedded shales and siltstones, siltstones, and sandstones. Total thickness is approximately 312 feet (95 metres).

The basal shales are 60 feet (18 metres) thick, dark grey in colour and contain thin limestone beds.

The overlying interbedded shales and siltstones are typically dark grey, fissile and sometimes orange weathering.

The sandstones at the top are typically fine to medium-grained, light to dark grey, noncalcareous, orange weathering and sometimes cross-bedded.

Member C

Member C consists of the highly resistant, ridge-forming"Torrens" sandstone. It is 240 feet (43 metres) thick.

The member contains a central shale parting, approximately 100 feet (30 metres) below its top surface, with the overlying sandstone massive and the underlying sandstone well-bedded. The sandstone is medium-grained, light grey, buff to orange weathering and noncalcareous. Thin siltstones and thin chert pebble conglomerates are occasionally present.

Member D

Member D consists of thick sandstones and siltstones, interbedded sandstones, siltstones and shales and thick and thin coal seams. It is 597 feet (182 metres) thick.

At the base of this member is the Jewel coal seam, which averages 40 feet (12 metres) thick. This is the main economic coal seam. It contains three thin shale partings.

Approximately 243 feet (74 metres) above the base of Member D is the Ryder coal seam. It averages 12 feet (3.5 metres) thick and is much more shaley than the Jewel seam. The Ryder has not usually been mined.

The two coal seams are separated by thick-bedded sandstones and siltstones, with thin coal or carbonaceous shale seams occurring in or above the dark grey fissile siltstones.

The sandstones are typically light grey, weathering to orange and are mostly non-calcareous. Fine, medium and coarse-grained sizes are present in both massive and well-bedded units. The sandstones toward the top of the member are green-grey, grading into the Mountain Park Formation.

2.8 Regional Hydrogeology

Groundwater flow typically occurs along jointing and bedding. The most active groundwater flow is near surface and is strongly influenced by surface topography. Most groundwater is discharged into local topographic lows, with a small amount of recharge flowing to regional flow systems to the northeast.

Piezometric response during spring breakup or sudden rainstorms can be substantial, sometimes exceeding 100 feet (30 metres) over a few days.

Hydraulic conductivity (permeability) parallel to bedding is generally greater than across bedding, despite well-developed jointing patterns.

Due to the short groundwater flow path and slightly alkaline bedrock, groundwater quality is typically high. Total dissolved solids generally do not exceed 1,000 ppm, and carbonate-bicarbonate anions predominate.

3.0 SITE DESCRIPTION

3.1 Site Configuration

3.1.1 Pit 51-B-2 Configuration

Pit 51-B-2 is depicted in Figure A.4 and Plate 1.

Highway 40 crosses the 51-B pit area immediately west of Pit 51-B-2. The original topography prior to mining sloped to the west, with surface drainage flowing to Cabin Creek.

The pit is oriented Northwest-Southeast parallel to the regional structural trend, and is approximately 3000 feet by 3000 feet (900 metres by 900 metres) in size. Elevation ranged from approximately 5810 feet (1771 metres) at the highest point on the east wall to approximately 5333 feet (1625 metres) at the pit floor at the time of the November 10, 1979 slope failure. Pit design floor was 5067 feet (1544 metres).

Mining progressed in 33 foot (10 metre) lifts, with safety berms every second lift.

3.1.2 North Wall Slope Failure Configuration

The November 10, 1979 slope failure occurred in the North Wall of Pit 51-B-2, as depicted in Figure A.4 and Plates 2 to 7.

The original slope design (Golder Associates, 1975) recommended a 38° overall slope, with 30 foot (9 metre) wide safety berms at 67 foot (20 metre) intervals. The actual overall slope inclination measured through Section A-A' was 36°, Figure A.5. Berm widths were generally narrower than design width, due to back-break at the crest. Berm spacing was 67 feet (20 metres), starting from the 5633 foot (1717 metre) elevation.

The slope failure was 800 feet (245 metres) in length and contained an estimated volume of approximately one million cubic yards (1 million cubic metres) of rock. The height of the failure ranged from 290 feet (88 metres) at the west limit of the failure to 340 feet (104 metres) at the east limit. Elevation at the crest of the slope failure ranged from 5550 feet (1692 metres) at the west limit to 5670 feet (1728 metres) at the east limit. The natural slope above the failure rose gradually to approximately 5940 feet (1811 metres) elevation. The toe of the failure ranged in elevation from approximately 5367 feet (1636 metres) across the west half to approximately 5333 feet (1625 metres) across the east half.

3.2 Site Instrumentation

Measurements of slope displacements (movements) and piezometric elevations were performed before, during and after the failure. All instrument locations are shown in Figure A.4.

3.2.1 Slope Displacement Measurements

Slope displacement measurements employed the standard Radial Survey Method using a theodolite and Electronic Distance Measurement (EDM) instrument. A one-second theodolite was used to measure horizontal and vertical angles. The EDM unit measured the "slope distance" from the instrument to each retroreflector prism target on the slope, with a rated accuracy of $\pm$ 0.02 feet (0.005 metres). The three-dimensional coordinate of each target was calculated, and vectors of displacement derived from changes in target locations with subsequent measurements. A one-dimensional "slope distance" component of displacement was also used, since it provided somewhat higher accuracy.

The theodolite and EDM unit were mounted on a permanent concrete monument at Station KR-7 (Figure A.4). Target prisms were permanently mounted on steel posts, which were cemented into holes in the slope.

Inaccuracy in theodolite readings is generally due to pointing error.

Inaccuracy in EDM readings is generally due to inherent difficulties in measuring the atmospheric correction parameters (barometric pressure and temperature) along the line of measurement. Additional sources of error for both instruments are movement of survey reference stations, wind shake of instruments, and atmospheric heat waves.

Slope displacement data is included in Appendix B, and discussed in Section 4.0 of this report.

3.2.2 Piezometers

Standpipe piezometers were installed in individual boreholes, with two or three adjacent boreholes drilled to different depths constituting a "piezometer nest". Piezometer nests B04 (A and B), B07 (A,B and C) and B08 (A, B and C) were located in the north wall as depicted in Figure A.4. In each case, instrument A was established in the shallow borehole, with B and C progressively deeper. Each piezometer consisted of a 2 inch (50mm) nominal PVC plastic standpipe, slotted for an appropriate interval near the bottom of the borehole. The slotted "screen" inlet section was surrounded by clean, coarse sand and hydraulically isolated from overlying strata by bentonite balls and cement grout to surface. Measurements were taken using an electronic "dropline" to detect the water elevation in the standpipe.

Inaccuracy in a standpipe piezometer is generally due to hydraulic "plugging" of the screen inlet section, or to the misapplication of standpipes in relatively impervious ground such that the response of the instrument to changing groundwater pressure is excessively slow.

Piezometer data is included in Appendix C, and discussed in Section 4.0 of this report. The screen elevations of piezometer nests B07 and B08 are depicted in Figure A.5.

3.3 Site Structural Geology

3.3.1 Pit 51-B-2 Structural Geology

Strata in Pit 51-B-2 are folded into a broad syncline which follows the regional northwest-southeast trend and plunges gently to the southeast at an average angle of 5°.

In the north side of the pit, the coal seam is displaced downward and thickened due to an east-west striking thrust fault which dips steeply to the south, as depicted in Figure A.6. This fault is associated with tight chevron faulting and folding observed in the north end of the east pit wall. Fault displacement ranges from near zero at the east wall to approximately 100 feet (30 metres) at Section F0 + 00 in the failure area. The fault strikes sub-parallel to the synclinal fold structure which defines the geometry of Pit 51-B-2, such that its proximity to the north wall increases as it progresses to the northwest.

3.3.2 North Wall Structural Geology

Hebil (1980a) summarized the north wall structural geology based on 260 measurements of discontinuities made by mine and consultant's personnel in 1979. The results are depicted in plan in Figure A.7 and in a pole plot in Figure A.8, and the most significant discontinuity sets are summarized in Table 3.1.

Table 3.1 - North Wall Structural Discontinuities

Discontinuity	Strike	Dip	Dip Direction
Bedding	114°	38°S	204°
Joint Set J_1	213°	79°NW	303°
Joint Set J_2	281°	54°N	11°
Joint Set J_3	164°	70°E	74°
Joint Set J_4	143°	58°E	53°

Hebil divided the north wall into east and west portions at approximately 104,600E, the eastern limit of the slope failure. The average bedding dip of 38° was generally uniform, ranging between 35 to 40°. Major variations in bedding have been caused by structural features of local extent.

The east portion of the north wall was generally more uniform and planar than the west portion, averaging 38° bedding dip. This is believed to be due to the greater distance between the wall and the east-west trending thrust fault discussed above. However, folding and faulting associated with this thrust fault may intersect the east portion of the wall at greater depth. A northeast trending structural zone intersected the east end of the north wall causing local abrupt changes in bedding orientation, but was too far to the east to contribute to the failure.

The west portion of the wall included the slope failure. Bedding dip in the upper half of the west portion was relatively uniform, averaging 38°. The lower half of the west portion exhibited much more variable bedding. There were widespread observations of bedding dipping out of the slope at 25°, which undercut the overall slope, and steeply dipping upright and overturned beds at the toe of the slope. It was hypothesized that these features were associated with the thrust fault discussed above. It is believed that these features observed in the lower half of the slope were directly involved in the failure, as discussed further below.

Joint sets J1 and J2 were by far the most prominent in terms of frequency of occurrence. Sets J1 and J2 are essentially orthogonal with bedding, and are aligned with the northwest-southeast trending regional structural trend. The steep northwesterly dip of J1 correlates with the 5° average southeasterly plunge of the syncline.

The main fault mechanism observed in this area is thrusting along bedding planes. Moderately to intensely sheared surfaces exist on set J1, and to a lesser extent on J3 and J4. Set J1 joint spacing averaged approximately 1 to 3 feet (0.3 to 1 metre) in the north wall, but J1 frequency increased by approximately tenfold at the east limit of the failure.

Set J2 is generally not sheared. However, where bedding is steeply overturned at the toe of the failure, J2 could act as a plane of weakness dipping out of the slope at a shallow angle, thus facilitating failure surface development (Figure A.6).

3.4 North Wall Stratigraphy and Lithology

Pit 51-B-2 strata are situated entirely within the Luscar Formation, and the Jewel coal seam is the only seam of economic significance.

Information on lithology in the north wall is scant due to limited exposure and coreholes. Surficial soil typically consisted of sandy colluvium, in the order of 10 feet (3 metres) thick. A single corehole, number E21-R50 was drilled by Golder Associates in 1975 for design of the north wall. This hole is 900 feet (274 metres) east of Section F0 + 00, as shown in Figure A.4, and has been extrapolated onto section in Figure A.6. The corehole log is included in Appendix D.

Bedrock exposures at the surface of the north wall were predominantly sandstone, locally interbedded with thin siltstone and coal seams. Bedding plane partings were slickensided. An east trending linear depression in the crest of the north wall original ground surface coincided with the location of the tension crack. It was hypothesized by Hebil (1980a) that this depression coincided with weaker, more erodable beds deeper in the wall, which could have contributed to slope instability.

There is some support for this hypothesis from corehole E21-R50. At a depth of 133 to 141 feet (40.5 to 43.0 metres), which coincides with the inferred location of the failure surface, a zone of interbedded soft carbonaceous clay was observed in the core. Clay infilling of fractures was observed repeatedly along the length of the corehole, and occasional coal stringers were also present. RQD (rock quality designation) from 122 to 142 feet (37.2 to 43.3 metres) ranged as low as 20%. Since the overall geologic structure plunged approximately 5° to the southeast, this weak zone would be expected to occur at a somewhat higher elevation in the failure area.

In summary, lithology in the footwall consisted primarily of sandstones and siltstones, with frequent clay infilling of bedding fractures, occasional coal stringers, and a soft carbonaceous clay layer in the vicinity of the failure surface.

3.5 Site Hydrogeology

Piezometers in the slopes of open pit mines at Cardinal River Coals Ltd. typically exhibit downward hydraulic gradients. The shallowest (A) piezometers respond rapidly to surface runoff and precipitation, and the deeper piezometers respond more slowly or not at all. During spring thaw, increases in groundwater elevations in shallow piezometers of up to 100 feet (30 metres) are not uncommon.

Piezometer nests B04 (A and B), B07 (A, B, and C) and B08 (A, B, and C) are depicted in Figures A.4 and A.5. Piezometric data is summarized in Appendix C.

In Figures C.1 to C.3, piezometric elevations are plotted with respect to time. Piezometric elevations in early March 1979 (Day 60) ranged from 5587 down to 5489 feet (1702.9 to 1673.0 metres). This is the seasonal low for groundwater elevations, and the time when flow systems are closest to steady-state conditions.

Certain anomalous behaviour was apparent in the north wall piezometers. In early March (Day 60), piezometers B07B and B08B exhibited strongly artesian conditions with groundwater elevations approximately 60 feet (18 metres) higher than the adjacent A and C piezometers. The similarity in profile of B04B and B07B, and the slight hydraulic gradient to the west from B04B to B07B to B08B, indicate that these piezometers intersected the same artesian aquifer along strike, and that recharge was primarily from the east. This inference correlates with the local topographic high up bedding dip to the northeast. It is also apparent that piezometer BO7A is plugged, which was confirmed by response tests.

The substantial hydraulic gradient across bedding indicates that hydraulic conductivity (permeability) across bedding is much less than that parallel to bedding.

The rapid response of piezometers BO7A and BO8A to spring thaw is apparent starting in early April (Day 94), when levels in both piezometers rose approximately 50 feet (15 metres). A smaller, delayed response is observed in deeper piezometers BO4B and BO7B.

Further comments on groundwater conditions related to the slope failure will be included in Section 4.0 of this report.

4.0 ANALYSIS OF SLOPE FAILURE

The following section includes an overview summary of events, a more detailed analysis of the mechanics of the failure, and a computer back-analysis of the failure.

Due to the very large amount of data available from Pit 51-B-2, only that data considered directly pertinent to the failure is included in this report. Certain slope displacement targets on the north wall were deleted (for example, targets which were lost in the early stages of movement, or targets which were distant from the failure). Unfortunately, much of the original "slope distance" data obtained by contract surveyors from the continuous monitoring of the slope has been lost; all remaining data has been included. Dewatering data was sparse and of little practical value to this analysis; it has not been included, although the results are apparent in the piezometric data.

The rate of progress of mining is apparent in Figures A.10 to A.20 inclusive, Appendix A.

Slope displacement data is summarized in Appendix B and piezometric data is included in Appendix C.

4.1 Summary of Major Events

A brief overview of the major events of this case history is presented, as these events were interpreted in monthly site inspection reports by the project geotechnical consultants. A more detailed analysis of events with the benefit of hindsight is provided in Section 4.2.

Time is represented in days, starting with Day 1 on January 1, 1979.

Prior to the beginning of 1979, the north wall of Pit 51-B-2 exhibited no significant movement, with the exception of a small localized slope failure in the area of Target 22B. The adverse orientation of bedding with respect to slope stability had been identified. The artesian piezometric condition in the north wall had also been identified, and recommendations for slope dewatering were submitted.

From January 28 (Day 28) to May 8, 1979 (Day 128), a slope displacement of 0.05 feet (0.015 metres) was observed in Target 26B. This apparent slope movement was too close to measurement system accuracy for conclusive analysis. Piezometers B07A and B08A reached annual minimum elevations of approximately 5500 feet (1676 metres) on or about March 1 (Day 60), and then rose sharply due to spring thaw.

From May 8 (Day 128) to June 11 (Day 162), movement occurred at all north wall targets, with the maximum observed change at Target 26B equal to 0.20 feet (0.061 metres) over this time interval.

Piezometers B07A and B08A reached their annual maximum elevations of approximately 5550 feet (1692 metres) in this period, approximately 50 feet (15 metres) above annual minimum elevations. Mining immediately below the north wall was considered a major contributing factor to these slope movements. The north slope was flagged as an area requiring particular vigilance.

From June 11 (Day 162) to July 9 (Day 190), movements at all targets on the north wall progressed more slowly, with the maximum change of 0.05 feet (0.015 metres) occurring at Target 26B. Cumulative movement in Target 26B was now 0.31 feet (0.094 metres) in the horizontal component, and continued movement of the north wall was identified as cause for major concern as the pit deepened.

From July 9 (Day 190) to August 13 (Day 225), slope movements were relatively insignificant. The north wall was reported to be temporarily stable, but renewed movement was predicted.

From August 13 (Day 225) to September 4 (Day 247), major renewed movement was observed, with the maximum change of 0.29 feet (0.088 metres) at Target 26B, and lesser changes at Targets 21B and 22B. Cumulative displacement at Target 26B was now 0.60 feet (0.183 metres) in horizontal component at an azimuth of 245° (trending downslope to the west), and 0.21 feet (0.064 metres) downward in vertical component. Between August 14 (Day 226) and September 6 (Day 249), Piezometer B08B was observed to fall sharply from 5547 to 5507 feet (1691 to 1679 metres).
On September 11 (Day 254), the north slope area was inspected in detail. There was no visual evidence of any slope movement. Concern with regard to measured slope movements was restated, and recommendations were made to perform a more detailed evaluation of north wall slope stability and to install additional targets for slope displacement measurements.

From September 4 (Day 247) to October 4 (Day 277), movements at all targets on the north wall progressed more slowly. The maximum change of 0.15 feet (0.046 metres) in horizontal component occurred at Target 26B.

From October 4 (Day 277) to October 22 (Day 295), movement at Target 26B accelerated, changing 0.23 feet (0.070 metres) in horizontal component.

On October 26 (Day 299), a 33 foot (10 metre) lift was blasted immediately below Target 26B.

Between October 22 (Day 295) to October 29 (Day 302), movement at Target 26B accelerated sharply, changing 0.70 feet (0.213 metres) in horizontal component. A large tension crack was observed at the crest of the slope, confirming that a full height slope failure was in progress.

The following steps were initiated:

- access of men and equipment in front of the failure was stopped, and a rock window barricade placed across the pit floor;
- surface water infiltration into the tension crack was controlled by surface grading;
- remedial dewatering was commenced to attempt to stabilize the failure;
- additional displacement measurement targets were installed;
- continuous survey displacement monitoring was established;
- a "critical slope velocity" of 0.10 feet/hour (0.030 metres/hour), measured in "slope distance" component, was established, at which point all pit personnel and equipment would be evacuated;

Of the targets existing prior to October 31 (Day 304), only 26B was located on the failure. On October 31, Targets 37B to 40B were installed on the failure.

From October 31 (Day 304) to November 10 (Day 314) at 9:00 hours, movements of all targets on the failure strongly accelerated. Target 26B on the east end of the failure moved the least, changing 2.68 feet (0.817 metres) in horizontal component. Movement increased toward the west end of failure, changing a maximum of 4.94 feet (1.505 metres) in horizontal component at Target 37B.

On November 10 (Day 314) at approximately 8:00 hours, the critical slope velocity was attained. Pit personnel and equipment were evacuated. Failure cumulative displacement to this time was approximately 7 feet (2 metres) maximum horizontal component at Target 37B.
At approximately 13:00 hours, rapid slope failure occurred. Maximum displacement of an additional 16 feet (4.9 metres) horizontal component occurred at Target 37B, after which the failure decelerated.

On November 11 (Day 315), operations resumed in the east half of the pit, distant from the failure, under continuous survey displacement monitoring. A new "critical slope velocity" of 0.05 feet/hour (0.015 metres/hour) was established.

During November and December, attempts were made to dewater the slope to enhance stability. Due to access and cold weather difficulties, dewatering progress and effectiveness was limited.

A rock fill buttress was proposed to stabilize the slide, with continued dewatering as a secondary stabilization measure.

In January 1980, the rock buttress was placed in front of the slide, with the aid of continuous survey displacement monitoring. By January 31 (Day 396) slope movement had ceased.

During the time of this slope failure, mining of Pit 51-B-2 continued safely with a loss of only 1 day of production on November 10. Mining was completed with a minimal redesign and no loss of coal.

4.2 Detailed Analysis of Events

The following detailed analysis of events has been developed with the benefit of hindsight, and utilizes information summarized in Appendices A to C inclusive. In order to obtain the highest possible accuracy, one-dimensional "slope distance" measurements are used where available instead of three-dimensional components, which exhibit slightly lower accuracy. Mining progress is expressed in terms of 33 foot (10 metre) "lifts", with fractional lifts being used to indicate the approach of a subsequent lift to the north wall.

From March 31, 1978 to March 6, 1979 (Day 65), Targets 21B and 23B exhibited no measurable movement. Target 22B moved approximately 2.1 feet (0.6 metres) in a small, single bench scale failure. The failure was approximately 150 feet (45 metres) long and the tension crack was a maximum of 30 feet (9 metres) from the crest of the 5633 foot (1717 metre) bench. The failure was due to adverse localized bedding orientation and temporary surface water ingress, and was not a contributing factor to the November 10, 1979 failure.

From March 6 (Day 65) to May 8 (Day 128), Targets 21B to 26B all moved 0.05 feet (0.015 metres) or less, as depicted in Figure B.13c. This movement was within the range of accuracy of the measurement system and no true slope movement is inferred. During this time Piezometer B08A rose by 48 feet (14.6 metres) to its seasonal maximum of 5553 feet (1693 metres), as depicted in Figure C.3. Mining consisted of 1 1/2 lifts across the west half of the November 10 future failure area, and 1/2 lift across the rest of the north slope.

It is apparent that, to this time, neither high seasonal groundwater conditions nor major mining below the slope had any significant impact on stability.

From May 8 (Day 128) to May 29 (Day 149), Targets 21B to 26B all moved rapidly. Cumulative displacements correlated with distance to the west along the slope, ranging from 0.063 feet (0.019 metres) at Target 25B to 0.178 feet (0.054 metres) at Target 26B. Piezometer B08A fell by 18 feet (5.5 metres) to 5535 feet (1687 metres) while B07A remained high. Mining consisted of 1 1/2 lifts across the west half of the failure to elevation 5433 feet (1656 metres) and 1/2 lift across the rest of the north slope to 5400 feet (1646 metres).

It is apparent that mining below 5500 feet (1676 metres) in the west half of the failure and below 5433 feet (1659 metres) to the east, was the primary change which affected slope stability during this time. However, the relative importance of groundwater as a destabilizing factor is not being disregarded, and will be quantified further in the Stability Analysis, Section 4.4.

The lack of symmetry between piezometers B08A and B07A is of interest, since these instruments displayed virtually identical behavior in 1978 (1978 data not shown). It is possible that near-surface ground displacements in the western portion of the slope enhanced drainage in this area.

From May 29 (Day 149) to July 30 (Day 211), virtually no movement occurred in any target. Piezometer B08A continued to fall by 25 feet (7.6 metres) to 5510 feet (1679 metres). Mining was relatively inactive, removing less than 1/2 lift across the slope.
The correlation of slope displacement with mining activity remains strong.

From July 30 (Day 211) to August 27 (Day 239), Targets 21B to 26B all moved rapidly. Cumulative displacements again correlated with distance to the west along the slope, ranging from 0.150 feet (0.046 metres) at Target 23B to 0.351 feet (0.107 metres) at Target 26B. Piezometer B08A continued to decline by 6 feet (1.8 metres) to 5504 feet (1678 metres). Piezometer B08B fell sharply from its artesian level of 5547 feet (1691 metres) on August 14 (Day 226) to 5511 feet (1680 metres) by August 27 (Day 239). Mining in this period excavated 1 lift below the future failure to elevation 5400 feet (1646 metres), and approximately 1/2 lift to the east to elevation 5367 feet (1636 metres).
The correlation of slope displacement with mining activity continues to gain strength. The magnitude of displacements was increasing for equivalent mining increments, which could indicate

that the pit floor was approaching a structural discontinuity which strongly contributed to the displacements. The entire slope continued to move essentially as a single block - the failure volume which included Target 26B had not yet broken away from the remaining slope, although movements continued to be greatest at the west side of the slope.

The cause of the rapid fall of Piezometer B08B is of interest, and is discussed further below. For the purpose of slope stability analysis, it is reasonable to assume a groundwater elevation of approximately 5500 feet (1676 metres) at the B08 piezometer locations from this time onward.

From August 27 (Day 239) to September 10 (Day 253), Target 26B accelerated to 0.519 feet (0.158 metres), while the remaining targets were comparatively inactive (Figures B.13b and B.13c). This could indicate the initial separation of the failure volume from the rest of the slope along the subsequently observed surface parallel to joint set J1.

From September 10 (Day 253) to October 4 (Day 277), movement of all targets continued at a somewhat slower rate than during August. Cumulative displacements ranged from 0.163 feet (0.050 metres) at Target 23B, increasing to the west to 0.624 feet (0.190 metres) at Target 26B. Piezometer B08B fell to 5501 feet (1677 metres). Mining excavated 1 lift below the east half of the failure, to elevation 5367 feet (1636 metres) amd 1/2 lift further to the east.

The conclusions drawn from August data continue to be valid.

From October 4 (Day 277) to October 22 (Day 295), movement of Target 22B accelerated to 0.629 feet (0.192 metres) and Target 26B accelerated to 0.824 feet (0.251 metres), while the remaining targets were inactive. Piezometric elevations were unchanged. Mining had excavated 1 lift from the west half of the failure to 5367 feet (1636 metres) elevation, and had completed the 1/2 lift to the east to 5333 feet (1625 metres) elevation.

It is clear that the failure volume had separated from the remainder of the slope, and Target 26B was accelerating.

The small bench scale failure of 1978, on which Target 22B was located, was immediately adjacent to the new larger failure and was being dragged along due to the "edge effect" of the new failure.

To this point, no surface cracking was apparent from visual inspection.

Mining continues to correlate strongly with slope displacement.

On October 26 (Day 299), the lift from elevation 5367 feet (1636 metres) to 5333 feet (1625 metres) was blasted across the east half of the failure.

By October 29 (Day 302), Target 26B displacement had accelerated to 1.457 feet (0.444 metres), and average velocity was 0.004 feet/hour (0.001 metres/hour). The tension crack delineating the failure became visible. As detailed in Section 4.1, safety and remedial measures were implemented.

A "critical slope velocity" of 0.10 feet per hour (0.030 metres/ hour) was established. Actual slope velocities at individual targets are depicted in Table B.5 and plotted in Figures B.15 to B.19. The informational basis for selection of the critical slope velocity was quite limited. The fact that no further work was conducted in front of the failure permitted the use of a relatively high critical velocity. Also, since the failure encompassed the full slope height and was "dozing" the toe in front, it was unlikely that the failure would move excessively far or fast. The selected "critical slope velocity" allowed several hours to evacuate the pit, which was highly desirable from the standpoint of labour and government relations as well as for safety reasons.

On November 10 (Day 314), rapid slope failure occurred following a steady acceleration of target displacements. As measured previously, displacement was greatest at the west end of the failure. As of 13:45 hours on November 10, the cumulative "slope distance" displacements (Figure B.14a) on the failure, proceeding from east to west were:

Target 26B - 12.008 feet (3.660 metres) since March 6, 1979,
Target 38B - 12.900 feet (3.932 metres) since Oct. 31, 1979,
Target 40B - 14.888 feet (4.538 metres) since Oct. 31, 1979,
Target 37B - 19.803 feet (6.036 metres) since Oct. 31, 1979,
Target 39B - 17.497 feet (5.333 metres) since Oct. 31, 1979.

The behaviour of Target 39B was slightly anomalous. This is discussed further in Section 4.3, together with a more detailed analysis of three-dimensional slope displacements.

From November 10 (Day 314) to January 16, 1980 (Day 381), the slope decelerated steadily, as depicted in Figure B.5b. The timing of buttress placement is estimated to be from approximately January 2 (Day 367) to January 20 (Day 385), as inferred from the last date of reading of targets as follows:

Target 39B - January 7 (Day 372),
Target 37B - January 10 (Day 375),
Target 40B - January 10 (Day 375),
Target 38B - January 16 (Day 381).

It is apparent that the failure was decelerating significantly before the buttress was placed. There is no doubt, however, that the buttress arrested the movement and provided an additional degree of safety for future mining operations.

The impact of dewatering on slope stability was minor. Practical problems associated with access and winter conditions made dewatering of the upper strata in contact with Piezometer B08A relatively ineffective. The 120 foot (37 metre) fall of B08C in response to pumping may indicate that dewatering of upper horizons could have been effected under less adverse conditions. The high contrast in hydraulic conductivity across bedding versus parallel to bedding is demonstrated by this data (Figure C.3).

The rapid fall of Piezometer B08B in August 1979 is due to one of two possible, if improbable, causes: either slope displacements directly affected the strata near the inlet screen, which is 150 feet (45 metres) stratigraphically below the inferred failure surface; or the piezometer standpipe sheared near the ground surface in response to movement, while the adjacent Piezometer B08C remained intact.

This analysis, derived with the benefit of hindsight, is not materially different from that derived from monthly consultants reports in Section 4.1. This fact strongly supports the continued practise of slope displacement monitoring as a key predictive and analytical tool for open pit mine slope stability management.

4.3 Detailed Analysis of Slope Displacements

Target displacements are tabulated and plotted in Appendix B.

Displacement directions (azimuths and inclinations) were remarkably constant over the full range of displacement. Initially, variability was greatest due to the small size of the cumulative displacement, which was of the same order of magnitude as measurement system accuracy.

The true magnitudes of target displacements and the displacement directions are summarized in Table 4.1, and plotted in Figure A.19.

The azimuths for Targets 21B to 26B, which were oriented to the west of the downslope direction, appear valid and must reflect some stress relief in that direction as a result of mining. The additional westerly movement of Target 26B, as compared with Targets 21B to 25B probably reflects a degree of dilation occurring along the near-vertical eastern failure surface parallel to joint set J1. Azimuths of targets on the failure can be "grouped" by elevation, which logically correlates with individual beds which can slide over one another - Target 37B and 38B azimuths are 208° and 206°, respectively, and Target 39B and 40B azimuths are 202° and 200°, respectively.

Table 4.1 - Magnitude and Direction of Target Displacements

Time Interval	Target Number	Magnitude feet (m)	Azimuth degrees*	Inclination degrees*
Mar. 6, 1979 (Day 65) to Jan. 3, 1980 (Day 368)	21B	0.669 (0.204)	250	20
"	22B	1.148 (0.350)	240	30
"	23B	0.343 (0.105)	250	20
"	25B	0.351 (0.107)	260	15
Mar. 6, 1979 (Day 65) to Oct. 31, 1979 (Day 304)	26B	2.030 (0.619)	239	23.5
Oct. 31, 1979 (Day 304) to Jan. 7, 1979 (Day 372)	26B	23.941 (7.297)	223	30.7
"	37B	40.550 (12.360)	208	24.9
"	38B	27.409 (8.354)	206	23.7
"	39B	36.099 (11.003)	202	31.4
"	40B	29.632 (9.032)	200	14.5
Nov. 3, 1979 (Day 307) to Nov. 9, 1979 (Day 313)	42B	1.232 (0.376)	198	-10.7° (upward)

* Azimuths and inclinations for Targets 21B to 25B have been rounded to the nearest 5° to reflect actual accuracy at small displacements.

The inclinations of Targets 26B, 38B, 40B and 42B were respectively 30.7°, 23.7°. 14.7°, and - 10.7° (upward). These targets form a nearly vertical section through the slope. The gradually decreasing inclination of these targets, the magnitude and the consistency of inclinations with time tend to support the hypothesis that these inclinations were parallel to the curved failure surface. An inferred failure surface parallel to these movements is depicted in Figure A.5.

The inclination of Target 37B was 24.9°, which correlates well with Target 38B, at the same elevation to the east. The inclination of Target 39B was 31.4°, which does not correlate with Target 40B to the east. The magnitude of Target 39B displacement was also anomalous, as discussed further below.

The magnitudes of displacements at Targets 21B to 25B adjacent to the failure logically correlate with proximity to the failure. As previously stated, Target 22B was situated on a bench-scale failure which moved alongside the November 10 failure, and so exhibited disproportionally large displacements.

As stated previously, displacement was greatest in the western portion of the failure, with the maximum total vector of 40.6 feet (12.36 metres) observed at Target 37B. Target 38B, at the same elevation and 334 feet (102 metres) to the east, moved only 27.4 feet (8.35 metres).

Total displacements through the vertical section at Target 38B were "normalized" to remove the effect of the observed increase in displacement toward the west. The resulting normalized total displacement vectors of Targets 26B, 38B and 40B are 26.8 feet, 27.4 feet, and 26.7 feet (8.17 metres, 8.35 metres, and 8.14 metres, respectively). Within the accuracy limitations of the normalizing technique, these numbers are identical.

The magnitude of Target 39B displacement was 4.5 feet (1.37 metres) less than that of nearby Target 37B. As stated previously, the inclination of Target 39B displacement was also anomalous. It is apparent that Target 39B was involved in a bench scale failure which separated from the total failure. Since total displacement of Target 39B is less than Target 37B, the main failure surface at the west end of the failure must lie above Target 39B. The absence of movement at Target 43B supports but does not conclusively prove this hypothesis.

The use of velocities calculated from displacements to assess impending slope failure involves certain complications, which must be recognized. The reading interval between displacements must be sufficiently large to permit displacements well in excess of measurement accuracy, or the resulting velocities will be misleading. This phenomenon is responsible for some of the "scatter" in velocities, as apparent in Figures B.15 to B.19.
The use of the same time interval between subsequent readings

helps to control this potential problem. This was practised in the field, but unfortunately not all the hourly readings were available for this report. Accordingly, velocity data presented herein must be evaluated with allowance for the above limitation.

The displacements in Targets 21B, 23B and 25B after the November 10 failure, as depicted in Figure B.13c, exhibit "scatter" in displacements ranging in excess of 0.10 foot (0.003 metres), substantially larger than demonstrated measurement system accuracy. Although not conclusively proved, it is concluded that the above displacements were real, and reflect "chatter" of the stable slope in response to "slip-stick" action of the adjacent failure along the near-vertical eastern failure surface parallel to joint set J1.

4.4 Stability Analysis

A back-analysis of the slope failure was performed with the GEOSLOPE computer program, which utilizes the Janbu analytical procedure. The analysis was run through an idealized section A-A' as depicted in Figure A.9. Detailed data on individual stability analyses is included in Appendix E.

The analysis was run for several different failure surfaces, piezometric surfaces, and material strength properties, for slope geometries without and with the stabilizing rock fill buttress. These trials are summarized in Table E.1.

The initial failure surface analysed was a bilinear surface, with the lower surface assumed to be in disturbed bedrock dipping at a shallow angle out of the slope and the upper surface parallel to the average bedding angle. The disturbed bedrock surface was assumed to have a friction angle of 25°, and the bedding effective friction angle was back-calculated to 35°, at a factor of safety of 0.985. The stablizing impact of the buttress was substantial, raising the factor of safety to 1.433. In comparison, dewatering to lower the piezometric surface by 40 feet (12.2 metres) produced a factor of safety of only 1.145. Lowering the piezometric surface by 80 feet (24.4 metres) produced a factor of safety of 1.259. A buttress half the height of the actual buttress produced a safety factor of 1.269.

The second failure surface investigated was a curved surface parallel to the measured displacements of the slope (labelled Curve 1 in Table E.1). This surface exhibited a factor of safety of 1.121, 14% higher than the equivalent analysis which utilized the bilinear surface. This difference is, however, due largely to the longer length of the bilinear surface in the 25° disturbed material. There is no significant higher degree of stability of the curved surface over the bilinear surface. The stabilizing impact of the buttress is of similar magnitude for both surfaces. The curved surface was back-analysed at a factor of safety of 0.986, to yield a friction angle approximately parallel to bedding of 31.3°.

Other failure surfaces investigated included a modified curved surface (Curve 2) with no upward component at the toe, and a series of circular surfaces. Both displayed factors of safety slightly higher than Curve 1.

The above analyses demonstrate the relative insensitivity of the factor of safety to minor geometric variations in the failure surface, and its higher sensitivity to frictional properties along the failure surface. Additional runs were performed using a single shear strength for upper and lower portions of the rock slope, in both drained and undrained modes.

The bilinear surface demonstrated a back-calculated friction angle of 32.1°, and a factor of safety after buttress completion of 1.550. For the curved failure surface, the back-calculated friction angle was 30.8°, and the factor of safety after buttress completion was 1.449.

Undrained (ϕ = 0) analyses were run since there were clay seams in the slope near the failure surface. For the bilinear surface, an undrained shear strength of 3900 pounds per square foot (187 kPa) was back-calculated. While this figure is not considered realistic, the impact of using the undrained analysis on the factor of safety after buttress placement is significant. With the buttress, the factor of safety for the undrained case is only 1.053, versus 1.550 for the corresponding drained case. If only part of the failure surface behaved for some time in the undrained mode, the stabilizing effect of the buttress would have been decreased and delayed as excess pore pressures dissipated.

5.0 CONCLUSIONS

1. Using displacement monitoring methods which measure the movements on the surface of the slope, the following practical accomplishments were achieved:

   i) The November 10, 1979 (Day 314) failure was flagged as an area requiring particular vigilance as early as June 11 (Day 162), 152 days before failure.

   ii) By July 9, (Day 190) continued movement of the north wall was confirmed as a cause of major concern as the pit deepened. This was 112 days before the appearance of any visual signs of failure, and 124 days before failure occurred.

   iii) Pit 51-B-2 operations were safely conducted up to several hours before failure, and only one day of production from the pit was lost due to the failure.

   iv) The stabilizing buttress was safely placed in front of the moving failure, with no danger to men or equipment.

2. Analysis of slope displacements provided insight into the detailed mechanics of the failure:

   i) Prior to the separation of the failure volume from the rest of the slope, the entire slope displaced horizontally. Movement to August 13 (Day 225), was 0.159 feet (0.048 metres) at Target 23B, increasing to the west to 0.311 feet (0.095 metres) at Target 26B.

ii) Initial separation of the failure volume from the rest of the slope occurred between August 13 (Day 225) and September 4 (Day 247).

iii) Following separation of the failure volume, the stable slope to the east displaced horizontally inward and outward, reflecting "chatter" in response to "slip-stick" actions of the adjacent moving failure.

iv) Slope displacements correlated strongly with mining activity. This could indicate that the pit floor was approaching a structural discontinuity which strongly contributed to the displacements, although other valid interpretations are possible.

v) Placement of the buttress decelerated the failure gradually to a stop. The buttress was more than half placed by January 16 (Day 381), and was fully placed by January 21 (Day 386), but movements continued until at least January 31 (Day 396).

vi) The failure volume moved as a single intact volume, with the exception of the area near Target 39B which was part of a separate smaller failure. Total displacement of the failure volume ranged from approximately 26 feet (7.9 metres) at Target 26B, increasing to the west to approximately 45 feet (13.7 metres) at Target 37B.

vii) It is believed that the consistent inclinations displayed by Targets 26B, 37B, 38B and 40B are parallel to the actual failure surface.

3. The results of the stability analyses, combined with the slope displacement data, provide further insight into the mechanics of the failure:

   i) As noted above, the failure decelerated slowly in response to buttress placement. In the drained analysis, the high factor of safety demonstrated after buttress placement would lead to a rapid cessation of failure movement. It is concluded that at least part of the failure surface material acted in the undrained mode.

   ii) While there are many variables involved which lead to a wide range of possible results, the back-calculated average effective angle of friction along the failure surface is believed to range from 30° to 32°.

   iii) The factor of safety after buttress placement will ultimately equal 1.4 to 1.5, after dissipation of excess pore pressures along the failure surface. The failure could, however, be susceptible to renewed movements due to excess pore pressures generated by blast vibrations.

4. Piezometric data yielded the following conclusions:

   i) Displacement of the slope prior to failure resulted in dewatering of the strata containing Piezometer B08A in May 1979. This is inferred to be due to the opening of jointing in response to slope deformation.

   ii) The cause of the fall in Piezometer B08B in August 1979 is less obvious. This is possibly due to slope deformation causing dewatering of the strata, but the depth is too great to strongly support this hypothesis.

LIST OF REFERENCES

Currie, D.V. 1976. Hydrogeology of the Tri-Creek Basin, Alberta Research Council, Bulletin 33, Edmonton.

Dahlstrom, C.D.A. 1970. Structural Geology in the Eastern Margin of the Canadian Rocky Mountains. Bulletin of Canadian Petroleum Geology, V18, pp. 332-406.

Hebil, K.E. 1980a. Report of Geological Investigation of the North Wall of 51-B-2 Pit. Cardinal River Coals Ltd.

Hebil, K.E. 1980b. Report on Structural Mapping of Pit Walls at the Cardinal River Mine.

Hill, K.C. 1980. Structure and Stratigraphy of the Coal-Bearing and Adjacent Strata near Cadomin, Alberta. M.Sc. Thesis, University of Alberta, Edmonton.

Holter, M.E. and Mellon, G.B. 1972. Geology of the Luscar (Blairmore) Coal Beds, Central Alberta Foothills. Proceedings of the First Geological Conference on Western Canadian Coal. ed. G.B. Mellon, J.W. Kramers and E.J. Sengal, pp. 125-135.

Irish, E.J.W. 1965. Geology of the Rocky Mountain Foothills, Alberta. Geological Survey of Canada, Memoir 334, Ottawa.

Johnson, R.S. 1982. Slope Stability Monitoring. Proceedings of the Fourth Canadian Symposium on Mining Surveying and Deformation Measurements, Banff.

MacKay, B.R. 1929. Cadomin, Alberta. Geological Survey of Canada Map 209A, Ottawa.

MacRae, A.M. 1978. Pit Slope Displacement Monitoring - An Aid to Open Pit Mine Operation. E/MJ Operating Handbook of Mineral Surface Mines, McGraw-Hill Inc., New York.

MacRae, A.M. 1982. Case Histories of Pit Slope and Waste Dump Failures in Western Canada. Fourth Open Pit Operators Conference, Edmonton. Canadian Institute of Mining and Metallurgy, Montreal.

Reimchen, T.H.F. and Bayrock, L.A. 1977. Surficial Geology and Erosion Potential, Rocky Mountains and Foothills of Alberta. Alberta Research Council, Open File Report 1977-14, Edmonton.

LIST OF REFERENCES (Continued)

Tribe, J. 1980. Luscar's Coal Mining Operations.CIM Bulletin, January 1980. Canadian Institute of Mining and Metallurgy, Montreal.

Golder Associates 1975. Report to Cardinal River Coals Ltd. on Rock Slope Design for Pit 51-B-2.

Cardinal River Coals Ltd. 1977. Development and Reclamation Plan.

Cardinal River Coals Ltd. 1978. Application for Pit Licence for Pit 51-B-2 Phase II Pit.

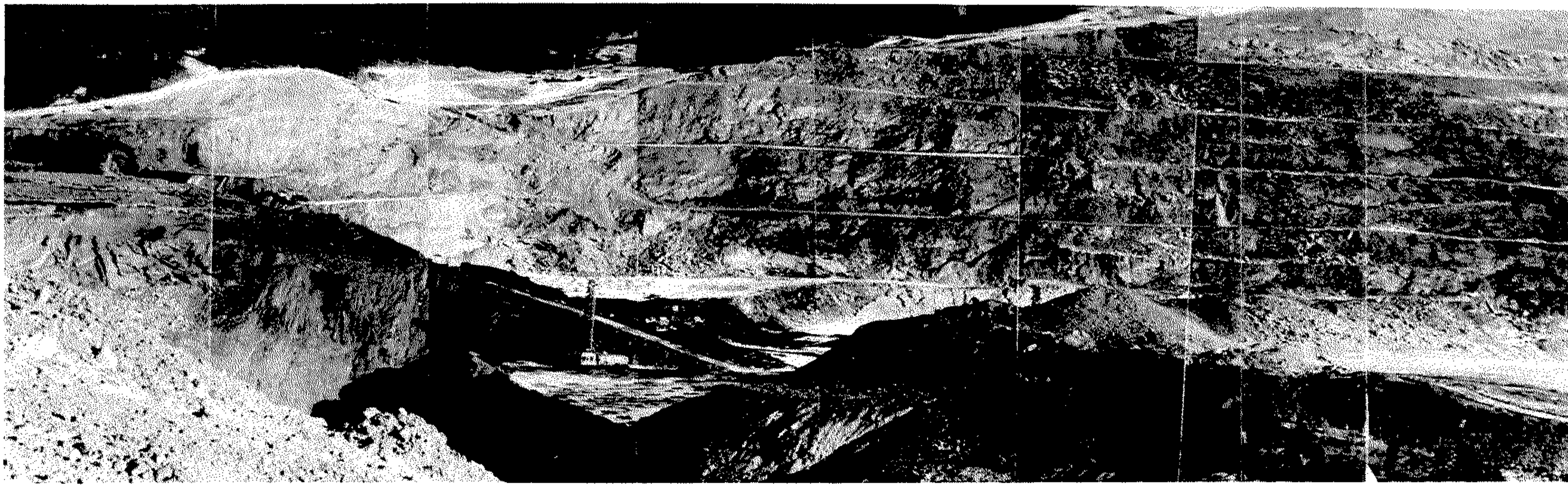
Cardinal River Coals Ltd. 1978. Pit 51-B-2 Phase II Deficiency Response.

EBA Engineering Consultants Ltd. 1978. Appraisal of Pit 51-B-2 Dewatering Requirements, Cardinal River Coals Ltd.

EBA Engineering Consultants Ltd. 1978 to 1980. Pit 51-B-2 Monthly Inspection Reports, Cardinal River Coals Ltd.

EBA Engineering Consultants Ltd. 1979. Preliminary Report on Mapping of Pitwalls at Cardinal River Coals Ltd.

PHOTOGRAPHIC PLATES



NORTH WALL

PLATE 1 - Pit 51-B-2 North and East Walls - Looking Northeast
Early Nov. 1979 - Before Failure

EAST WALL

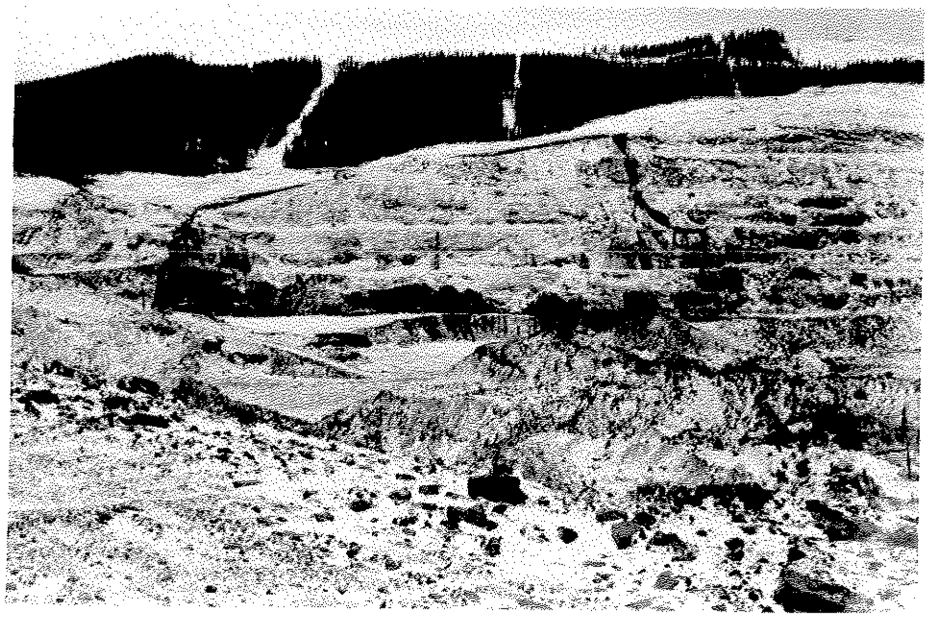


PLATE 2
North Wall Slope Failure - Looking North
Approx. Nov. 12,1979 - After Failure

PLATE 3
North Wall Slope Failure - Looking Northwest
Approx. Nov. 12,1979 - After Failure
NOTE: Observe Windrows on Pit Floor to Prevent
Access Below Failure, Plate 3

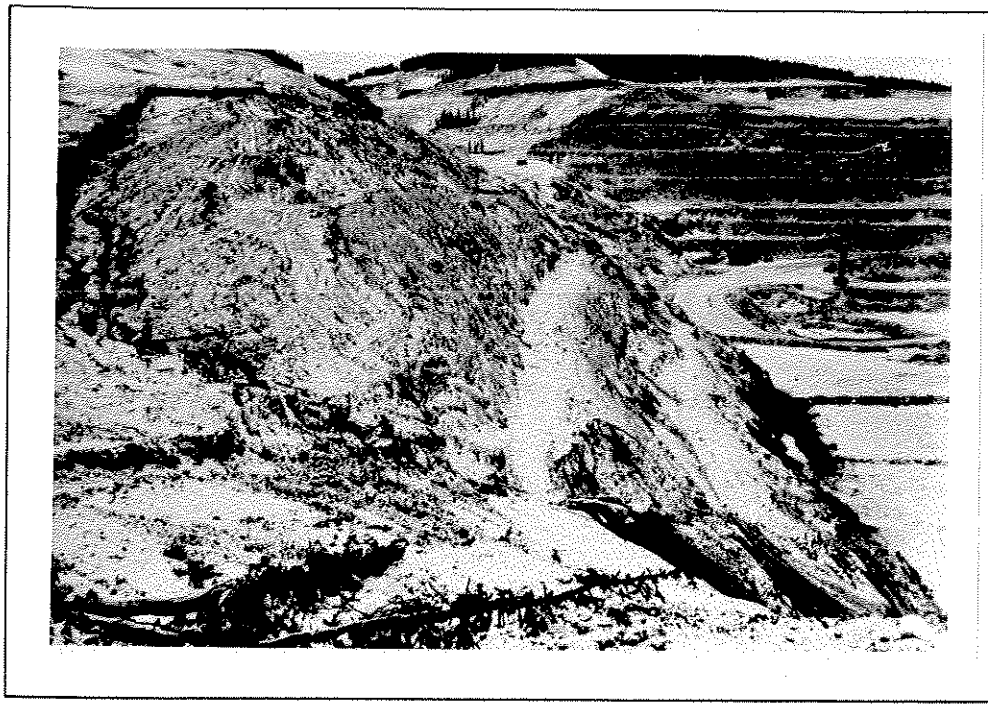


PLATE 4
North Wall Slope Failure - Looking East
Approx. Nov. 12,1979 - After Failure

PLATE 5
North Wall Slope Failure - Close-Up of West Limit Looking East
Approx. Nov. 12,1979 - After Failure

NOTE: For Scale, Observe the Power Pole, Foreground of Plates 4 & 5

PLATE 6
North Wall Slope Failure – Looking West
Approx. Nov. 12,1979 – After Failure

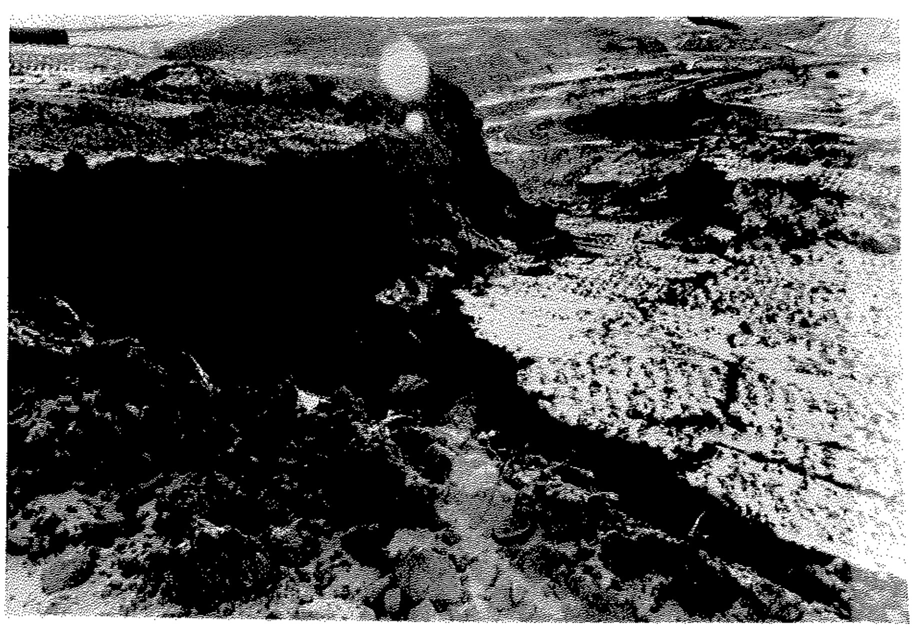


PLATE 7
North Wall Slope Failure and Close–Up of East Limit Looking South
Approx. Nov. 12,1979 – After Failure

NOTE: For Scale, Observe the Tractor Tracks, Foreground of Plates 6 & 7

APPENDIX A

FIGURES

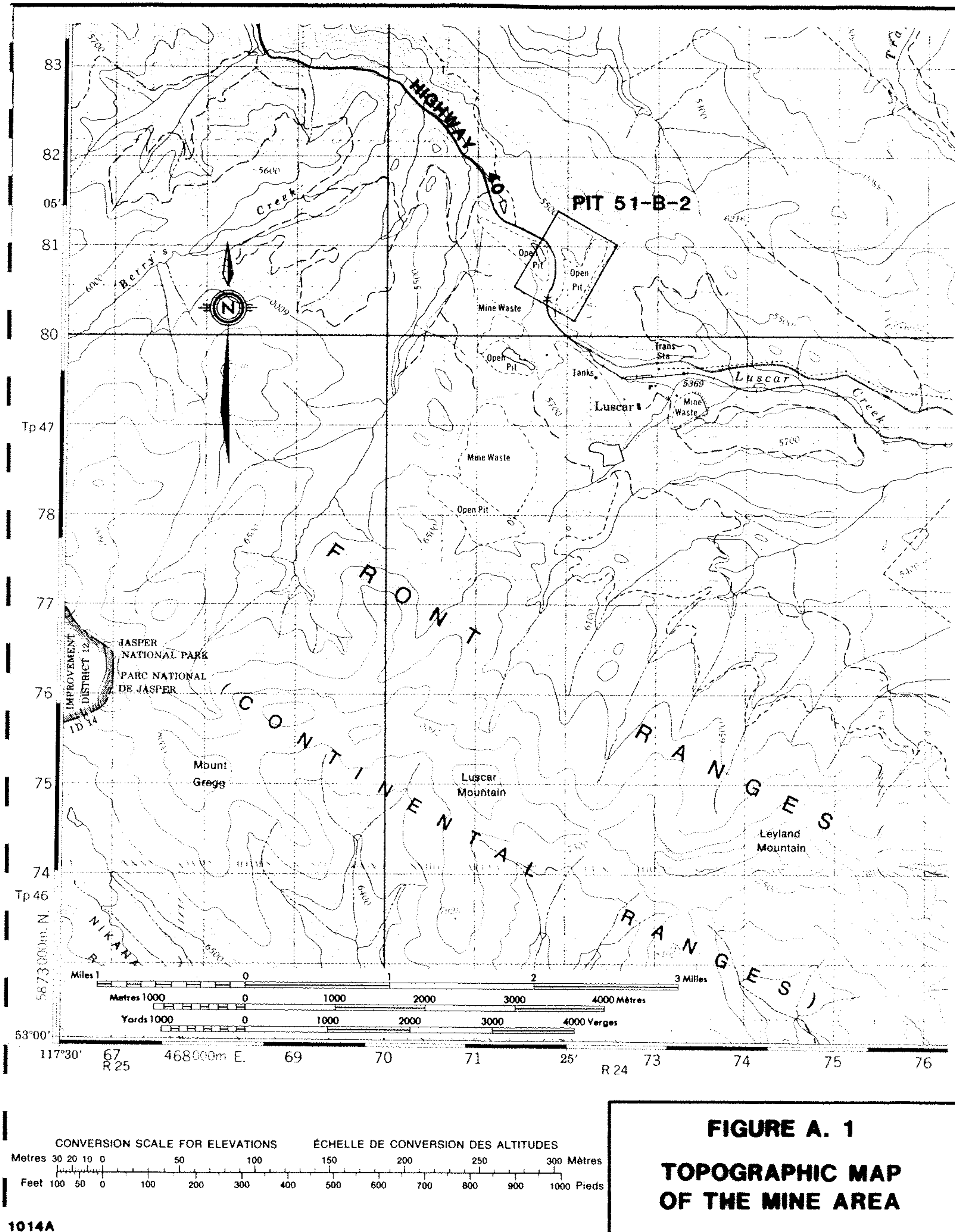


FIGURE A. 1

TOPOGRAPHIC MAP OF THE MINE AREA

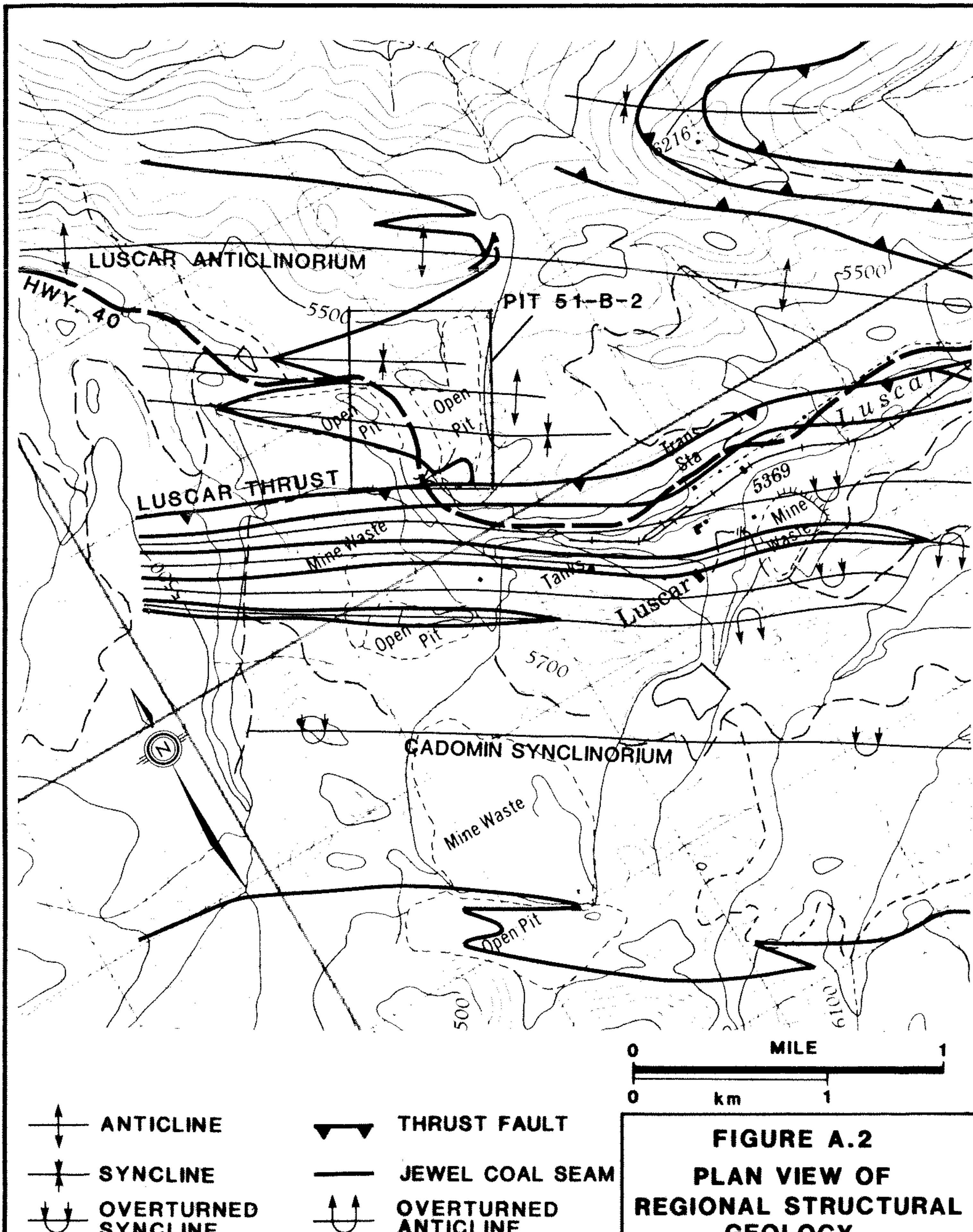
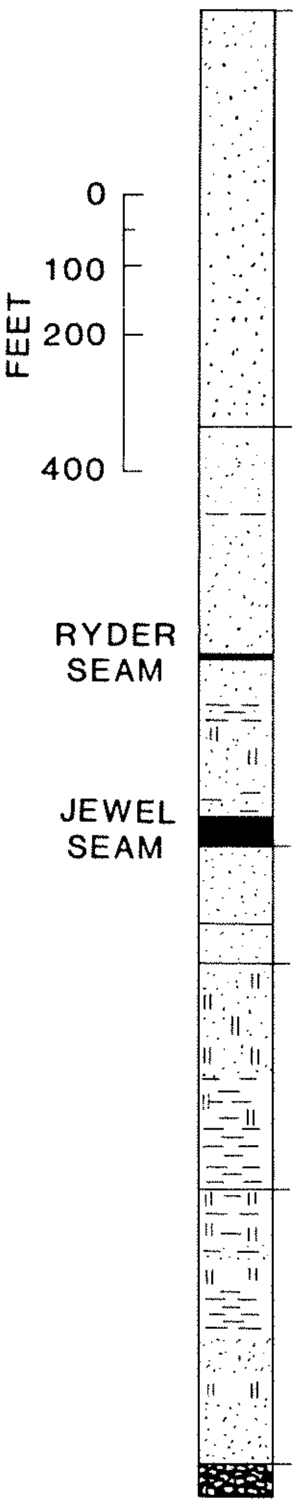


FIGURE A.2
PLAN VIEW OF REGIONAL STRUCTURAL GEOLOGY

1012A



MOUNTAIN PARK FORMATION

Massive grey green sandstone separated by dark green siltstones and chert pebble lenses chlorite cement.

LUSCAR FORMATION

MEMBER 'D'

- Grey green sandstone at top of member. Thick sandstone and shale beds common in lower half. Coarsening downwards of grain size in zone dominated by thick basal sandstone, which are massive and well bedded, cemented by kaolinite or illite.

- Thin, dark grey fissile siltstone separated by sandstones. Thin coal or carbonaceous shale laminations occuring in above siltstones.

MEMBER 'C'

- Torrens sandstone. Highly resistant, thin central shale parting. Breaks into boulder sized rectangular blocks. Occasional thin chert pebbles conglomerate. Sandstone massive at top, bedded at bottom.

MEMBER 'B'

- Exposed in 50-A-3 pit. Mainly fissile shales coarsening upwards to siltstones then sandstones.

- Fissile shales

MEMBER 'A'

- Thinly bedded medium to fine grained sandstones, fissile siltstones and carbonaceous shales which grade to thin coal seams.

- No exposure

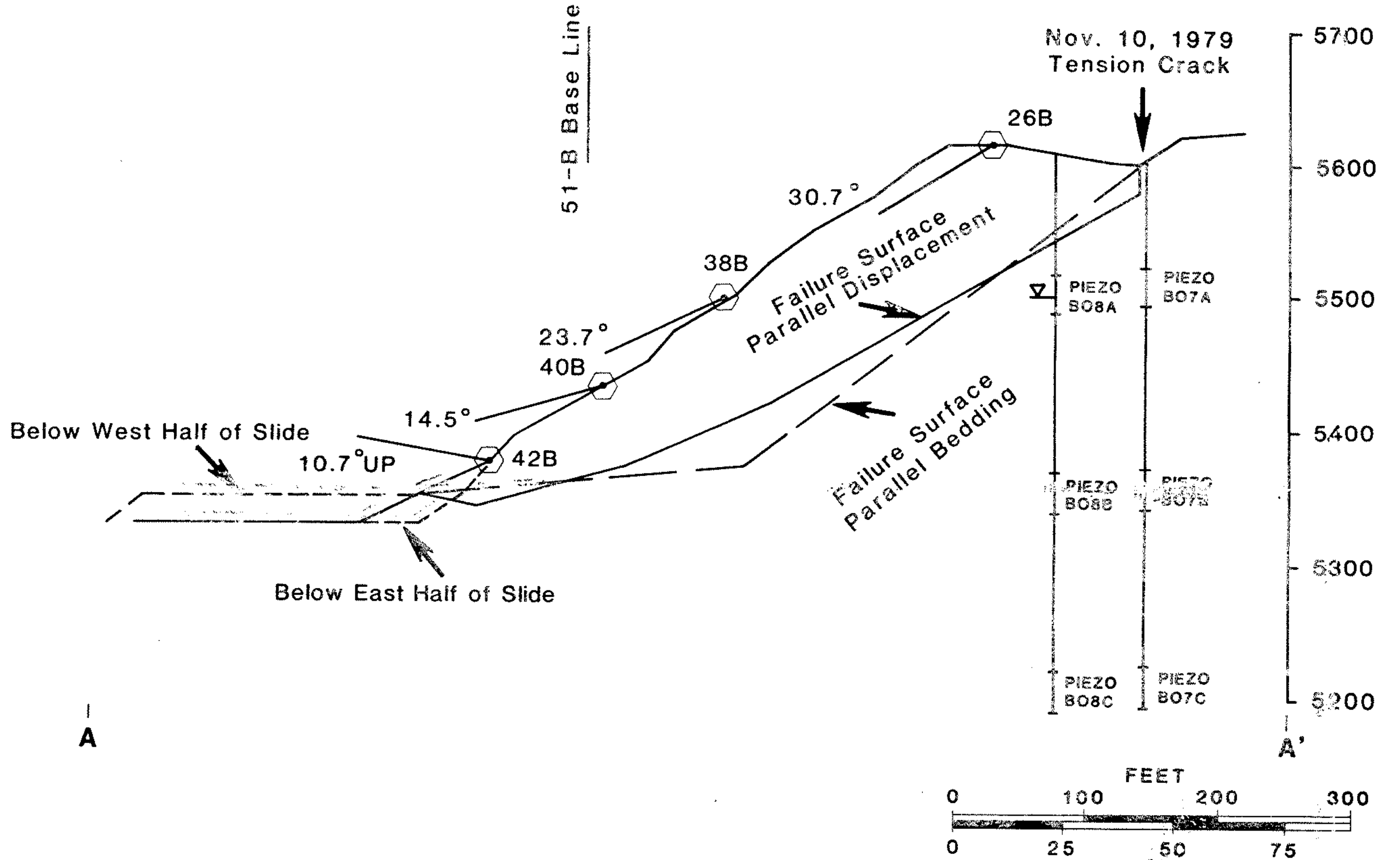
CADOMIN FORMATION

- Highly resistant, ridge forming conglomerate 2 to 6cm, clasts of chert and quartzite in well cemented silica matrix.

FIGURE A. 3

STRATIGRAPHIC COLUMN FOR THE LUSCAR AREA

013A



NOTE: Inclinations of Displacements
From Oct. 31, 1979
to Jan. 7, 1980

FIGURE A. 5
SECTION A-A'
THROUGH NORTH WALL
NOV. 23, 1979 (DAY 327)

1010A

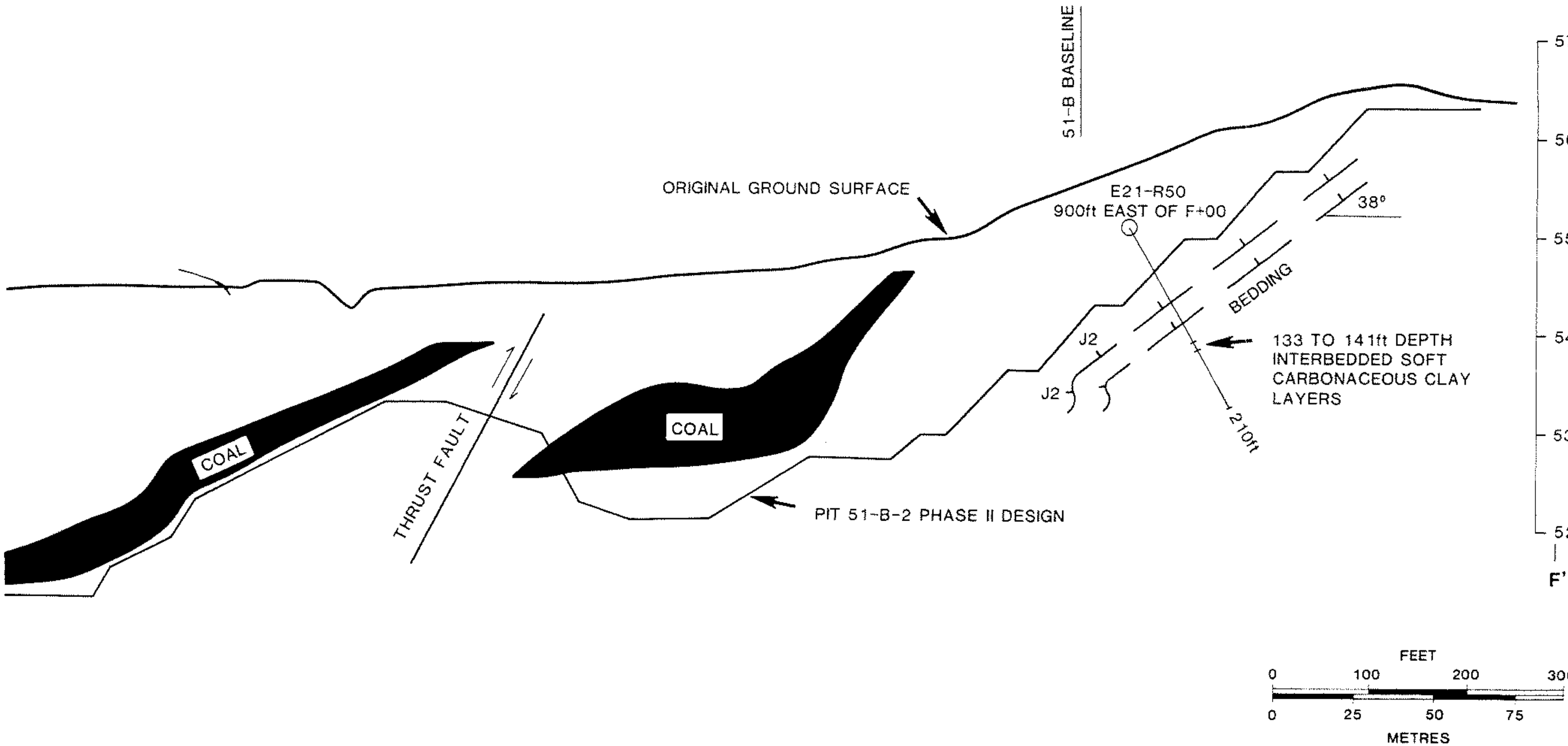


FIGURE A.6

GEOLOGICAL SECTION F+00

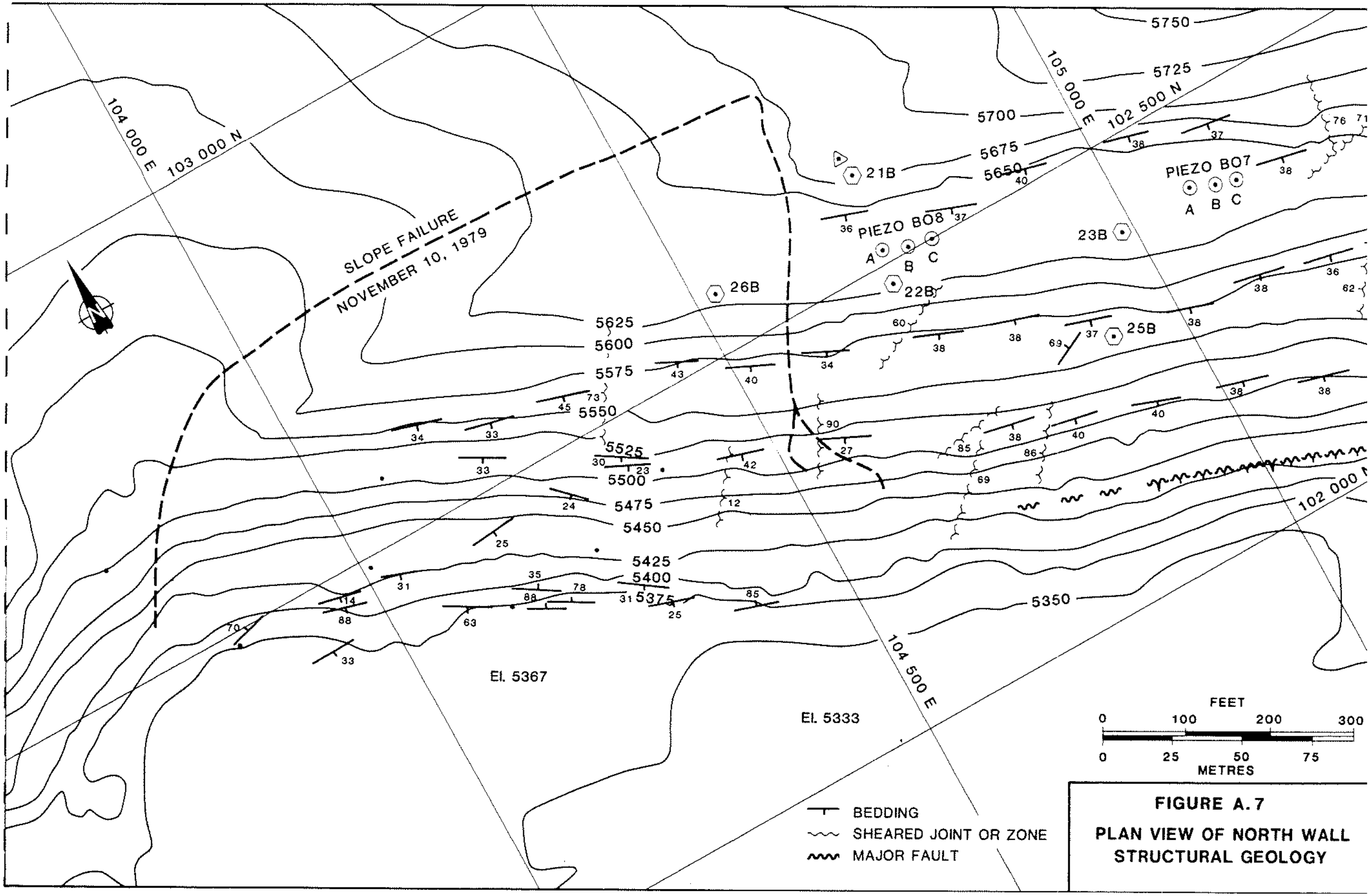
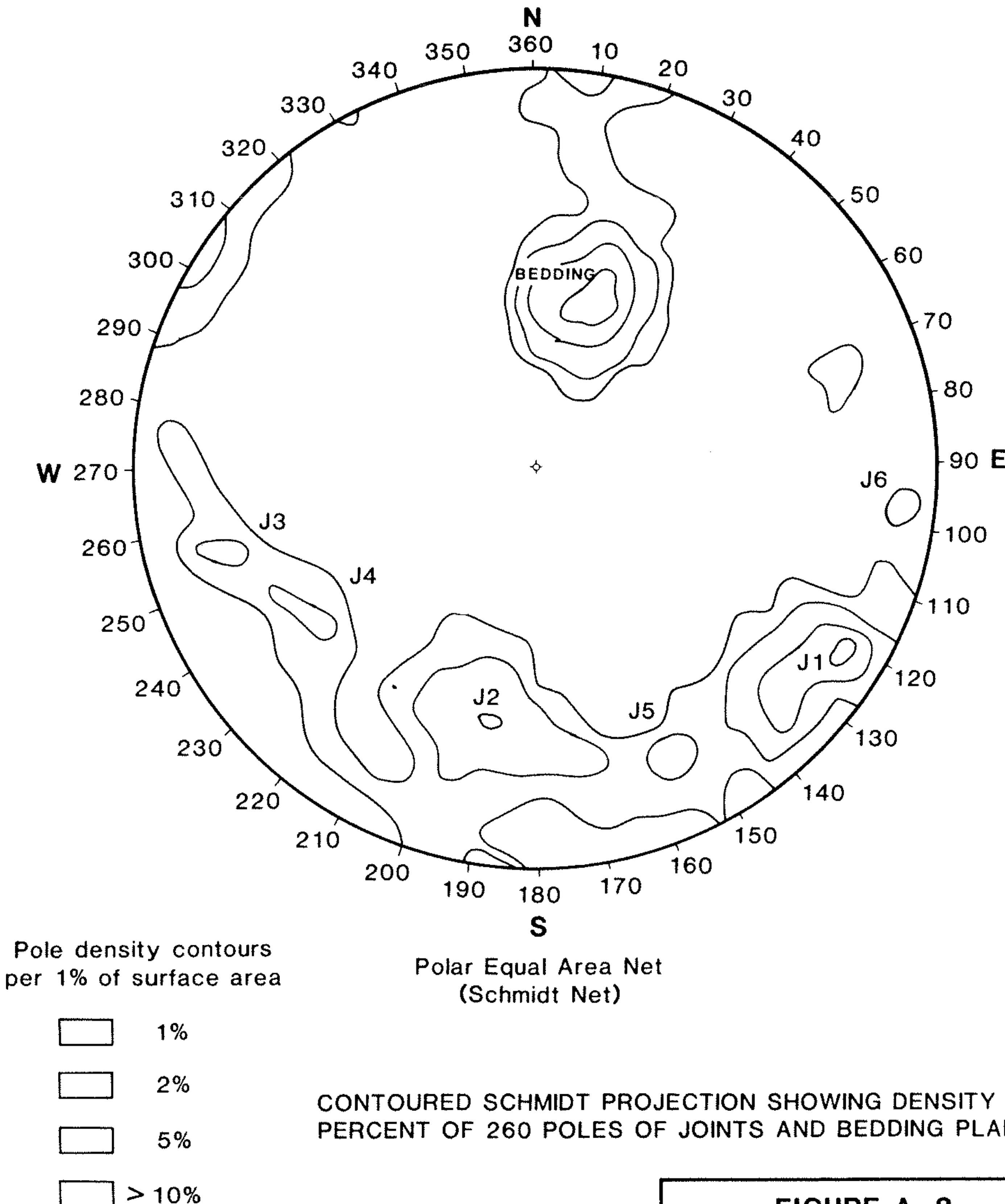


FIGURE A.7

PLAN VIEW OF NORTH WALL STRUCTURAL GEOLOGY



CONTOURED SCHMIDT PROJECTION SHOWING DENSITY PERCENT OF 260 POLES OF JOINTS AND BEDDING PLANES.

FIGURE A. 8

POLAR PLOT OF NORTH WALL BEDDING AND JOINTING

1015A

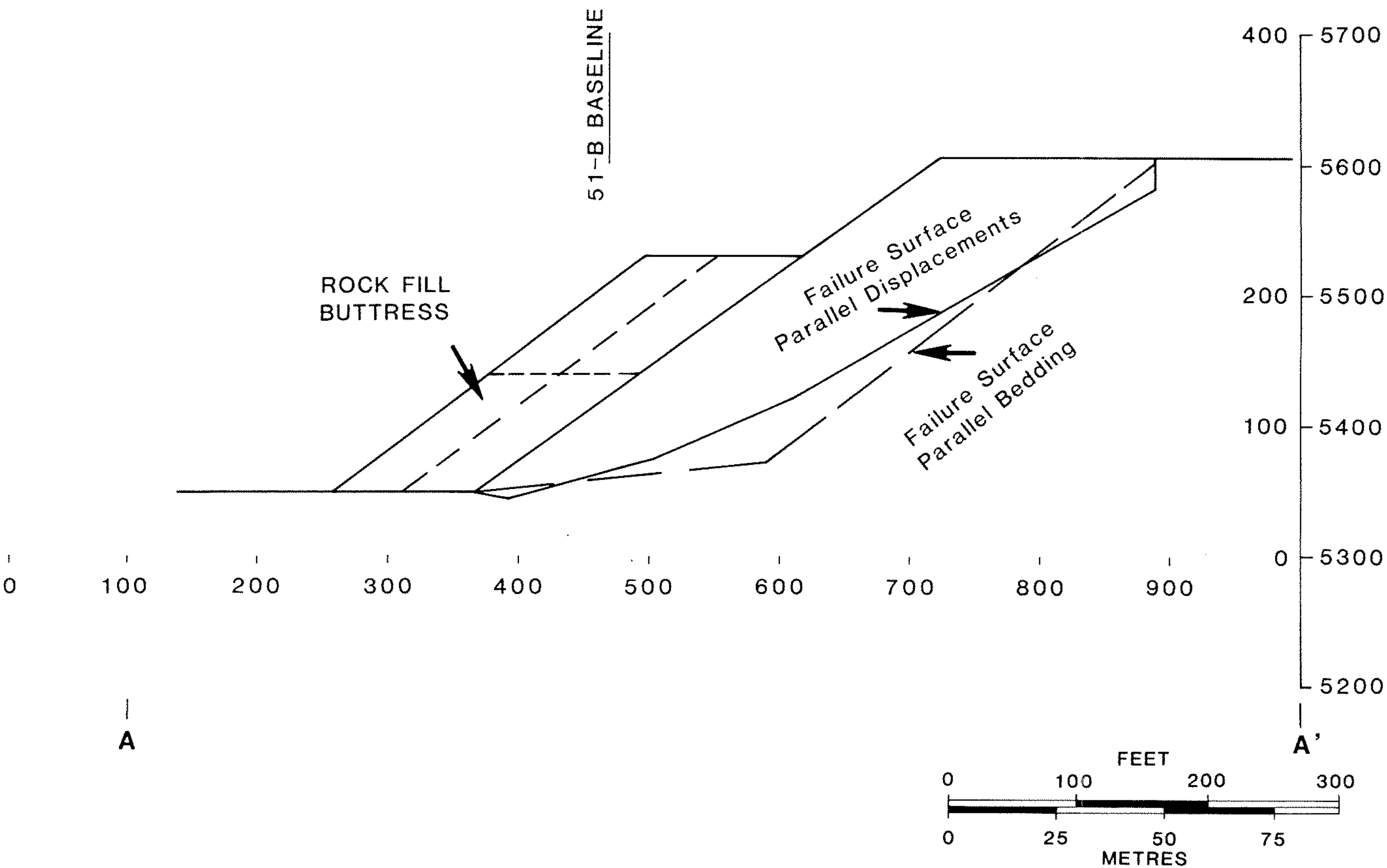


FIGURE A. 9
SECTION A-A'
FOR STABILITY
ANALYSIS
NOV. 79 TO JAN. 80

1011A

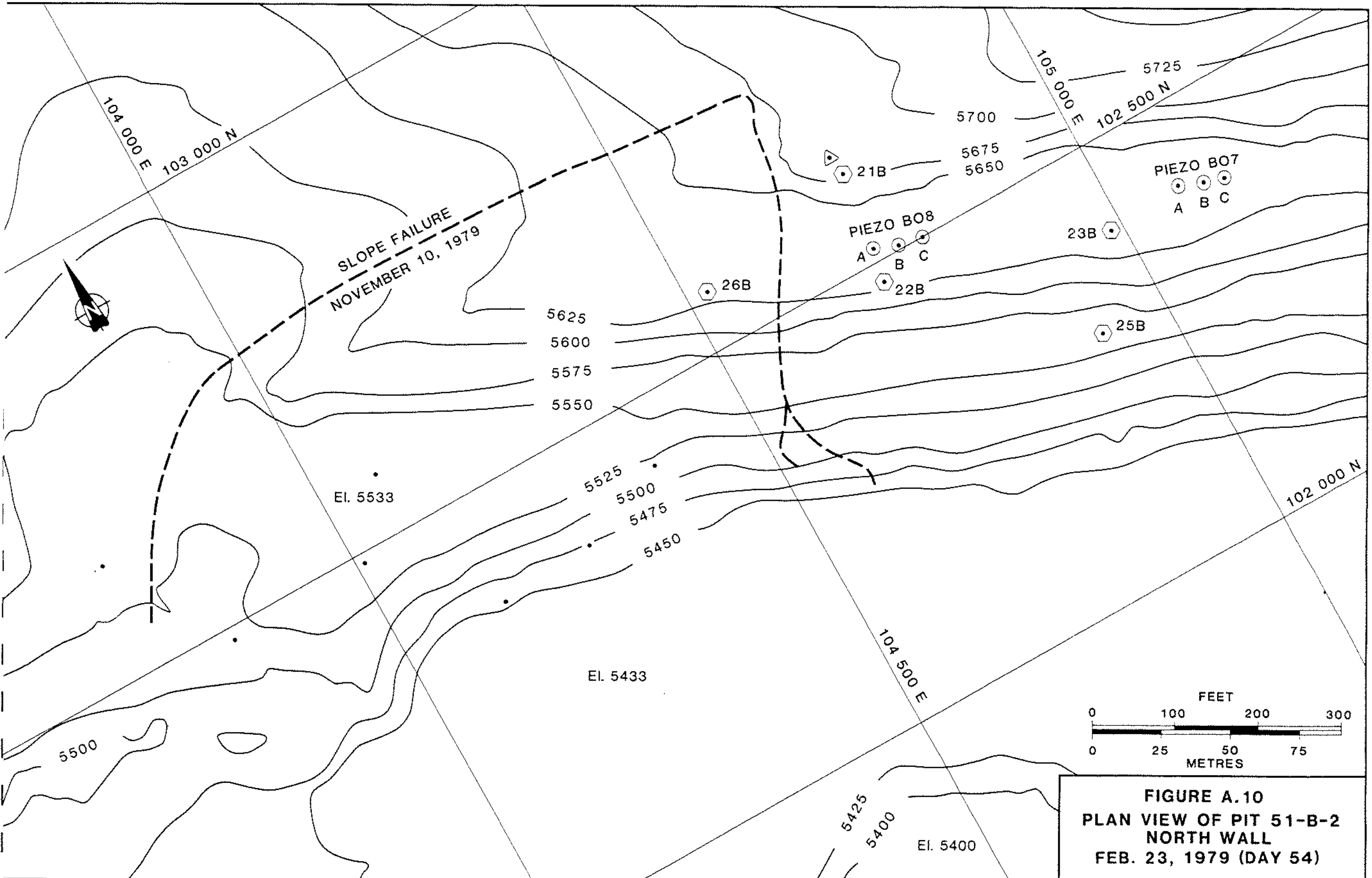


FIGURE A.10
PLAN VIEW OF PIT 51-B-2
NORTH WALL
FEB. 23, 1979 (DAY 54)

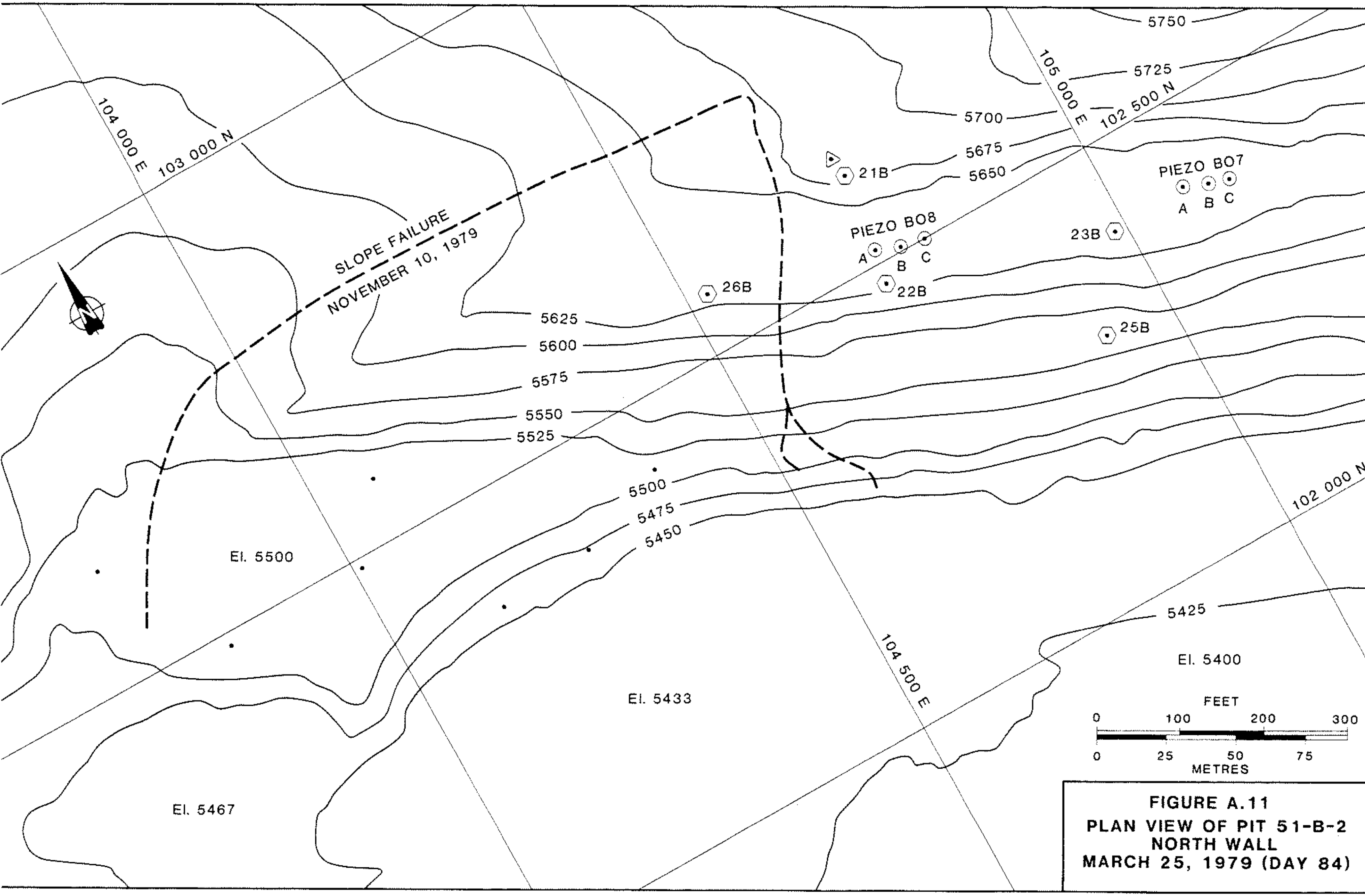


FIGURE A.11
PLAN VIEW OF PIT 51-B-2
NORTH WALL
MARCH 25, 1979 (DAY 84)

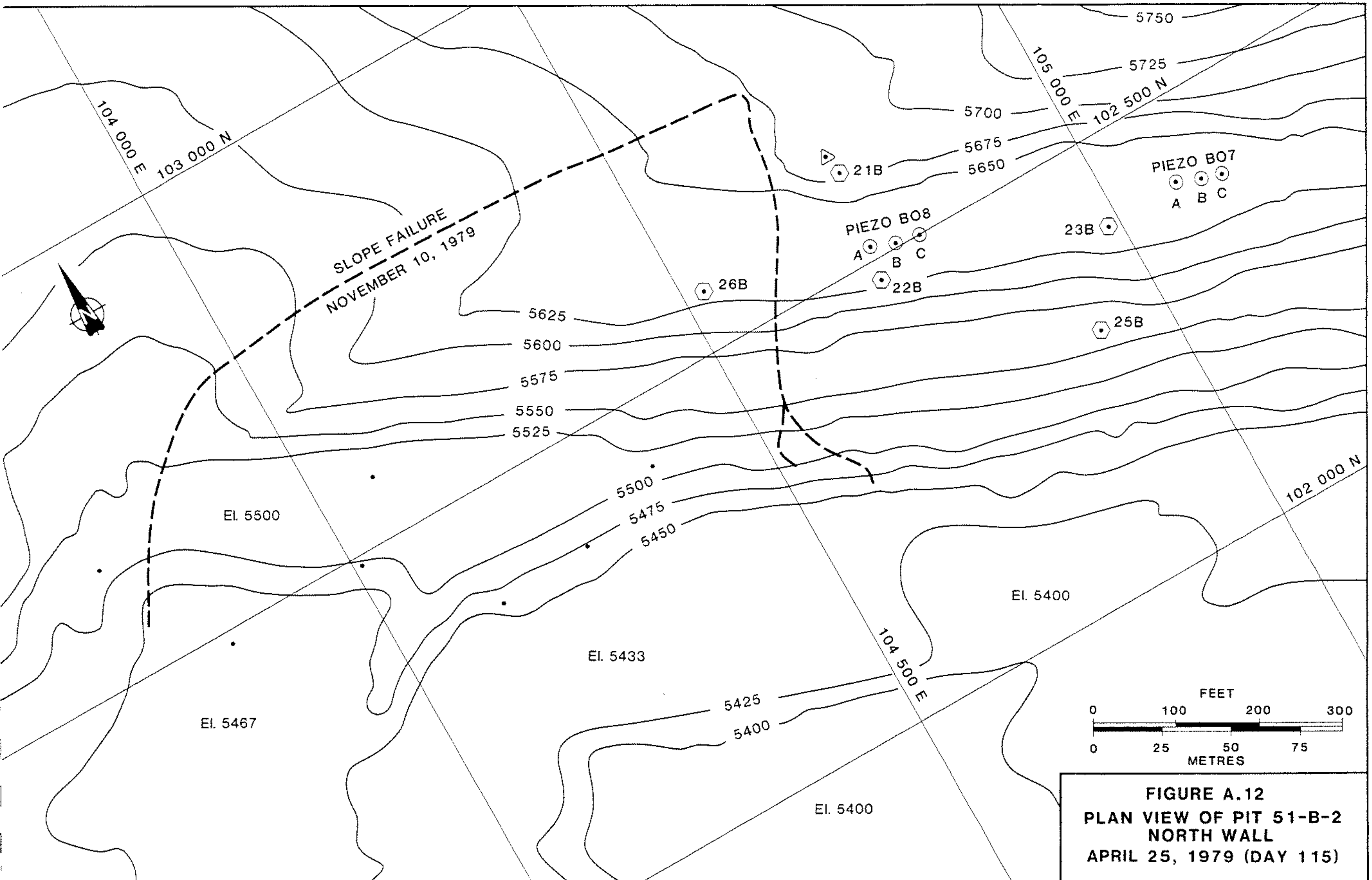


FIGURE A.12
PLAN VIEW OF PIT 51-B-2
NORTH WALL
APRIL 25, 1979 (DAY 115)

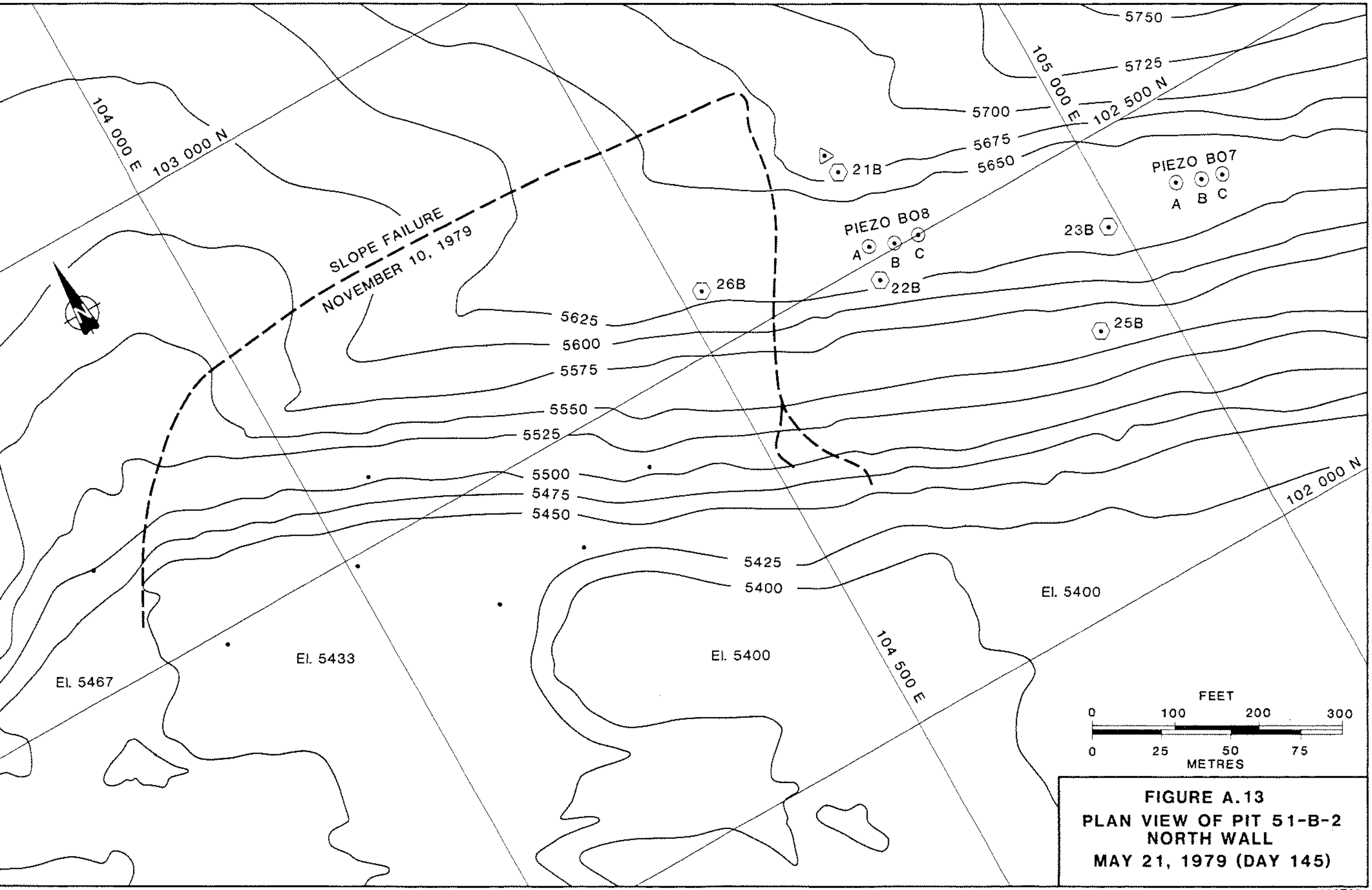


FIGURE A.13
PLAN VIEW OF PIT 51-B-2
NORTH WALL
MAY 21, 1979 (DAY 145)

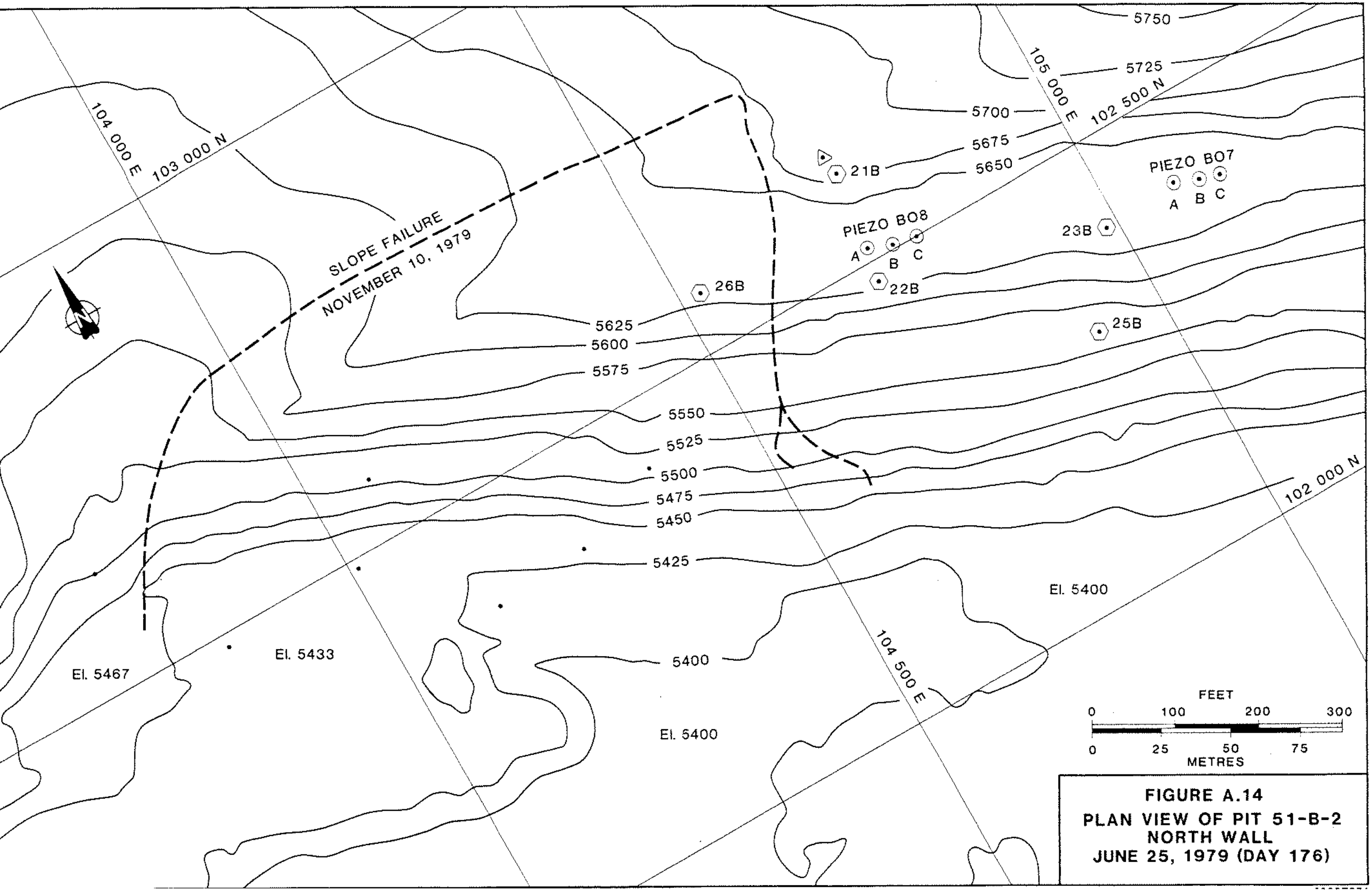


FIGURE A.14
PLAN VIEW OF PIT 51-B-2
NORTH WALL
JUNE 25, 1979 (DAY 176)

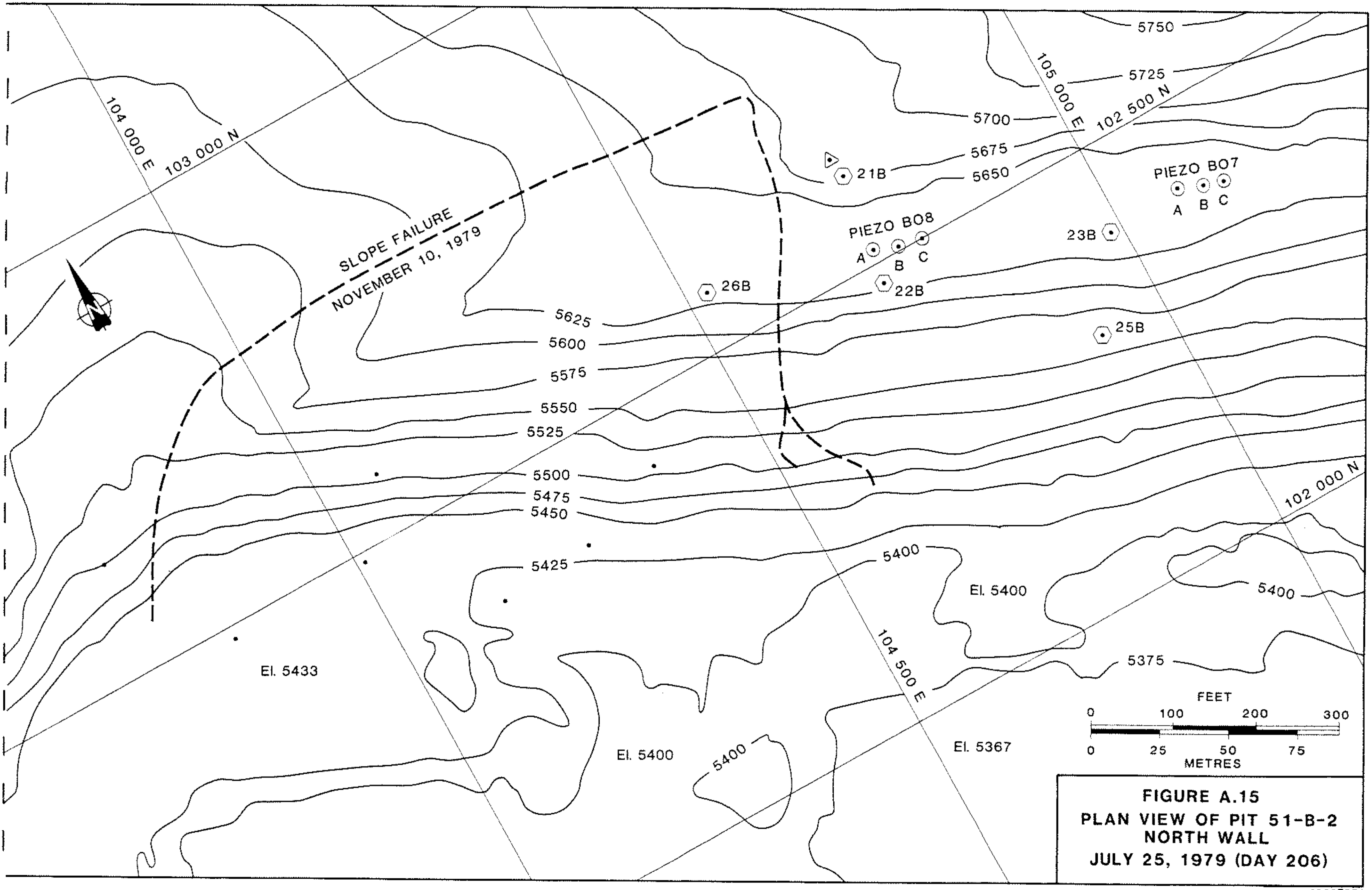


FIGURE A.15
PLAN VIEW OF PIT 51-B-2
NORTH WALL
JULY 25, 1979 (DAY 206)

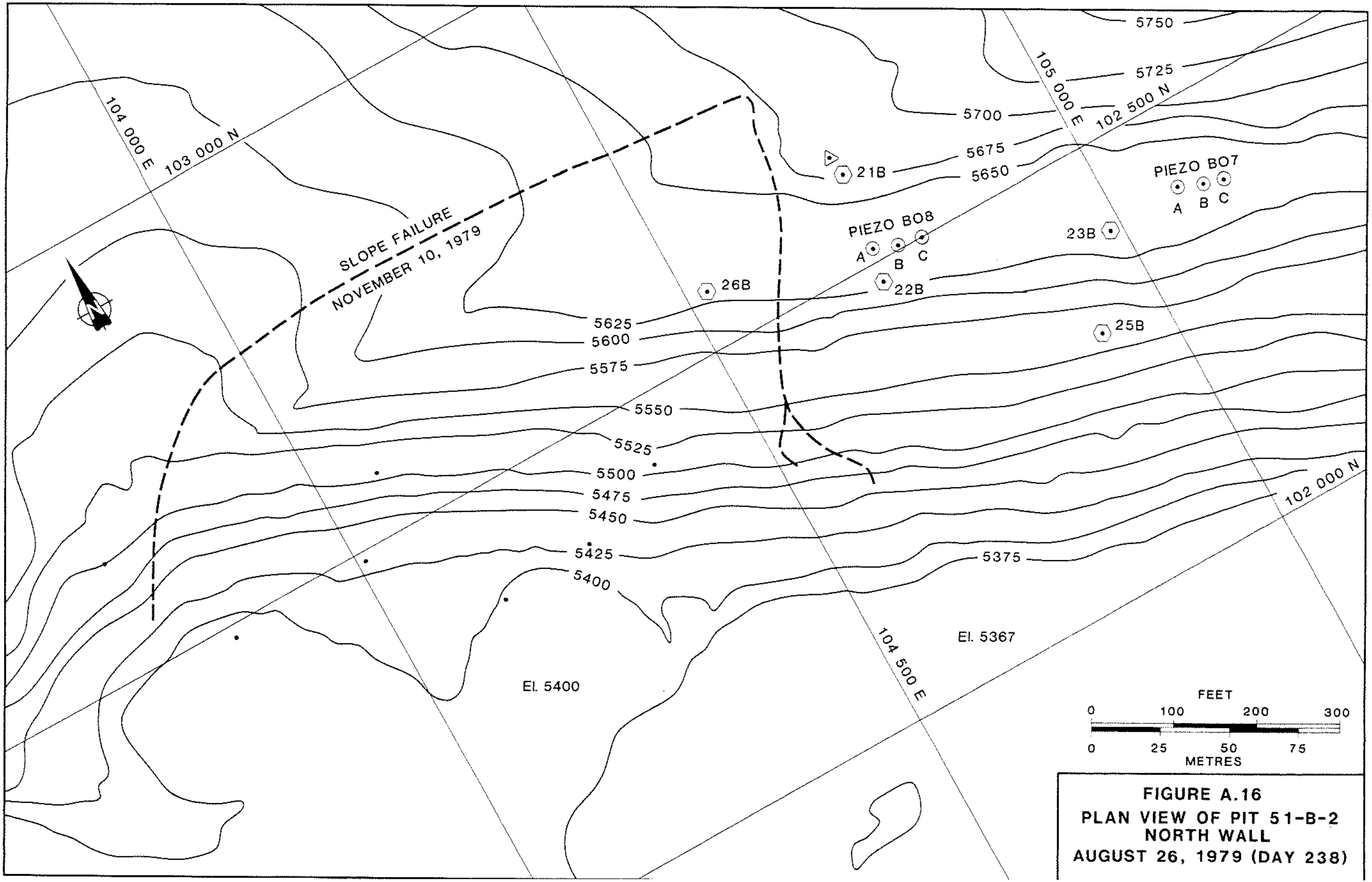


FIGURE A.16
PLAN VIEW OF PIT 51-B-2 NORTH WALL
AUGUST 26, 1979 (DAY 238)

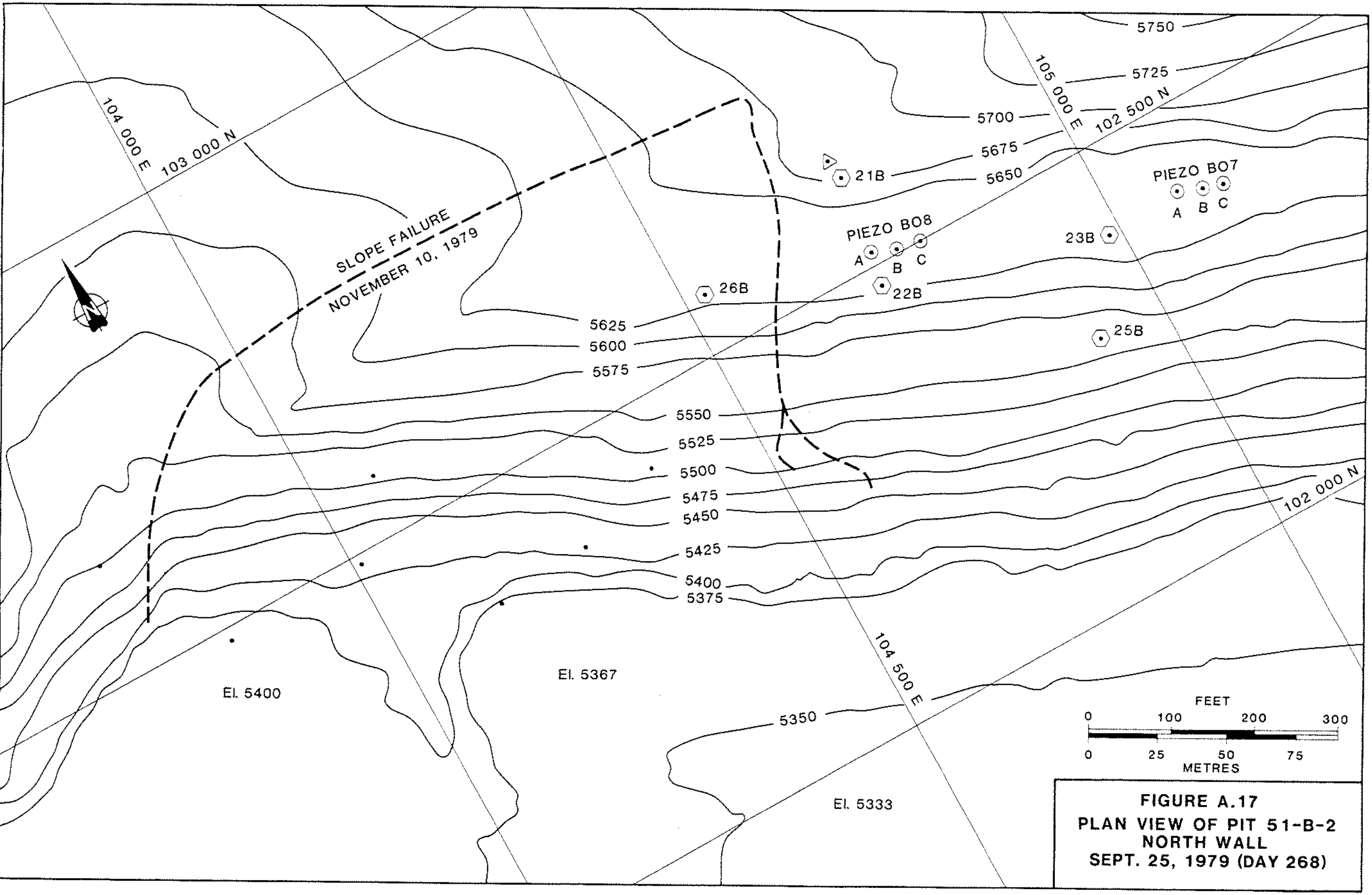


FIGURE A.17
PLAN VIEW OF PIT 51-B-2
NORTH WALL
SEPT. 25, 1979 (DAY 268)

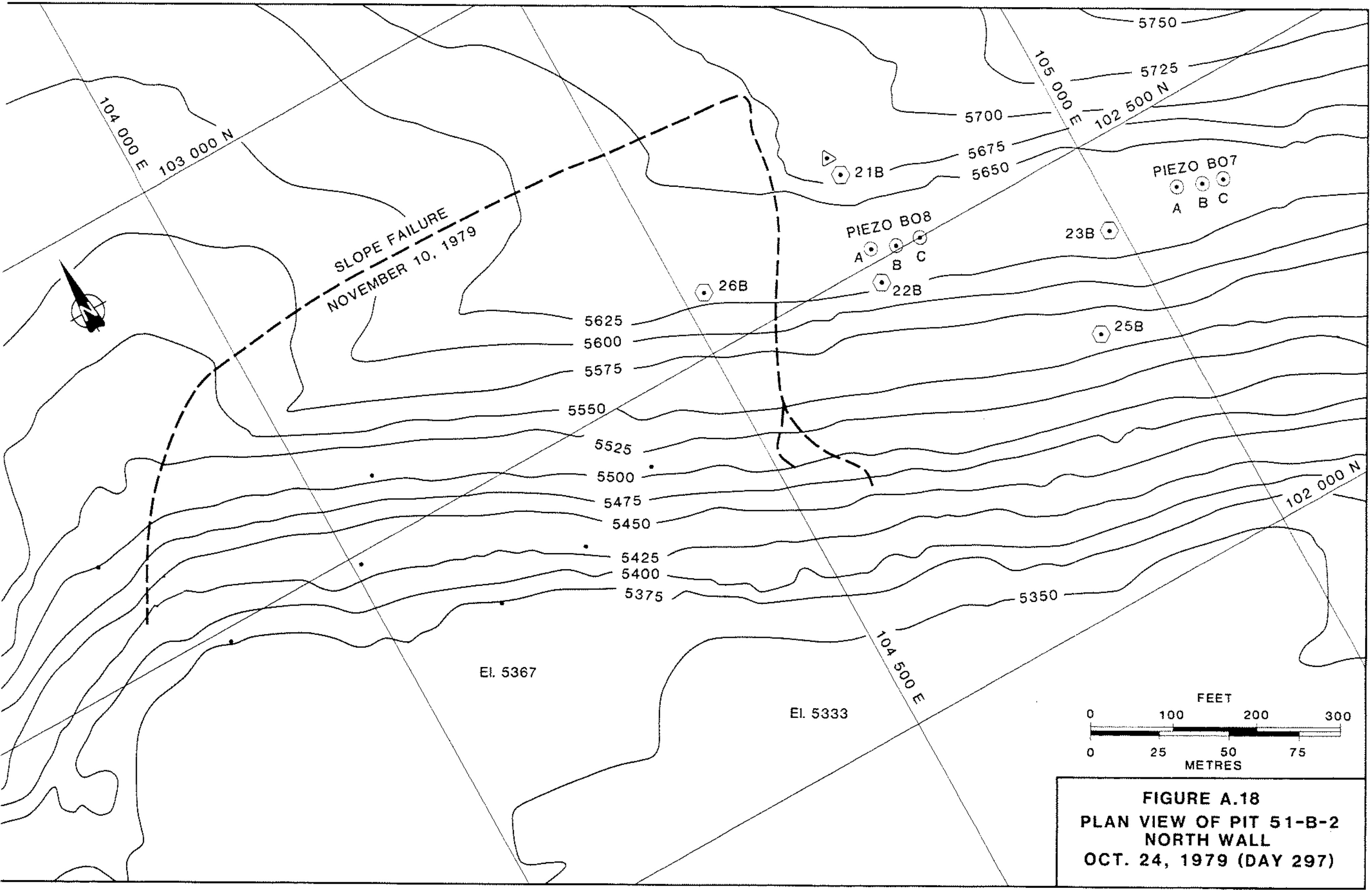
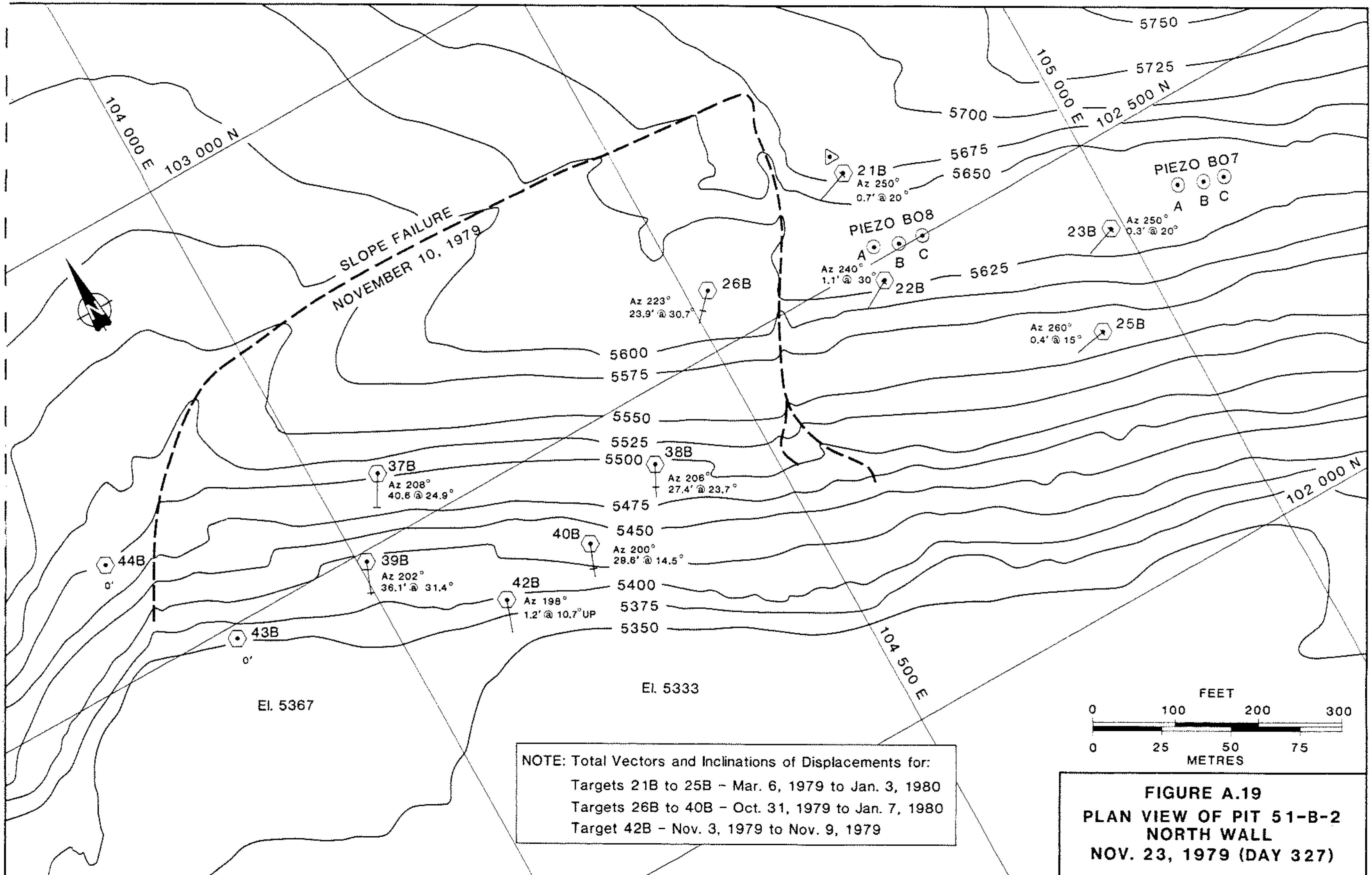


FIGURE A.18
PLAN VIEW OF PIT 51-B-2
NORTH WALL
OCT. 24, 1979 (DAY 297)



NOTE: Total Vectors and Inclinations of Displacements for:

Targets 21B to 25B - Mar. 6, 1979 to Jan. 3, 1980

Targets 26B to 40B - Oct. 31, 1979 to Jan. 7, 1980

Target 42B - Nov. 3, 1979 to Nov. 9, 1979

FIGURE A.19

PLAN VIEW OF PIT 51-B-2 NORTH WALL NOV. 23, 1979 (DAY 327)

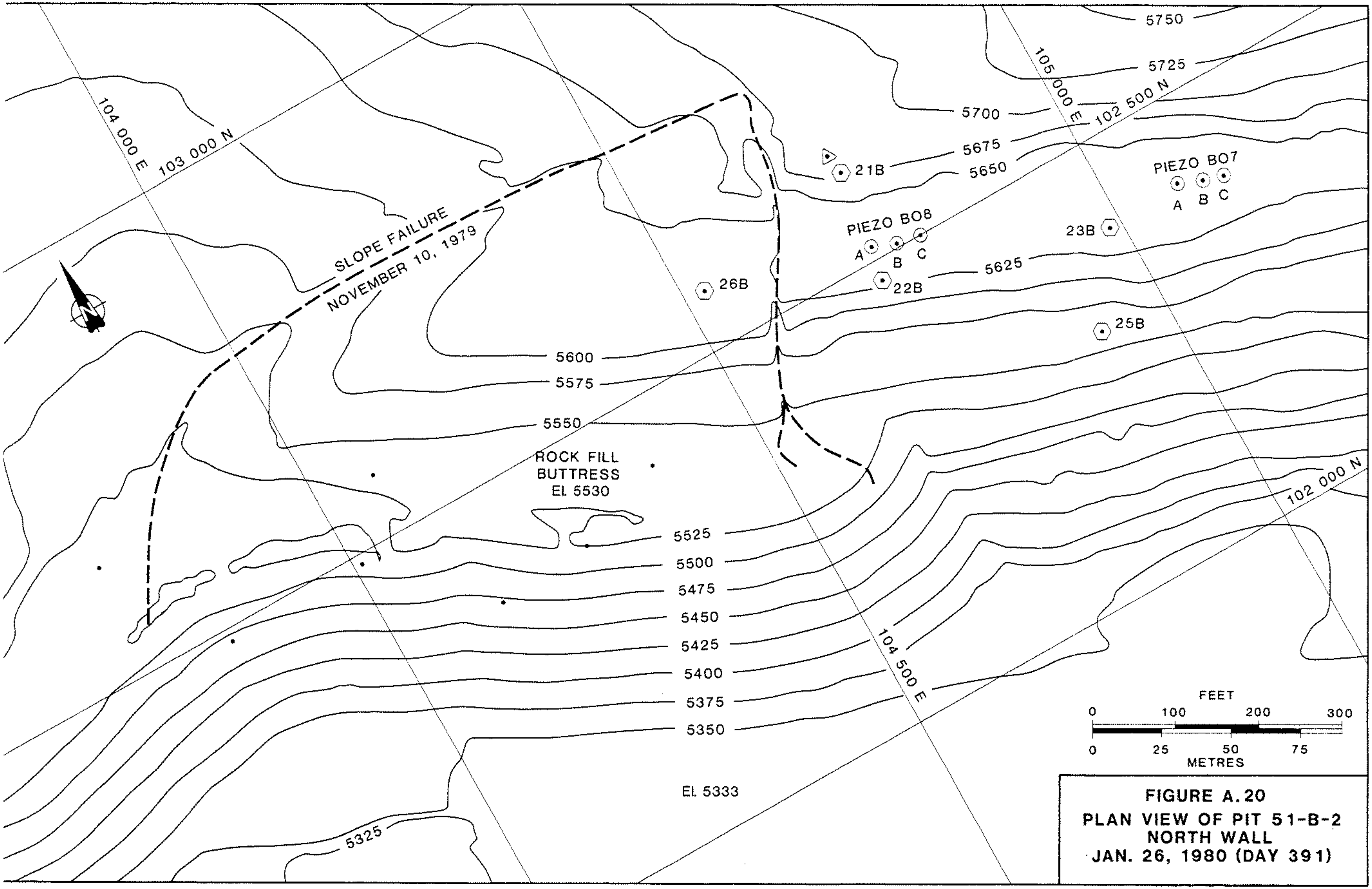


FIGURE A.20
PLAN VIEW OF PIT 51-B-2
NORTH WALL
JAN. 26, 1980 (DAY 391)

APPENDIX B

SLOPE DISPLACEMENT DATA AND PLOTS

TABLE B.1 - THREE-DIMENSIONAL SLOPE DISPLACEMENTS, TARGETS 21B,22B,23B,25B,26B. PAGE 1 OF 2.

Note: Horiz and Vert are Horizontal and Vertical Components in Feet. Azim and Incl are Azimuth and Inclination (from horizontal) Angles in Degrees.
Vertical Displacement and Inclination are Positive in the Downward Direction.

			[-----	TARGET 21B		-----]	[-----	TARGET 22B		-----]	[-----	TARGET 23B		-----]	[-----	TARGET 25B		-----]	[-----	TARGET 26B		-----]
Date	Time	Days	Horiz	Azim	Vert	Incl	Horiz	Azim	Vert	Incl	Horiz	Azim	Vert	Incl	Horiz	Azim	Vert	Incl	Horiz	Azim	Vert	Incl
Mar 06 79	12.00	65.50	0.000	ERR	0.000	ERR	0.000	ERR	0.000	ERR	0.000	ERR	0.000	ERR	0.000	ERR	0.000	ERR	0.000	ERR	0.000	ERR
Mar 28 79	12.00	87.50	0.091	264	0.023	14.18	0.045	307	0.026	30.02	0.041	297	0.007	9.69	0.060	300	0.000	0.00	0.073	270	0.012	9.33
Apr 24 79	12.00	114.50	0.058	261	0.002	1.97	0.056	329	0.025	24.06	0.074	304	0.000	0.00	0.134	309	0.013	5.54	0.107	261	-0.056	-27.63
May 08 79	12.00	128.50	0.056	202	-0.045	-38.78	0.020	135	-0.013	-33.02	0.008	180	0.013	58.39	ERR	ERR	ERR	ERR	0.058	222	-0.050	-40.76
May 24 79	12.00	144.50	0.142	249	0.031	12.32	0.105	265	0.085	38.99	0.108	253	0.042	21.25	0.146	286	0.006	2.35	0.184	242	0.067	20.01
Jun 11 79	10.45	162.45	0.184	252	0.059	17.78	0.181	254	0.112	31.75	0.119	270	0.042	19.44	0.191	279	0.025	7.46	0.258	251	0.087	18.63
Jul 03 79	10.30	184.44	0.192	264	0.058	16.81	0.213	254	0.151	35.33	0.107	270	0.015	7.98	0.129	283	0.019	8.38	0.271	257	0.055	11.47
Jul 09 79	10.00	190.42	0.215	250	0.008	2.13	0.249	255	0.055	12.46	0.192	273	0.016	4.76	0.212	278	-0.077	-19.96	0.310	256	0.043	7.90
Jul 30 79	9.50	211.41	0.224	262	0.052	13.07	0.242	267	0.061	14.15	0.147	292	0.028	10.78	0.174	282	0.439	68.38	0.301	265	-0.022	-4.18
Aug 13 79	10.15	225.43	0.229	275	0.051	12.56	0.290	253	0.281	44.10	0.159	287	0.048	16.80	0.184	296	-0.045	-13.74	0.311	261	0.042	7.69
Aug 27 79	10.00	239.42	0.345	255	0.083	13.53	0.433	242	0.188	23.47	0.181	251	-0.017	-5.37	0.318	247	-0.020	-3.60	0.448	249	0.211	25.22
Sep 04 79	10.30	247.44	0.349	254	0.137	21.43	0.478	241	0.253	27.89	0.190	254	0.063	18.34	0.184	270	0.018	5.59	0.603	245	0.207	18.95
Sep 10 79	10.30	253.44	0.379	260	0.124	18.12	0.508	244	0.253	26.47	0.201	264	0.030	8.49	0.306	259	0.012	2.25	0.638	246	0.271	23.01
Oct 04 79	13.00	277.54	0.434	251	0.180	22.53	0.557	243	0.376	34.02	0.225	263	0.143	32.44	0.272	267	0.063	13.04	0.753	244	0.318	22.89
Oct 09 79	12.30	282.52	0.435	255	0.153	19.38	0.606	240	0.313	27.32	0.230	257	0.070	16.93	0.279	254	0.082	16.38	0.812	241	0.313	21.08
Oct 15 79	13.30	288.56	0.526	257	0.189	19.76	0.666	247	0.333	26.57	0.296	264	0.044	8.46	0.436	252	0.082	10.65	0.893	245	0.352	21.51
Oct 22 79	13.00	295.54	0.480	260	0.214	24.03	0.707	243	0.372	27.75	0.236	270	0.103	23.58	0.277	264	0.075	15.15	0.983	244	0.468	25.46
Oct 29 79	14.00	302.58	0.556	258	0.203	20.06	0.851	244	0.497	30.29	0.275	261	0.151	28.77	0.340	259	0.094	15.45	1.682	241	0.856	26.97
Oct 31 79	14.00	304.58	0.563	258	0.169	16.71	0.881	243	0.459	27.52	0.270	260	0.018	3.81	ERR	ERR	ERR	ERR	1.862	239	0.809	23.48
Nov 01 79	13.45	305.57	0.588	252	0.212	19.83	0.917	242	0.543	30.63	0.311	257	0.099	17.66	ERR	ERR	ERR	ERR	1.993	240	0.995	26.53
Nov 02 79	14.00	306.58	0.622	260	0.197	17.57	0.974	244	0.512	27.73	0.338	278	0.084	13.96	ERR	ERR	ERR	ERR	2.107	240	1.042	26.31
Nov 03 79	14.00	307.58	0.600	252	0.232	21.14	0.923	243	0.549	30.74	0.305	263	0.111	20.00	ERR	ERR	ERR	ERR	2.234	239	1.133	26.89
Nov 04 79	10.15	308.43	0.622	256	0.198	17.66	0.970	246	0.466	25.66	0.362	269	0.098	15.15	0.484	256	0.030	3.55	2.421	239	1.162	25.64
Nov 05 79	12.30	309.52	0.624	254	0.205	18.19	0.929	240	0.531	29.75	0.275	247	0.099	19.80	0.320	260	0.120	20.56	2.479	237	1.249	26.57
Nov 06 79	12.15	310.51	0.619	259	0.204	18.24	0.971	243	0.499	27.20	0.307	262	0.105	18.88	0.319	259	0.101	17.57	2.678	238	1.345	26.67
Nov 07 79	13.30	311.56	0.541	255	0.219	21.21	0.890	243	0.581	33.14	0.270	264	0.097	19.76	0.325	259	0.088	15.15	2.869	237	1.475	27.21
Nov 08 79	13.30	312.56	0.570	254	0.224	21.45	0.940	241	0.576	31.50	0.297	261	0.111	20.49	0.323	262	0.107	18.33	3.138	236	1.621	27.32
Nov 09 79	8.30	313.35	0.608	257	0.265	23.55	0.967	244	0.569	30.47	0.281	265	0.118	22.78	0.331	261	0.107	17.91	3.463	237	1.817	27.69
Nov 09 79	16.30	313.69	0.614	258	0.238	21.19	0.962	245	0.543	29.44	0.334	254	0.119	19.61	0.352	261	0.107	16.91	3.576	237	1.857	27.44
Nov 10 79	9.00	314.38	0.614	255	0.151	13.82	0.976	244	0.524	28.23	0.287	259	0.058	11.43	0.419	252	0.087	11.73	4.544	235	2.339	27.24
Nov 10 79	17.00	314.71	0.656	258	0.212	17.91	1.003	245	0.518	27.31	0.395	268	0.066	9.49	0.396	264	0.101	14.31	13.252	228	7.474	29.42
Nov 10 79	20.00	314.83	0.628	257	0.144	12.91	1.029	246	0.455	23.85	0.363	274	-0.022	-3.47	0.318	268	0.005	0.90	13.319	227	7.564	29.59
Nov 11 79	6.00	315.25	0.649	266	0.115	10.05	0.952	246	0.399	22.23	0.346	276	0.077	12.55	0.380	266	0.126	18.34	13.435	228	7.680	29.75
Nov 11 79	21.00	315.88	0.634	258	0.171	15.09	0.904	241	0.479	27.92	0.359	258	-0.027	-4.30	0.334	257	0.018	3.08	13.506	227	7.732	29.79
Nov 12 79	9.00	316.38	0.604	255	0.258	23.13	0.956	240	0.518	28.45	0.309	257	0.172	29.10	0.322	255	0.132	22.29	13.678	227	7.817	29.75
Nov 13 79	13.30	317.56	0.551	253	0.204	20.32	0.944	239	0.557	30.54	0.263	247	0.178	34.09	ERR	ERR	ERR	ERR	13.922	227	7.974	29.80
Nov 14 79	12.30	318.52	0.651	248	0.261	21.85	1.019	239	0.608	30.82	0.259	249	0.085	18.17	ERR	ERR	ERR	ERR	14.144	227	8.167	30.00
Nov 15 79	16.30	319.69	0.543	249	0.238	23.67	0.922	237	0.582	32.26	0.320	240	0.053	9.40	0.346	253	0.088	14.27	14.529	226	8.408	30.06
Nov 16 79	14.00	320.58	0.560	249	0.245	23.63	0.963	243	0.560	30.18	0.395	255	0.125	17.56	0.390	247	0.088	12.72	14.699	226	8.519	30.10
Nov 17 79	16.00	321.67	0.607	255	0.232	20.92	0.993	249	0.557	29.29	0.308	252	-0.148	-25.67	0.317	257	-0.020	-3.61	14.985	226	8.682	30.09
Nov 18 79	14.45	322.61	0.610	248	0.132	12.21	1.013	238	0.468	24.80	0.242	257	0.077	17.65	ERR	ERR	ERR	ERR	15.273	226	8.731	29.75
Nov 19 79	6.00	323.25	0.550	253	0.123	12.61	0.975	244	0.435	24.04	0.346	272	0.051	8.38	0.355	269	0.120	18.68	15.366	226	8.859	29.96

TABLE R.1 - THREE-DIMENSIONAL SLOPE DISPLACEMENTS, TARGETS 21B,22B,23B,25B,26B. PAGE 2 OF 2.

Note: Horiz and Vert are Horizontal and Vertical Components in Feet. Azim and Incl are Azimuth and Inclination (from horizontal) Angles in Degrees.
Vertical Displacement and Inclination are Positive in the Downward Direction.

Date	Time	Days	TARGET 21B Horiz	TARGET 21B Azim	TARGET 21B Vert	TARGET 21B Incl	TARGET 22B Horiz	TARGET 22B Azim	TARGET 22B Vert	TARGET 22B Incl	TARGET 23B Horiz	TARGET 23B Azim	TARGET 23B Vert	TARGET 23B Incl	TARGET 25B Horiz	TARGET 25B Azim	TARGET 25B Vert	TARGET 25B Incl	TARGET 26B Horiz	TARGET 26B Azim	TARGET 26B Vert	TARGET 26B Incl
Nov 20 79	6.00	324.25	0.582	251	0.225	21.14	0.966	240	0.461	25.51	0.315	255	0.079	14.08	0.291	255	0.012	2.36	15.591	226	8.958	29.88
Nov 22 79	6.30	326.27	0.630	254	0.266	22.89	0.993	241	0.525	27.87	0.317	255	0.099	17.34	0.349	252	0.132	20.72	16.088	226	9.383	30.25
Nov 23 79	6.00	327.25	0.528	253	0.257	25.95	0.933	238	0.550	30.52	0.255	250	0.151	30.63	0.312	258	0.082	14.73	16.232	226	9.462	30.24
Nov 24 79	6.30	328.27	0.609	255	0.279	24.61	0.965	240	0.518	28.23	0.310	260	0.138	24.00	0.348	260	0.088	14.19	16.487	226	9.561	30.11
Nov 27 79	6.30	331.27	0.673	251	0.275	22.23	0.987	240	0.564	29.74	0.369	261	0.086	13.12	ERR	ERR	ERR	ERR	17.184	226	9.933	30.03
Nov 28 79	6.00	332.25	ERR	ERR	ERR	ERR	0.976	237	0.506	27.40	0.284	253	-0.002	-0.40	0.356	250	-0.091	-14.34	17.285	225	9.947	29.92
Nov 30 79	11.00	334.46	0.568	252	0.278	26.08	0.954	241	0.576	31.12	0.265	261	0.144	28.52	0.293	259	0.120	22.27	17.653	225	10.301	30.26
Dec 01 79	6.00	335.25	0.592	254	0.272	24.68	1.013	242	0.570	29.37	0.341	260	0.112	18.18	0.406	255	0.107	14.76	17.853	225	10.367	30.14
Dec 02 79	6.00	336.25	ERR	ERR	ERR	ERR	1.032	236	0.578	29.25	0.360	260	0.079	12.38	0.362	245	0.062	9.72	18.083	225	10.447	30.02
Dec 03 79	6.00	337.25	0.612	252	0.206	18.60	1.010	241	0.538	28.04	0.320	256	0.119	20.40	0.352	260	0.043	6.96	18.165	225	10.492	30.01
Dec 06 79	7.45	340.32	0.619	251	0.233	20.63	0.994	239	0.519	27.57	0.313	257	0.085	15.19	0.349	259	0.088	14.15	18.636	225	10.835	30.17
Dec 10 79	15.00	344.63	0.613	254	0.205	18.49	0.993	235	0.520	27.64	0.329	258	0.106	17.86	ERR	ERR	ERR	ERR	19.306	225	11.174	30.06
Dec 13 79	6.00	347.25	0.631	254	0.239	20.74	0.955	241	0.557	30.25	0.282	258	0.065	12.98	ERR	ERR	ERR	ERR	19.703	225	11.534	30.34
Dec 16 79	5.30	350.23	0.644	248	0.281	23.57	0.922	240	0.569	31.68	0.358	243	0.127	19.53	ERR	ERR	ERR	ERR	20.114	225	11.749	30.29
Dec 20 79	7.30	354.31	0.607	256	0.218	19.76	0.972	241	0.531	28.65	0.260	260	0.091	19.29	0.313	259	0.069	12.43	20.622	225	12.041	30.28
Dec 23 79	8.00	357.33	0.662	251	0.126	10.78	1.022	239	0.411	21.91	0.304	246	-0.028	-5.26	0.330	250	-0.033	-5.71	21.072	224	12.124	29.91
Dec 27 79	10.00	361.42	0.646	250	0.207	17.77	1.029	240	0.552	28.21	0.322	262	0.098	16.93	0.457	242	0.074	9.20	21.475	224	12.503	30.21
Dec 31 79	8.00	365.33	0.610	250	0.233	20.91	0.997	235	0.520	27.54	0.279	237	0.092	18.82	0.282	242	0.024	4.86	21.864	224	12.749	30.25
Jan 03 80	13.00	368.54	0.619	250	0.253	22.23	0.993	240	0.577	30.16	0.301	258	0.165	28.73	0.338	260	0.094	15.54	22.129	224	12.879	30.20
Jan 07 80	9.00	372.38	0.633	252	0.220	19.16	1.138	239	0.490	23.30	0.515	245	0.070	7.74	ERR	ERR	ERR	ERR	22.385	224	13.021	30.19
Jan 10 80	7.30	375.31	0.668	247	0.208	17.30	1.071	237	0.418	21.32	0.385	253	0.067	9.87	ERR	ERR	ERR	ERR	22.521	224	13.018	30.03
Jan 16 80	9.30	381.40	0.625	253	0.239	20.93	1.012	238	0.539	28.04	0.339	258	0.066	11.02	ERR	ERR	ERR	ERR	22.470	224	13.124	30.29
Jan 21 80	11.00	386.46	0.618	246	0.160	14.52	1.014	236	0.462	24.50	0.316	242	0.013	2.36	0.309	246	-0.040	-7.38	22.511	224	13.074	30.15
Jan 26 80	22.00	391.92	0.596	250	0.185	17.24	1.010	236	0.475	25.19	0.304	243	0.026	4.89	0.396	241	-0.015	-2.17	22.531	224	13.112	30.20
Jan 31 80	10.30	396.44	0.638	246	0.282	23.85	1.051	236	0.546	27.45	0.339	241	0.107	17.52	0.342	244	0.049	8.15	22.570	224	13.170	30.26
Feb 04 80	10.30	400.44	0.800	264	0.281	19.35	1.157	250	0.565	26.03	0.512	279	0.086	9.53	0.545	280	0.101	10.50	22.617	225	13.157	30.19
Feb 15 80	9.00	411.38	0.657	260	0.258	21.44	1.046	244	0.564	28.33	0.326	266	0.111	18.80	0.423	261	0.094	12.53	22.482	224	13.174	30.37
Feb 20 80	10.00	416.42	0.696	262	0.191	15.35	1.037	243	0.513	26.32	0.362	271	0.031	4.89	0.369	270	0.018	2.79	22.559	224	13.137	30.21
Feb 25 80	9.40	421.40	0.751	267	0.265	19.44	1.094	248	0.526	25.68	0.447	280	0.085	10.77	0.485	280	0.043	5.07	22.577	224	13.143	30.21
Feb 29 80	13.00	425.54	0.739	259	0.254	18.97	1.060	244	0.565	29.06	0.379	269	0.072	10.76	0.390	270	0.075	10.89	22.563	224	13.163	30.26

TABLE B.2 - THREE-DIMENSIONAL SLOPE DISPLACEMENTS, TARGETS 37B, 38B, 39B, 40B. PAGE 1 OF 2.

Note: Horiz and Vert are Horizontal and Vertical Components in Feet. Azim and Incl are Azimuth and Inclination (from horizontal) Angles in Degrees.
Vertical Displacement and Inclination are Positive in the Downward Direction.

			[-----	TARGET 37B		-----]	[-----	TARGET 38B		-----]	[-----	TARGET 39B		-----]	[-----	TARGET 40B		-----]
Date	Time	Days	Horiz	Azim	Vert	Incl	Horiz	Azim	Vert	Incl	Horiz	Azim	Vert	Incl	Horiz	Azim	Vert	Incl
Oct 31 79	14.00	304.58	0.000	ERR	0.000	ERR	0.000	ERR	0.000	ERR	0.000	ERR	0.000	ERR	0.000	ERR	0.000	ERR
Nov 01 79	13.45	305.57	0.295	216	0.204	34.66	0.204	218	0.147	35.78	0.270	218	0.200	36.53	0.211	220	0.112	27.96
Nov 02 79	14.00	306.58	0.579	223	0.291	26.68	0.387	234	0.166	23.22	0.507	222	0.357	35.15	0.370	228	0.200	28.39
Nov 03 79	14.00	307.58	0.803	214	0.408	26.93	0.490	217	0.238	25.91	0.720	209	0.468	33.02	0.520	214	0.212	22.18
Nov 04 79	10.15	308.43	1.066	218	0.412	21.13	0.638	221	0.304	25.48	0.950	213	0.579	31.36	0.690	215	0.263	20.86
Nov 05 79	12.30	309.52	1.322	211	0.540	22.22	0.839	211	0.398	25.62	1.215	206	0.749	31.65	0.876	204	0.269	17.07
Nov 06 79	12.15	310.51	1.645	213	0.699	23.05	1.018	213	0.439	23.33	1.479	206	0.909	31.58	1.100	206	0.402	20.08
Nov 07 79	13.30	311.56	1.990	213	0.880	23.86	1.208	215	0.516	23.13	1.776	206	1.123	32.31	1.337	206	0.450	18.60
Nov 08 79	13.30	312.56	2.467	212	1.049	23.04	1.549	213	0.705	24.47	2.252	205	1.411	32.07	1.730	203	0.544	17.46
Nov 09 79	8.30	313.35	3.019	212	1.310	23.46	1.904	213	0.835	23.68	2.777	205	1.691	31.34	2.115	204	0.679	17.80
Nov 09 79	16.30	313.69	3.239	213	1.398	23.35	2.044	213	0.912	24.05	2.985	206	1.826	31.46	2.275	206	0.737	17.95
Nov 10 79	9.00	314.38	4.939	211	2.941	22.45	ERR	ERR	ERR	ERR	4.575	204	2.713	30.67	3.570	204	1.148	17.83
Nov 10 79	17.00	314.71	21.514	209	9.499	23.82	13.919	207	5.961	23.18	19.062	202	11.737	31.62	16.274	199	4.325	14.88
Nov 10 79	20.00	314.83	21.692	209	9.464	23.58	14.061	207	5.992	23.08	19.200	202	11.744	31.45	16.360	199	4.275	14.64
Nov 11 79	6.00	315.25	21.827	209	9.518	23.56	14.108	207	6.043	23.19	19.294	202	11.806	31.46	16.531	199	4.331	14.68
Nov 11 79	21.00	315.88	22.118	209	9.707	23.70	14.327	207	6.106	23.08	19.498	202	11.933	31.47	16.802	199	4.371	14.58
Nov 12 79	9.00	316.38	22.306	209	9.901	23.94	14.478	207	6.206	23.20	19.704	202	12.116	31.59	16.907	199	4.510	14.94
Nov 13 79	13.30	317.56	22.774	209	10.158	24.04	14.819	207	6.375	23.28	20.114	202	12.342	31.53	17.308	199	4.614	14.93
Nov 14 79	12.30	318.52	23.149	209	10.409	24.21	15.101	207	6.524	23.37	20.447	201	12.557	31.56	17.642	199	4.705	14.93
Nov 15 79	16.30	319.69	23.857	208	10.677	24.11	15.573	207	6.712	23.32	20.915	201	12.824	31.51	18.167	199	4.795	14.79
Nov 16 79	14.00	320.58	24.191	208	10.823	24.10	15.804	207	6.814	23.32	21.197	201	13.036	31.59	18.446	199	4.912	14.91
Nov 17 79	16.00	321.67	24.698	209	11.023	24.05	16.150	207	6.888	23.10	21.587	202	13.206	31.46	18.842	199	4.949	14.72
Nov 18 79	14.45	322.61	25.143	208	11.200	24.01	16.472	207	7.044	23.15	21.928	202	13.409	31.45	19.918	199	5.037	14.19
Nov 19 79	6.00	323.25	25.339	209	11.299	24.03	16.616	207	7.185	23.38	22.146	202	13.619	31.59	19.347	199	5.119	14.82
Nov 20 79	6.00	324.25	25.734	208	11.519	24.11	16.941	206	7.250	23.17	22.476	201	13.726	31.41	19.726	199	5.135	14.59
Nov 22 79	6.30	326.27	26.539	208	11.917	24.18	17.494	207	7.599	23.48	23.114	201	14.184	31.54	20.372	199	5.351	14.72
Nov 23 79	6.00	327.25	26.887	208	12.151	24.32	17.750	206	7.672	23.38	23.392	201	14.351	31.53	20.669	199	5.455	14.78
Nov 24 79	6.30	328.27	27.240	208	12.320	24.34	17.992	207	7.792	23.42	23.651	201	14.536	31.58	20.954	199	5.521	14.76
Nov 27 79	6.30	331.27	28.312	209	12.785	24.30	ERR	ERR	ERR	ERR	ERR	ERR	ERR	ERR	ERR	ERR	ERR	ERR
Nov 28 79	6.00	332.25	28.660	208	12.801	24.07	19.026	206	8.084	23.02	ERR	ERR	ERR	ERR	22.138	199	5.720	14.49
Nov 30 79	11.00	334.46	29.161	208	13.251	24.44	19.378	206	8.457	23.58	25.153	201	15.462	31.58	22.561	199	5.974	14.83
Dec 01 79	6.00	335.25	29.460	208	13.339	24.36	19.652	206	8.570	23.56	25.444	201	15.583	31.49	22.793	199	6.020	14.79
Dec 02 79	6.00	336.25	29.760	208	13.469	24.35	19.764	206	8.612	23.54	25.633	201	15.694	31.48	23.044	199	6.038	14.68
Dec 03 79	6.00	337.25	30.019	208	13.664	24.47	20.010	206	8.592	23.24	25.872	202	15.795	31.40	23.257	199	6.097	14.69
Dec 06 79	7.45	340.32	30.791	208	14.027	24.49	20.580	206	8.951	23.51	26.466	202	16.120	31.34	23.897	199	6.235	14.62
Dec 10 79	15.00	344.63	31.942	208	14.608	24.58	21.396	206	9.354	23.61	27.320	202	16.701	31.44	24.843	199	6.504	14.67
Dec 13 79	6.00	347.25	32.657	208	14.903	24.53	21.932	206	9.522	23.47	27.698	202	16.956	31.47	25.354	199	6.499	14.38
Dec 16 79	5.30	350.23	33.316	208	15.351	24.74	22.416	206	9.814	23.64	28.313	201	17.284	31.40	25.354	199	6.499	14.38
Dec 20 79	7.30	354.31	34.085	208	15.697	24.73	23.064	206	10.030	23.50	28.842	202	17.596	31.39	26.647	200	6.908	14.53
Dec 23 79	8.00	357.33	34.704	207	15.918	24.64	23.554	206	10.135	23.28	29.283	201	17.688	31.13	27.205	199	6.889	14.21
Dec 27 79	10.00	361.42	35.395	208	16.324	24.76	24.060	206	10.467	23.51	29.822	202	18.156	31.33	27.731	200	7.179	14.51
Dec 31 79	8.00	365.33	35.991	207	16.750	24.96	24.551	206	10.723	23.59	30.234	202	18.380	31.30	28.316	199	7.282	14.42

TABLE D.2 - THREE-DIMENSIONAL SLOPE DISPLACEMENTS, TARGETS 37B, 38B, 39B, 40B. PAGE 2 OF 2.

Note: Horiz and Vert are Horizontal and Vertical Components in Feet. Azim and Incl are Azimuth and Inclination (from horizontal) Angles in Degrees.
Vertical Displacement and Inclination are Positive in the Downward Direction.

			TARGET 37B				TARGET 38B				TARGET 39B				TARGET 40B			
Date	Time	Days	Horiz	Azim	Vert	Incl	Horiz	Azim	Vert	Incl	Horiz	Azim	Vert	Incl	Horiz	Azim	Vert	Incl
Jan 03 89	13.00	368.54	36.429	207	16.856	24.83	24.899	206	10.874	23.59	30.558	202	18.638	31.38	28.684	200	7.436	14.53
Jan 07 89	9.00	372.38	36.768	208	17.190	24.94	25.107	206	10.994	23.65	30.824	202	18.788	31.36	28.945	200	7.598	14.54
Jan 10 89	7.30	375.31	36.846	207	17.097	24.89	25.223	206	11.002	23.57	ERR	ERR	ERR	ERR	29.908	200	7.476	14.03
Jan 16 89	9.30	381.40	ERR	ERR	ERR	ERR	25.299	206	11.069	23.64	ERR	ERR	ERR	ERR	ERR	ERR	ERR	ERR

TABLE B.3 - THREE-DIMENSIONAL SLOPE DISPLACEMENTS, TARGETS 42B, 43B, 44B. PAGE 1 OF 1.

Note: Horiz and Vert are Horizontal and Vertical Components in Feet. Azim and Incl are Azimuth and Inclination (from horizontal) Angles in Degrees.
Vertical Displacement and Inclination are Positive in the Downward Direction.

			TARGET 42B				TARGET 43B				TARGET 44B			
Date	Time	Days	Horiz	Azim	Vert	Incl	Horiz	Azim	Vert	Incl	Horiz	Azim	Vert	Incl
Nov 03 79	14.00	307.58	0.000	ERR	0.000	ERR	0.000	ERR	0.000	ERR	0.000	ERR	0.000	ERR
Nov 04 79	10.15	308.43	0.158	229	-0.086	-28.56	0.027	251	-0.013	-25.71	0.094	273	-0.035	-20.42
Nov 05 79	12.30	309.52	0.301	187	-0.083	-15.42	0.126	103	-0.094	-36.72	0.006	80	-0.041	-81.67
Nov 06 79	12.15	310.51	0.461	195	-0.087	-10.69	0.049	130	0.009	10.41	0.020	79	-0.035	-60.26
Nov 07 79	13.30	311.56	0.632	192	-0.080	-7.21	0.054	83	-0.043	-38.53	0.024	14	-0.034	-54.78
Nov 08 79	13.30	312.56	0.853	192	-0.123	-8.21	0.094	108	0.011	6.67	0.032	128	0.005	8.88
Nov 09 79	8.30	313.35	1.098	194	-0.179	-9.26	ERR	ERR	ERR	ERR	0.039	337	0.024	31.61
Nov 09 79	16.30	313.69	1.211	198	-0.229	-10.71	ERR	ERR	ERR	ERR	0.060	270	0.000	0.00
Nov 10 79	9.00	314.38	ERR	ERR	ERR	ERR	ERR	ERR	ERR	ERR	0.023	288	0.023	45.00
Nov 10 79	17.00	314.71	ERR	ERR	ERR	ERR	ERR	ERR	ERR	ERR	0.081	296	-0.006	-4.24

TABLE B.4 - ONE-DIMENSIONAL SLOPE DISPLACEMENTS, SLOPE DISTANCE COMPONENT. PAGE 1 OF 4.

Note: Slope Distance is the Direct Reading from the Electronic Distance Measuring Instrument to the Target.

			[-----			CUMULATIVE DISPLACEMENT (in feet)				-----]	[-----				SLOPE DISTANCE (in metres)				-----]
TARGET			21B	22B	23B	25B	26B	37B	38B	39B	40B	21B	22B	23B	25B	26B	37B	38B	39B	40B
Zero Reading												844.771	807.376	838.380	800.743	799.472	743.161	738.221	713.482	710.668
Zero Reading Date												Mar0679	Mar0679	Mar0679	Mar0679	Mar0679	Oct3179	Oct3179	Oct3179	Oct3179
Date	Time	Days																		
Mar 06 79	12.00	65.50	0.000	0.000	0.000	0.000	0.000	ERR	ERR	ERR	ERR	844.771	807.376	838.380	800.743	799.472	ERR	ERR	ERR	ERR
Mar 23 79	12.00	82.50	0.050	-0.010	0.040	ERR	0.010	ERR	ERR	ERR	ERR	844.756	807.379	838.368	ERR	799.469	ERR	ERR	ERR	ERR
Mar 28 79	12.00	87.50	0.060	0.000	0.010	ERR	0.030	ERR	ERR	ERR	ERR	844.753	807.376	838.377	ERR	799.463	ERR	ERR	ERR	ERR
Apr 24 79	12.00	114.50	0.044	-0.021	0.006	0.004	0.063	ERR	ERR	ERR	ERR	844.758	807.382	838.378	800.742	799.453	ERR	ERR	ERR	ERR
May 02 79	12.00	122.50	0.021	-0.060	0.032	0.030	0.040	ERR	ERR	ERR	ERR	844.765	807.394	838.370	800.734	799.460	ERR	ERR	ERR	ERR
May 08 79	12.00	128.50	0.054	0.002	-0.001	ERR	0.053	ERR	ERR	ERR	ERR	844.755	807.375	838.380	ERR	799.456	ERR	ERR	ERR	ERR
May 15 79	12.00	135.50	0.054	0.025	0.016	0.030	0.092	ERR	ERR	ERR	ERR	844.755	807.368	838.375	800.734	799.444	ERR	ERR	ERR	ERR
May 24 79	12.00	144.50	0.103	0.071	0.085	0.066	0.155	ERR	ERR	ERR	ERR	844.740	807.354	838.354	800.723	799.425	ERR	ERR	ERR	ERR
May 29 79	12.00	149.50	0.123	0.117	0.072	0.063	0.178	ERR	ERR	ERR	ERR	844.734	807.340	838.358	800.724	799.418	ERR	ERR	ERR	ERR
Jun 05 79	12.00	156.50	0.126	0.117	0.055	0.053	0.168	ERR	ERR	ERR	ERR	844.733	807.340	838.363	800.727	799.421	ERR	ERR	ERR	ERR
Jun 11 79	10.45	162.45	0.153	0.146	0.075	0.102	0.194	ERR	ERR	ERR	ERR	844.725	807.331	838.357	800.712	799.413	ERR	ERR	ERR	ERR
Jul 30 79	9.50	211.41	0.153	0.150	0.042	0.082	0.168	ERR	ERR	ERR	ERR	844.725	807.330	838.367	800.718	799.421	ERR	ERR	ERR	ERR
Aug 27 79	10.00	239.42	0.264	0.389	0.150	0.283	0.351	ERR	ERR	ERR	ERR	844.691	807.257	838.334	800.657	799.365	ERR	ERR	ERR	ERR
Sep 10 79	12.00	253.50	0.267	0.448	0.141	0.240	0.519	ERR	ERR	ERR	ERR	844.690	807.239	838.337	800.670	799.314	ERR	ERR	ERR	ERR
Oct 04 79	12.00	277.50	0.349	0.501	0.163	0.187	0.624	ERR	ERR	ERR	ERR	844.665	807.223	838.330	800.686	799.282	ERR	ERR	ERR	ERR
Oct 09 79	12.30	282.52	0.333	0.553	0.180	0.233	0.696	ERR	ERR	ERR	ERR	844.670	807.207	838.325	800.672	799.260	ERR	ERR	ERR	ERR
Oct 15 79	13.30	288.56	0.392	0.573	0.209	0.371	0.739	ERR	ERR	ERR	ERR	844.652	807.201	838.316	800.630	799.247	ERR	ERR	ERR	ERR
Oct 22 79	12.00	295.50	0.346	0.629	0.150	0.201	0.824	ERR	ERR	ERR	ERR	844.666	807.184	838.334	800.682	799.221	ERR	ERR	ERR	ERR
Oct 29 79	14.00	302.58	0.405	0.753	0.206	0.266	1.457	ERR	ERR	ERR	ERR	844.648	807.146	838.317	800.662	799.028	ERR	ERR	ERR	ERR
Oct 31 79	14.00	304.58	0.405	0.786	0.203	ERR	1.605	0.000	0.000	0.000	0.000	844.648	807.136	838.318	ERR	798.983	743.161	738.221	713.482	710.668
Nov 01 79	13.45	305.57	0.467	0.825	0.246	ERR	1.739	0.295	0.203	0.400	0.144	844.629	807.124	838.305	ERR	798.942	743.071	738.159	713.360	710.624
Nov 02 79	8.45	306.36	0.425	0.819	0.229	0.286	1.857	0.469	0.325	0.581	0.282	844.642	807.126	838.310	800.656	798.906	743.018	738.122	713.305	710.582
Nov 03 79	9.30	307.40	0.464	0.829	0.219	0.371	2.041	0.758	0.479	0.807	0.453	844.630	807.123	838.313	800.630	798.850	742.930	738.075	713.236	710.530
Nov 04 79	10.15	308.43	0.464	0.842	0.236	0.394	2.133	1.020	0.620	1.047	0.614	844.630	807.119	838.308	800.623	798.822	742.850	738.032	713.163	710.481
Nov 05 79	12.30	309.52	0.481	0.848	0.242	0.246	2.221	1.299	0.823	1.316	0.804	844.625	807.117	838.306	800.668	798.795	742.765	737.970	713.081	710.423
Nov 06 79	12.15	310.51	0.441	0.861	0.226	0.250	2.392	1.598	1.007	1.568	1.020	844.637	807.113	838.311	800.667	798.743	742.674	737.914	713.004	710.357
Nov 08 79	13.30	312.56	0.445	ERR	ERR	ERR	2.842	2.405	ERR	2.310	1.637	844.636	ERR	ERR	ERR	798.606	742.428	ERR	712.778	710.169
Nov 09 79	8.30	313.35	0.448	ERR	ERR	ERR	3.127	2.926	ERR	2.812	2.014	844.635	ERR	ERR	ERR	798.519	742.269	ERR	712.625	710.054
Nov 09 79	13.50	313.57	0.448	ERR	ERR	ERR	3.232	3.140	ERR	3.005	2.172	844.635	ERR	ERR	ERR	798.487	742.204	ERR	712.566	710.006
Nov 10 79	9.00	314.38	0.464	ERR	ERR	ERR	4.157	4.813	ERR	4.541	3.435	844.630	ERR	ERR	ERR	798.205	741.694	ERR	712.098	709.621
Nov 10 79	13.45	314.57	0.467	ERR	ERR	ERR	12.008	19.803	12.900	17.497	14.888	844.629	ERR	ERR	ERR	795.812	737.125	734.289	708.149	706.130
Nov 10 79	14.03	314.58	0.445	ERR	ERR	ERR	12.336	20.262	13.182	17.808	15.210	844.636	ERR	ERR	ERR	795.712	736.985	734.203	708.054	706.032
Nov 10 79	14.20	314.60	0.425	ERR	ERR	ERR	12.444	20.505	13.369	18.025	15.436	844.642	ERR	ERR	ERR	795.679	736.911	734.146	707.988	705.963
Nov 10 79	15.00	314.63	ERR	ERR	ERR	ERR	12.651	20.853	13.642	18.317	15.692	ERR	ERR	ERR	ERR	795.616	736.805	734.063	707.899	705.895
Nov 10 79	16.30	314.69	0.474	ERR	ERR	ERR	12.733	20.977	13.727	18.412	15.774	844.627	ERR	ERR	ERR	795.591	736.767	734.037	707.870	705.860
Nov 10 79	20.00	314.83	ERR	ERR	ERR	ERR	12.845	21.155	13.865	18.550	15.856	ERR	ERR	ERR	ERR	795.557	736.713	733.995	707.828	705.835
Nov 10 79	24.00	315.00	ERR	ERR	ERR	ERR	12.864	21.191	13.848	18.597	15.969	ERR	ERR	ERR	ERR	795.551	736.702	734.000	707.813	705.801

TABLE B.4 - ONE-DIMENSIONAL SLOPE DISPLACEMENTS, SLOPE DISTANCE COMPONENT. PAGE 2 OF 4.

Note: Slope Distance is the Direct Reading from the Electronic Distance Measuring Instrument to the Target.

			[-----				CUMULATIVE DISPLACEMENT (in feet)				-----]	[-----				SLOPE DISTANCE (in metres)				-----]
TARGET			21B	22B	23B	25B	26B	37B	38B	39B	40B	21B	22B	23B	25B	26B	37B	38B	39B	40B
Zero Reading												844.771	807.376	838.380	800.743	799.472	743.161	738.221	713.482	710.668
Zero Reading Date												Mar0679	Mar0679	Mar0679	Mar0679	Mar0679	Oct3179	Oct3179	Oct3179	Oct3179
Date	Time	Days																		
Nov 11 79	9.00	315.38	ERR	ERR	ERR	ERR	12.956	21.315	13.979	18.710	16.079	ERR	ERR	ERR	ERR	795.523	736.664	733.960	707.779	705.767
Nov 11 79	12.00	315.50	ERR	ERR	ERR	ERR	12.956	21.374	13.996	18.737	16.158	ERR	ERR	ERR	ERR	795.523	736.646	733.955	707.771	705.743
Nov 11 79	14.00	315.58	ERR	ERR	ERR	ERR	12.969	21.384	14.012	18.740	16.145	ERR	ERR	ERR	ERR	795.519	736.643	733.950	707.770	705.747
Nov 11 79	21.00	315.88	0.454	ERR	ERR	ERR	13.028	21.578	14.127	18.835	16.292	844.633	ERR	ERR	ERR	795.501	736.584	733.915	707.741	705.702
Nov 11 79	23.00	315.96	0.497	ERR	ERR	ERR	13.038	21.470	14.183	18.947	16.296	844.620	ERR	ERR	ERR	795.498	736.617	733.898	707.707	705.701
Nov 12 79	6.00	316.25	0.494	ERR	ERR	ERR	13.107	21.650	14.199	18.976	16.374	844.621	ERR	ERR	ERR	795.477	736.562	733.893	707.698	705.677
Nov 12 79	8.45	316.36	ERR	ERR	ERR	ERR	13.156	21.722	14.242	19.048	16.371	ERR	ERR	ERR	ERR	795.462	736.540	733.880	707.676	705.678
Nov 12 79	10.00	316.42	ERR	ERR	ERR	ERR	13.215	21.739	14.268	19.045	16.397	ERR	ERR	ERR	ERR	795.444	736.535	733.872	707.677	705.670
Nov 12 79	11.25	316.48	ERR	ERR	ERR	ERR	13.199	21.762	14.262	19.048	16.420	ERR	ERR	ERR	ERR	795.449	736.528	733.874	707.676	705.663
Nov 12 79	12.45	316.53	ERR	ERR	ERR	ERR	13.179	21.785	14.334	19.061	16.450	ERR	ERR	ERR	ERR	795.455	736.521	733.852	707.672	705.654
Nov 12 79	13.20	316.55	ERR	ERR	ERR	ERR	13.215	21.781	14.327	19.081	16.450	ERR	ERR	ERR	ERR	795.444	736.522	733.854	707.666	705.654
Nov 13 79	6.30	317.27	0.500	ERR	ERR	ERR	13.416	22.122	14.511	19.337	16.742	844.619	ERR	ERR	ERR	795.383	736.418	733.798	707.588	705.565
Nov 13 79	12.00	317.50	0.418	ERR	ERR	ERR	13.432	22.181	14.537	19.403	16.742	844.644	ERR	ERR	ERR	795.378	736.400	733.790	707.568	705.565
Nov 13 79	14.20	317.60	0.464	ERR	ERR	ERR	13.455	22.214	14.616	19.419	16.781	844.630	ERR	ERR	ERR	795.371	736.390	733.766	707.563	705.553
Nov 13 79	15.15	317.64	ERR	ERR	ERR	ERR	13.452	22.546	14.616	19.442	16.817	ERR	ERR	ERR	ERR	795.372	736.289	733.766	707.556	705.542
Nov 14 79	4.00	318.17	0.458	ERR	ERR	ERR	13.648	22.549	14.816	19.649	17.034	844.632	ERR	ERR	ERR	795.312	736.288	733.705	707.493	705.476
Nov 14 79	6.30	318.27	0.464	ERR	ERR	ERR	13.668	22.575	14.855	19.659	17.008	844.630	ERR	ERR	ERR	795.306	736.280	733.693	707.490	705.484
Nov 14 79	10.30	318.44	0.504	ERR	ERR	ERR	13.704	22.644	14.898	19.747	17.080	844.618	ERR	ERR	ERR	795.295	736.259	733.680	707.463	705.462
Nov 14 79	12.30	318.52	0.543	ERR	ERR	ERR	13.685	22.588	14.885	19.741	17.103	844.606	ERR	ERR	ERR	795.301	736.276	733.684	707.465	705.455
Nov 14 79	16.00	318.67	0.467	ERR	ERR	ERR	13.740	22.792	14.944	19.793	17.208	844.629	ERR	ERR	ERR	795.284	736.214	733.666	707.449	705.423
Nov 15 79	4.00	319.17	0.458	ERR	ERR	ERR	13.878	22.962	15.121	19.954	17.395	844.632	ERR	ERR	ERR	795.242	736.162	733.612	707.400	705.366
Nov 15 79	10.00	319.42	0.487	ERR	ERR	ERR	13.967	23.120	15.229	20.078	17.483	844.623	ERR	ERR	ERR	795.215	736.114	733.579	707.362	705.339
Nov 15 79	21.00	319.88	0.500	ERR	ERR	ERR	14.108	23.356	15.367	20.243	17.654	844.619	ERR	ERR	ERR	795.172	736.042	733.537	707.312	705.287
Nov 16 79	6.30	320.27	0.422	ERR	ERR	ERR	14.160	23.445	15.462	20.338	17.733	844.643	ERR	ERR	ERR	795.156	736.015	733.508	707.283	705.263
Nov 16 79	9.30	320.40	0.461	ERR	ERR	ERR	14.229	23.530	15.531	20.393	17.838	844.631	ERR	ERR	ERR	795.135	735.989	733.487	707.266	705.231
Nov 16 79	22.00	320.92	0.481	ERR	ERR	ERR	14.347	23.769	15.656	20.561	17.989	844.625	ERR	ERR	ERR	795.099	735.916	733.449	707.215	705.185
Nov 17 79	9.15	321.39	0.438	ERR	ERR	ERR	14.528	23.953	15.797	20.699	18.153	844.638	ERR	ERR	ERR	795.044	735.860	733.406	707.176	705.135
Nov 17 79	20.30	321.85	0.441	ERR	ERR	ERR	14.577	24.157	15.945	20.892	18.317	844.637	ERR	ERR	ERR	795.029	735.798	733.361	707.114	705.085
Nov 18 79	9.00	322.38	0.458	ERR	ERR	ERR	14.738	24.376	16.155	21.105	18.527	844.632	ERR	ERR	ERR	794.980	735.731	733.297	707.049	705.021
Nov 18 79	20.00	322.83	0.471	ERR	ERR	ERR	14.843	24.596	16.279	21.243	18.691	844.628	ERR	ERR	ERR	794.948	735.664	733.259	707.007	704.971
Nov 19 79	9.30	323.40	0.520	ERR	ERR	ERR	15.003	24.813	16.479	21.394	18.848	844.613	ERR	ERR	ERR	794.899	735.598	733.201	706.961	704.923
Nov 20 79	9.00	324.38	0.497	ERR	ERR	ERR	15.220	25.170	16.719	21.716	19.193	844.620	ERR	ERR	ERR	794.833	735.489	733.125	706.863	704.818
Nov 21 79	6.00	325.25	0.454	ERR	ERR	ERR	15.407	25.515	16.958	21.991	19.442	844.633	ERR	ERR	ERR	794.776	735.384	733.052	706.779	704.742
Nov 21 79	13.00	325.54	0.484	ERR	ERR	ERR	15.437	25.636	17.034	22.047	19.537	844.624	ERR	ERR	ERR	794.767	735.347	733.029	706.762	704.713
Nov 21 79	16.00	325.67	0.513	ERR	ERR	ERR	15.512	25.718	17.024	22.080	19.596	844.615	ERR	ERR	ERR	794.744	735.322	733.032	706.752	704.695
Nov 21 79	24.00	326.00	0.490	ERR	ERR	ERR	15.581	25.777	17.159	22.188	19.672	844.622	ERR	ERR	ERR	794.723	735.304	732.991	706.719	704.672
Nov 22 79	6.30	326.27	0.490	ERR	ERR	ERR	15.630	25.899	17.237	22.290	19.770	844.622	ERR	ERR	ERR	794.708	735.267	732.967	706.689	704.642

TABLE B.4 - ONE-DIMENSIONAL SLOPE DISPLACEMENTS, SLOPE DISTANCE COMPONENT. PAGE 3 OF 4.

Note: Slope Distance is the Direct Reading from the Electronic Distance Measuring Instrument to the Target.

			[-----				CUMULATIVE DISPLACEMENT (in feet)				-----]	[-----				SLOPE DISTANCE (in metres)				-----]
TARGET			21B	22B	23B	25B	26B	37B	38B	39B	40B	21B	22B	23B	25B	26B	37B	38B	39B	40B
Zero Reading												844.771	807.376	838.380	809.743	799.472	743.161	738.221	713.482	710.668
Zero Reading Date												Mar0679	Mar0679	Mar0679	Mar0679	Mar0679	Oct3179	Oct3179	Oct3179	Oct3179
Date	Time	Days																		
Nov 22 79	11.00	326.46	0.477	ERR	ERR	ERR	15.647	25.948	17.280	22.306	19.777	844.626	ERR	ERR	ERR	794.703	735.252	732.954	706.683	704.640
Nov 22 79	21.00	326.88	0.504	ERR	ERR	ERR	15.761	26.089	17.359	22.437	19.911	844.618	ERR	ERR	ERR	794.668	735.209	732.930	706.643	704.599
Nov 23 79	7.00	327.29	0.448	ERR	ERR	ERR	15.883	26.282	17.460	22.477	20.033	844.635	ERR	ERR	ERR	794.631	735.150	732.899	706.631	704.562
Nov 23 79	12.00	327.50	0.481	ERR	ERR	ERR	15.876	26.312	17.536	22.615	20.115	844.625	ERR	ERR	ERR	794.633	735.141	732.876	706.589	704.537
Nov 23 79	14.30	327.60	0.481	ERR	ERR	ERR	15.893	26.348	17.552	22.634	20.144	844.625	ERR	ERR	ERR	794.628	735.130	732.871	706.583	704.528
Nov 23 79	24.00	328.00	0.494	ERR	ERR	ERR	16.017	26.440	17.664	22.743	20.266	844.621	ERR	ERR	ERR	794.590	735.102	732.837	706.550	704.491
Nov 24 79	12.30	328.52	0.451	ERR	ERR	ERR	16.070	26.650	17.808	22.890	20.387	844.634	ERR	ERR	ERR	794.574	735.038	732.793	706.505	704.454
Nov 24 79	21.00	329.00	0.497	ERR	ERR	ERR	16.208	26.811	17.867	23.092	20.535	844.620	ERR	ERR	ERR	794.532	734.989	732.775	706.471	704.409
Nov 25 79	7.30	329.31	0.563	ERR	ERR	ERR	16.372	26.985	17.982	ERR	ERR	844.600	ERR	ERR	ERR	794.482	734.936	732.740	ERR	ERR
Nov 27 79	0.30	331.02	0.464	ERR	ERR	ERR	16.582	27.487	ERR	ERR	ERR	844.630	ERR	ERR	ERR	794.418	734.783	ERR	ERR	ERR
Nov 27 79	3.00	331.13	0.422	ERR	ERR	ERR	16.513	27.569	ERR	ERR	ERR	844.643	ERR	ERR	ERR	794.439	734.758	ERR	ERR	ERR
Nov 27 79	7.30	331.31	0.415	ERR	ERR	ERR	16.647	27.595	ERR	ERR	ERR	844.645	ERR	ERR	ERR	794.398	734.750	ERR	ERR	ERR
Nov 27 79	16.00	331.67	0.445	ERR	ERR	ERR	16.664	27.687	18.539	23.655	21.223	844.636	ERR	ERR	ERR	794.393	734.722	732.573	706.272	704.199
Nov 27 79	24.00	332.00	0.563	ERR	ERR	ERR	16.903	27.877	18.704	23.874	21.384	844.600	ERR	ERR	ERR	794.320	734.664	732.529	706.205	704.150
Nov 28 79	8.00	332.33	0.517	ERR	ERR	ERR	16.896	27.956	18.710	ERR	21.584	844.614	ERR	ERR	ERR	794.322	734.640	732.518	ERR	704.089
Nov 28 79	15.00	332.63	0.556	ERR	ERR	ERR	17.005	28.071	18.838	23.999	21.561	844.602	ERR	ERR	ERR	794.289	734.605	732.479	706.167	704.096
Nov 29 79	1.00	333.04	0.566	ERR	ERR	ERR	17.041	28.153	18.927	24.058	21.598	844.599	ERR	ERR	ERR	794.278	734.580	732.452	706.149	704.085
Nov 29 79	8.00	333.33	0.517	ERR	ERR	ERR	17.015	28.116	18.917	24.055	21.663	844.614	ERR	ERR	ERR	794.286	734.591	732.455	706.150	704.065
Nov 29 79	15.30	333.65	0.579	ERR	ERR	ERR	17.097	28.323	19.042	24.157	21.788	844.595	ERR	ERR	ERR	794.261	734.528	732.417	706.119	704.027
Nov 30 79	7.45	334.32	0.474	ERR	ERR	ERR	17.192	28.448	19.094	24.265	21.850	844.627	ERR	ERR	ERR	794.232	734.490	732.401	706.086	704.008
Nov 30 79	16.00	334.67	0.481	ERR	ERR	ERR	17.264	28.553	19.176	24.376	21.978	844.625	ERR	ERR	ERR	794.210	734.458	732.376	706.052	703.969
Nov 30 79	24.00	335.00	0.490	ERR	ERR	ERR	17.297	28.661	19.245	24.442	22.060	844.622	ERR	ERR	ERR	794.200	734.425	732.355	706.032	703.944
Dec 01 79	8.00	335.33	0.458	ERR	ERR	ERR	17.395	28.740	19.357	24.517	22.129	844.632	ERR	ERR	ERR	794.170	734.401	732.321	706.009	703.923
Dec 01 79	15.00	335.63	0.464	ERR	ERR	ERR	17.431	28.815	19.347	24.557	22.165	844.630	ERR	ERR	ERR	794.159	734.378	732.324	705.997	703.912
Dec 01 79	24.00	336.00	0.474	ERR	ERR	ERR	17.497	28.937	19.458	24.678	22.286	844.627	ERR	ERR	ERR	794.139	734.341	732.290	705.960	703.875
Dec 02 79	6.00	336.25	0.546	ERR	ERR	ERR	17.641	29.042	19.465	24.698	22.368	844.605	ERR	ERR	ERR	794.095	734.309	732.288	705.954	703.859
Dec 02 79	15.00	336.63	0.451	ERR	ERR	ERR	17.582	29.104	19.577	24.789	22.421	844.634	ERR	ERR	ERR	794.113	734.290	732.254	705.929	703.834
Dec 02 79	24.00	337.00	0.484	ERR	ERR	ERR	17.658	29.219	19.649	24.872	22.523	844.624	ERR	ERR	ERR	794.090	734.255	732.232	705.901	703.803
Dec 03 79	7.30	337.31	0.487	ERR	ERR	ERR	17.719	29.278	19.714	24.928	22.582	844.623	ERR	ERR	ERR	794.074	734.237	732.212	705.884	703.785
Dec 03 79	16.00	337.67	0.458	ERR	ERR	ERR	17.740	29.343	19.780	24.957	22.618	844.632	ERR	ERR	ERR	794.065	734.217	732.192	705.875	703.774
Dec 03 79	24.00	338.00	0.464	ERR	ERR	ERR	17.799	29.452	19.829	25.042	22.710	844.630	ERR	ERR	ERR	794.047	734.184	732.177	705.849	703.746
Dec 04 79	8.00	338.33	0.523	ERR	ERR	ERR	17.891	29.534	19.872	25.193	22.874	844.612	ERR	ERR	ERR	794.022	734.159	732.164	705.803	703.696
Dec 04 79	15.00	338.63	0.454	ERR	ERR	ERR	17.877	29.583	19.954	25.154	22.815	844.633	ERR	ERR	ERR	794.023	734.144	732.139	705.815	703.714
Dec 04 79	24.00	339.00	0.464	ERR	ERR	ERR	17.923	29.685	20.013	25.210	22.903	844.630	ERR	ERR	ERR	794.009	734.113	732.121	705.798	703.697
Dec 05 79	6.00	339.25	0.458	ERR	ERR	ERR	17.982	29.754	20.062	25.279	22.969	844.632	ERR	ERR	ERR	793.991	734.092	732.106	705.777	703.667
Dec 05 79	17.00	339.71	0.500	ERR	ERR	ERR	18.087	29.901	20.183	25.397	23.084	844.619	ERR	ERR	ERR	793.959	734.047	732.069	705.741	703.632
Dec 05 79	23.00	339.96	0.474	ERR	ERR	ERR	18.019	29.957	20.197	25.400	23.103	844.627	ERR	ERR	ERR	793.980	734.030	732.065	705.740	703.626

TABLE B.4 - ONE-DIMENSIONAL SLOPE DISPLACEMENTS, SLOPE DISTANCE COMPONENT. PAGE 4 OF 4.

Note: Slope Distance is the Direct Reading from the Electronic Distance Measuring Instrument to the Target.

			[-----			CUMULATIVE DISPLACEMENT (in feet)					-----]	[-----				SLOPE DISTANCE (in metres)				-----]
TARGET			21B	22B	23B	25B	26B	37B	38B	39B	40B	21B	22B	23B	25B	26B	37B	38B	39B	40B
Zero Reading												844.771	807.376	838.380	800.743	799.472	743.161	738.221	713.482	710.668
Zero Reading Date												Mar0679	Mar0679	Mar0679	Mar0679	Mar0679	Oct3179	Oct3179	Oct3179	Oct3179
Date	Time	Days																		
Dec 06 79	6.00	340.25	0.497	ERR	ERR	ERR	18.173	30.039	20.269	25.498	23.205	844.620	ERR	ERR	ERR	793.933	734.005	732.043	705.710	703.595
Dec 06 79	14.30	340.60	0.490	ERR	ERR	ERR	ERR	30.137	20.341	25.544	23.294	844.622	ERR	ERR	ERR	ERR	733.975	732.021	705.696	703.568
Dec 06 79	24.00	341.00	0.464	ERR	ERR	ERR	18.268	30.242	ERR	ERR	ERR	844.630	ERR	ERR	ERR	793.904	733.943	ERR	ERR	ERR
Dec 07 79	7.00	341.29	0.510	ERR	ERR	ERR	18.412	30.367	20.535	25.761	23.507	844.616	ERR	ERR	ERR	793.860	733.905	731.962	705.630	703.503
Dec 07 79	17.00	341.71	0.481	ERR	ERR	ERR	18.415	30.436	20.567	25.790	23.536	844.625	ERR	ERR	ERR	793.859	733.884	731.952	705.621	703.494
Dec 07 79	23.30	341.98	0.517	ERR	ERR	ERR	18.481	30.544	20.640	25.849	23.648	844.614	ERR	ERR	ERR	793.839	733.851	731.930	705.603	703.460
Dec 08 79	8.30	342.35	0.467	ERR	ERR	ERR	18.511	30.669	20.754	25.951	23.740	844.629	ERR	ERR	ERR	793.830	733.813	731.895	705.572	703.432
Dec 08 79	15.00	342.63	0.448	ERR	ERR	ERR	18.543	30.698	20.741	25.941	23.717	844.635	ERR	ERR	ERR	793.820	733.804	731.899	705.575	703.439
Dec 08 79	22.00	342.93	0.487	ERR	ERR	ERR	18.612	30.800	20.820	26.004	23.786	844.623	ERR	ERR	ERR	793.799	733.773	731.875	705.556	703.418
Dec 10 79	15.30	344.65	0.474	ERR	ERR	ERR	18.862	31.210	21.096	26.319	24.127	844.627	ERR	ERR	ERR	793.723	733.648	731.791	705.460	703.314
Dec 10 79	23.30	344.98	0.490	ERR	ERR	ERR	18.927	31.315	21.204	26.391	24.258	844.622	ERR	ERR	ERR	793.703	733.616	731.758	705.438	703.274
Dec 11 79	7.30	345.31	0.458	ERR	ERR	ERR	18.954	31.341	21.210	26.401	24.255	844.632	ERR	ERR	ERR	793.695	733.608	731.756	705.435	703.275
Dec 11 79	15.30	345.65	0.438	ERR	ERR	ERR	18.983	31.443	21.283	26.450	24.327	844.638	ERR	ERR	ERR	793.686	733.577	731.734	705.420	703.253
Dec 12 79	15.00	346.63	0.471	ERR	ERR	ERR	19.167	31.834	21.463	26.647	24.540	844.628	ERR	ERR	ERR	793.630	733.458	731.679	705.369	703.188
Dec 12 79	23.30	346.98	0.497	ERR	ERR	ERR	19.226	31.817	21.552	26.732	24.665	844.620	ERR	ERR	ERR	793.612	733.463	731.652	705.334	703.150
Dec 13 79	7.30	347.31	0.464	ERR	ERR	ERR	19.242	31.850	21.624	26.752	24.675	844.630	ERR	ERR	ERR	793.607	733.453	731.630	705.328	703.147
Dec 13 79	17.30	347.73	0.595	ERR	ERR	ERR	19.423	ERR	21.722	26.945	24.895	844.590	ERR	ERR	ERR	793.552	ERR	731.600	705.269	703.080
Dec 13 79	23.00	347.96	0.507	ERR	ERR	ERR	ERR	ERR	21.912	27.080	25.049	844.617	ERR	ERR	ERR	ERR	ERR	731.542	705.228	703.033
Dec 15 79	16.30	349.69	0.507	ERR	ERR	ERR	19.574	32.352	21.968	27.113	25.141	844.617	ERR	ERR	ERR	793.506	733.300	731.525	705.218	703.005
Dec 15 79	23.30	349.98	0.520	ERR	ERR	ERR	19.646	32.470	22.047	27.231	25.220	844.613	ERR	ERR	ERR	793.484	733.264	731.501	705.182	702.981
Dec 16 79	7.00	350.29	0.533	ERR	ERR	ERR	19.741	32.565	22.119	27.270	25.302	844.609	ERR	ERR	ERR	793.455	733.235	731.479	705.170	702.956
Dec 16 79	17.00	350.71	0.504	ERR	ERR	ERR	19.744	32.631	22.198	27.329	25.311	844.618	ERR	ERR	ERR	793.454	733.215	731.455	705.152	702.953
Dec 16 79	23.00	350.96	0.513	ERR	ERR	ERR	19.800	32.680	22.227	27.349	25.357	844.615	ERR	ERR	ERR	793.437	733.200	731.446	705.146	702.939
Dec 17 79	7.00	351.29	0.523	ERR	ERR	ERR	19.849	32.736	22.283	27.398	25.429	844.612	ERR	ERR	ERR	793.422	733.183	731.429	705.131	702.917
Dec 17 79	18.00	351.75	0.566	ERR	ERR	ERR	19.944	32.923	22.378	27.450	25.485	844.599	ERR	ERR	ERR	793.393	733.126	731.400	705.115	702.909
Dec 18 79	8.00	352.33	0.513	ERR	ERR	ERR	19.984	32.939	22.428	27.546	25.603	844.615	ERR	ERR	ERR	793.381	733.121	731.385	705.086	702.864

TABLE B.5 - ONE-DIMENSIONAL SLOPE DISPLACEMENTS AND VELOCITIES, SLOPE DISTANCE COMPONENT, PAGE 1 OF 4.

Note: Slope Distance is the Direct Reading from the Electronic Distance Measuring Instrument to the Target.

			CUMULATIVE DISPLACEMENT (in feet)									COMPONENT VELOCITY (feet/hour)									
TARGET			21B	22B	23B	25B	26B	37B	38B	39B	40B	21B	22B	23B	25B	26B	37B	38B	39B	40B	
Zero Reading																					
Zero Reading Date																					Velocity Median
Date	Time	Days																			Days
Mar 06 79	12.00	65.50	0.000	0.000	0.000	0.000	0.000	ERR	ERR	ERR	ERR										
Mar 23 79	12.00	82.50	0.050	-0.010	0.040	ERR	0.010	ERR	ERR	ERR	ERR	0.0001	.0000	0.0001	ERR	.0000	ERR	ERR	ERR	ERR	74.00
Mar 28 79	12.00	87.50	0.060	0.000	0.010	ERR	0.030	ERR	ERR	ERR	ERR	0.0001	0.0001	-0.0002	ERR	0.0002	ERR	ERR	ERR	ERR	85.00
Apr 24 79	12.00	114.50	0.044	-0.021	0.006	0.004	0.063	ERR	ERR	ERR	ERR	.0000	.0000	.0000	ERR	0.0001	ERR	ERR	ERR	ERR	101.00
May 02 79	12.00	122.50	0.021	-0.060	0.032	0.030	0.040	ERR	ERR	ERR	ERR	-0.0001	-0.0002	0.0001	0.0001	-0.0001	ERR	ERR	ERR	ERR	118.50
May 08 79	12.00	128.50	0.054	0.002	-0.001	ERR	0.053	ERR	ERR	ERR	ERR	0.0002	0.0004	-0.0002	ERR	0.0001	ERR	ERR	ERR	ERR	125.50
May 15 79	12.00	135.50	0.054	0.025	0.016	0.030	0.092	ERR	ERR	ERR	ERR	0.0000	0.0001	0.0001	ERR	0.0002	ERR	ERR	ERR	ERR	132.00
May 24 79	12.00	144.50	0.103	0.071	0.085	0.066	0.155	ERR	ERR	ERR	ERR	0.0002	0.0002	0.0003	0.0002	0.0003	ERR	ERR	ERR	ERR	140.00
May 29 79	12.00	149.50	0.123	0.117	0.072	0.063	0.178	ERR	ERR	ERR	ERR	0.0002	0.0004	-0.0001	.0000	0.0002	ERR	ERR	ERR	ERR	147.00
Jun 05 79	12.50	156.50	0.126	0.117	0.055	0.053	0.168	ERR	ERR	ERR	ERR	.0000	0.0000	-0.0001	-0.0001	-0.0001	ERR	ERR	ERR	ERR	153.00
Jun 11 79	10.45	162.45	0.153	0.146	0.075	0.102	0.194	ERR	ERR	ERR	ERR	0.0002	0.0002	0.0001	0.0003	0.0002	ERR	ERR	ERR	ERR	159.48
Jul 30 79	9.50	211.41	0.153	0.150	0.042	0.082	0.168	ERR	ERR	ERR	ERR	.0000	.0000	.0000	.0000	.0000	ERR	ERR	ERR	ERR	186.93
Aug 27 79	10.00	239.42	0.264	0.389	0.150	0.283	0.351	ERR	ERR	ERR	ERR	0.0002	0.0004	0.0002	0.0003	0.0003	ERR	ERR	ERR	ERR	225.42
Sep 10 79	12.00	253.50	0.267	0.448	0.141	0.240	0.519	ERR	ERR	ERR	ERR	.0000	0.0002	.0000	-0.0001	0.0005	ERR	ERR	ERR	ERR	246.46
Oct 04 79	12.00	277.50	0.349	0.501	0.163	0.187	0.624	ERR	ERR	ERR	ERR	0.0001	0.0001	.0000	-0.0001	0.0002	ERR	ERR	ERR	ERR	265.50
Oct 09 79	12.30	282.52	0.333	0.553	0.189	0.233	0.696	ERR	ERR	ERR	ERR	-0.0001	0.0004	0.0001	0.0004	0.0006	ERR	ERR	ERR	ERR	280.01
Oct 15 79	13.30	288.56	0.392	0.573	0.209	0.371	0.739	ERR	ERR	ERR	ERR	0.0004	0.0001	0.0002	0.0010	0.0003	ERR	ERR	ERR	ERR	285.54
Oct 22 79	12.00	295.50	0.346	0.629	0.150	0.201	0.824	ERR	ERR	ERR	ERR	-0.0003	0.0003	-0.0004	-0.0010	0.0005	ERR	ERR	ERR	ERR	292.03
Oct 29 79	14.00	302.58	0.405	0.753	0.206	0.266	1.457	ERR	ERR	ERR	ERR	0.0003	0.0007	0.0003	0.0004	0.0037	ERR	ERR	ERR	ERR	299.04
Oct 31 79	14.00	304.58	0.405	0.786	0.203	ERR	1.605	0.000	0.000	0.000	0.000	0.0000	0.0007	-0.0001	ERR	0.0031	ERR	ERR	ERR	ERR	303.58
Nov 01 79	13.45	305.57	0.467	0.825	0.246	ERR	1.739	0.295	0.203	0.400	0.144	0.0026	0.0017	0.0018	ERR	0.0057	0.0124	0.0086	0.0168	0.0061	305.08
Nov 02 79	8.45	306.36	0.425	0.819	0.229	0.286	1.857	0.469	0.325	0.581	0.282	-0.0022	-0.0003	-0.0009	ERR	0.0062	0.0092	0.0064	0.0095	0.0073	305.97
Nov 03 79	9.30	307.40	0.464	0.829	0.219	0.371	2.041	0.758	0.479	0.807	0.453	0.0016	0.0004	-0.0004	0.0034	0.0074	0.0116	0.0062	0.0091	0.0068	306.88
Nov 04 79	10.15	308.43	0.464	0.842	0.236	0.394	2.133	1.020	0.620	1.047	0.614	0.0000	0.0005	0.0007	0.0009	0.0037	0.0106	0.0057	0.0097	0.0065	307.92
Nov 05 79	12.30	309.52	0.481	0.848	0.242	0.246	2.221	1.299	0.823	1.316	0.804	0.0006	0.0003	0.0003	-0.0056	0.0034	0.0107	0.0078	0.0103	0.0073	308.98
Nov 06 79	12.15	310.51	0.441	0.861	0.226	0.250	2.392	1.598	1.007	1.568	1.020	-0.0017	0.0006	-0.0007	0.0001	0.0072	0.0126	0.0077	0.0106	0.0091	310.02
Nov 08 79	13.30	312.56	0.445	ERR	ERR	ERR	2.842	2.405	ERR	2.310	1.637	0.0001	ERR	ERR	ERR	0.0091	0.0164	ERR	0.0151	0.0125	311.54
Nov 09 79	8.30	313.35	0.448	ERR	ERR	ERR	3.127	2.926	ERR	2.812	2.014	0.0002	ERR	ERR	ERR	0.0151	0.0275	ERR	0.0265	0.0199	312.96
Nov 09 79	13.50	313.57	0.448	ERR	ERR	ERR	3.232	3.140	ERR	3.005	2.172	0.0000	ERR	ERR	ERR	0.0199	0.0404	ERR	0.0367	0.0298	313.46
Nov 10 79	9.00	314.38	0.464	ERR	ERR	ERR	4.157	4.813	ERR	4.541	3.435	0.0008	ERR	ERR	ERR	0.0476	0.0861	ERR	0.0790	0.0650	313.98
Nov 10 79	13.45	314.57	0.467	ERR	ERR	ERR	12.008	19.803	12.900	17.497	14.888	0.0007	ERR	ERR	ERR	1.7217	3.2873	ERR	2.8412	2.5117	314.48
Nov 10 79	14.03	314.58	0.445	ERR	ERR	ERR	12.336	20.262	13.182	17.808	15.210	-0.0957	ERR	ERR	ERR	1.3670	1.9138	1.1756	1.2987	1.3397	314.58
Nov 10 79	14.20	314.60	0.425	ERR	ERR	ERR	12.444	20.505	13.369	18.025	15.436	-0.0410	ERR	ERR	ERR	0.2256	0.5058	0.3896	0.4511	0.4716	314.59
Nov 10 79	15.00	314.63	ERR	ERR	ERR	ERR	12.651	20.853	13.642	18.317	15.692	ERR	ERR	ERR	ERR	0.2871	0.4830	0.3782	0.4055	0.3554	314.62
Nov 10 79	16.30	314.69	0.474	ERR	ERR	ERR	12.733	20.977	13.727	18.412	15.774	ERR	ERR	ERR	ERR	0.0570	0.0866	0.0592	0.0661	0.0570	314.66
Nov 10 79	20.00	314.83	ERR	ERR	ERR	ERR	12.845	21.155	13.865	18.550	15.856	ERR	ERR	ERR	ERR	0.0332	0.0527	0.0410	0.0410	0.0244	314.76
Nov 10 79	24.00	315.00	ERR	ERR	ERR	ERR	12.864	21.191	13.848	18.599	15.968	ERR	ERR	ERR	ERR	0.0048	0.0088	-0.0040	0.0121	0.0273	314.92

TABLE 8.5 - ONE-DIMENSIONAL SLOPE DISPLACEMENTS AND VELOCITIES, SLOPE DISTANCE COMPONENT. PAGE 2 OF 4.

Note: Slope Distance is the Direct Reading from the Electronic Distance Measuring Instrument to the Target.

TARGET			[-----		CUMULATIVE DISPLACEMENT (in feet)						-----] [-----		COMPONENT VELOCITY (feet/hour)						-----]	
			21B	22B	23B	25B	26B	37B	38B	39B	40B	21B	22B	23B	25B	26B	37B	38B	39B	40B	
Zero Reading																					
Zero Reading Date																					
Date	Time	Days																			Velocity Median Days
Nov 11 79	9.00	315.38	ERR	ERR	ERR	ERR	12.956	21.315	13.979	18.710	16.079	ERR	ERR	ERR	ERR	0.0101	0.0137	0.0144	0.0122	0.0122	315.19
Nov 11 79	12.00	315.50	ERR	ERR	ERR	ERR	12.956	21.374	13.996	18.737	16.158	ERR	ERR	ERR	ERR	0.0000	0.0205	0.0057	0.0091	0.0273	315.44
Nov 11 79	14.00	315.58	ERR	ERR	ERR	ERR	12.969	21.384	14.012	18.740	16.145	ERR	ERR	ERR	ERR	0.0068	0.0051	0.0085	0.0017	-0.0068	315.54
Nov 11 79	21.00	315.88	0.454	ERR	ERR	ERR	13.028	21.578	14.127	18.835	16.292	ERR	ERR	ERR	ERR	0.0082	0.0269	0.0159	0.0132	0.0205	315.73
Nov 11 79	23.00	315.96	0.497	ERR	ERR	ERR	13.038	21.470	14.183	18.947	16.296	0.0222	ERR	ERR	ERR	0.0051	-0.0564	0.0290	0.0581	0.0017	315.92
Nov 12 79	6.00	316.25	0.494	ERR	ERR	ERR	13.107	21.650	14.199	18.976	16.374	-0.0005	ERR	ERR	ERR	0.0099	0.0259	0.0024	0.0042	0.0113	316.11
Nov 12 79	8.45	316.36	ERR	ERR	ERR	ERR	13.156	21.722	14.242	19.048	16.371	ERR	ERR	ERR	ERR	0.0186	0.0273	0.0162	0.0273	-0.0012	316.31
Nov 12 79	10.00	316.42	ERR	ERR	ERR	ERR	13.215	21.739	14.268	19.045	16.397	ERR	ERR	ERR	ERR	0.0410	0.0114	0.0182	-0.0023	0.0182	316.39
Nov 12 79	11.25	316.48	ERR	ERR	ERR	ERR	13.199	21.762	14.262	19.048	16.420	ERR	ERR	ERR	ERR	-0.0114	0.0159	-0.0046	0.0023	0.0159	316.45
Nov 12 79	12.45	316.53	ERR	ERR	ERR	ERR	13.179	21.785	14.334	19.061	16.450	ERR	ERR	ERR	ERR	-0.0164	0.0191	0.0601	0.0109	0.0246	316.51
Nov 12 79	13.20	316.55	ERR	ERR	ERR	ERR	13.215	21.781	14.327	19.081	16.450	ERR	ERR	ERR	ERR	0.0752	-0.0068	-0.0137	0.0410	0.0000	316.54
Nov 13 79	6.30	317.27	0.500	ERR	ERR	ERR	13.416	22.122	14.511	19.337	16.742	ERR	ERR	ERR	ERR	0.0116	0.0197	0.0106	0.0148	0.0169	316.91
Nov 13 79	12.00	317.50	0.418	ERR	ERR	ERR	13.432	22.181	14.537	19.403	16.742	-0.0149	ERR	ERR	ERR	0.0030	0.0107	0.0048	0.0119	0.0000	317.39
Nov 13 79	14.20	317.60	0.464	ERR	ERR	ERR	13.455	22.214	14.616	19.419	16.781	0.0191	ERR	ERR	ERR	0.0096	0.0137	0.0328	0.0069	0.0164	317.55
Nov 13 79	15.15	317.64	ERR	ERR	ERR	ERR	13.452	22.546	14.616	19.442	16.817	ERR	ERR	ERR	ERR	-0.0034	0.3452	0.0000	0.0239	0.0376	317.62
Nov 14 79	4.00	318.17	0.458	ERR	ERR	ERR	13.648	22.549	14.816	19.649	17.034	ERR	ERR	ERR	ERR	0.0155	0.0003	0.0157	0.0162	0.0170	317.91
Nov 14 79	6.30	318.27	0.464	ERR	ERR	ERR	13.668	22.575	14.855	19.659	17.008	0.0027	ERR	ERR	ERR	0.0082	0.0109	0.0164	0.0041	-0.0109	318.22
Nov 14 79	10.30	318.44	0.504	ERR	ERR	ERR	13.704	22.644	14.898	19.747	17.080	0.0096	ERR	ERR	ERR	0.0088	0.0169	0.0105	0.0217	0.0177	318.36
Nov 14 79	12.30	318.52	0.543	ERR	ERR	ERR	13.685	22.588	14.885	19.741	17.103	0.0205	ERR	ERR	ERR	-0.0103	-0.0290	-0.0068	-0.0034	0.0120	318.48
Nov 14 79	16.00	318.67	0.467	ERR	ERR	ERR	13.740	22.792	14.944	19.793	17.208	-0.0210	ERR	ERR	ERR	0.0155	0.0565	0.0164	0.0146	0.0292	318.60
Nov 15 79	4.00	319.17	0.458	ERR	ERR	ERR	13.878	22.962	15.121	19.954	17.395	-0.0008	ERR	ERR	ERR	0.0115	0.0142	0.0148	0.0134	0.0156	318.92
Nov 15 79	10.00	319.42	0.487	ERR	ERR	ERR	13.967	23.120	15.229	20.078	17.483	0.0049	ERR	ERR	ERR	0.0148	0.0262	0.0180	0.0208	0.0148	319.30
Nov 15 79	21.00	319.88	0.500	ERR	ERR	ERR	14.108	23.356	15.367	20.243	17.654	0.0012	ERR	ERR	ERR	0.0128	0.0214	0.0125	0.0149	0.0155	319.65
Nov 16 79	6.30	320.27	0.422	ERR	ERR	ERR	14.160	23.445	15.462	20.338	17.733	-0.0084	ERR	ERR	ERR	0.0056	0.0095	0.0102	0.0192	0.0084	320.08
Nov 16 79	9.30	320.40	0.461	ERR	ERR	ERR	14.229	23.530	15.531	20.393	17.838	0.0126	ERR	ERR	ERR	0.0221	0.0273	0.0221	0.0179	0.0336	320.34
Nov 16 79	22.00	320.92	0.481	ERR	ERR	ERR	14.347	23.769	15.656	20.561	17.989	0.0016	ERR	ERR	ERR	0.0095	0.0192	0.0100	0.0134	0.0121	320.66
Nov 17 79	9.15	321.39	0.438	ERR	ERR	ERR	14.528	23.953	15.797	20.689	18.153	-0.0038	ERR	ERR	ERR	0.0160	0.0163	0.0125	0.0113	0.0145	321.16
Nov 17 79	20.30	321.85	0.441	ERR	ERR	ERR	14.577	24.157	15.945	20.892	18.317	0.0003	ERR	ERR	ERR	0.0045	0.0184	0.0134	0.0184	0.0149	321.62
Nov 18 79	9.00	322.38	0.458	ERR	ERR	ERR	14.738	24.376	16.155	21.105	18.527	0.0013	ERR	ERR	ERR	0.0126	0.0173	0.0165	0.0168	0.0165	322.12
Nov 18 79	20.00	322.83	0.471	ERR	ERR	ERR	14.843	24.596	16.279	21.243	18.691	0.0012	ERR	ERR	ERR	0.0097	0.0204	0.0115	0.0128	0.0152	322.61
Nov 19 79	9.30	323.40	0.520	ERR	ERR	ERR	15.003	24.813	16.470	21.394	18.848	0.0036	ERR	ERR	ERR	0.0118	0.0158	0.0139	0.0110	0.0115	323.12
Nov 20 79	9.00	324.38	0.497	ERR	ERR	ERR	15.220	25.170	16.719	21.716	19.193	-0.0010	ERR	ERR	ERR	0.0092	0.0152	0.0106	0.0137	0.0146	323.89
Nov 21 79	6.00	325.25	0.454	ERR	ERR	ERR	15.407	25.515	16.958	21.991	19.442	-0.0020	ERR	ERR	ERR	0.0090	0.0165	0.0115	0.0132	0.0119	324.82
Nov 21 79	13.00	325.54	0.484	ERR	ERR	ERR	15.437	25.636	17.034	22.047	19.537	0.0042	ERR	ERR	ERR	0.0042	0.0174	0.0108	0.0080	0.0137	325.40
Nov 21 79	16.00	325.67	0.513	ERR	ERR	ERR	15.512	25.718	17.024	22.080	19.596	0.0095	ERR	ERR	ERR	0.0242	0.0263	-0.0032	0.0105	0.0189	325.61
Nov 21 79	24.00	326.00	0.490	ERR	ERR	ERR	15.581	25.777	17.159	22.188	19.672	-0.0029	ERR	ERR	ERR	0.0087	0.0075	0.0170	0.0137	0.0095	325.94
Nov 22 79	6.30	326.27	0.490	ERR	ERR	ERR	15.630	25.899	17.237	22.290	19.770	0.0000	ERR	ERR	ERR	0.0076	0.0187	0.0122	0.0157	0.0152	326.14

TABLE B.5 - ONE-DIMENSIONAL SLOPE DISPLACEMENTS AND VELOCITIES, SLOPE DISTANCE COMPONENT. PAGE 3 OF 4.

Note: Slope Distance is the Direct Reading from the Electronic Distance Measuring Instrument to the Target.

Zero Reading
Zero Reading Date

TARGET Date	Time	Days	CUMULATIVE DISPLACEMENT (in feet) 21B	22B	23B	25B	26B	37B	38B	39B	40B
Nov 22 79	11.00	326.46	0.477	ERR	ERR	ERR	15.647	25.948	17.280	22.306	19.777
Nov 22 79	21.00	326.88	0.504	ERR	ERR	ERR	15.761	26.089	17.359	22.437	19.911
Nov 23 79	7.00	327.29	0.448	ERR	ERR	ERR	15.883	26.282	17.460	22.477	20.033
Nov 23 79	12.00	327.50	0.481	ERR	ERR	ERR	15.876	26.312	17.536	22.615	20.115
Nov 23 79	14.30	327.60	0.481	ERR	ERR	ERR	15.893	26.348	17.552	22.634	20.144
Nov 23 79	24.00	328.00	0.494	ERR	ERR	ERR	16.017	26.440	17.664	22.743	20.266
Nov 24 79	12.30	328.52	0.451	ERR	ERR	ERR	16.970	26.650	17.808	22.890	20.387
Nov 24 79	24.00	329.00	0.497	ERR	ERR	ERR	16.208	26.811	17.867	23.002	20.535
Nov 25 79	7.30	329.31	0.563	ERR	ERR	ERR	16.372	26.985	17.982	ERR	ERR
Nov 27 79	0.30	331.02	0.464	ERR	ERR	ERR	16.582	27.487	ERR	ERR	ERR
Nov 27 79	3.00	331.13	0.422	ERR	ERR	ERR	16.513	27.569	ERR	ERR	ERR
Nov 27 79	7.30	331.31	0.415	ERR	ERR	ERR	16.647	27.595	ERR	ERR	ERR
Nov 27 79	16.00	331.67	0.445	ERR	ERR	ERR	16.664	27.687	18.530	23.655	21.223
Nov 27 79	24.00	332.00	0.563	ERR	ERR	ERR	16.903	27.877	18.704	23.874	21.384
Nov 28 79	8.00	332.33	0.517	ERR	ERR	ERR	16.896	27.956	18.710	ERR	21.584
Nov 28 79	15.00	332.63	0.556	ERR	ERR	ERR	17.095	28.071	18.838	23.999	21.561
Nov 29 79	1.00	333.04	0.566	ERR	ERR	ERR	17.041	28.153	18.927	24.058	21.598
Nov 29 79	8.00	333.33	0.517	ERR	ERR	ERR	17.015	28.116	18.917	24.055	21.663
Nov 29 79	15.30	333.65	0.579	ERR	ERR	ERR	17.097	28.323	19.042	24.157	21.788
Nov 30 79	7.45	334.32	0.474	ERR	ERR	ERR	17.192	28.448	19.094	24.265	21.850
Nov 30 79	16.00	334.67	0.481	ERR	ERR	ERR	17.264	28.553	19.176	24.376	21.978
Nov 30 79	24.00	335.00	0.490	ERR	ERR	ERR	17.297	28.661	19.245	24.442	22.060
Dec 01 79	8.00	335.33	0.458	ERR	ERR	ERR	17.395	28.740	19.357	24.517	22.129
Dec 01 79	15.00	335.63	0.464	ERR	ERR	ERR	17.431	28.815	19.347	24.557	22.165
Dec 01 79	24.00	336.00	0.474	ERR	ERR	ERR	17.497	28.937	19.458	24.678	22.286
Dec 02 79	6.00	336.25	0.546	ERR	ERR	ERR	17.641	29.042	19.465	24.698	22.368
Dec 02 79	15.00	336.63	0.451	ERR	ERR	ERR	17.582	29.104	19.577	24.780	22.421
Dec 02 79	24.00	337.00	0.484	ERR	ERR	ERR	17.658	29.219	19.649	24.872	22.523
Dec 03 79	7.30	337.31	0.487	ERR	ERR	ERR	17.710	29.278	19.714	24.928	22.582
Dec 03 79	16.00	337.67	0.458	ERR	ERR	ERR	17.740	29.343	19.780	24.957	22.618
Dec 03 79	24.00	338.00	0.464	ERR	ERR	ERR	17.799	29.452	19.829	25.042	22.710
Dec 04 79	8.00	338.33	0.523	ERR	ERR	ERR	17.881	29.534	19.872	25.193	22.874
Dec 04 79	15.00	338.63	0.454	ERR	ERR	ERR	17.877	29.583	19.954	25.154	22.815
Dec 04 79	24.00	339.00	0.464	ERR	ERR	ERR	17.923	29.685	20.013	25.210	22.903
Dec 05 79	6.00	339.25	0.458	ERR	ERR	ERR	17.982	29.754	20.062	25.279	22.969
Dec 05 79	17.00	339.71	0.500	ERR	ERR	ERR	18.087	29.901	20.183	25.397	23.084
Dec 05 79	23.00	339.96	0.474	ERR	ERR	ERR	18.019	29.957	20.197	25.400	23.103

TARGET Date	COMPONENT VELOCITY (feet/hour) 21B	22B	23B	25B	26B	37B	38B	39B	40B	Velocity Median Days
Nov 22 79	-0.0029	ERR	ERR	ERR	0.0036	0.0108	0.0094	0.0036	0.0014	326.37
Nov 22 79	0.0026	ERR	ERR	ERR	0.0114	0.0140	0.0078	0.0130	0.0133	326.67
Nov 23 79	-0.0057	ERR	ERR	ERR	0.0123	0.0197	0.0103	0.0040	0.0123	327.09
Nov 23 79	0.0065	ERR	ERR	ERR	-0.0013	0.0059	0.0150	0.0273	0.0163	327.40
Nov 23 79	0.0000	ERR	ERR	ERR	0.0068	0.0150	0.0068	0.0082	0.0123	327.55
Nov 23 79	0.0014	ERR	ERR	ERR	0.0130	0.0096	0.0116	0.0113	0.0126	327.80
Nov 24 79	-0.0034	ERR	ERR	ERR	0.0042	0.0168	0.0116	0.0118	0.0097	328.26
Nov 24 79	0.0040	ERR	ERR	ERR	0.0120	0.0140	0.0051	0.0097	0.0128	328.76
Nov 25 79	0.0088	ERR	ERR	ERR	0.0220	0.0234	0.0154	ERR	ERR	329.16
Nov 27 79	-0.0024	ERR	ERR	ERR	0.0051	0.0122	ERR	ERR	ERR	330.17
Nov 27 79	-0.0162	ERR	ERR	ERR	-0.0261	0.0311	ERR	ERR	ERR	331.08
Nov 27 79	-0.0015	ERR	ERR	ERR	0.0311	0.0061	ERR	ERR	ERR	331.22
Nov 27 79	0.0034	ERR	ERR	ERR	0.0019	0.0106	ERR	ERR	ERR	331.49
Nov 27 79	0.0149	ERR	ERR	ERR	0.0302	0.0240	0.0220	0.0278	0.0203	331.84
Nov 28 79	-0.0058	ERR	ERR	ERR	-0.0008	0.0099	0.0008	ERR	0.0253	332.17
Nov 28 79	0.0055	ERR	ERR	ERR	0.0150	0.0159	0.0178	ERR	-0.0032	332.48
Nov 29 79	0.0010	ERR	ERR	ERR	0.0037	0.0083	0.0090	0.0060	0.0037	332.84
Nov 29 79	-0.0071	ERR	ERR	ERR	-0.0038	-0.0052	-0.0014	-0.0005	0.0094	333.19
Nov 29 79	0.0081	ERR	ERR	ERR	0.0107	0.0269	0.0162	0.0132	0.0162	333.49
Nov 30 79	-0.0065	ERR	ERR	ERR	0.0059	0.0078	0.0033	0.0067	0.0039	333.99
Nov 30 79	0.0008	ERR	ERR	ERR	0.0086	0.0125	0.0098	0.0133	0.0152	334.50
Nov 30 79	0.0012	ERR	ERR	ERR	0.0041	0.0137	0.0087	0.0083	0.0104	334.84
Dec 01 79	-0.0041	ERR	ERR	ERR	0.0124	0.0099	0.0141	0.0095	0.0087	335.17
Dec 01 79	0.0009	ERR	ERR	ERR	0.0050	0.0105	-0.0014	0.0055	0.0050	335.48
Dec 01 79	0.0011	ERR	ERR	ERR	0.0074	0.0137	0.0126	0.0137	0.0137	335.82
Dec 02 79	0.0120	ERR	ERR	ERR	0.0241	0.0175	0.0011	0.0033	0.0137	336.13
Dec 02 79	-0.0104	ERR	ERR	ERR	-0.0065	0.0068	0.0122	0.0090	0.0058	336.44
Dec 02 79	0.0037	ERR	ERR	ERR	0.0085	0.0129	0.0081	0.0103	0.0115	336.82
Dec 03 79	0.0004	ERR	ERR	ERR	0.0071	0.0079	0.0088	0.0075	0.0079	337.16
Dec 03 79	-0.0034	ERR	ERR	ERR	0.0034	0.0076	0.0076	0.0034	0.0042	337.49
Dec 03 79	0.0008	ERR	ERR	ERR	0.0075	0.0137	0.0062	0.0108	0.0116	337.84
Dec 04 79	0.0075	ERR	ERR	ERR	0.0104	0.0104	0.0054	0.0191	0.0207	338.17
Dec 04 79	-0.0096	ERR	ERR	ERR	-0.0005	0.0068	0.0114	-0.0055	-0.0082	338.48
Dec 04 79	0.0011	ERR	ERR	ERR	0.0052	0.0115	0.0067	0.0063	0.0100	338.82
Dec 05 79	-0.0011	ERR	ERR	ERR	0.0098	0.0115	0.0082	0.0115	0.0109	339.13
Dec 05 79	0.0039	ERR	ERR	ERR	0.0095	0.0134	0.0110	0.0107	0.0104	339.48
Dec 05 79	-0.0044	ERR	ERR	ERR	-0.0115	0.0093	0.0022	0.0005	0.0033	339.84

TABLE B.5 - ONE-DIMENSIONAL SLOPE DISPLACEMENTS AND VELOCITIES, SLOPE DISTANCE COMPONENT. PAGE 4 OF 4.

Note: Slope Distance is the Direct Reading from the Electronic Distance Measuring Instrument to the Target.

			[-----			CUMULATIVE DISPLACEMENT (in feet)				-----]	[-----				COMPONENT VELOCITY (feet/hour)				-----]	
TARGET			21B	22B	23B	25B	26B	37B	38B	39B	40B	21B	22B	23B	25B	26B	37B	38B	39B	40B	
Zero Reading																					
Zero Reading Date																					Velocity Median Days
Date	Time	Days																			
Dec 06 79	6.00	340.25	0.497	ERR	ERR	ERR	18.173	30.039	20.269	25.498	23.205	0.0033	ERR	ERR	ERR	0.0222	0.0118	0.0104	0.0141	0.0146	340.11
Dec 06 79	14.30	340.60	0.490	ERR	ERR	ERR	ERR	30.137	20.341	25.544	23.294	-0.0008	ERR	ERR	ERR	ERR	0.0117	0.0086	0.0055	0.0105	340.43
Dec 06 79	24.00	341.00	0.464	ERR	ERR	ERR	18.268	30.242	ERR	ERR	ERR	-0.0027	ERR	ERR	ERR	ERR	0.0109	ERR	ERR	ERR	340.80
Dec 07 79	7.00	341.29	0.519	ERR	ERR	ERR	18.412	30.367	20.535	25.761	23.507	0.0066	ERR	ERR	ERR	0.0207	0.0179	ERR	ERR	ERR	341.15
Dec 07 79	17.00	341.71	0.481	ERR	ERR	ERR	18.415	30.436	20.567	25.790	23.536	-0.0029	ERR	ERR	ERR	0.0003	0.0068	0.0033	0.0029	0.0029	341.50
Dec 07 79	23.30	341.98	0.517	ERR	ERR	ERR	18.481	30.544	20.640	25.849	23.648	0.0056	ERR	ERR	ERR	0.0101	0.0167	0.0111	0.0091	0.0172	341.85
Dec 08 79	8.30	342.35	0.467	ERR	ERR	ERR	18.511	30.669	20.754	25.951	23.740	-0.0055	ERR	ERR	ERR	0.0033	0.0140	0.0129	0.0115	0.0103	342.17
Dec 08 79	15.00	342.63	0.448	ERR	ERR	ERR	18.543	30.698	20.741	25.941	23.717	-0.0029	ERR	ERR	ERR	0.0049	0.0044	-0.0020	-0.0015	-0.0034	342.49
Dec 08 79	22.00	342.93	0.487	ERR	ERR	ERR	18.612	30.800	20.820	26.004	23.786	0.0055	ERR	ERR	ERR	0.0096	0.0141	0.0109	0.0087	0.0096	342.78
Dec 10 79	15.30	344.65	0.474	ERR	ERR	ERR	18.862	31.210	21.096	26.319	24.127	-0.0003	ERR	ERR	ERR	0.0060	0.0099	0.0067	0.0076	0.0083	343.79
Dec 10 79	23.30	344.98	0.490	ERR	ERR	ERR	18.927	31.315	21.204	26.391	24.258	0.0021	ERR	ERR	ERR	0.0083	0.0133	0.0137	0.0091	0.0166	344.82
Dec 11 79	7.30	345.31	0.458	ERR	ERR	ERR	18.954	31.341	21.210	26.401	24.255	-0.0041	ERR	ERR	ERR	0.0033	0.0033	0.0008	0.0012	-0.0004	345.15
Dec 11 79	15.30	345.65	0.438	ERR	ERR	ERR	18.983	31.443	21.283	26.450	24.327	-0.0024	ERR	ERR	ERR	0.0036	0.0125	0.0088	0.0060	0.0088	345.48
Dec 12 79	15.00	346.63	0.471	ERR	ERR	ERR	19.167	31.834	21.463	26.647	24.540	0.0014	ERR	ERR	ERR	0.0078	0.0166	0.0077	0.0084	0.0091	346.14
Dec 12 79	23.30	346.98	0.497	ERR	ERR	ERR	19.226	31.817	21.552	26.732	24.665	0.0031	ERR	ERR	ERR	0.0070	-0.0020	0.0105	0.0102	0.0148	346.81
Dec 13 79	7.30	347.31	0.464	ERR	ERR	ERR	19.242	31.850	21.624	26.752	24.675	-0.0041	ERR	ERR	ERR	0.0021	0.0041	0.0091	0.0025	0.0012	347.15
Dec 13 79	17.30	347.73	0.595	ERR	ERR	ERR	19.423	ERR	21.722	26.945	24.895	0.0130	ERR	ERR	ERR	0.0179	ERR	0.0098	0.0192	0.0218	347.52
Dec 13 79	23.00	347.96	0.507	ERR	ERR	ERR	ERR	ERR	21.912	27.080	25.049	-0.0160	ERR	ERR	ERR	ERR	ERR	0.0345	0.0244	0.0279	347.85
Dec 15 79	16.30	349.69	0.507	ERR	ERR	ERR	19.574	32.352	21.968	27.113	25.141	0.0000	ERR	ERR	ERR	ERR	ERR	0.0013	0.0008	0.0022	348.83
Dec 15 79	23.30	349.98	0.520	ERR	ERR	ERR	19.646	32.470	22.047	27.231	25.220	0.0019	ERR	ERR	ERR	0.0104	0.0170	0.0113	0.0170	0.0113	349.84
Dec 16 79	7.00	350.29	0.533	ERR	ERR	ERR	19.741	32.565	22.119	27.270	25.302	0.0018	ERR	ERR	ERR	0.0128	0.0128	0.0097	0.0053	0.0110	350.14
Dec 16 79	17.00	350.71	0.594	ERR	ERR	ERR	19.744	32.631	22.198	27.329	25.311	-0.0029	ERR	ERR	ERR	0.0003	0.0065	0.0078	0.0059	0.0010	350.50
Dec 16 79	23.00	350.96	0.513	ERR	ERR	ERR	19.800	32.680	22.227	27.349	25.357	0.0016	ERR	ERR	ERR	0.0093	0.0082	0.0049	0.0033	0.0077	350.84
Dec 17 79	7.00	351.29	0.523	ERR	ERR	ERR	19.849	32.736	22.283	27.398	25.429	0.0012	ERR	ERR	ERR	0.0062	0.0070	0.0070	0.0062	0.0091	351.13
Dec 17 79	18.00	351.75	0.566	ERR	ERR	ERR	19.944	32.923	22.378	27.450	25.485	0.0039	ERR	ERR	ERR	0.0086	0.0169	0.0086	0.0048	0.0051	351.52
Dec 18 79	8.00	352.33	0.513	ERR	ERR	ERR	19.984	32.939	22.428	27.546	25.603	-0.0038	ERR	ERR	ERR	0.0028	0.0012	0.0035	0.0068	0.0085	352.04

FIGURE B.1a— TARGET 21B DISPLACEMENT

HORIZONTAL AND VERTICAL COMPONENTS

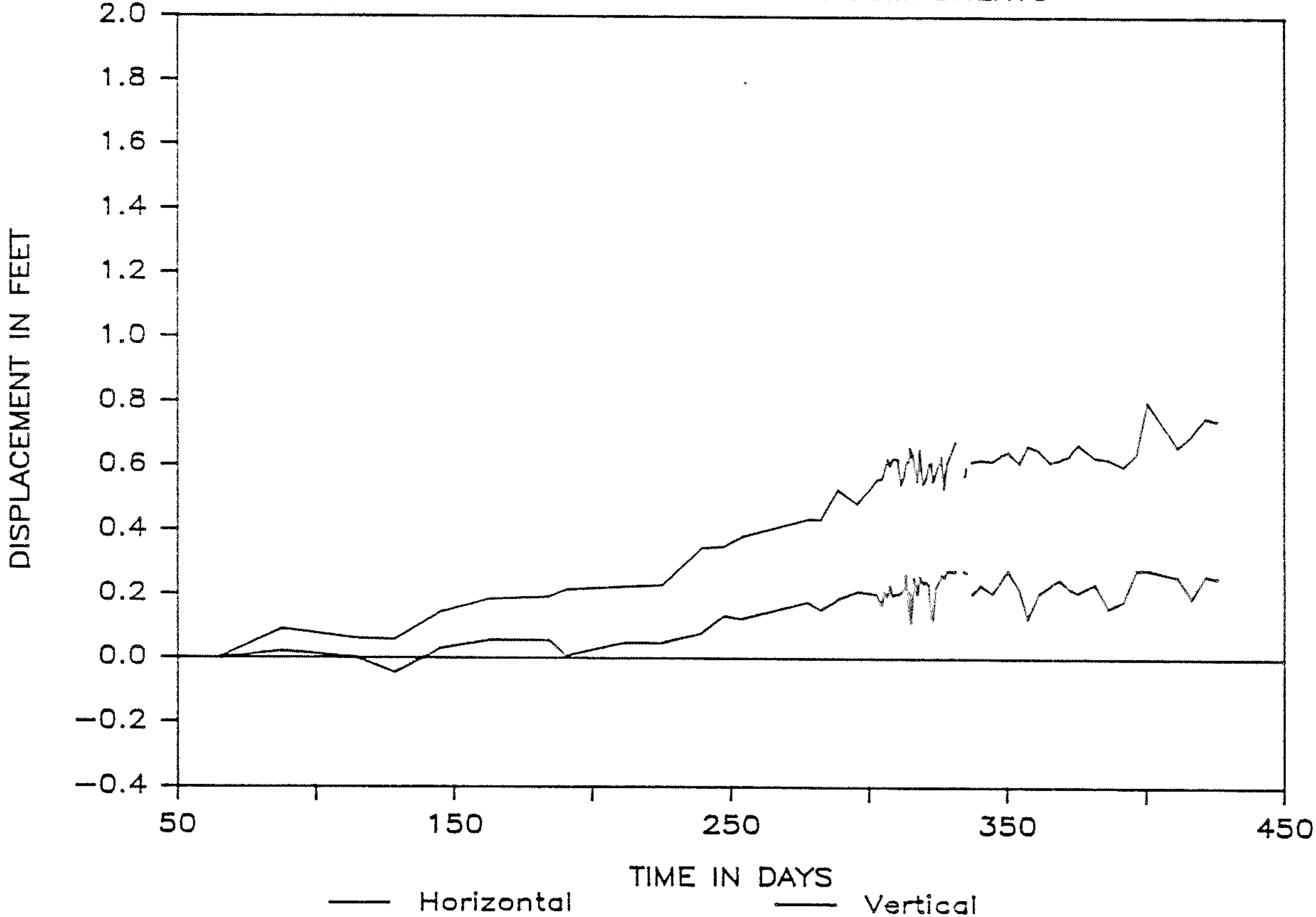


FIGURE B.1b— TARGET 21B DISPLACEMENT

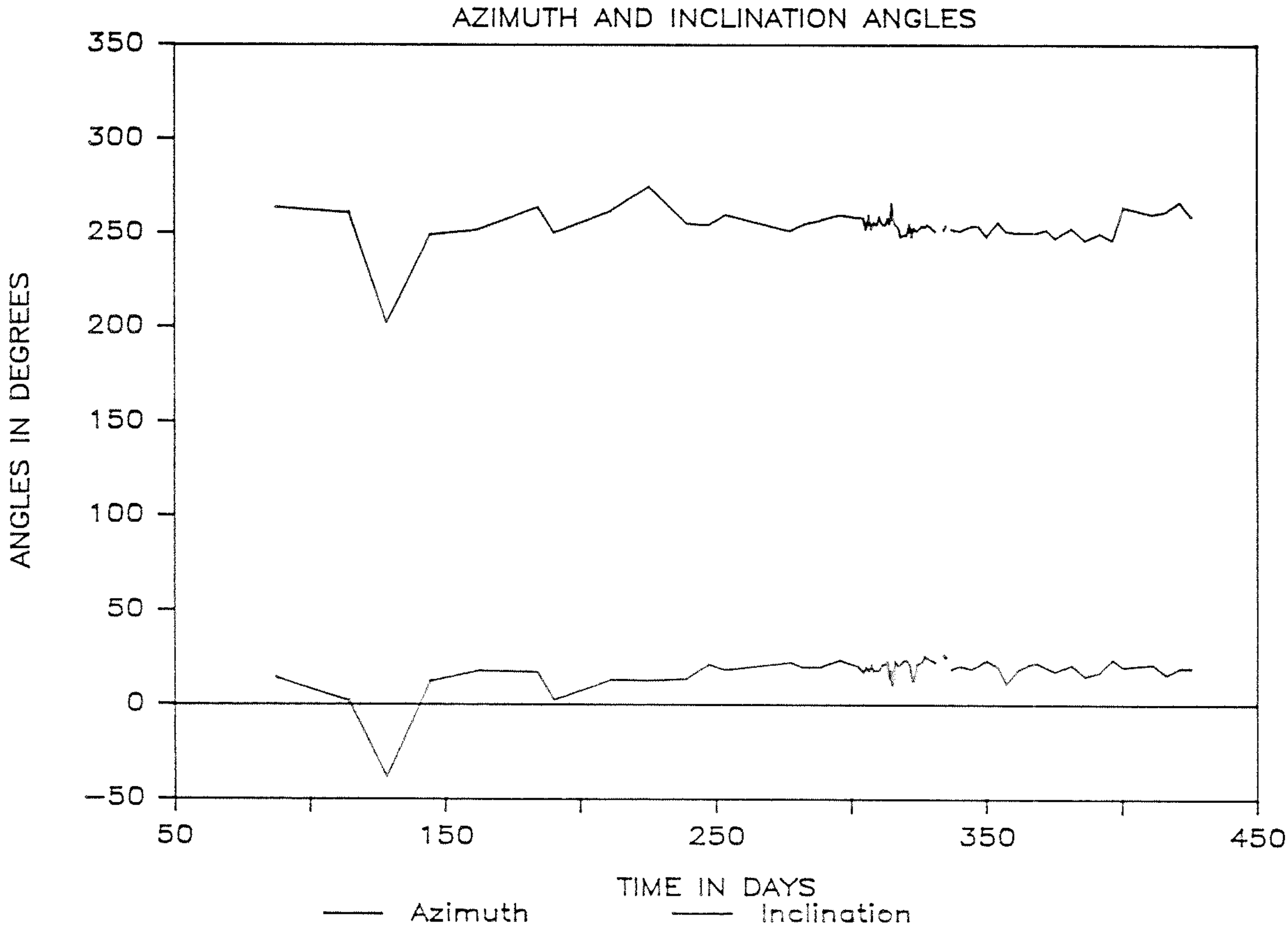


FIGURE B.2a— TARGET 22B DISPLACEMENT

HORIZONTAL AND VERTICAL COMPONENTS

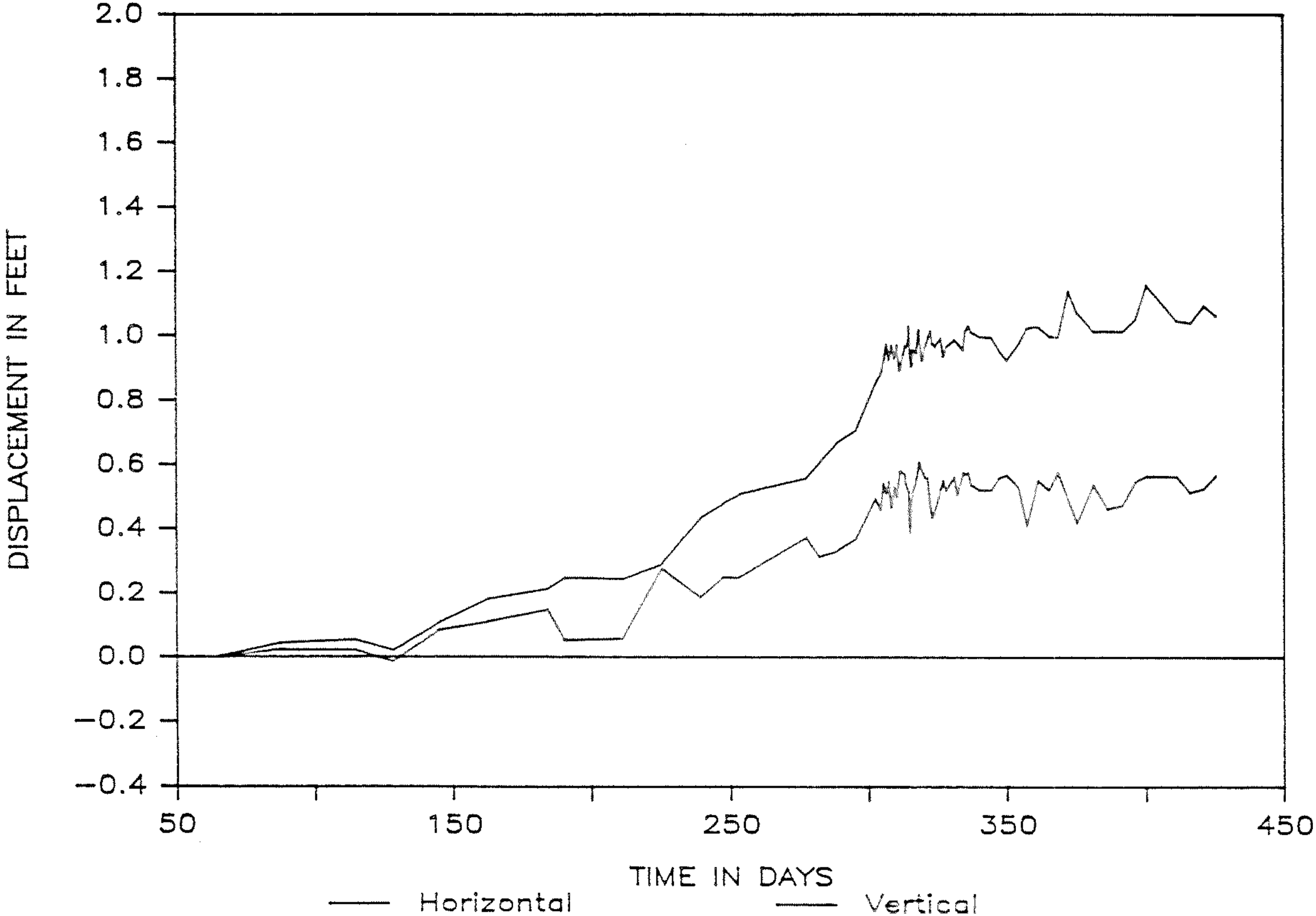


FIGURE B.2b— TARGET 22B DISPLACEMENT

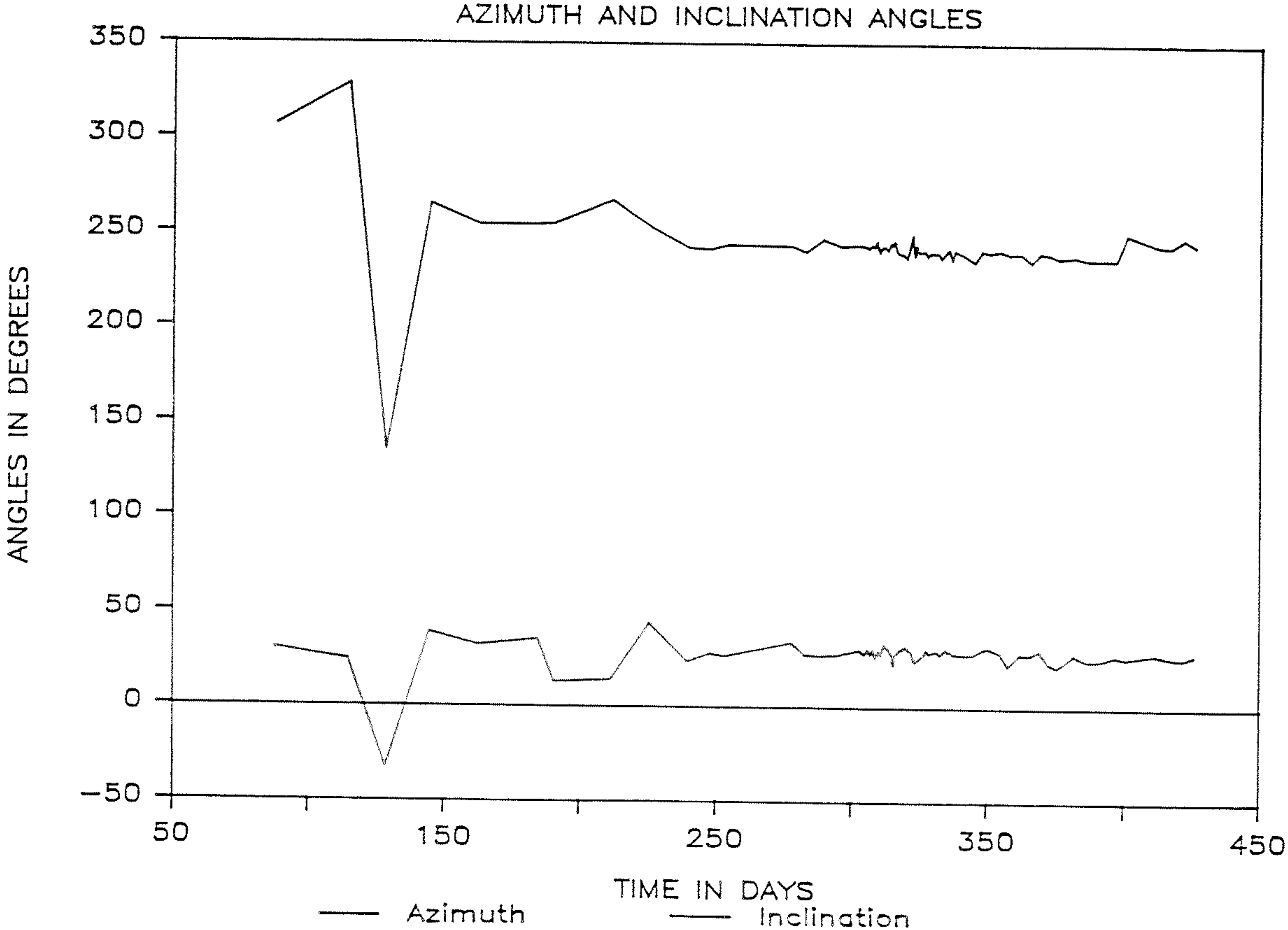


FIGURE B.3a— TARGET 23B DISPLACEMENT

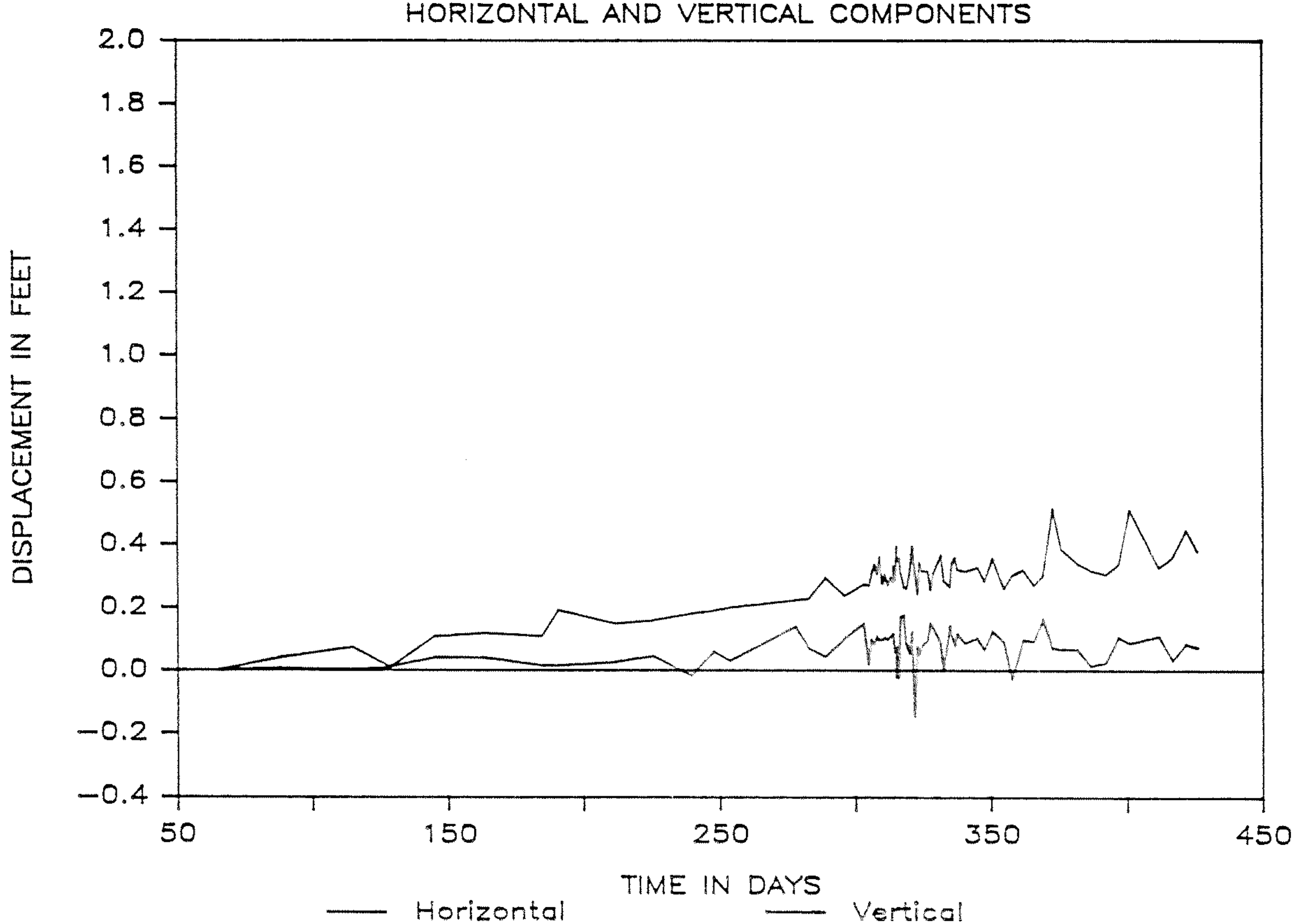


FIGURE B.3b— TARGET 23B DISPLACEMENT

AZIMUTH AND INCLINATION ANGLES

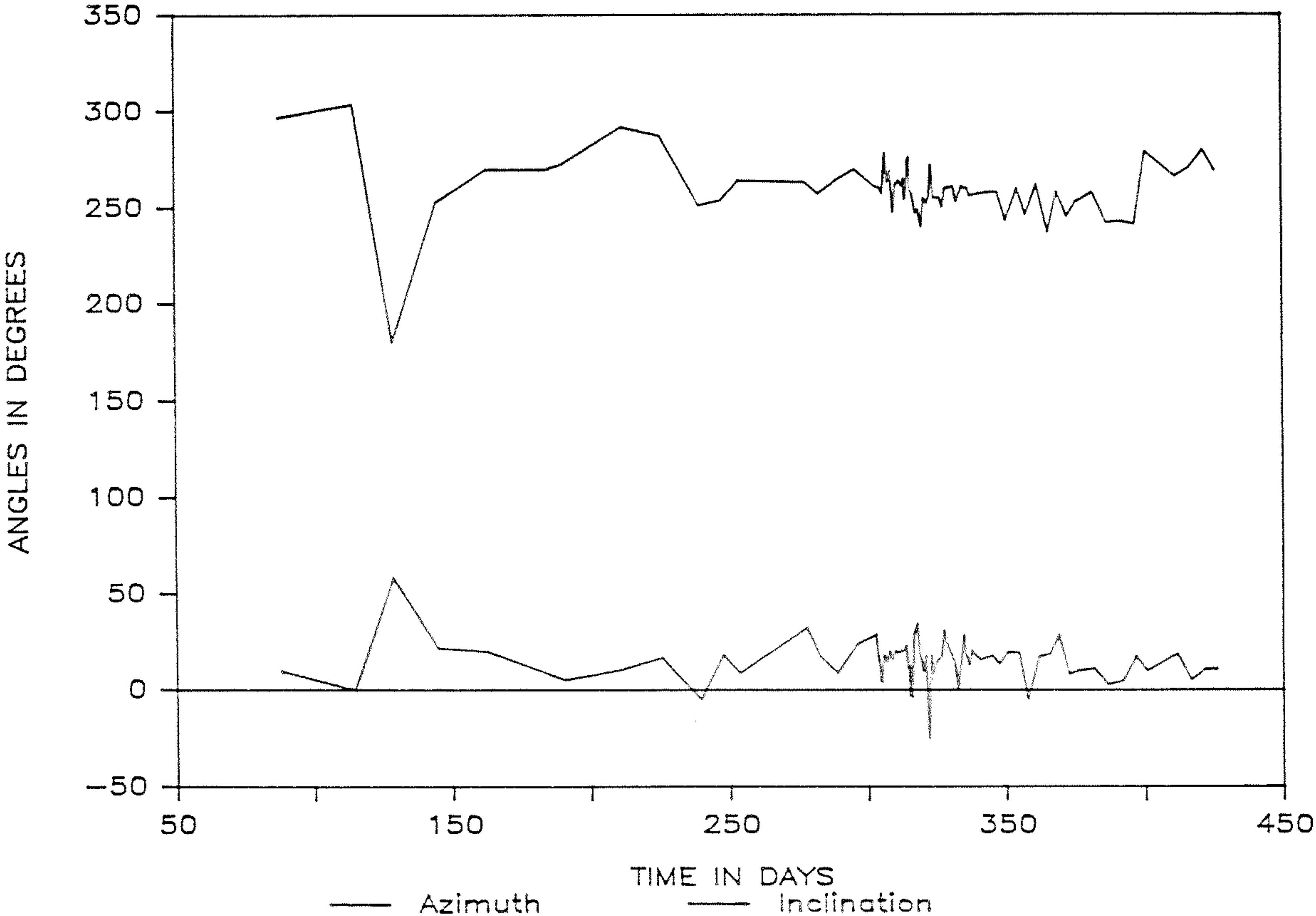


FIGURE B.4a— TARGET 25B DISPLACEMENT

HORIZONTAL AND VERTICAL COMPONENTS

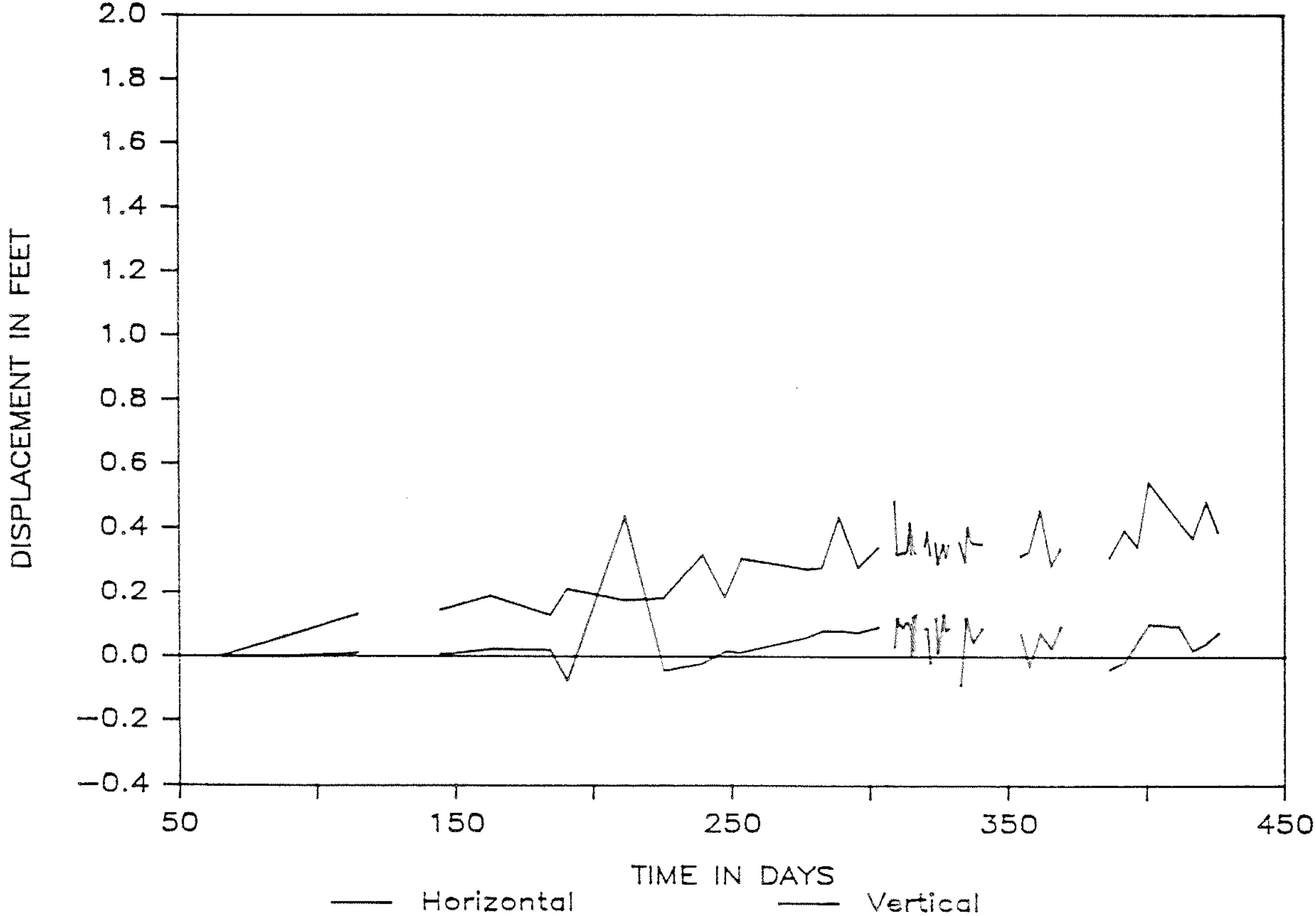


FIGURE B.4b— TARGET 25B DISPLACEMENT

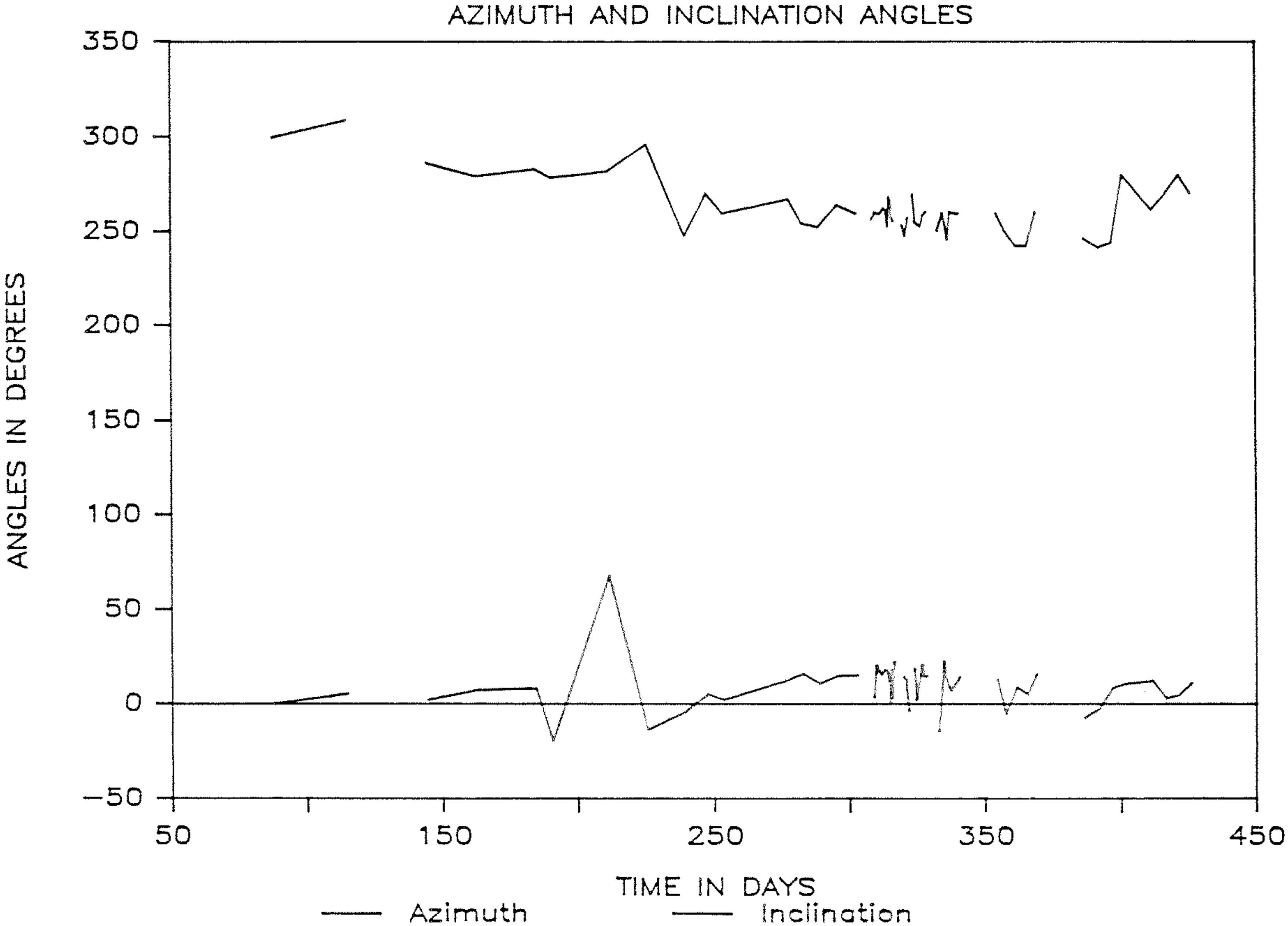


FIGURE B.5a— TARGET 26B DISPLACEMENT

HORIZONTAL AND VERTICAL COMPONENTS

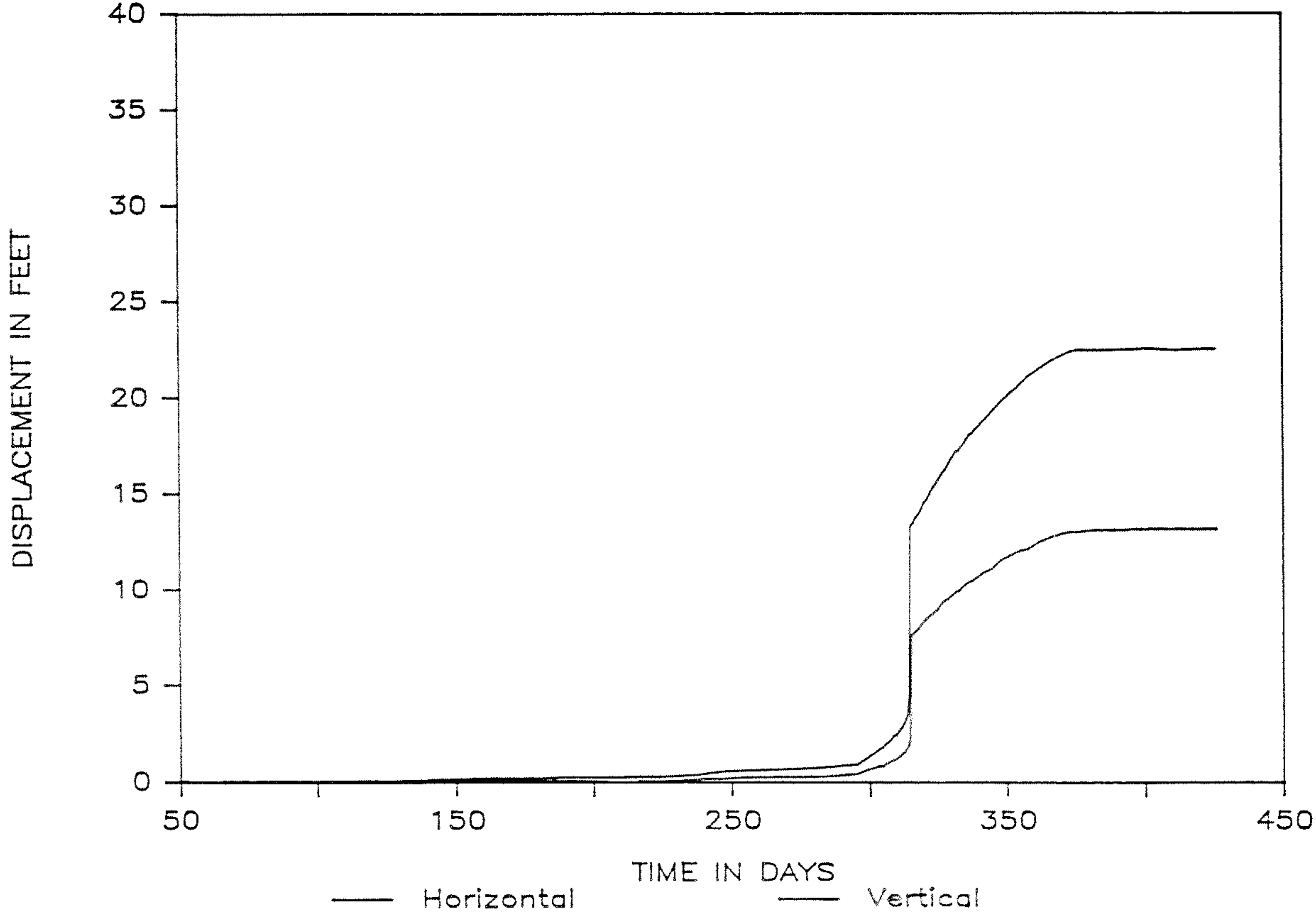


FIGURE B.5b— TARGET 26B DISPLACEMENT

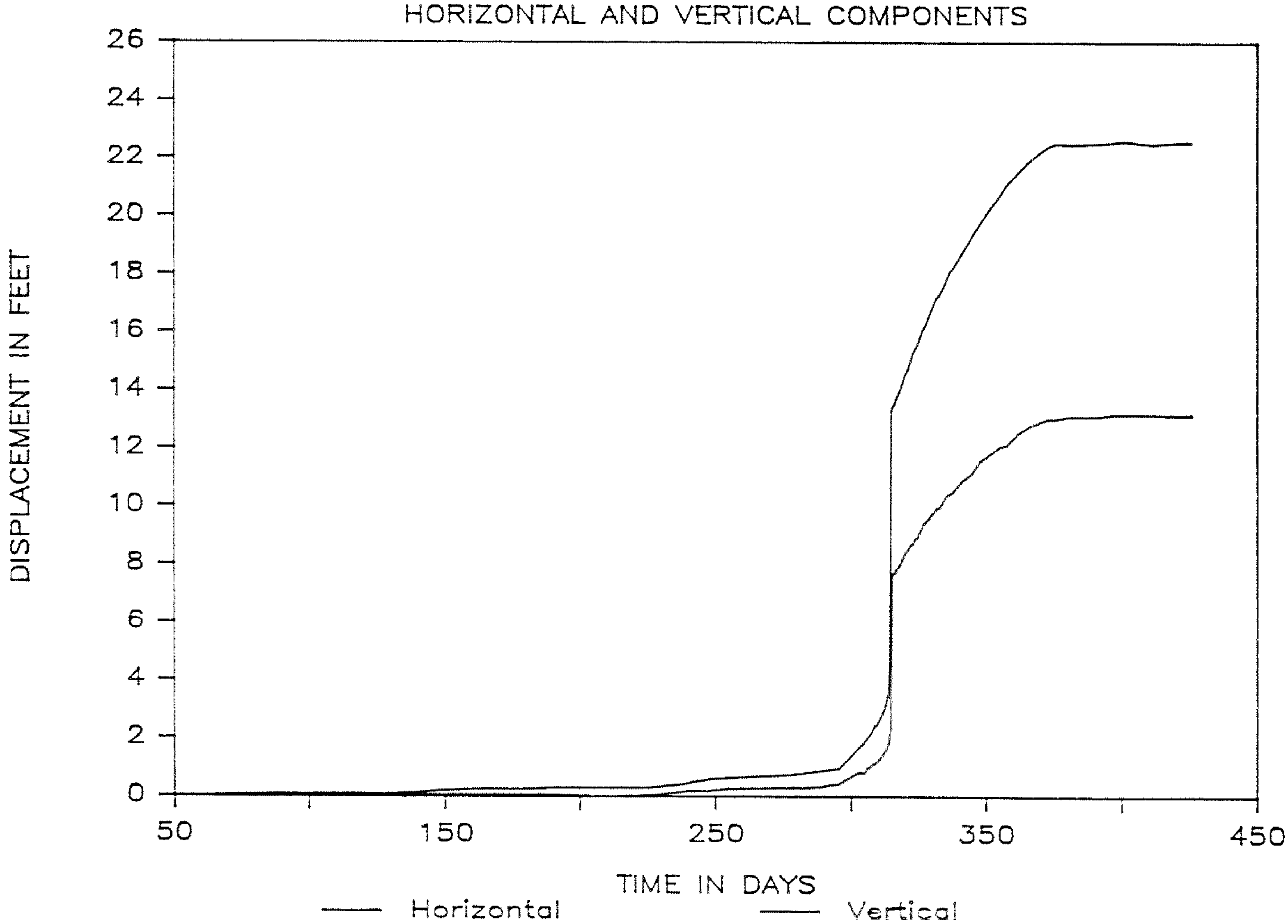


FIGURE B.5c— TARGET 26B DISPLACEMENT

HORIZONTAL AND VERTICAL COMPONENTS

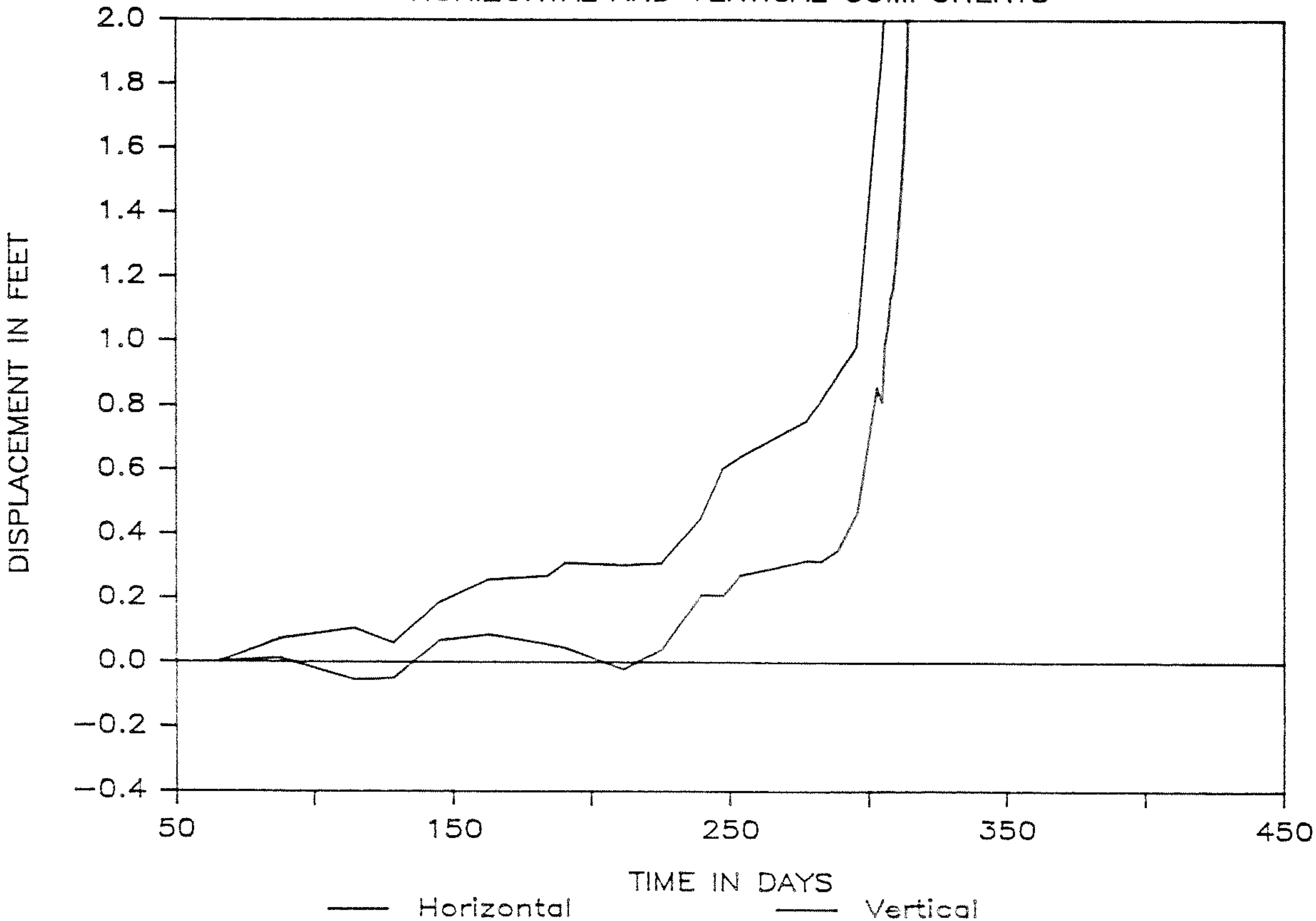


FIGURE B.5d– TARGET 26B DISPLACEMENT

AZIMUTH AND INCLINATION ANGLES

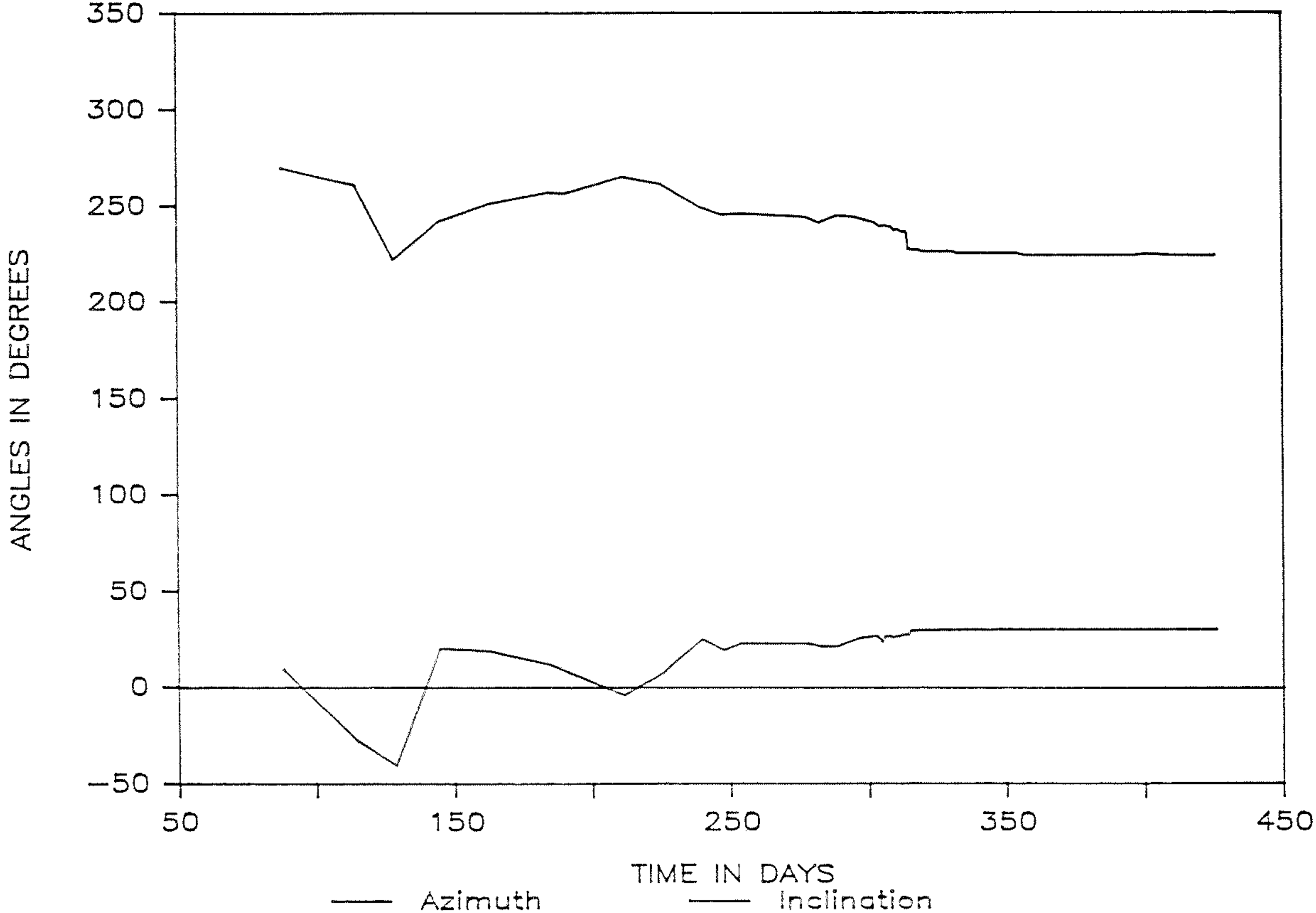


FIGURE B.6a— TARGET 37B DISPLACEMENT

HORIZONTAL AND VERTICAL COMPONENTS

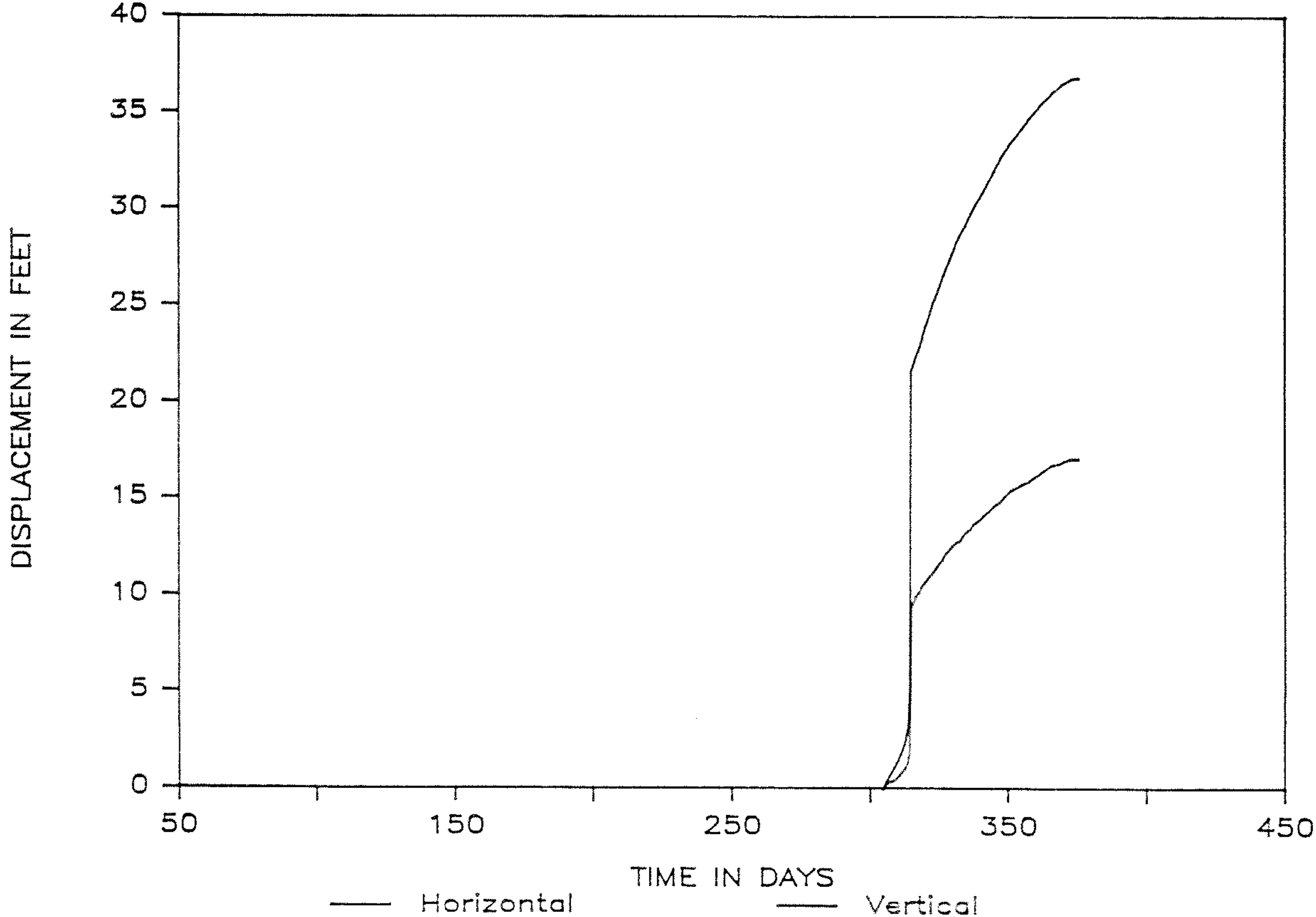


FIGURE B.6b– TARGET 37B DISPLACEMENT

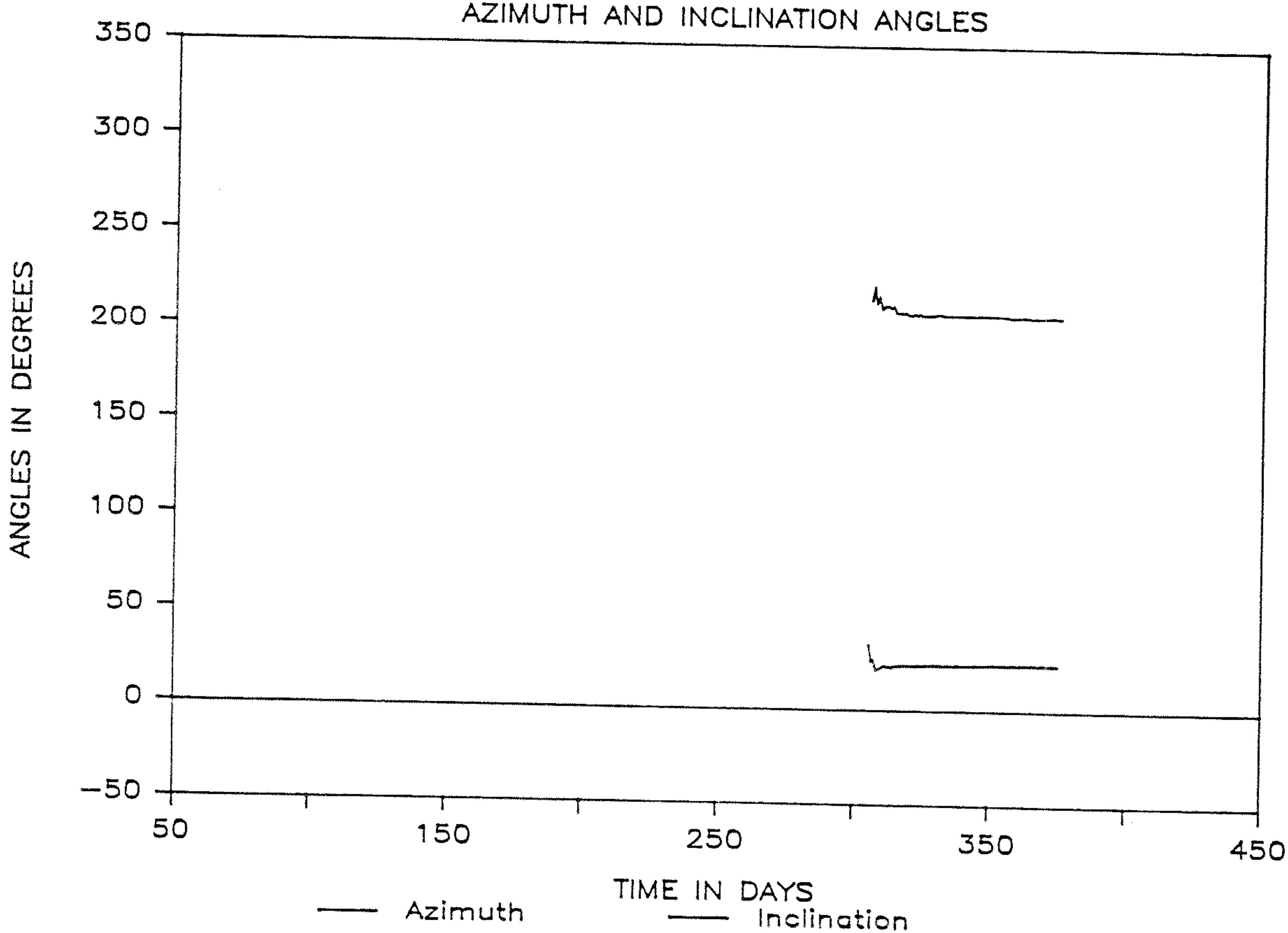


FIGURE B.7a— TARGET 38B DISPLACEMENT

HORIZONTAL AND VERTICAL COMPONENTS

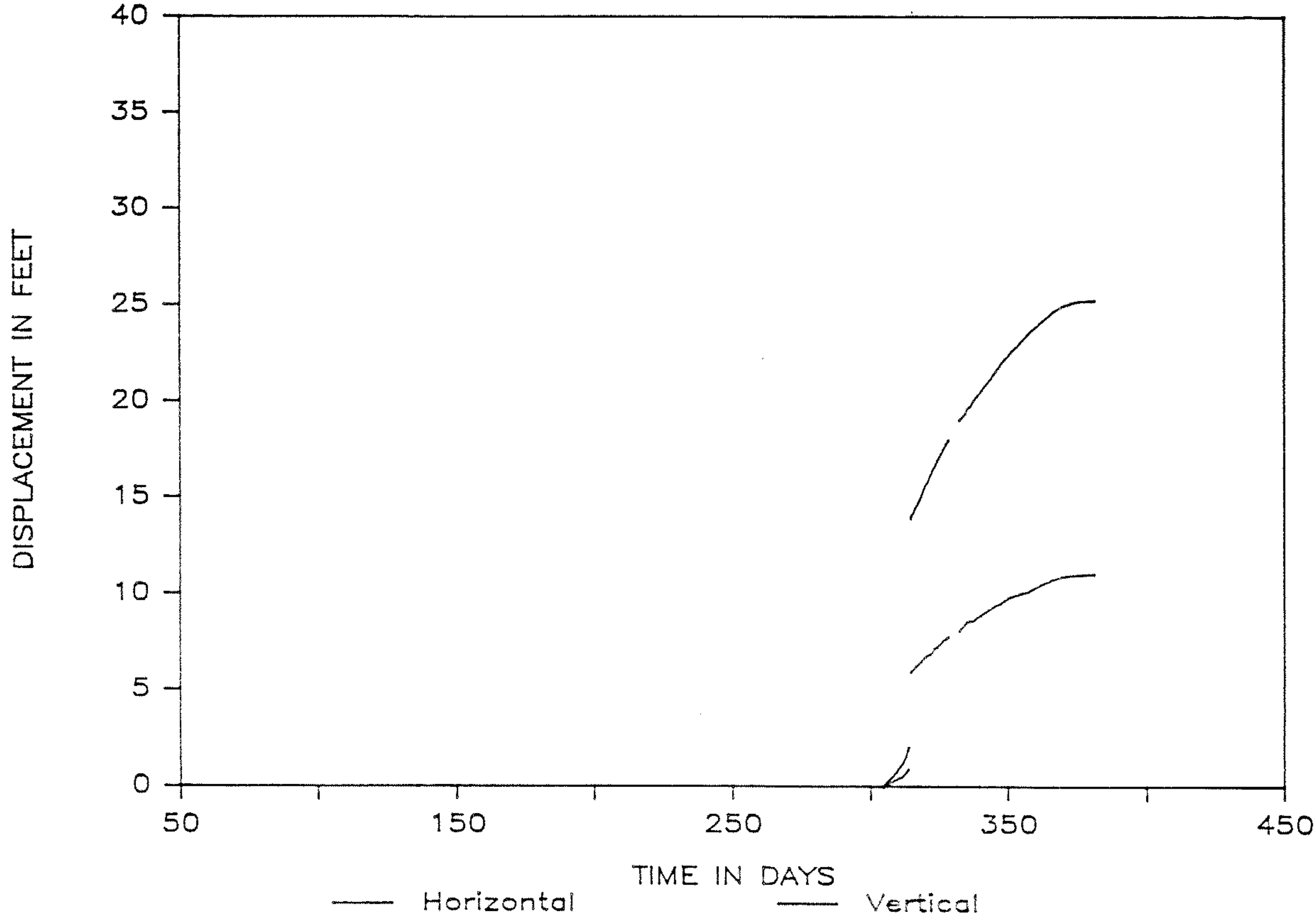


FIGURE B.7b– TARGET 38B DISPLACEMENT

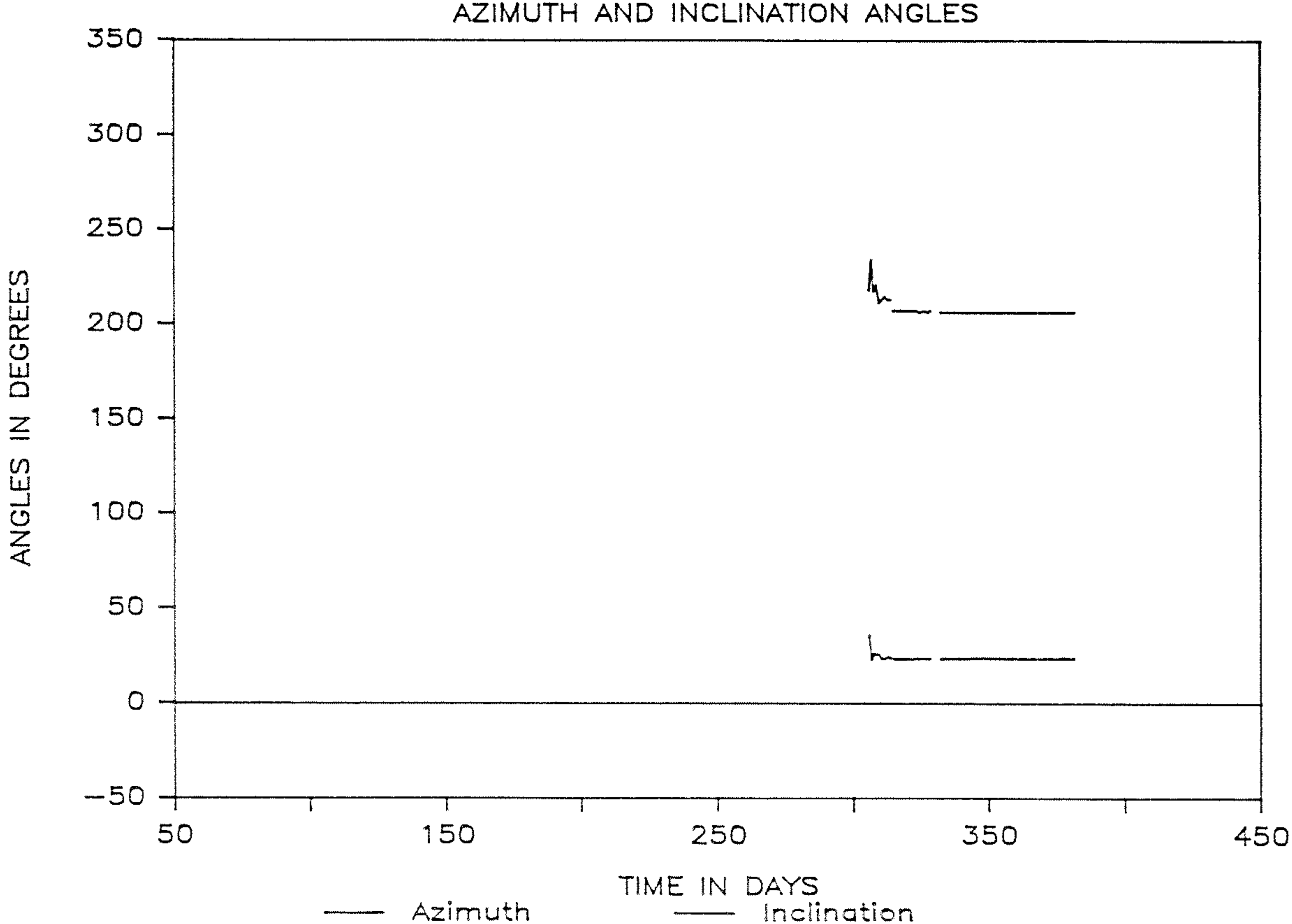


FIGURE B.8a— TARGET 39B DISPLACEMENT

HORIZONTAL AND VERTICAL COMPONENTS

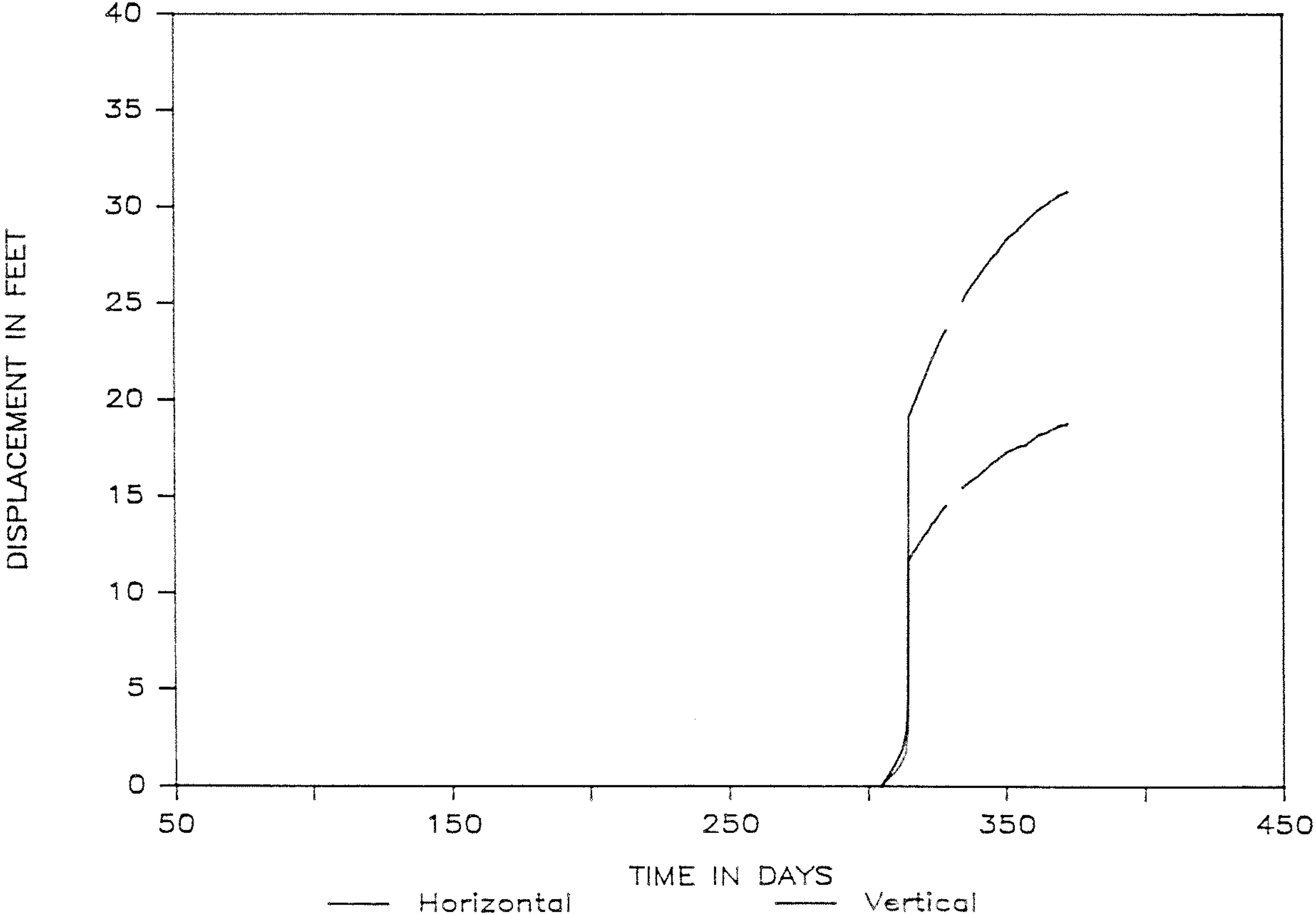


FIGURE B.8b– TARGET 39B DISPLACEMENT

AZIMUTH AND INCLINATION ANGLES

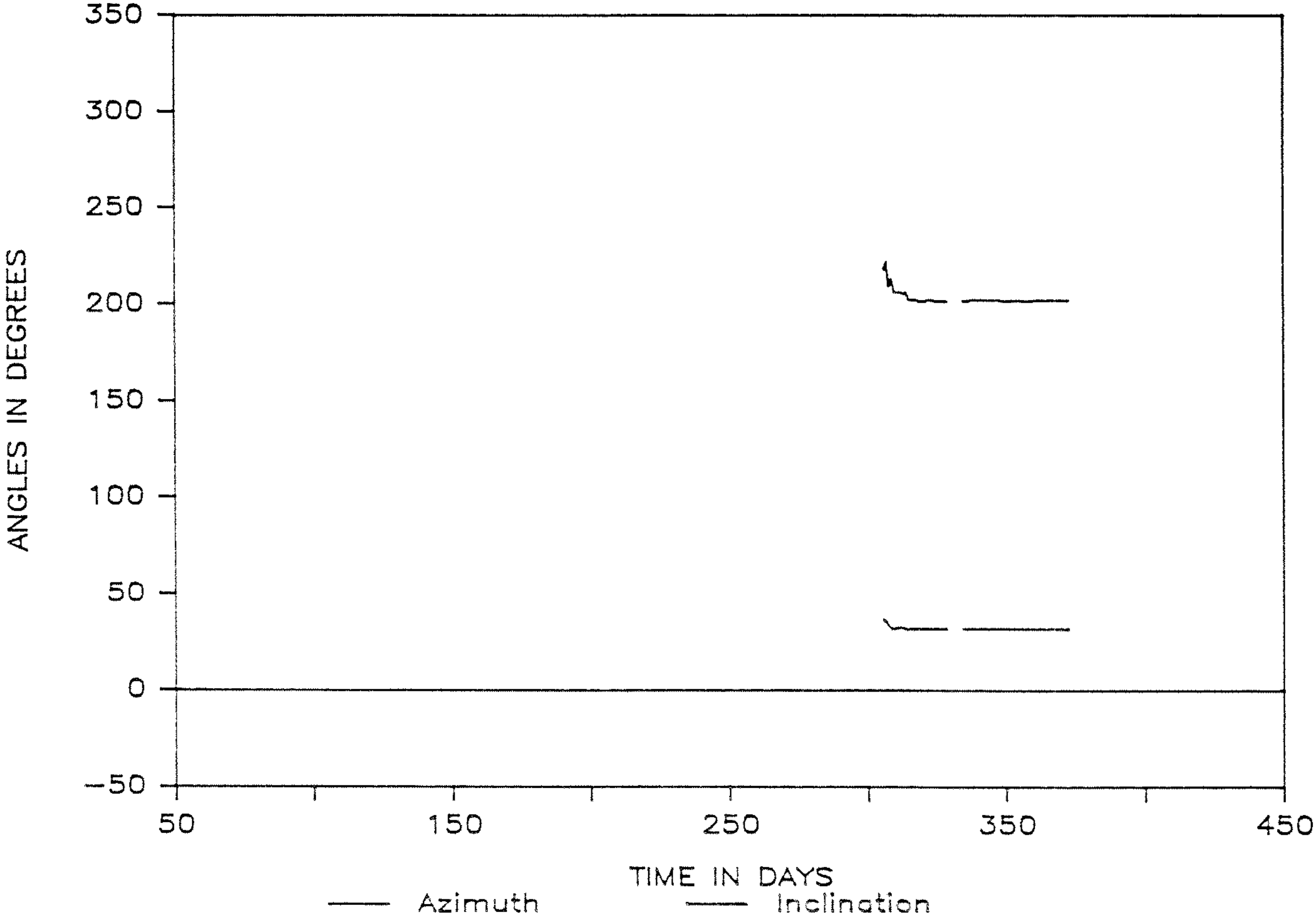


FIGURE B.9a— TARGET 40B DISPLACEMENT

HORIZONTAL AND VERTICAL COMPONENTS

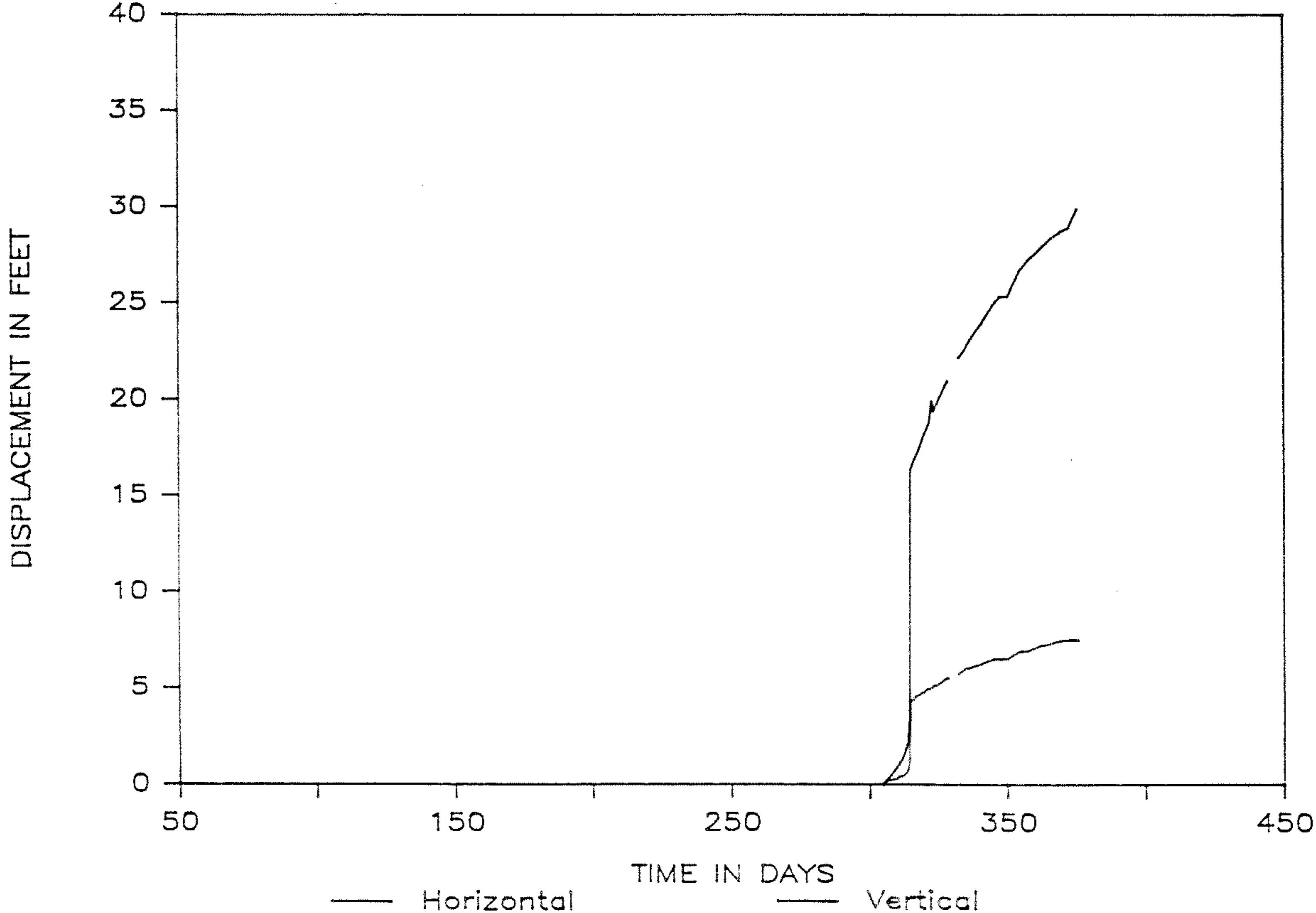


FIGURE B.9b— TARGET 40B DISPLACEMENT

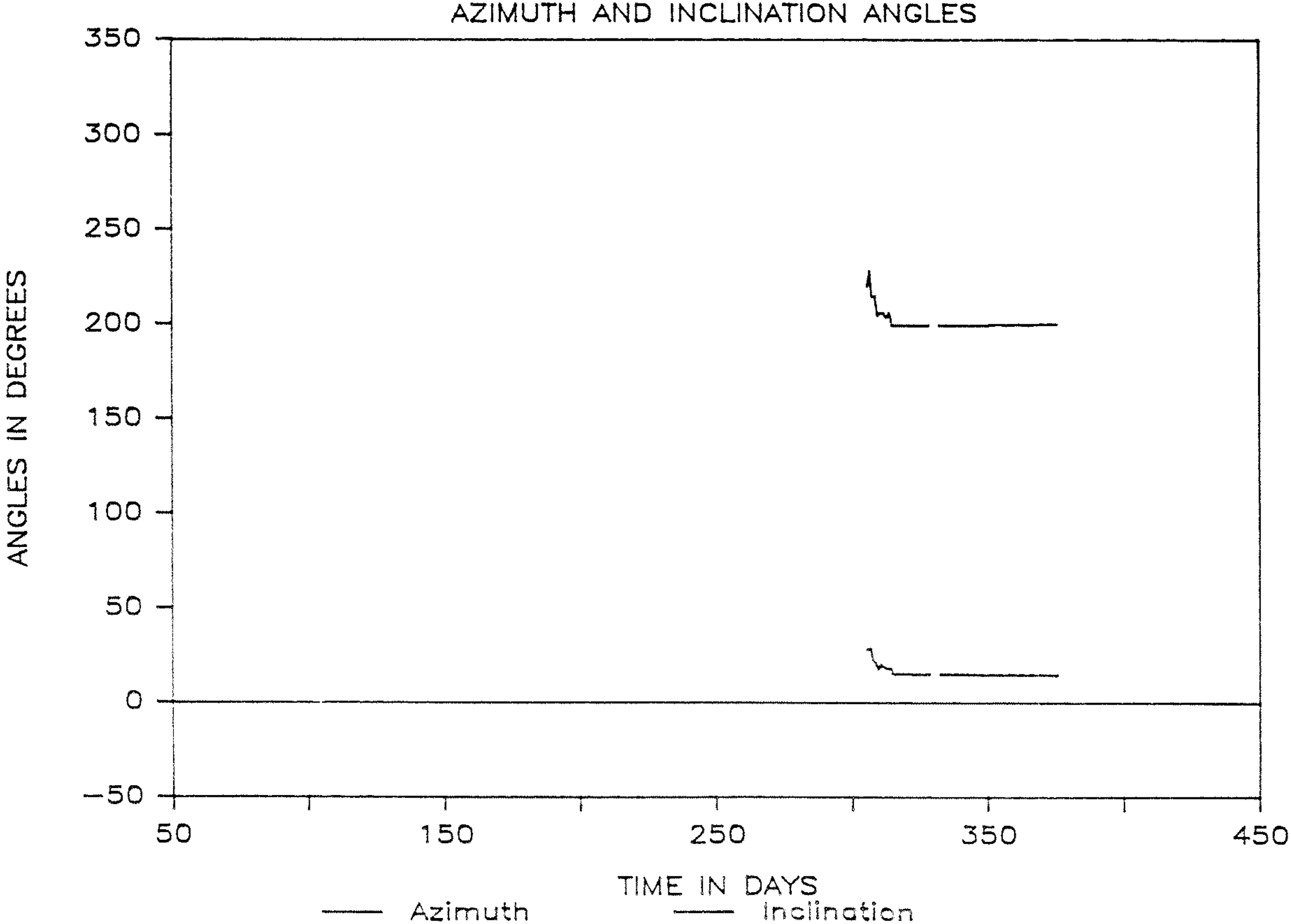


FIGURE B.10a— TARGET 42B DISPLACEMENT

HORIZONTAL AND VERTICAL COMPONENTS

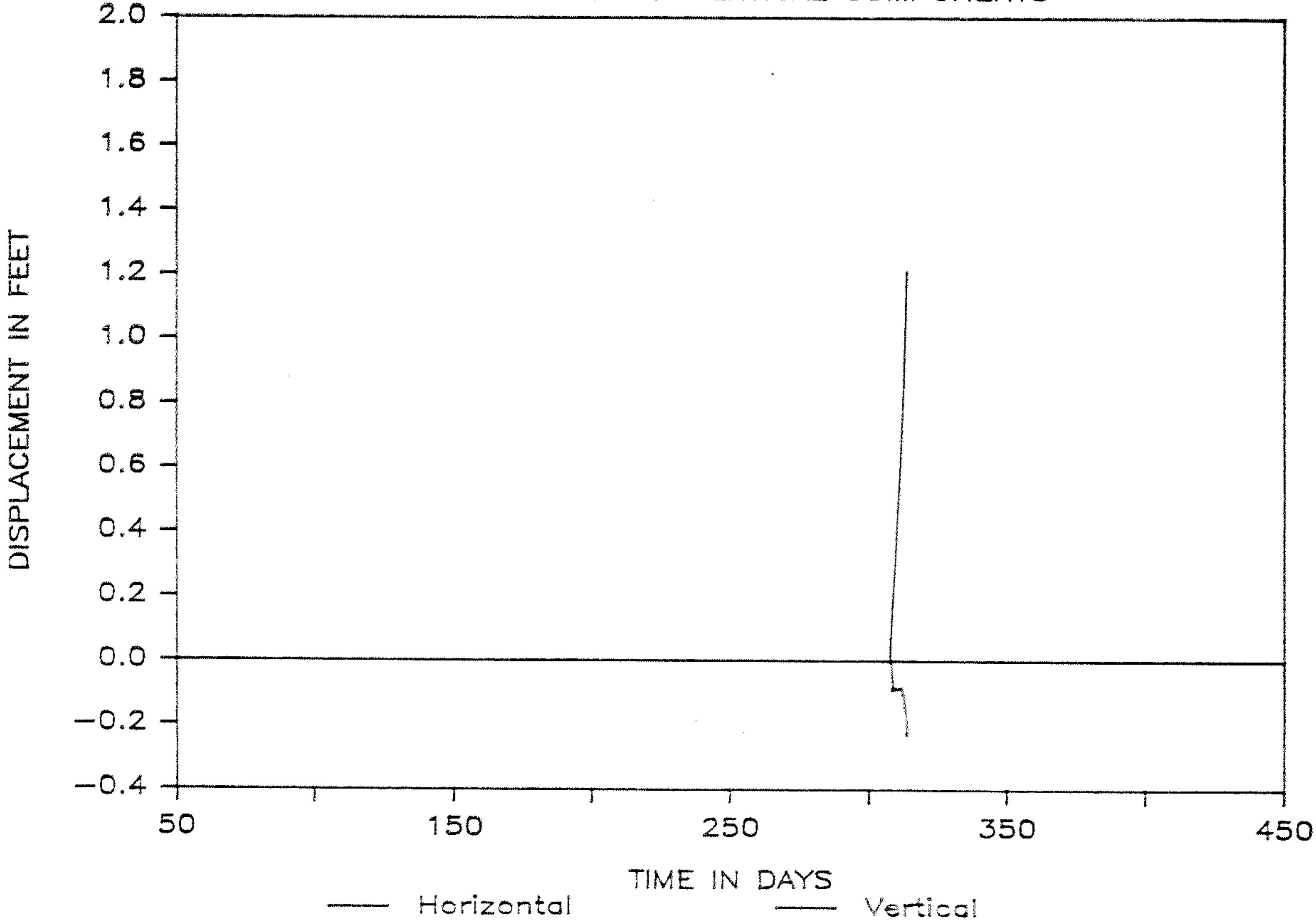


FIGURE B.10b— TARGET 42B DISPLACEMENT

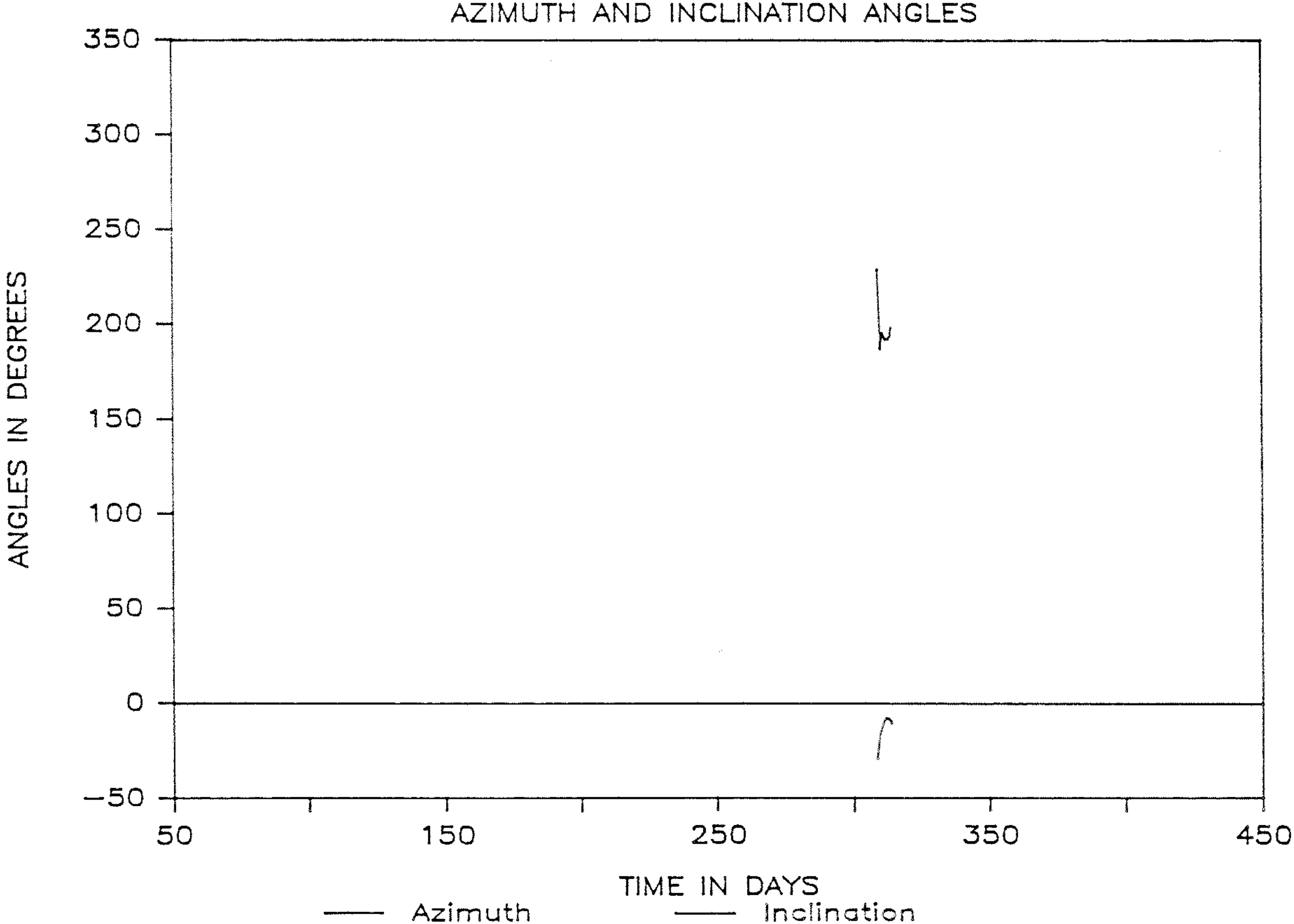


FIGURE B.11a— TARGET 43B DISPLACEMENT

HORIZONTAL AND VERTICAL COMPONENTS

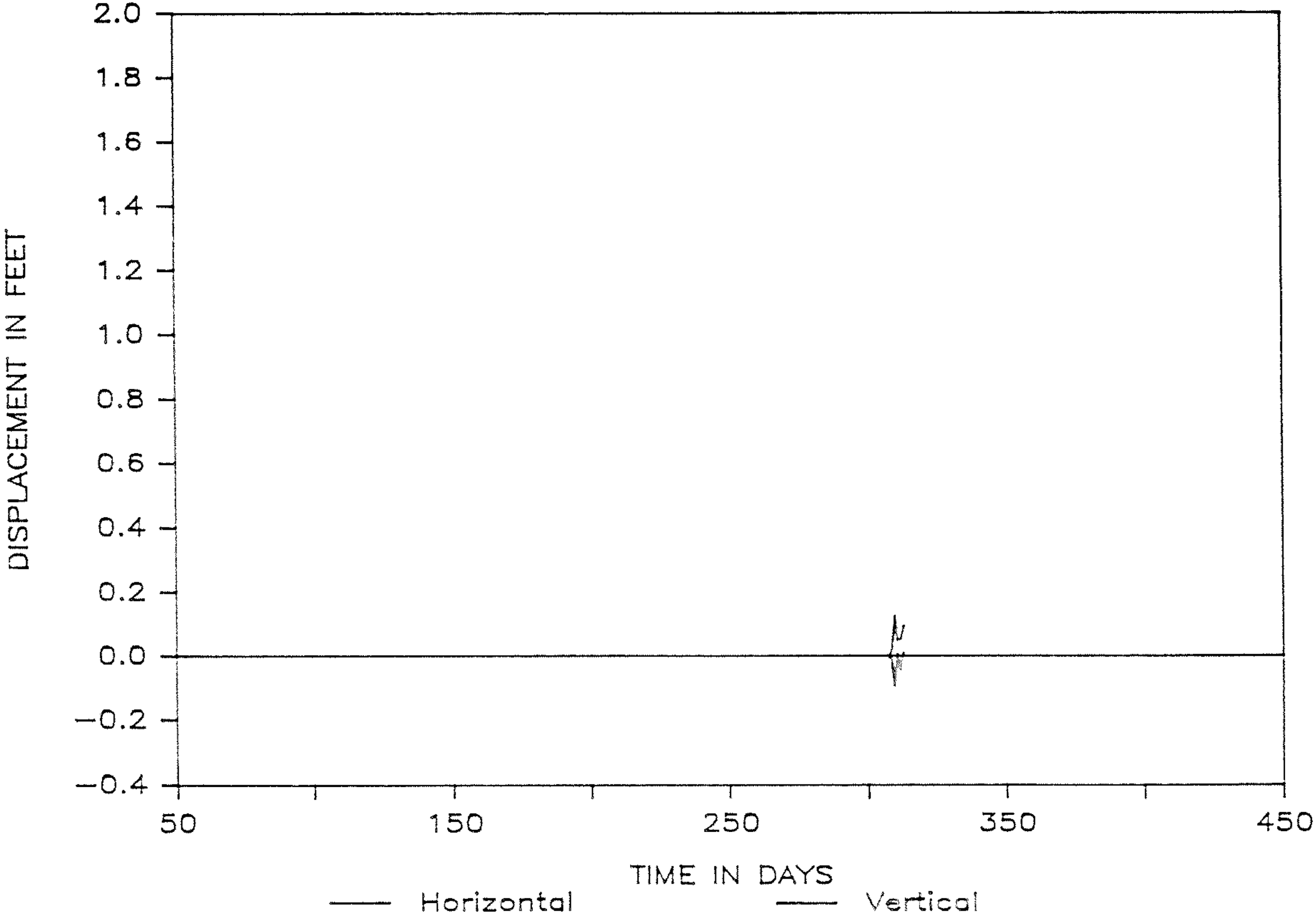


FIGURE B.11b– TARGET 43B DISPLACEMENT

AZIMUTH AND INCLINATION ANGLES

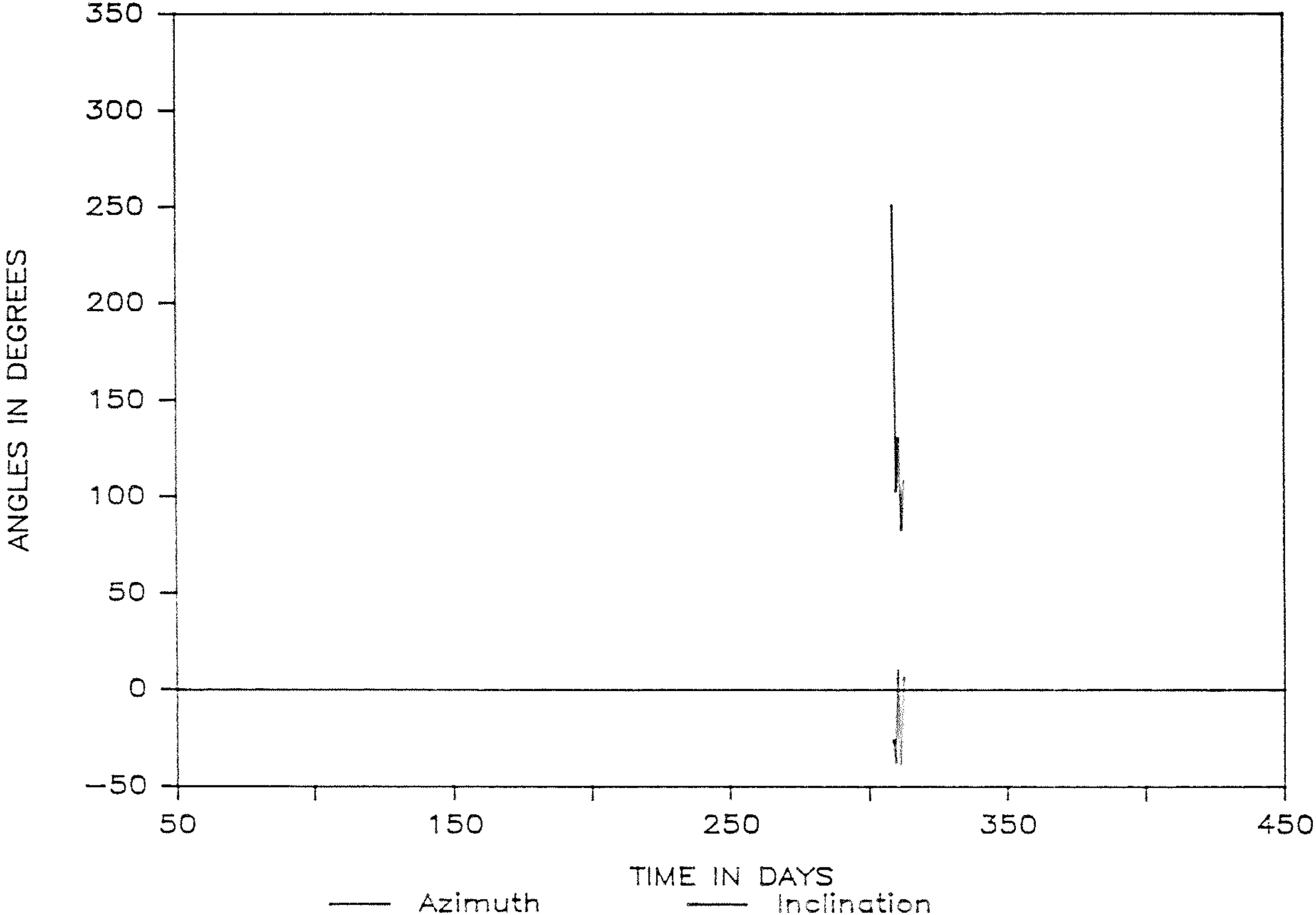


FIGURE B.12a— TARGET 44B DISPLACEMENT

HORIZONTAL AND VERTICAL COMPONENTS

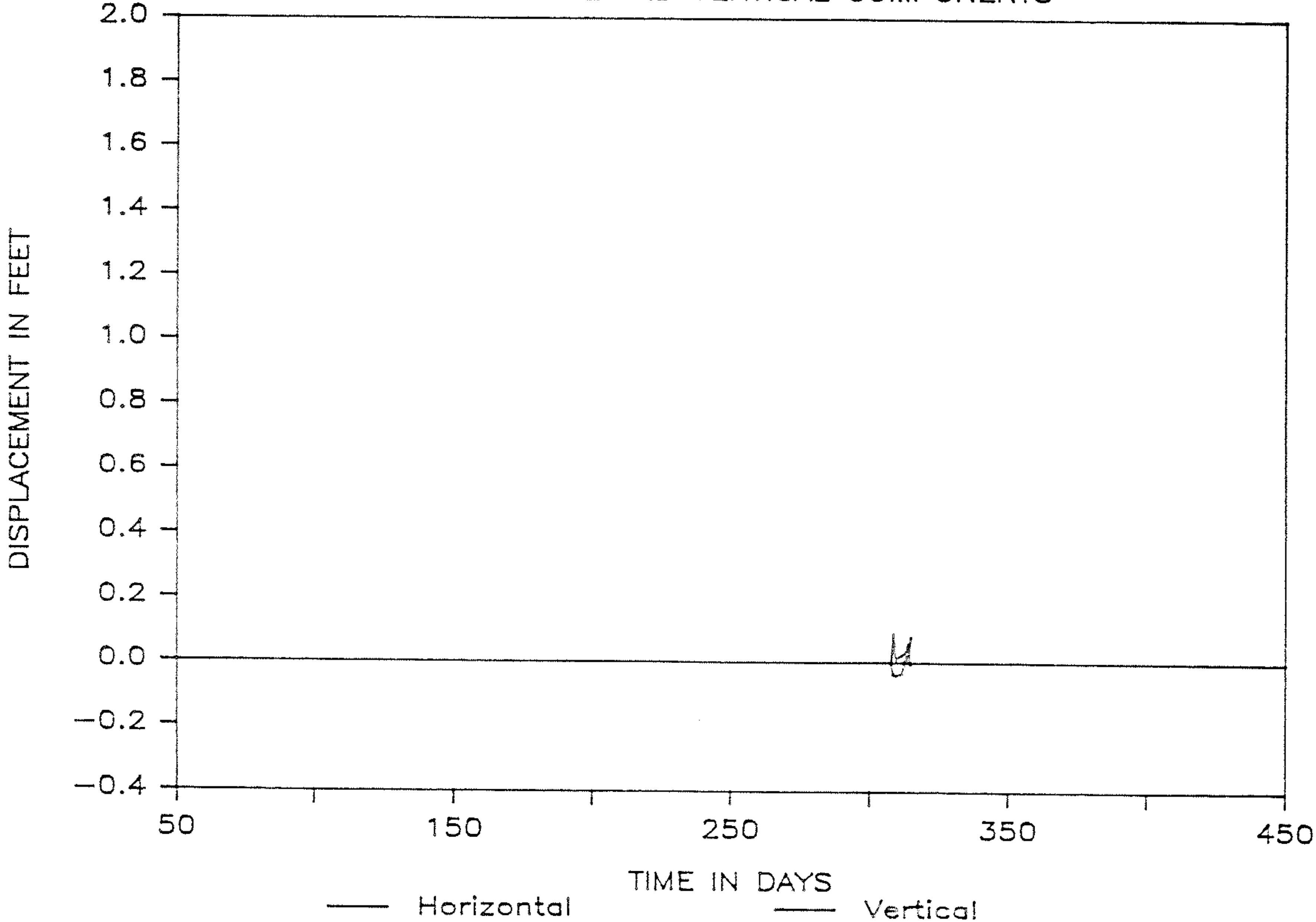


FIGURE B.12b— TARGET 44B DISPLACEMENT

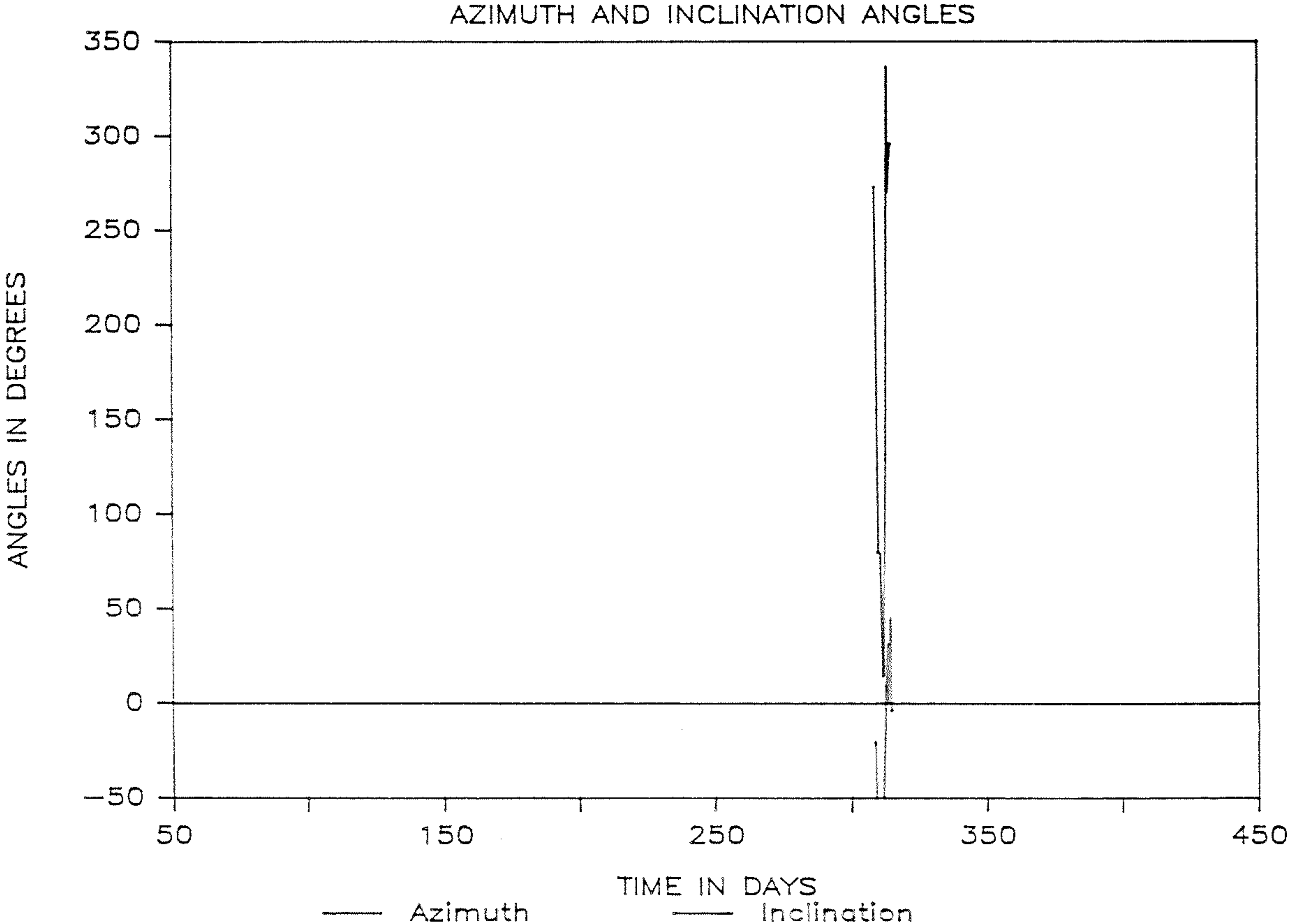


FIGURE B.13a— 21—26B SLOPE DISTANCE

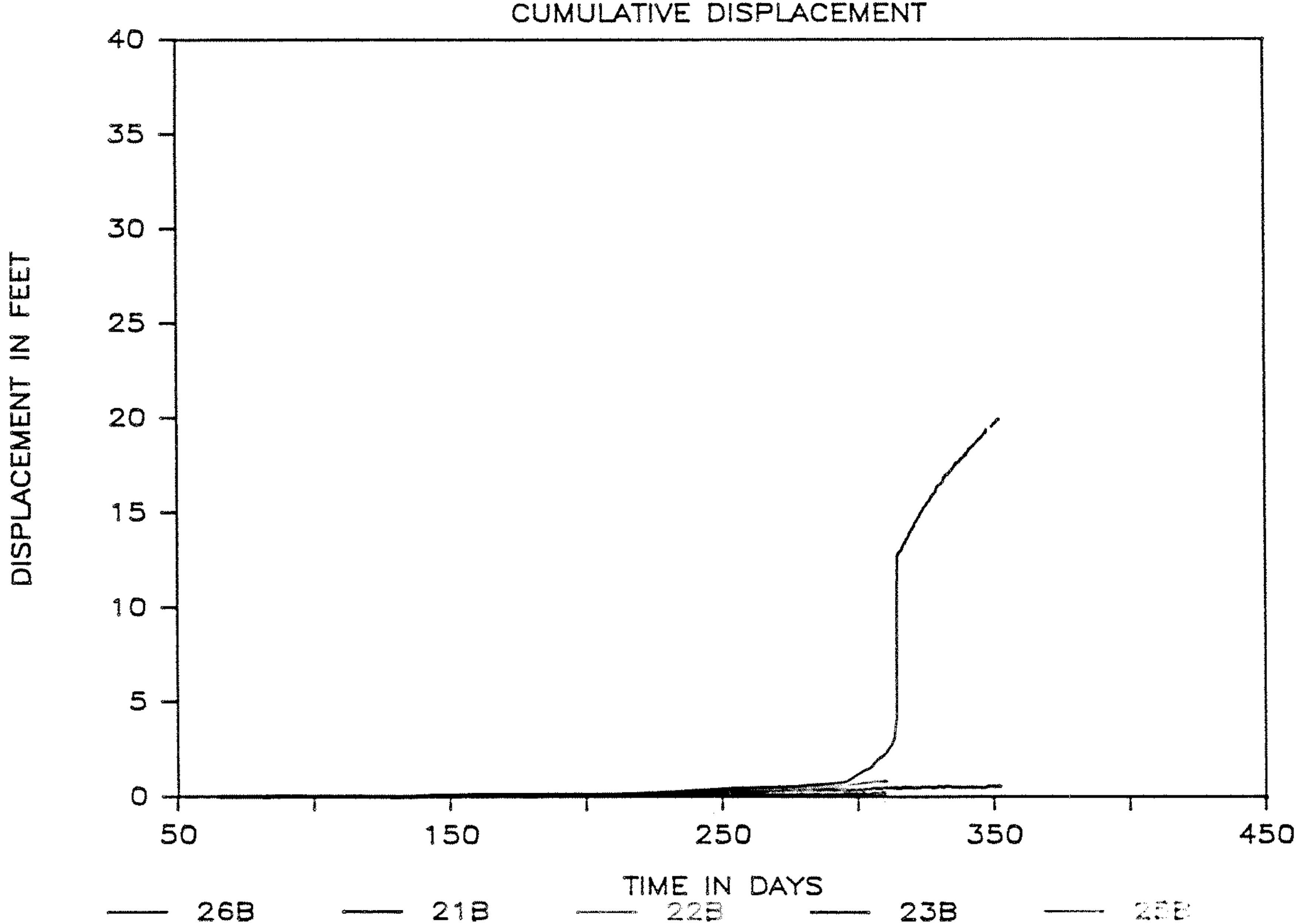


FIGURE B.13b— 21—26B SLOPE DISTANCE

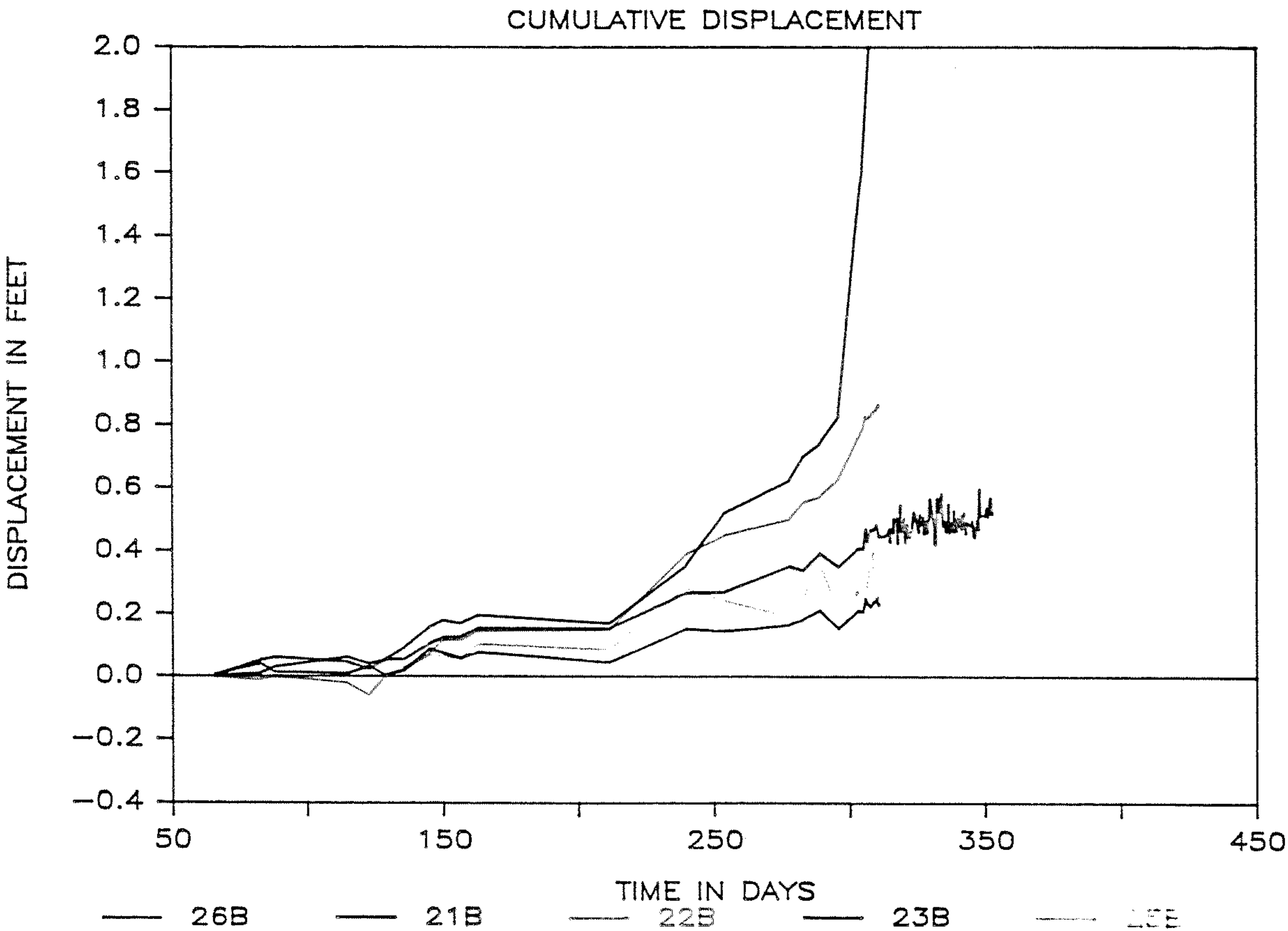


FIGURE B.13c— 21—26B SLOPE DISTANCE

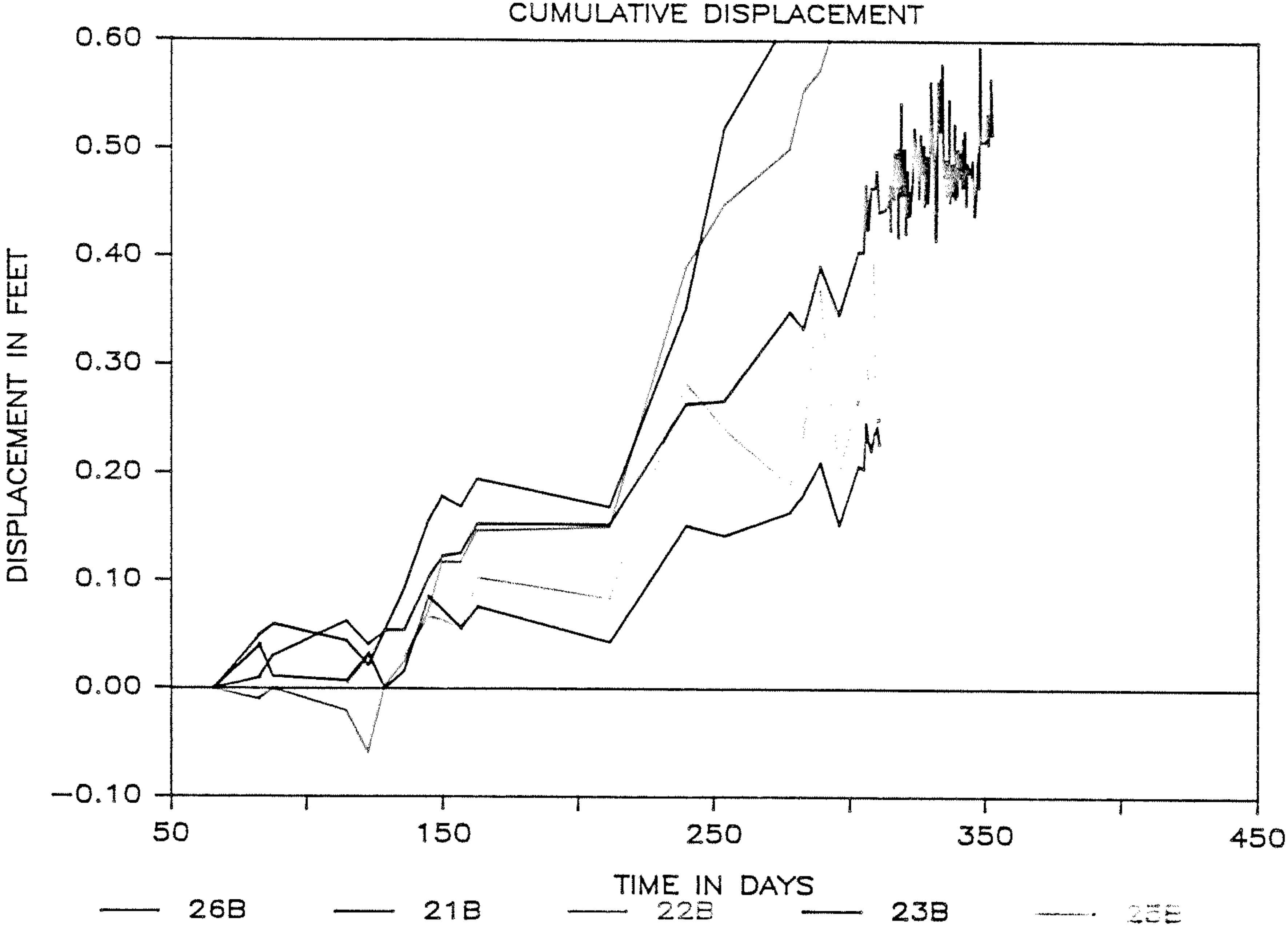


FIGURE B.14a— 26—40B SLOPE DISTANCE

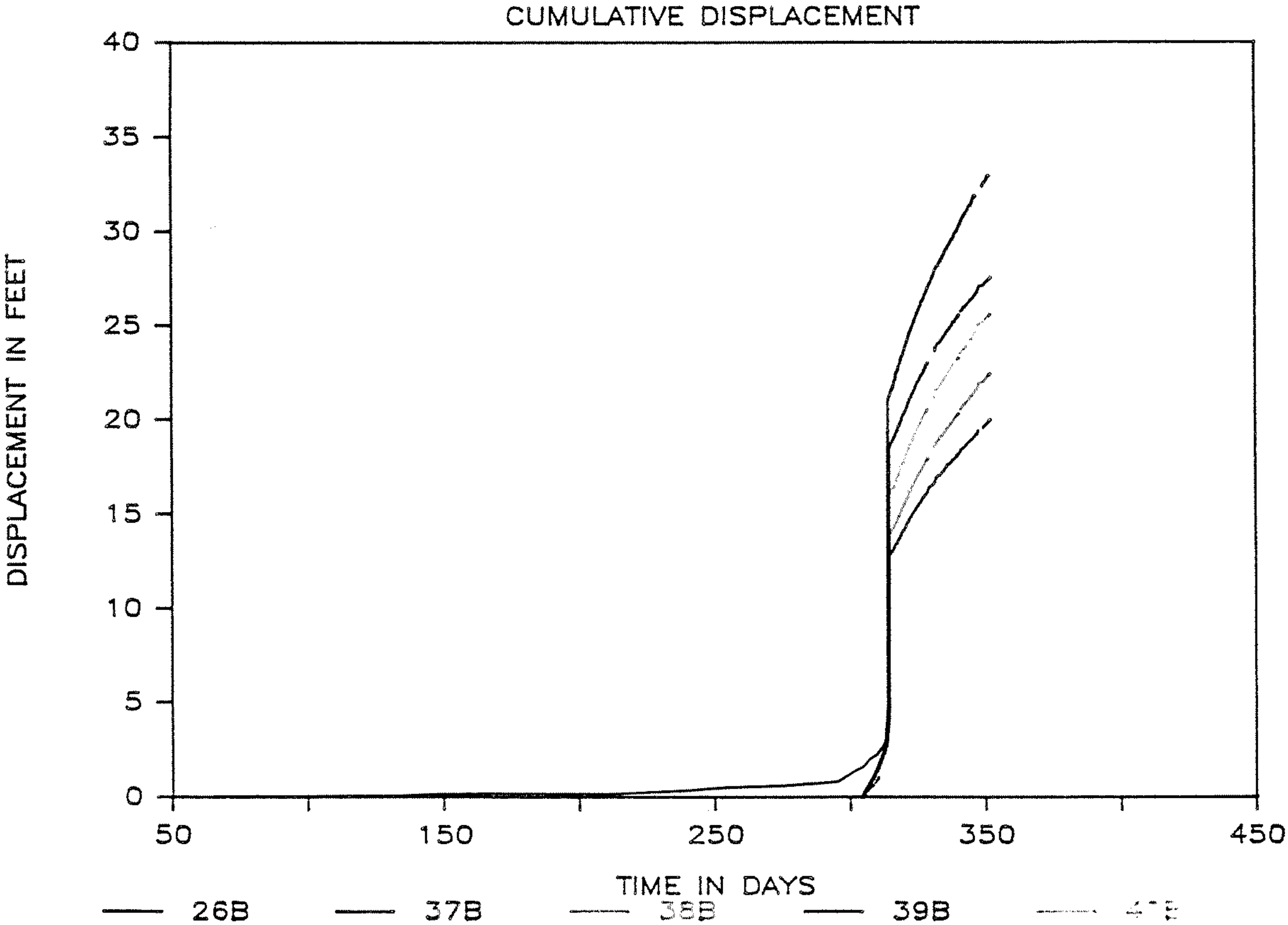


FIGURE B.14b– 26–40B SLOPE DISTANCE

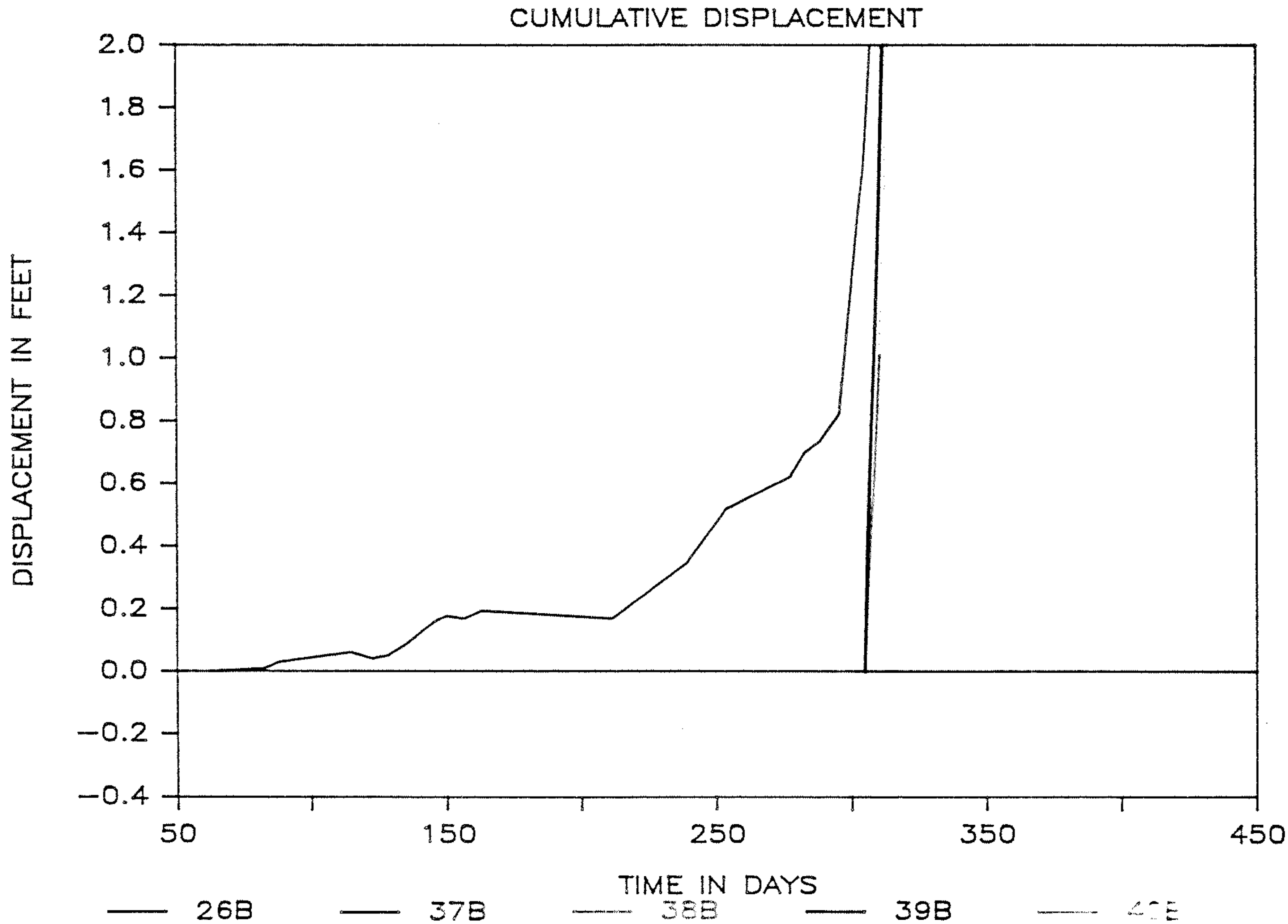


FIGURE B.15a– 21–26B SLOPE DISTANCE

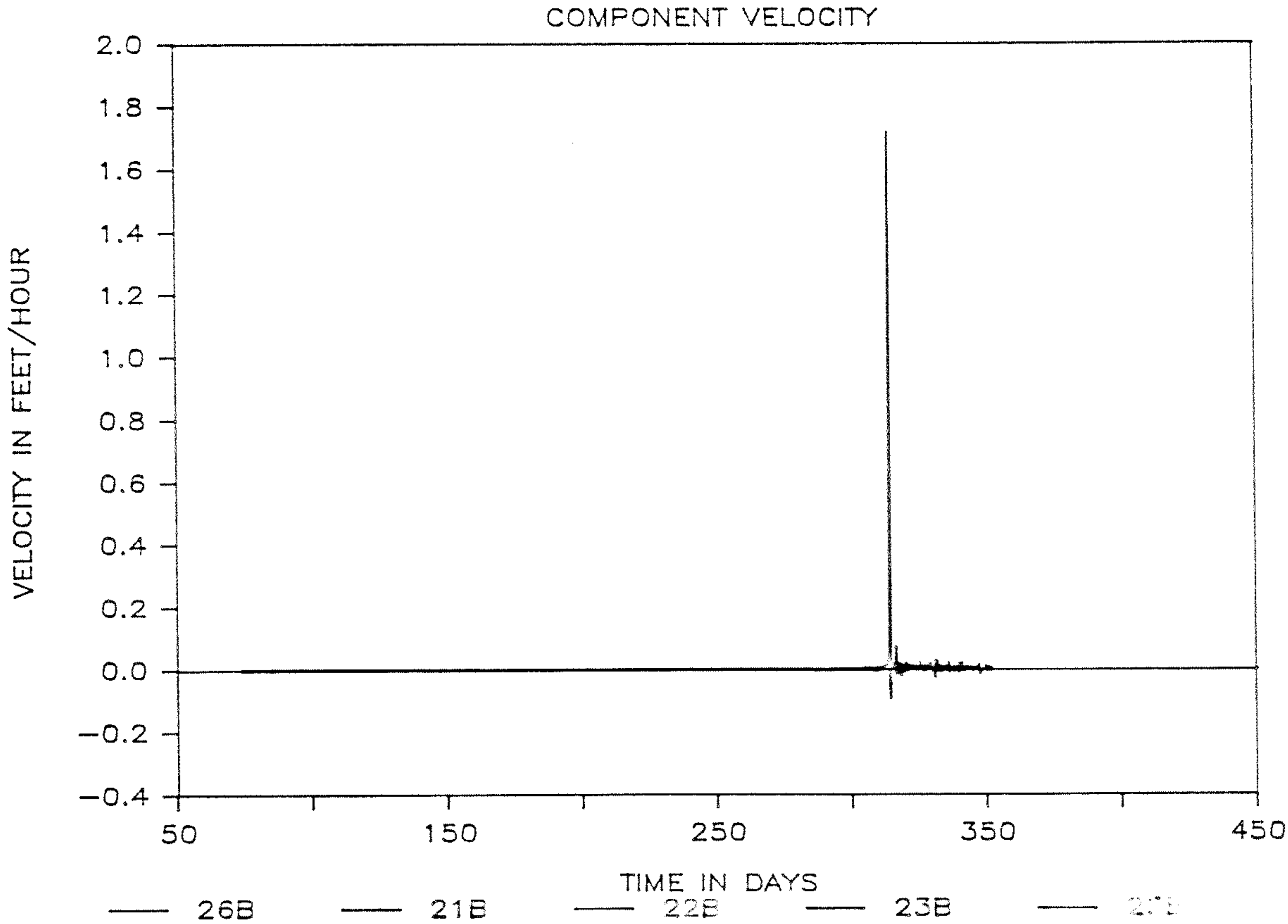


FIGURE B.15b— 21—26B SLOPE DISTANCE

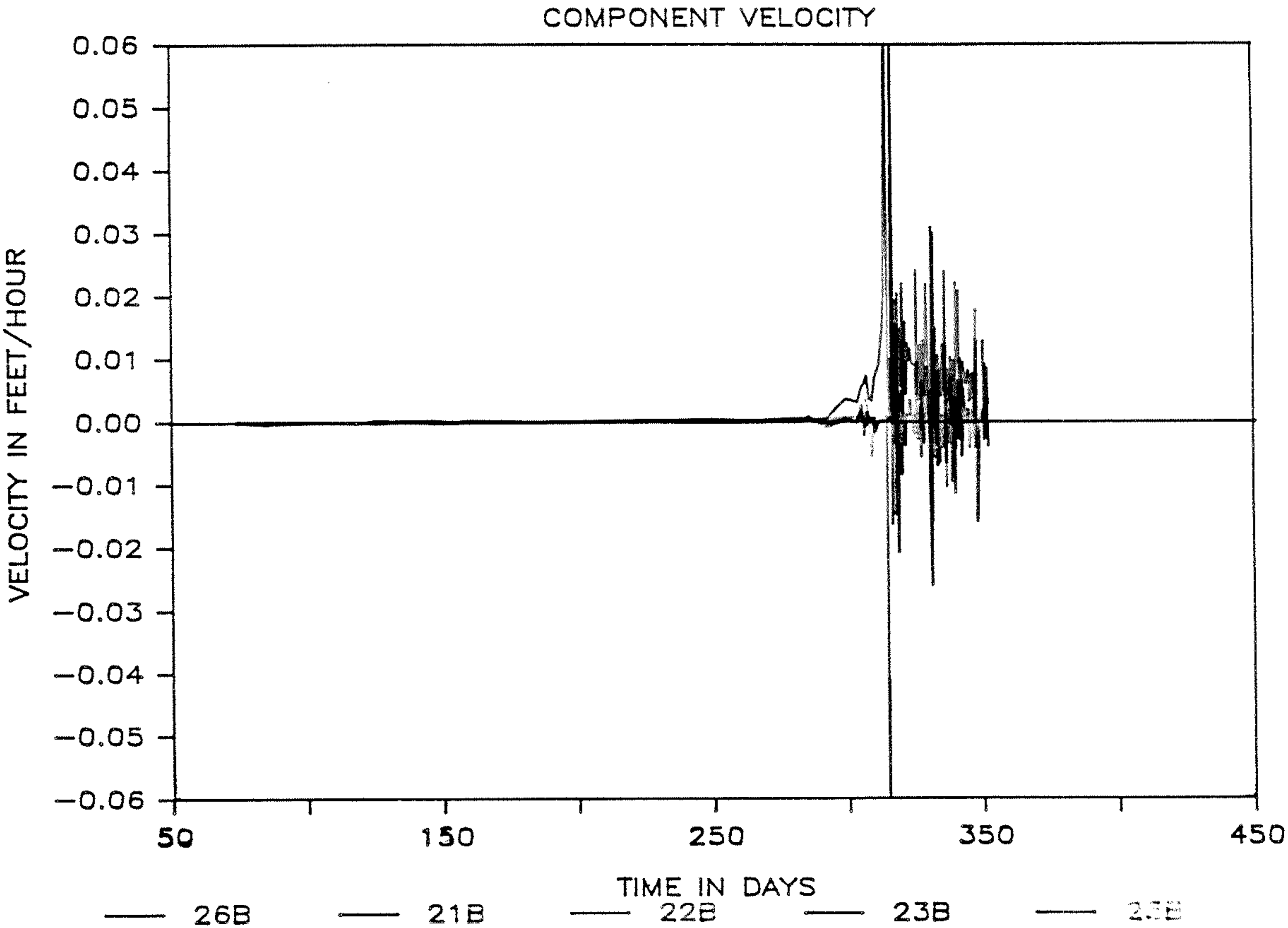


FIGURE B.16 — 37B SLOPE DISTANCE

COMPONENT VELOCITY

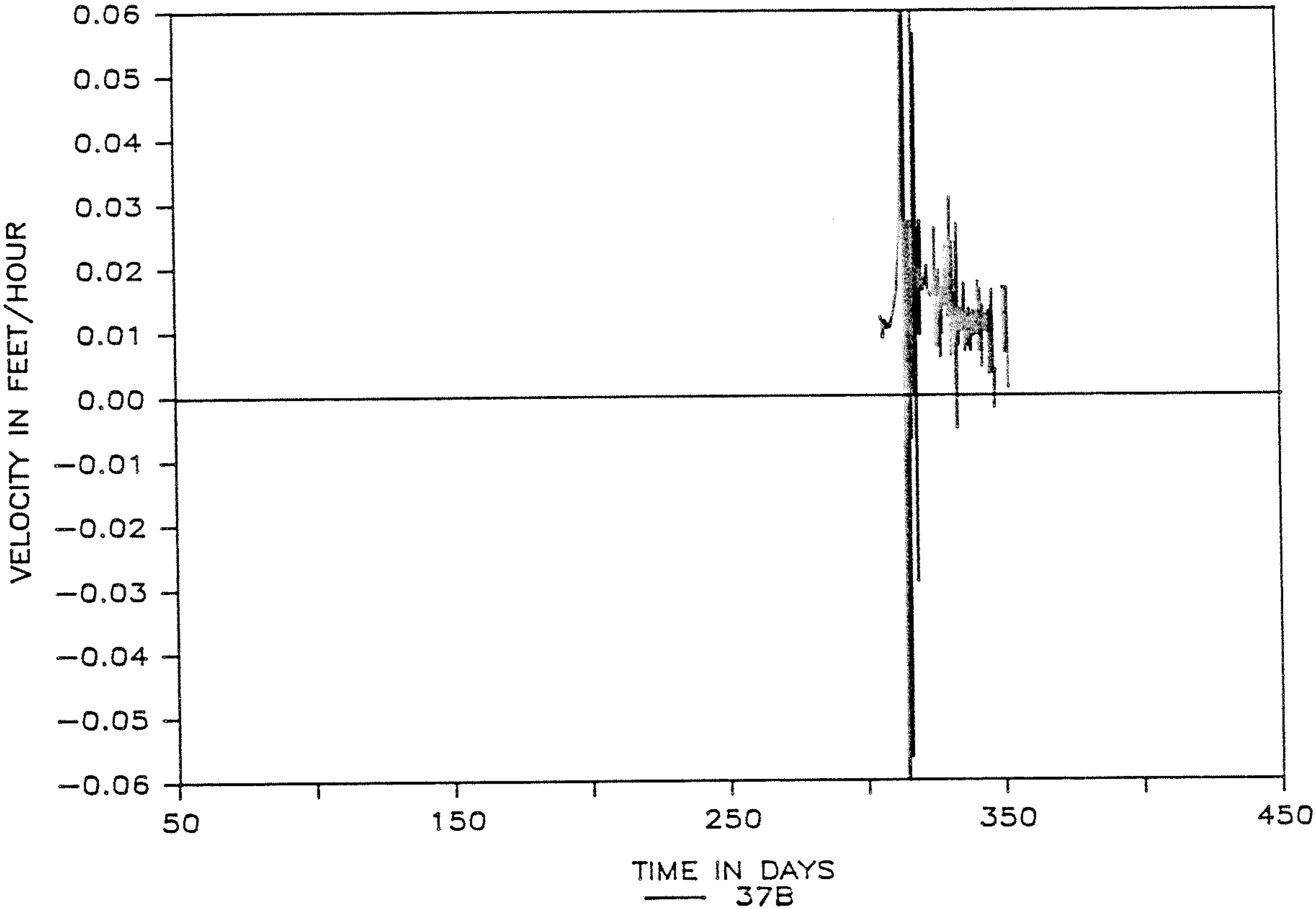


FIGURE B.17 — 38B SLOPE DISTANCE

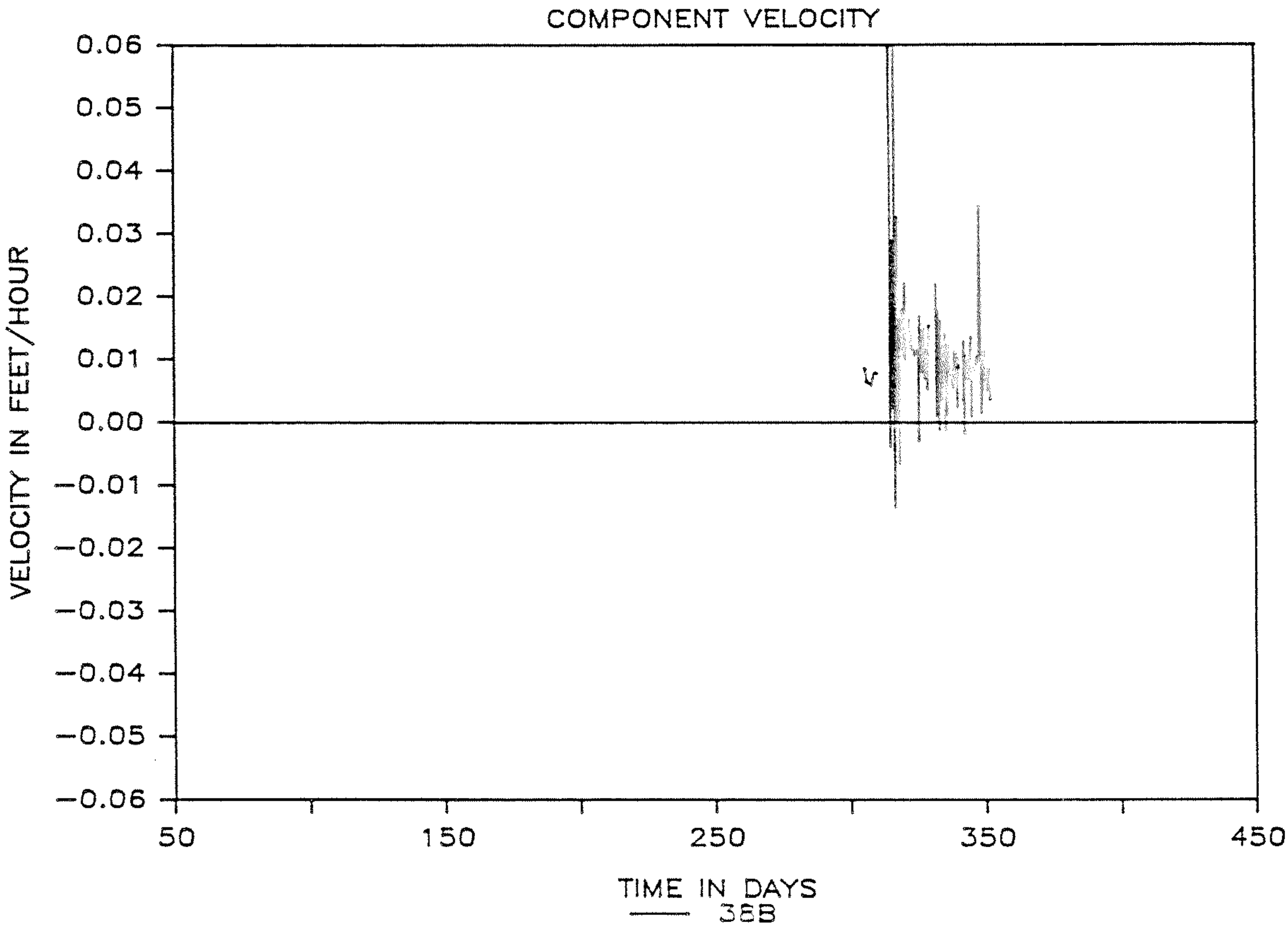


FIGURE B.18 — 39B SLOPE DISTANCE

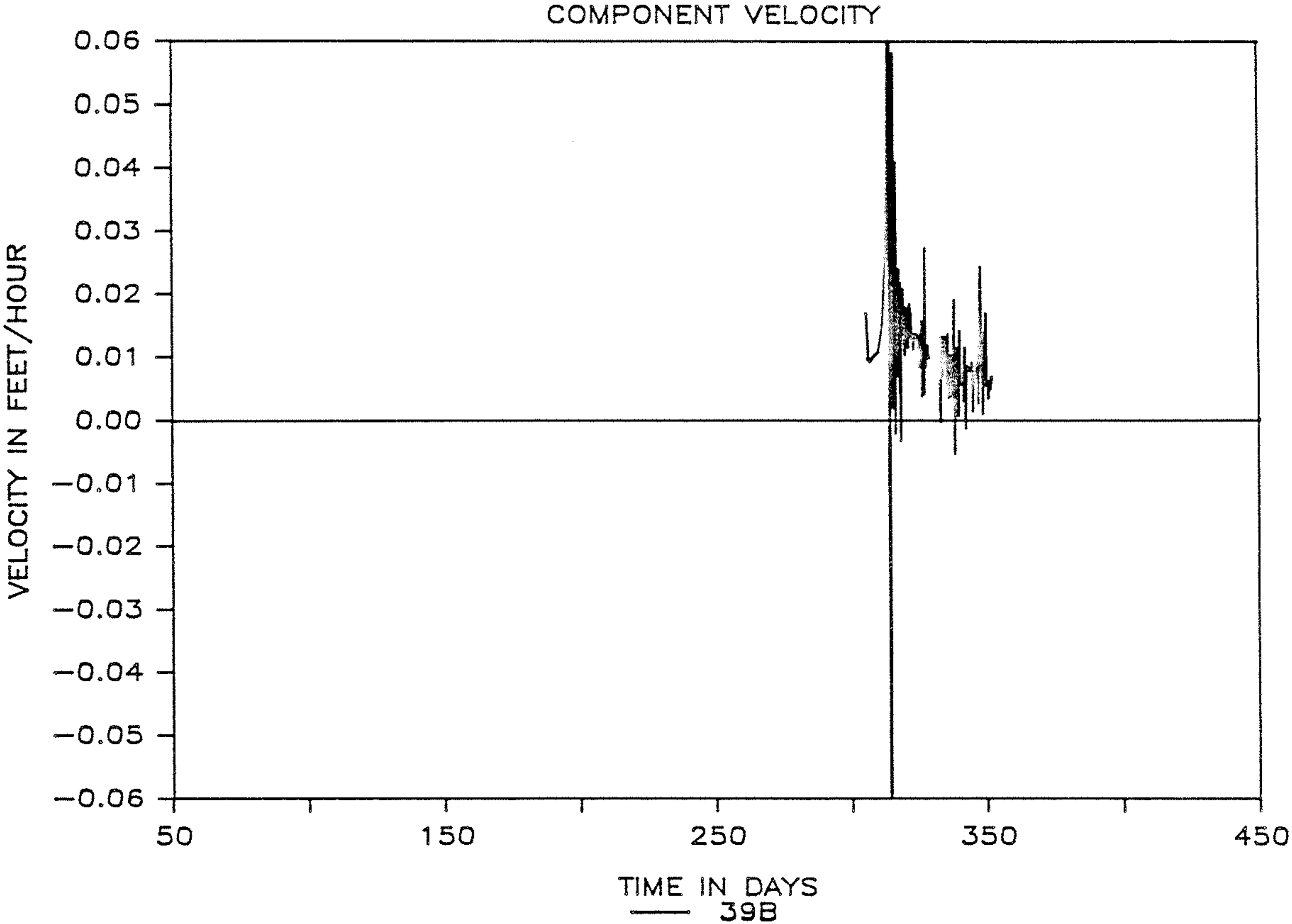
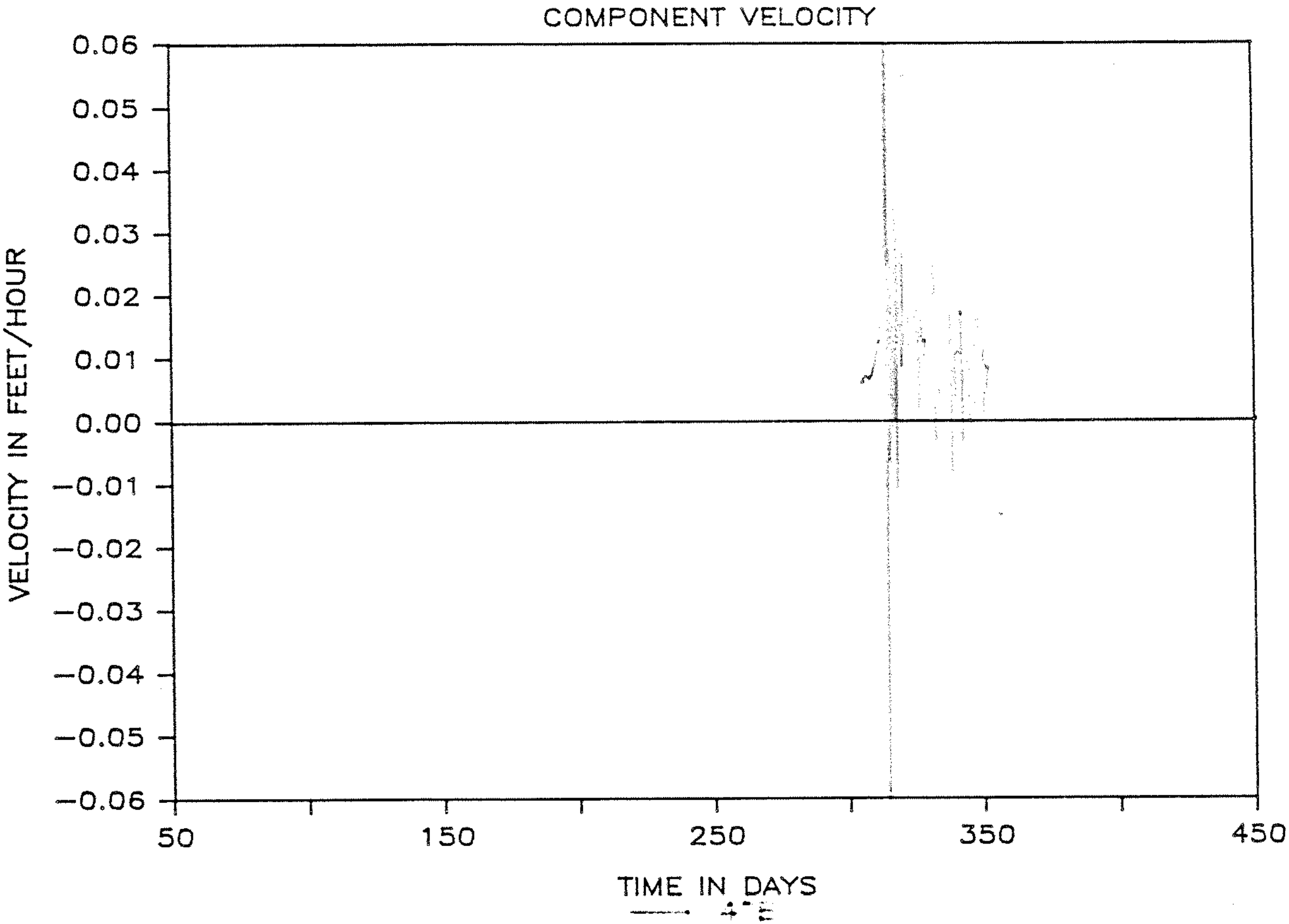


FIGURE B.19 — 40B SLOPE DISTANCE



APPENDIX C

PIEZOMETER DATA AND PLOTS

TABLE C.1 - GROUNDWATER ELEVATIONS AND PIEZOMETER READINGS. PAGE 1 OF 2.

Note: Piezometer Nests B04, B07, and B08 Consist of 2, 3, and 3 Individual Standpipes per Hole, Respectively.
Piezometer B04A is Plugged and Exhibits Very Slow Response.

			[-----			GROUNDWATER ELEVATIONS (in feet)				-----]	[-----			PIEZOMETER DROPLINE READINGS (in metres)				-----]
PIEZOMETER			B04A	B04B	B07A	B07B	B07C	B08A	B08B	B08C	B04A	B04B	B07A	B07B	B07C	B08A	B08B	B08C
Datum Elevation			5695.90	5695.74	5639.94	5641.69	5641.22	5635.20	5635.60	5636.83								
Screen Elevation, base			5396.00	5246.00	5493.00	5342.00	5194.00	5488.00	5339.00	5190.00								
top			5446.00	5296.00	5523.00	5372.00	5224.00	5518.00	5369.00	5220.00								
Date	Time	Days																
Mar 01 79	13.00	60.54	5587.08	5570.68	5506.15	5567.31	5489.25	5504.46	5564.47	5508.71	33.17	38.12	40.78	22.67	46.32	39.85	21.68	39.05
Apr 04 79	10.00	94.42	5586.91	5565.85	5514.42	5562.95	5488.86	5514.07	5563.16	5508.22	33.22	39.59	38.26	24.00	46.44	36.92	22.08	39.20
May 03 79	14.00	123.58	5586.85	5562.74	5534.76	5560.85	5487.68	5552.75	5558.40	5504.97	33.24	40.54	32.06	24.64	46.80	25.13	23.53	40.19
May 10 79	10.00	130.42	5586.75	5562.80	5539.09	5561.08	5486.46	5552.16	5557.71	5503.73	33.27	40.52	30.74	24.57	47.17	25.31	23.74	40.57
May 17 79	10.00	137.42	5586.68	5563.29	5539.32	5562.36	5486.27	5553.15	5557.32	5503.14	33.29	40.37	30.67	24.18	47.23	25.01	23.86	40.75
May 23 79	14.00	143.58	5586.65	5564.38	5552.01	5564.79	5484.73	5549.57	5553.88	5503.50	33.30	40.04	26.80	23.44	47.70	26.10	24.91	40.64
May 29 79	11.00	149.46	5586.58	5565.56	5550.41	5567.87	5484.79	5535.20	5555.09	5504.91	33.32	39.68	27.29	22.50	47.68	30.48	24.54	40.21
Jun 04 79	11.00	155.46	5586.55	5568.28	5549.49	5570.56	5484.27	5522.21	5557.02	5506.75	33.33	38.85	27.57	21.68	47.84	34.44	23.95	39.65
Jun 11 79	13.00	162.54	5586.52	5569.72	5548.90	5571.84	5483.94	5524.87	5556.34	5506.25	33.34	38.41	27.78	21.29	47.94	33.63	24.16	39.80
Jun 18 79	14.00	169.58	5586.55	5571.46	5547.82	5573.12	5484.79	5516.24	5554.99	5505.57	33.33	37.88	28.08	20.90	47.68	36.26	24.57	40.01
Jun 27 79	10.00	178.42	5586.52	5572.55	5548.11	5573.68	5484.73	5516.89	5554.93	5505.43	33.34	37.55	27.99	20.73	47.70	36.06	24.59	40.05
Jul 06 79	10.00	187.42	5586.52	5573.40	5547.68	5573.81	5484.89	5510.79	5552.96	5504.48	33.34	37.29	28.12	20.69	47.65	37.92	25.19	40.34
Jul 12 79	9.00	193.38	5586.49	5573.76	5548.50	5573.71	5484.99	5518.40	5552.53	5504.42	33.35	37.18	27.87	20.72	47.62	35.60	25.32	40.36
Jul 19 79	11.00	200.46	5586.49	5573.56	5546.14	5573.25	5485.05	5506.59	5552.10	5503.43	33.35	37.24	28.59	20.86	47.60	39.20	25.45	40.66
Jul 25 79	13.00	206.54	5586.45	5573.63	5545.91	5573.06	5486.66	5505.15	5551.55	5502.22	33.36	37.22	28.66	20.92	47.11	39.64	25.62	41.03
Aug 01 79	14.00	213.58	5586.45	5573.30	5547.22	5572.27	5485.45	5510.07	5550.82	5501.83	33.36	37.32	28.26	21.16	47.48	38.14	25.84	41.15
Aug 07 79	14.00	219.58	5586.42	5572.97	5549.03	5571.48	5483.91	5506.82	5548.40	5500.64	33.37	37.42	27.71	21.40	47.95	39.13	26.58	41.51
Aug 14 79	13.00	226.54	5586.42	5572.74	5550.34	5571.05	5483.51	5504.89	5547.08	5499.13	33.37	37.49	27.31	21.53	48.07	39.72	26.98	41.97
Aug 21 79	13.00	233.54	5586.42	5571.69	5547.95	5569.61	5482.49	5501.21	5519.72	5495.36	33.37	37.81	28.04	21.97	48.38	40.84	35.32	43.12
Aug 27 79	13.00	239.54	5597.57	5570.91	5550.77	5568.27	5481.25	5504.10	5511.59	5492.74	33.02	38.05	27.18	22.38	48.76	39.96	37.80	43.92
Sep 06 79	12.00	249.50	5586.58	5568.90	5548.93	5566.17	5480.20	5497.60	5506.86	5491.33	33.32	38.66	27.74	23.02	49.08	41.94	39.24	44.35
Sep 14 79	13.00	257.54	5586.35	5567.40	5546.67	5564.13	5479.41	5497.34	5504.07	5491.00	33.39	39.12	28.43	23.64	49.32	42.02	40.09	44.45
Sep 21 79	13.00	264.54	5596.42	5566.02	5544.14	5562.59	5479.35	5497.34	5502.20	5491.29	33.37	39.54	29.20	24.11	49.34	42.02	40.66	44.36
Sep 28 79	13.00	271.54	5586.55	5564.77	5542.30	5560.95	5478.95	5496.82	5501.58	5493.10	33.33	39.92	29.76	24.61	49.46	42.18	40.85	43.81
Oct 04 79	14.00	277.58	5586.65	5563.10	5541.78	5559.80	5479.64	5496.36	5501.02	5495.43	33.30	40.43	29.92	24.96	49.25	42.32	41.02	43.10
Oct 12 79	14.00	285.58	5586.71	5561.29	5540.86	5557.73	5478.69	5496.32	5500.79	5495.03	33.28	40.98	30.20	25.59	49.54	42.33	41.09	43.22
Oct 17 79	15.00	290.62	5586.45	5557.98	5543.29	5556.26	5478.36	5496.42	5500.46	5493.85	33.36	41.38	29.46	26.04	49.64	42.30	41.19	43.58
Oct 24 79	13.00	297.54	5586.39	5558.14	5543.68	5554.03	5477.28	5497.37	5500.17	5492.25	33.38	41.94	29.34	26.72	49.97	42.01	41.28	44.07
Oct 30 79	13.00	303.54	5586.39	5556.50	5541.52	5552.39	5476.66	5497.18	5499.94	5491.00	33.38	42.44	30.00	27.22	50.16	42.07	41.35	44.45
Nov 03 79	12.00	307.50	ERR	ERR	5542.11	5551.53	5476.29	5500.62	5499.91	5490.11	ERR	ERR	29.82	27.48	50.27	41.02	41.36	44.72
Nov 06 79	12.00	310.50	ERR	EPR	5542.11	5550.55	5475.93	5500.46	5499.91	5486.70	ERR	ERR	29.82	27.78	50.38	41.07	41.36	45.76
Nov 10 79	12.00	314.50	EPR	ERR	5540.53	5548.58	5472.59	5500.33	5499.84	5438.41	EPR	ERR	30.30	28.38	51.40	41.11	41.38	60.48
Nov 13 79	12.00	317.50	EFR	ERR	5539.22	5546.45	5466.39	5500.06	5499.61	5418.49	EFR	ERR	30.70	29.03	53.29	41.19	41.45	66.55
Nov 16 79	12.00	320.50	EFR	EPR	5538.46	5545.40	5459.17	5500.00	5499.45	5407.76	EPR	ERR	30.93	29.35	55.49	41.21	41.50	69.82
Nov 20 79	12.00	324.50	EFR	ERR	5536.37	5543.50	5451.59	5499.83	5499.09	5397.00	ERR	ERR	31.57	29.93	57.80	41.26	41.61	73.10
Nov 23 79	12.00	327.50	ERR	ERR	5533.84	5540.48	5446.60	5499.67	5498.99	5391.85	ERR	ERR	32.34	30.85	59.32	41.31	41.64	74.67

TABLE C.1 - GROUNDWATER ELEVATIONS AND PIEZOMETER READINGS. PAGE 2 OF 2.

Note: Piezometer Nests B04, B07, and B08 Consist of 2, 3, and 3 Individual Standpipes per Hole, Respectively.
Piezometer B04A is Plugged and Exhibits Very Slow Response.

			[----- GROUNDWATER ELEVATIONS (in feet) -----]								[----- PIEZOMETER DROPLINE READINGS (in metres) -----]							
PIEZOMETER			B04A	B04B	B07A	B07B	B07C	B08A	B08B	B08C	B04A	B04B	B07A	B07B	B07C	B08A	B08B	B08C
Datum Elevation			5695.90	5695.74	5639.94	5641.69	5641.22	5635.20	5635.60	5636.83								
Screen Elevation, base			5396.00	5246.00	5493.00	5342.00	5194.00	5488.00	5339.00	5190.00								
top			5446.00	5296.00	5523.00	5372.00	5224.00	5518.00	5369.00	5220.00								
Date	Time	Days																
Nov 27 79	12.00	331.50	ERR	ERR	5530.26	5535.13	5443.98	5499.67	5498.23	5386.73	ERR	ERR	33.43	32.48	60.12	41.31	41.87	76.23
Nov 30 79	12.00	334.50	ERR	ERR	5526.10	5535.49	5443.58	5499.80	5496.10	5382.40	ERR	ERR	34.70	32.37	60.24	41.27	42.52	77.55
Dec 05 79	12.00	339.50	ERR	ERR	5525.93	5531.16	5447.49	5500.20	5497.81	5381.49	ERR	ERR	34.75	33.69	59.05	41.15	42.00	77.83
Dec 28 79	12.00	362.50	ERR	ERR	5514.02	5522.14	5446.60	5499.67	5491.28	5402.06	ERR	ERR	38.38	36.44	59.32	41.31	43.99	71.56
Jan 04 80	12.00	369.50	ERR	5528.78	ERR	ERR	ERR	ERR	ERR	ERR	ERR	50.89	ERR	ERR	ERR	ERR	ERR	ERR
Jan 16 80	12.00	381.50	ERR	ERR	5511.56	5516.59	5453.95	5499.57	5488.55	5430.24	ERR	ERR	39.13	38.13	57.08	41.34	44.82	62.97
Jan 22 80	12.00	387.50	ERR	ERR	5504.38	5493.99	5430.95	5504.82	5508.89	5451.53	ERR	ERR	41.32	45.02	64.09	39.74	38.65	56.48
Feb 18 80	12.00	414.50	ERR	5517.56	5509.33	5508.62	5450.51	5499.67	5500.07	5421.38	ERR	54.31	39.81	40.56	58.13	41.31	41.31	65.67

FIGURE C.1 — PIEZOMETER NEST B04

GROUNDWATER ELEVATIONS

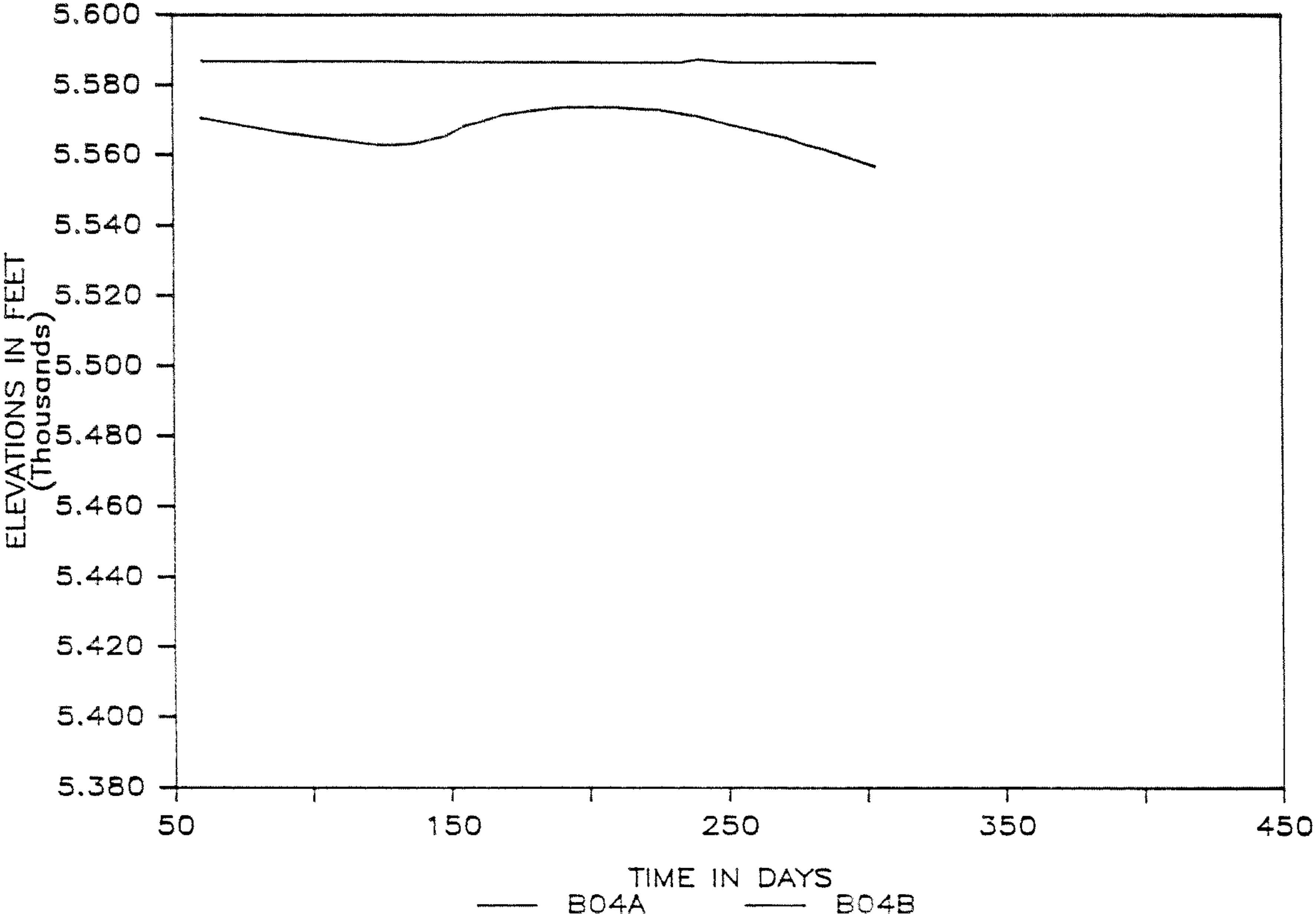


FIGURE C.2 — PIEZOMETER NEST B07

GROUNDWATER ELEVATIONS

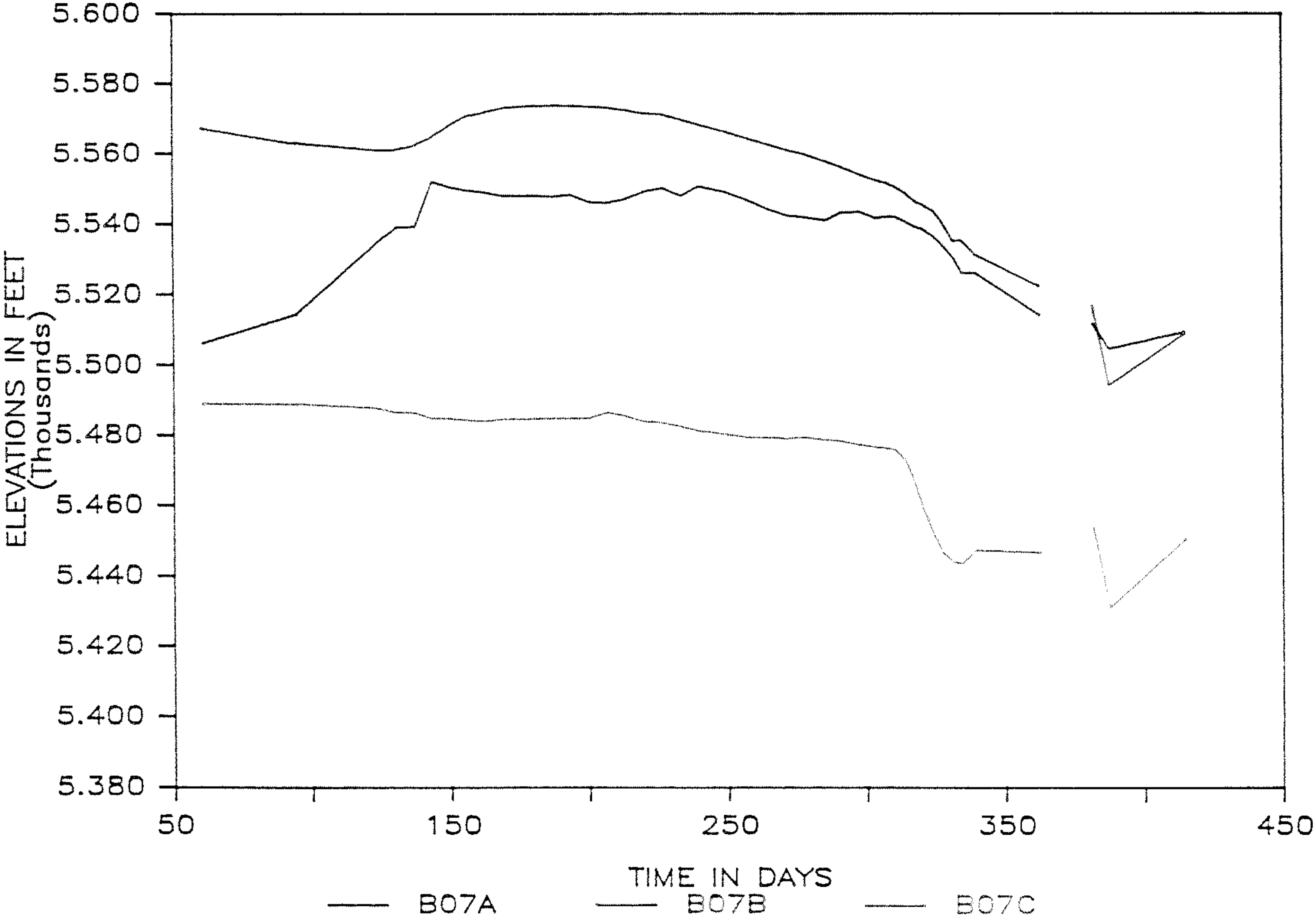
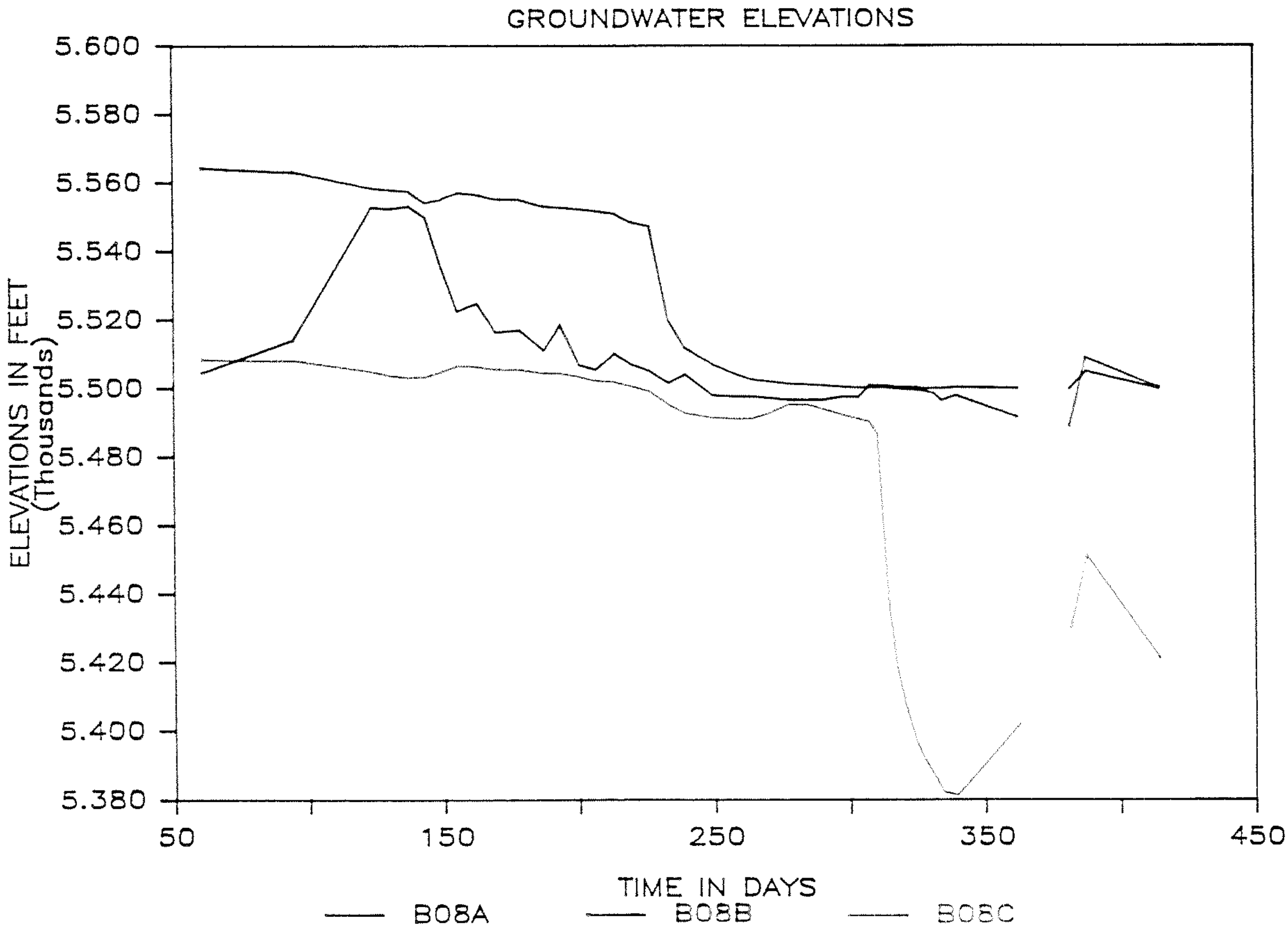


FIGURE C.3 — PIEZOMETER NEST B08



APPENDIX D

LOG OF COREHOLE E21-R50

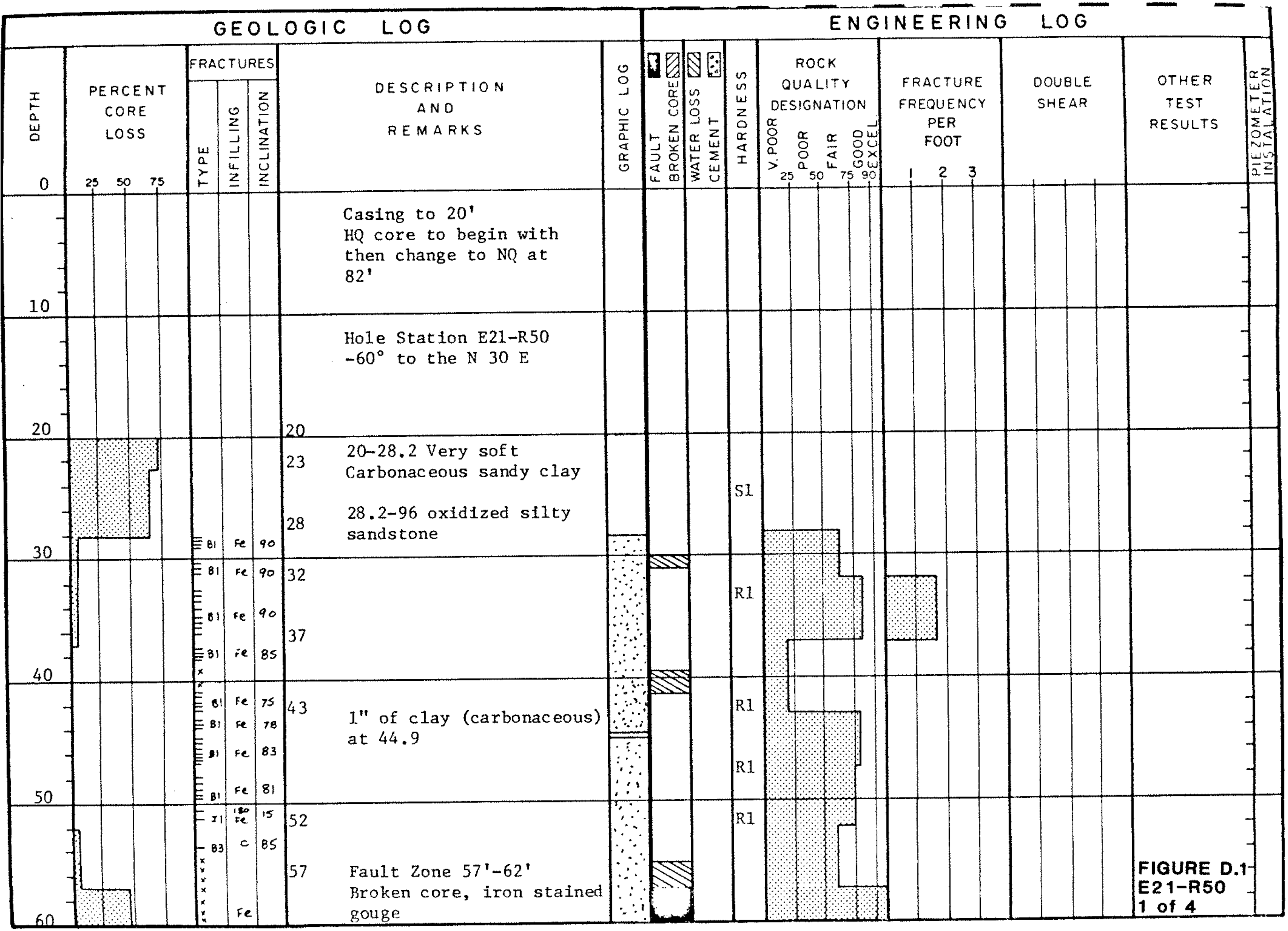


FIGURE D.1
E21-R50
1 of 4

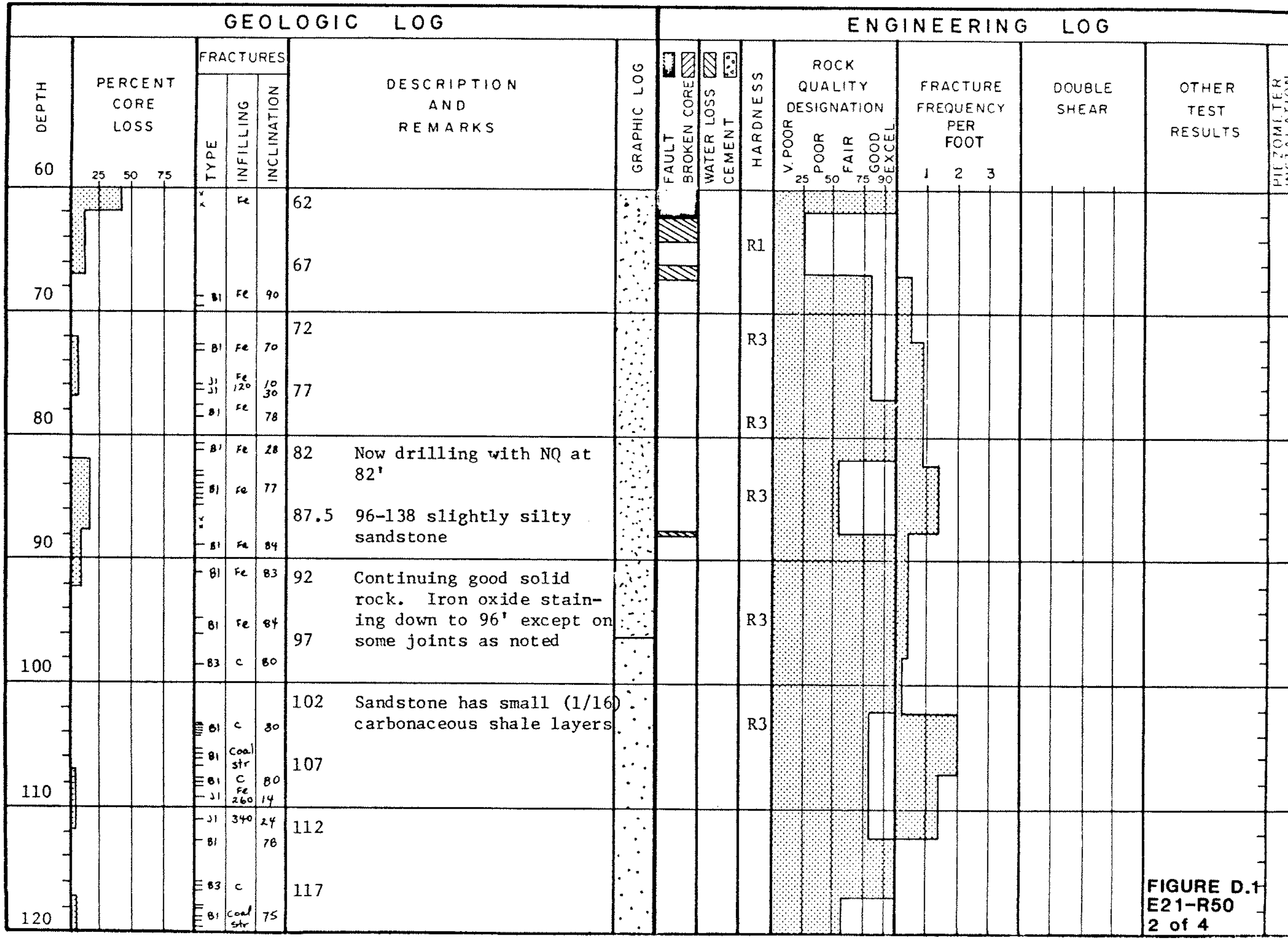


FIGURE D.1
E21-R50
2 of 4

GEOLOGIC LOG / ENGINEERING LOG

Depth	Percent Core Loss (25, 50, 75)	Fractures: Type	Fractures: Infilling	Fractures: Inclination	Description and Remarks	Graphic Log	Fault / Broken Core / Water Loss / Cement	Hardness	Rock Quality Designation (V. Poor 25, Poor 50, Fair 75, Good 90, Excel)	Fracture Frequency per Foot (1, 2, 3)	Double Shear	Other Test Results	Piezometer Installation
120–130		B1/B3		85	122 127 Core tube did not lock ground core			R2					
130–140		B1 B1 19 B1	clay c +clay	78 80 75 85	132 133 3" soft carbonaceous clay 135 1" " " clay 137 137 3" " " "			S1 S1 S1 R2					
140–150		B1 B1	c clay	80 80	142 138-141 Silty sandstone with some soft clay layers 147 141 Slightly silty sandstone			R2					
150–160		B1 B1 B3	clay layers CLAY LAYERS	76 77 77	152 157			R3 R3 R3					
160–170		B1 B1 B1	c c c	75 75 75	162 167								
170–180		B1 F1-J1? B1	c	75 35 75	172 Iron stained joint - fault? making water at 20 gal/min 177								

FIGURE D.1
E21-R50
3 of 4

GEOLOGIC LOG							ENGINEERING LOG									
DEPTH	PERCENT CORE LOSS (25, 50, 75)	FRACTURES: TYPE	FRACTURES: INFILLING	FRACTURES: INCLINATION	DESCRIPTION AND REMARKS	GRAPHIC LOG	FAULT	BROKEN CORE	WATER LOSS	CEMENT	HARDNESS	ROCK QUALITY DESIGNATION (V. POOR 25, POOR 50, FAIR 75, GOOD 90, EXCEL.)	FRACTURE FREQUENCY PER FOOT (1, 2, 3)	DOUBLE SHEAR	OTHER TEST RESULTS	PIEZOMETER INSTALATION
180		53			182						R3					
					187						R3					
190		81	irreg.	clay	192						R3					
		81	irreg.		197 Tube didn't catch ground core						R3					
200					201 TD 201'											
210																

FIGURE D.1
E21-R50
4 of 4

APPENDIX E

SLOPE STABILITY ANALYSES

TABLE E.1 - SUMMARY OF STABILITY ANALYSIS TRIALS

Figure Number	Trial Number	Failure Surface	Phreatic Surface	Friction Angles ϕ_1	ϕ_2	ϕ_3	Factor of Safety	Comments
E.1	AMT2	Bilinear	180-200	25°	35'	38'	0.985	No buttress
E.2	AMT3	"	"	"	"	"	1.433	With buttress
E.3	AMT4	"	140-160	"	"	"	1.145	No buttress, Dewatered 40 ft.
E.4	AMT5	"	100-120	"	"	"	1.259	No buttress, Dewatered 80 ft.
E.5	AMT6	"	60-80	"	"	"	1.308	No buttress, Completely Dewatered
E.6	AMT43	"	180-200	"	"	"	1.206	Half width buttress
E.7	AMT44	"	"	"	"	"	1.269	Half height buttress
E.8	AMT12	Curve 1	"	"	"	"	1.121	No buttress
E.9	AMT13	"	"	"	"	"	1.503	With buttress
E.10	AMT15	"	30-30	"	"	"	1.411	No buttress, Completely dewatered
E.11	AMT14	Curve 2	180-200	"	"	"	1.137	No buttress
E.12	AMT22	Circles	"	"	"	"	1.130	No buttress Circle through toe
-	AMT32AC	Curve 1	180-200	25°	31.3°	38°	0.986	Back calculate ϕ_2 to match AMT2
-	AMT33AC	"	"	"	"	"	1.368	With buttress
-	AMT22AC	Circles	"	"	"	"	0.941	No buttress
-	AMT12C	Curve 1	200-200	25°	35°	38°	1.027	Higher groundwater profile
-	AMT12CS	"	"	"	"	"	1.024	25 ft. slices (vs. 50 ft. standard)
-	AMT7E	Bilinear	30-30	24°	24°	38°	0.950	Back analysis, completely dewatered

TABLE E.1 - SUMMARY OF STABILITY ANALYSIS TRIALS (Continued)

Figure Number	Trial Number	Failure Surface	Phreatic Surface	Friction Angles ϕ_1	ϕ_2	ϕ_3	Factor of Safety	Comments
-	AMT52	Bilinear	180-200	32.1	32.1	38°	0.984	No buttress
-	AMT53	"	"	"	"	"	1.550	With buttress
-	AMT54	"	140-160	"	"	"	1.154	No buttress, Dewatered 40 ft.
-	AMT55	"	100-120	"	"	"	1.282	No buttress, Dewatered 80 ft.
-	AMT56	"	30-30	"	"	"	1.343	No buttress, Completely Dewatered
-	AMT62	"	"	0 $c_1 = c_2 = 3900 lb./ft.^2$	0	38	0.984	No buttress, Undrained analysis
-	AMT63	"	"	"	"	"	1.053	With buttress, Undrained analysis
-	AMT72	Curve 1	180-200	32.1	32.1	38°	1.037	No buttress
-	AMT73	"	"	"	"	"	1.517	With buttress
-	AMT75	"	30-30	"	"	"	1.333	No buttress Completely dewatered
-	AMT74	Curve 2	180-200	"	"	"	1.049	No buttress
-	AMT82AC	Curve 1	"	30.8	30.8	"	0.986	Back calculate ϕ_2 to match AMT52
-	AMT83AC	"	"	"	"	"	1.449	With buttress
-	AMT92	"	30-30	0 $c_1 = c_2 = 3900 lb./ft.^2$	0	38	1.078	No buttress Undrained Analysis
-	AMT93	"	"	"	"	"	1.142	With buttress Undrained Analysis

TABLE E.1 - SUMMARY OF STABILITY ANALYSIS (continued)

NOTES:

1. Failure Surface: "Curve 1" and "Curve 2" are identical and parallel to the measured slope displacements, except that Curve 2 has no upward inclination at the toe of the failure.

2. Phreatic Surface: "180-200" refers to the elevation of the upper portion of the phreatic surface; "180" equates to 5480 feet (1670 metres) elevation at the "crest" of the piezometric surface near the slope; "200" equates to 5500 feet (1676 meters) the measured piezometric elevation is piezometer nest B08 distant from the slope.

3. Friction Angles: "ϕ_1" applies to disturbed material at the toe of the slope; "ϕ_2" applies to strata above the toe, parallel to bedding; "ϕ_3" applies to the rock fill buttress.

PROJECT :CRC PIT 51-B-2

ANALYSIS DESCRIPTION :AMT2

FIGURE E.1

JANBU ITERATIVE ANALYSIS

CORRECTION FACTOR: 1.039

FOS CONVERGENCE:

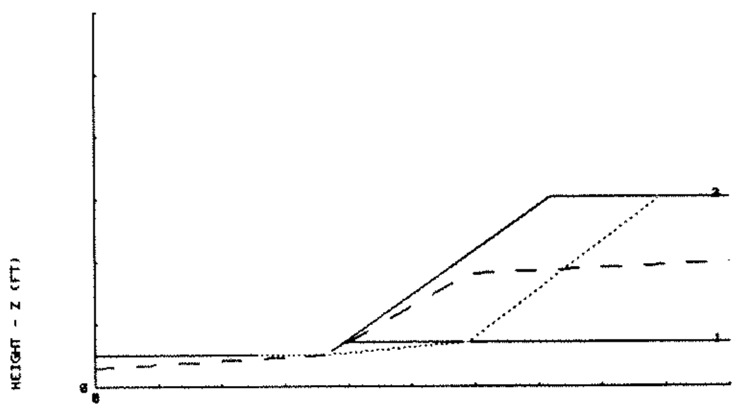
.989
.986

FINAL FOS = .985 RESISTING FORCE= 2957277 DRIVING FORCE= 3117992

PROJECT :CRC PIT 51-B-2

DATA LIST FOR FILE :

SLOPE GEOMETRY



PROJECT :CRC PIT 51-B-2

MATERIAL PROPERTIES

NUMBER OF LAYERS : 3
WATER DENSITY : 62.4 (lbf/ft3)

LAYER # 1 MATERIAL PROPERTIES
DENSITY : 120.0 (lbf/ft3) COHESION : 0.0 (lbf/ft2) PHI : 25.0 (deg)

LAYER # 2 MATERIAL PROPERTIES
DENSITY : 130.0 (lbf/ft3) COHESION : 0.0 (lbf/ft2) PHI : 35.0 (deg)

LAYER # 3 MATERIAL PROPERTIES
DENSITY : 125.0 (lbf/ft3) COHESION : 0.0 (lbf/ft2) PHI : 30.0 (deg)

PROJECT :CRC PIT 51-B-2

LAYER GEOMETRY

LAYER # 1 SURFACE (FT)

X:	0.0	0.0	365.0	390.0	1000.0
Z:	0.0	50.0	50.0	72.0	72.0

LAYER # 2 SURFACE (FT)

X:	0.0	0.0	365.0	720.0	1000.0
Z:	0.0	50.1	50.1	305.0	305.0

LAYER # 3 SURFACE (FT)

X:	0.0	0.0	365.0	720.0	1000.0
Z:	0.0	50.2	50.2	305.1	305.1

PHREATIC SURFACE (FT)

X:	0.0	365.0	590.0	1000.0
Z:	30.0	49.9	180.0	200.0

FAILURE SURFACE (FT)
MAXIMUM SLICE WIDTH (FT): 50.0

X:	255.0	365.0	590.0	800.0	800.1
Z:	50.3	50.3	72.0	300.0	305.2

PROJECT :CRC PIT 51-B-2

ANALYSIS DESCRIPTION :AMT3

FIGURE E.2

JANBU ITERATIVE ANALYSIS

CORRECTION FACTOR: 1.040

FOS CONVERGENCE:

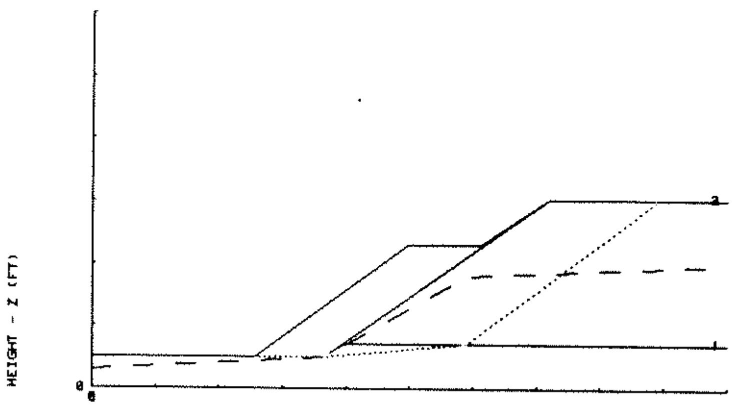
1.338
1.416
1.430
1.432

FINAL FOS = 1.433 RESISTING FORCE= 4605747 DRIVING FORCE= 3342560

PROJECT :CRC PIT 51-B-2

DATA LIST FOR FILE :

SLOPE GEOMETRY



PROJECT :CRC PIT 51-B-2

MATERIAL PROPERTIES

NUMBER OF LAYERS : 3
WATER DENSITY : 62.4 (lbf/ft3)

LAYER # 1 MATERIAL PROPERTIES
DENSITY : 120.0 (lbf/ft3) COHESION : 0.0 (lbf/ft2) PHI : 25.0 (deg)

LAYER # 2 MATERIAL PROPERTIES
DENSITY : 130.0 (lbf/ft3) COHESION : 0.0 (lbf/ft2) PHI : 35.0 (deg)

LAYER # 3 MATERIAL PROPERTIES
DENSITY : 125.0 (lbf/ft3) COHESION : 0.0 (lbf/ft2) PHI : 30.0 (deg)

PROJECT :CRC PIT 51-B-2

LAYER GEOMETRY

LAYER # 1 SURFACE (FT)

X:	0.0	0.0	365.0	390.0	1000.0
Z:	0.0	50.0	50.0	72.0	72.0

LAYER # 2 SURFACE (FT)

X:	0.0	0.0	365.0	720.0	1000.0
Z:	0.0	50.1	50.1	305.0	305.0

LAYER # 3 SURFACE (FT)

X:	0.0	0.0	255.0	497.0	612.0	720.0	1000.0
Z:	0.0	50.2	50.2	230.0	230.0	305.1	305.1

PHREATIC SURFACE (FT)

X:	0.0	365.0	590.0	1000.0
Z:	30.0	49.9	180.0	200.0

FAILURE SURFACE (FT)
MAXIMUM SLICE WIDTH (FT): 50.0

X:	255.0	365.0	590.0	880.0	880.1
Z:	50.3	50.3	72.0	300.0	305.2

PROJECT :CRC PIT 51-B-2

ANALYSIS DESCRIPTION :AMT4

FIGURE E.3

JANBU ITERATIVE ANALYSIS

CORRECTION FACTOR: 1.039

FOS CONVERGENCE:

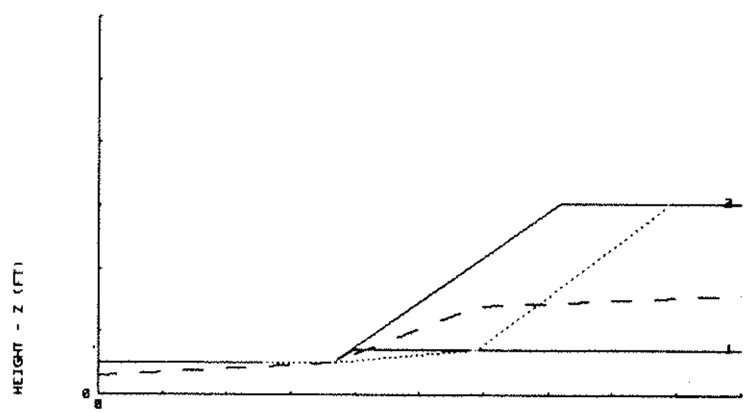
1.103
1.134
1.142
1.144

FINAL FOS = 1.145 RESISTING FORCE= 3434665 DRIVING FORCE= 3117992

PROJECT :CRC PIT 51-B-2

DATA LIST FOR FILE :

SLOPE GEOMETRY



PROJECT :CRC PIT 51-B-2

MATERIAL PROPERTIES

NUMBER OF LAYERS : 3
WATER DENSITY : 62.4 (lbf/ft3)

LAYER # 1 MATERIAL PROPERTIES
DENSITY : 120.0 (lbf/ft3) COHESION : 0.0 (lbf/ft2) PHI : 25.0 (deg)

LAYER # 2 MATERIAL PROPERTIES
DENSITY : 130.0 (lbf/ft3) COHESION : 0.0 (lbf/ft2) PHI : 35.0 (deg)

LAYER # 3 MATERIAL PROPERTIES
DENSITY : 125.0 (lbf/ft3) COHESION : 0.0 (lbf/ft2) PHI : 30.0 (deg)

PROJECT :CRC PIT 51-B-2

LAYER GEOMETRY

LAYER # 1 SURFACE (FT)

X:	0.0	0.0	365.0	390.0	1000.0
Z:	0.0	50.0	50.0	72.0	72.0

LAYER # 2 SURFACE (FT)

X:	0.0	0.0	365.0	720.0	1000.0
Z:	0.0	50.1	50.1	305.0	305.0

LAYER # 3 SURFACE (FT)

X:	0.0	0.0	365.0	720.0	1000.0
Z:	0.0	50.2	50.2	305.1	305.1

PHREATIC SURFACE (FT)

X:	0.0	365.0	590.0	1000.0
Z:	30.0	49.9	140.0	160.0

FAILURE SURFACE (FT)
MAXIMUM SLICE WIDTH (FT): 50.0

X:	255.0	365.0	590.0	880.0	880.1
Z:	50.3	50.3	72.0	300.0	305.2

PROJECT :CRC PIT 51-B-2

ANALYSIS DESCRIPTION :AMT5

FIGURE E.4

JANBU ITERATIVE ANALYSIS

CORRECTION FACTOR: 1.039

FOS CONVERGENCE:

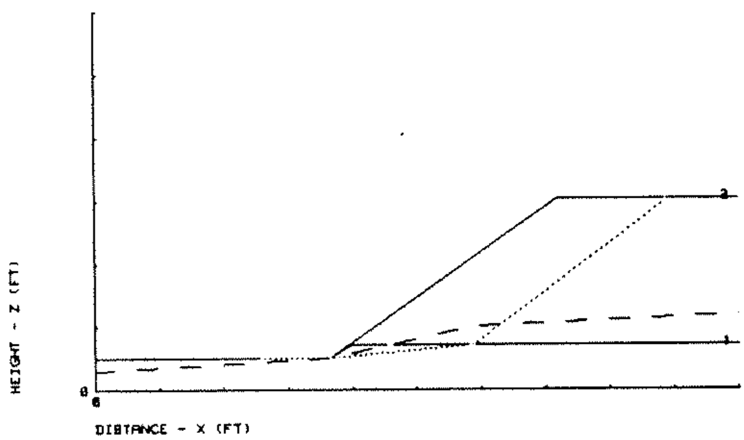
1.106
1.241
1.255
1.258

FINAL FOS = 1.259 RESISTING FORCE= 3778110 DRIVING FORCE= 3117992

PROJECT :CRC PIT 51-B-2

DATA LIST FOR FILE :

SLOPE GEOMETRY



PROJECT :CRC PIT 51-B-2

MATERIAL PROPERTIES

NUMBER OF LAYERS : 3
WATER DENSITY : 62.4 (lbf/ft3)

LAYER # 1 MATERIAL PROPERTIES
DENSITY : 120.0 (lbf/ft3) COHESION : 0.0 (lbf/ft2) PHI : 25.0 (deg)

LAYER # 2 MATERIAL PROPERTIES
DENSITY : 130.0 (lbf/ft3) COHESION : 0.0 (lbf/ft2) PHI : 35.0 (deg)

LAYER # 3 MATERIAL PROPERTIES
DENSITY : 125.0 (lbf/ft3) COHESION : 0.0 (lbf/ft2) PHI : 30.0 (deg)

PROJECT :CRC PIT 51-B-2

LAYER GEOMETRY

LAYER # 1 SURFACE (FT)

X:	0.0	0.0	365.0	398.0	1000.0
Z:	0.0	50.0	50.0	72.0	72.0

LAYER # 2 SURFACE (FT)

X:	0.0	0.0	365.0	720.0	1000.0
Z:	0.0	50.1	50.1	305.0	305.0

LAYER # 3 SURFACE (FT)

X:	0.0	0.0	365.0	720.0	1000.0
Z:	0.0	50.2	50.2	305.1	305.1

PHREATIC SURFACE (FT)

X:	0.0	365.0	590.0	1000.0
Z:	30.0	49.9	100.0	120.0

FAILURE SURFACE (FT)
MAXIMUM SLICE WIDTH (FT): 50.0

X:	255.0	365.0	590.0	800.0	800.1
Z:	50.3	50.3	72.0	300.0	305.2

PROJECT :CRC PIT 51-B-2

ANALYSIS DESCRIPTION :AMT6

FIGURE E.5

JANBU ITERATIVE ANALYSIS

CORRECTION FACTOR: 1.039

FOS CONVERGENCE:

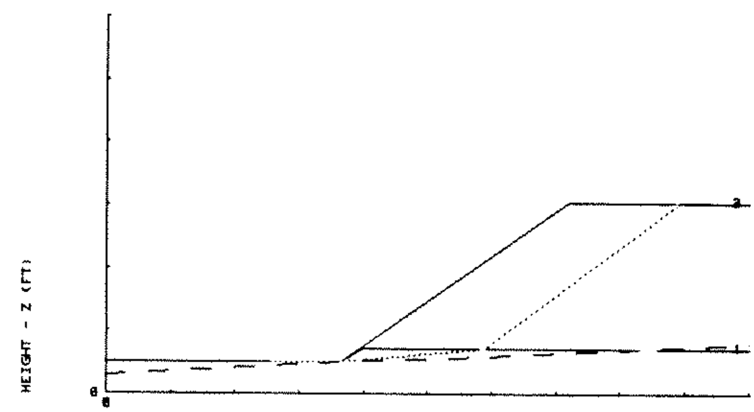
1.223
1.288
1.304
1.307

FINAL FOS = 1.308 RESISTING FORCE= 3925620 DRIVING FORCE= 3117992

PROJECT :CRC PIT 51-B-2

DATA LIST FOR FILE :

SLOPE GEOMETRY



PROJECT :CRC PIT 51-B-2

MATERIAL PROPERTIES

NUMBER OF LAYERS : 3
WATER DENSITY : 62.4 (lbf/ft3)

LAYER # 1 MATERIAL PROPERTIES
DENSITY : 120.0 (lbf/ft3) COHESION : 0.0 (lbf/ft2) PHI : 25.0 (deg)

LAYER # 2 MATERIAL PROPERTIES
DENSITY : 130.0 (lbf/ft3) COHESION : 0.0 (lbf/ft2) PHI : 35.0 (deg)

LAYER # 3 MATERIAL PROPERTIES
DENSITY : 125.0 (lbf/ft3) COHESION : 0.0 (lbf/ft2) PHI : 30.0 (deg)

PROJECT :CRC PIT 51-B-2

LAYER GEOMETRY

LAYER # 1 SURFACE (FT)

X:	0.0	0.0	365.0	390.0	1000.0
Z:	0.0	50.0	50.0	72.0	72.0

LAYER # 2 SURFACE (FT)

X:	0.0	0.0	365.0	720.0	1000.0
Z:	0.0	50.1	50.1	305.0	305.0

LAYER # 3 SURFACE (FT)

X:	0.0	0.0	365.0	720.0	1000.0
Z:	0.0	50.2	50.2	305.1	305.1

PHREATIC SURFACE (FT)

X:	0.0	365.0	590.0	1000.0
Z:	30.0	49.9	60.0	80.0

FAILURE SURFACE (FT)
MAXIMUM SLICE WIDTH (FT): 50.0

X:	255.0	365.0	590.0	880.0	880.1
Z:	50.3	50.3	72.0	300.0	305.2

PROJECT :CRC PIT 51-B-2

ANALYSIS DESCRIPTION :AMT43

FIGURE E.8

JANBU ITERATIVE ANALYSIS

CORRECTION FACTOR: 1.040

FOS CONVERGENCE:

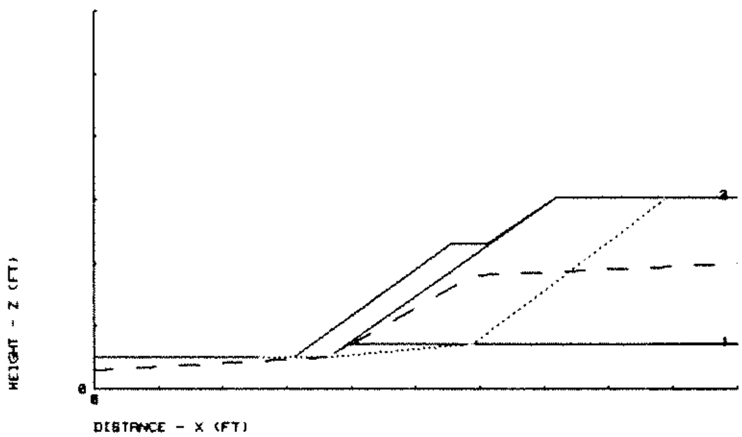
1.154
1.194
1.203
1.205

FINAL FOS = 1.206 RESISTING FORCE= 3782268 DRIVING FORCE= 3261116

PROJECT :CRC PIT 51-B-2

DATA LIST FOR FILE :

SLOPE GEOMETRY



PROJECT :CRC PIT 51-B-2

MATERIAL PROPERTIES

NUMBER OF LAYERS : 3
WATER DENSITY : 62.4 (lbf/ft3)

LAYER # 1 MATERIAL PROPERTIES
DENSITY : 120.0 (lbf/ft3) COHESION : 0.0 (lbf/ft2) PHI : 25.0 (deg)

LAYER # 2 MATERIAL PROPERTIES
DENSITY : 130.0 (lbf/ft3) COHESION : 0.0 (lbf/ft2) PHI : 35.0 (deg)

LAYER # 3 MATERIAL PROPERTIES
DENSITY : 125.0 (lbf/ft3) COHESION : 0.0 (lbf/ft2) PHI : 30.0 (deg)

PROJECT :CRC PIT 51-B-2

LAYER GEOMETRY

LAYER # 1 SURFACE (FT)

X:	0.0	0.0	365.0	390.0	1000.0
Z:	0.0	50.0	50.0	72.0	72.0

LAYER # 2 SURFACE (FT)

X:	0.0	0.0	365.0	720.0	1000.0
Z:	0.0	50.1	50.1	305.0	305.0

LAYER # 3 SURFACE (FT)

X:	0.0	0.0	310.0	555.0	612.0	720.0	1000.0
Z:	0.0	50.2	50.2	230.0	230.0	305.1	305.1

PHREATIC SURFACE (FT)

X:	0.0	365.0	590.0	1000.0
Z:	30.0	49.9	180.0	200.0

FAILURE SURFACE (FT)
MAXIMUM SLICE WIDTH (FT): 50.0

X:	255.0	365.0	590.0	800.0	800.1
Z:	50.3	50.3	72.0	300.0	305.2

PROJECT :CRC PIT 51-B-2

ANALYSIS DESCRIPTION :AMT44

FIGURE E.7

JANBU ITERATIVE ANALYSIS

CORRECTION FACTOR: 1.039

FOS CONVERGENCE:

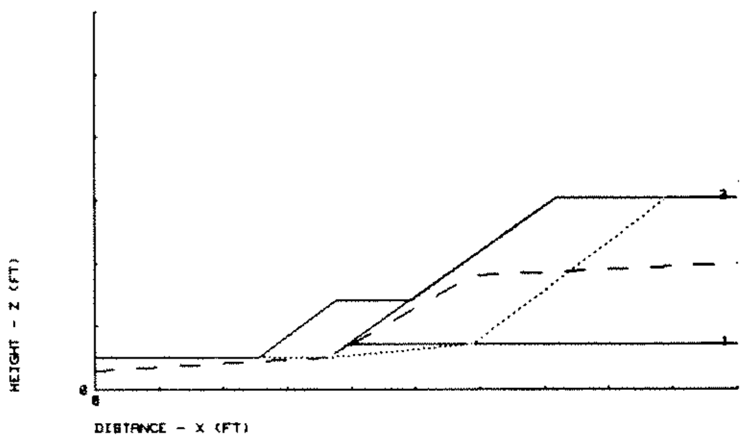
1.204
1.256
1.267
1.269

FINAL FOS = 1.269 RESISTING FORCE= 3892985 DRIVING FORCE= 3105623

PROJECT :CRC PIT 51-B-2

DATA LIST FOR FILE :

SLOPE GEOMETRY



PROJECT :CRC PIT 51-B-2

MATERIAL PROPERTIES

NUMBER OF LAYERS : 3
WATER DENSITY : 62.4 (lbf/ft3)

LAYER # 1 MATERIAL PROPERTIES
DENSITY : 120.0 (lbf/ft3) COHESION : 0.0 (lbf/ft2) PHI : 25.0 (deg)

LAYER # 2 MATERIAL PROPERTIES
DENSITY : 130.0 (lbf/ft3) COHESION : 0.0 (lbf/ft2) PHI : 35.0 (deg)

LAYER # 3 MATERIAL PROPERTIES
DENSITY : 125.0 (lbf/ft3) COHESION : 0.0 (lbf/ft2) PHI : 30.0 (deg)

PROJECT :CRC PIT 51-B-2

LAYER GEOMETRY

LAYER # 1 SURFACE (FT)

X:	0.0	0.0	365.0	390.0	1000.0
Z:	0.0	50.0	50.0	72.0	72.0

LAYER # 2 SURFACE (FT)

X:	0.0	0.0	365.0	720.0	1000.0
Z:	0.0	50.1	50.1	305.0	305.0

LAYER # 3 SURFACE (FT)

X:	0.0	0.0	255.0	376.0	492.0	720.0	1000.0
Z:	0.0	50.2	50.2	140.0	140.0	305.1	305.1

PHREATIC SURFACE (FT)

X:	0.0	365.0	590.0	1000.0
Z:	30.0	49.9	180.0	200.0

FAILURE SURFACE (FT)
MAXIMUM SLICE WIDTH (FT): 50.0

X:	255.0	365.0	590.0	880.0	880.1
Z:	50.3	50.3	72.0	300.0	305.2

PROJECT :CRC PIT 51-B-2

ANALYSIS DESCRIPTION :AMT12

FIGURE E.8

JANBU ITERATIVE ANALYSIS

CORRECTION FACTOR: 1.031

FOS CONVERGENCE:

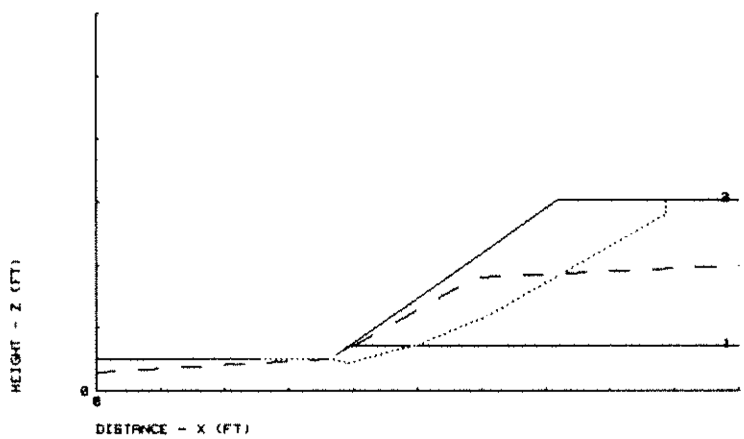
1.089
1.113
1.119
1.121

FINAL FOS = 1.121 RESISTING FORCE= 2820307 DRIVING FORCE= 2593293

PROJECT :CRC PIT 51-B-2

DATA LIST FOR FILE :

SLOPE GEOMETRY



PROJECT :CRC PIT 51-B-2

MATERIAL PROPERTIES

NUMBER OF LAYERS : 3
WATER DENSITY : 62.4 (lbf/ft3)

LAYER # 1 MATERIAL PROPERTIES
DENSITY : 120.0 (lbf/ft3) COHESION : 0.0 (lbf/ft2) PHI : 25.0 (deg)

LAYER # 2 MATERIAL PROPERTIES
DENSITY : 130.0 (lbf/ft3) COHESION : 0.0 (lbf/ft2) PHI : 35.0 (deg)

LAYER # 3 MATERIAL PROPERTIES
DENSITY : 125.0 (lbf/ft3) COHESION : 0.0 (lbf/ft2) PHI : 30.0 (deg)

PROJECT :CRC PIT 51-B-2

LAYER GEOMETRY

LAYER # 1 SURFACE (FT)

X:	0.0	0.0	365.0	390.0	1000.0
Z:	0.0	50.0	50.0	72.0	72.0

LAYER # 2 SURFACE (FT)

X:	0.0	0.0	365.0	720.0	1000.0
Z:	0.0	50.1	50.1	305.0	305.0

LAYER # 3 SURFACE (FT)

X:	0.0	0.0	365.0	720.0	1000.0
Z:	0.0	50.2	50.2	305.1	305.1

PHREATIC SURFACE (FT)

X:	0.0	365.0	590.0	1000.0
Z:	30.0	49.9	100.0	200.0

FAILURE SURFACE (FT)
MAXIMUM SLICE WIDTH (FT): 50.0

X:	255.0	365.0	393.0	501.0	610.0	800.0	800.1
Z:	50.3	50.3	44.0	73.0	120.0	282.0	305.2

PROJECT :CRC PIT 51-B-2

ANALYSIS DESCRIPTION :AMT13

FIGURE E.9

JANBU ITERATIVE ANALYSIS

CORRECTION FACTOR: 1.031

FOS CONVERGENCE:

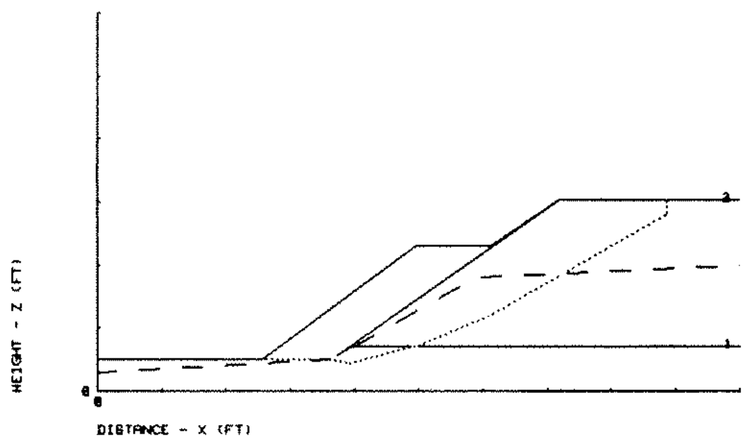
1.399
1.486
1.500
1.503

FINAL FOS = 1.503 RESISTING FORCE= 4511174 DRIVING FORCE= 3093048

PROJECT :CRC PIT 51-B-2

DATA LIST FOR FILE :

SLOPE GEOMETRY



PROJECT :CRC PIT 51-B-2

MATERIAL PROPERTIES

NUMBER OF LAYERS : 3
WATER DENSITY : 62.4 (lbf/ft3)

LAYER # 1 MATERIAL PROPERTIES
DENSITY : 120.0 (lbf/ft3) COHESION : 0.0 (lbf/ft2) PHI : 25.0 (deg)

LAYER # 2 MATERIAL PROPERTIES
DENSITY : 130.0 (lbf/ft3) COHESION : 0.0 (lbf/ft2) PHI : 35.0 (deg)

LAYER # 3 MATERIAL PROPERTIES
DENSITY : 125.0 (lbf/ft3) COHESION : 0.0 (lbf/ft2) PHI : 30.0 (deg)

PROJECT :CRC PIT 51-B-2

LAYER GEOMETRY

LAYER # 1 SURFACE (FT)

X:	0.0	0.0	365.0	390.0	1000.0
Z:	0.0	50.0	50.0	72.0	72.0

LAYER # 2 SURFACE (FT)

X:	0.0	0.0	365.0	720.0	1000.0
Z:	0.0	50.1	50.1	305.0	305.0

LAYER # 3 SURFACE (FT)

X:	0.0	0.0	255.0	497.0	612.0	720.0	1000.0
Z:	0.0	50.2	50.2	230.0	230.0	305.1	305.1

PHREATIC SURFACE (FT)

X:	0.0	365.0	590.0	1000.0
Z:	30.0	49.9	180.0	200.0

FAILURE SURFACE (FT)
MAXIMUM SLICE WIDTH (FT): 50.0

X:	255.0	365.0	393.0	501.0	610.0	888.0	888.1
Z:	50.3	50.3	44.0	73.0	120.0	282.0	305.2

PROJECT :CRC PIT 51-B-2

ANALYSIS DESCRIPTION :AMT15

FIGURE E.10

JANBU ITERATIVE ANALYSIS

CORRECTION FACTOR: 1.031

FOS CONVERGENCE:

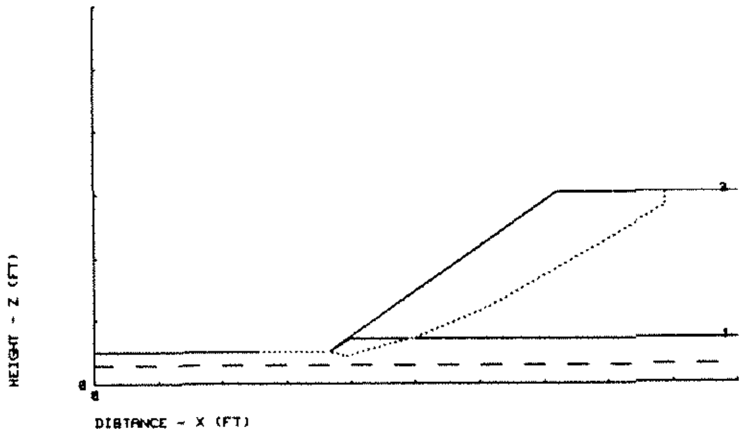
1.306
1.389
1.407
1.410

FINAL FOS = 1.411 RESISTING FORCE= 3550634 DRIVING FORCE= 2593293

PROJECT :CRC PIT 51-B-2

DATA LIST FOR FILE :

SLOPE GEOMETRY



PROJECT :CRC PIT 51-B-2

MATERIAL PROPERTIES

NUMBER OF LAYERS : 3
WATER DENSITY : 62.4 (lbf/ft3)

LAYER # 1 MATERIAL PROPERTIES
DENSITY : 120.0 (lbf/ft3) COHESION : 0.0 (lbf/ft2) PHI : 25.0 (deg)

LAYER # 2 MATERIAL PROPERTIES
DENSITY : 130.0 (lbf/ft3) COHESION : 0.0 (lbf/ft2) PHI : 35.0 (deg)

LAYER # 3 MATERIAL PROPERTIES
DENSITY : 125.0 (lbf/ft3) COHESION : 0.0 (lbf/ft2) PHI : 30.0 (deg)

PROJECT :CRC PIT 51-B-2

LAYER GEOMETRY

LAYER # 1 SURFACE (FT)

X:	0.0	0.0	365.0	398.0	1000.0
Z:	0.0	50.0	50.0	72.0	72.0

LAYER # 2 SURFACE (FT)

X:	0.0	0.0	365.0	720.0	1000.0
Z:	0.0	50.1	50.1	305.0	305.0

LAYER # 3 SURFACE (FT)

X:	0.0	0.0	365.0	720.0	1000.0
Z:	0.0	50.2	50.2	305.1	305.1

PHREATIC SURFACE (FT)

X:	-.7	1006.7
Z:	30.6	30.6

FAILURE SURFACE (FT)
MAXIMUM SLICE WIDTH (FT): 50.0

X:	255.0	365.0	393.0	501.0	610.0	888.0	888.1
Z:	50.3	50.3	44.0	73.0	120.0	202.0	305.2

PROJECT :CRC PIT 51-B-2

ANALYSIS DESCRIPTION :AMT14

FIGURE E.11

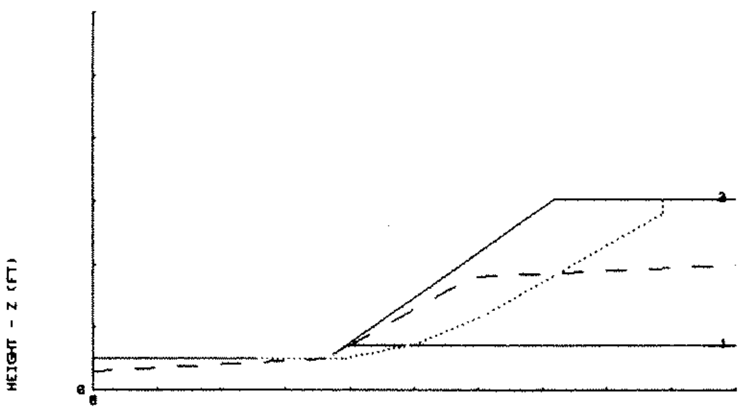
JANBU ITERATIVE ANALYSIS

```
   CORRECTION FACTOR:  1.031

   FOS CONVERGENCE:

                 1.101
                 1.129
                 1.135
                 1.137

   FINAL FOS =   1.137  RESISTING FORCE=   2817959  DRIVING FORCE=   2553433
```

PROJECT :CRC PIT 51-B-2

DATA LIST FOR FILE :

SLOPE GEOMETRY



PROJECT :CRC PIT 51-B-2

MATERIAL PROPERTIES

```
NUMBER OF LAYERS :  3
WATER DENSITY :  62.4 (lbf/ft3)

LAYER #  1 MATERIAL PROPERTIES
  DENSITY :  120.0 (lbf/ft3)   COHESION :     0.0 (lbf/ft2)   PHI : 25.0 (deg)

LAYER #  2 MATERIAL PROPERTIES
  DENSITY :  130.0 (lbf/ft3)   COHESION :     0.0 (lbf/ft2)   PHI : 35.0 (deg)

LAYER #  3 MATERIAL PROPERTIES
  DENSITY :  125.0 (lbf/ft3)   COHESION :     0.0 (lbf/ft2)   PHI : 30.0 (deg)
```

PROJECT :CRC PIT 51-B-2

LAYER GEOMETRY

```
LAYER #  1 SURFACE (FT)
  X:       0.0     0.0   365.0   390.0  1000.0
  Z:       0.0    50.0    50.0    72.0    72.0

LAYER #  2 SURFACE (FT)
  X:       0.0     0.0   365.0   720.0  1000.0
  Z:       0.0    50.1    50.1   305.0   305.0

LAYER #  3 SURFACE (FT)
  X:       0.0     0.0   365.0   720.0  1000.0
  Z:       0.0    50.2    50.2   305.1   305.1

PHREATIC SURFACE (FT)
  X:       0.0   365.0   590.0  1000.0
  Z:      30.0    49.9   180.0   200.0

FAILURE SURFACE (FT)
  MAXIMUM SLICE WIDTH (FT):  50.0
  X:     255.0   365.0   393.0   501.0   610.0   888.0   888.1
  Z:      50.3    50.3    50.3    73.0   120.0   282.0   305.2
```

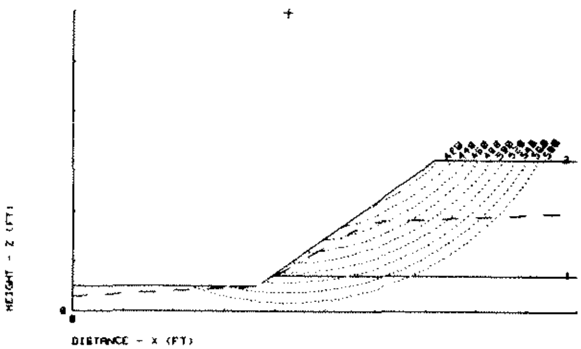
PROJECT :CRC PIT 51-B-2

ANALYSIS DESCRIPTION :AMT22

FIGURE E.12

JANBU ITERATIVE ANALYSIS

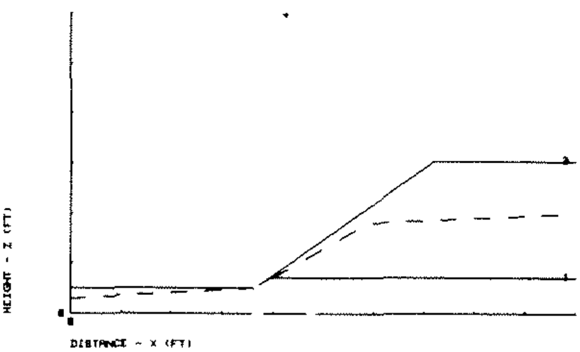
CENTER(424.0, 597.1)		FOS	CORRECTION FACTOR	RESISTING FORCE	DRIVING FORCE
RADIUS	420	1.025	1.017	119641	118749
RADIUS	440	1.156	1.024	530401	469760
RADIUS	460	1.226	1.028	1080529	905727
RADIUS	480	1.212	1.031	1652371	1405523
RADIUS	500	1.191	1.034	2254671	1957321
RADIUS	520	1.176	1.036	2907952	2561172
RADIUS	540	1.084	1.039	3348444	3206620
RADIUS	560	1.016	1.041	3796162	3890896
RADIUS	580	.993	1.044	4351545	4574331



PROJECT :CRC PIT 51-B-2

DATA LIST FOR FILE :

SLOPE GEOMETRY



PROJECT :CRC PIT 51-B-2

MATERIAL PROPERTIES

NUMBER OF LAYERS : 3
WATER DENSITY : 62.4 (lbf/ft3)

LAYER # 1 MATERIAL PROPERTIES
DENSITY : 120.0 (lbf/ft3) COHESION : 0.0 (lbf/ft2) PHI : 25.0 (deg)

LAYER # 2 MATERIAL PROPERTIES
DENSITY : 130.0 (lbf/ft3) COHESION : 0.0 (lbf/ft2) PHI : 35.0 (deg)

LAYER # 3 MATERIAL PROPERTIES
DENSITY : 125.0 (lbf/ft3) COHESION : 0.0 (lbf/ft2) PHI : 38.0 (deg)

PROJECT :CRC PIT 51-B-2

LAYER GEOMETRY

LAYER # 1 SURFACE (FT)

X:	0.0	0.0	365.0	390.0	1000.0
Z:	0.0	50.0	50.0	72.0	72.0

LAYER # 2 SURFACE (FT)

X:	0.0	0.0	365.0	720.0	1000.0
Z:	0.0	50.1	50.1	305.0	305.0

LAYER # 3 SURFACE (FT)

X:	0.0	0.0	365.0	720.0	1000.0
Z:	0.0	50.2	50.2	305.1	305.1

PHREATIC SURFACE (FT)

X:	0.0	365.0	590.0	1000.0
Z:	30.0	49.9	100.0	200.0

CIRCLE CENTER POINTS (FT)
MAXIMUM SLICE WIDTH (FT): 50.0 RADIUS INCREMENT (FT): 20.0
X: 424.0
Z: 597.1

April 19, 1985

University of Alberta
Department of Civil Engineering
Edmonton, Alberta
T6G 2G7

Attention: Dr. N.R. Morgenstern, P.Eng.

Dear Dr. Morgenstern:

Subject: M.Eng. Project - Final Report

Enclosed are two final copies of my M.Eng. Project entitled "Case History of an Open Pit Coal Mine Slope Failure at Luscar, Alberta". I understand that the deadline for receipt of these reports by the Faculty of Graduate Studies is April 24, 1985.

I will forward three additional copies for Dr. Cruden, yourself and the Civil Engineering Department within a few days. Thank you very much for your guidance and encouragement in the completion of this project.

Yours truly,

Allan M. MacRae, P.Eng.
c/o Canadian Occidental
Petroleum Ltd.
1500, 635 8th Avenue S.W.
Calgary, Alberta
T2P 3Z1
Telephone: 234-6097

AMMcR/slc

Encl.

cc: Mr. Fred Munn, P.Eng.
Chief Engineer
Cardinal River Coals Ltd.
Hinton, Alberta