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Long Term Settlement Study At Bridge Approaches (North Maxwell).

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**7. AUTHOR(S)**
Yee, W.S.

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The study was conducted in cooperation with the U.S. Department of Transportation, Federal Highway Administration.

**16. ABSTRACT**
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**17. KEYWORDS**
Lime treated soil, differential settlement, bridge approaches, clays embankment foundation, embankment material, soil stabilization

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**LONG TERM SETTLEMENT STUDY AT BRIDGE APPROACHES**

FINAL REPORT # FHWA/CA/TL-74/28

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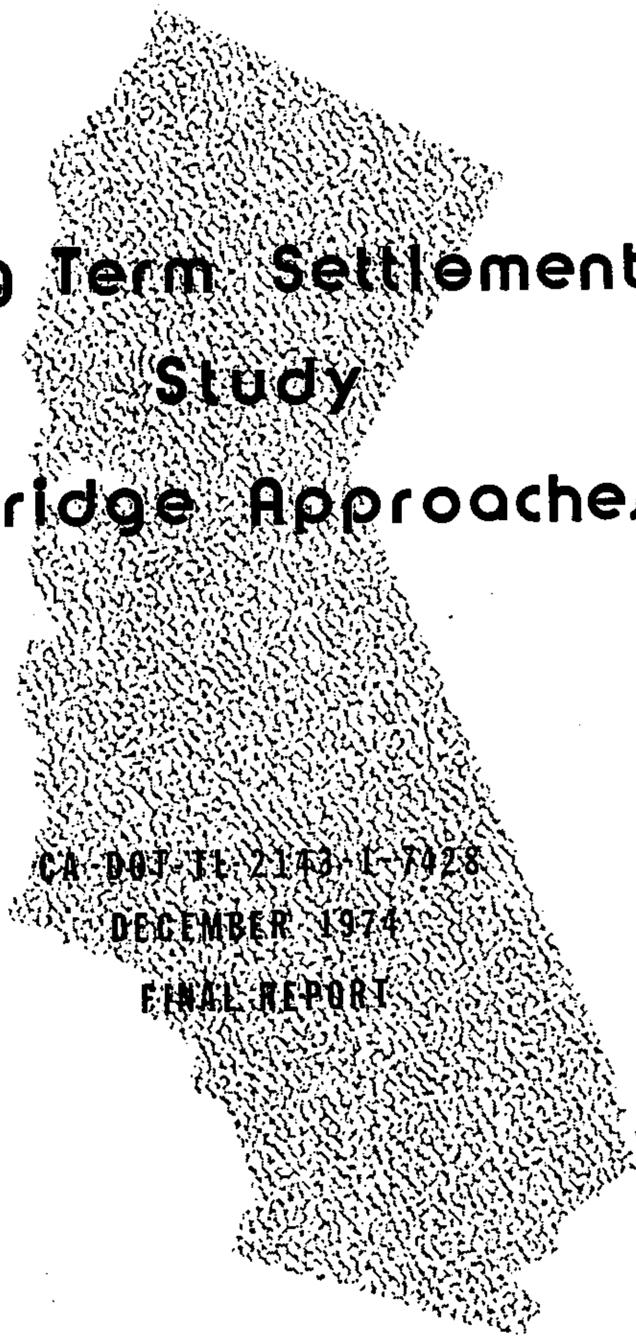
74-28

DIVISION OF CONSTRUCTION AND RESEARCH
TRANSPORTATION LABORATORY
RESEARCH REPORT



# Long Term Settlement Study At Bridge Approaches

CA-DOT-TL-2143-1-7428
DECEMBER 1974
FINAL REPORT

Prepared in Cooperation with the U.S. Department of Transportation, Federal Highway Administration

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STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION
DIVISION OF CONSTRUCTION AND RESEARCH
TRANSPORTATION LABORATORY

December 1974
FHWA D-4-35
TL 632400-A

Mr. R. J. Datel
Chief Engineer

Dear Sir:

I have approved and now submit for your information this final research project report titled:

LONG TERM SETTLEMENT STUDY
AT
BRIDGE APPROACHES (NORTH MAXWELL)

Study made by . . . . . . . . . . . . . . . Geotechnical Branch

Under the Supervision of . . . . . . . . . R. A. Forsyth, P.E.

Principal Investigator . . . . . . . . . . A. D. Hirsch, P.E.

Co-Investigator . . . . . . . . . . . . . W. F. Kleiman

Report Prepared by . . . . . . . . . . . W. S. Yee, P.E.

Very truly yours,

JOHN L. BEATON
Chief Engineer, Transportation Laboratory

Attachment

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## ACKNOWLEDGMENTS

Research work described in this report was sponsored and financed in part by the United States Department of Transportation, Federal Highway Administration.

The contents of this report reflect the views of the Transportation Laboratory which is responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the State of California or the Federal Highway Administration. This report does not constitute a standard, specification or regulation.

Instrumentation and data collection in this study were performed by the Foundation Section. Appreciation is extended to Ben Zeiler for his field assistance on this project.

## Introduction

This project was undertaken to evaluate the use of lime treatment as a means to reduce differential settlement which frequently occurs between bridges and their approach embankments. The study compares the compressional characteristics of lime-treated vs untreated approach embankments consisting of silty clay. The experimental and control sections consisted of a twin bridge site on Interstate 5 north of Maxwell, California. A location map is shown on Figure 1. The approaches were constructed with gradients of about 6-1/2% and reach a maximum height of 35 feet at the bridge abutments. Transition slabs of unreinforced concrete were poured at both ends of the twin bridges. A longitudinal distance of 100 feet from each end of the abutments for the right bridge approaches was lime treated. Figure 2 shows the areas subject to treatment.

## Subsoil Conditions

Logs of test borings reveal that the north end of the embankment subsoil consisted of soft to very stiff brown silty clay, and soft to stiff brown silty clay at the south end (see Figures 3a, 3b, 3c and 3d). The unit weights, moisture contents, and unconfined compressive strength, are also shown on these figures. The unit weight of the subsoil at 5 feet below ground elevation was approximately 128 $lb/ft^3$ and the moisture content was 21% for both the north and south embankments. Groundwater was encountered during the subsurface exploration at elevation +78 or about 2.5 feet below ground surface. Unconfined compressive strengths varied from 0.4 tsf to 2.5 tsf. R-values (Test Method No. Calif. 301) on the untreated material ranged from 5 to 10. The addition of 2% lime by dry weight increased the R-value range of the untreated soil from 40 to 54. The addition of 5% lime increased the R-values to 60 or higher.

## Fill Materials

The approach embankments were constructed with imported borrow from the Demmer and Sutton Farm sites. The average soil properties are shown on Table I.

TABLE I - AVERAGE PROPERTIES OF FILL SOIL

| Approaches | Unit Wt. lb/ft$^3$ | Moisture Content % | Grain Size Analysis Gr | Sd | Si | Cl | LL | PI |
|---|---|---|---|---|---|---|---|---|
| South | 124 | 20 | 0 | 25 | 35 | 40 | 45 | 24 |
| North | 122 | 21 | 0 | 12 | 34 | 54 | 46 | 25 |
| (South) | 131 | 18 | 0 | 21 | 34 | 45 | 39 | 21 |
| (North) | 122 | 22 | 0 | 16 | 29 | 55 | 42 | 25 |

( ) UNTREATED SOIL

## Construction Phase

The construction of the approach fills began May 12, 1970, and was completed October 8, 1970. The commercial dry hydrated lime was obtained from Flintkote in Richmond, California, and was mixed at the Demmer and Sutton sites. Extensive controls were maintained to ensure uniformity of the mixing operation. Lime was added at a rate of 2% of the dry weight of the soil.

The approach embankments were constructed approximately 5 feet beyond the bridge abutment walls. Preliminary laboratory studies indicated that settlement of the foundation soils would be completed during construction without a surcharge requirement. This was substantiated by actual settlement data of the foundation soil. A 90-day settlement period was specified which was followed by excavation for the abutment foundation.

A relative compaction of 90% was required for the embankment, except for that portion 2.5 feet below the roadbed surface for which 95% was specified. The specified loose thickness of each layer of embankment material placed prior to compaction was a maximum of 8 inches. The area excavated for the construction of the abutment walls were backfilled with aggregate subbase material and compacted to 95% by plate compactors. The untreated and lime-treated fills were compacted by 15-ton segmented rollers.

The structural section consisted of 0.75-feet PCC pavement, 0.45-feet of cement treated base, and 0.50-feet of lime treated (5%) fill material. Figure 4 shows the typical section of the pavement for both bridge approach embankments.

## Settlement Records

Vented fluid type settlement platforms were installed near ground elevation to record settlement of the subsoil. After completion of the embankments, March 8, 1972, surface hubs were installed and routinely read to monitor the compression within the embankment. The last readings taken of the surface hubs in April, 1974, reveal the following: (1) for the control bridge approaches the maximum settlement reading occurred about 25 feet from the bridge paving notch and was 0.04 feet, (2) for the experimental bridge approaches the maximum settlement occurred about 7 feet from the paving notch and was 0.05 feet.

Settlement platform readings are shown on Figures 4a, 4b, 4c and 4d. Settlement from hub readings are shown on Figures 5a and 5b. The longitudinal distributions of settlement on the approaches to the bridge are shown on Figures 6a, 6b, and 6c.

## Conclusion

Due to the minor embankment compressions actually measured (0.04' for the control section vs 0.05' for the experimental section) and the lack of any significant difference between the two measurements, there is no evidence from this study for the potential benefit of embankment stabilization with lime for minimizing differential settlement for this test site. On the other hand, the possibility still exists for beneficial results of lime usage for minimizing differential settlement should the embankment soil exhibit high compressibility characteristics on some future project.

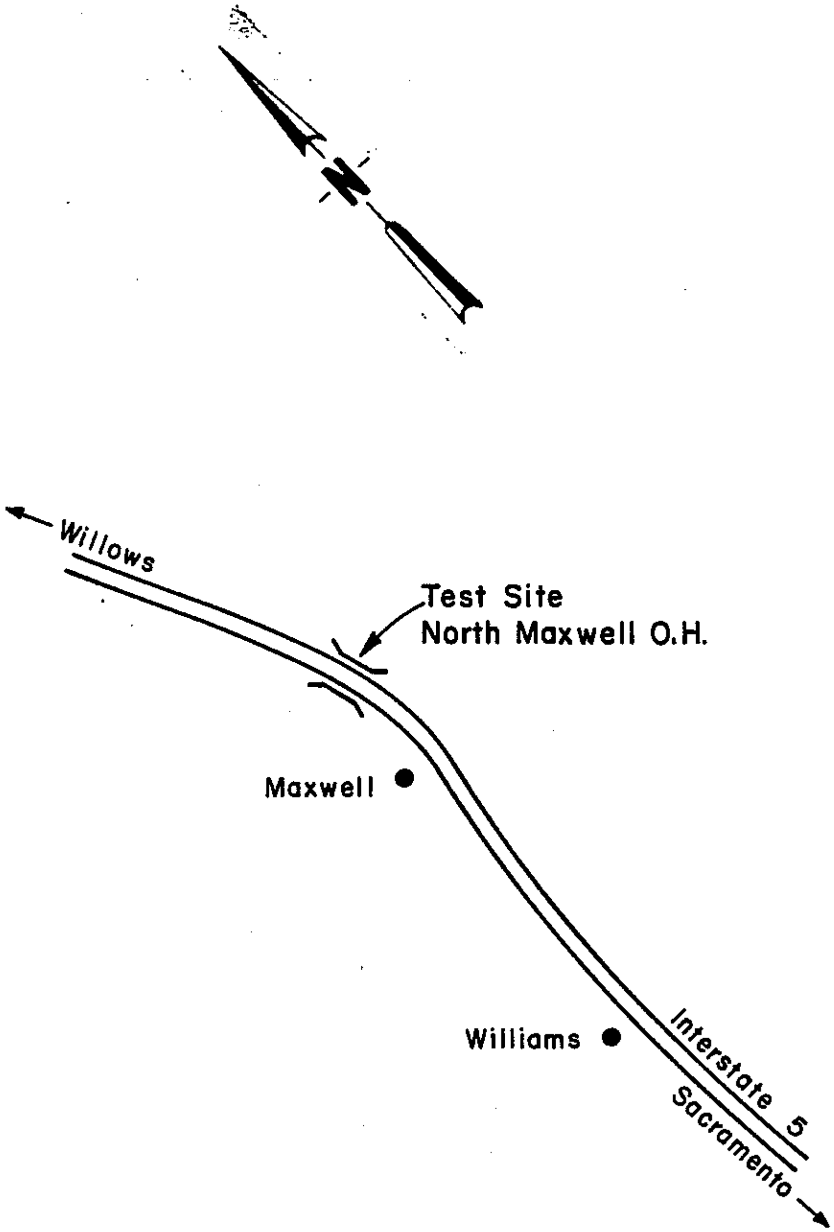


FIG. 1 TEST SITE LOCATION

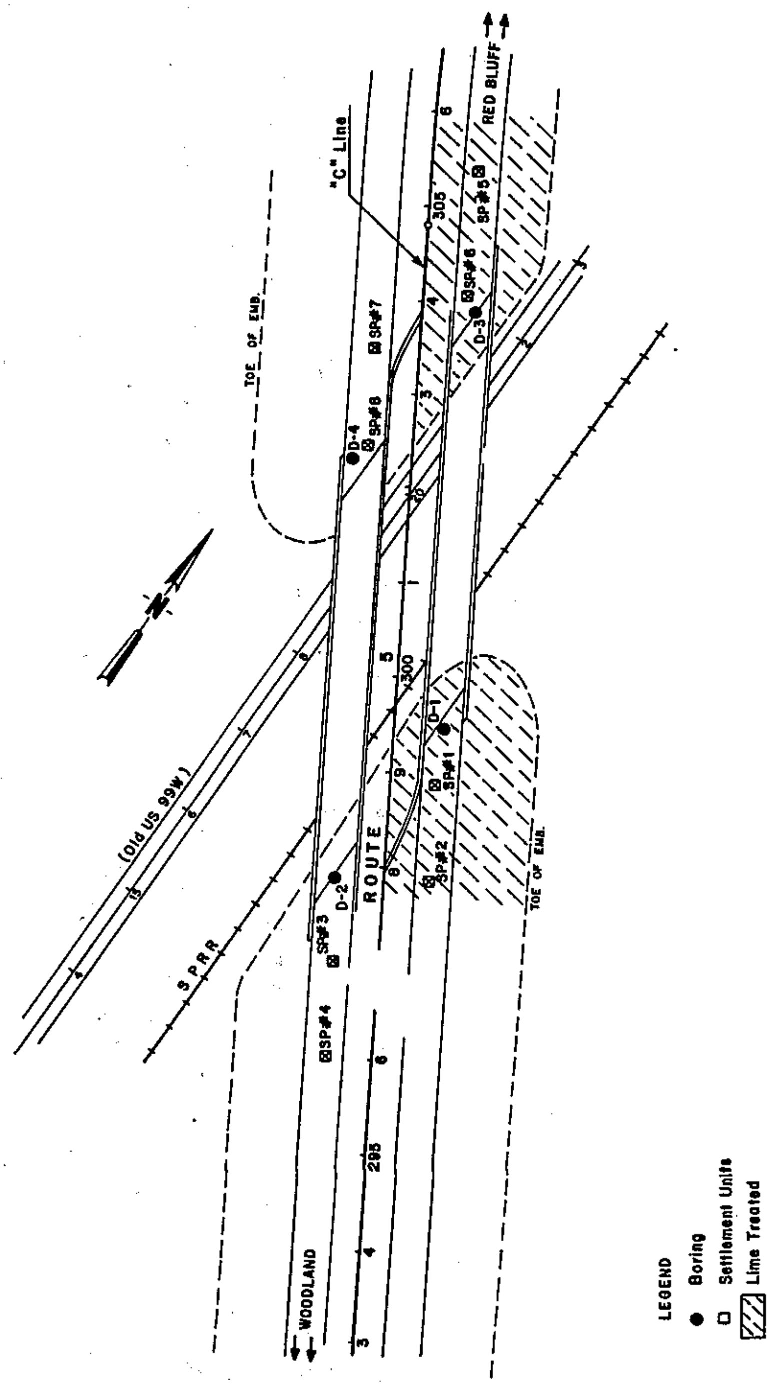


FIG. 2 SITE PLAN

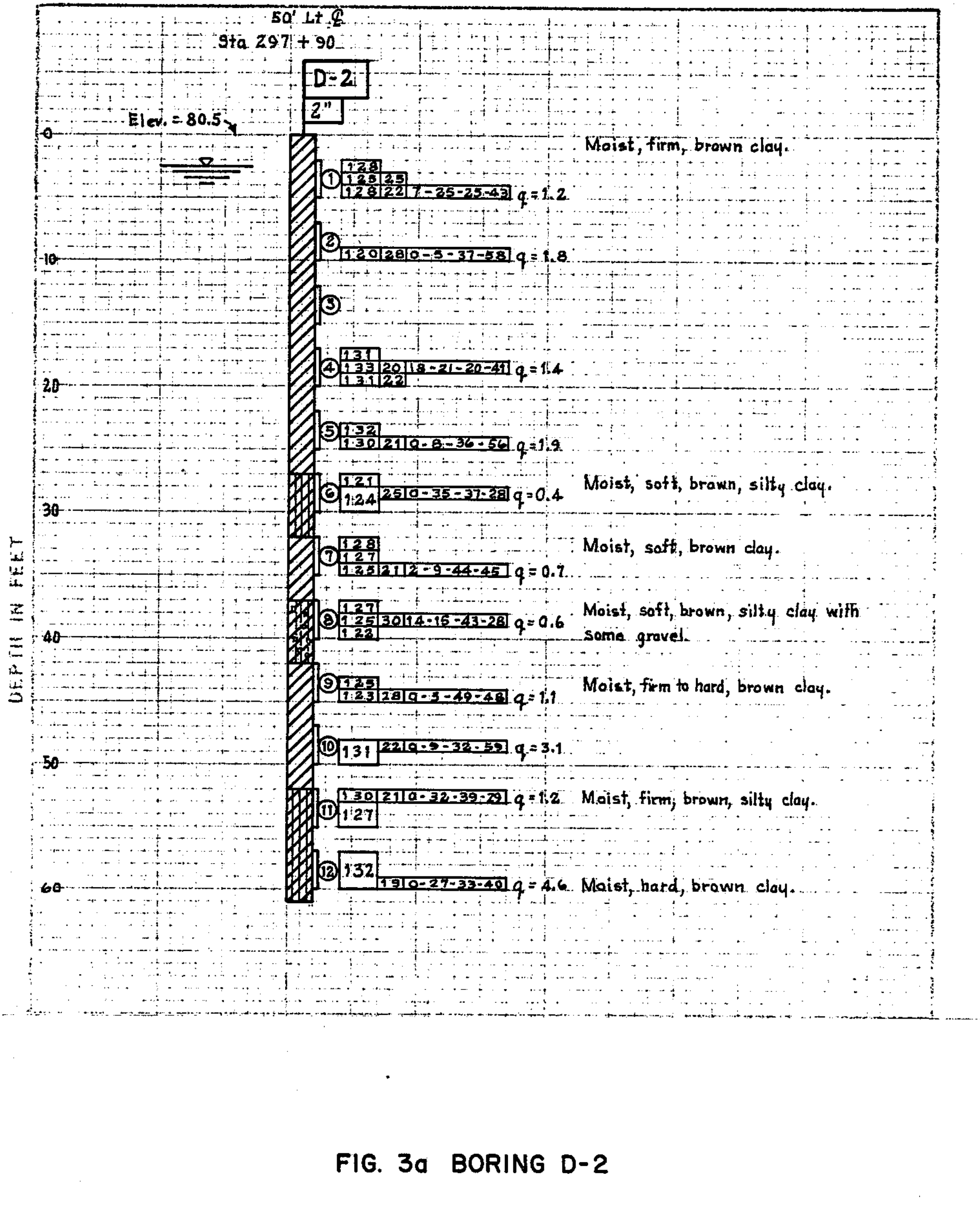


FIG. 3a BORING D-2

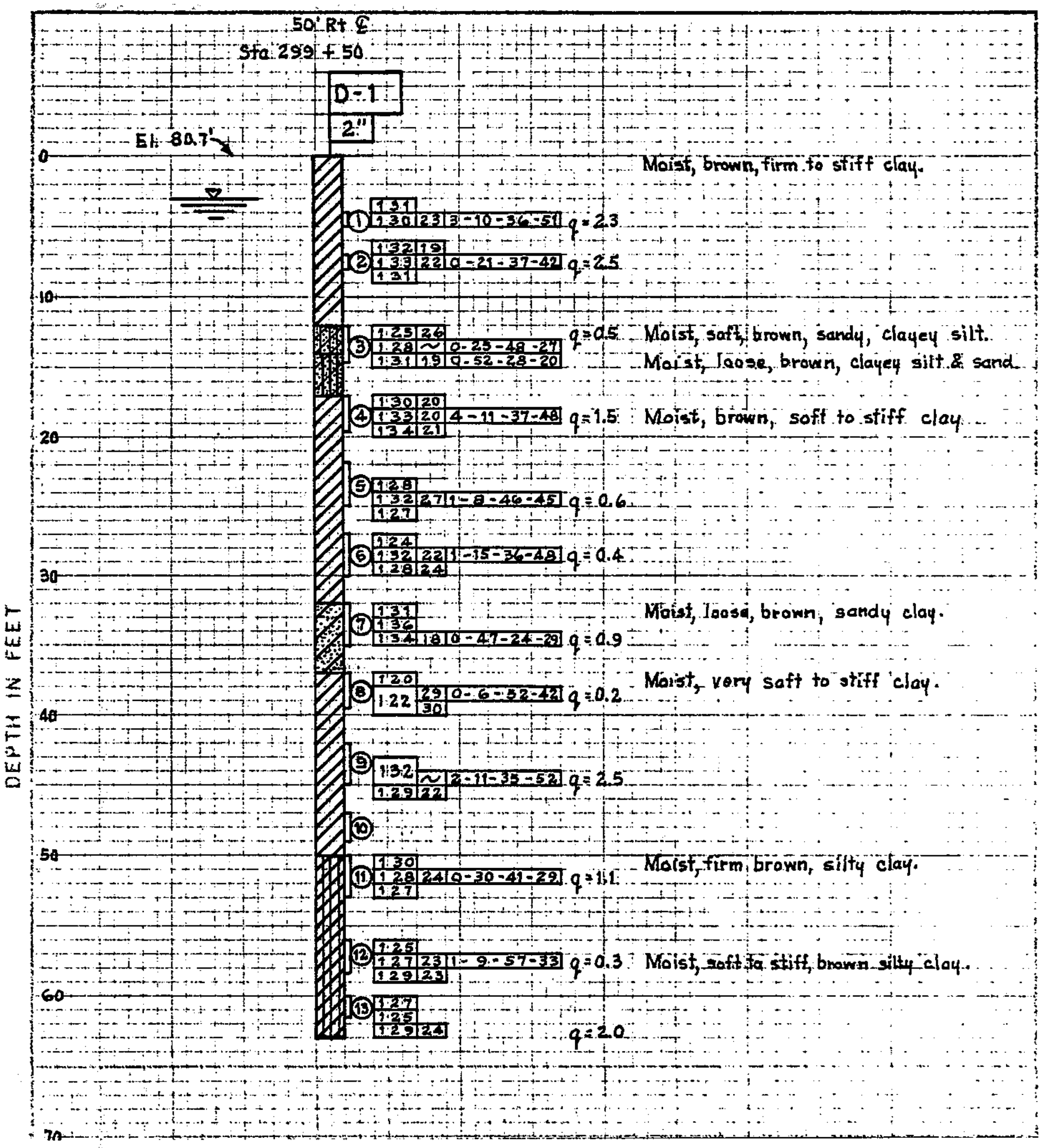


FIG. 3b BORING D-1

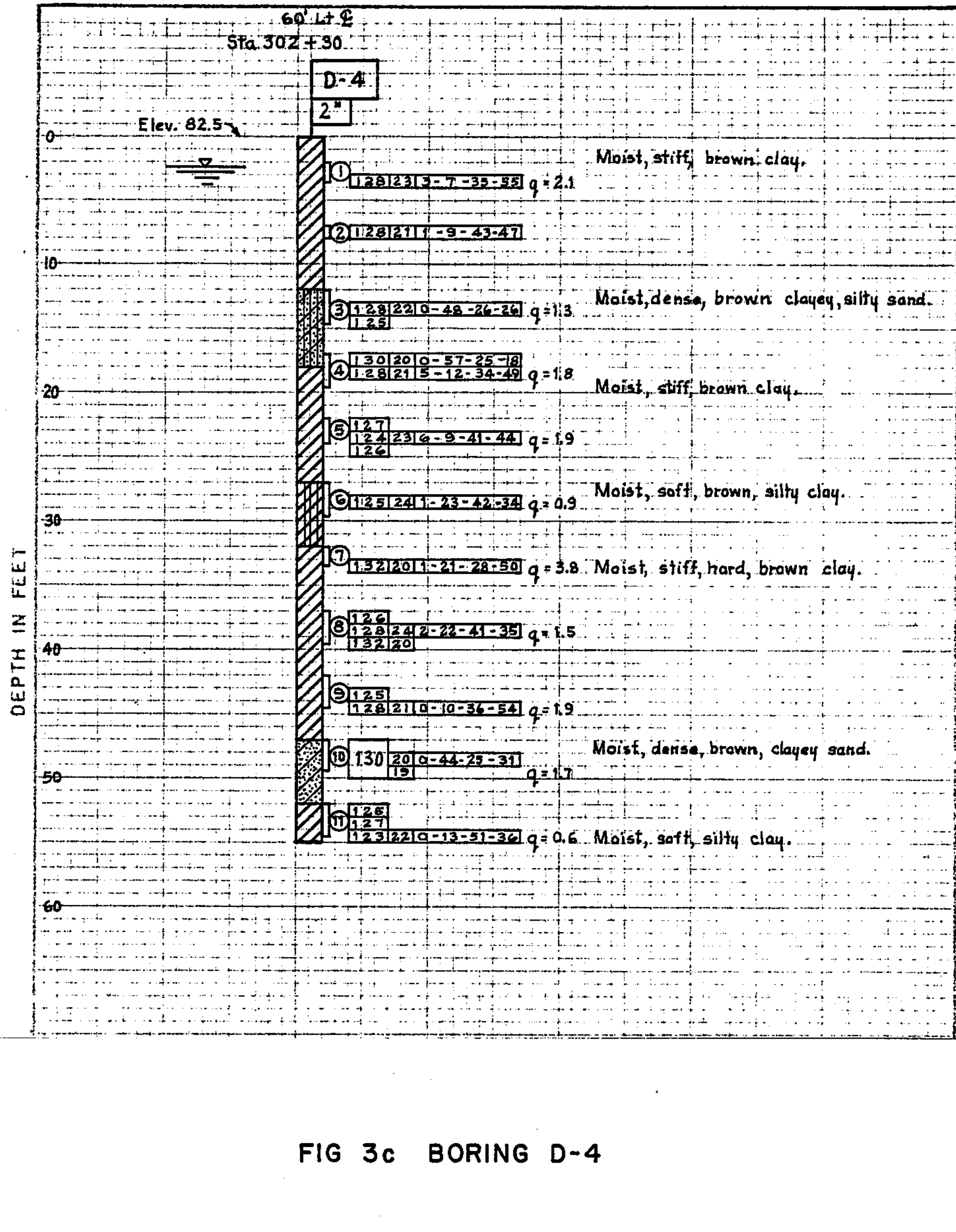


FIG 3c BORING D-4

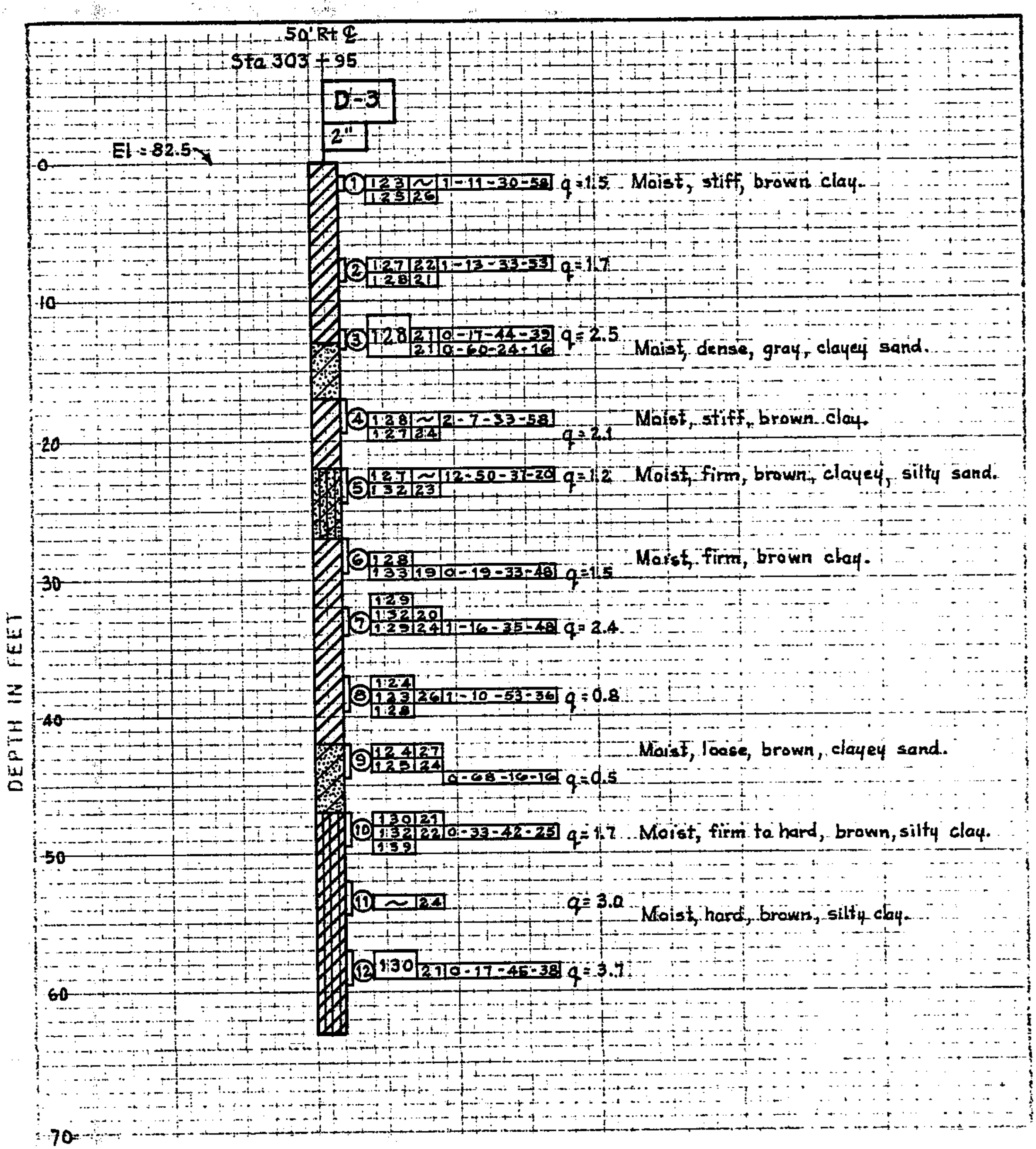


FIG. 3d BORING D-3

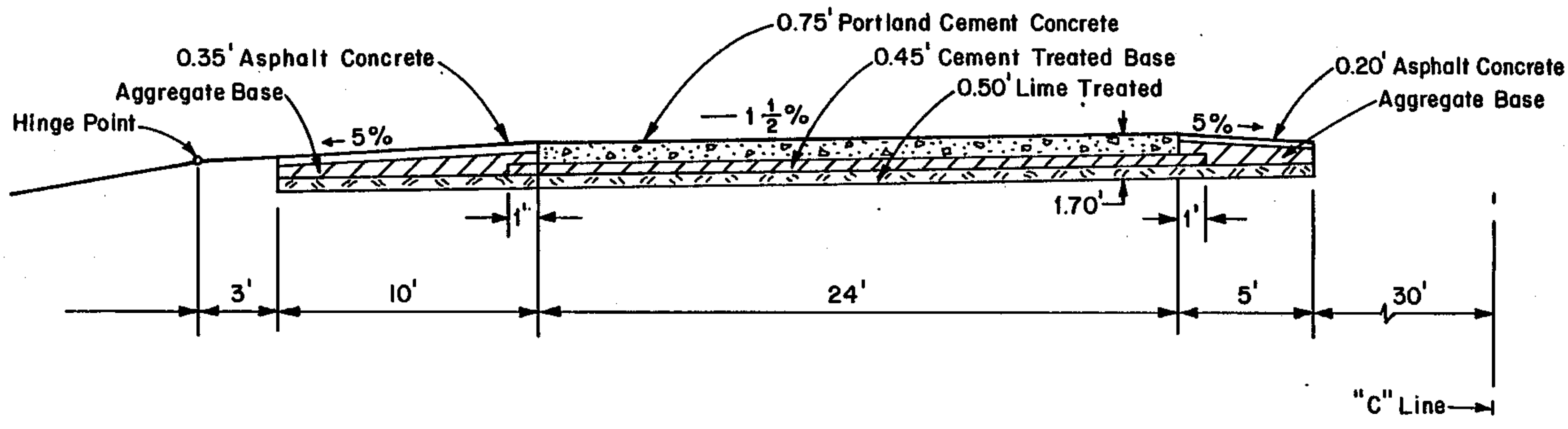


**FIG. 4 TYPICAL PAVEMENT LEFT SECTION**

(RIGHT SECTION SIMILAR)

SCALE: 1" = 6'

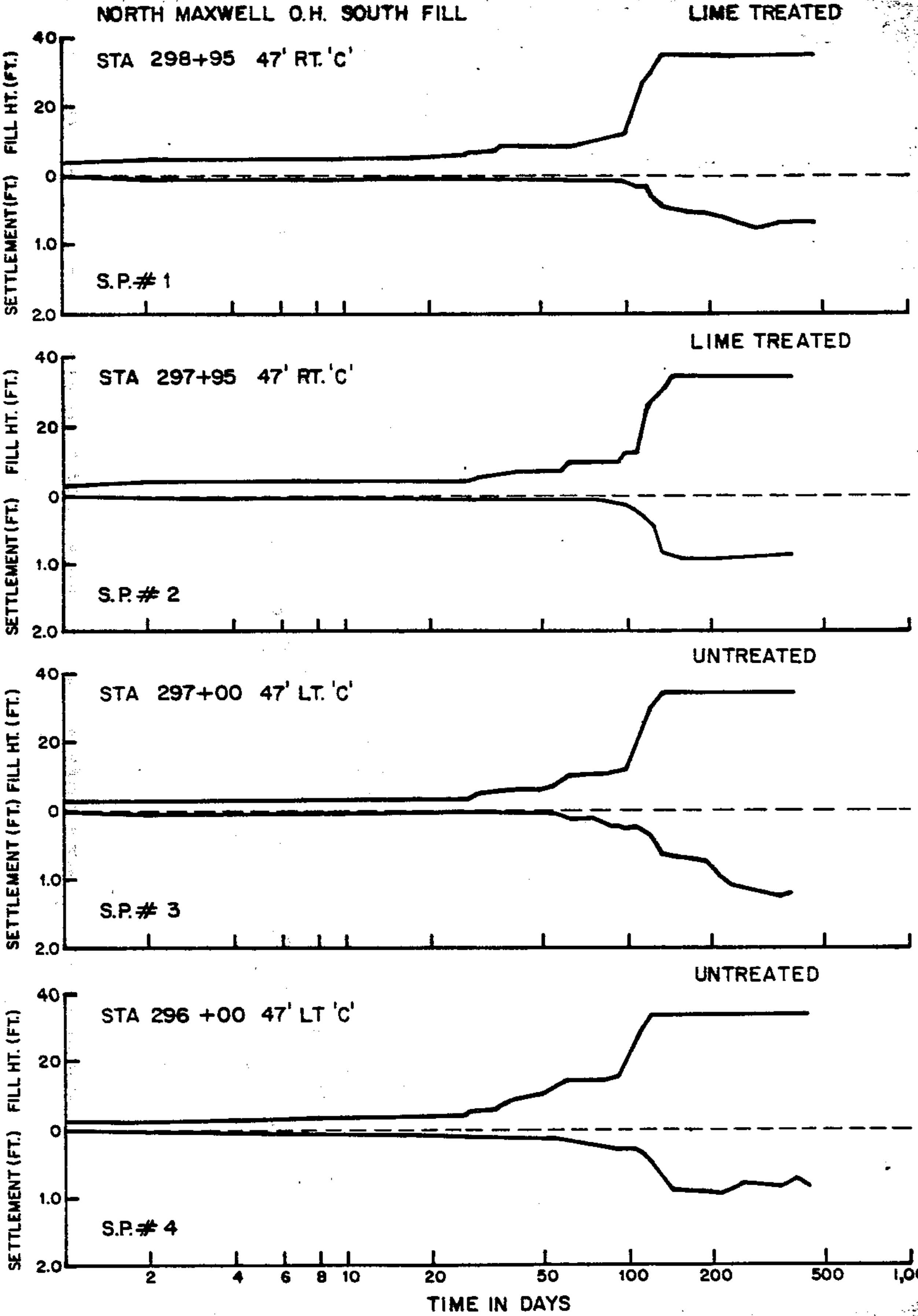


FIG. 5g SETTLEMENT PLATFORM READINGS

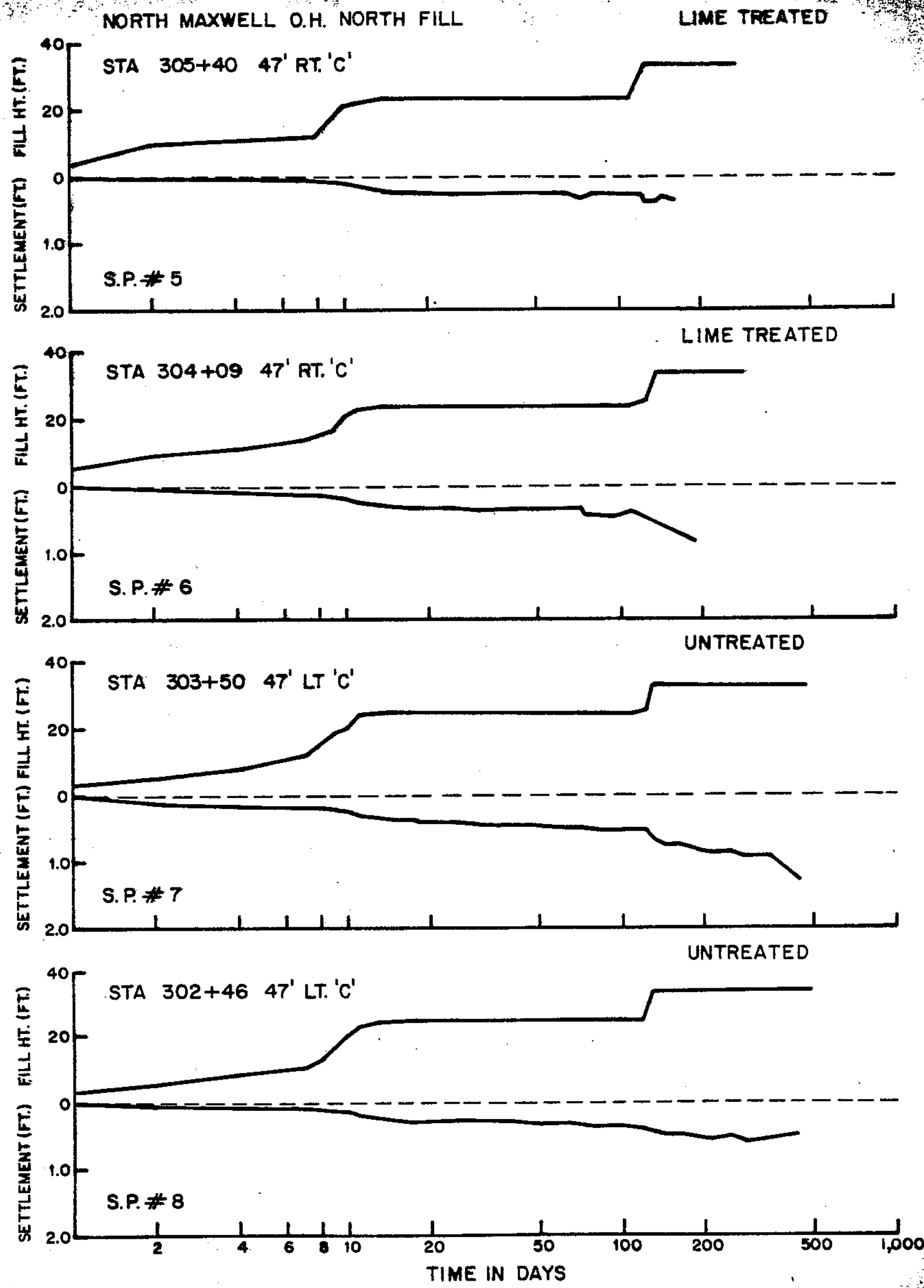


FIG. 5b SETTLEMENT PLATFORM READINGS

TIME SETTLEMENT DATA SOUTH FILL

SOUTHBOUND LANES (UNTREATED) SUBGRADE HUB

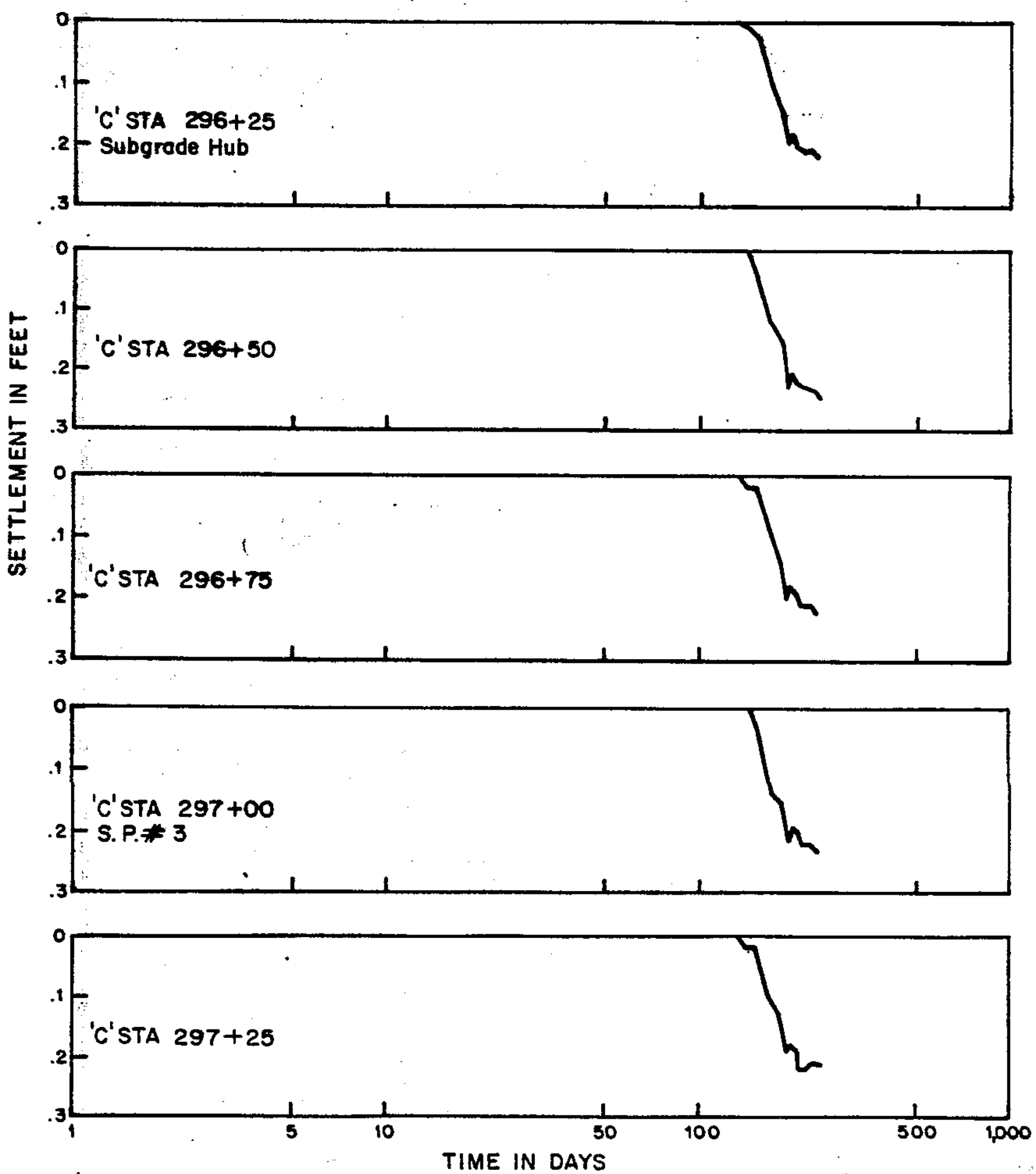


FIG. 6a SETTLEMENT HUB READINGS

TIME SETTLEMENT DATA SOUTH FILL
NORTHBOUND LANES (LIME TREATED) SUBGRADE HUB

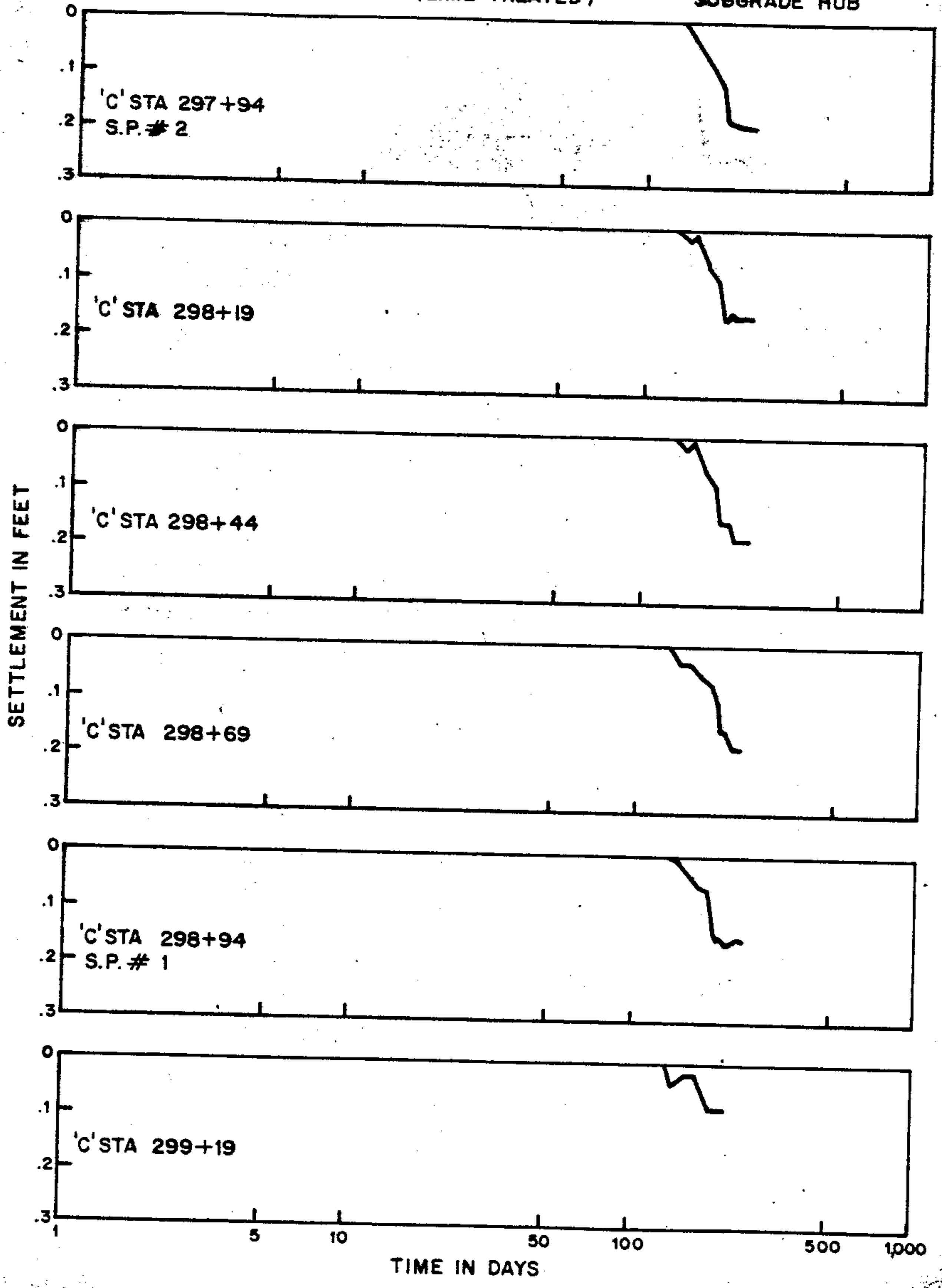


FIG. 6b SETTLEMENT HUB READING

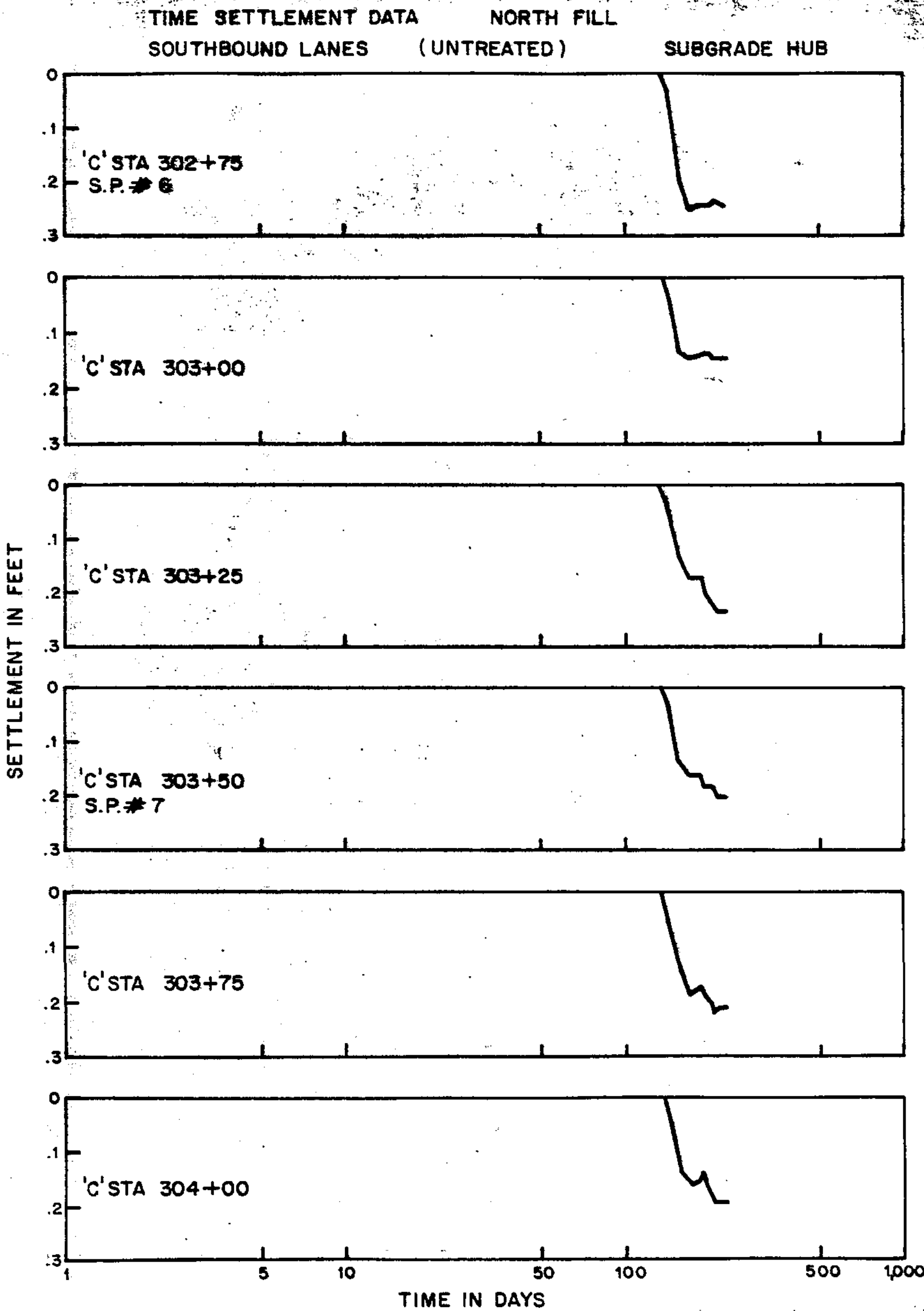


FIG. 6c SETTLEMENT HUB READINGS

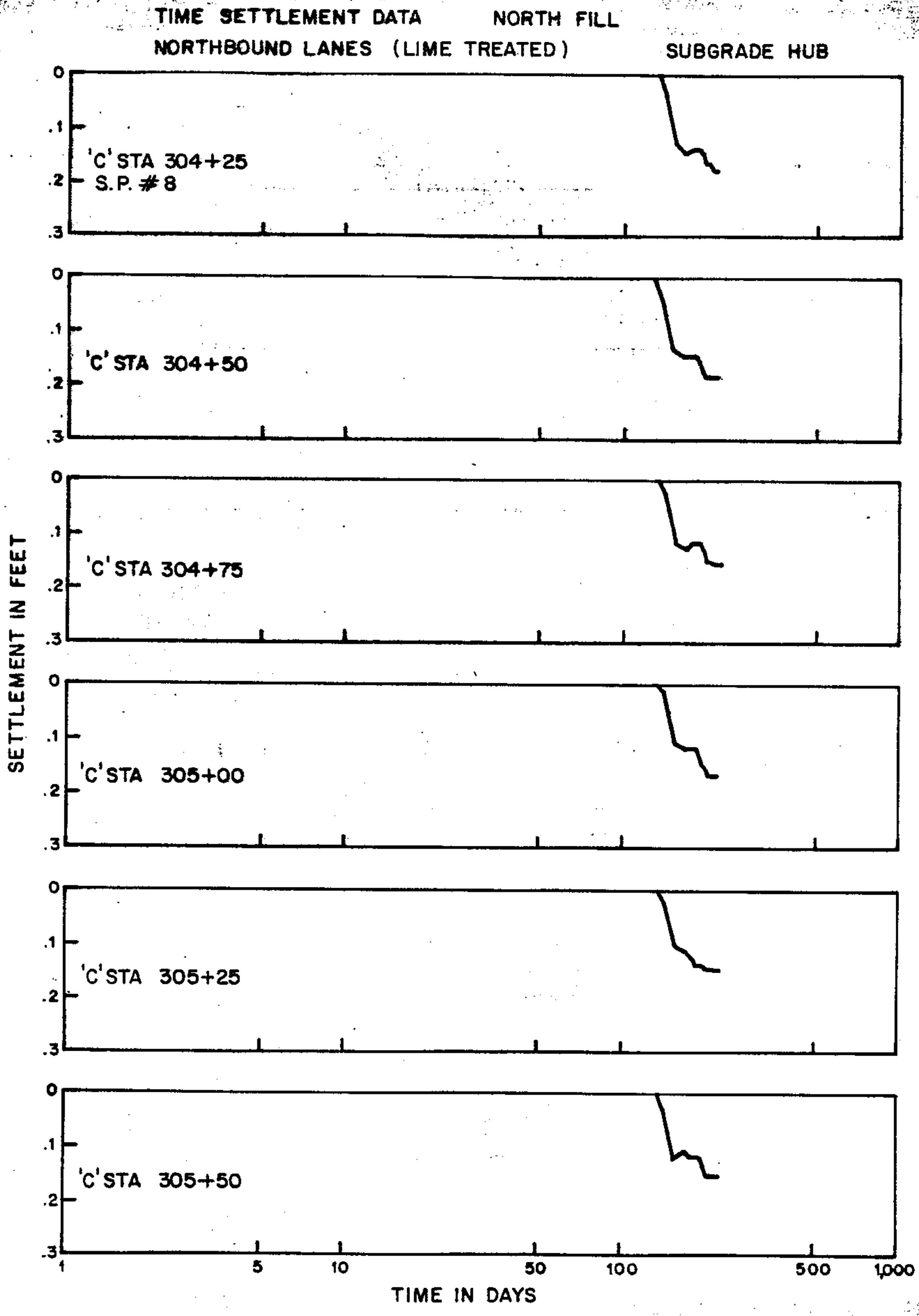


FIG. 6d SETTLEMENT HUB READINGS

SETTLEMENT DATA — AFTER PAVING

SOUTH FILL — SOUTHBOUND LANES (UNTREATED)

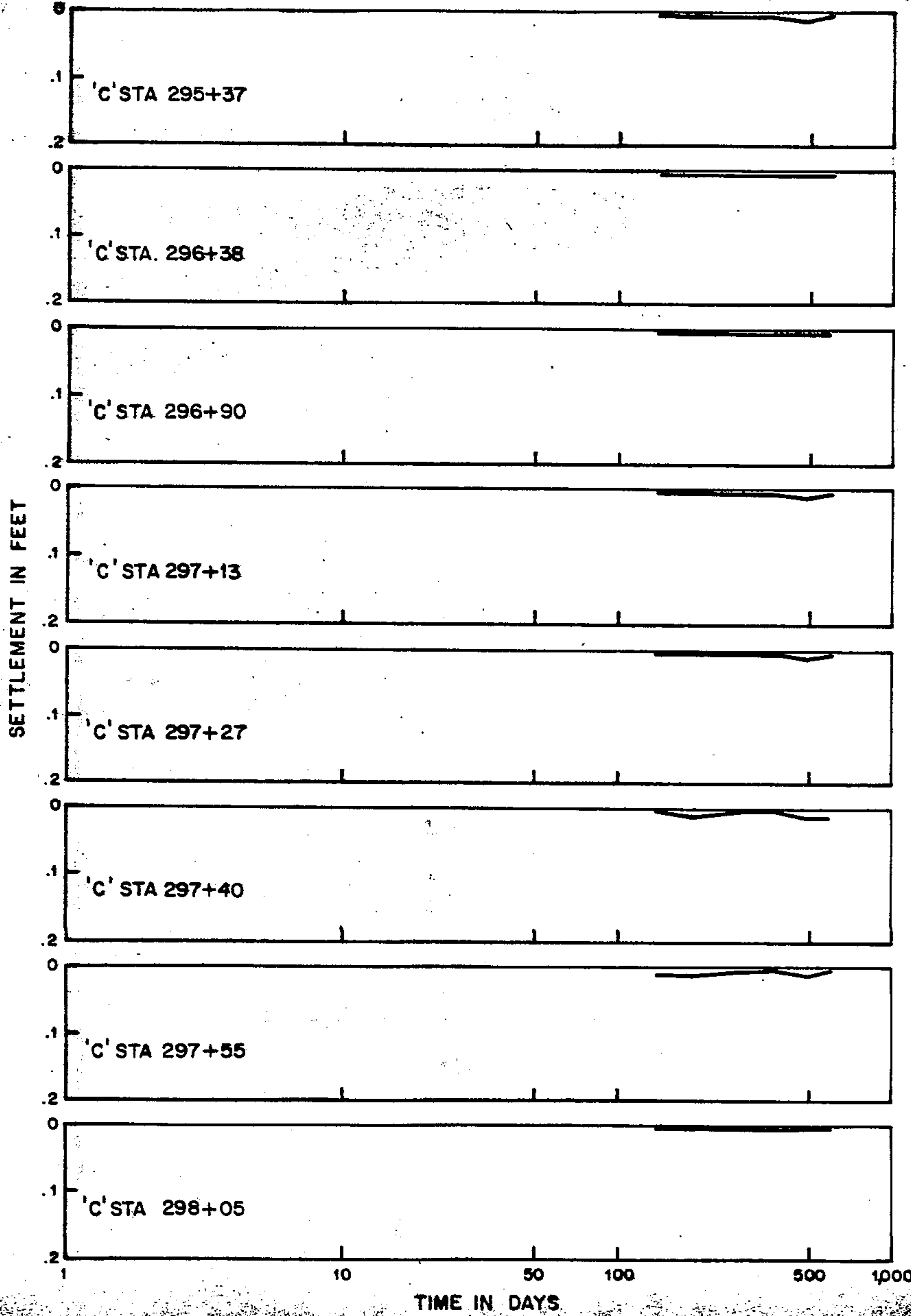


FIG 7a SETTLEMENT AFTER PAVING

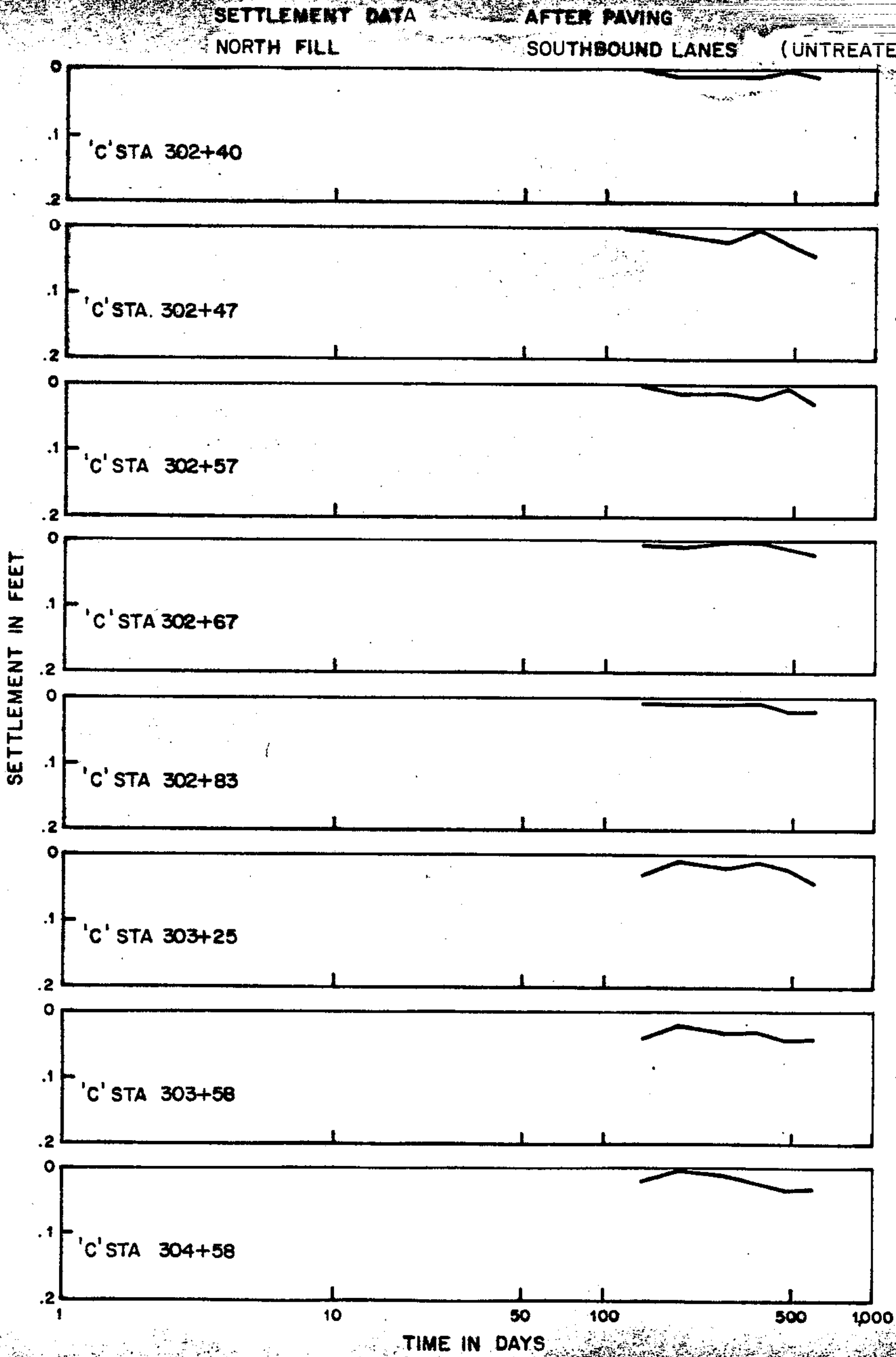


FIG 7b SETTLEMENT AFTER PAVING

SETTLEMENT DATA AFTER PAVING
SOUTH FILL NORTHBOUND LANES (LIME TREATED)

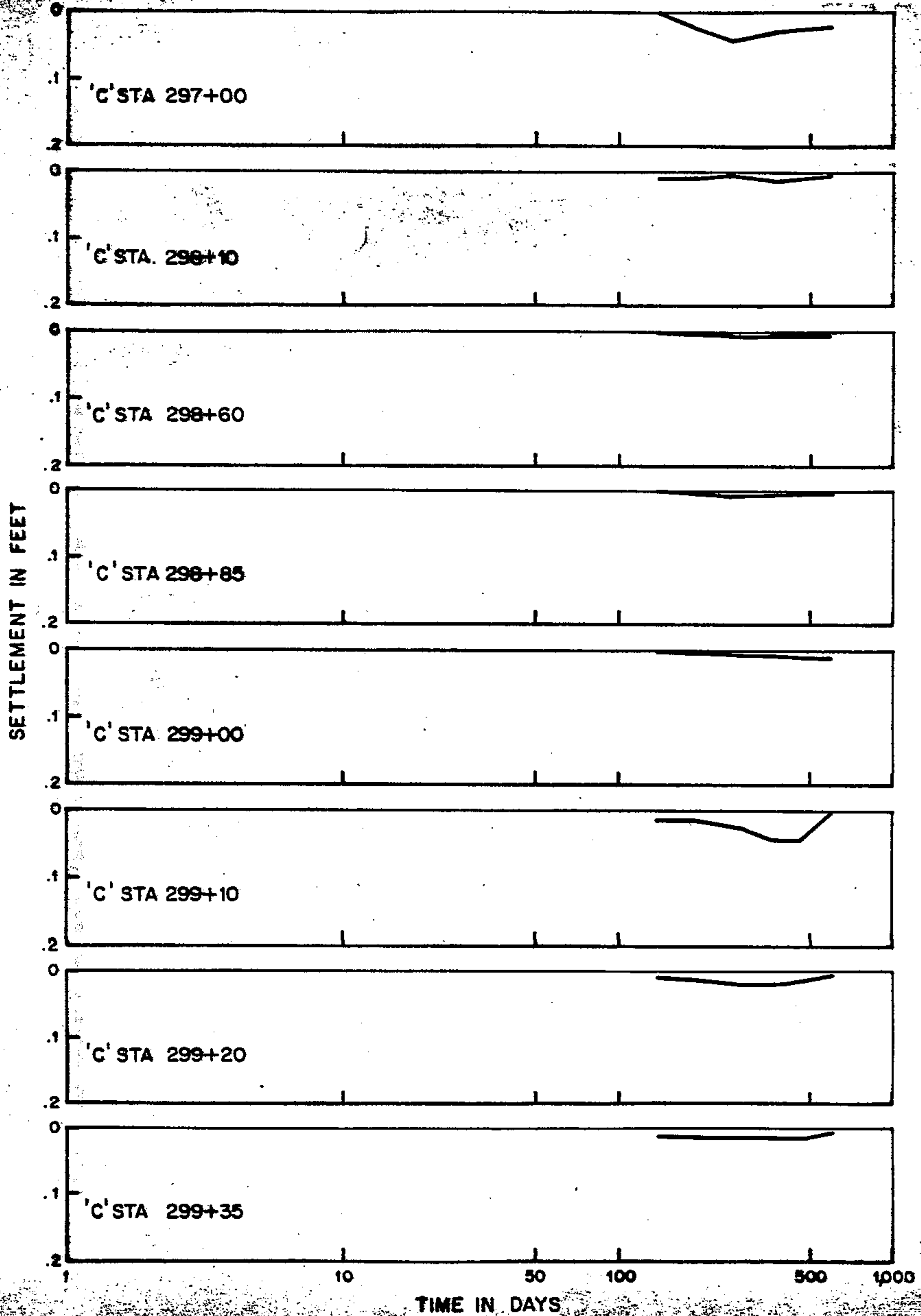


FIG 7c SETTLEMENT AFTER PAVING

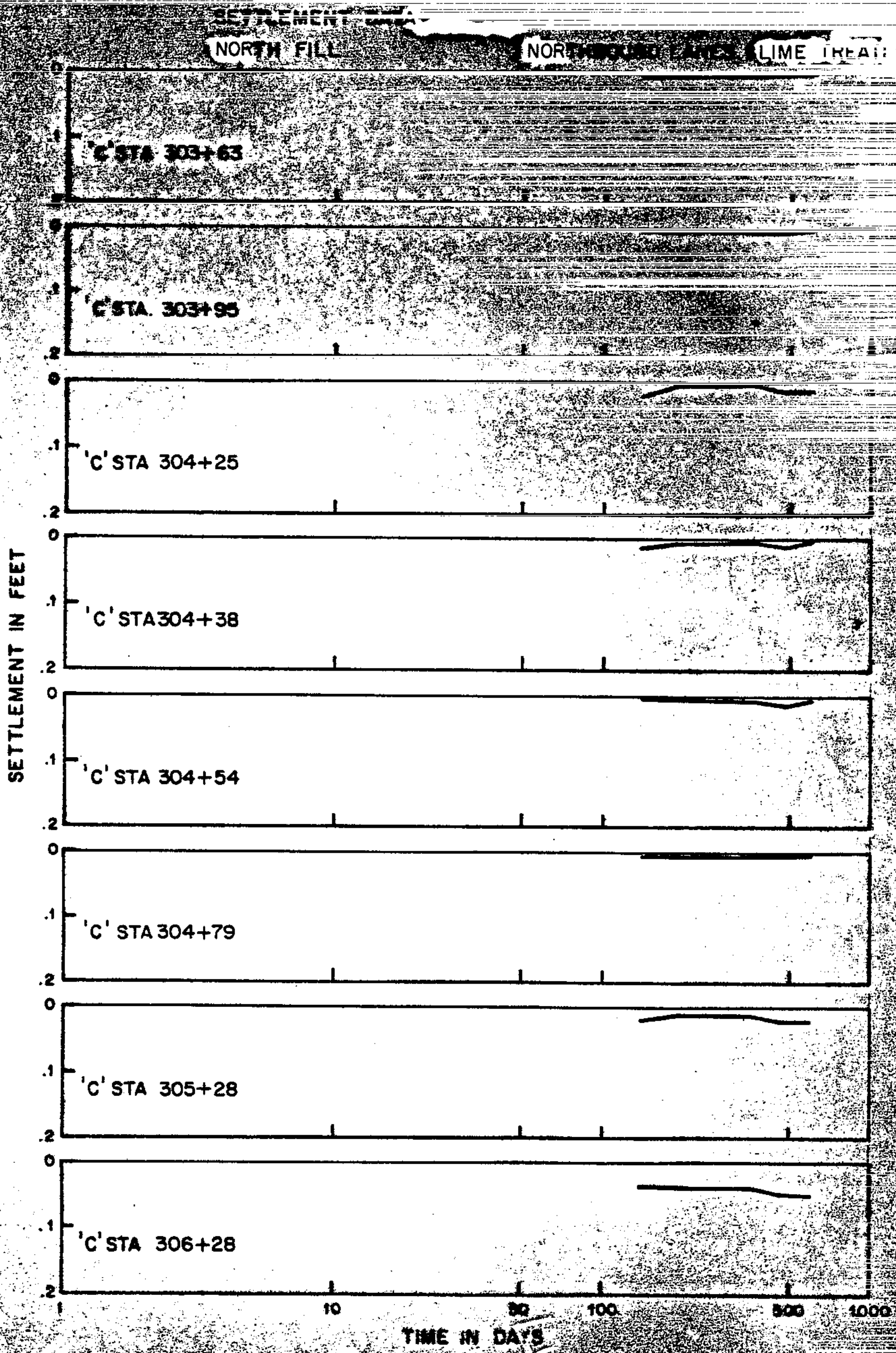


FIG 7b SETTLEMENT AFTER