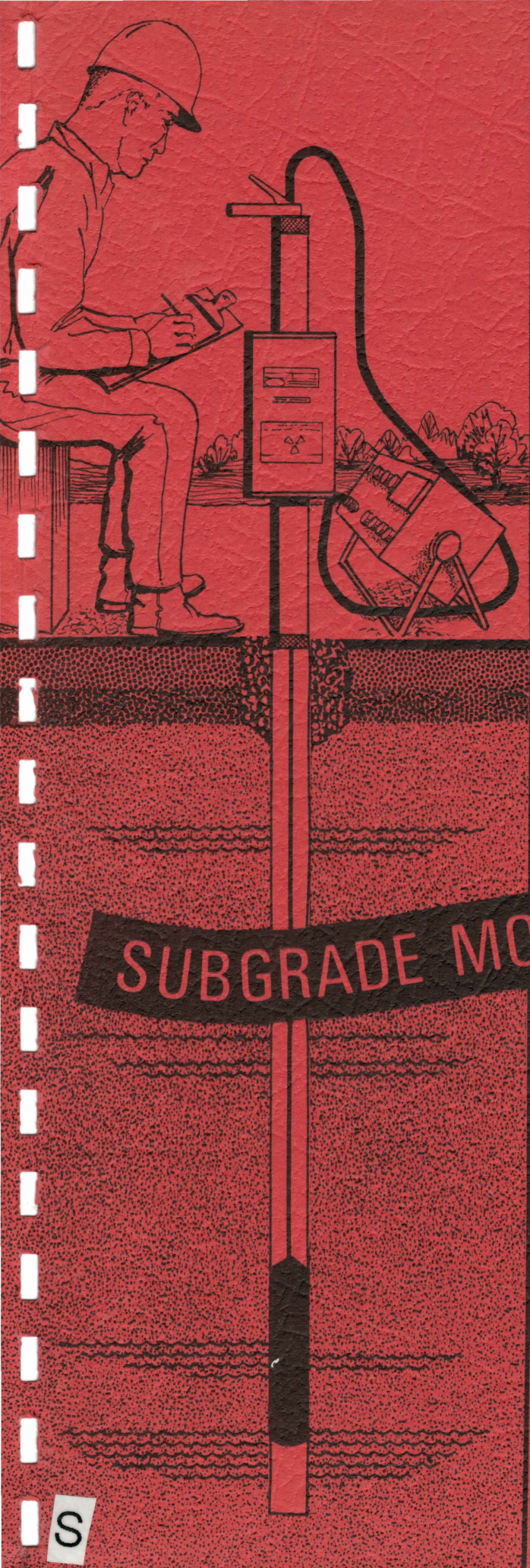


1968

OKLAHOMA RESEARCH PROGRAM
PROJECT 64-01-3

#41



SUBGRADE MOISTURE VARIATIONS

INTERIM REPORT V

DATA SUMMARY 1966-1967

T. Allan Haliburton

School of Civil Engineering

OKLAHOMA STATE UNIVERSITY

Stillwater, Oklahoma

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SUBGRADE MOISTURE VARIATIONS
INTERIM REPORT V: DATA SUMMARY 1966-1967

by

T. Allan Haliburton
Project Director

Research Project 64-01-3
Oklahoma Research Program

conducted for the
State of Oklahoma, Department of Highways

in cooperation with the
U.S. Department of Transportation
Federal Highway Administration
Bureau of Public Roads

by the
School of Civil Engineering
(Civil Engineering Research Report No. 30)
Office of Engineering Research
Oklahoma State University
Stillwater, Oklahoma

April, 1968

The opinions, findings, and conclusions expressed
in this publication are those of the author and
not necessarily those of the State of Oklahoma or
the Bureau of Public Roads.

PREFACE

The scope of project research includes measurement of subgrade moisture changes under Oklahoma highways with nuclear depth gages and correlation of these data with soil, climate, and pavement conditions. Previous interim reports have been primarily concerned with methodology required to install field test sites and calibrate the nuclear gages to provide more nearly accurate measurement of moisture conditions. Actual moisture data collection has been underway since the first field installation was made in June, 1966. In addition, data relating to soil, climate, and pavement conditions have been collected.

Efficient research management requires that one does not just collect data and let it accumulate. Field data collection is a costly process and some insight and judgement are required to get maximum results with minimum effort. Any data collection procedure must be continually scrutinized, evaluated, and optimumized. The first step in this process is obviously to present data in forms useful for evaluation and correlation.

This report is the fifth of an interim nature submitted by the Subgrade Moisture Variations Project, Oklahoma Research Program Number 64-01-3. Future interim reports will describe evaluation and correlation of collected data and present new data as they become available.

Support for this study is provided by the State of Oklahoma, Department of Highways, in cooperation with the U.S. Department of Transportation, Federal Highway Administration, Bureau of Public Roads. This support is gratefully acknowledged.

T.A.H.

LIST OF REPORTS

Interim Report I: "Preliminary Planning," by T. Allan Haliburton, June, 1966, reviews current utilization of nuclear equipment and presents a tentative plan for project operations.

Interim Report II: "Access Tube Installation," by Wayne L. Heiliger and T. Allan Haliburton, January, 1967, describes procedures used to install access tubing for nuclear depth moisture-density equipment beneath highway pavements.

Interim Report III: "A Preliminary Standardization and Calibration Procedure for Nuclear Depth Moisture/Density Gages," by E. W. LeFevre and Phillip G. Manke, May, 1967, describes an interim calibration procedure for project use of nuclear depth moisture and density gages.

Interim Report IV: "Suggested Nuclear Depth Gage Calibration Procedures," by Raymond K. Moore and T. Allan Haliburton, January, 1968, describes final procedures used in calibrating project nuclear depth moisture and density gages.

ABSTRACT

All data collected at the first 30 field test sites during the period June 1966-August 1967 are presented. Procedures for data collection, reduction, and display are described and discussed but no evaluation or correlation of collected data is attempted.

Data presented include measured moisture conditions, soil densities, soil profiles, temperature and precipitation records, site descriptions, roadway sections, pavement condition ratings, and traffic counts at each test site.

TABLE OF CONTENTS

PREFACE	ii
LIST OF REPORTS	iv
ABSTRACT.	
LIST OF FIGURES	viii
 Chapter	 Page
1. INTRODUCTION.	1
Current Project Status	1
Problems Associated with Data Collection	2
Scope of This Report	2
2. DATA COLLECTION	4
General Remarks.	4
Subsurface Moisture and Density Data	6
Subsurface Soils Data.	7
Climatological Data	8
Pavement and Traffic Data.	9
Miscellaneous Field Data	9
Summary.	10
3. DATA REDUCTION AND DISPLAY	11
Reduction of Moisture and Density Data	11
Reduction of Other Data.	13
Display of Measured Moisture Data.	13
Display of Measured Density Data	16
Display of Subgrade Soils Data	18
Display of Climate Data.	20
Display of Miscellaneous Data.	20
Organization of Collected Data in Appendix Form.	20
4. CONCLUSION.	25

Chapter	Page
REFERENCES.	26
APPENDIX 1.	27
APPENDIX 2.	32
APPENDIX 3.	37
APPENDIX 4.	40
Site No. 1	41
Site No. 2	51
Site No. 3	62
Site No. 4	72
Site No. 5	82
Site No. 6	92
Site No. 7	102
Site No. 8	112
Site No. 9	122
Site No. 10.	132
Site No. 11.	142
Site No. 12.	152
Site No. 13.	162
Site No. 14.	172
Site No. 15.	174
Site No. 16.	184
Site No. 17.	194
Site No. 18.	204
Site No. 19.	206
Site No. 20.	216
Site No. 21.	226
Site No. 22.	236
Site No. 23.	246
Site No. 24.	256
Site No. 25.	266
Site No. 26.	276
Site No. 27.	286
Site No. 28.	296
Site No. 29.	306
Site No. 30.	316

LIST OF FIGURES

Figure		Page
2.1	Field Test Site Locations for Subgrade Moisture Variations Project	5
3.1	Summary Flow Diagram of Data Reduction Process	12
3.2	Typical Plot of Subgrade Moisture Variations	14
3.3	Typical Soils Data for a Field Test Site	19
3.4	Typical Temperature and Precipitation Plot	21
3.5	Sample Test Site Data Summary Sheet.	22
3.6	Sample Site Installation Information Sheet	23
A1.1	Field Test Site Installation Drilling Log.	28
A1.2	Field Test Site Installation Information	29
A1.3	Nuclear Data Collection Record	30
A1.4	Field Test Site Observation Record	31

CHAPTER 1. INTRODUCTION

Subgrade moisture variations, with resulting changes in soil volume and strength, may cause poor pavement performance. Measurement of subsurface moisture changes and subsequent correlation of these data with soil, climate, and pavement conditions may lead to improved procedures for highway design and construction.

Accordingly, the School of Civil Engineering at Oklahoma State University, in cooperation with the Oklahoma Department of Highways and the Bureau of Public Roads, U.S.D.T., initiated, in June, 1964, a six-year study to measure subgrade moisture variations under Oklahoma highways. Scope of the study is fourfold: 1) to develop an efficient method of measuring subgrade moisture variations, 2) to develop procedures for making these measurements throughout Oklahoma, 3) to relate measured subgrade moisture changes to soil, climate, and pavement conditions, and, hopefully, 4) to suggest revisions in current highway design procedures.

Current Project Status

Nuclear depth moisture and density gages were selected for use in measuring subgrade moisture conditions. After initial planning (Ref 1) a total of 50 test sites were installed in north central and northeastern Oklahoma, 30 in the summer of 1966 and 20 in the summer of 1967. Procedures for test site installation have been given elsewhere (Ref 2). It was necessary to calibrate the nuclear equipment for Oklahoma soils

(Refs 3,4) but same was accomplished satisfactorily. Subgrade moisture data collection at the test sites is currently proceeding on a six-to-eight week interval.

Problems Associated with Data Collection

It is fairly obvious that a large mass of data must be taken in any field research study. To correctly evaluate the relevant factors all possible factors must be considered because which ones are relevant is unknown until the study is completed. Thus much insignificant data must be taken along with the few data that are useful--it is the price one pays for not knowing answers in advance.

Large masses of data are problems in themselves. They must be reduced, tabulated, plotted, evaluated, and correlated. It is not efficient to let data accumulate without looking at it continuously, else one becomes overwhelmed by sheer volume. Efficient procedures for reducing and plotting data as it becomes available must be devised, and a running evaluation carried out during the data collection period, to refine the collection procedure and identify relevant factors at the earliest possible opportunity.

Scope of This Report

The scope of this report is threefold: 1) to indicate just what data are being collected, 2) to describe procedures used for data reduction and display, and 3) to provide a convenient reference for use in data evaluation and correlation. Data collected at the first 30 sites during the period June 1966-August 1967 are presented. Data presented include measured moisture conditions, soil densities, soil pro-

files, temperature and precipitation records, site descriptions, roadway sections, pavement condition ratings, and traffic counts at each test site.

CHAPTER 2. DATA COLLECTION

The scope of research includes collection and evaluation of data concerning subgrade moisture changes and soil, climate, and pavement conditions. Procedures for collecting these data are described in this Chapter. Reasons for some particular procedures will be given, but no critical evaluation of data is made at this time.

General Remarks

As noted previously, 50 field test sites have been installed. Locations of these sites are shown in Fig 2.1. Exact locations are given in Appendix 2. Only data collected from sites 1-30 are presented in this report.

Experimental data taken by research project personnel consist primarily of subsurface moisture and density measurements, made with nuclear depth equipment. All data collection is scheduled from Stillwater, with some overnight trips required by project personnel.

Traffic control for on-pavement data collection is provided by Oklahoma Department of Highways maintenance personnel. Scheduling and coordination is accomplished through the Assistant District Engineers for Maintenance of the five divisions having test sites in their areas. A two-man flag crew is usually dispatched to meet OSU personnel at a designated time and place. The collection schedule has been optimized to make maximum effective use of both research and traffic control personnel. It is felt a maximum of field time is used to collect data

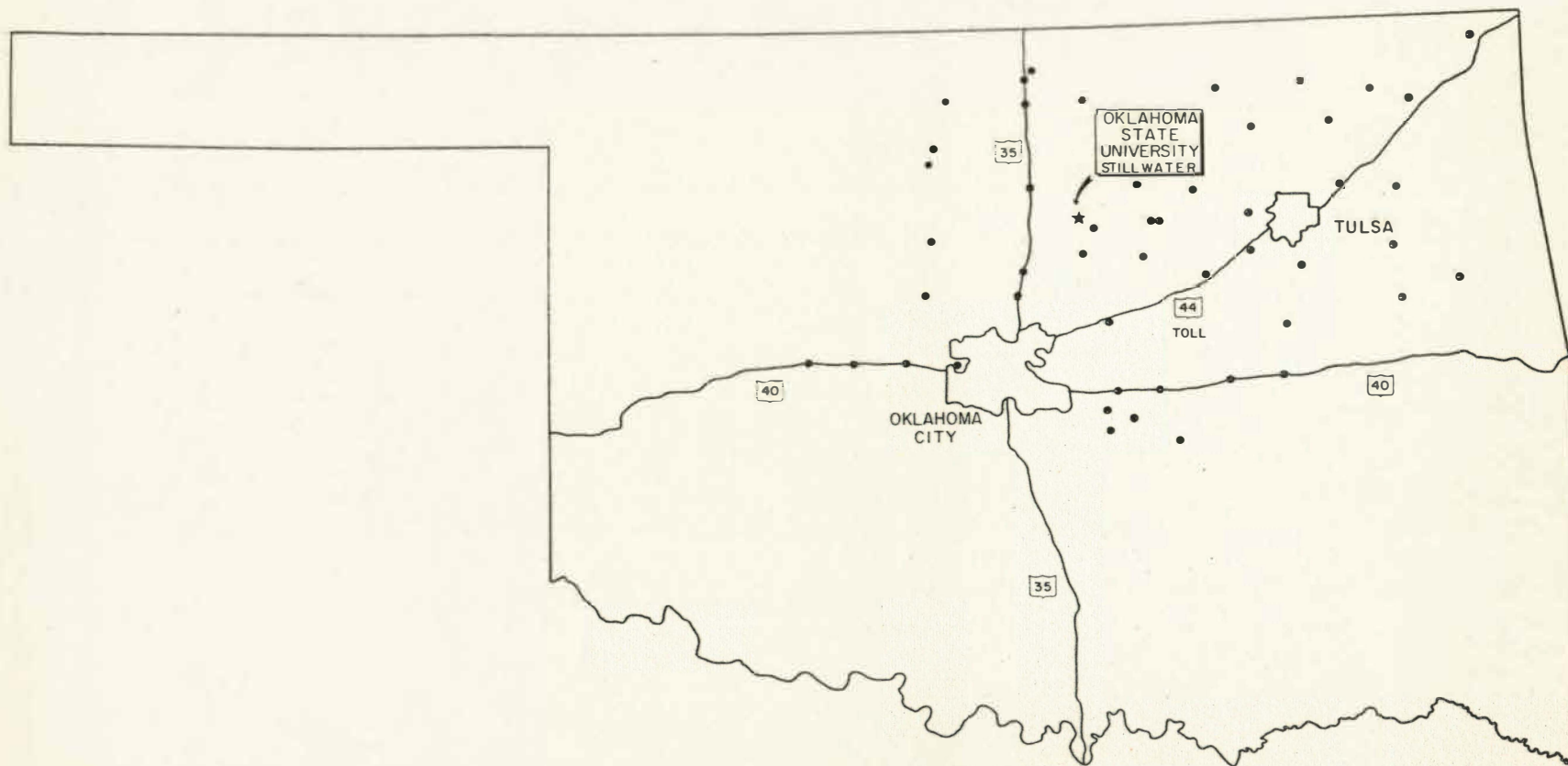


Figure 2.1 Field Test Site Locations for Subgrade Moisture Variations Project

and a minimum of time spent driving between sites. From an overall viewpoint, the scheduling procedure has worked well. Excellent cooperation has been received from Oklahoma Department of Highways maintenance forces. Some cancellations have occurred in winter months when maintenance personnel are needed for snow and ice control, but such is to be expected. Research personnel also cancel data collection when rainfall, snow, etc., make data collection difficult, or when nuclear equipment difficulties occur. Provision for make-up of field readings is a part of normal scheduling.

Subsurface Moisture and Density Data

After much experimentation, the following procedure has evolved for collection of moisture and density data by nuclear methods:

1. After traffic control is established, ten counts are taken with the probe in its combination shield/standard. As used herein, "count" is taken to mean all gamma particles or slow neutrons counted by probe detectors over a specified time interval.
2. The probe is then lowered to the access tube bottom and allowed to reach temperature equilibrium. The access tube bottom is used as a reference location for all nuclear data readings. The probe is then raised to the first reading level and two counts are taken at this level, the probe is then raised one foot and the procedure repeated, etc., until the probe is at the access tube top. Some tubes are not exactly 10 feet long, and the distance between tube bottom and first reading level

is variable, chosen so the last reading is with the top of the probe just below the bottom pavement surface.

3. The above procedure is repeated for the other two access tubes at the site. Similar procedures are used for both moisture and density data collection.

The decision to use two counts per level represents a compromise between pure statistical accuracy and data collection efficiency. Initially a one-minute counting period was used, but a 30-second counting interval has been used since November, 1967. As will be mentioned later, the procedure appears to produce results of practical significance. Moisture data are collected at each site on a six-to-eight week interval. The choice of this interval is a compromise between desire to obtain a maximum amount of useful data and available funds. While an exact evaluation of the data collection interval will not be attempted here it is felt a reasonable compromise has been achieved. Density data are collected at six-month intervals, during summer and winter months.

Subsurface Soils Data

Soils samples were collected at one-foot depth intervals during test site installation (Ref 2) and sealed in labelled pint jars. The samples were taken as brought up by auger, except that the last two or three (at greatest depths) were taken from the auger string after it had been pulled from the hole. Some mixing was obviously caused by the augering process; nevertheless the samples are thought to be from within one foot of their indicated level and representative of actual subsurface conditions.

The samples were taken to the OSU Soil Mechanics Laboratory and

tested for initial moisture content. The first 30 sites produced about 900 individual soil samples. To achieve efficient testing, only the soil samples from the centerline hole were tested, reducing the total number of samples to 300. Checks of drilling logs for each site plus visual inspection of actual soil samples indicated almost uniform subsurface profiles under pavement at the great majority of sites. Thus minimal error was thought to be introduced by taking the centerline soil profile to be representative of the entire cross-section.

Only routine tests were run on the 300 soil samples: liquid limit, plastic limit, specific gravity, and lineal shrinkage. The Texas Highway Department bar method for lineal shrinkage was used rather than the ASTM shrinkage limit test. The THD method is faster, less dangerous, and has reasonable correlation with ASTM volumetric shrinkage. The samples were also classified by AASHO and UNIFIED systems.

The one-pint volumes of sampled soil were not large enough to provide material for extensive testing; also requirements of time and available funds made such testing impractical. Future work may include detailed sampling and testing at selected sites, if warranted.

Climatological Data

Criteria for field test site selection required that each site be located within 10 miles of a U.S. Weather Bureau Climatological Recording Station, keeping continuous precipitation and temperature records. While local thunderstorms, etc. may give differences between recorded conditions and those actually occurring at each site, monthly mean data are probably representative enough to be useful. Data are obtained by subscription to Climatological Data - Oklahoma, published by the U.S.

Department of Commerce, National Weather Records Center, U.S. Weather Bureau, Asheville, North Carolina.

Pavement and Traffic Data

Pavement condition ratings at all test sites were made by the Research and Development Division, Oklahoma Department of Highways, during the Fall of 1967. It is anticipated that pavement sections will be re-rated at periodic intervals until project termination. Condition ratings are included in the data summary for each site, given in Appendix 4, while a list of all ratings and the rating procedure are given in Appendix 3.

Data describing pavement age, history, typical cross-section, base and subbase type, etc., were also obtained from the Research and Development Division, OSHD. Complete records were not available for every site but all relevant information obtained is listed on the test site data summary sheets in Appendix 4.

Traffic count data for the sites were also obtained from the Research and Development Division, OSHD. Latest counts available (1967) have been included on the data summary sheets in Appendix 4. It is anticipated that revised traffic count data will be added as received from the OSHD.

Miscellaneous Field Data

Additional relevant data about each test site have been recorded by research project personnel and listed in Appendix 4, by site number. Data include terrain and drainage conditions, vegetation, etc., at each site, plus observations made each time data were collected. Condition

of pavement and shoulders, repairs by maintenance personnel, and observed drainage behavior are among the factors noted on each data collection visit. Photographs are taken at each site as a visual record of behavior and selected photographs will be included in later reports.

Summary

A large volume of data is obviously being obtained at each test site. Procedures for reduction and display of this data must be efficient, else evaluation will be hindered by sheer volume of material to process. Such procedures are described in the following chapters.

It should be noted that some additional data at each test site, such as subgrade temperatures, soil suction, etc., are not currently being measured. Perhaps initial evaluations of collected data will indicate whether or not such additional measurements are warranted.

CHAPTER 3. DATA REDUCTION AND DISPLAY

Once field data are collected they must be reduced and displayed in suitable form for evaluation and correlation. Procedures for reducing, tabulating, plotting, and summarizing research project data are given in this chapter. Reasons for some display procedures are discussed but no evaluation of procedures is attempted at this time.

Reduction of Moisture and Density Data

Nuclear depth moisture and density data (counts) are recorded with respect to site number, access tube number, and level in access tube. Standard counts are also recorded. A single data sheet is used for each site. Sample data sheets are shown in Appendix 1. Counts for each level, hole and site are rechecked for gross recording errors and then punched on IBM cards. Site identification and control cards are added, and the data reduced on an IBM 7040 digital computer. A flow chart of the data reduction process is shown in Fig 3.1. Output for each site includes appropriate identification, count ratios, reading levels, and computed values of bulk (wet) density, volumetric water content, dry density, and engineering moisture content. Calibration curves used for reduction of nuclear data have been described elsewhere (Refs 3,4).

Output sheets are checked for input data errors and then filed by site number, providing an accessible record of moisture behavior for each site. Data cards and original data sheets are filed for possible

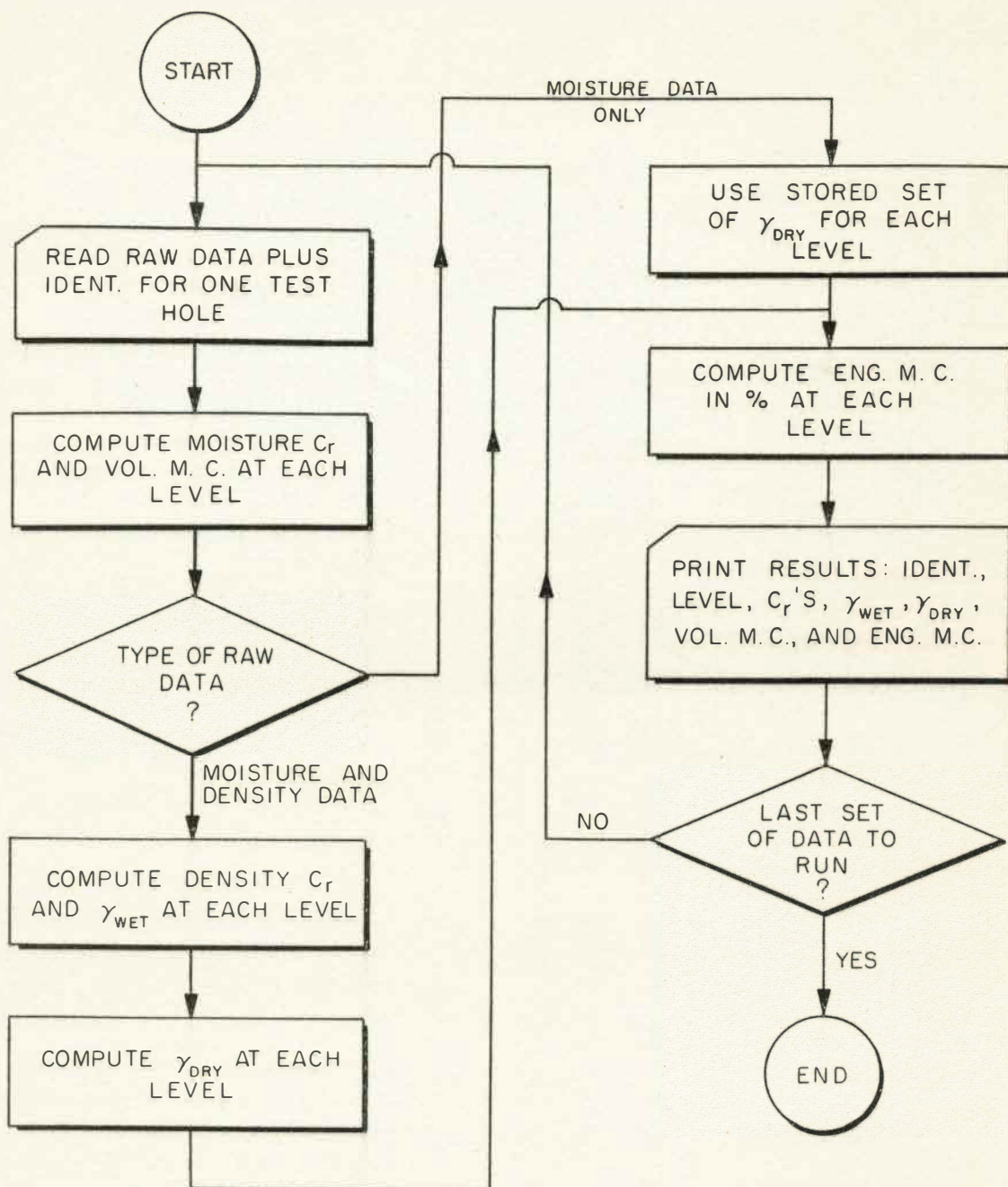


Figure 3.1 Summary Flow Diagram of Data Reduction Process

future reference. It should be noted that revision of equipment calibration curves or other major changes in data reduction calculations would only cause minor inconvenience as all original data are available on IBM cards and could be easily processed by the new procedure.

As moisture data are taken more often than density data, a set of dry density data cards for each site can be included as input for reduction of moisture data and computation of engineering moisture content. Data card punching begins as soon as raw data sheets are filed, and computerized reduction of all data is performed after each complete round of field data collection, or about every eight weeks.

Reduction of Other Data

Original drilling logs, location/description sheets, soil test result sheets, and field observation sheets are all filed by site number. Pavement condition ratings, traffic counts, original roadway design and history data, etc., are tabulated and also filed by site number. Thus all information concerning a particular field test site is filed together for easy reference. Duplicate lists for specific conditions at all sites are also maintained. The filing system has been designed to give easy accessibility to any required original or reduced data and appears to work reasonably well.

Display of Measured Moisture Data

Moisture data from each access tube is plotted versus time at each one-foot level beneath the pavement. Specific data points are connected by straight lines. A typical moisture plot is shown in Fig 3.2. Three plots are obtained for each test site, at center and edges of

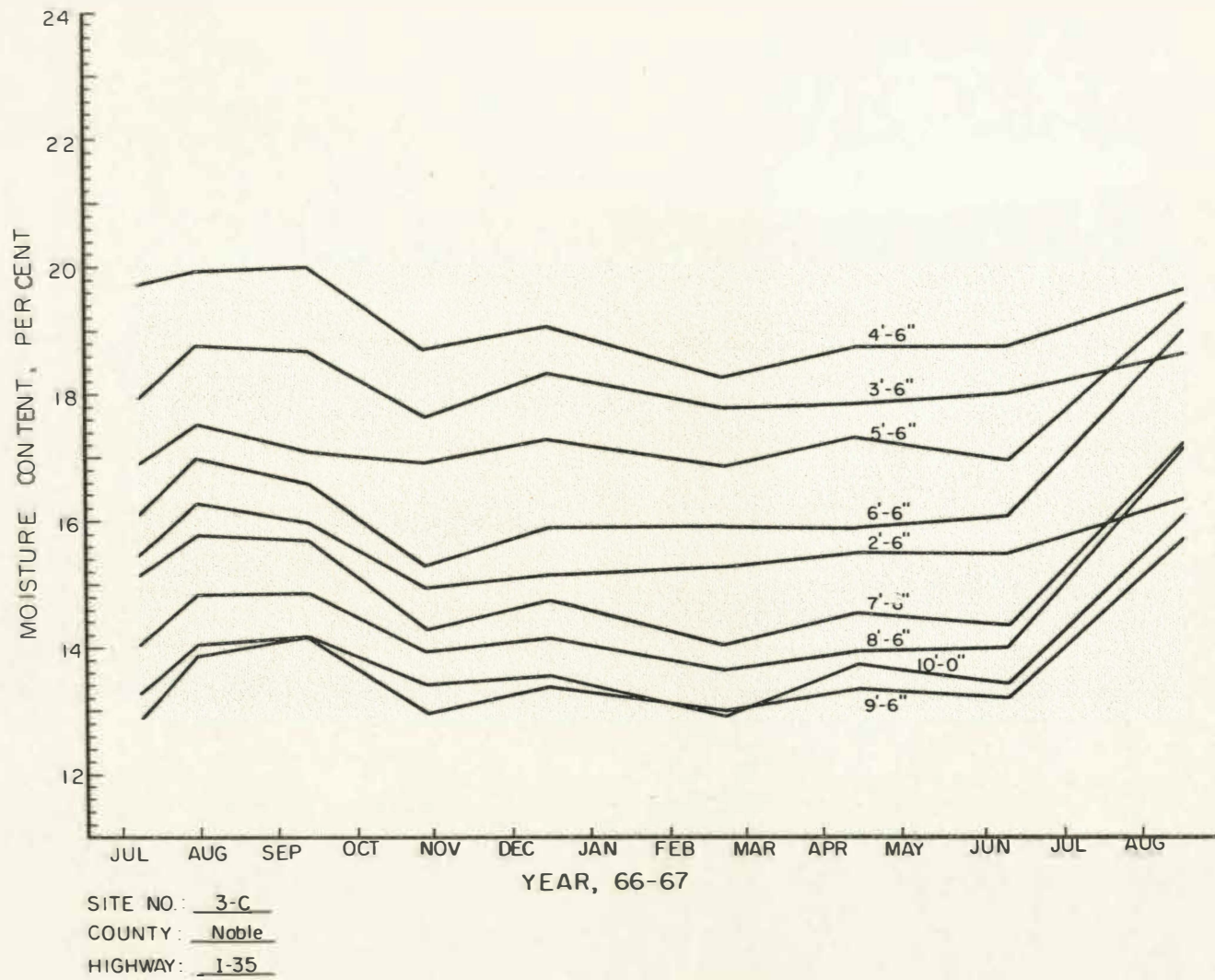


Figure 3.2 Typical Plot of Subgrade Moisture Variations

pavement.

Note that engineering moisture content in percent is plotted rather than volumetric water content. If any correlations are to be made with engineering soil properties it is necessary to work with engineering moisture content. Also, depths referenced on the plot of Fig 3.2 are distances from the top of the access tube to the bottom of the nuclear probe. The top of the access tube is located approximately six inches below the pavement surface. As the nuclear probes measure an integrated volume of soil and are about 16 inches in length there is some dissention regarding exactly what point of reference should be used.

Actual project procedures to insure periodic measurements at the same levels require that the probes be lowered to the bottom of each access tube and then pulled up as nuclear counts are taken. Thus, project data is collected and reduced in reverse order, from bottom to top. For easier reference, the depths shown in Fig 3.2 have been computed as the distance from top of access tube to bottom of probe. When six inches from access tube top to pavement surface are added the tabulated depth is thus an approximate distance from pavement surface to center of nuclear probe.

It should be noted that moisture data variations are not thought to be the result of experimental or statistical error as they follow general trends from level to level, site to site, and season to season. In fact, for some sites where granular material is encountered below a relatively constant water table, similar measurements have been obtained for a two-year period. Deviations in measured engineering moisture content have been less than one-half percent, considerably below the amount of variation to be expected on a purely statistical

basis. A definite conclusion of the research study is that nuclear depth equipment gives reliable and repeatable results, and more nearly accurate results than a pure statistical analysis would predict. Future reports on evaluation of measured data are expected to reinforce this hypothesis.

Display of Measured Density Data

Density data have been taken at six-month intervals. Only density data for the first year of measurements (3 observations) are presented in this report. Values of engineering dry density are reported. All density data are presented in tabular form by site number, as seen in Table 3.1. The values of tabulated density exhibit a phenomenon which occurred at almost all sites.

Note that initial measurements taken when the sites were installed in June-August 1966 are consistently lower than values taken in January 1967. However, the values obtained in August 1967 are also lower than the January values. As this general trend occurred at the majority of sites and a two-month period was required each time to collect density data from all sites it was felt that errors in equipment response were not responsible for the differences.

The initial density readings were expected to be low, as the tubes were installed in slightly oversize holes and an air gap of approximately 1/16 inch existed around each tube. The January moisture readings were, as a rule, considerably higher than summer values, and during this period the tubes were observed to have a rather tight fit. In the summer of 1967 moisture values decreased and the access tubes were noted to be loose in their holes, though not as much as when first

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SUBGRADE MOISTURE VARIATIONS RESEARCH PROJECT

SUBGRADE SOIL DRY DENSITY TABULATION

Date of Measurement	August 1966			January 1967			August 1967		
Site & Hole Number	1-A	1-B	1-C	1-A	1-B	1-C	1-A	1-B	1-C
Depth from top of tube to bottom of probe									
1 ft 6 in.				114.87	126.85	131.42	99.06	96.06	101.45
2 ft 0 in.									
2 ft 6 in.	89.02	91.92	94.70	94.20	97.87	101.24	90.53	93.41	92.22
3 ft 0 in.									
3 ft 6 in.	97.27	86.98	90.59	88.07	92.08	94.88	84.45	88.35	93.03
4 ft 0 in.									
4 ft 6 in.	79.89	78.39	86.71	86.45	86.08	92.94	83.96	84.13	92.37
5 ft 0 in.									
5 ft 6 in.	89.52	86.10	88.27	96.78	92.82	95.28	91.34	87.71	94.34
6 ft 0 in.									
6 ft 6 in.	92.12	90.48	89.31	98.08	96.13	96.46	92.13	92.61	93.81
7 ft 0 in.									
7 ft 6 in.	97.39	93.39	94.62	103.69	99.45	102.05	98.11	94.69	99.18
8 ft 0 in.									
8 ft 6 in.	94.05	95.47	96.90	100.38	99.78	102.57	94.96	96.77	99.29
9 ft 0 in.									
9 ft 6 in.	93.01	94.87	97.16	98.07	97.21	100.86	92.10	95.70	98.25
10 ft 0 in.	95.23	93.90	97.45	101.60	97.10	101.56	95.42	94.75	98.29

Note: All density values reported in units of lb per cu ft

Table 3.1 Typical Tabulation of Measured Subgrade Dry Density Values

installed.

Because of the expansive soils encountered in Oklahoma, visual observations of access tube fit, and the differences in moisture content observed between summer and winter months it has been tentatively concluded that differences in measured density are the result of a variable air gap around the access tube, caused by swelling and shrinkage of subgrade soil. In reality one should probably expect lower dry densities during winter months, as moisture increases and soil volume expands. Measured values indicate just the opposite occurrence, thus effects of the variable air gap must obscure any actual decrease in soil dry density. As the minimum air gap occurred when higher moisture contents produced swelling, the larger values of dry density obtained during this period have been taken as being more nearly accurate, and are the ones actually used in computing engineering moisture content.

Display of Subgrade Soils Data

Results of routine soil tests on the material from each center hole are plotted in the form shown by Fig 3.3. A soil log is plotted versus depth and AASHO and UNIFIED classifications are tabulated, as are liquid limit, plasticity index, lineal shrinkage, and specific gravity. Pavement thickness data, as obtained from actual pavement cores, is also included. Base material is also indicated, to the extent that same could be identified during the site installation process. Some discrepancies have been found between drilling log data on base materials (principally lack of it) and OSHD records of actual roadway design. In most cases of discrepancy a non-stabilized base was used and appears to have been destroyed or dispersed by subgrade intrusion.

SITE NO.: 29
 COUNTY: Tulsa
 HIGHWAY: US 64

○ LIQUID LIMIT
 △ PLASTIC LIMIT
 □ LINEAL SHRINKAGE

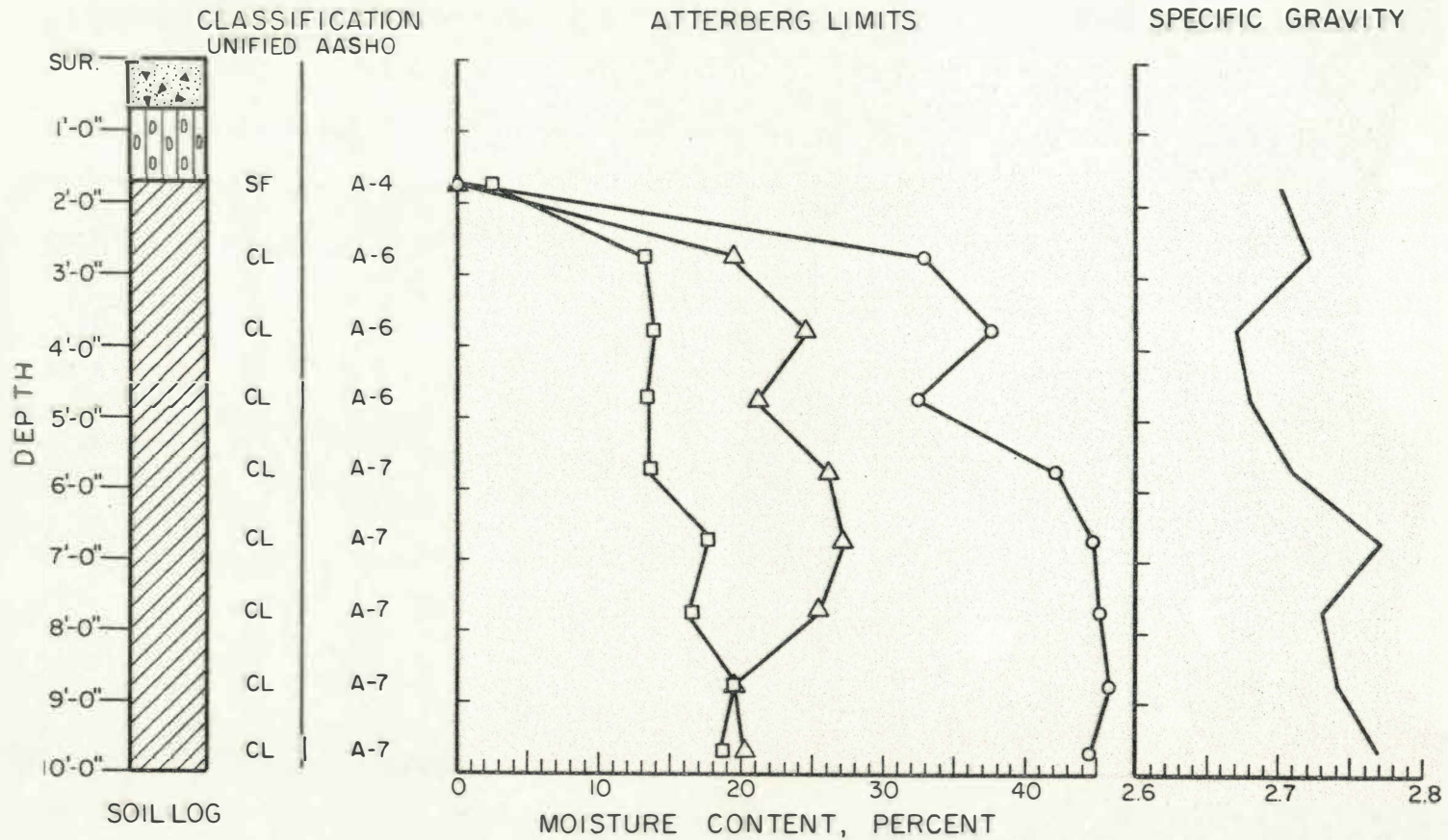


Figure 3.3 Typical Soils Data for a Field Test Site

Display of Climate Data

Temperature and precipitation records have been plotted for each site, as shown in Fig 3.4. Mean monthly values of high temperature and low temperature, as well as total precipitation, are plotted versus month of record. Data were taken from Climatological Data - Oklahoma. Recording stations are within 10 miles of each field test site.

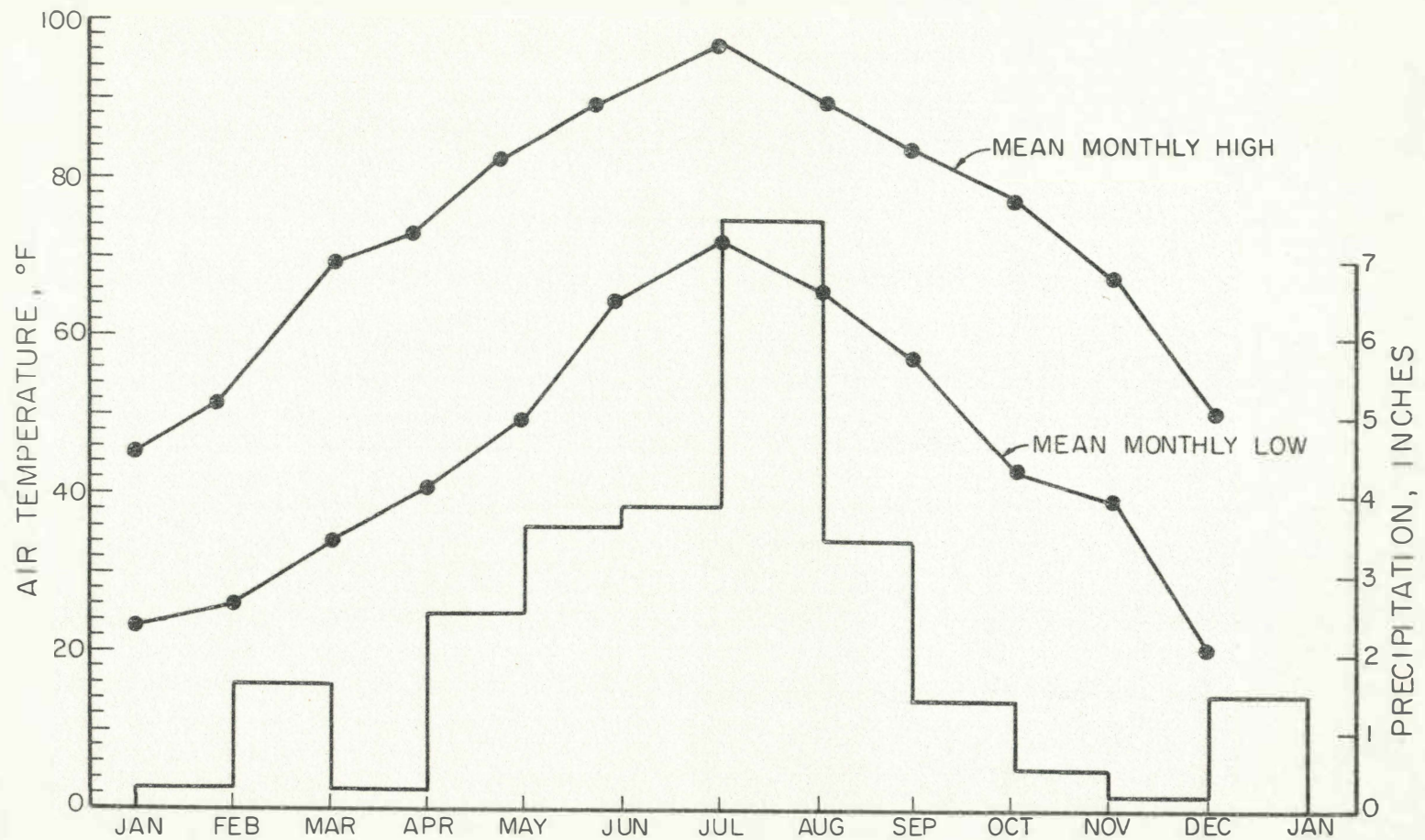
Display of Miscellaneous Data

Various other data for each test site are summarized on a test site summary sheet, shown in Fig 3.5. Data include site location and description, pavement type, condition, and history, traffic count, and field observations by research personnel. Exact orientation of the test site is indicated on the test site installation sheet, shown in Fig 3.6. This sheet is actually completed at the time of site installation.

Organization of Collected Data in Appendix Form

All data collected for each of the first 30 sites during the period June 1966-August 1967 is included in Appendix 4. A colored sheet labelled with the site number precedes the site data, organized in the form:

1. Test Site Data Summary Sheet,
2. Test Site Installation Sheet,
3. Soils Data Summary Sheet,
4. Temperature/Precipitation Record (2 sheets),
5. Measured Moisture Variations (3 sheets), and
6. Tabulated Values of Dry Density.



SITE NO: 2
COUNTY: Payne
HIGHWAY: SH 51

Figure 3.4 Typical Temperature and Precipitation Plot

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TEST SITE DATA SUMMARY SHEET

LOCATION DATA:

Site No. 27 Highway No. I 35 County: Logan Date Installed: 9/6/66

Distance from access tube to Lane ℄: 21' 0" a, 1' 0" b, 13' 0" c

Exact Location:

In Logan County southwest of Guthrie, 6.0 miles north on I 35 from jct. of I 35 and S 33. Approximately 100 yds south of overpass. Site in west lane of divided highway. Marker on west fence row.

PAVEMENT/DESIGN DATA:

No. of Lanes: 4D Pavement Type: PCC Shoulder Type: Improved

Pavement Thickness: 10 in. ℄, 3 in. Edge Latest Pavement Condition Rating: Good

Latest Traffic Count: 7400 vpd Heavy Truck Traffic: Yes

Terrain: Upland/ Drainage: Good Year of Original Paving: 1960
Cut

Original Design and History:

24 ft width; ℄ to 12 ft lt and rt: 9 in. air-entrained PCC/4in. sand/8 in. subbase; inside 12 ft to 16 ft and outside 12 ft to 22 ft: double bituminous surface shoulder over 7 in. soil-cement base.

FIELD OBSERVATIONS BY RESEARCH PERSONNEL:

12/15/66 - Large transverse crack across pavement 3 ft from expansion joint, between site and north expansion joint.

3/23/67 - Protective cover of hole "a" regouted.

Figure 3.5 Sample Test Site Data Summary Sheet

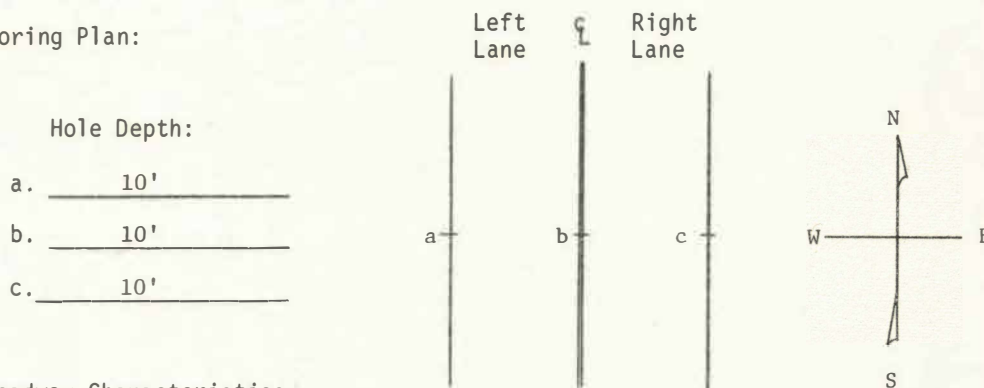
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OKLAHOMA STATE UNIVERSITY
Stillwater, Oklahoma
SUBGRADE MOISTURE VARIATION STUDY
SITE INSTALLATION INFORMATION

Installation: Noble I. 35 3 Date: 5 7 66
County Highway No. day month year

Location of site: Northwest of Perry, 1.8 miles north on I.-35 from intersection
of I.-35 and U.S. 64. Site in East lane, approximately 100 yards south of
"Tonkawa 31, Wichita 101" mileage sign.

Description of Terrain and Vegetation: Adequate drainage - good grass cover,
Pavement on open, gently rolling upland terrain.

Boring Plan:



Roadway Characteristics:

Pavement: Type Asphaltic Concrete
Width 23' Thickness 6"
Condition Good
Shoulders: Type _____ Width L-10' R-4'
Condition Improved

Base Course Characteristics Select gravel

Figure 3.6 Sample Site Installation Information Sheet

CHAPTER 4. CONCLUSION

This report has identified the particular data collected by project personnel, described procedures used for data reduction and display, and presented all data collected at the first 30 field test sites installed, during the initial 12 months of measurement. Some discussion of data collection procedures is given, but no attempt at data evaluation or correlation is made. These topics will be the subject of a forthcoming interim report. The prime purpose of this report is to provide a convenient reference for use by project personnel in data evaluation and correlation.

It is anticipated that this data summary will be revised and updated each year until project termination in 1970. Considerable time and expense is involved in preparation and publication of annual data summaries. However, considering the volume and diversity of field data collected by research personnel, the benefits are felt to greatly exceed the costs.

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2. Heiliger, Wayne L., and T. Allan Haliburton. "Interim Report II: Access Tube Installation." Subgrade Moisture Variations Research Project, School of Civil Engineering, Oklahoma State University, Stillwater, Oklahoma, January, 1967.
3. Manke, Phillip G., and E. Walter LeFevre. "Interim Report III: A Preliminary Standardization and Calibration Procedure for Nuclear Moisture/Density Gages." Subgrade Moisture Variations Research Project, School of Civil Engineering, Oklahoma State University, Stillwater, Oklahoma, May, 1967.
4. Moore, Raymond K., and T. Allan Haliburton. "Interim Report IV: Suggested Nuclear Depth Gage Calibration Procedures." Subgrade Moisture Variations Research Project, School of Civil Engineering, Oklahoma State University, Stillwater, Oklahoma, January, 1968.

APPENDIX 1
SAMPLE FIELD DATA SHEETS

SCHOOL OF CIVIL ENGINEERING
OKLAHOMA STATE UNIVERSITY
SUBGRADE MOISTURE VARIATIONS RESEARCH PROJECT
FIELD TEST SITE INSTALLATION
DRILLING RECORD

Site No. _____ Highway _____ Date _____ Hole: _____ a _____ b _____ c
Drilling Crew: _____ Pavement Type: _____ Base Type: _____
_____ Core Thickness: _____ Subbase Type: _____

Depth (ft)	Sample No.	Description of Stratum
	1	
	2	
	3	
	4	
	5	
	6	
	7	
	8	
	9	
	10	

Figure A1.1 Field Test Site Installation Drilling Log

SCHOOL OF CIVIL ENGINEERING
OKLAHOMA STATE UNIVERSITY

SUBGRADE MOISTURE VARIATIONS RESEARCH PROJECT
NUCLEAR DATA COLLECTION RECORD

Site No: _____ Highway: _____ County: _____ Date: _____ Hole: a b c d e

_____ Moisture Data Collected Probe No: _____ Gain: _____ Probe Voltage: _____

_____ Density Data Collected Scaler No: _____ Count: _____ 30 sec _____ 60 sec

Collected by: _____ Initial Battery Voltage: _____ Final Battery Voltage: _____

Level*						Ref Stds
1						1
2						2
3						3
Σ						4
Av						5

						6
Level*						7
1						8
2						9
3						10
Σ						Σ
Av						Av

Level*						
1						
2						
3						
Σ						
Av						

Level*						
1						
2						
3						
Σ						
Av						

*All levels measured in feet and inches from bottom of access tube to bottom of probe.

Figure A1.3 Nuclear Data Collection Record

APPENDIX 2

FIELD TEST SITE LOCATIONS, SITES NO. 1 - 30

FIELD TEST SITE LOCATIONS, SITES NO. 1 - 30

Site No. 1

In Payne Co. northwest of Perkins, 0.3 mile north on US 177 from wye jct. of US 177 and S 33, adjacent to mileage sign indicating 10 miles to Stillwater. Marker on west fence row. Site on level upland terrain.

Site No. 2

In Payne Co. east of Stillwater, approximately 300 yds east on S 51 from GRDA sub-station. Site in rolling upland area. Marker on south fence row. GRDA sub-station is approximately 1.5 miles east of Stillwater on S 51.

Site No. 3

In Noble Co. northwest of Perry, 1.8 miles north on I 35 from jct. of I 35 and US 64. Site in east lane, approximately 100 yds south of "Tonkawa 31, Wichita 101" mileage sign. Marker on east fence row. Site on open, gently rolling upland terrain.

Site No. 4

In Pawnee Co. southeast of Pawnee, 4.8 miles east on US 64 from Oklahoma Highway Department division yard on outskirts of Pawnee, $\frac{1}{4}$ mile east of bridge over Bear Creek, $\frac{1}{4}$ mile west of Santa Fe railroad bridge overpass. Marker on south fence row. Site in creek-bottom area.

Site No. 5

In Osage Co. northeast of Pawhuska, 1.5 miles southwest on US 60 from jct. of US 60 and S 99, approximately 100 ft southwest of US 60 - S 99 route marker facing southwest. Marker on northwest fence row. Site on open upland terrain.

Site No. 6

In Washington Co. east of Bartlesville, 6.2 miles east on US 60 from jct. of US 60 and US 75, approximately 200 yds west on US 60 from Hog Shooter Creek. Site on fill section in creek-bottom area. Marker on south fence row.

Site No. 7

In Craig Co. west of Vinita, 0.6 mile east on US 66-60 from wye jct. of US 66 and US 60. In south lane of divided highway, approximately 30 ft west of entrance to Martin ranch. Marker on south fence row. Site on open gently rolling upland terrain.

Site No. 8

In Mayes Co. south of Pryor, 0.2 miles north on US 69 from jct. of US 69 and US 69A. Approximately adjacent to billboard facing north on west side of highway. Marker on east fence row. Site on open, fairly level upland terrain.

Site No. 9

In Muskogee Co. northeast of Muskogee, in west-bound lane of US 64 0.7 miles west from Arkansas River bridge. Marker on north fence row. Site in rolling upland area.

Site No. 10

In Okmulgee Co. north of Okmulgee, 2.0 miles north on US 75 from railroad crossing, end of divided highway, and Okmulgee north city limit. Site in west lane of divided highway, marker on west fence row. Site on upland terrain in slight cut.

Site No. 11

In Creek Co. west of Sapulpa, 1.3 miles east on US 66 from jct. of US 66 and S 33, adjacent to an "Animal Clinic". Marker on south fence row. Site in creek-bottom area.

Site No. 12

In Creek Co. north of Bristow, 2.6 miles north on US 66 from jct. of US 66, S 48, and S 16, 0.3 miles north of bridge over Sand Creek. Marker on west fence row. Site on upland terrain in slight cut.

Site No. 13

In Lincoln Co. west of Chandler, 0.8 miles west on US 66 from jct. of US 66 and S 18, 200 ft west of Champlin service station. Marker on south fence row. Site in rolling hilly terrain.

Site No. 14

This site has been abandoned.

Site No. 15

In Osage Co. east of Ponca City, 1.6 miles east of US 60 from jct. of US 60, S 11, and US 177. Marker on north fence row. Site on level upland terrain.

Site No. 16

In Nowata Co. east of Nowata, 0.3 mile south on S 28 from jct. of US 60 and S 28. Marker on west fence row. Site on upland terrain.

Site No. 26

In Pawnee Co. southeast of Cleveland, 2.4 miles southeast on US 64 from jct. of US 64 and S 99, 0.5 mile southeast of Cleveland drive-in theater. Marker on southwest fence row. Site on hilly upland terrain.

Site No. 27

In Logan Co. northeast of Guthrie, 6.0 miles north on I 35 from jct. of I 35 and S 33. Approximately 100 yds south of overpass. Site in west lane of divided highway. Marker on west fence row. Site in slight cut on rolling, upland terrain.

Site No. 28

In Payne Co. east of Cushing, 1.5 miles east on S 33 from jct. of S 33 and S 18, at end of four-lane undivided highway. Marker on north fence row. Site in creek-bottom area.

Site No. 29

In Tulsa Co. southeast of Bixby, 5.5 miles south and east on US 64 from jct. of US 64 and S 67, 0.8 mile east of bridge over Snake Creek. Marker on south fence row. Site on slight fill in creek-bottom area.

Site No. 30

In Tulsa Co. east of Sand Springs, 0.5 mile east on US 64 from US 64 - S 151 overpass, 100 ft east of "Keystone Dam - ST 51" exit sign. Site in north lane of divided highway $\frac{1}{2}$ mile north of Arkansas River, marker on north fence row. Site on slight fill in Arkansas River bottom.

APPENDIX 3

PAVEMENT RATINGS AND RATING PROCEDURE

SITE NUMBER	CONDITION RATING PAVEMENT	CONDITION RATING SHOULDERS
1	91	Unimproved
2	81	94
3	93	96
4	50	Unimproved
5	64	65
6	85	Unimproved
7	85	91
8	60	85
9	95	92
10	87	79
11	90	91
12	97	95
13	79	Unimproved
14	Abandoned	Abandoned
15	91	94
16	90	90
17	75	80
18	Abandoned	Abandoned
19	82	93
20	96	93
21	95	92
22	89	95
23	92	90
24	90	85
25	65	80
26	97	94
27	88	92
28	94	90
29	93	91
30	97	90

Table A3.1 Pavement and Shoulder Ratings for Each Test Site

PAVEMENT RATING PROCEDURE

The Oklahoma Department of Highways used conventional procedures to rate highway pavement and shoulders for use in this research study. Their method consisted of a visual inspection and evaluation of pavement and shoulder surfaces, based on type and total number of surface defects. Profilometer and Benkleman beam data were not collected.

Ratings are expressed as a percentage with 100% being perfect. Excellent pavements rate from 90-100%, while lesser ratings of good (80-90%), fair (65-80%), and poor (50-65%) are also assigned. Major defects which affect pavement rating are

1. number of patches,
2. surface cracking,
3. raveling in flexible pavement,
4. localized base failures,
5. mud or water pumping by rigid pavement,
6. faulting or differential vertical displacement of rigid pavement,
7. corner breaks on rigid pavement, and
8. spalling or chipping at rigid pavement joints.

Shoulders are rated in similar manner, though total number and type of defects may be less on wide shoulders.

Additional information concerning actual methodology may be obtained from the Oklahoma Department of Highways, Research and Development Division, Jim Thorpe Building, Oklahoma City, Oklahoma.

APPENDIX 4

DATA COLLECTED AT TEST SITES NO. 1 - 30

SITE NO. 1

SCHOOL OF CIVIL ENGINEERING
OKLAHOMA STATE UNIVERSITY
SUBGRADE MOISTURE VARIATIONS PROJECT
TEST SITE DATA SUMMARY SHEET

LOCATION DATA:

Site No. 1 Highway No. US 177 County: Payne Date Installed: 6/30/66

Distance from access tube to Lane ℄: 9'6" a, 1'0" b, 9'6" c

Exact Location:

In Payne County, northwest of Perkins, 0.3 mile north on US 177 from wye junction of US 177 and S 33. Marker on west fence row.

PAVEMENT/DESIGN DATA:

No. of Lanes: 2 Pavement Type: PCC Shoulder Type: Natural

Pavement Thickness: 7 in.℄, 10 in. Edge Latest Pavement Condition Rating: Fair

Latest Traffic Count: 2200 vpd Heavy Truck Traffic: No

Terrain: Upland Drainage: Poor Year of Original Paving: 1931

Original Design and History:

Variable section PCC, 20 ft width; ℄ to 6 ft rt and lt: 6in. PCC; 6 ft to 10 ft rt and lt: 10 in. PCC.

No subbase.

FIELD OBSERVATIONS BY RESEARCH PERSONNEL:

10/21/66 - All protective covers regouted

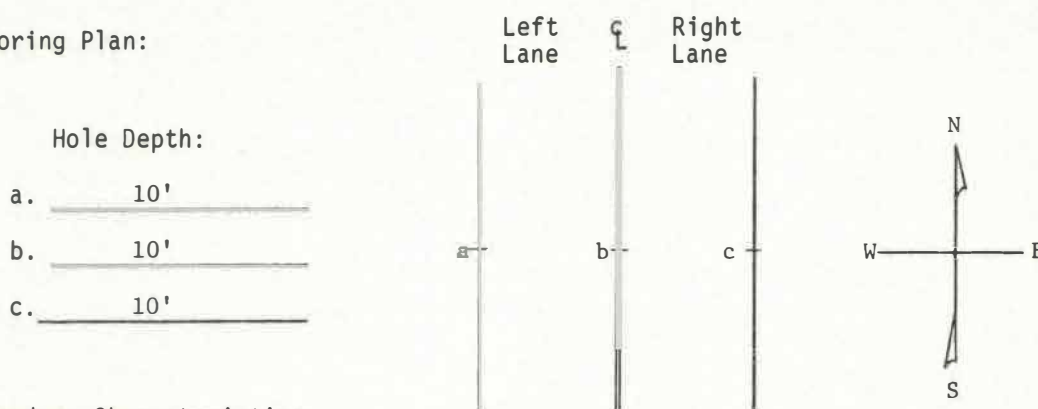
SCHOOL OF CIVIL ENGINEERING
OKLAHOMA STATE UNIVERSITY
Stillwater, Oklahoma
SUBGRADE MOISTURE VARIATION STUDY
SITE INSTALLATION INFORMATION

Installation: Payne U.S. 177 1 Date: 30 6 66
County Highway No. day month year

Location of site: Northwest of Perkins, 0.3 miles North on U.S. 177 from wye
intersection of U.S. 177 and St. 33, adjacent to sign indicating 10 miles from
Stillwater.

Description of Terrain and Vegetation: Farmland on E. slightly higher than
roadway. Pavement on level upland terrain.

Boring Plan:



Roadway Characteristics:

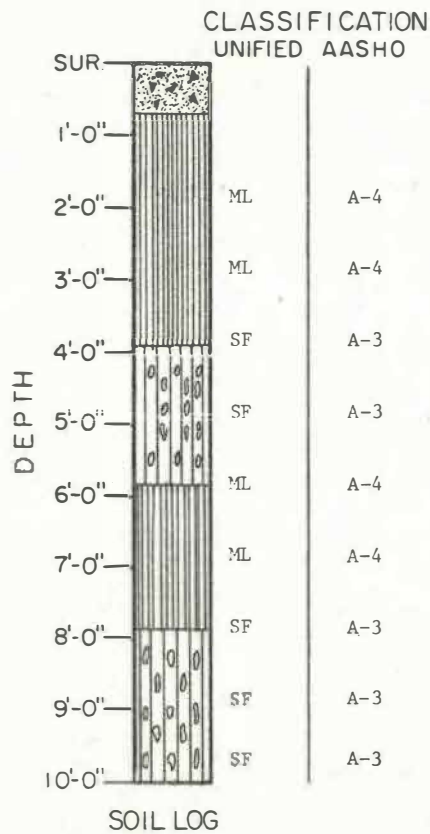
Pavement: Type P.C. Concrete
Width 20' Thickness 9" - 7" - 9"
Condition Fair

Shoulders: Type Bermuda Grass Width 15' to Barditch
Condition Unimproved

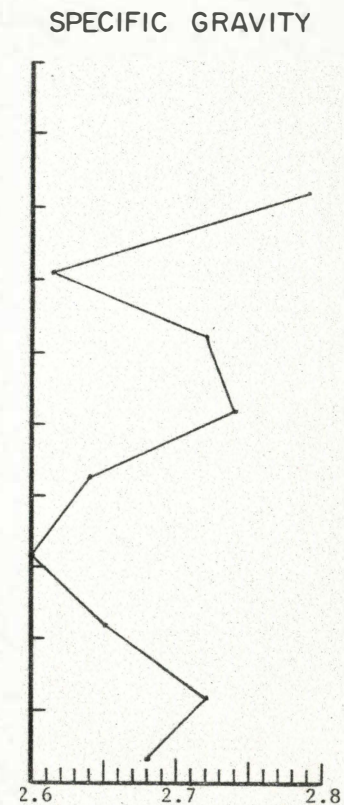
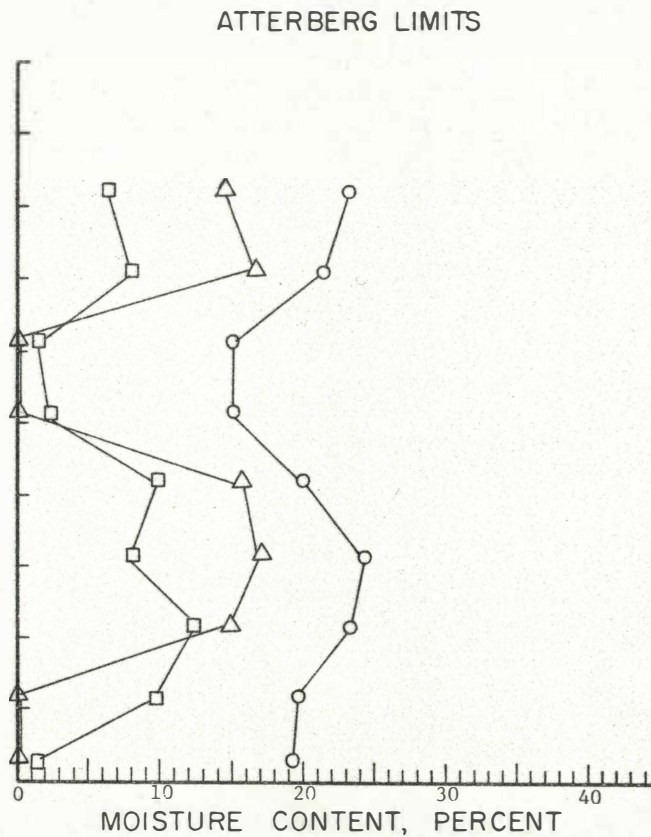
Base Course Characteristics 6" Sand

SITE NO: 1
 COUNTY: Payne
 HIGHWAY: U.S. 177

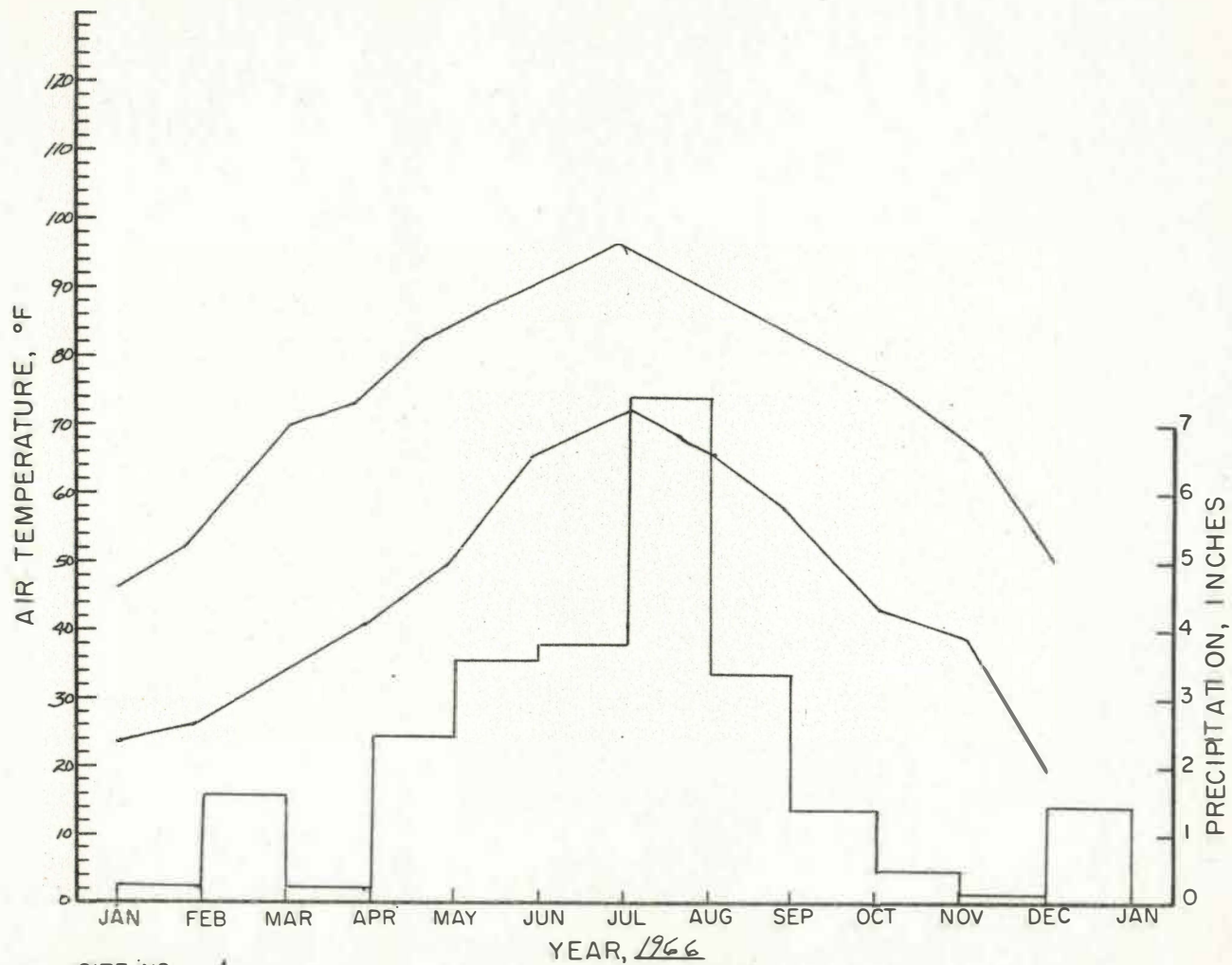
● LIQUID LIMIT
 ▲ PLASTIC LIMIT
 ■ LINEAL SHRINKAGE



DATE: 17 November 1967
 PLOTTED BY: AAP

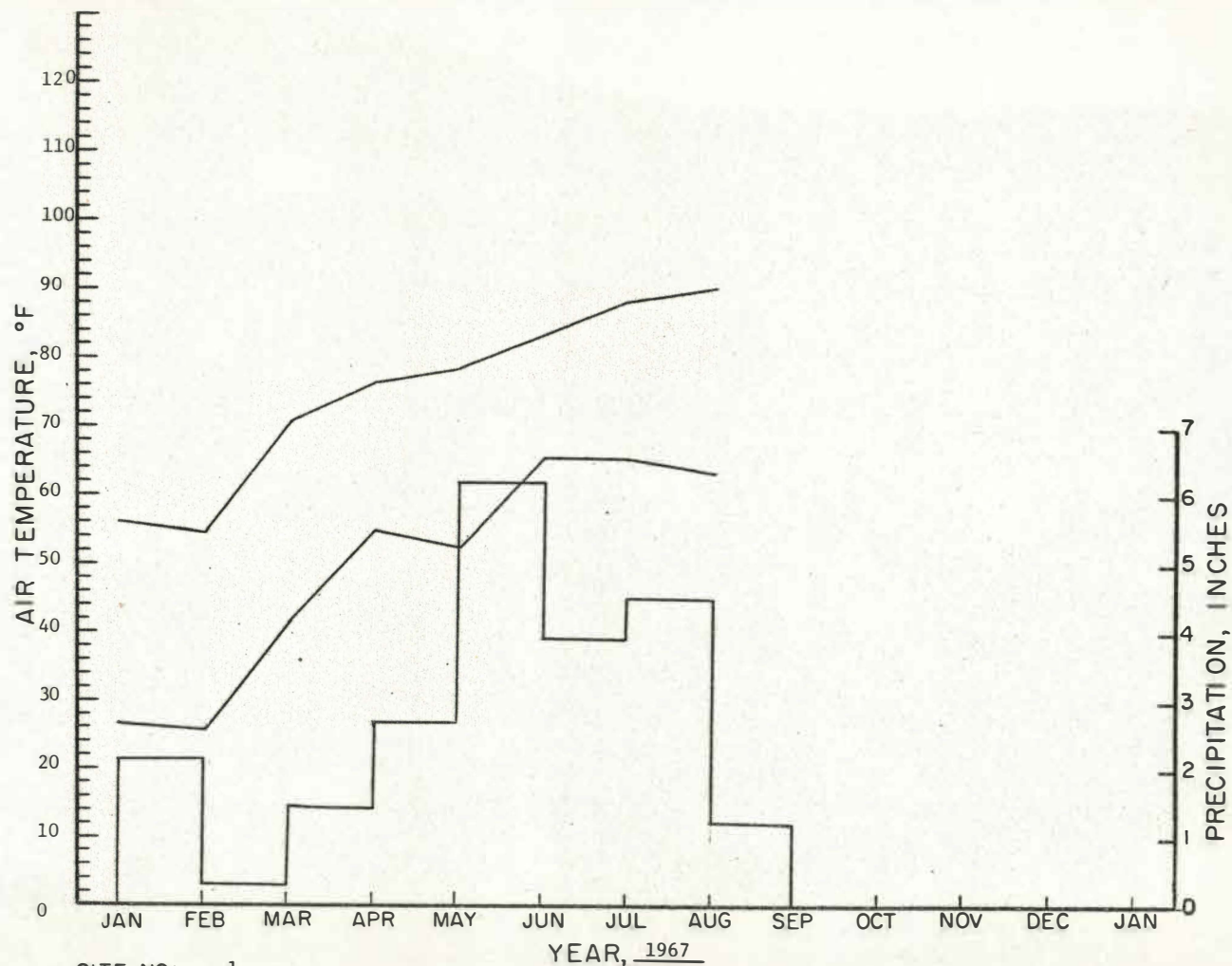


SUBGRADE MOISTURE VARIATIONS PROJECT



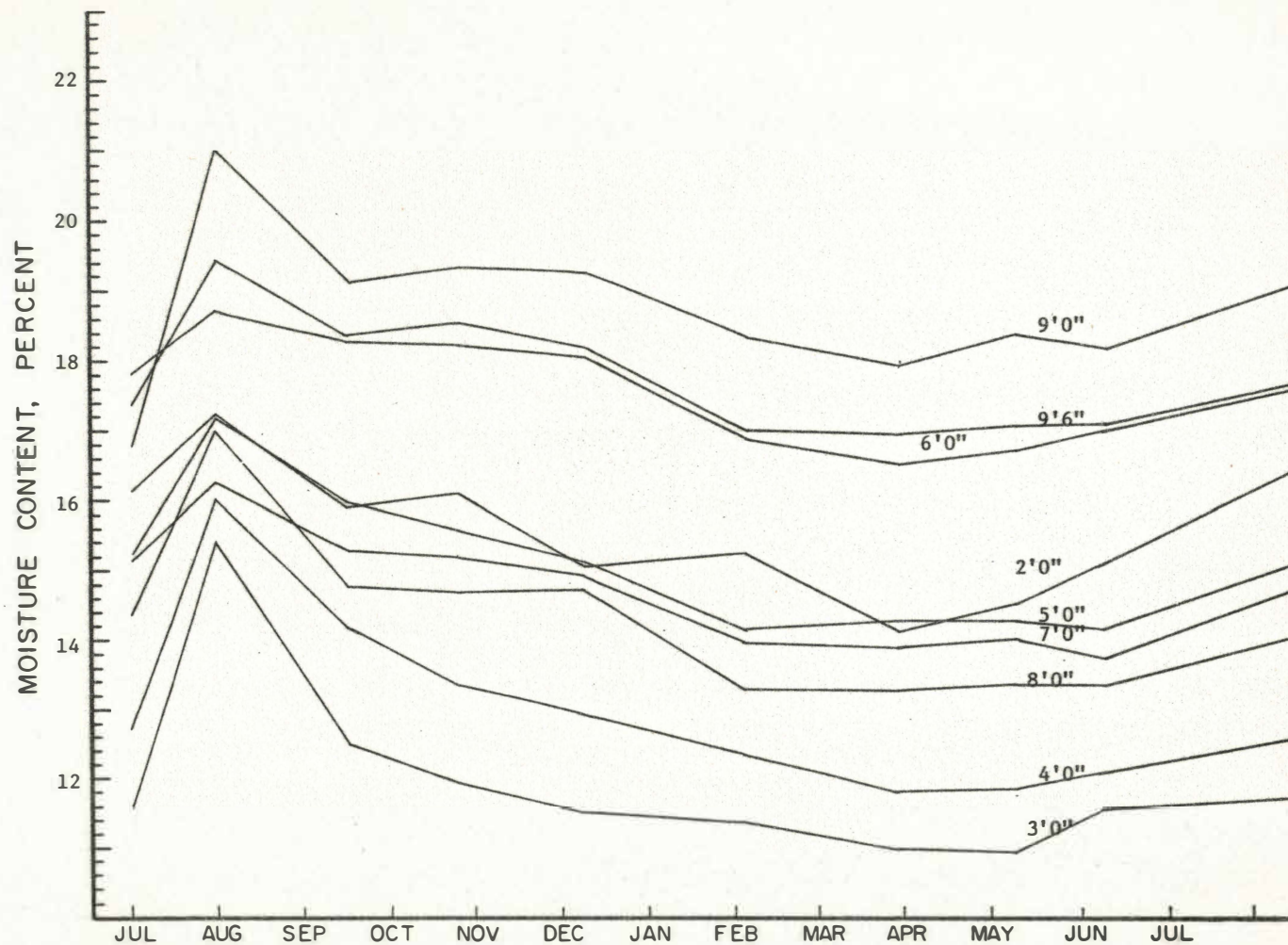
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COUNTY: PRYNE
HIGHWAY: US 177

SUBGRADE MOISTURE VARIATIONS PROJECT



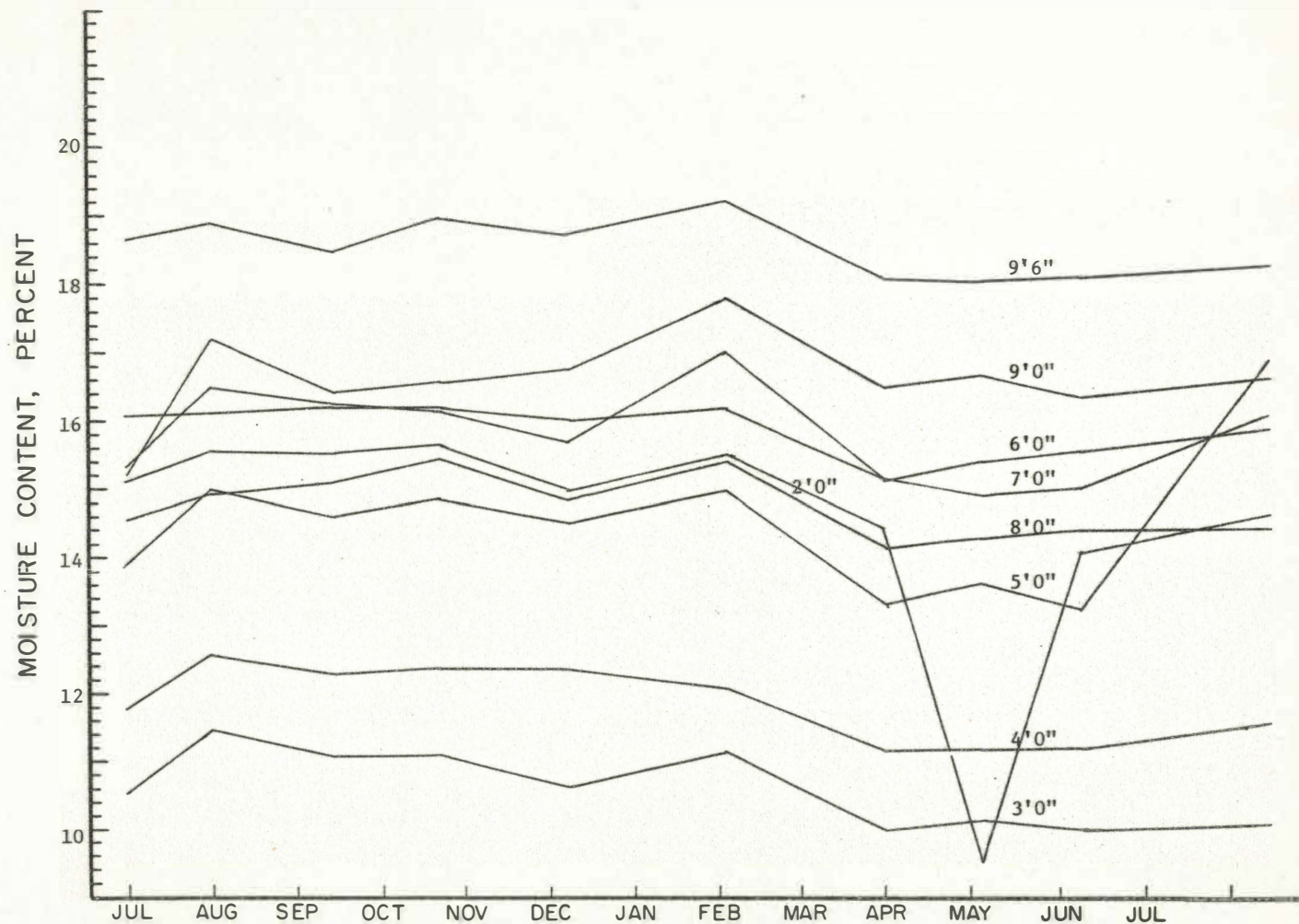
SITE NO: 1
 COUNTY: Payne
 HIGHWAY: US 177

SUBGRADE MOISTURE VARIATIONS PROJECT



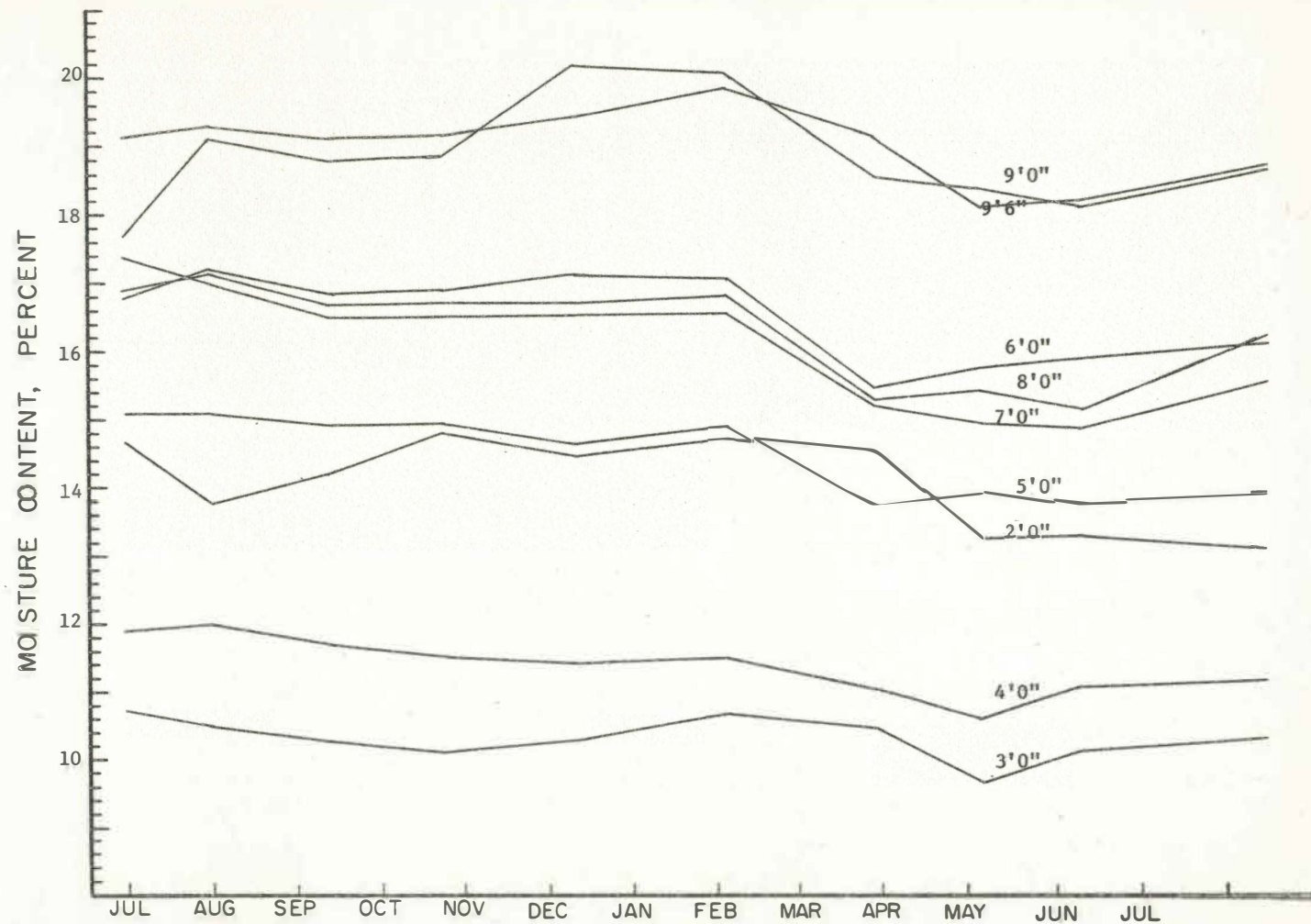
SITE NO: 1-A
COUNTY: Payne
HIGHWAY: US 177

SUBGRADE MOISTURE VARIATIONS PROJECT



SITE NO: 1-B
 COUNTY: Payne
 HIGHWAY: US 177

SUBGRADE MOISTURE VARIATIONS PROJECT



SITE NO: 1-c
COUNTY: Payne
HIGHWAY: US 177

SUBGRADE MOISTURE VARIATIONS PROJECT

SCHOOL OF CIVIL ENGINEERING
OKLAHOMA STATE UNIVERSITY

SUBGRADE MOISTURE VARIATIONS RESEARCH PROJECT

SUBGRADE SOIL DRY DENSITY TABULATION

Date of Measurement	August 1966			January 1967			August 1967		
Site & Hole Number	1-A	1-B	1-C	1-A	1-B	1-C	1-A	1-B	1-C
Depth from top of tube to bottom of probe									
1 ft 6 in.				114.87	126.85	131.42	99.06	96.06	101.45
2 ft 0 in.									
2 ft 6 in.	89.02	91.92	94.70	94.20	97.87	101.24	90.53	93.41	92.22
3 ft 0 in.									
3 ft 6 in.	97.27	86.98	90.59	88.07	92.08	94.88	84.45	88.35	93.03
4 ft 0 in.									
4 ft 6 in.	79.89	78.39	86.71	86.45	86.08	92.94	83.96	84.13	92.37
5 ft 0 in.									
5 ft 6 in.	89.52	86.10	88.27	96.78	92.82	95.28	91.34	87.71	94.34
6 ft 0 in.									
6 ft 6 in.	92.12	90.48	89.31	98.08	96.13	96.46	92.13	92.61	93.81
7 ft 0 in.									
7 ft 6 in.	97.39	93.39	94.62	103.69	99.45	102.05	98.11	94.69	99.18
8 ft 0 in.									
8 ft 6 in.	94.05	95.47	96.90	100.38	99.78	102.57	94.96	96.77	99.29
9 ft 0 in.									
9 ft 6 in.	93.01	94.87	97.16	98.07	97.21	100.86	92.10	95.70	98.25
10 ft 0 in.	95.23	93.90	97.45	101.60	97.10	101.56	95.42	94.75	98.29

Note: All density values reported in units of lb per cu ft

SCHOOL OF CIVIL ENGINEERING
OKLAHOMA STATE UNIVERSITY
SUBGRADE MOISTURE VARIATIONS PROJECT
TEST SITE DATA SUMMARY SHEET

LOCATION DATA:

Site No. 2 Highway No. S 51 County: Payne Date Installed: 7/1/66
Distance from access tube to Lane ℓ: 11'6" a, 1'0" b, 11'6" c, 1'0" d

Exact Location:

In Payne County east of Stillwater, approximately 300 yards east on S 51 from GRDA sub-station. Marker on south fence row.

PAVEMENT/DESIGN DATA:

No. of Lanes: 2 Pavement Type: AC/PCC Shoulder Type: Improved-AC
Pavement Thickness: 9 in. ℓ, 1 in. Edge Latest Pavement Condition Rating: Good
Latest Traffic Count: 4800 vpd Heavy Truck Traffic: No
Terrain: Upland Drainage: Good Year of Original Paving: 1930

Original Design and History:

Variable section PCC, 24 ft width, AC overlay in 1955; ℓ to 9 ft rt and lt: 4 in AC/7 in. PCC; 9 ft to 12 ft rt and lt: 11 in. AC; 12 ft to 22 ft rt and lt: 1 in. sealed shoulder.

No subbase, top 6 in. of subgrade compacted to 95% SPD.

FIELD OBSERVATIONS BY RESEARCH PERSONNEL:

10/14/66 - Access tube "d" shortened 6 in.

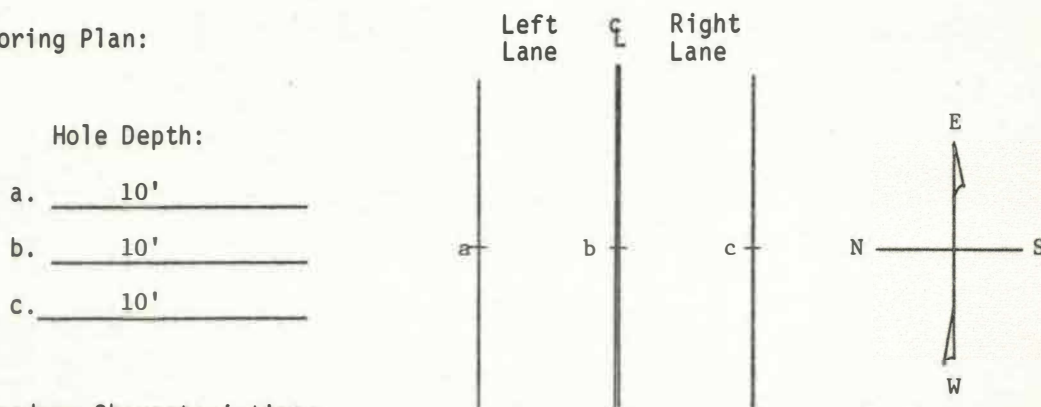
SCHOOL OF CIVIL ENGINEERING
OKLAHOMA STATE UNIVERSITY
Stillwater, Oklahoma
SUBGRADE MOISTURE VARIATION STUDY
SITE INSTALLATION INFORMATION

Installation: Payne St. 51 2 Date: 1 7 66
County Highway No. day month year

Location of site: East of Stillwater approximately 300 yards east on St. 51
from G.R.D.A. Sub-station.

Description of Terrain and Vegetation: Pavement on rolling upland terrain.

Boring Plan:



Roadway Characteristics:

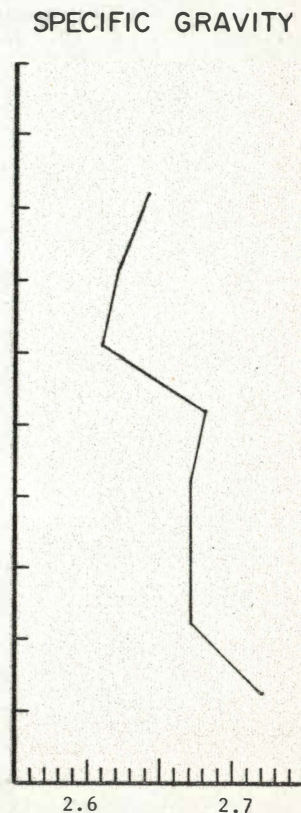
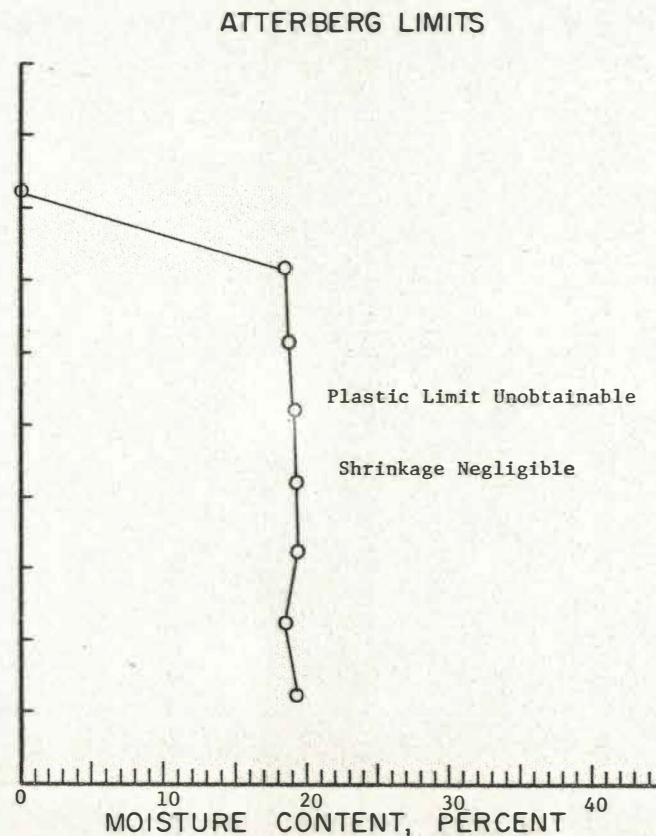
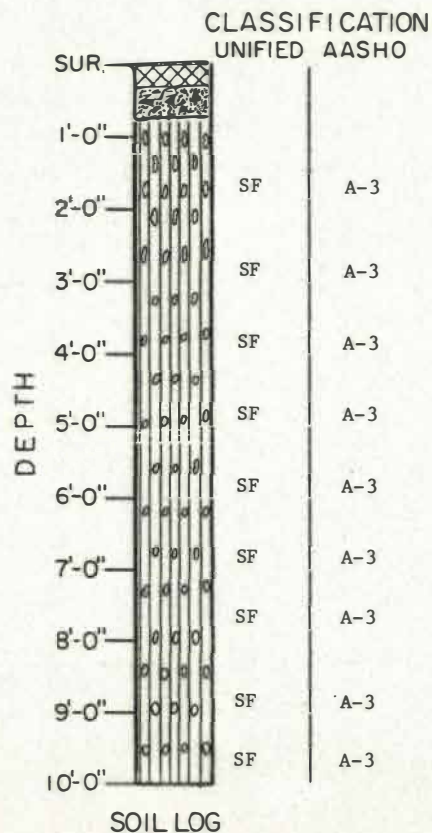
Pavement: Type Asphaltic concrete over P.C. Concrete
Width 24' Thickness 3" A.C. - 6" P.C.
Condition Good

Shoulders: Type Asphalt over P.C. Concrete Width 11'
Condition Barditch on both sides - Good drainage

Base Course Characteristics Natural sand

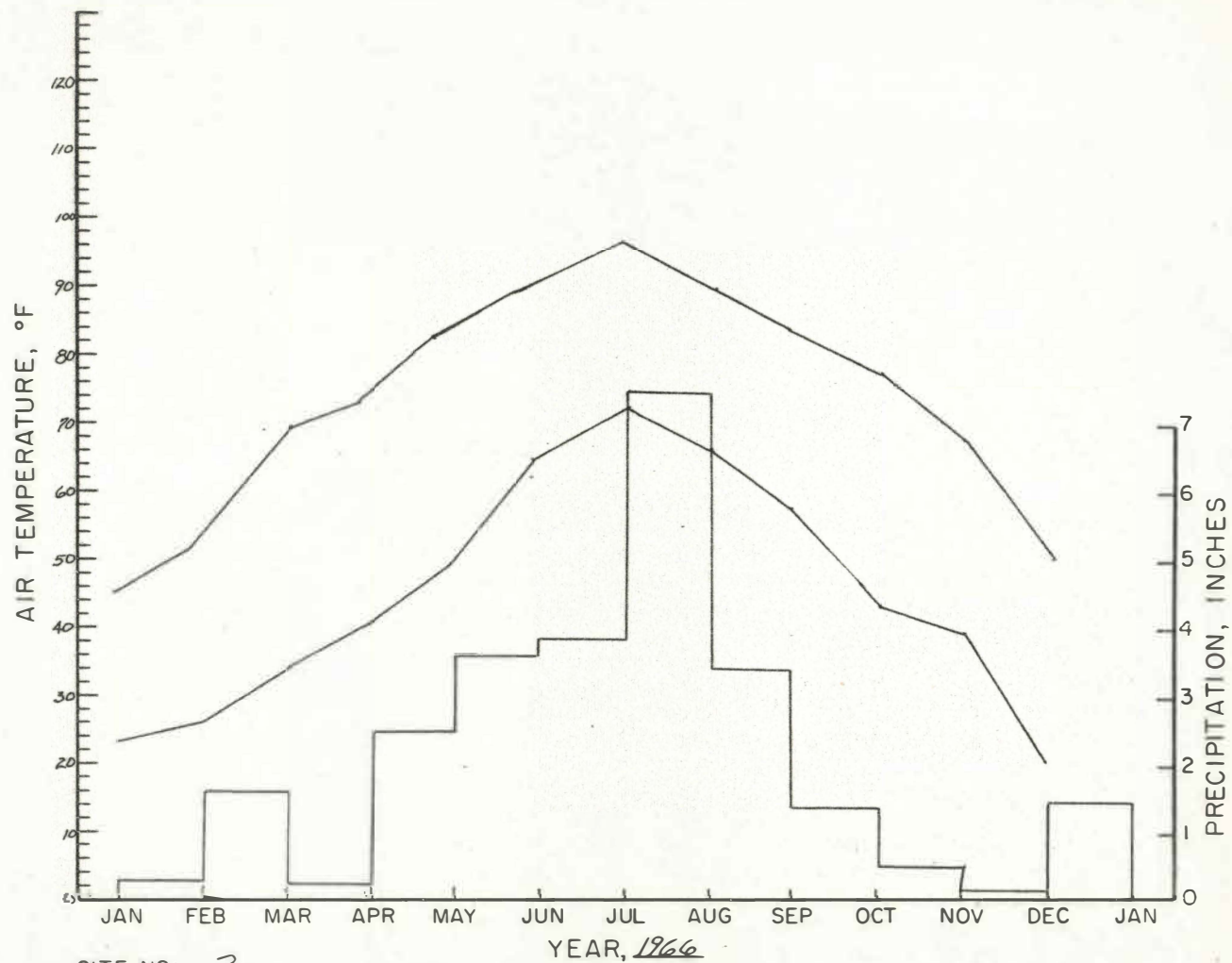
SITE NO.: 2
 COUNTY : Payne
 HIGHWAY : St 51

● LIQUID LIMIT
 ▲ PLASTIC LIMIT
 ■ LINEAL SHRINKAGE



DATE : 17 November 1967
 PLOTTED BY : AAP

SUBGRADE MOISTURE VARIATIONS PROJECT



SITE NO: 2

COUNTY: PRYNE

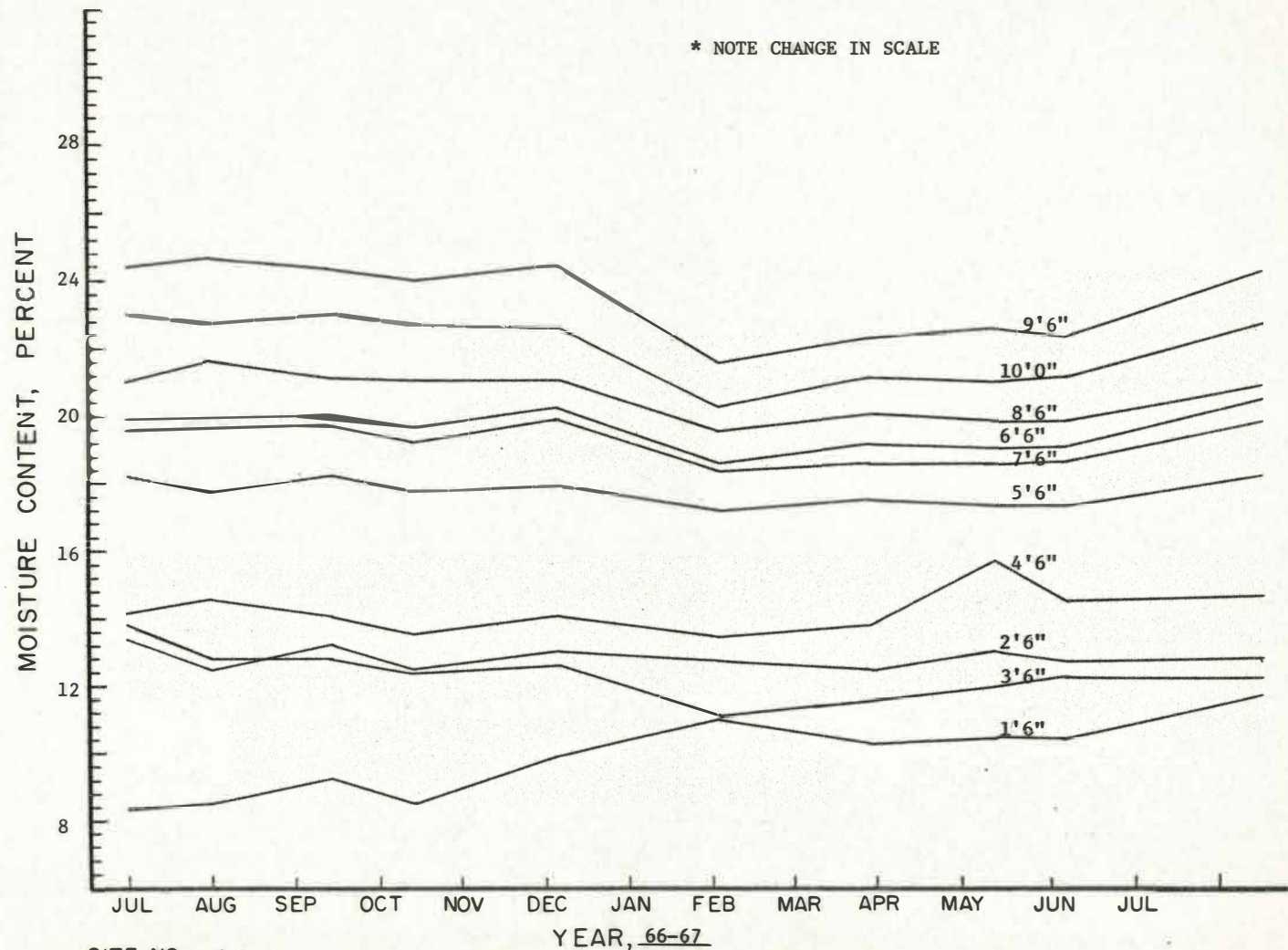
HIGHWAY: S.H. 51

SUBGRADE MOISTURE VARIATIONS PROJECT



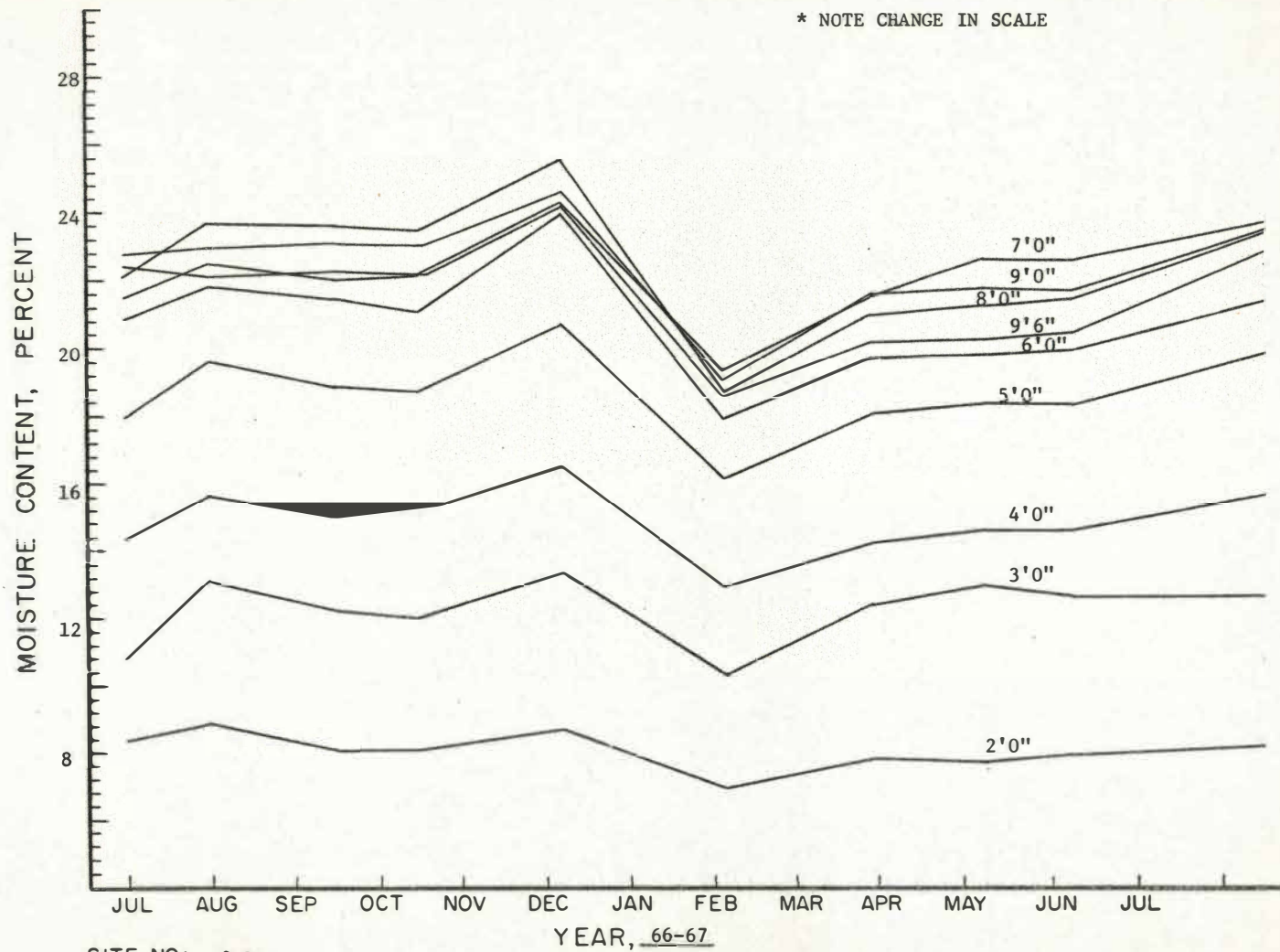
SITE NO: 2
COUNTY: Payne
HIGHWAY: SH 51

SUBGRADE MOISTURE VARIATIONS PROJECT



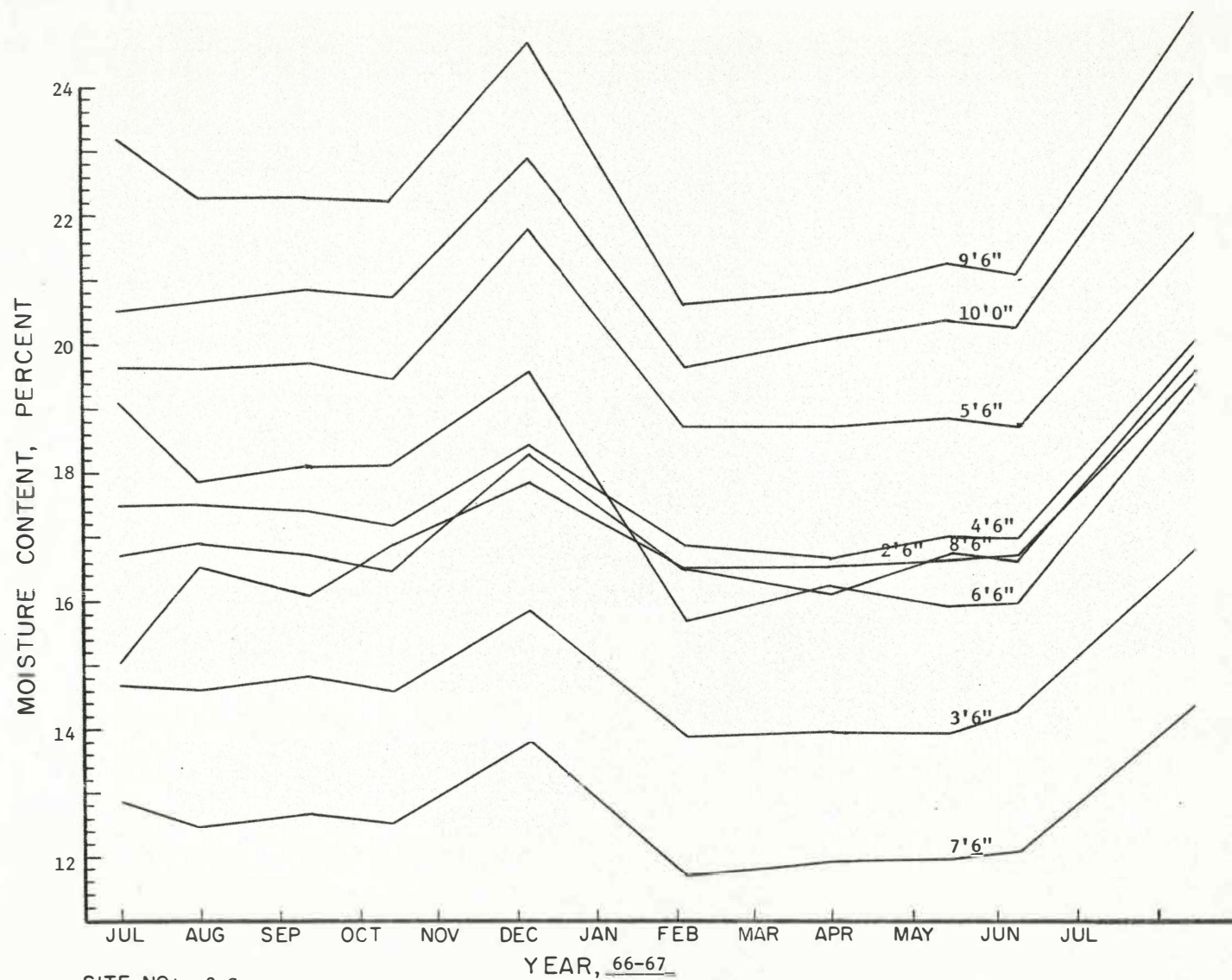
SITE NO: 2-A
 COUNTY: Payne
 HIGHWAY: State 51

SUBGRADE MOISTURE VARIATIONS PROJECT



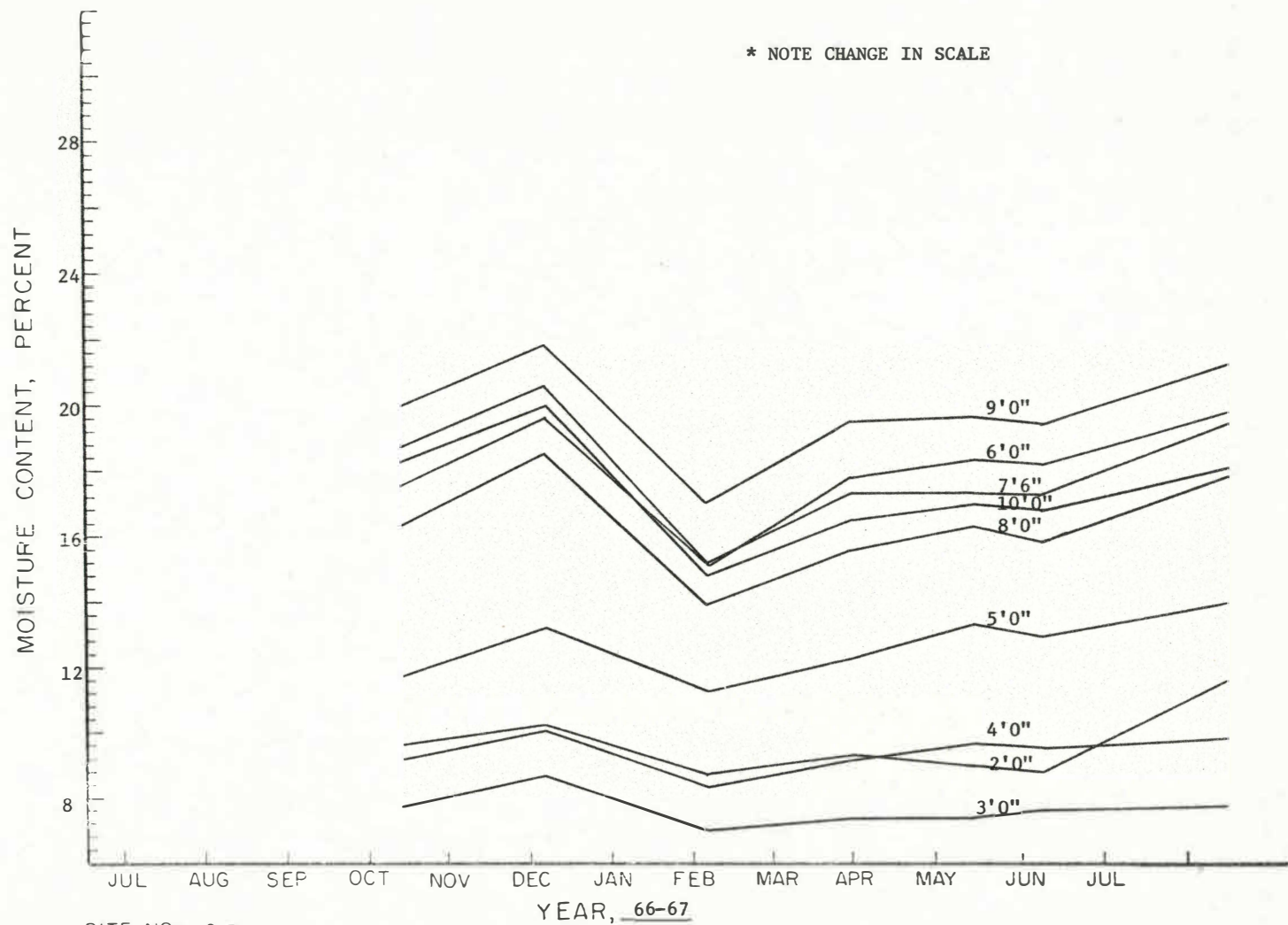
SITE NO: 2-B
 COUNTY: Payne
 HIGHWAY: State 51

SUBGRADE MOISTURE VARIATIONS PROJECT



SITE NO: 2-C
 COUNTY: Payne
 HIGHWAY: State 51

SUBGRADE MOISTURE VARIATIONS PROJECT



SITE NO 2-D
 COUNTY Payne
 HIGHWAY State 51

SUBGRADE MOISTURE VARIATIONS PROJECT

SCHOOL OF CIVIL ENGINEERING
OKLAHOMA STATE UNIVERSITY

SUBGRADE MOISTURE VARIATIONS RESEARCH PROJECT

SUBGRADE SOIL DRY DENSITY TABULATION

Date of Measurement	August 1966			January 1967			August 1967		
Site & Hole Number	2-A	2-B	2-C	2-A	2-B	2-C	2-A	2-B	2-C
Depth from top of tube to bottom of probe									
1 ft 6 in.	162.10			147.18	135.25	121.59	111.81	117.60	106.75
2 ft 0 in.									
2 ft 6 in.	92.07	96.51	90.22	99.67	103.45	96.83	94.86	95.70	80.34
3 ft 0 in.									
3 ft 6 in.	98.05	87.69	97.20	109.28	94.94	103.16	102.71	86.92	86.07
4 ft 0 in.									
4 ft 6 in.	91.35	98.32	96.02	100.04	105.77	100.92	94.75	95.63	84.97
5 ft 0 in.									
5 ft 6 in.	100.97	94.44	96.62	107.35	99.77	103.75	101.33	89.41	87.30
6 ft 0 in.									
6 ft 6 in.	97.38	89.52	100.76	104.51	98.48	112.64	97.83	88.31	93.79
7 ft 0 in.									
7 ft 6 in.	100.13	91.59	125.79	109.17	99.60	132.36	102.64	87.21	111.64
8 ft 0 in.									
8 ft 6 in.	96.39	95.20	123.27	104.09	107.99	122.99	98.77	96.88	102.91
9 ft 0 in.									
9 ft 6 in.	96.37	101.48	100.01	106.18	109.24	106.47	98.89	98.60	88.46
10 ft 0 in.	100.23	102.09	105.26	108.05	110.48	109.12	101.76	98.64	92.10

Note: All density values reported in units of lb per cu ft

SCHOOL OF CIVIL ENGINEERING
OKLAHOMA STATE UNIVERSITY
SUBGRADE MOISTURE VARIATIONS PROJECT
TEST SITE DATA SUMMARY SHEET

LOCATION DATA:

Site No. 3 Highway No. I35 County: Noble Date Installed: 7/5/68

Distance from access tube to Lane ℓ: 13'0" a, 8" b, 12'6" c

Exact Location:

In Noble County northwest of Perry, 1.8 miles north on I35 from jct. of I35 and US 64. Site in east lane of divided highway, marker on east fence row.

PAVEMENT/DESIGN DATA:

No. of Lanes: 4D Pavement Type: AC Shoulder Type: Improved-AC

Pavement Thickness: 6 in. ℓ, 4 in. Edge Latest Pavement Condition Rating: Good

Latest Traffic Count: 5100 vpd Heavy Truck Traffic: Yes

Terrain: Upland Drainage: Good Year of Original Paving: 1963

Original Design and History:

24 ft width; ℓ to 12 ft rt and lt: 4.5 in. AC Hot Mix/10 in. HSAB/6 in. aggregate subbase; 12 ft to 16 ft lt. and 12 ft to 22 ft rt.: 4 in. AC Hot Mix/8 in. HSAB/6 in. aggregate subbase.

FIELD OBSERVATIONS BY RESEARCH PERSONNEL:

4/13/67 - Protective cover of hole "a" regROUTED

SCHOOL OF CIVIL ENGINEERING
OKLAHOMA STATE UNIVERSITY
Stillwater, Oklahoma
SUBGRADE MOISTURE VARIATION STUDY
SITE INSTALLATION INFORMATION

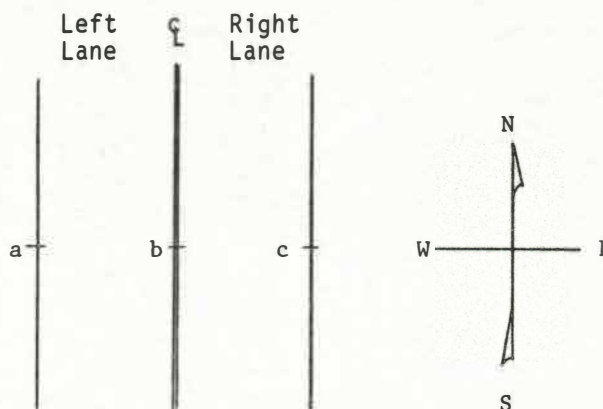
Installation: Noble I. 35 3 Date: 5 7 66
County Highway No. day month year

Location of site: Northwest of Perry, 1.8 miles north on I.-35 from intersection
of I.-35 and U.S. 64. Site in East lane, approximately 100 yards south of
"Tonkawa 31, Wichita 101" mileage sign.

Description of Terrain and Vegetation: Adequate drainage - good grass cover,
Pavement on open, gently rolling upland terrain.

Boring Plan:

Hole Depth:
a. 10'
b. 10'
c. 10'



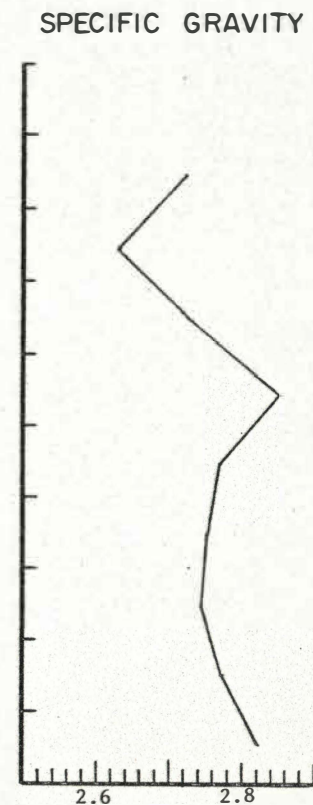
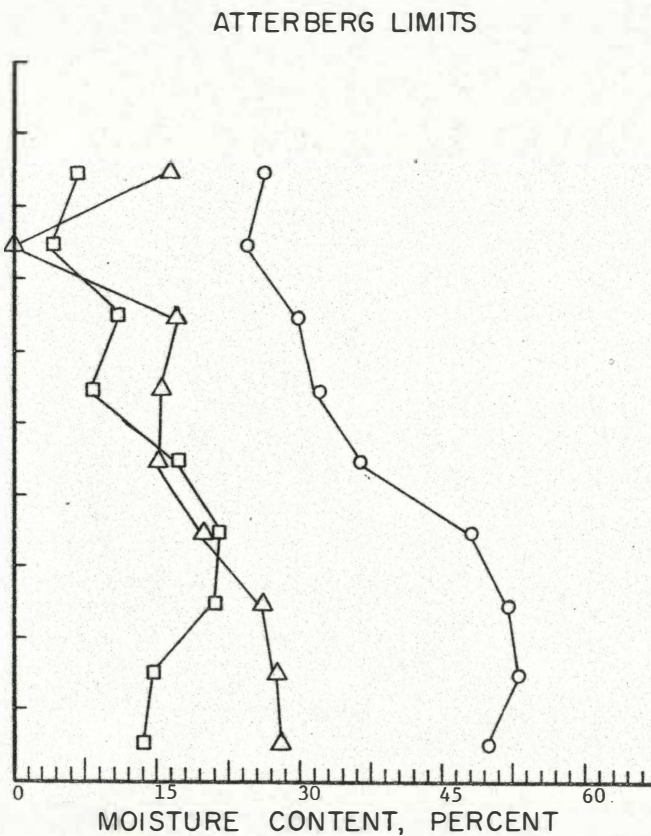
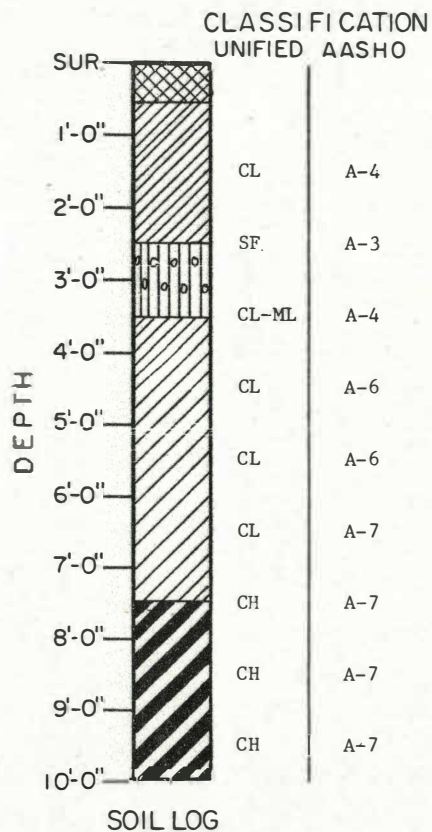
Roadway Characteristics:

Pavement: Type Asphaltic Concrete
Width 23' Thickness 6"
Condition Good
Shoulders: Type _____ Width L-10' R-4'
Condition Improved

Base Course Characteristics Select gravel

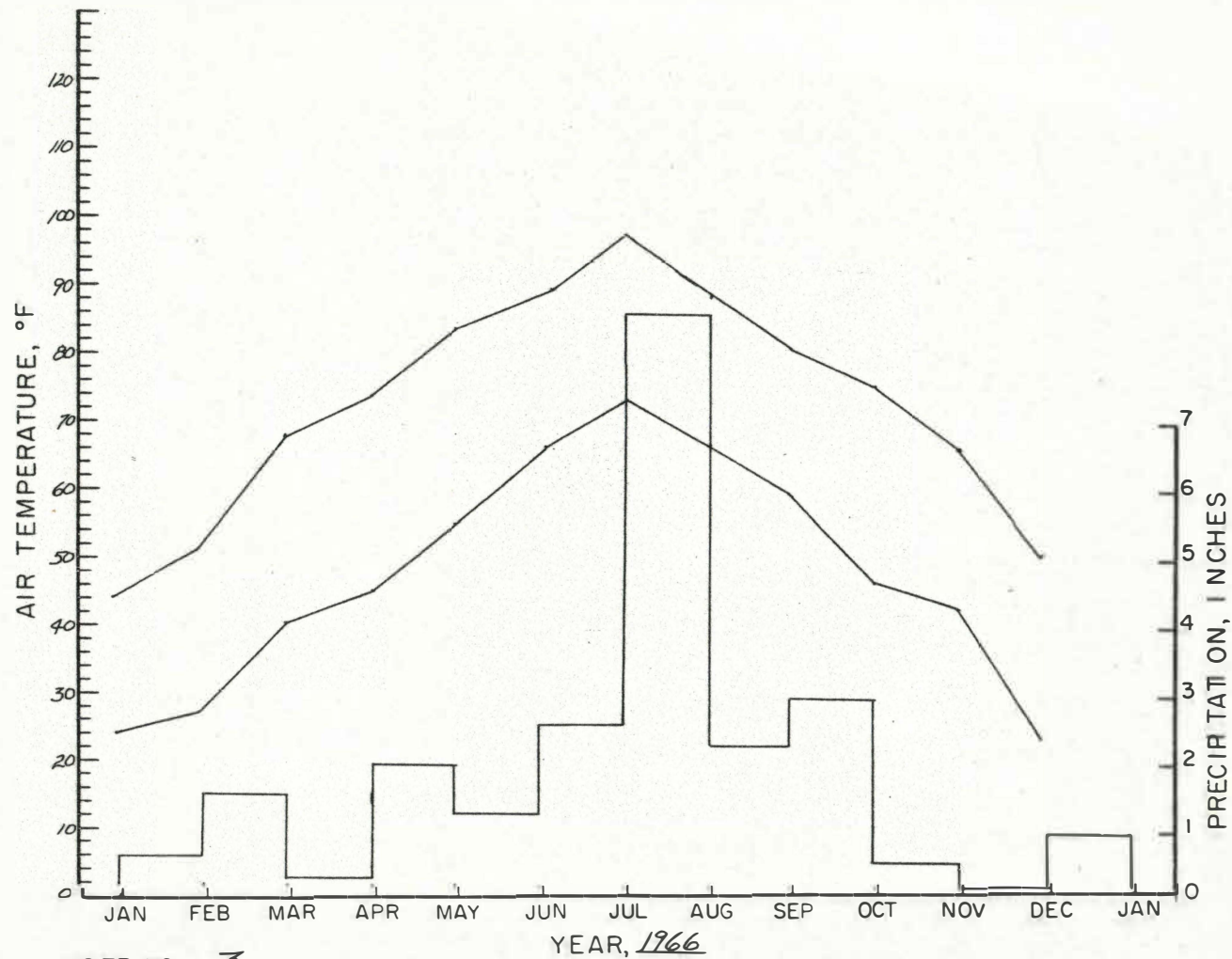
SITE NO: 3
COUNTY: Noble
HIGHWAY: I-35

● LIQUID LIMIT
▲ PLASTIC LIMIT
■ LINEAL SHRINKAGE



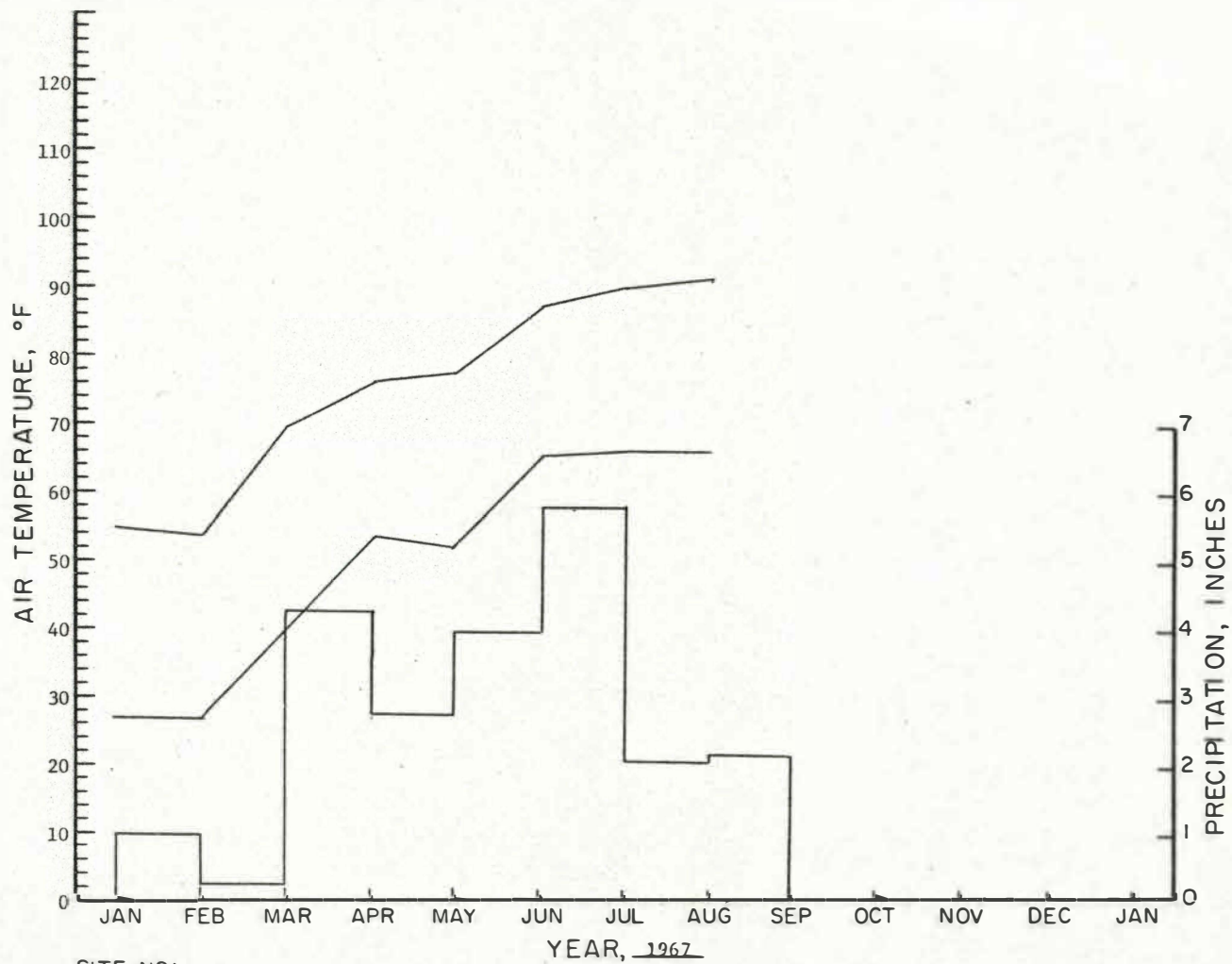
DATE: 17 November 1967
PLOTTED BY: AAP

SUBGRADE MOISTURE VARIATIONS PROJECT



SITE NO: 3
COUNTY: Noble
HIGHWAY: I-35

SUBGRADE MOISTURE VARIATIONS PROJECT

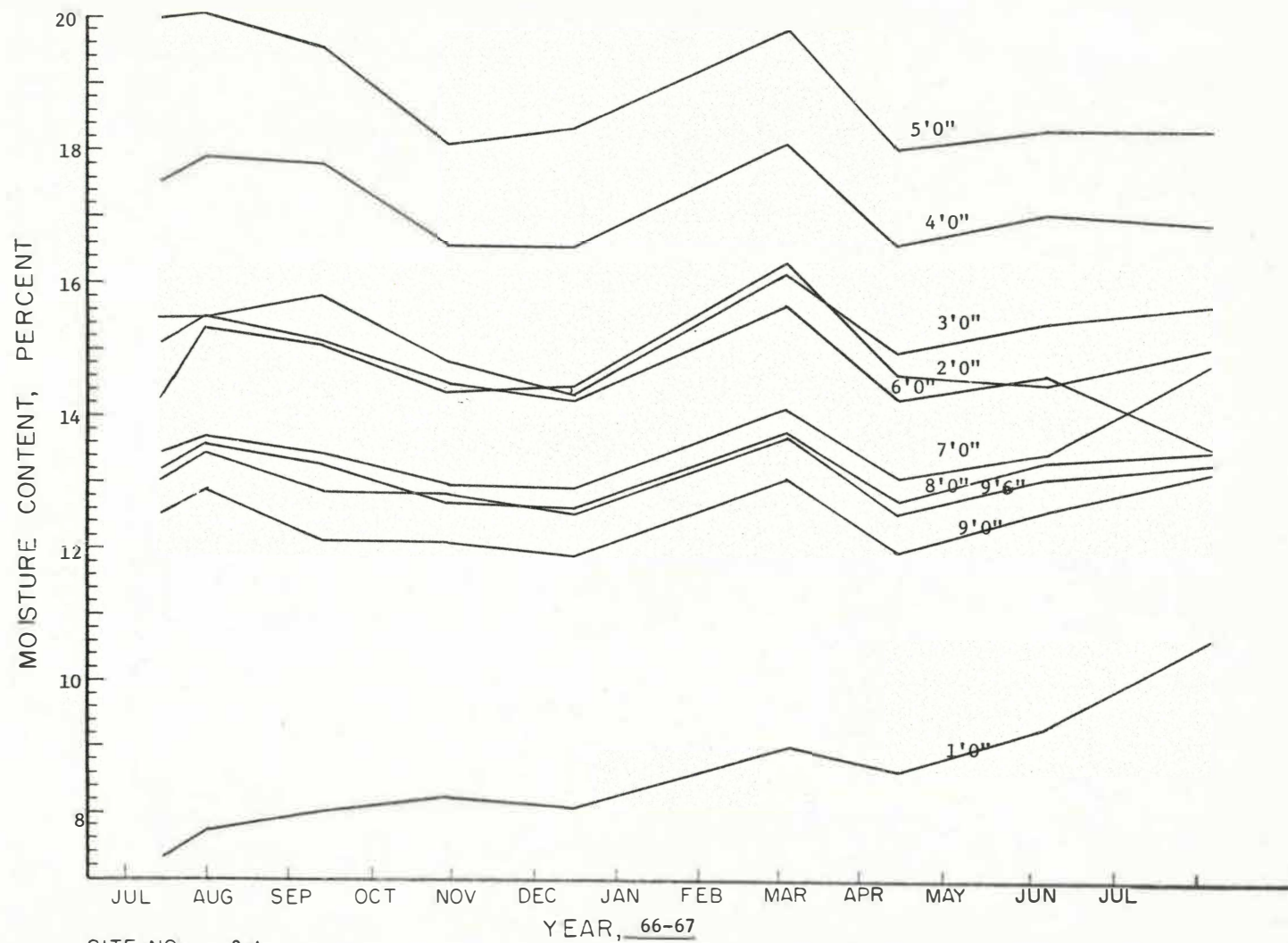


SITE NO: 3

COUNTY: Noble

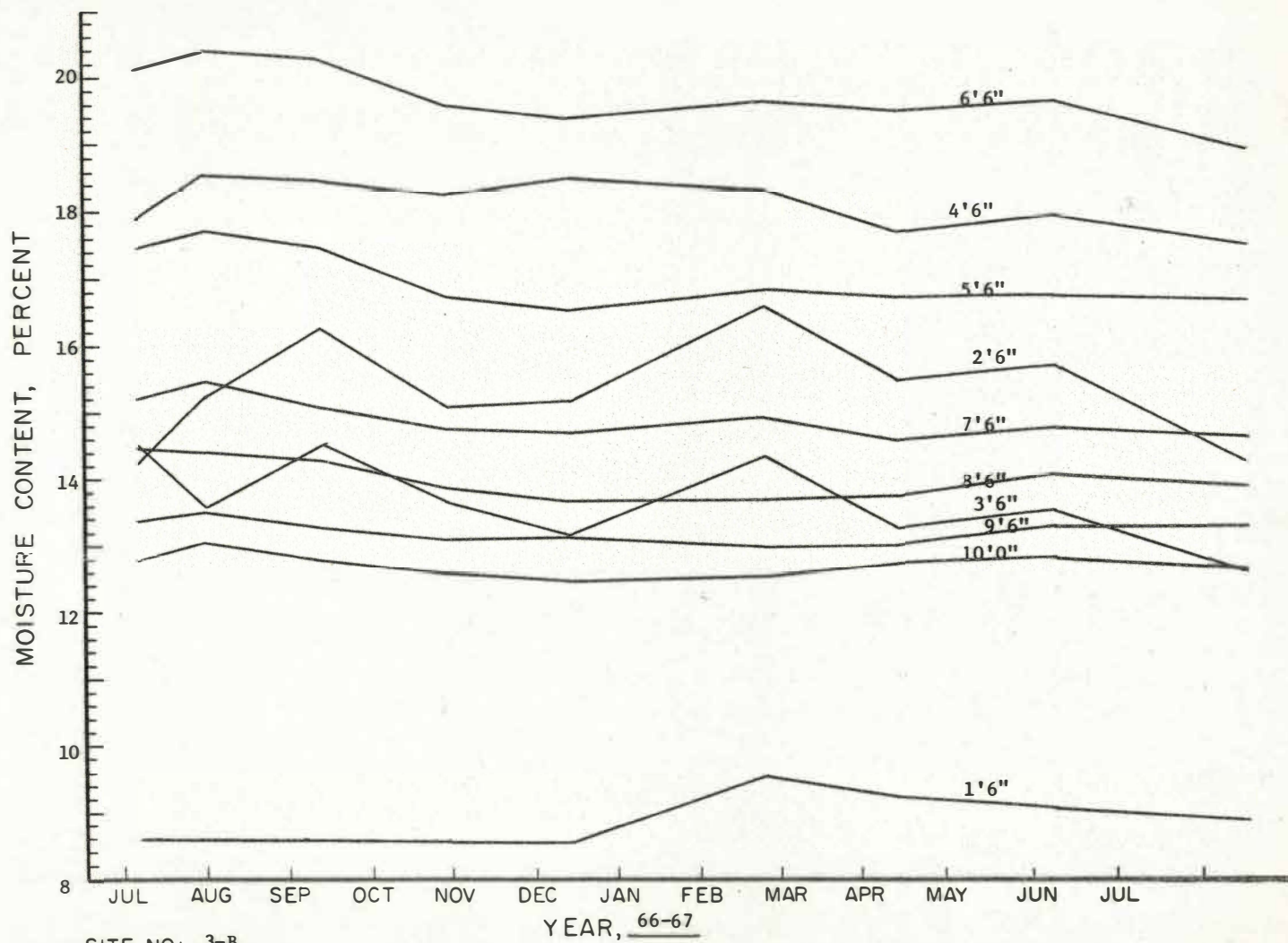
HIGHWAY: I-35

SUBGRADE MOISTURE VARIATIONS PROJECT



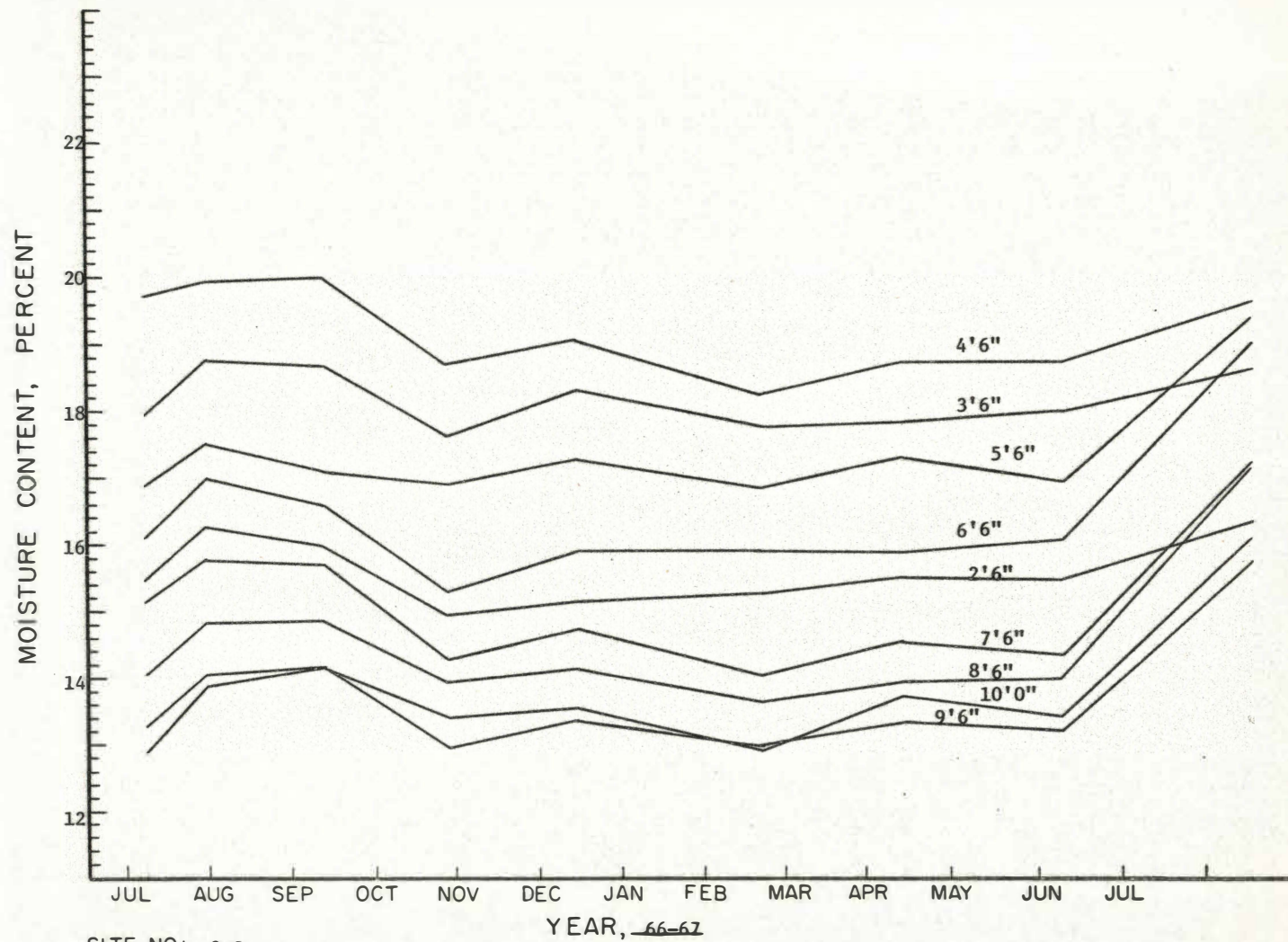
SITE NO 3-A
 COUNTY Noble
 HIGHWAY I-35

SUBGRADE MOISTURE VARIATIONS PROJECT



SITE NO: 3-B
 COUNTY: Noble
 HIGHWAY: I-35

SUBGRADE MOISTURE VARIATIONS PROJECT



SITE NO: 3-C
 COUNTY: Noble
 HIGHWAY: I-35

SUBGRADE MOISTURE VARIATIONS PROJECT

SCHOOL OF CIVIL ENGINEERING
OKLAHOMA STATE UNIVERSITY

SUBGRADE MOISTURE VARIATIONS RESEARCH PROJECT

SUBGRADE SOIL DRY DENSITY TABULATION

Date of Measurement	August 1966			January 1967			August 1967		
Site & Hole Number	3-A	3-B	3-C	3-A	3-B	3-C	3-A	3-B	3-C
Depth from top of tube to bottom of probe									
1 ft 6 in.	132.74			129.44	130.60	123.18	112.42	126.13	117.64
2 ft 0 in.									
2 ft 6 in.	107.99	100.97	106.79	113.45	103.10	114.16	111.75	106.44	108.56
3 ft 0 in.									
3 ft 6 in.	105.93	102.66	101.57	100.91	105.26	108.01	109.48	107.94	103.63
4 ft 0 in.									
4 ft 6 in.	98.84	96.83	99.75	105.86	100.02	106.85	106.55	102.27	101.16
5 ft 0 in.									
5 ft 6 in.	94.96	100.25	104.29	101.43	104.22	107.09	102.87	105.94	94.36
6 ft 0 in.									
6 ft 6 in.	111.20	93.55	106.45	117.74	96.48	114.18	117.24	99.83	95.60
7 ft 0 in.									
7 ft 6 in.	116.75	110.71	110.10	122.07	113.71	121.36	122.00	115.41	101.42
8 ft 0 in.									
8 ft 6 in.	118.37	112.52	115.20	124.48	116.94	122.42	122.26	117.53	100.42
9 ft 0 in.									
9 ft 6 in.	120.51	117.77	118.04	125.96	119.85	125.87	122.80	120.53	104.37
10 ft 0 in.	117.35	119.79	118.07	122.20	122.88	124.07	122.27	122.76	103.13

Note: All density values reported in units of lb per cu ft

SCHOOL OF CIVIL ENGINEERING
OKLAHOMA STATE UNIVERSITY
SUBGRADE MOISTURE VARIATIONS PROJECT
TEST SITE DATA SUMMARY SHEET

LOCATION DATA:

Site No. 4 Highway No. US 64 County: Pawnee Date Installed: 7/11/66
Distance from access tube to Lane ℓ: 9'6" a, 8" b, 9'6" c

Exact Location:

In Payne County southeast of Pawnee, 4.8 miles east on US 64 from OSHD division yard on outskirts of Pawnee, $\frac{1}{4}$ mile east of bridge over Bear Creek, $\frac{1}{4}$ mile west of Santa Fe railroad overpass. Marker on south fence row.

PAVEMENT/DESIGN DATA:

No. of Lanes: 2 Pavement Type: AC/PCC Shoulder Type: Improved - AC
Pavement Thickness: 10 in.ℓ, 4 in. Edge Latest Pavement Condition Rating: Good
Latest Traffic Count: 1400 vpd Heavy Truck Traffic: No
Terrain: Creek-bottom Drainage: Fair Year of Original Paving: 1930

Original Design and History:

Variable section PCC, 18 ft width; ℓ to 7 ft rt and lt: 6 in. PCC; 7 ft to 9 ft rt and lt: 9 in. PCC; periodic AC overlay by OSHD maintenance forces. No subbase.

FIELD OBSERVATIONS BY RESEARCH PERSONNEL:

4/13/67 - Protective cover for hole "c" regROUTED

10/2/67 - $\frac{1}{2}$ in. wide transverse crack in pavement 10 ft west of holes "a" and "b".

SCHOOL OF CIVIL ENGINEERING
OKLAHOMA STATE UNIVERSITY
Stillwater, Oklahoma
SUBGRADE MOISTURE VARIATION STUDY
SITE INSTALLATION INFORMATION

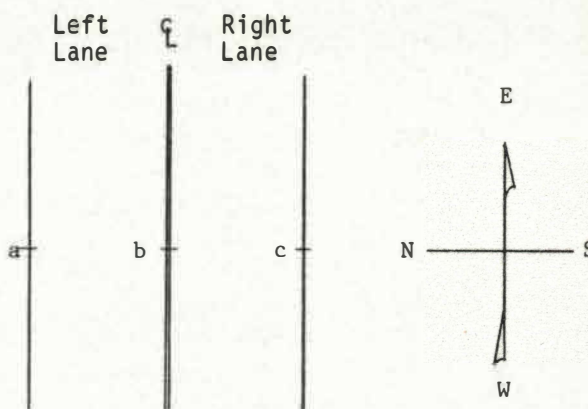
Installation: Pawnee County U.S. 64 Highway 4 No. Date: 11 day 7 month 66 year

Location of site: Southeast of Pawnee, 4.8 miles east on U.S. 64 from O.S.H.D.
division yard on outskirts of Pawnee. 1/4 mile east of bridge over Bear Creek.
1/4 mile west of Santa Fe railroad bridge overpass.

Description of Terrain and Vegetation: Pavement in creek bottom area.

Boring Plan:

Hole Depth:
a. 8'6"
b. 10'
c. 4'



Roadway Characteristics:

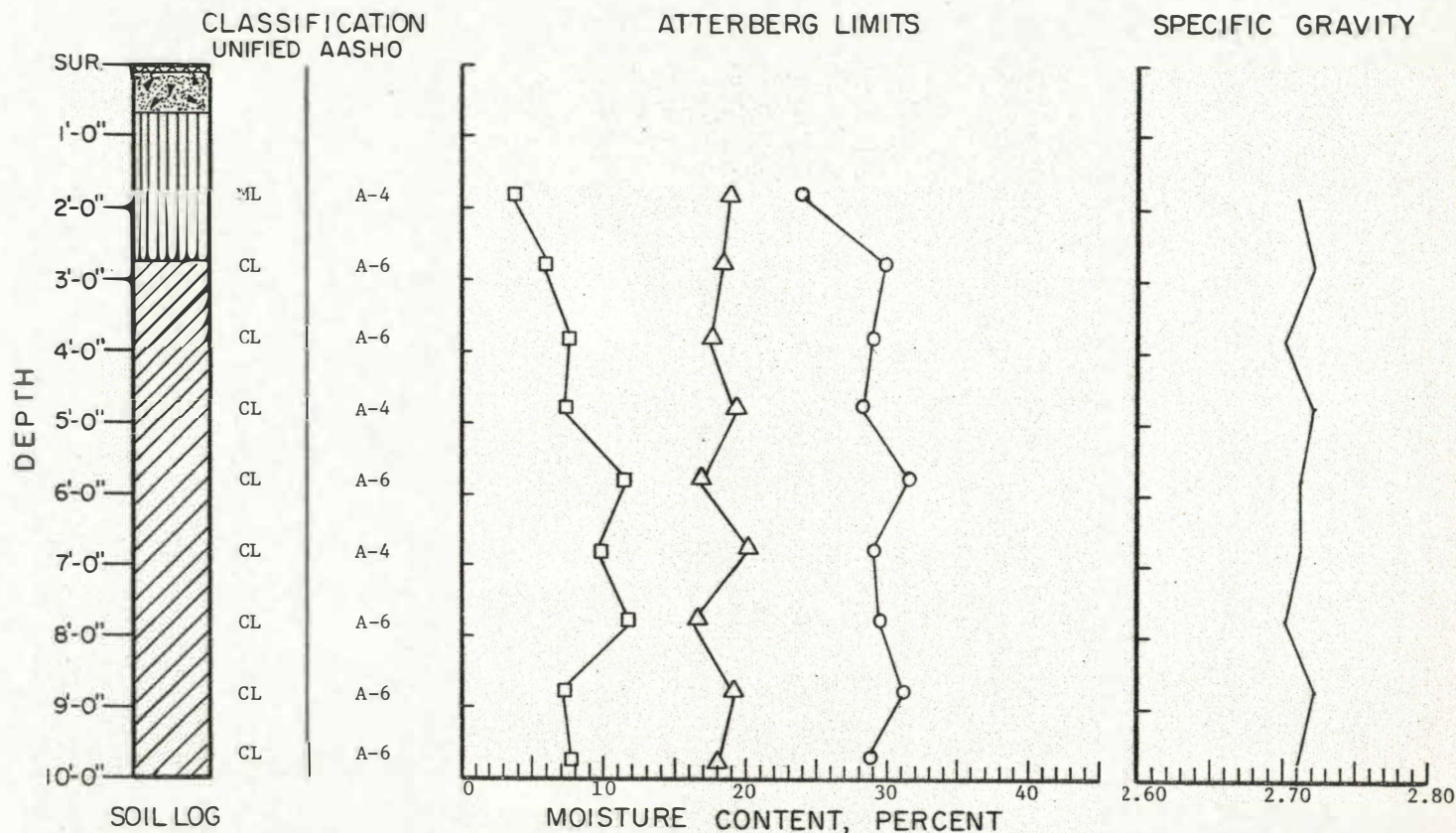
Pavement: Type Asphaltic Concrete over P.C. Concrete
Width 10' Thickness 1"-AC - 7"-P.C.
Condition Good

Shoulders: Type Unimproved Width _____
Condition Bermuda Grass - Barditch on both sides

Base Course Characteristics Sandy silt

SITE NO.: 4
 COUNTY : Pawnee
 HIGHWAY : US 64

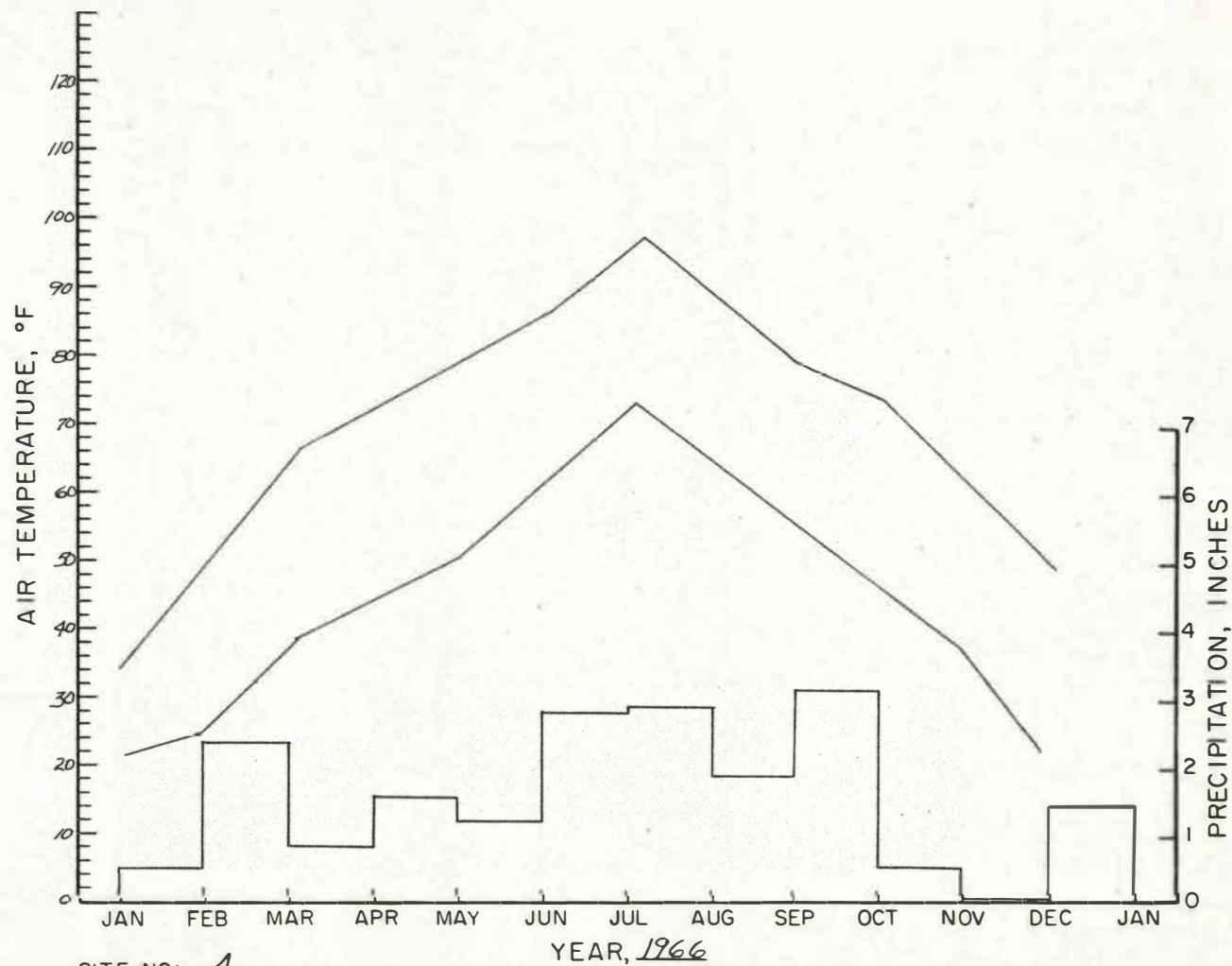
● LIQUID LIMIT
 ▲ PLASTIC LIMIT
 ■ LINEAL SHRINKAGE



DATE : 17 November 1967

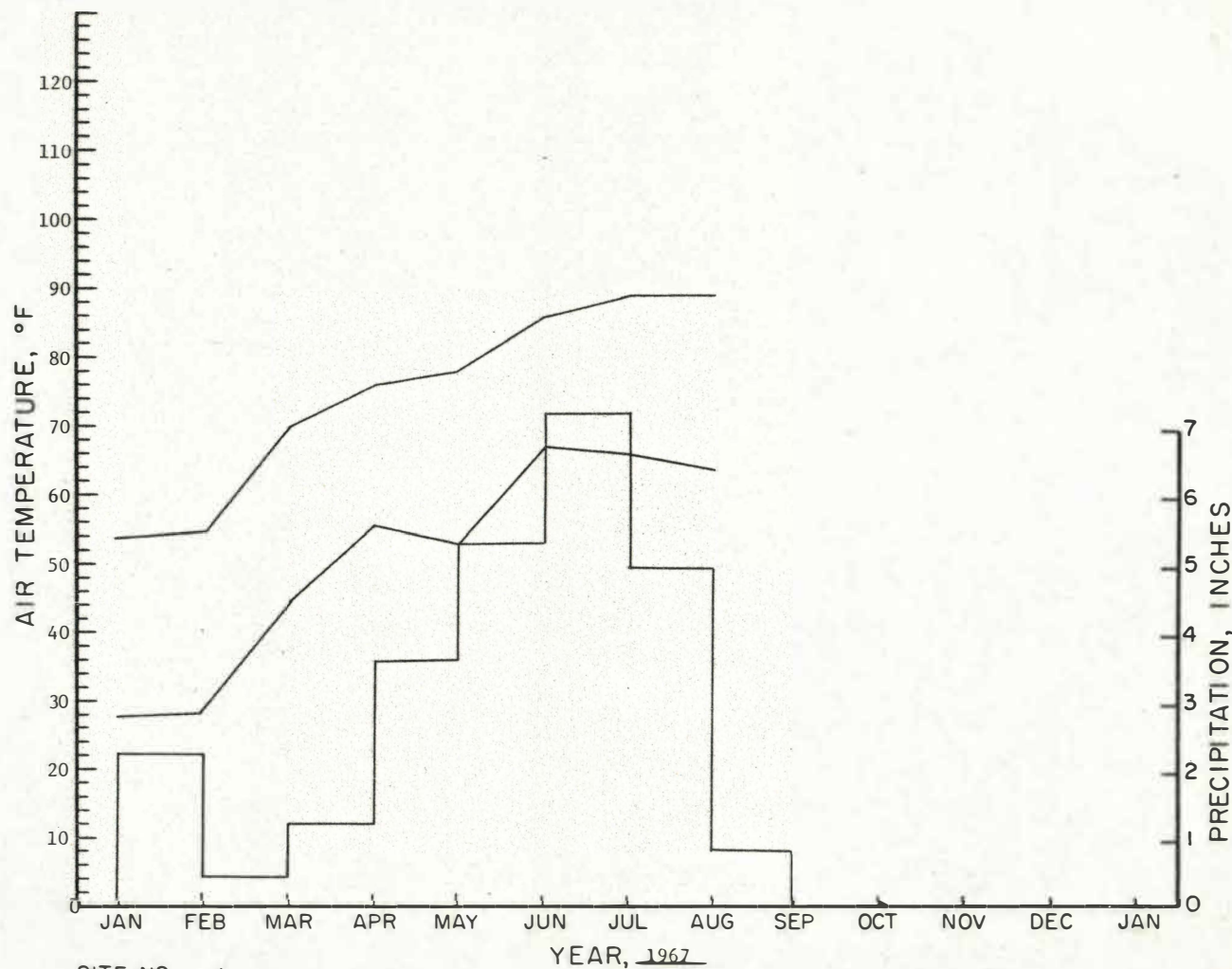
PLOTTED BY : AAP

SUBGRADE MOISTURE VARIATIONS PROJECT



SITE NO: 4
COUNTY: PAWNEE
HIGHWAY: US 64

SUBGRADE MOISTURE VARIATIONS PROJECT

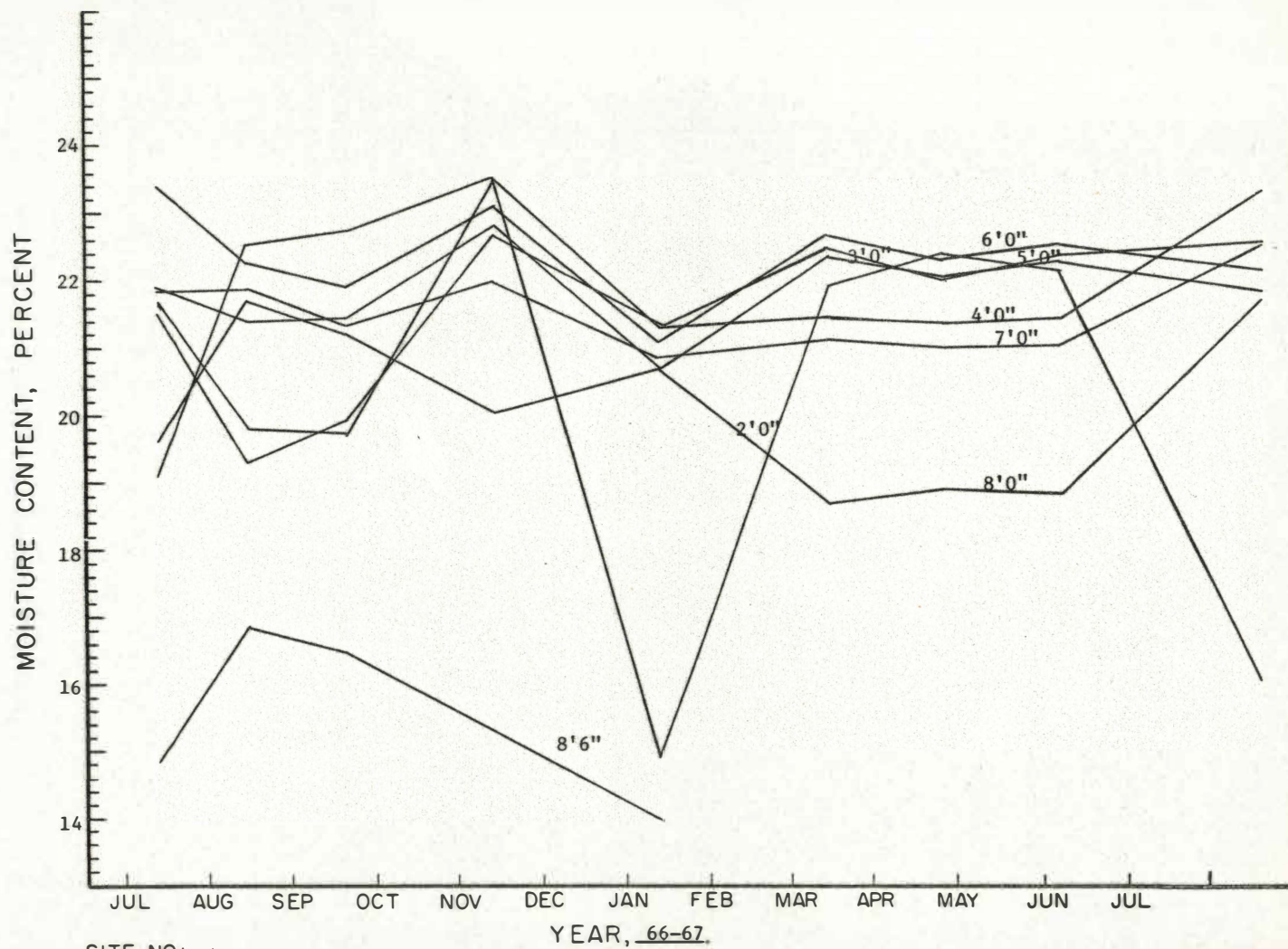


SITE NO: 4

COUNTY: Pawnee

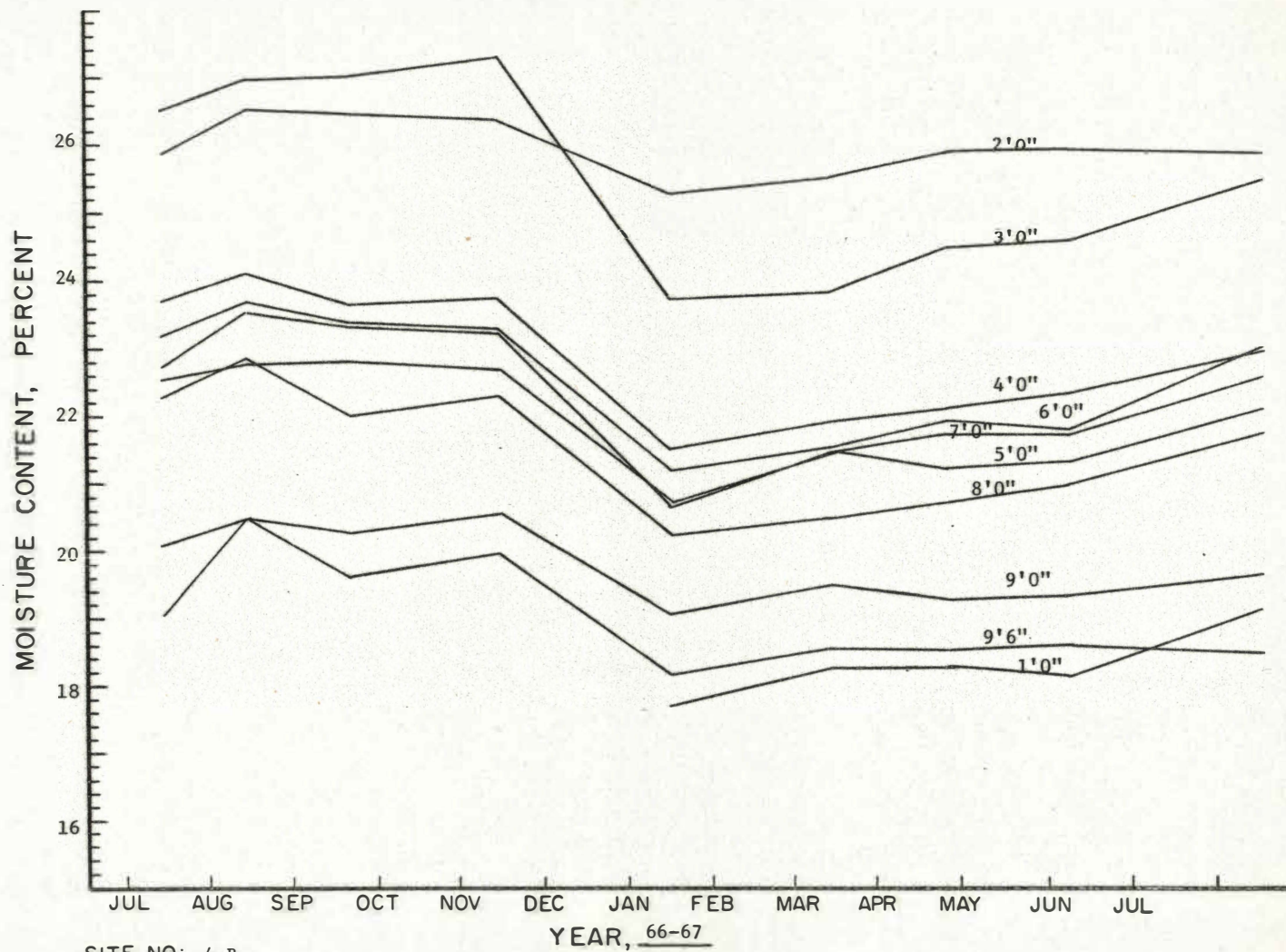
HIGHWAY: US 64

SUBGRADE MOISTURE VARIATIONS PROJECT



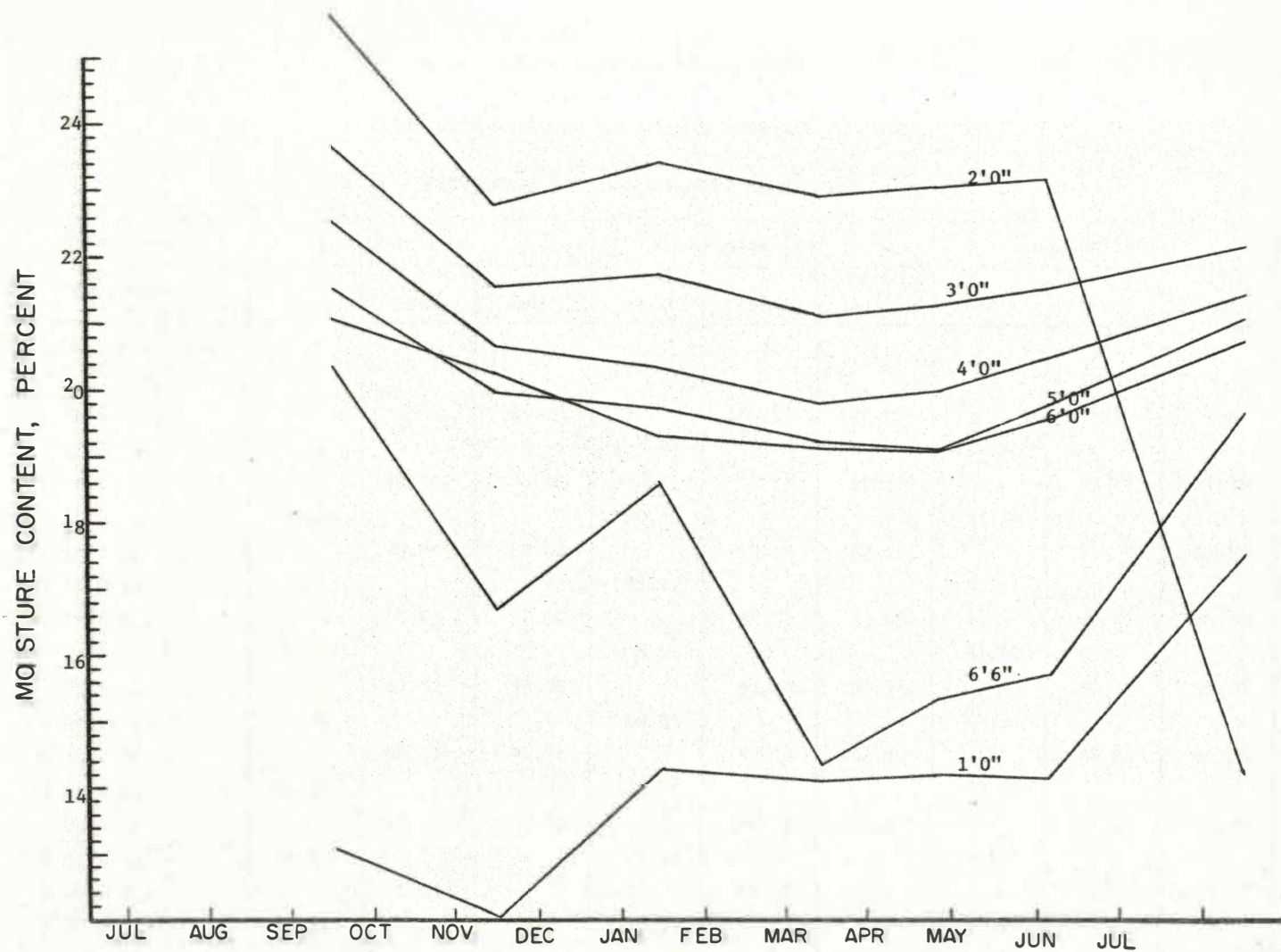
SITE NO: 4-A
 COUNTY: Pawnee
 HIGHWAY: US 64

SUBGRADE MOISTURE VARIATIONS PROJECT



SITE NO: 4-B
 COUNTY: Pawnee
 HIGHWAY: US 64

SUBGRADE MOISTURE VARIATIONS PROJECT



SITE NO: 4-C
 COUNTY: Pawnee
 HIGHWAY: US 64

SUBGRADE MOISTURE VARIATIONS PROJECT

SCHOOL OF CIVIL ENGINEERING
OKLAHOMA STATE UNIVERSITY
SUBGRADE MOISTURE VARIATIONS PROJECT
TEST SITE DATA SUMMARY SHEET

LOCATION DATA:

Site No. 5 Highway No. US 60 County: Osage Date Installed: 7/12/66

Distance from access tube to Lane ℓ : 11'6" a, 8" b, 10'6" c

Exact Location:

In Osage County, northeast of Pawhuska, 1.5 miles southwest on US 60 from jct. of US 60 and S 99. Marker on northeast fence row.

PAVEMENT/DESIGN DATA:

No. of Lanes: 2 Pavement Type: AC Shoulder Type: Natural

Pavement Thickness: 5 in. ℓ , 5 in. Edge Latest Pavement Condition Rating: Good

Latest Traffic Count: 1700 vpd Heavy Truck Traffic: No

Terrain: Upland Drainage: Good Year of Original Paving: 1937 & 1962

Original Design and History:

20 ft width; ℓ to 10 ft lt. and rt.: 5 in. AC over SABC; 10 ft to 12 ft lt. and rt.: double bituminous sealed shoulder over SABC.

FIELD OBSERVATIONS BY RESEARCH PERSONNEL:

4/18/68 - Protective covers of holes "b" and "c" regROUTED.

SCHOOL OF CIVIL ENGINEERING
OKLAHOMA STATE UNIVERSITY
Stillwater, Oklahoma
SUBGRADE MOISTURE VARIATION STUDY
SITE INSTALLATION INFORMATION

Installation: Osage U.S. 60 5 Date: 12 7 66
County Highway No. day month year

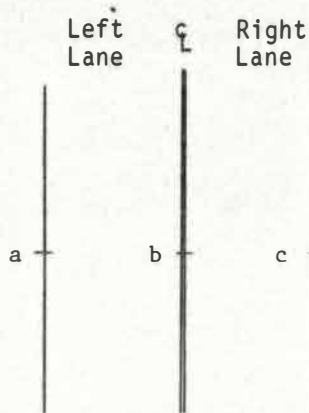
Location of site: Northeast of Pawhuska, 1.5 miles southwest on U.S. 60 from
intersection of U.S. 60 and St. 99, approximately 100 ft. Southwest of U.S. 60
St. 99 route marker facing southwest.

Description of Terrain and Vegetation: Pavement on open upland terrain.

Boring Plan:

Hole Depth:

- a. 5'
b. 5'
c. 5' - 6"



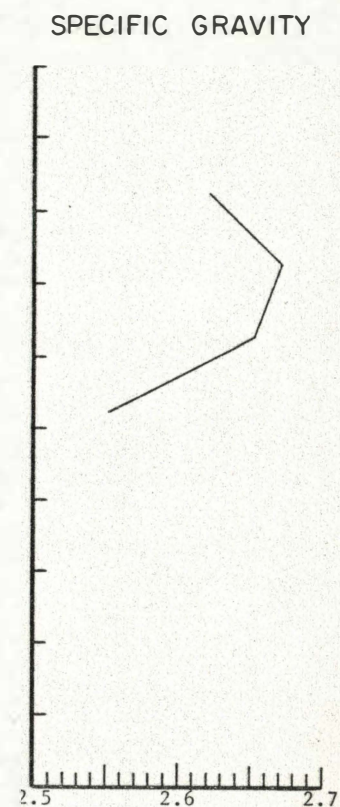
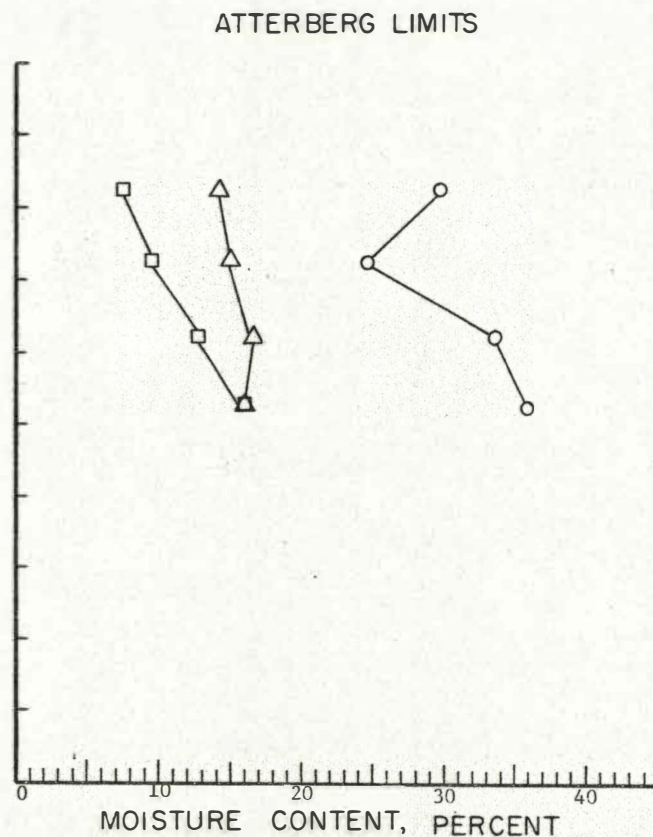
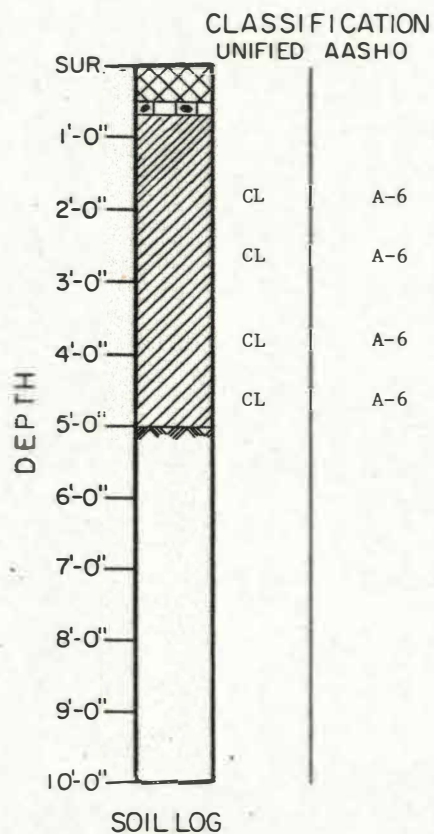
Roadway Characteristics:

Pavement: Type Asphaltic Concrete
Width 24' Thickness 5"
Condition Good
Shoulders: Type Grass Width _____
Condition Unimproved

Base Course Characteristics Gravel

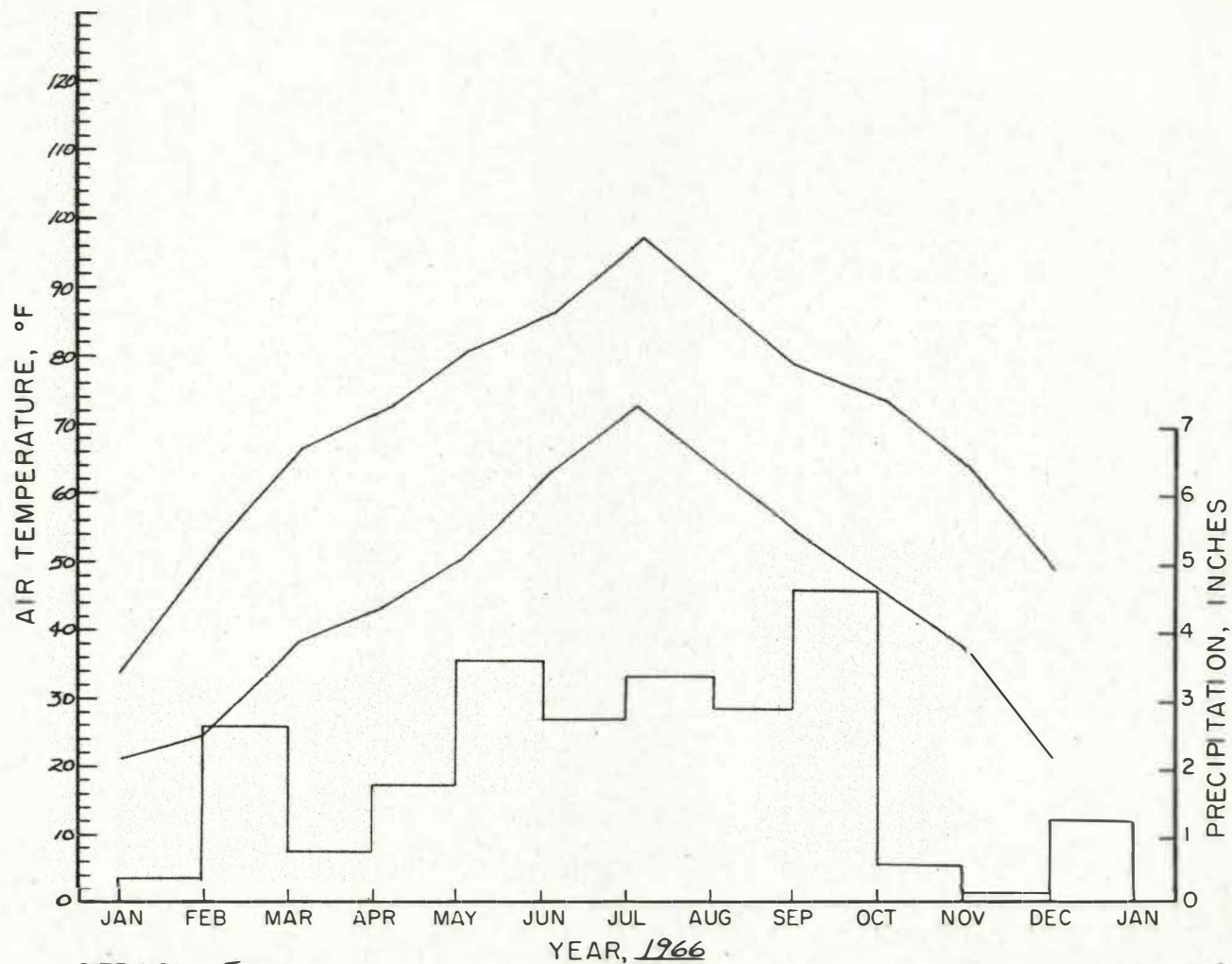
SITE NO.: 5
COUNTY : Osage
HIGHWAY : US 60

- LIQUID LIMIT
- ▲ PLASTIC LIMIT
- LINEAL SHRINKAGE



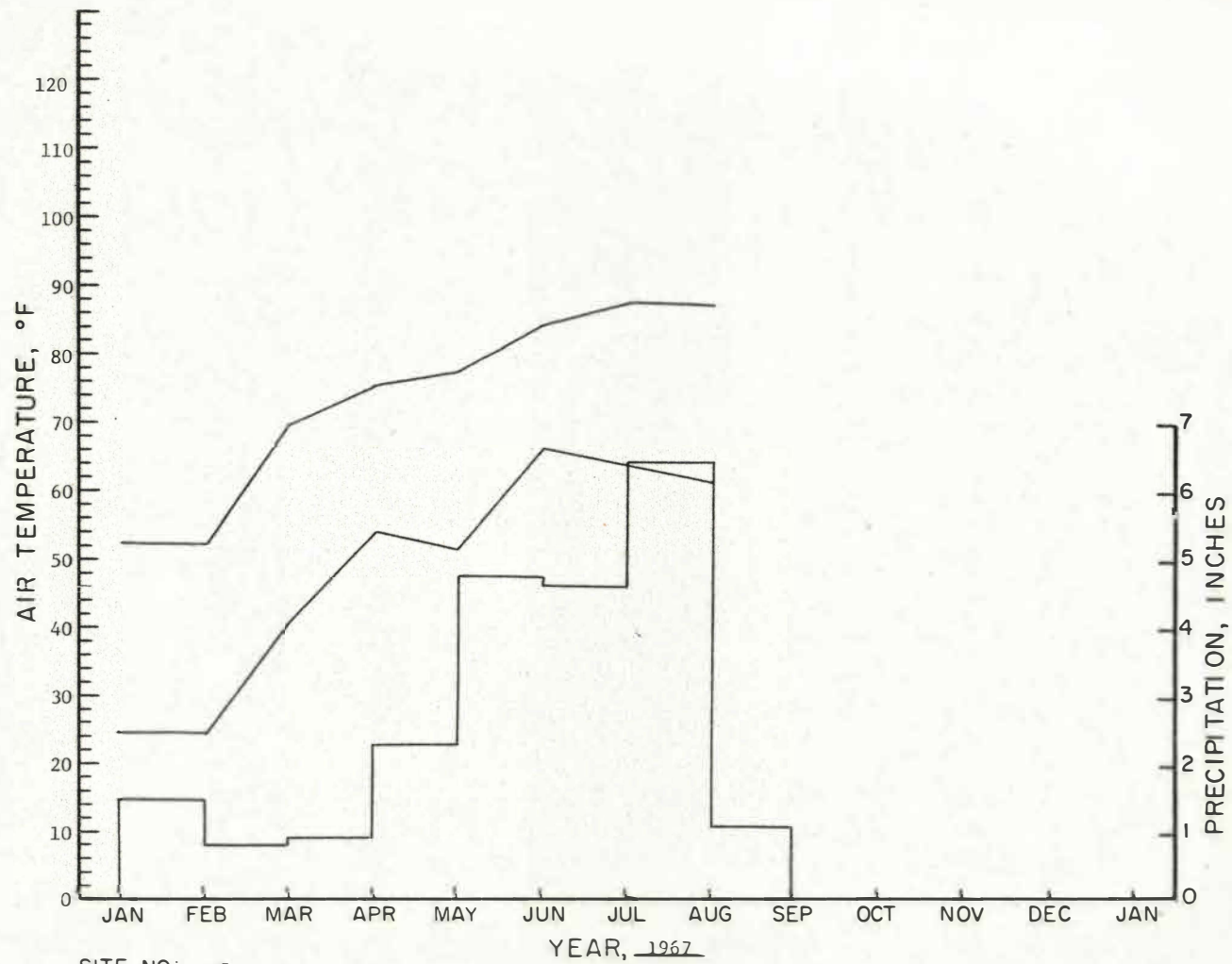
DATE : 20 November 1967
PLOTTED BY : AAP

SUBGRADE MOISTURE VARIATIONS PROJECT



SITE NO: 5
COUNTY: OSAGE
HIGHWAY: U.S. 60

SUBGRADE MOISTURE VARIATIONS PROJECT

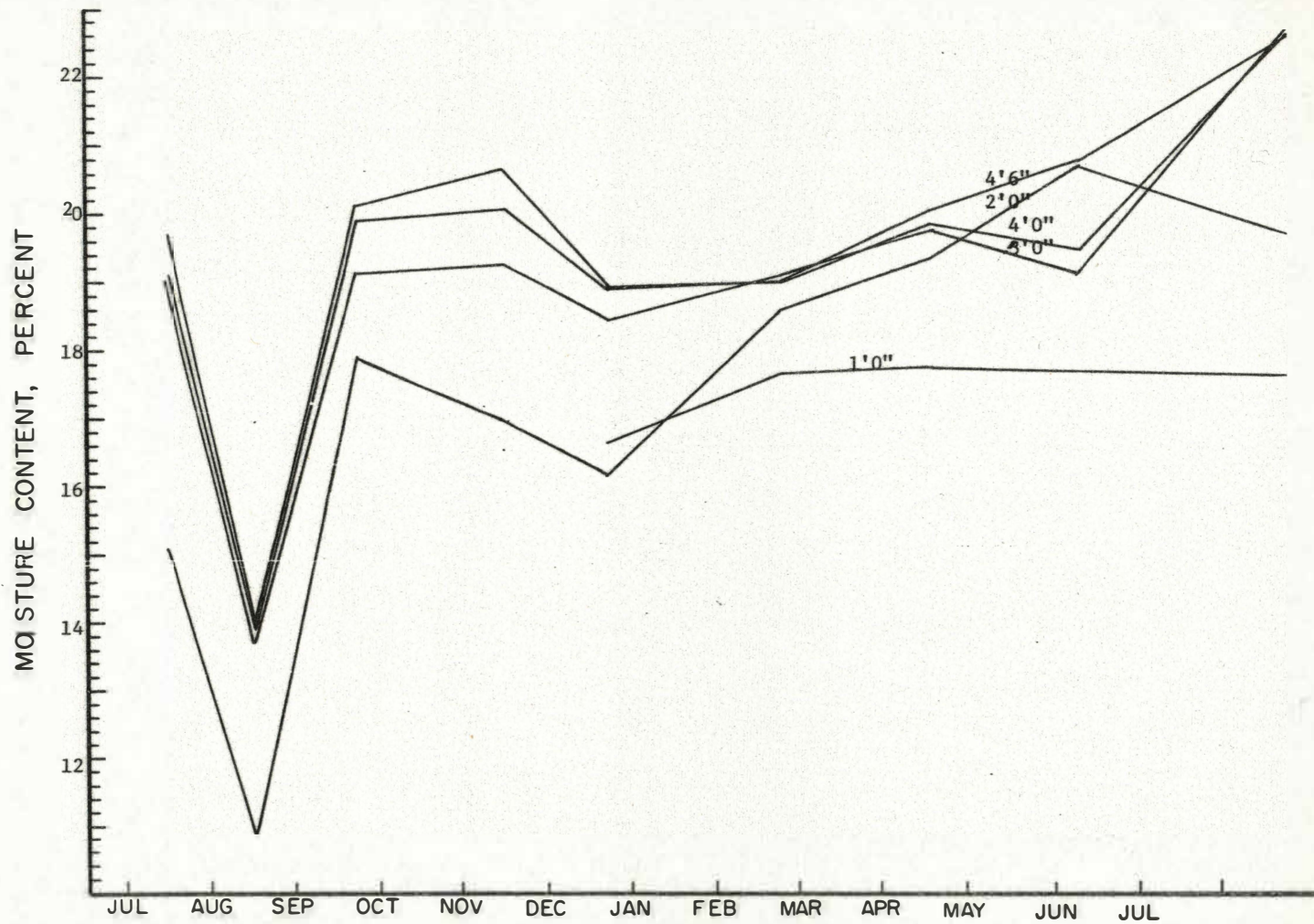


SITE NO: 5

COUNTY: Osage

HIGHWAY: US 60

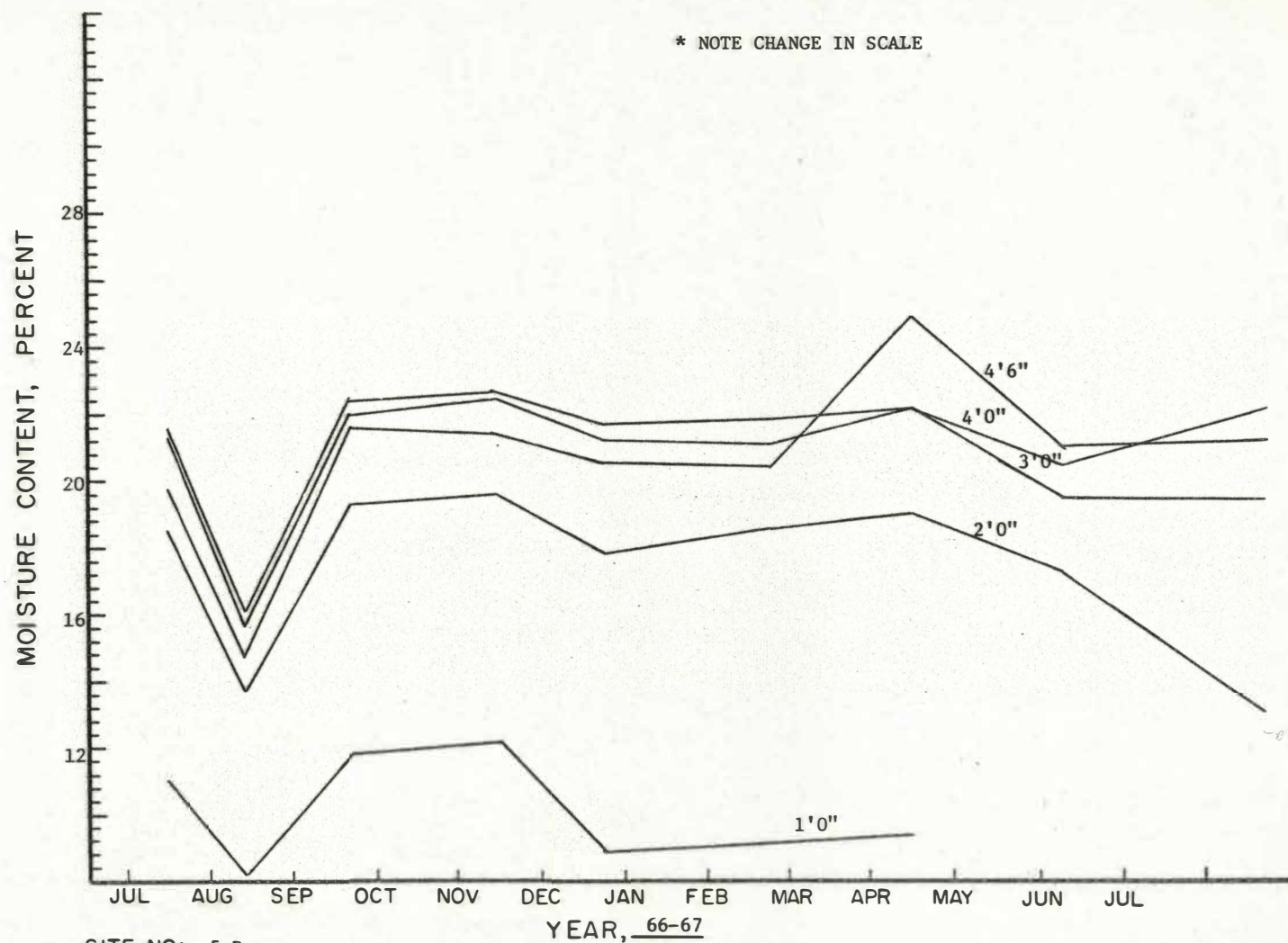
SUBGRADE MOISTURE VARIATIONS PROJECT



SITE NO: 5-A
 COUNTY: Osage
 HIGHWAY: US 60

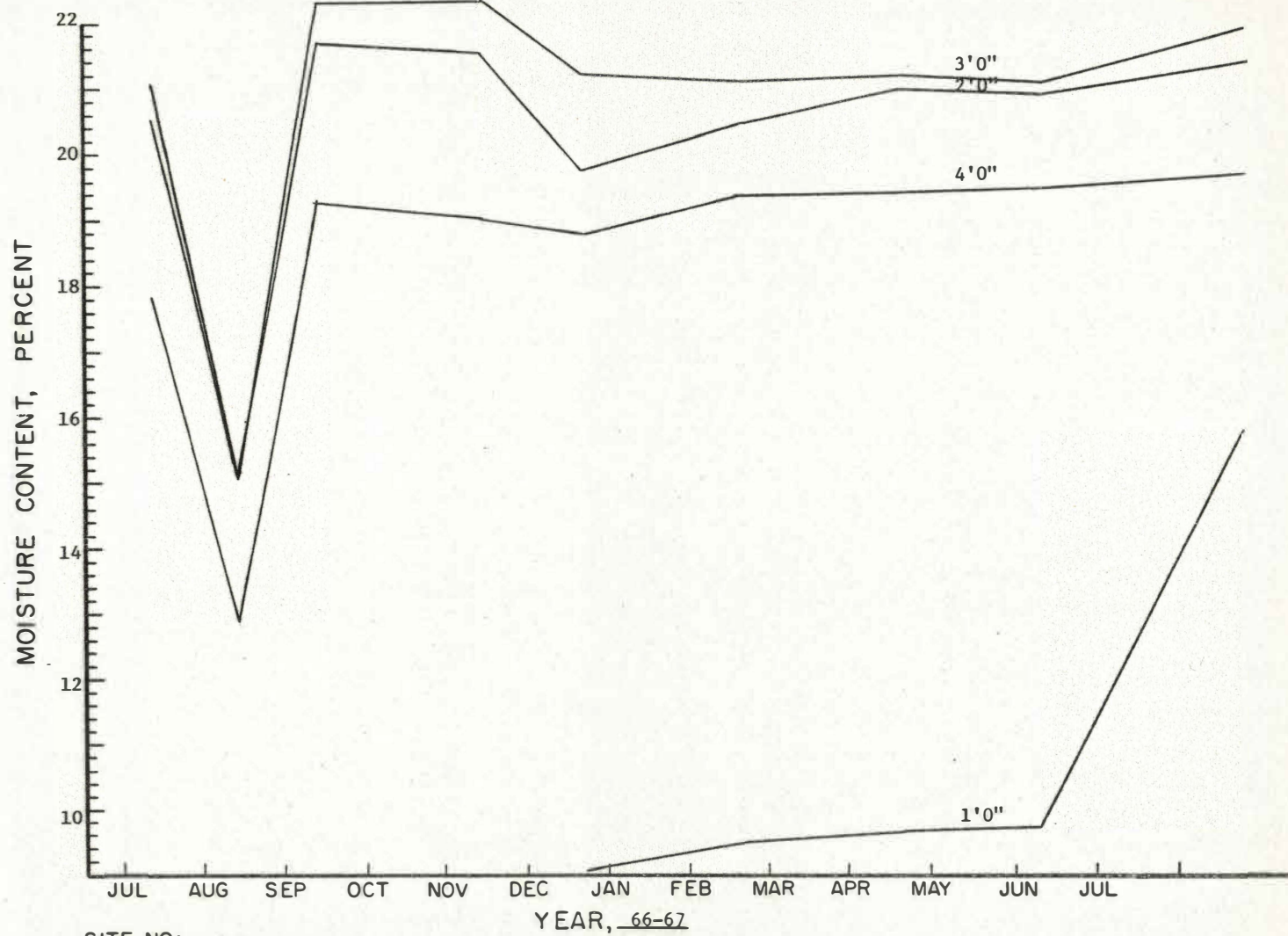
YEAR, 66-67

SUBGRADE MOISTURE VARIATIONS PROJECT



SITE NO: 5-B
 COUNTY: Osage
 HIGHWAY: US 60

SUBGRADE MOISTURE VARIATIONS PROJECT



SITE NO: S-C
COUNTY: Osage
HIGHWAY: US 60

SUBGRADE MOISTURE VARIATIONS PROJECT

SCHOOL OF CIVIL ENGINEERING
OKLAHOMA STATE UNIVERSITY

SUBGRADE MOISTURE VARIATIONS RESEARCH PROJECT

SUBGRADE SOIL DRY DENSITY TABULATION

Date of Measurement	August 1966			January 1967			August 1967		
Site & Hole Number	5-A	5-B	5-C	5-A	5-B	5-C	5-A	5-B	5-C
Depth from top of tube to bottom of probe									
1 ft 6 in.		124.30		113.40	166.71		105.23		
2 ft 0 in.								120.49	112.42
2 ft 6 in.	95.33	82.93		92.24	87.22		82.36		
3 ft 0 in.			93.76			98.42		86.19	95.40
3 ft 6 in.	85.38	83.51		88.63	84.70		81.71		
4 ft 0 in.			93.08			97.79		86.56	97.06
4 ft 6 in.	88.30	89.34		92.40	91.73		84.50		
5 ft 0 in.	91.62	91.54	105.19	94.88	93.81	103.03	85.80	93.31	102.74
5 ft 6 in.									
6 ft 0 in.									
6 ft 6 in.									
7 ft 0 in.									
7 ft 6 in.									
8 ft 0 in.									
8 ft 6 in.									
9 ft 0 in.									
9 ft 6 in.									
10 ft 0 in.									

Note: All density values reported in units of lb per cu ft

SCHOOL OF CIVIL ENGINEERING
OKLAHOMA STATE UNIVERSITY
SUBGRADE MOISTURE VARIATIONS PROJECT
TEST SITE DATA SUMMARY SHEET

LOCATION DATA:

Site No. 6 Highway No. US 60 County: Washington Date Installed: 7/13/66

Distance from access tube to Lane ℓ : 8' 4" a, 6" b, 8' 0" c

Exact Location:

In Washington County east of Bartlesville, 6.2 miles east on US 60 from jct.
US 60 and US 75, approximately 200 yds west of Hog Shooter Creek. Marker on
south fence row.

PAVEMENT/DESIGN DATA:

No. of Lanes: 2 Pavement Type: PCC Shoulder Type: Natural

Pavement Thickness: 6 in. ℓ , 9 in. Edge Latest Pavement Condition Rating: Good

Latest Traffic Count: 2200 vpd Heavy Truck Traffic: Yes

Terrain: Fill on CB Drainage: Fair Year of Original Paving: 1930

Original Design and History:

Variable section PCC, 18 ft width, ℓ to 7 ft rt and lt: 6 in. PCC; 7 ft to
9 ft rt. and lt: 9 in. PCC. No subbase.

FIELD OBSERVATIONS BY RESEARCH PERSONNEL:

4/18/67 - Protective covering on hole "b" regROUTED

10/17/67 - Access tube "a" loose in hole

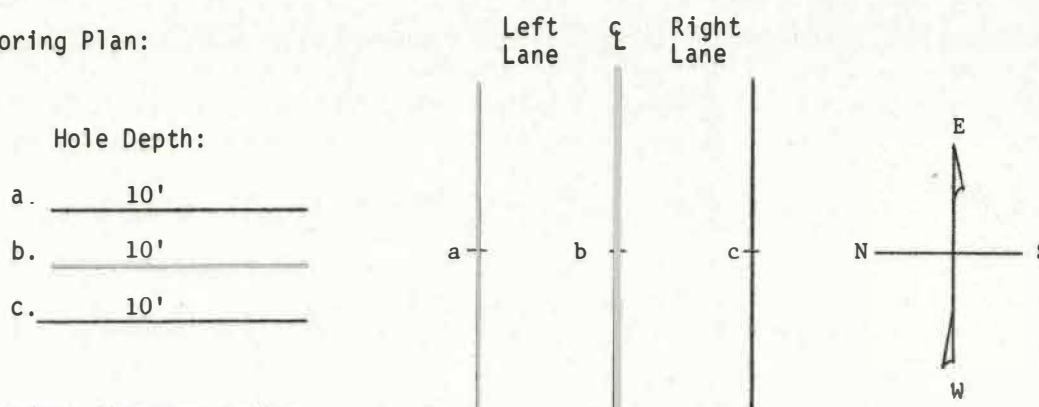
SCHOOL OF CIVIL ENGINEERING
OKLAHOMA STATE UNIVERSITY
Stillwater, Oklahoma
SUBGRADE MOISTURE VARIATION STUDY
SITE INSTALLATION INFORMATION

Installation: Washington U.S. 60 6 Date: 13 7 66
County Highway No. day month year

Location of site: East of Bartlesville, 6.2 miles east of junction of U.S. 60
and U.S. 75, approximately 200 yards west on U.S. 60 from "Hog Shooter Creek"

Description of Terrain and Vegetation: Pavement on fill section in creek-bottom
area.

Boring Plan:



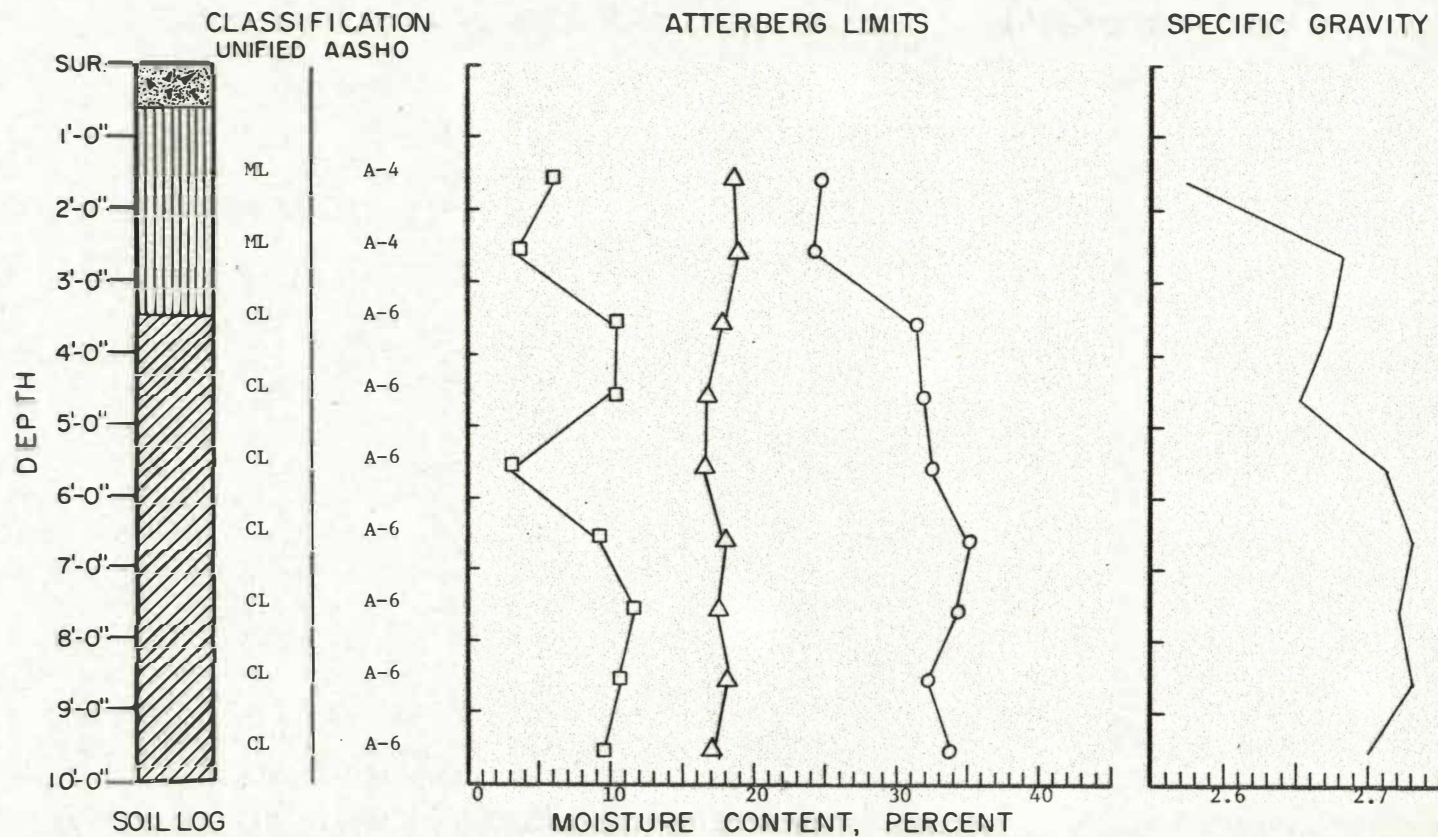
Roadway Characteristics:

Pavement: Type P.C. Concrete
Width 18' Thickness 6"
Condition Good-Edges are thickened to 9"
Shoulders: Type Grass Width _____
Condition Barditch on both sides of fill.

Base Course Characteristics Silty sand

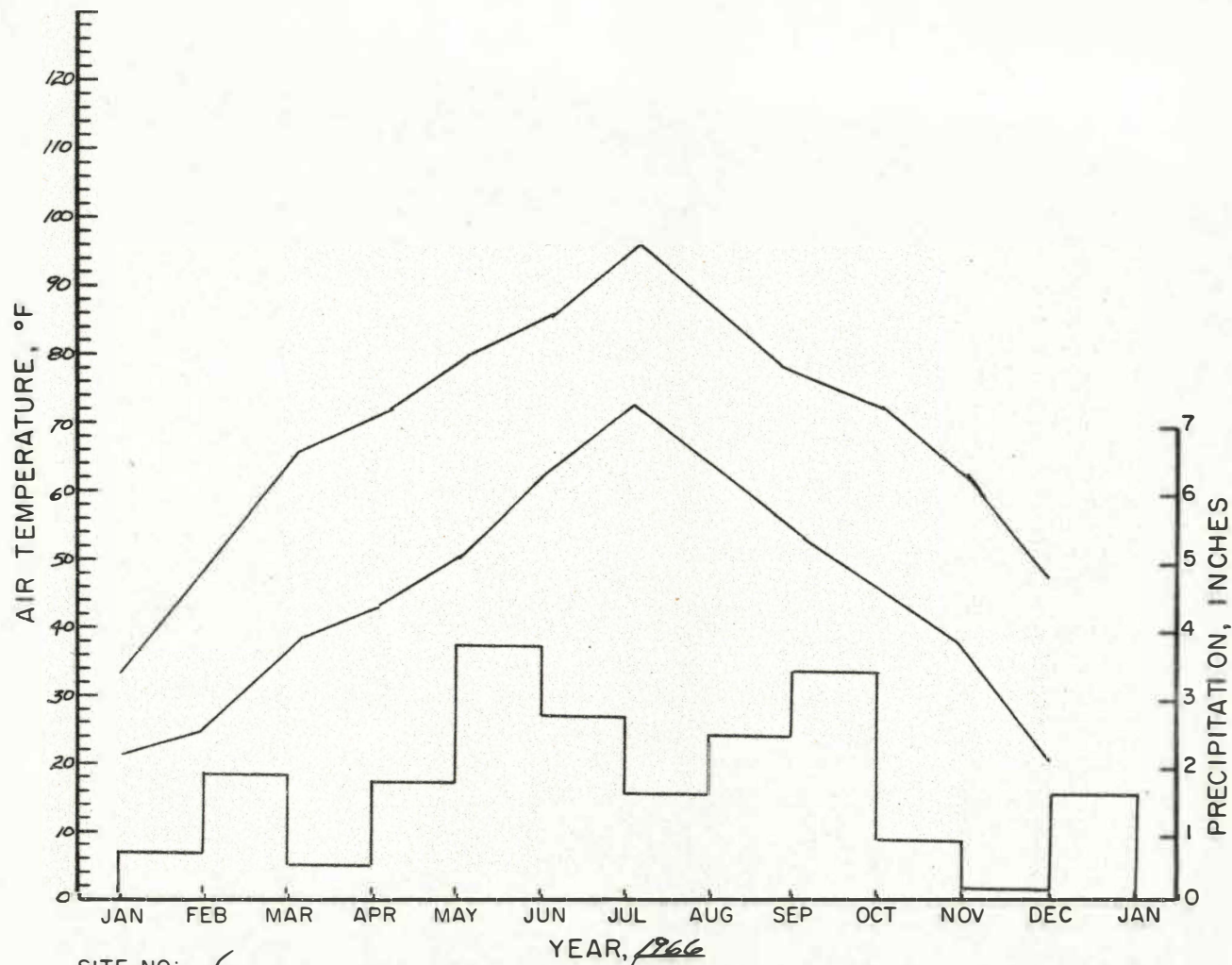
SITE NO.: 6
 COUNTY : Washington
 HIGHWAY : US 60

● LIQUID LIMIT
 ▲ PLASTIC LIMIT
 ■ LINEAL SHRINKAGE



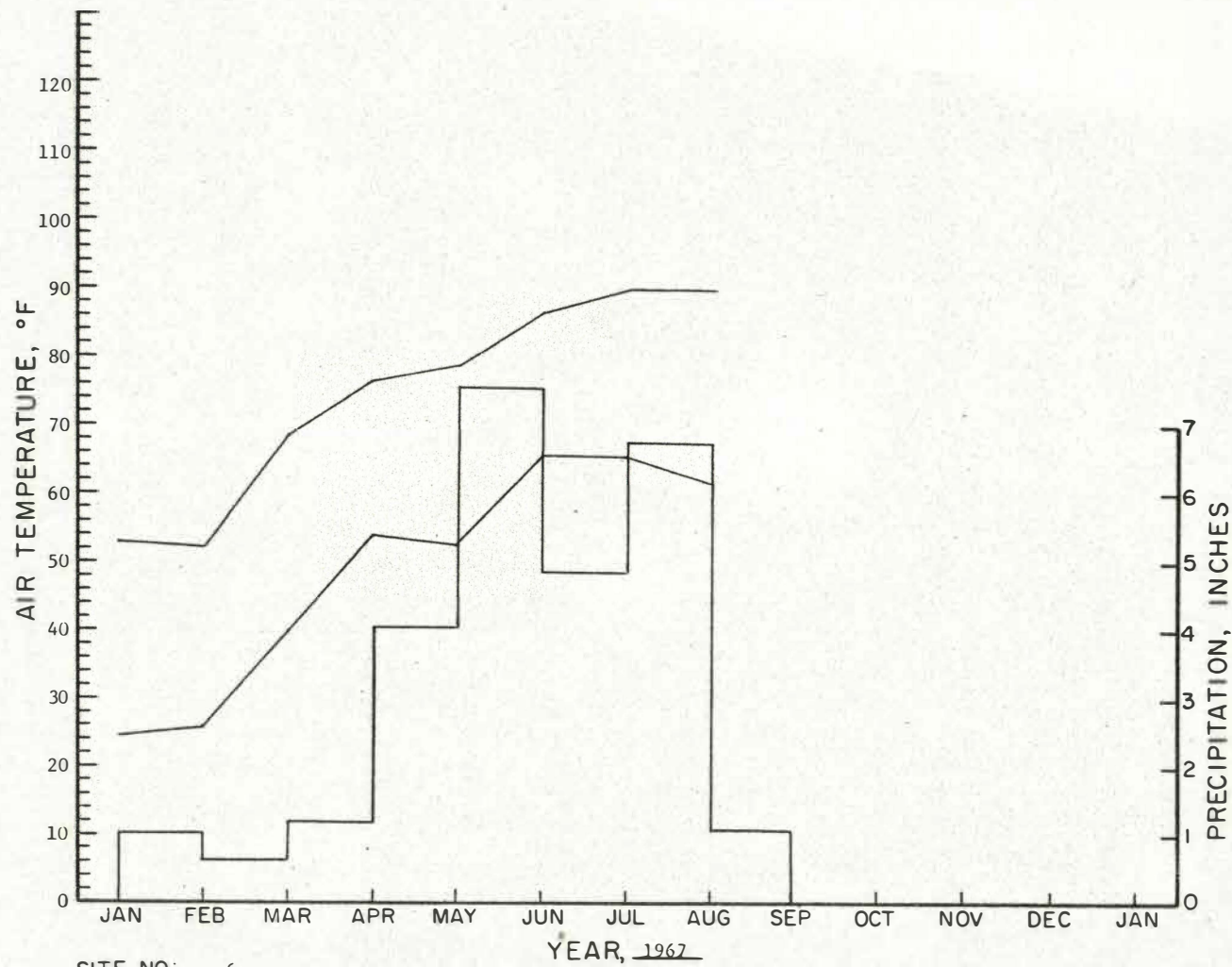
DATE : 20 November 1967
 PLOTTED BY : AAP

SUBGRADE MOISTURE VARIATIONS PROJECT



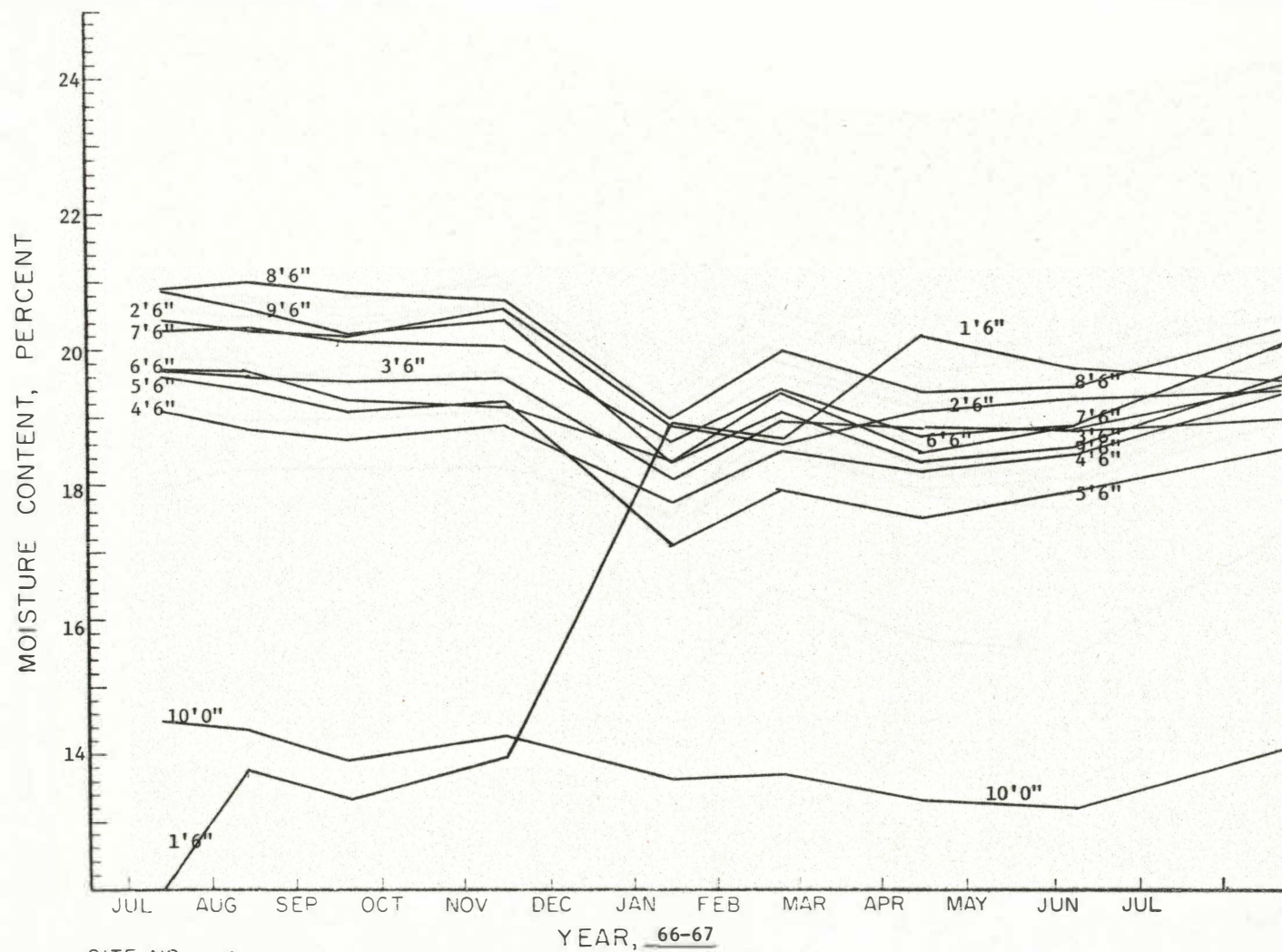
SITE NO: 6
COUNTY: Washington
HIGHWAY: U.S. 60

SUBGRADE MOISTURE VARIATIONS PROJECT



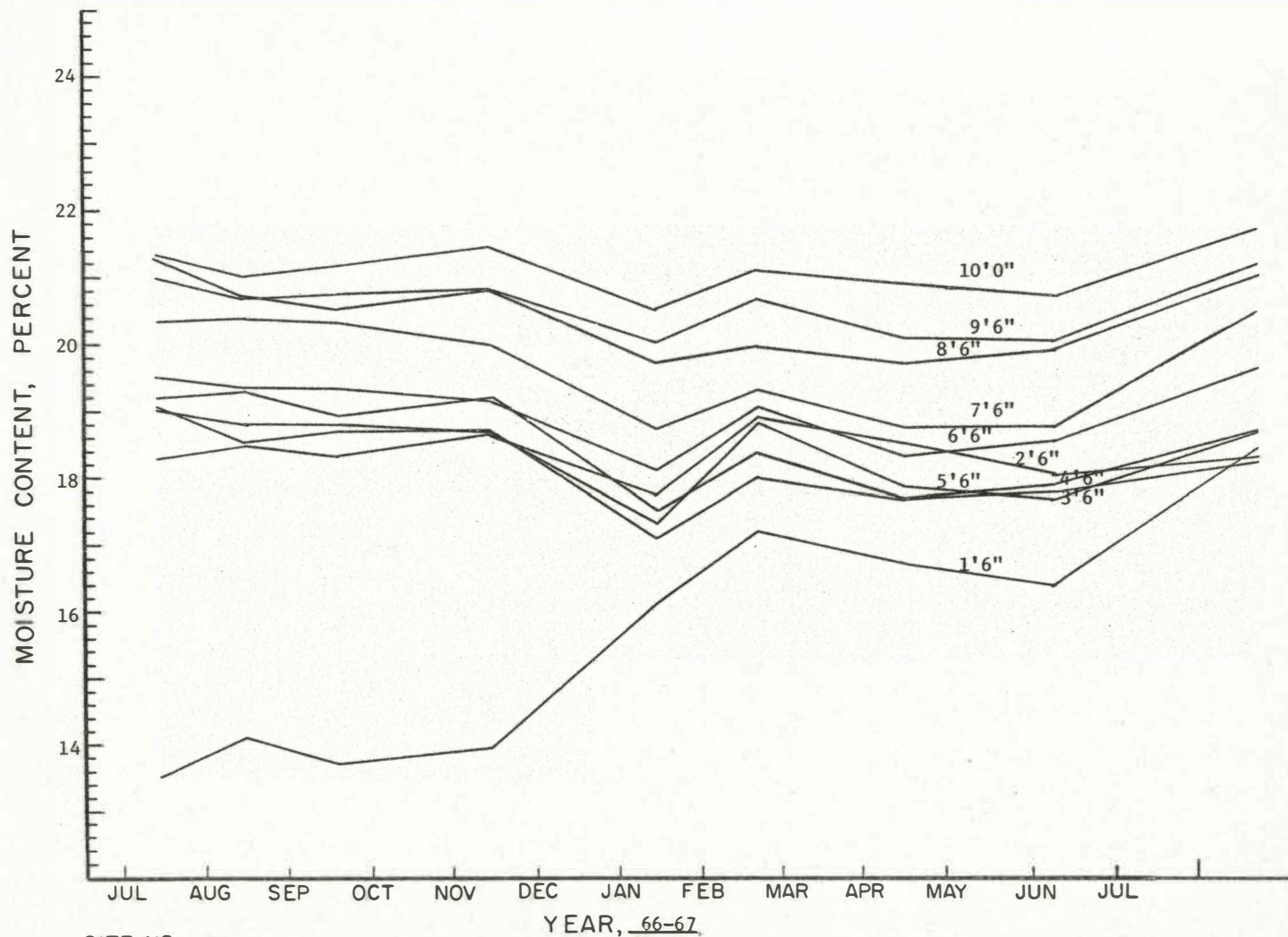
SITE NO: 6
COUNTY: Washington
HIGHWAY: US 60

SUBGRADE MOISTURE VARIATIONS PROJECT



SITE NO 6-A
 COUNTY Washington
 HIGHWAY US 60

SUBGRADE MOISTURE VARIATIONS PROJECT



SITE NO: 6-C
 COUNTY: Washington
 HIGHWAY: US 60

SUBGRADE MOISTURE VARIATIONS PROJECT

SCHOOL OF CIVIL ENGINEERING
OKLAHOMA STATE UNIVERSITY

SUBGRADE MOISTURE VARIATIONS RESEARCH PROJECT

SUBGRADE SOIL DRY DENSITY TABULATION

Date of Measurement	August 1966			January 1967			August 1967		
Site & Hole Number	6-A	6-B	6-C	6-A	6-B	6-C	6-A	6-B	6-C
Depth from top of tube to bottom of probe									
1 ft 6 in.	128.35		124.89	90.70	112.07	107.15	88.34	98.99	93.45
2 ft 0 in.									
2 ft 6 in.	83.68	89.66	91.67	91.45	92.31	96.31	87.95	85.91	90.32
3 ft 0 in.									
3 ft 6 in.	86.41	88.02	88.96	93.16	96.02	94.14	88.43	90.14	90.07
4 ft 0 in.									
4 ft 6 in.	87.44	87.99	88.32	92.44	94.38	95.27	86.93	88.75	89.12
5 ft 0 in.									
5 ft 6 in.	87.76	87.49	88.54	97.39	97.32	96.73	92.20	90.59	90.75
6 ft 0 in.									
6 ft 6 in.	87.67	87.83	88.52	93.94	93.94	93.67	89.30	89.00	88.45
7 ft 0 in.									
7 ft 6 in.	86.92	87.49	86.89	93.60	97.32	93.13	88.53	90.59	87.02
8 ft 0 in.									
8 ft 6 in.	85.31	85.53	85.45	92.73	92.79	90.42	88.63	87.68	85.54
9 ft 0 in.									
9 ft 6 in.	87.39	87.76	86.94	94.54	94.31	89.99	89.59	88.79	86.19
10 ft 0 in.	95.69	87.75	86.02	102.69	93.57	88.34	97.25	87.58	85.30

Note: All density values reported in units of lb per cu ft

SITE NO. 7

SCHOOL OF CIVIL ENGINEERING
OKLAHOMA STATE UNIVERSITY
SUBGRADE MOISTURE VARIATIONS PROJECT
TEST SITE DATA SUMMARY SHEET

LOCATION DATA:

Site No. 7 Highway No. US 66 County: Craig Date Installed: 8/24/66
Distance from access tube to Lane ℄: 15' 6" a, 6" b, 23' 6" c

Exact Location:

In Craig County west of Vinita, 0.6 mile east on US 66 - US 60 from wye jct.
US 66 and US 60. In south lane of divided highway, about 30 ft west of Martin
Ranch entrance.

PAVEMENT/DESIGN DATA:

No. of Lanes: 4D Pavement Type: AC/PCC Shoulder Type: Improved-AC
Pavement Thickness: 11 in. ℄, 9 in. Edge Latest Pavement Condition Rating: Good
Latest Traffic Count: 3400 vpd Heavy Truck Traffic: No
Terrain: Upland Drainage: Good Year of Original Paving: 1965

Original Design and History:

AC over PC, 20 ft width; ℄ to 10 ft rt and lt: 4 in. AC, 7 in. PCC, 8 in. gravel
subbase; 10 ft to 16 ft lt and 10 ft to 20 ft rt: sealed shoulder over 8 in. gravel
subbase.

FIELD OBSERVATIONS BY RESEARCH PERSONNEL:

- 5/31/67 - Access tube "c" apparently leaks at bottom; new tube installed.
10/3/67 - Access tube "a" contains 6 in. of water; water in and around cover
of access tube "b"; water around cover of access tube "c".

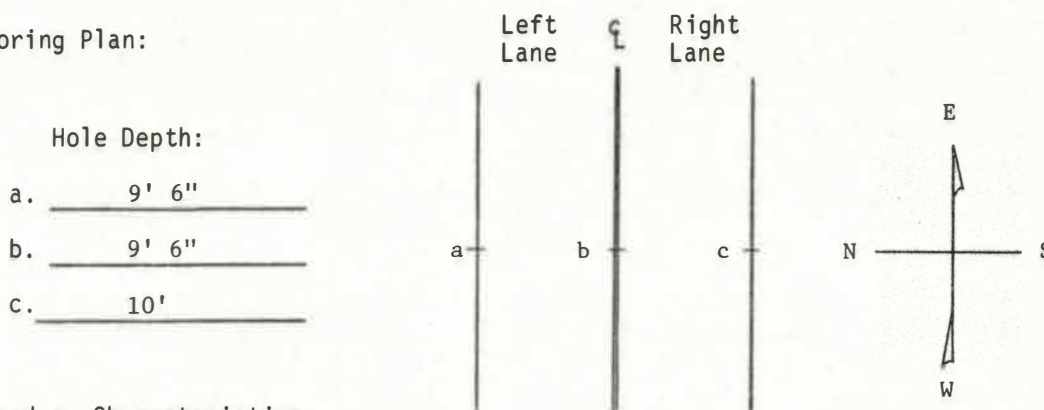
SCHOOL OF CIVIL ENGINEERING
OKLAHOMA STATE UNIVERSITY
Stillwater, Oklahoma
SUBGRADE MOISTURE VARIATION STUDY
SITE INSTALLATION INFORMATION

Installation: Graig U.S. 66 7 Date: 24 8 66
County Highway No. day month year

Location of site: West of Vinita, 0.6 miles east on U.S. 66 - 60 from wye
intersection of U.S. 66 and U.S. 60. In south lane of divided highway, approx-
imately 30 ft west of entrance to "Martin Ranch".

Description of Terrain and Vegetation: Pavement on open, gently rolling,
upland terrain.

Boring Plan:



Roadway Characteristics:

Pavement: Type Asphaltic Concrete overlaying P.C. Concrete
Width 24' Thickness 4" AC - 7" PC
Condition Good

Shoulders: Type Asphaltic Concrete Width L-4' R-10'
Condition Good

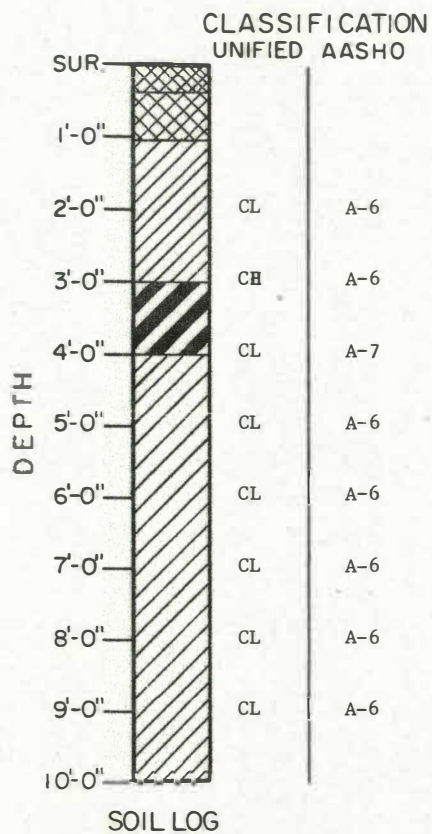
Base Course Characteristics Select gravel

SITE NO: 7

COUNTY : Ottawa

HIGHWAY : US 66

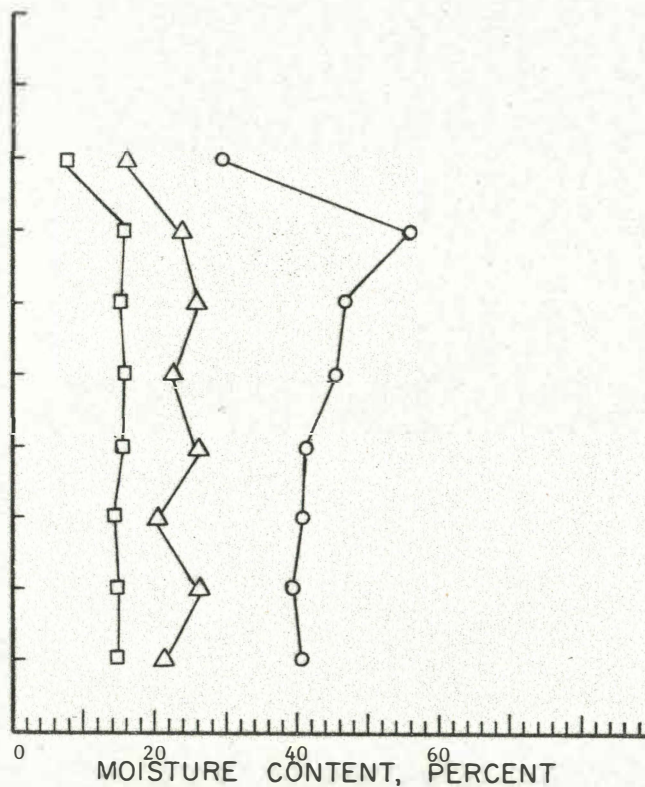
- LIQUID LIMIT
- ▲ PLASTIC LIMIT
- LINEAL SHRINKAGE



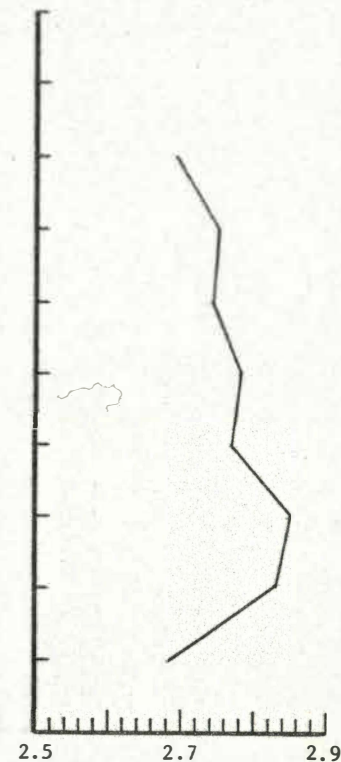
DATE : 24 November 1967

PLOTTED BY : AAP

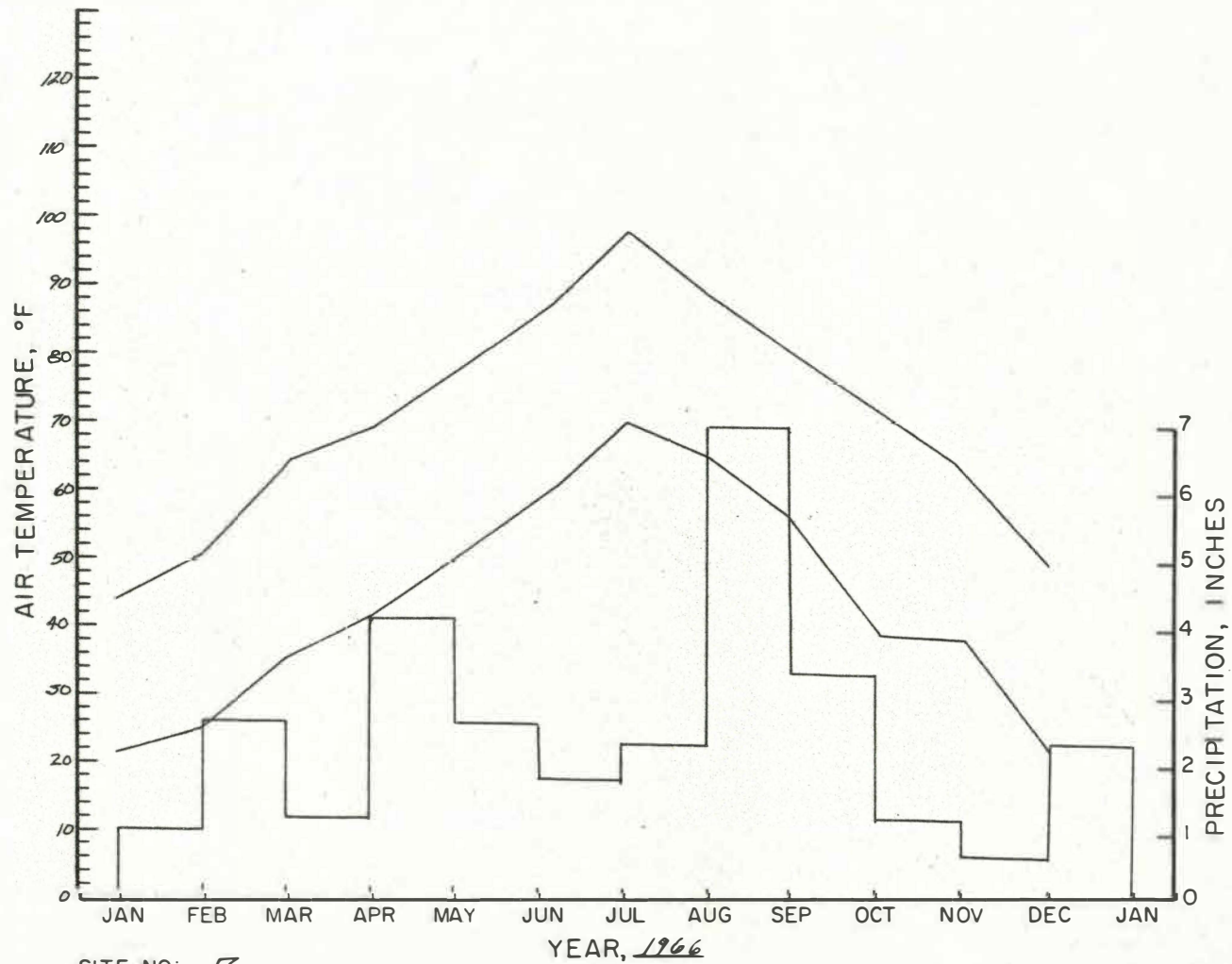
ATTERBERG LIMITS



SPECIFIC GRAVITY

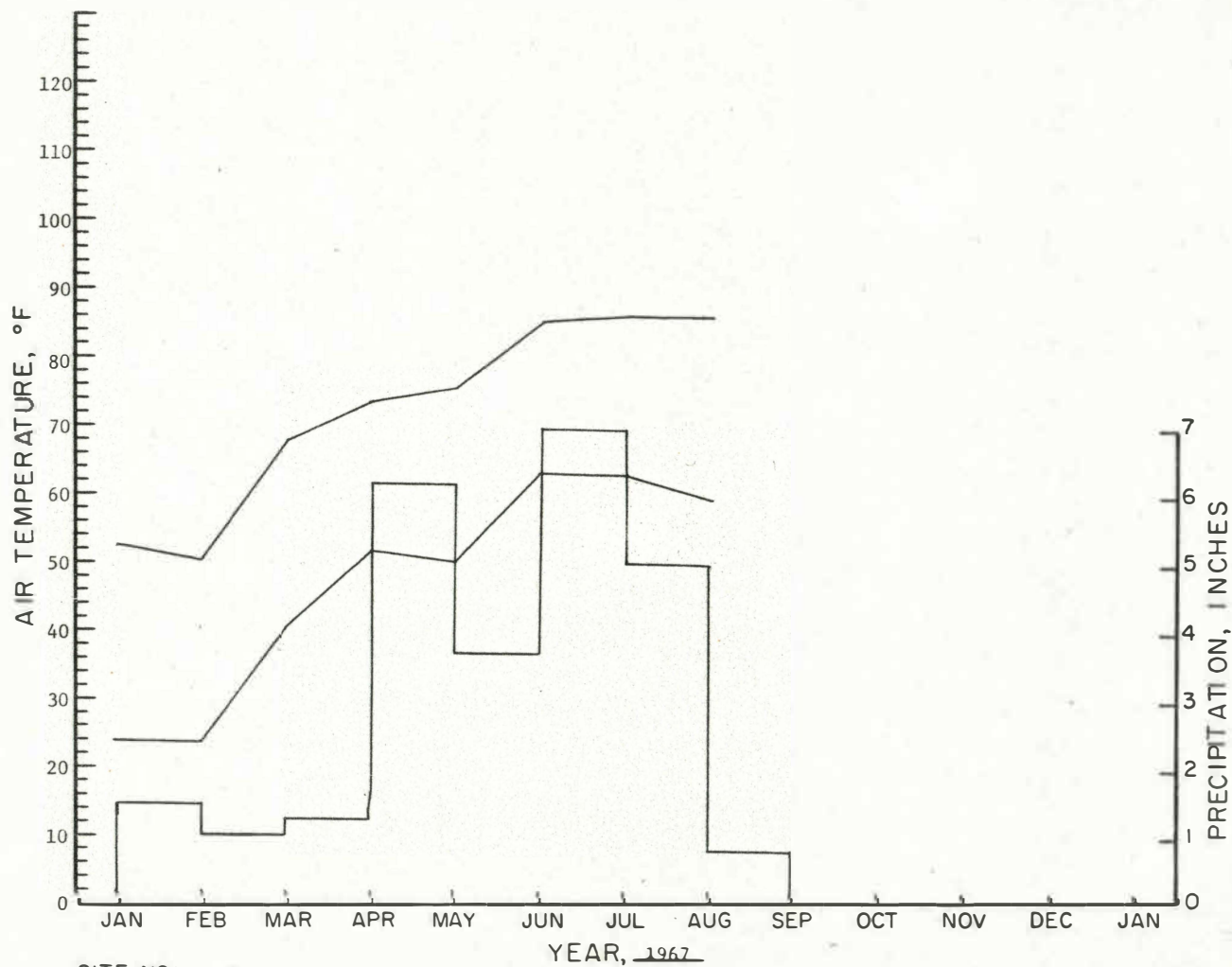


SUBGRADE MOISTURE VARIATIONS PROJECT



SITE NO: 7
COUNTY: Craig
HIGHWAY: US 60

SUBGRADE MOISTURE VARIATIONS PROJECT

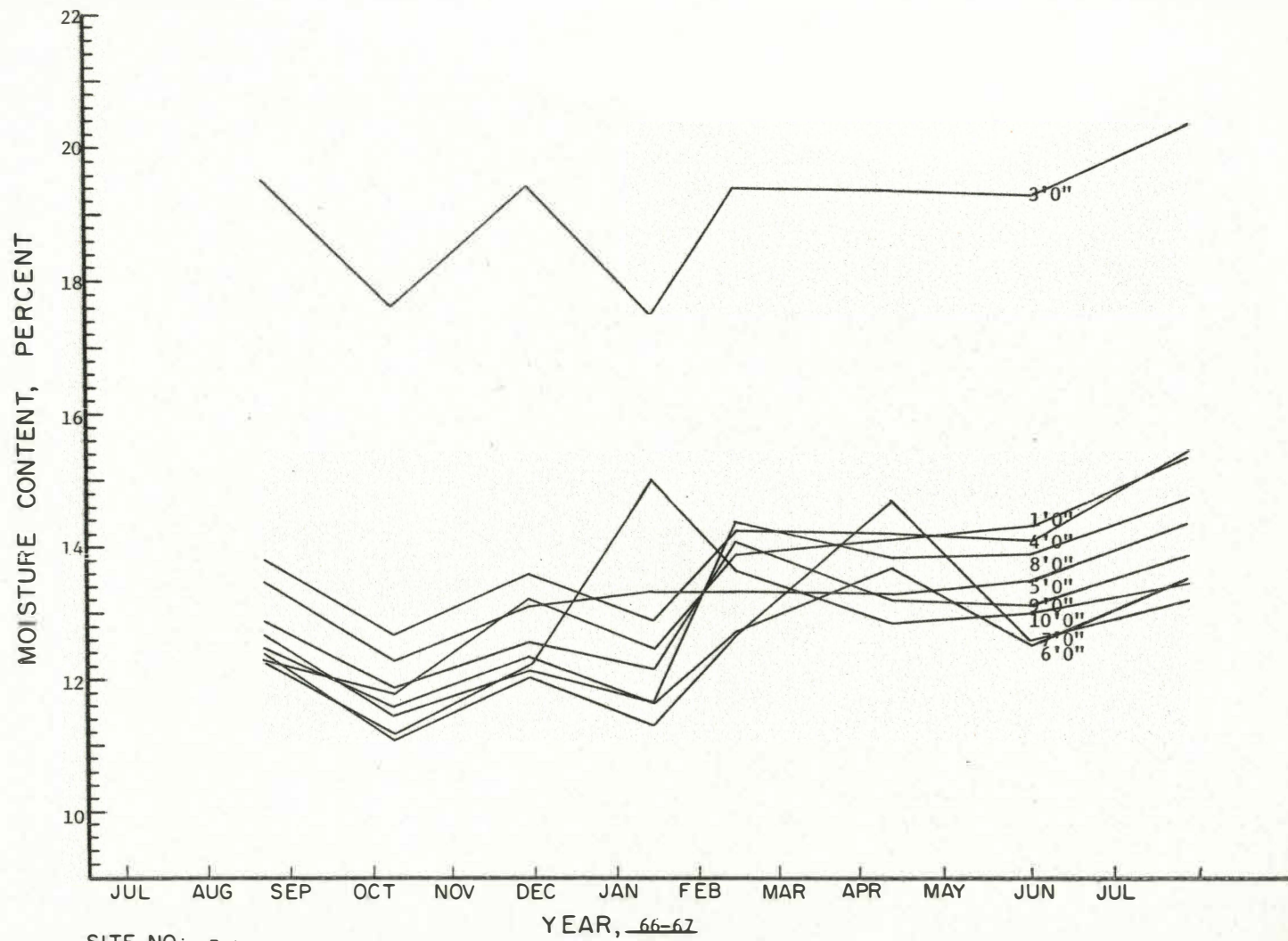


SITE NO: 7

COUNTY: Craig

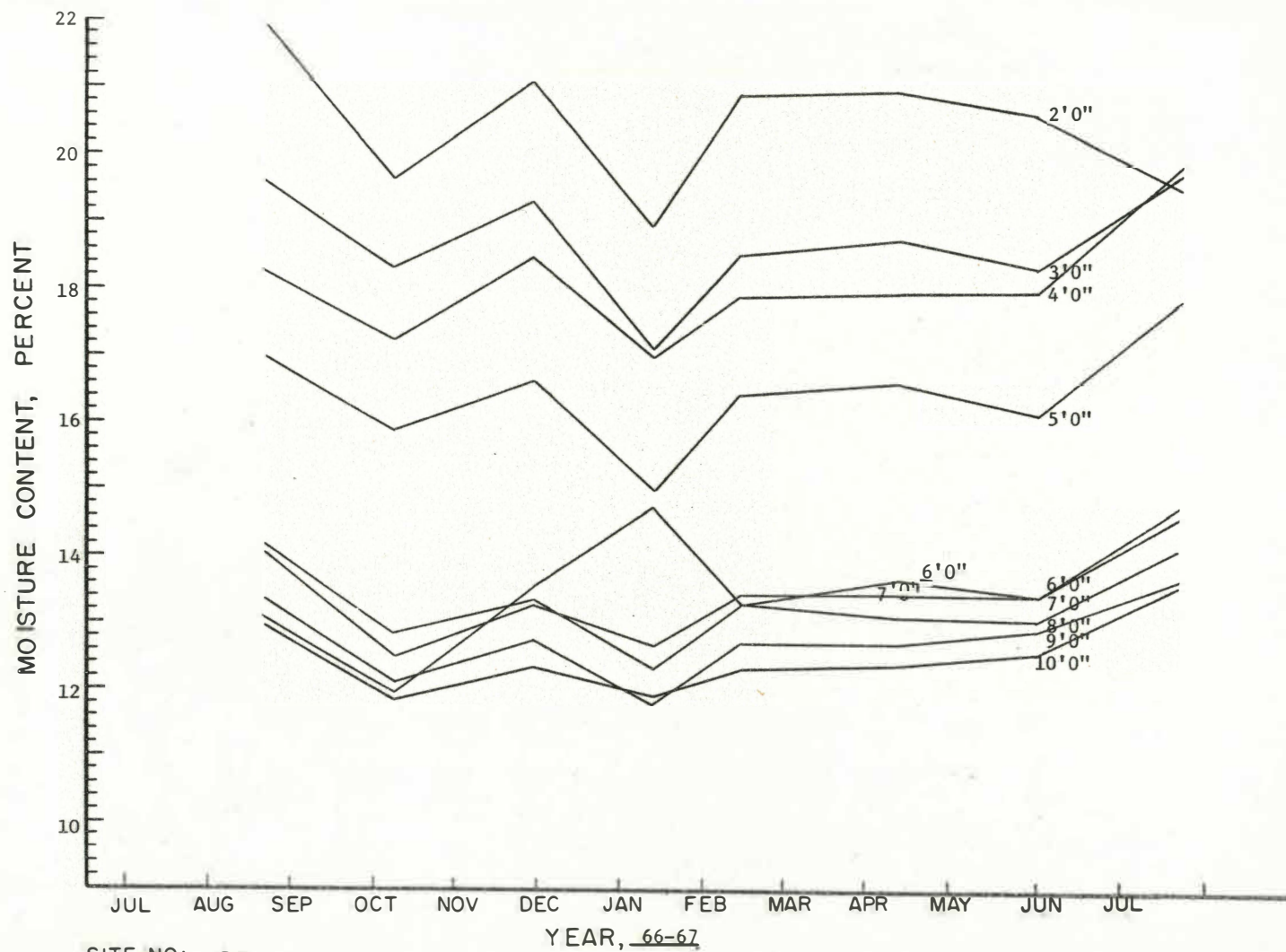
HIGHWAY: I-44

SUBGRADE MOISTURE VARIATIONS PROJECT



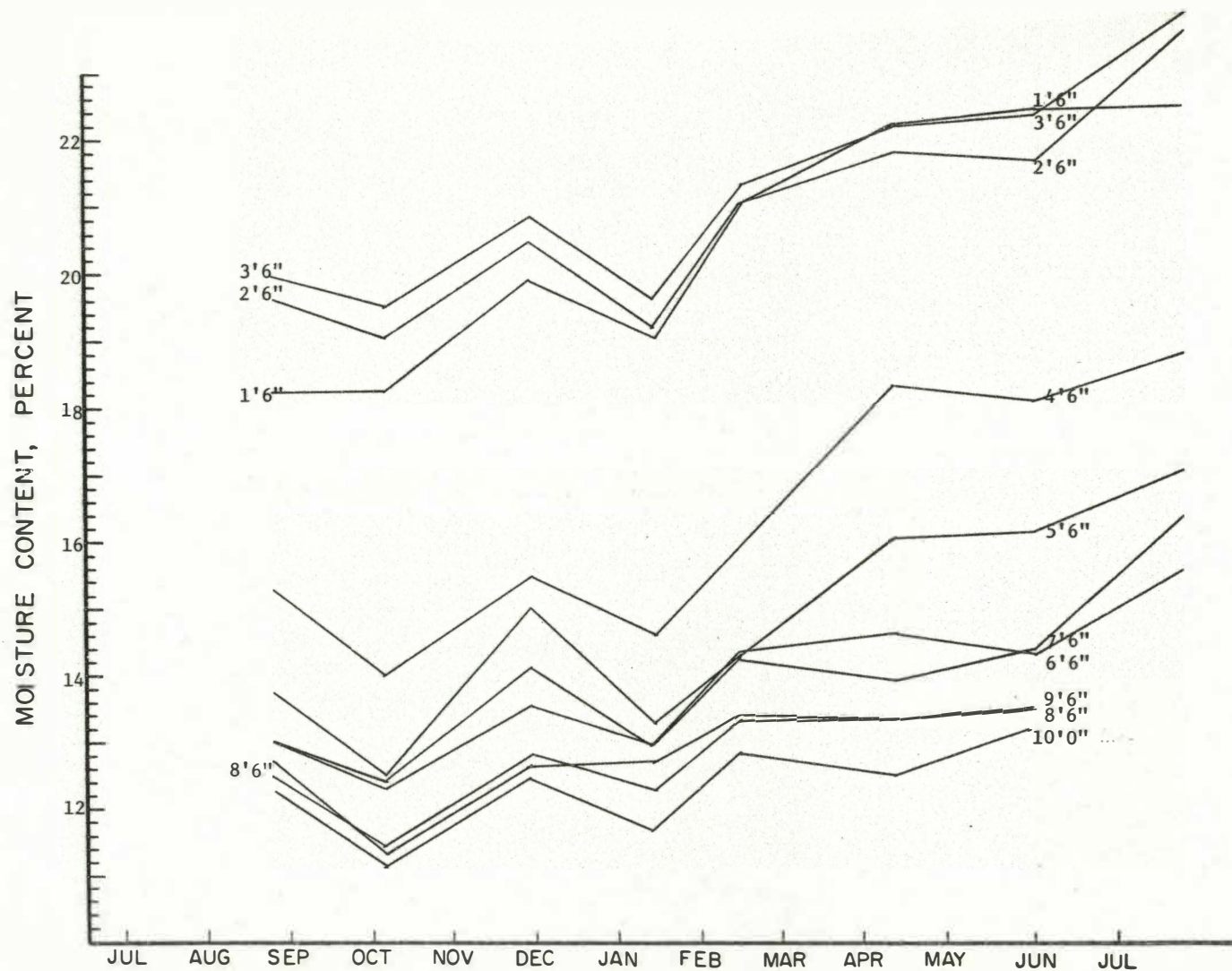
SITE NO: 7-A
 COUNTY: Ottawa
 HIGHWAY: US 66

SUBGRADE MOISTURE VARIATIONS PROJECT



SITE NO: 7-B
 COUNTY: Ottawa
 HIGHWAY: US 66

SUBGRADE MOISTURE VARIATIONS PROJECT



SITE NO: 7-C
 COUNTY: Ottawa
 HIGHWAY: US 66

SUBGRADE MOISTURE VARIATIONS PROJECT

SCHOOL OF CIVIL ENGINEERING
OKLAHOMA STATE UNIVERSITY

SUBGRADE MOISTURE VARIATIONS RESEARCH PROJECT

SUBGRADE SOIL DRY DENSITY TABULATION

Date of Measurement	August 1966			January 1967			August 1967		
Site & Hole Number	7-A	7-B	7-C	7-A	7-B	7-C	7-A	7-B	7-C
Depth from top of tube to bottom of probe									
1 ft 6 in.			103.03			104.15			99.02
2 ft 0 in.	138.89	96.02		139.42	104.15		126.78	112.98	
2 ft 6 in.			105.73			109.36			101.14
3 ft 0 in.	98.10	99.21		102.36	108.27		96.10	102.49	
3 ft 6 in.			100.77			104.75			98.62
4 ft 0 in.	116.31	102.67		118.41	108.79		111.05	100.03	
4 ft 6 in.			113.92			114.39			109.70
5 ft 0 in.	119.01	102.12		121.73	109.49		114.87	100.34	
5 ft 6 in.			121.02			120.81			115.47
6 ft 0 in.	126.72	117.35		130.04	125.39		120.79	114.68	
6 ft 6 in.			121.68			126.43			118.36
7 ft 0 in.	125.05	115.71		127.52	121.41		119.50	112.48	
7 ft 6 in.			125.23			128.66			111.27
8 ft 0 in.	124.04	118.52		126.39	124.22		121.68	117.28	
8 ft 6 in.			129.19			131.33			
9 ft 0 in.	125.93	124.41		127.98	131.74		122.10	121.46	
9 ft 6 in.			129.46			131.31			
10 ft 0 in.	129.82	126.83	132.47	129.02	133.05	135.80	125.74	123.18	

Note: All density values reported in units of lb per cu ft

SITE NO. 8

SCHOOL OF CIVIL ENGINEERING
OKLAHOMA STATE UNIVERSITY
SUBGRADE MOISTURE VARIATIONS PROJECT
TEST SITE DATA SUMMARY SHEET

LOCATION DATA:

Site No. 8 Highway No. US 69 County: Mayes Date Installed: 8/26/66

Distance from access tube to Lane ℓ : 19' 6" a, 8" b, 19' 6" c

Exact Location:

In Mayes County south of Pryor, 0.2 mile north on US 69 from jct. US 69 and US 69A.
Marker on east fence row.

PAVEMENT/DESIGN DATA:

No. of Lanes: 2 Pavement Type: AC/PCC Shoulder Type: Improved AC

Pavement Thickness: 15 in. ℓ , 1 in. Edge Latest Pavement Condition Rating: Good

Latest Traffic Count: 7700 vpd Heavy Truck Traffic: Yes

Terrain: Upland Drainage: Good Year of Original Paving: 1938

Original Design and History:

AC over PCC in 1962, 20 ft width; ℓ to 10 ft rt and lt: 2.5 in. AC, 6 in. PCC,
10 in. SABC; 10 ft to 20 ft rt and lt: 1 in. sealed shoulder over 10 in. SABC

FIELD OBSERVATIONS BY RESEARCH PERSONNEL:

12/25/67 - Protective covers on holes "a" and "c" regROUTED.

3/6/68 - Cracks in pavement have been sealed by OCHD.

SCHOOL OF CIVIL ENGINEERING
OKLAHOMA STATE UNIVERSITY
SUBGRADE MOISTURE VARIATIONS PROJECT
TEST SITE DATA SUMMARY SHEET

LOCATION DATA:

Site No. 8 Highway No. US 69 County: Mayes Date Installed: 8/26/66

Distance from access tube to Lane ℓ : 19' 6" a, 8" b, 19' 6" c

Exact Location:

In Mayes County south of Pryor, 0.2 mile north on US 69 from jct. US 69 and US 69A.
Marker on east fence row.

PAVEMENT/DESIGN DATA:

No. of Lanes: 2 Pavement Type: AC/PCC Shoulder Type: Improved AC

Pavement Thickness: 15 in. ℓ , 1 in. Edge Latest Pavement Condition Rating: Good

Latest Traffic Count: 7700 vpd Heavy Truck Traffic: Yes

Terrain: Upland Drainage: Good Year of Original Paving: 1938

Original Design and History:

AC over PCC in 1962, 20 ft width; ℓ to 10 ft rt and lt: 2.5 in. AC, 6 in. PCC,
10 in. SABC; 10 ft to 20 ft rt and lt: 1 in. sealed shoulder over 10 in. SABC

FIELD OBSERVATIONS BY RESEARCH PERSONNEL:

12/25/67 - Protective covers on holes "a" and "c" regROUTED.

3/6/68 - Cracks in pavement have been sealed by OSHD.

SCHOOL OF CIVIL ENGINEERING
OKLAHOMA STATE UNIVERSITY
Stillwater, Oklahoma
SUBGRADE MOISTURE VARIATION STUDY
SITE INSTALLATION INFORMATION

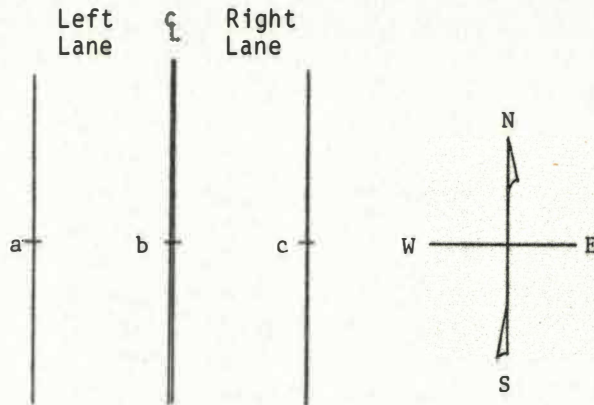
Installation: Mayes U.S. 69 8 Date: 26 8 66
County Highway No. day month year

Location of site: South of Pryor, 0.2 miles north on U.S. 69 from intersection
of U.S. 69 and U.S. 69A. Approximately adjacent to billboard facing north on
west side of highway.

Description of Terrain and Vegetation: Pavement on open, fairly level
upland terrain.

Boring Plan:

Hole Depth:
a. 8'
b. 10'
c. 6'



Roadway Characteristics:

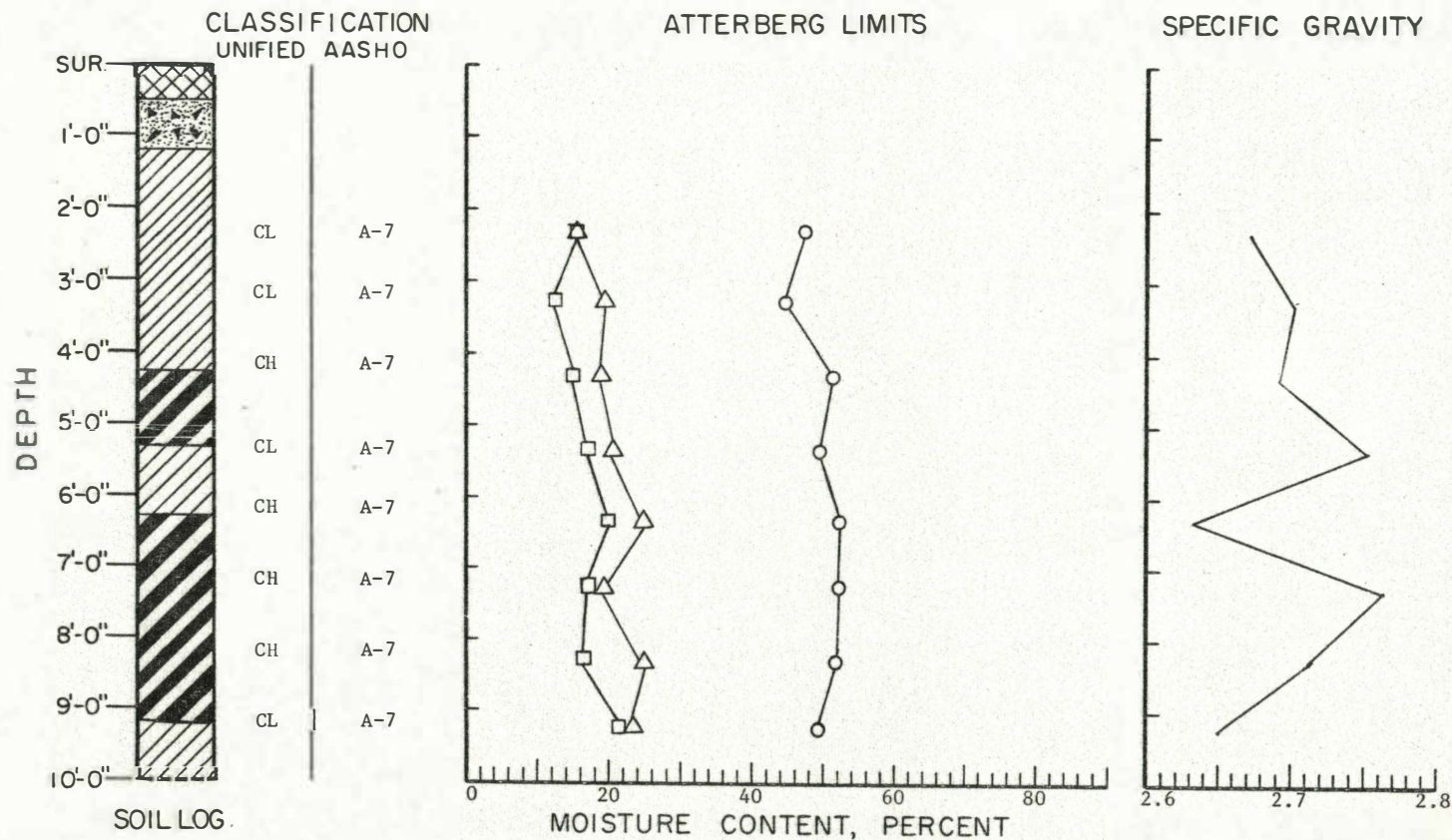
Pavement: Type Asphaltic Concrete over P.C. Concrete
Width 24' Thickness 5"-A.C. - 10"-P.C.
Condition Good

Shoulders: Type Asphaltic Concrete Width 8'
Condition Good

Base Course Characteristics Select gravel

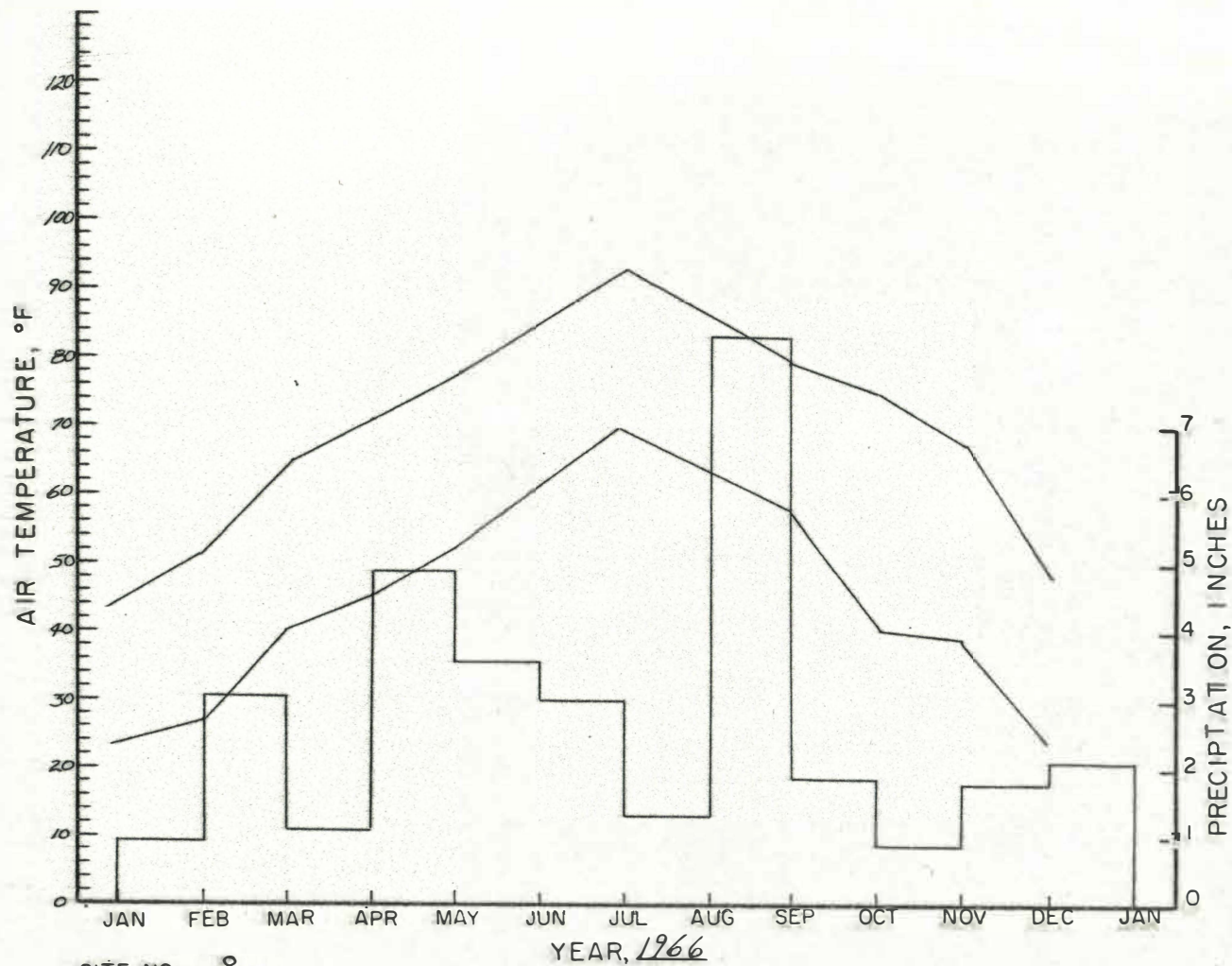
SITE NO.: 8
 COUNTY : Maves
 HIGHWAY : US 69

● LIQUID LIMIT
 ▲ PLASTIC LIMIT
 ■ LINEAL SHRINKAGE



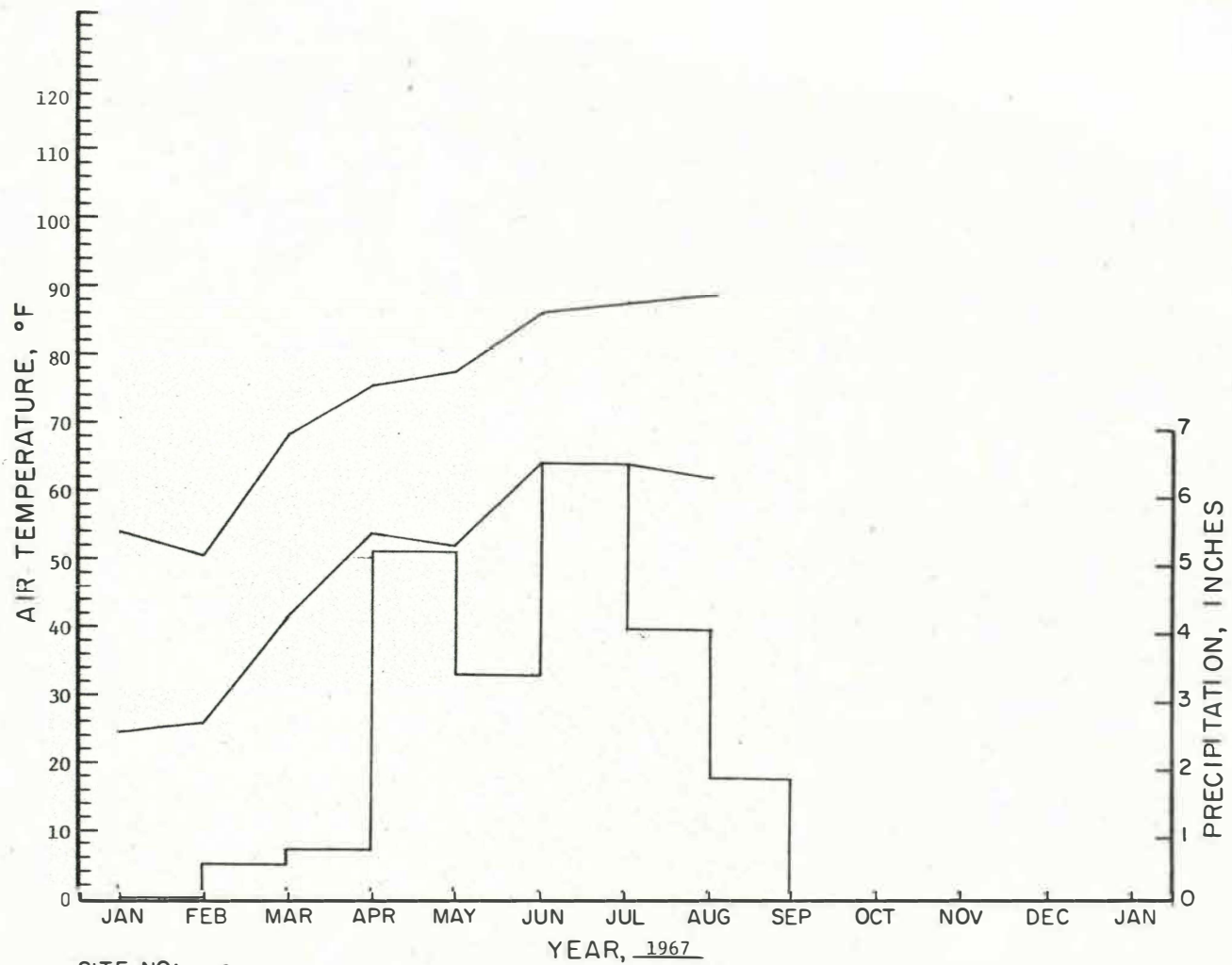
DATE : 26 November 1967
 PLOTTED BY : AAP

SUBGRADE MOISTURE VARIATIONS PROJECT



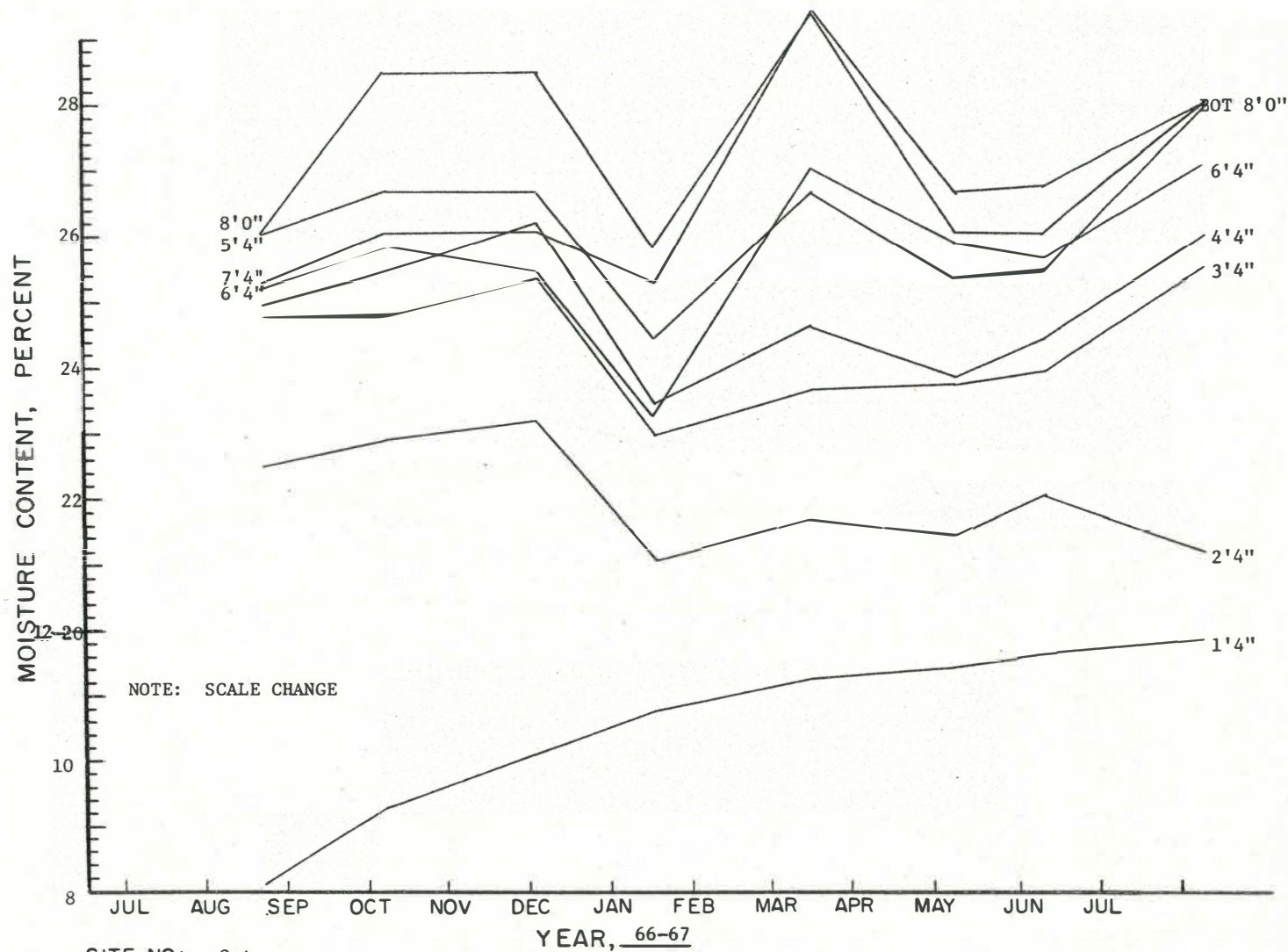
SITE NO: 8
COUNTY: MAYES
HIGHWAY: U.S. 69

SUBGRADE MOISTURE VARIATIONS PROJECT



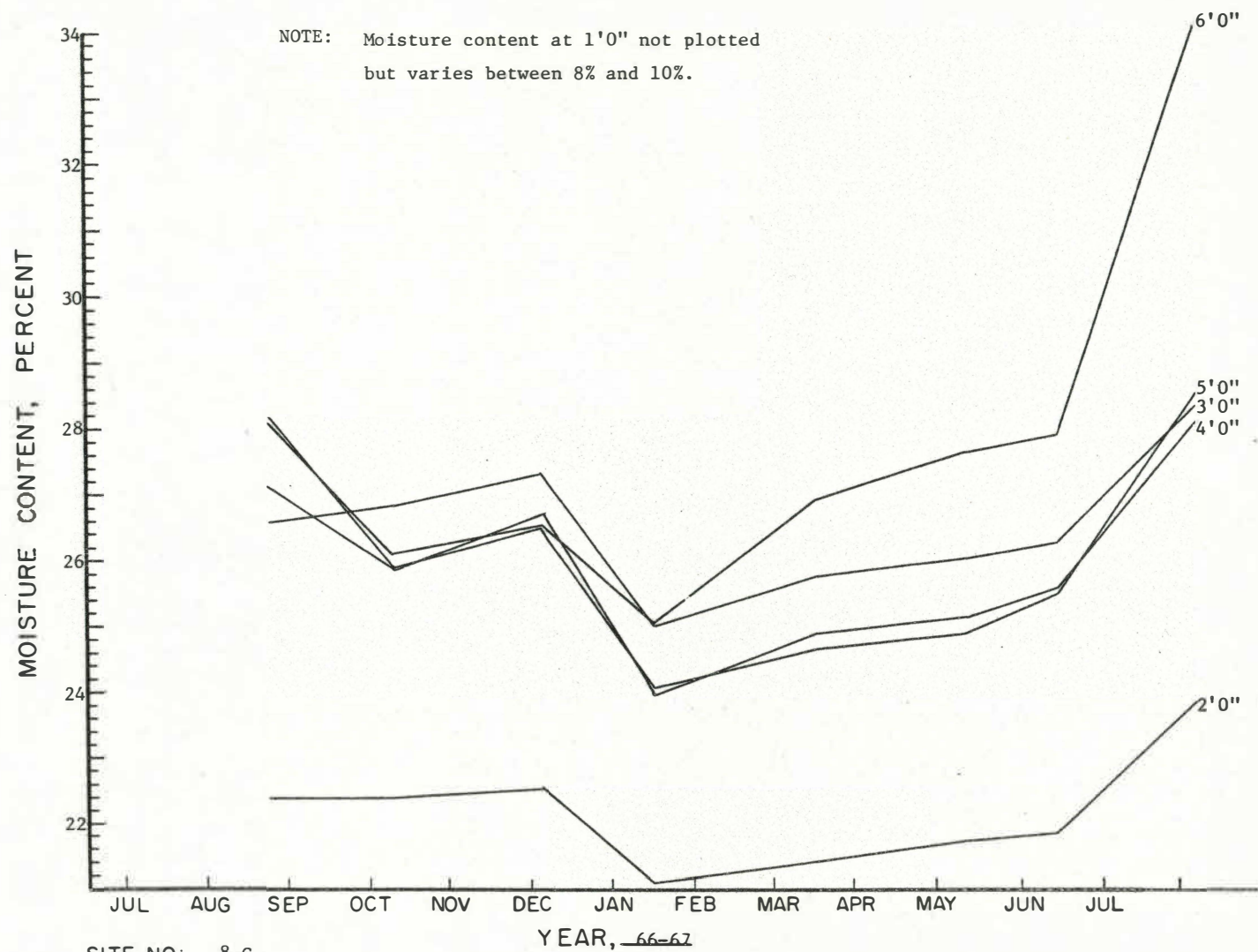
SITE NO: 8
 COUNTY: Maves
 HIGHWAY: US 69

SUBGRADE MOISTURE VARIATIONS PROJECT



SITE NO: 8-A
 COUNTY: Mayes
 HIGHWAY: US 69

SUBGRADE MOISTURE VARIATIONS PROJECT



SITE NO: 8-C
COUNTY: Mayes
HIGHWAY: US 60

SUBGRADE MOISTURE VARIATIONS PROJECT

SCHOOL OF CIVIL ENGINEERING
OKLAHOMA STATE UNIVERSITY

SUBGRADE MOISTURE VARIATIONS RESEARCH PROJECT

SUBGRADE SOIL DRY DENSITY TABULATION

Date of Measurement	August 1966			January 1967			August 1967		
Site & Hole Number	8-A	8-B	8-C	8-A	8-B	8-C	8-A	8-B	8-C
Depth from top of tube to bottom of probe									
1 ft 6 in.					87.53			77.65	
2 ft 0 in.	156.24		140.94	130.94		159.19	126.58		134.57
2 ft 6 in.		92.08			96.49			88.46	
3 ft 0 in.	93.32		94.15	99.96		100.57	99.87		90.28
3 ft 6 in.		89.39			91.96			84.51	
4 ft 0 in.	84.22		82.52	90.31		87.67	84.31		79.57
4 ft 6 in.		92.33			95.43			87.00	
5 ft 0 in.	85.62		81.84	92.28		90.16	85.47		80.23
5 ft 6 in.		89.88			92.84			84.46	
6 ft 0 in.	83.06		85.15	88.65		93.77	82.00		81.41
6 ft 6 in.		87.43			91.06			83.11	
7 ft 0 in.	85.70		83.73	92.53		91.17	84.42		73.61
7 ft 6 in.		87.60			90.80			82.75	
8 ft 0 in.	85.94			91.46			85.86		
8 ft 6 in.		86.75			90.58			85.60	
9 ft 0 in.	84.46			90.87			84.64		
9 ft 6 in.		95.27			99.78			90.62	
10 ft 0 in.		101.83			104.51			96.65	

Note: All density values reported in units of lb per cu ft

SITE NO. 9

SCHOOL OF CIVIL ENGINEERING
OKLAHOMA STATE UNIVERSITY
SUBGRADE MOISTURE VARIATIONS PROJECT
TEST SITE DATA SUMMARY SHEET

LOCATION DATA:

Site No. 9 Highway No. US 62 County: Muskogee Date Installed: 7/19/66

Distance from access tube to Lane ℓ : 22' 0" a, 6" b, 14' 6" c

Exact Location:

In Muskogee County northeast of Muskogee. Site in westbound lane US 62, 0.7 mile west from Arkansas River bridge. Marker on north fence row.

PAVEMENT/DESIGN DATA:

No. of Lanes: 4D Pavement Type: PCC Shoulder Type: Improved AC

Pavement Thickness: 8 in. ℓ , 2 in. Edge Latest Pavement Condition Rating: Good

Latest Traffic Count: 8600 vpd Heavy Truck Traffic: Yes

Terrain: Upland Drainage: Good Year of Original Paving: 1959

Original Design and History:

PCC, 24 ft width; ℓ to 12 ft rt and lt: 8 in. PCC over 4 in. sand subbase;
12 ft to 22 ft rt and lt: sealed shoulder over 6 in. SABC.

FIELD OBSERVATIONS BY RESEARCH PERSONNEL:

- 2/28/67 - Protective cover of hole "a" regouted
- 4/25/67 - Water in access tube "c"
- 8/23/67 - Subgrade intrusion between cover and access tube "a"; protective covers of holes "b" and "c" regouted.
- 12/20/67 - Protective cover of hole "a" regouted.

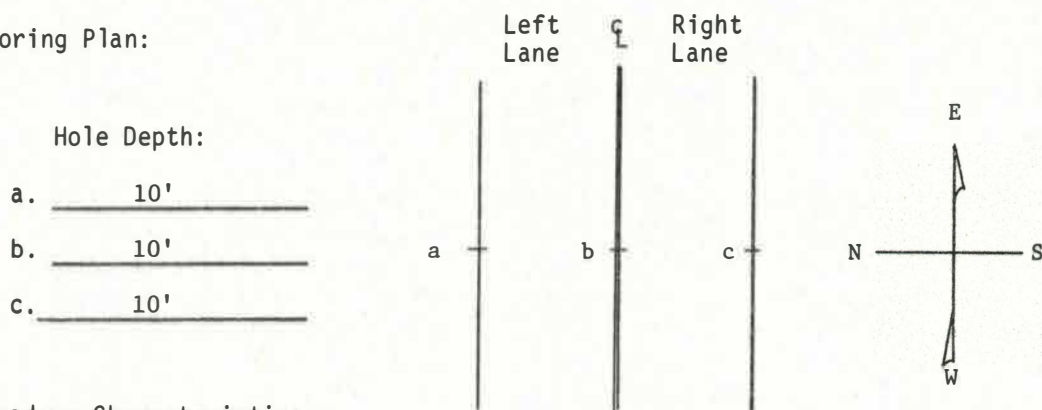
SCHOOL OF CIVIL ENGINEERING
OKLAHOMA STATE UNIVERSITY
Stillwater, Oklahoma
SUBGRADE MOISTURE VARIATION STUDY
SITE INSTALLATION INFORMATION

Installation: Muskogee U.S. 62 9 Date: 19 7 66
County Highway No. day month year

Location of site: Northeast of Muskogee, in west-bound lane of U.S. 64, 1.5
miles west from Arkansas River bridge.

Description of Terrain and Vegetation: Rolling upland terrain with good
drainage.

Boring Plan:



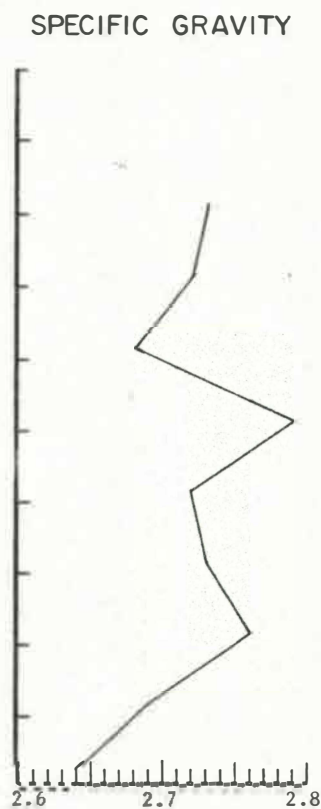
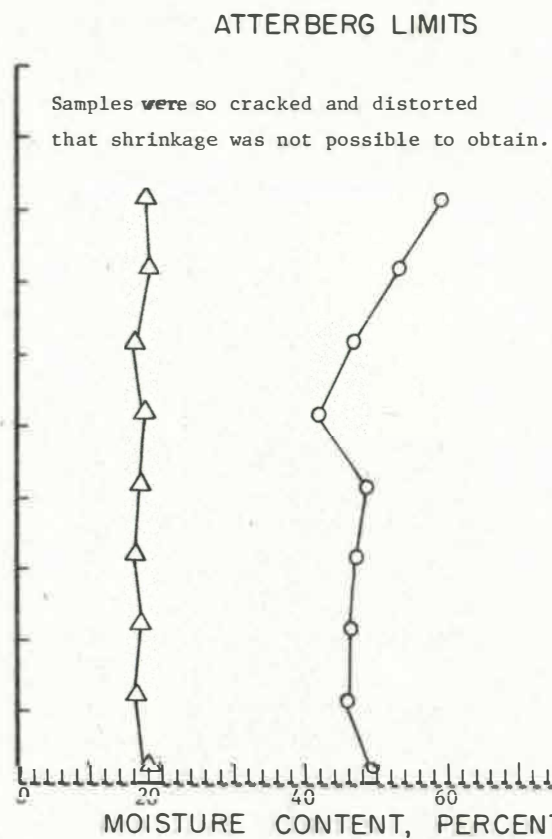
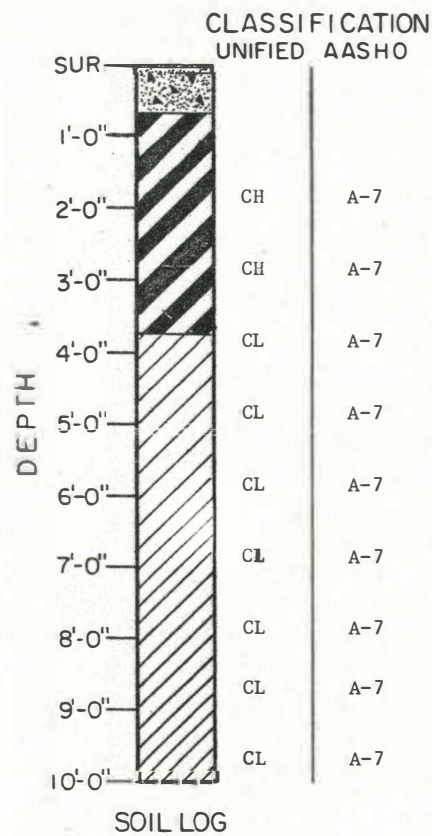
Roadway Characteristics:

Pavement: Type P.C. Concrete
Width 12' Thickness 8"
Condition Good
Shoulders: Type Sealed Asphalt Width L-11' R-3'
Condition Good

Base Course Characteristics Sand

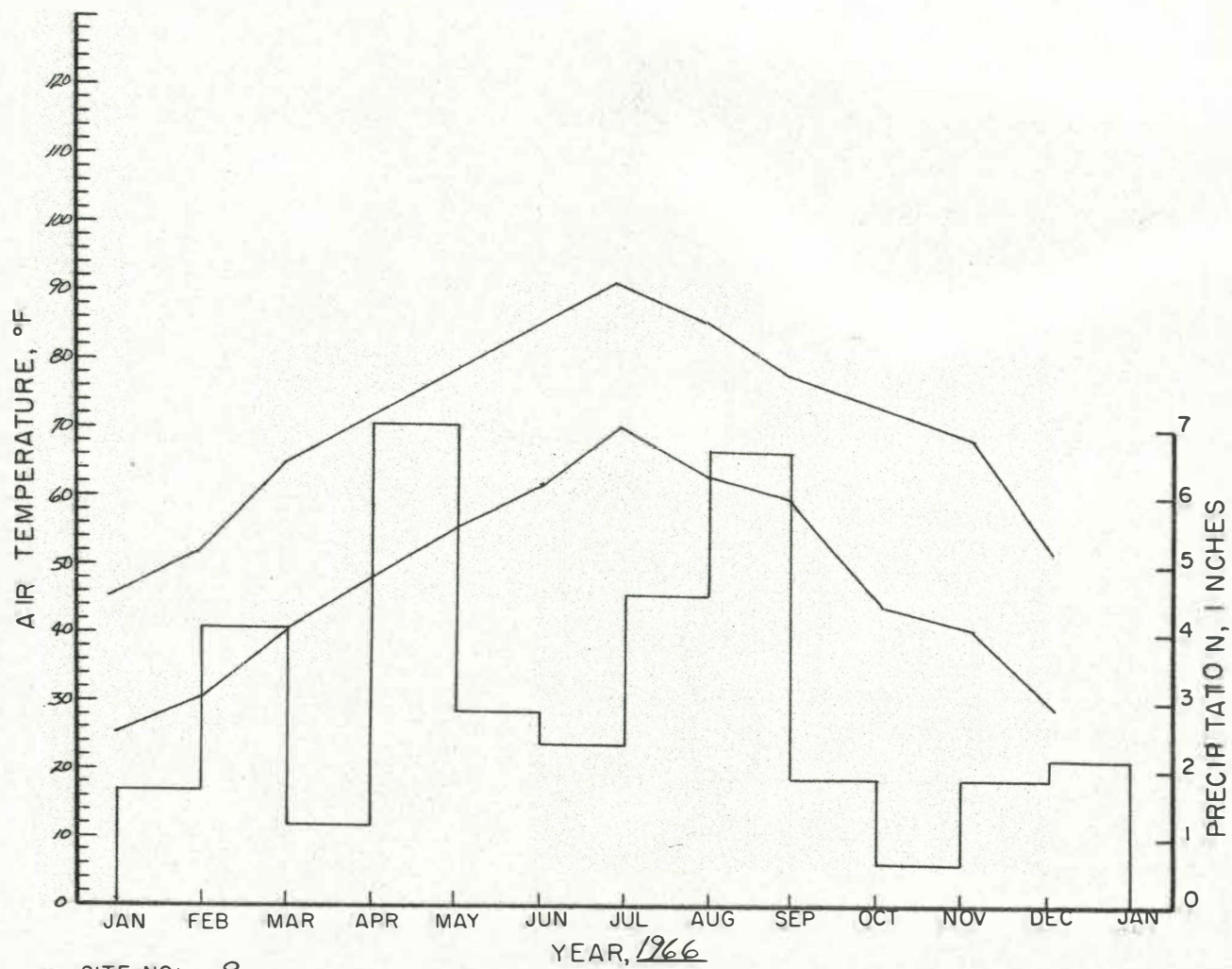
SITE NO.: 9
 COUNTY : Muskogee
 HIGHWAY : US 64

- LIQUID LIMIT
- ▲ PLASTIC LIMIT
- LINEAL SHRINKAGE



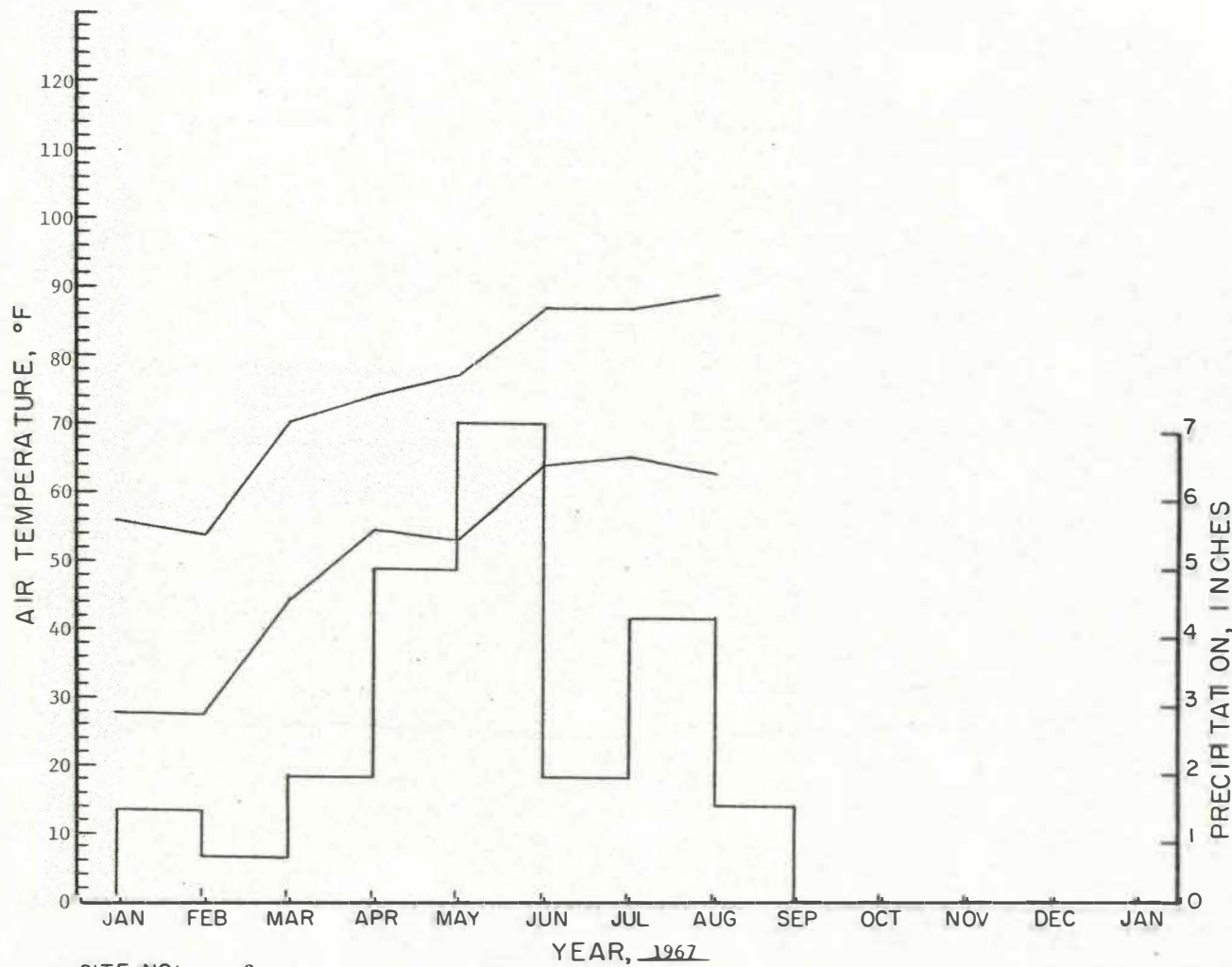
DATE : 26 November 1967
 PLOTTED BY : AAP

SUBGRADE MOISTURE VARIATIONS PROJECT



SITE NO: 9
 COUNTY: Muskogee
 HIGHWAY: US 62

SUBGRADE MOISTURE VARIATIONS PROJECT

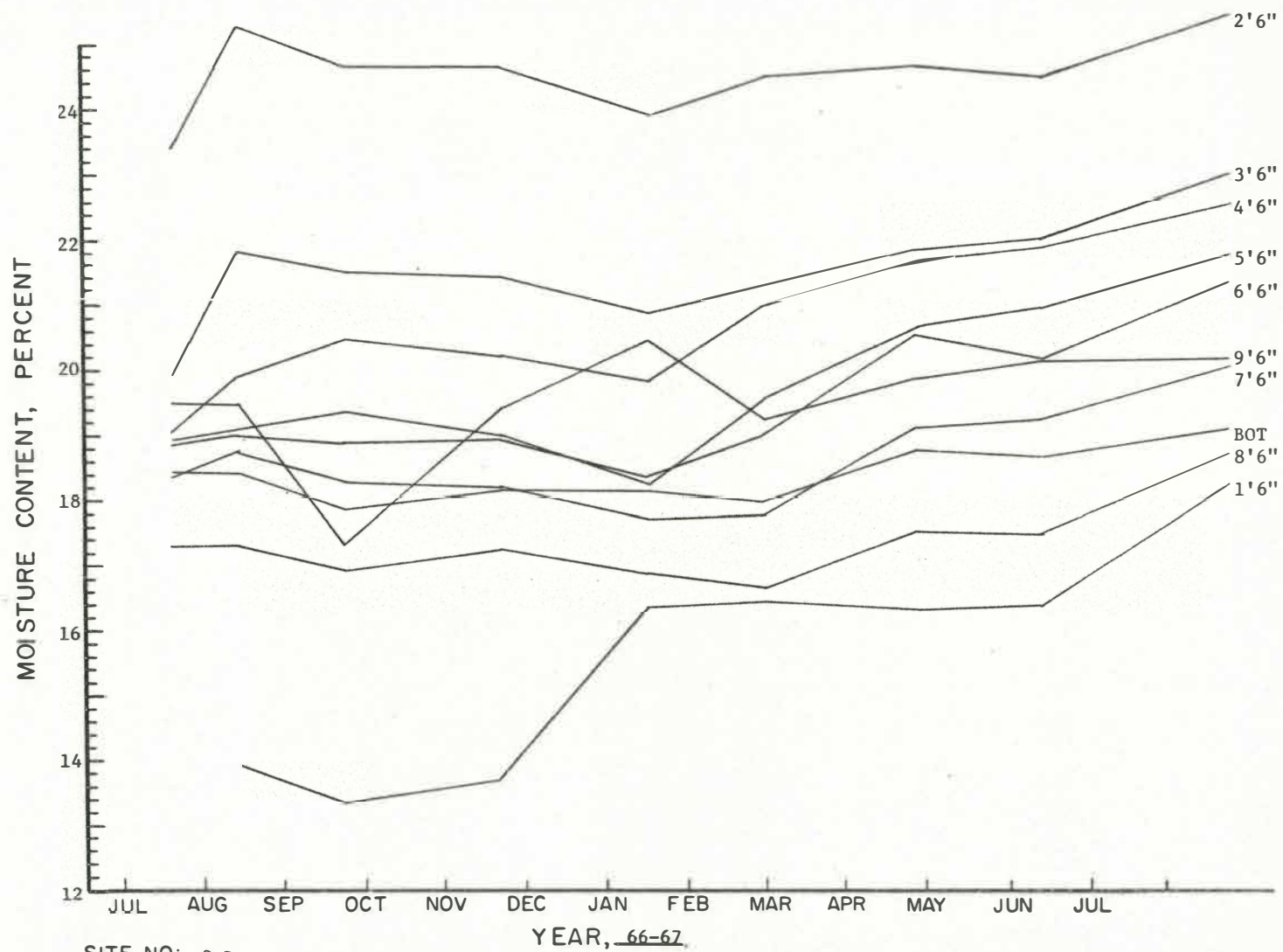


SITE NO: 9

COUNTY: Muskegon

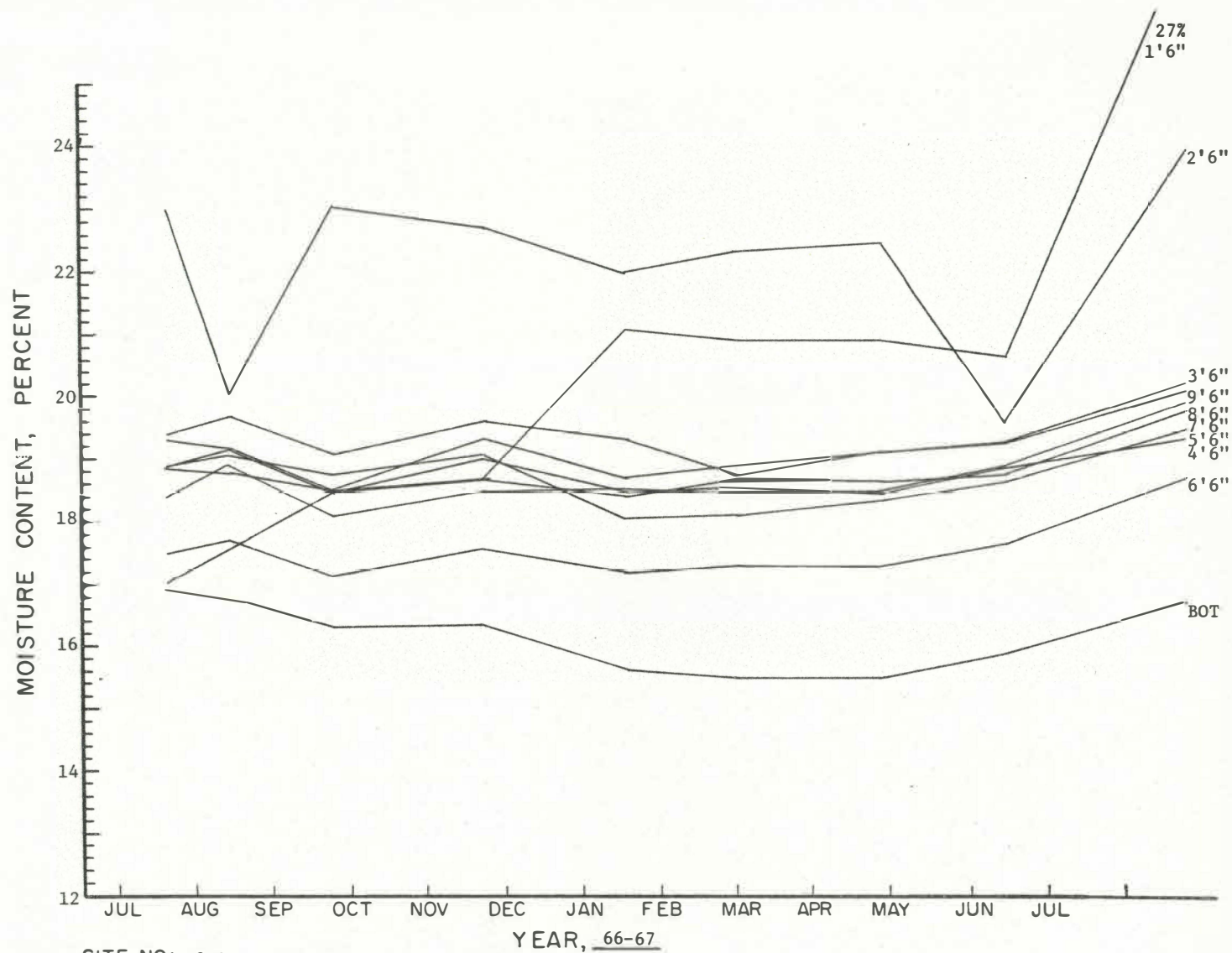
HIGHWAY: US 62

SUBGRADE MOISTURE VARIATIONS PROJECT



SITE NO: 9-B
 COUNTY: Muskogee
 HIGHWAY: US 62

SUBGRADE MOISTURE VARIATIONS PROJECT



SITE NO: 9-C
 COUNTY: Muskogee
 HIGHWAY: US 62

SUBGRADE MOISTURE VARIATIONS PROJECT

SCHOOL OF CIVIL ENGINEERING
OKLAHOMA STATE UNIVERSITY

SUBGRADE MOISTURE VARIATIONS RESEARCH PROJECT

SUBGRADE SOIL DRY DENSITY TABULATION

Date of Measurement	August 1966			January 1967			August 1967		
Site & Hole Number	9-A	9-B	9-C	9-A	9-B	9-C	9-A	9-B	9-C
Depth from top of tube to bottom of probe									
1 ft 6 in.	111.09	153.52	119.42	104.11	131.01	107.35	96.82	121.39	83.96
2 ft 0 in.									
2 ft 6 in.	110.44	95.13	96.52	101.97	97.75	99.73	94.13	93.33	93.63
3 ft 0 in.									
3 ft 6 in.	99.34	99.87	100.02	101.86	103.30	100.31	93.66	98.68	95.00
4 ft 0 in.									
4 ft 6 in.	96.13	98.46	99.26	98.96	102.16	100.09	91.72	97.35	95.39
5 ft 0 in.									
5 ft 6 in.	102.73	101.75	99.55	104.08	104.01	101.11	95.74	98.89	95.25
6 ft 0 in.									
6 ft 6 in.	103.16	103.39	100.44	103.44	104.90	100.70	95.21	99.79	95.44
7 ft 0 in.									
7 ft 6 in.	103.06	102.78	99.82	106.16	104.19	99.71	95.98	99.53	94.40
8 ft 0 in.									
8 ft 6 in.	100.50	104.58	99.39	101.21	104.93	99.08	92.35	100.05	93.97
9 ft 0 in.									
9 ft 6 in.	102.53	100.67	97.80	101.32	100.29	98.21	92.80	97.38	93.85
10 ft 0 in.	99.11	101.87	97.95	98.09	102.07	99.25	92.03	97.70	94.77

Note: All density values reported in units of lb per cu ft

SITE NO. 10

SCHOOL OF CIVIL ENGINEERING

OKLAHOMA STATE UNIVERSITY

SUBGRADE MOISTURE VARIATIONS PROJECT

TEST SITE DATA SUMMARY SHEET

LOCATION DATA:Site No. 10 Highway No. US 75 County: Okmulgee Date Installed: 7/18/66Distance from access tube to Lane ℓ: 18' 6" a, 8" b, 10' 6" c

Exact Location:

In Okmulgee County north of Okmulgee, 2.0 miles north on US 75 from railroad crossing, end of divided highway, and Okmulgee north city limit. Site in west lane of divided highway, marker on west fence row.

PAVEMENT/DESIGN DATA:No. of Lanes: 4D Pavement Type: AC Shoulder Type: Improved ACPavement Thickness: 6 in. ℓ, 2 in. Edge Latest Pavement Condition Rating: GoodLatest Traffic Count: 6600 vpd Heavy Truck Traffic: NoTerrain: Upland Drainage: Good Year of Original Paving: 1957

Original Design and History:

In 1957, 24 ft width; ℓ to 12 ft lt and rt: 6 in. AC over 8.5 in. SABC.

In 1963, inside 12 ft to 15 ft: 10.5 in. SABC with double bituminous surface; outside 12 ft to 22 ft: 8.5 in. SABC with double bituminous surface.

FIELD OBSERVATIONS BY RESEARCH PERSONNEL:

SCHOOL OF CIVIL ENGINEERING
OKLAHOMA STATE UNIVERSITY
Stillwater, Oklahoma
SUBGRADE MOISTURE VARIATION STUDY
SITE INSTALLATION INFORMATION

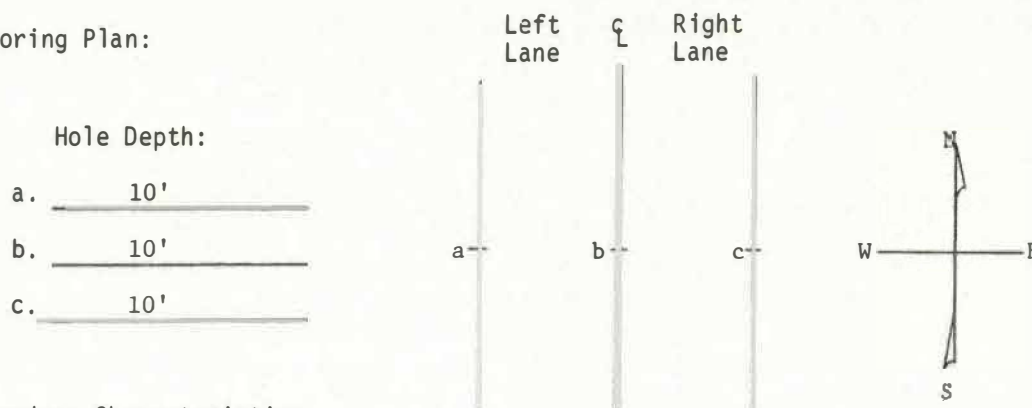
Installation: Okmulgee U.S. 75 10 Date: 18 7 66
County Highway No. day month year

Location of site: North of Okmulgee, 2.0 miles north -on U.S. 75 from railroad
crossing at end of divided highway, and at Okmulgee north city limits.

Site in west lane of divided highway.

Description of Terrain and Vegetation: Pavement on upland terrain in
slight cut with good drainage and heavy grass cover.

Boring Plan:



Roadway Characteristics:

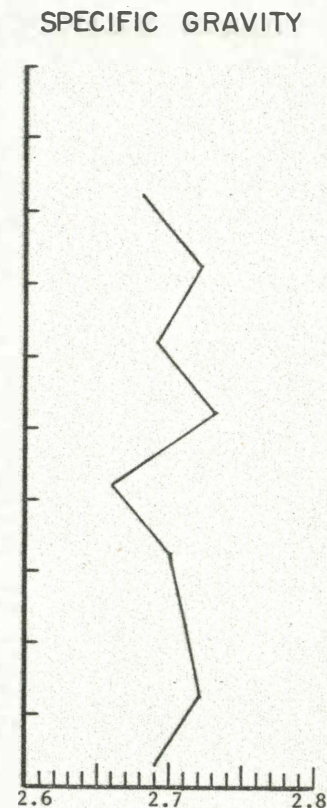
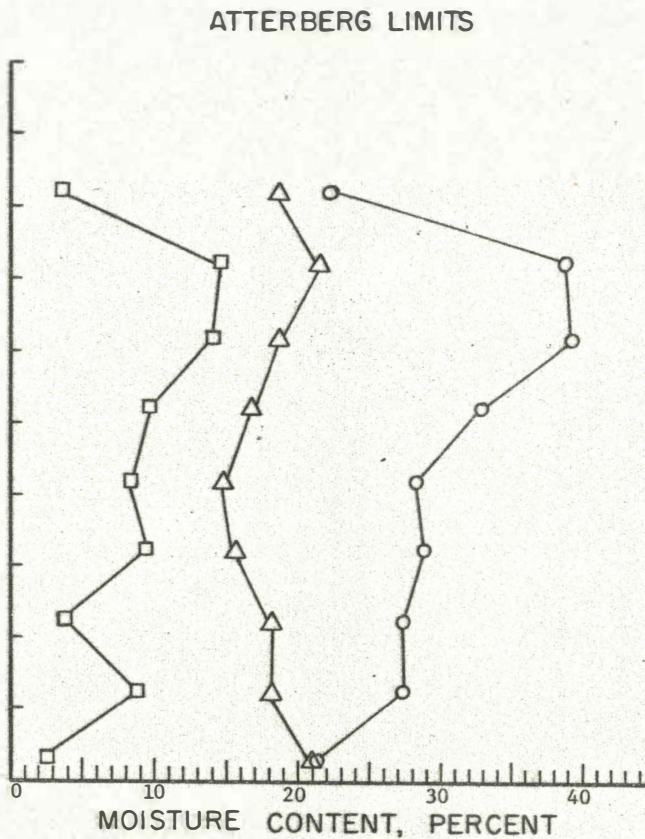
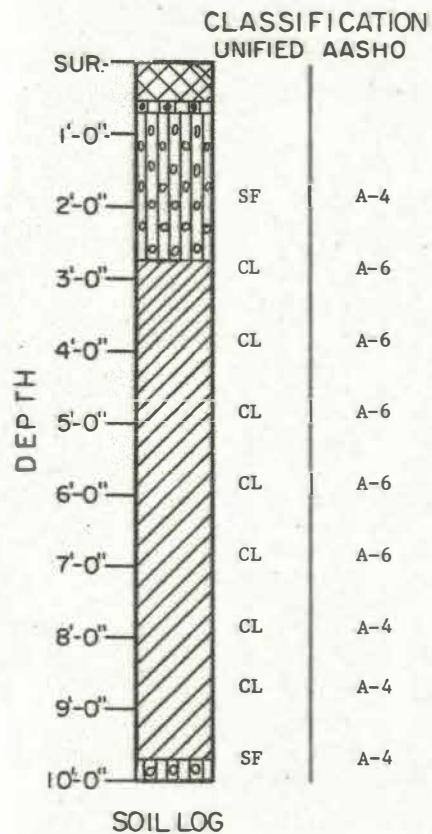
Pavement: Type Asphaltic Concrete
Width 22' Thickness 6"
Condition Good

Shoulders: Type Sealed Asphalt Width 11'
Condition Good

Base Course Characteristics Sand

SITE NO: 10
 COUNTY: Okmulgee
 HIGHWAY: US 75

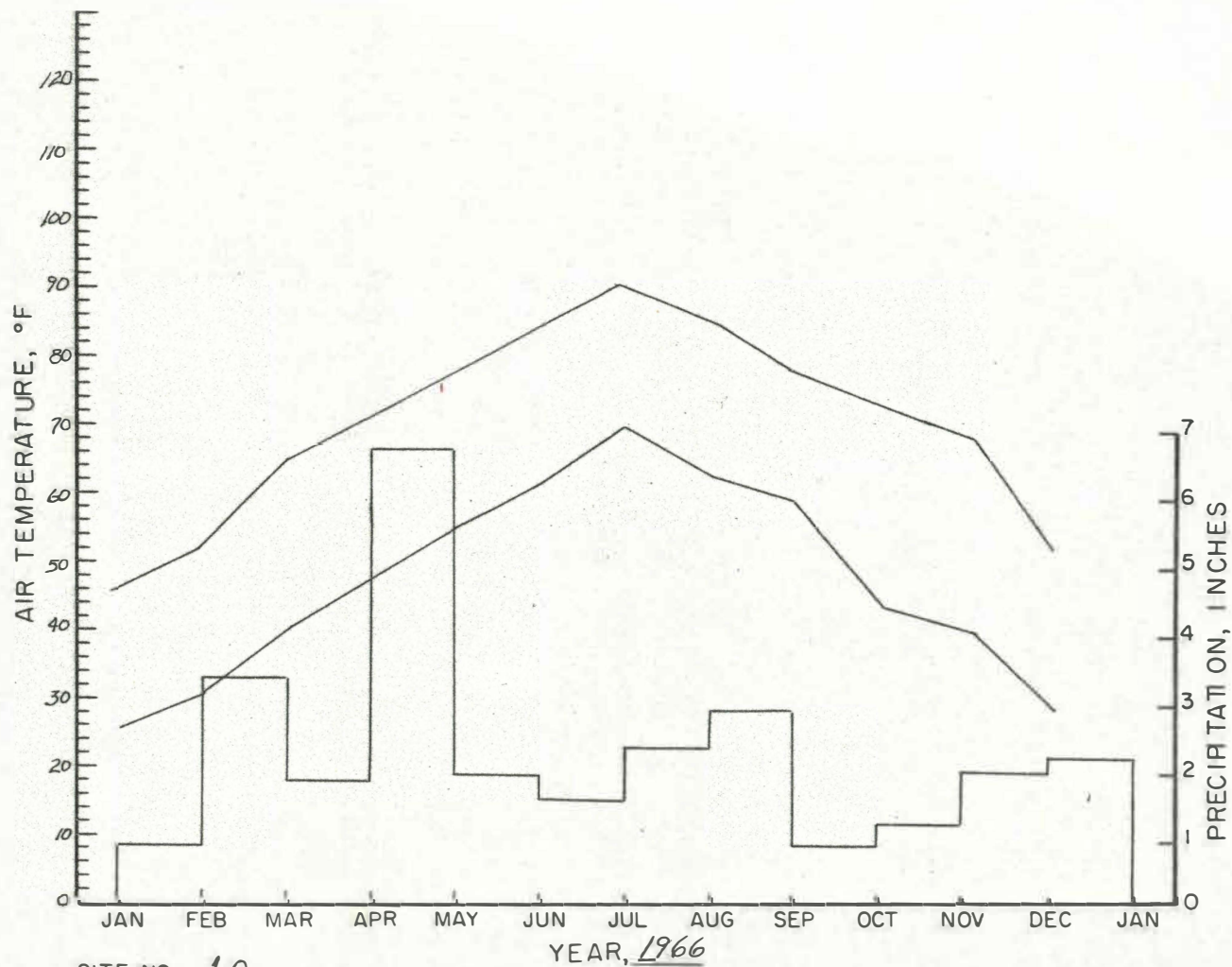
● LIQUID LIMIT
 ▲ PLASTIC LIMIT
 ■ LINEAL SHRINKAGE



DATE: 26 November 1967

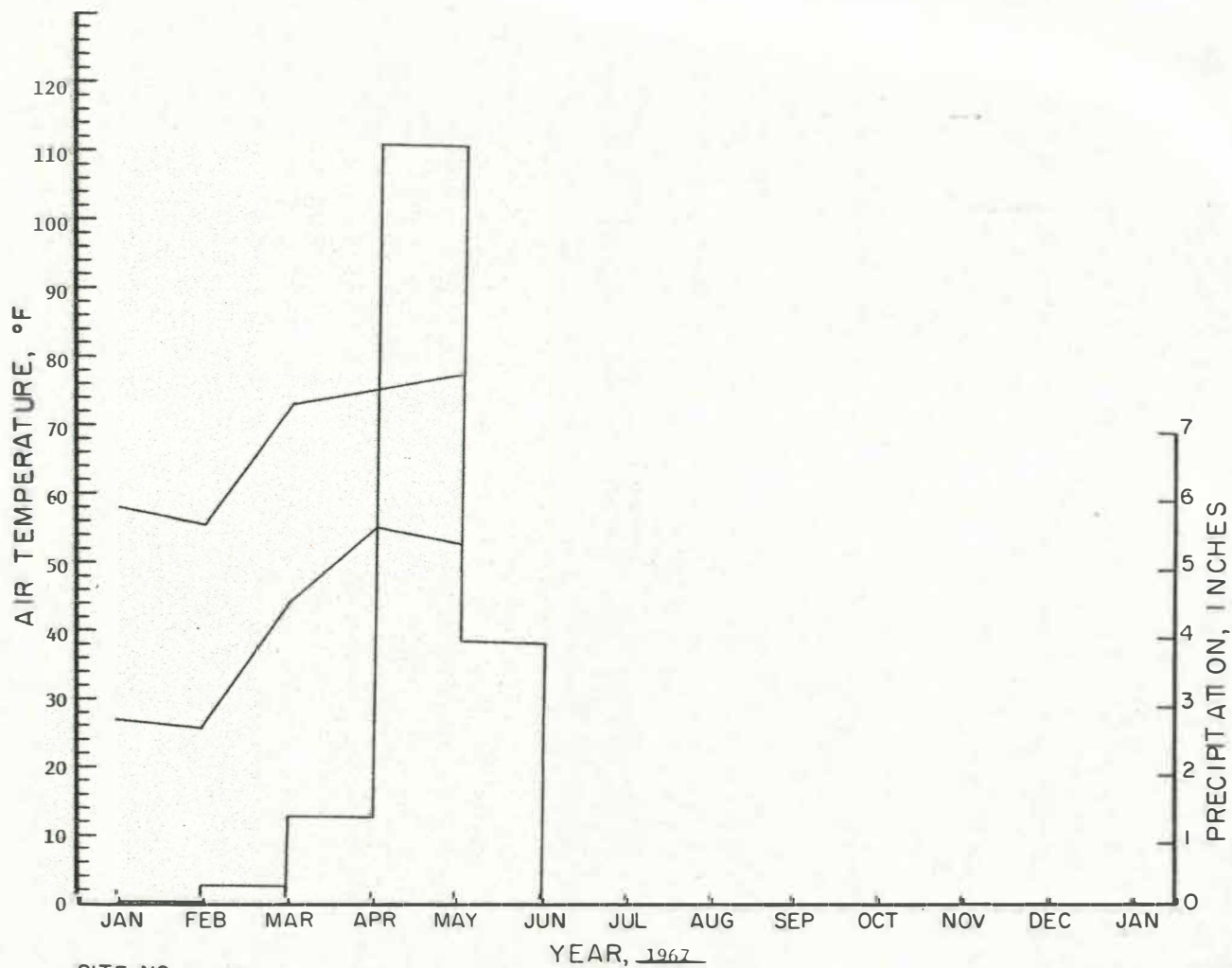
PLOTTED BY: AAP

SUBGRADE MOISTURE VARIATIONS PROJECT



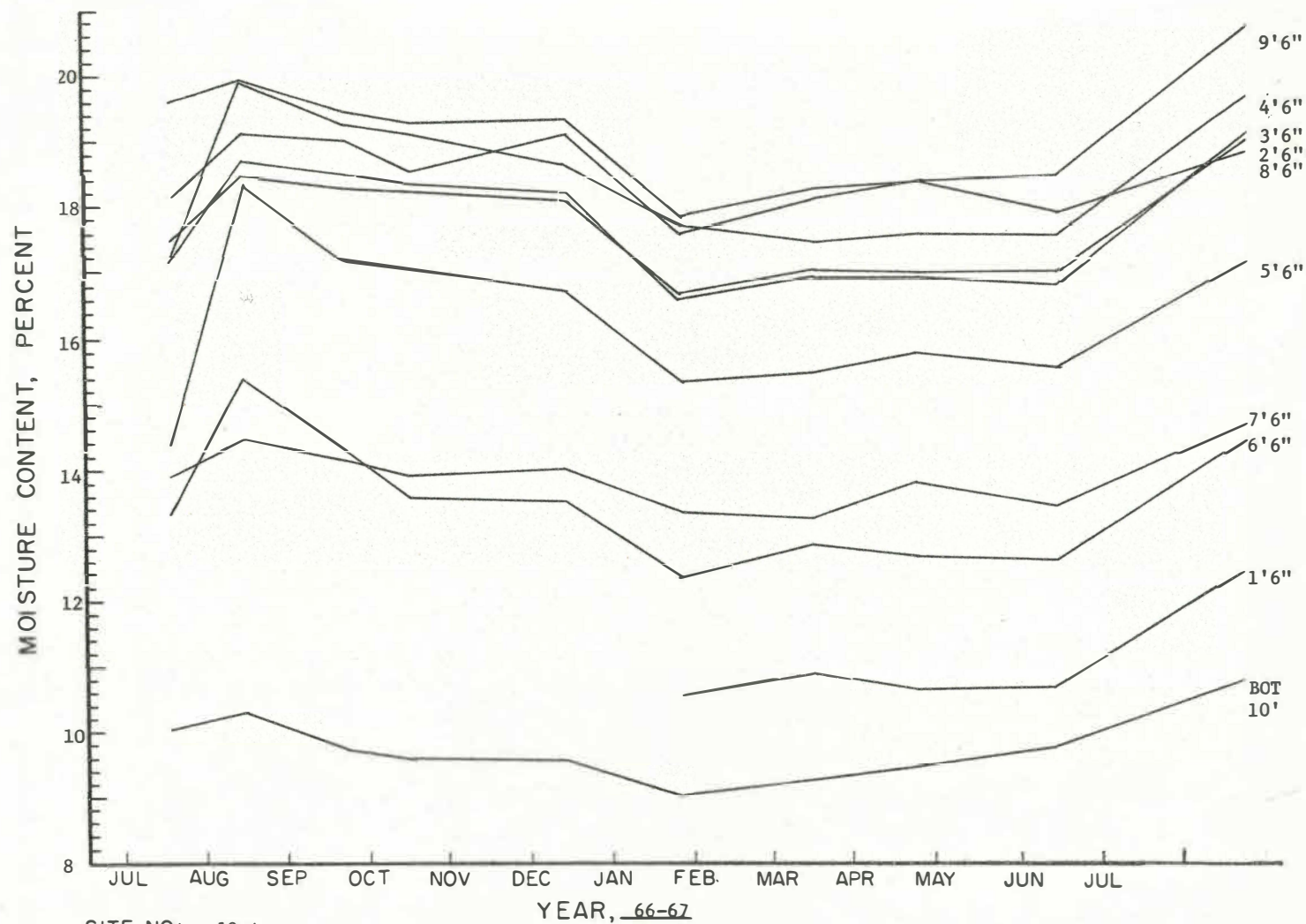
SITE NO: 10
COUNTY: Okmulgee
HIGHWAY: U.S. 75

SUBGRADE MOISTURE VARIATIONS PROJECT



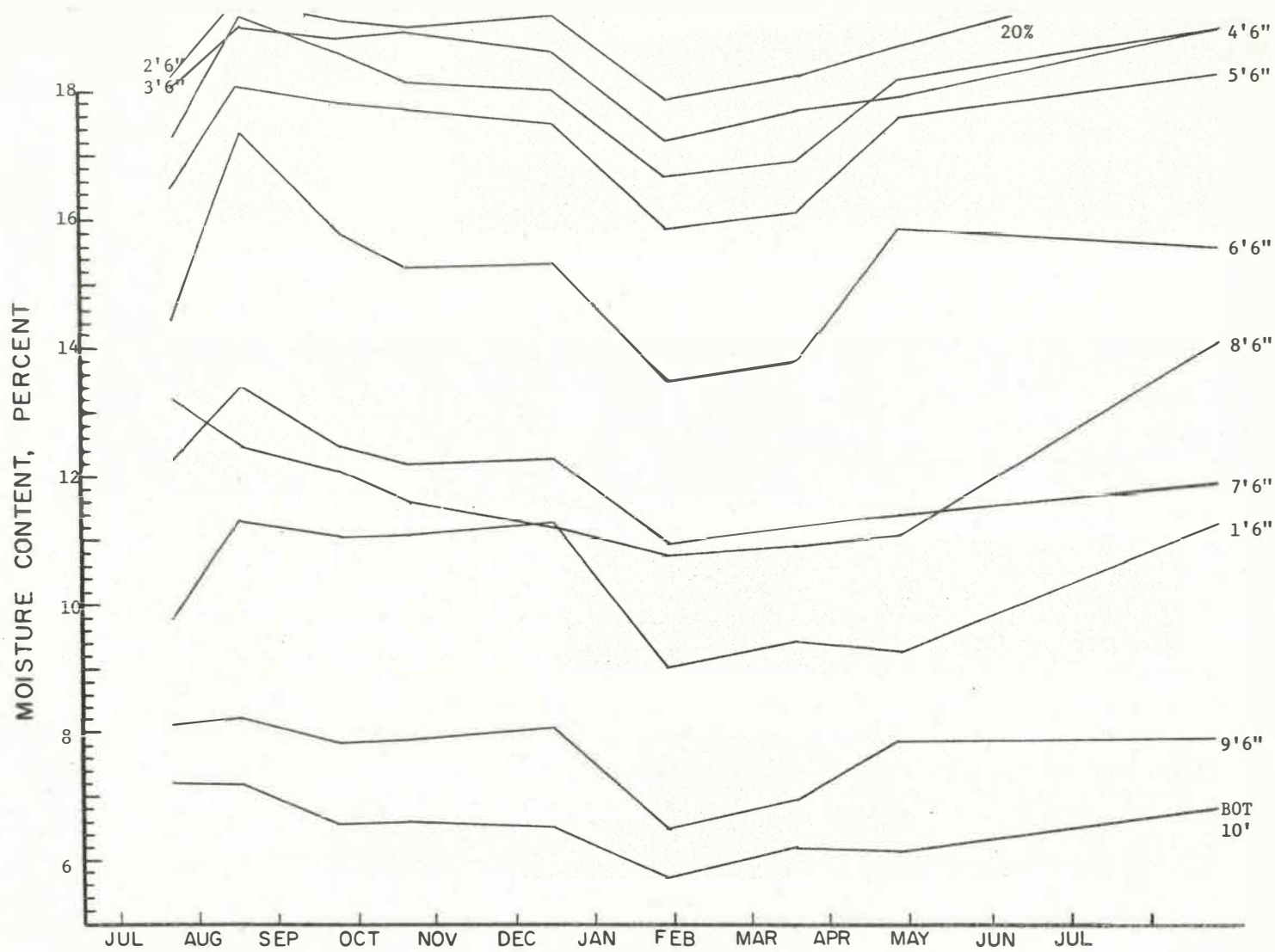
SITE NO: 10
COUNTY: Oklmulgee
HIGHWAY: US 75

SUBGRADE MOISTURE VARIATIONS PROJECT



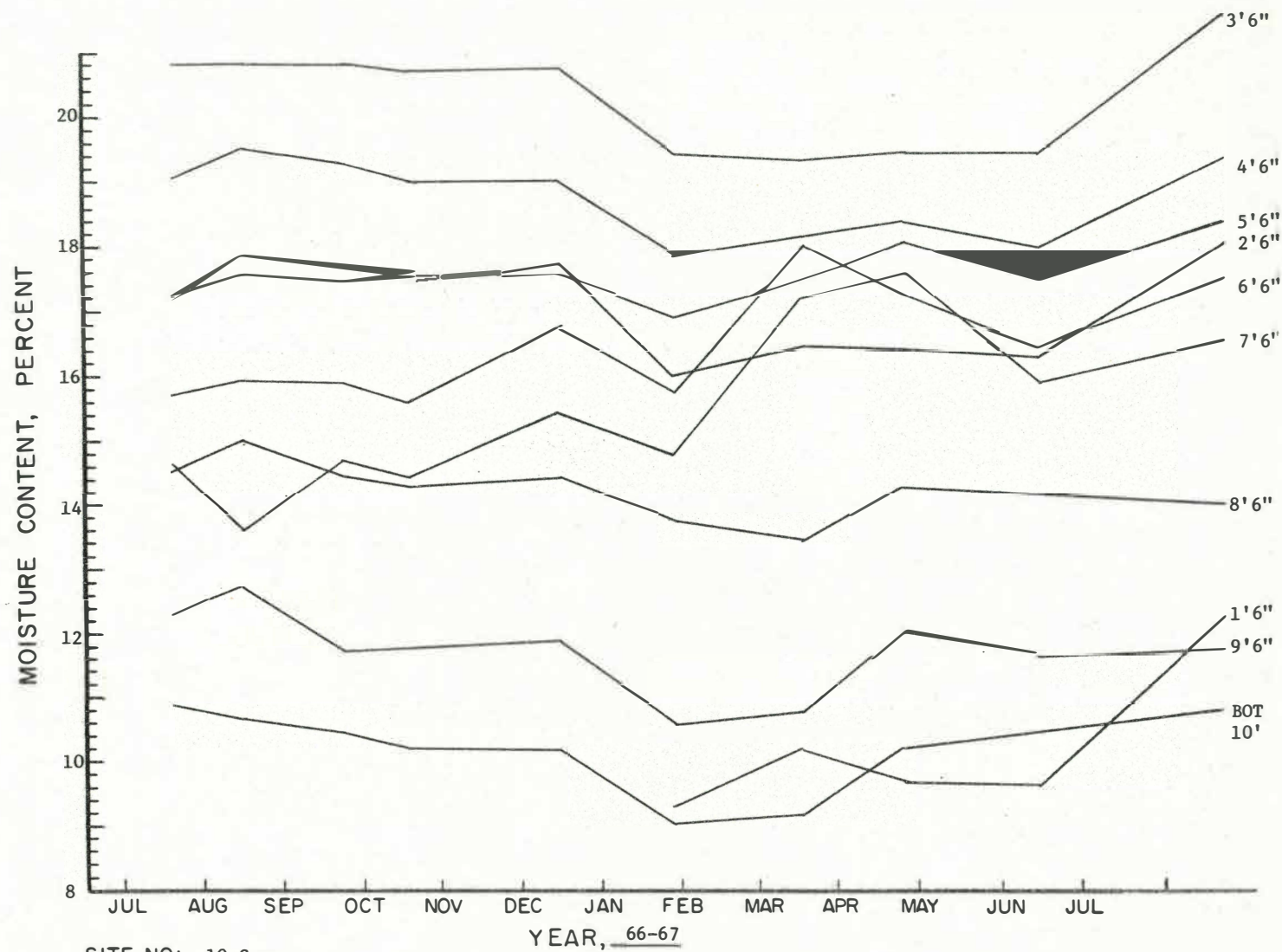
SITE NO: 10-A
 COUNTY: Okmulgee
 HIGHWAY: US 75

SUBGRADE MOISTURE VARIATIONS PROJECT



SITE NO: 10-B
 COUNTY: Okmulgee
 HIGHWAY: US 75

SUBGRADE MOISTURE VARIATIONS PROJECT



SITE NO: 10-C
 COUNTY: Okmulgee
 HIGHWAY: US 75

SUBGRADE MOISTURE VARIATIONS PROJECT

SCHOOL OF CIVIL ENGINEERING
OKLAHOMA STATE UNIVERSITY

SUBGRADE MOISTURE VARIATIONS RESEARCH PROJECT

SUBGRADE SOIL DRY DENSITY TABULATION

Date of Measurement	August 1966			January 1967			August 1967		
Site & Hole Number	10-A	10-B	10-C	10-A	10-B	10-C	10-A	10-B	10-C
Depth from top of tube to bottom of probe									
1 ft 6 in.		129.91		105.48	161.38	151.74	136.55	134.05	121.30
2 ft 0 in.									
2 ft 6 in.	97.90	98.48	100.21	106.52	105.88	109.06	92.98	96.01	98.68
3 ft 0 in.									
3 ft 6 in.	93.35	94.32	95.35	101.48	101.45	103.99	90.01	92.52	93.15
4 ft 0 in.									
4 ft 6 in.	90.46	90.36	94.41	97.76	97.95	101.90	87.50	89.82	93.32
5 ft 0 in.									
5 ft 6 in.	90.90	94.02	93.38	99.26	101.30	98.85	89.04	93.20	92.30
6 ft 0 in.									
6 ft 6 in.	78.37	92.01	91.89	86.93	100.77	100.10	77.35	93.26	90.96
7 ft 0 in.									
7 ft 6 in.	86.47	87.24	87.39	92.78	96.23	95.34	84.02	89.58	86.08
8 ft 0 in.									
8 ft 6 in.	89.06	79.43	91.35	94.69	86.93	97.70	86.62	80.15	92.50
9 ft 0 in.									
9 ft 6 in.	77.17	83.10	83.89	85.58	90.64	90.88	77.57	85.07	85.74
10 ft 0 in.	89.99	75.50	79.26	97.20	82.46	86.72	88.00	78.06	80.66

Note: All density values reported in units of lb per cu ft

SITE NO. 11

SCHOOL OF CIVIL ENGINEERING
OKLAHOMA STATE UNIVERSITY
SUBGRADE MOISTURE VARIATIONS PROJECT
TEST SITE DATA SUMMARY SHEET

LOCATION DATA:

Site No. 11 Highway No. US 66 County: Creek Date Installed: 8/5/66

Distance from access tube to Lane ℓ: 18' 6" a, 6" b, 18' 6" c

Exact Location:

In Creek County west of Sapulpa, 1.3 miles east on US 66 from jct. of US 66 and S 33.
Marker on south fence row.

PAVEMENT/DESIGN DATA:

No. of Lanes: 2 Pavement Type: AC Shoulder Type: Improved

Pavement Thickness: 10 in.ℓ, 2 in.Edge Latest Pavement Condition Rating: Good

Latest Traffic Count: 5200 vpd Heavy Truck Traffic: Yes

Terrain: Creek- Drainage: Fair Year of Original Paving: 1952
bottom

Original Design and History:

23 ft width; ℓ to 12 ft rt and lt: 10 in. AC over natural sand base; 12 ft to 20 ft
rt and lt: double bituminous sealed shoulder o er SABC.

FIELD OBSERVATIONS BY RESEARCH PERSONNEL:

SCHOOL OF CIVIL ENGINEERING
OKLAHOMA STATE UNIVERSITY
Stillwater, Oklahoma
SUBGRADE MOISTURE VARIATION STUDY
SITE INSTALLATION INFORMATION

Installation: Creek U.S. 66 11 Date: 5 8 66
County Highway No. day month year

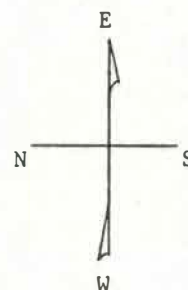
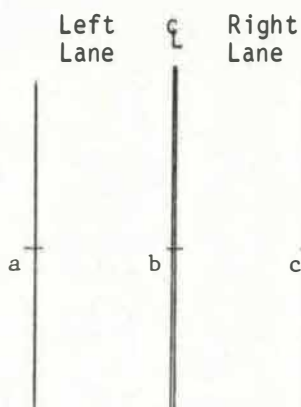
Location of site: West of Sapulpa, 1.3 miles east on U.S. 66 from intersection
of U.S. 66 and St. 33, adjacent to an "animal clinic".

Description of Terrain and Vegetation: Pavement in rolling creek-bottom terrain

Boring Plan:

Hole Depth:

a. 10'
b. 10'
c. 10'



Roadway Characteristics:

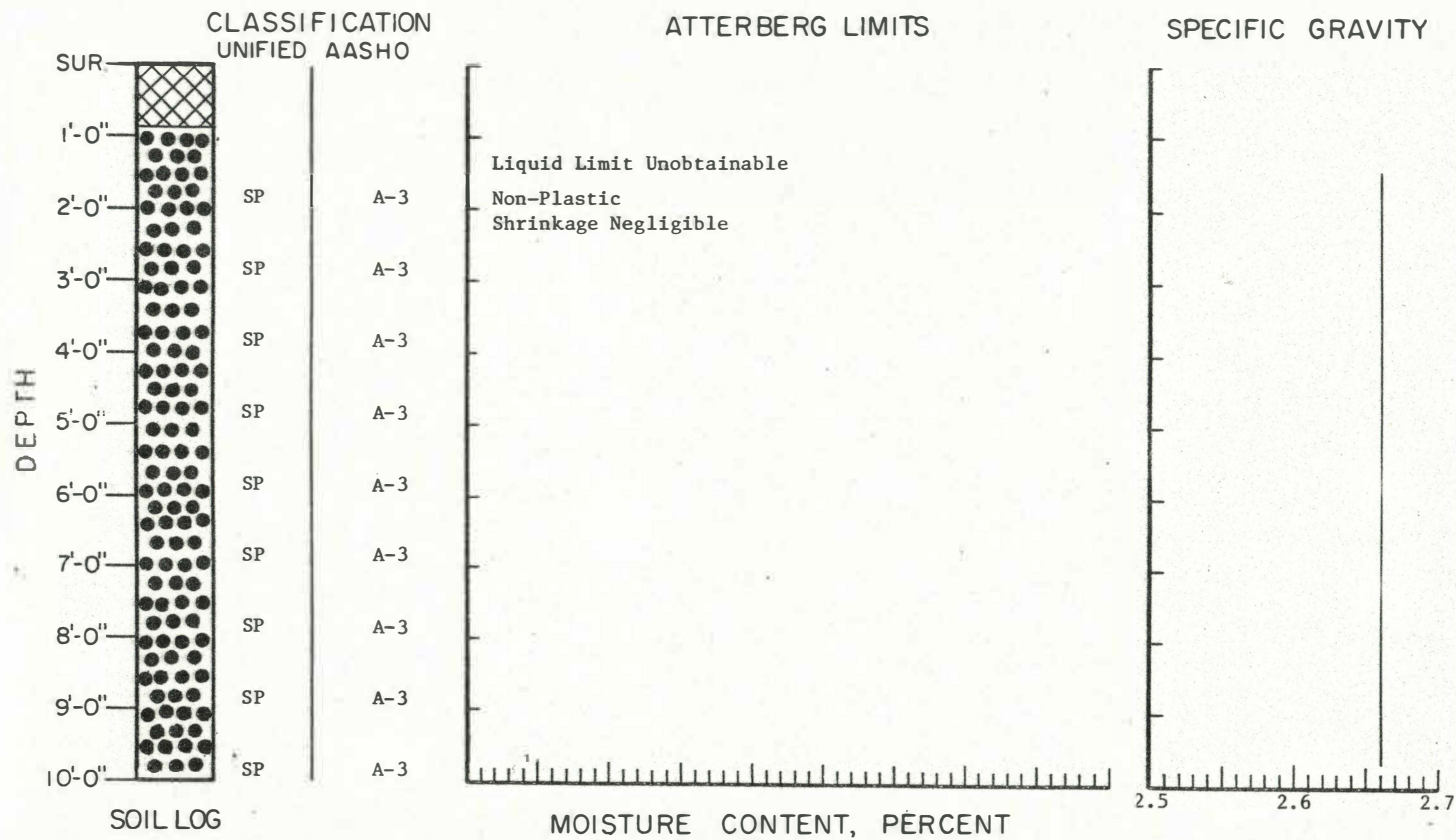
Pavement: Type Asphaltic Concrete
Width 24' Thickness 10"
Condition Good

Shoulders: Type Sealed Asphalt Width 7'
Condition Good

Base Course Characteristics Natural sand

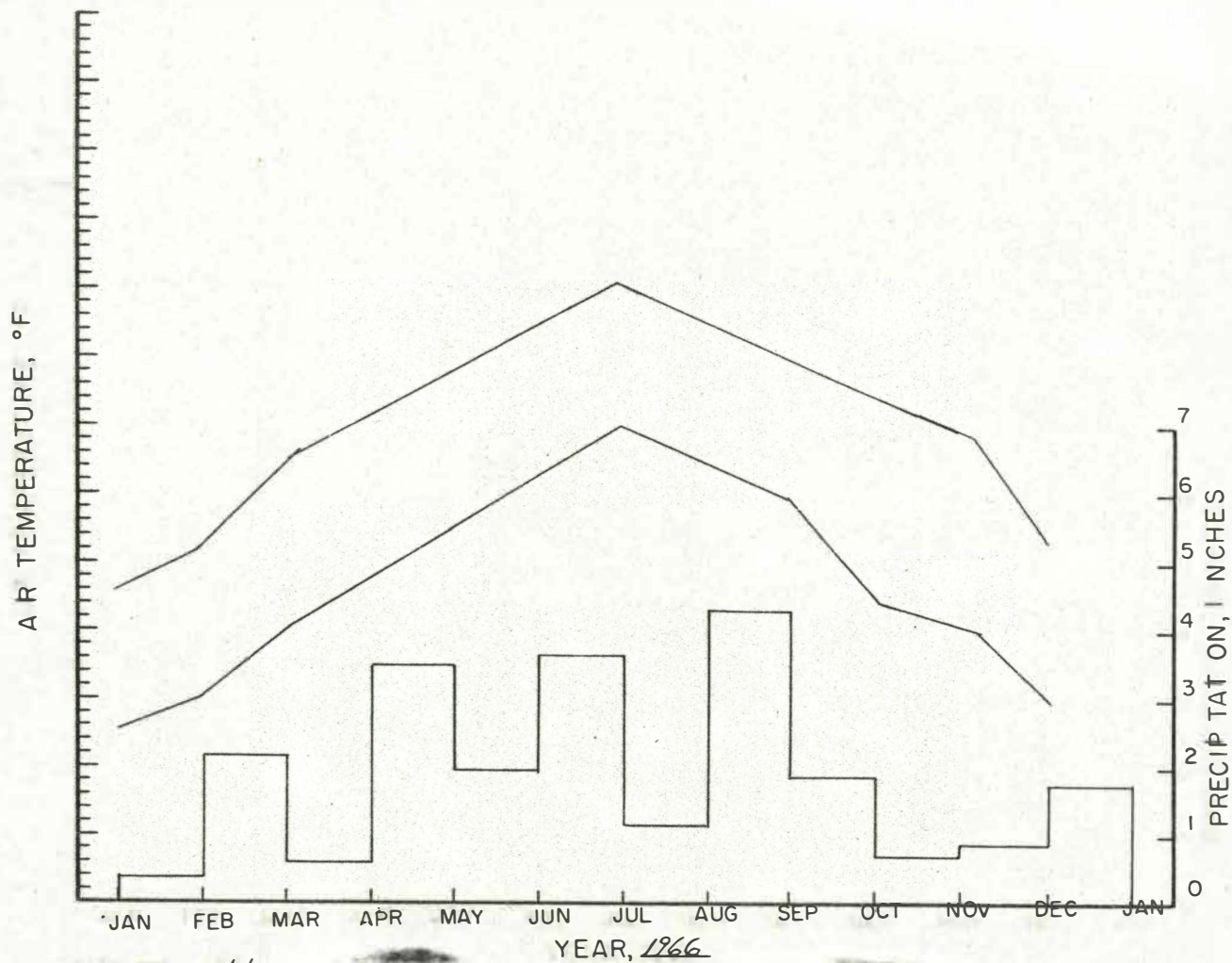
SITE NO.: 11
COUNTY : Creek
HIGHWAY : US 66

● LIQUID LIMIT
▲ PLASTIC LIMIT
■ LINEAL SHRINKAGE



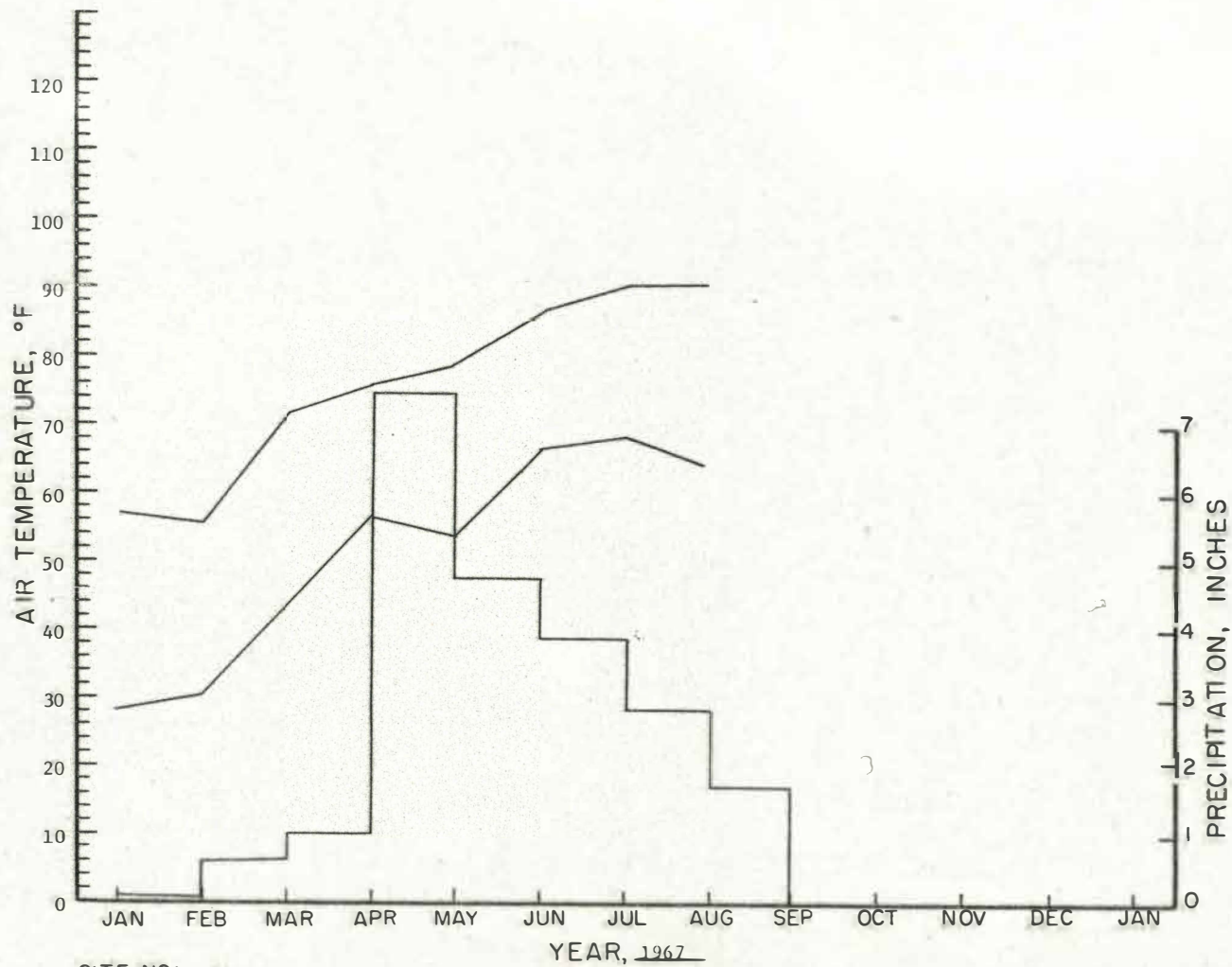
DATE : 9 January 1968
PLOTTED BY : AAP

SUBGRADE MOISTURE VARIATIONS PROJECT



SITE NO: 11
COUNTY: CREEK
HIGHWAY: US 66

SUBGRADE MOISTURE VARIATIONS PROJECT

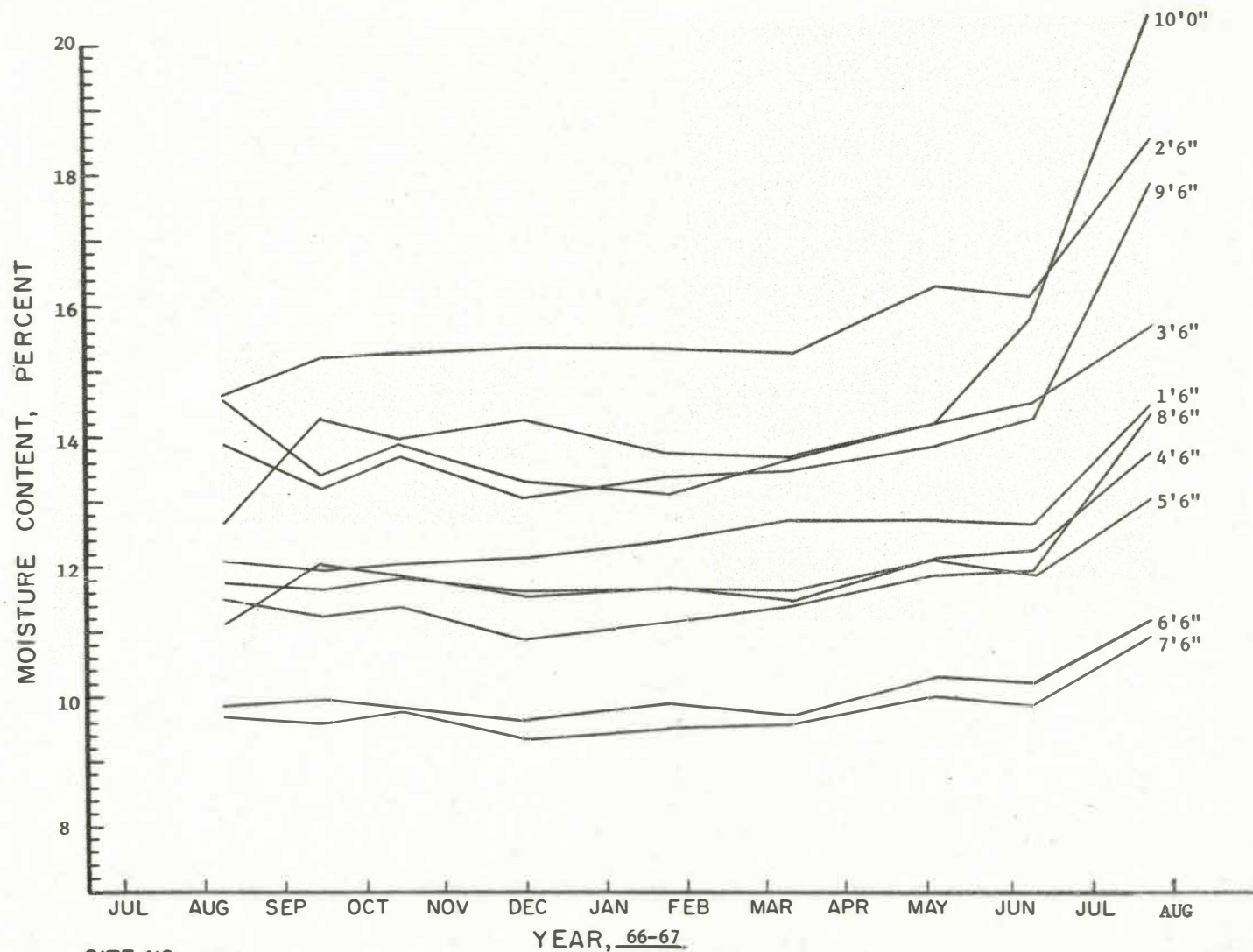


SITE NO: 11

COUNTY: Creek

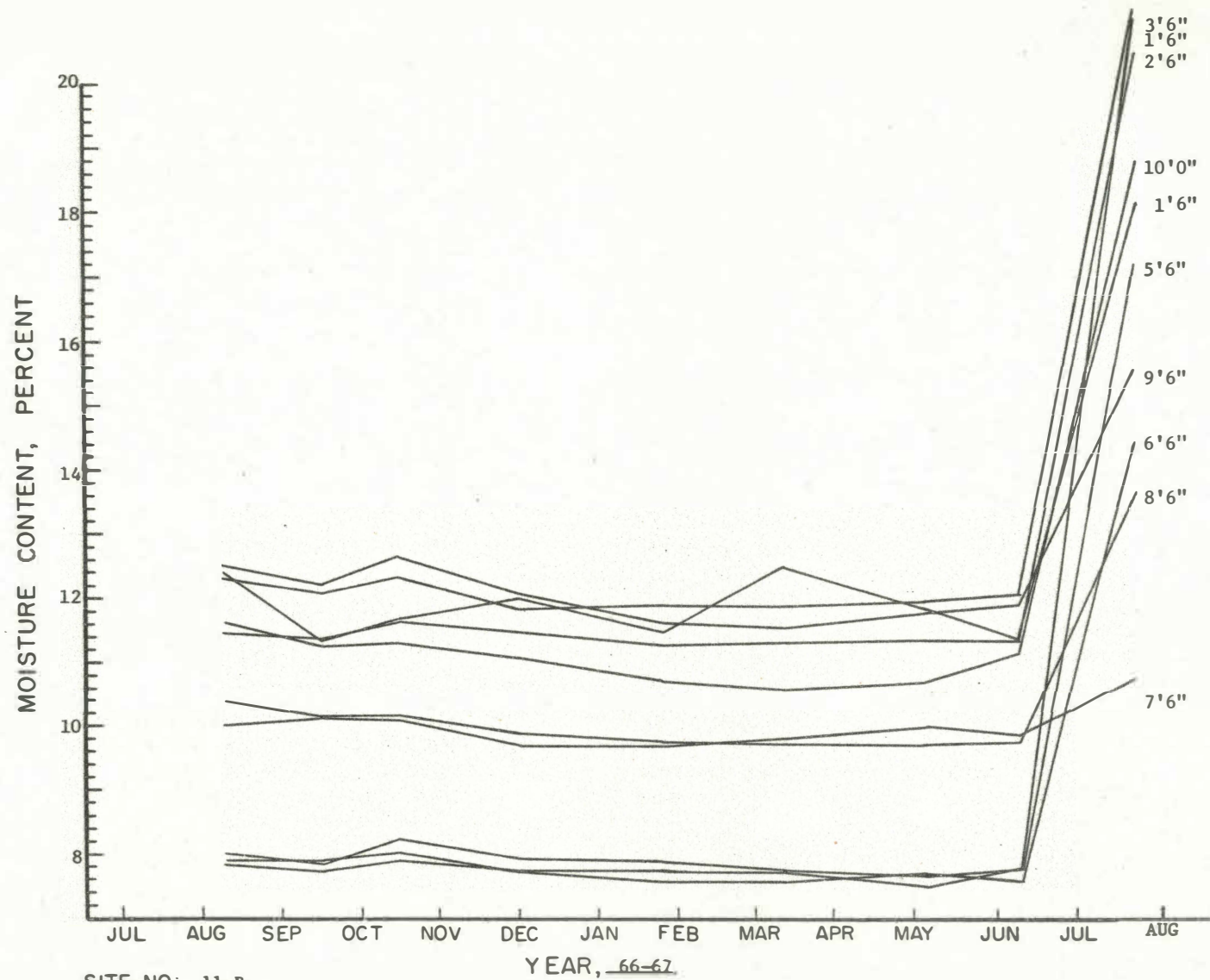
HIGHWAY: US 66

SUBGRADE MOISTURE VARIATIONS PROJECT



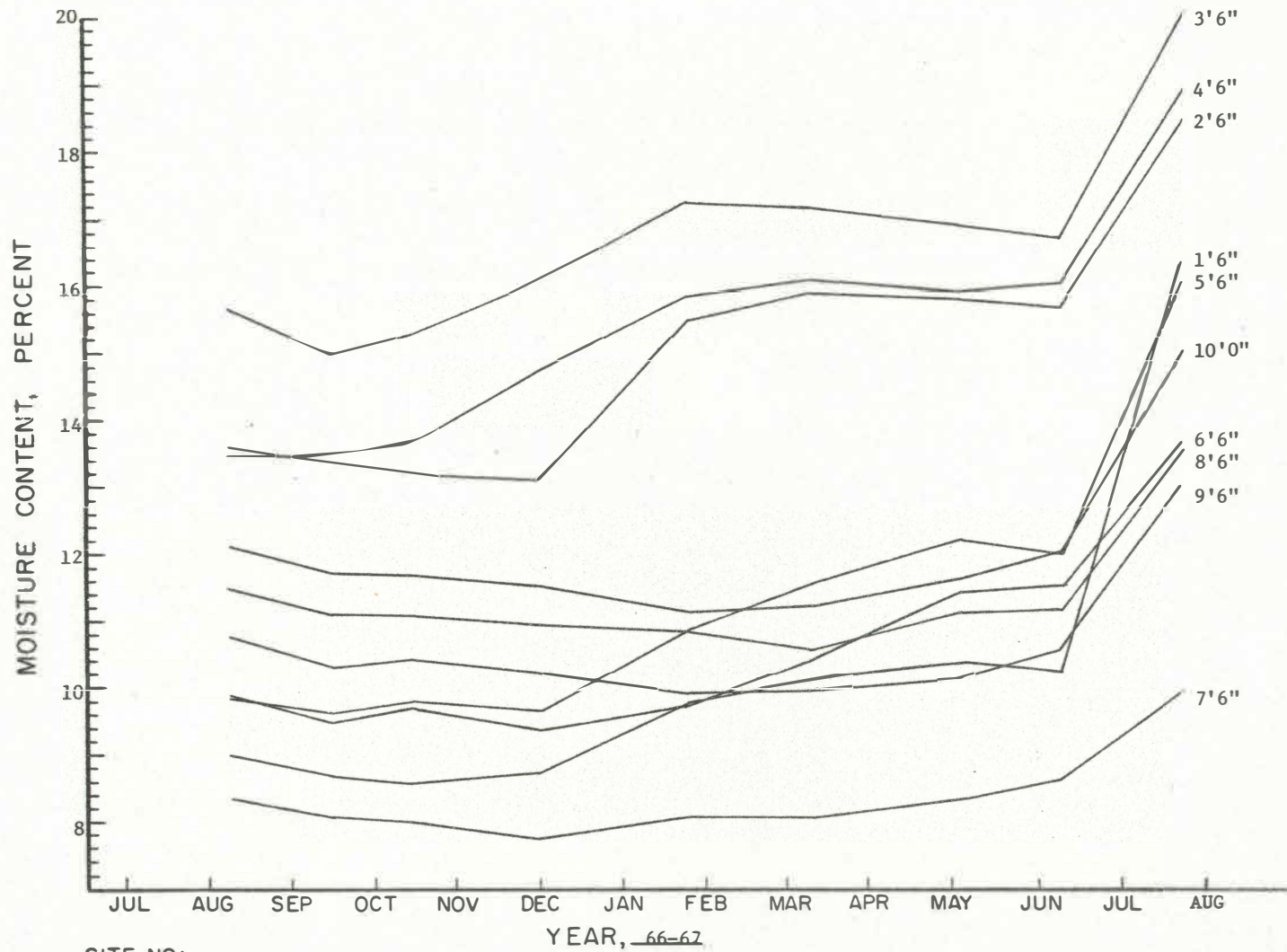
SITE NO: 11-A
 COUNTY: Creek
 HIGHWAY: US 66

SUBGRADE MOISTURE VARIATIONS PROJECT



SITE NO: 11-B
COUNTY: Creek
HIGHWAY: US 66

SUBGRADE MOISTURE VARIATIONS PROJECT



SITE NO: 11-c
 COUNTY: Creek
 HIGHWAY: US 66

SUBGRADE MOISTURE VARIATIONS PROJECT

SCHOOL OF CIVIL ENGINEERING
OKLAHOMA STATE UNIVERSITY

SUBGRADE MOISTURE VARIATIONS RESEARCH PROJECT

SUBGRADE SOIL DRY DENSITY TABULATION

Date of Measurement	August 1966			January 1967			August 1967		
Site & Hole Number	11-A	11-B	11-C	11-A	11-B	11-C	11-A	11-B	11-C
Depth from top of tube to bottom of probe									
1 ft 6 in.	140.94	115.63	143.16	146.13	121.17	138.25	119.33	94.75	89.93
2 ft 0 in.									
2 ft 6 in.	97.51	97.42	101.97	100.31	100.81	100.39	91.05	80.50	87.01
3 ft 0 in.									
3 ft 6 in.	103.20	99.47	103.17	105.73	101.86	103.04	95.69	81.41	87.86
4 ft 0 in.									
4 ft 6 in.	96.90	100.47	105.28	99.86	102.52	103.09	90.79	79.00	88.70
5 ft 0 in.									
5 ft 6 in.	98.53	98.36	101.62	100.64	101.43	102.17	93.00	80.40	87.11
6 ft 0 in.									
6 ft 6 in.	98.89	98.92	100.38	101.87	101.85	100.98	93.09	82.19	86.67
7 ft 0 in.									
7 ft 6 in.	97.58	97.21	101.09	100.49	100.61	100.25	89.60	85.02	87.84
8 ft 0 in.									
8 ft 6 in.	98.36	101.63	98.60	102.16	104.61	99.32	85.51	86.95	85.56
9 ft 0 in.									
9 ft 6 in.	100.44	100.33	100.25	103.12	103.78	101.23	87.18	86.01	87.10
10 ft 0 in.	98.30	101.63	98.69	101.22	104.76	99.87	84.80	84.04	85.75

Note: All density values reported in units of lb per cu ft

SITE NO. 12

SCHOOL OF CIVIL ENGINEERING
OKLAHOMA STATE UNIVERSITY
SUBGRADE MOISTURE VARIATIONS PROJECT
TEST SITE DATA SUMMARY SHEET

LOCATION DATA:

Site No. 12 Highway No. US66 County: Creek Date Installed: 8/8/66

Distance from access tube to Lane ℄: 21' 0" a, 6" b, 21' 6" c

Exact Location:

In Creek County north of Bristow, 2.6 miles north on US 66 from jct. of US 66, S 48 and S 16, 0.3 mile north of bridge over Sand Creek. Marker on west fence row.

PAVEMENT/DESIGN DATA:

No. of Lanes: 2 Pavement Type: AC Shoulder Type: Improved AC

Pavement Thickness: 10 in. ℄, 9 in. Edge Latest Pavement Condition Rating: Good

Latest Traffic Count: 3100 vpd Heavy Truck Traffic: No

Terrain: Upland/ Drainage: Fair Year of Original Paving: 1965
cut

Original Design and History:

24 ft width; ℄ to 12 ft lt and rt: 4.5 in. AC over 7 in. black base; 12 ft to 22 ft lt. and rt.: 7 in. black base shoulder.

FIELD OBSERVATIONS BY RESEARCH PERSONNEL:

SCHOOL OF CIVIL ENGINEERING
OKLAHOMA STATE UNIVERSITY
Stillwater, Oklahoma
SUBGRADE MOISTURE VARIATION STUDY
SITE INSTALLATION INFORMATION

Installation: Creek U.S. 66 12 Date: 8 8 66
County Highway No. day month year

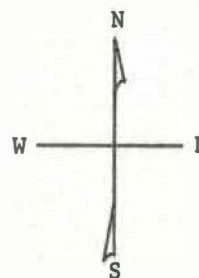
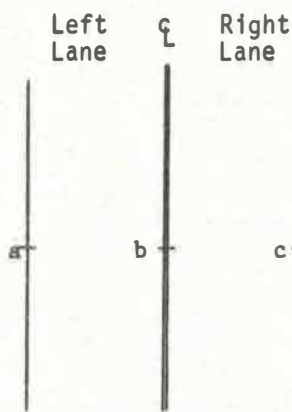
Location of site: North of Bristow, 2.6 miles north on U.S. 66 from intersection
of U.S. 66, St. 48, and St. 16, 0.3 miles north of bridge over "Sand Creek"

Description of Terrain and Vegetation: Pavement on upland slightly rolling
terrain in slight cut

Boring Plan:

Hole Depth:

a. 10'
b. 10'
c. 10'



Roadway Characteristics:

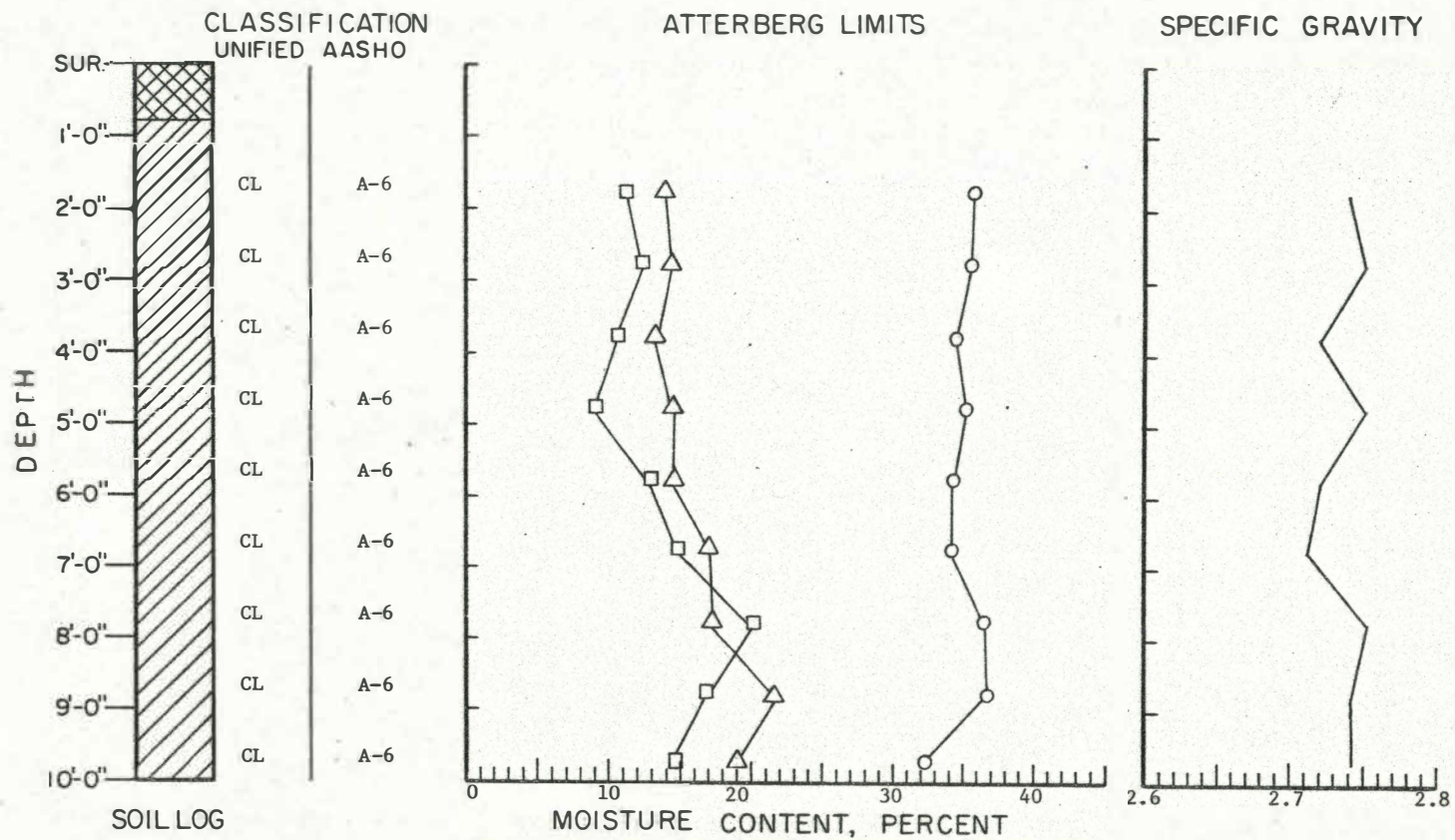
Pavement: Type Asphaltic Concrete
Width 24' Thickness 10"
Condition Good

Shoulders: Type Asphaltic Concrete Width 10'
Condition Good

Base Course Characteristics Sand

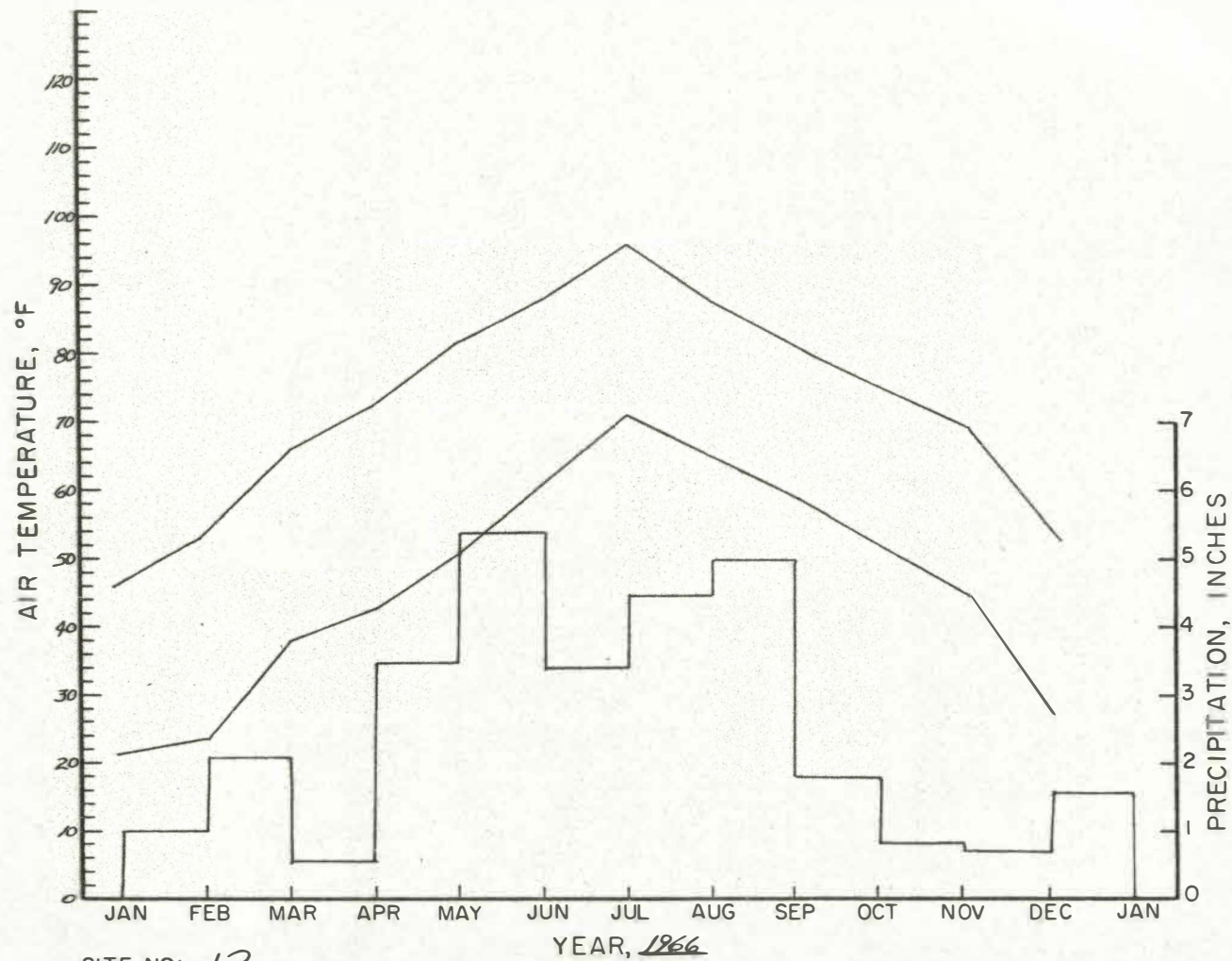
SITE NO.: 12
COUNTY: Creek
HIGHWAY: U.S. 66

- LIQUID LIMIT
- ▲ PLASTIC LIMIT
- LINEAL SHRINKAGE



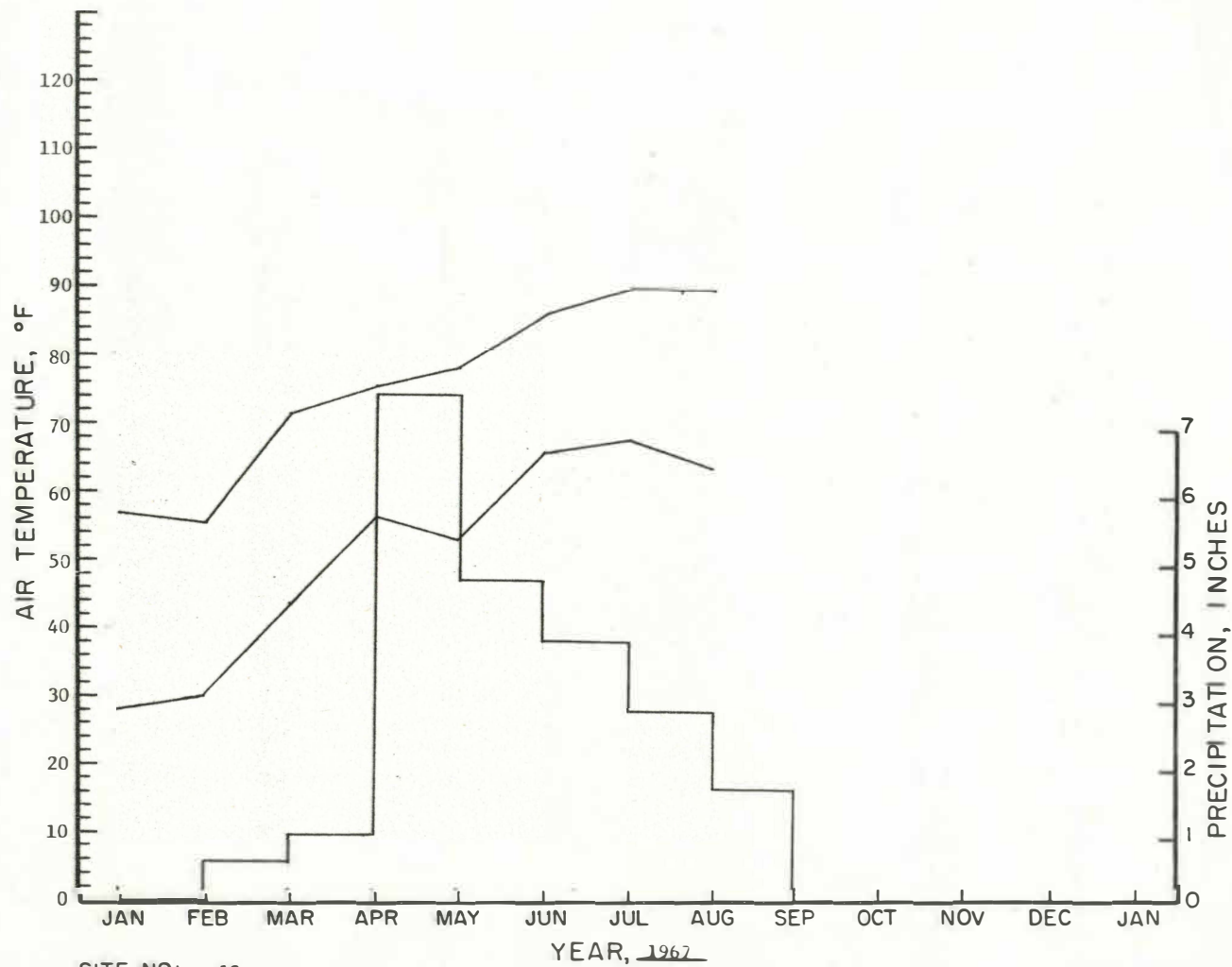
DATE: 27 November 1967
PLOTTED BY: AAP

SUBGRADE MOISTURE VARIATIONS PROJECT



SITE NO: 12
COUNTY: CREEK
HIGHWAY: U.S. 66

SUBGRADE MOISTURE VARIATIONS PROJECT

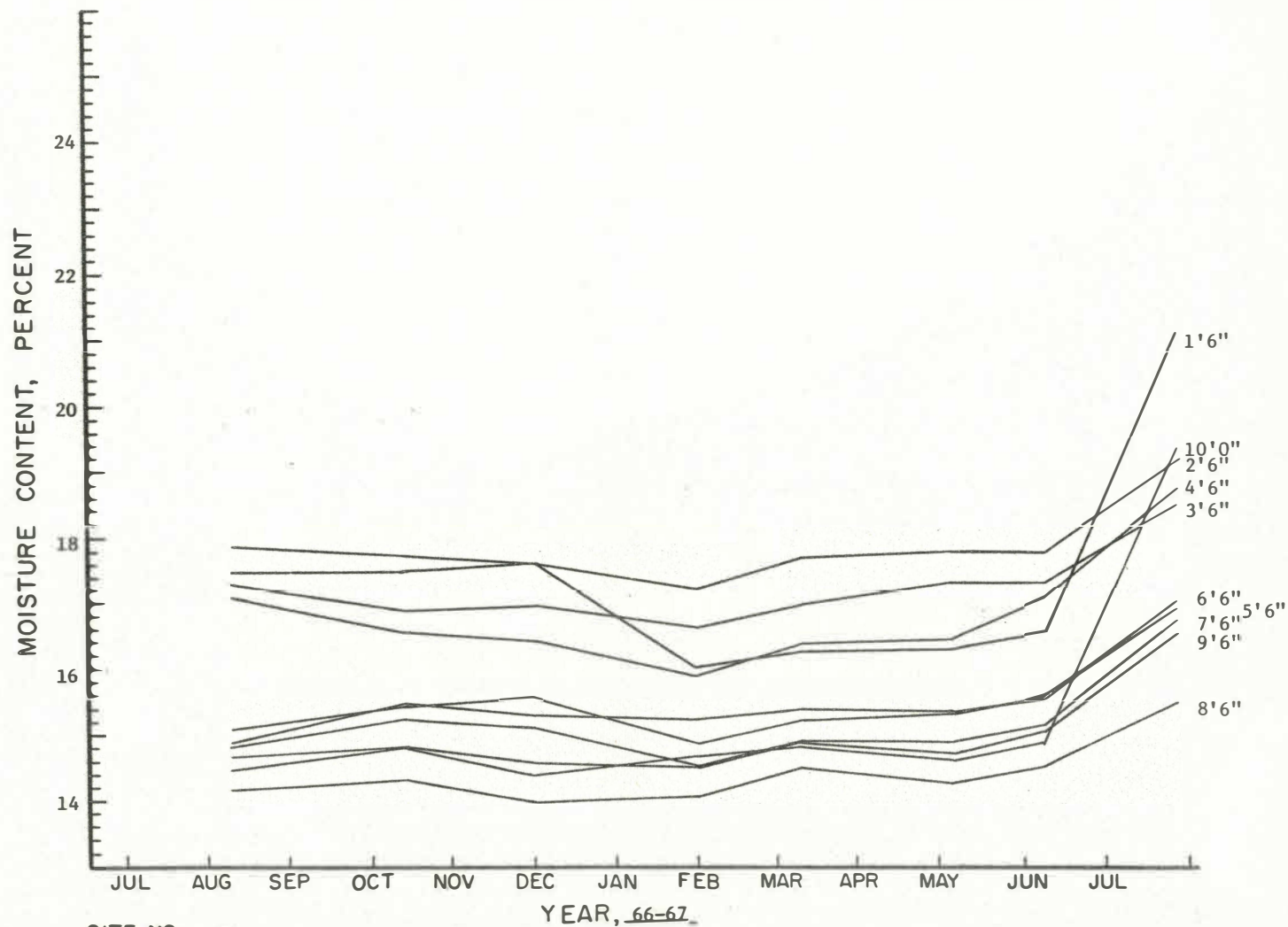


SITE NO: 12

COUNTY: Creek

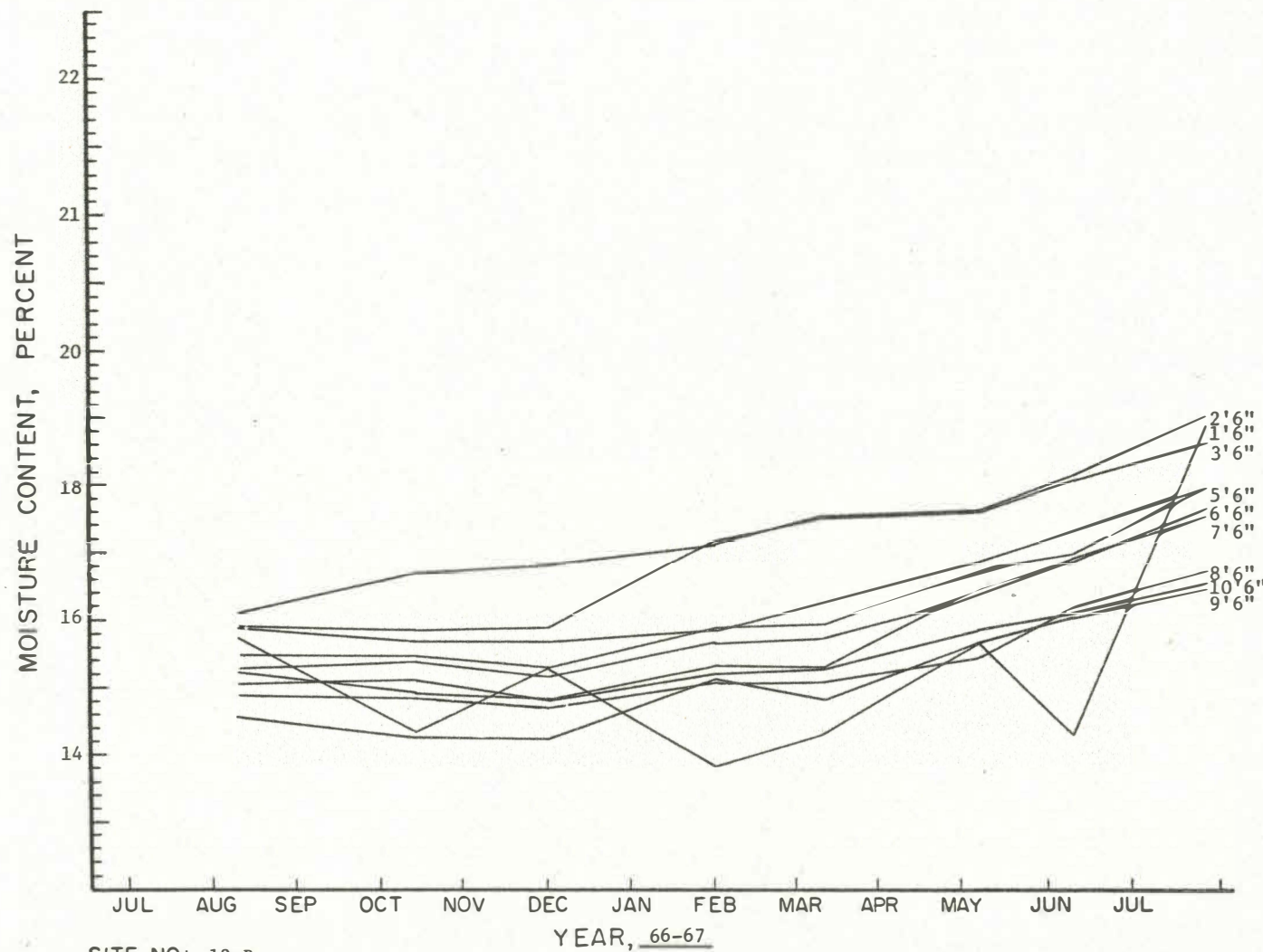
HIGHWAY: US 66

SUBGRADE MOISTURE VARIATIONS PROJECT



SITE NO: 12-A
COUNTY: Creek
HIGHWAY: US 66

SUBGRADE MOISTURE VARIATIONS PROJECT

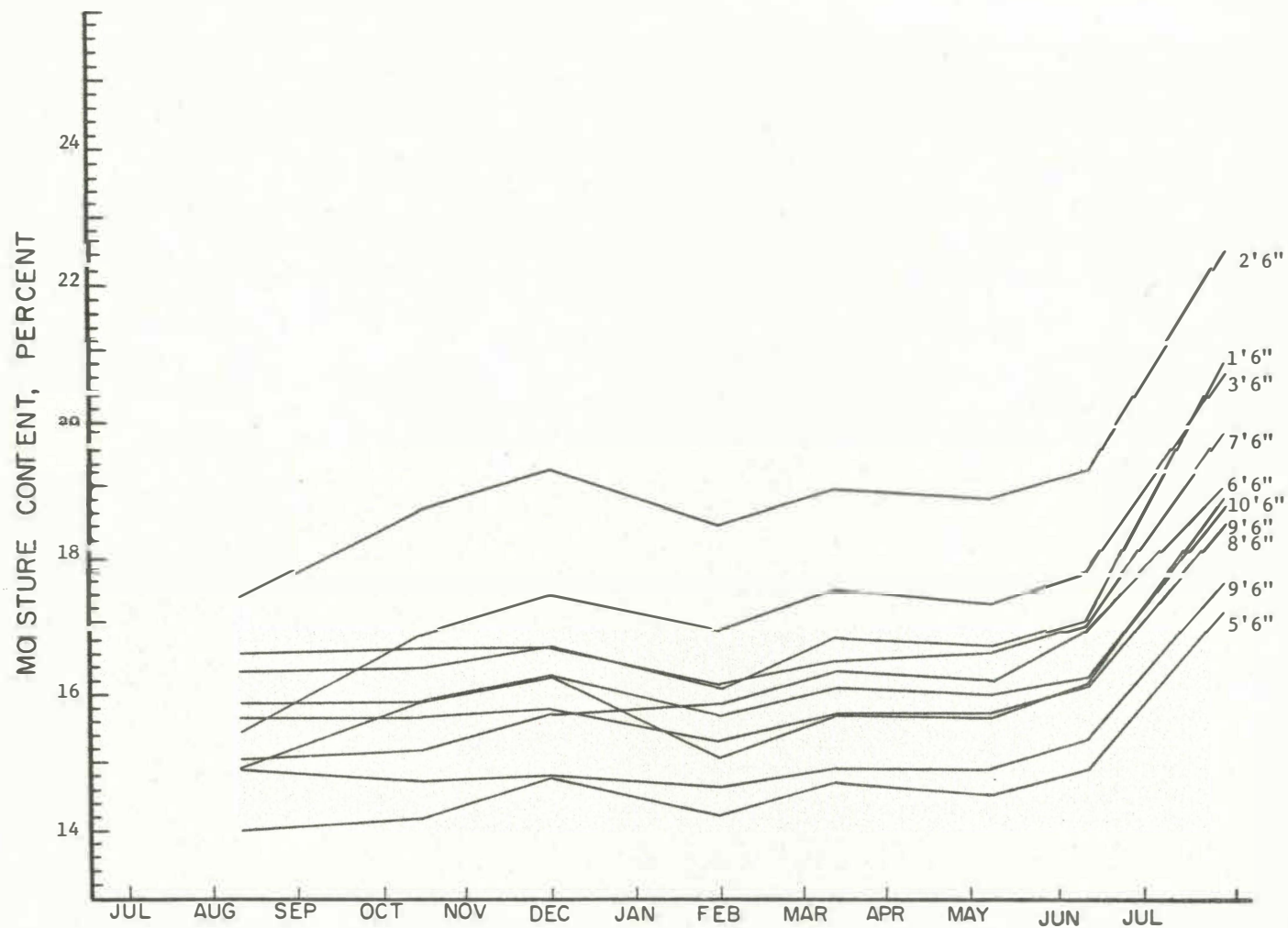


SITE NO: 12-B

COUNTY: Creek

HIGHWAY: US 66

SUBGRADE MOISTURE VARIATIONS PROJECT



SITE NO: 12-c
 COUNTY: Creek
 HIGHWAY: US 66

SUBGRADE MOISTURE VARIATIONS PROJECT

SCHOOL OF CIVIL ENGINEERING
OKLAHOMA STATE UNIVERSITY

SUBGRADE MOISTURE VARIATIONS RESEARCH PROJECT

SUBGRADE SOIL DRY DENSITY TABULATION

Date of Measurement	August 1966			January 1967			August 1967		
Site & Hole Number	12-A	12-B	12-C	12-A	12-B	12-C	12-A	12-B	12-C
Depth from top of tube to bottom of probe									
1 ft 6 in.	107.19	112.11	115.37	118.68	126.13	119.92	93.72	98.49	94.96
2 ft 0 in.									
2 ft 6 in.	99.35	106.43	101.49	103.50	110.78	106.35	94.77	105.08	89.98
3 ft 0 in.									
3 ft 6 in.	99.89	102.57	107.04	102.95	107.80	112.04	95.38	102.89	95.62
4 ft 0 in.									
4 ft 6 in.	100.30	104.90	107.57	104.53	110.19	114.19	95.40	105.38	97.88
5 ft 0 in.									
5 ft 6 in.	103.72	106.51	110.33	106.96	111.15	115.09	97.82	105.07	98.50
6 ft 0 in.									
6 ft 6 in.	103.97	106.78	107.31	107.74	111.60	110.37	99.59	105.67	95.70
7 ft 0 in.									
7 ft 6 in.	105.26	107.03	103.90	109.63	111.96	108.63	99.33	106.07	93.12
8 ft 0 in.									
8 ft 6 in.	109.11	108.34	108.58	110.76	112.48	112.57	103.61	106.93	95.81
9 ft 0 in.									
9 ft 6 in.	106.59	107.95	110.27	109.36	111.52	112.36	98.66	107.17	96.97
10 ft 0 in.	106.04	106.60	107.20	109.49	111.44	111.74	85.56	106.67	94.81

Note: All density values reported in units of lb per cu ft

SITE NO. 13

SCHOOL OF CIVIL ENGINEERING
OKLAHOMA STATE UNIVERSITY
SUBGRADE MOISTURE VARIATIONS PROJECT
TEST SITE DATA SUMMARY SHEET

LOCATION DATA:

Site No. 13 Highway No. US 66 County: Lincoln Date Installed: 8/2/66

Distance from access tube to Lane ℓ: 11' 0" a, 6" b, 11' 0" c

Exact Location:

In Lincoln County west of Chandler, 0.8 mile west on US 66 from jct. US 66 and S 18. Marker on south fence row.

PAVEMENT/DESIGN DATA:

No. of Lanes: 2 Pavement Type: AC/PCC Shoulder Type: Natural

Pavement Thickness: 12 in. ℓ, 12 in. Edge Latest Pavement Condition Rating: Good

Latest Traffic Count: 2400 vpd Heavy Truck Traffic: No

Terrain: Upland Drainage: Fair Year of Original Paving: 1929

Original Design and History:

Variable section PCC, at ℓ 7 in. PCC; at 9 ft rt and lt: 9 in. PCC.
In 1951; ℓ to 9 ft lt and rt: 6 in. AC overlay; 9 ft to 12 ft lt and rt:
11 in. AC. No sand cushion or subbase.

FIELD OBSERVATIONS BY RESEARCH PERSONNEL:

12/15/66 - $\frac{1}{2}$ in. transverse crack 2 ft from holes "b" and "c" with
several other small cracks in area.

1/31/67 - cracks sealed by OSHD

SCHOOL OF CIVIL ENGINEERING
OKLAHOMA STATE UNIVERSITY
Stillwater, Oklahoma
SUBGRADE MOISTURE VARIATION STUDY
SITE INSTALLATION INFORMATION

Installation: Lincoln U.S. 66 13 Date: 2 8 66
County Highway No. day month year

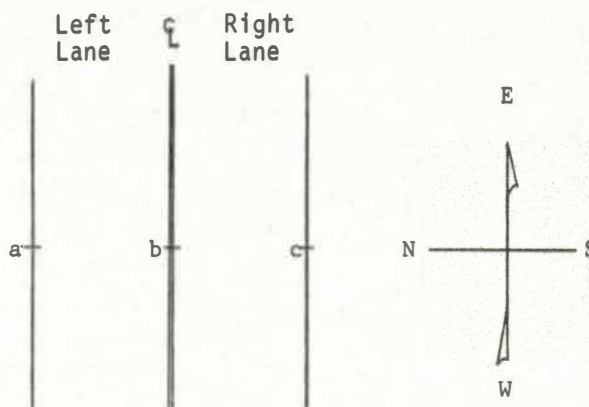
Location of site: West of Chandler 0.8 miles west on U.S. 66 from intersection
of U.S. 66 and St. 18, 200 ft. west of service station.

Description of Terrain and Vegetation: Pavement in rolling hilly upland
terrain.

Boring Plan:

Hole Depth:

a. 10'
b. 9'
c. 10'



Roadway Characteristics:

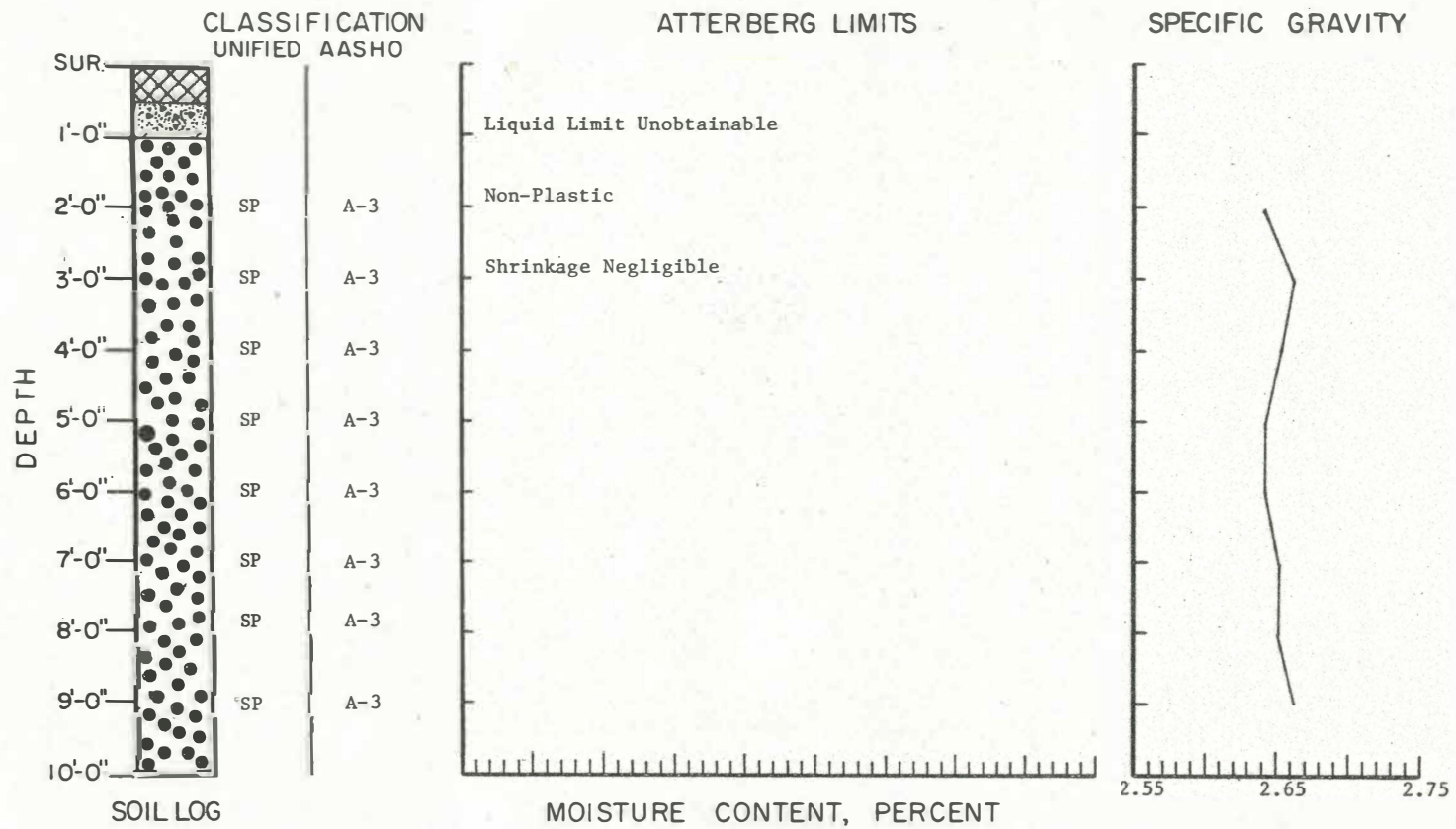
Pavement: Type Asphaltic Concrete over Portland Cement Concrete
Width 24' Thickness 6"-A.C. - 6"-P.C.
Condition Good

Shoulders: Type _____ Width _____
Condition Fair

Base Course Characteristics Sand

SITE NO.: 13
COUNTY : Lincoln
HIGHWAY : US 66

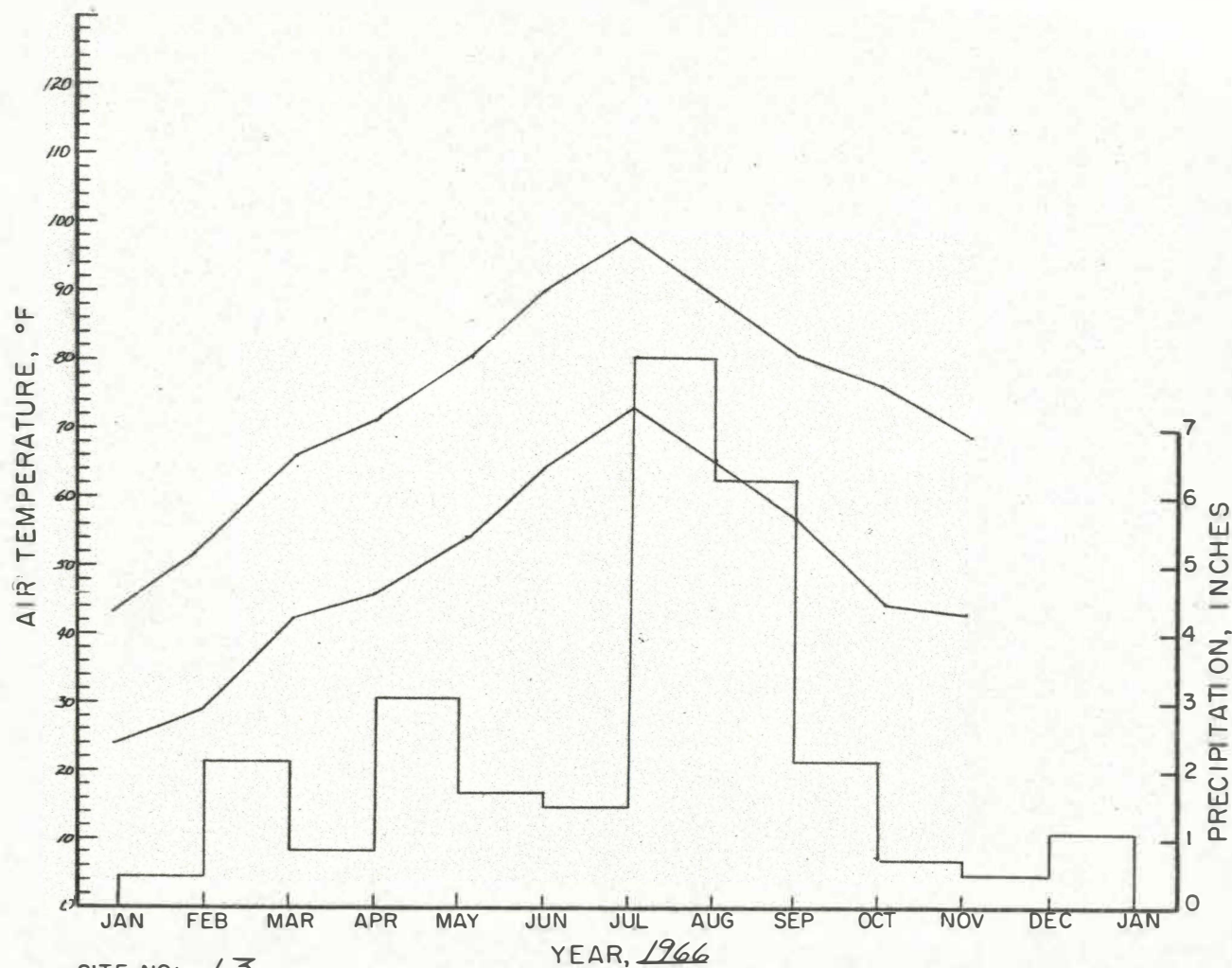
- LIQUID LIMIT
- ▲ PLASTIC LIMIT
- LINEAL SHRINKAGE



DATE : 30 November 1967

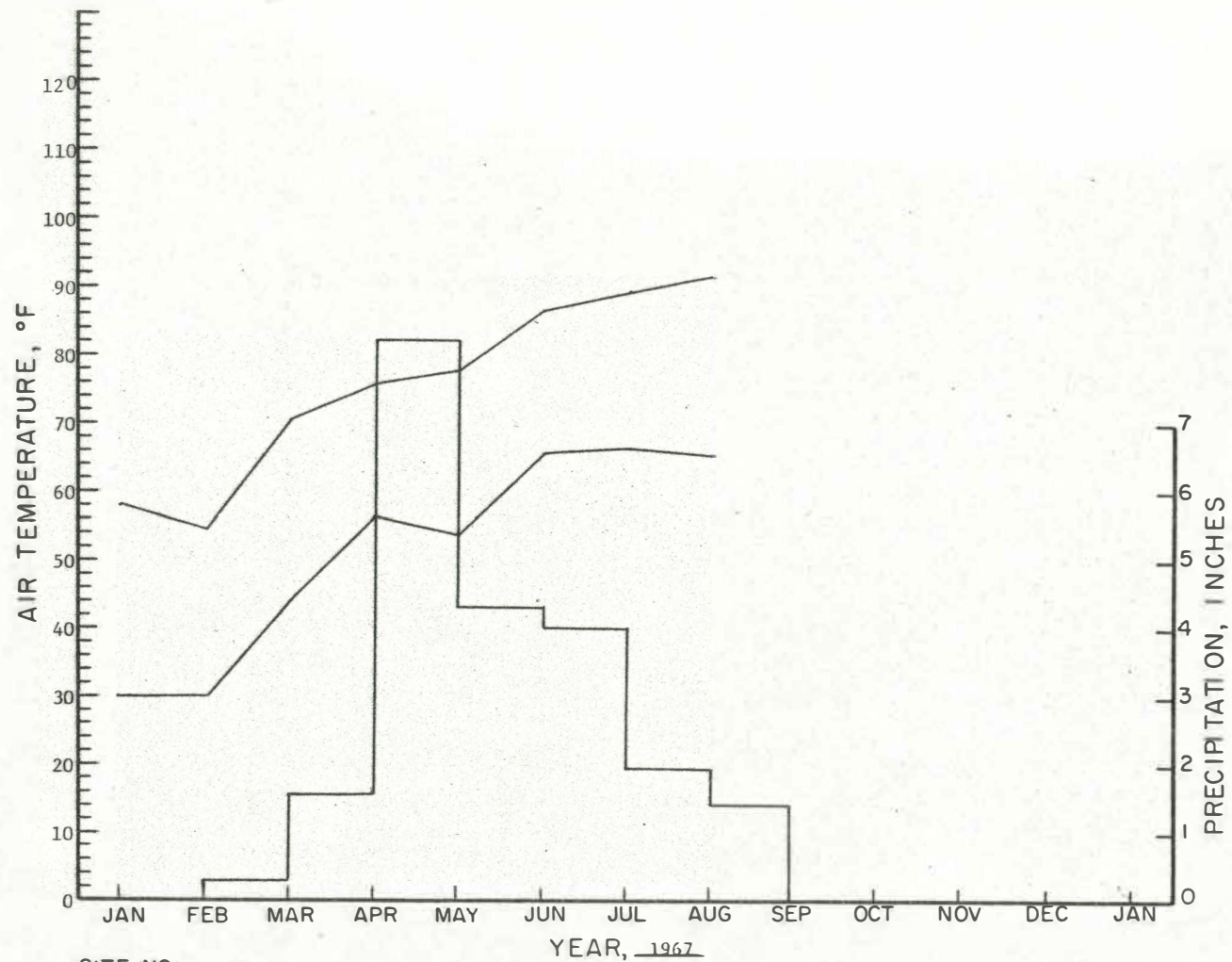
PLOTTED BY : AAP

SUBGRADE MOISTURE VARIATIONS PROJECT



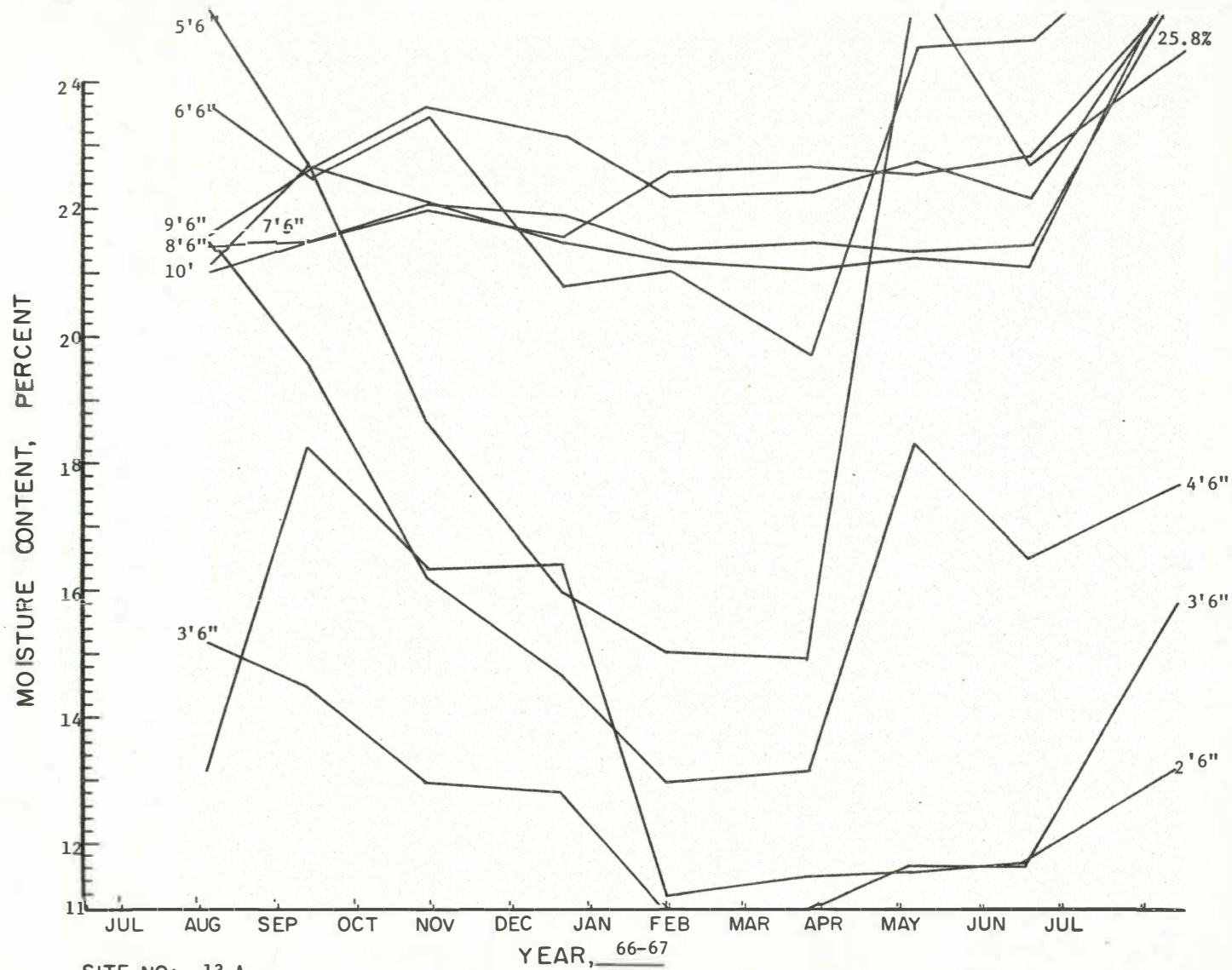
SITE NO: 13
 COUNTY: Lincoln
 HIGHWAY: U.S. 66

SUBGRADE MOISTURE VARIATIONS PROJECT



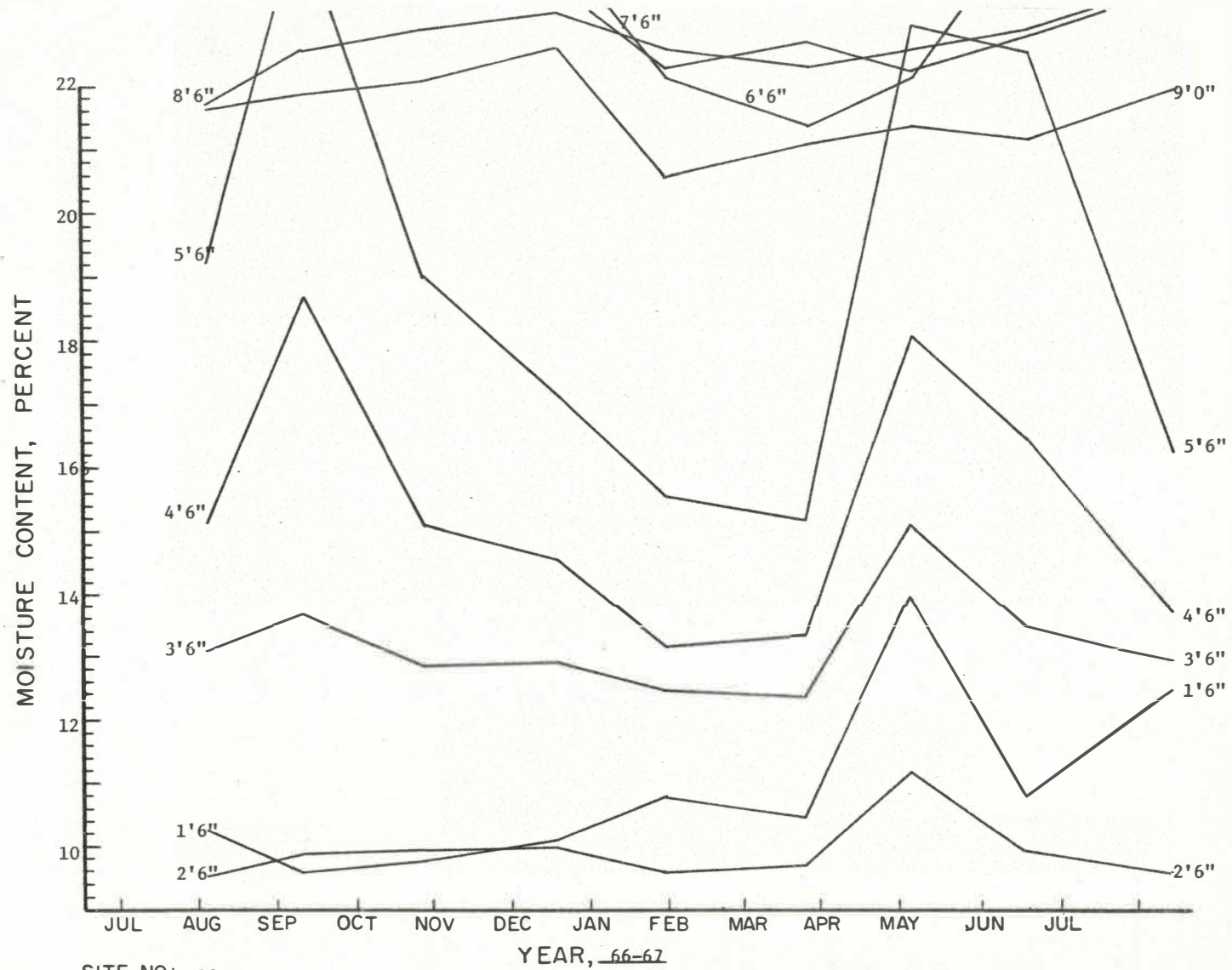
SITE NO: 13
COUNTY: Lincoln
HIGHWAY: US 66

SUBGRADE MOISTURE VARIATIONS PROJECT



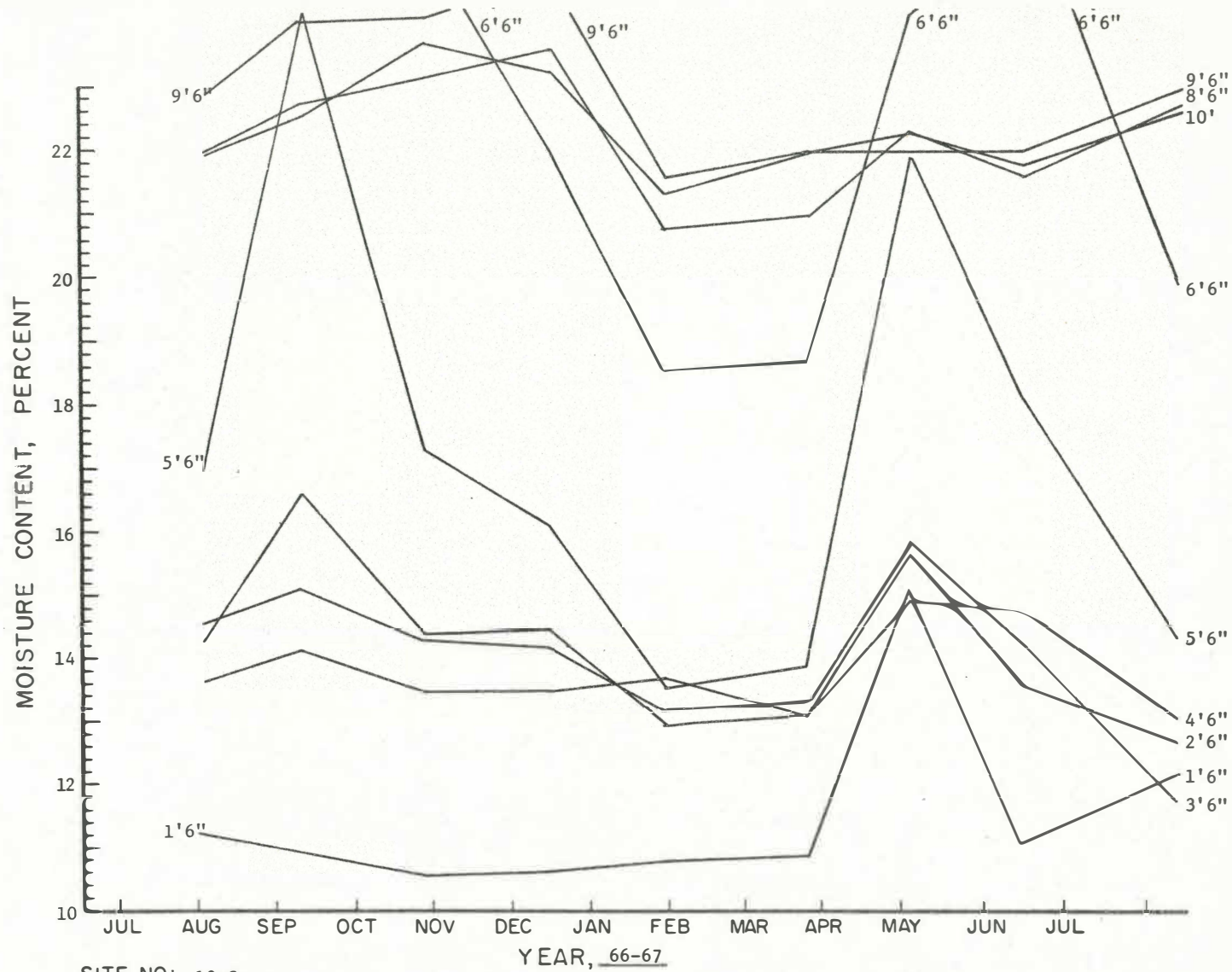
SITE NO: 13-A
COUNTY: Lincoln
HIGHWAY: US 66

SUBGRADE MOISTURE VARIATIONS PROJECT



SITE NO: 13-B
COUNTY: Lincoln
HIGHWAY: US 66

SUBGRADE MOISTURE VARIATIONS PROJECT



SITE NO: 13-C

COUNTY: Lincoln

HIGHWAY: US 66

SUBGRADE MOISTURE VARIATIONS PROJECT

SCHOOL OF CIVIL ENGINEERING
OKLAHOMA STATE UNIVERSITY

SUBGRADE MOISTURE VARIATIONS RESEARCH PROJECT

SUBGRADE SOIL DRY DENSITY TABULATION

Date of Measurement	August 1966			January 1967			August 1967		
Site & Hole Number	13-A	13-B	13-C	13-A	13-B	13-C	13-A	13-B	13-C
Depth from top of tube to bottom of probe									
1 ft 6 in.	149.48	146.39	141.37		139.00	137.15	94.95	115.79	116.47
2 ft 0 in.				134.29					
2 ft 6 in.	92.27	104.08	95.74		104.91	98.45	81.59	100.30	94.09
3 ft 0 in.				95.26					
3 ft 6 in.	83.03	90.75	81.11		91.68	85.16	73.88	88.25	94.80
4 ft 0 in.				85.62					
4 ft 6 in.	78.77	80.86	73.14		84.50	77.99	70.62	82.03	76.85
5 ft 0 in.				82.10					
5 ft 6 in.	81.08	81.84	72.88		85.61	81.67	75.89	83.11	78.60
6 ft 0 in.				88.59					
6 ft 6 in.	93.01	82.10	74.35		88.62	82.06	81.31	84.95	77.94
7 ft 0 in.				97.64					
7 ft 6 in.	102.30	95.60	70.87		100.37	93.07	87.48	94.66	87.87
8 ft 0 in.				104.77					
8 ft 6 in.	102.17	99.39	94.66		101.88	103.13	86.36	96.07	96.05
9 ft 0 in.		97.04		103.35	103.12			97.33	
9 ft 6 in.	97.45		89.75			100.32	85.36		94.78
10 ft 0 in.	100.28		93.91	103.16		100.92	86.69		95.75

Note: All density values reported in units of lb per cu ft

SITE NO. 14

NOTE: THIS SITE HAS BEEN ABANDONED

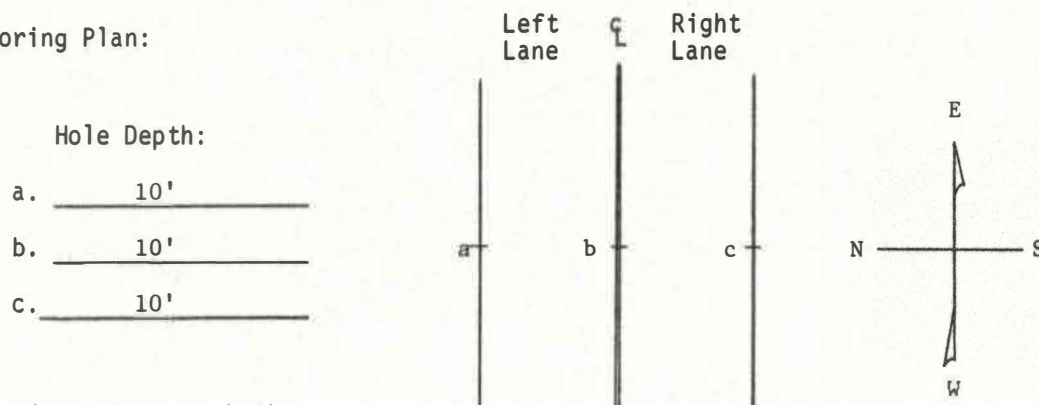
SCHOOL OF CIVIL ENGINEERING
OKLAHOMA STATE UNIVERSITY
Stillwater, Oklahoma
SUBGRADE MOISTURE VARIATION STUDY
SITE INSTALLATION INFORMATION

Installation: Kay St. 11 14 Date: 29 8 66
County Highway No. day month year

Location of site: West of Blackwell 1/4 miles east on St. 11 from jct. of I.-35
and St. 11, 150 ft. east of farm house on south side of the highway. Site in
south lane of divided highway.

Description of Terrain and Vegetation: Pavement on level upland terrain in
slight cut

Boring Plan:



Roadway Characteristics:

Pavement: Type Asphaltic Concrete
Width 26' Thickness 24"
Condition Good

Shoulders: Type Asphalt Concrete Width R-9' L-4'
Condition Good

Base Course Characteristics Natural subgrade

SITE NO. 15

SCHOOL OF CIVIL ENGINEERING
OKLAHOMA STATE UNIVERSITY
SUBGRADE MOISTURE VARIATIONS PROJECT
TEST SITE DATA SUMMARY SHEET

LOCATION DATA:

Site No. 15 Highway No. US 60 County: Osage Date Installed: 8/30/66

Distance from access tube to Lane ℄: 18' 0" a, 1' 0" b, 18' 0" c

Exact Location:

In Osage County east of Ponca City, 1.6 miles east of US 60 from jct. US 60, S 11, and US 177. Marker on north fence row.

PAVEMENT/DESIGN DATA:

No. of Lanes: 2 Pavement Type: PCC Shoulder Type: Improved

Pavement Thickness: 10 in. ℄, 2 in. Edge Latest Pavement Condition Rating: Good

Latest Traffic Count: 4300 vpd Heavy Truck Traffic: Yes

Terrain: Upland Drainage: Good Year of Original Paving: 1952

Original Design and History:

24 ft width; ℄ to 12 ft rt and lt: 8 in. PCC over 4 in. sand where needed;
12 ft to 20 ft lt. and rt: 4 in. gravel with armour coat.

FIELD OBSERVATIONS BY RESEARCH PERSONNEL:

2/23/67 - Access tube "a" loose in hole.

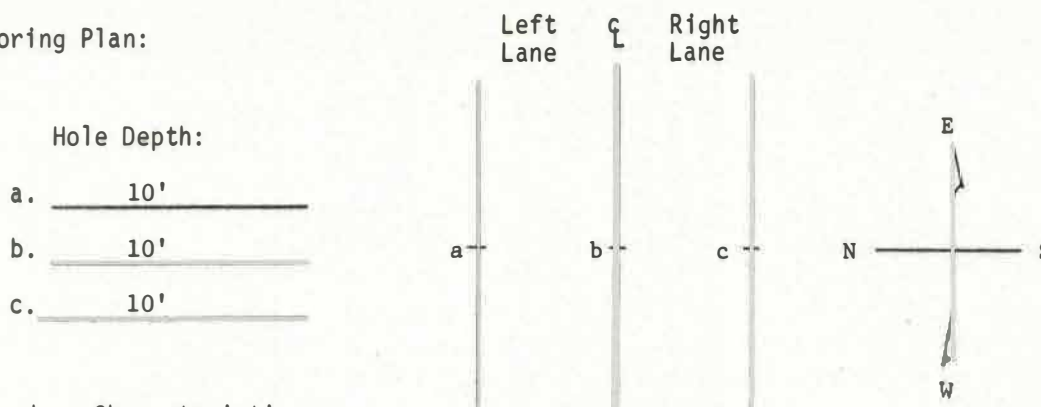
SCHOOL OF CIVIL ENGINEERING
OKLAHOMA STATE UNIVERSITY
Stillwater, Oklahoma
SUBGRADE MOISTURE VARIATION STUDY
SITE INSTALLATION INFORMATION

Installation: Osage U.S. 60 15 Date: 30 8 66
County Highway No. day month year

Location of site: East of Ponca City, 1.6 miles east on U.S. 60 from jct. of
U.S. 60, St. 11, and U.S. 177.'

Description of Terrain and Vegetation: Pavement on level upland terrain

Boring Plan:



Roadway Characteristics:

Pavement: Type P.C. Concrete
Width 24' Thickness 10"
Condition Good

Shoulders: Type Asphaltic Concrete Width 7'
Condition Good

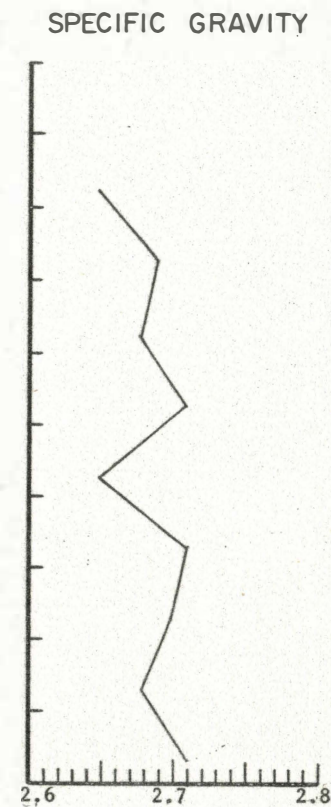
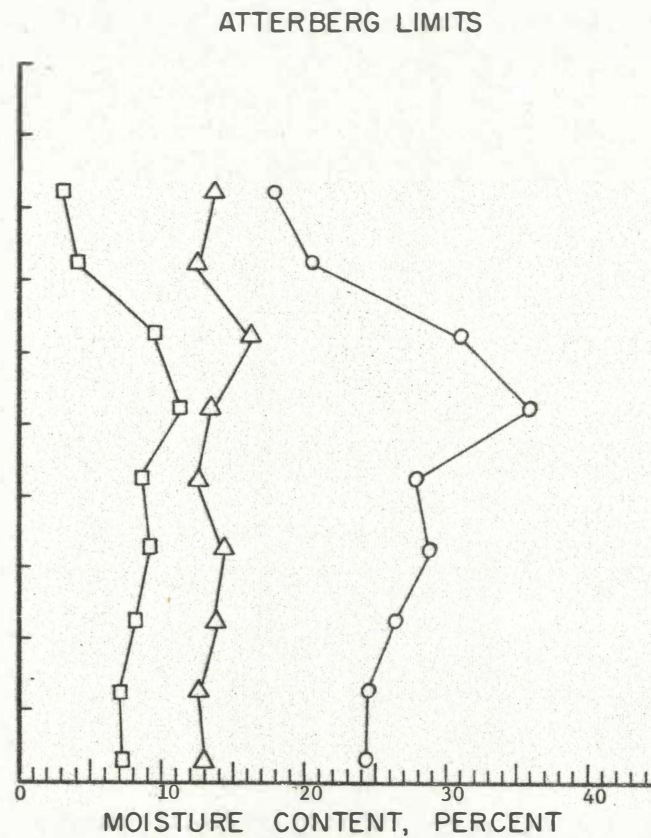
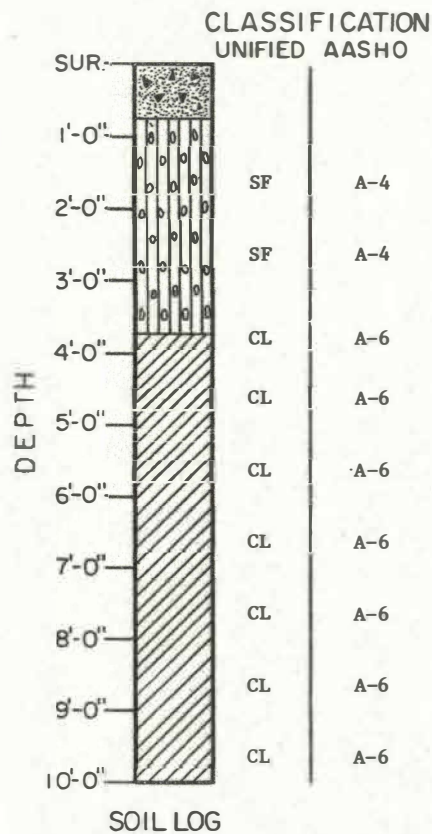
Base Course Characteristics Gravel

SITE NO.: 15

COUNTY : Osage

HIGHWAY : US 60

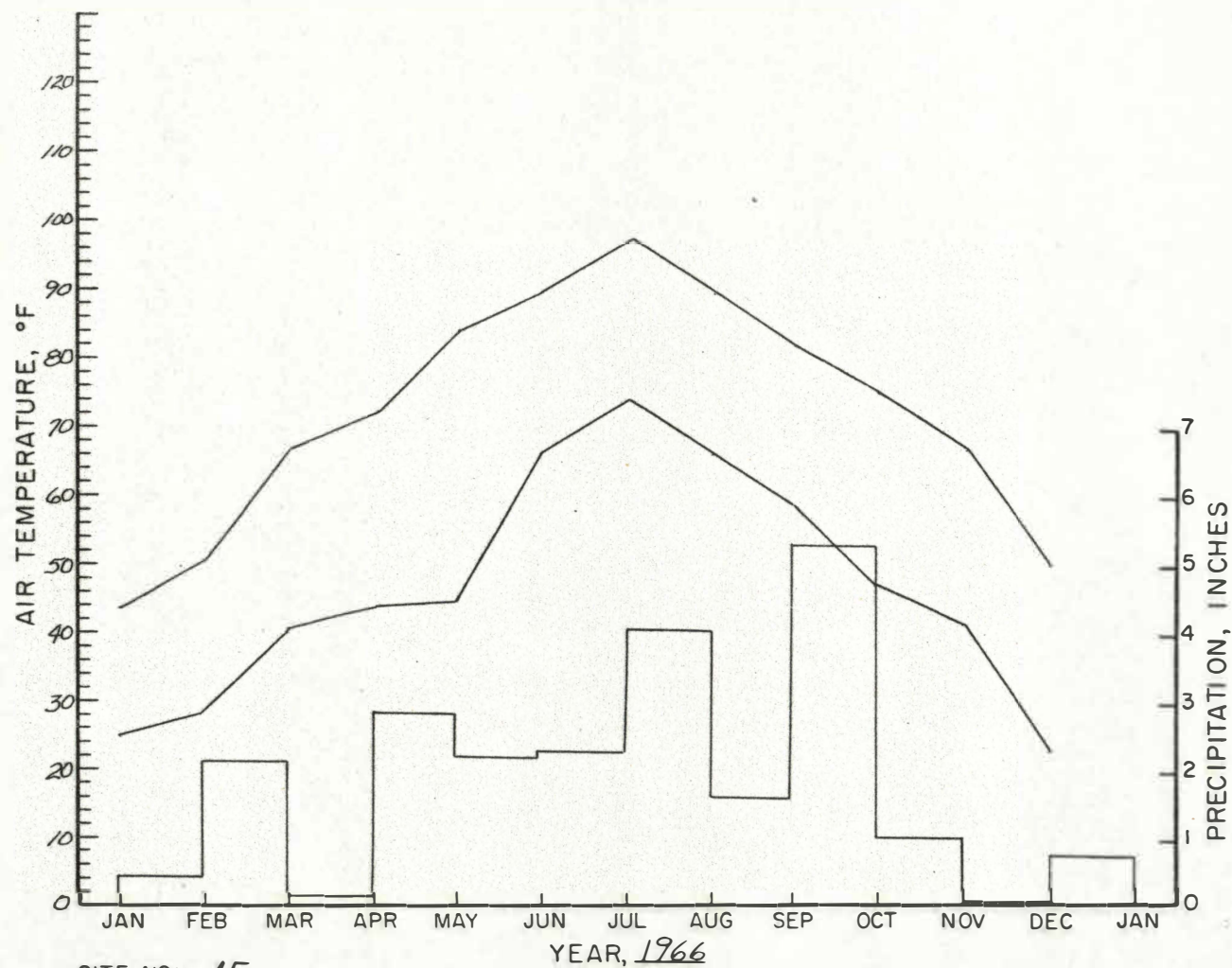
- LIQUID LIMIT
- ▲ PLASTIC LIMIT
- LINEAL SHRINKAGE



DATE : 29 November 1967

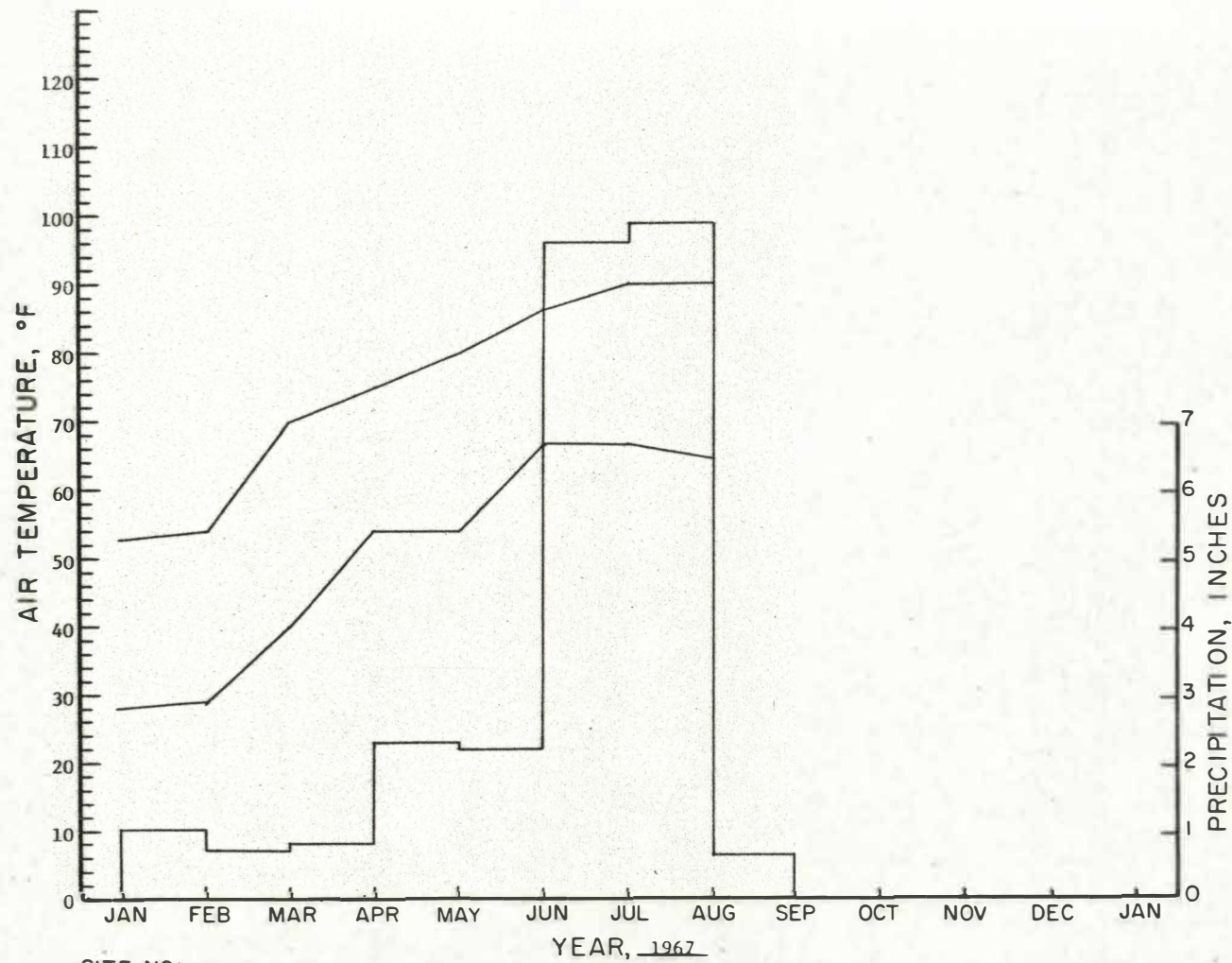
PLOTTED BY : AAP

SUBGRADE MOISTURE VARIATIONS PROJECT



SITE NO: 15
COUNTY: OSAGE
HIGHWAY: US 60

SUBGRADE MOISTURE VARIATIONS PROJECT

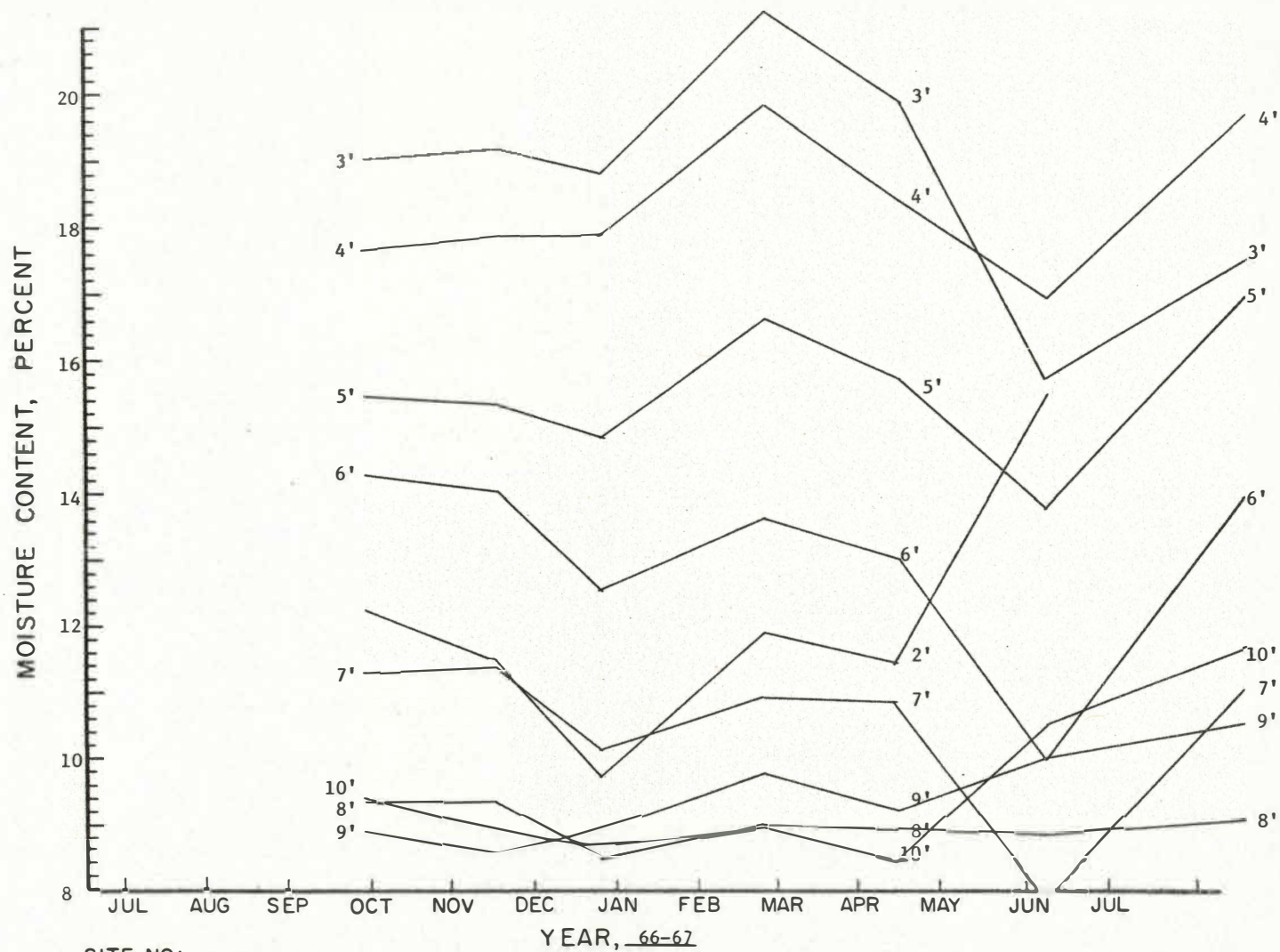


SITE NO: 15

COUNTY: Osage

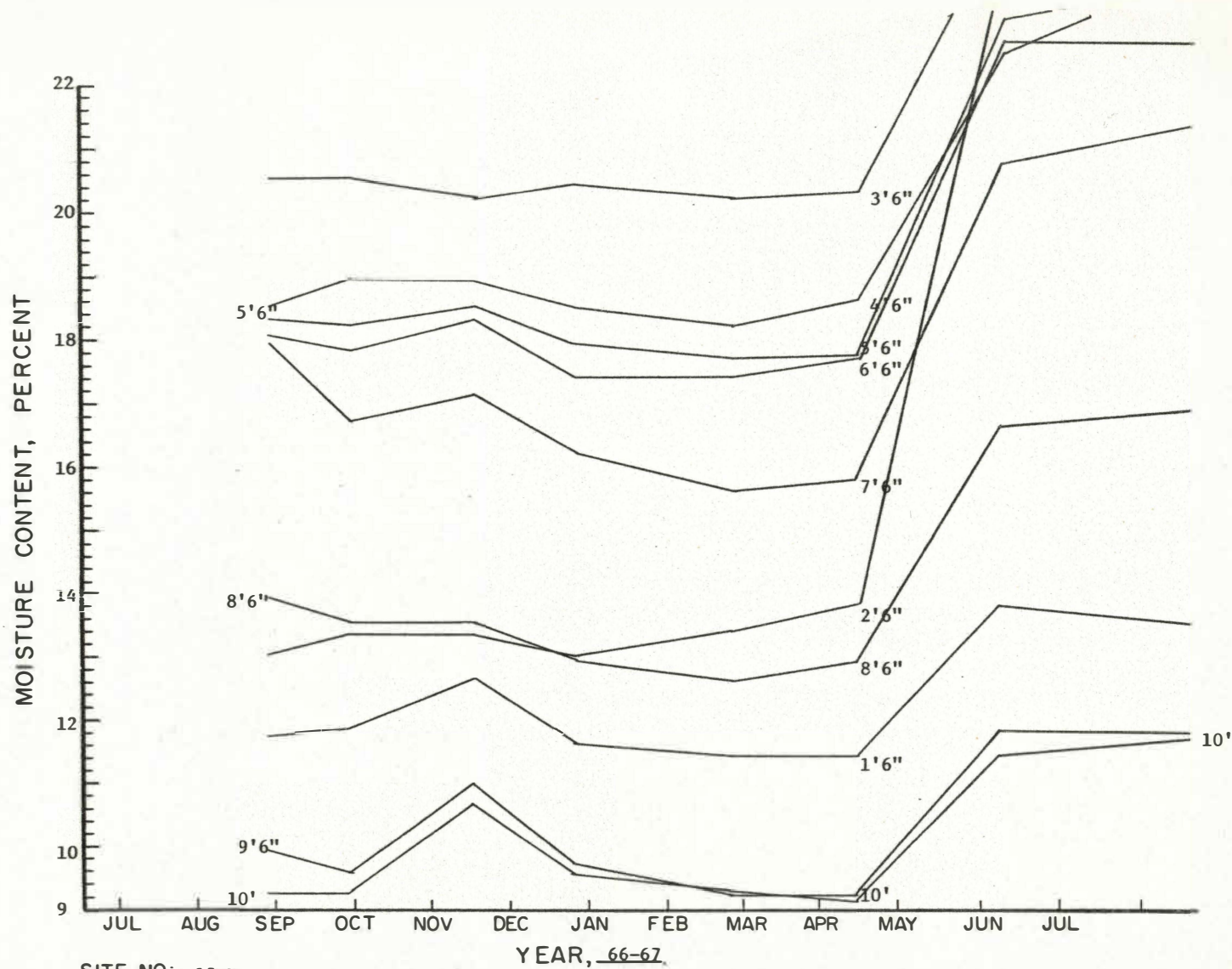
HIGHWAY: US 60

SUBGRADE MOISTURE VARIATIONS PROJECT



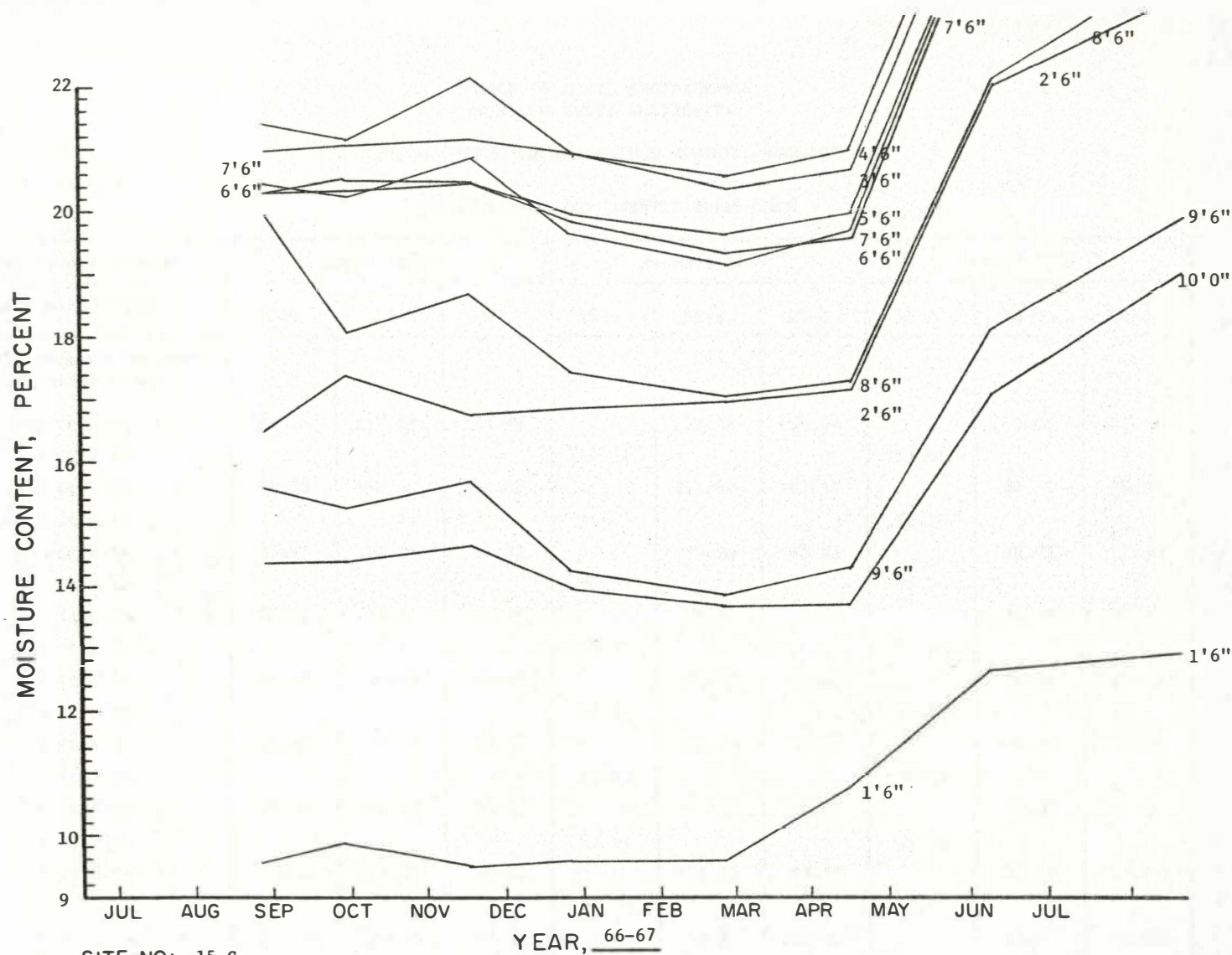
SITE NO: 15-A
 COUNTY: Osage
 HIGHWAY: US 60

SUBGRADE MOISTURE VARIATIONS PROJECT



SITE NO: 15-B
 COUNTY: Osage
 HIGHWAY: US 60

SUBGRADE MOISTURE VARIATIONS PROJECT



SITE NO: 15-C
 COUNTY: Osage
 HIGHWAY: US 60

SUBGRADE MOISTURE VARIATIONS PROJECT

SITE NO. 16

SCHOOL OF CIVIL ENGINEERING
OKLAHOMA STATE UNIVERSITY
SUBGRADE MOISTURE VARIATIONS PROJECT
TEST SITE DATA SUMMARY SHEET

LOCATION DATA:

Site No. 16 Highway No. S 28 County: Nowata Date Installed: 8/25/66

Distance from access tube to Lane ℓ: 18' 0" a, 6" b, 18' 0" c

Exact Location:

In Nowata County east of Nowata, 0.3 mile south on S 28 from jct. US 60 and S 28.
Marker on west fence row.

PAVEMENT/DESIGN DATA:

No. of Lanes: 2 Pavement Type: AC Shoulder Type: Improved

Pavement Thickness: 2 in. ℓ, 1 in. Edge Latest Pavement Condition Rating: Good

Latest Traffic Count: 600 vpd Heavy Truck Traffic: No

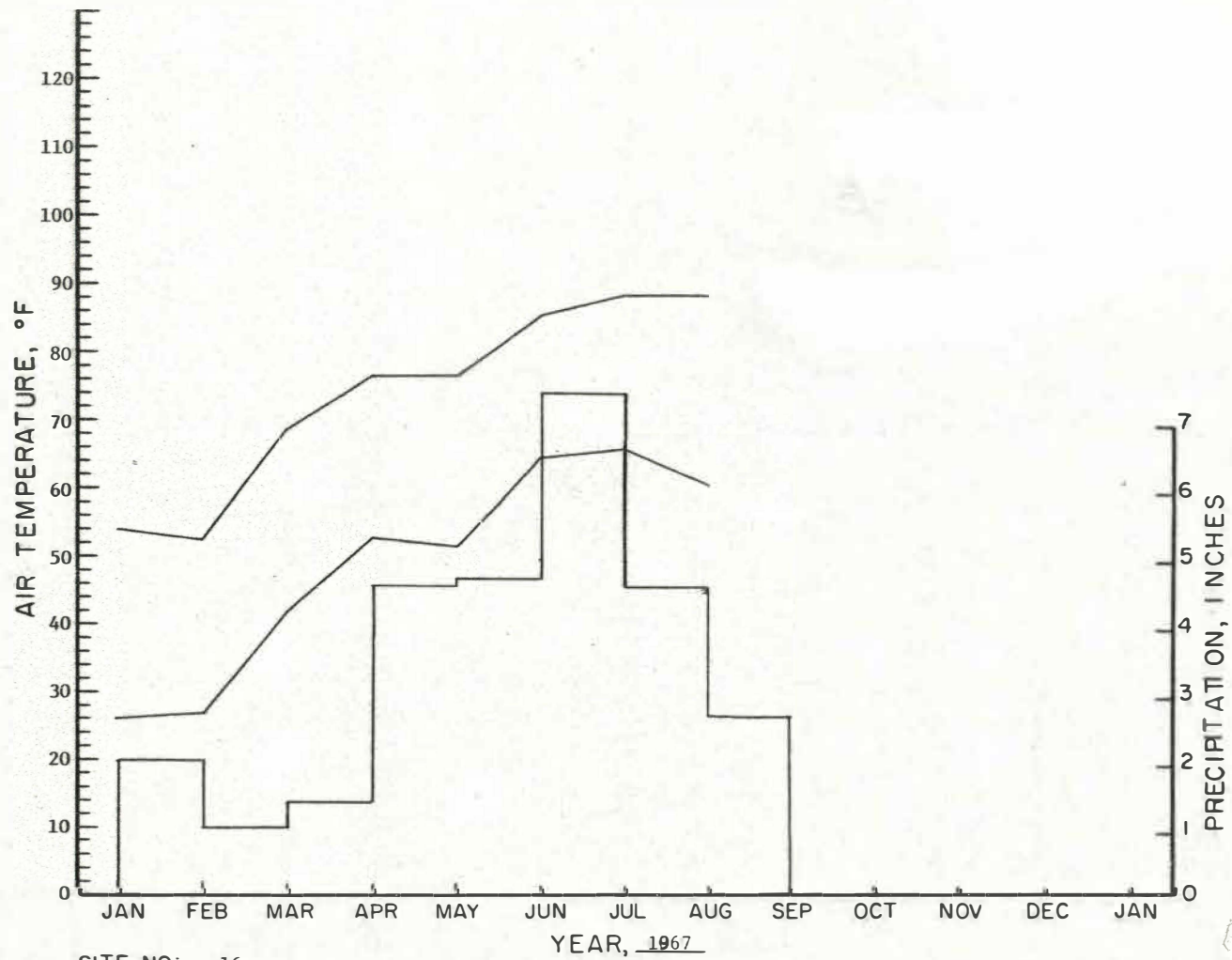
Terrain: Fill Drainage: Good Year of Original Paving: 1931

Original Design and History:

36 years of periodic armour coating, etc. by OSHD maintenance forces over original gravel surfacing.

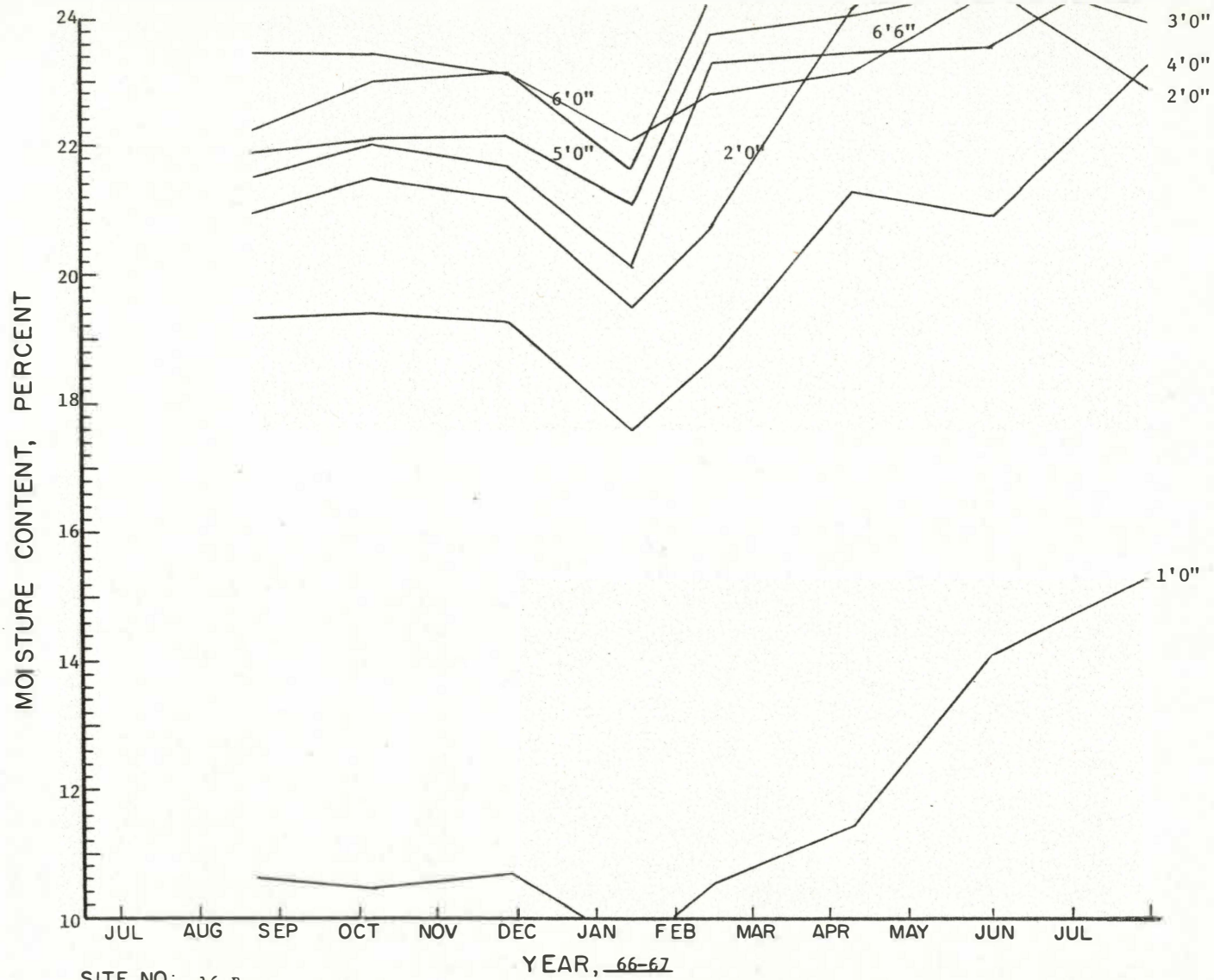
FIELD OBSERVATIONS BY RESEARCH PERSONNEL:

11/29/66 - Access tube "a" shortened 6 in.



SITE NO: 16
COUNTY: Nowata
HIGHWAY: SH 28

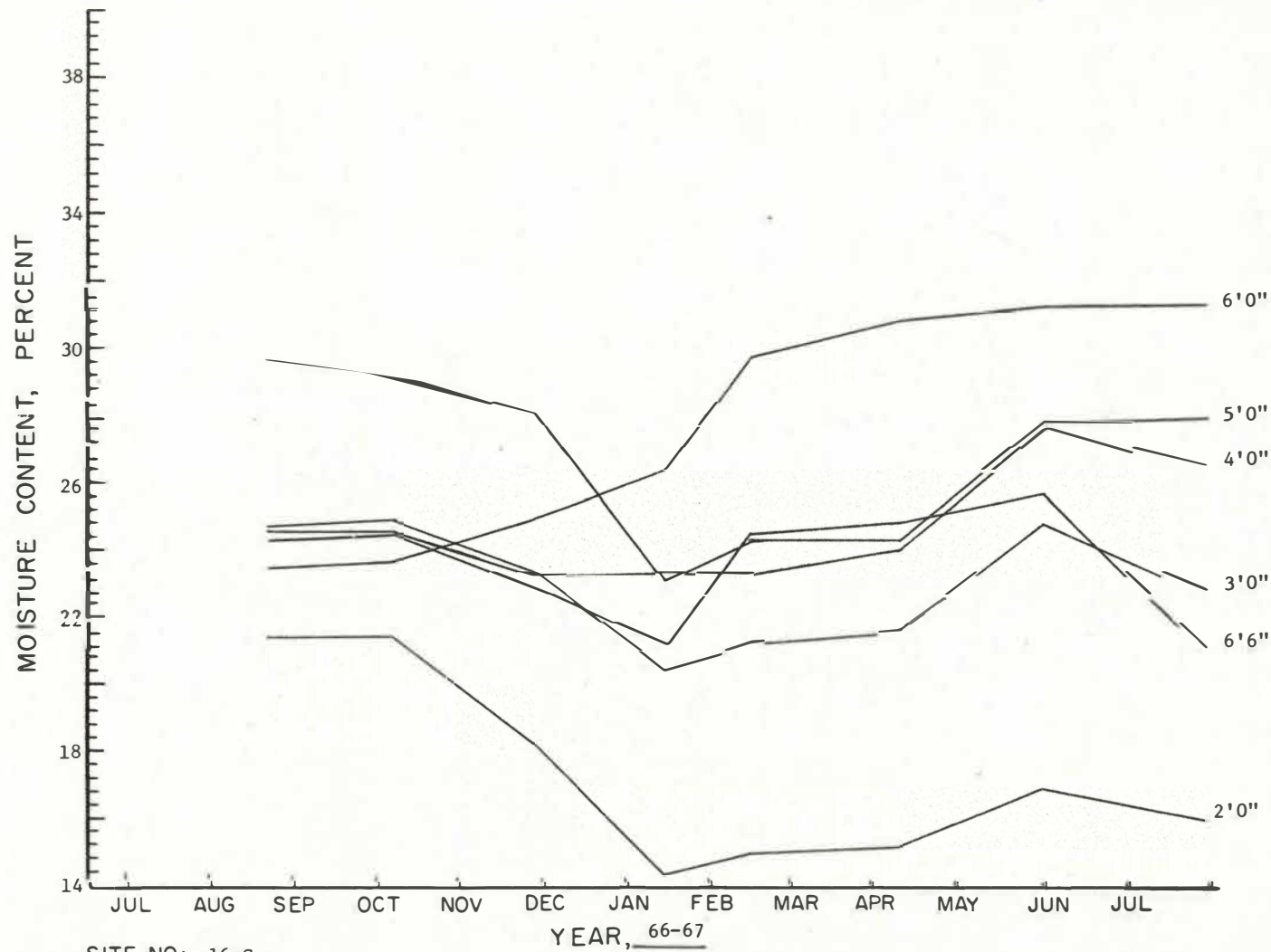
SUBGRADE MOISTURE VARIATIONS PROJECT



SITE NO: 16-B
 COUNTY: Nowata
 HIGHWAY: St. 28

SUBGRADE MOISTURE VARIATIONS PROJECT

* NOTE SCALE



SITE NO: 16-C

COUNTY: Nowata

HIGHWAY: St. 28

SUBGRADE MOISTURE VARIATIONS PROJECT

SCHOOL OF CIVIL ENGINEERING
OKLAHOMA STATE UNIVERSITY

SUBGRADE MOISTURE VARIATIONS RESEARCH PROJECT

SUBGRADE SOIL DRY DENSITY TABULATION

Date of Measurement	August 1966			January 1967			August 1967		
Site & Hole Number	16-A	16-B	16-C	16-A	16-B	16-C	16-A	16-B	16-C
Depth from top of tube to bottom of probe									
1 ft 6 in.		129.54	131.67	120.31	133.64		99.19		
2 ft 0 in.	98.07					115.70			108.59
2 ft 6 in.		96.69	94.49	98.53	97.46		82.86	111.41	
3 ft 0 in.	90.82					97.50			92.65
3 ft 6 in.		91.10	88.26	91.26	92.89		77.98	93.78	
4 ft 0 in.	94.83					91.23			88.56
4 ft 6 in.		96.36	93.46	98.70	99.87		84.15	88.41	
5 ft 0 in.	88.70					94.00			91.56
5 ft 6 in.		101.00	81.04	96.87	101.41		80.34	91.79	
6 ft 0 in.	89.69			97.32		85.55	81.31		83.12
6 ft 6 in.		93.32	93.00		96.31			90.19	
7 ft 0 in.		98.43	91.62		100.79	96.43		95.14	92.36
7 ft 6 in.									
8 ft 0 in.									
8 ft 6 in.									
9 ft 0 in.									
9 ft 6 in.									
10 ft 0 in.									

Note: All density values reported in units of lb per cu ft

SITE NO. 17

SCHOOL OF CIVIL ENGINEERING
OKLAHOMA STATE UNIVERSITY
SUBGRADE MOISTURE VARIATIONS PROJECT
TEST SITE DATA SUMMARY SHEET

LOCATION DATA:

Site No. 17 Highway No. US 69 County: Ottawa Date Installed: 8/17/66

Distance from access tube to Lane ℓ : 18" a, 27' 0" b, 32' 0" c

Exact Location:

In Ottawa County north of Miami, 2.5 miles north on US 69 from jct. of US 66, US 69, and S 10, adjacent to Sacred Heart Catholic Church. Site on four lane undivided highway, marker on east fence row.

PAVEMENT/DESIGN DATA:

No. of Lanes: 4UD Pavement Type: AC Shoulder Type: Improved

Pavement Thickness: 10 in. ℓ , 8 in. Edge Latest Pavement Condition Rating: Good

Latest Traffic Count: 12,200 vpd Heavy Truck Traffic: Yes

Terrain: Upland Drainage: Fair Year of Original Paving: 1954

Original Design and History:

Before 1954; ℓ to 9 ft lt and rt: 6 in. AC over 8 in. Telford stone base.

In 1954, 48 ft width; 9 ft to 24 ft lt and rt: 8 in. AC over 6 in. select subbase.

FIELD OBSERVATIONS BY RESEARCH PERSONNEL:

7/27/67 - Access tube "a" shortened 6 in.; access tube "b" has settled 6 in. - tube pulled and hole filled 6 in.

10/3/67 - Access tube "b" has settled 3 in. - tube pulled and hole filled 3 in.

SCHOOL OF CIVIL ENGINEERING
OKLAHOMA STATE UNIVERSITY
Stillwater, Oklahoma
SUBGRADE MOISTURE VARIATION STUDY
SITE INSTALLATION INFORMATION

Installation: Ottawa U.S. 69 17 Date: 17 8 66
County Highway No. day month year

Location of site: North of Miami, 2.5 miles north on U.S. 69 from jct. of U.S.
69, 66, and St. 10, adjacent to Sacred Heart Catholic Church. Site on
four-lane undivided highway

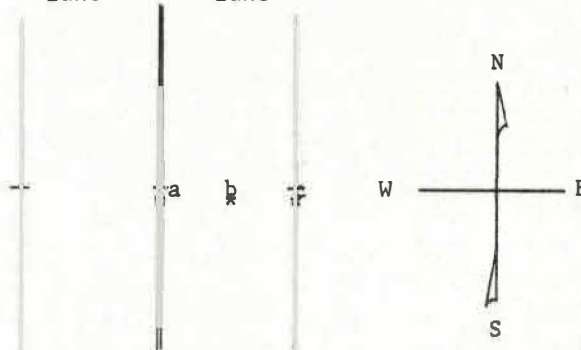
Description of Terrain and Vegetation: Pavement on level upland terrain

Boring Plan:

Hole Depth:

- a. 10'
b. 10'
c. 10'

Left Lane ζ Right Lane



Roadway Characteristics:

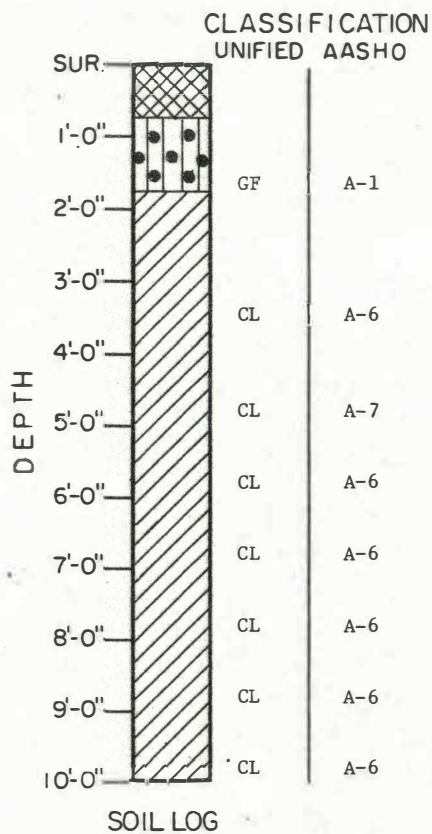
Pavement: Type Asphaltic Concrete
Width 54' Thickness 18"
Condition Good

Shoulders: Type Asphaltic Concrete Width 6'
Condition Good

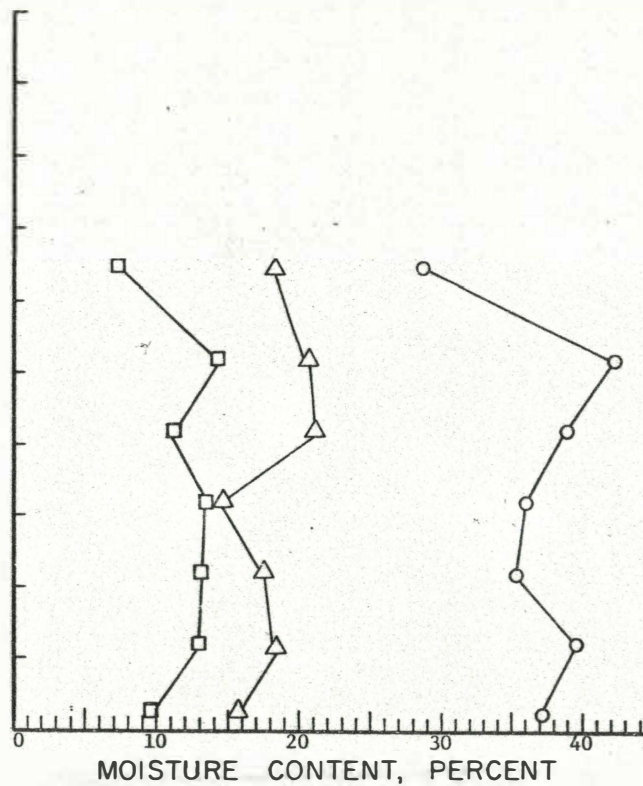
Base Course Characteristics Crushed rock

SITE NO.: 17
 COUNTY : Ottawa
 HIGHWAY : US 62

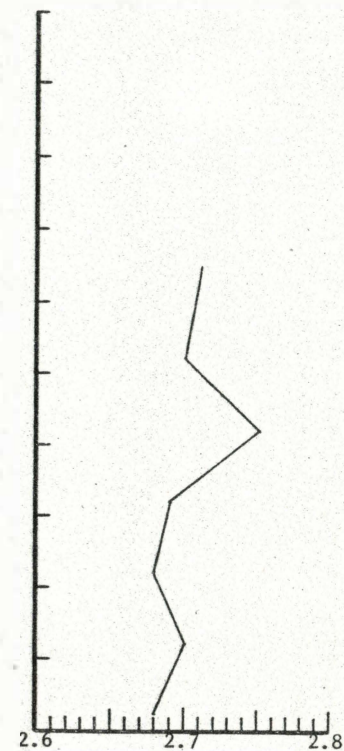
● LIQUID LIMIT
 ▲ PLASTIC LIMIT
 ■ LINEAL SHRINKAGE



ATTERBERG LIMITS

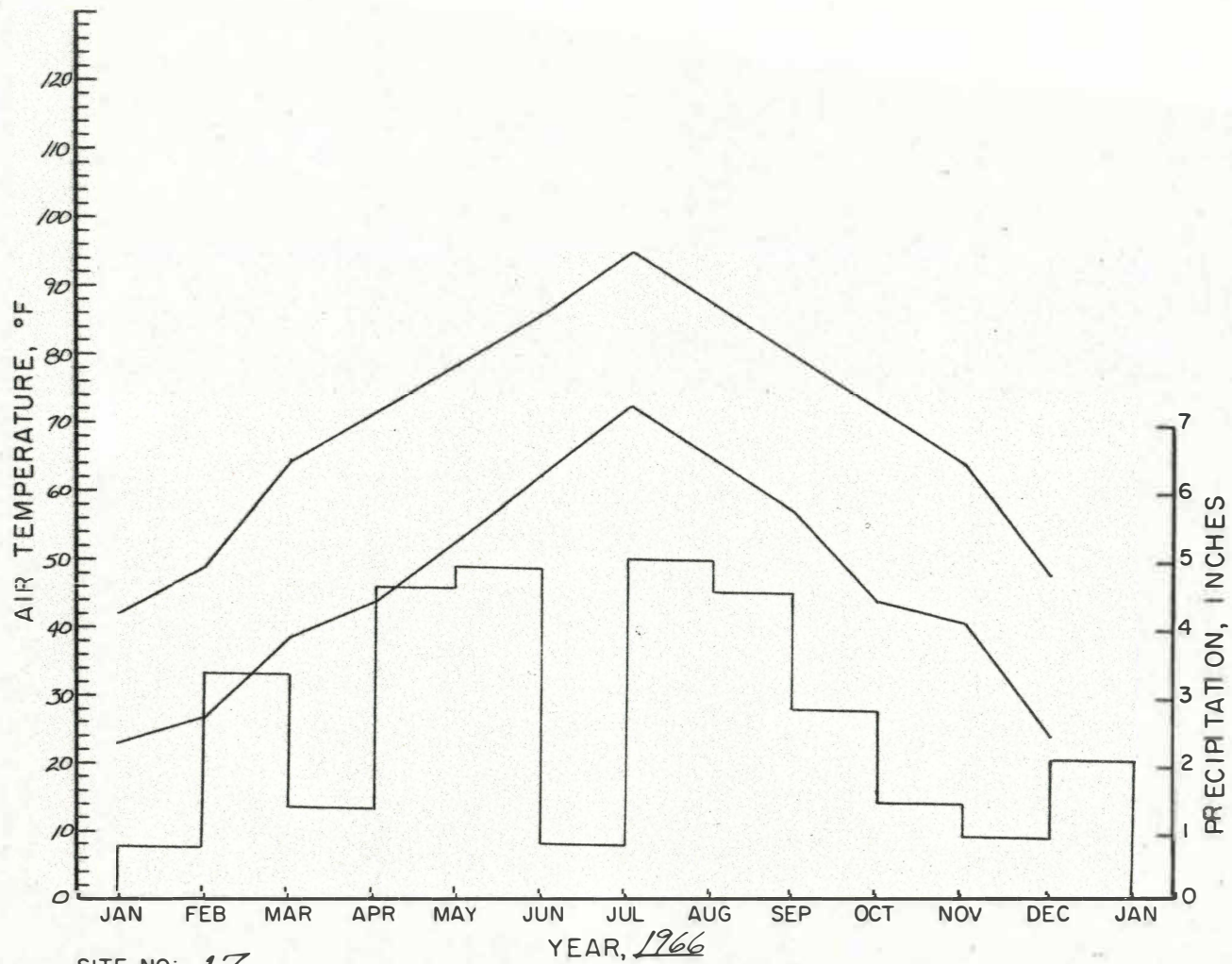


SPECIFIC GRAVITY



DATE : 4 December 1967
 PLOTTED BY : AAP

SUBGRADE MOISTURE VARIATIONS PROJECT

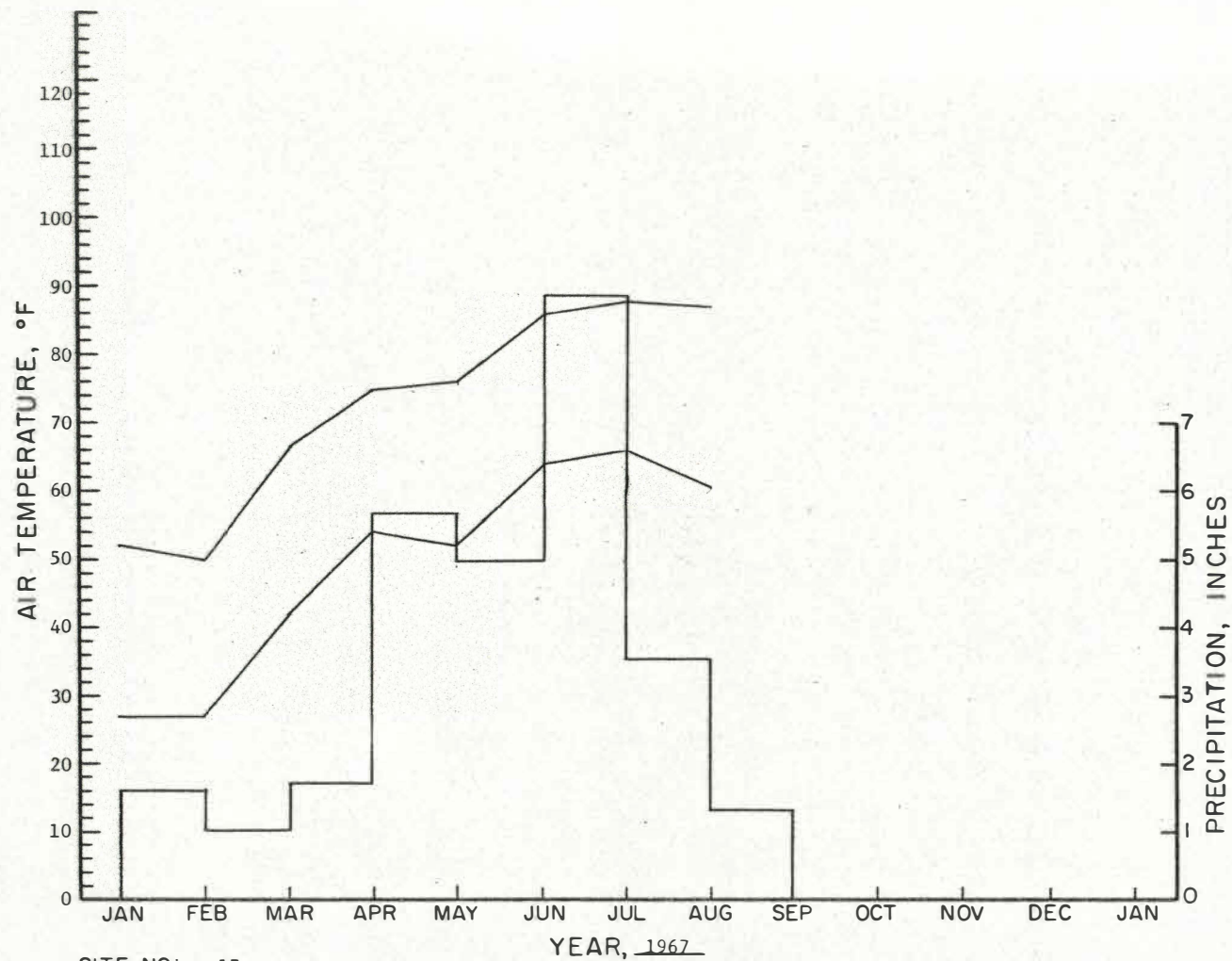


SITE NO: 17

COUNTY: Ottawa

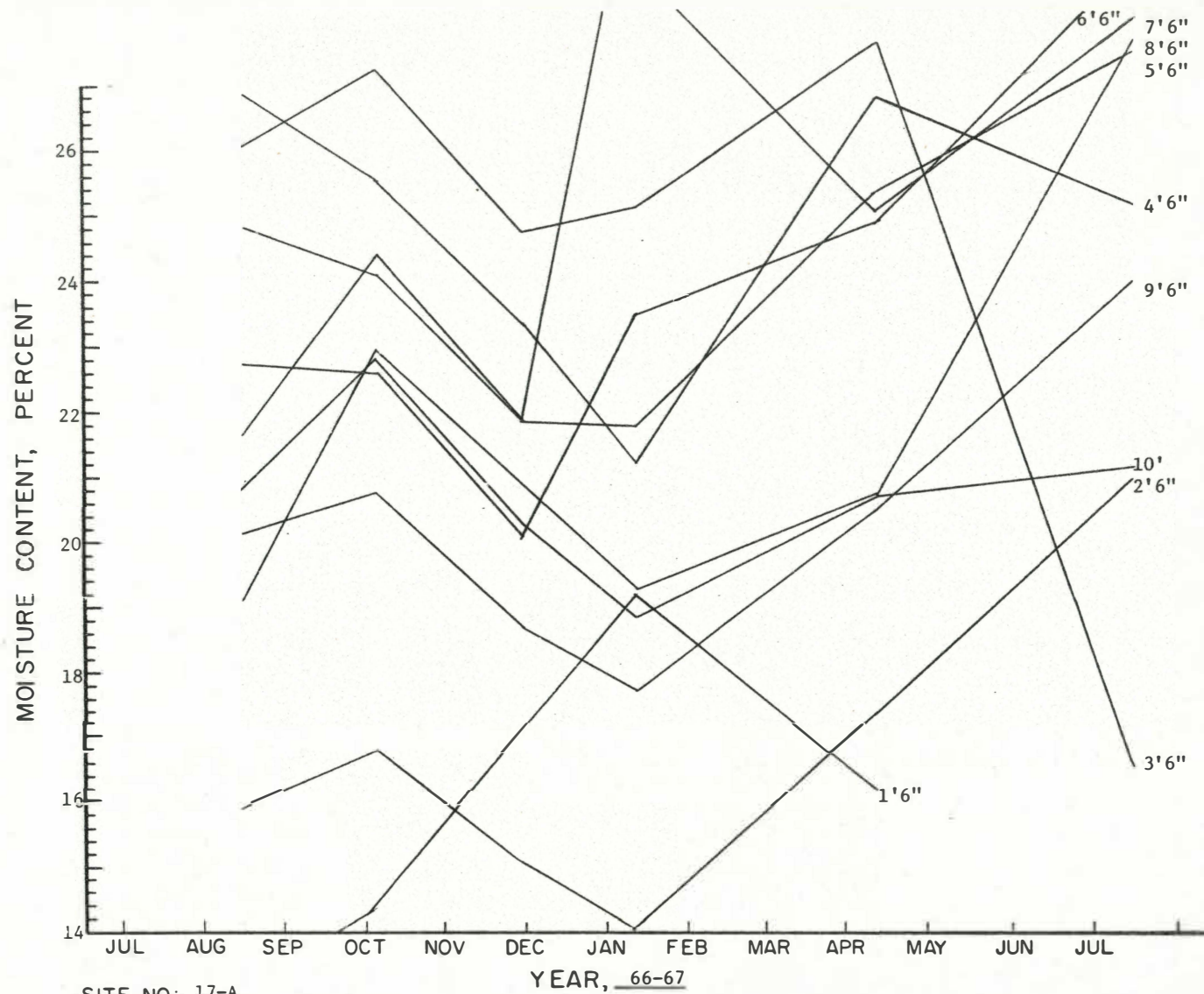
HIGHWAY: U.S. 66

SUBGRADE MOISTURE VARIATIONS PROJECT



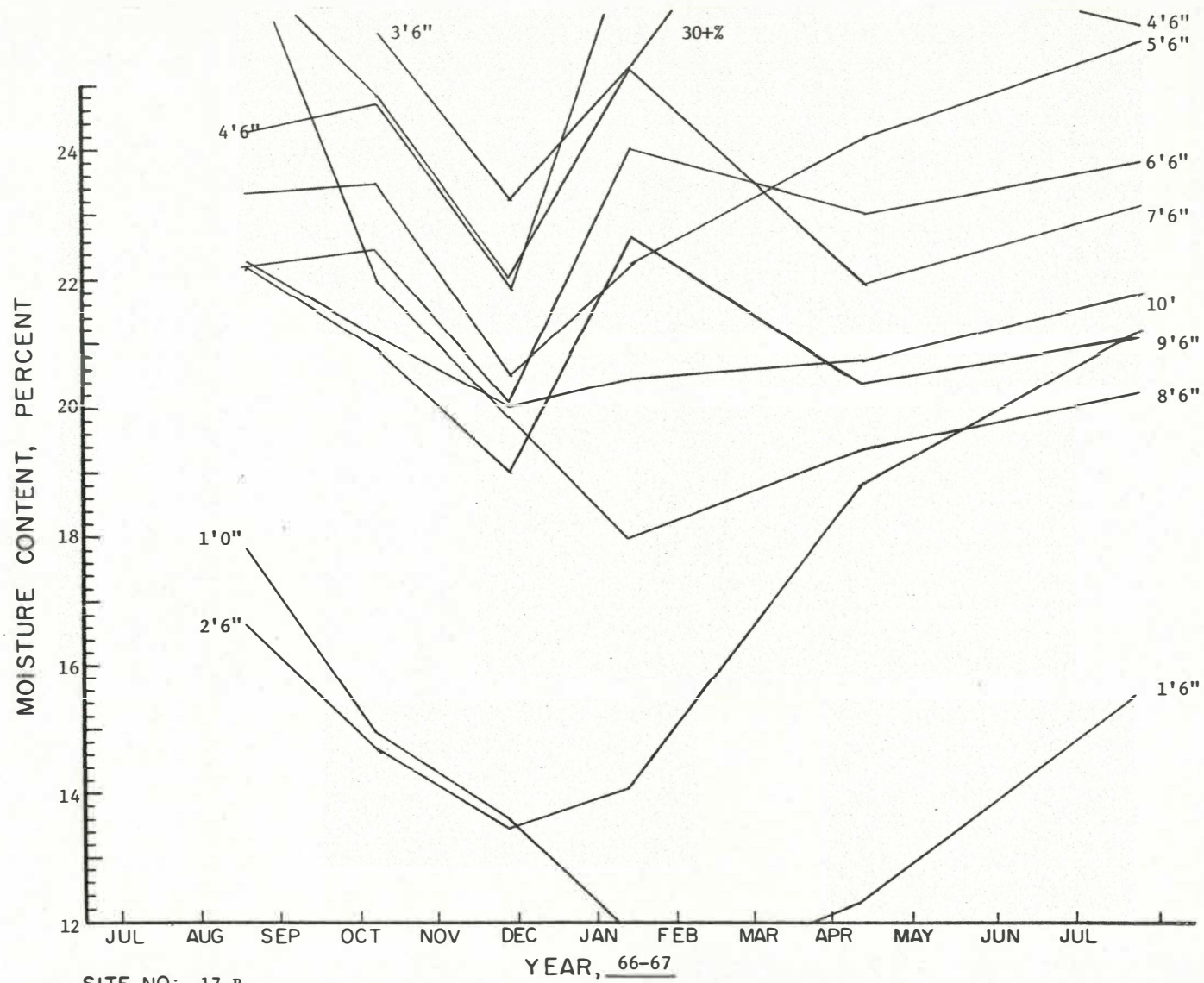
SITE NO: 17
COUNTY : Ottawa
HIGHWAY: US 69

SUBGRADE MOISTURE VARIATIONS PROJECT



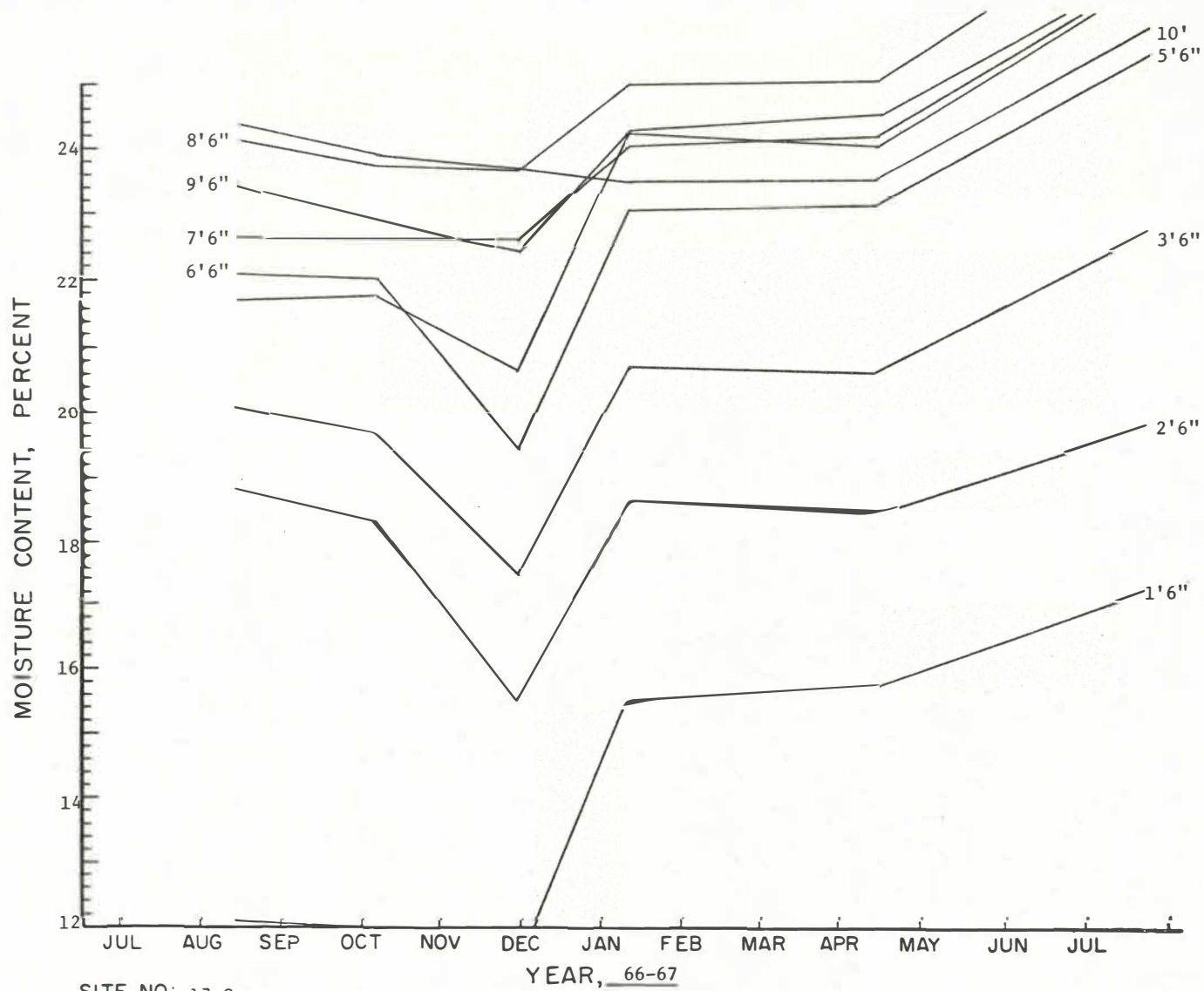
SITE NO: 17-A
 COUNTY: Ottawa
 HIGHWAY: US 69

SUBGRADE MOISTURE VARIATIONS PROJECT



SITE NO: 17-B
 COUNTY: Ottawa
 HIGHWAY: US 69

SUBGRADE MOISTURE VARIATIONS PROJECT



SITE NO: 17-C

COUNTY: Ottawa

HIGHWAY: US 69

SUBGRADE MOISTURE VARIATIONS PROJECT

SCHOOL OF CIVIL ENGINEERING
OKLAHOMA STATE UNIVERSITY

SUBGRADE MOISTURE VARIATIONS RESEARCH PROJECT

SUBGRADE SOIL DRY DENSITY TABULATION

Date of Measurement	August 1966			January 1967			August 1967		
Site & Hole Number	17-A	17-B	17-C	17-A	17-B	17-C	17-A	17-B	17-C
Depth from top of tube to bottom of probe									
1 ft 6 in.	122.60	90.38	136.17	89.57	124.85	110.26		102.34	102.27
2 ft 0 in.							90.54		
2 ft 6 in.	106.36	113.04	103.26	118.46	109.65	105.94		103.05	98.60
3 ft 0 in.							106.18		
3 ft 6 in.	88.20	86.50	100.66	89.83	89.91	101.14		82.26	93.20
4 ft 0 in.							94.40		
4 ft 6 in.	84.45	89.08	85.05	93.09	89.91	90.33		91.62	82.13
5 ft 0 in.							87.33		
5 ft 6 in.	91.35	93.87	96.26	97.37	98.49	100.20		94.58	92.08
6 ft 0 in.							86.48		
6 ft 6 in.	95.71	95.46	100.93	100.32	101.85	101.41		97.44	92.53
7 ft 0 in.							92.10		
7 ft 6 in.	96.77	92.85	103.14	95.20	104.63	101.68		99.99	93.20
8 ft 0 in.							91.43		
8 ft 6 in.	101.35	96.71	101.36	108.08	112.94	100.28		107.08	91.39
9 ft 0 in.							95.24		
9 ft 6 in.	104.52	104.40	103.05	113.48	110.06	101.82		105.05	94.31
10 ft 0 in.	101.77	104.18	101.77	111.14	110.37	102.44	104.23	101.81	93.85

Note: All density values reported in units of lb per cu ft

SITE NO. 18

SCHOOL OF CIVIL ENGINEERING
OKLAHOMA STATE UNIVERSITY
Stillwater, Oklahoma
SUBGRADE MOISTURE VARIATION STUDY
SITE INSTALLATION INFORMATION

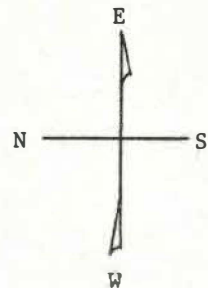
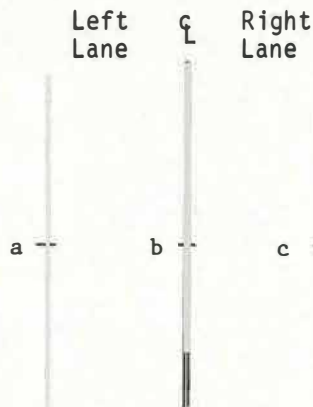
Installation: Cherokee U.S. 62 18 Date: 20 7 66
County Highway No. day month year

Location of site: South-southwest of Tahlequah, 1.0 miles southwest on
U.S. 62 from intersection of U.S. 62 and St. 82, 0.6 miles southwest of
Sequoyah Cherokee Seminary.

Description of Terrain and Vegetation: Pavement on rolling upland terrain

Boring Plan:

Hole Depth:
a. 10'
b. 8' 6"
c. 7' 6"



Roadway Characteristics:

Pavement: Type P.C. Concrete
Width 12' Thickness 8"
Condition Good
Shoulders: Type Sealed asphalt Width 10'
Condition Good

Base Course Characteristics Sand

SITE NO. 19

SCHOOL OF CIVIL ENGINEERING
OKLAHOMA STATE UNIVERSITY
SUBGRADE MOISTURE VARIATIONS PROJECT
TEST SITE DATA SUMMARY SHEET

LOCATION DATA:

Site No. 19 Highway No. US 69 County: Wagoner Date Installed: 7/21/66

Distance from access tube to Lane ℓ : 19' 6" a, 6" b, 19' 6" c

Exact Location:

In Wagoner County north of Wagoner, 3.9 miles north on US 69 from jct. US 69 and S 51. 100 yds south of east-west powerline crossing. Marker on east fence row.

PAVEMENT/DESIGN DATA:

No. of Lanes: 2 Pavement Type: AC/PCC Shoulder Type: Improved

Pavement Thickness: 10 in. ℓ , 8" in. Edge Latest Pavement Condition Rating: V.Good

Latest Traffic Count: 5100 vpd Heavy Truck Traffic: Yes

Terrain: Upland Drainage: Good Year of Original Paving: 1947

Original Design and History:

In 1947, 24 ft width, ℓ 6 in. PCC to 9 in. PCC at 12 ft lt and rt; in 1966, ℓ to 12 ft rt and lt: 3.5 in. AC overlay; also in 1966, 12 ft to 20 ft lt and rt: 8 in. black base.

FIELD OBSERVATIONS BY RESEARCH PERSONNEL:

8/16/66 - Protective cover of hole "b" regROUTED.

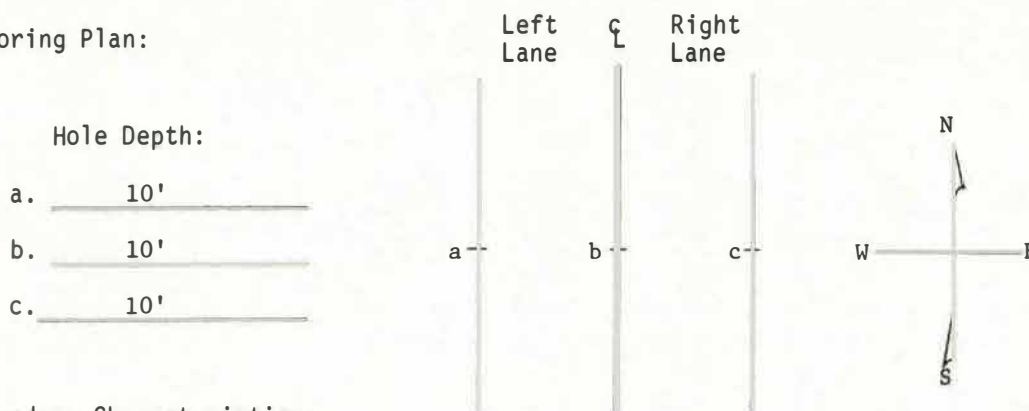
SCHOOL OF CIVIL ENGINEERING
OKLAHOMA STATE UNIVERSITY
Stillwater, Oklahoma
SUBGRADE MOISTURE VARIATION STUDY
SITE INSTALLATION INFORMATION

Installation: Wagoner U.S. 69 19 Date: 21 7 66
County Highway No. day month year

Location of site: North of Wagoner, 3.9 miles north, on U.S. 69 from inter-
section of U.S. 69 and St. 51, 100 yards south of east-west power line
crossing.

Description of Terrain and Vegetation: Pavement on rolling pasture upland
terrain; soil consists of very fine silty material

Boring Plan:



Roadway Characteristics:

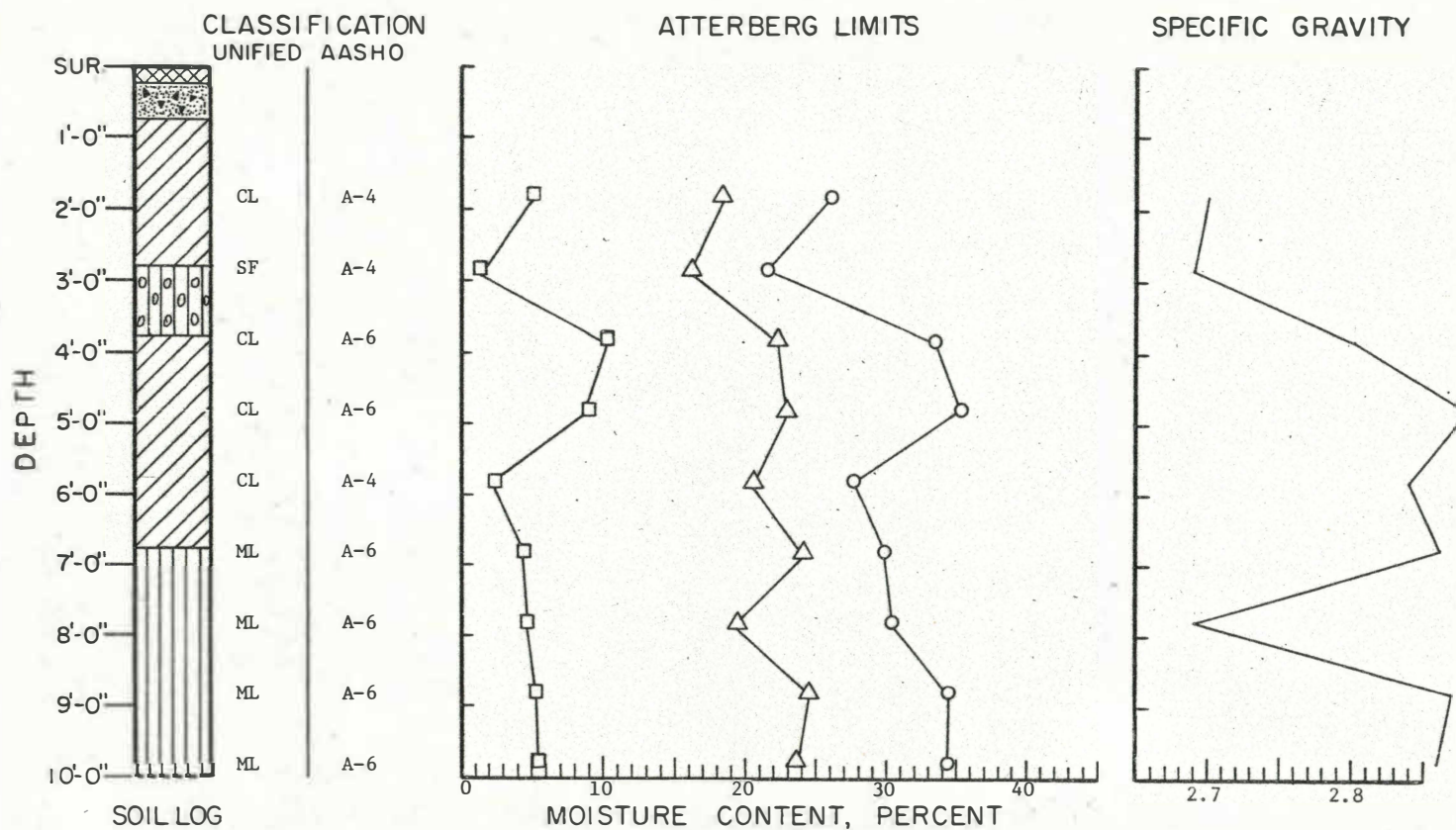
Pavement: Type Asphalt Concrete overlaying P.C. Concrete
Width 24' Thickness 3"-AC - 7"-PC
Condition Very good

Shoulders: Type Sealed asphalt Width 8'
Condition Very good

Base Course Characteristics Sand

SITE NO: 19
 COUNTY: Wagoner
 HIGHWAY: US 69

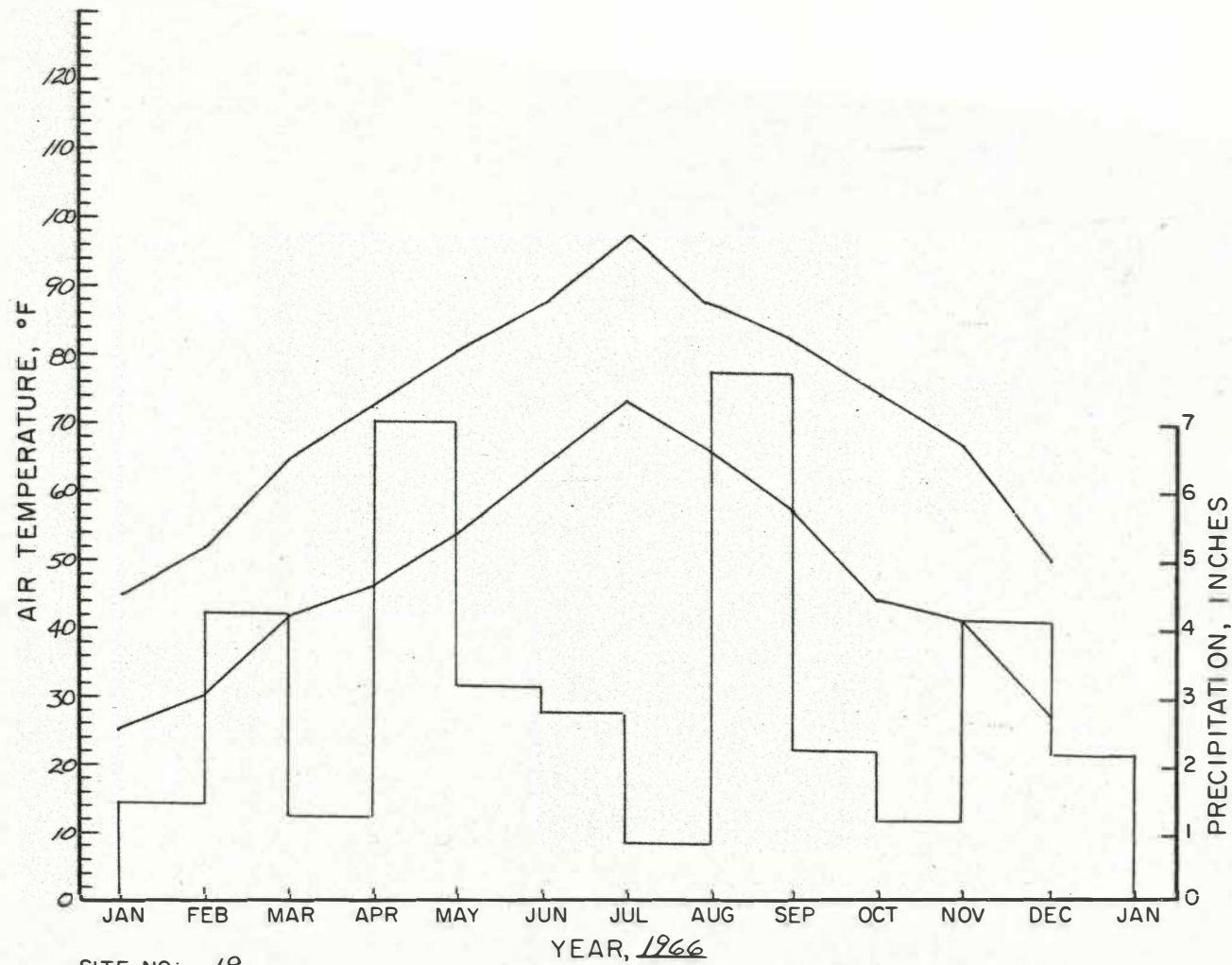
● LIQUID LIMIT
 ▲ PLASTIC LIMIT
 ■ LINEAL SHRINKAGE



DATE: 5 December 1967

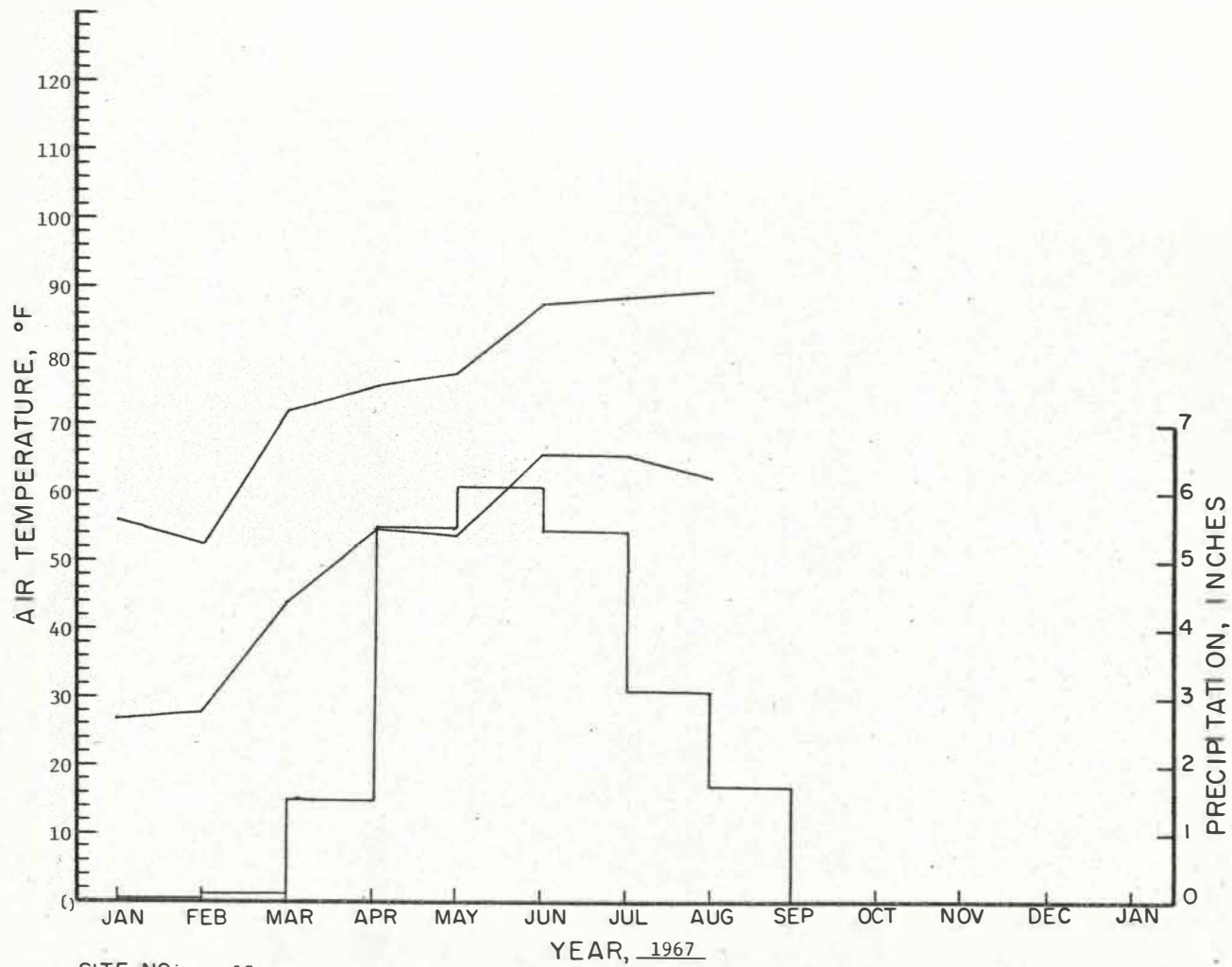
PLOTTED BY: AAP

SUBGRADE MOISTURE VARIATIONS PROJECT



SITE NO: 19
COUNTY: WAGNER
HIGHWAY: U.S. 69

SUBGRADE MOISTURE VARIATIONS PROJECT

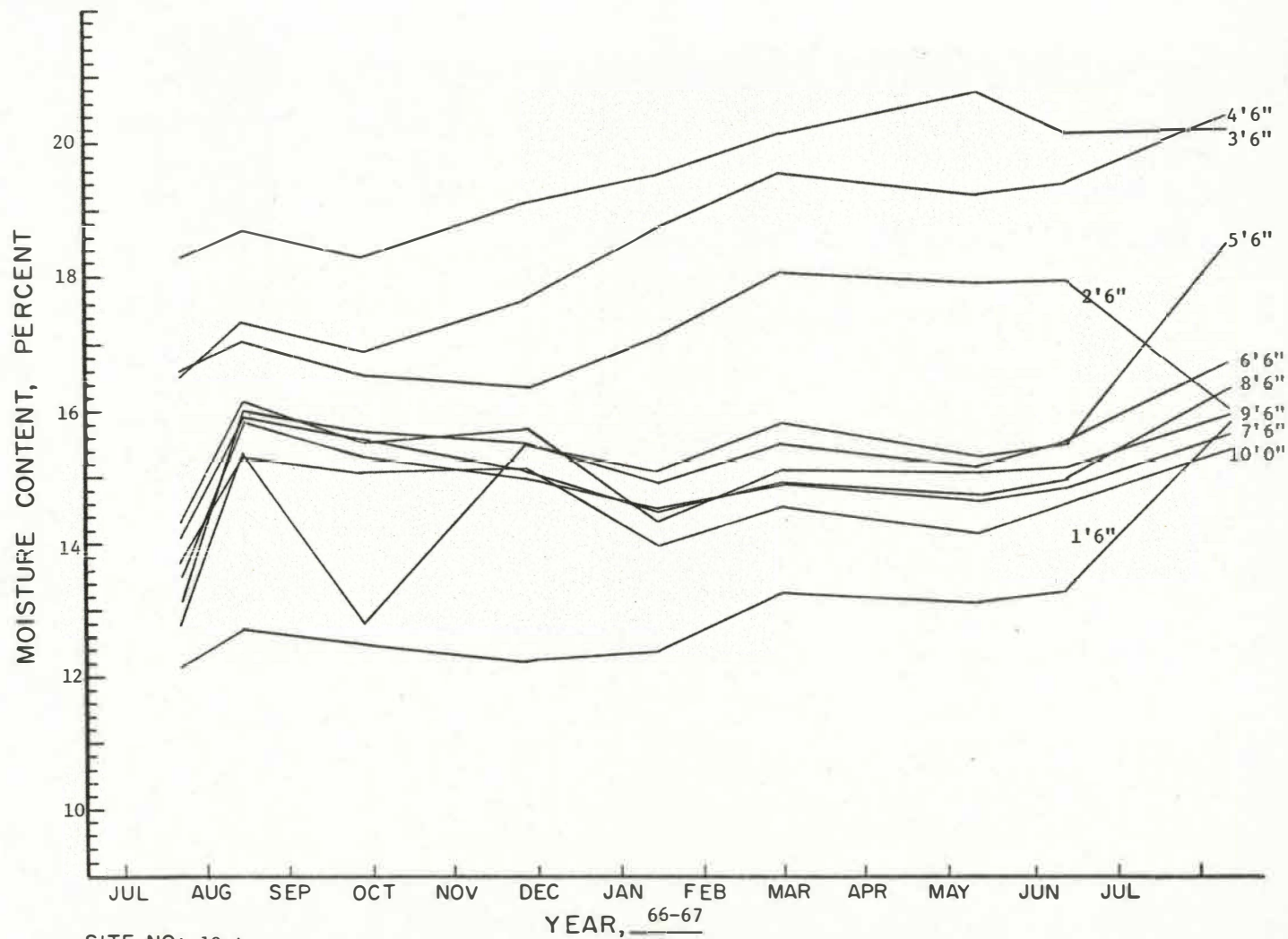


SITE NO: 19

COUNTY: Wagoner

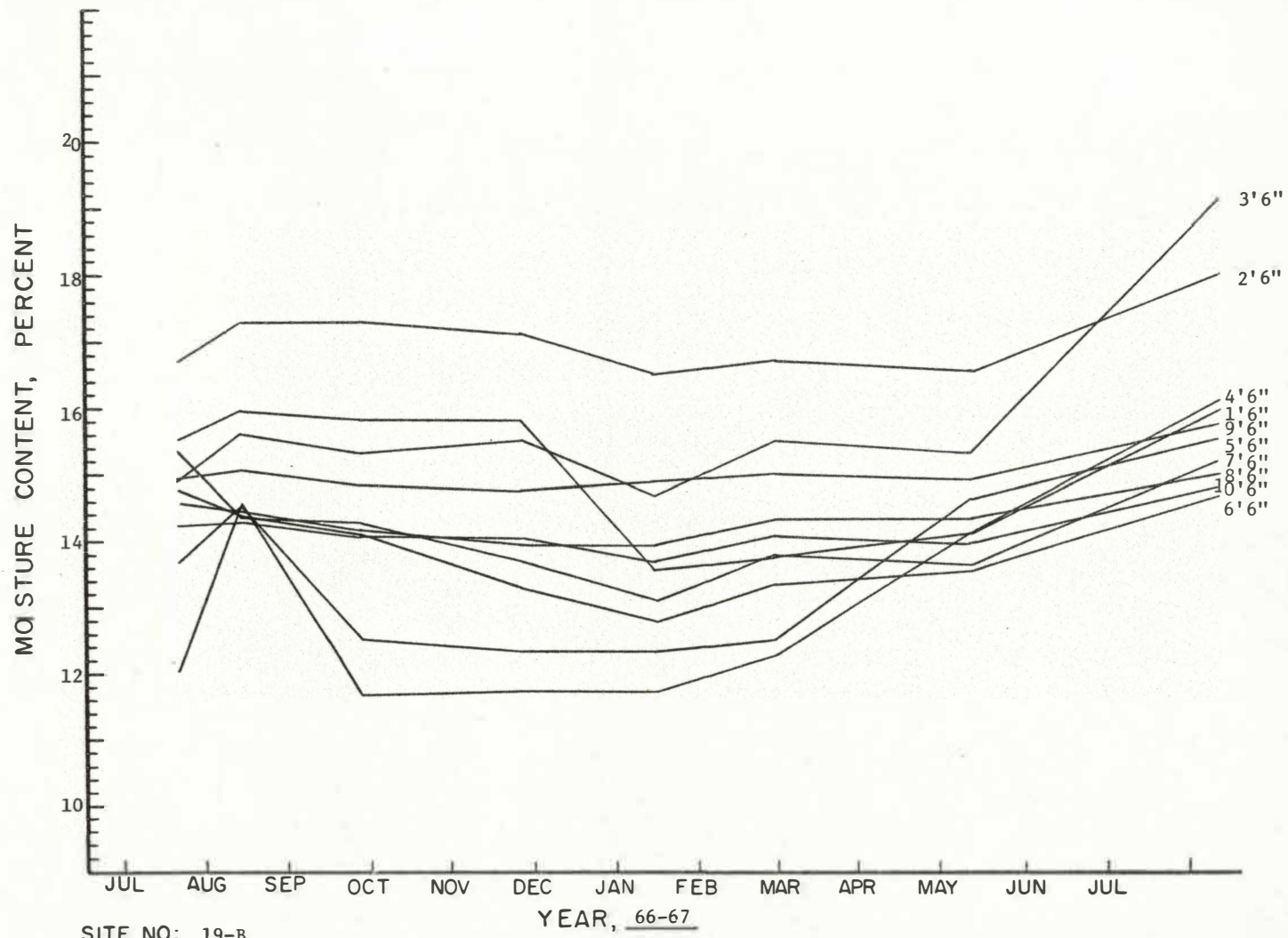
HIGHWAY: US 69

SUBGRADE MOISTURE VARIATIONS PROJECT



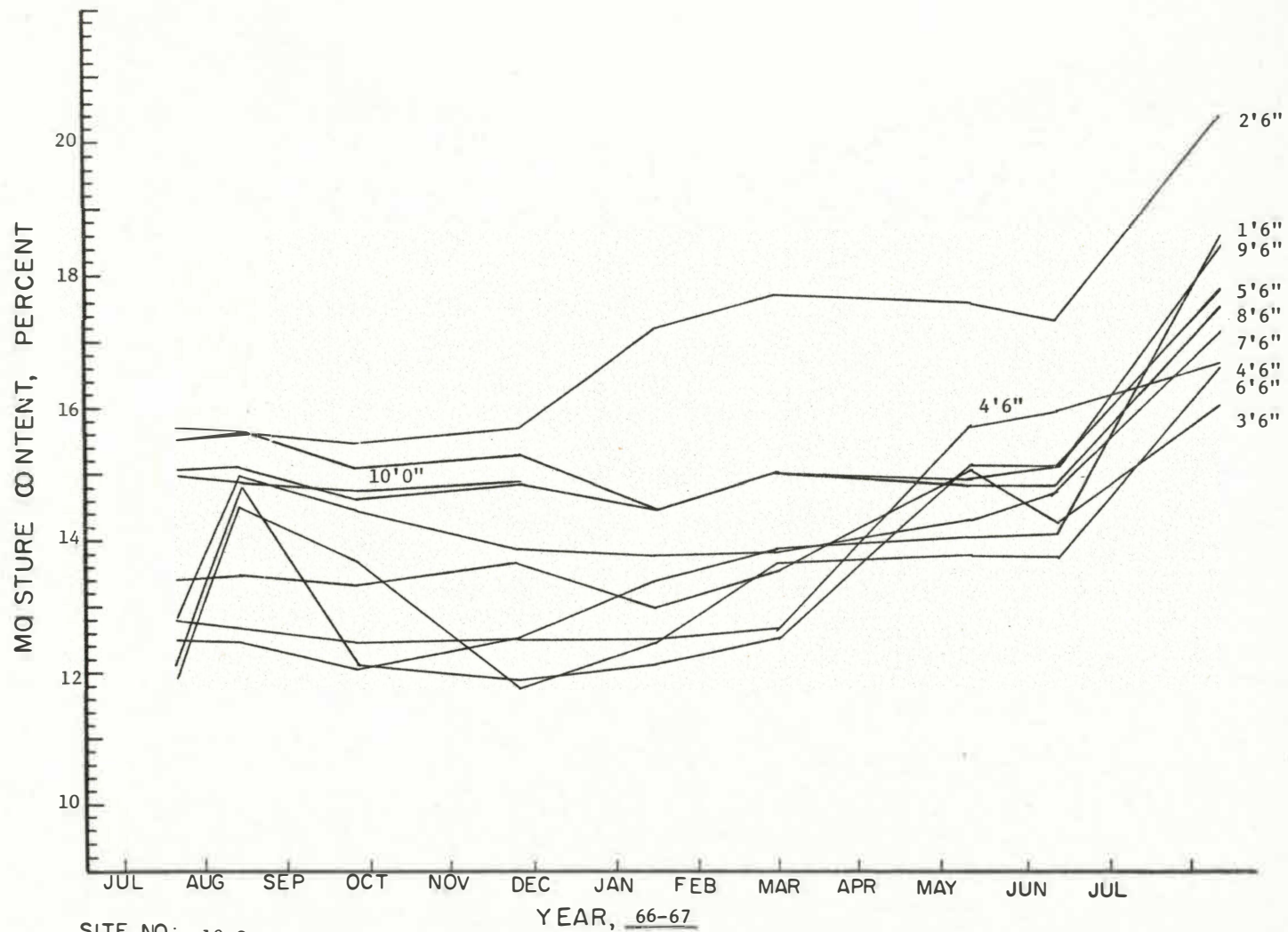
SITE NO: 19-A
COUNTY: Wagoner
HIGHWAY: US 69

SUBGRADE MOISTURE VARIATIONS PROJECT



SITE NO: 19-B
 COUNTY: Wagoner
 HIGHWAY: US 69

SUBGRADE MOISTURE VARIATIONS PROJECT



SITE NO: 19-c
 COUNTY: Wagoner
 HIGHWAY: US 69

SUBGRADE MOISTURE VARIATIONS PROJECT

SCHOOL OF CIVIL ENGINEERING
OKLAHOMA STATE UNIVERSITY

SUBGRADE MOISTURE VARIATIONS RESEARCH PROJECT

SUBGRADE SOIL DRY DENSITY TABULATION

Date of Measurement	August 1966			January 1967			August 1967		
Site & Hole Number	19-A	19-B	19-C	19-A	19-B	19-C	19-A	19-B	19-C
Depth from top of tube to bottom of probe									
1 ft 6 in.	139.44	116.54	130.15	147.74	137.66	135.49	121.76	118.83	
2 ft 0 in.									101.73
2 ft 6 in.	104.70	111.17	104.95	105.78	114.76	105.74	116.78	106.58	
3 ft 0 in.									87.87
3 ft 6 in.	102.31	111.74	116.77	103.09	112.03	120.25	100.98	102.11	
4 ft 0 in.									100.76
4 ft 6 in.	103.97	125.66	123.83	106.09	123.51	121.45	98.15	114.57	
5 ft 0 in.									99.11
5 ft 6 in.	122.46	125.81	123.52	122.41	122.58	121.21	102.55	115.41	
6 ft 0 in.									102.32
6 ft 6 in.	120.81	123.90	127.19	123.75	127.20	125.44	114.65	117.34	
7 ft 0 in.									104.81
7 ft 6 in.	119.54	123.75	124.40	123.37	128.68	126.44	115.75	116.53	
8 ft 0 in.									104.19
8 ft 6 in.	119.73	125.89	121.49	126.01	126.06	124.78	117.36	117.56	
9 ft 0 in.									102.37
9 ft 6 in.	117.42	125.18	123.05	123.51	125.34	122.07	115.67	116.30	
10 ft 0 in.	118.84	125.41	122.07	124.81	127.14		116.99	116.91	99.57

Note: All density values reported in units of lb per cu ft

SITE NO. 20

SCHOOL OF CIVIL ENGINEERING
OKLAHOMA STATE UNIVERSITY
SUBGRADE MOISTURE VARIATIONS PROJECT
TEST SITE DATA SUMMARY SHEET

LOCATION DATA:

Site No. 20 Highway No. S 51 County: Tulsa Date Installed: 8/3/66'

Distance from access tube to Lane ℓ : 22' 6" a, 6" b, 16' 6" c

Exact Location:

In Tulsa County northwest of Broken Arrow, 0.5 mile northwest of S 51 (Broken Arrow Expressway) from Lynn Lane overpass and exit. Site in north lane of divided highway, north of unusual church. Marker on north fence row.

PAVEMENT/DESIGN DATA:

No. of Lanes: 4D Pavement Type: AC Shoulder Type: Improved

Pavement Thickness: 12 in. ℓ , 8 in. Edge Latest Pavement Condition Rating: V. Good to Excellent

Latest Traffic Count: 12,800 vpd Heavy Truck Traffic: Yes

Terrain: Upland Drainage: Good Year of Original Paving: 1964

Original Design and History:

24 ft width, ℓ to 12 ft lt and rt: 4.5 in. AC surface/7 in. hot mix blackbase/6 in. lime stabilization; inside 12 ft to 16 ft and outside 12 ft to 22 ft: double bituminous surface over 13 in. select subbase.

FIELD OBSERVATIONS BY RESEARCH PERSONNEL:

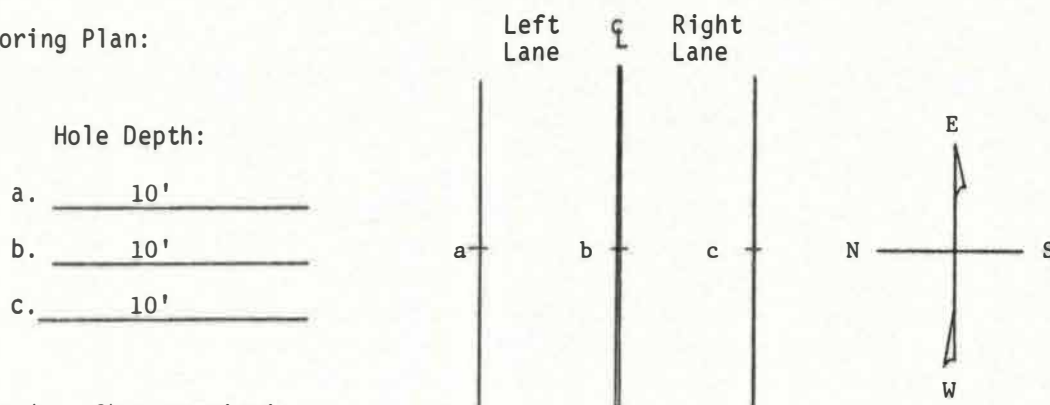
SCHOOL OF CIVIL ENGINEERING
OKLAHOMA STATE UNIVERSITY
Stillwater, Oklahoma
SUBGRADE MOISTURE VARIATION STUDY
SITE INSTALLATION INFORMATION

Installation: Tulsa St. 51 20 Date: 3 8 66
County Highway No. day month year

Location of site: Northwest of Broken Arrow, 0.5 miles northwest on St. 51
(Broken Arrow Expressway) from Lynn Lane overpass and exit, site in north
lane of divided highway, north of unusual church.

Description of Terrain and Vegetation: Pavement on rolling upland terrain

Boring Plan:



Roadway Characteristics:

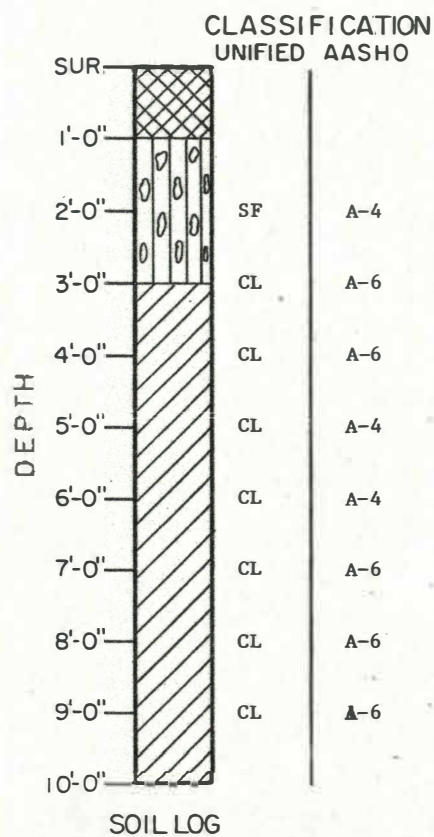
Pavement: Type Asphaltic Concrete
Width 25' Thickness 12"
Condition Good to Excellent

Shoulders: Type Asphaltic Concrete Width R-4' L-11'
Condition Good to Excellent

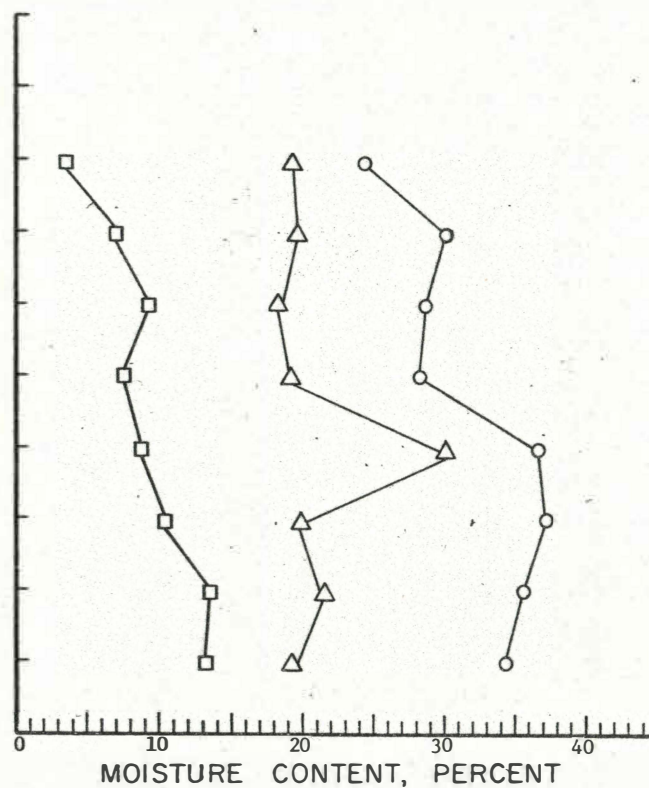
Base Course Characteristics Select Gravel

SITE NO.: 20
 COUNTY : Tulsa
 HIGHWAY: State 51

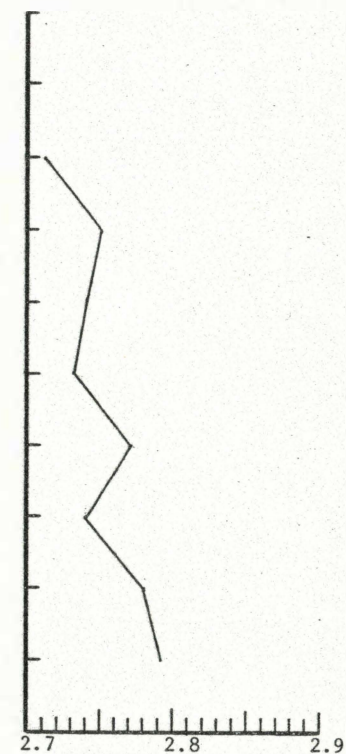
● LIQUID LIMIT
 ▲ PLASTIC LIMIT
 ■ LINEAL SHRINKAGE



ATTERBERG LIMITS

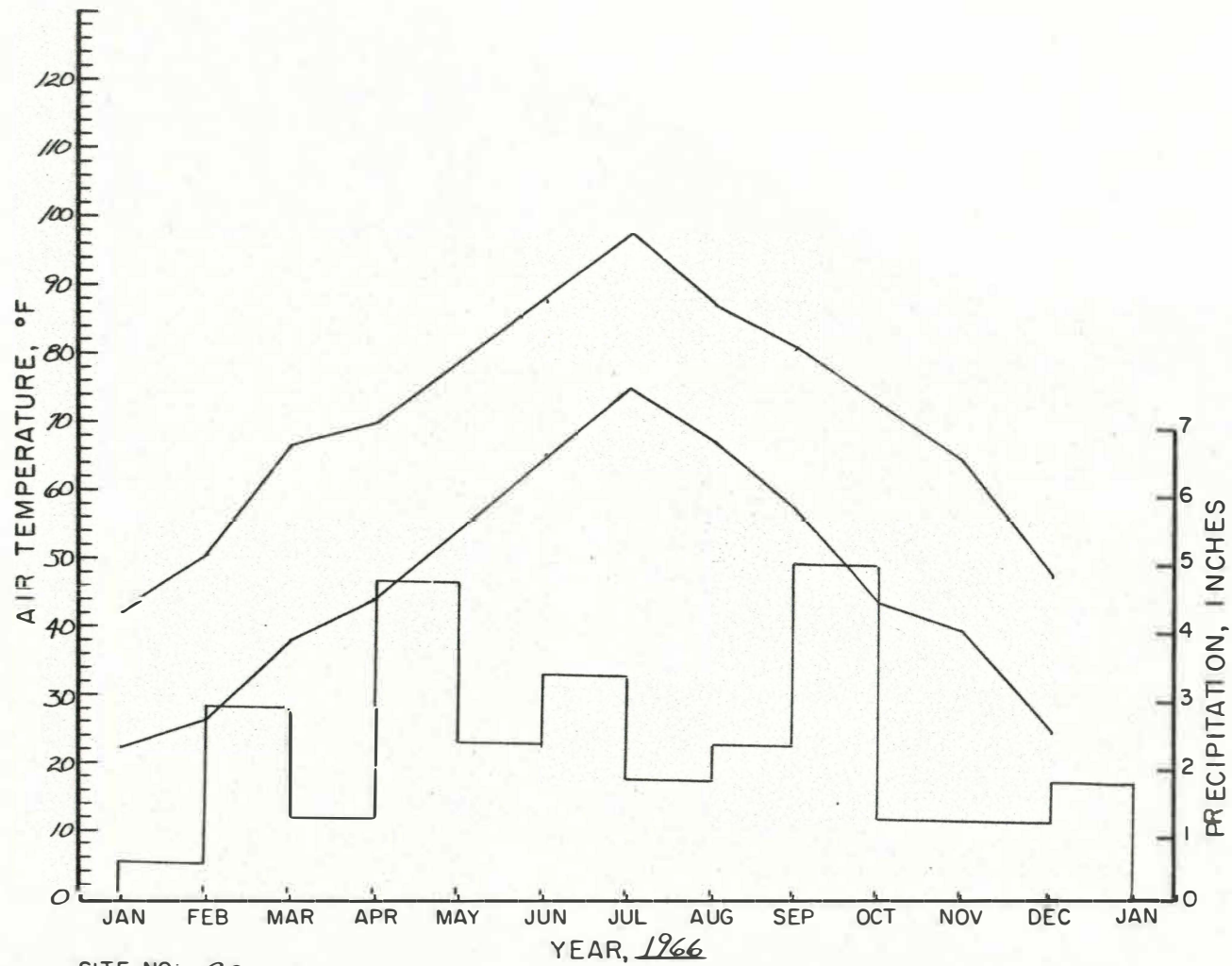


SPECIFIC GRAVITY



DATE : 7 December 1967
 PLOTTED BY: AAP

SUBGRADE MOISTURE VARIATIONS PROJECT

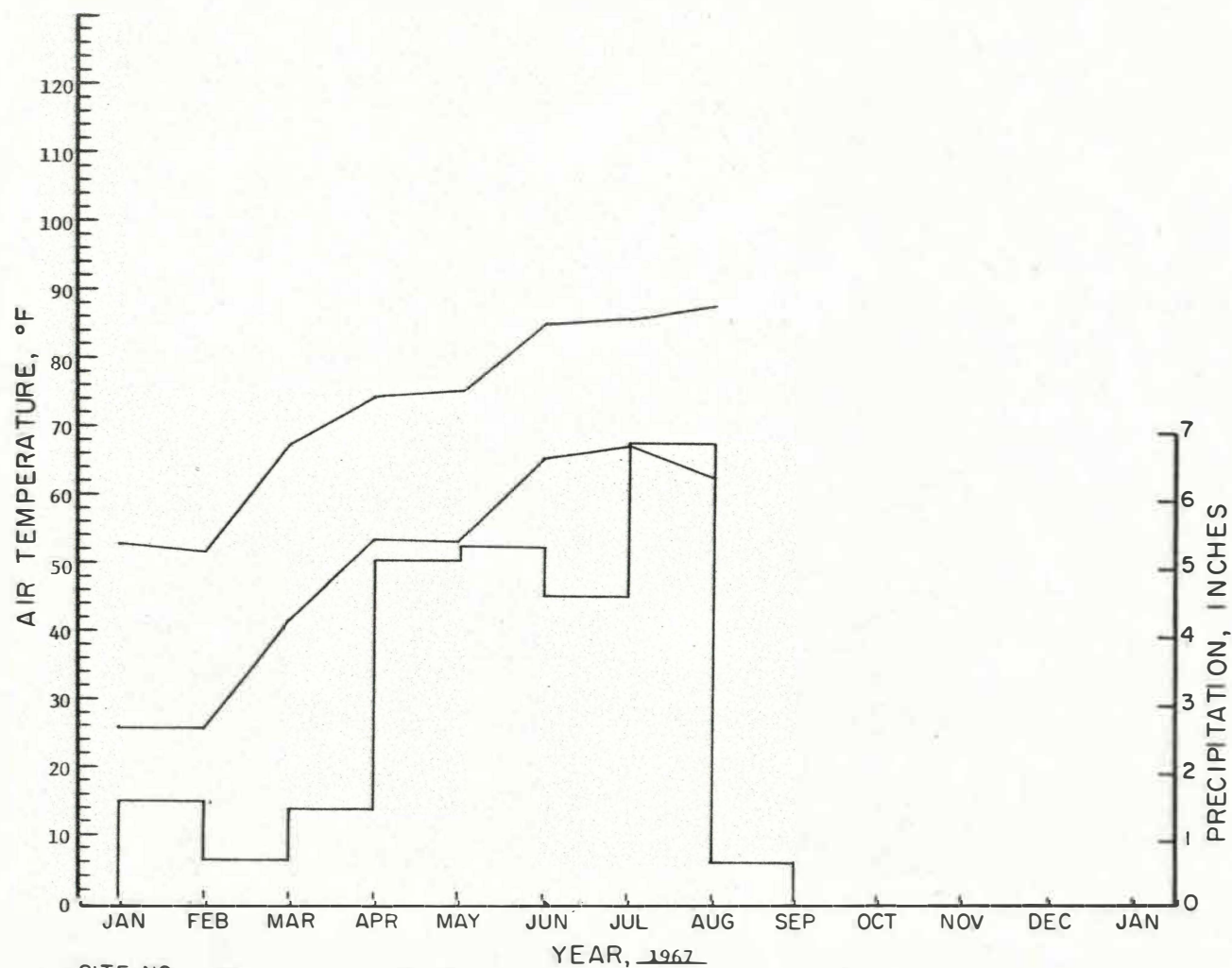


SITE NO: 20

COUNTY: TULSA

HIGHWAY: SH51

SUBGRADE MOISTURE VARIATIONS PROJECT

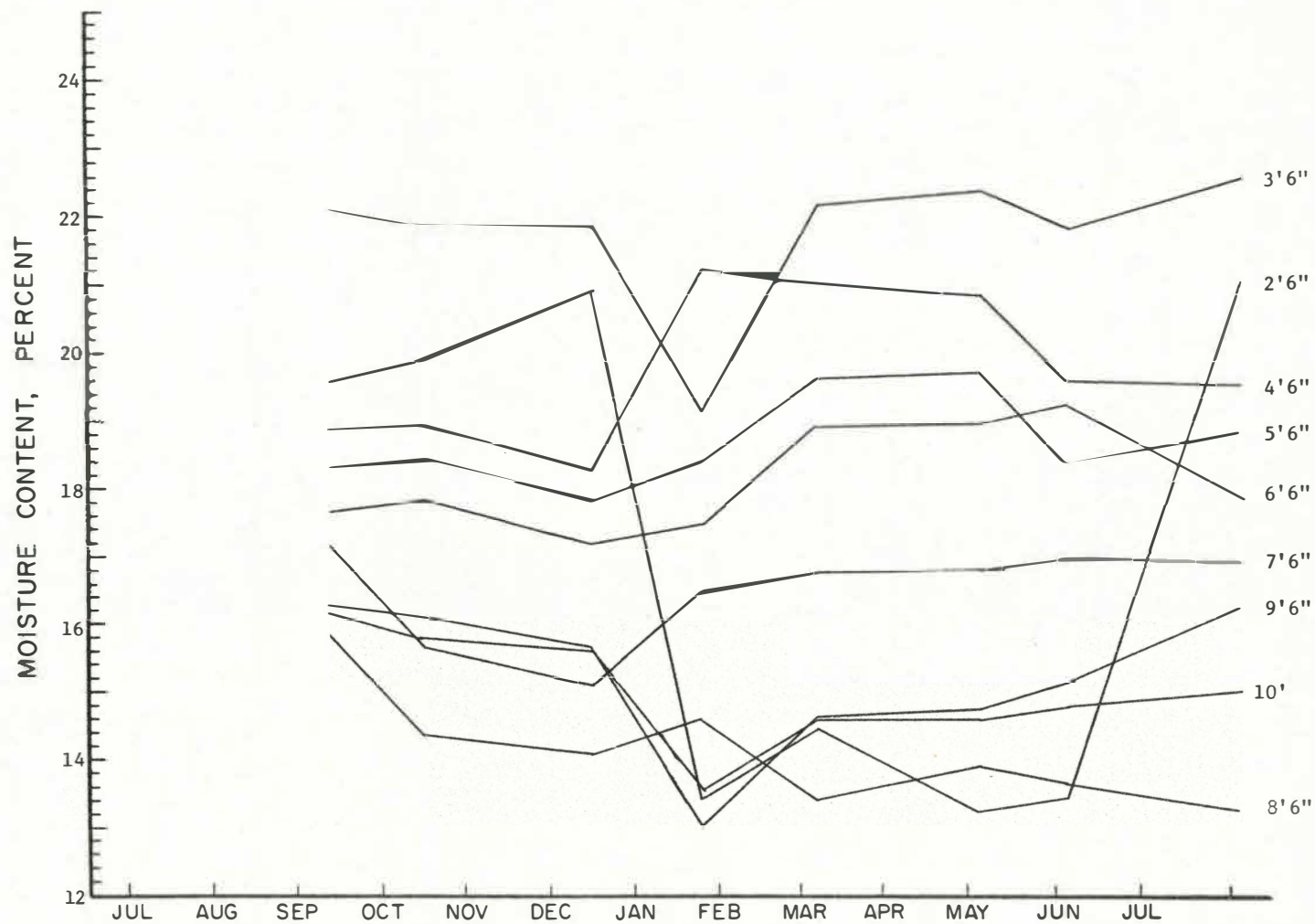


SITE NO: 20

COUNTY: Tulsa

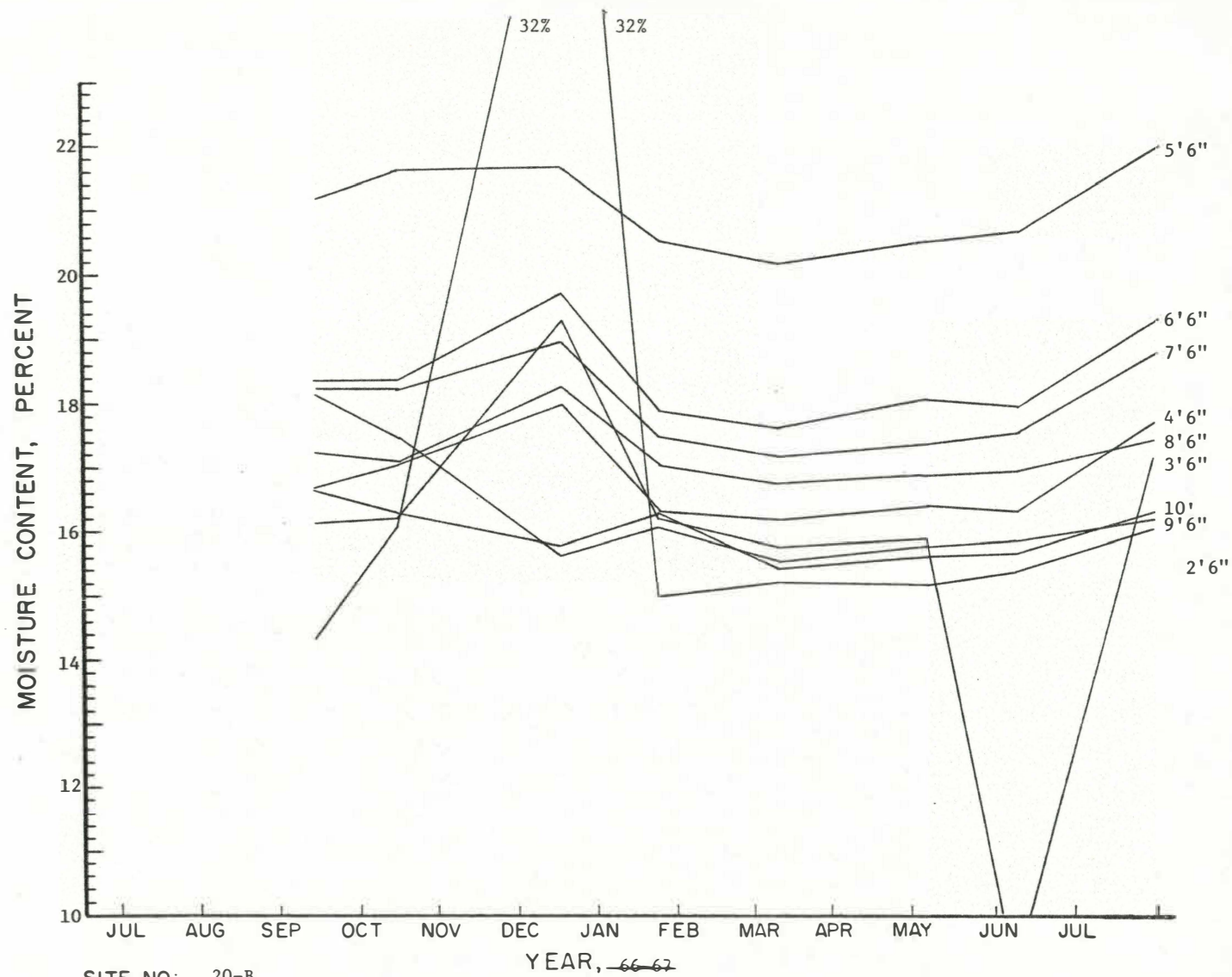
HIGHWAY: SH 51

SUBGRADE MOISTURE VARIATIONS PROJECT



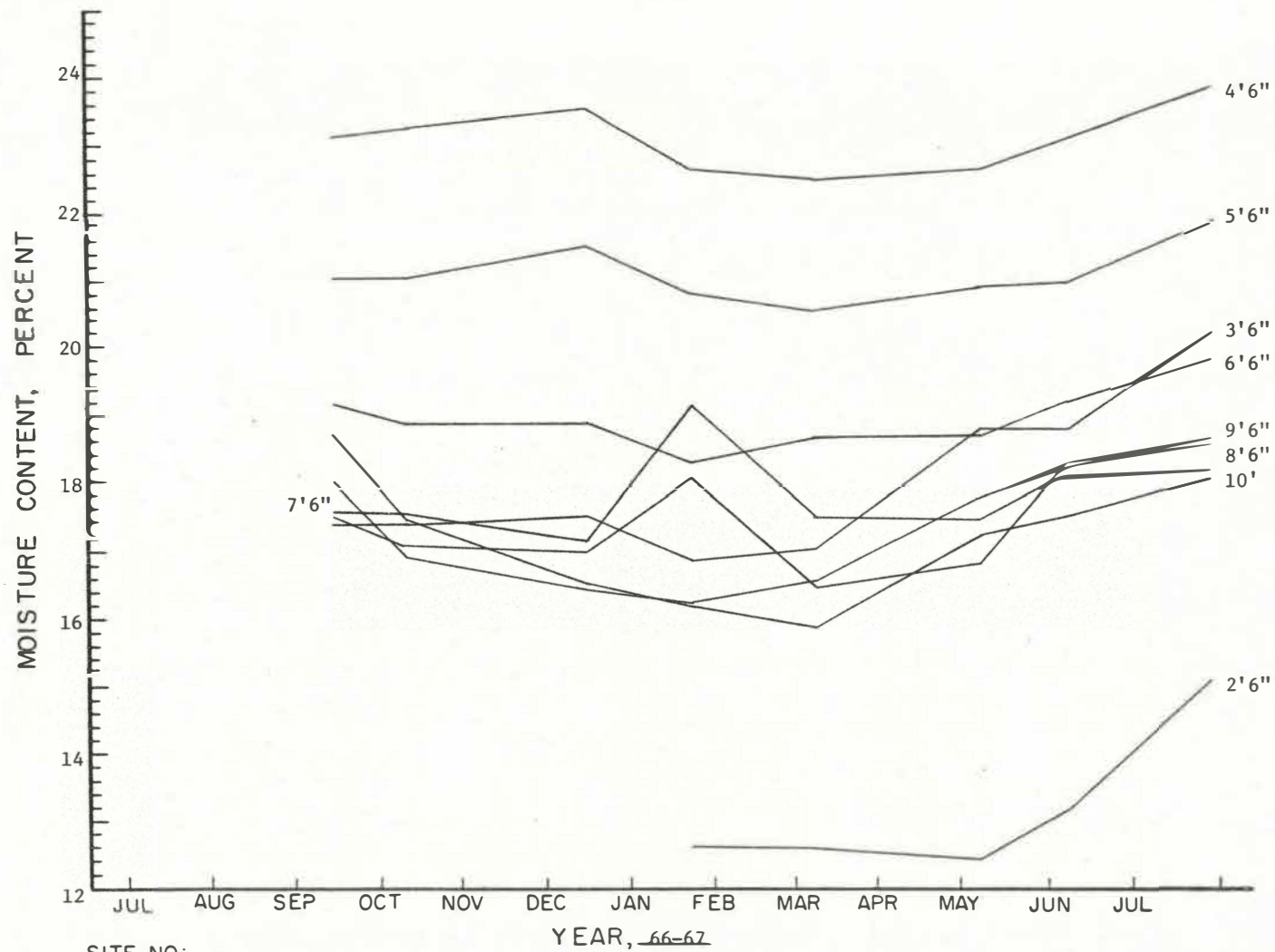
SITE NO: 20-A
 COUNTY: Tulsa
 HIGHWAY: St 51

SUBGRADE MOISTURE VARIATIONS PROJECT



SITE NO: 20-B
 COUNTY: Tulsa
 HIGHWAY: St 51

SUBGRADE MOISTURE VARIATIONS PROJECT



SITE NO: 20-C
 COUNTY: Tulsa
 HIGHWAY: St 51

SUBGRADE MOISTURE VARIATIONS PROJECT

SCHOOL OF CIVIL ENGINEERING
OKLAHOMA STATE UNIVERSITY

SUBGRADE MOISTURE VARIATIONS RESEARCH PROJECT

SUBGRADE SOIL DRY DENSITY TABULATION

Date of Measurement	August 1966			January 1967			August 1967		
Site & Hole Number	20-A	20-B	20-C	20-A	20-B	20-C	20-A	20-B	20-C
Depth from top of tube to bottom of probe									
1 ft 6 in.					157.75	133.06	103.75	145.26	109.48
2 ft 0 in.				150.66					
2 ft 6 in.	99.16	101.27	101.28		104.00	103.38	96.63	97.87	96.54
3 ft 0 in.				102.78					
3 ft 6 in.	98.81	105.93	99.51		107.94	102.06	96.39	101.84	95.17
4 ft 0 in.				102.55					
4 ft 6 in.	103.35	103.47	95.61		106.36	98.20	101.25	100.28	93.47
5 ft 0 in.				105.40					
5 ft 6 in.	104.90	95.95	100.72		98.69	102.37	103.33	92.62	97.00
6 ft 0 in.				108.72					
6 ft 6 in.	105.45	99.72	101.81		101.46	104.27	105.18	94.69	98.77
7 ft 0 in.				110.16					
7 ft 6 in.	106.96	100.41	107.87		103.74	107.69	110.80	97.44	104.68
8 ft 0 in.				114.34					
8 ft 6 in.	113.66	105.43	106.85		108.19	108.64	116.71	102.07	103.55
9 ft 0 in.				123.20					
9 ft 6 in.	112.43	110.92	113.10		111.62	113.89	115.15	105.95	108.60
10 ft 0 in.	111.19	115.28	111.52	120.78	115.10	114.11	116.01	109.08	109.95

Note: All density values reported in units of lb per cu ft

SITE NO. 21

SCHOOL OF CIVIL ENGINEERING
OKLAHOMA STATE UNIVERSITY
SUBGRADE MOISTURE VARIATIONS PROJECT
TEST SITE DATA SUMMARY SHEET

LOCATION DATA:

Site No. 21 Highway No. US 81 County: Garfield Date Installed: 9/7/66

Distance from access tube to Lane ℓ: 11' 0" a, 1' 0" b, 20' 0" c

Exact Location:

In Garfield County on the northwest edge of Enid, 100 yds north of Atwood's Farm and Home store on US 81. Marker on west fence row.

PAVEMENT/DESIGN DATA:

No. of Lanes: 4D Pavement Type: PCC Shoulder Type: Improved

Pavement Thickness: 8 in.ℓ, 1 in.Edge Latest Pavement Condition Rating: Good

Latest Traffic Count: 2500 vpd Heavy Truck Traffic: Yes

Terrain: Upland Drainage: Fair Year of Original Paving: 1959

Original Design and History:

24 ft width; ℓ to 12 ft rt and lt: 8 in. PCC over 8 in. sand cushion; inside 12 ft to 15 ft and outside 12 ft to 22 ft: 1 in. sealed shoulders over 8 in. SABC .

FIELD OBSERVATIONS BY RESEARCH PERSONNEL:

9/7/66 - Access tube "b" is only 9 ft 6 in. long.

SCHOOL OF CIVIL ENGINEERING
OKLAHOMA STATE UNIVERSITY
Stillwater, Oklahoma
SUBGRADE MOISTURE VARIATION STUDY
SITE INSTALLATION INFORMATION

Installation: Garfield U.S. 81 21 Date: 7 9 66
County Highway No. day month year

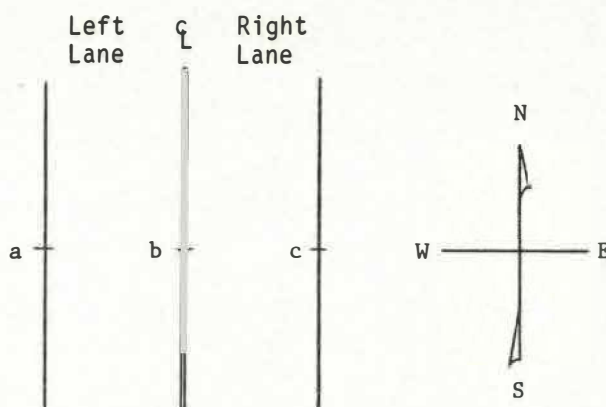
Location of site: On the Northwest edge of Enid, 100 yards north of Atwood's
Farm and Home Supply Store on U.S. 81

Description of Terrain and Vegetation: Pavement on upland terrain

Boring Plan:

Hole Depth:

- a. 10'
b. 10'
c. 10'



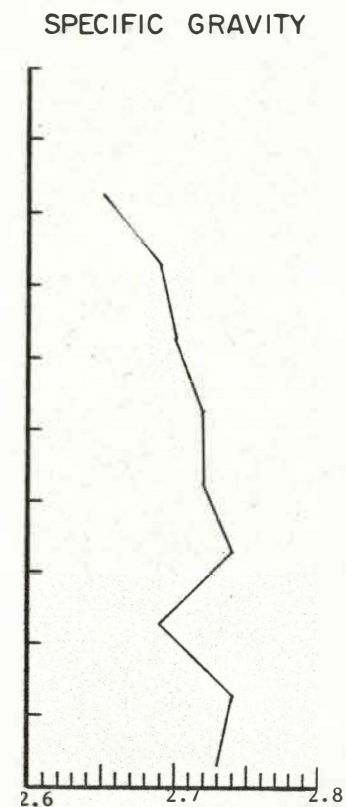
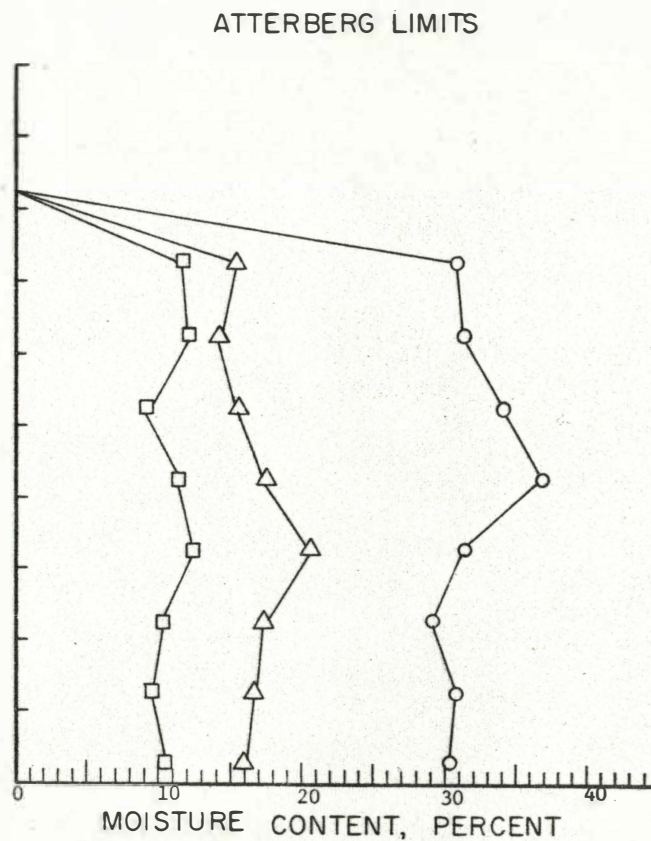
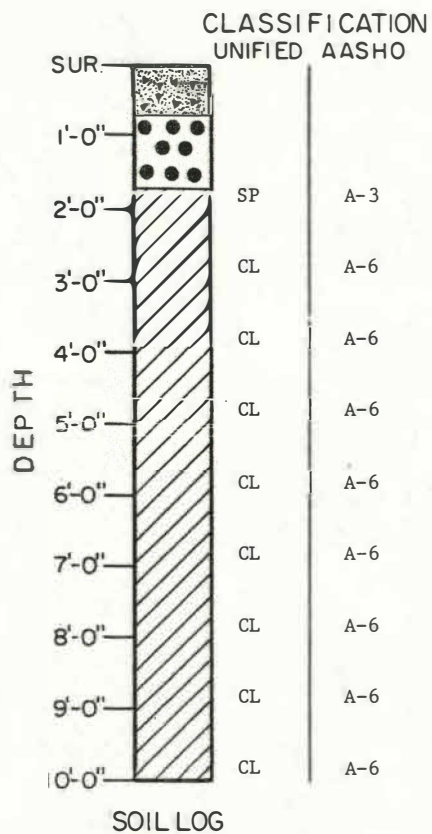
Roadway Characteristics:

Pavement: Type P.C. Concrete
Width 24' Thickness 8"
Condition Good
Shoulders: Type Sealed Asphalt Width 10'
Condition Good

Base Course Characteristics Natural Sand

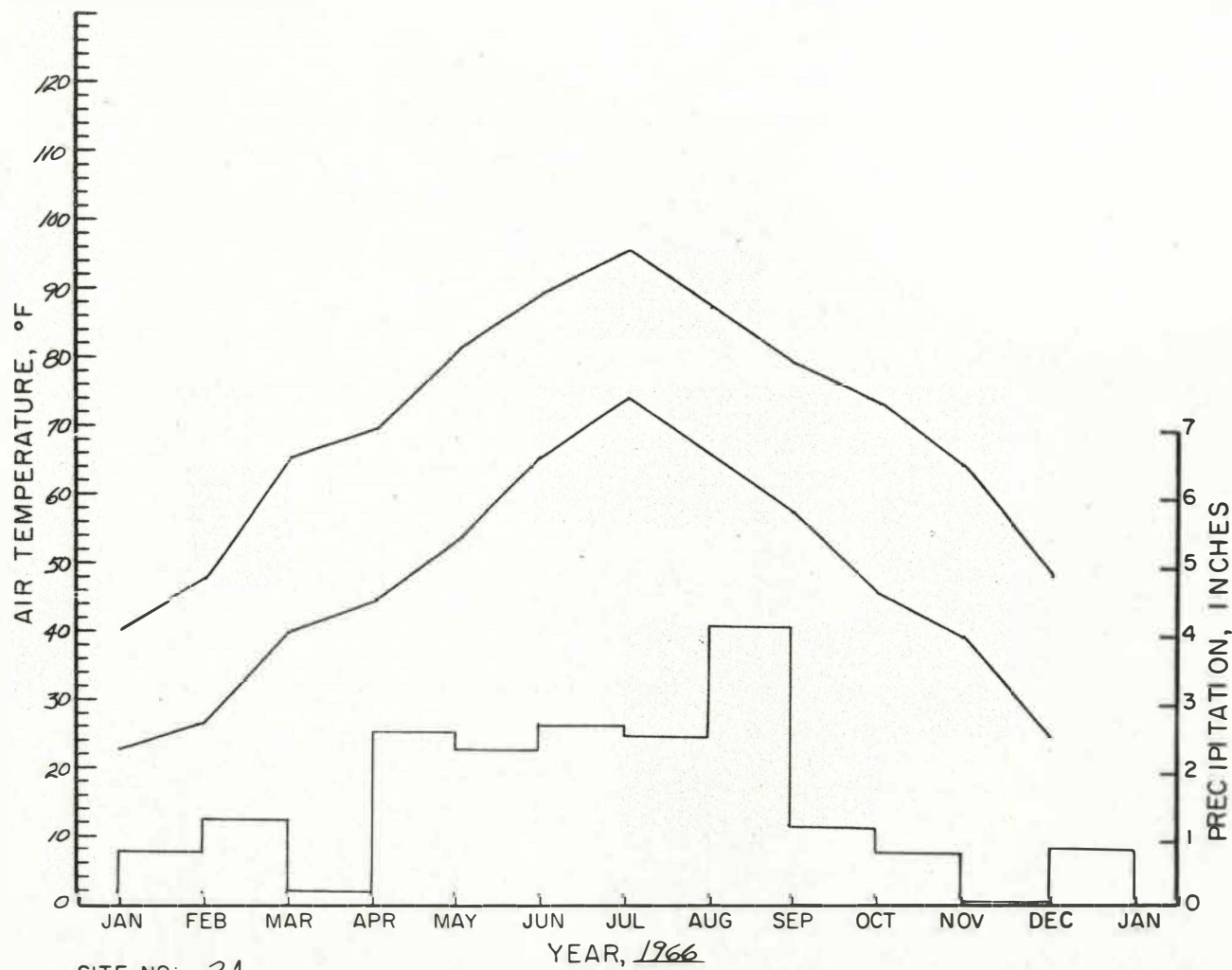
SITE NO.: 21
 COUNTY : Garfield
 HIGHWAY : US 81

● LIQUID LIMIT
 ▲ PLASTIC LIMIT
 ■ LINEAL SHRINKAGE



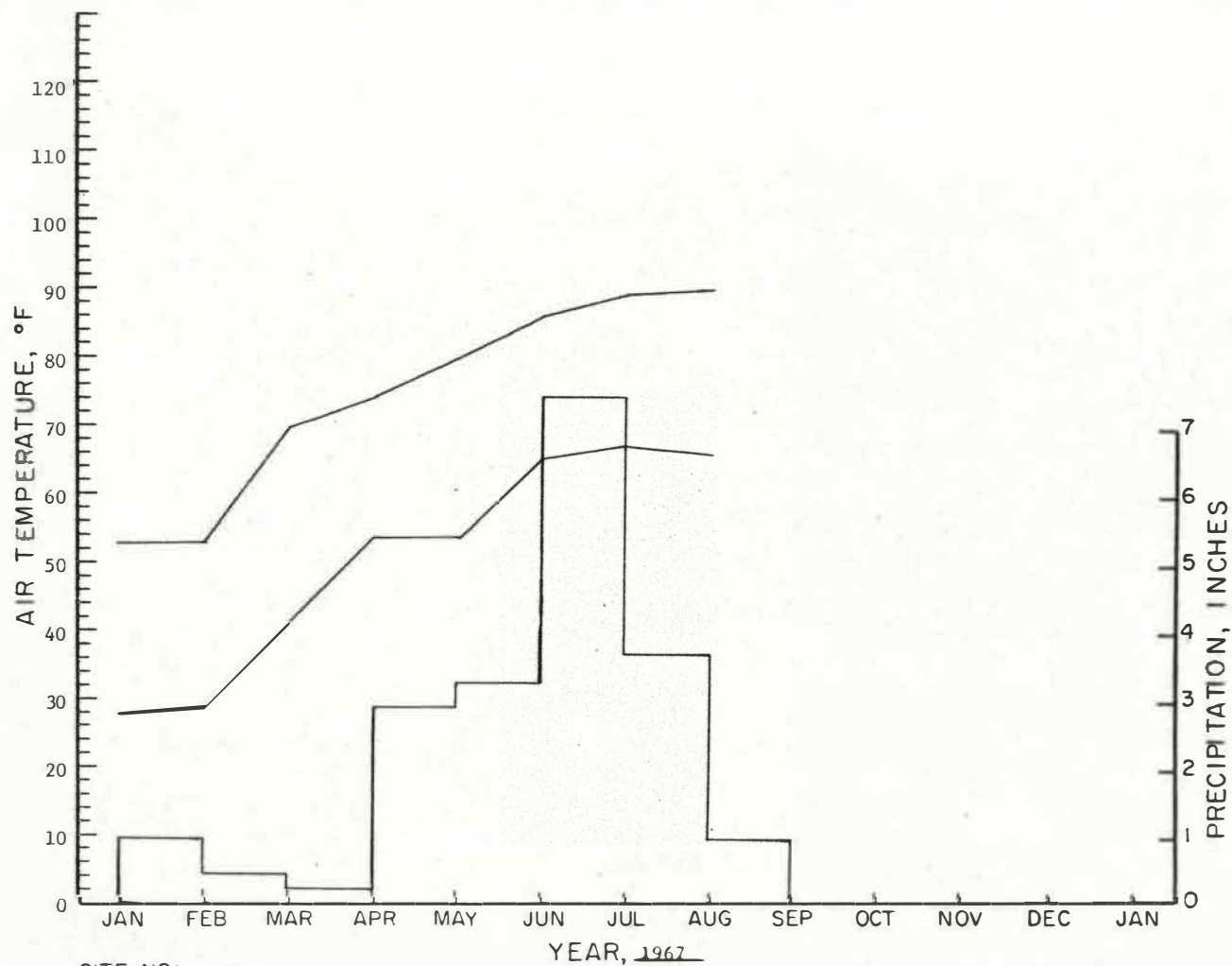
DATE : 7 December 1967
 PLOTTED BY: AAP

SUBGRADE MOISTURE VARIATIONS PROJECT



SITE NO: 21
COUNTY: Garfield
HIGHWAY: U.S. 81

SUBGRADE MOISTURE VARIATIONS PROJECT

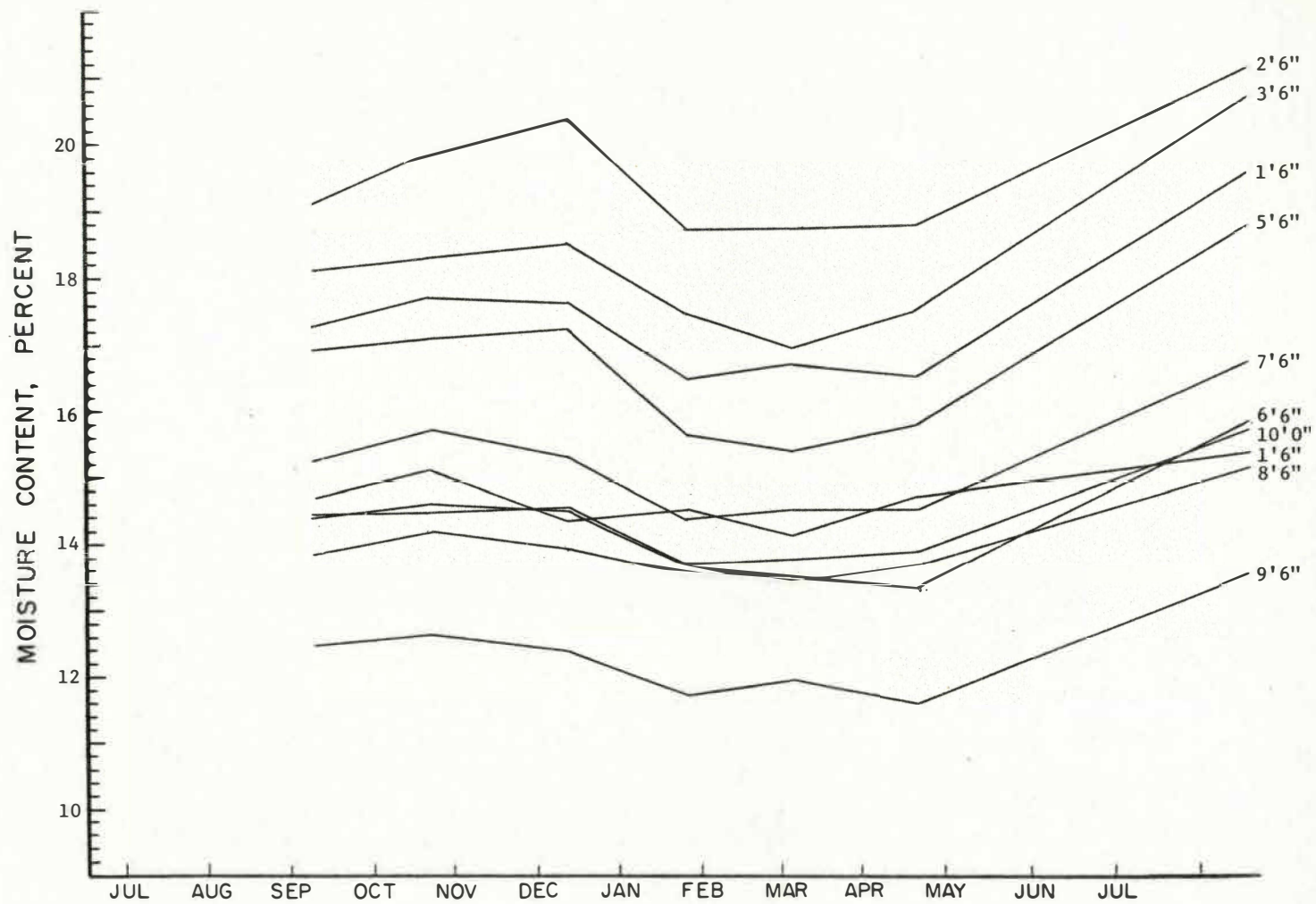


SITE NO: 21

COUNTY: Garfield

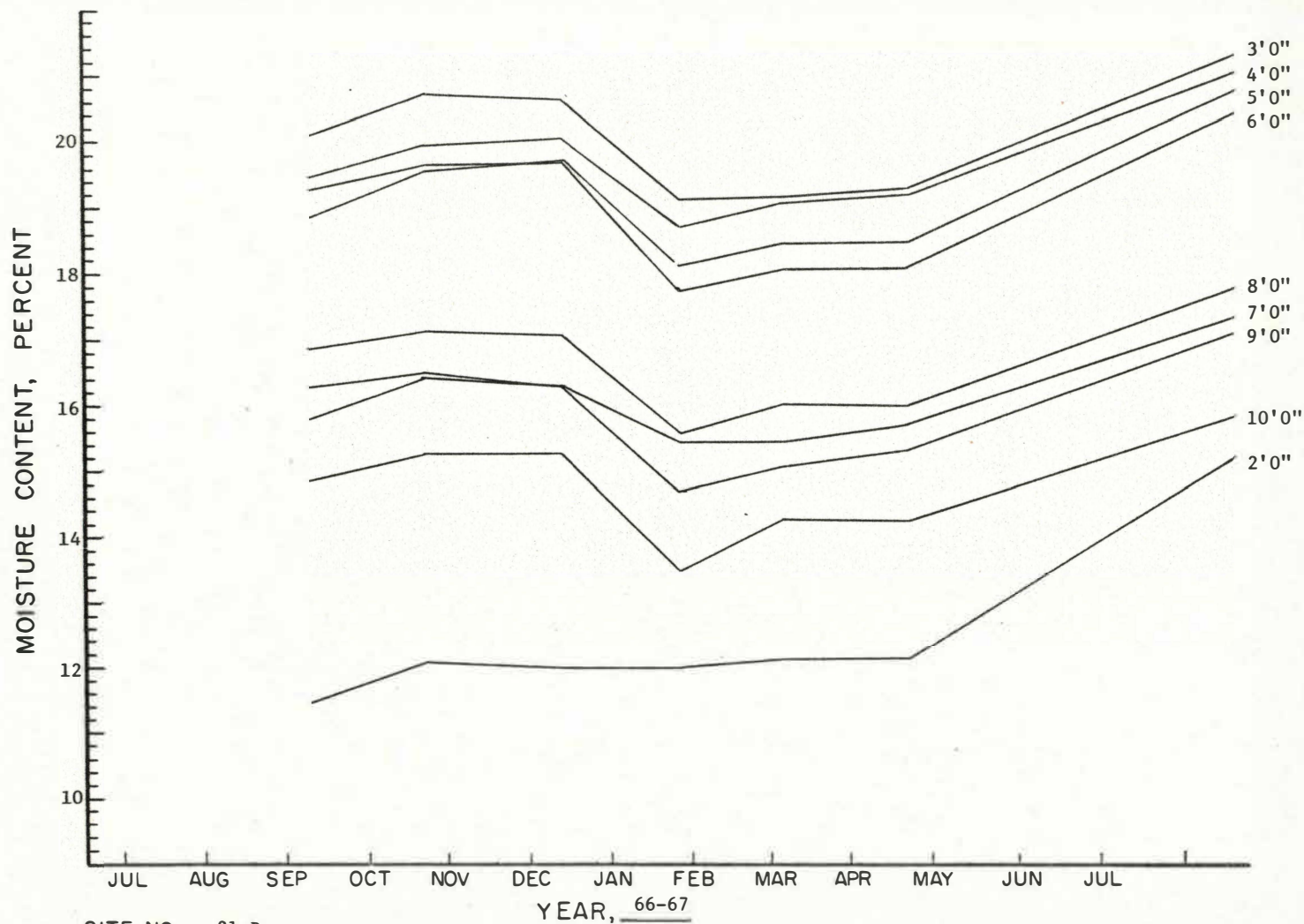
HIGHWAY: US 81

SUBGRADE MOISTURE VARIATIONS PROJECT



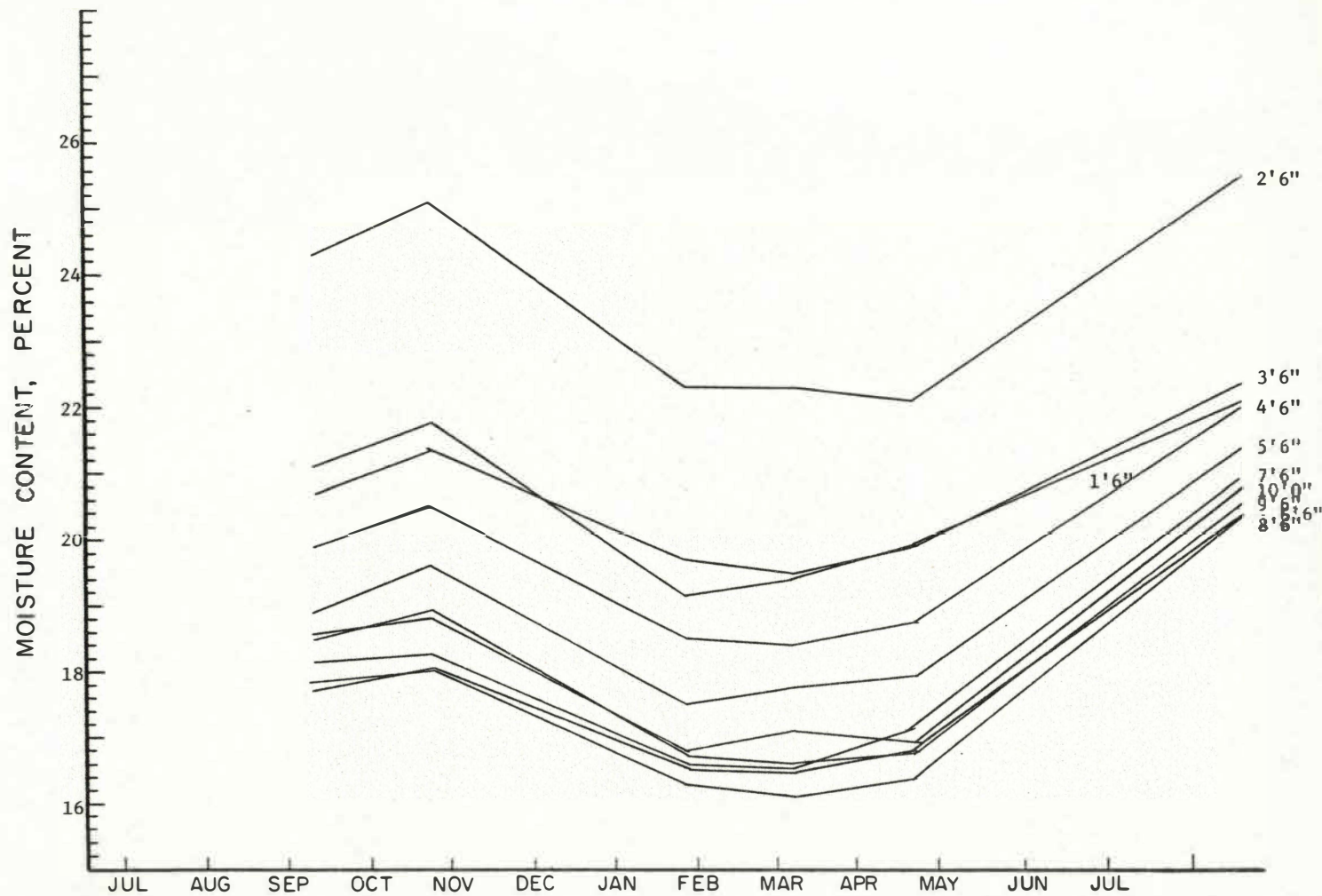
SITE NO: 21-A
COUNTY: Garfield
HIGHWAY: US 81

SUBGRADE MOISTURE VARIATIONS PROJECT



SITE NO: 21-B
 COUNTY: Garfield
 HIGHWAY: US 81

SUBGRADE MOISTURE VARIATIONS PROJECT



SITE NO: 21-C
 COUNTY: Garfield
 HIGHWAY: US 81

SUBGRADE MOISTURE VARIATIONS PROJECT

SCHOOL OF CIVIL ENGINEERING
OKLAHOMA STATE UNIVERSITY

SUBGRADE MOISTURE VARIATIONS RESEARCH PROJECT

SUBGRADE SOIL DRY DENSITY TABULATION

Date of Measurement	August 1966			January 1967			August 1967		
Site & Hole Number	21-A	21-B	21-C	21-A	21-B	21-C	21-A	21-B	21-C
Depth from top of tube to bottom of probe									
1 ft 6 in.	106.27		95.79	115.01		108.78	94.29		94.19
2 ft 0 in.		129.37			128.16			106.67	
2 ft 6 in.	95.66		87.83	102.69		99.32	92.95		87.05
3 ft 0 in.		92.89			99.42			90.52	
3 ft 6 in.	94.99		92.92	101.18		102.95	93.56		91.37
4 ft 0 in.		94.88			99.98			90.69	
4 ft 6 in.	94.94		89.24	100.03		100.30	93.14		89.12
5 ft 0 in.		93.69			98.95			88.83	
5 ft 6 in.	94.02		94.49	100.24		103.36	93.32		88.42
6 ft 0 in.		92.76			99.41			89.43	
6 ft 6 in.	106.54		97.52	112.06		106.86	103.00		88.62
7 ft 0 in.		102.57			107.21			97.43	
7 ft 6 in.	104.93		95.30	112.01		104.83	101.39		86.63
8 ft 0 in.		100.59			107.46			96.90	
8 ft 6 in.	106.06		96.08	111.14		106.24	102.48		87.47
9 ft 0 in.		101.26			108.14			98.16	
9 ft 6 in.	102.90		93.91	109.74		104.04	101.23		86.18
10 ft 0 in.	101.73	103.03	93.71	103.93	110.32	103.80	98.98	99.42	86.24

Note: All density values reported in units of lb per cu ft

SITE NO. 22

SCHOOL OF CIVIL ENGINEERING
OKLAHOMA STATE UNIVERSITY
SUBGRADE MOISTURE VARIATIONS PROJECT
TEST SITE DATA SUMMARY SHEET

LOCATION DATA:

Site No. 22 Highway No. US 81 County: Kingfisher Date Installed: 9/8/66

Distance from access tube to Lane ℓ: 20' 6" a, 6" b, 20' 6" c

Exact Location:

In Kingfisher County south of Hennessey, 3.9 miles south on US 81 from jct. US 81 and S 51. Marker on west fence row.

PAVEMENT/DESIGN DATA:

No. of Lanes: 2 Pavement Type: AC Shoulder Type: Improved

Pavement Thickness: 6 in. ℓ, 1 in. Edge Latest Pavement Condition Rating: Fair

Latest Traffic Count: 4800 vpd Heavy Truck Traffic: Yes

Terrain: Upland/ Drainage: Good Year of Original Paving: 1924
Cut

Original Design and History:

Before 1957, 24 ft width; ℓ to 12 ft lt and rt: 4.5 in. AC/10 in. stabilized base/9 in. select subbase. In 1957, 12 ft to 21 ft lt and rt: 1 in. seal coat/4 in. stabilized base/13.5 in. select subbase.

FIELD OBSERVATIONS BY RESEARCH PERSONNEL:

SCHOOL OF CIVIL ENGINEERING
OKLAHOMA STATE UNIVERSITY
Stillwater, Oklahoma
SUBGRADE MOISTURE VARIATION STUDY
SITE INSTALLATION INFORMATION

Installation: Kingfisher U.S. 81 22 Date: 8 9 66
County Highway No. day month year

Location of site: South of Hennessey, 3.9 miles south on U.S. 81 from jct.
U.S. 81 and St. 51

Description of Terrain and Vegetation: Pavement on rolling upland terrain
in slight cut.

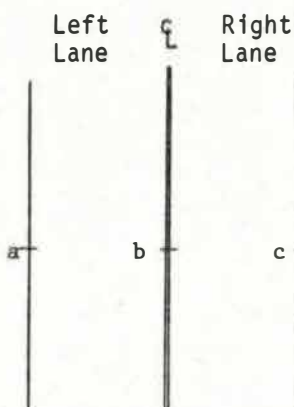
Boring Plan:

Hole Depth:

a. 10'

b. 10'

c. 10'



Roadway Characteristics:

Pavement: Type Asphalt Concrete

Width 24' Thickness 8"

Condition Fair

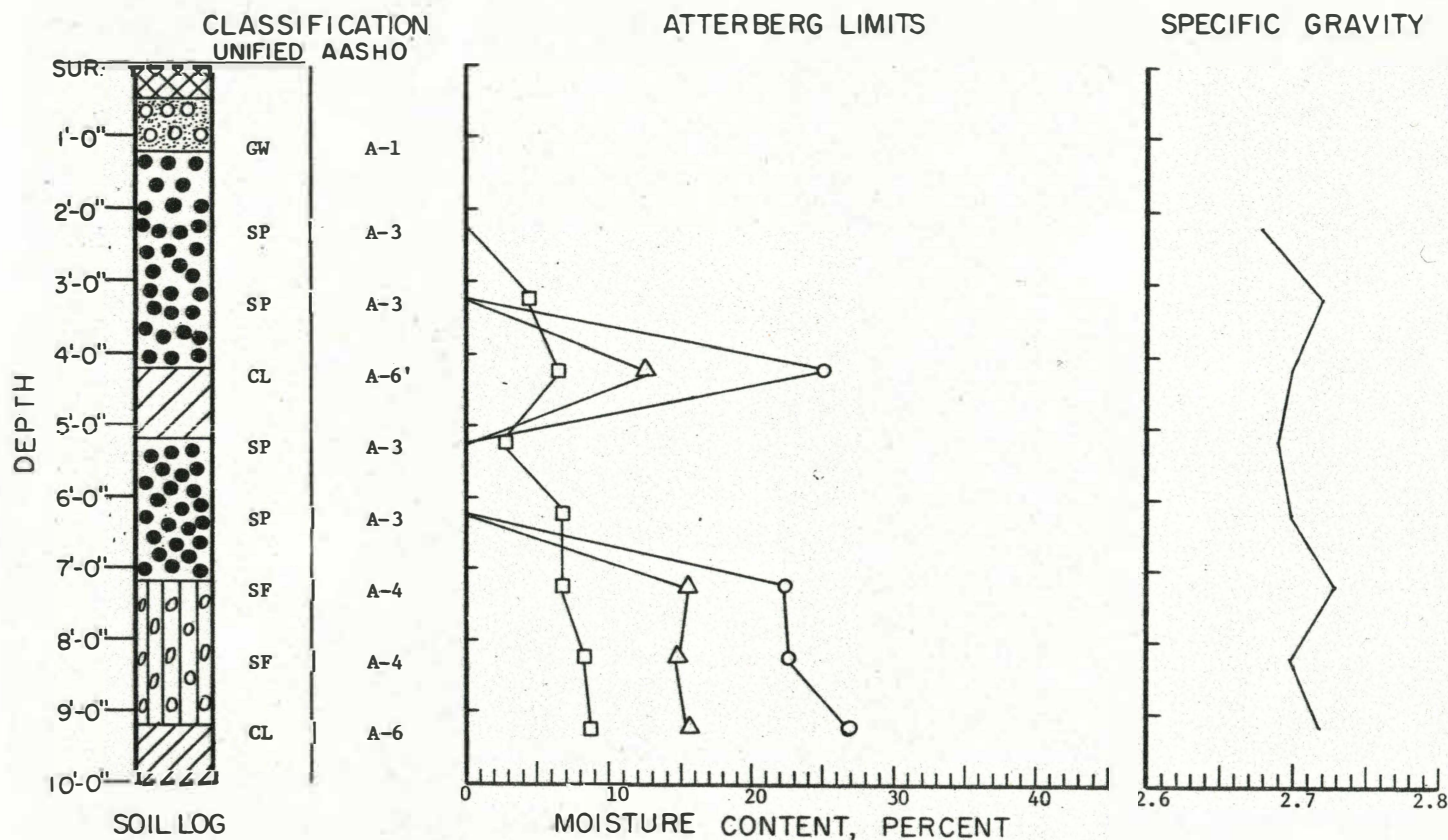
Shoulders: Type Sealed Asphalt Width 9'

Condition Poor

Base Course Characteristics Stabilized gravel

SITE NO.: 22
 COUNTY : Kingfisher
 HIGHWAY : US 81

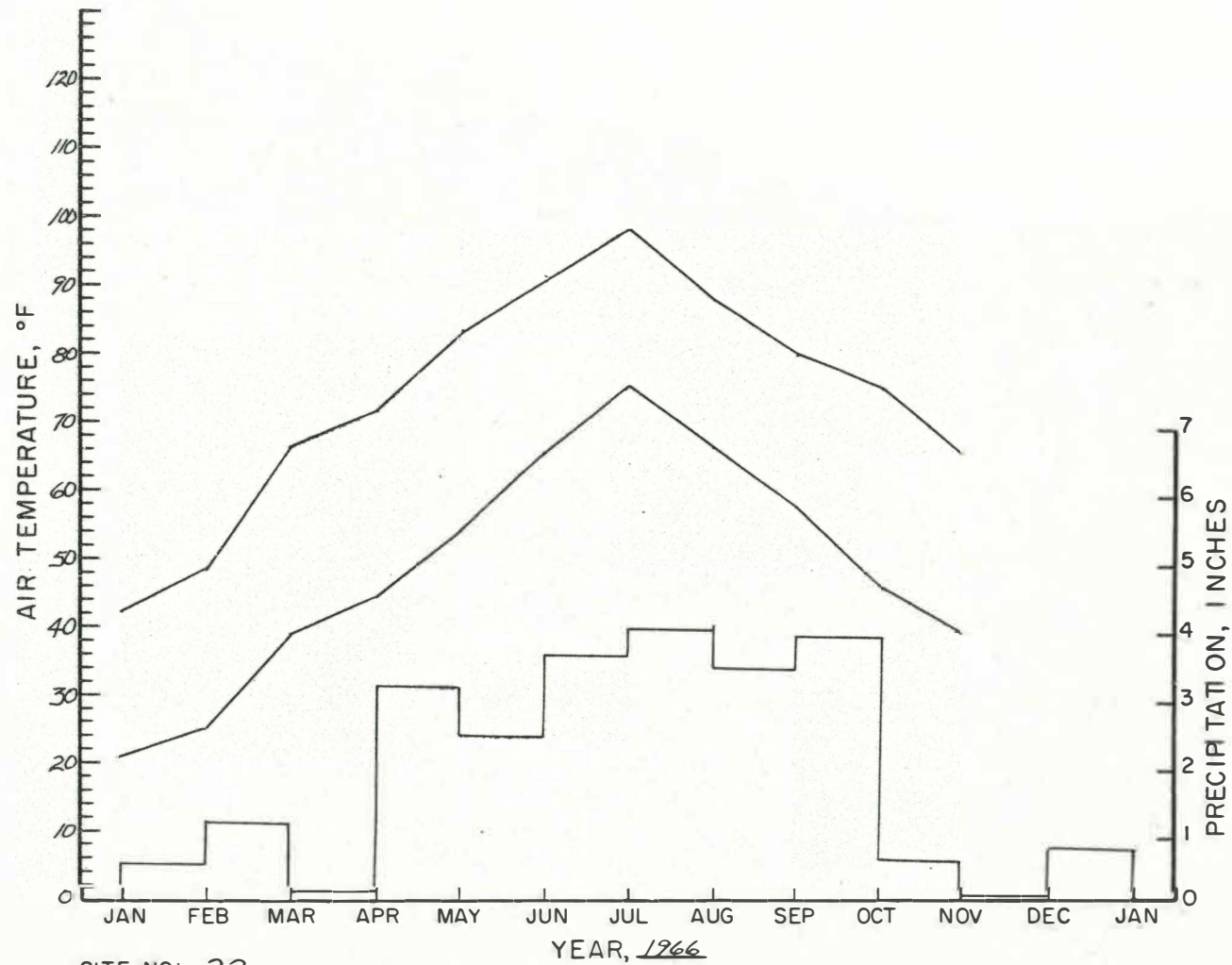
- LIQUID LIMIT
- ▲ PLASTIC LIMIT
- LINEAL SHRINKAGE



DATE : 8 December 1967

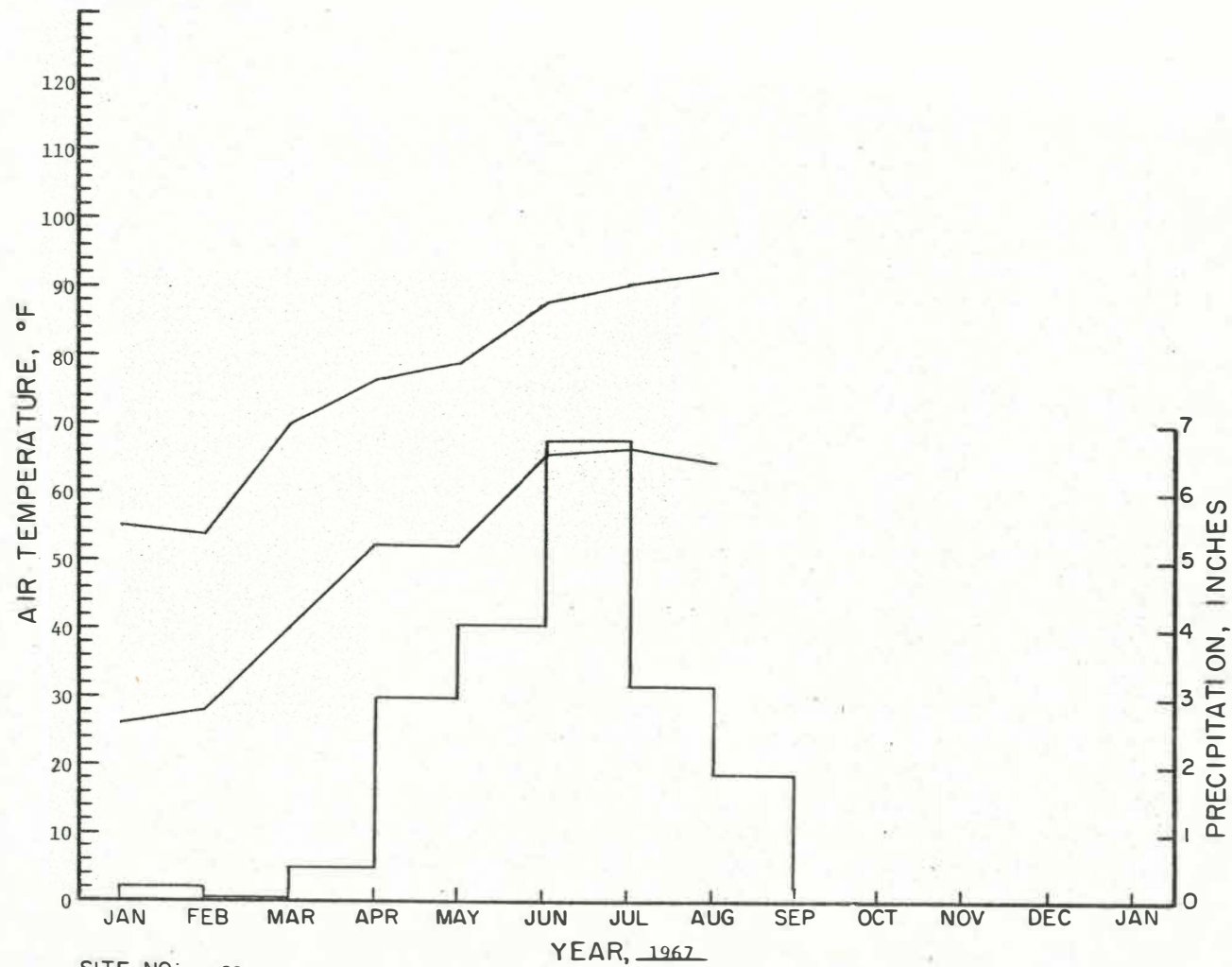
PLOTTED BY: AAP

SUBGRADE MOISTURE VARIATIONS PROJECT



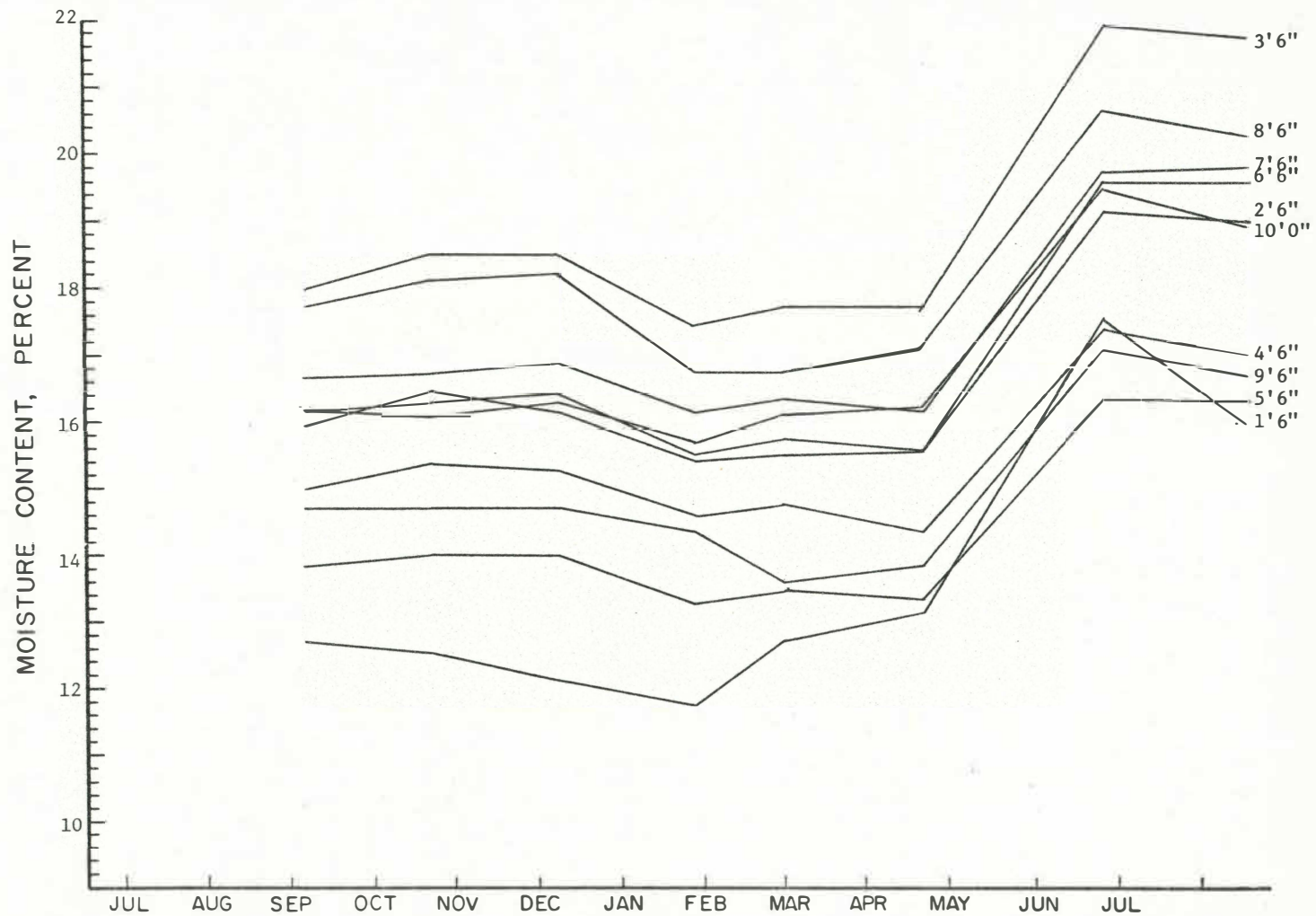
SITE NO: 22
COUNTY: Kingfisher
HIGHWAY: U.S. 81

SUBGRADE MOISTURE VARIATIONS PROJECT



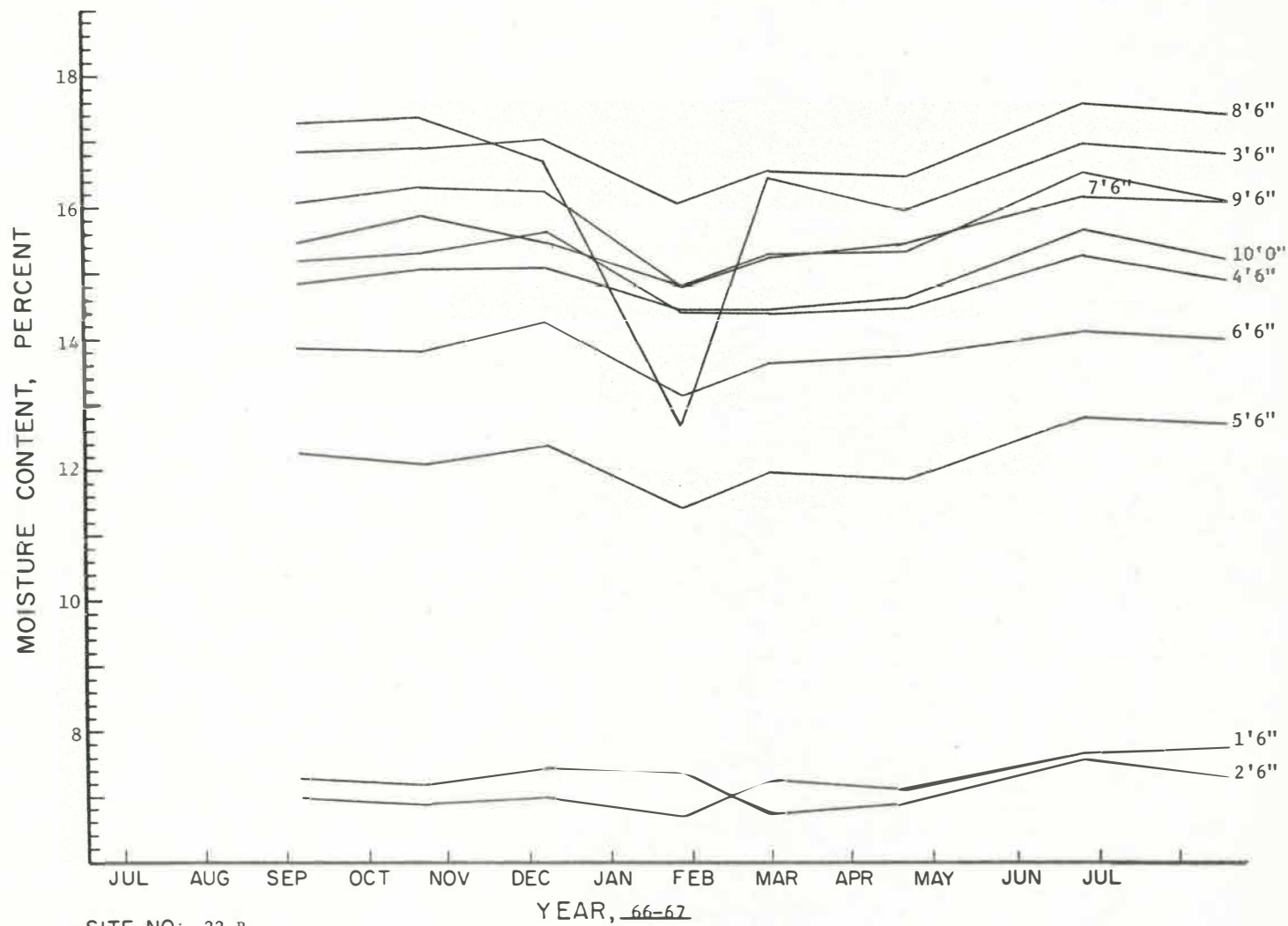
SITE NO: 22
COUNTY: Kingfisher
HIGHWAY: US 81

SUBGRADE MOISTURE VARIATIONS PROJECT



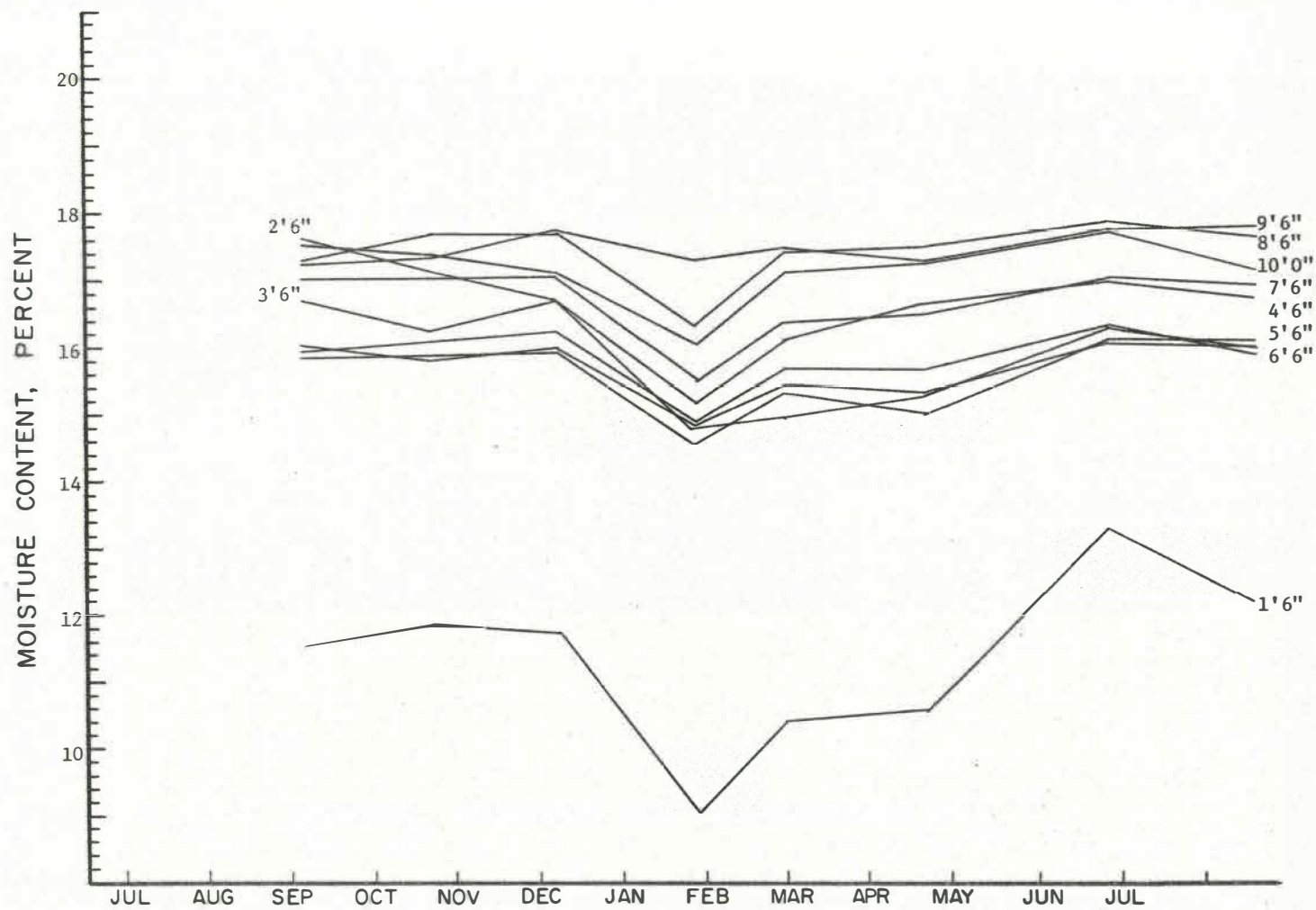
SITE NO: 22-A
COUNTY: Kingfisher
HIGHWAY: US 81

SUBGRADE MOISTURE VARIATIONS PROJECT



SITE NO: 22-B
 COUNTY: Kingfisher
 HIGHWAY: US 81

SUBGRADE MOISTURE VARIATIONS PROJECT



SITE NO: 22-C
 COUNTY: Kingfisher
 HIGHWAY: US 81

SUBGRADE MOISTURE VARIATIONS PROJECT

SCHOOL OF CIVIL ENGINEERING
OKLAHOMA STATE UNIVERSITY

SUBGRADE MOISTURE VARIATIONS RESEARCH PROJECT

SUBGRADE SOIL DRY DENSITY TABULATION

Date of Measurement	August 1966			January 1967			August 1967		
Site & Hole Number	22-A	22-B	22-C	22-A	22-B	22-C	22-A	22-B	22-C
Depth from top of tube to bottom of probe									
1 ft 6 in.	109.70	123.40	109.59	107.58	125.30	121.50	85.53	118.90	103.37
2 ft 0 in.									
2 ft 6 in.	103.75	99.79	87.03	106.40	102.66	90.73	86.65	90.72	90.97
3 ft 0 in.									
3 ft 6 in.	96.73	89.32	101.81	99.62	98.54	105.99	81.47	97.34	101.33
4 ft 0 in.									
4 ft 6 in.	99.79	104.06	99.52	103.00	109.04	102.82	85.52	102.49	98.88
5 ft 0 in.									
5 ft 6 in.	95.44	102.22	96.92	98.65	107.09	100.53	81.33	99.52	97.90
6 ft 0 in.									
6 ft 6 in.	96.62	99.36	100.53	101.60	101.77	103.65	81.91	98.02	100.15
7 ft 0 in.									
7 ft 6 in.	97.72	100.50	99.84	100.65	106.13	103.59	82.32	101.21	100.38
8 ft 0 in.									
8 ft 6 in.	96.32	104.10	103.12	102.11	107.28	104.93	83.87	101.06	102.54
9 ft 0 in.									
9 ft 6 in.	102.29	109.13	105.81	106.61	112.21	107.33	88.22	104.51	104.59
10 ft 0 in.	101.18	110.62	105.67	104.37	113.89	108.49	86.36	106.61	105.64

Note: All density values reported in units of lb per cu ft

SITE NO. 23

SCHOOL OF CIVIL ENGINEERING
OKLAHOMA STATE UNIVERSITY
SUBGRADE MOISTURE VARIATIONS PROJECT
TEST SITE DATA SUMMARY SHEET

LOCATION DATA:

Site No. 23 Highway No. US 169 County: Rogers Date Installed: 7/26/68
Distance from access tube to Lane ℄: 17' 6" a, 6" b, 17' 6" c

Exact Location:

In Rogers County, north of Talala, 1.6 miles north of Talala city limit on US 169.
Approximately 100 yds north of beginning of PCC pavement with improved shoulders.

PAVEMENT/DESIGN DATA:

No. of Lanes: 2 Pavement Type: PCC Shoulder Type: Improved
Pavement Thickness: 8 in. ℄, 1 in. Edge Latest Pavement Condition Rating: Good
Latest Traffic Count: 2200 vpd Heavy Truck Traffic: Yes
Terrain: Upland Drainage: Good Year of Original Paving: 1961

Original Design and History:

US Army Corps of Engineers relocation in conjunction with Oolagah Dam construction.
24 ft width; ℄ to 12 ft rt and lt: 8 in. PCC over sand base course; 12 ft to 20 ft
rt and lt: double bituminous sealed shoulder over 6 in. SABC.

FIELD OBSERVATIONS BY RESEARCH PERSONNEL:

2/7/67 - Water sponged from access tube "a"
3/14/67 - Water in access tube "a"
7/28/67 - About 3 in. of water in tube "a"

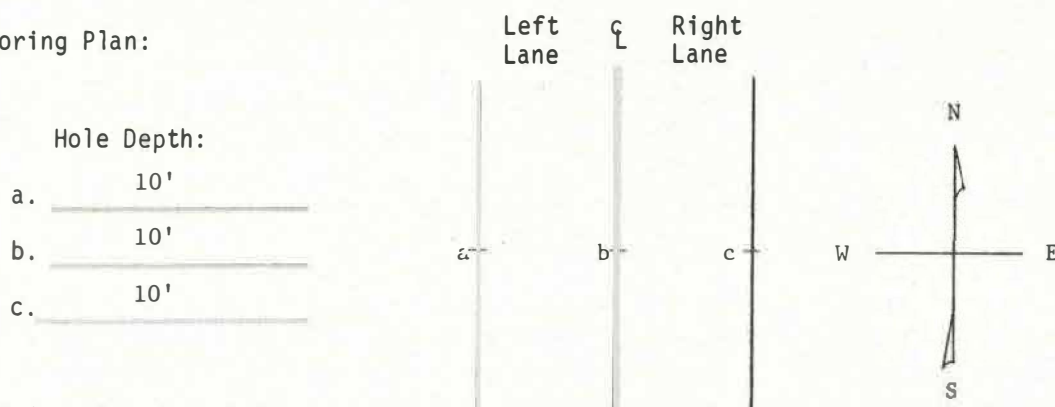
SCHOOL OF CIVIL ENGINEERING
OKLAHOMA STATE UNIVERSITY
Stillwater, Oklahoma
SUBGRADE MOISTURE VARIATION STUDY
SITE INSTALLATION INFORMATION

Installation: Rogers U.S. 169 23 Date: 26 7 66
County Highway No. day month year

Location of site: North of Talala, 1.6 miles north on U.S. 169 of Talala city
limits. Approximately 100 yards north of beginning of P.C. Concrete pave-
ment with improved shoulders.

Description of Terrain and Vegetation: Pavement on level upland terrain

Boring Plan:



Roadway Characteristics:

Pavement: Type P.C. Concrete
Width 12' Thickness 8"
Condition Good

Shoulders: Type Sealed Asphalt Width 6½'
Condition Good

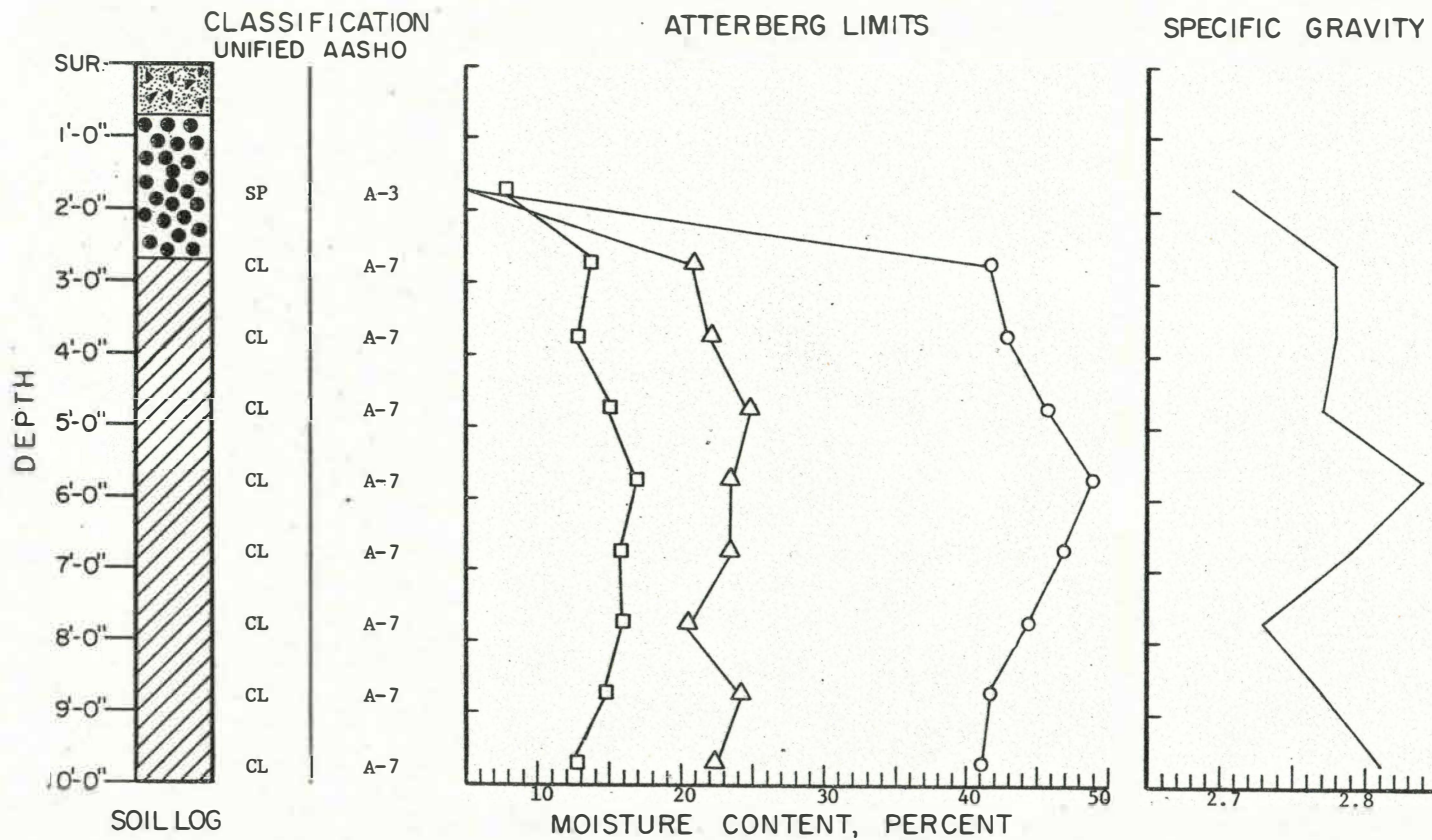
Base Course Characteristics Select gravel

SITE NO.: 23

COUNTY : Rogers

HIGHWAY : US 169

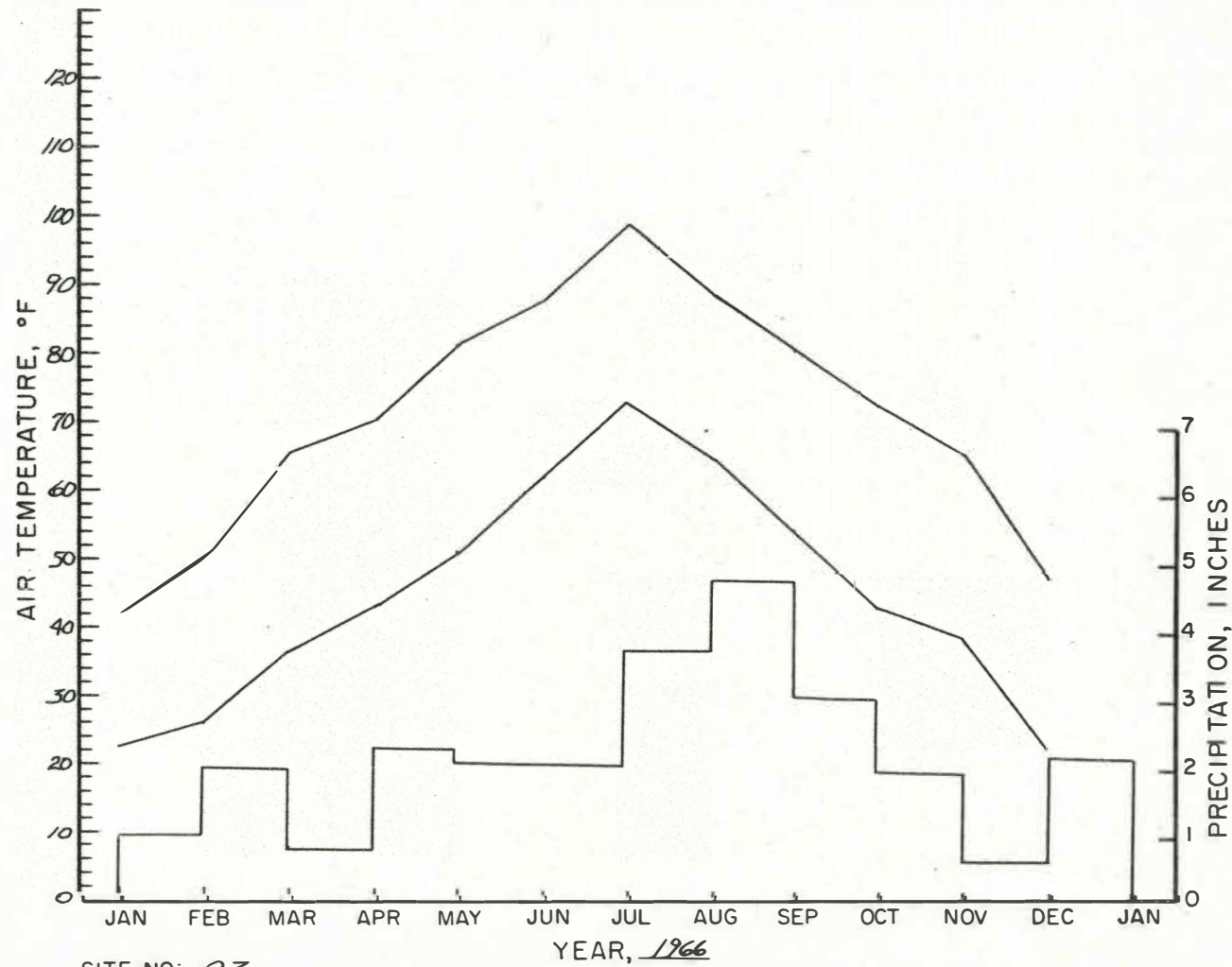
- LIQUID LIMIT
- ▲ PLASTIC LIMIT
- LINEAL SHRINKAGE



DATE : 11 December 1967

PLOTTED BY : AAP

SUBGRADE MOISTURE VARIATIONS PROJECT

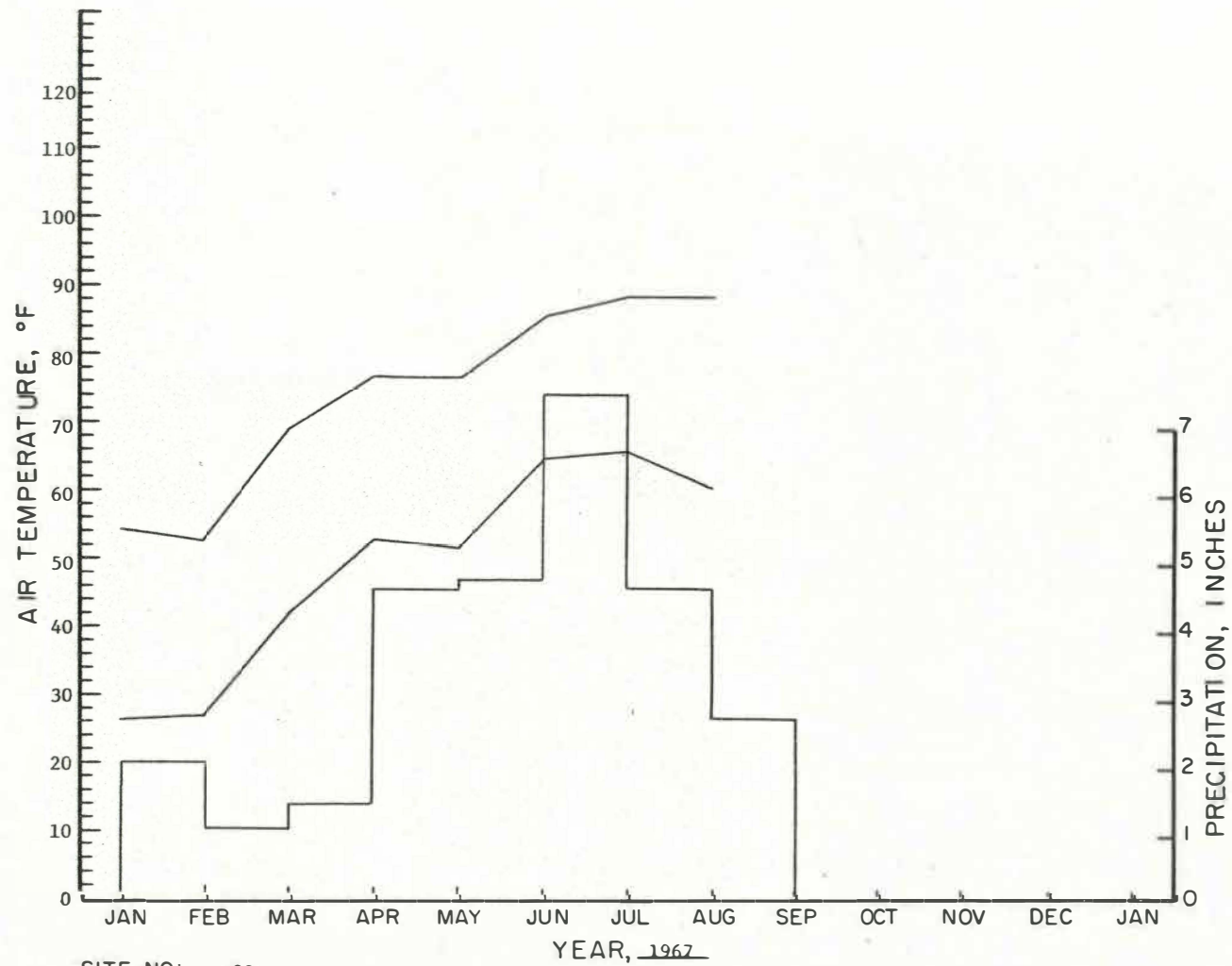


SITE NO: 23

COUNTY: ROGERS

HIGHWAY: U.S. 169

SUBGRADE MOISTURE VARIATIONS PROJECT

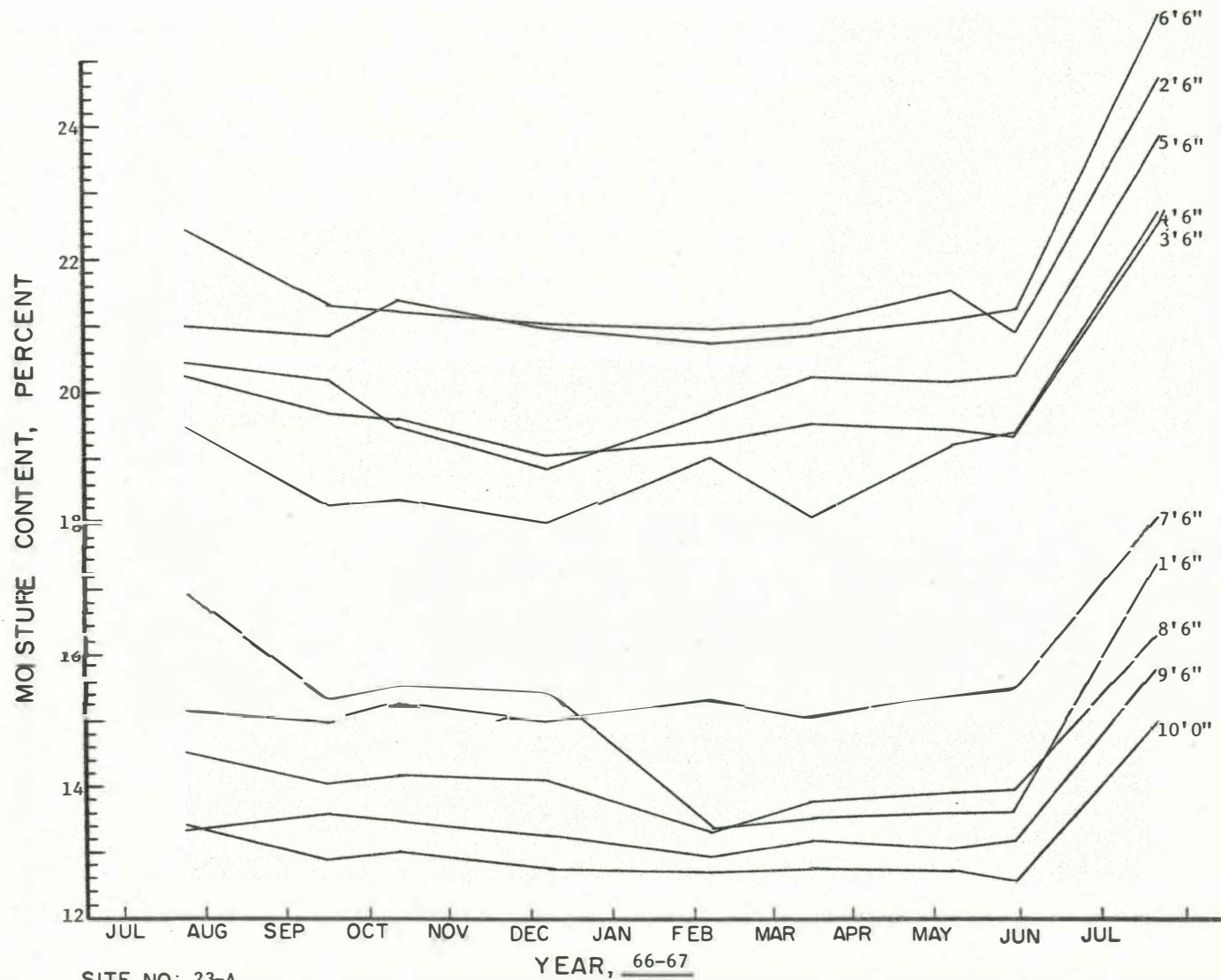


SITE NO: 23

COUNTY : Nowata

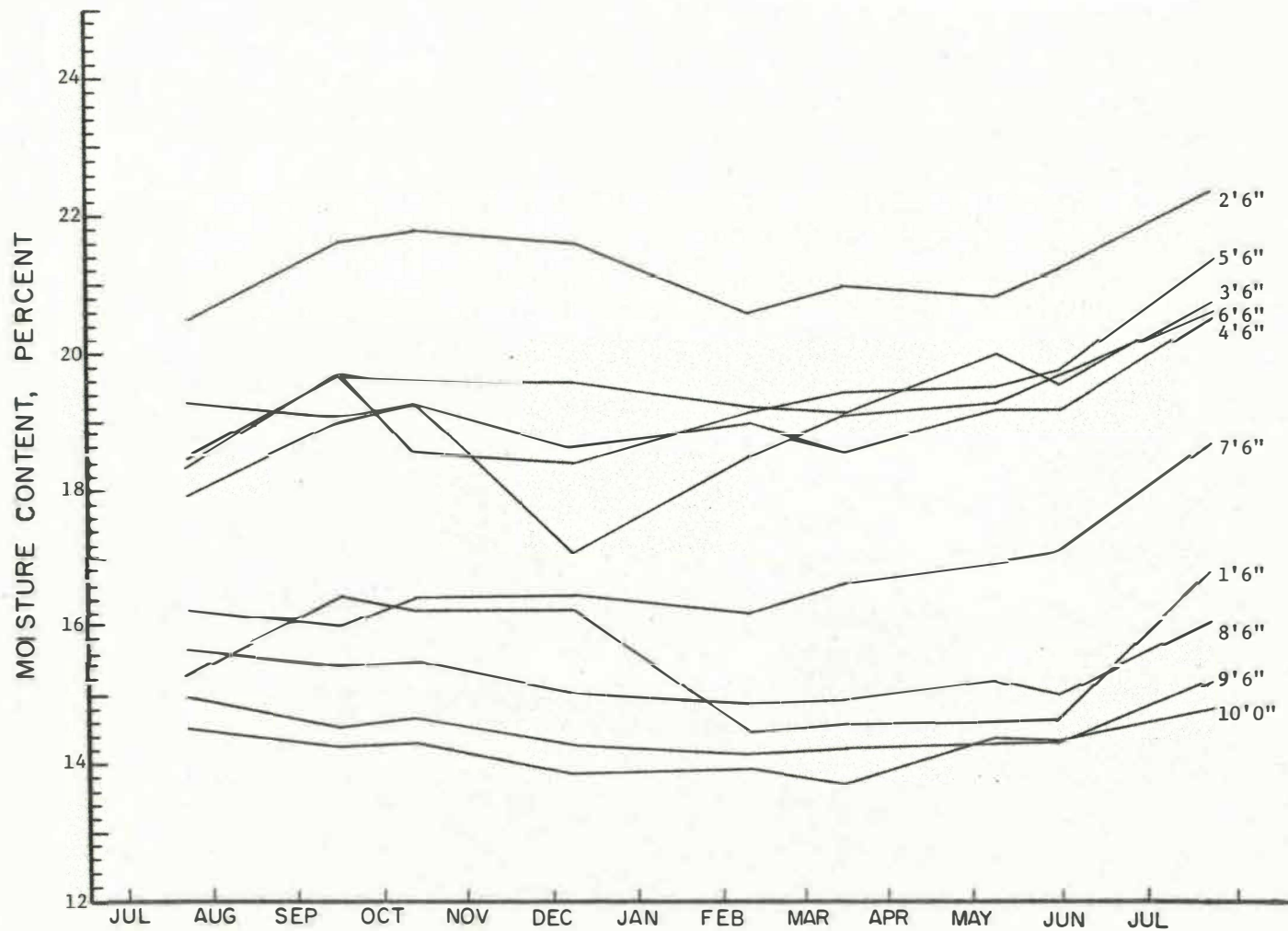
HIGHWAY : US 169

SUBGRADE MOISTURE VARIATIONS PROJECT



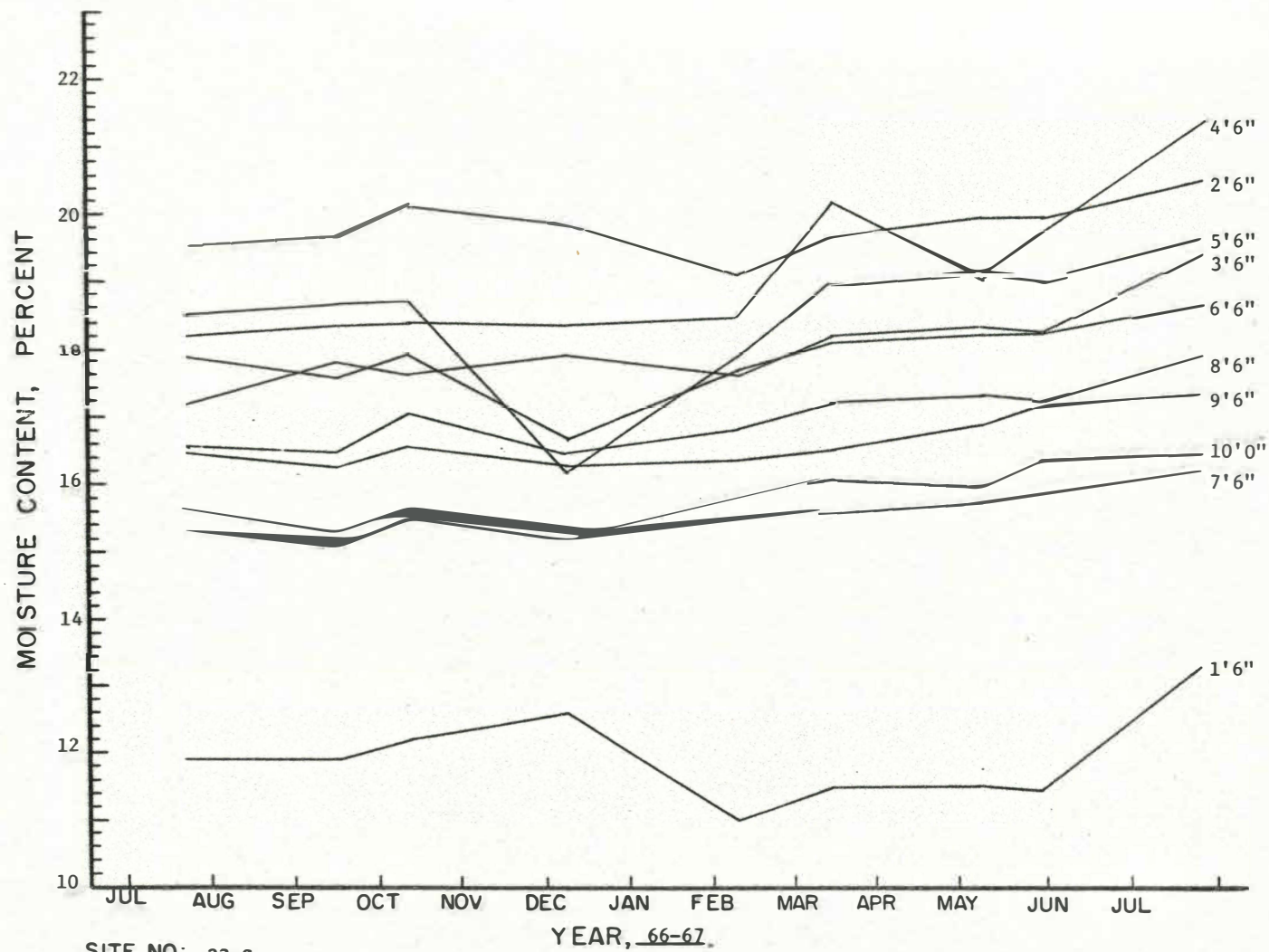
SITE NO: 23-A
 COUNTY: Rogers
 HIGHWAY: US 169

SUBGRADE MOISTURE VARIATIONS PROJECT



SITE NO: 23-B
 COUNTY: Rogers
 HIGHWAY: US 169

SUBGRADE MOISTURE VARIATIONS PROJECT



SITE NO: 23-C
 COUNTY: Rogers
 HIGHWAY: US 169

SUBGRADE MOISTURE VARIATIONS PROJECT

SCHOOL OF CIVIL ENGINEERING
OKLAHOMA STATE UNIVERSITY

SUBGRADE MOISTURE VARIATIONS RESEARCH PROJECT

SUBGRADE SOIL DRY DENSITY TABULATION

Date of Measurement	August 1966			January 1967			August 1967		
Site & Hole Number	23-A	23-B	23-C	23-A	23-B	23-C	23-A	23-B	23-C
Depth from top of tube to bottom of probe									
1 ft 6 in.	114.05	117.12	142.75	131.46	130.34	156.79	101.81	114.27	134.22
2 ft 0 in.									
2 ft 6 in.	103.76	103.24	105.78	104.79	106.91	106.59	89.87	99.68	104.36
3 ft 0 in.									
3 ft 6 in.	105.74	105.45	109.19	106.64	107.42	108.71	90.92	100.46	106.19
4 ft 0 in.									
4 ft 6 in.	108.68	106.59	107.68	110.16	109.40	108.48	92.39	101.88	103.30
5 ft 0 in.									
5 ft 6 in.	106.67	105.45	108.02	106.60	108.52	108.75	89.29	100.24	105.23
6 ft 0 in.									
6 ft 6 in.	103.24	107.80	112.90	104.75	109.89	111.89	86.08	102.28	108.44
7 ft 0 in.									
7 ft 6 in.	121.46	117.20	119.79	121.26	115.36	118.10	102.36	106.17	114.24
8 ft 0 in.									
8 ft 6 in.	123.45	119.31	118.06	126.54	120.70	115.26	105.97	111.83	111.43
9 ft 0 in.									
9 ft 6 in.	126.30	121.42	116.98	128.51	124.09	114.93	106.96	114.74	111.76
10 ft 0 in.	127.81	122.94	120.51	129.82	124.71	115.66	108.65	114.85	114.28

Note: All density values reported in units of lb per cu ft

SITE NO. 24

SCHOOL OF CIVIL ENGINEERING
OKLAHOMA STATE UNIVERSITY
SUBGRADE MOISTURE VARIATIONS PROJECT
TEST SITE DATA SUMMARY SHEET

LOCATION DATA:

Site No. 24 Highway No. US 66 County: Rogers Date Installed: 7/28/66

Distance from access tube to Lane ℓ : 11'6" a, 6" b, 20'6" c

Exact Location:

In Rogers County, southwest of Claremore, 1.5 miles southwest on US 66 from jct. of US 66 and US 66 - Truck Route. Site in southeast lane of divided highway. Marker on southeast fence row.

PAVEMENT/DESIGN DATA:

No. of Lanes: 4D Pavement Type: PCC Shoulder Type: Improved

Pavement Thickness: 9 in. ℓ , 2 in. Edge Latest Pavement Condition Rating: V. Good

Latest Traffic Count: 8900 vpd Heavy Truck Traffic: Yes

Terrain: Upland Drainage: Good Year of Original Paving: 1930

Original Design and History:

Before 1955, 24 ft width; ℓ to 12 ft lt and rt: 8 in. PCC/4 in. sand/8 in. subbase.
In 1955, inside 12 ft to 15 ft and outside 12 ft to 22 ft: sealed shoulder over 6 in. SABC.

FIELD OBSERVATIONS BY RESEARCH PERSONNEL:

7/28/67 - Access tube "a" shortened 6 in.

SCHOOL OF CIVIL ENGINEERING
OKLAHOMA STATE UNIVERSITY
Stillwater, Oklahoma
SUBGRADE MOISTURE VARIATION STUDY
SITE INSTALLATION INFORMATION

Installation: Rogers U.S. 66 24 Date: 28 7 66
County Highway No. day month year

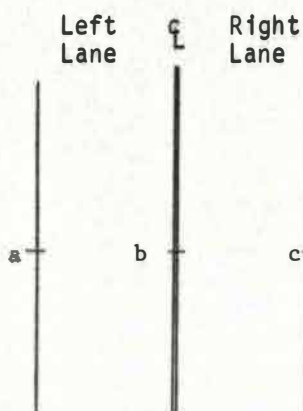
Location of site: Southwest of Claremore, 1.5 miles Southwest on U.S. 66 from
U.S. 66-U.S. 66 Truck Route jct. Site in southeast lane of divided four-lane
highway.

Description of Terrain and Vegetation: Pavement in rolling upland terrain.
with adequate drainage on all sides.

Boring Plan:

Hole Depth:

a. 10'
b. 10'
c. 10'



Roadway Characteristics:

Pavement: Type P.C. Concrete
Width 24' Thickness 9"
Condition Very Good

Shoulders: Type Asphaltic Concrete Width 9'
Condition Good

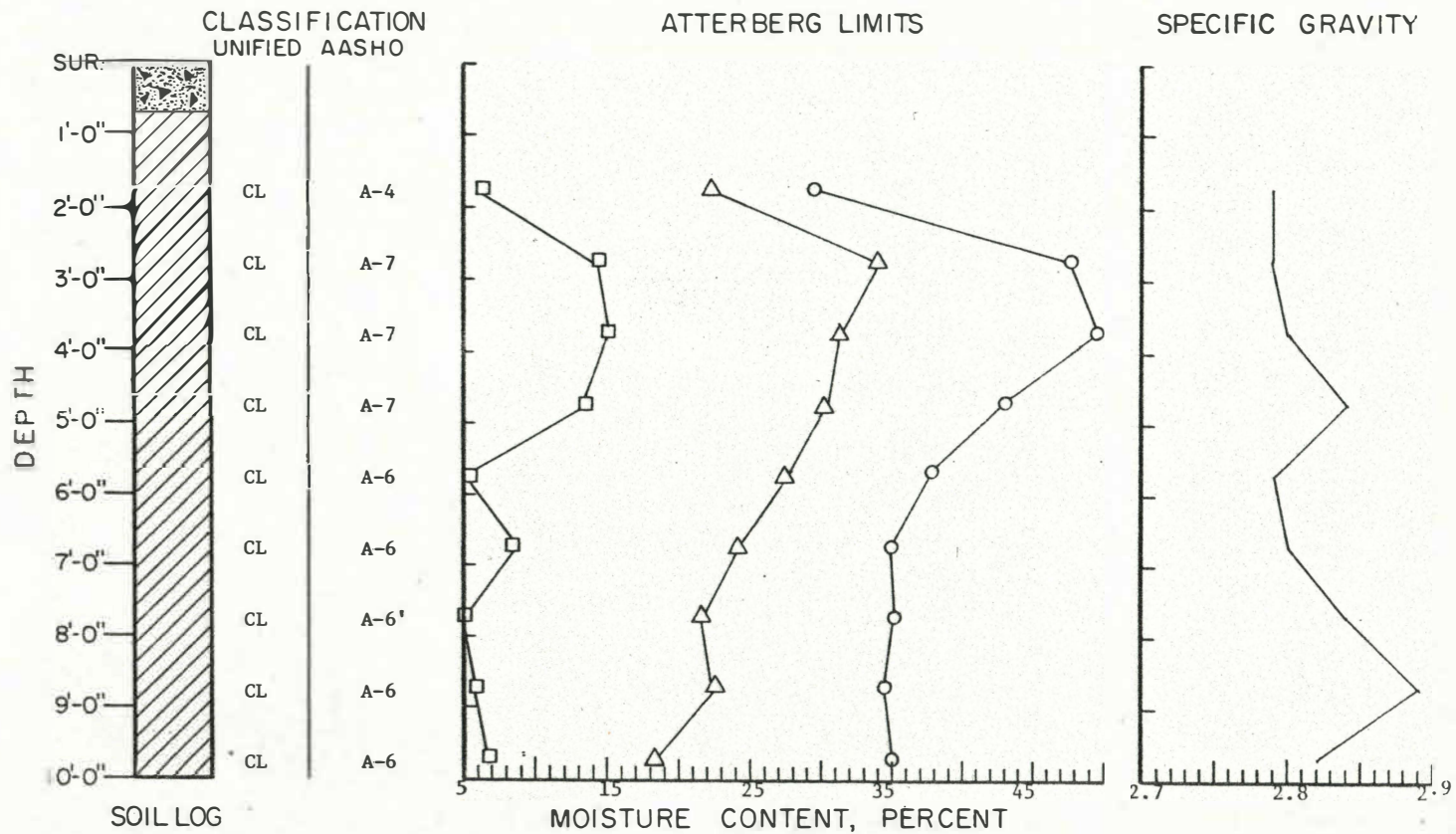
Base Course Characteristics Sand

SITE NO.: 24

COUNTY : Rogers

HIGHWAY : US 66

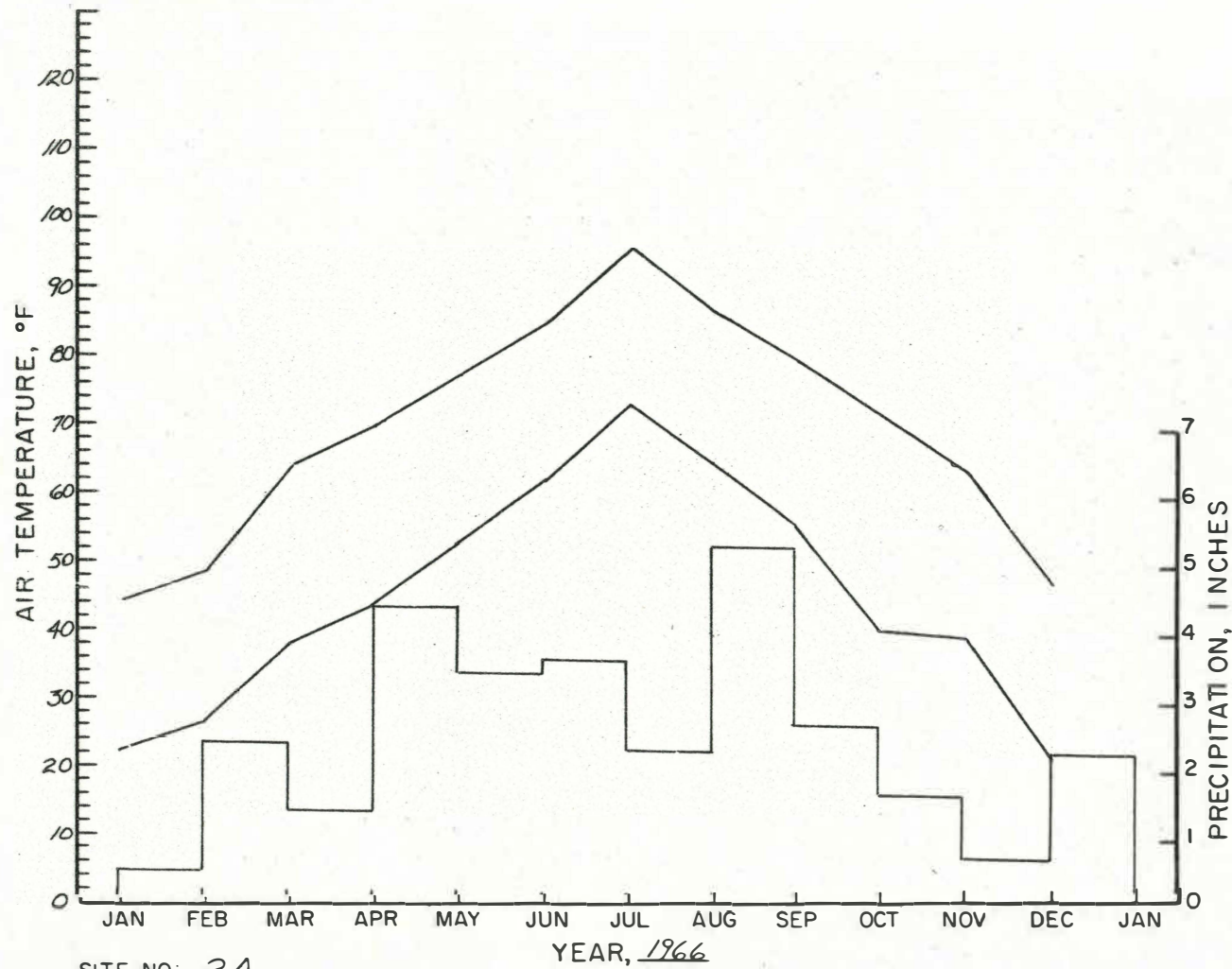
- LIQUID LIMIT
- ▲ PLASTIC LIMIT
- LINEAL SHRINKAGE



DATE : 15 December 1967

PLOTTED BY : AAP

SUBGRADE MOISTURE VARIATIONS PROJECT



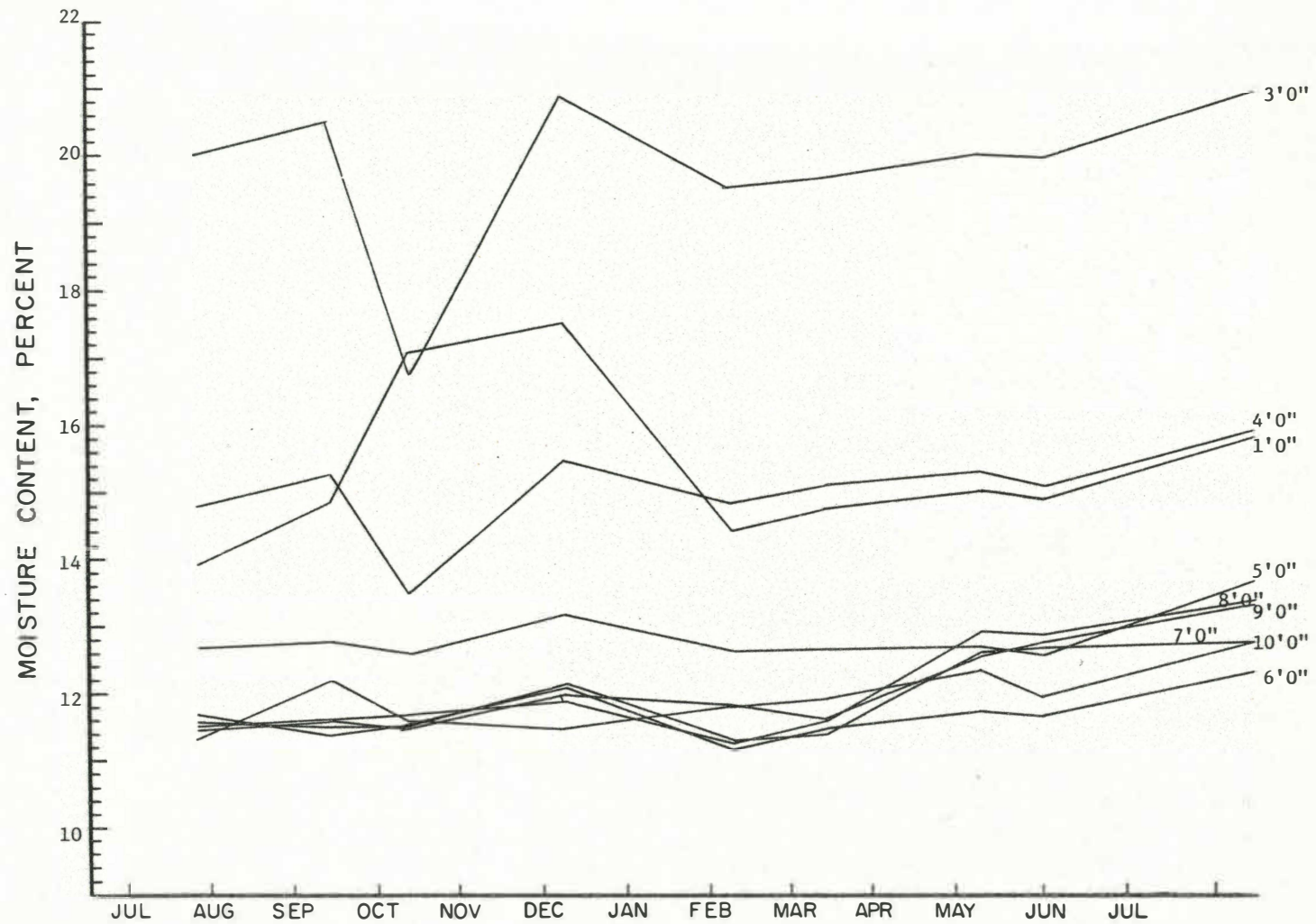
SITE NO: 24
COUNTY: ROGERS
HIGHWAY: U.S. 66

SUBGRADE MOISTURE VARIATIONS PROJECT



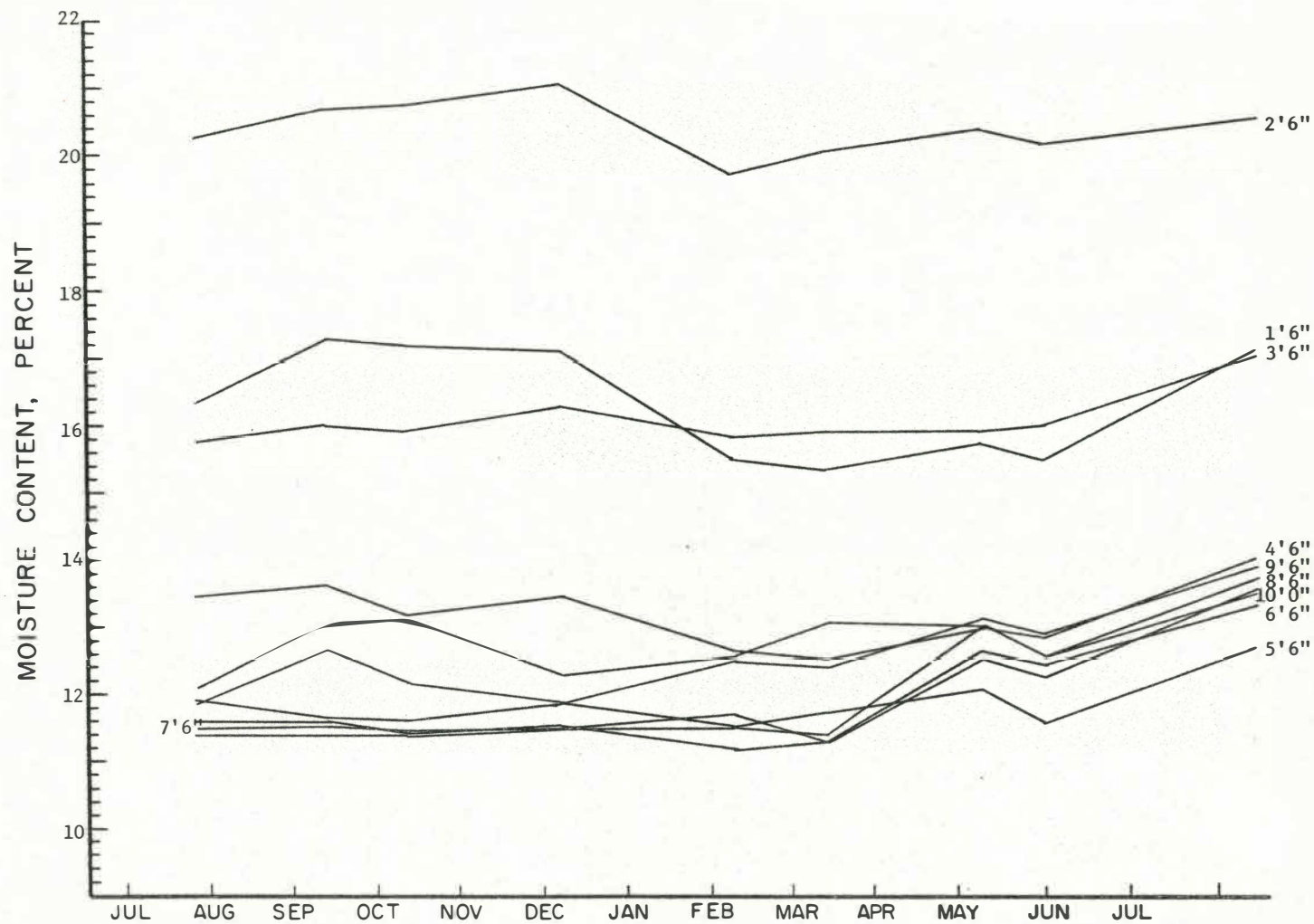
SITE NO: 24
 COUNTY: Rogers
 HIGHWAY: US 66

SUBGRADE MOISTURE VARIATIONS PROJECT



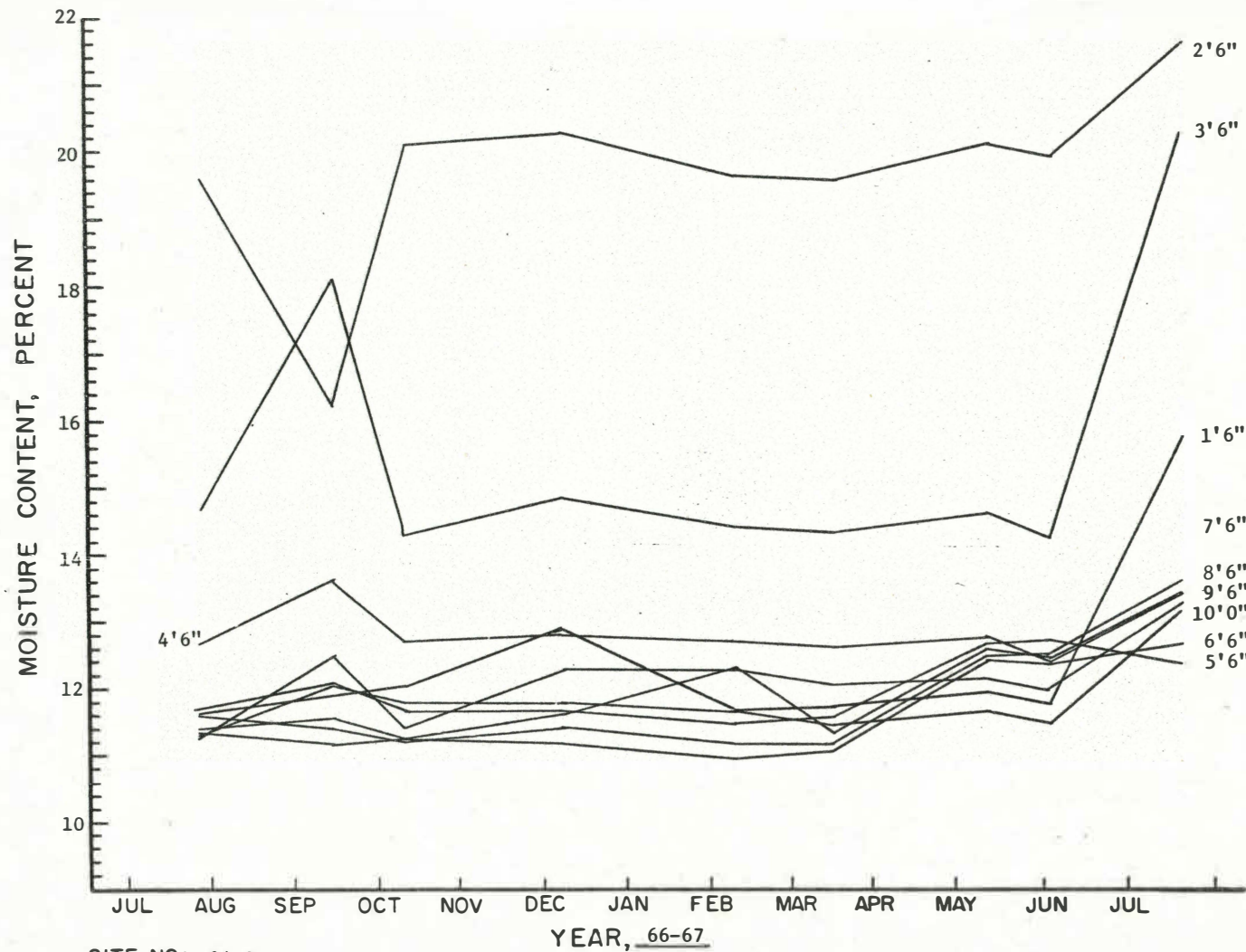
SITE NO: 24-A
 COUNTY: Rogers
 HIGHWAY: US 66

SUBGRADE MOISTURE VARIATIONS PROJECT



SITE NO: 24-B
 COUNTY: Rogers
 HIGHWAY: US 66

SUBGRADE MOISTURE VARIATIONS PROJECT



SITE NO: 24-C
 COUNTY: Rogers
 HIGHWAY: US 66

SUBGRADE MOISTURE VARIATIONS PROJECT

SCHOOL OF CIVIL ENGINEERING
OKLAHOMA STATE UNIVERSITY

SUBGRADE MOISTURE VARIATIONS RESEARCH PROJECT

SUBGRADE SOIL DRY DENSITY TABULATION

Date of Measurement	August 1966			January 1967			August 1967		
Site & Hole Number	24-A	24-B	24-C	24-A	24-B	24-C	24-A	24-B	24-C
Depth from top of tube to bottom of probe									
1 ft 6 in.		108.39	136.27		119.94	148.00		110.27	111.51
2 ft 0 in.	124.16			125.36			115.10		
2 ft 6 in.		103.73	103.94		106.79	107.26		102.38	98.94
3 ft 0 in.	104.54			109.06			101.96		
3 ft 6 in.		113.52	115.30		115.27	116.97		108.30	105.16
4 ft 0 in.	115.82			117.98			110.70		
4 ft 6 in.		120.64	123.47		124.45	124.45		115.36	115.60
5 ft 0 in.	122.51			123.83			116.43		
5 ft 6 in.		128.67	129.16		129.58	129.86		119.76	120.01
6 ft 0 in.	129.27			130.20			122.75		
6 ft 6 in.		129.01	130.54		130.89	131.39		120.70	122.66
7 ft 0 in.	129.51			130.74			121.95		
7 ft 6 in.		130.59	129.71		131.05	131.29		122.01	120.18
8 ft 0 in.	129.32			129.44			123.00		
8 ft 6 in.		130.31	130.68		131.87	131.42		121.43	120.64
9 ft 0 in.	130.23			129.21			123.30		
9 ft 6 in.		128.72	131.40		130.30	132.86		120.89	120.82
10 ft 0 in.	130.97	128.75	129.87	130.45	130.24	133.30	125.54	120.74	119.85

Note: All density values reported in units of lb per cu ft

SITE NO. 25

SCHOOL OF CIVIL ENGINEERING
OKLAHOMA STATE UNIVERSITY
SUBGRADE MOISTURE VARIATIONS PROJECT
TEST SITE DATA SUMMARY SHEET

LOCATION DATA:

Site No. 25 Highway No. S 11 County: Osage Date Installed: 7/14/66

Distance from access tube to Lane ℄: 9' 6" a, 6" b, 9' 6" c

Exact Location:

In Osage County east of Barnsdall, 1.4 miles east on S 11 from jct. of S 11 and S 123.
Marker on north fence row. Approximately 50 yds east of bridge.

PAVEMENT/DESIGN DATA:

No. of Lanes: 2 Pavement Type: AC/PCC Shoulder Type: Natural

Pavement Thickness: 7 in. ℄, 11 in. Edge Latest Pavement Condition Rating: Fair

Latest Traffic Count: 900 vpd Heavy Truck Traffic: Yes

Terrain: Creek- Drainage: Fair Year of Original Paving: 1929
Bottom

Original Design and History:

Variable section PCC, 18 ft width; ℄ 5 in. PCC to 9 in. PCC at 9 ft lt and rt;
periodic work by OSHD maintenance forces has accumulated 2 in. AC overlay. No
subbase or shoulders.

FIELD OBSERVATIONS BY RESEARCH PERSONNEL:

4/18/67 - Access tube "b" shortened 6 in.

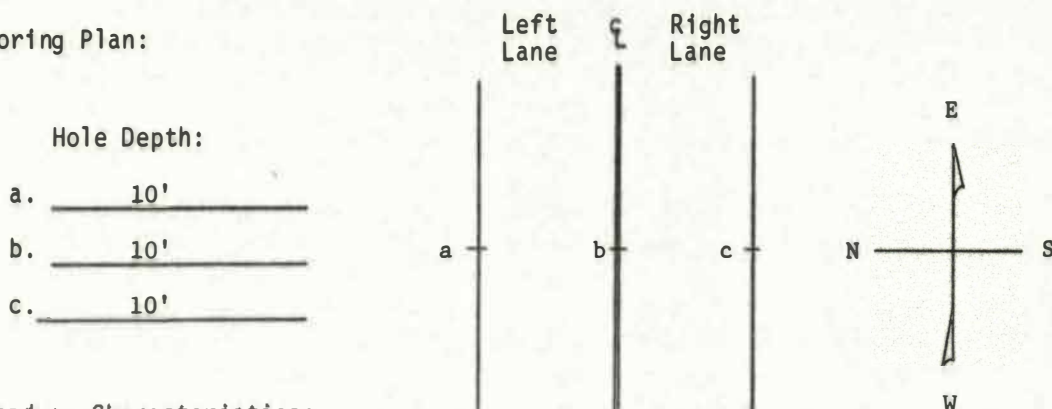
SCHOOL OF CIVIL ENGINEERING
OKLAHOMA STATE UNIVERSITY
Stillwater, Oklahoma
SUBGRADE MOISTURE VARIATION STUDY
SITE INSTALLATION INFORMATION

Installation: Osage St. 11 25 Date: 14 7 66
County Highway No. day month year

Location of site: East of Barnsdall, 1.4 miles east from jct. of St. 11 and
St. 123.

Description of Terrain and Vegetation: Pavement in creek bottom area in
rolling upland terrain

Boring Plan:



Roadway Characteristics:

Pavement: Type Asphaltic concrete overlaying P.C. Concrete
Width 10' Thickness 1" AC - 6" PC
Condition Fair

Shoulders: Type Grass Width _____
Condition Poor

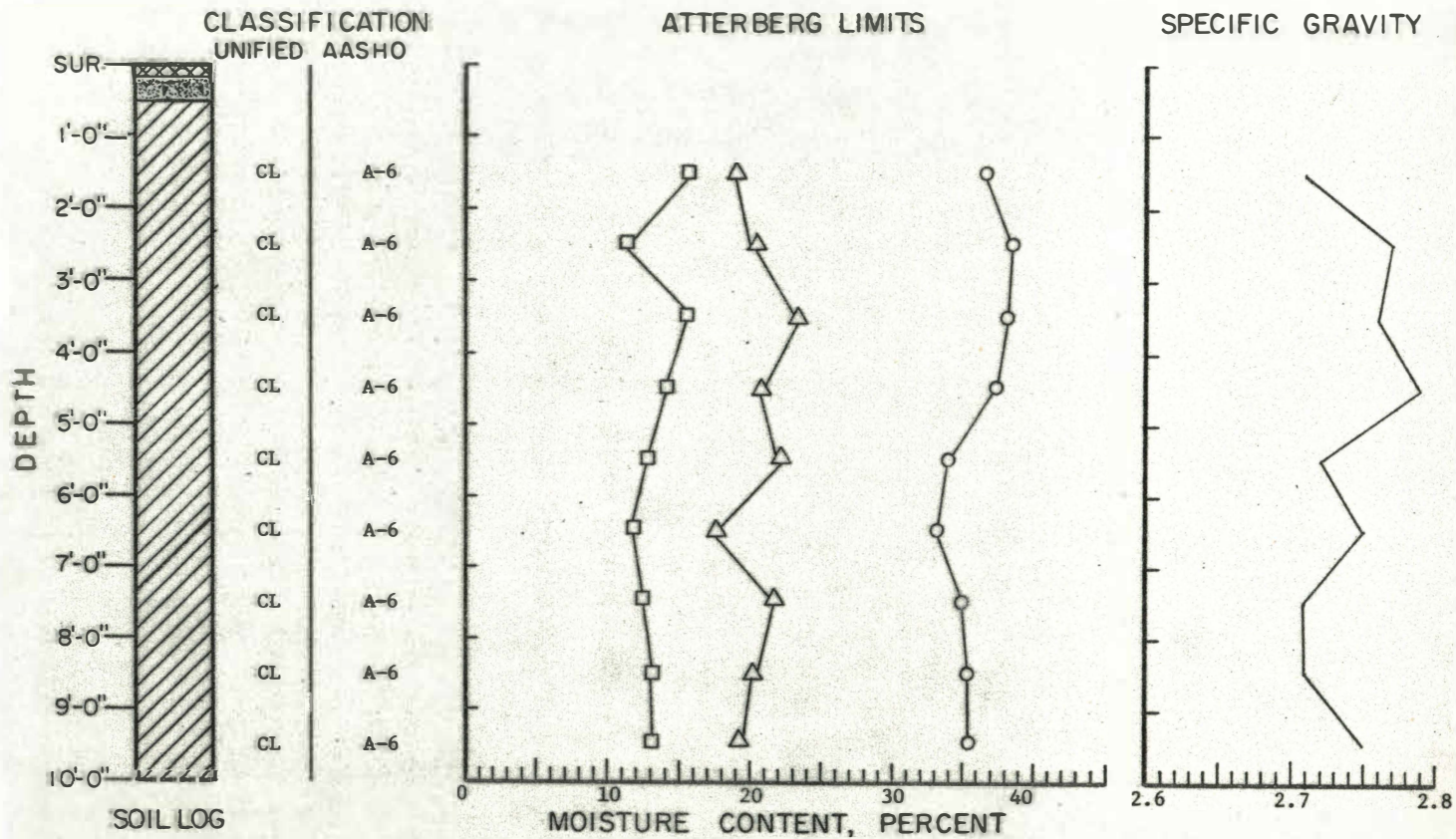
Base Course Characteristics Sand

SITE NO.: 25

COUNTY : Osage

HIGHWAY : State 11

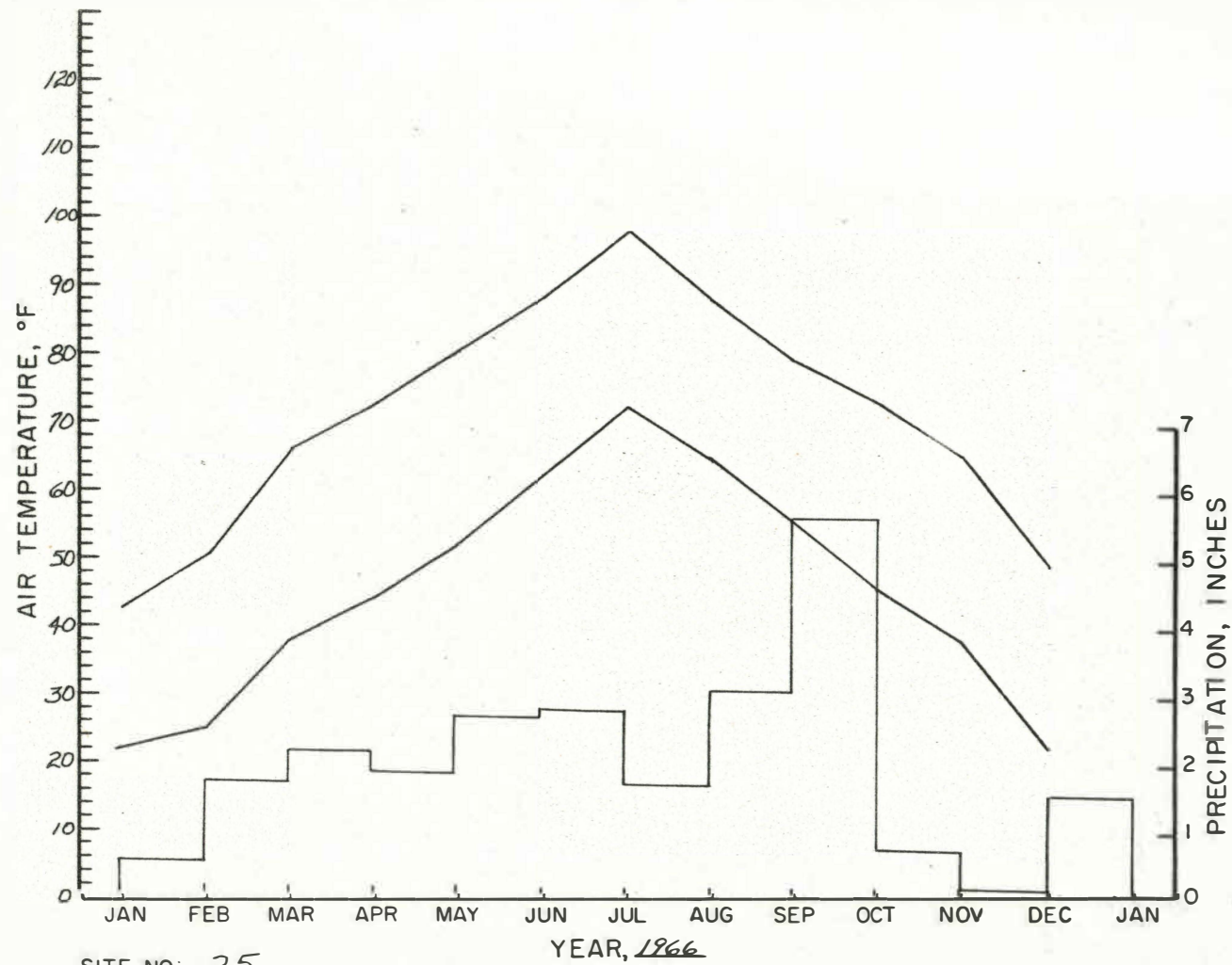
- LIQUID LIMIT
- ▲ PLASTIC LIMIT
- LINEAL SHRINKAGE



DATE : 12 December 1967

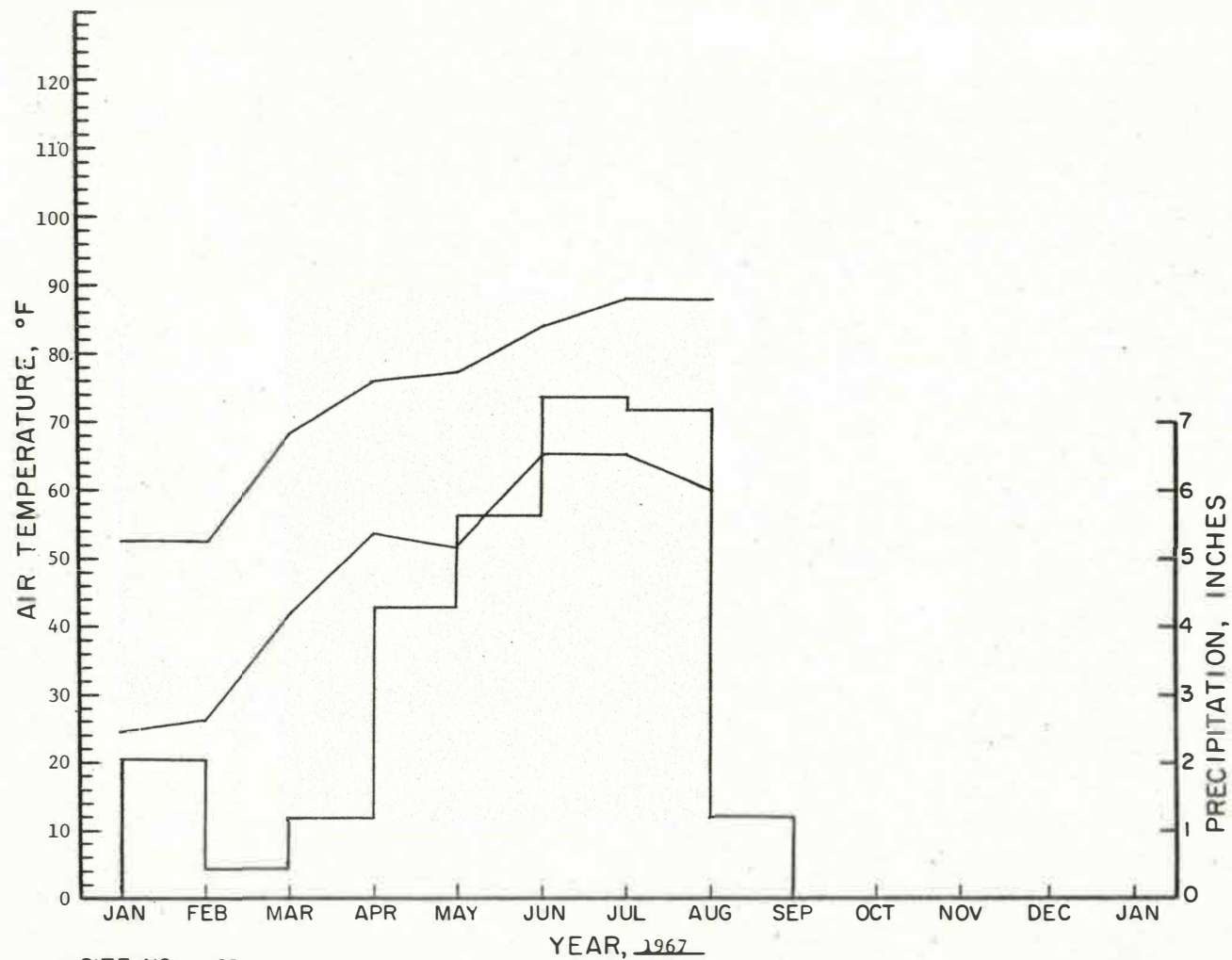
PLOTTED BY : AAP

SUBGRADE MOISTURE VARIATIONS PROJECT



SITE NO: 25
COUNTY: Osage
HIGHWAY: SH 11

SUBGRADE MOISTURE VARIATIONS PROJECT

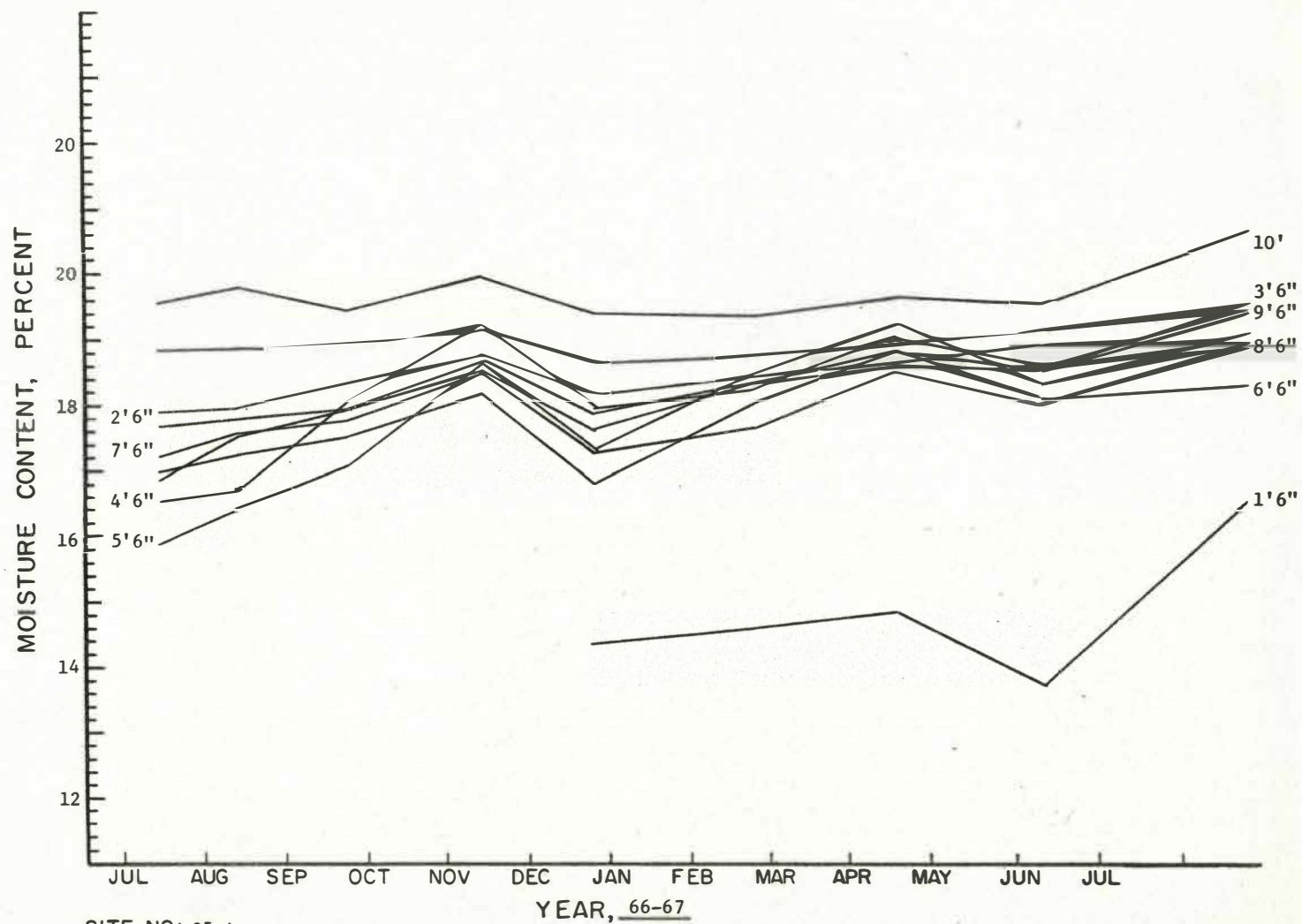


SITE NO: 25

COUNTY: Osage

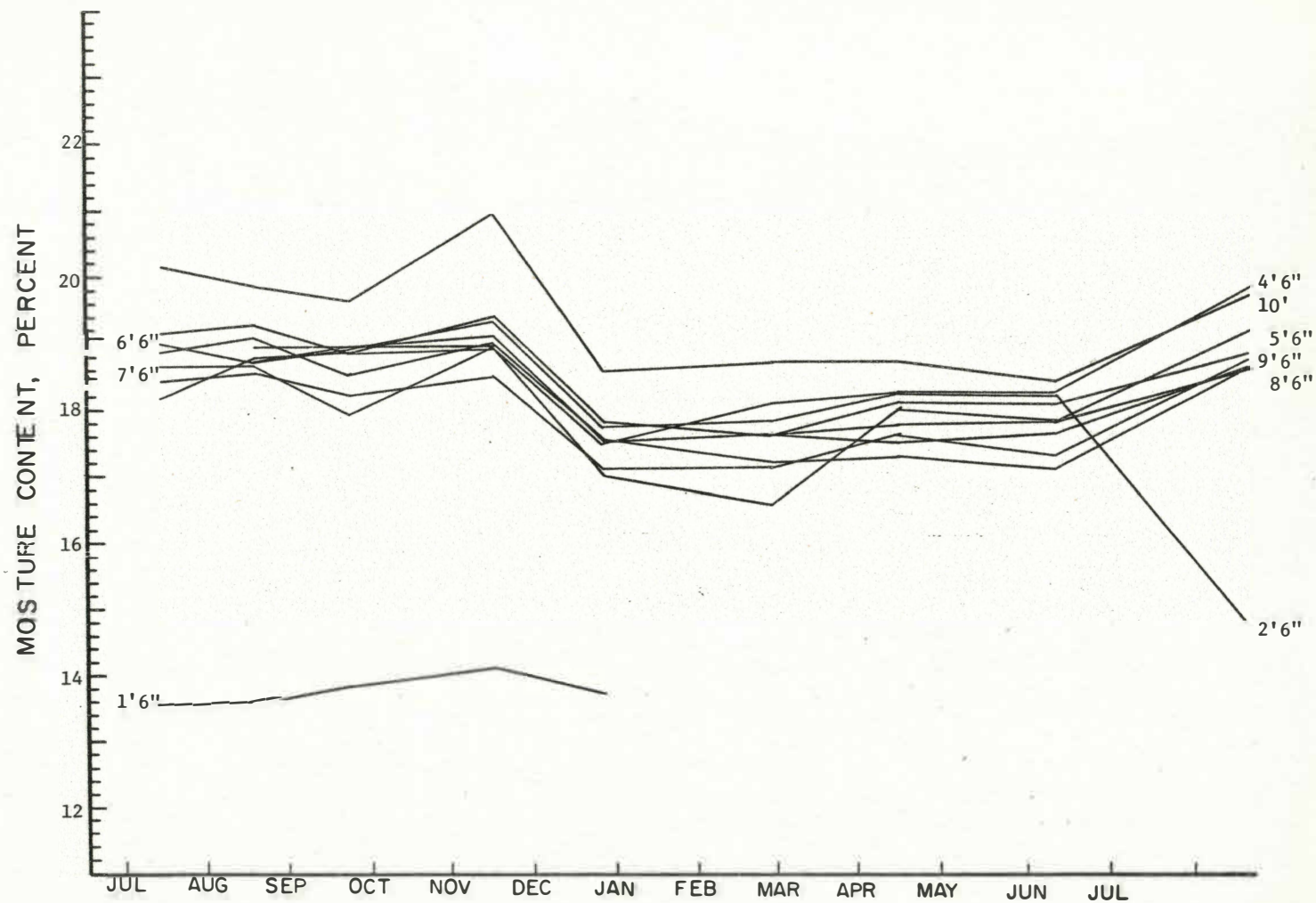
HIGHWAY: SH 11

SUBGRADE MOISTURE VARIATIONS PROJECT



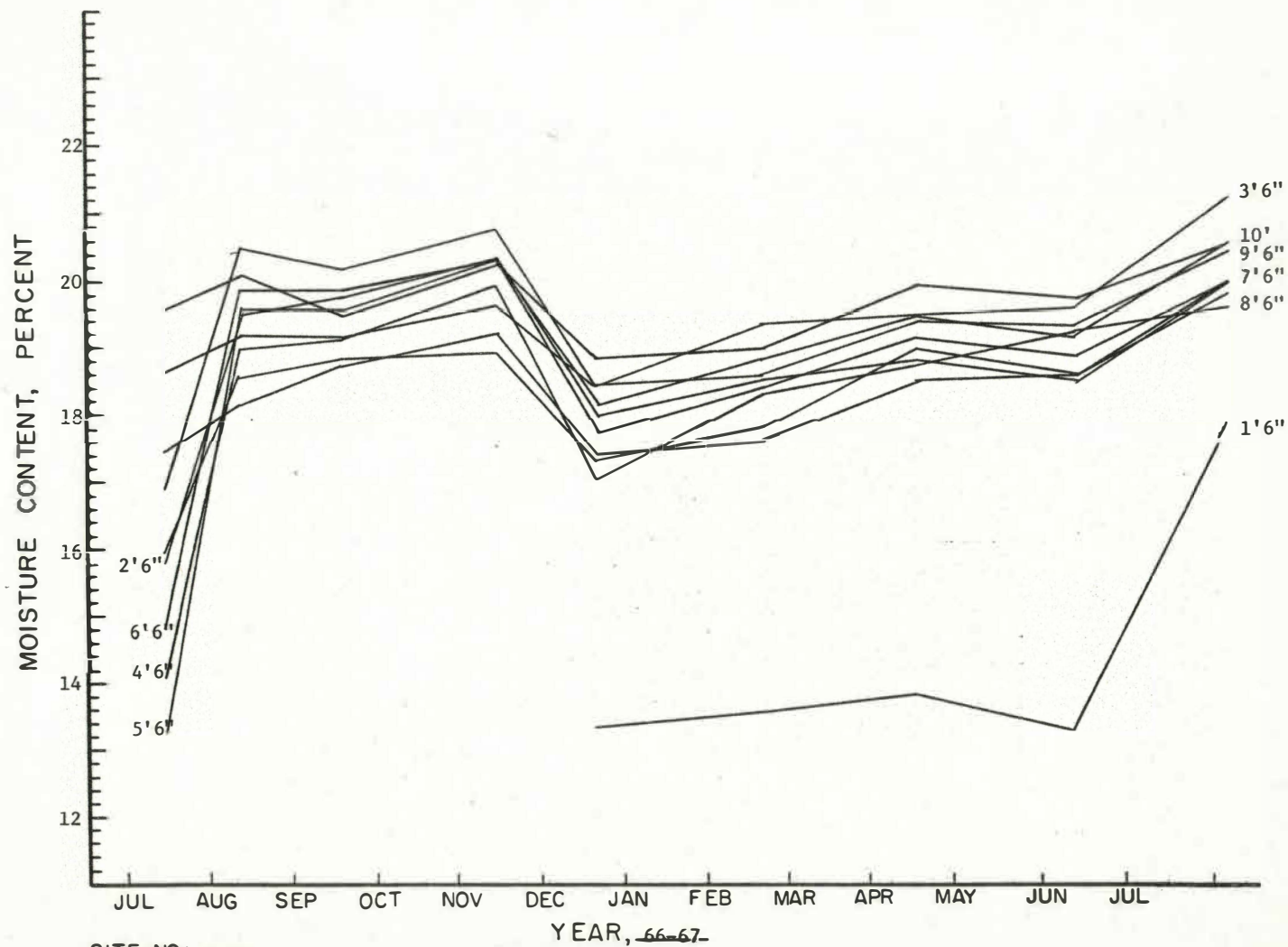
SITE NO: 25-A
 COUNTY: Osage
 HIGHWAY: St 11

SUBGRADE MOISTURE VARIATIONS PROJECT



SITE NO: 25-B
 COUNTY: Osage
 HIGHWAY: St 11

SUBGRADE MOISTURE VARIATIONS PROJECT



SITE NO: 25-C
 COUNTY: Osage
 HIGHWAY: St 11

SUBGRADE MOISTURE VARIATIONS PROJECT

SCHOOL OF CIVIL ENGINEERING
OKLAHOMA STATE UNIVERSITY

SUBGRADE MOISTURE VARIATIONS RESEARCH PROJECT

SUBGRADE SOIL DRY DENSITY TABULATION

Date of Measurement	August 1966			January 1967			August 1967		
Site & Hole Number	25-A	25-B	25-C	25-A	25-B	25-C	25-A	25-B	25-C
Depth from top of tube to bottom of probe									
1 ft 6 in.		135.26		133.05	135.01	141.41	118.09		107.01
2 ft 0 in.								123.07	
2 ft 6 in.	98.21	95.80	92.55	99.58	101.79	100.68	95.32		93.64
3 ft 0 in.								95.27	
3 ft 6 in.	97.67	95.06	92.16	100.29	101.16	99.69	95.41		92.38
4 ft 0 in.								93.07	
4 ft 6 in.	94.66	94.12	92.65	98.28	98.86	100.31	95.10		94.53
5 ft 0 in.								92.40	
5 ft 6 in.	92.72	91.76	91.55	96.52	98.35	98.42	93.64		91.60
6 ft 0 in.								91.30	
6 ft 6 in.	93.76	91.95	91.05	97.05	97.64	99.24	93.67		93.43
7 ft 0 in.								91.91	
7 ft 6 in.	94.96	93.37	92.72	97.53	99.20	98.49	93.86		91.31
8 ft 0 in.								91.31	
8 ft 6 in.	94.91	92.04	90.25	96.00	97.99	96.74	92.95		89.47
9 ft 0 in.								91.29	
9 ft 6 in.	92.89	92.12	88.76	94.79	96.86	91.30	91.65		88.59
10 ft 0 in.	91.86	90.33	88.40	92.94	95.03	91.96	90.15	89.84	88.86

Note: All density values reported in units of lb per cu ft

SITE NO. 26

SCHOOL OF CIVIL ENGINEERING
OKLAHOMA STATE UNIVERSITY
SUBGRADE MOISTURE VARIATIONS PROJECT
TEST SITE DATA SUMMARY SHEET

LOCATION DATA:

Site No. 26 Highway No. US 64 County: Pawnee Date Installed: 7/25/66

Distance from access tube to Lane ℓ : 21' 6" a, 6" b, 21' 6" c

Exact Location:

In Pawnee County southeast of Cleveland, 2.4 miles southeast on US 64 from jct. of US 64 and S 99, 0.5 mile southeast of Cleveland drive-in theater. Marker on southwest fence row.

PAVEMENT/DESIGN DATA:

No. of Lanes: 2 Pavement Type: PCC Shoulder Type: Improved

Pavement Thickness: 8 in. ℓ , 2 in. Edge Latest Pavement Condition Rating: Excellent

Latest Traffic Count: 2900 vpd Heavy Truck Traffic: No

Terrain: Upland Drainage: Good Year of Original Paving: 1963

Original Design and History:

US Army Corps of Engineers relocation in conjunction with Keystone Dam construction. 24 ft width; ℓ 12 ft rt and lt: 8 in. PCC over sand base course; 12 ft to 22 ft rt and lt: double bituminous sealed shoulder over 6 in. SABC.

FIELD OBSERVATIONS BY RESEARCH PERSONNEL:

3/16/67 - Protective cover of "c" hole regROUTED.

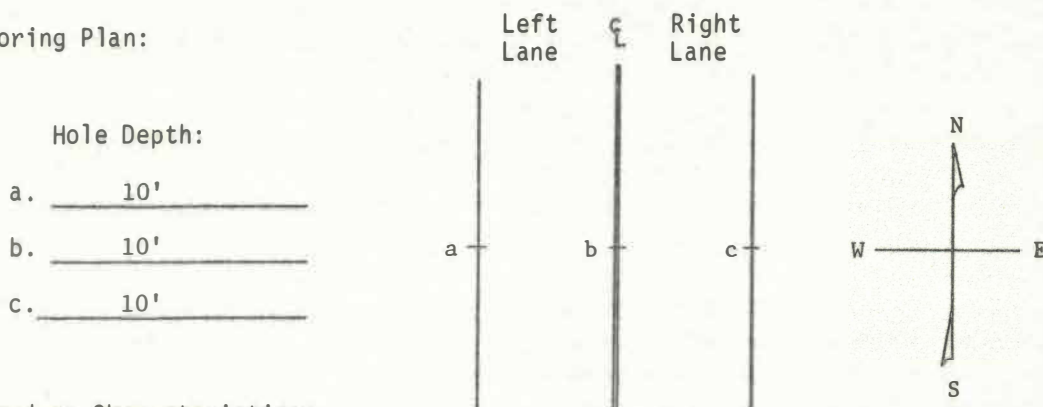
SCHOOL OF CIVIL ENGINEERING
OKLAHOMA STATE UNIVERSITY
Stillwater, Oklahoma
SUBGRADE MOISTURE VARIATION STUDY
SITE INSTALLATION INFORMATION

Installation: Pawnee U.S. 64 26 Date: 25 7 66
County Highway No. day month year

Location of site: Southeast of Cleveland, 2.4 miles southeast on U.S. 64 from jct.
of U.S. 64 and St. 99, 0.5 miles southeast of Cleveland drive-in theater.

Description of Terrain and Vegetation: Pavement on hilly upland terrain
with good drainage

Boring Plan:



Roadway Characteristics:

Pavement: Type P.C. Concrete
Width 12' Thickness 8"
Condition Excellent

Shoulders: Type Asphaltic Concrete Width 10'
Condition Excellent

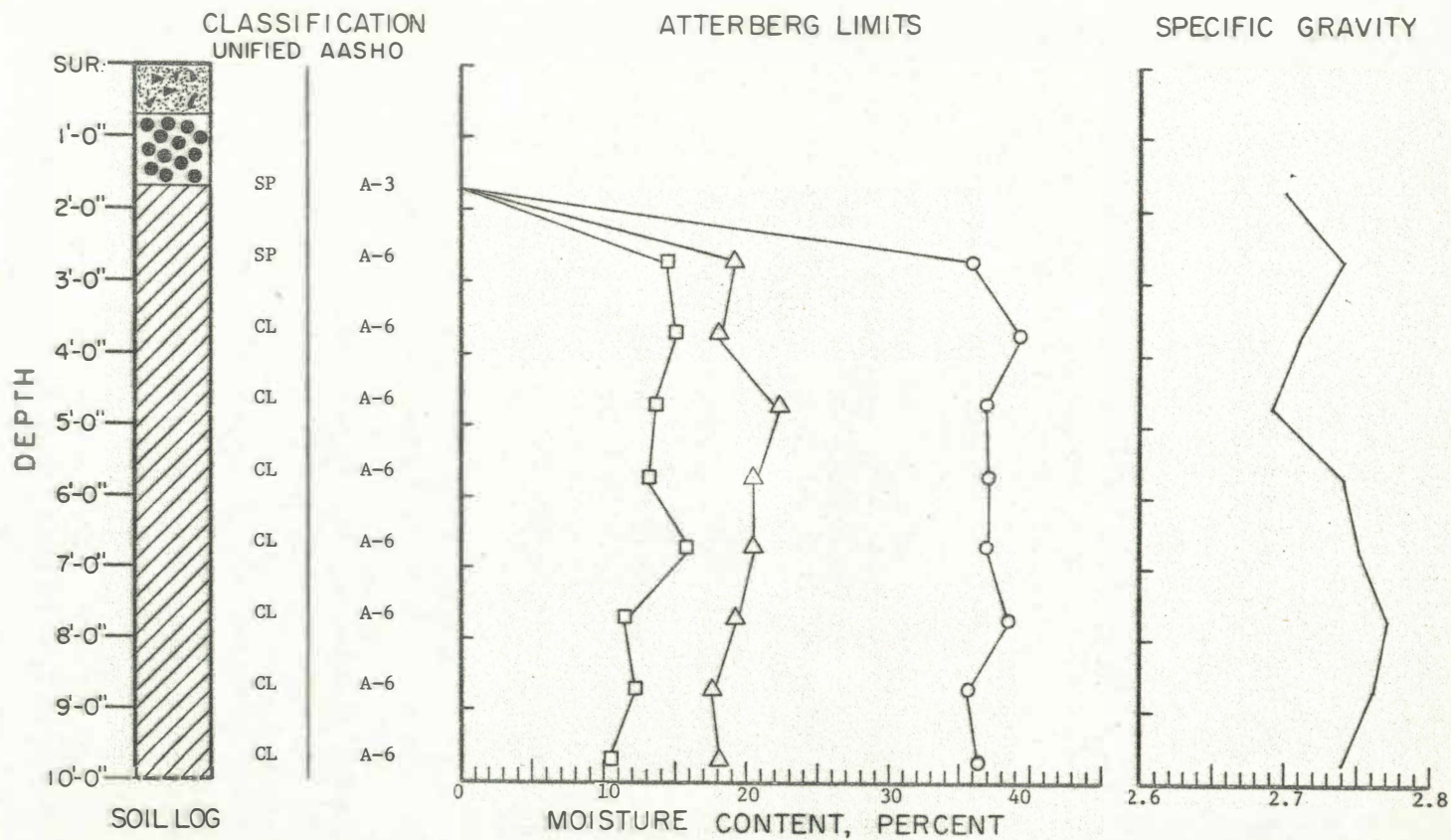
Base Course Characteristics Sand

SITE NO.: 26

COUNTY : Pawnee

HIGHWAY: US 64

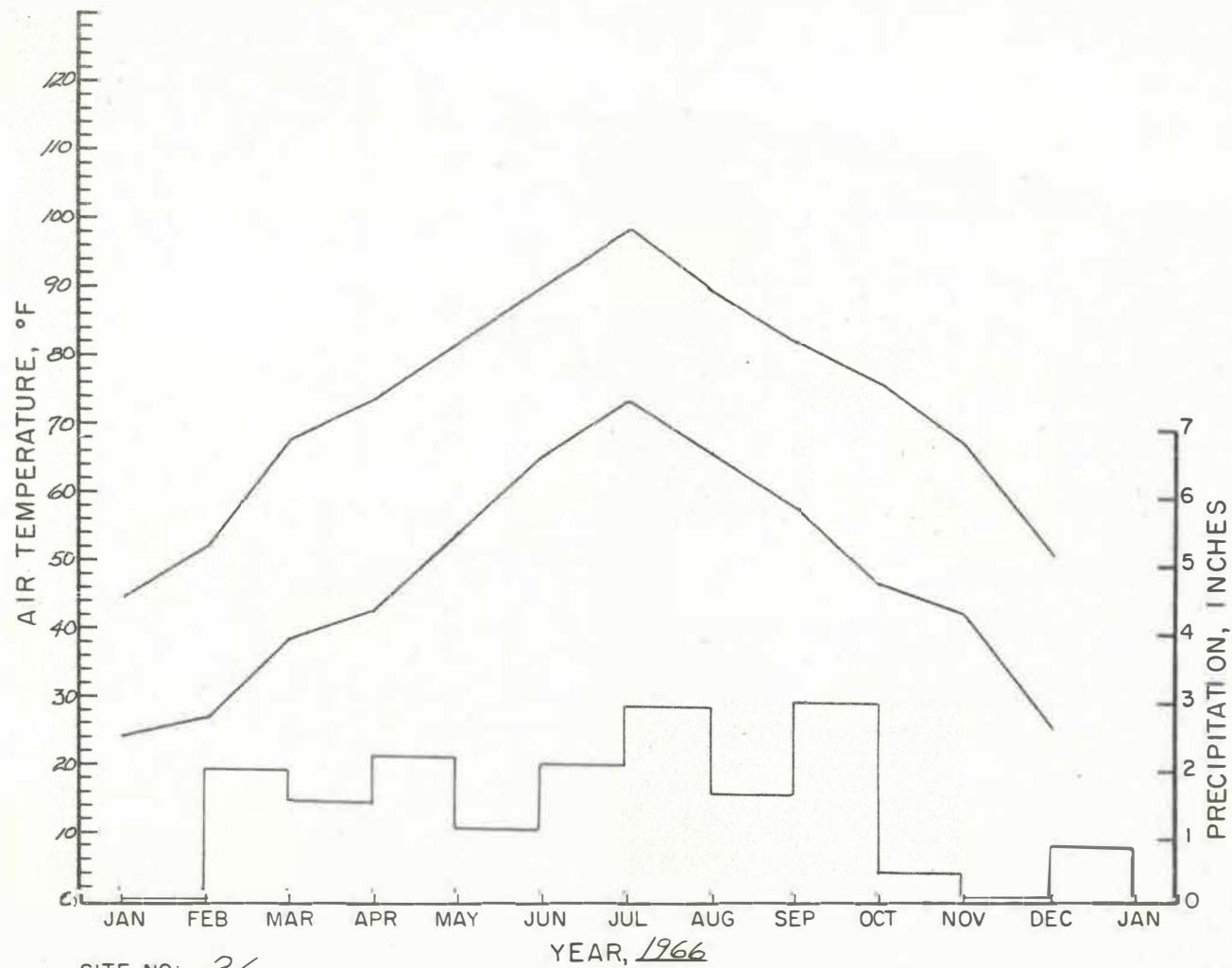
- LIQUID LIMIT
- ▲ PLASTIC LIMIT
- LINEAL SHRINKAGE



DATE : 15 December 1967

PLOTTED BY : AAP

SUBGRADE MOISTURE VARIATIONS PROJECT

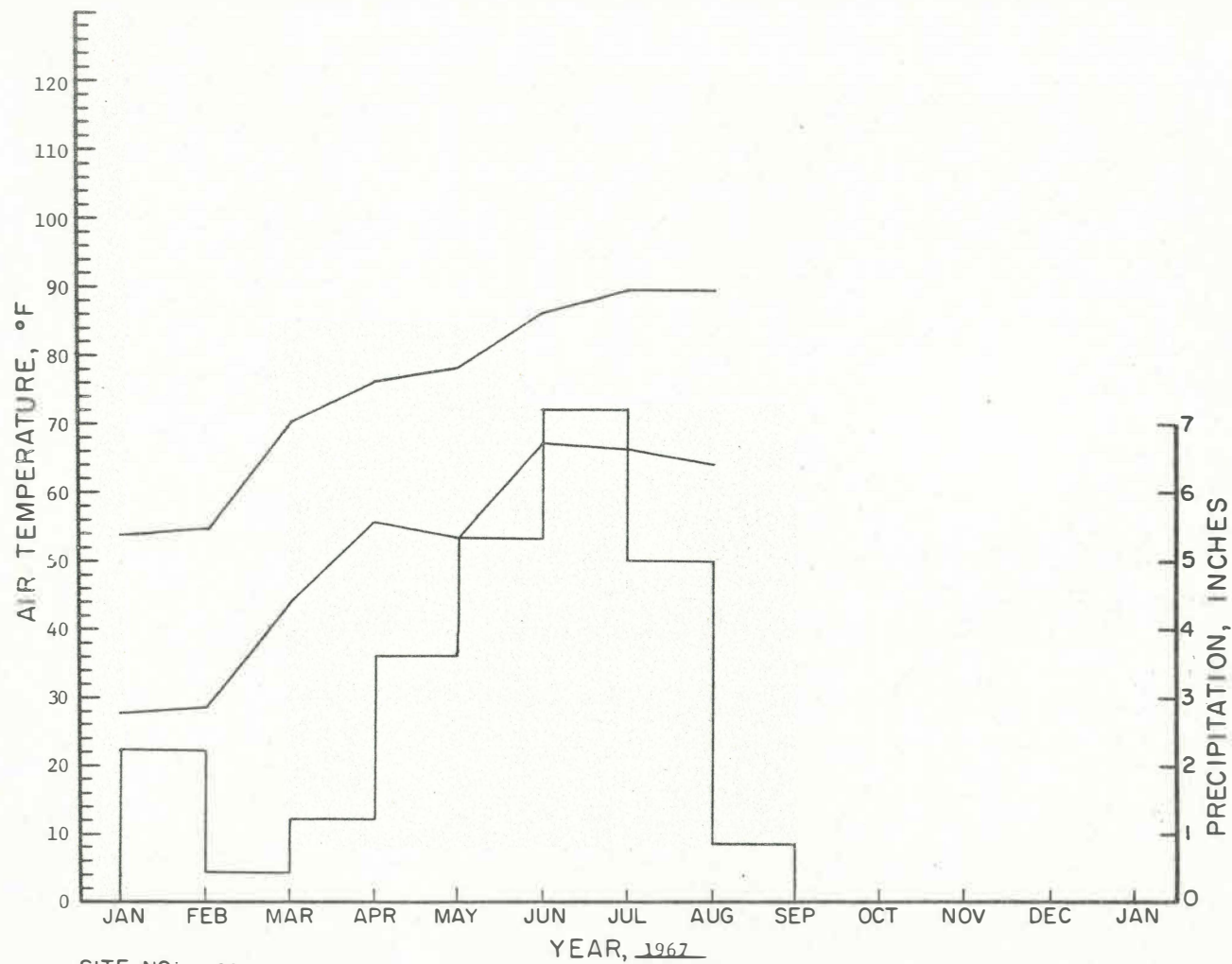


SITE NO: 26

COUNTY: PAWNEE

HIGHWAY: US 64

SUBGRADE MOISTURE VARIATIONS PROJECT

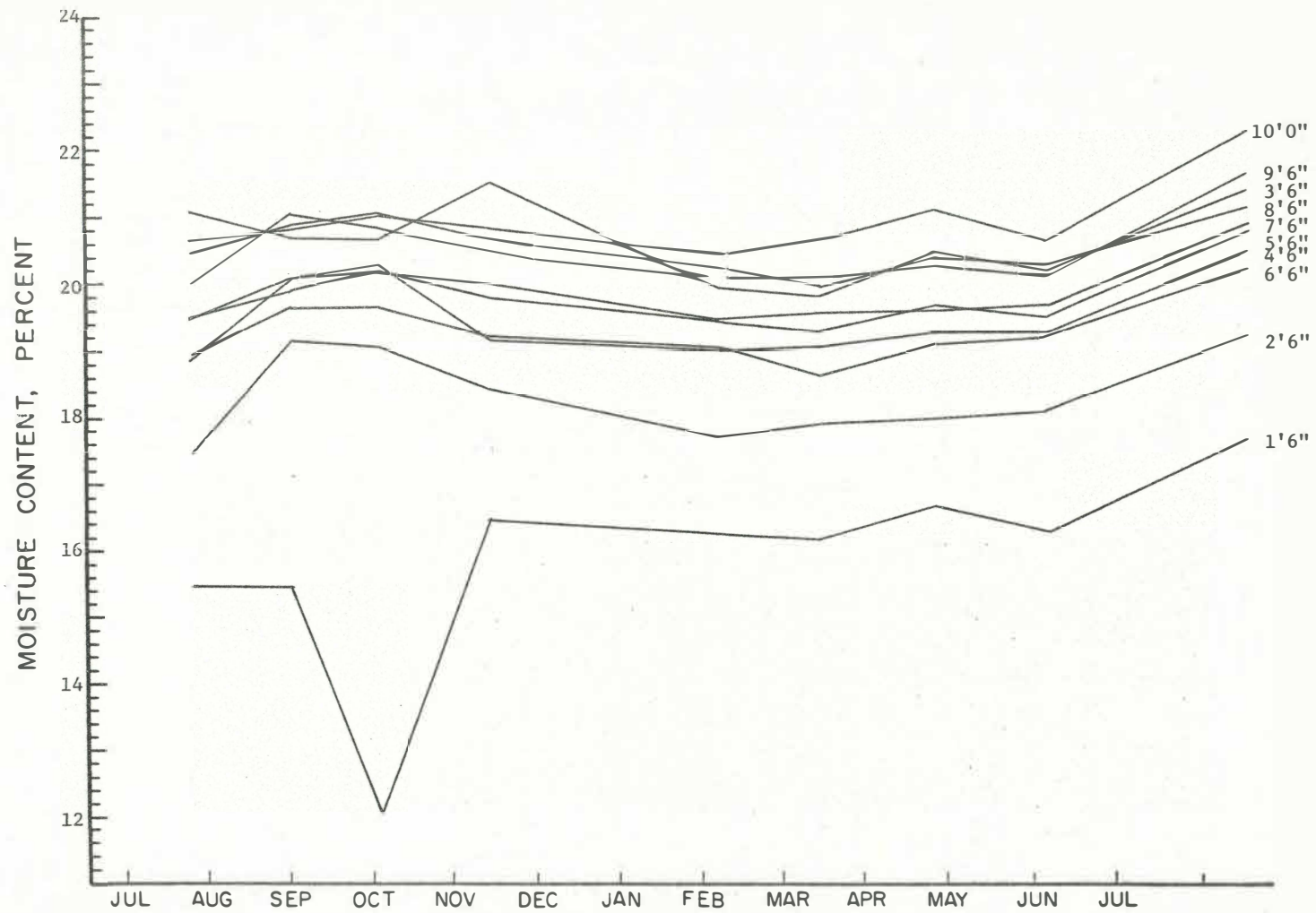


SITE NO: 26

COUNTY: Pawnee

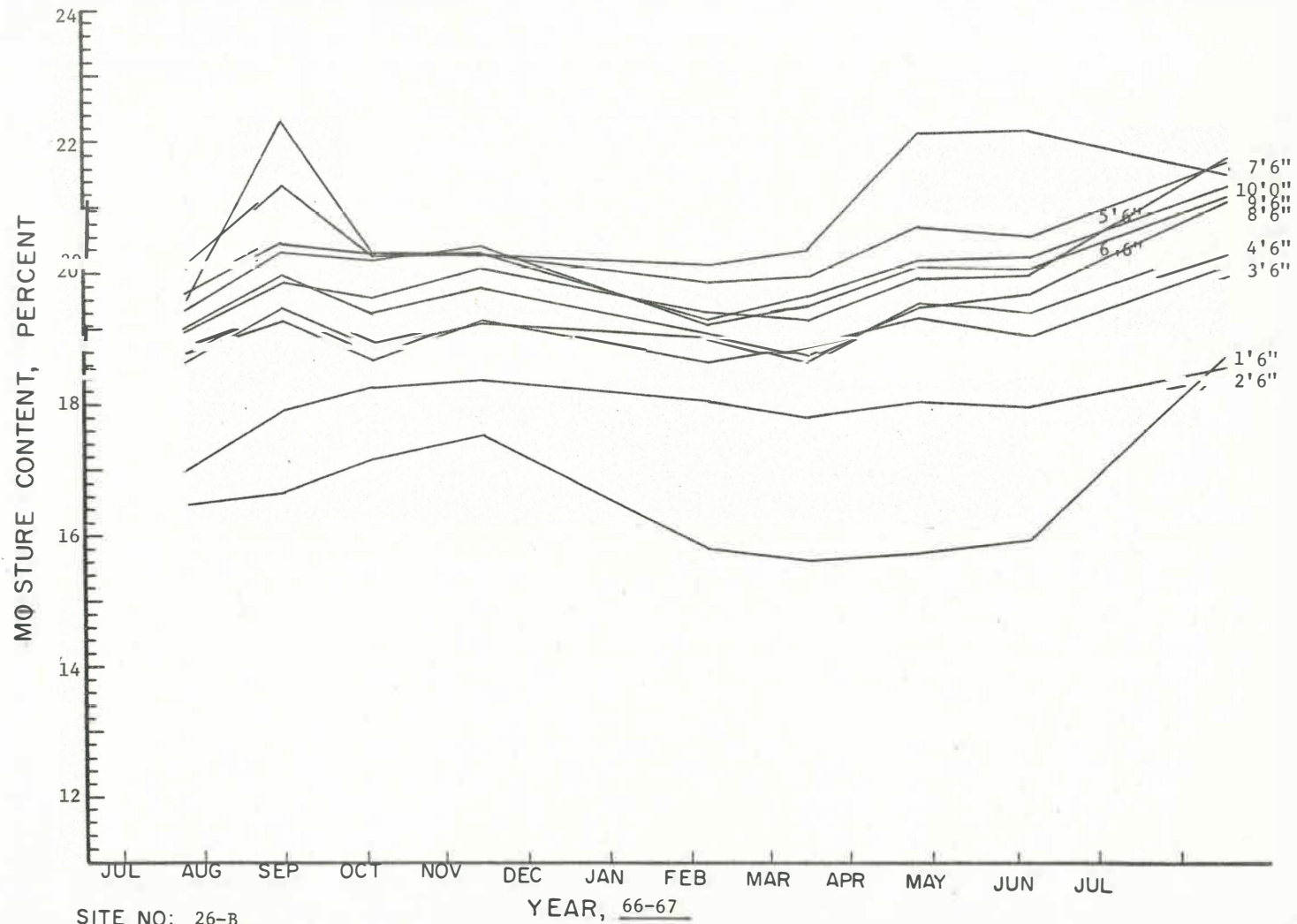
HIGHWAY: US 64

SUBGRADE MOISTURE VARIATIONS PROJECT



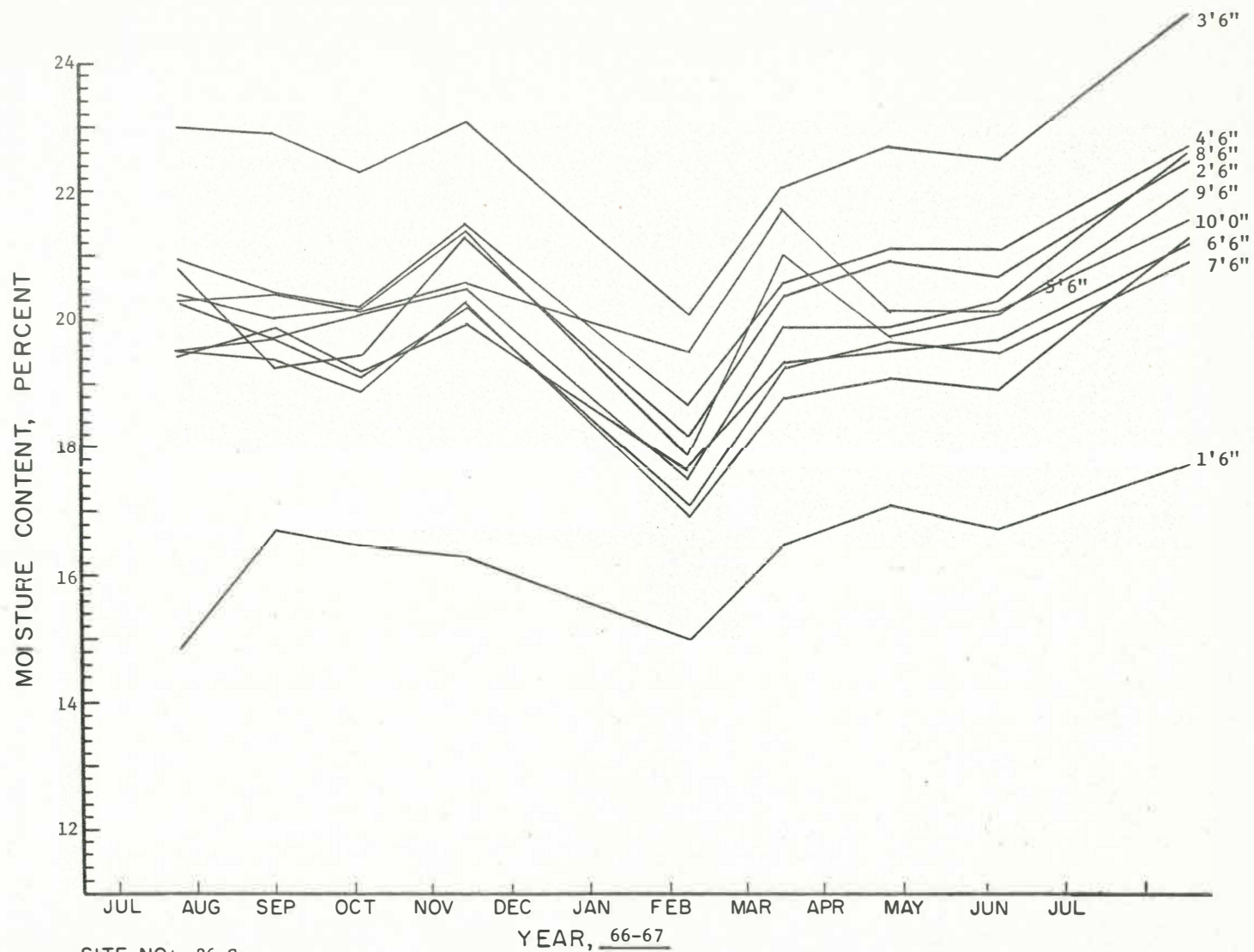
SITE NO: 26-A
 COUNTY: Pawnee
 HIGHWAY: US 64

SUBGRADE MOISTURE VARIATIONS PROJECT



SITE NO: 26-B
 COUNTY: Pawnee
 HIGHWAY: US 64

SUBGRADE MOISTURE VARIATIONS PROJECT



SITE NO: 26-C
 COUNTY: Pawnee
 HIGHWAY: US 64

SUBGRADE MOISTURE VARIATIONS PROJECT

SCHOOL OF CIVIL ENGINEERING
OKLAHOMA STATE UNIVERSITY

SUBGRADE MOISTURE VARIATIONS RESEARCH PROJECT

SUBGRADE SOIL DRY DENSITY TABULATION

Date of Measurement	August 1966			January 1967			August 1967		
Site & Hole Number	26-A	26-B	26-C	26-A	26-B	26-C	26-A	26-B	26-C
Depth from top of tube to bottom of probe									
1 ft 6 in.	115.86	111.98	113.91	117.52	125.88	111.93	107.12	105.21	102.99
2 ft 0 in.									
2 ft 6 in.	107.65	108.41	100.54	109.15	110.34	104.59	102.69	105.22	95.43
3 ft 0 in.									
3 ft 6 in.	101.96	107.28	90.63	102.71	110.12	94.10	97.06	100.52	85.07
4 ft 0 in.									
4 ft 6 in.	101.09	100.15	95.60	102.55	101.38	97.98	96.44	94.19	90.28
5 ft 0 in.									
5 ft 6 in.	98.60	101.79	99.14	100.89	102.58	101.09	94.66	96.04	93.12
6 ft 0 in.									
6 ft 6 in.	100.62	99.78	100.55	102.50	101.46	104.00	96.61	93.72	94.73
7 ft 0 in.									
7 ft 6 in.	99.06	98.80	100.84	100.54	99.51	103.81	94.40	92.33	95.40
8 ft 0 in.									
8 ft 6 in.	97.21	99.73	100.95	99.51	102.21	104.00	93.33	96.39	94.31
9 ft 0 in.									
9 ft 6 in.	99.09	100.47	100.72	99.83	102.11	104.44	93.20	95.51	96.13
10 ft 0 in.	98.47	99.70	101.46	98.91	99.48	103.29	92.18	94.09	94.96

Note: All density values reported in units of lb per cu ft

SITE NO. 27

SCHOOL OF CIVIL ENGINEERING
OKLAHOMA STATE UNIVERSITY
SUBGRADE MOISTURE VARIATIONS PROJECT
TEST SITE DATA SUMMARY SHEET

LOCATION DATA:

Site No. 27 Highway No. I 35 County: Logan Date Installed: 9/6/66

Distance from access tube to Lane ℓ: 21' 0" a, 1' 0" b, 13' 0" c

Exact Location:

In Logan County southwest of Guthrie, 6.0 miles north on I 35 from jct. of I 35 and S 33. Approximately 100 yds south of overpass. Site in west lane of divided highway. Marker on west fence row.

PAVEMENT/DESIGN DATA:

No. of Lanes: 4D Pavement Type: PCC Shoulder Type: Improved

Pavement Thickness: 10 in. ℓ, 3 in. Edge Latest Pavement Condition Rating: Good

Latest Traffic Count: 7400 vpd Heavy Truck Traffic: Yes

Terrain: Upland/ Drainage: Good Year of Original Paving: 1960
Cut

Original Design and History:

24 ft width; ℓ to 12 ft lt and rt: 9 in. air-entrained PCC/4in. sand/8 in. subbase; inside 12 ft to 16 ft and outside 12 ft to 22 ft: double bituminous surface shoulder over 7 in. soil-cement base.

FIELD OBSERVATIONS BY RESEARCH PERSONNEL:

12/15/66 - Large transverse crack across pavement 3 ft from expansion joint, between site and north expansion joint.

3/23/67 - Protective cover of hole "a" regROUTED.

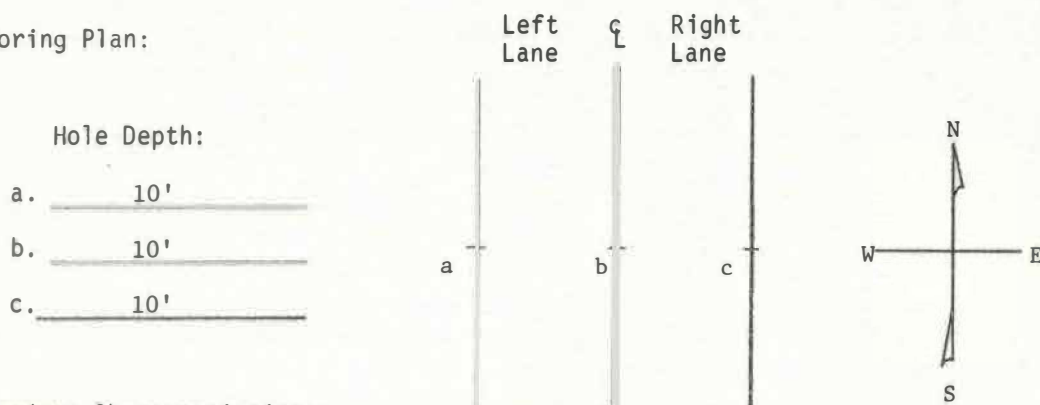
SCHOOL OF CIVIL ENGINEERING
OKLAHOMA STATE UNIVERSITY
Stillwater, Oklahoma
SUBGRADE MOISTURE VARIATION STUDY
SITE INSTALLATION INFORMATION

Installation: Logan I.-35 27 Date: 6 9 66
County Highway No. day month year

Location of site: Northeast of Guthrie, 6.0 miles north on I-35 of jct. of
I-35 and St. 33; approximately 100 yards south of overpass; site in west lane
of divided four-lane highway.

Description of Terrain and Vegetation: Pavement in rolling upland terrain in
slight cut.

Boring Plan:



Roadway Characteristics:

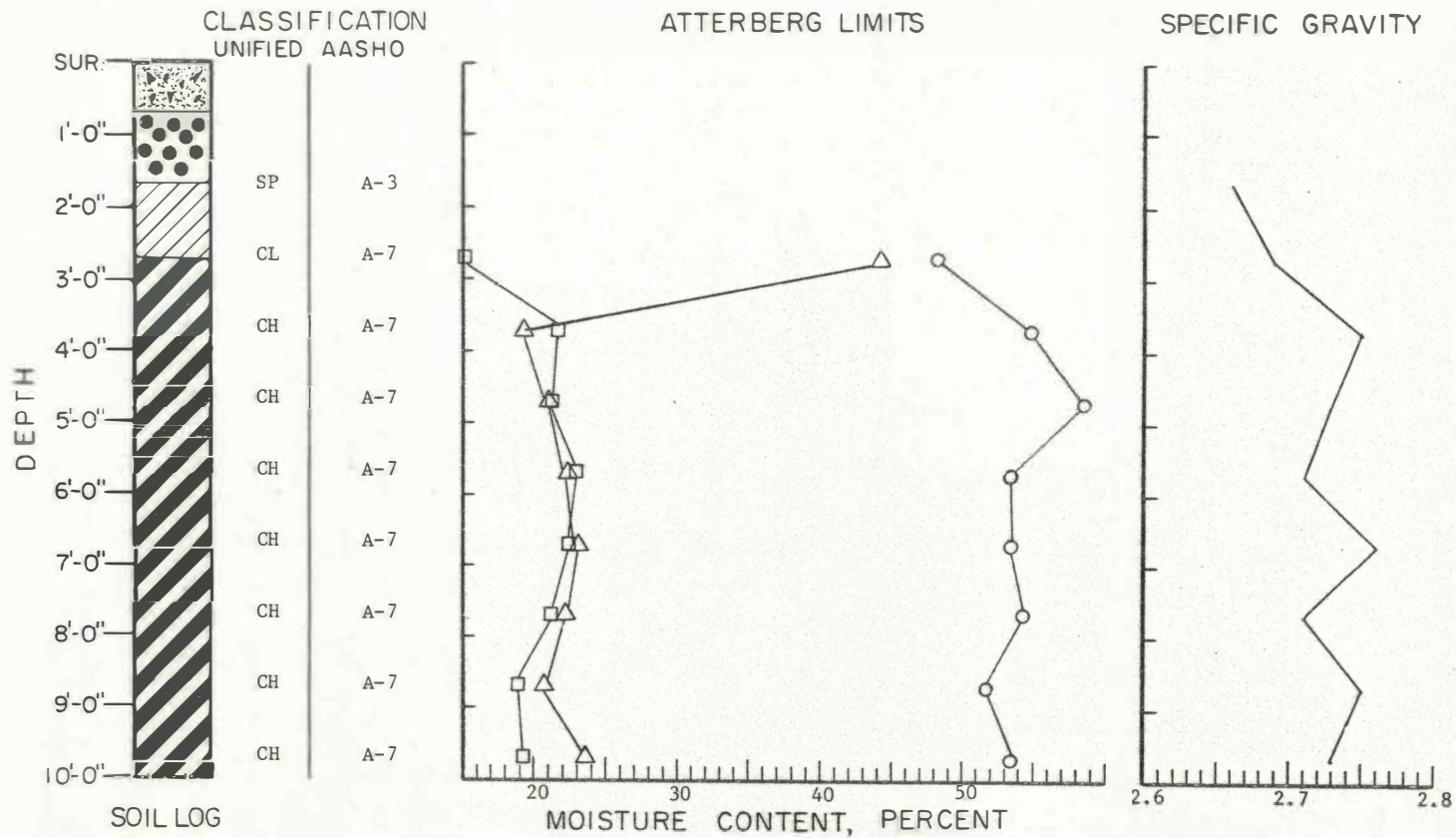
Pavement: Type P.C. Concrete
Width 24' Thickness 10"
Condition Excellent

Shoulders: Type Asphaltic Concrete Width R-4' L-10'
Condition Excellent

Base Course Characteristics Soil cement on shoulders - stabilized
crushed rock under pavement

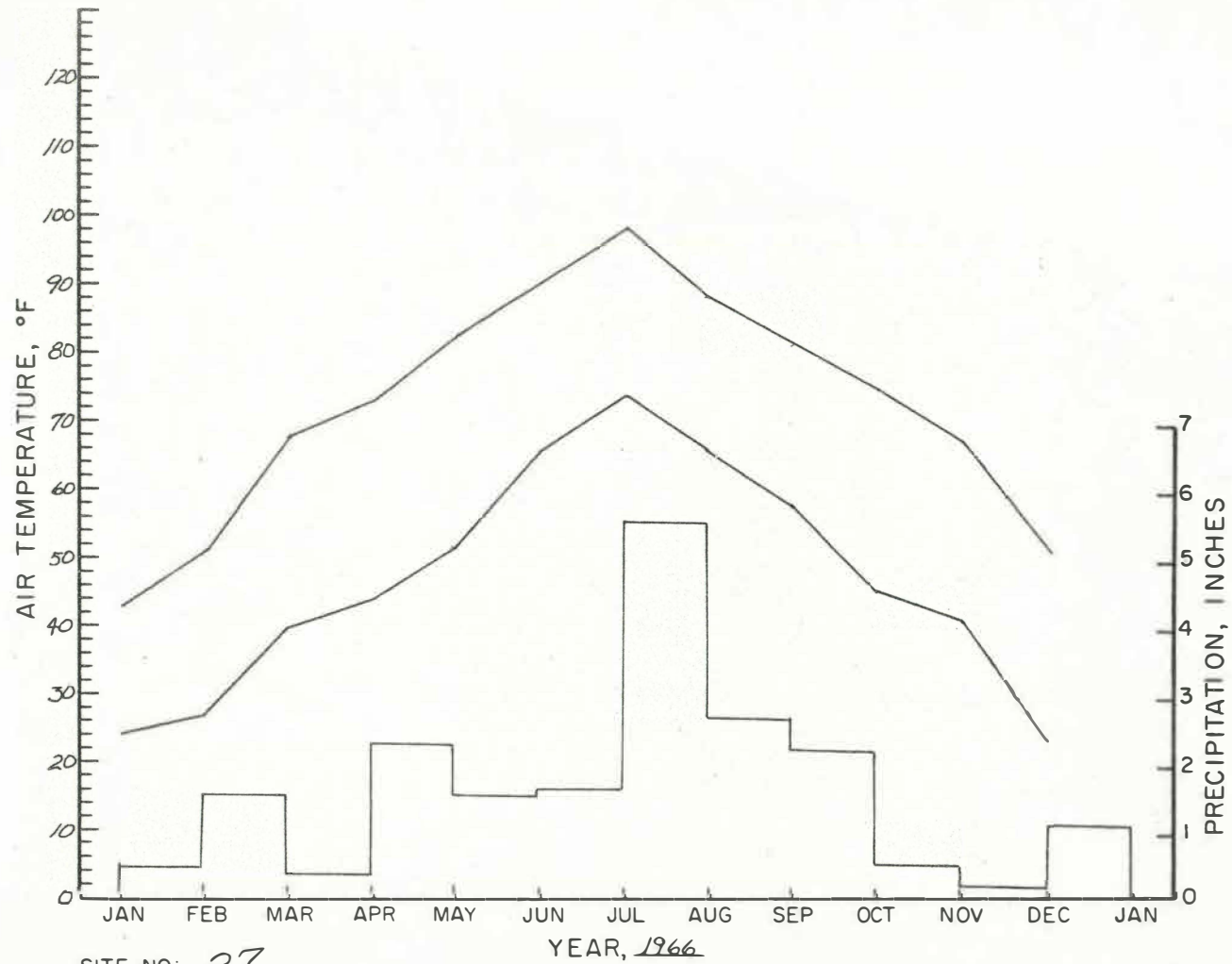
SITE NO.: 27
 COUNTY : Logan
 HIGHWAY : T-35

● LIQUID LIMIT
 ▲ PLASTIC LIMIT
 ■ LINEAL SHRINKAGE



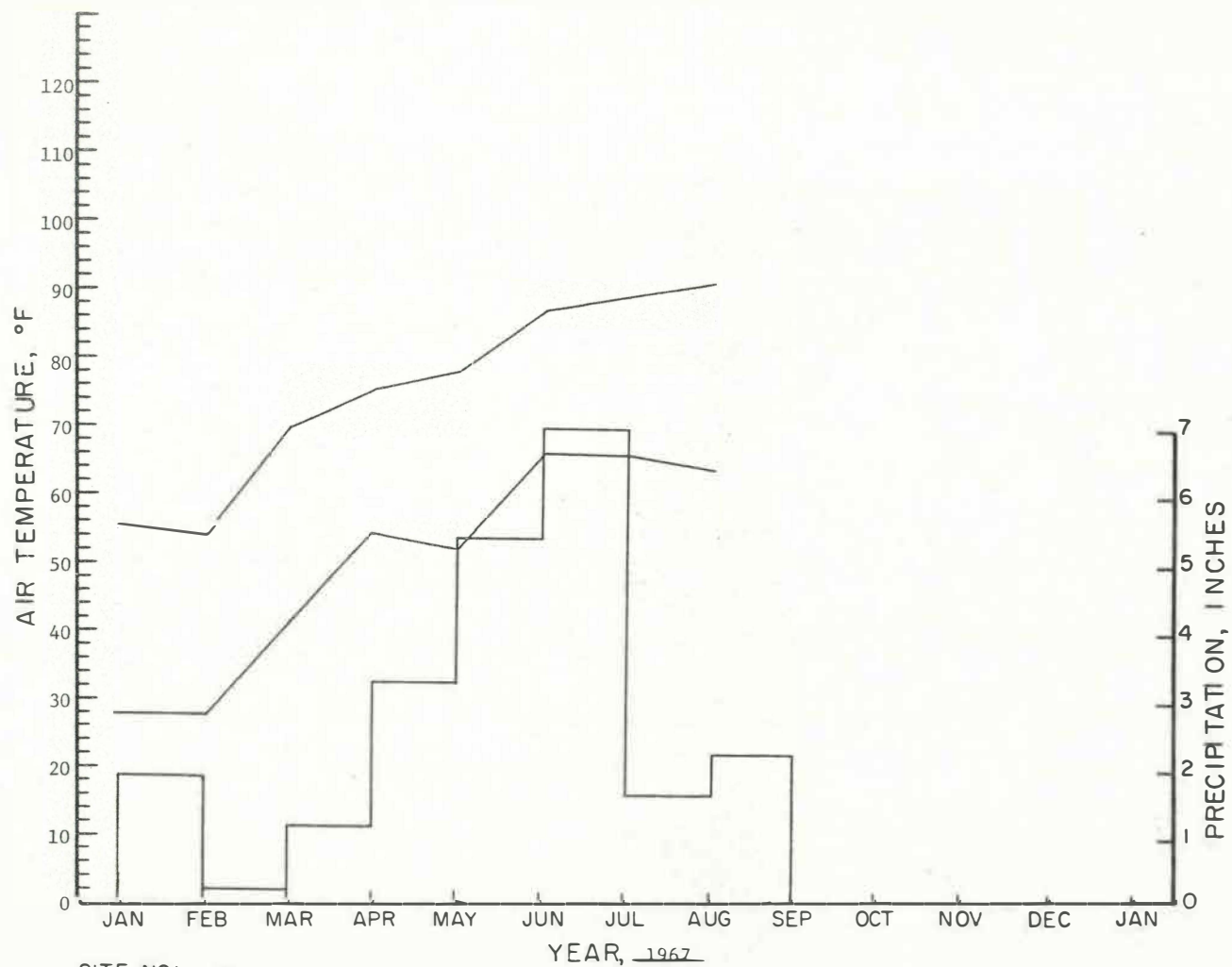
DATE : 19 December 1967
 PLOTTED BY : AAP

SUBGRADE MOISTURE VARIATIONS PROJECT



SITE NO: 27
COUNTY: Logan
HIGHWAY: I-35

SUBGRADE MOISTURE VARIATIONS PROJECT

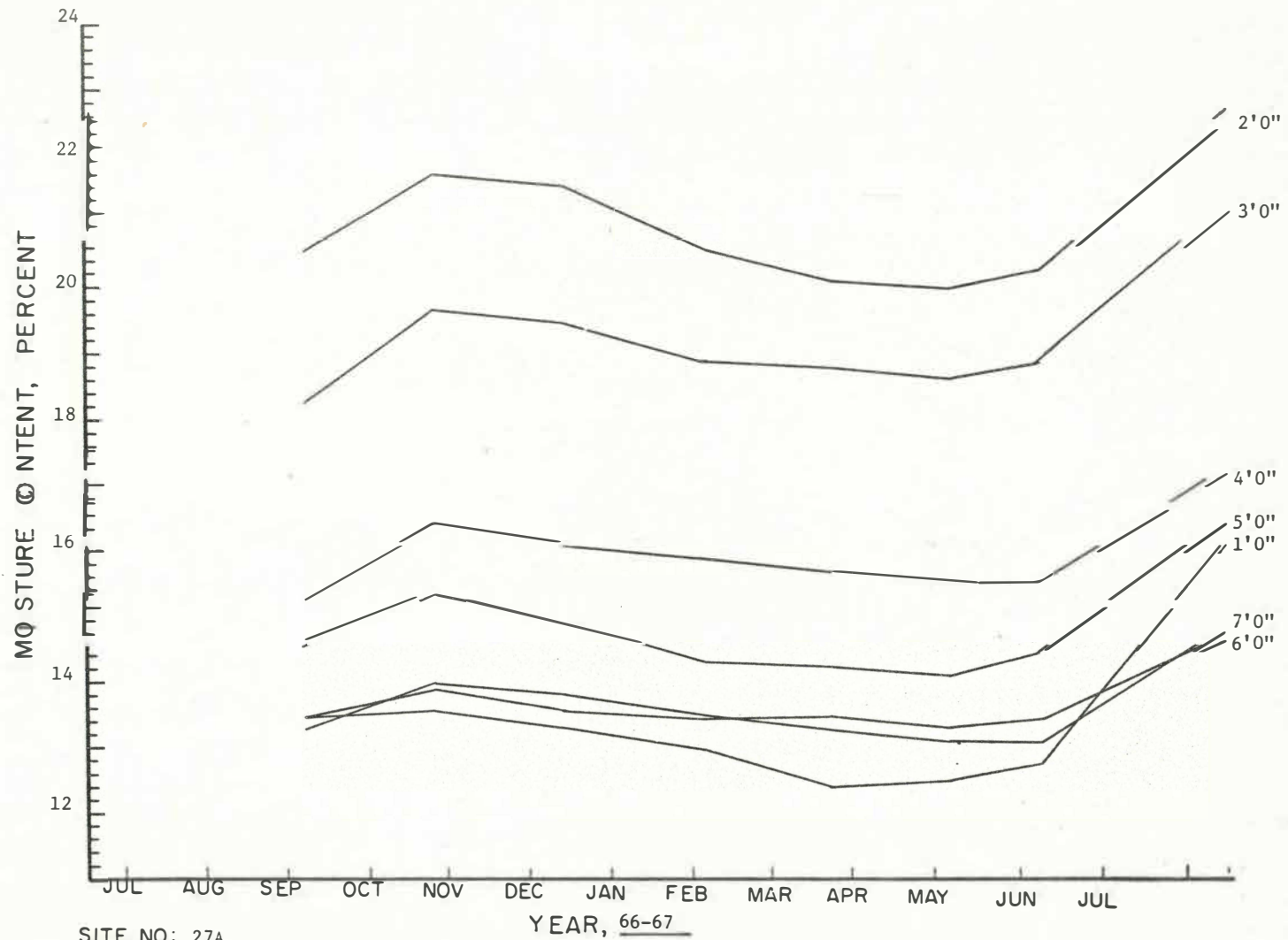


SITE NO: 27

COUNTY: Logan

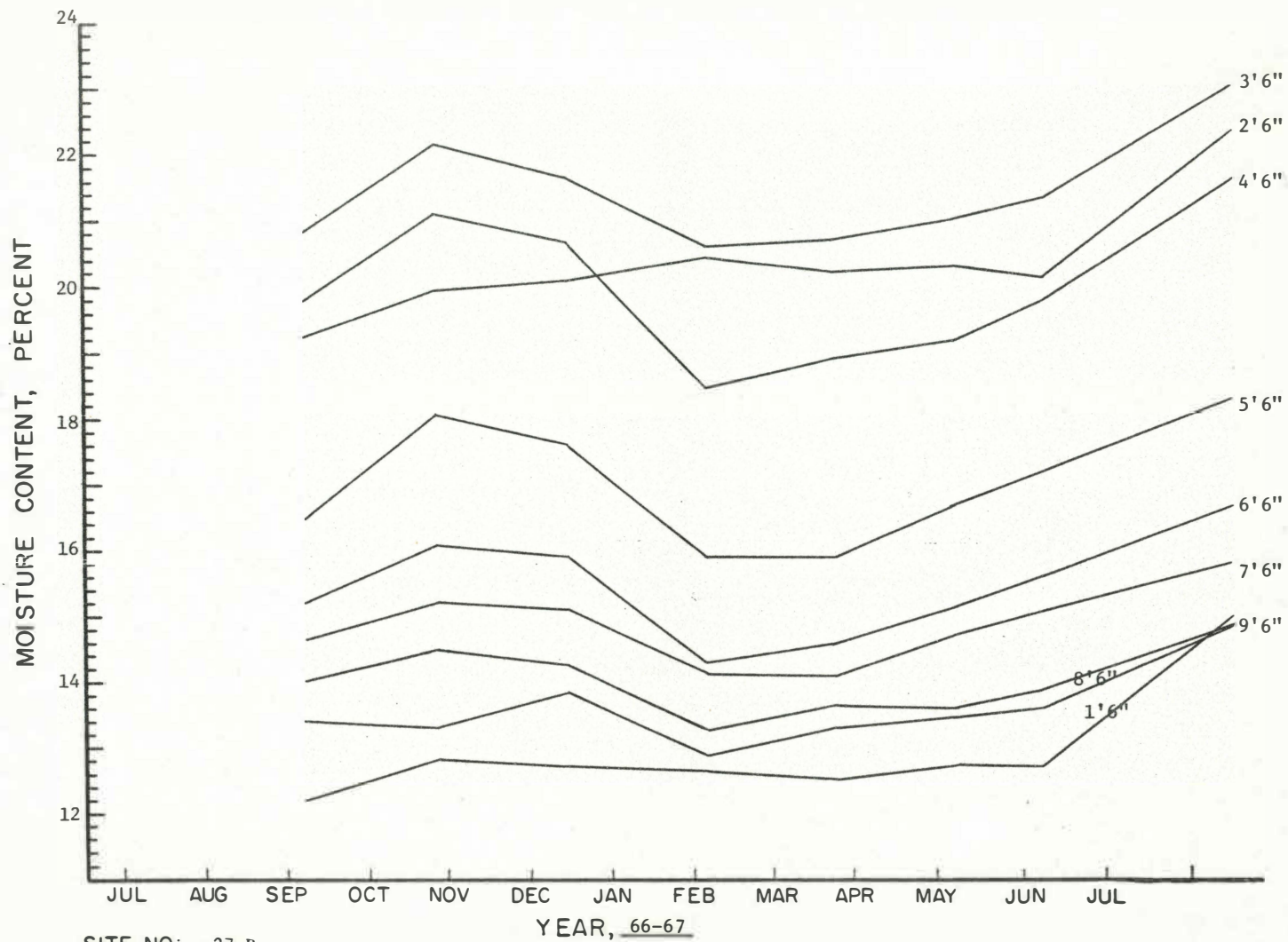
HIGHWAY: I-35

SUBGRADE MOISTURE VARIATIONS PROJECT



SITE NO: 27A
 COUNTY: Logan
 HIGHWAY: I-35

SUBGRADE MOISTURE VARIATIONS PROJECT

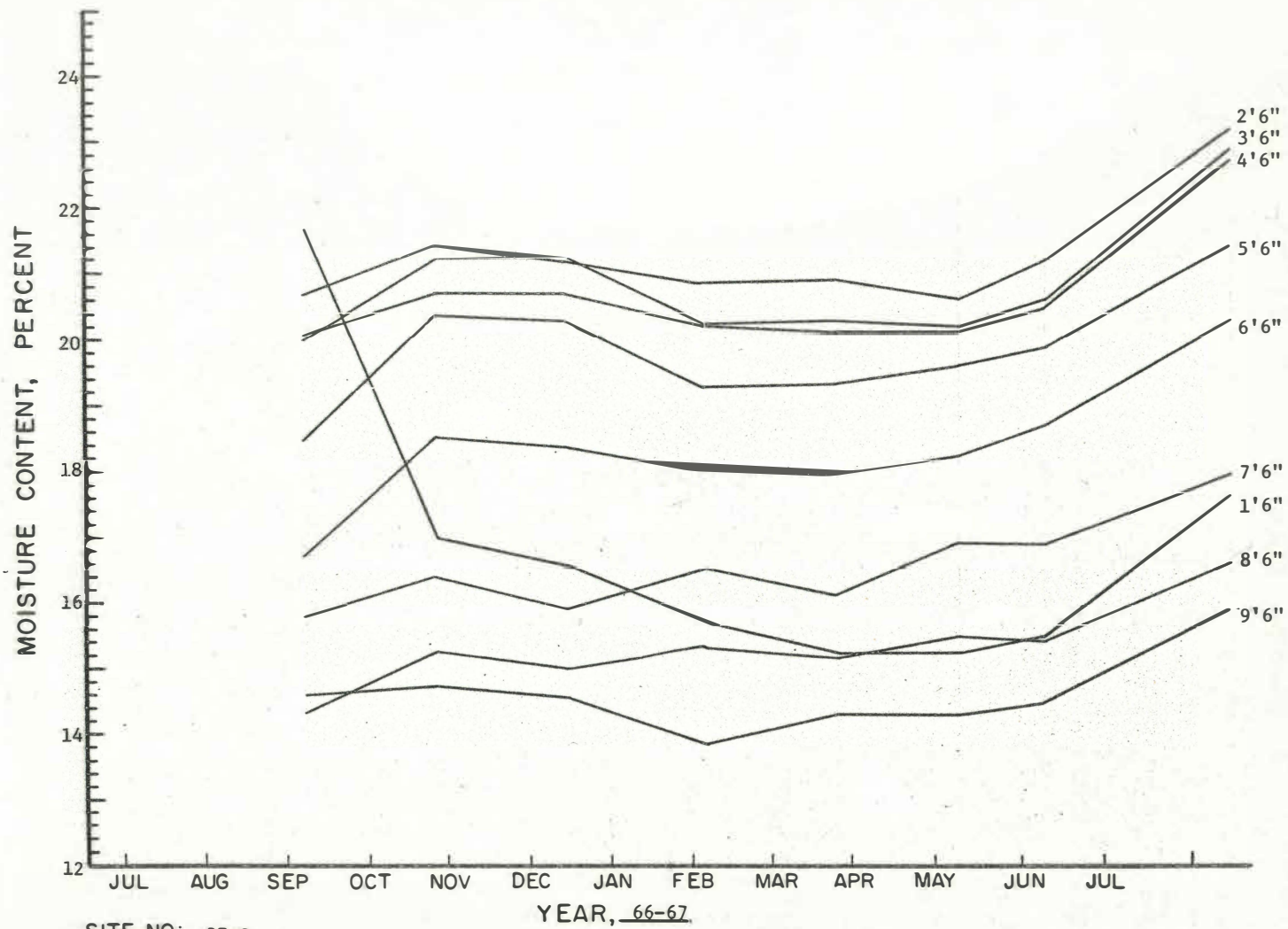


SITE NO: 27-B

COUNTY: Logan

HIGHWAY: I-35

SUBGRADE MOISTURE VARIATIONS PROJECT



SITE NO: 27-c
 COUNTY: Logan
 HIGHWAY: I-35

SUBGRADE MOISTURE VARIATIONS PROJECT

SCHOOL OF CIVIL ENGINEERING
OKLAHOMA STATE UNIVERSITY

SUBGRADE MOISTURE VARIATIONS RESEARCH PROJECT

SUBGRADE SOIL DRY DENSITY TABULATION

Date of Measurement	August 1966			January 1967			August 1967		
Site & Hole Number	27-A	27-B	27-C	27-A	27-B	27-C	27-A	27-B	27-C
Depth from top of tube to bottom of probe									
1 ft 6 in.					139.36				
2 ft 0 in.	118.87	126.33	114.53	130.15		108.50	101.75		95.14
2 ft 6 in.					121.19			101.98	
3 ft 0 in.	98.23	101.66	93.83	104.24		99.55	94.41		91.00
3 ft 6 in.					101.62			94.31	
4 ft 0 in.	100.41	95.03	96.41	106.36		102.02	96.34		92.88
4 ft 6 in.					98.36			91.22	
5 ft 0 in.	106.01	93.09	96.58	113.22		101.39	103.90		92.92
5 ft 6 in.					100.89			93.94	
6 ft 0 in.	111.61	101.23	96.78	119.72		103.86	107.77		96.02
6 ft 6 in.					109.00			101.91	
7 ft 0 in.	118.86	104.33	98.77	123.82		105.80	112.62		97.61
7 ft 6 in.					111.45			103.53	
8 ft 0 in.	118.22	105.65	101.54	124.12		108.22	112.12		102.21
8 ft 6 in.					112.82			107.32	
9 ft 0 in.		116.79	108.15			115.06			108.09
9 ft 6 in.					123.18			113.60	
10 ft 0 in.		115.83	114.83		121.66	120.66		113.58	110.58

Note: All density values reported in units of lb per cu ft

SITE NO. 28

SCHOOL OF CIVIL ENGINEERING
OKLAHOMA STATE UNIVERSITY
SUBGRADE MOISTURE VARIATIONS PROJECT
TEST SITE DATA SUMMARY SHEET

LOCATION DATA:

Site No. 28 Highway No. S 33 County: Payne Date Installed: 8/31/66

Distance from access tube to Lane ℓ: 23' 0" a, 1' 0" b, 24' 0" c

Exact Location:

In Payne County east of Cushing, 1.5 miles east on S 33 from jct. of S 33 and S 18, at end of four-land undivided highway. Marker on north fence row.

PAVEMENT/DESIGN DATA:

No. of Lanes: 4UD Pavement Type: AC/PCC Shoulder Type: Natural

Pavement Thickness: 9 in. ℓ, 8 in. Edge Latest Pavement Condition Rating: Good

Latest Traffic Count: 3700 vpd Heavy Truck Traffic: Yes

Terrain: Creek- Drainage: Fair Year of Original Paving: 1930
bottom

Original Design and History:

Before 1963, 48 ft width; ℓ to 24 ft rt and lt: 7 in. PCC/4 in. sand/8 in. subbase; with 5 in. intergal curb. In 1963, 2 in. AC overlay.

FIELD OBSERVATIONS BY RESEARCH PERSONNEL:

10/7/66 - 2 in. of water in access tube "a", tube removed, emptied, and replaced.

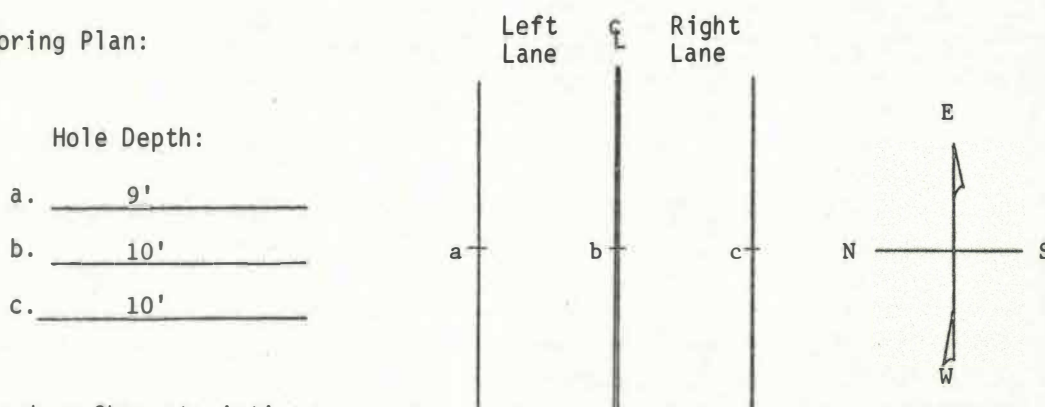
SCHOOL OF CIVIL ENGINEERING
OKLAHOMA STATE UNIVERSITY
Stillwater, Oklahoma
SUBGRADE MOISTURE VARIATION STUDY
SITE INSTALLATION INFORMATION

Installation: Payne St. 33 28 . Date: 31 8 66
County Highway No. day month year

Location of site: East of Cushing, 1.5 miles east on St. 33, from jct. of St.
33 and St. 18, at end of four-lane undivided highway.

Description of Terrain and Vegetation: Pavement in gently rolling bottom
area.

Boring Plan:



Roadway Characteristics:

Pavement: Type Asphaltic Concrete over P.C. Concrete
Width 50' Thickness 1" AC & 8" PC
Condition Good

Shoulders: Type Grass Width _____
Condition _____

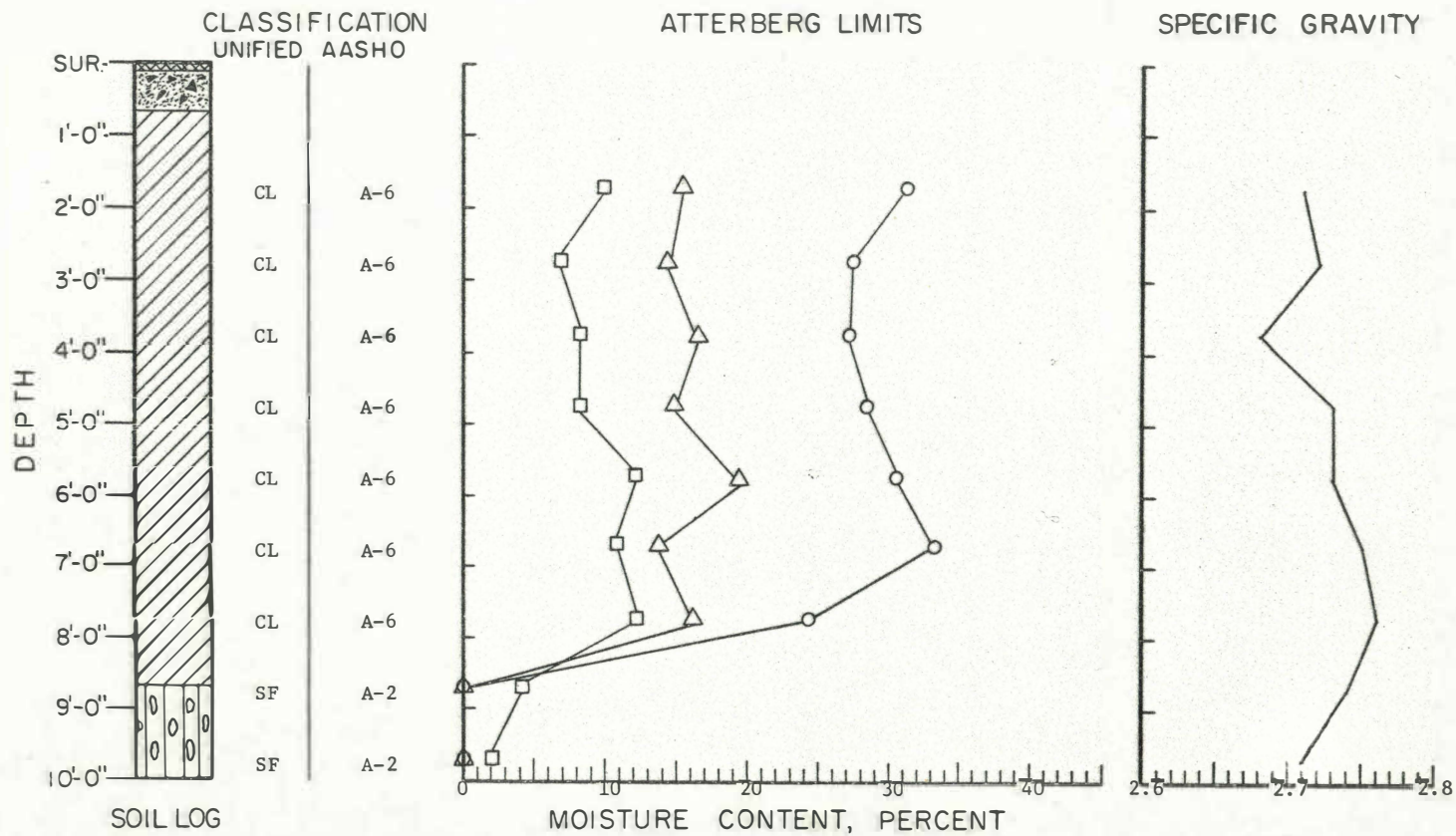
Base Course Characteristics Natural sand

SITE NO: 28

COUNTY : Payne

HIGHWAY : State 33

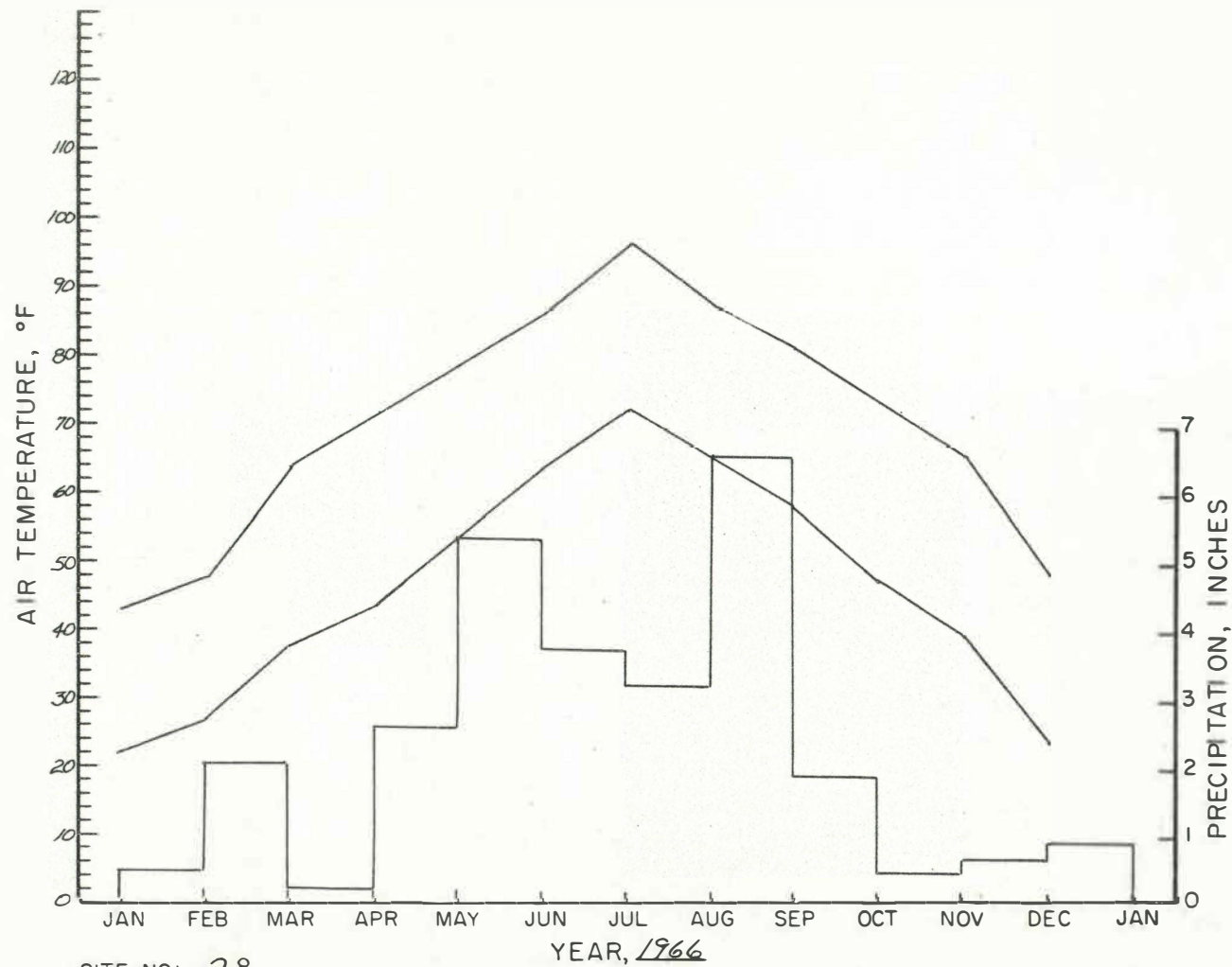
- LIQUID LIMIT
- ▲ PLASTIC LIMIT
- LINEAL SHRINKAGE



DATE : 19 December 1967

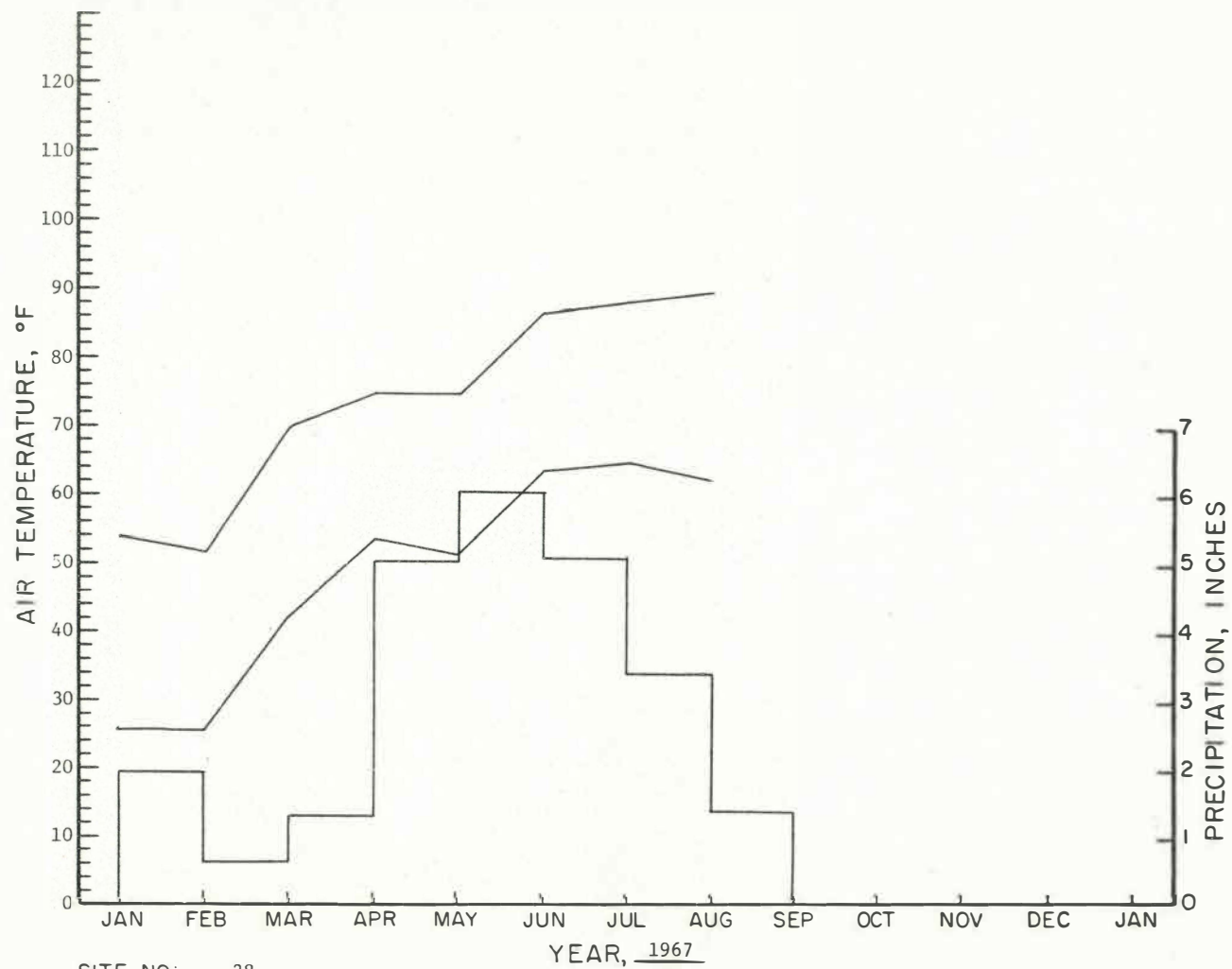
PLOTTED BY: AAP

SUBGRADE MOISTURE VARIATIONS PROJECT



SITE NO: 28
COUNTY: Payne
HIGHWAY: SH33

SUBGRADE MOISTURE VARIATIONS PROJECT

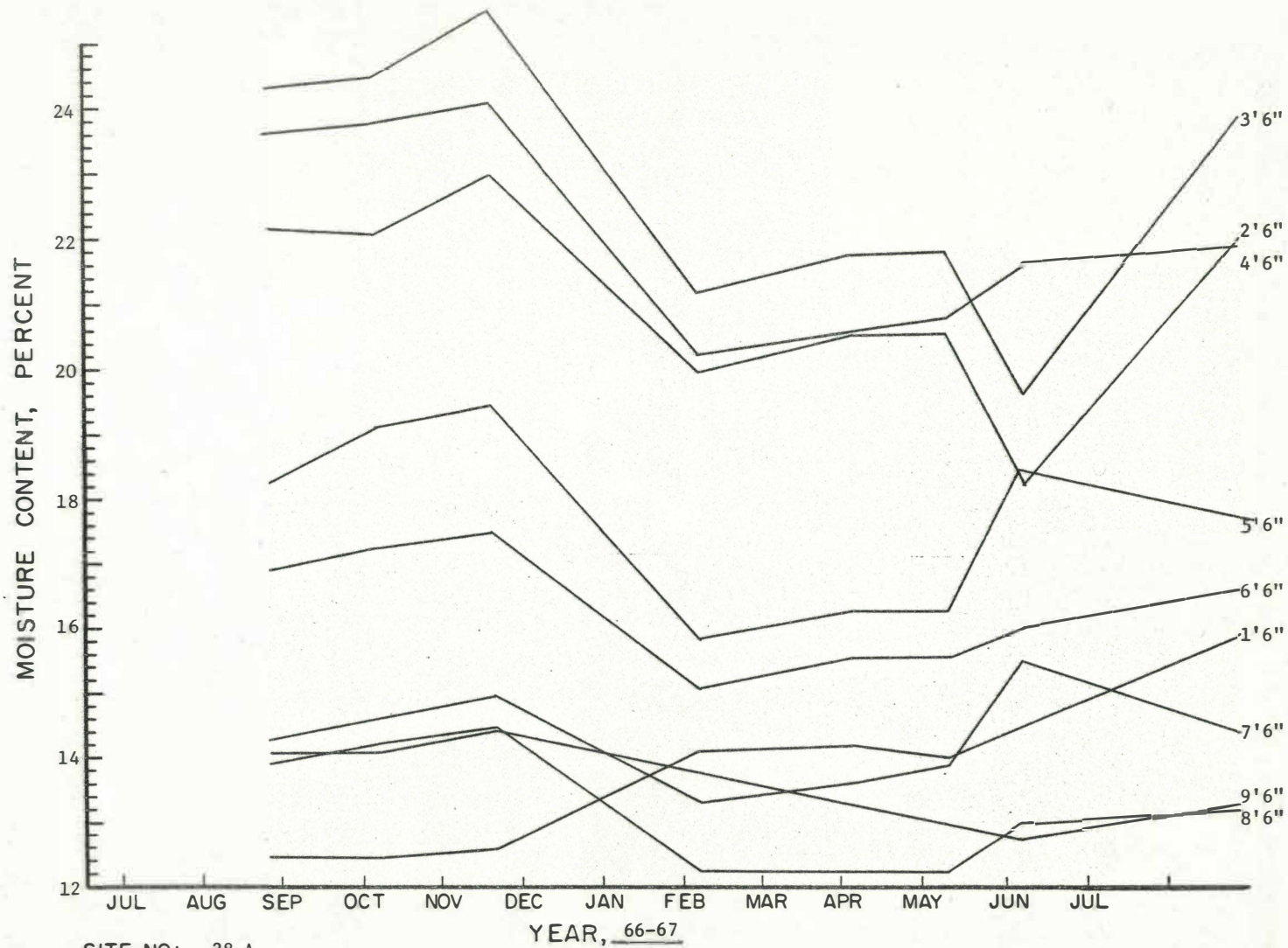


SITE NO: 28

COUNTY: Payne

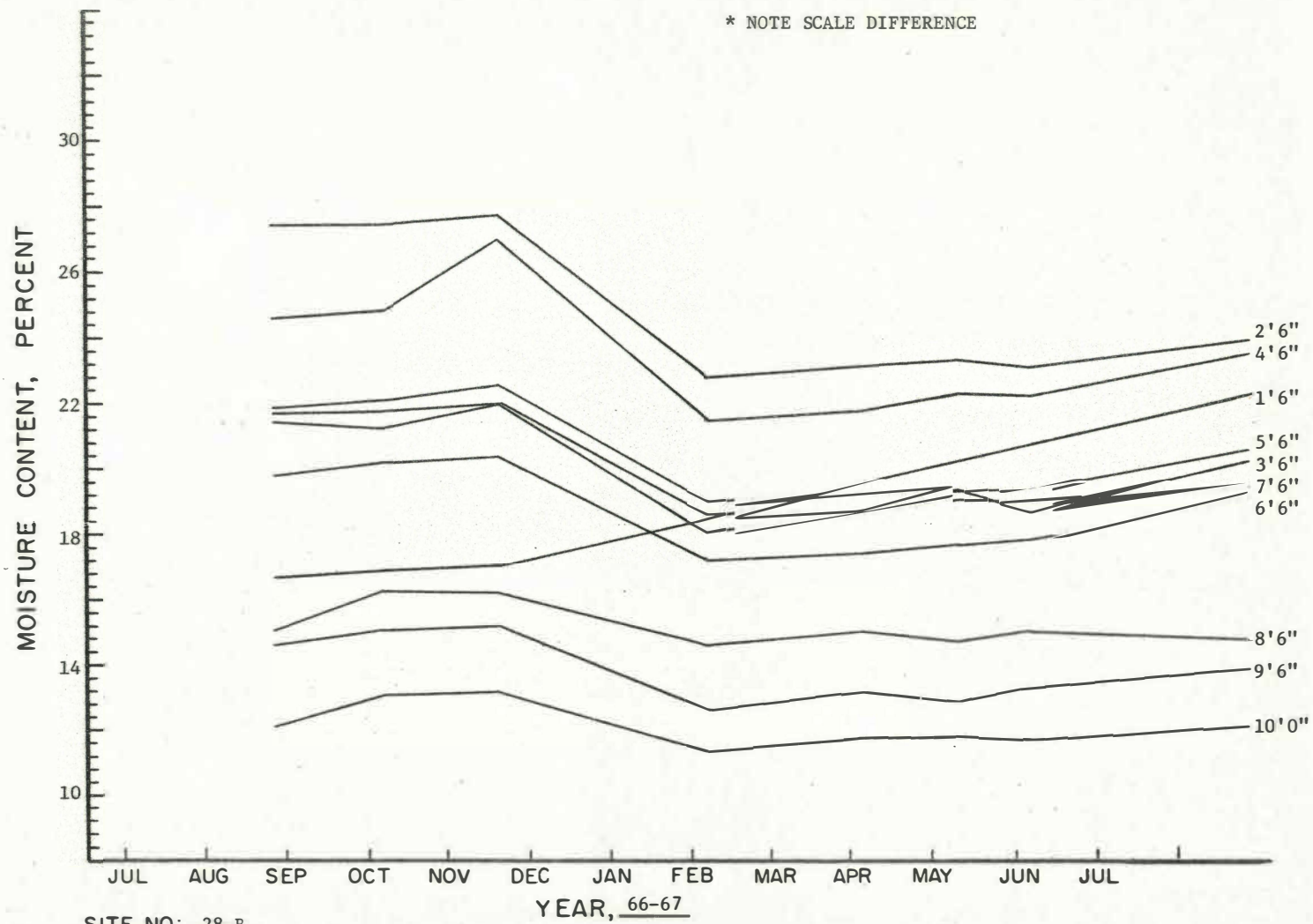
HIGHWAY: SH 33

SUBGRADE MOISTURE VARIATIONS PROJECT



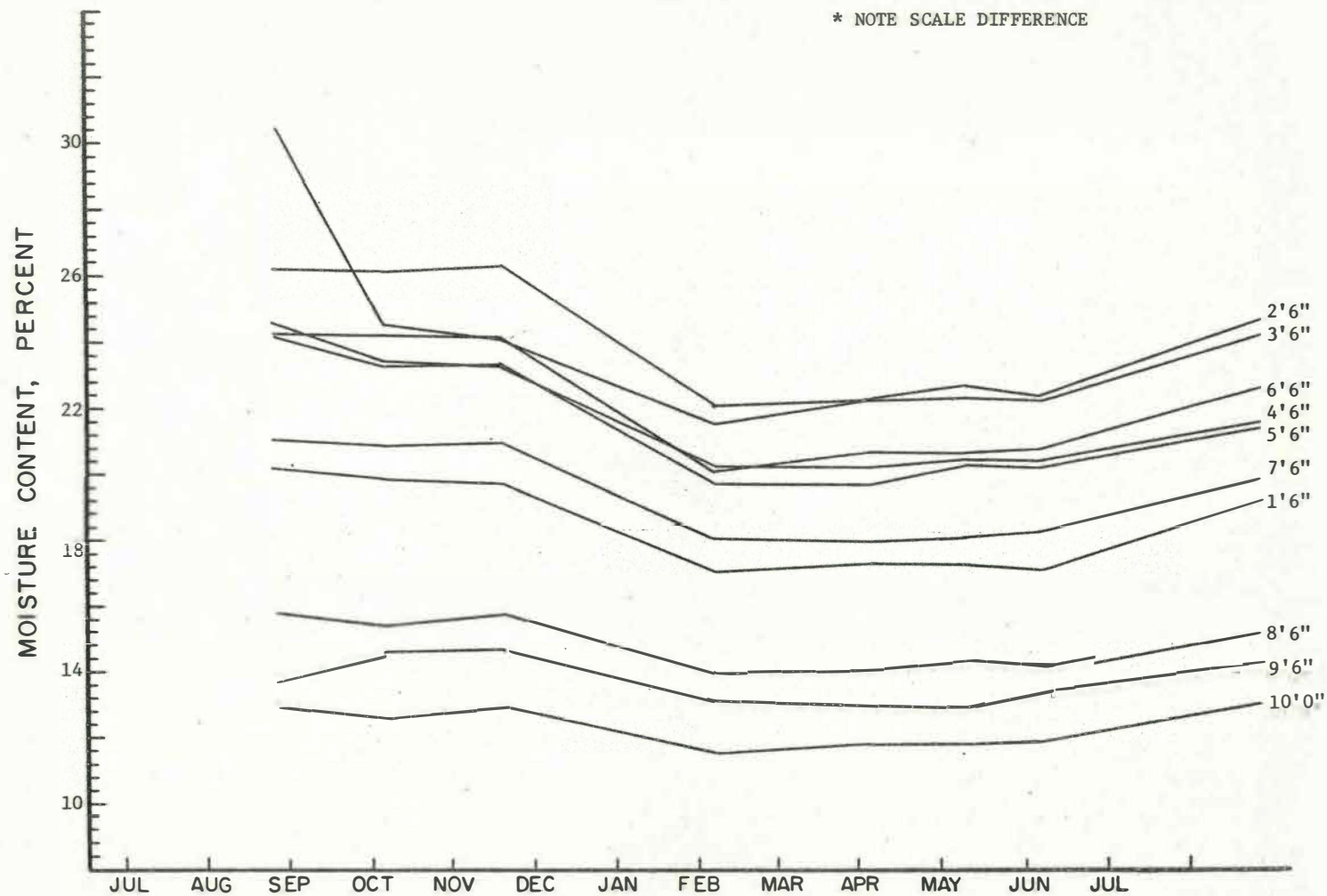
SITE NO: 28-A
COUNTY: Payne
HIGHWAY: St 33

SUBGRADE MOISTURE VARIATIONS PROJECT



SITE NO: 28-B
 COUNTY: Payne
 HIGHWAY: St 33

SUBGRADE MOISTURE VARIATIONS PROJECT



SITE NO: 28-C
 COUNTY: Payne
 HIGHWAY: St 33

SUBGRADE MOISTURE VARIATIONS PROJECT

SCHOOL OF CIVIL ENGINEERING
OKLAHOMA STATE UNIVERSITY

SUBGRADE MOISTURE VARIATIONS RESEARCH PROJECT

SUBGRADE SOIL DRY DENSITY TABULATION

Date of Measurement	August 1966			January 1967			August 1967		
Site & Hole Number	28-A	28-B	28-C	28-A	28-B	28-C	28-A	28-B	28-C
Depth from top of tube to bottom of probe									
1 ft 6 in.	130.25	123.68	101.78			119.52	102.47	95.72	108.12
2 ft 0 in.				115.09					
2 ft 6 in.	91.77	75.01	83.64		89.83	99.01	94.76	85.67	91.61
3 ft 0 in.				102.86					
3 ft 6 in.	79.92	88.71	80.06		103.09	92.00	85.47	96.79	85.53
4 ft 0 in.				92.86					
4 ft 6 in.	82.64	81.64	89.06		94.48	102.47	91.43	88.75	95.74
5 ft 0 in.				96.64					
5 ft 6 in.	93.21	90.04	91.38		104.23	106.55	101.83	97.84	99.78
6 ft 0 in.				108.21					
6 ft 6 in.	97.78	91.63	88.84		105.01	103.02	105.30	98.00	95.37
7 ft 0 in.				111.95					
7 ft 6 in.	110.56	89.64	96.71		103.81	111.25	117.65	98.76	103.16
8 ft 0 in.				124.56					
8 ft 6 in.	112.65	107.30	109.12		119.41	123.43	122.17	114.47	115.37
9 ft 0 in.				131.16					
9 ft 6 in.	116.40	111.32	112.16		127.91	125.45	122.66	119.15	117.43
10 ft 0 in.		117.97	118.16		132.68	131.87		124.18	121.04

Note: All density values reported in units of lb per cu ft

SITE NO. 29

SCHOOL OF CIVIL ENGINEERING
OKLAHOMA STATE UNIVERSITY
SUBGRADE MOISTURE VARIATIONS PROJECT
TEST SITE DATA SUMMARY SHEET

LOCATION DATA:

Site No. 29 Highway No. US 64 County: Tulsa Date Installed: 8/4/66

Distance from access tube to Lane ℓ: 20' 0" a, 6" b, 20' 6" c

Exact Location:

In Tulsa County, southeast of Bisby, 5.5 miles south and east on US 64 from jct. of US 64 and S 67, 0.8 mile east of bridge over Snake Creek. Marker on south fence row.

PAVEMENT/DESIGN DATA:

No. of Lanes: 2 Pavement Type: PCC Shoulder Type: Improved

Pavement Thickness: 8 in.ℓ, 1 in.Edge Latest Pavement Condition Rating: Excellent

Latest Traffic Count: 5600 vpd Heavy Truck Traffic: Yes

Terrain: Fill/CB Drainage: Good Year of Original Paving: 1960

Original Design and History:

24 ft width; ℓ to 12 ft lt and rt: 8 in. PCC/4 in. sand/8 in. subbase.

FIELD OBSERVATIONS BY RESEARCH PERSONNEL:

8/4/66 - Access tube "b" is 9 ft 6 in. long.

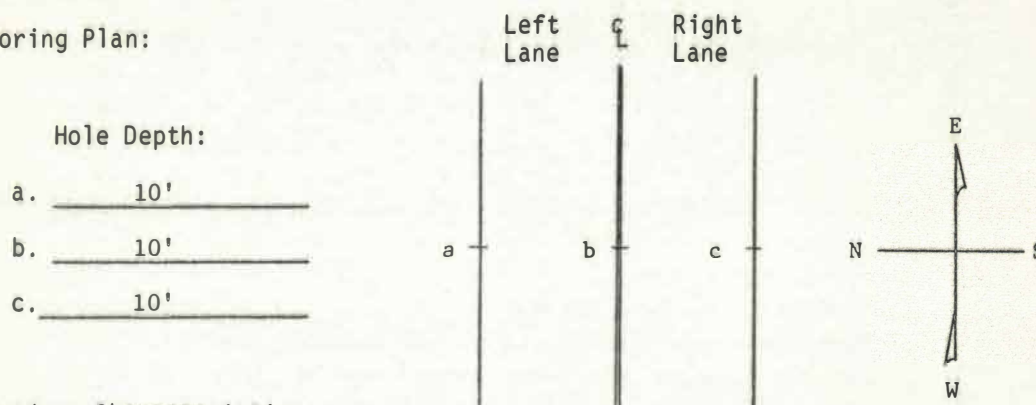
SCHOOL OF CIVIL ENGINEERING
OKLAHOMA STATE UNIVERSITY
Stillwater, Oklahoma
SUBGRADE MOISTURE VARIATION STUDY
SITE INSTALLATION INFORMATION

Installation: Tulsa U.S. 64 29 Date: 4 8 66
County Highway No. day month year

Location of site: Southeast of Bixby, 5.5 miles south and east on U.S. 64 from
jct. of U.S. 64 and St. 67, 0.8 miles east of bridge over Snake Creek.

Description of Terrain and Vegetation: Pavement in creek bottom area on
slight fill.

Boring Plan:



Roadway Characteristics:

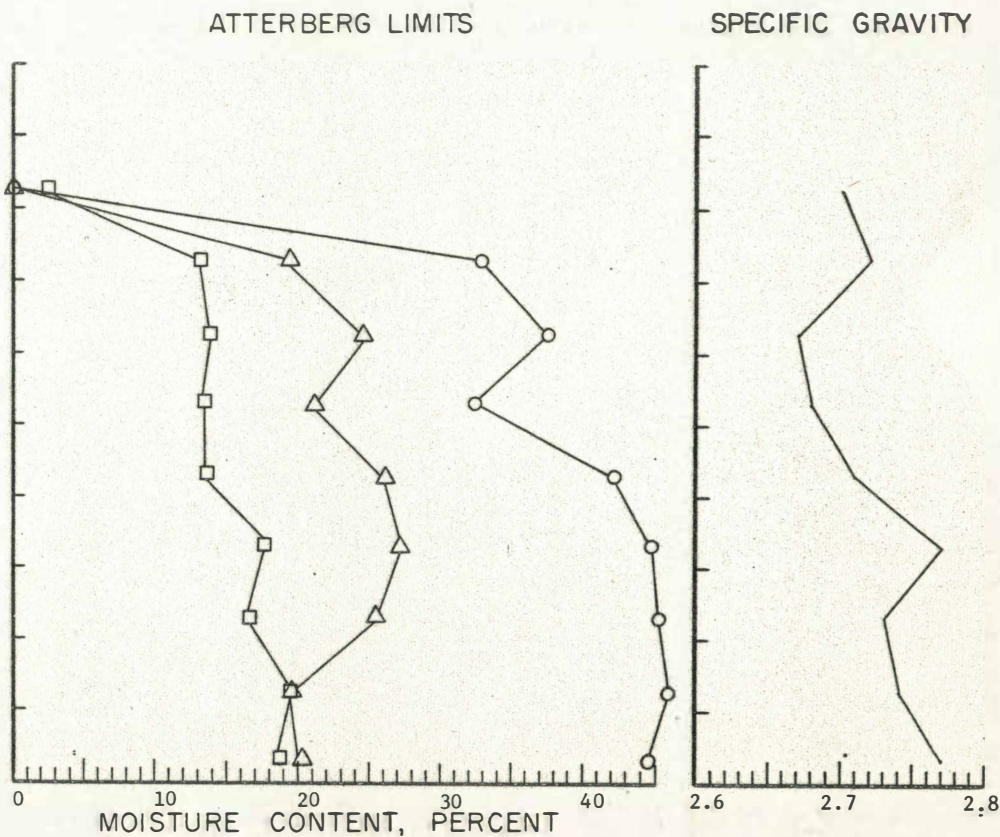
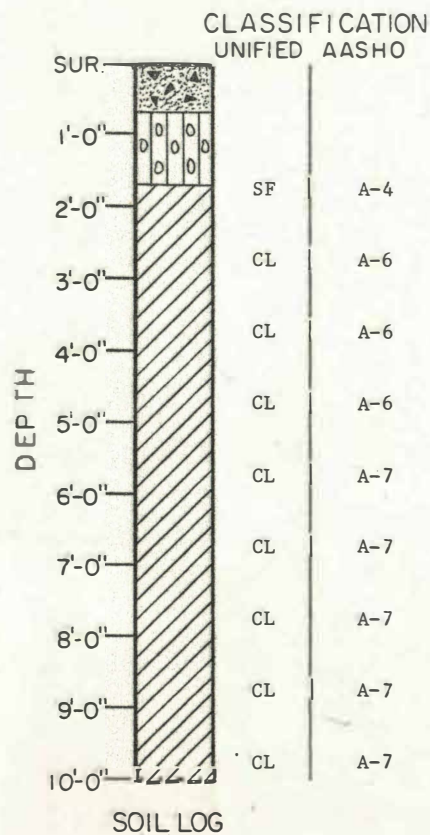
Pavement: Type P.C. Concrete
Width 24' Thickness 8"
Condition Excellent

Shoulders: Type Asphaltic Concrete Width 9'
Condition Good

Base Course Characteristics Sand

SITE NO.: 29
 COUNTY : Tulsa
 HIGHWAY : U.S. 64

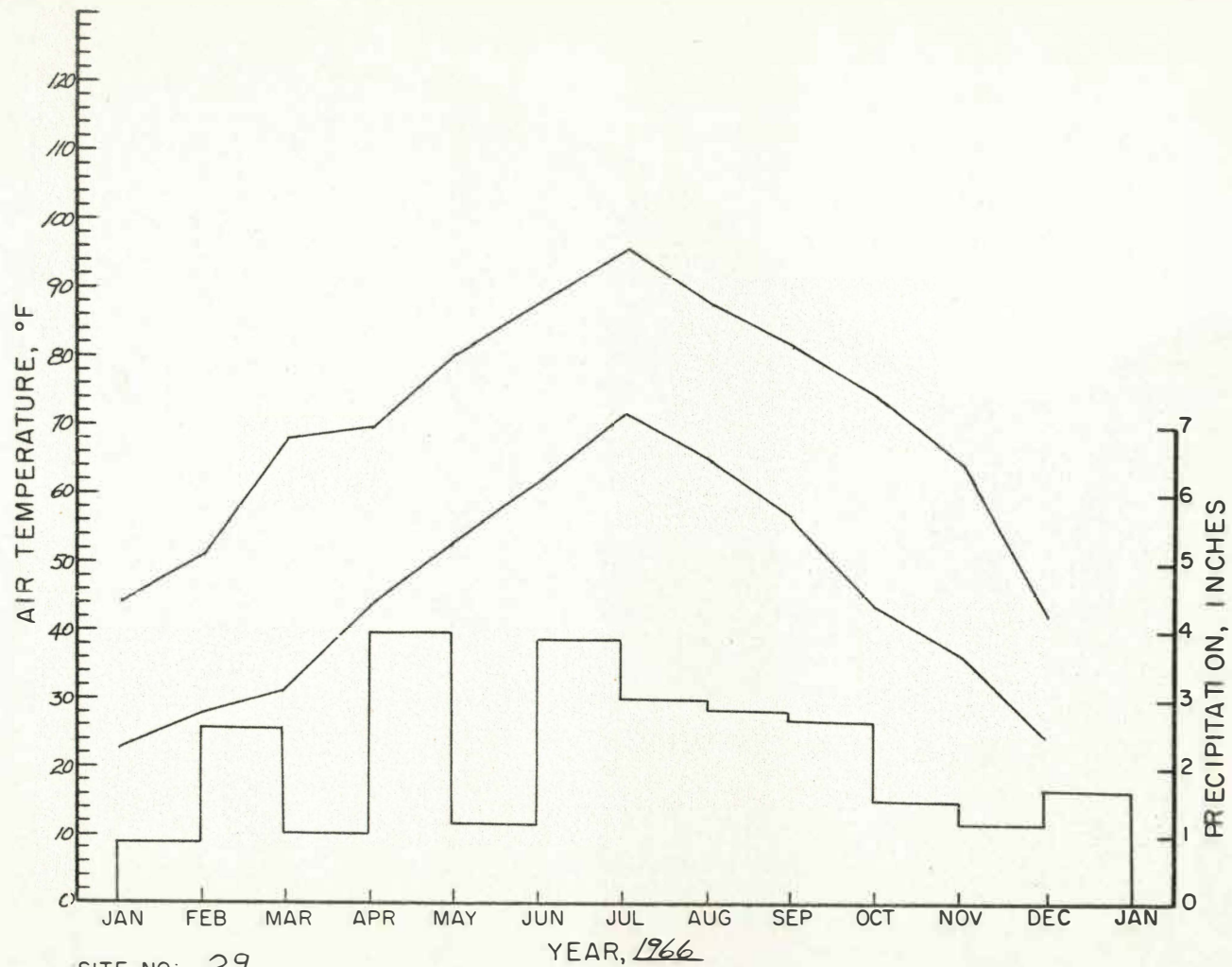
● LIQUID LIMIT
 ▲ PLASTIC LIMIT
 ■ LINEAL SHRINKAGE



DATE : 19 December 1967

PLOTTED BY : AAE

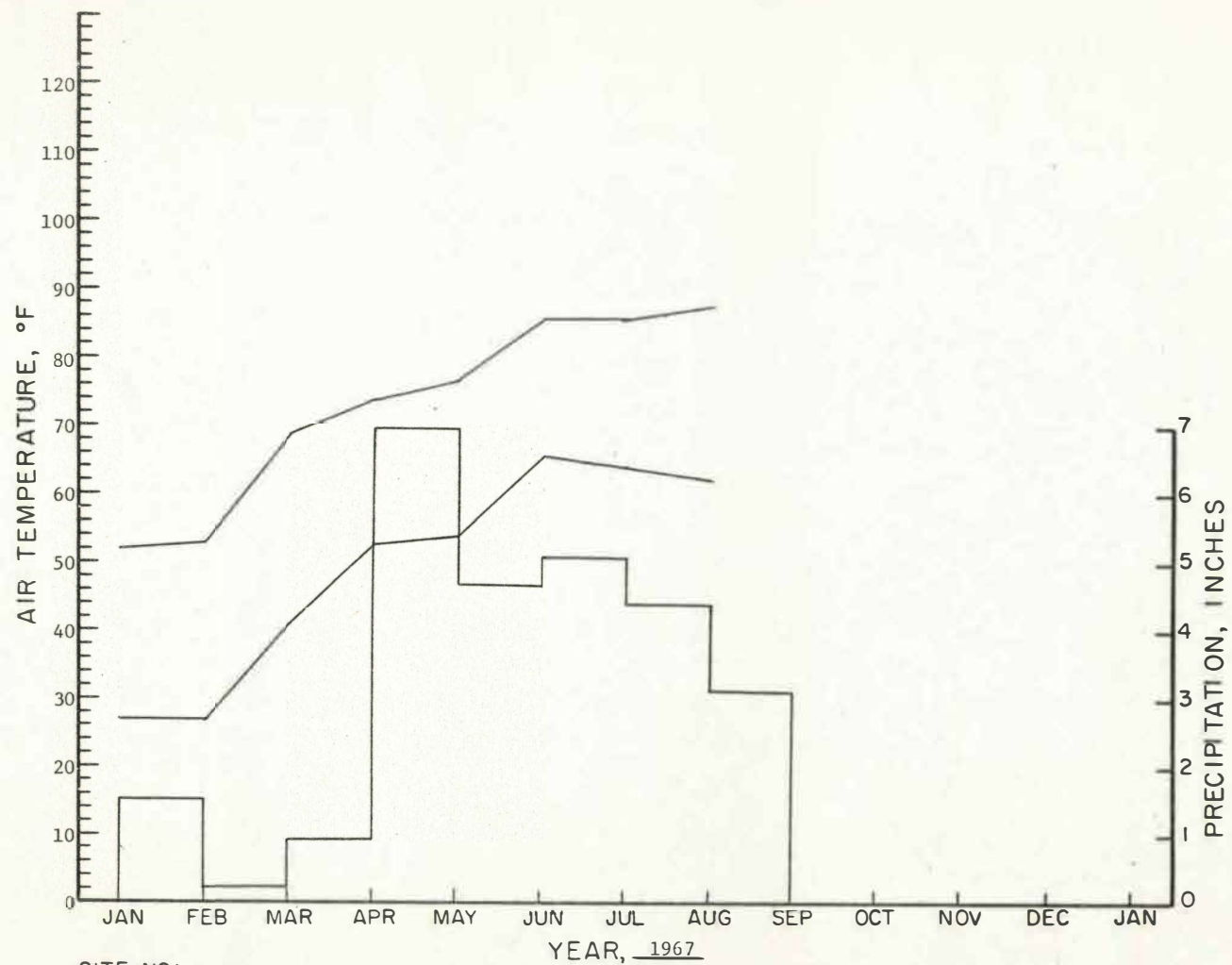
SUBGRADE MOISTURE VARIATIONS PROJECT



SITE NO: 29
COUNTY: Tulsa
HIGHWAY: U.S. 64

YEAR, 1966

SUBGRADE MOISTURE VARIATIONS PROJECT

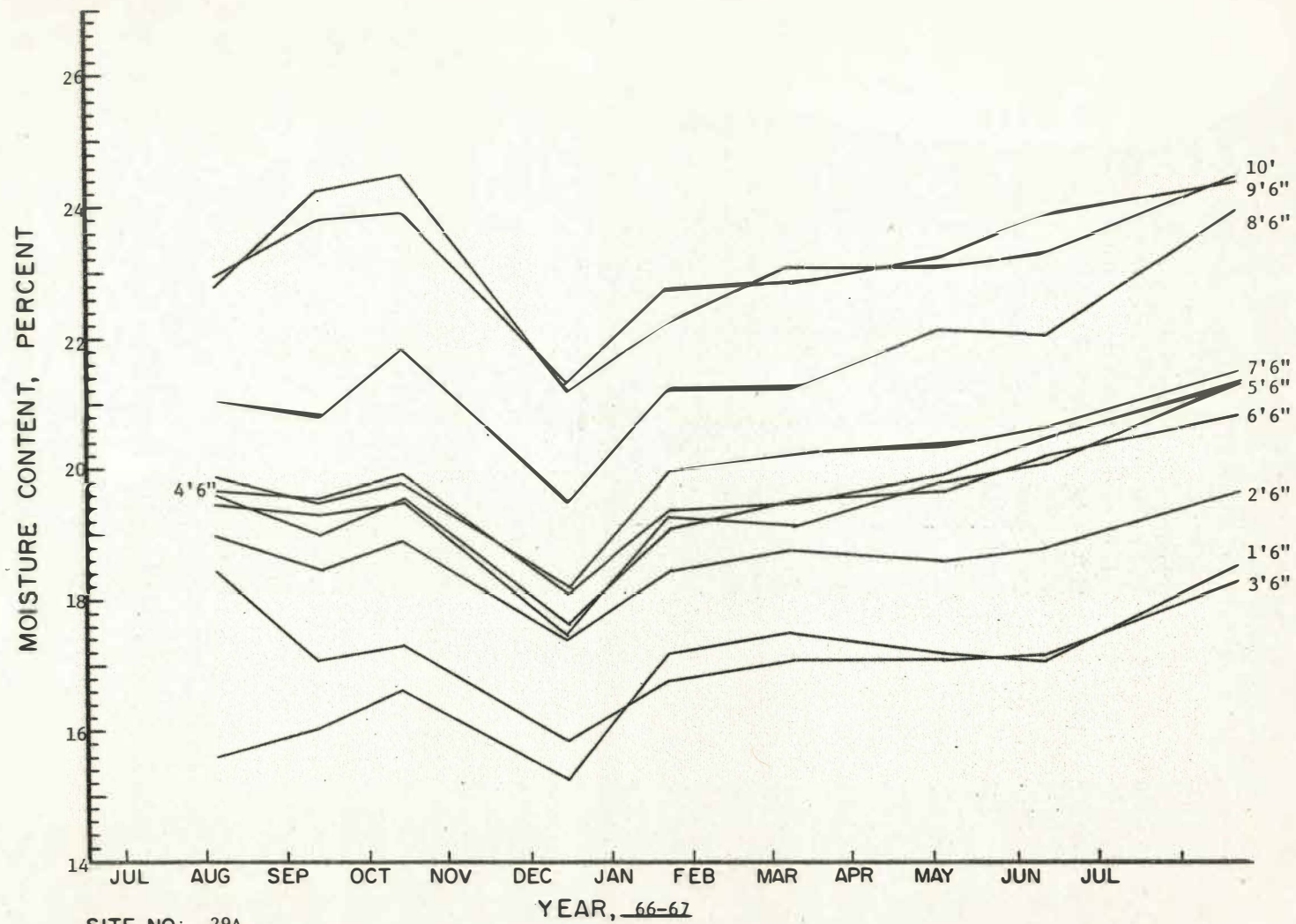


SITE NO: 29

COUNTY : Tulsa

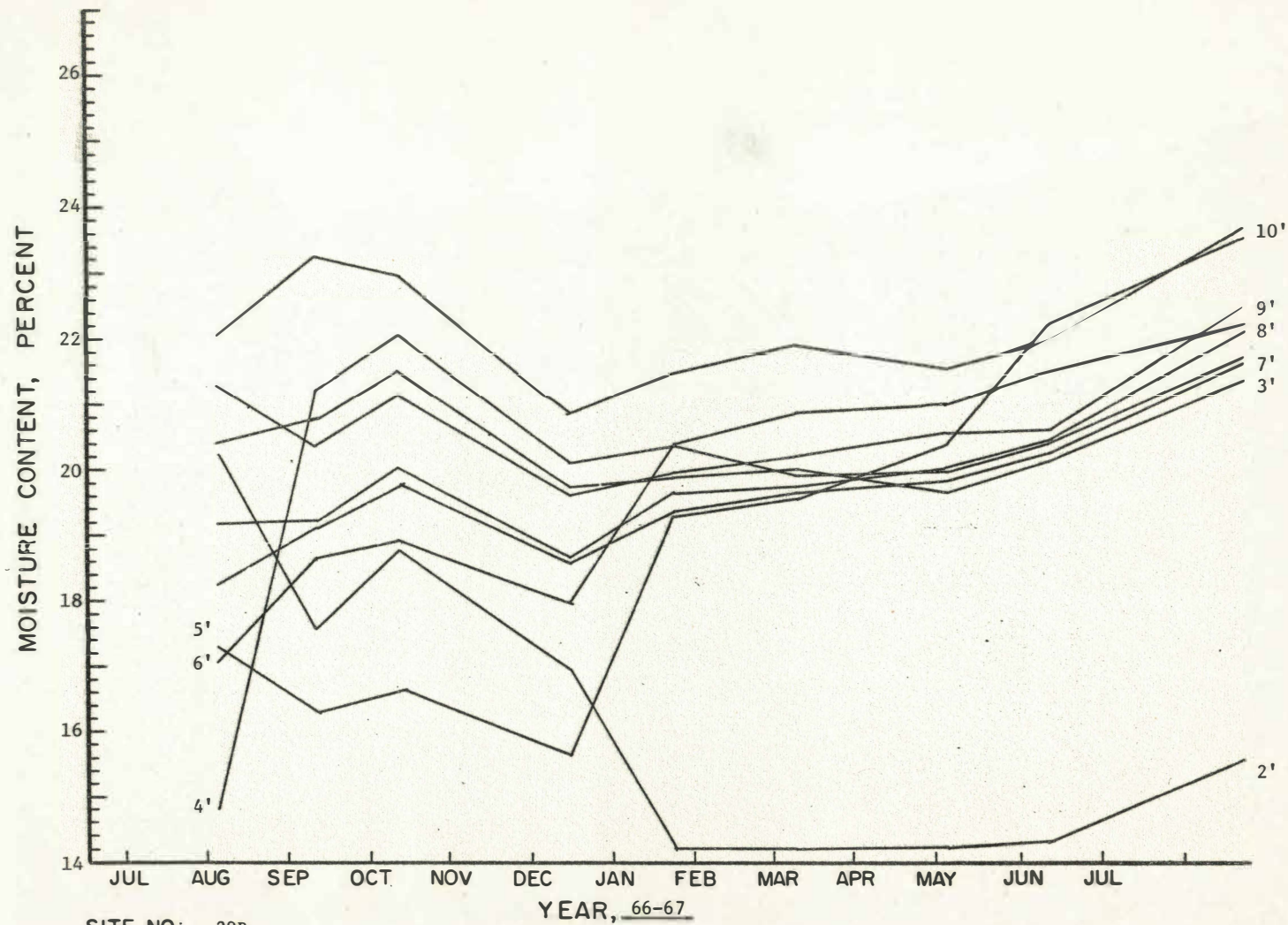
HIGHWAY : US 64

SUBGRADE MOISTURE VARIATIONS PROJECT



SITE NO: 29A
 COUNTY: Tulsa
 HIGHWAY: US 64

SUBGRADE MOISTURE VARIATIONS PROJECT

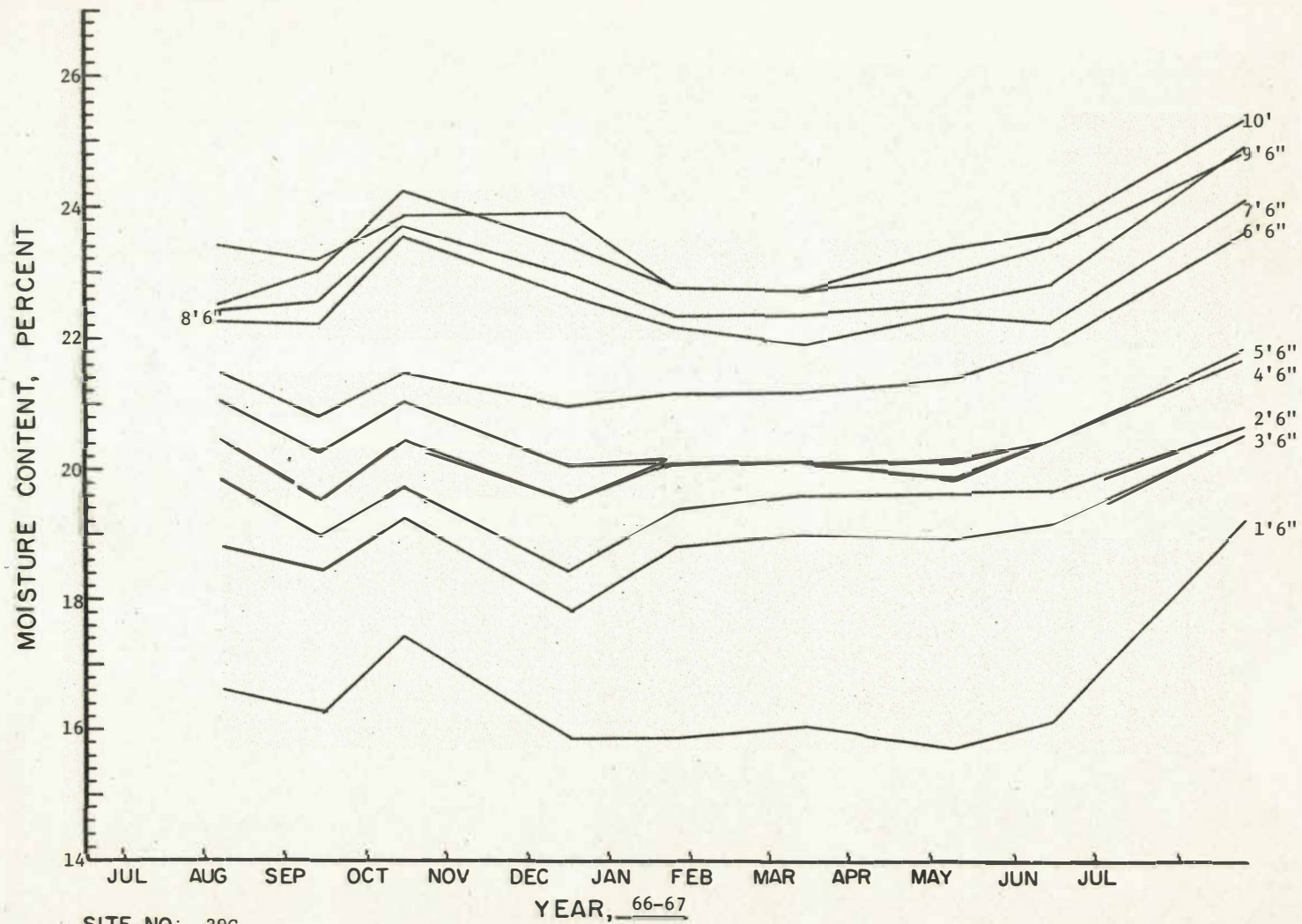


SITE NO: 29B

COUNTY: Tulsa

HIGHWAY: US 64

SUBGRADE MOISTURE VARIATIONS PROJECT



SITE NO: 29C
 COUNTY: Tulsa
 HIGHWAY: US 64

SUBGRADE MOISTURE VARIATIONS PROJECT

SCHOOL OF CIVIL ENGINEERING
OKLAHOMA STATE UNIVERSITY

SUBGRADE MOISTURE VARIATIONS RESEARCH PROJECT

SUBGRADE SOIL DRY DENSITY TABULATION

Date of Measurement	August 1966			January 1967			August 1967		
Site & Hole Number	29-A	29-B	29-C	29-A	29-B	29-C	29-A	29-B	29-C
Depth from top of tube to bottom of probe									
1 ft 6 in.	110.54	122.50	101.18	109.03		112.32	101.43		93.44
2 ft 0 in.					126.36			113.86	
2 ft 6 in.	103.09	95.17	98.68	106.46		101.13	101.70		95.17
3 ft 0 in.					99.24			92.44	
3 ft 6 in.	101.41	91.45	95.81	105.19		98.78	100.32		91.30
4 ft 0 in.					93.53			86.63	
4 ft 6 in.	90.83	84.45	93.73	94.62		98.45	92.89		90.73
5 ft 0 in.					86.39			80.77	
5 ft 6 in.	98.26	95.56	98.79	101.99		101.44	97.67		94.24
6 ft 0 in.					100.28			94.57	
6 ft 6 in.	101.50	102.06	96.49	104.91		99.78	100.95		91.47
7 ft 0 in.					106.78			98.73	
7 ft 6 in.	101.85	101.04	96.94	104.64		102.05	102.05		93.12
8 ft 0 in.					108.02			99.22	
8 ft 6 in.	100.44	101.87	98.62	103.24		103.36	98.62		94.84
9 ft 0 in.					107.53			98.96	
9 ft 6 in.	96.93	99.00	97.90	101.62		102.38	99.35		94.95
10 ft 0 in.	98.56	97.86	98.28	103.07	104.58	103.56	98.93	96.77	95.20

Note: All density values reported in units of lb per cu ft

SITE NO. 30

SCHOOL OF CIVIL ENGINEERING
OKLAHOMA STATE UNIVERSITY
SUBGRADE MOISTURE VARIATIONS PROJECT
TEST SITE DATA SUMMARY SHEET

LOCATION DATA:

Site No. 30 Highway No. US 64 County: Tulsa Date Installed: 8/23/66

Distance from access tube to Lane $\mathcal{C}$: 15' 0" a, 1' 0" b, 20' 0" c

Exact Location:

In Tulsa County west of Sand Springs, 0.5 mile east on US 64 from US 64 - S 51 overpass. Site in north lane of divided highway, 1/2 mile north of Arkansas River. Marker on north fence row.

PAVEMENT/DESIGN DATA:

No. of Lanes: 2 Pavement Type: PCC Shoulder Type: Improved

Pavement Thickness: 8 in. $\mathcal{C}$, 9 in. Edge Latest Pavement Condition Rating: Good

Latest Traffic Count: 1200 vpd Heavy Truck Traffic: No

Terrain: Fill/R.B. Drainage: Good Year of Original Paving: 1963

Original Design and History:

US Army Corps of Engineers relocation in conjunction with Keystone Dam construction. 24 ft width; $\mathcal{C}$ to 12 ft lt and rt: 8 in. PCC over natural sandstone base; 12 ft to 16 ft rt and 12 ft to 21 ft lt: double bituminous surface shoulders over 8 in. soil-cement base.

FIELD OBSERVATIONS BY RESEARCH PERSONNEL:

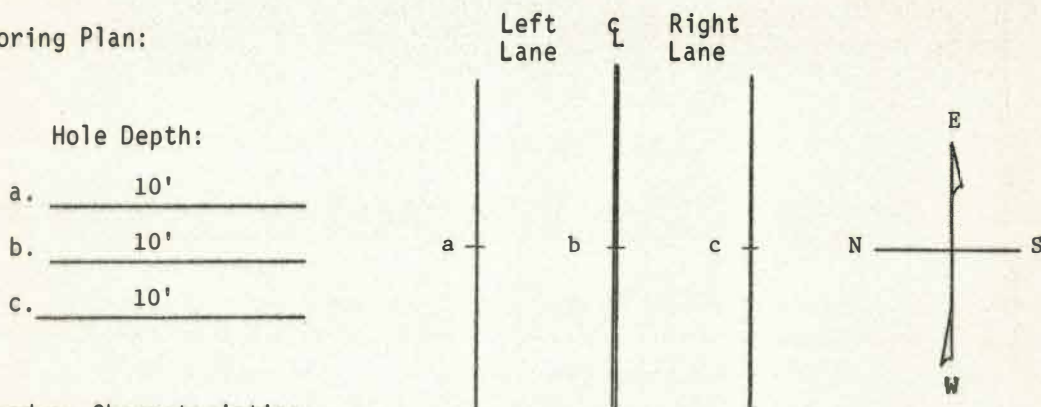
SCHOOL OF CIVIL ENGINEERING
OKLAHOMA STATE UNIVERSITY
Stillwater, Oklahoma
SUBGRADE MOISTURE VARIATION STUDY
SITE INSTALLATION INFORMATION

Installation: Tulsa U.S. 64 30 Date: 23 8 66
County Highway No. day month year

Location of site: West of Sand Springs, 0.5 miles east on U.S. 64 from U.S. 64-
St. 151 overpass, 100 ft east of "Keystone Dam" -- St. 51" exit sign. Site in
north lane of divided four-lane highway 1/2 mile of Arkansas River.

Description of Terrain and Vegetation: Pavement in Arkansas River Bottom on
fill section.

Boring Plan:



Roadway Characteristics:

Pavement: Type P.C. Concrete
Width 24' Thickness 8"
Condition Good

Shoulders: Type Asphaltic Concrete Width R-4' L-9'
over soil cement
Condition Good

Base Course Characteristics Sand

SITE NO.: 30

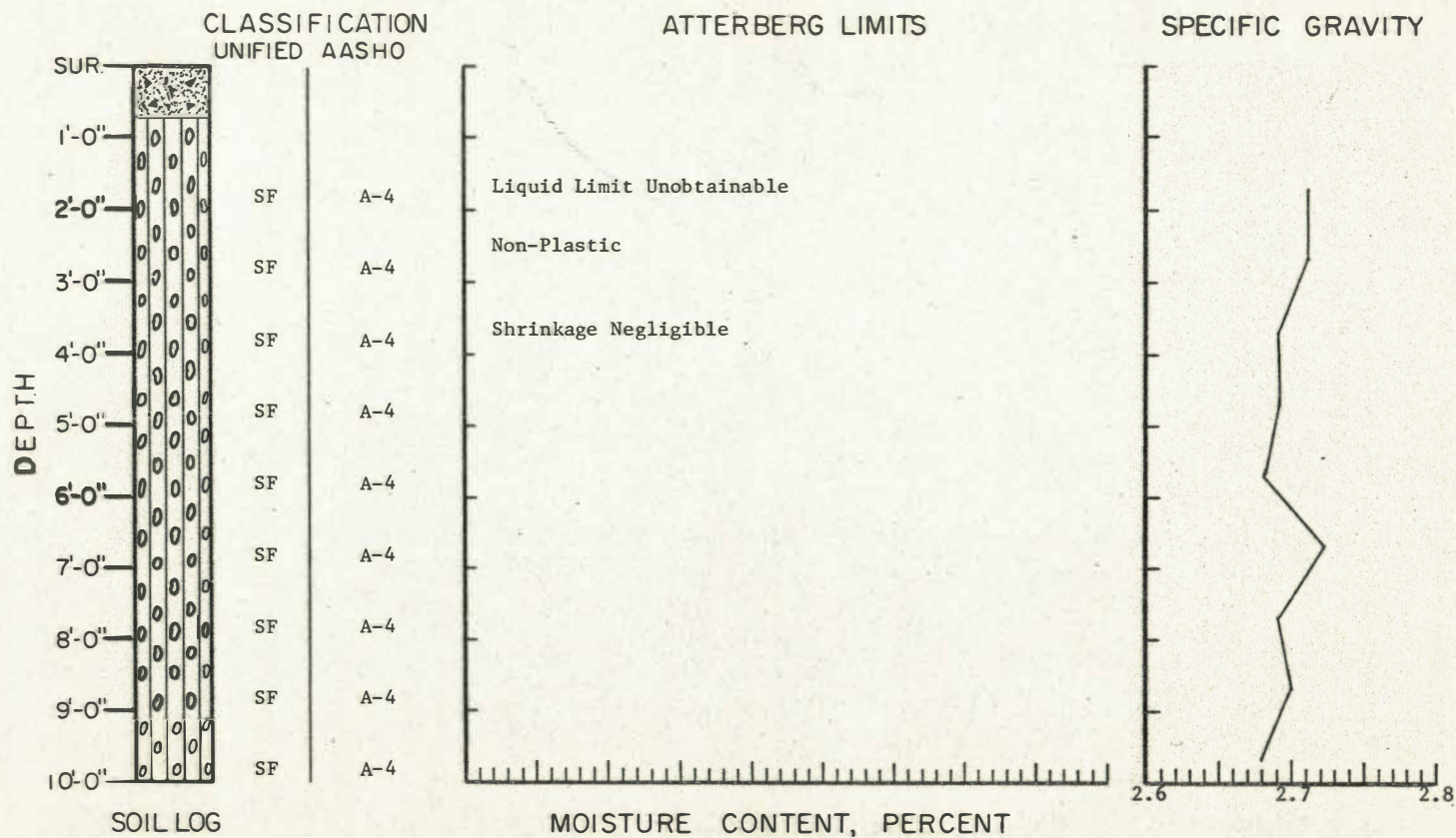
COUNTY : Tulsa

HIGHWAY : US 64

● LIQUID LIMIT

▲ PLASTIC LIMIT

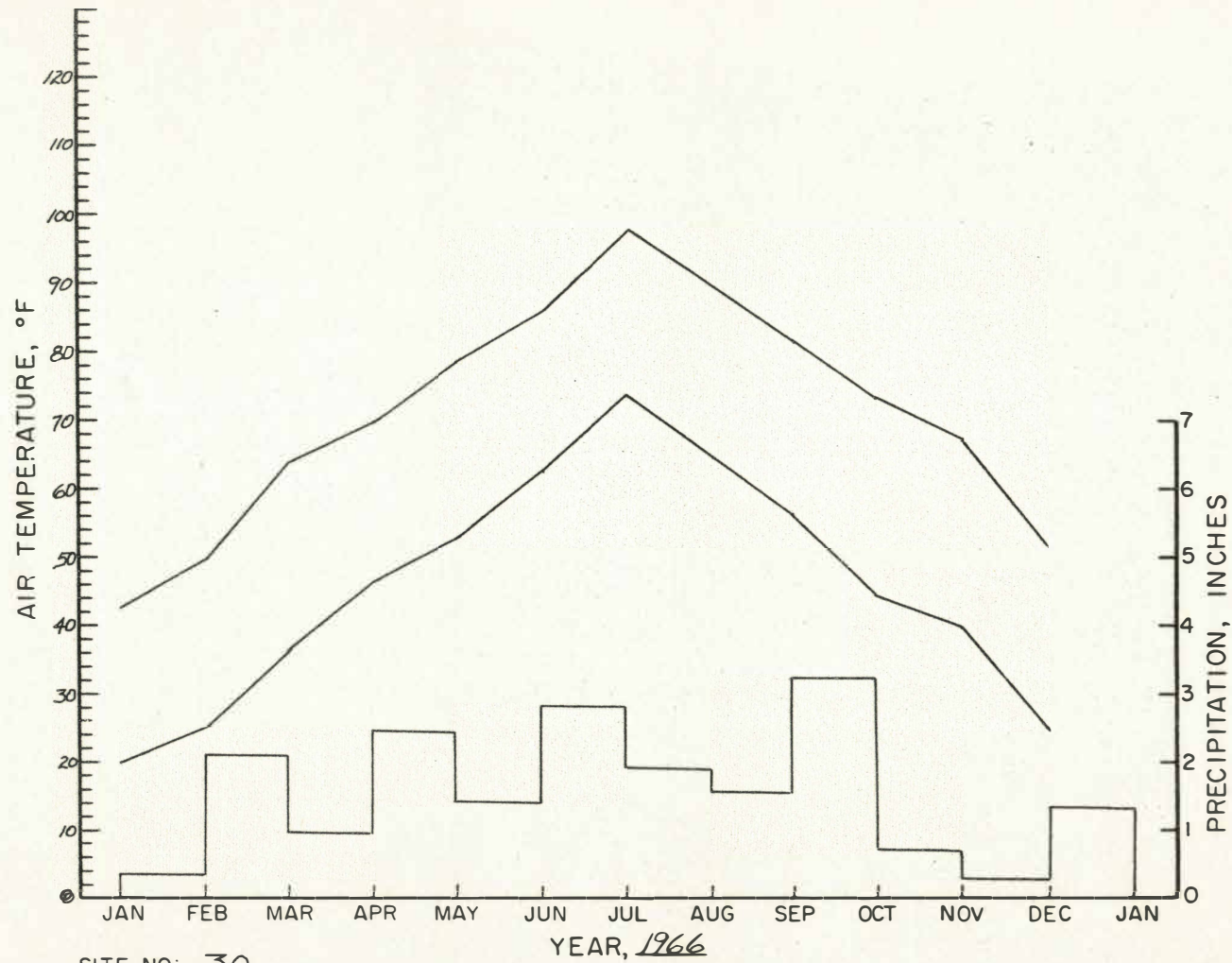
■ LINEAL SHRINKAGE



DATE : 19 December 1967

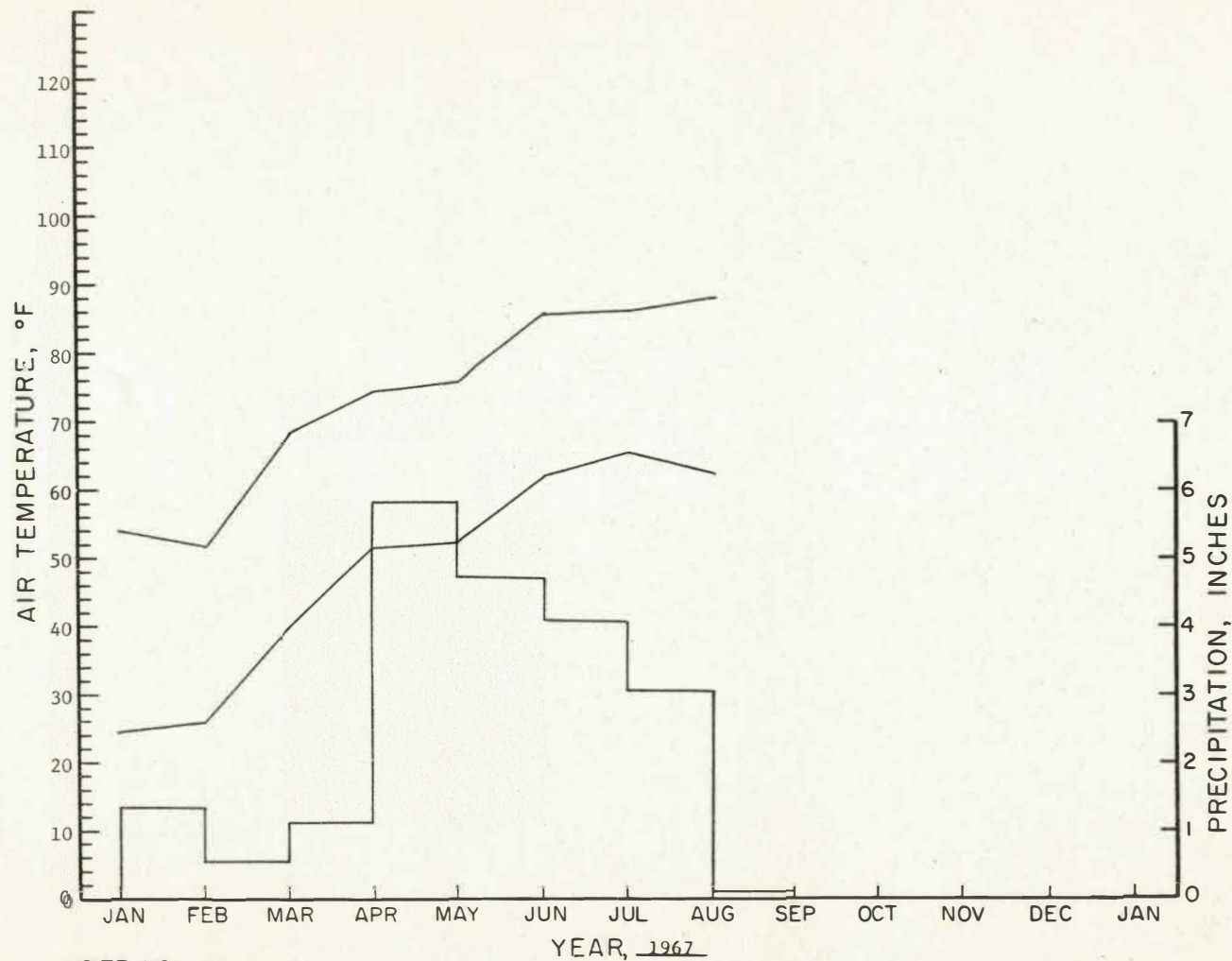
PLOTTED BY : AAP

SUBGRADE MOISTURE VARIATIONS PROJECT



SITE NO: 30
COUNTY: Tulsa
HIGHWAY: U.S. 64

SUBGRADE MOISTURE VARIATIONS PROJECT

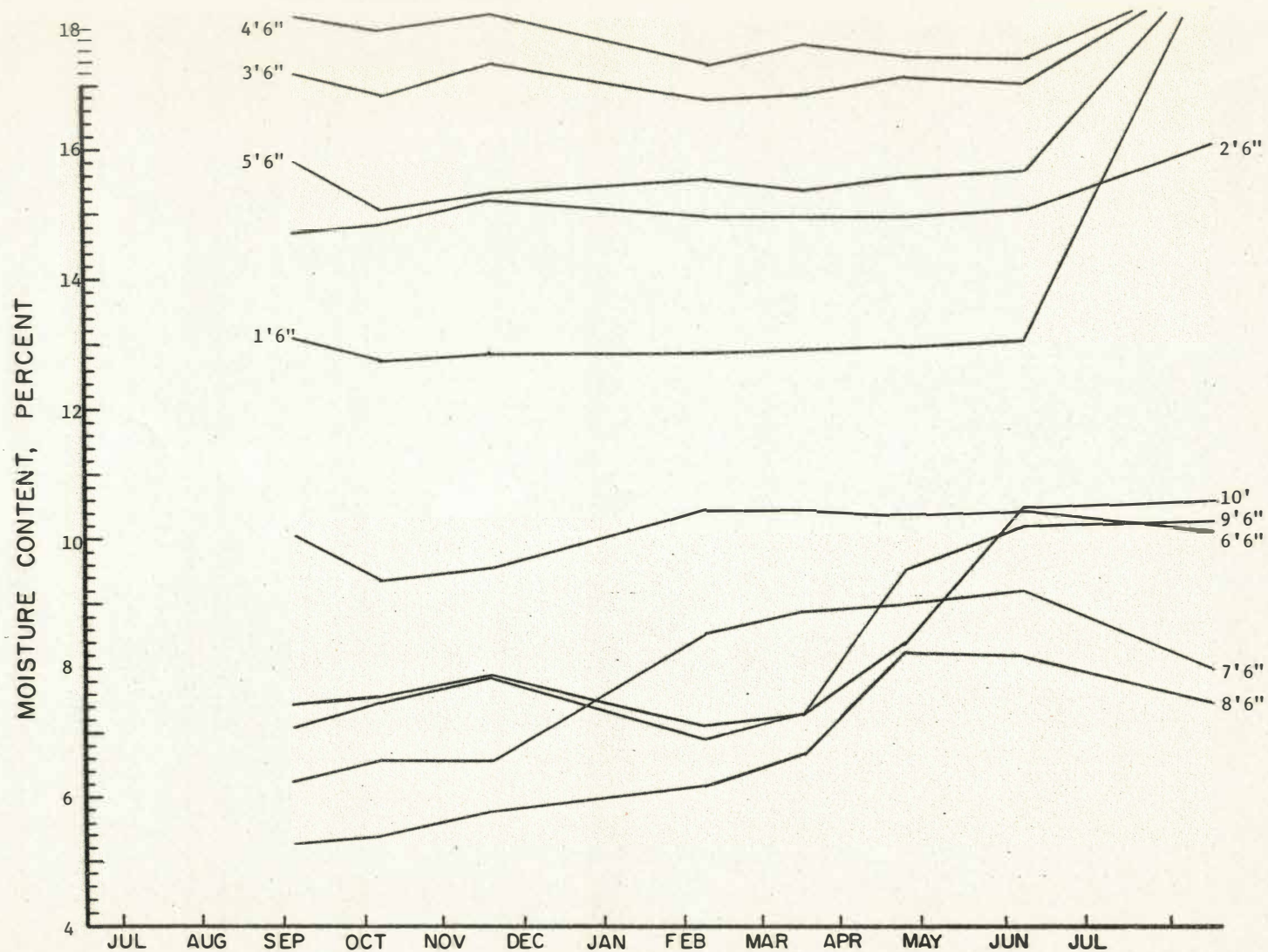


SITE NO: 30

COUNTY: Tulsa

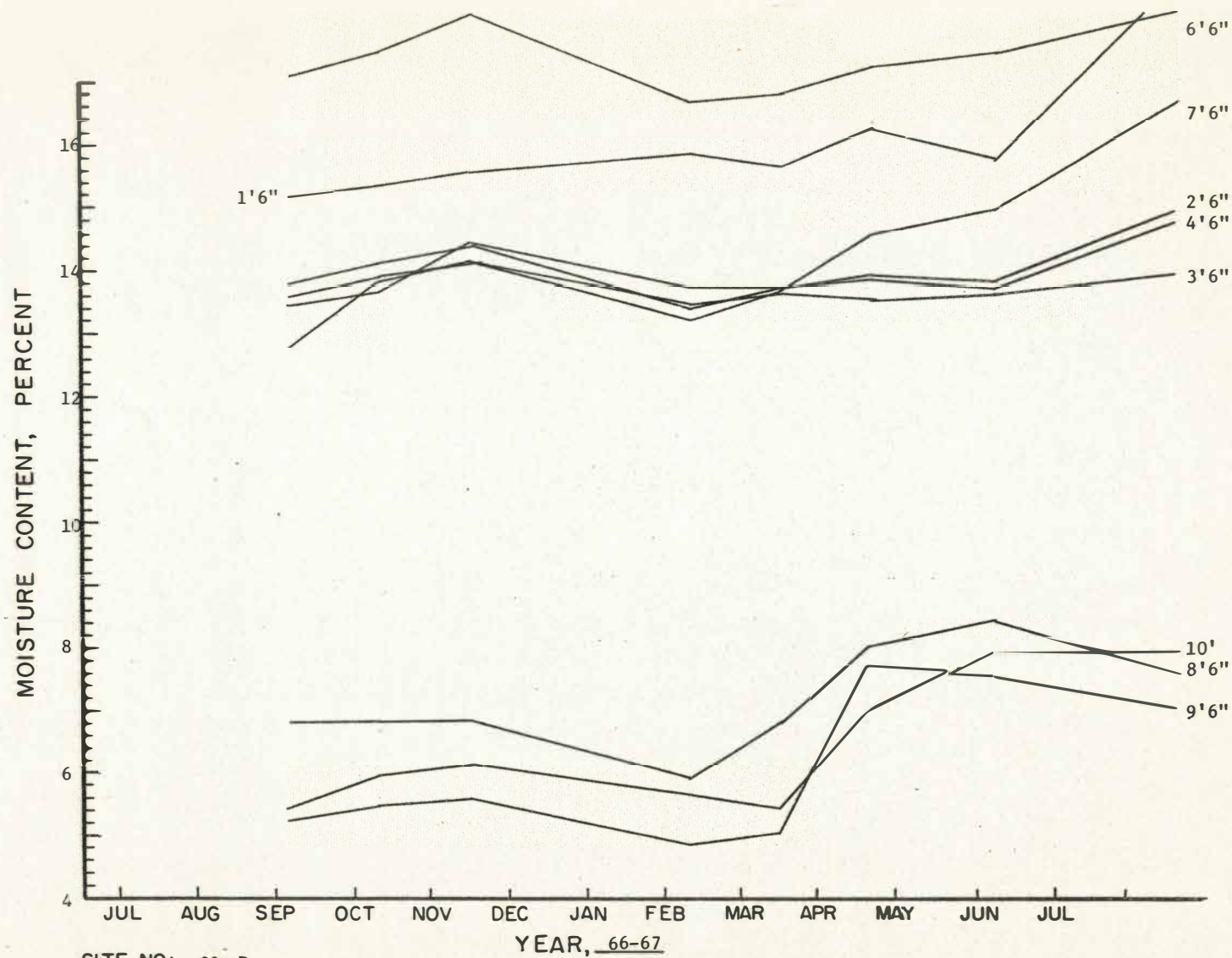
HIGHWAY: US 64

SUBGRADE MOISTURE VARIATIONS PROJECT



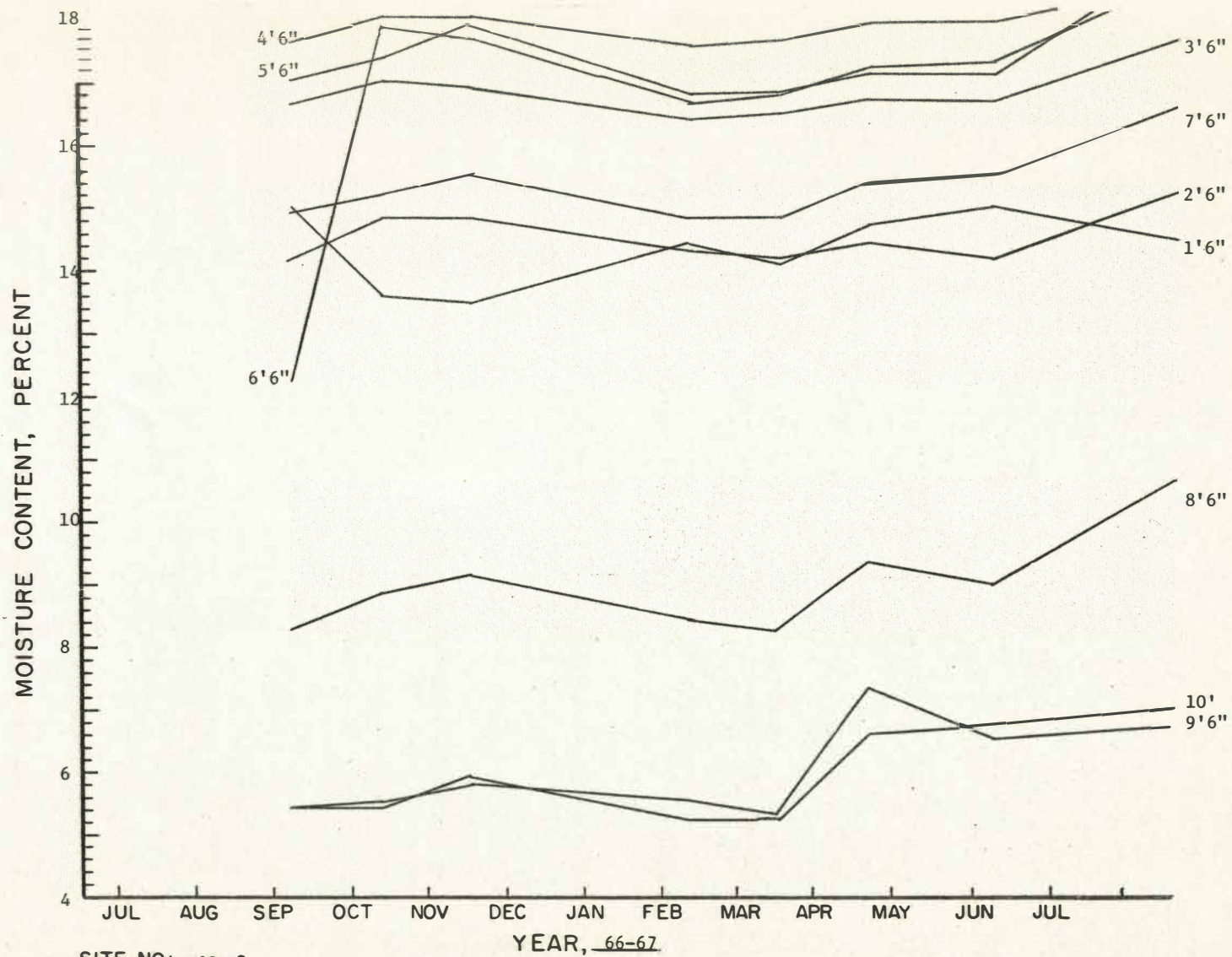
SITE NO: 30-A
 COUNTY: Tulsa
 HIGHWAY: US 64

SUBGRADE MOISTURE VARIATIONS PROJECT



SITE NO: 30-B
COUNTY: Tulsa
HIGHWAY: US 64

SUBGRADE MOISTURE VARIATIONS PROJECT



SITE NO: 30 -C

COUNTY: Tulsa

HIGHWAY: US 64

SUBGRADE MOISTURE VARIATIONS PROJECT

SCHOOL OF CIVIL ENGINEERING
OKLAHOMA STATE UNIVERSITY

SUBGRADE MOISTURE VARIATIONS RESEARCH PROJECT

SUBGRADE SOIL DRY DENSITY TABULATION

Date of Measurement	August 1966			January 1967			August 1967		
Site & Hole Number	30-A	30-B	30-C	30-A	30-B	30-C	30-A	30-B	30-C
Depth from top of tube to bottom of probe									
1 ft 6 in.	135.30	108.40	106.81	138.06	108.55	110.80	92.55	91.54	96.33
2 ft 0 in.									
2 ft 6 in.	104.56	105.61	109.39	107.37	108.69	112.43	97.42	102.42	105.10
3 ft 0 in.									
3 ft 6 in.	104.30	109.62	103.63	106.99	112.67	106.89	95.67	107.97	99.58
4 ft 0 in.									
4 ft 6 in.	102.22	110.50	102.72	105.30	113.88	104.95	95.76	103.80	97.75
5 ft 0 in.									
5 ft 6 in.	105.17	103.08	105.19	106.89	105.85	108.41	84.52	97.18	98.92
6 ft 0 in.									
6 ft 6 in.	90.89	98.42	97.59	94.54	102.85	101.33	85.16	93.35	93.27
7 ft 0 in.									
7 ft 6 in.	78.52	96.95	96.38	80.31	99.73	99.80	75.59	86.33	92.19
8 ft 0 in.									
8 ft 6 in.	81.15	89.85	95.19	83.79	94.39	99.07	84.72	91.34	91.87
9 ft 0 in.									
9 ft 6 in.	82.56	86.47	85.25	84.87	88.89	89.29	81.34	83.71	83.58
10 ft 0 in.	82.39	85.39	83.60	84.55	88.53	87.16	80.71	82.59	82.61

Note: All density values reported in units of lb per cu ft