TECHNICAL REPORT STANDARD TITLE PAGE

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle "The Waco Ponding Project"		5. Report Date January 1974 6. Performing Organization Code
7. Author(s) Robert L. McKinney, Jr., James E. Kelly, Chester McDowell		8. Performing Organization Report No. Research Report 118-7
9. Performing Organization Name and Address Center for Highway Research The University of Texas at Austin Austin, Texas 78712		10. Work Unit No. 11. Contract or Grant No. Research Study 3-8-68-118
12. Sponsoring Agency Name and Address Texas Highway Department Planning & Research Division P. O. Box 5051 Austin, Texas 78763		13. Type of Report and Period Covered Interim 1957-1972 14. Sponsoring Agency Code

15. Supplementary Notes

Research performed in cooperation with Department of Transportation, Federal Highway Administration - Research Study Title: Study of Expansive Clays in Roadway Structural Systems

16. Abstract

This report presents results of field studies conducted between 1957 and 1972 which were concerned with the effectiveness of ponding and lime stabilization of clay subgrade in minimizing volume change beneath portland cement concrete pavements. Potential Vertical Rise (PVR) was calculated to identify sections in need of ponding and the relationship of PVR to roughness and heaving of pavement is presented. The thickness of asphaltic concrete overlay required for pavement over untreated subgrade is compared to that required for concrete pavement placed over lime-stabilized subgrade, some of which was ponded.

Although a study of underdrains was not intended to become a part of Research Report 118-7, it became noticeable that the result of connection of perforated underdrains to ditch drop inlets was to increase heaving and overlay repair thicknesses.

A method for determination of "desired" moisture content is presented in the report and it correlates fairly well with moisture contents obtained from below pavement after a period of several years had elapsed.

17. Key Words	18. Distribution Statement
potential vertical rise, ponding, lime-stabilized subgrade, clay, swelling clay, expansive clay, heave, roughness	

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	92	

Form DOT F 1700.7 (8-69)

THE WACO PONDING PROJECT

by

Robert L. McKinney, Jr.
James E. Kelly
Chester McDowell

Research Report Number 118-7

Study of Expansive Clays in
Roadway Structural Systems

Research Project 3-8-68-118

conducted for

The Texas Highway Department

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

by the

CENTER FOR HIGHWAY RESEARCH
THE UNIVERSITY OF TEXAS AT AUSTIN

January 1974

PREFACE

This report is the seventh in a series of reports developed under Research Project 3-8-68-118, "Study of Expansive Clays in Roadway Structural Systems." It presents results of field studies conducted between 1957 and 1972 relative to the effectiveness of ponding and lime stabilization of clay subgrade in minimizing excessive volume change beneath portland cement concrete pavements.

Although the Waco project was not originally set up for research study, numerous investigations were performed, including those of moisture movements, pavement movements, and pavement performance over a period of several years. Because some of the studies made pertained to the scope of Research Project 118, the Center for Highway Research, in 1971, entered into a cooperative effort to record the work to assure that the results would not be lost. Since the experimental ponded sections were scattered throughout the length of the project and since pavement performance varied between as well as within sections it became necessary to evaluate this project thoroughly before forming conclusions. Since thirteen years had lapsed after the pavement on this project was placed it was necessary to establish thickness of overlay, moisture contents, and performance records as a basis for the evaluation of ponding.

So much information and data have been collected from so many people over such a long period of time that it is difficult to name those who have contributed to this project, but the authors are grateful to all who have given assistance and encouragement to the performance of the experiments and the preparation of this report.

Some of the outstanding contributors are listed as follows:

(1) For planning and implementation of the research phase of the construction project of 1957:

Talbot S. Huff	Chief Engineer of Highway Design, THD*

* Texas Highway Department.

Mac D. Shelby	Research Engineer, THD
Thomas C. Collier	District Engineer, THD
James H. Aiken	Assistant District Engineer, THD
James P. Ledbetter	Senior Resident Engineer, THD
John B. Chambless	Chief Inspector, THD
Laboratory Personnel	Waco District 9 Laboratory, THD
Contractor	Worth Construction Company, Fort Worth, Texas

(2) For support and guidance during the final evaluation and preparation of this report:

Robert L. Lewis	Chief Engineer of Highway Design, THD
Elton B. Evans	District Engineer, THD
John F. Nixon	Research Engineer, THD
Robert E. Burns, Jr.	District Construction Engineer, THD
Dr. Clyde E. Lee	Professor of Civil Engineering and Director of the Center for Highway Research, The University of Texas at Austin
Professor Hudson Matlock	Project Supervisor and Chairman of the Civil Engineering Department, The University of Texas at Austin
Raymond J. Hodge	Partner, TAMS*
Albert C. Morris	Resident Manager, TAMS

Special acknowledgement is made of members of the Texas Highway Department Waco District Laboratory for their efforts in making this report possible. Those deserving special mention are Ovid K. Williams and Gerald W. McCauley of the Waco District Laboratory and Mrs. Glenna Holmes of TAMS.

---

* Tippetts-Abbett-McCarthy-Stratton.

Thanks are also due to the Federal Highway Administration for their sponsorship of the project.

Robert L. McKinney, Jr.[1]
James E. Kelly[2]
Chester McDowell[3]

January 1974

[1] District Geologist, Texas Highway Department, Waco.

[2] Chief Construction Engineer, Tippetts-Abbett-McCarthy-Stratton, Dallas-Fort Worth Airport; former District Construction Engineer, Texas Highway Department, Waco.

[3] Research Engineer, Center for Highway Research, The University of Texas at Austin; former Materials and Tests Soils Engineer, Texas Highway Department, Austin.

LIST OF REPORTS

Report No. 118-1, "Theory of Moisture Movement in Expansive Clay" by Robert L. Lytton, presents a theoretical discussion of moisture movement in clay soil.

Report No. 118-2, "Continuum Theory of Moisture Movement and Swell in Expansive Clays" by R. Ray Nachlinger and Robert L. Lytton, presents a theoretical study of the phenomenon of expansive clay.

Report No. 118-3, "Prediction of Moisture Movement in Expansive Clay" by Robert L. Lytton and Ramesh K. Kher, uses the theoretical results of Research Reports 118-1 and 118-2 in developing one and two-dimensional computer programs for solving the concentration-dependent partial differential equation for moisture movement in expansive clay.

Report No. 118-4, "Prediction of Swelling in Expansive Clay" by Robert L. Lytton and W. Gordon Watt, uses the theoretical results presented in Research Report 118-1 and the moisture distribution computer programs of Research Report 118-3 to arrive at a method for predicting vertical swelling in one and two-dimensional soil regions.

Report No. 118-5, "An Examination of Expansive Clay Problems in Texas" by John R. Wise and W. Ronald Hudson, examines the problems of expansive clays related to highway pavements and describes a field test in progress to study the moisture-swell relationships in an expansive clay.

Report No. 118-6, "Measurements of a Swelling Clay in a Ponded Cut," by W. Gordon Watt and Malcolm L. Steinberg, reviews the use of ponding as a solution to the problem of swelling clays and presents the procedures used and results obtained to date from a ponding project conducted in 1970 in San Antonio, Texas.

Report No. 118-7, "The Waco Ponding Project," by Robert L. McKinney, Jr., James E. Kelly, and Chester McDowell, presents results of 1957-72 field studies concerned with the effectiveness of ponding and lime stabilization of clay subgrade in minimizing volume change beneath portland cement concrete pavements.

ABSTRACT

This report presents results of field studies conducted between 1957 and 1972 which were concerned with the effectiveness of ponding and lime stabilization of clay subgrade in minimizing volume change beneath portland cement concrete pavements. Potential Vertical Rise (PVR) was calculated to identify sections in need of ponding and the relationship of PVR to roughness and heaving of pavement is presented. The thickness of asphaltic concrete overlay required for pavement over untreated subgrade is compared to that required for concrete pavement placed over lime-stabilized subgrade, some of which was ponded.

Although a study of underdrains was not intended to become a part of Research Report 118-7, it became noticeable that the result of connection of perforated underdrains to ditch drop inlets was to increase heaving and overlay repair thicknesses.

A method for determination of "desired" moisture content is presented in the report and it correlates fairly well with moisture contents obtained from below pavement after a period of several years had elapsed.

KEY WORDS: potential vertical rise, ponding, lime-stabilized subgrade, clay, swelling clay, expansive clay, heave, roughness.

SUMMARY

If all of the 18 experimental sections except sections 9, 17, and 18 (drop inlet sections) had been constructed adjacent to each other as a single segment of the road the results would have weighed heavily in favor of ponding. This is because, after seven years service, only two bumps occurred in the aforementioned sections, and also because, after thirteen years service, the maximum variation in overlay thickness for all of these sections except one (8) was less than 1-1/2 inches, thereby indicating that the slabs in the above mentioned sections are still fairly smooth. On the basis of this information and other data given in the report, the following conclusions appear to be justified:

(1) Ponding was beneficial toward reduction of heaving of the pavement. This is based on a comparison of the number of bumps per mile of ponded sections with those occurring in the unponded part.

(2) The combination of ponding and lime stabilization of subgrade was very successful in prevention of pavement roughness due to volume change of the subgrade. This is based on a comparison of the performance of pavement in northbound main lane (NBML) sections with southbound main lane (SBML) sections.

(3) Perforated underdrains placed in swelling soils should not be connected to drop inlet drainage systems. This is based upon the number of bumps and overlay thicknesses.

(4) Potential vertical rise (PVR) is a useful tool for determination of areas in need of ponding.

(5) The procedure used for determination of desired moisture contents of various depths below pavements (Appendix 1) correlated well with results of moisture content samples taken from underneath old pavement. This method was found to be very useful in determining when to terminate ponding.

(6) Moisture content samples taken before, during, and after ponding indicate that moisture did not penetrate more than a 4-foot depth of subgrade in a period of 24 days but that during this same time moisture content samples of the 16 to 20-foot level increased to a satisfactory level after a period of several days ponding. This increase continued to be noticeable at lesser depths for a period of 24 days, leaving the driest area at a depth of 5 to 10 feet. These studies also revealed that moisture content of subgrade beneath pavement remained fairly constant over a period of seven years after ponding and that this moisture content can be estimated fairly

closely by using the method for determination of desired moisture given in Appendix 1. Data for samples from beneath the shoulders taken subsequent to the seven-year period are limited and inconclusive, possibly because the shoulders had shrunk away from the concrete pavement.

In view of the above conclusions, the following recommendations appear to be justified:

(1) Any subgrade for heavy traffic pavement having a potential vertical rise in excess of 1/2 inch should be investigated to determine which one of the following approaches may be used:

   (a) watering, mixing, compacting, and sealing of moisture in upper layers;

   (b) change of grade line and use of select soils;

   (c) use of deep mixing of lime combined with flooding with water; and

   (d) ponding followed by lime stabilization.

(2) In the case where it is necessary to use perforated underdrains in swelling soils, avoid connecting them to any other drainage system, especially if drop inlets are involved.

(3) Stabilized soils, impermeable flexible materials, or membranes should be used to protect a wide strip against future evaporation or absorption of large amounts of gravity water into the untreated subgrade.

(4) Special steps should be taken in design and construction to prevent shoulders from shrinking away from edge of pavement.

IMPLEMENTATION STATEMENT

The correlations obtained from this investigation can be very useful in improving the performance of pavements constructed over swelling clay soils. More specifically the findings indicate that:

(1) Calculation of "potential vertical rise" is useful in determining the limits where ponding is necessary.

(2) Equilibrium moisture contents at various depths below pavements over swelling soils can be determined by the method reported. This means that existence of proper moisture content can be determined at any time prior to or during ponding.

(3) The use of a combination of ponding and lime stabilization is effective in reducing pavement roughness. Lime stabilization alone was not as effective as use of the combination. A study of moisture and soil characteristics should indicate whether lime stabilization alone is sufficient.

(4) The connection of underdrain systems to drop inlets in swelling soils should be avoided.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1. INTRODUCTION

This report discusses work begun in the Waco area in 1957 to decrease the detrimental effects of heaving suffered by portland cement concrete pavement previously placed in the same area. Eighteen sections of the highway, selected so that they would be representative of some of the highest volume change conditions, were ponded and lime stabilized. The project was not set up for research study, but numerous investigations were performed, including those of moisture movements, pavement movements, and pavement performance over a period of several years.

In 1971 the Center for Highway Research of The University of Texas at Austin, recognizing that some of the studies made pertained to the scope of Research Project 118, entered into a cooperative venture with the Waco District of the Texas Highway Department and its former District Construction Engineer, aimed at reporting the project.

Many concrete pavements constructed on expansive clay subgrade material in the Central Texas area are greatly reduced in serviceability a few years after construction due to high volume change in the foundation units. Since the foundation units are the result of natural weathering and depositional processes, as either soils or parent material, there is an extreme lack of uniformity in their characteristics. This lack of homogeneity, combined with variable and uncontrolled access to water, produces detrimental differentials in swell that are as varied as the many contributing factors.

The site of the subject project (see Figs 1 and 2 for location) provided dramatic evidence of the detrimental results of high volume change in the subgrade. The District Engineer, Thomas C. Collier, and his staff observed two concrete highways side by side; one highway was 35 years old and the other was 5 years old. Both highways were rough and in need of level-up to improve serviceability. Since the plans were to construct the new southbound main lanes between the two existing highways, the decision was made to investigate the possibility of a procedure to control detrimental volume change in the new lane.

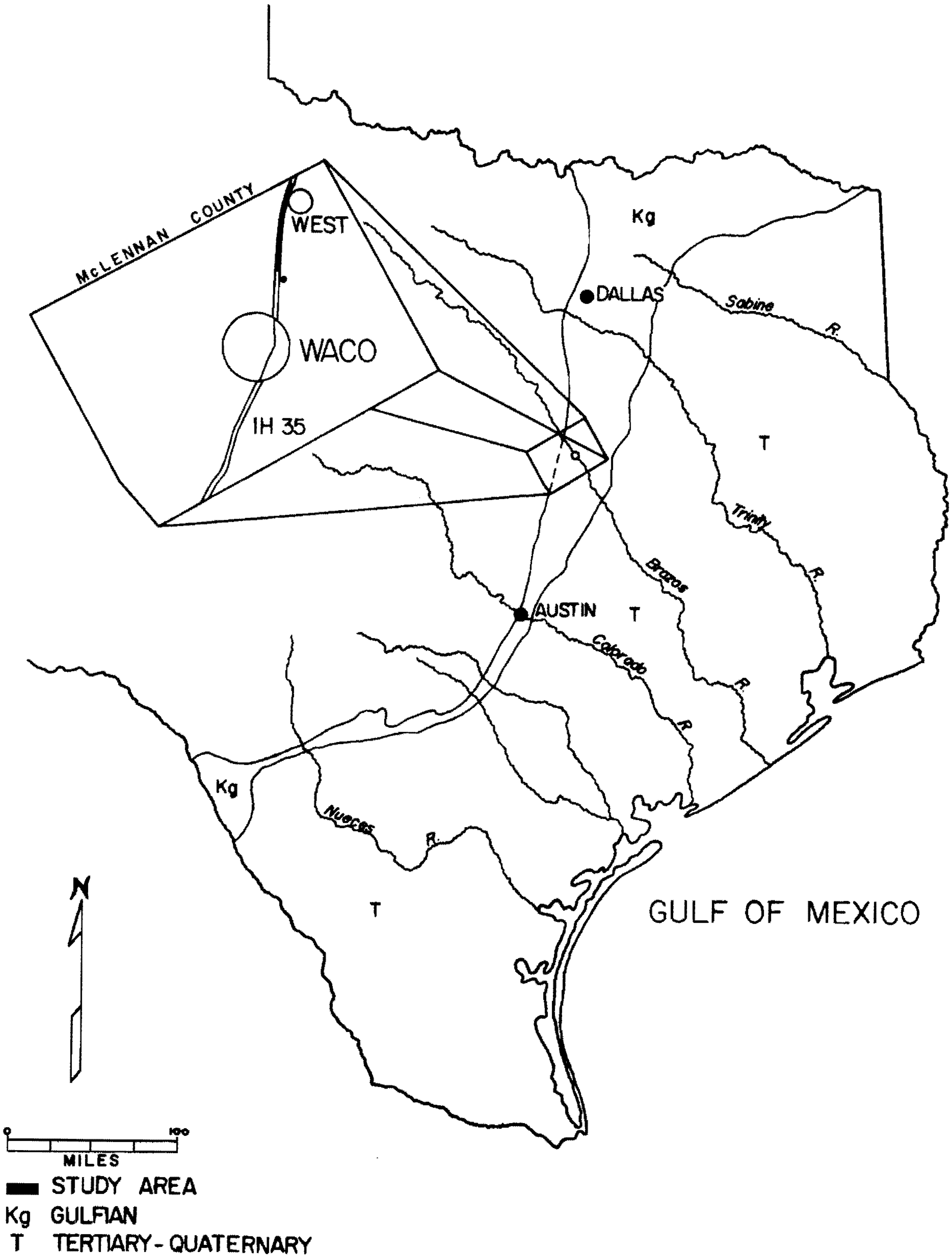


Fig 1. Location of study area within Texas.

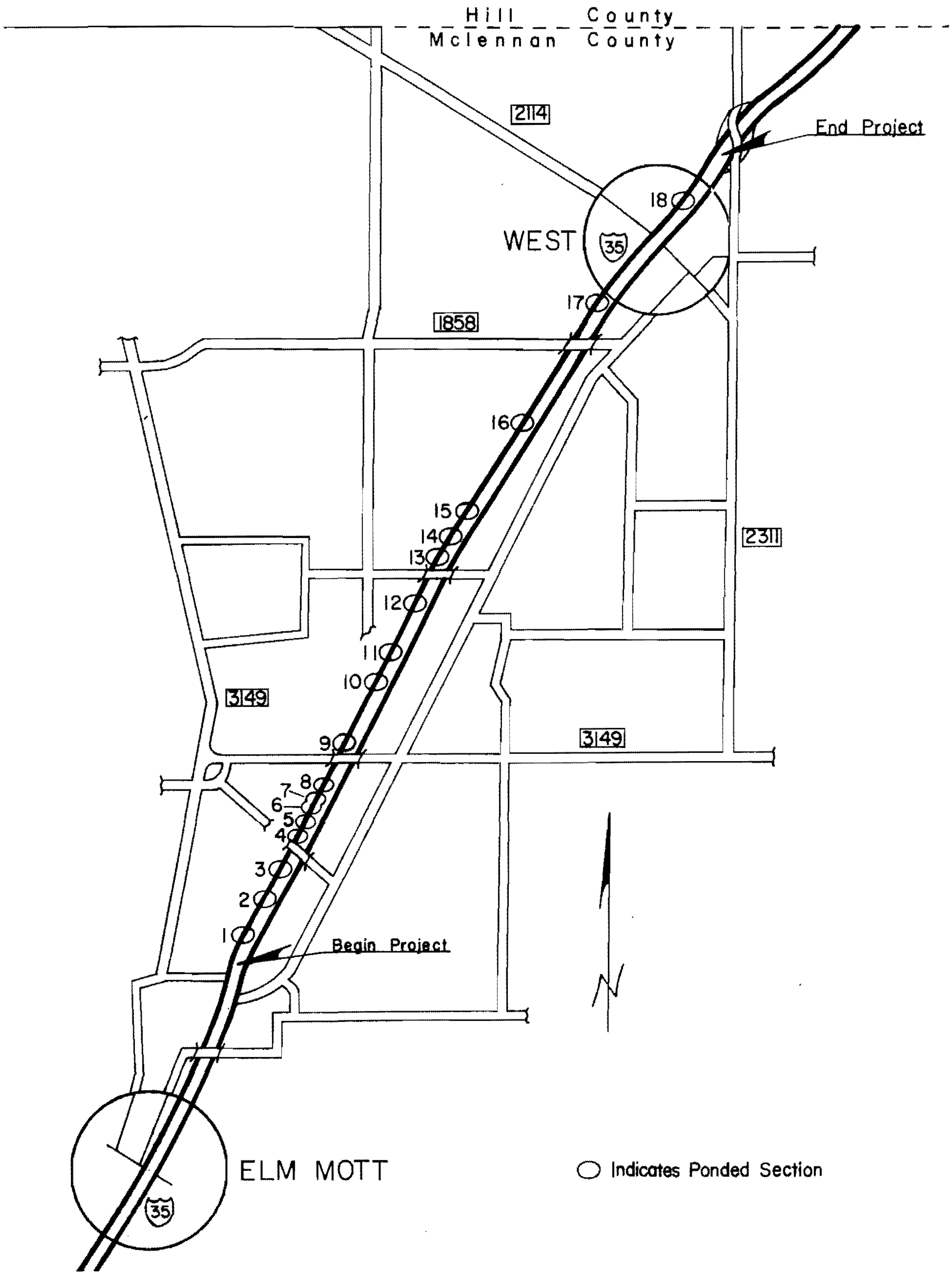


Fig 2. Location of study sections between Elm Mott and West.

Geology

The basic geological units encountered on this location are Upper Eagle Ford group, Austin Chalk, and Lower Taylor Marl member. The Lower Taylor member is the predominant unit as approximately 75 percent of the location is over this outcrop area. Test sections 1 through 16 are within this unit. An upthrust segment of the Austin Formation is encountered approximately 1/2 mile south of the town of West. This segment is present due to the Balcones Fault. The underlying Eagle Ford group is encountered near test sections 17 and 18 (see Fig 2 and Table 1). This unit of the Eagle Ford group has soil constants and swell characteristics similar to the Taylor member.

Although the Taylor unit is of major influence in the study area, the Austin-Eagle Ford contact has contributed much interest to this project. The objectionable grade changes at this contact are always very abrupt, with a swell just at the contact and a sharp depression at 5 to 10 feet up on the chalk. A possible explanation of this would deal with the reduction of load on the underlying shale and its subsequent expansion lifting the thinned chalk slab to failure.

The Taylor Formation is a neritic marine unit deposited near the edge of the stable Texas craton. The Lower Taylor Marl is a dark gray to dark yellow clay. Fresh exposures display blocky conchoidal fracture and develop poor fissility and lighter color upon weathering. The marl is composed of silt-sized quartz, calcite fragments, phosphate nodules, hematite, and finely disseminated pyrite and pyrite nodules. The dominant clay mineral is montmorillonite.

Although not within the scope of this investigation, it is believed that a detailed clay mineral analysis would have contributed to a more complete understanding of the problem. Beall (Ref 4) analyzed 46 samples in his "Stratigraphy of the Taylor Formation, East-Central Texas." The X-ray diffraction data are too lengthy and complex to present here. However, this statement from Beall will serve as summary:

> "The dominant clay mineral in the Lower Taylor Marl member as determined by X-ray diffraction is dioctahedral montmorillonite, which ranges from (1) a dominantly sodium montmorillonite associated with marl containing more than 5 percent kaolinite, a high percentage of silt-sized quartz, and a low percentage of calcite fragments and microfossils to (2) a dominantly calcium-magnesium montmorillonite with low kaolinite and quartz and a high calcite content."

TABLE 1. STATION LIMITS OF SECTIONS

SECTION NUMBER	LIMITS	LENGTH (FEET)	PERCENT OF TOTAL LENGTH
1	482 + 00 — 487 + 50	550	1.3
2	499 + 00 — 505 + 00	600	1.4
3	512 + 00 — 514 + 00	200	.5
4	526 + 00 — 529 + 00	300	.7
5	532 + 00 — 537 + 00	500	1.2
6 } Overlap	539 + 00 — 545 + 00	600	1.4
7 } Area	542 + 00 — 550 + 00	800	1.8
8	551 + 00 — 557 + 00	600	1.4
9	572 + 00 — 588 + 00	1600	3.7
10	617 + 00 — 620 + 00	300	.7
11	629 + 00 — 633 + 00	400	.9
12	653 + 00 — 657 + 00	400	.9
13	666 + 00 — 671 + 00	500	1.2
14	682 + 00 — 688 + 00	600	1.4
15	698 + 00 — 709 + 00	1100	2.6
16	744 + 00 — 749 + 00	500	1.2
17	802 + 00 — 817 + 00	1500	3.5
18	863 + 00 — 870 + 00	700	1.6

11,450' Total Ponded Area

Overall Length of Project: 43,000'
Ponded Area Represents 26.7% of Total Length

Pedology

Soils on the location identified by soil series as established by the Soil Conservation Service, U. S. Department of Agriculture (Ref 5), are as follows: Houston Black Clay, Houston Clay, Wilson Clay, Burleson Clay, Axtell Fine Sandy Loam, Irving Sandy Loam and Clay Loam, and Austin-Eddy Soils over the Austin Chalk outcrop area.

Most of the soils listed are heavy black to gray residual clays with high to extremely high plasticity indices. The Axtell and Irving Soils are developed on old high terraces. The surface soils of these units are shallow sandy loam to clay loam with tight clay subsoils mixed with fine sandy gravel. The combination of the terrace material, sandy surface soil, and underlying Taylor Marl resulted in a more difficult analysis and control situation.

CHAPTER 2. REVIEW OF THE PROJECT

The term "Waco Ponding Project" used in this report applies to special portions of an 8.133-mile project on Interstate Highway 35 in McLennan County, Texas (see Fig 1). More specifically the term applies to 18 sections (26.7 percent of the total length of project) in the southbound main lanes between Elm Mott and a point just north of West (see Fig 2 and Table 1). These sections varied in length from 200 to 1600 feet and were distributed throughout the length of the project. They were selected so that they would be representative of some of the highest volume change conditions on the project.

When the southbound main lanes (SBML) of IH 35 between Elm Mott and West were constructed in the late fifties, it was decided to try to employ the most promising techniques for improvement of highway pavement performance in an area where pavement performance had been very poor, with the intent of decreasing the detrimental effects of heaving suffered by portland cement concrete pavements previously placed in the same area.

Of all the factors influencing volume change, addition and control of moisture appeared to be the only practicable remedial procedure to consider. Compaction control on the disturbed layers was also expected to contribute favorably. To aid in moisture retention after ponding, it was decided to extend the lime-stabilized subgrade to the width of the ponded section. These sections were ponded and lime stabilized in 1958.

When the construction project of 1957 was first conceived, the existing facility consisted of a four-lane divided highway with the southbound section being a concrete pavement completed in 1933 and the northbound pavement, a concrete section completed in 1952. The serviceability of these two sections of pavement was so low that the forthcoming construction project was to include level-up and overlay on these pavements. This loss in serviceability was not the result of any loss in structural capabilities but primarily could be attributed to the characteristic volume change in the naturally occurring soils in the area.

Prior to this date, the Portland Cement Association had conducted a brief experimentation in the area that indicated that soaking could produce the desired volume change prior to construction (Ref 1) and eliminate the differential vertical movement which was plaguing all construction in the area. McDowell's report (Ref 2) on potential vertical rise had correlated very closely with the findings of the Portland Cement Association experimentation.

As a result of this close correlation, it was decided to pond limited sections of the subgrade prior to construction of the section that was to become the southbound main lanes of the interstate highway in the area. The plan included the construction with flexible base and penetration surface of an east frontage road and the use of the existing southbound lanes as the west frontage road. The existing northbound lanes were to remain as the northbound lanes and new southbound lanes were to be constructed between the existing surfaces.

It was decided that certain areas of the existing ground would be ponded prior to grading and then the area would be graded and the surface of the grading protected by lime stabilizing of the surface of the subgrade. Because it was felt that funds would not be available to pond the entire area, basic criteria were established which would lead to the selection of the ponded sites. The initial investigation was carried on by staff personnel of the District Laboratory of Texas Highway Department District 9 at Waco.

Areas to be ponded were selected on the basis of potential vertical rise in excess of 1 inch. The method used to calculate the PVR was generally the same as the present procedure Tex-124-E (Ref 3) (see Appendix 3, Tables A1 and A2). Of course, this method immediately indicates the need for extensive push-barrel sampling to determine existing moisture content and soil constants. Since it was felt that not all of the locations could be or needed to be ponded, it was decided to consider the areas where proposed fill was less than 6 feet.

This was based on the premise that moisture and density of the fills would be controlled so as to minimize swell from the fills themselves and that the surcharge load from 6 feet of fill and 24 inches of pavement would be sufficient to restrain swell of most clay sublayers. Deep cuts were investigated after the material was removed to approximately the proposed grade line. In areas of severe swell, it was found necessary to investigate to a depth of 20 feet due to the fact that the potential swell would not "load out" above 16 to 18 feet. The limits of these areas were provided the contractor who then diked and ponded 18 experimental sections, in accordance with the plans and specifications, for 30 days, at which time he was allowed to remove the ponds and proceed with the grading in accordance with standard Texas Highway Department procedures.

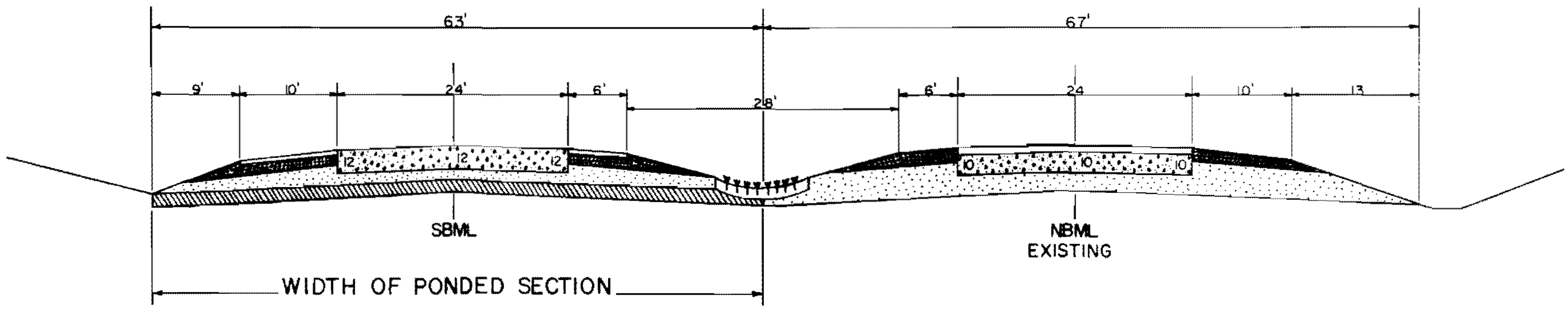
A typical cross section of both the northbound and southbound main lanes is shown in Fig 3. The proposed SBML concrete pavement contained corrugated metal contraction joints on 15-foot centers with no expansion joints except at bridge ends. The portland cement concrete was designed and constructed so as to have a minimum 7-day flexural strength of 650 psi. The SBML probably is stronger structurally than the NBML; however, since all observed distortions causing uncomfortable riding appeared to be a result of heaving, it is doubtful that the structure strength had appreciable influence on the road's performance.

Plans for the construction of the SBML specified standard procedures for a grading, drainage, and pavement project with the exception of a requirement that selected areas of the natural ground and subgrade would be water treated for a period not to exceed 30 days.

Two pay items were provided in the contract to cover the water treatment. These were "Preparation for Water Treatment" and Water Treatment." Estimated quantities and bid prices were 160,000 square yards at \$0.015/sy for "Preparation for Water Treatment" and 19,000 M/gal at \$0.75 M/gal for "Water Treatment." Final quantities for each of these items was 82,950 square yards and 5,220 M/gal of water respectively. The total price per square yard was calculated to be 19.7 cents. Construction and removal of dikes for water treatment was accomplished using motor graders and bulldozers. Water was hauled to the site using standard water trucks.

The structural section of the pavement (Fig 3) called for a 6-inch lime-stabilized subgrade, a 5-inch foundation course and 12 inches of non-reinforced concrete pavement.

Studies of soils with a range in plasticity indices of 25 to 55 indicated that the triaxial strength (former test method, THD-80; current, Tex-117-E, Ref 3) improved from Class 5 to Class 1 with the addition of 6 percent hydrated lime by weight. During construction 25 pounds of hydrated lime per square yard or approximately 6 percent lime by weight was added to the subgrade. The PI of the lime-treated soil taken from the road varied from 6 to 21.



DEPTH OF INDIVIDUAL MATERIALS, inches

Material	SHOULDER	SBML	NBML	SHOULDER
ASPHALTIC CONCRETE PAVEMENT	1½		3	(*)
CONCRETE PAVEMENT		12	10	
CEMENT STABILIZED FOUNDATION COURSE	6			6
FOUNDATION COURSE (GRAVEL)	9½	5	10	17
LIME STABILIZED SUBGRADE	6	6		
TOTALS	23	23	23	23

* ONE COURSE SURFACE TREATMENT

Fig 3. Typical cross section of highway.

Preliminary results of unconfined compression tests on 18-day cured specimens containing 6 percent lime varied from 62 to 281 psi.

Specifications for the foundation course were as follows:

Retained on 3-inch screen	0%
Retained on 2-inch screen	0-8%
Retained on 1/4-inch screen	50-75%
Retained on 40-mesh sieve	70-85%
The liquid limit shall not exceed	45
The plasticity index shall not be less than 4 and shall not exceed	15
The linear shrinkage shall not exceed	10%

Shoulders were constructed of 6-inch soil cement base using 8 percent cement by volume with 1-1/2 inch type "D" asphaltic concrete surface. The intention of the specification was to require that the average minimum unconfined compressive strength be not less than 700 psi after specimens were moist cured for a period of 7 days.

The contract contained pay items for "Sprinkling" and "Rolling." Items of work other than "Embankment" and "Lime-Stabilized Subgrade" were placed using "Compaction Ratio" control procedures as a guide but were not required in the contract. Density for embankment was specified to be not less than 95 percent and the density for lime-stabilized subgrade was specified to be not less than 98 percent. These percentages were determined in accordance with the former test method, THD-110, and the current method, Tex-114-E (see Ref 3).

At that time, there was no intention of making a research project out of the study; however, observations of pavement performance and moisture content tests were continued over a period of several years. In 1971 the Center for Highway Research entered into a cooperative venture to write up this project. It was then necessary to find some means of describing the distortion of the original pavement slabs. Since the experimental ponded sections were scattered throughout the length of the project and since pavement performance varied between as well as within sections it became necessary to evaluate this project thoroughly before forming conclusions. Since thirteen years had lapsed after the pavement on this project was placed it was necessary to establish thickness of overlay, moisture contents, and performance records as a basis for the evaluation of ponding. At this time the pavement had been overlayed with hot mix asphaltic concrete (HMAC) and sealed so effectively (see Fig 8) that it was difficult to conclude that any one section was better than another. No cracks were evident, thereby eliminating the possibility of making a crack survey. Profilometer measurements were made on the entire 8-mile project, but since no previous measurements had been made they failed to reveal the past behavior of these pavements. The measurements are on file at the District Laboratory of the Texas Highway Department in Waco.

Since it was known from field bump survey observations made during a 7-year period that pavement roughness developed erratically between sections, it was decided to determine the thickness of asphaltic concrete overlay at regular intervals. After the project was restaked, the thickness of AC overlay was determined at each 100-foot station for all experimental sections and each opposite station in the older, northbound main lanes. Detailed logs of the core thickness, which varied from nearly 2 to over 19 inches, are shown in Appendix 2.

CHAPTER 3. GATHERING AND ANALYSIS OF DATA

Field exploration and testing was started in May of 1957. The initial investigation consisted of classification and surface mapping of soil series plus pertinent geological factors. Since fills in excess of 6 feet were to be excluded, the limits of these areas were established. This information, along with test data obtained at all stages of operation, was recorded on a continuous roll profile plot. Thirty-seven locations were selected for detailed testing. One hole was drilled in each location for primary data. The equipment used in obtaining test samples consisted of a truck-mounted auger with a 2.25-inch square kelly bar capable of forcing a 4-inch OD push barrel to a depth of 22 feet. The push barrels were approximately 30 inches in length. The kelly bar of the drill unit could attain the full depth without extensions.

The necessary data obtained from each pilot hole were soil constants, gradation, moisture content, and physical description (see Tables A5-A15, Appendix 4; Tables A1-A4, Appendix 3). Generally, samples were taken every 6 inches in depth. Some deviation from this procedure was necessary due to material changes. After tests were completed, grouping into major units could be accomplished when control factors were in agreement. At the completion of this phase of investigation, 477 samples had been tested for soil constants, gradation, etc.

Calculations of PVR values were made from the pilot hole data from each location as tests were finished (see Tables A1 and A2 for details of PVR calculations). After all locations were checked for PVR, 18 of these indicated swell potential in excess of 1 inch. All test data were then plotted on the profile roll and the 18 sections proposed for ponding were established. The sections in cut areas were investigated further after completion of excavation.

The equilibrium moisture content was determined for each section selected for ponding. Appendix 1 is a detailed explanation of the procedure used in the calculations of desired moisture. Tables A3 and A4 of Appendix 3 are examples of the procedure and values obtained for 2 of the sections.

Section 1 was diked and flooded on October 10, 1957. The next section was ponded the following day. These sections were observed and all details evaluated. Full-depth moisture tests were taken after 14, 20, and 24 days of soaking (see Fig 4). Test information as well as experience gained from these first sections was essential to the planning of a workable procedure for the remainder of the operation. Moisture tests during the initial ponding indicated that about 30 days soaking on most of the sections would be adequate to reach equilibrium moisture content. Sections 5 and 7 were ponded less time because the required change in moisture (from start of soaking to desired content) was not as much as for the average section.

There had been considerable doubt that the truck-mounted drill could work as a self-propelled unit in ponded areas. This was accomplished with the use of removable wrap-around plated tracks on the tandum rear wheels. With this equipment it was possible to move into a ponded area immediately after the water was drained and proceed with push barrel sampling (Fig 5).

An approximate time requirement for soaking was established after the first 2 sections; however, confirmation moisture tests were continued through the remainder of the project. Extended time testing was continued on a random basis (random time) on several sections. Results through 1964 were used in Fig 4. Moisture tests were taken in sections 1 and 9 as late as March 1972. The latest tests (taken at the edge of the concrete pavement) were not considered to be reliable due to the depth of the crack that has developed between the pavement and shoulder. It is very probable that the condition of this joint has had a detrimental effect on the pavement serviceability in several sections.

Over 9,000 moisture tests were taken on this project. Approximately 85 percent of these tests were made during planning and construction. All moisture and soil constants test results are on file in the Waco District Laboratory. It is obvious that the previous reference in the Introduction to "extensive push barrel sampling" is something of an understatement. However, without the expertise gained on this project, it is doubtful that the number of samples could have been effectively reduced. A future project over similar materials could probably be adequately planned and controlled with fewer moisture samples, but a reduction in soil constants tests would be questionable.

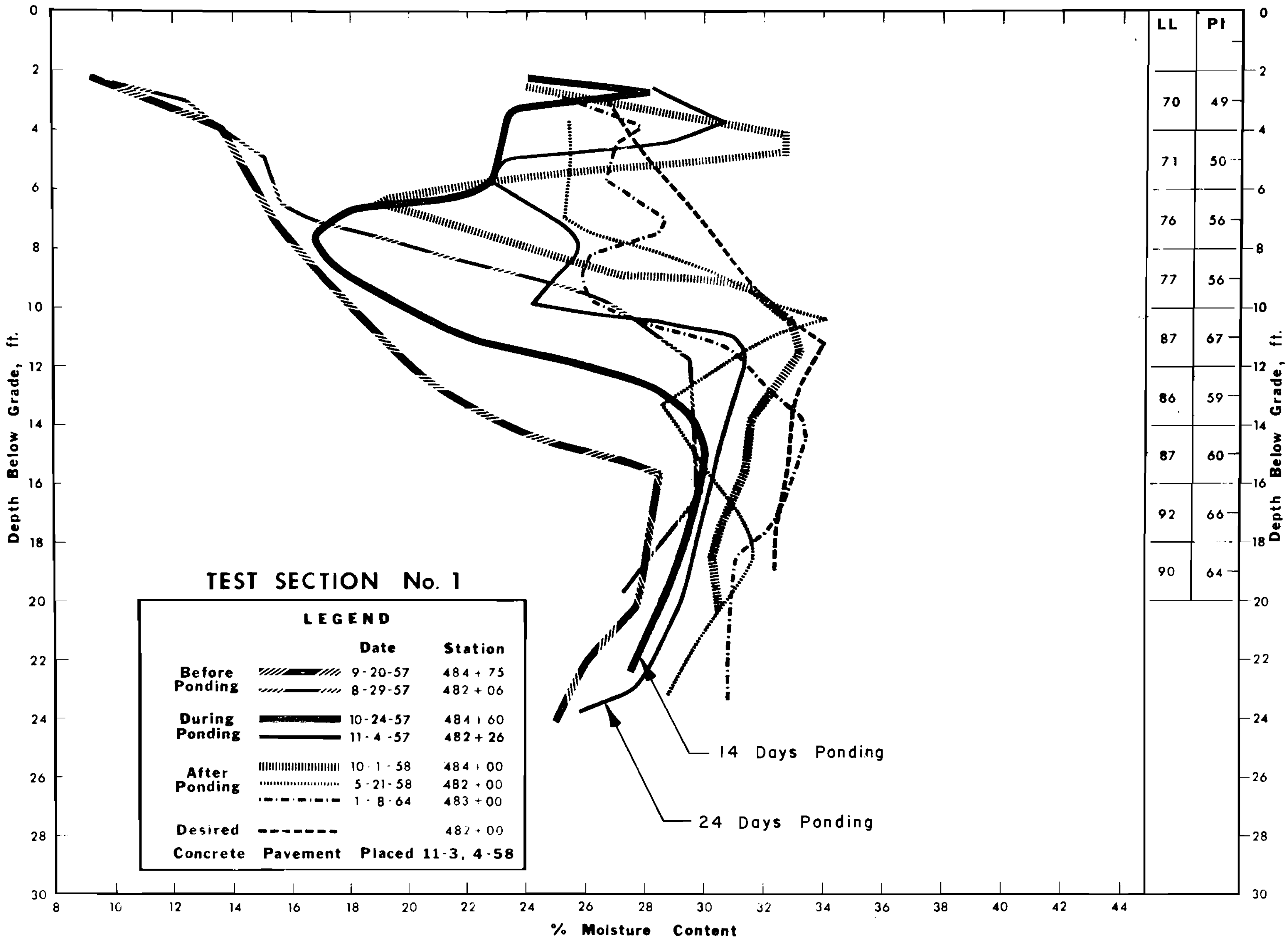


Fig 4. Depth versus moisture prior to and during ponding (section 1).

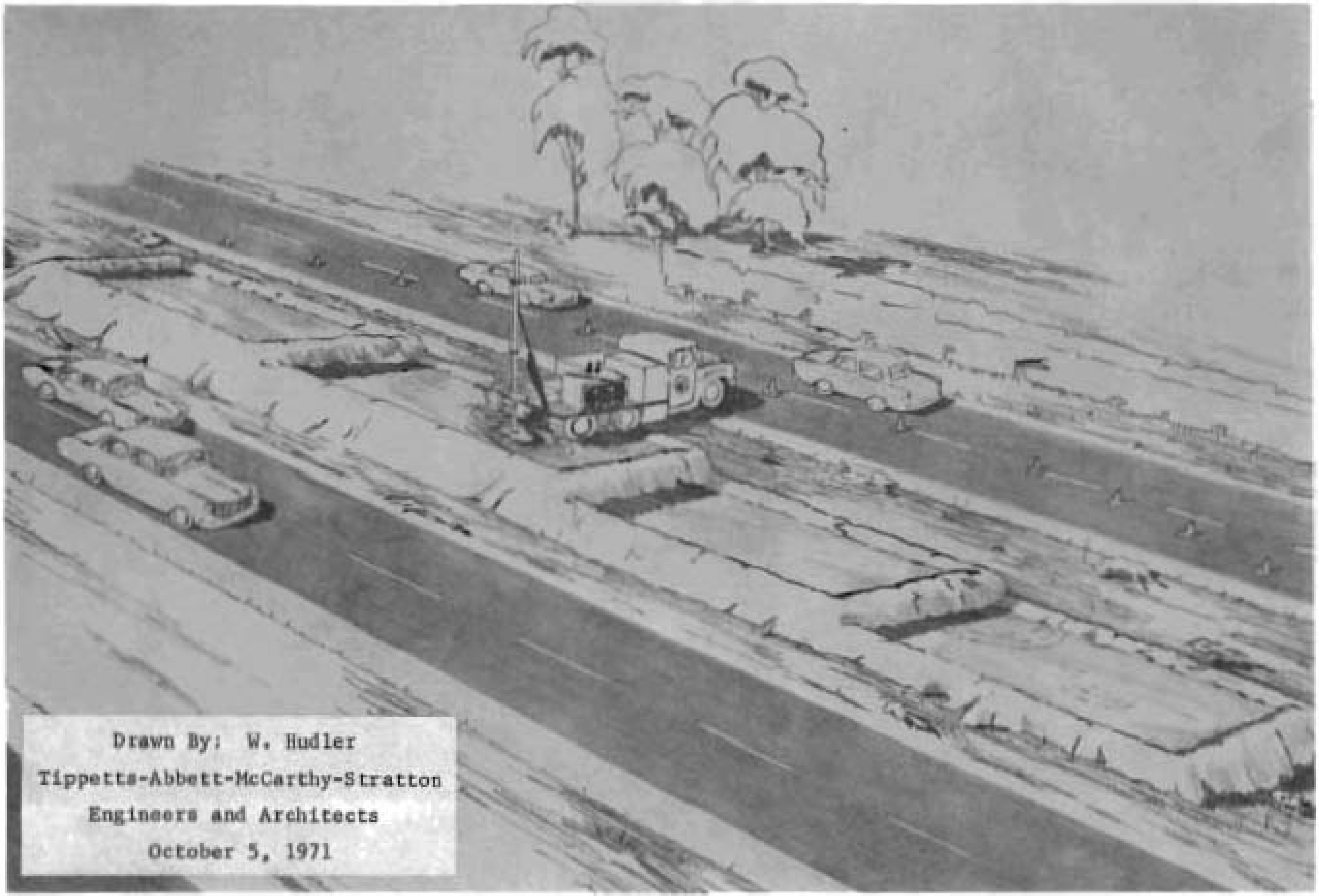


Fig 5. Sketch of drilling rig in pond.

The results of moisture content tests at various depths and at various stages of the project's history for sections 1 and 9 are shown in Figs 4 and 6. The moisture content curves are the averages of many samples taken at 6-inch-depth intervals and are believed to represent the range of values to be found in the other sections. The LL and PI values are shown along the right edge of Figs 4 and 6 and in Tables A3 and A4 of Appendix 3. These data are also shown in Tables A5 and A13 of Appendix 4. Appendix 4 also contains similar but less complete information for 9 other sections. Moisture content and soil constants data for sections 12 through 18 are not shown because complete data are no longer available and level profiles for only the first 11 sections could be found. The moisture content curves shown in Figs 4 and 6 are presented in such a manner as to depict the moisture conditions before, during, and after ponding at depths below the top of the concrete pavement grade. The data shown in Fig 4 are believed to be typical of most of the sections, especially those that performed well, and the curves shown in Fig 6 are believed to be typical of a few sections that performed poorly. Many other samples were taken in less detail in all of the other 18 sections but for the sake of brevity are not included in this report. Usually the magnitude of the areas bounded by the after ponding curves and the desired moisture curve represents swell potential. It may be noted that these areas are much larger in Fig 6 than they are in Fig 4. This could be part of the reason for the poor performance of section 9.

The solid black curves in Fig 4 show the moisture contents after 14 and 24 days of ponding. These and the desired moisture content curve indicate the following:

(1) Moisture did not penetrate more than about 4 feet of subgrade (6 feet below finish grade) during 24 days of ponding.

(2) During the time of ponding, moisture contents at the 16 to 20-foot depths also began to increase, leaving the driest areas at a depth of 5 to 10 feet below pavement grade.

(3) The dot-dash curve shows that moisture contents taken 7 years after ponding (6 years after paving) were slightly in excess of those shown at the conclusion of ponding. The dashed line, for "desired" moisture content, is located fairly close to the dot-dash line, indicating that the moisture content to be anticipated in clay soils, at various depths, can be determined with a fair degree of accuracy (see Appendix 1).

During the years from 1958 to 1965 several observations for bumps in both the north and southbound main lanes were made for the entire 8-mile project.

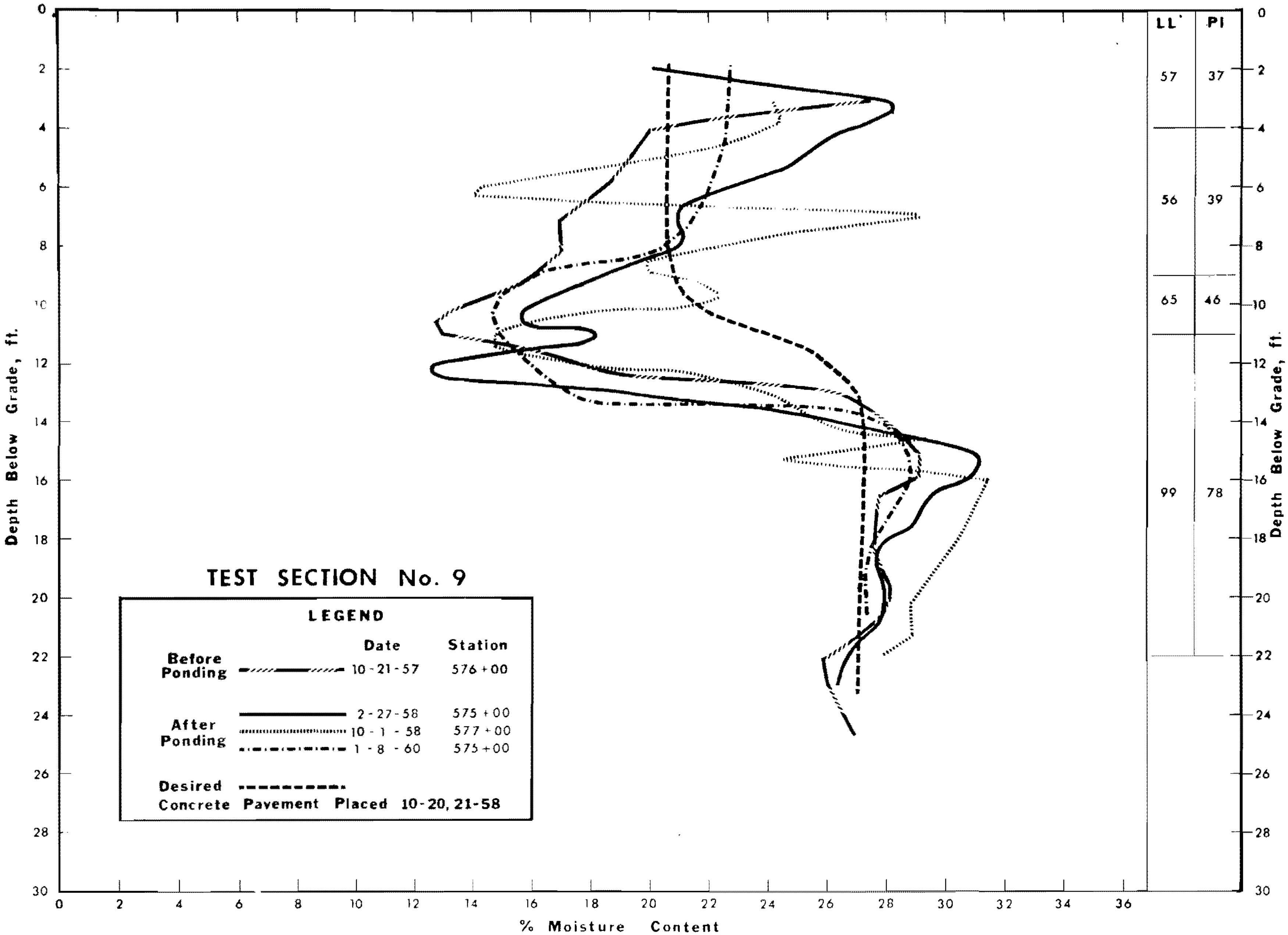


Fig 6. Depth versus moisture prior to and during ponding (section 9).

(a) Looking north at section 9. Patch in left background is just beyond limits of section 9.

(b) Looking north, excellent condition of overlay and sealcoat in southbound main lane is shown.

Fig 7. Condition of pavement in 1973.

This was done by driving a passenger car at 60 miles per hour and noting on the plan-profile sheet the station number where the deformations causing uncomfortable riding were located. It is interesting to note that on April 12, 1961, three bumps had occurred in the northbound main lanes, but none had occurred in the southbound main lanes. Subsequent observations for heaving were made up until 1965, at which time placement of intermittent patches of overlay made it difficult to accurately record new bumps. After three more years (1968), it was decided to place 2 inches of HMAC overlay throughout the entire 8 miles of southbound main lanes. Figure 8 shows that during the first 7 years one bump occurred in each of sections 5, 8, 17, and 18. Another four bumps occurred in section 9. The cross-hatched bars at the right side of the chart show that twice as many bumps per mile occurred in the unponded portion of the southbound main lanes as in the ponded sections. Reference to the plans reveals that sections 9, 17, and 18 are the only ponded sections that have drop inlets connected to perforated underdrains. Section 9 has ditch drop inlets for large drainage areas connected to underdrains. When it rains, a head of water can back up into the underdrains and during dry weather wide belts of soil can dry out due to evaporation. This makes for extreme fluctuations of moisture and volume change in this section of high volume change soils. It is possible that these bumps might not have occurred if underdrains had not been connected to drop inlets. In this case, there would have been four bumps in all sections or only about one-fourth as many per mile as occurred in the unponded portion. One bump each occurred in sections 17 and 18. These sections were in small drainage areas such as are found at underpasses and the drop inlets were at curbs. If all bumps from ponded sections which have drop inlets connected to underdrains are ruled out, there would be only two bumps left in all sections and the unponded portion could be said to have between seven and eight times as many bumps per mile as the ponded sections had. The reader's interpretation of these findings will depend a great deal upon his background and attitude but the most conservative cannot help but conclude that ponding was beneficial. The authors believe that had they known the things now known, it would have been possible to construct large portions of this project so that they would have remained relatively free from heaving.

Since potential vertical rise (PVR) has been used as a basis for determination of areas to be ponded, it was decided to try to relate this factor to

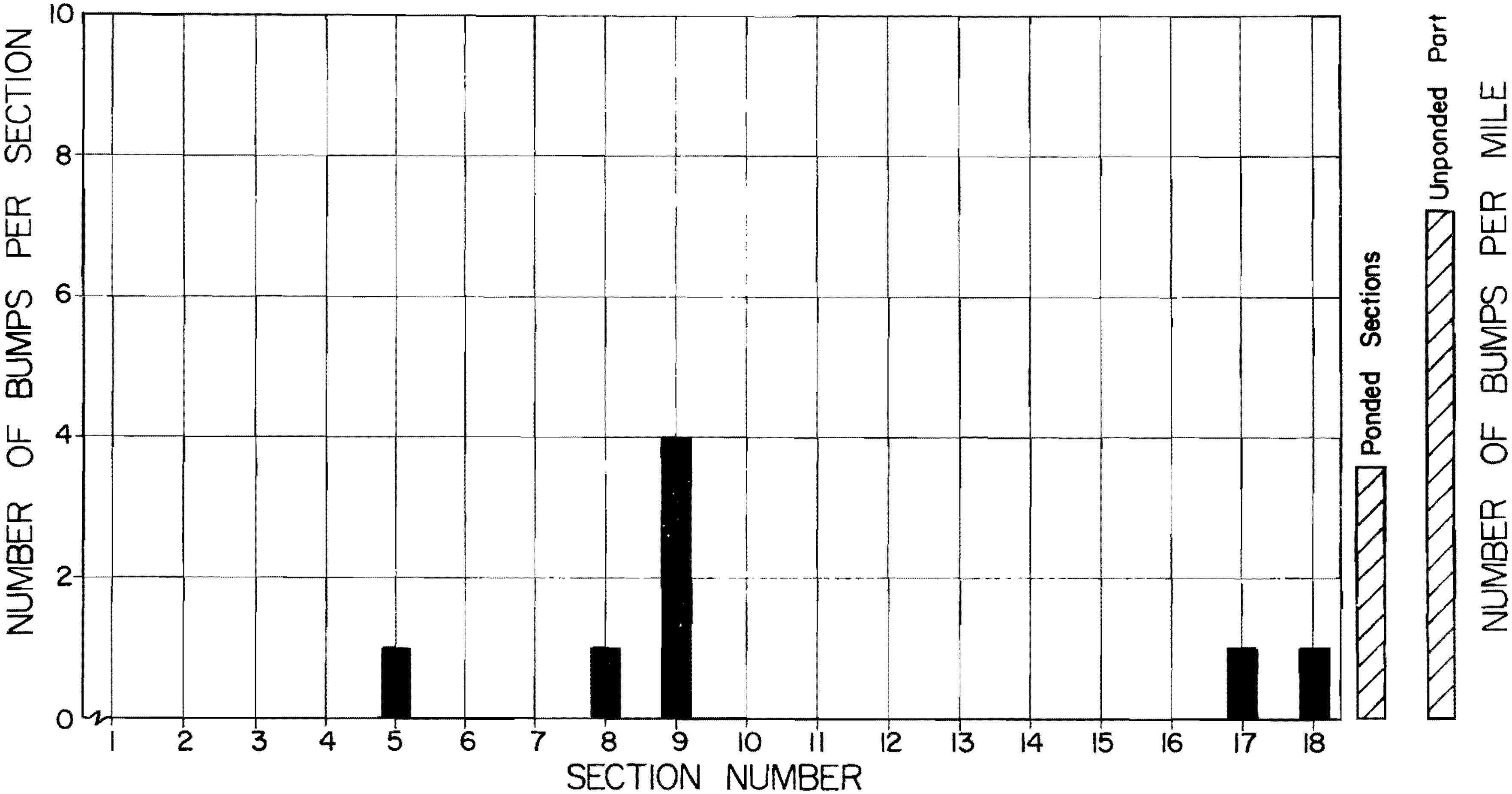


Fig 8. Bumps recorded between 1958 and 1965.

the number of bumps occurring in the unponded portions of the southbound main lanes. Figure 9 shows that the number of bumps can be expected to increase as the PVR increases. The heavy dashed line on Fig 9 shows that when the PVR exceeds 2 inches a rapid increase in the number of bumps per mile can be expected. Since this chart is based upon a 7-year study, it does not clearly indicate the magnitude of the minimum PVR for design but the figure is probably somewhere between 1/2 and 1 inch.

Figure 10 relates the original PVR values to level measurements of movements recorded in May 1965. Paving grade level notes for ponded sections 1 through 11 were all that could be found in the files. This chart shows the original PVR values (which varies from 0.25 to 3.12 inches). It may be noted that the average movement as measured from levels is approximately 1-1/4 inches whereas the target for ponding was 1 inch.

In 1971 it was agreed that probing for thicknesses of AC overlay would be helpful in studying the manner in which the pavement performed. Figure 11 shows the average thickness of overlay for each section. A complete log of thicknesses is given in Appendix 2. It may be noted that section 9 (the section with ditch drop inlets connected to underdrains) had the greatest average thicknesses of overlay of any section. It may also be noted that the overlay thicknesses are much greater for the northbound main lanes than they are for the southbound main lanes. This is as would be expected since the NBML are about six years older; however, a difference of 3 to 8 inches for several sections seems unusual, to say the least.

Figure 12 shows that the maximum variation in thickness of AC overlay of the northbound main lanes is greater than that of the southbound main lanes in nearly all sections. This means that the original slabs of the SBML's are not out of grade as much as those of the NBML's. It should be kept in mind that the NBML's are not the same age as the SBML's. Points marked 2nd and 3rd represent the second and third highest values of thickness variation. They are presented to show that the peak values are not unusual values.

As stated before, it is difficult to compare overlay thicknesses of the northbound and southbound main lanes because of the difference in their service lives. In an attempt to place these data in their proper perspective the Fig 13 histogram was prepared. The straight lines on Fig 13 are plotted against the scale on the right side of the chart. The dashed line is for the SBML and the

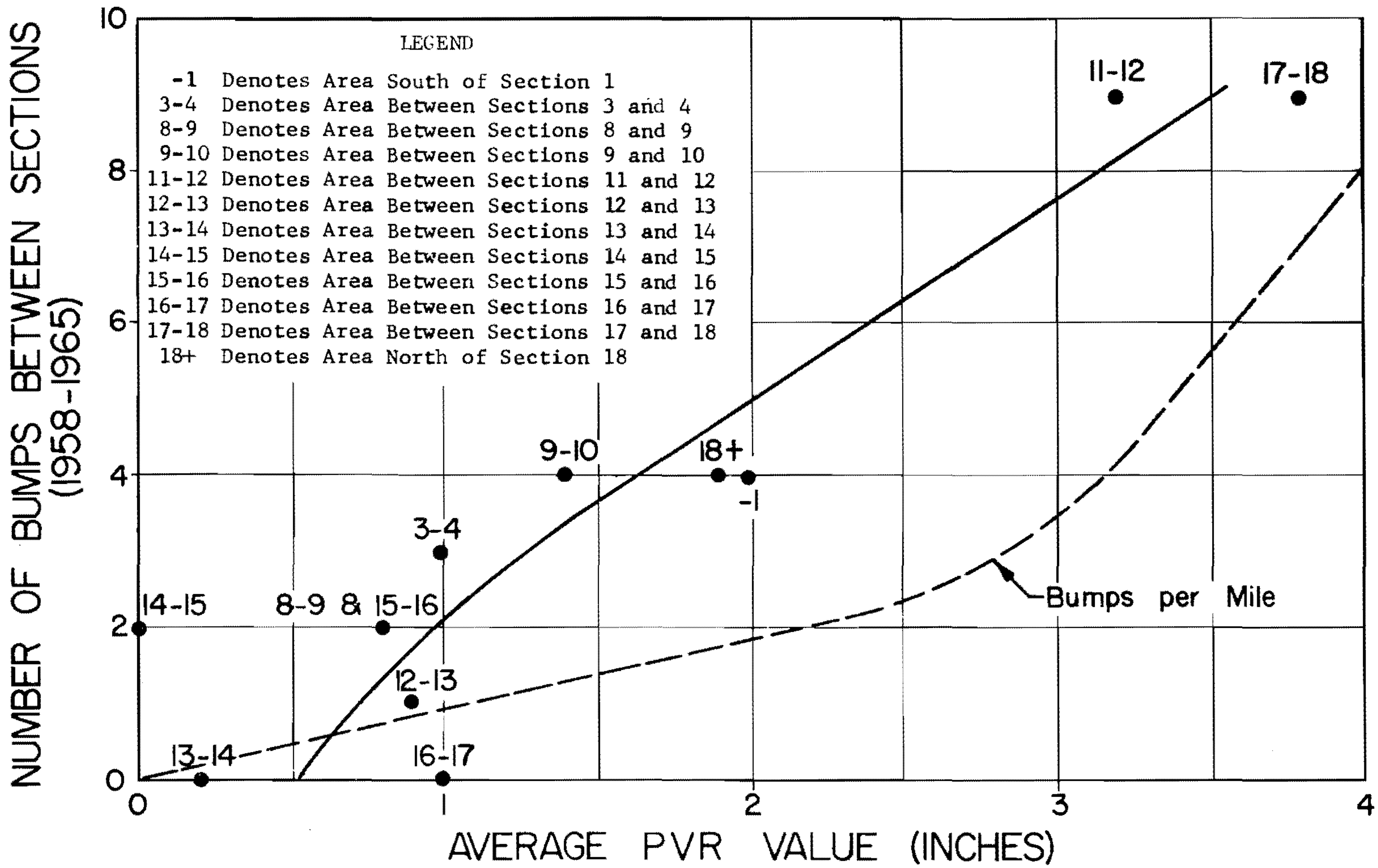


Fig 9. Relation of number of bumps for unponded portion of SBML after seven years of traffic to average PVR.

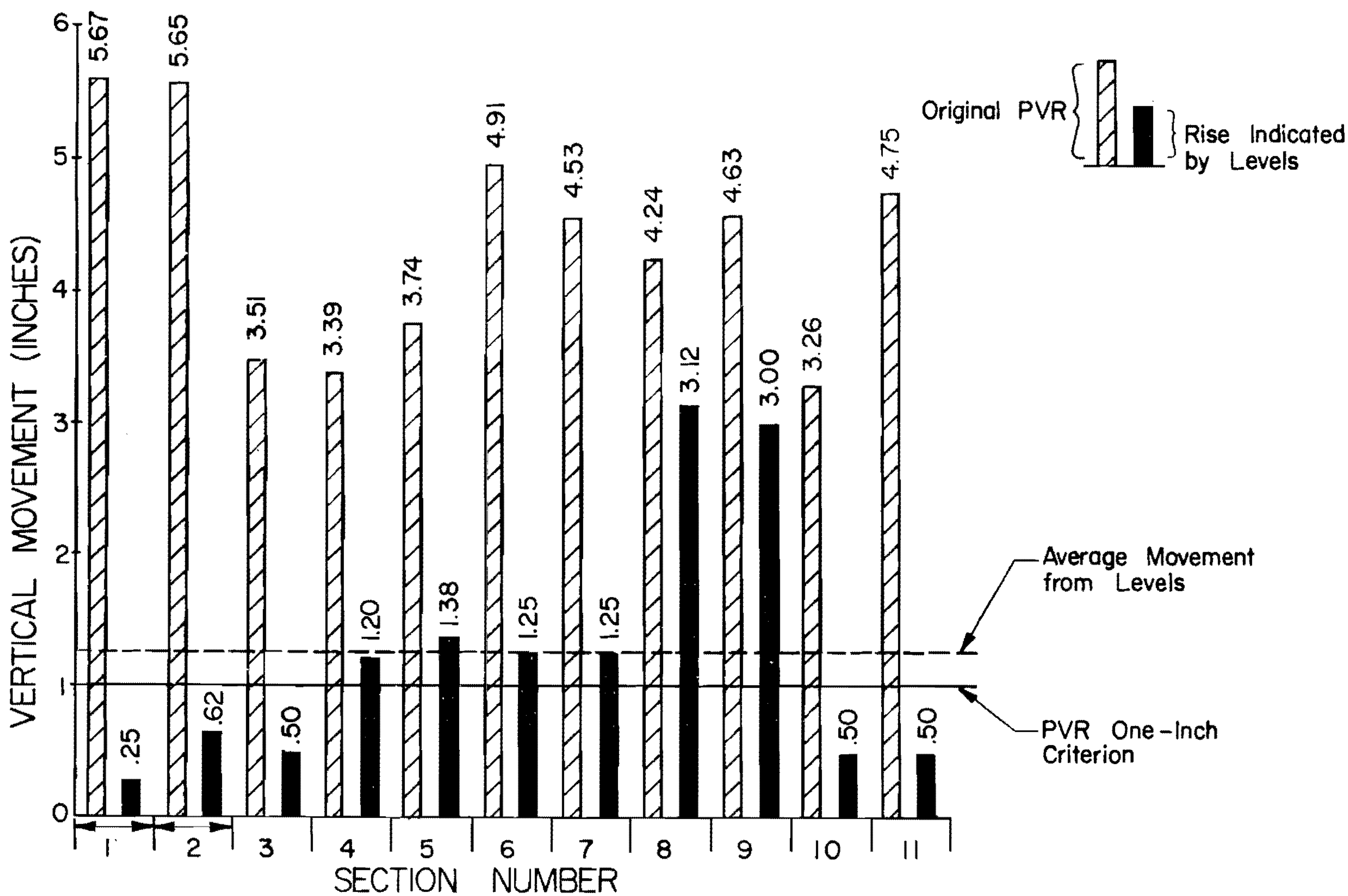


Fig 10. Relation of original PVR to movements as measured by levels.

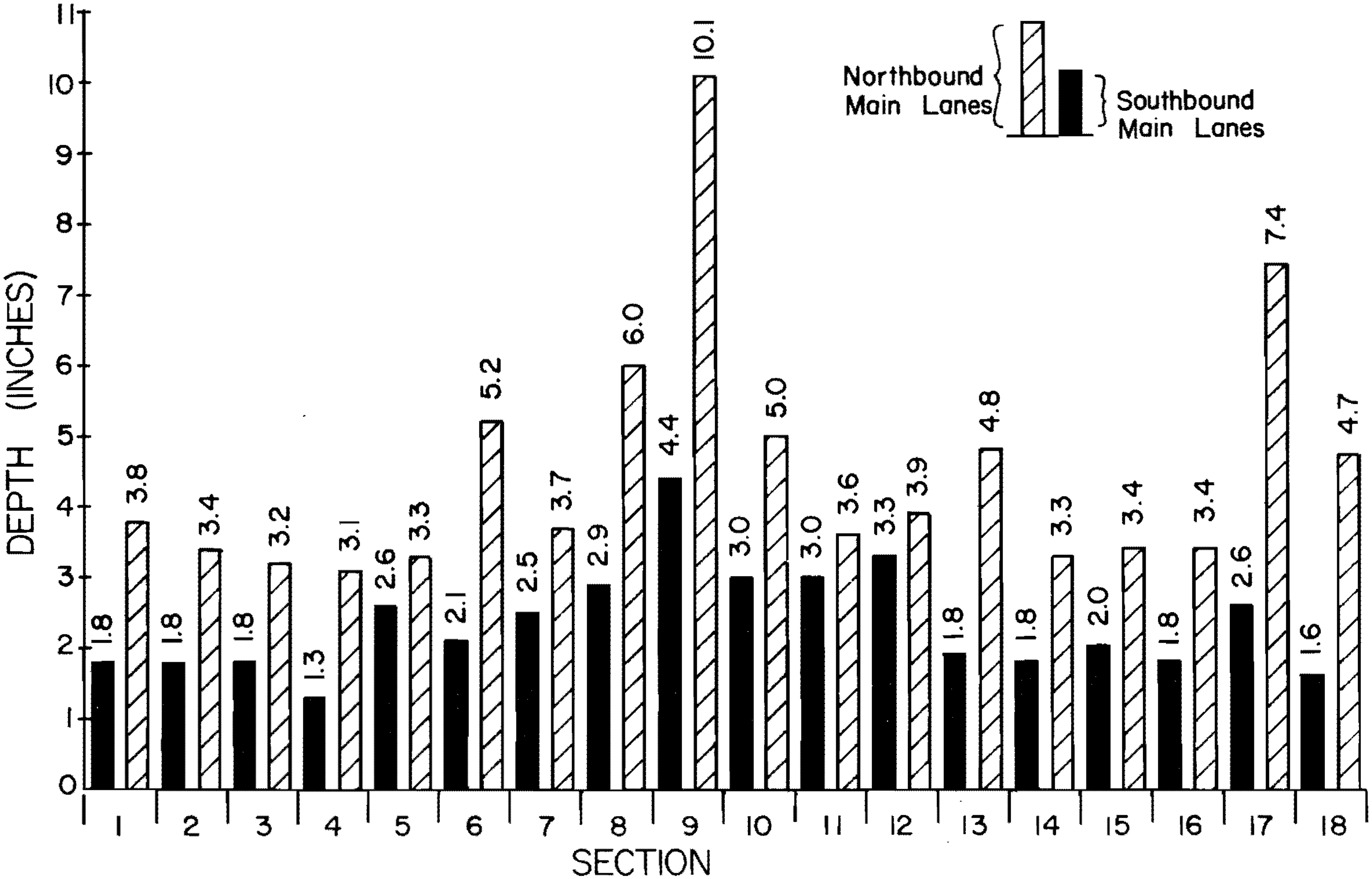


Fig 11. Average thickness of asphaltic concrete overlay (1971).

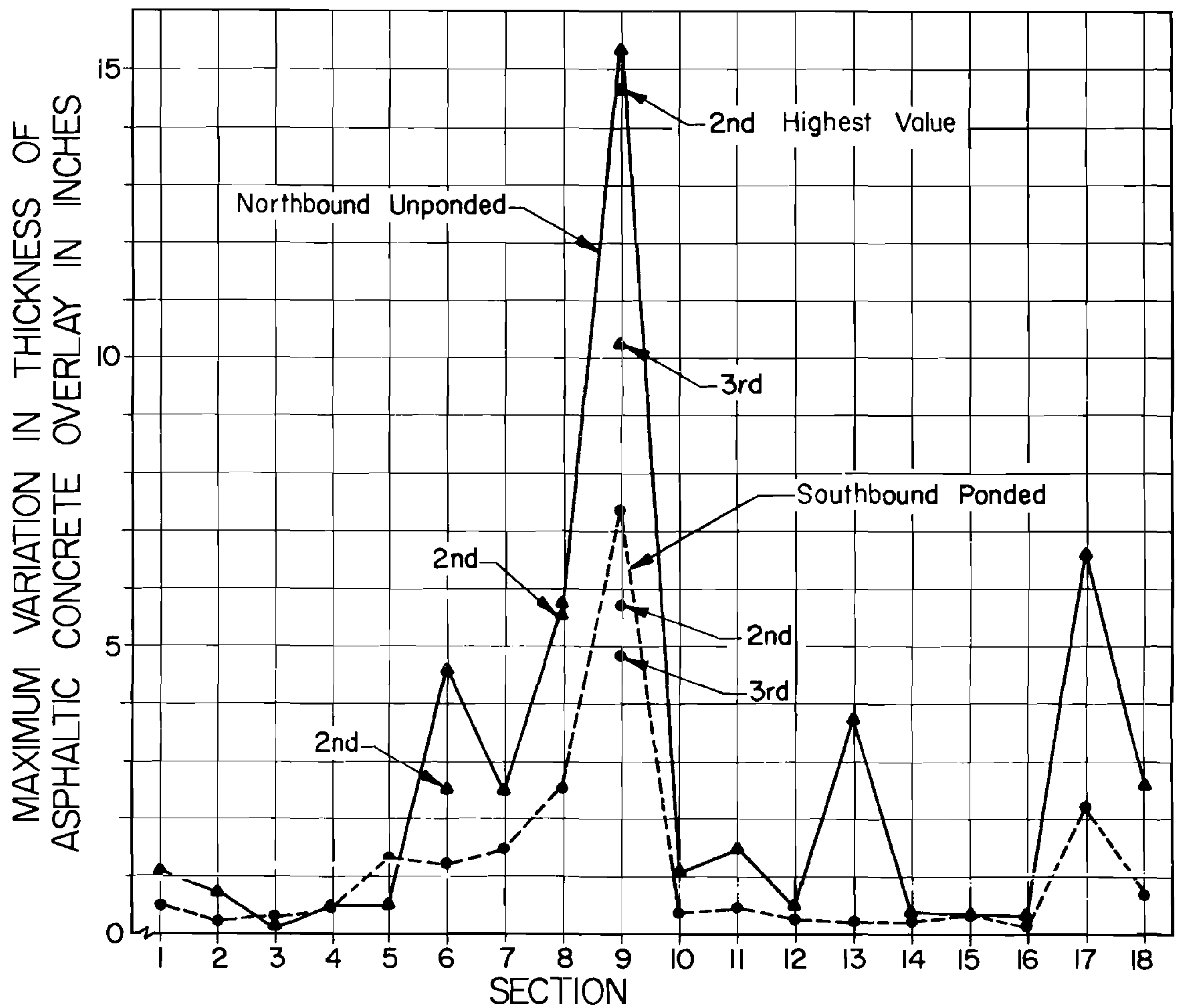


Fig 12. Maximum variation in thickness of asphaltic concrete overlay in inches.

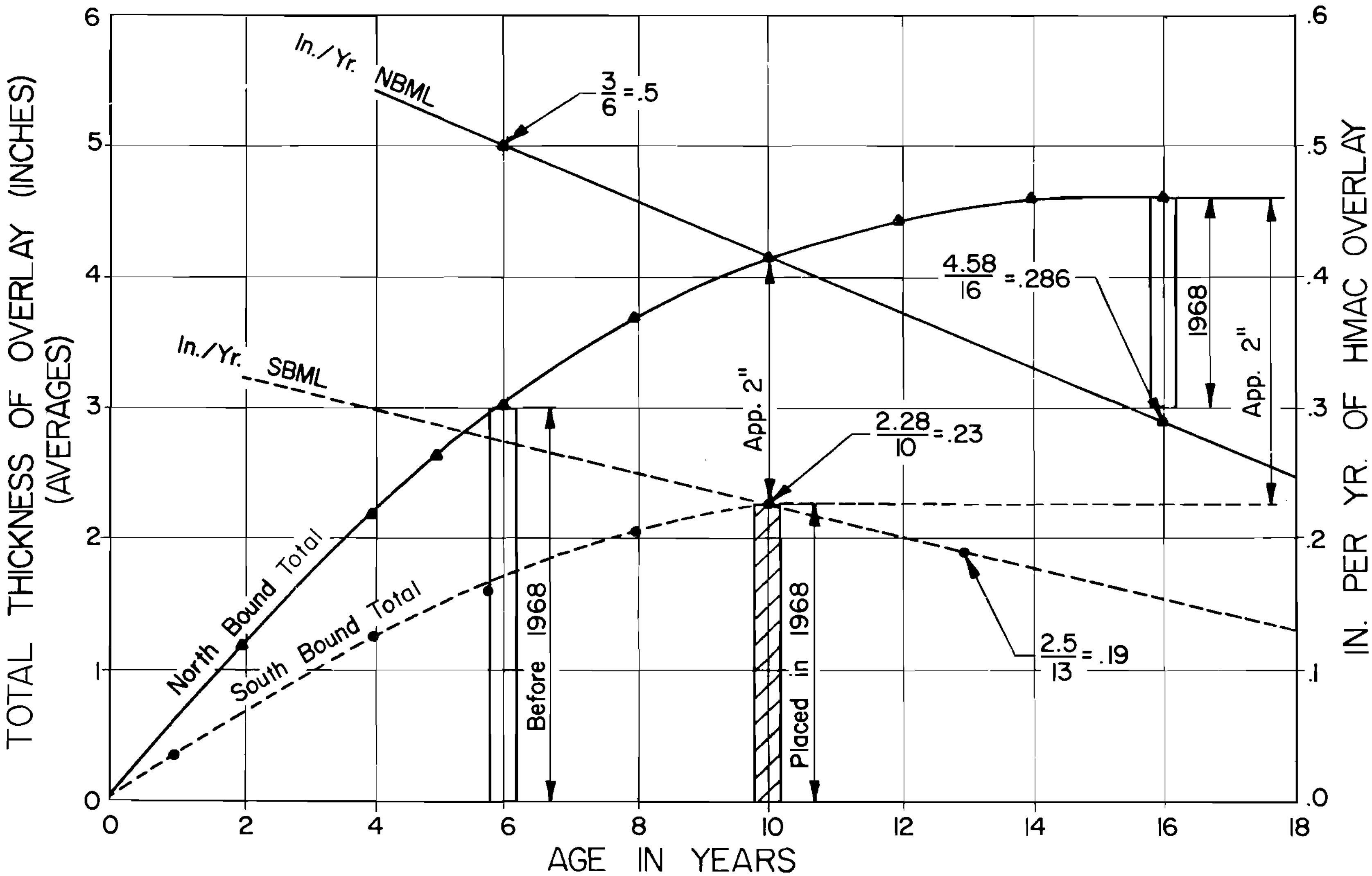


Fig 13. History of HMAC level-up.

solid line is for the NBML. The coefficients for these lines were determined by dividing the thickness of overlay by the age of the road at the time the overlay was placed. Points for the curved lines were determined by multiplying the age in years by the corresponding coefficients taken from the scale on the right edge of the chart. Considering both the northbound and southbound lanes to be of adequate structural strength to carry the traffic loads (there were no overload failures) it appears that the use of a combination of ponding and lime stabilization required approximately 2 inches less thickness of asphaltic concrete overlay during the first 10 years.

CHAPTER 4. CONCLUDING REMARKS AND RECOMMENDATIONS

A careful study of all of the data available on this project warrants the following statements:

(1) Moisture content tests taken before, during, and after ponding indicate the following:

(a) Moisture from ponding did not penetrate the subgrade more than 4 feet downward during a period of 24 days. A study of the horizontal movement of moisture was not made, but in one instance ponding was believed to have caused the tilting of the northbound main lanes. There was a distance of 20 feet between the edge of the pond and the edge of the portland cement concrete.

(b) Moisture contents at depths of 16 to 20 feet began to increase after a period of several days ponding and continued to increase all the way up to the 4-foot level (6 feet below finished grade) within a period of approximately 24 days. Although no data were taken to prove it, the vertical travel of moisture (up or down) was probably somewhat dependent upon elevation of water tables.

(c) Tests indicate that moisture contents below pavement in ponded sections have remained fairly constant for 13 years since placement of pavement. There has been some fluctuation of moisture contents at various depths but it is believed that these have not been sufficient to cause severe movement of pavement in most of the ponded sections. Moisture content samples taken in 1972 below the cement stabilized shoulders, which had severely cracked away from the edge of the portland cement concrete, were very erratic. Such samples are probably not representative of conditions below the portland cement concrete.

(d) The moisture contents found under the pavement at various depths, before shoulders cracked away from the concrete, are in fairly close agreement with the "desired" moisture contents calculated in accordance with the method given in Appendix 1.

(2) The maximum movements measured by profile levels are in general agreement with the movements predicted by use of the "Potential Vertical Rise Method" for after ponding conditions. The PVR method was very useful in helping select locations for ponding and determination of moisture contents required before termination of ponding.

(3) The bump surveys made after the pavement of the southbound main lanes was seven years old showed that the ponded sections had only 1/2 as many bumps per mile as did the unponded portion of the same lanes.

Out of a total of eight occurring in all ponded sections one-half of these occurred in section 9. Strangely enough this is the only section on the project where underdrains were connected to drainage ditch drop inlets that were supposed to handle fairly large drainage areas. If the bumps in this section were excluded from the data, there would have been four times as many bumps per mile in the unponded portion of the project as there were in the ponded sections.

(4) A study of the overlay level-up applications shows the following:

(a) The level-up overlay thickness for the northbound main lane unponded sections is considerably thicker than it is for the ponded sections in the southbound lanes.

(b) The roughness of PCC slabs, as measured by maximum variation in overlay thickness, shows that 14 of the 18 sections contain rougher slabs in the unponded northbound lanes than in the southbound ponded lanes.

(c) The validity of conclusions (a) and (b) are in jeopardy because the northbound pavement lanes are six years older than the southbound lanes. Accordingly, a histogram study of overlay thicknesses was made, and it showed that ponding and lime stabilization of swelling subgrades can be expected to reduce the amount of HMAC overlay by an amount of approximately 2 inches within the first 10 years of pavement life.

(5) In general, it is concluded that ponding and lime stabilization of subgrade were highly successful in preventing heaving in all sections except the one section where underdrains were connected to ditch surface drainage by use of drop inlets.

(6) A study of the unponded areas (between and beyond the ponded sections, see Table 2 and Fig 10) indicates that if ponding had been used more extensively and that if underdrains had not been connected to ditch drop inlets, probably only 5 of the 43 bumps recorded would have occurred in these areas. Table 2 indicates that the higher the PVR the greater the number of bumps to be expected and that if few to no bumps are desired a criterion of 1/2 inch PVR should be used. If this criterion had been followed during construction only two bumps should have occurred in the ponded sections and five in the remaining portions. If only seven bumps had occurred on the entire length of the southbound main lanes, overlaying the entire project with HMAC probably could have been prevented for a great many more than 10 years.

The foregoing conclusions appear to justify the following recommendations:

(1) For all subgrades with PI in excess of 35 calculate "Potential Vertical Rise Values" and determine if ponding of subgrade is necessary and feasible. PVR data should be used to calculate desired moisture contents at various depths below pavement in order to know when to cease ponding.

TABLE 2. BUMPS OCCURRING BETWEEN PONDED SECTIONS DURING 1958 TO 1965

Station Numbers From	Station Numbers To	Between Section Numbers	Number of Bumps	Original Avg. PVR, Inches	Remarks
459+70.4	482+00	So. End & 1	4	2.0	Ponding probably would have prevented bumps.
487+50	499+00	1 & 2	1	No Data	
505+00	512+00	2 & 3	0	No Data	
514+00	526+00	3 & 4	3	1.0	Ponding probably would have prevented bumps.
529+00	532+00	4 & 5	1	No Data	
537+00	539+00	5 & 6	0	No Data	
550+00	551+00	7 & 8	0	No Data	
557+00	572+00	8 & 9	2	0.8	Ponding probably would have prevented bumps.
588+00	617+00	9 & 10	4	1.4	Underdrains connected to ditch drop inlets.
620+00	629+00	10 & 11	1	No Data	
633+00	653+00	11 & 12	9	3.2	Ponding probably would have prevented bumps.
657+00	666+00	12 & 13	1	0.9	Ponding probably would have prevented bumps.
671+00	682+00	13 & 14	0	0.2	
688+00	698+00	14 & 15	2	0.0	
709+00	744+00	15 & 16	2	0.8	Ponding probably would have prevented bumps.
749+00	802+00	16 & 17	0	1.0	
817+00	863+00	17 & 18	9	3.8	Ponding probably would have prevented bumps.
870+00	889+00	18 & No. End	4	1.9	Ponding probably would have prevented bumps.
		Total	43*		

* 38 or 88% could have been eliminated by ponding more extensively and/or avoiding the attachment of underdrains to ditch drop inlets.

(2) Where a heavy traffic facility is involved and it has been determined that ponding is necessary and feasible the use of ponding should be given serious consideration.

(3) If ponding is used, every effort should be made to prevent evaporative drying before placement of pavement. One of the most practical ways to accomplish this is by the use of a wide belt of lime-stabilized subgrade. The use of this stabilizer enables the work to proceed before excessive drying takes place. In addition, the lime-treated subgrade helps form a strong working table and if extended widely enough makes an excellent barrier to evaporative drying and shrinking. Various granular materials will also decrease evaporation but usually will not form a strong working table unless placed in very thick layers.

(4) It is recommended that underdrains should be used sparingly in swelling soils and that they should not be connected to drainage ditch drop inlets.

(5) For all future projects in swelling soils, ponding should be used more extensively than was done on this project and its use in conjunction with deep plow mixing of lime should be investigated.

(6) Special effort should be made to prevent cracks formed by shoulders shrinking away from the edges of pavement.

REFERENCES

1. Felt, Earl J., "Field Trials to Locate and Eliminate Potential Wave Areas Prior to Construction of Concrete Pavement on Soils Developed from Taylor Marl," Portland Cement Association.

2. McDowell, Chester, "Inter-Relationship of Load, Volume Change and Layer Thicknesses of Soils to the Behavior of Engineering Structures," Vol 35, Proceedings of the Highway Research Board.

3. Texas Highway Department, Manual of Testing Procedures, 100-E Series, 1972.

4. Beall, A. O., "Stratigraphy of the Taylor Formation (Upper Cretaceous), East-Central Texas," Baylor Geological Studies Bulletin No. 6, 1965.

5. Elder, W. R., "Urban Geology of Greater Waco, Part II; Soils," Baylor Geological Studies Bulletin No. 9, 1965.

APPENDIX 1

PROCEDURE FOR DETERMINATION OF DESIRED MOISTURE CONTENTS IN SWELLING CLAYS AT VARIOUS DEPTHS BELOW PAVEMENTS

APPENDIX 1. PROCEDURE FOR DETERMINATION OF DESIRED MOISTURE CONTENTS IN SWELLING CLAYS AT VARIOUS DEPTHS BELOW PAVEMENTS*

Scope

The desired moisture content below a pavement is defined as the condition of the subgrade soil at which it will be susceptible to low amounts of volumetric swell and at the same time will have adequate bearing power to support the usual loads imposed on it. This moisture content will vary as the characteristics of the soil vary and also as the restraint from variation in depths of overburden varies. In order to solve the problem by this method it is necessary to obtain soil samples at various depths and perform soil constants tests on these samples.

Procedure

(1) Enter PI as abscissa on Fig 14 and project upward until the line for average conditions is intercepted. Then project horizontally and read percent volumetric change on the ordinate.

(2) On Fig 15 plot value of volume change obtained in step (1) versus a load of 1 psi for identification of the family swell curve to use.

(3) Determine the load in psi for the depth in question. Usually the depth in feet divided by 1.15 plus weight of pavement in psi will give a fairly accurate value of the load in psi.

(4) On Fig 15 plot the load in psi from step (3) on the family swell curve determined in step (2). Also plot the load of the pavement, usually 1 to 2 psi, on the same family swell curve. The difference in the ordinate readings represents the reduction in volumetric swell due to surcharge weight.

(5) On Fig 16 enter a value on the abscissa equal to $.47LL + 2$ and project upward until the curve representing the proper shrinkage limit or shrinkage ratio is intercepted. Project horizontally until a value on the ordinate is obtained and subtract the value found in step (4). From this point on the ordinate project horizontally until the same curve for SL or SR used before is intercepted. Then project downward to the abscissa and read the percent moisture desired.

---

* The basic data for development of Figs 14, 15, and 16 are given in Ref 2.

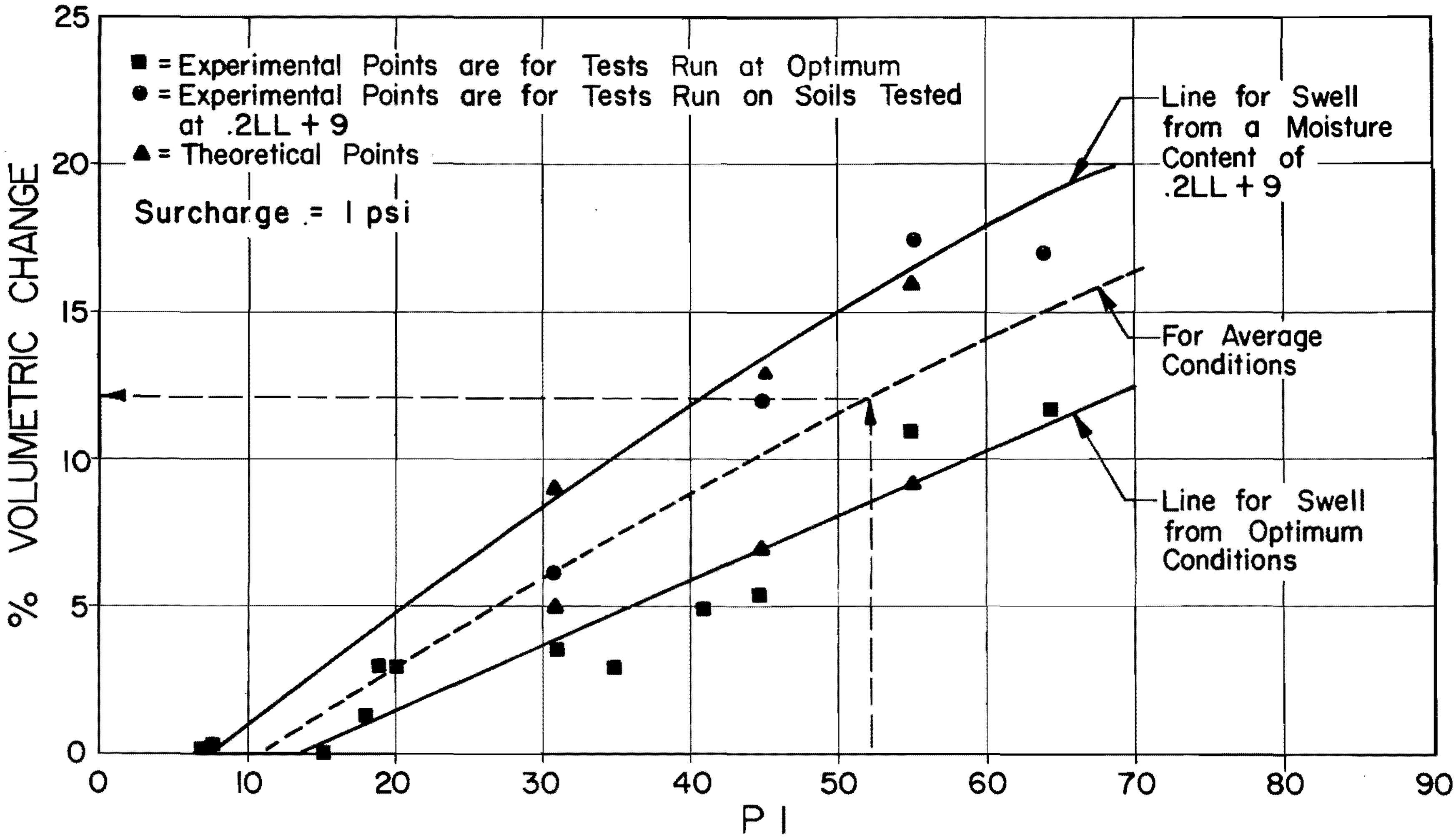


Fig 14. Interrelationship of PI and volume change.

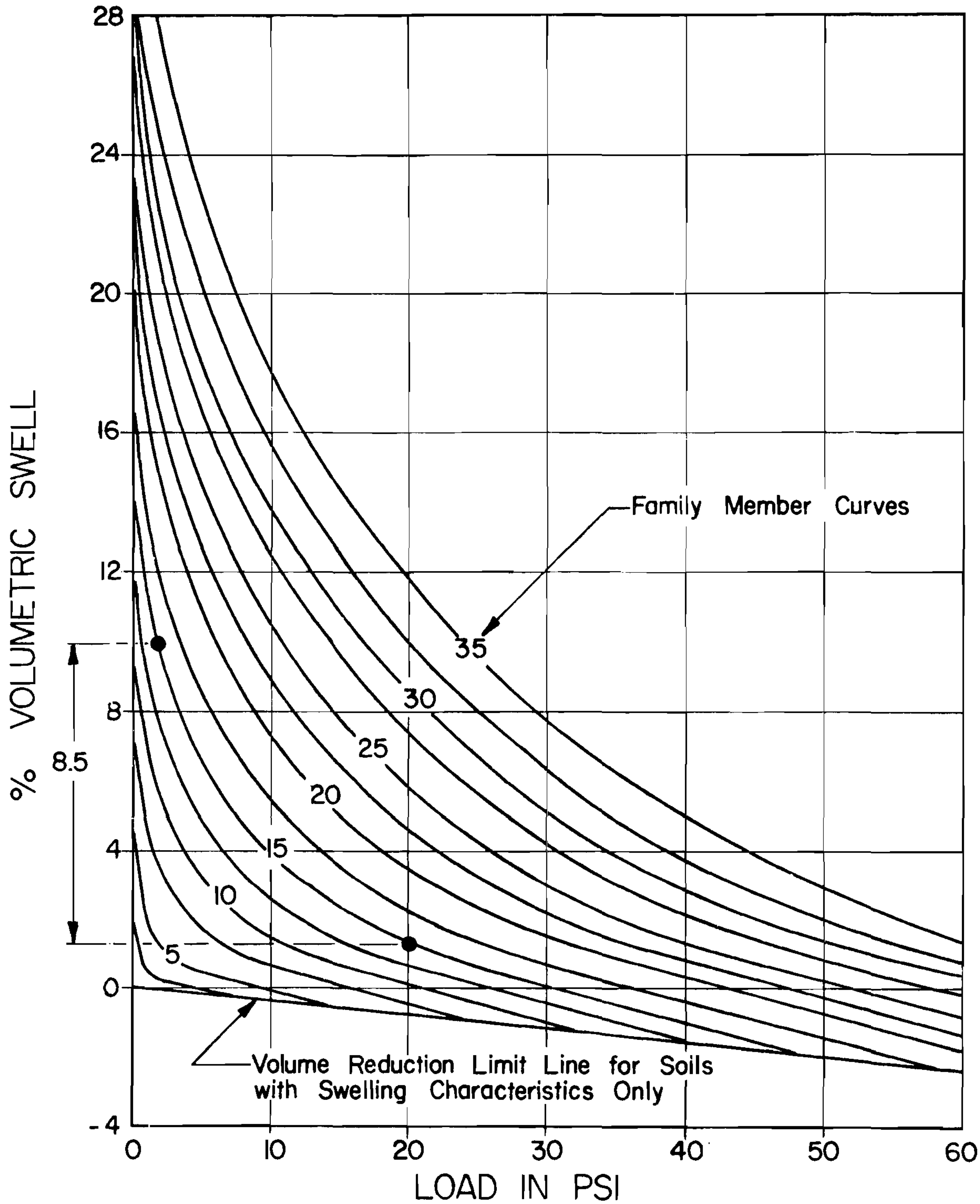


Fig 15. Relation of load to the volume change of swelling clay soil.

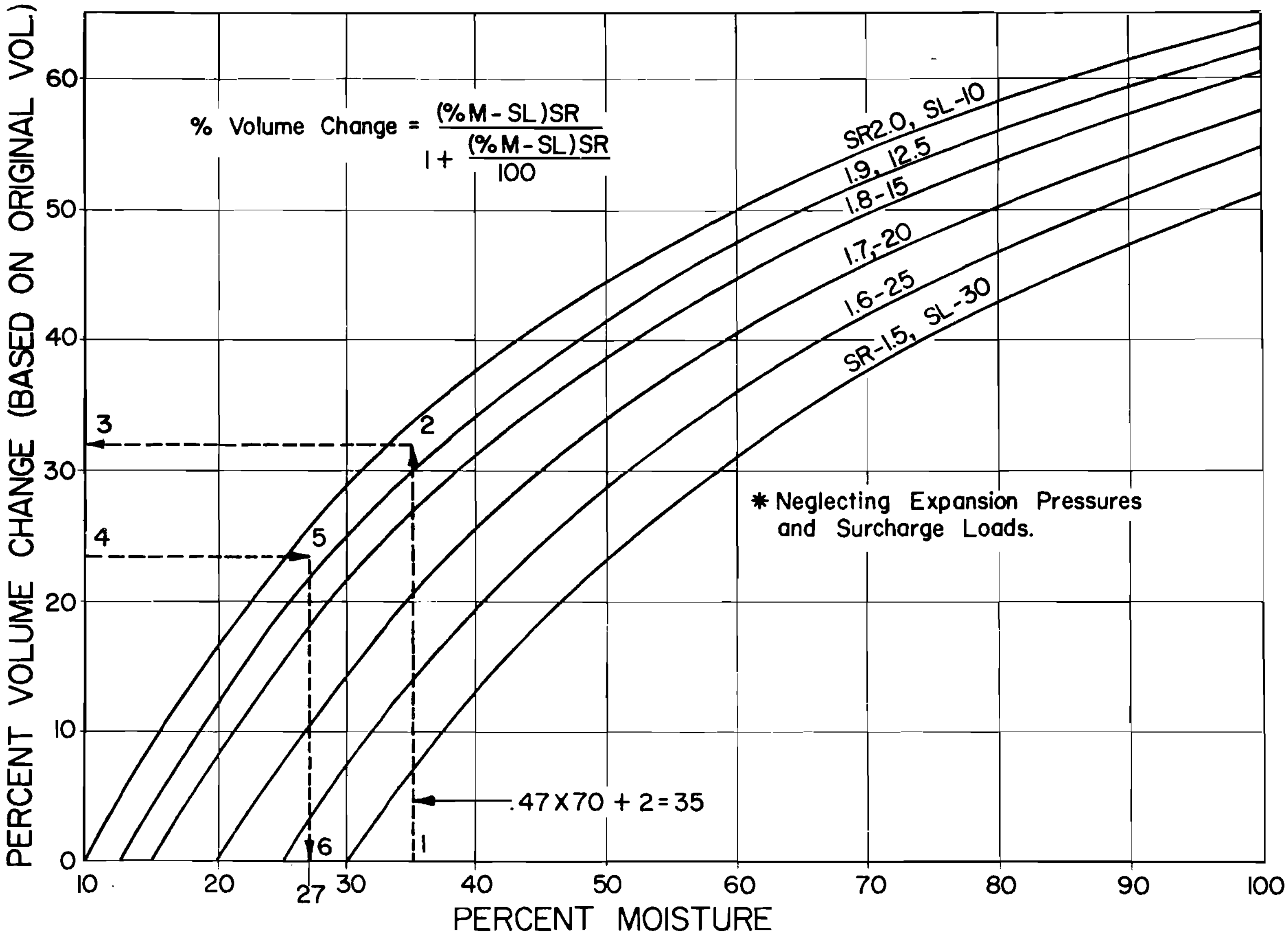


Fig 16. Relation of moisture change to free volume change.

APPENDIX 2

DEPTH MEASUREMENTS OF HMAC

APPENDIX 2. DEPTH MEASUREMENTS OF HMAC

I. SBML (Approx. Center of Outside Lane)

Section 1

Depth, Inches	
	Sta. 482 + 00
0 - 2 1/4	Type D, 1968
2 1/4	Concrete Pavement
	Sta. 483 + 00
0 - 1 3/4	Type D, 1968
1 3/4	Concrete Pavement
	Sta. 484 + 00
0 - 2 1/8	Type D, 1968
2 1/8	Concrete Pavement
	Sta. 485 + 00
0 - 1 7/8	Type D, 1968
1 7/8	Concrete Pavement
	Sta. 486 + 00
0 - 1 5/8	Type D, 1968
1 5/8	Concrete Pavement
	Sta. 487 + 00
0 - 1 7/8	Type D, 1968
1 7/8	Concrete Pavement
	Sta. 487 + 50
0 - 1 3/4	Type D, 1968
1 3/4	Concrete Pavement

Section 2

Depth, Inches	
	Sta. 499 + 00
0 - 1 3/4	Type D, 1968
1 3/4	Concrete Pavement
	Sta. 500 + 00
0 - 1 3/4	Type D, 1968
1 3/4	Concrete Pavement
	Sta. 501 + 00
0 - 1 7/8	Type D, 1968
1 7/8	Concrete Pavement
	Sta. 502 + 00
0 - 1 3/4	Type D, 1968
1 3/4	Concrete Pavement
	Sta. 503 + 00
0 - 1 7/8	Type D, 1968
1 7/8	Concrete Pavement
	Sta. 504 + 00
0 - 1 7/8	Type D, 1968
1 7/8	Concrete Pavement
	Sta. 505 + 00
0 - 2	Type D, 1968
2	Concrete Pavement

Section 3

Depth, Inches	
	Sta. 512 + 00
0 - 2	Type D, 1968
2	Concrete Pavement
	Sta. 513 + 00
0 - 1 7/8	Type D, 1968
1 7/8	Concrete Pavement
	Sta. 514 + 00
0 - 1 3/4	Type D, 1968
1 3/4	Concrete Pavement

Section 4

Depth, Inches	
	Sta. 526 + 00
0 - 1 1/8	Type D, 1968
1 1/8	Concrete Pavement
	Sta. 527 + 00
0 - 1 1/8	Type D, 1968
1 1/8	Concrete Pavement
	Sta. 528 + 00
0 - 1 1/2	Type D, 1968
1 1/2	Concrete Pavement
	Sta. 529 + 00
0 - 1 5/8	Type D, 1968
1 5/8	Concrete Pavement

Section 5		Section 6	
Depth, Inches		Depth, Inches	
	Sta. 532 + 00		Sta. 539 + 00
0 - 3	Type D, 1968	0 - 2	Type D, 1968
3	Concrete Pavement	2	Concrete Pavement
	Sta. 533 + 00		Sta. 540 + 00
0 - 2 5/8	Type D, 1968	0 - 2	Type D, 1968
2 5/8	Concrete Pavement	2	Concrete Pavement
	Sta. 534 + 00		Sta. 541 + 00
0 - 3 1/4	Type D, 1968	0 - 1 3/4	Type D, 1968
3 1/4	Concrete Pavement	1 3/4	Concrete Pavement
	Sta. 535 + 00		Sta. 542 + 00
0 - 3	Type D, 1968	0 - 2	Type D, 1968
3	Concrete Pavement	2	Concrete Pavement
	Sta. 536 + 00		Sta. 543 + 00
0 - 2 1/8	Type D, 1968	0 - 2 1/8	Type D, 1968
2 1/8	Concrete Pavement	2 1/8	Concrete Pavement
	Sta. 537 + 00		Sta. 544 + 00
0 - 1 7/8	Type D, 1968	0 - 1 3/4	Type D, 1968
1 7/8	Concrete Pavement	1 3/4	Concrete Pavement
			Sta. 545 + 00
		0 - 3	Type D, 1968
		3	Concrete Pavement

Section 7

Depth, Inches	
	Sta. 542 + 00
0 - 2	Type D, 1968
2	Concrete Pavement
	Sta. 543 + 00
0 - 2 1/8	Type D, 1968
2 1/8	Concrete Pavement
	Sta. 544 + 00
0 - 1 3/4	Type D, 1968
1 3/4	Concrete Pavement
	Sta. 545 + 00
0 - 3	Type D, 1968
3	Concrete Pavement
	Sta. 546 + 00
0 - 3 1/4	Type D, 1968
3 1/4	Concrete Pavement
	Sta. 547 + 00
0 - 3 1/4	Type D, 1968
3 1/4	Concrete Pavement
	Sta. 548 + 00
0 - 2 5/8	Type D, 1968
2 5/8	Concrete Pavement
	Sta. 549 + 00
0 - 2 3/4	Type D, 1968
2 3/4	Concrete Pavement
	Sta. 550 + 00
0 - 2	Type D, 1968
2	Concrete Pavement

Section 8

Depth, Inches	
	Sta. 551 + 00
0 - 1 7/8	Type D, 1968
1 7/8	Concrete Pavement
	Sta. 552 + 00
0 - 2 1/4	Type D, 1968
2 1/4	Concrete Pavement
	Sta. 553 + 00
0 - 1 7/8	Type D, 1968
1 7/8	Concrete Pavement
	Sta. 554 + 00
0 - 1 7/8	Type D, 1968
1 7/8	Concrete Pavement
	Sta. 555 + 00
0 - 4 1/8	Type D, 1968
4 1/8	Concrete Pavement
	Sta. 556 + 00
0 - 4	Type D, 1968
4	Concrete Pavement
	Sta. 557 + 00
0 - 4 1/2	Type D, 1968
4 1/2	Concrete Pavement

Section 9

Depth, Inches	
0 - 2 1/4	Sta. 572 + 00
2 1/4	Type D, 1968 Concrete Pavement
0 - 2 3/4	Sta. 573 + 00
2 3/4	Type D, 1968 Concrete Pavement
0 - 3 1/2	Sta. 574 + 00
3 1/2	Type D, 1968 Concrete Pavement
0 - 3 3/4	Sta. 575 + 00
3 3/4	Type D, 1968 Concrete Pavement
0 - 3 5/8	Sta. 576 + 00
3 5/8	Type D, 1968 Concrete Pavement
0 - 3 3/4	Sta. 577 + 00
3 3/4	Type D, 1968 Concrete Pavement
0 - 3 3/4	Sta. 578 + 00
3 3/4	Type D, 1968 Concrete Pavement
0 - 3 1/2	Sta. 579 + 00
3 1/2	Type D, 1968 Concrete Pavement
0 - 3 5/8	Sta. 580 + 00
3 5/8	Type D, 1968 Concrete Pavement

Section 9 (cont.)

Depth, Inches	
0 - 3 5/8	Sta. 581 + 00
3 5/8	Type D, 1968 Concrete Pavement
0 - 3 1/2	Sta. 582 + 00
3 1/2	Type D, 1968 Concrete Pavement
0 - 3 5/8	Sta. 583 + 00
3 5/8	Type D, 1968 Concrete Pavement
0 - 4 1/8	Sta. 584 + 00
4 1/8	Type D, 1968 Concrete Pavement
0 - 5	Sta. 585 + 00
5	Type D, 1968 Concrete Pavement
0 - 9 5/8	Sta. 586 + 00
9 5/8	Type D, 1968 Concrete Pavement
0 - 8	Sta. 587 + 00
8	Type D, 1968 Concrete Pavement
0 - 7 1/8	Sta. 588 + 00
7 1/8	Type D, 1968 Concrete Pavement

Section 10		Section 11	
Depth, Inches		Depth, Inches	
	Sta. 617 + 00		Sta. 629 + 00
0 - 3	Type D, 1968	0 - 2 3/4	Type D, 1968
3	Concrete Pavement	2 3/4	Concrete Pavement
	Sta. 618 + 00		Sta. 630 + 00
0 - 2 3/4	Type D, 1968	0 - 3 1/4	Type D, 1968
2 3/4	Concrete Pavement	3 1/4	Concrete Pavement
	Sta. 619 + 00		Sta. 631 + 00
0 - 3	Type D, 1968	0 - 3	Type D, 1968
3	Concrete Pavement	3	Concrete Pavement
	Sta. 620 + 00		Sta. 632 + 00
0 - 3 1/8	Type D, 1968	0 - 2 3/4	Type D, 1968
3 1/8	Concrete Pavement	2 3/4	Concrete Pavement
			Sta. 633 + 00
		0 - 3	Type D, 1968
		3	Concrete Pavement

Section 12

Depth, Inches	
	Sta. 653 + 00
0 - 3 1/4	Type D, 1968
3 1/4	Concrete Pavement
	Sta. 654 + 00
0 - 3 3/8	Type D, 1968
3 3/8	Concrete Pavement
	Sta. 655 + 00
0 - 3 1/2	Type D, 1968
3 1/2	Concrete Pavement
	Sta. 656 + 00
0 - 3 1/4	Type D, 1968
3 1/4	Concrete Pavement
	Sta. 657 + 00
0 - 3 1/4	Type D, 1968
3 1/4	Concrete Pavement

Section 13

Depth, Inches	
	Sta. 666 + 00
0 - 1 7/8	Type D, 1968
1 7/8	Concrete Pavement
	Sta. 667 + 00
0 - 1 3/4	Type D, 1968
1 3/4	Concrete Pavement
	Sta. 668 + 00
0 - 1 7/8	Type D, 1968
1 7/8	Concrete Pavement
	Sta. 669 + 00
0 - 2	Type D, 1968
2	Concrete Pavement
	Sta. 670 + 00
0 - 2	Type D, 1968
2	Concrete Pavement
	Sta. 671 + 00
0 - 2	Type D, 1968
2	Concrete Pavement

Section 14

Depth, Inches	
0 - 1 7/8 1 7/8	Sta. 682 + 00 Type D, 1968 Concrete Pavement
0 - 1 7/8 1 7/8	Sta. 683 + 00 Type D, 1968 Concrete Pavement
0 - 1 7/8 1 7/8	Sta. 684 + 00 Type D, 1968 Concrete Pavement
0 - 2 2	Sta. 685 + 00 Type D, 1968 Concrete Pavement
0 - 1 3/4 1 3/4	Sta. 686 + 00 Type D, 1968 Concrete Pavement
0 - 2 2	Sta. 687 + 00 Type D, 1968 Concrete Pavement
0 - 2 2	Sta. 688 + 00 Type D, 1968 Concrete Pavement

Section 15

Depth, Inches	
0 - 1 7/8 1 7/8	Sta. 698 + 00 Type D, 1968 Concrete Pavement
0 - 1 7/8 1 7/8	Sta. 699 + 00 Type D, 1968 Concrete Pavement
0 - 2 2	Sta. 700 + 00 Type D, 1968 Concrete Pavement
0 - 2 2	Sta. 701 + 00 Type D, 1968 Concrete Pavement
0 - 2 2	Sta. 702 + 00 Type D, 1968 Concrete Pavement
0 - 1 7/8 1 7/8	Sta. 703 + 00 Type D, 1968 Concrete Pavement
0 - 1 7/8 1 7/8	Sta. 704 + 00 Type D, 1968 Concrete Pavement
0 - 1 7/8 1 7/8	Sta. 705 + 00 Type D, 1968 Concrete Pavement
0 - 2 2	Sta. 706 + 00 Type D, 1968 Concrete Pavement
0 - 2 1/4 2 1/4	Sta. 707 + 00 Type D, 1968 Concrete Pavement
0 - 2 1/8 2 1/8	Sta. 708 + 00 Type D, 1968 Concrete Pavement
0 - 2 1/4 2 1/4	Sta. 709 + 00 Type D, 1968 Concrete Pavement

Section 16

Depth, Inches	
0 - 1 7/8	Sta. 744 + 00
1 7/8	Type D, 1968 Concrete Pavement
0 - 1 3/4	Sta. 745 + 00
1 3/4	Type D, 1968 Concrete Pavement
0 - 1 7/8	Sta. 746 + 00
1 7/8	Type D, 1968 Concrete Pavement
0 - 1 3/4	Sta. 747 + 00
1 3/4	Type D, 1968 Concrete Pavement
0 - 1 7/8	Sta. 748 + 00
1 7/8	Type D, 1968 Concrete Pavement
0 - 1 7/8	Sta. 749 + 00
1 7/8	Type D, 1968 Concrete Pavement

Section 17

Depth, Inches	
0 - 1 7/8	Sta. 802 + 00
1 7/8	Type D, 1968 Concrete Pavement
0 - 2	Sta. 803 + 00
2	Type D, 1968 Concrete Pavement
0 - 2	Sta. 804 + 00
2	Type D, 1968 Concrete Pavement
0 - 2 1/2	Sta. 805 + 00
2 1/2	Type D, 1968 Concrete Pavement
0 - 3 3/8	Sta. 806 + 00
3 3/8	Type D, 1968 Concrete Pavement
0 - 4 1/8	Sta. 807 + 00
4 1/8	Type D, 1968 Concrete Pavement
0 - 3 5/8	Sta. 808 + 00
3 5/8	Type D, 1968 Concrete Pavement
0 - 2 5/8	Sta. 809 + 00
2 5/8	Type D, 1968 Concrete Pavement

Section 17 (cont.)

Depth, Inches	
	Sta. 810 + 00
0 - 2 3/8	Type D, 1968
2 3/8	Concrete Pavement
	Sta. 811 + 00
0 - 1 7/8	Type D, 1968
1 7/8	Concrete Pavement
	Sta. 812 + 00
0 - 2 1/2	Type D, 1968
2 1/2	Concrete Pavement
	Sta. 813 + 00
0 - 2 3/8	Type D, 1968
2 3/8	Concrete Pavement
	Sta. 814 + 00
0 - 2 7/8	Type D, 1968
2 7/8	Concrete Pavement
	Sta. 815 + 00
0 - 2 3/4	Type D, 1968
2 3/4	Concrete Pavement
	Sta. 816 + 00
0 - 2 3/4	Type D, 1968
2 3/4	Concrete Pavement
	Sta. 817 + 00
0 - 2 1/2	Type D, 1968
2 1/2	Concrete Pavement

Section 18

Depth, Inches	
	Sta. 863 + 00
0 - 1 1/2	Type D, 1968
1 1/2	Concrete Pavement
	Sta. 864 + 00
0 - 1 1/2	Type D, 1968
1 1/2	Concrete Pavement
	Sta. 865 + 00
0 - 1 5/8	Type D, 1968
1 5/8	Concrete Pavement
	Sta. 866 + 00
0 - 1 3/4	Type D, 1968
1 3/4	Concrete Pavement
	Sta. 867 + 00
0 - 1 3/4	Type D, 1968
1 3/4	Concrete Pavement
	Sta. 868 + 00
0 - 1 1/4	Type D, 1968
1 1/4	Concrete Pavement
	Sta. 869 + 00
0 - 1 3/4	Type D, 1969
1 3/4	Concrete Pavement
	Sta. 870 + 00
0 - 2	Type D, 1968
2	Concrete Pavement

II. NBML (Approx. Center of Outside Lane)

Section 1

Station	Depth, Inches	Layer
Sta. 482 + 00	0 - 1 3/8	Type D, 1968
	1 3/8 - 4 3/8	Type D and C, 1959
	4 3/8	Concrete Pavement
Sta. 483 + 00	0 - 1 1/4	Type D, 1968
	1 1/4 - 4 1/4	Type D and C, 1959
	4 1/4	Concrete Pavement
Sta. 484 + 00	0 - 1 3/8	Type D, 1968
	1 3/8 - 3 5/8	Type D and C, 1959
	3 5/8	Concrete Pavement
Sta. 485 + 00	0 - 1 1/4	Type D, 1968
	1 1/4 - 3 1/4	Type D and C, 1959
	3 1/4	Concrete Pavement
Sta. 486 + 00	0 - 1 1/8	Type D, 1968
	1 1/8 - 3 5/8	Type D and C, 1959
	3 5/8	Concrete Pavement
Sta. 487 + 00	0 - 1 1/4	Type D, 1968
	1 1/4 - 3 5/8	Type D and C, 1959
	3 5/8	Concrete Pavement
Sta. 487 + 50	0 - 1 1/8	Type D, 1968
	1 1/8 - 3 5/8	Type D and C, 1959
	3 5/8	Concrete Pavement

Section 2

Station	Depth, Inches	Layer
Sta. 499 + 00	0 - 1 7/8	Type D, 1968
	1 7/8 - 3	Type D and C, 1959
	3	Concrete Pavement
Sta. 500 + 00	0 - 1 1/4	Type D, 1968
	1 1/4 - 3 1/4	Type D and C, 1959
	3 1/4	Concrete Pavement
Sta. 501 + 00	0 - 1 3/8	Type D, 1968
	1 3/8 - 3 3/4	Type D and C, 1959
	3 3/4	Concrete Pavement
Sta. 502 + 00	0 - 1 3/8	Type D, 1968
	1 3/8 - 3 5/8	Type D and C, 1959
	3 5/8	Concrete Pavement
Sta. 503 + 00	0 - 1 1/4	Type D, 1968
	1 1/4 - 3 1/4	Type D and C, 1959
	3 1/4	Concrete Pavement
Sta. 504 + 00	0 - 1 1/8	Type D, 1968
	1 1/8 - 3 1/4	Type D and C, 1959
	3 1/4	Concrete Pavement
Sta. 505 + 00	0 - 1 1/4	Type D, 1968
	1 1/4 - 3 1/2	Type D and C, 1959
	3 1/2	Concrete Pavement

Section 3

Depth, Inches	
	Sta. 512 + 00
0 - 1	Type D, 1968
1 - 3 1/4	Type D and C, 1959
3 1/4	Concrete Pavement
	Sta. 513 + 00
0 - 1	Type D, 1968
1 - 3 1/4	Type D and C, 1959
3 1/4	Concrete Pavement
	Sta. 514 + 00
0 - 1	Type D, 1968
1 - 3 1/8	Type D and C, 1959
3 1/8	Concrete Pavement

Section 4

Depth, Inches	
	Sta. 526 + 00
0 - 1	Type D, 1968
1 - 3 1/4	Type D and C, 1959
3 1/4	Concrete Pavement
	Sta. 527 + 00
0 - 1	Type D, 1968
1 - 3 1/8	Type D and C, 1959
3 1/8	Concrete Pavement
	Sta. 528 + 00
0 - 1	Type D, 1968
1 - 3	Type D and C, 1959
3	Concrete Pavement
	Sta. 529 + 00
0 - 1	Type D, 1968
1 - 3 1/4	Type D and C, 1959
3 1/4	Concrete Pavement

Section 5

Depth, Inches	
	Sta. 532 + 00
0 - 1	Type D, 1968
1 - 3 1/4	Type D and C, 1959
3 1/4	Concrete Pavement
	Sta. 533 + 00
0 - 1	Type D, 1968
1 - 3 1/4	Type D and C, 1959
3 1/4	Concrete Pavement
	Sta. 534 + 00
0 - 7/8	Type D, 1968
7/8 - 3 1/4	Type D and C, 1959
3 1/4	Concrete Pavement
	Sta. 535 + 00
0 - 7/8	Type D, 1968
7/8 - 3 1/8	Type D and C, 1959
3 1/8	Concrete Pavement
	Sta. 536 + 00
0 - 1 3/4	Type D, 1968
1 3/4 - 3 1/4	Type D and C, 1959
3 1/4	Concrete Pavement
	Sta. 537 + 00
0 - 1 1/4	Type D, 1968
1 1/4 - 3 5/8	Type D and C, 1959
3 5/8	Concrete Pavement

Section 6

Depth, Inches	
	Sta. 539 + 00
0 - 1 3/4	Type D, 1968
1 3/4 - 5 3/4	Type D and C, 1959
5 3/4	Concrete Pavement
	Sta. 540 + 00
0 - 1 1/2	Type D, 1968
1 1/2 - 8 1/4	Type D and C, 1959
8 1/4	Concrete Pavement
	Sta. 541 + 00
0 - 2	Type D, 1968
2 - 4 3/4	Type D and C, 1959
4 3/4	Concrete Pavement
	Sta. 542 + 00
0 - 1 1/4	Type D, 1968
1 1/4 - 5 1/2	Type D and C, 1959
5 1/2	Concrete Pavement
	Sta. 543 + 00
0 - 1 1/2	Type D, 1968
1 1/2 - 3 7/8	Type D and C, 1959
3 7/8	Concrete Pavement
	Sta. 544 + 00
0 - 1 3/4	Type D, 1968
1 3/4 - 3 5/8	Type D and C, 1959
3 5/8	Concrete Pavement
	Sta. 545 + 00
0 - 1 1/2	Type D, 1968
1 1/2 - 4 1/4	Type D and C, 1959
4 1/4	Concrete Pavement

Section 7

Depth, Inches	
	Sta. 542 + 00
0 - 1 1/4	Type D, 1968
1 1/4 - 5 1/2	Type D and C, 1959
5 1/2	Concrete Pavement
	Sta. 543 + 00
0 - 1 1/2	Type D, 1968
1 1/2 - 3 7/8	Type D and C, 1959
3 7/8	Concrete Pavement
	Sta. 544 + 00
0 - 1 3/4	Type D, 1968
1 3/4 - 3 5/8	Type D and C, 1959
3 5/8	Concrete Pavement
	Sta. 545 + 00
0 - 1 1/2	Type D, 1968
1 1/2 - 4 1/4	Type D and C, 1959
4 1/4	Concrete Pavement
	Sta. 546 + 00
0 - 1 1/2	Type D, 1968
1 1/2 - 3 1/2	Type D and C, 1959
3 1/2	Concrete Pavement
	Sta. 547 + 00
0 - 1 1/4	Type D, 1968
1 1/4 - 3 1/4	Type D and C, 1959
3 1/4	Concrete Pavement
	Sta. 548 + 00
0 - 1 1/8	Type D, 1968
1 1/8 - 3	Type D and C, 1959
3	Concrete Pavement
	Sta. 549 + 00
0 - 1	Type D, 1968
1 - 3 1/4	Type D and C, 1959
3 1/4	Concrete Pavement
	Sta. 550 + 00
0 - 1	Type D, 1968
1 - 3 1/4	Type D and C, 1959
3 1/4	Concrete Pavement

Section 8

Depth, Inches	
	Sta. 551 + 00
0 - 1 3/4	Type D, 1968
1 3/4 - 3 3/4	Type D and C, 1959
3 3/4	Concrete Pavement
	Sta. 552 + 00
0 - 1 5/8	Type D, 1968
1 5/8 - 3 3/4	Type D and C, 1959
3 3/4	Concrete Pavement
	Sta. 553 + 00
0 - 1 7/8	Type D, 1968
1 7/8 - 3 7/8	Type D and C, 1959
3 7/8	Concrete Pavement
	Sta. 554 + 00
0 - 2 3/4	Type D, 1968
2 3/4 - 4 7/8	Type D and C, 1959
4 7/8	Concrete Pavement
	Sta. 555 + 00
0 - 5	Type D, 1968
5 - 8 1/8	Type D and C, 1959
8 1/8 - 9 1/2	PRE-1959, Patch
9 1/2	Concrete Pavement
	Sta. 556 + 00
0 - 2	Type D, 1968
2 - 5 3/4	Type D and C, 1959
5 3/4 - 7 1/4	PRE-1959, Patch
7 1/4	Concrete Pavement
	Sta. 557 + 00
0 - 4 1/4	Type D, 1968
4 1/4 - 8	Type D and C, 1959
8 - 9 1/4	PRE-1959, Patch
9 1/4	Concrete Pavement

Section 9

Depth, Inches	Sta. 572 + 00
0 - 1	Type D, 1968
1 - 4	Type D and C, 1959
4	Concrete Pavement

Depth, Inches	Sta. 573 + 00
0 - 1 5/8	Type D, 1968
1 5/8 - 4 1/2	Type D and C, 1959
4 1/2 - 5 1/4	PRE-1959, Patch
5 1/4	Concrete Pavement

Depth, Inches	Sta. 574 + 00
0 - 1	Type D, 1968
1 - 5 7/8	Type D and C, 1959
5 7/8 - 6 7/8	PRE-1959, Patch
6 7/8	Concrete Pavement

Depth, Inches	Sta. 575 + 00
0 - 4 1/8	Type D, 1968
4 1/8 - 8 1/4	Type D and C, 1959
8 1/4	Concrete Pavement

Depth, Inches	Sta. 576 + 00
0 - 4 1/8	Type D, 1968
4 1/8 - 9	Type D and C, 1959
9	Concrete Pavement

Depth, Inches	Sta. 577 + 00
0 - 4 3/8	Type D, 1968
4 3/8 - 9 3/8	Type D and C, 1959
9 3/8	Concrete Pavement

Depth, Inches	Sta. 578 + 00
0 - 4 3/8	Type D, 1968
4 3/8 -12 5/8	Type D and C, 1959
12 5/8	Concrete Pavement

Depth, Inches	Sta. 579 + 00
0 - 5 3/8	Type D, 1968
5 3/8 -10 3/4	Type D and C, 1959
10 3/4	Concrete Pavement

Section 9 (cont.)

Depth, Inches	Sta. 580 + 00
0 - 4 1/2	Type D, 1968
4 1/2 - 9 1/8	Type D and C, 1959
9 1/8	Concrete Pavement

Depth, Inches	Sta. 581 + 00
0 - 4 1/8	Type D, 1968
4 1/8 - 9 5/8	Type D and C, 1959
9 5/8	Concrete Pavement

Depth, Inches	Sta. 582 + 00
0 - 4 3/8	Type D, 1968
4 3/8 -10 7/8	Type D and C, 1959
10 7/8 -	Concrete Pavement

Depth, Inches	Sta. 583 + 00
0 - 7 1/2	Type D, 1968
7 1/2 -14 1/4	Type D and C, 1959
14 1/4	Concrete Pavement

Depth, Inches	Sta. 584 + 00
0 - 6 5/8	Type D, 1968
6 5/8 -17 1/4	Type D and C, 1959
17 1/4 -18 5/8	PRE-1959, Patch
18 5/8	Concrete Pavement

Depth, Inches	Sta. 585 + 00
0 - 2 1/2	Type D, 1968
2 1/2 - 5 1/2	Type D and C, 1959
5 1/2	Concrete Pavement

Depth, Inches	Sta. 586 + 00
0 - 7 3/8	Type D, 1968
7 3/8 -17 5/8	Type D and C, 1959
17 5/8 -19 3/8	PRE-1959, Patch
19 3/8	Concrete Pavement

Depth, Inches	Sta. 587 + 00
0 - 4 3/4	Type D, 1968
4 3/4 - 9 3/4	Type D and C, 1959
9 3/4	Concrete Pavement

Depth, Inches	Sta. 588 + 00
0 - 3 1/2	Type D, 1968
3 1/2 - 7 3/4	Type D and C, 1959
7 3/4 - 8 7/8	PRE-1959, Patch
8 7/8	Concrete Pavement

Section 10

Depth, Inches	
	Sta. 617 + 00
0 - 2 3/8	Type D, 1968
2 3/8 - 5 5/8	Type D and C, 1959
5 5/8	Concrete Pavement
	Sta. 618 + 00
0 - 2	Type D, 1968
2 - 5 1/2	Type D and C, 1959
5 1/2	Concrete Pavement
	Sta. 619 + 00
0 - 1 1/4	Type D, 1968
1 1/4 - 4 1/2	Type D and C, 1959
4 1/2	Concrete Pavement
	Sta. 620 + 00
0 - 2	Type D, 1968
2 - 4 1/2	Type D and C, 1959
4 1/2	Concrete Pavement

Section 11

Depth, Inches	
	Sta. 629 + 00
0 - 1	Type D, 1968
1 - 4 5/8	Type D and C, 1959
4 5/8	Concrete Pavement
	Sta. 630 + 00
0 - 1	Type D, 1968
1 - 4 1/4	Type D and C, 1959
4 1/4	Concrete Pavement
	Sta. 631 + 00
0 - 1	Type D, 1968
1 - 3 1/8	Type D and C, 1959
3 1/8	Concrete Pavement
	Sta. 632 + 00
0 - 7/8	Type D, 1968
7/8 - 3 1/8	Type D and C, 1959
3 1/8	Concrete Pavement
	Sta. 633 + 00
0 - 7/8	Type D, 1968
7/8 - 3 1/8	Type D and C, 1959
3 1/8	Concrete Pavement

Section 12

Depth, Inches	Sta. 653 + 00
0 - 1	Type D, 1968
1 - 4	Type D and C, 1959
4	Concrete Pavement

Depth, Inches	Sta. 654 + 00
0 - 1 3/8	Type D, 1968
1 3/8 - 4	Type D and C, 1959
4	Concrete Pavement

Depth, Inches	Sta. 655 + 00
0 - 1 3/8	Type D, 1968
1 3/8 - 3 7/8	Type D and C, 1959
3 7/8	Concrete Pavement

Depth, Inches	Sta. 656 + 00
0 - 1 3/8	Type D, 1968
1 3/8 - 3 7/8	Type D and C, 1959
3 7/8	Concrete Pavement

Depth, Inches	Sta. 657 + 00
0 - 1 3/8	Type D, 1968
1 3/8 - 3 3/4	Type D and C, 1959
3 3/4	Concrete Pavement

Section 13

Depth, Inches	Sta. 666 + 00
0 - 1 3/8	Type D, 1968
1 3/8 - 3 1/2	Type D and C, 1959
3 1/2	Concrete Pavement

Depth, Inches	Sta. 667 + 00
0 - 2	Type D, 1968
2 - 4 7/8	Type D and C, 1959
4 7/8	Concrete Pavement

Depth, Inches	Sta. 668 + 00
0 - 2 1/8	Type D, 1968
2 1/8 - 5 3/4	Type D and C, 1959
5 3/4	Concrete Pavement

Depth, Inches	Sta. 669 + 00
0 - 1 5/8	Type D, 1968
1 5/8 - 7 1/4	Type D and C, 1959
7 1/4	Concrete Pavement

Depth, Inches	Sta. 670 + 00
0 - 1 1/4	Type D, 1968
1 1/4 - 3 7/8	Type D and C, 1959
3 7/8	Concrete Pavement

Depth, Inches	Sta. 671 + 00
0 - 1 1/8	Type D, 1968
1 1/8 - 3 1/2	Type D and C, 1959
3 1/2	Concrete Pavement

Section 14

Depth, Inches	
	Sta. 682 + 00
0 - 1	Type D, 1968
1 - 3 1/2	Type D and C, 1959
3 1/2	Concrete Pavement
	Sta. 683 + 00
0 - 1 1/8	Type D, 1968
1 1/8 - 3 1/2	Type D and C, 1959
3 1/2	Concrete Pavement
	Sta. 684 + 00
0 - 1	Type D, 1968
1 - 3 1/2	Type D and C, 1959
3 1/2	Concrete Pavement
	Sta. 685 + 00
0 - 1	Type D, 1968
1 - 3 1/4	Type D and C, 1959
3 1/4	Concrete Pavement
	Sta. 686 + 00
0 - 1 1/8	Type D, 1968
1 1/8 - 3 1/8	Type D and C, 1959
3 1/8	Concrete Pavement
	Sta. 687 + 00
0 - 1 1/8	Type D, 1968
1 1/8 - 3 1/4	Type D and C, 1959
3 1/4	Concrete Pavement
	Sta. 688 + 00
0 - 1 1/8	Type D, 1968
1 1/8 - 3 1/8	Type D and C, 1959
3 1/8	Concrete Pavement

Section 15

Depth, Inches	
	Sta. 698 + 00
0 - 1	Type D, 1968
1 - 3 5/8	Type D and C, 1959
3 5/8	Concrete Pavement
	Sta. 699 + 00
0 - 1	Type D, 1968
1 - 3 3/8	Type D and C, 1959
3 3/8	Concrete Pavement
	Sta. 700 + 00
0 - 1	Type D, 1968
1 - 3 1/4	Type D and C, 1959
3 1/4	Concrete Pavement
	Sta. 701 + 00
0 - 1	Type D, 1968
1 - 3 3/8	Type D and C, 1959
3 3/8	Concrete Pavement
	Sta. 702 + 00
0 - 1 1/8	Type D, 1968
1 1/8 - 3 3/8	Type D and C, 1959
3 3/8	Concrete Pavement
	Sta. 703 + 00
0 - 1	Type D, 1968
1 - 3 1/4	Type D and C, 1959
3 1/4	Concrete Pavement

Section 15 (cont.)

Depth, Inches		
		Sta. 704 + 00
0	- 1	Type D, 1968
1	- 3 3/8	Type D and C, 1959
3 3/8		Concrete Pavement
		Sta. 705 + 00
0	- 1	Type D, 1968
1	- 3 3/8	Type D and C, 1959
3 3/8		Concrete Pavement
		Sta. 706 + 00
0	- 1	Type D, 1968
1	- 3 1/2	Type D and C, 1959
3 1/2		Concrete Pavement
		Sta. 707 + 00
0	- 1	Type D, 1968
1	- 3 1/2	Type D and C, 1959
3 1/2		Concrete Pavement
		Sta. 708 + 00
0	- 1	Type D, 1968
1	- 3 1/2	Type D and C, 1959
3 1/2		Concrete Pavement
		Sta. 709 + 00
0	- 1	Type D, 1968
1	- 3 1/2	Type D and C, 1959
3 1/2		Concrete Pavement

Section 16

Depth, Inches		
		Sta. 744 + 00
0	- 3/4	Type D, 1968
3/4	- 3 1/4	Type D and C, 1959
3 1/4		Concrete Pavement
		Sta. 745 + 00
0	- 7/8	Type D, 1968
7/8	- 3 1/2	Type D and C, 1959
3 1/2		Concrete Pavement
		Sta. 746 + 00
0	- 7/8	Type D, 1968
7/8	- 3 1/2	Type D and C, 1959
3 1/2		Concrete Pavement
		Sta. 747 + 00
0	- 3/4	Type D, 1968
3/4	- 3 3/8	Type D and C, 1959
3 3/8		Concrete Pavement
		Sta. 748 + 00
0	- 7/8	Type D, 1968
7/8	- 3 3/8	Type D and C, 1959
3 3/8		Concrete Pavement
		Sta. 749 + 00
0	- 1	Type D, 1968
1	- 3 3/8	Type D and C, 1959
3 3/8		Concrete Pavement

Section 17

Depth, Inches	Sta. 802 + 00
0 - 1 5/8	Type D, 1968
1 5/8 - 3 3/4	Type D and C, 1959
3 3/4	Concrete Pavement

Depth, Inches	Sta. 803 + 00
0 - 1 1/2	Type D, 1968
1 1/2 - 3 5/8	Type D and C, 1959
3 5/8	Concrete Pavement

Depth, Inches	Sta. 804 + 00
0 - 1 1/2	Type D, 1968
1 1/2 - 4 1/8	Type D and C, 1959
4 1/8	Concrete Pavement

Depth, Inches	Sta. 805 + 00
0 - 1 3/4	Type D, 1968
1 3/4 - 3 7/8	Type D and C, 1959
3 7/8	Concrete Pavement

Depth, Inches	Sta. 806 + 00
0 - 1 5/8	Type D, 1968
1 5/8 - 4 7/8	Type D and C, 1959
4 7/8	Concrete Pavement

Depth, Inches	Sta. 807 + 00
0 - 1 1/2	Type D, 1968
1 1/2 - 6 1/4	Type D and C, 1959
6 1/4	Concrete Pavement

Depth, Inches	Sta. 808 + 00
0 - 5	Type D, 1968
5 - 9 3/8	Type D and C, 1959
9 3/8	Concrete Pavement

Depth, Inches	Sta. 809 + 00
0 - 4 7/8	Type D, 1968
4 7/8 - 9 1/4	Type D and C, 1959
9 1/4	Concrete Pavement

Section 17 (cont.)

Depth, Inches	Sta. 810 + 00
0 - 5 1/8	Type D, 1968
5 1/8 - 8	Type D and C, 1959
8	Concrete Pavement

Depth, Inches	Sta. 811 + 00
0 - 5 3/8	Type D, 1968
5 3/8 - 6 3/4	Type D and C, 1959
6 3/4	Concrete Pavement

Depth, Inches	Sta. 812 + 00
0 - 5	Type D, 1968
5 - 7 5/8	Type D and C, 1959
7 5/8	Concrete Pavement

Depth, Inches	Sta. 813 + 00
0 - 4 1/4	Type D, 1968
4 1/4 -10 3/8	Type D and C, 1959
10 3/8	Concrete Pavement

Depth, Inches	Sta. 814 + 00
0 - 5 1/4	Type D, 1968
5 1/4 -12	Type D and C, 1959
12	Concrete Pavement

Depth, Inches	Sta. 815 + 00
0 - 5 5/8	Type D, 1968
5 5/8 -10 1/4	Type D and C, 1959
10 1/4	Concrete Pavement

Depth, Inches	Sta. 816 + 00
0 - 3	Type D, 1968
3 - 8 1/4	Type D and C, 1959
8 1/4	Concrete Pavement

Depth, Inches	Sta. 817 + 00
0 - 5 1/2	Type D, 1968
5 1/2 -10 1/8	Type D and C, 1959
10 1/8	Concrete Pavement

Section 18

Depth, Inches	
	Sta. 863 + 00
0 - 1 1/8	Type D, 1968
1 1/8 - 3 3/8	Type D and C, 1959
3 3/8	Concrete Pavement
	Sta. 864 + 00
0 - 1 1/4	Type D, 1968
1 1/4 - 3 3/4	Type D and C, 1959
3 3/4	Concrete Pavement
	Sta. 865 + 00
0 - 1 3/8	Type D, 1968
1 3/8 - 3 3/4	Type D and C, 1959
3 3/4	Concrete Pavement
	Sta. 866 + 00
0 - 1 5/8	Type D, 1968
1 5/8 - 4	Type D and C, 1959
4	Concrete Pavement
	Sta. 867 + 00
0 - 2	Type D, 1968
2 - 4 3/4	Type D and C, 1959
4 3/4	Concrete Pavement
	Sta. 868 + 00
0 - 2 1/2	Type D, 1968
2 1/2 - 5 7/8	Type D and C, 1959
5 7/8	Concrete Pavement
	Sta. 869 + 00
0 - 3	Type D, 1968
3 - 6 1/2	Type D and C, 1959
6 1/2	Concrete Pavement
	Sta. 870 + 00
0 - 2	Type D, 1968
2 - 5 3/8	Type D and C, 1959
5 3/8	Concrete Pavement

APPENDIX 3

EXAMPLES SHOWING TYPICAL PVR AND "DESIRED MOISTURE CONTENT" DETERMINATIONS

TABLE A1

CALCULATIONS FOR PVR

Section No. 1

Depth in Feet *	Load Range PSI **	L.L.	Dry (.2 LL + 9)	Wet (.47 LL + 2)	% Moisture	Dry, Avg., or Wet	% - No. 40	P.I.	% Vol. Swell	% Free Swell	PVR, In. Top of Layer	PVR, In. Bottom of Layer	Diff.	Mod. - 40 Factor	PVR in Layer, In.
0 - 2	2 - 4	70	23	35	12	Dry	84	49	14.5	18.1	1.56	2.70	1.14	0.84	0.96
2 - 4	4 - 6	71	23	35	15	Dry	91	50	15.0	18.7	2.80	3.60	0.80	0.91	0.73
4 - 6	6 - 8	76	24	38	17	Dry	93	56	17.0	20.8	4.20	5.00	0.80	0.93	0.74
6 - 8	8 - 10	77	24	38	24	Dry	96	56	17.0	20.8	5.00	5.70	0.70	0.96	0.67
8 - 10	10 - 12	87	26	43	25	Dry	100	67	19.5	23.5	6.60	7.30	0.70	1.00	0.70
10 - 14	12 - 16	87	26	43	30	Dry	100	60	17.0	20.8	6.30	7.29	0.99	1.00	0.99
14 - 18	16 - 20	91	27	45	29	Dry	100	65	19.0	22.9	8.22	9.10	0.88	1.00	0.88

Total PVR = 5.67"

* Depths from original log, based on natural ground line at this point.
** Includes load for 24 inches of pavement structure.

Note: Procedure used in these calculations essentially conforms to Test Method Tex-124-E of the Texas Highway Department Manual of Testing Procedures. Since 125 pounds per cubic foot wet density was assumed for all layers, no factor for density modification was needed and is therefore not listed in the calculations.

TABLE A2

CALCULATIONS FOR PVR

Section No. 9

Depth in Feet	Load Range PSI **	L.L.	Dry (.2 LL + 9)	Wet (.47 LL + 2)	% Mois-ture	Dry, Avg., or Wet	% - No. 40	P.I.	% Vol. Swell	% Free Swell	PVR, In. Top of Layer	PVR, In. Bottom of Layer	Diff.	Mod. - 40 Factor	PVR in Layer, In.
Fill-3 *	2 - 5	63	22	32	***	Avg.	90	43	9.5	12.8	1.02	1.92	0.90	0.90	0.81
0 - 4	5 - 9	57	20	29	21	Dry	81	37	11.0	14.4	2.21	3.06	0.85	0.81	0.69
4 - 9	9 - 14	56	20	28	16	Dry	86	39	11.5	14.9	3.18	3.82	0.64	0.86	0.55
9 - 11	14 - 16	65	22	33	25	Dry	91	46	13.0	16.5	4.70	4.91	0.21	0.91	0.19
11 - 22	16 - 27	99	29	49	28	Dry	93	78	22.5	26.7	10.08	12.65	2.57	0.93	2.39

Total PVR = 4.63"

* Depths from original log, based on natural ground line at this point.

** Includes load for 24 inches of pavement section plus 3 feet of fill to be constructed.

*** Moisture content for fill assumed as average since moisture to be controlled during construction. Soil constants for fill are average values from adjacent cuts.

Note: Procedure used in these calculations essentially conforms to Test Method Tex-124-E of the Texas Highway Department Manual of Testing Procedures. Since 125 pounds per cubic foot wet density was assumed for all layers, no factor for density modification was needed and is therefore not listed in the calculations.

TABLE A3

CALCULATIONS FOR DESIRED MOISTURE CONTENT

Section No. 1

Depth in Feet **	Load PSI *	L.L.	.47 LL + 2	P.I.	S.R.	% Vol. Change [1]	Swell Curve Family [2]	% Vol. Swell [2] From Layer Depth Load (A)	% Vol. Swell [2] From Pavt. Load (B)	Effective % Vol. Swell (B-A)	Desired % Moisture [3] (Uncorr.)	Corr. Factor % No. - 40	Desired % Moisture (Correct.)
0-2	3.7	70	35	49	2.06	11.5	15.0	7.5	9.5	2.0	32.0	0.84	26.9
2-4	5.5	71	35	50	2.01	11.5	15.0	6.5	9.5	3.0	31.0	0.91	28.2
4-6	7.2	76	38	56	1.84	13.0	16.0	5.5	10.5	5.0	32.5	0.93	30.2
6-8	9.0	77	38	56	1.93	13.0	16.0	5.0	10.5	5.5	32.0	0.96	30.7
8-10	10.7	87	43	67	1.88	15.5	19.0	6.5	14.0	7.5	34.0	1.00	34.0
10-14	14.2	87	43	60	1.85	14.0	17.5	3.5	12.0	8.5	33.0	1.00	33.0
14-18	17.7	91	45	65	1.87	15.5	19.0	3.5	14.0	9.5	32.5	1.00	32.5

* Includes 2 PSI for pavement section.
** Depths from original log, based on natural ground line at the point.
1 From Fig 15.
2 From Fig 16.
3 From Fig 17.(Note: Desired moisture contents shown were determined for the lower level of each stratum. If necessary, they may be determined for any level within the stratum.)

TABLE A4

CALCULATIONS FOR DESIRED MOISTURE CONTENT

Section No. 9

Depth in Feet	Load PSI*	L.L.	.47 LL + 2	P.I.	S.R.	% Vol. Change[1]	Swell Curve Family[2]	% Vol. Swell[2] From Layer Depth Load (A)	% Vol. Swell[2] From Pavt. Load (B)	Effective % Vol. Swell (B-A)	Desired % Moisture[3] (Uncorr.)	Corr. Factor % No. - 40	Desired % Moisture (Correct.)
Fill-3	4.6	63	32	43	1.90	9.5	13.0	5.5	8.0	2.5	29.5	0.90	26.6
** 0-4	8.1	57	29	37	2.06	8.0	11.0	2.5	6.5	4.0	25.5	0.81	20.7
4-9	12.4	56	28	39	2.14	8.5	12.0	2.0	7.0	5.0	24.0	0.86	20.6
9-11	14.2	65	33	46	1.88	10.5	14.0	2.5	9.0	6.5	27.5	0.91	25.0
11-22	23.7	99	49	78	2.01	18.5	22.5	3.5	16.5	13.0	29.0	0.93	27.0

* Includes 2 PSI for pavement.
** Depths from original log, based on natural ground line at this point.
1 From Fig 15.
2 From Fig 16.
3 From Fig 17. (Note: Desired moisture contents shown were determined for the lower level of each stratum. If necessary, they may be determined for any level within the stratum.)

APPENDIX 4

TABULATION OF MOISTURE CONTENT DATA, SOIL CONSTANTS AND DESIRED MOISTURE CONTENTS FOR SECTIONS 1 THROUGH 11

TABLE A5

TABULATION OF MOISTURE CONTENT DATA

TEST SECTION 1 DATE OF TEST 8/29/57

STATION NO. 482 + 06 DATE PONDING BEGAN 10/10/57

LOCATION SBML APPROX. TIME PONDED 39 days *

Depth in Feet	LL	PI	% Pass No. 40	Description of Material	Percent Moisture	
					From Sample	Calculated Desired
0-2.0	70	49	84	Black clay	11.7	26.9
2.0-4.0	71	50	91	Dark brown clay with some gravel	14.6	28.2
4.0-6.0	76	56	93	Gray clay with white spots	17.2	30.2
6.0-8.0	77	56	96	Same as 4.0-6.0	24.0	30.7
8.0-10.0	87	67	100	Yellow clay with gray and white streaks	25.4	34.0
10.0-12.0	86	59	100	Same as 8.0-10.0	29.5	33.0
12.0-14.0	87	60	100	Same as 8.0-10.0	29.5	33.0
14.0-16.0	92	66	100	Same as 8.0-10.0	28.5	32.5
16.0-18.0	90	64	99	Same as 8.0-10.0	28.5	32.5

* Ponding terminated 11/19/57

TABLE A6

TABULATION OF MOISTURE CONTENT DATA

TEST SECTION 2 DATE OF TEST 8/29/57

STATION NO. 502 + 04 DATE PONDING BEGAN 10/11/57

LOCATION SBML APPROX. TIME PONDED 38 days *

Depth in Feet	LL	PI	% Pass No. 40	Description of Material	Percent Moisture From Sample	Percent Moisture Calculated Desired
0-2.0	104	68	94	Black clay and dark gray clay	13.9	38.1
2.0-4.0	78	50	96	Same as 0-2.0	18.3	30.7
4.0-6.0	79	57	99	Light gray clay	19.0	30.7
6.0-10.0	86	60	100	Yellow clay with white streaks	24.0	32.5
10.0-14.0	76	51	98	Yellow clay with white and gray streaks	23.4	28.4
14.0-15.7	85	61	100	Same as 10.0-14.0	24.0	33.0
15.7-18.0	88	69	99	Same as 10.0-14.0	24.0	30.7

Note: 2.5' of fill to be constructed at this point when grading complete

* Ponding terminated 11/19/57

TABLE A7

TABULATION OF MOISTURE CONTENT DATA

TEST SECTION 3 DATE OF TEST 8/30/57

STATION NO. 512 + 00 DATE PONDING BEGAN 10/19/57

LOCATION SBML APPROX. TIME PONDED 30 days *

Depth in Feet	LL	PI	% Pass No. 40	Description of Material	Percent Moisture	
					From Sample	Calculated Desired
0-2.0	46	28	82	Black clay with some gravel	6.5	18.5
2.0-6.0	59	42	78	Same as 0-2.0	10.1	19.9
6.0-8.0	44	28	38	Gray clay with sand and gravel	6.1	7.6
8.0-10.0	63	47	67	Yellow clay with sand and gravel	14.6	17.8
10.0-12.0	82	61	87	Yellow and gray clay with gravel	24.5	27.0
12.0-14.0	85	61	100	Yellow and gray clay	27.7	31.5
14.0-18.0	92	65	100	Same as 12.0-14.0	26.2	33.0
Note:	2.0' of fill to be constructed at this point when grading complete					
* Ponding terminated 11/19/57						

TABLE A8

TABULATION OF MOISTURE CONTENT DATA

TEST SECTION 4

STATION NO. 527 + 30

LOCATION SBML

DATE OF TEST 9/20/57

DATE PONDING BEGAN 10/19/57

APPROX. TIME PONDED 30 days *

Depth in Feet	LL	PI	% Pass No. 40	Description of Material	Percent Moisture	
					From Sample	Calculated Desired
0-3.7	43	28	92	Black clay	12.4	18.4
3.7-7.0	43	28	92	Brown to black clay with few yellow strs	15.5	18.4
7.0-10.2	43	28	92	Yellow clay with gray streaks	19.9	18.4
10.2-13.8	68	51	94	Same as 7.0-10.2	27.5	26.8
13.8-19.8	99	73	100	Gray clay with yellow streaks	28.0	35.5

Note: 2.0' of fill to be constructed at this point when grading complete

* Ponding terminated 11/19/57

TABLE A9

TABULATION OF MOISTURE CONTENT DATA

TEST SECTION 5 DATE OF TEST 8/1/57

STATION NO. 534 + 11 DATE PONDING BEGAN 6/13/58

LOCATION SBML APPROX. TIME PONDED 17 days *

Depth in Feet	LL	PI	% Pass No. 40	Description of Material	Percent Moisture	
					From Sample	Calculated Desired
2.0-4.0	46	27	94	Black clay with some gravel	13.4	19.7
4.0-6.0	51	35	100	Yellow clay with white spots	13.4	24.0
6.0-7.7	72	52	100	Same as 4.0-6.0	20.4	32.0
7.7-9.0	74	49	100	Same as 4.0-6.0	20.4	31.5
9.0-10.7	81	59	100	Yellow clay with gray streaks	20.4	33.5
10.7-12.0	82	58	100	Same as 9.0-10.7	24.0	33.5
12.0-13.5	81	51	100	Same as 9.0-10.7	24.0	29.5
13.5-15.0	79	52	100	Same as 9.0-10.7	24.0	29.5
15.0-17.0	77	48	100	Same as 9.0-10.7	23.0	29.5
17.0-18.0	75	44	100	Same as 9.0-10.7	23.0	31.0
Note:	3.0' of cut will be made at this point					
* Ponding terminated 7/1/58						

TABLE A10

TABULATION OF MOISTURE CONTENT DATA

TEST SECTION 6 DATE OF TEST 9/20/57

STATION NO. 541 + 00 DATE PONDING BEGAN 10/25/57

LOCATION SBML APPROX. TIME PONDED 30 days

Depth in Feet	LL	PI	% Pass No. 40	Description of Material	Percent Moisture	
					From Sample	Calculated Desired
0-6.0	70	39	74	Black to brown clay	7.5	23.5
6.0-7.8	63	45	94	Gray clay with yellow tint	12.0	26.8
7.8-9.6	82	59	100	Same as 6.0-7.8	20.0	31.0
9.6-11.4	91	67	100	Same as 6.0-7.8	18.5	33.0
11.4-20.0	82	56	100	Same as 6.0-7.8	20.0	32.0
Note:	2.0' of fill to be constructed at this point when grading complete					

TABLE A11

TABULATION OF MOISTURE CONTENT DATA

TEST SECTION 7 DATE OF TEST 8/2/57

STATION NO. 548 + 10 DATE PONDING BEGAN 6/14/58

LOCATION SBML APPROX. TIME PONDED 16 days *

Depth in Feet	LL	PI	% Pass No. 40	Description of Material	Percent Moisture	
					From Sample	Calculated Desired
3.0-11.0	77	55	100	Yellow clay with white spots	22.0	31.0
11.0-12.6	69	47	100	Same as 3.0-11.0	26.0	29.0
12.6-16.0	76	50	100	Same as 3.0-11.0	26.0	31.0
16.0-18.0	81	57	100	Same as 3.0-11.0	26.0	31.0
Note: 3.0' of cut will be made at this point						
* Ponding terminated 7/1/58						

TABLE A12

TABULATION OF MOISTURE CONTENT DATA

TEST SECTION 8 DATE OF TEST 10/21/57

STATION NO. 554 + 00 DATE PONDING BEGAN 10/26/57

LOCATION SBML APPROX. TIME PONDED 30 days

Depth in Feet	LL	PI	% Pass No. 40	Description of Material	Percent Moisture	
					From Sample	Calculated Desired
0-6.0	67	45	93	Black clay with some small gravel	22.0	27.0
6.0-14.0	65	46	95	Yellow to brown clay with chalky streaks	20.0	25.2
14.0-18.0	86	63	100	Yellow and gray clay with hard streaks	26.0	33.5
18.0-23.0	78	48	100	Same as 14.0-18.0	27.0	30.0
Note:	1.0' of fill to be constructed at this point when grading complete					

TABLE A13

TABULATION OF MOISTURE CONTENT DATA

TEST SECTION 9

STATION NO. 576 + 00

LOCATION SBML

DATE OF TEST 10/21/57

DATE PONDING BEGAN 10/28/57

APPROX. TIME PONDED 30 days

Depth in Feet	LL	PI	% Pass No. 40	Description of Material	Percent Moisture	
					From Sample	Calculated Desired
0-4.0	57	37	81	Black clay	21.0	20.7
4.0-9.0	56	39	86	Brown clay	16.0	20.6
9.0-11.0	65	46	91	Lt. brown clay with sand and gravel strs	25.0	25.0
11.0-22.0	99	78	93	Yellow and gray shaley clay	28.0	27.0
Note:	3.0' of fill to be constructed at this point when grading complete					

TABLE A14

TABULATION OF MOISTURE CONTENT DATA

TEST SECTION 10 **DATE OF TEST** 8/28/57

STATION NO. 618 + 08 **DATE PONDING BEGAN** 10/29/57

LOCATION SBML **APPROX. TIME PONDED** 30 days

Depth in Feet	LL	PI	% Pass No. 40	Description of Material	Percent Moisture	
					From Sample	Calculated Desired
0-2.0	53	30	87	Black clay with some small gravel	7.0	22.2
2.0-5.2	52	32	88	Gray clay with white streaks	8.5	21.6
5.2-7.4	44	29	88	Yellow and gray clay with white streaks	10.9	17.6
7.4-9.0	97	72	98	Yellow and gray clay	14.6	36.8
9.0-11.0	71	51	81	Yellow and gray clay with some small gravel	14.6	22.7
11.0-12.9	54	39	87	Yellow clay with gray streaks	22.0	20.0
12.9-14.3	77	57	100	Yellow clay with gray and white streaks	23.0	29.5
14.3-15.6	79	55	100	Yellow clay with gray streaks	24.3	30.0
15.6-18.0	82	59	100	Same as 14.3-15.6	24.0	30.5

TABLE A15

TABULATION OF MOISTURE CONTENT DATA

TEST SECTION 11

STATION NO. 632 + 60

LOCATION SBML

DATE OF TEST 11/18/57

DATE PONDING BEGAN 10/30/57

APPROX. TIME PONDED 30 days

Depth in Feet	LL	PI	% Pass No. 40	Description of Material	Percent Moisture	
					From Sample	Calculated Desired
0-0.6	53	33	93	Brown clay topsoil with few small gravel	17.5	22.3
0.6-7.8	74	50	100	Yellow to gray clay	14.9	27.5
7.8-19.8	80	53	100	Gray and yellow clay with alternating hard streaks	27.2	31.2

Note: 4.0' of fill to be constructed at this point when grading complete

APPENDIX 5

TEXAS HIGHWAY DEPARTMENT
SPECIAL SPECIFICATION
"WATER TREATMENT"

APPENDIX 5. TEXAS HIGHWAY DEPARTMENT SPECIAL SPECIFICATION "WATER TREATMENT"

Description

This item shall consist of the application of water to those areas of the subgrade or the natural ground surface upon which embankments are to be placed as designated by the Engineer and as herein specified.

Construction Methods

Those areas, as designated by the Engineer, of the subgrade that have been excavated and shaped to approximate line, grade and section, or of the natural ground, shall be treated with water. Dikes or levees shall be built, where necessary, along and across the roadbed so as to impound the water entirely and uniformly over the designated areas. These areas shall be continuously wetted with water until the required penetration by the desired quantity of water has been uniformly secured, except that continuous ponding will not be required on any area for a period longer than thirty (30) days. After completion of the treatment, the dikes or levees shall be leveled down and the natural ground prepared in compliance with Specification Item 106 "Embankment" or the subgrade shaped to the required lines, grades and sections in conformity with the pertinent governing items.

The above operations shall be performed in proper sequence in order that there will be no appreciable loss of moisture following the treatment of the natural ground or of the subgrade as herein prescribed and the placement thereon of the embankment or the lime stabilization of subgrade.

Measurement

Work required for the "Preparation for Water Treatment" will be measured by the square yard of area as designated by the Engineer.

"Water Treatment" will be measured by the 1,000 gallons as delivered on the ponded area.

Payment

Work performed as prescribed by this item and measured as provided under "Measurement" will be paid for at the unit price bid per square yard for "Preparation for Water Treatment," which price shall be full compensation for constructing, maintaining and leveling necessary dikes or levees and for all manipulation, labor, tools, equipment, and incidentals necessary to complete the work.

Water furnished and the work performed as prescribed by this item and measured as provided under "Measurement" will be paid for at the unit price bid per 1,000 gallons for "Water Treatment," which price shall be full compensation for all cost in connection with furnishing the water; for all cost in connection with furnishing and operating approved water trucks, and/or pumps and water systems, and all necessary measuring devices; and for applying the water as directed including all equipment, tools, materials, labor, and incidentals necessary to complete the work.