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16. Abstract

Swelling and shrinkage of subgrade soils are critical factors contributing to increases in roughness and degradation of serviceability of highway pavements. Existing procedures for predicting swell are largely based on the potential vertical rise (PVR) procedure developed by McDowell in 1956. While the PVR procedure represents a major development in the design of pavements on expansive soils, instances of apparently over-conservative PVR predictions have led some designers to suggest revision or replacement of the existing procedure. This project reviews the basic assumptions of the existing PVR procedure and identifies the likely sources of the questionable predictions that have arisen in the past. An alternative procedure is presented that features rigorous modeling of both the moisture diffusion process that induces changes in suction within a soil mass and the deformations that occur in response to changes in suction. This alternative procedure includes provisions for measuring and/or estimating soil and environmental input parameters necessary for the predictions. A procedure for predicting the impact of soil deformations on pavement performance is also presented. The proposed procedure is applied to three study sections involving Texas roadways on expansive soils, and parametric studies are presented evaluating the effectiveness of various design measures including moisture barriers, lime treatment, and replacement of in situ sub-grade soils with “inert” soils.

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# DESIGN PROCEDURE FOR PAVEMENTS ON EXPANSIVE SOILS
# VOLUME 2

by

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# APPENDIX A
# THE FILTER PAPER METHOD FOR TOTAL AND MATRIC SUCTION MEASUREMENTS

## OVERVIEW

This procedure determines the soil total and matric suction components using the filter paper method. The procedure uses the wetting filter paper calibration curve developed in the Bulut et al. (2001)[1] paper for both total and matric suction components. The wetting filter paper calibration curve was constructed for Schleicher & Schuell No. 589-White Hard (WH) 5.5 cm in diameter filter papers. Thus, the same brand of filter paper must be adopted for both total and matric soil suction measurements.

Basically, the filter paper comes to equilibrium with the soil either through vapor (total suction measurement) or liquid (matric suction measurement) flow. At equilibrium, the suction value of the filter paper and the soil will be equal. After equilibrium is established between the filter paper and the soil, the water content of the filter paper disc is measured. Then, by using the wetting filter paper calibration curve, the corresponding suction value is found from the curve.

Before commencing the soil suction measurements, carefully clean all the items related to filter paper testing. Use latex gloves and tweezers to handle the materials in nearly all steps of the experiment. The filter papers and aluminum cans for water content measurements are never touched with bare hands. In addition, it is suggested that two people perform the filter paper water content measurements in order to reduce the time during which the filter papers are exposed to the laboratory atmosphere and minimize the amount of moisture lost or gained during the measurements.

NOTE: This procedure can be used along with the help of illustrations given in the Power Point presentation in Appendix AA.

## DEFINITIONS

The following definitions are referenced in this test method:

- Total suction – total suction is expressed in log kPa or pF scales, and is the equivalent suction derived from the measurement of the partial pressure of the water vapor in equilibrium with the soil water, relative to the partial pressure of water vapor in equilibrium with free pure water.
- Matric suction – matric suction is expressed in log kPa or pF scales, and is the equivalent suction derived from the measurement of the partial pressure of the water vapor in equilibrium with the soil water, relative to the partial pressure of the water vapor in equilibrium with a solution identical in composition with the soil water.
- Wetting filter paper calibration curve – the calibration curve adopted for this procedure is obtained from initially dry filter papers that are held over salt solutions, in a non-contact manner, at isothermal conditions.
- Suction in pF – suction in pF scale is expressed as pF = $\log_{10}$ (suction in cm of water).
- Suction in log kPa – suction in log kPa scale is expressed as log kPa ≈ pF – 1.

## APPARATUS

The following apparatus is required:

- Schleicher & Schuell No. 589-White Hard quantitative 5.5 cm in diameter filter papers.
- Sensitive balance, with 0.0001 grams accuracy and ±0.0001 grams repeatability.
- Constant temperature environment, with stability in temperature less than ±1.8 $^{o}$F (±1 $^{o}$C), preferably in the order of ±0.18 $^{o}$F (±0.1 $^{o}$C).
- Oven for 230 ±9 $^{o}$F (110 ±5 $^{o}$C).
- Glass jars; glass jars that are between 250 to 500 ml volume sizes are readily available in the market and can be easily adopted for suction measurements. Glass jars, especially, with 3.5 to 4 inch (8.89 to 10.16 cm) diameter can contain the 3 inch (7.62 cm) diameter Shelby tube samples very nicely.
- Protective filter papers; filter papers of any brand that are larger in diameter than the 5.5 cm diameter Schleicher & Schuell No. 589-WH filter papers can be employed as

protective filter papers for relatively wet soil samples during matric suction measurements. Filter papers that are 7 cm in diameter are available in the market and are ideal for Shelby tube soil sample sizes.

- Moisture tins for the filter paper water content determination.
- Ring type support; a ring support that has a diameter smaller than the filter paper diameter and in between 0.59 to 0.78 inch (1.5 to 2 cm) in height. Care must be taken when selecting the support material. Materials that can corrode should be avoided, while plastic or glass type materials are much better for this job. The PVC pipes work nicely for this purpose.
- Aluminum block; an aluminum block functions as a heat sink and expedites the cooling of the hot moisture tins.
- Ice chests, tweezers, scissors, latex gloves, electrical tape, knives, and spatula.

## PROCEDURE FOR TOTAL SUCTION MEASUREMENTS

The following steps are necessary to determine total suction.

1. Cut and trim the sides of the Shelby tube soil specimen with minimum disturbance into right circular cylinder (see Figure A-1), if possible, to fit into the glass jar.
2. Fill at least 75 percent by volume of the glass jar with the soil; the smaller the empty space remaining in the glass jar, the smaller the time period that the filter paper and the soil system requires to come to equilibrium, and also the smaller the change in the soil specimen water content as a result of the release of water vapor into the empty space in the jar.
3. Put a ring-type support on top of the soil to provide a non-contact system between the filter paper and the soil.
4. Insert two Schleicher & Schuell No. 589-WH filter papers, one on top of the other, on the ring using tweezers. The filter papers should not touch the soil, the inside wall of the jar, or underneath the lid in any way.
5. Seal the glass jar lid very tightly with electrical tape.
6. Repeat steps 1 through 5 for every soil specimen.

7. Carry the glass jars very carefully to the ice chests in a temperature-controlled room for equilibrium.

After an equilibration time of at least one week in the temperature-controlled room, the procedure for the filter paper water content measurements is as follows:

1. Before removing the glass jars from the temperature-controlled room, weigh all aluminum cans that are used for moisture content measurements to the nearest 0.0001 g accuracy as *Cold tare mass* ($T_c$) and record in Table A-1.
2. Remove a glass jar from the ice chest in the temperature-controlled room.
3. Carry out all measurements by two people. For example, while one person is opening the sealed glass jar, the other is putting the filter paper into the aluminum can very quickly (i.e., in a few seconds) using tweezers.
4. Take the weights of each can with wet filter paper inside very quickly and record as *Mass of wet filter paper + Cold tare mass* ($M_1$) in the corresponding space in Table A-1, and mark whether it is a top or bottom filter paper.
5. Record the other relevant information (such as the moisture tin number, depth, etc.) on the sheet.
6. Follow steps 2 through 5 for every glass jar.
7. Put all the cans into the oven with the lids half-open to allow evaporation.

Keep all filter papers at 230 ±9 $^{o}$F (110 ±5 $^{o}$C) temperature inside the oven for at least 10 hrs. Before taking measurements of the dried filter papers, close the cans with their lids and allow to equilibrate for about 5 minutes inside the oven.

1. Remove a can from the oven and put it on an aluminum block (i.e., heat sink) for about 20 seconds to cool down.
2. Weigh the can with the dry filter paper inside very quickly and record as *Mass of dry filter paper + Hot tare mass* ($M_2$) in Table A-1.
3. Take the dry filter paper from the can and weigh the cooled can again in a few seconds and record as *Hot tare mass* ($T_h$) in Table A-1.

4. Repeat steps 1 through 3 for every can.

### Calculations

The filter paper water contents for obtaining total suctions are calculated as follows (see Table A-1).

1. Mass of dry filter paper, $M_f = M_2 - T_h$
2. Mass of water in filter paper, $M_w = M_1 - M_2 - T_c + T_h$
3. Water content of filter paper, $W_f = M_w / M_f$
4. Repeat steps 1, 2, and 3 for every filter paper.

After obtaining all of the filter paper water contents, the equation for the wetting filter paper calibration curve (Figure A-2) is employed to get total suction values of the soil samples.

$$h_1 = -8.247W_f + 5.4246 \quad (h_1 > 1.5 \text{ log kPa})$$

where:

$h_1$ = total suction (in log kPa)

$W_f$ = water content of filter paper (in decimals)

and

$$h_2 = -8.247W_f + 6.4246 \quad (h_2 > 2.5 \text{ pF})$$

where:

$h_2$ = total suction (in pF)

### Reporting Test Results

Total suction values are reported to the nearest two decimal places in log kPa or pF scales.

### PROCEDURE FOR MATRIC SUCTION MEASUREMENTS

Soil matric suction measurements are very similar to the total suction measurements except instead of inserting filter papers in a non-contact manner with the soil for total suction testing, a good intimate contact should be provided between the filter paper and the soil for matric suction measurements. Both matric and total suction measurements can be performed on the same soil sample in a glass jar as shown in Figure A-1.

The following steps are necessary to determine matric suction:

1. Cut and trim the soil specimen with minimum disturbance into two right circular cylinders (see Figure A-1), if possible, that can fit into the glass jar.
2. Sandwich a Schleicher & Schuell No. 589-WH 5.5 cm in diameter filter paper between two larger diameter protective filter papers.
3. Insert the sandwiched filter papers into the soil sample in a very good contact manner. An intimate contact between the filter paper and the soil is very important.
4. Bring the two halves of the cylindrical samples together and seal with electrical tape to keep the two specimens together in a good contact manner.
5. Put the whole sample with embedded filter papers into the glass jar container. Fill at least 75 percent by volume of the glass jar with the soil; the smaller the empty space remaining in the glass jar, the smaller the change in the soil specimen water content as a result of the release of water vapor into the empty space in the jar.

NOTE: The same soil sample can be used to infer both total and matric suction.

6. Seal the glass jar lid very tightly with electrical tape.
7. Repeat steps 1 through 6 for every soil specimen.
8. Carry the glass jars very carefully to the ice chests in a temperature- controlled room for equilibrium.

After an equilibration time of at least one week in the temperature-controlled room, the procedure for the filter paper water content measurements is as follows:

1. Before removing the glass jars from the temperature-controlled room, weigh all aluminum cans that are used for moisture content measurements to the nearest 0.0001 g accuracy as *Cold tare mass ($T_c$)* and record in Table A-1.
2. Remove a glass jar from the ice chest in the temperature-controlled room.

3. After that, carry out all measurements by two people. For example, while one person is opening the sealed glass jar, the other is putting the filter paper into the aluminum can very quickly (i.e., in a few seconds) using tweezers.
4. Take the weights of each can with wet filter paper inside very quickly and record as *Mass of wet filter paper + Cold tare mass ($M_1$)* in the corresponding space in Table A-1, and mark as matric suction.
5. Record the other relevant information (such as the moisture tin number, depth, etc.) on the sheet.
6. Repeat steps 2 through 5 for every glass jar.
7. Put all cans into the oven with the lids half-open to allow evaporation.

Keep all filter papers at 230 ±9 $^{o}$F (110 ±5 $^{o}$C) temperature inside the oven for at least 10 hrs. Before taking measurements on the dried filter papers, close the cans with their lids and allow to equilibrate for about 5 minutes inside the oven.

1. Remove a can from the oven and put it on an aluminum block (i.e., heat sinker) for about 20 seconds to cool down.
2. Weigh the can with the dry filter paper inside very quickly and record as *Mass of dry filter paper + Hot tare mass ($M_2$)* in Table A-1.
3. Take the dry filter paper from the can and weigh the cooled empty can again in a few seconds and record as *Hot tare mass ($T_h$)* in Table A-1.
4. Repeat steps 1 through 3 for every can.

**Calculations**

The filter paper water contents for obtaining matric suctions are calculated as follows (see Table A-1).

1. Mass of dry filter paper, $M_f = M_2 – T_h$
2. Mass of water in filter paper, $M_w = M_1 – M_2 – T_c + T_h$
3. Water content of filter paper, $W_f = M_w / M_f$
4. Repeat steps 1, 2, and 3 for every filter paper.

After obtaining all of the filter paper water contents, the equation for the wetting filter paper calibration curve (Figure A-2) is employed to get the matric suction values of the soil samples.

$$h_1 = -8.247W_f + 5.4246 \qquad (h_1 > 1.5 \text{ log kPa})$$

where:

$h_1$ = matric suction (in log kPa)

$W_f$ = water content of filter paper (in decimals)

and

$$h_2 = -8.247W_f + 6.4246 \qquad (h_2 > 2.5 \text{ pF})$$

where:

$h_2$ = matric suction (in pF)

**Reporting Test Results**

Matric suction values are reported to the nearest two decimal places in log kPa or pF scales.

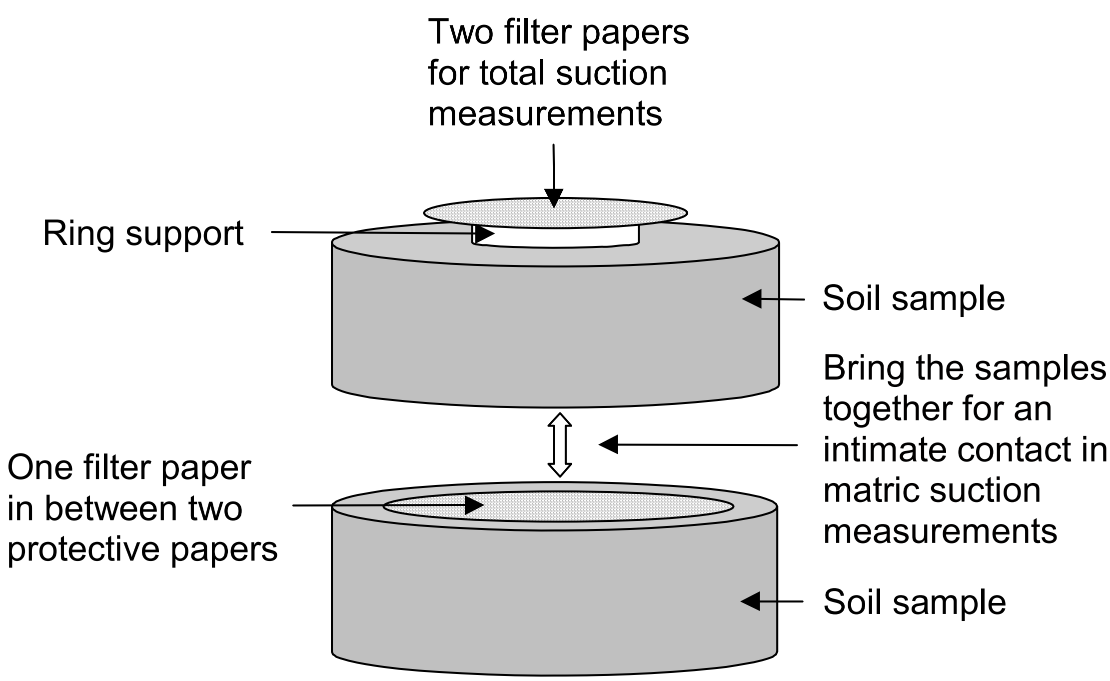



**Figure A-1. Total and Matric Suction Measurements (from Bulut et al., 2001)[1].**

**Table A-1. The Filter Paper Method Suction Measurements Worksheet.**

| THE FILTER PAPER METHOD SUCTION MEASUREMENTS WORKSHEET | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Date Sampled: | | | | | | | | Date Tested: | |
| Boring No.: | | | | | | | | Tested By: | |
| Sample No.: | | | | | | | | | |
| Depth | | | | | | | | | |
| Moisture Tin No.: | | | | | | | | | |
| Total or Matric Suction | | | | | | | | | |
| Top or Bottom Filter Paper | | | | | | | | | |
| Cold tare mass, g | $T_c$ | | | | | | | | |
| Mass of wet filter paper + cold tare mass, g | $M_1$ | | | | | | | | |
| Mass of dry filter paper + hot tare mass, g | $M_2$ | | | | | | | | |
| Hot tare mass, g | $T_h$ | | | | | | | | |
| Mass of dry filter paper, g ($M_2 - T_h$) | $M_f$ | | | | | | | | |
| Mass of water in filter paper, g ($M_1 - M_2 - T_c + T_h$) | $M_w$ | | | | | | | | |
| Water content of filter paper, g ($M_w / M_f$) | $W_f$ | | | | | | | | |
| Suction, log kPa | $h_1$ | | | | | | | | |
| Suction, pF | $h_2$ | | | | | | | | |

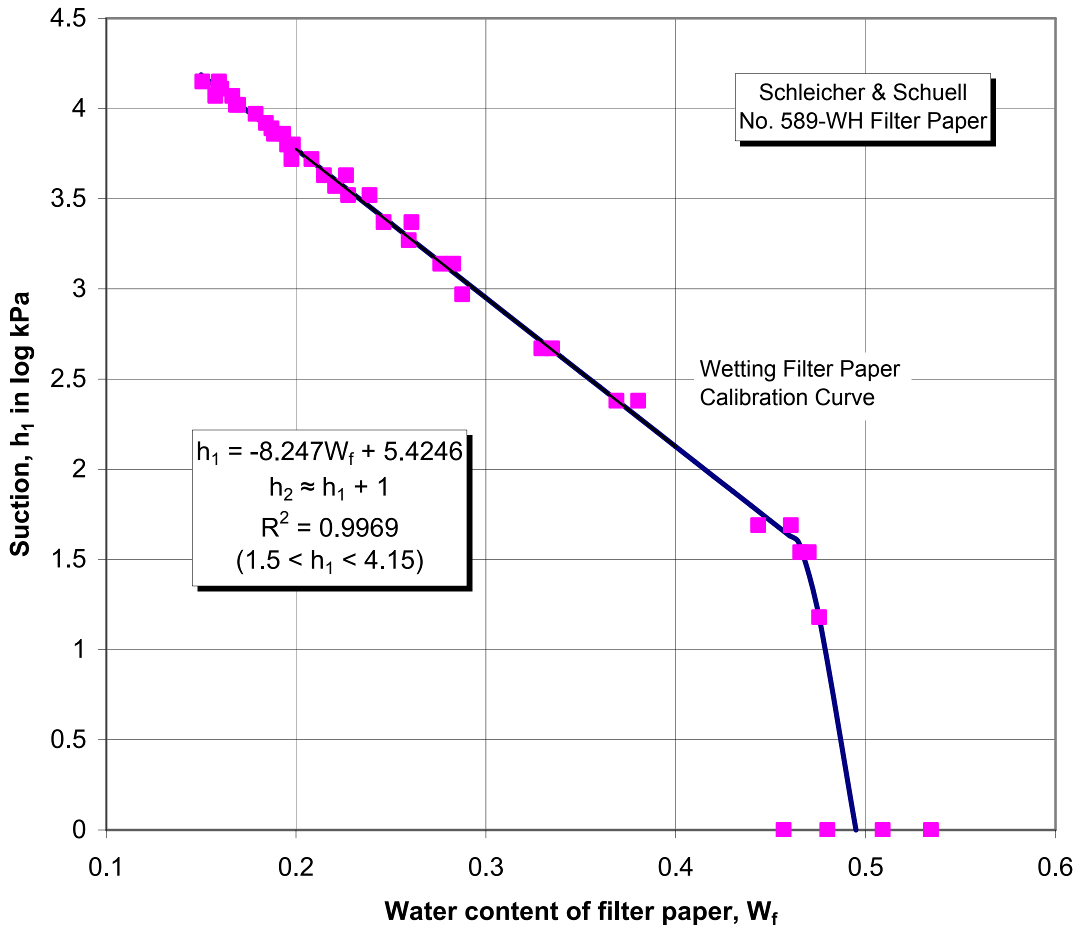
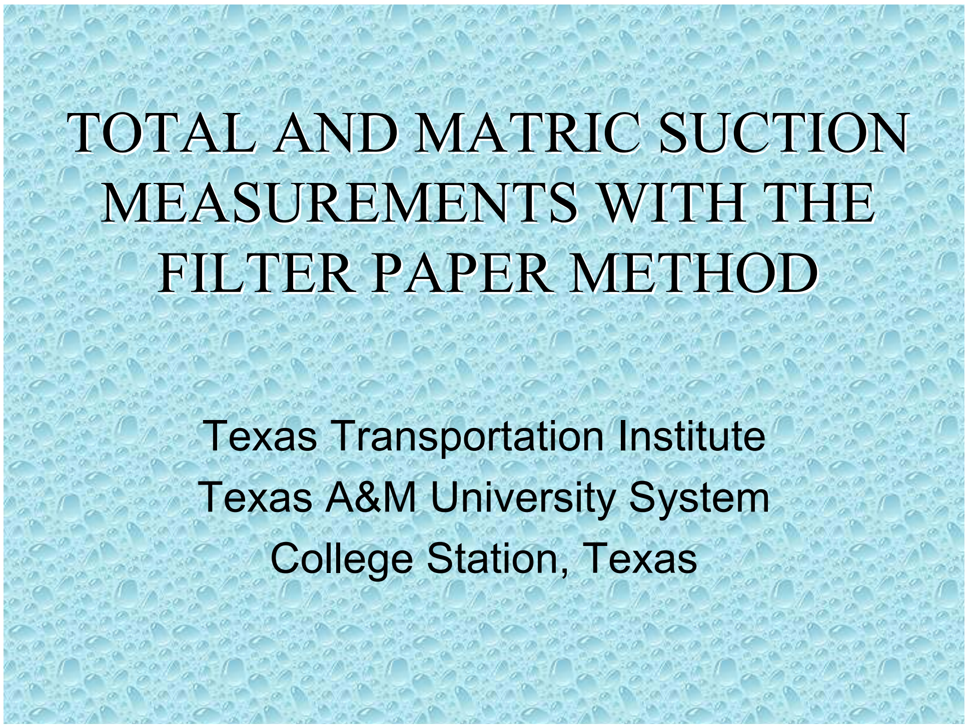



**Figure A-2. Filter Paper Calibration Curve (from Bulut et al., 2001)[1].**

## APPENDIX AA

In this section, total and matric suction measurements with the filter paper method are illustrated in a Power Point presentation.

**The Power Point presentation is given below**:



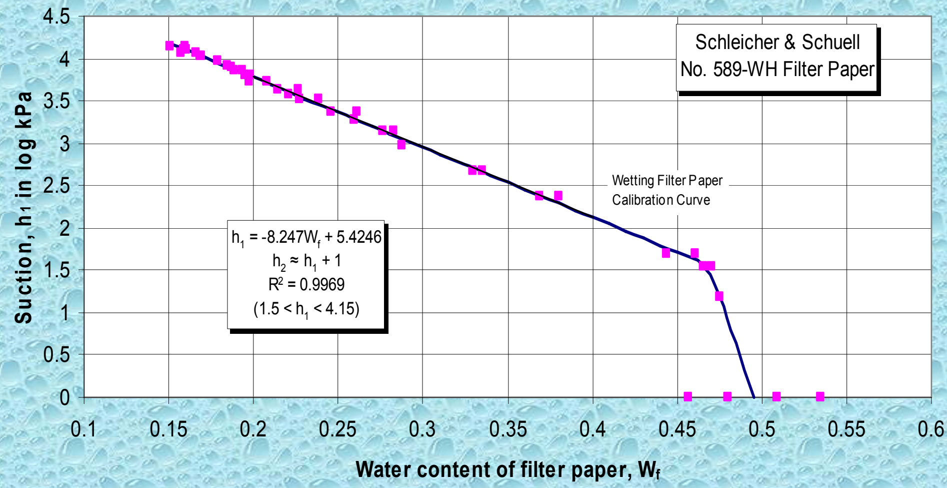
# APPARATUS

- ✓ Filter Papers
- ✓ Glass Jars
- ✓ Moisture Tins
- ✓ Tweezers
- ✓ Latex Gloves
- ✓ PVC-Rings
- ✓ Electrical Tape
- ✓ Aluminum Block

# APPARATUS

- ✓ Sensitive Balance (0.0001 g)
- ✓ Constant Temperature Container (stability less than ±1.8 ºF (± 1ºC))
- ✓ Oven (230±9 ºF (110 ± 5ºC))

# CALIBRATION CURVE




BEFORE COMMENCING THE TESTING, MAKE SURE THAT ALL ITEMS RELATED TO FILTER PAPER METHOD ARE CLEAN, MOISTURE, OIL, AND DUST FREE!

*NOTE:*

- *Make sure that tweezers are used to handle filter papers*
- *Make sure that moisture tins, o-rings are handled with gloves*

• Use a glass jar that a Shelby-tube soil sample can be fit into easily without the disturbance of the soil sample.

• Cut the soil sample into two halves for matric suction measurements.

• Make sure that the surfaces of the soil samples are smooth and flat for establishing an intimate contact between the soil sample and the filter paper for matric suction measurements.

NOTE: When preparing the soil samples make sure that sample disturbance is minimal.

• Remove a *Schleicher & Schuell No. 589-WH* filter paper from the box using tweezers (5.5 cm in diameter)

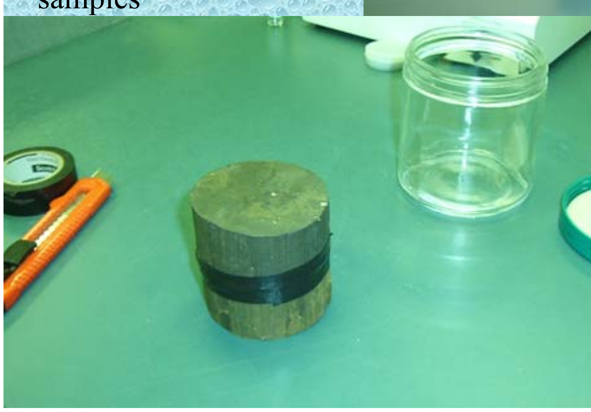



Almost any brand of high permeability and larger diameter filter paper can be used as protective filter papers for matric suction measurements (as shown in the lower left box and in the picture, about 70 mm in diameter)

• For matric suction measurements, insert a single Schleicher & Schuell No. 589-WH filter paper in between two larger in diameter protective filter papers as shown on the right

• Using tweezers put the sandwiched filter papers on top of the soil sample as shown on the left

• Put the other half of the soil sample on top, keeping the sandwiched filter papers in between and in intimate contact with the soil samples



• Tape the two pieces of the soil sample together

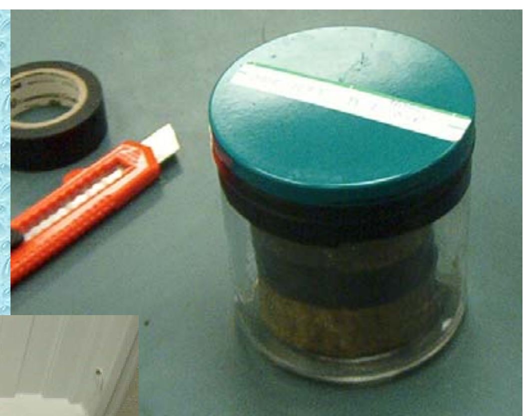
NOTE: Electrical tape works nicely for this purpose

• For matric suction measurements, insert a single Schleicher & Schuell No. 589-WH filter paper in between two larger in diameter protective filter papers as shown on the right

• Using tweezers put the sandwiched filter papers on top of the soil sample as shown on the left

• Put the lid on and tape it tight to prevent any moisture exchange between the air inside and the air outside of the jar

• Label the jar as necessary



• Insert the glass jar into a well-insulated container for suction equilibrium

NOTE: Temperature control is critically important!

- ✓ The setup, as described in the previous slides, will be kept in a temperature-controlled environment for at least one week

- ✓ Temperature fluctuations should be kept as low as possible, preferably below ±1.8 ºF (±1ºC)

AT THE END OF AT LEAST ONE WEEK OF EQUILIBRIUM PERIOD:

• Before opening the lid of the temperature-controlled container, take the dry, cold weight of the moisture tins $T_c$

• Record all the weights with their corresponding tin $T_c$ numbers

NOTE: Use a balance at least to the nearest 0.0001 g accuracy

• Remove a glass jar from the temperature-controlled container

• Time is critical at this stage and thus it is suggested that two people share the work

• The time that the filter papers are exposed to the lab environment should be minimal, preferably less than a few seconds

Note that while one person is opening the glass jar the other person is ready to pick up the filter papers

• Open the glass jar and quickly carry the filter paper to the moisture tin using tweezers, in less than a few seconds

• Immediately close the lid of the moisture tin with the wet filter paper inside

• After closing the lid of the moisture tin, immediately weigh the tin with the wet filter paper inside


• Record the weight as Cold tare plus wet filter paper mass, $M_1$

Note that this is a total suction measurement

• Continue with the matric suction measurement by removing the tape that was holding the soil samples together

• Remove the filter paper that was sandwiched between the two protective filter papers

• Immediately carry the filter paper to the moisture tin

- Immediately close the lid of the moisture tin and weigh the tin with the wet filter paper inside


- Record the weight as Cold tare plus wet filter paper mass, $M_1$

Note that this is a matric suction measurement

- After opening all the glass jars and recording the weight of the moisture tins with the wet filter papers inside, carry them to a hot oven with the lids half open
- Leave them in the oven for at least 10 hours

- Before taking them out from the oven, close their lids for equilibrium and leave them in the oven for about 5 minutes

• Remove a hot tin from the oven and put on a large aluminum block

NOTE: The aluminum block will expedite the process of the cooling

• Leave the tin on the block for about 20 seconds

• Weigh the hot tin with the dry filter paper inside

• Record the weight as Hot tare plus dry filter paper mass, $M_2$

• Finally, take the dry filter paper out of the tin

• Weigh the empty hot tin


• Record the weight as Hot tare mass, $T_h$

• Repeat the above process for other tins in the oven

- Calculate the moisture content of each filter paper for both total and matric suction measurements. A calculation work sheet as given in the next slide can be used

- Obtain the suction value from the calibration curve that was provided above

# SUCTION CALCULATION WORKSHEET

| THE FILTER PAPER METHOD SUCTION MEASUREMENTS WORKSHEET | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Date Sampled: | | | | | | | | Date Tested: | |
| Boring No.: | | | | | | | | Tested By: | |
| Sample No.: | | | | | | | | | |
| Depth | | | | | | | | | |
| Moisture Tin No.: | | | | | | | | | |
| Total or Matric Suction | | | | | | | | | |
| Top or Bottom Filter Paper | | | | | | | | | |
| Cold tare mass, g | $T_c$ | | | | | | | | |
| Mass of wet filter paper + cold tare mass, g | $M_1$ | | | | | | | | |
| Mass of dry filter paper + hot tare mass, g | $M_2$ | | | | | | | | |
| Hot tare mass, g | $T_h$ | | | | | | | | |
| Mass of dry filter paper, g ($M_2 - T_h$) | $M_f$ | | | | | | | | |
| Mass of water in filter paper, g ($M_1 - M_2 - T_c + T_h$) | $M_w$ | | | | | | | | |
| Water content of filter paper, g ($M_w$ / $M_f$) | $W_f$ | | | | | | | | |
| Suction, log kPa | $h_1$ | | | | | | | | |
| Suction, pF | $h_2$ | | | | | | | | |

# APPENDIX B
# TOTAL SUCTION MEASUREMENT WITH THERMOCOUPLE PSYCHROMETERS USING HR 33T MICROVOLTMETER

## OVERVIEW

This procedure determines the total suction of soil specimens with thermocouple psychrometers using the HR 33T microvoltmeter. The HR 33T permits suction determination with either the dew point or the psychrometric mode.

A thermocouple psychrometer is used to measure the total suction of soil by measuring the relative humidity in the air phase of the soil pores. It operates on the basis of temperature difference measurements between a non-evaporating surface (i.e., dry bulb) and an evaporating surface (i.e., wet bulb). The difference between these surfaces is related to the relative humidity. The lowest suction that can be measured using a thermocouple psychrometer is approximately 14.5 lb/in$^2$ (100 kPa) under a controlled temperature environment of ±0.18 ºF (±0.1 ºC). A thermocouple psychrometer is shown in Figure B-1.

Before using the psychrometer for total suction measurement in soil, it has to be calibrated. Calibrations are done using a salt solution of different molalities. A calibration curve is unique for each psychrometer and used to obtain the equation relating microvolt outputs from the thermocouple and corresponding suction value in bars.

The thermocouple psychrometer is either inserted in or kept over the soil sample in a temperature-controlled environment for isothermal conditions to determine total suction. The static testing time for total suction measurements using thermocouple psychrometers is about one hour.

## DEFINITIONS

The following definitions are referenced in this test method:

- Total suction – total suction is expressed in *pF*, and is the equivalent suction derived from the measurement of the partial pressure of the water vapor in equilibrium with the soil water, relative to the partial pressure of water vapor in equilibrium with free pure water.

- Cooling coefficient of a psychrometer – cooling coefficient is defined as the differential e.m.f. (electromagnetic force) in microvolts that results from the passage of a specified normally optimum cooling current through the junction at a specified ambient temperature.
- Suction in pF – suction in pF scale is expressed as pF = $\log_{10}$ (suction in cm of water).
- Suction in log kPa – suction in log kPa scale is expressed as log kPa ≈ pF – 1.
- Suction in bar – suction in bar scale is expressed as bar = 100 kPa ≈ 1019.8 cm ≈ 3 pF.

**APPARATUS**

The following apparatus is required:

- Sodium chloride salt (NaCl).
- Sensitive balance, with 0.0001 grams accuracy.
- Glass jars; glass jars of 500 ml volume sizes can be adopted for calibrating a number of psychrometers at one time.
- Constant temperature environment, with stability in temperature in the order of ±0.18 $^{o}$F (±0.1 $^{o}$C).
- Stainless steel wire-screen thermocouple psychrometers from Wescor, Inc.
- HR 33T microvoltmeter from Wescor, Inc.
- Plastic corks; corks of 0.59 to 0.79 inch (1.5 to 2 cm) diameter.
- Plastic bottles; to store the salt solutions (500 ml bottles were used).
- Ice chest, silicon sealant, knife, spatula, electrical tape.
- Volumetric flask (500 ml and 1000 ml) and measuring cylinder (500 ml and 1000 ml).

**PROCEDURE**

The whole procedure can be divided into two sets. The first set includes preparation of salt solutions and using these solutions for the calibration of the psychrometers. In the second set, total suction measurements are made using the calibrated psychrometers. These test procedures are discussed below.

## Preparation of Salt Solution

The calibration of the psychrometer is carried out between approximately 3 to 5 pF osmotic suction solutions as given in Table B-1.

1. Determine the amount of NaCl to be used depending upon the required suction value.
   The amount of NaCl required to the amount of distilled water in g/liter is provided in Table B-1.
2. Weigh the salt on the sensitive balance to the nearest 0.0001 g. The salt should not be exposed for a long period to the atmosphere, so seal the bottle containing the salt shortly after use.
3. Dissolve the salt in the required amount of distilled water in a volumetric flask.
4. Store the salt solution in plastic bottles and seal with electrical tape.

## Calibration of Psychrometers

1. Make holes of 0.59 to 0.79 inch (1.5 to 2 cm) diameter (depending on the size of the cork being used) on the lid of the glass jar (Figure B-2).
2. Cut the cork, lengthwise, to its middle.
3. Plug the psychrometer wire in the middle of the cork. Provide sufficient length of wire so that the tip of the psychrometer is within the solution in the glass jar.
4. Pass the psychrometers along with the corks through the lid holes. Put a silicon sealant on the cork and psychrometer contact area as well as the cork and lid contact area to prevent entry of air. Let the sealant dry for half an hour before proceeding.
5. Immerse the psychrometers in salt solution (prepared above) in a glass jar. Make the jar air and water tight using electrical tape.
6. Keep it in a water bath having a constant temperature of 77 ºF (25 ºC) and controlled within ±0.18 $^{o}$F (±0.1 $^{o}$C) accuracy for maintaining isothermal conditions. Leave the setup for an hour for the psychrometers to attain equilibrium.
7. Use the HR 33T microvoltmeter for measuring the total suction value in microvolts. Take a set of three readings for each psychrometer.
8. Repeat the process for different salt solutions having varying suction values.

9. Plot the readings for different salt solutions, in microvolts, against the suction value of the corresponding salt solution to get the required calibration curve. Use this curve to convert the microvolt output into total suction. The maximum microvolt value indicates the maximum total suction that can be measured using psychrometers. The psychrometer readings beyond this point are highly variable. A typical calibration curve obtained from the above procedure is given in Figure B-3.
10. Wash the psychrometers with distilled water and air dry them after each set of the calibration process to remove the salt from the fine screen of the psychrometers.

**A Testing Procedure for Total Suction Measurements**

The total suction of soil specimens is measured using thermocouple psychrometers. A hole is drilled into the soil sample and the psychrometer is inserted into the hole or the psychrometer is kept over the soil specimen in an insulated container for isothermal conditions. The whole setup is put in a constant temperature environment and an air-tight box to prevent any loss or gain of moisture. The readings for total suction are taken after one hour using the HR 33T microvoltmeter.

The procedure for using the HR 33T microvoltmeter for measurement of total suction using the dew point method is as follows [2]:

An HR 33T microvoltmeter is shown in Figure B-4.

1. Switch the microvoltmeter **on** and leave it for approximately 15 minutes to warm up.
2. Plug in the psychrometer as shown in Figure B-4.
3. Turn the function knob to the **read** position.
4. With **fine** and **coarse** adjustment, located on the zero offset panel of the microvoltmeter, bring the pointer to rest at zero.
5. Record the psychrometer temperature by changing to the temperature mode.
6. If the temperature reading is less than 77 $^{o}$F (25 $^{o}$C), adjust the cooling coefficient by using the following equation:

$$\pi_v = 0.7 * (T-T_0) + \pi_{v0}$$

where:

$T$ = temperature of the psychrometer in °C

$T_0$ = temperature at which psychometers have been calibrated (25 °C)

$\pi_{v0}$ = cooling coefficient of the psychrometer

7. Set the mode back to microvolts.
8. Adjust the calculated cooling coefficient ($\pi_v$) by pressing the $\boldsymbol{\pi_v}$ button and rotating the $\boldsymbol{\pi_v}$ **set** knob.
9. Release the $\boldsymbol{\pi_v}$ button and allow the dial reading to fall down to zero.
10. Use the zero offset panel to bring the dial reading to zero.
11. Bring the function knob to the **cool** position for 45 seconds to provide sufficient cooling time.
12. After 45 seconds, switch the function knob to **dew point** and take the reading.
13. For suction values greater than 30 μV, turn the knob on the range board clockwise to 100 μV scale to take the reading.

**Calculations**

The reading obtained from the HR 33T is in μV. This reading is further converted to suction value in bars by using the unique equation from the calibration curve for the individual psychrometer. This can be further converted into suction in pF or kPa.

**Reporting Test Results**

The total suction values of soil specimen are reported to the nearest two decimal places in pF.

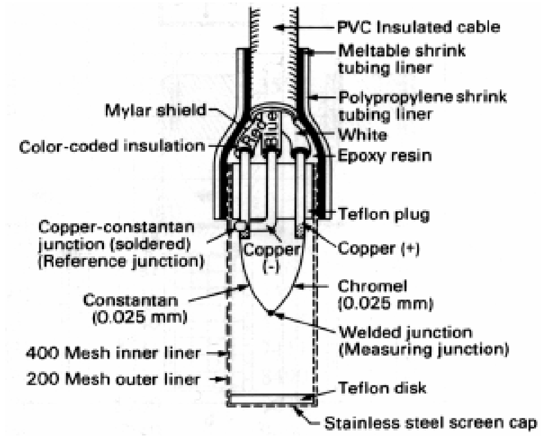




**Figure B-1. Screen Caged Single-Junction Peltier Thermocouple Psychrometer. (Source: Fredlund and Rahardjo [3])**

**Table B-1. NaCl Osmotic Suctions for Psychrometer Calibration. (Source: Bulut et al. [1])**

| Molality | NaCl Amount (grams/liter) | Osmotic Suction (bar) | Osmotic Suction (pF) | Osmotic Suction (kPa) |
|---|---|---|---|---|
| 0.02 | 1.1688 | 0.95 | 2.99 | 95.02 |
| 0.05 | 2.9221 | 2.34 | 3.38 | 233.90 |
| 0.10 | 5.8442 | 4.62 | 3.67 | 462.32 |
| 0.20 | 11.6885 | 9.16 | 3.97 | 916.08 |
| 0.50 | 29.2212 | 22.86 | 4.37 | 2286.15 |
| 0.70 | 40.9097 | 32.17 | 4.52 | 3216.82 |
| 1.20 | 70.1310 | 56.26 | 4.76 | 5626.15 |
| 2.20 | 128.5734 | 108.87 | 5.05 | 10887.35 |

1 Mole NaCl = 58.442468 grams
1 bar = 100 kPa

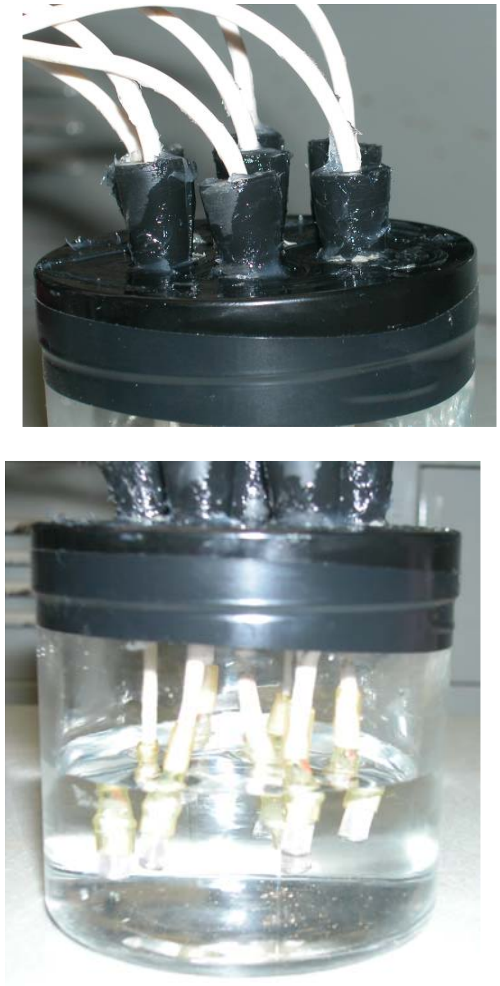


**Figure B-2. The Thermocouple Psychrometer Calibration Setup.**

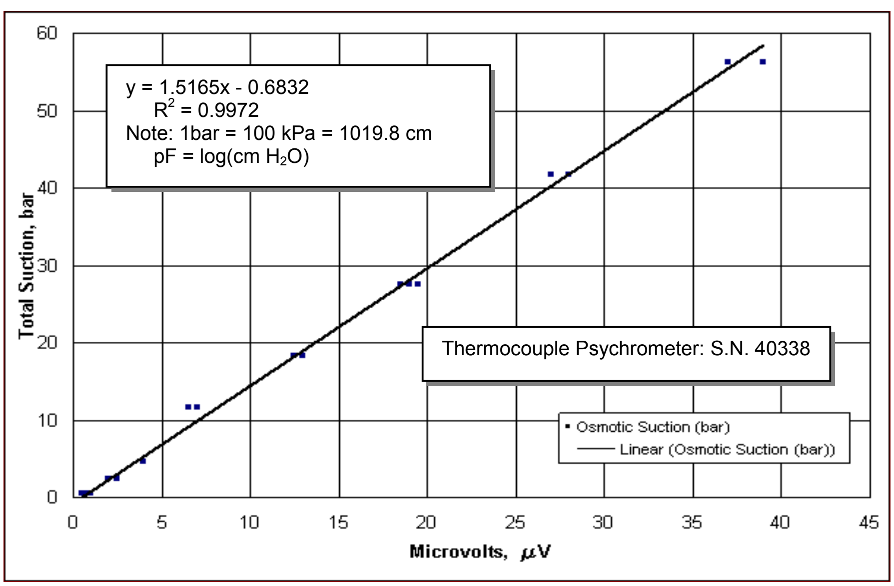



**Figure B-3. A Typical Calibration Curve.**


**Figure B-4. HR 33T Microvoltmeter.**

# APPENDIX C
## TOTAL SUCTION MEASUREMENTS WITH THERMOCOUPLE PSYCHROMETERS USING CR 7 DATALOGGER

### OVERVIEW

This procedure determines the total suction of the soil specimen with a thermocouple psychrometer using the CR 7 datalogger. The CR 7 device permits suction determination using the psychrometric method. It can measure up to 40 psychrometer readings at the same time.

A thermocouple psychrometer is used to measure the total suction of soil by measuring the relative humidity in the air phase of the soil pores. It operates on the basis of temperature difference measurements between a non-evaporating surface (i.e., dry bulb) and an evaporating surface (i.e., wet bulb). The difference between these surfaces is related to the relative humidity. The lowest suction that can be measured using a thermocouple psychrometer is approximately 14.5 lb/in$^2$ (100 kPa) under a controlled temperature environment of ±0.18 ºF (±0.1 ºC). A thermocouple psychrometer is shown in Figure C-1.

Before using the psychrometer for total suction measurement in soil, it has to be calibrated. Calibrations are done using salt solutions of different molalities. A calibration curve is unique for each psychrometer and is used to obtain the equation relating microvolt outputs from the thermocouple and the corresponding suction value in bars.

The thermocouple psychrometer is either inserted in or kept over the soil sample in a temperature-controlled environment for isothermal conditions to determine total suction. The static testing time for total suction measurements using thermocouple psychrometers is about one hour.

### DEFINITIONS

The following definitions are referenced in this test method:

- Total suction – total suction is expressed in *pF*, and is the equivalent suction derived from the measurement of the partial pressure of the water vapor in equilibrium with the soil water, relative to the partial pressure of water vapor in equilibrium with free pure water.

- Program Documentation, *.CSI – these are EDLOG program files that the user edits. When an EDLOG program is saved, EDLOG automatically adds a CSI extension to the program's name.
- Download Files, *.DLD – these can be downloaded to a datalogger. These are produced by compiling an EDLOG program.
- Suction in pF – suction in pF scale is expressed as pF = $\log_{10}$ (suction in cm of water).
- Suction in log kPa – suction in log kPa scale is expressed as log kPa ≈ pF – 1.
- Suction in bar – suction in bar scale is expressed as bar = 100 kPa ≈ 1019.8 cm ≈ 3 pF.

**APPARATUS**

The following apparatus is required:

- Sodium chloride salt (NaCl).
- Sensitive balance, with 0.0001 grams accuracy.
- Glass jars; glass jars of 500 ml volume sizes can be adopted for calibrating a number of psychrometers at one time.
- Constant temperature environment, with stability in temperature in the order of ±0.18 $^{o}$F (±0.1 $^{o}$C).
- Stainless steel wire-screen thermocouple psychrometers from Wescor, Inc.
- CR 7 Datalogger from Campbell Scientific, Inc.
- Plastic corks; corks of 0.59 to 0.79 inch (1.5 to 2 cm) diameter.
- Plastic bottles; to store the salt solutions (500 ml bottles were used).
- Ice chest, silicon sealant, knife, spatula, electrical tape.
- Volumetric flask (500 ml and 1000 ml) and measuring cylinder (500 ml and 1000 ml).

**PROCEDURE**

The whole procedure can be divided into two sets. The first set includes preparation of the salt solutions and using these solutions for the calibration of the psychrometers. In the second set, total suction measurements are made using the calibrated psychrometers. These test procedures are discussed below.

**Preparation of Salt Solution**

The calibration of the psychrometer is carried out between approximately 3 to 5 pF osmotic suction solutions as given in Table C-1.

1. Determine amount of NaCl to be used depending upon the required suction value. The amount of NaCl required to the amount of distilled water in g/liter is provided in Table C-1.
2. Weigh the salt on the sensitive balance to the nearest 0.0001 g. The salt should not be exposed for a long period to the atmosphere, so seal the bottle containing the salt shortly after use.
3. Dissolve the salt in the required amount of distilled water in a volumetric flask.
4. Store the salt solution in plastic bottles and seal with electrical tape.

**Calibration of Psychrometers**

1. Make holes of 0.59 to 0.79 inch (1.5 to 2 cm) diameter (depending on the size of the cork being used) on the lid of the glass jar (Figure C-2).
2. Cut the cork, lengthwise, to its middle.
3. Plug the psychrometer wire in the middle of the cork. Provide sufficient length of wire so that the tip of the psychrometer is within the solution in the glass jar.
4. Pass the psychrometers along with the corks through the lid holes. Put a silicon sealant on the cork and psychrometer contact area as well as the cork and lid contact area to prevent entry of air. Let the sealant dry for half an hour before proceeding.
5. Immerse the psychrometers in NaCl salt solution (prepared above) filled in a glass jar. Make the jar air and water tight using electrical tape.
6. Keep it in a water bath having a constant temperature of 77 $^{o}$F (25 ºC) and controlled within ±0.18 $^{o}$F (±0.1 $^{o}$C) accuracy for maintaining isothermal conditions. Leave the setup for an hour for the psychrometers to attain equilibrium.

7. Use the CR 7 datalogger for measuring the total suction value. The device takes the reading at 10-minute intervals for one hour.
8. Repeat the process for different salt solutions having varying suction values.
9. Plot the readings for different salt solutions, in microvolts, against the suction value of the corresponding salt solution to get the required calibration curve. Use this curve to convert the microvolt output into total suction.
10. Wash the psychrometers with distilled water and air dry them after each set of the calibration process to remove the salt from the fine screen of the psychrometers.

A typical calibration curve obtained is given in Figure C-3.

**Testing Procedure for Total Suction Measurements**

The total suction of soil specimens is measured using thermocouple psychrometers. A hole is drilled into the soil sample and the psychrometer is inserted into the hole or the psychrometer is kept over the soil specimen in an insulated container for isothermal conditions. The whole setup is put in a constant temperature environment and an air-tight box to prevent any loss or gain of moisture. The readings for total suction are taken after one hour using the CR 7 device.

A CR 7 datalogger is shown in Figure C-4. The CR 7 can be programmed via telecommunication using PC208 software or manually through the Remote Keyboard State.

The procedure for using the CR 7 device for measurement of total suction using the psychrometric method is as follows [4]:

1. Plug all the psychrometers into the CR 7 datalogger that are inserted in the soil specimen for the measurement of total suction.
2. Connect the datalogger to a computer to retrieve the readings of total suction.
3. Open the PC208W 3.3 datalogger support software on the computer.
4. The software opens a new window showing all the functions that can be performed by the software.
5. Click the ‘Connect’ icon to get another window to go online with a datalogger to set the clock, send programs, collect data, view and graph measurements, etc.

6. Click the ‘Connect’ icon on this window to connect the datalogger with the computer.
7. A DLD program is associated with the program.
8. The computer starts to take the readings after every 10 minutes.
9. After one hour click the ‘Collect’ icon on the window to extract all the data collected by the CR 7 datalogger.

**Calculations**

The CR 7 datalogger gives continuous readings at 10-minute intervals. For each psychrometer it gives three values. The first one depicts the temperature, the second is an offset, and the third is the reading in microvolts without any correction.

A correction has to be applied for the temperature and offset as given below:

$$\text{Corrected Reading} = (\text{Reading} / (0.325+0.027T)) - \text{offset}$$

where:

T = temperature of the psychrometer

The reading obtained from the CR 7 datalogger is in µV. This reading is further converted to suction value in bars by using the unique equation from the calibration curve for the individual psychrometer. This can be further converted into suction in pF or kPa.

**Reporting Test Results**

The total suction values of the soil specimen are reported to the nearest two decimal places in pF.

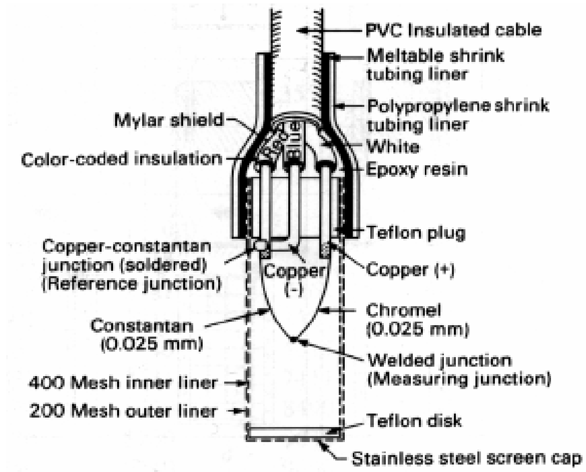




**Figure C-1. Screen Caged Single-Junction Peltier Thermocouple Psychrometer. (Source: Fredlund and Rahardjo [3])**

**Table C-1. NaCl Osmotic Suctions for Psychrometer Calibration. (Source: Bulut et al. [1])**

| Molality | NaCl Amount (grams/liter) | Osmotic Suction (bar) | Osmotic Suction (pF) | Osmotic Suction (kPa) |
|---|---|---|---|---|
| 0.02 | 1.1688 | 0.95 | 2.99 | 95.02 |
| 0.05 | 2.9221 | 2.34 | 3.38 | 233.90 |
| 0.10 | 5.8442 | 4.62 | 3.67 | 462.32 |
| 0.20 | 11.6885 | 9.16 | 3.97 | 916.08 |
| 0.50 | 29.2212 | 22.86 | 4.37 | 2286.15 |
| 0.70 | 40.9097 | 32.17 | 4.52 | 3216.82 |
| 1.20 | 70.1310 | 56.26 | 4.76 | 5626.15 |
| 2.20 | 128.5734 | 108.87 | 5.05 | 10887.35 |

1 Mole NaCl = 58.442468 grams
1 bar = 100 kPa

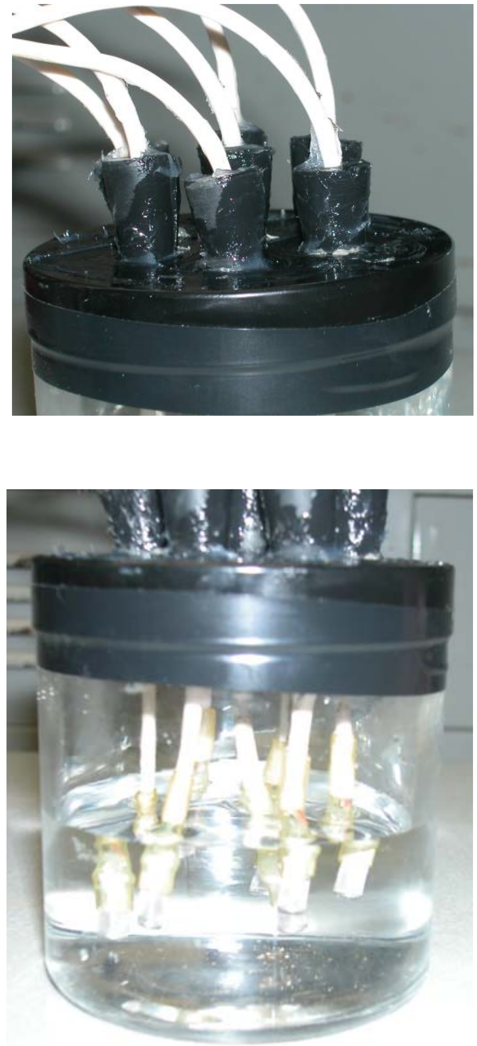


**Figure C-2. The Thermocouple Psychrometer Calibration Setup.**

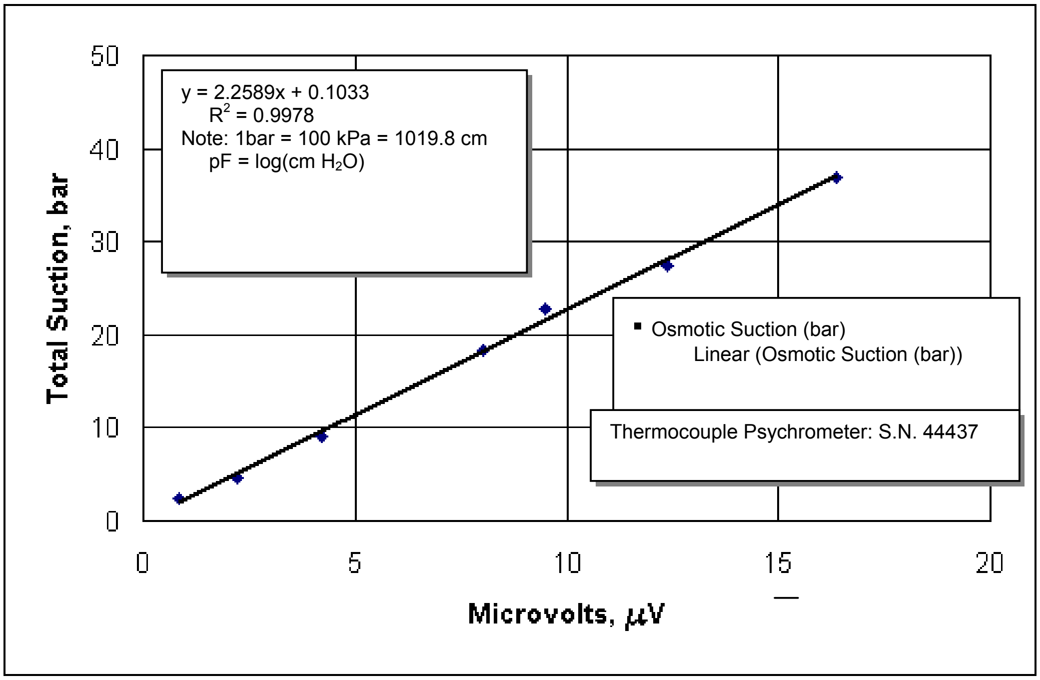



**Figure C-3. A Typical Calibration Curve.**


**Figure C-4. CR 7 Datalogger.**

# APPENDIX D
# SOIL DIFFUSION COEFFICIENT MEASUREMENTS IN LABORATORY

## OVERVIEW

This procedure determines the soil diffusion coefficient measurements in the laboratory. The process is based on the laboratory test proposed by Mitchell (1979)[5]. The unsaturated soil moisture diffusion coefficient controls transient moisture flow conditions within a soil mass in response to suctions imposed at the boundaries of the mass.

All the sides as well as one end of the soil specimen are sealed, allowing evaporation from only one open end of the soil specimen. Thermocouple psychrometers are used for the measurement of total suction of a soil specimen. The measurements for total suction with time are made at different locations along the length of the soil specimen. The filter paper method may also be employed to validate initial and final psychrometer measurements. The diffusion test time may change from about 3 days to a week depending on the soil type and its moisture and crack condition.

The Matlab programs given in Appendix D-1 are used for fitting the actual laboratory data in the theoretical curve. The values of the soil diffusion coefficient that best fit all the laboratory data are taken as the diffusion coefficient for the soil specimen.

NOTE: This procedure can be used along with the help of illustrations given in a Power Point presentation in Appendix D-2.

## DEFINITIONS

The following definitions are referenced in this test method:

- Diffusivity – soil water diffusivity is expressed in $cm^2/sec$, and is a function of the soil water characteristic curve and unsaturated soil permeability.
- Total suction – total suction is expressed in *pF*, and is the equivalent suction derived from the measurement of the partial pressure of the water vapor in equilibrium with the soil water, relative to the partial pressure of water vapor in equilibrium with free pure water.

- Suction in pF – suction in pF scale is expressed as pF = $\log_{10}$ (suction in cm of water).
- Suction in log kPa – suction in log kPa scale is expressed as log kPa ≈ pF $^{-1}$.
- Suction in bar – suction in bar scale is expressed as bar = 100 kPa ≈ 1019.8 cm ≈ 3 pF.

**APPARATUS**

The following apparatus is required:

- Constant temperature environment, with stability in temperature less than ±1.8 °F (±1 °C), preferably in the order of ±0.18 °F (±0.1 °C).
- Thermocouple psychrometers; stainless steel shield PST type psychrometers from Wescor, Inc.
- A sling psychrometer.
- A microvoltmeter; CR 7 or HR 33T from Wescor, Inc.
- A device to drill a hole into the soil specimen; a drillbit might work nicely for this purpose.
- Ice chest, silicon sealant, knife, spatula, electrical tape, sealing material (such as aluminum foil, plastic wrap, etc.).

**PROCEDURE**

A testing procedure for diffusion coefficient measurements can be outlined as follows:

1. From the boring log samples, select a soil specimen about 7.9 inch (200 mm) long, or cut approximately to the specified length from a longer sample and trim the ends of the specimen. Record the soil specimen length as *L*.
2. After deciding which end of the specimen will be exposed to the atmospheric suction, mark the locations of the thermocouple psychrometers on the specimen. Choose the location and spacing of the psychrometers relative to the closed end of the specimen (Figure D-1). Drill small holes on the lateral side of the soil sample as shown in Figure D-1. Drill the first hole approximately 0.59 inch (1.5 cm) from the open end and drill the second hole approximately 1.2 to 1.6 inch (3 to 4 cm) from the first hole. Drill the third hole approximately at the center of the soil

sample. The distance from the open end to the first psychrometer may change depending on the soil type, the current moisture state of the soil specimen, and the method of making a hole in the specimen for the installation of the psychrometer.

3. Use a drillbit to make the holes for the psychrometers. Keep the depth of the hole approximately half the diameter of the soil sample.
4. Insert the calibrated thermocouple psychrometers into the holes in the soil specimen. Assign each psychrometer number to its corresponding hole number in the specimen. Measure and record the coordinates of the psychrometers.
5. With the psychrometer inside, seal tightly each hole on the surface of the specimen to keep the psychrometer in place and to avoid any moisture loss or gain from the inside of the hole. Repeat this process for each psychrometer.
6. Seal the whole specimen, except the selected end that is exposed to the atmospheric suction, with aluminum foil and plastic wrap to prevent any moisture loss or gain.
7. Put the whole setup in a constant temperature environment (Figure D-2) for the suction measurements and the corresponding time recordings. With a water bath as depicted in Figure D-2, the temperature must be maintained at 77 $^{o}$F (25 $^{o}$C) and controlled within ±0.18 $^{o}$F (±0.1 $^{o}$C) accuracy.
8. Repeat steps 1 through 7 for each soil specimen.

NOTE: The suction level of the air in the laboratory is also determined by measuring the relative humidity in the air with a sling psychrometer. A sling psychrometer is comprised of a wet bulb thermometer that measures the saturation temperature, $T_{wb}$, and a dry bulb thermometer that measures the air temperature, $T_{db}$. The two thermometers are mounted on a common swivel and are rotated to ensure sufficient air flow around the wet bulb, or a small ventilator can be used to blow the air on the stationary wet bulb. The measured temperatures $T_{wb}$ and $T_{db}$ are employed with psychrometric charts (Table D-1) to determine relative humidity, $RH$.

The atmospheric suction in the laboratory air is calculated using Kelvin's equation (Fredlund and Rahardjo 1993) [3]:

$$h = \left(RT/V\right)\ln\left(RH\right) \qquad \text{(D-1)}$$

where:

$h =$ total suction

$R =$ universal gas constant

$T =$ absolute temperature in $^{o}F$

$V =$ molecular volume of water

$RH =$ relative humidity

**Calculations**

The data required for the determination of the α coefficient are as follows:

- Atmospheric suction (measured using a sling psychrometer).
- Initial total suction in soil (measured from the filter paper test).
- Length of the soil specimen.
- Distance of each psychrometer from the closed end.
- Evaporation coefficient, $h_e = 0.54\ cm^{-1}$.
- Total suction measurements with time along the length of the soil specimen.

Interpretation of measured data follows a procedure outlined by Aubeny and Lytton (2003)[6]:

An initial estimate of α is made to compute the theoretical value of suction corresponding to each measurement location *x* and measurement time *t* using the expression developed by Mitchell (1979)[5]:

$$u = u_a + \sum_{n=1}^{\infty} \frac{2(u_0 - u_a)\sin z_n}{z_n + \sin z_n \cos z_n} \exp\left[\frac{z_n{}^2 \alpha t}{l^2}\right] \cos\left[\frac{z_n x}{l}\right] \qquad \text{(D-2)}$$

$$\cot z_n = z_n / h_e L \qquad \text{(D-3)}$$

where:

$u_a =$ atmospheric suction

$u_0 =$ initial suction in soil

$\alpha =$ diffusion coefficient

$t =$ time

$L =$ sample length

$x =$ psychrometer coordinate

$h_e =$ evaporation coefficient

The difference (E) between the theoretical value of suction ($u_{theory}$) predicted from Equation D-2 and suction measured by the psychrometer ($u_{measured}$) is computed.

$$E = u_{theory} - u_{measured} \tag{D-4}$$

The square of the errors $E_{sum}$ for all measurements are summed.

$$E_{sum} = E(u_{theory} - u_{measured})^2 \tag{D-5}$$

The α coefficient is optimized to minimize the $E_{sum}$ in the previous step. This can be done by employing a trial and error approach.

Hand calculation of Equation D-2 is not practical; hence the two Matlab programs (alphadrytest and drytest given in Appendix D-1) are used to calculate the soil diffusion coefficient.

### Reporting Test Results

The soil diffusion coefficient values are reported to the nearest seven decimal places in inch$^2$/sec (cm$^2$/sec).

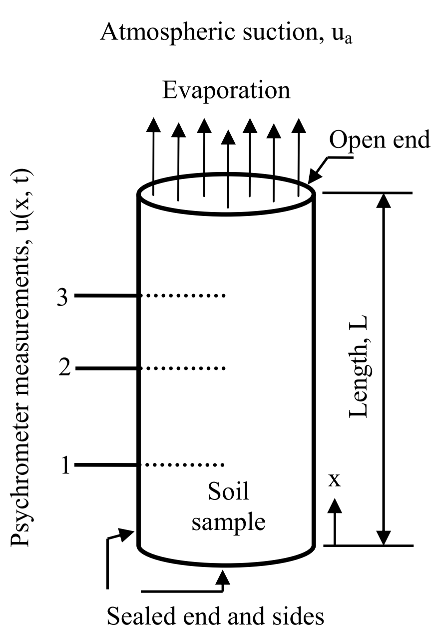



**Figure D-1. Cylindrical Soil Specimen.**

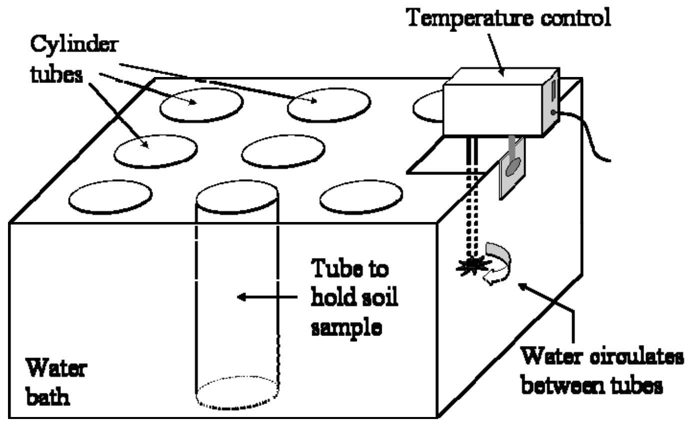



**Figure D-2. Water Bath.**

**Table D-1. Psychrometric Chart. (Source: Reynolds and Perkins, 1970 [7])**

| Air (dry Bulb Temperature) (°F) | Wet Bulb Depression (Dry Bulb Temperature minus Wet Bulb Temperature) (°F) | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 25 | 30 | 35 | 40 |
| 0 | 67 | 31 | 1 | | | | | | | | | | | | | | | | | | | | | |
| 5 | 73 | 46 | 20 | | | | | | | | | | | | | | | | | | | | | |
| 10 | 78 | 56 | 34 | 13 | | | | | | | | | | | | | | | | | | | | |
| 15 | 82 | 64 | 46 | 29 | 11 | | | | | | | | | | | | | | | | | | | |
| 20 | 85 | 70 | 55 | 40 | 26 | 12 | | | | | | | | | | | | | | | | | | |
| 25 | 87 | 74 | 62 | 49 | 37 | 25 | 13 | 1 | | | | | | | | | | | | | | | | |
| 30 | 89 | 78 | 67 | 56 | 46 | 36 | 26 | 16 | 6 | | | | | | | | | | | | | | | |
| 35 | 91 | 81 | 72 | 63 | 54 | 45 | 36 | 27 | 19 | 10 | 2 | | | | | | | | | | | | | |
| 40 | 92 | 83 | 75 | 68 | 60 | 52 | 45 | 37 | 29 | 22 | 15 | 7 | | | | | | | | | | | | |
| 45 | 93 | 86 | 78 | 71 | 64 | 57 | 51 | 44 | 38 | 31 | 25 | 18 | 12 | 6 | | | | | | | | | | |
| 50 | 93 | 87 | 80 | 71 | 67 | 61 | 55 | 49 | 43 | 38 | 32 | 27 | 21 | 16 | 10 | 5 | | | | | | | | |
| 55 | 94 | 88 | 82 | 76 | 70 | 65 | 59 | 54 | 49 | 43 | 38 | 33 | 28 | 23 | 19 | 14 | 9 | 5 | | | | | | |
| 60 | 94 | 89 | 83 | 78 | 73 | 68 | 63 | 58 | 53 | 48 | 43 | 39 | 34 | 30 | 26 | 21 | 17 | 13 | 9 | 5 | | | | |
| 65 | 95 | 90 | 85 | 80 | 75 | 70 | 66 | 61 | 56 | 52 | 48 | 44 | 39 | 35 | 31 | 27 | 24 | 20 | 16 | 12 | | | | |
| 70 | 95 | 90 | 86 | 81 | 77 | 72 | 68 | 64 | 59 | 55 | 51 | 48 | 44 | 40 | 36 | 33 | 29 | 25 | 22 | 19 | 3 | | | |
| 75 | 96 | 91 | 86 | 82 | 78 | 74 | 70 | 66 | 62 | 58 | 54 | 51 | 47 | 44 | 40 | 37 | 34 | 30 | 57 | 24 | 9 | | | |
| 80 | 96 | 91 | 87 | 83 | 79 | 75 | 72 | 68 | 64 | 61 | 57 | 54 | 50 | 47 | 44 | 41 | 38 | 35 | 32 | 29 | 15 | 3 | | |
| 85 | 96 | 92 | 88 | 84 | 80 | 76 | 73 | 69 | 66 | 62 | 59 | 56 | 52 | 49 | 46 | 43 | 41 | 38 | 35 | 32 | 20 | 8 | | |
| 90 | 96 | 92 | 89 | 85 | 81 | 78 | 74 | 71 | 68 | 65 | 61 | 58 | 55 | 52 | 49 | 47 | 44 | 41 | 39 | 36 | 24 | 13 | 3 | |
| 95 | 96 | 93 | 89 | 85 | 82 | 79 | 75 | 72 | 69 | 66 | 63 | 60 | 57 | 54 | 51 | 49 | 46 | 43 | 41 | 38 | 27 | 17 | 7 | 1 |
| 100 | 96 | 93 | 89 | 86 | 83 | 80 | 77 | 73 | 70 | 68 | 65 | 62 | 59 | 56 | 54 | 51 | 49 | 46 | 44 | 41 | 30 | 21 | 12 | 4 |
| 105 | 97 | 93 | 90 | 87 | 83 | 80 | 77 | 74 | 71 | 69 | 66 | 63 | 60 | 58 | 55 | 53 | 50 | 48 | 46 | 43 | 33 | 23 | 15 | 7 |
| 110 | 97 | 93 | 90 | 87 | 84 | 81 | 78 | 75 | 73 | 70 | 67 | 65 | 62 | 60 | 57 | 55 | 52 | 50 | 48 | 46 | 36 | 26 | 18 | 11 |
| 115 | 97 | 94 | 91 | 88 | 85 | 82 | 79 | 76 | 74 | 71 | 68 | 66 | 63 | 61 | 58 | 56 | 54 | 52 | 49 | 47 | 37 | 28 | 21 | 13 |
| 120 | 97 | 94 | 91 | 88 | 85 | 82 | 80 | 77 | 74 | 72 | 69 | 67 | 65 | 62 | 60 | 58 | 55 | 53 | 51 | 49 | 40 | 31 | 23 | 17 |

## Appendix D-1

The Matlab programs alphadrytest and drytest are enclosed.

**APPENDIX D-1**

**Alphadrytest**

The input variables for the program "alphadrytest" are outlined as:

alpha0 = Starting alpha in $cm^2$/min; typically 0.0001 can be used as the starting value.

alphaf = Final alpha in $cm^2$/min; typically 0.001 can be used as the final value.

NOTE: The starting and final alpha values may be changed depending on the output from the program.

nalpha = Number of alpha trials; typically a value of 11 is used.

he = 0.54 $cm^{-1}$; a constant evaporation coefficient.

ua = Atmospheric suction in pF.

u0 = Initial suction in pF.

x = Coordinate of the psychrometer in cm, from the closed end of the specimen.

L = Length of the specimen in cm.

tm = Suction measurement times in minutes.

um = Suction measurements in pF.

num = Number of suction measurements.

**The Matlab program "alphadrytest" is as follows:**

```
%program to estimate alpha from drying test
clear all

alpha0 = input('starting alpha    ');
alphaf = input('final alpha    ');
nalpha = input('number of alpha trials    ');
he     = input('he    ');
ua     = input('atmospheric suction, pF    ');
u0     = input('initial suction, pF    ');
x      = input('coordinate of psychrometer    ');
L      = input('length of specimen    ');
tm     = input('measurement times    ');
um     = input('suction measurements    ');
num    = input('number of measurements    ');
```

```
%evaluate zn
delta=.001*pi;
for n=1:20
  flag=0;
  zn=(n-1)*pi;
  for i=1:1000
    if(flag==0)
      zn=zn+delta;
      f=cot(zn)-zn/(he*L);
      if(f<0)
        fm1=cot(zn-delta)-(zn-delta)/(he*L);
        slope=(f-fm1)/delta;
        zn=zn-delta+fm1/slope;
        z(n)=zn;
        flag=1;
      end
    end
  end
end

%compute error as function of alpha
dalpha=(alphaf-alpha0)/(nalpha-1)
err(1:nalpha)=0
alpha=alpha0
for k=1:nalpha
    alph(k)=alpha;
  u=linspace(ua,ua,num);
  for n=1:20
    c1=z(n)*x/L;
    c2=(z(n))^2*tm*alpha/L^2;
    c3=2*(u0-ua)*sin(z(n))/(z(n)+sin(z(n))*cos(z(n)));
    du=c3*exp(-c2)*cos(c1);
    u=u+du;
  end
  errvector=um-u;
  err(k)=norm(errvector);
  alpha=alpha+dalpha;
end
```

```
alph=alph*1000
display(alph(1:nalpha)')
display(err(1:nalpha)')
```

**Drytest**

The input variables for the program “drytest” are outlined as:

alpha = Alpha value in $cm^2$/min as calculated by the program “alphadrytest.”

he = 0.54 $cm^{-1}$; a constant evaporation coefficient.

ua = Atmospheric suction in pF.

u0 = Initial suction in pF.

tstart = Start time in minutes; typically 100 min.

tstop = Stop time in minutes; typically 100,000 min.

num = Number of time increments per log cycle; typically 20.

x = Coordinate of the psychrometer in cm, from the closed end of the specimen.

L = Length of the specimen in cm.

**The Matlab program “drytest” is as follows:**

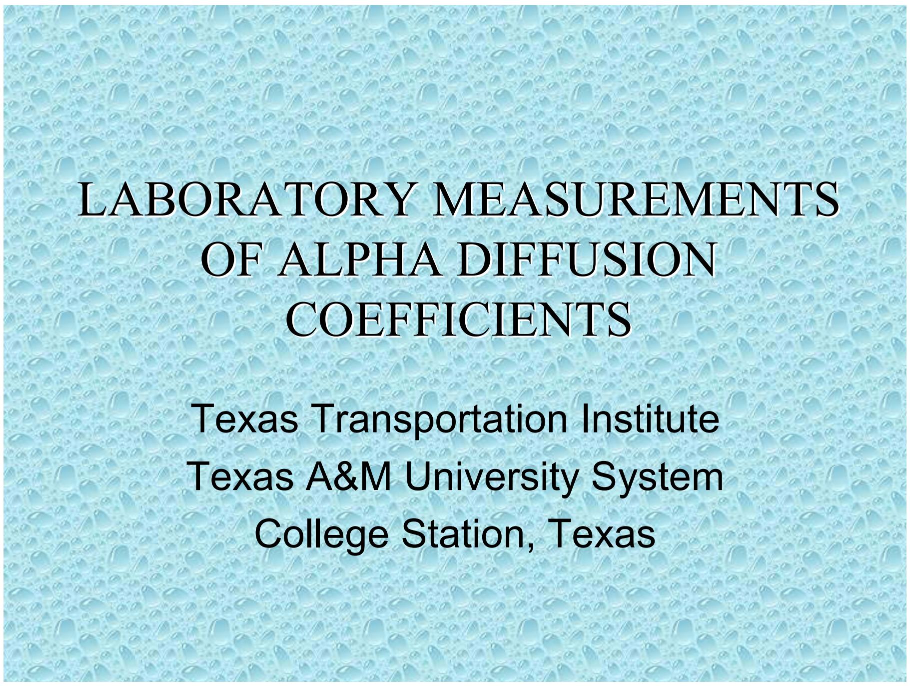
```
%program to plot theoretical curves for drying test
clear all

alpha=input('alpha    ');
he=input('he    ');
ua=input('atmospheric suction, pF    ');
u0=input('initial suction, pF    ');
tstart=input('start time    ');
tstop=input('end time    ');
num=input('number of time increments per log cycle   ');
x=input('coordinate of psychrometer   ');
L=input('length of specimen    ');

%select solution times
ncycle=log10(tstop/tstart);
num=num*ncycle+1;
logtstart=log10(tstart);
logtstop=log10(tstop);
```

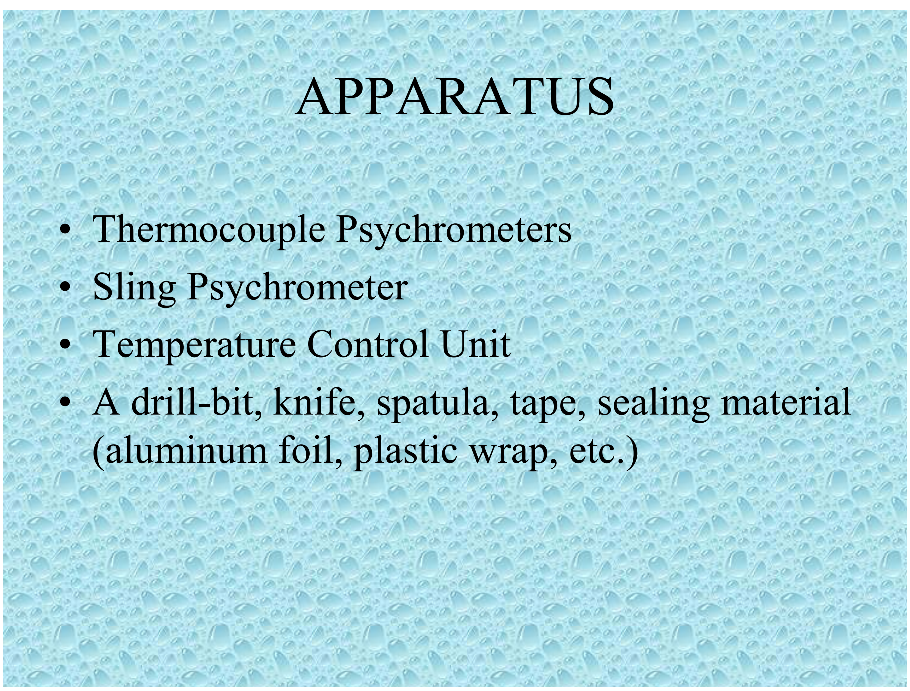
```
logt=linspace(logtstart,logtstop,num);
t=10.^logt;

%evaluate zn
delta=.001*pi;
for n=1:20
   flag=0;
   zn=(n-1)*pi;
   for i=1:1000
      if(flag==0)
         zn=zn+delta;
         f=cot(zn)-zn/(he*L);
         if(f<0)
            fm1=cot(zn-delta)-(zn-delta)/(he*L);
            slope=(f-fm1)/delta;
            zn=zn-delta+fm1/slope;
            z(n)=zn;
            flag=1;
         end
      end
   end
end
%solution for suction
u=linspace(ua,ua,num);
for n=1:20
   c1=z(n)*x/L;
   c2=(z(n))^2*t*alpha/L^2;
   c3=2*(u0-ua)*sin(z(n))/(z(n)+sin(z(n))*cos(z(n)));
   du=c3*exp(-c2)*cos(c1);
   u=u+du;
end
display(t(1:num)')
display(u(1:num)')
```

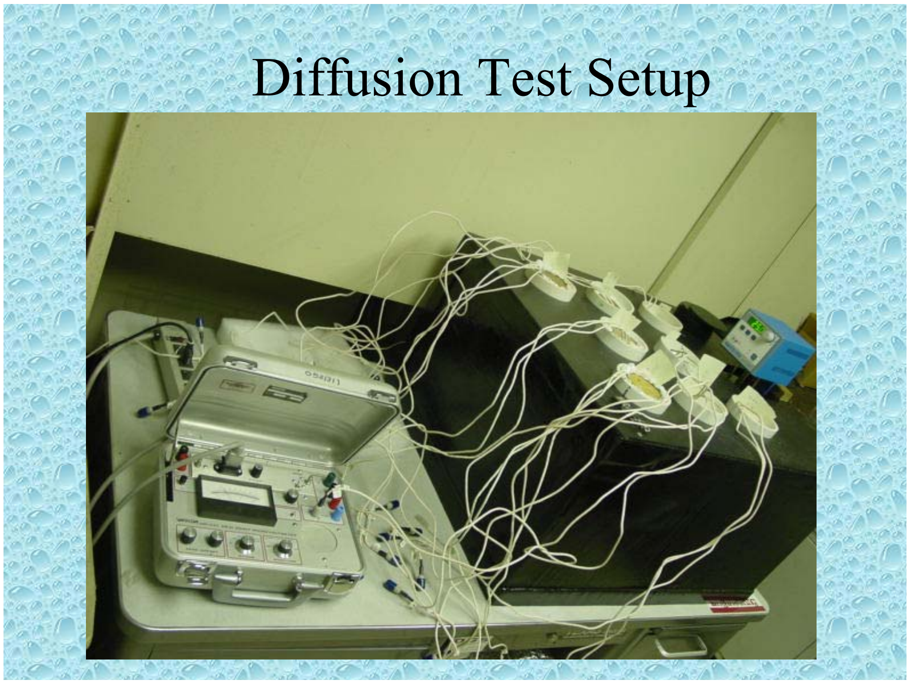
**APPENDIX D-2**

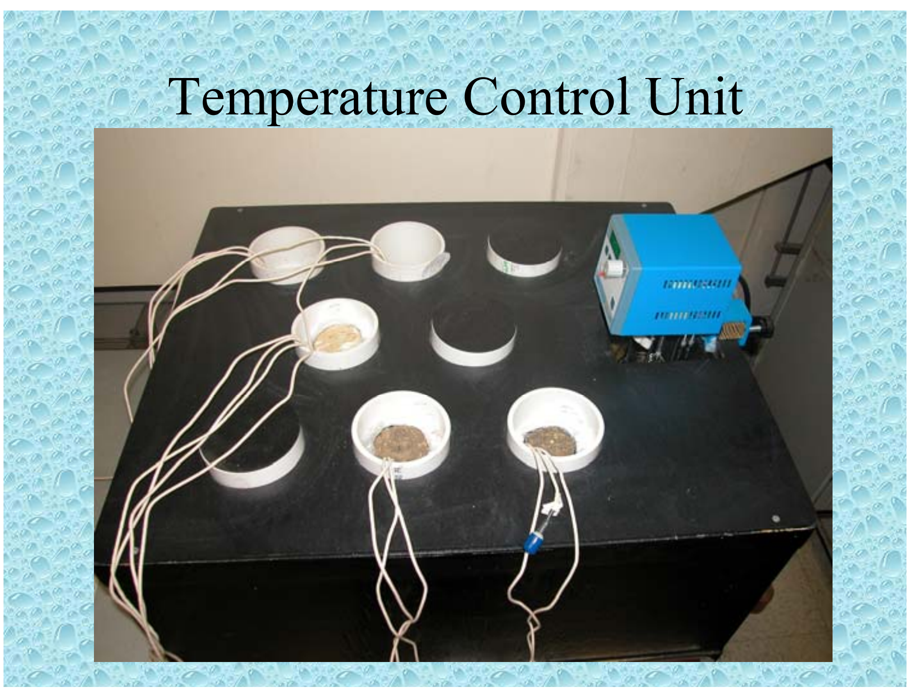
In this section, the laboratory soil diffusion coefficient measurements are illustrated in a Power Point presentation.

**The Power Point Presentation is given below**:



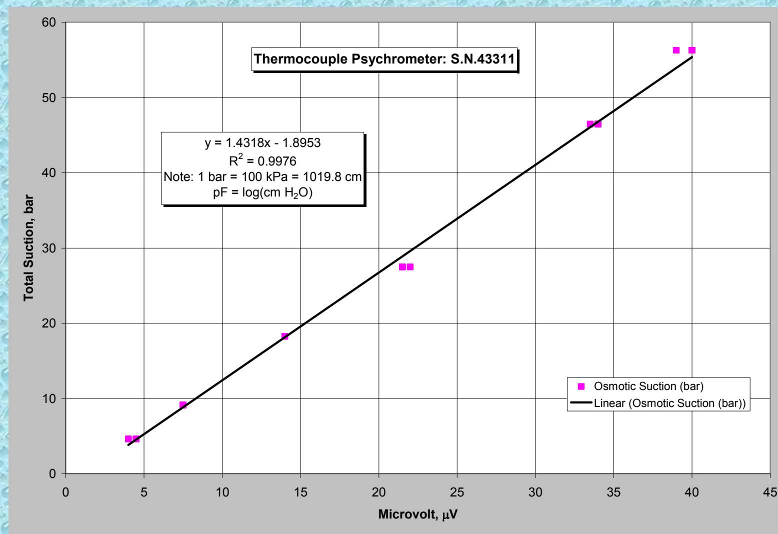

Diffusion Test Setup


Temperature Control Unit

# Thermocouple Psychrometer


# Psychrometer Calibration Salt Solutions

# Calibration Curve




# Wet Bulb Thermometer

# CR7 40-Channel Datalogger

# Shelby Tube Soil Sample

## Sample Preparation


## Sample Preparation

## Sample Preparation

## Sample Preparation

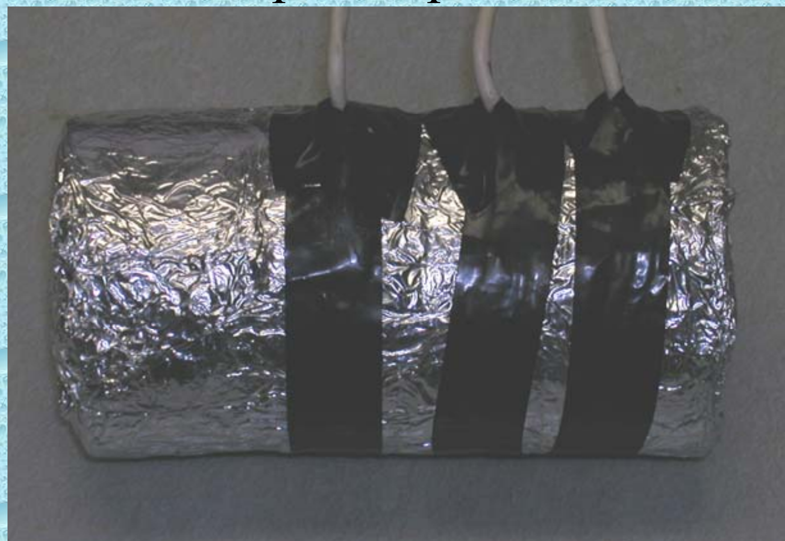
## Sample Preparation


## Psychrometer Installation

# Psychrometer Installation

# Sample Preparation

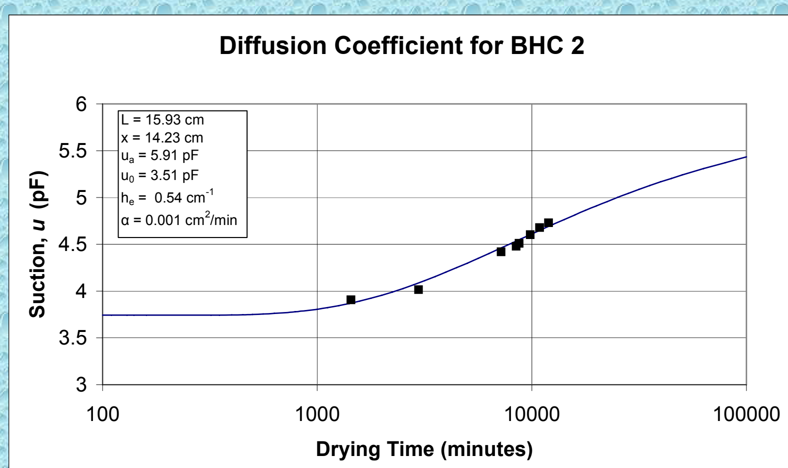
## Sample Preparation



## Sample Preparation

# Testing in Progress

# Diffusion Coefficient



# APPENDIX E
# INPUT DATA FOR ANALYSIS OF STUDY SECTIONS USING THE NEW METHOD

The input data required to use the program WinPRES for the six study sections are summarized in Tables E-1 through E-42. Figures E-1 through E-6 shows the typical dimension of road for each study section.

**Input Data for Section A, Fort Worth North Loop IH 820**

**Table E-1. Environmental and Geometry Conditions for Section A, Fort Worth North Loop IH 820.**

| | |
|---|---|
| TMI | -10.0 |
| Lateral Slope | Fill |
| Longitudinal Drainage | Slope |
| Root Zone | 0.0 (ft) |
| Depth of Moisture Active Zone, Zm | 15.0 (ft) |
| Equilibrium Suction | 2.58 (pF) |
| Note : water table is located at the depth of 17.0 ft (EL. 618) | |

**Table E-2. Soil Properties for Each Layer for Section A, Fort Worth North Loop IH 820.**

| Soil Type | Layer | Thickness (ft) | LL (%) | PI (%) | -#200 (%) | -2μm (%) | $\gamma_d$ (pcf) | |
|---|---|---|---|---|---|---|---|---|
| Natural Soil | 1 | 3.0 | 60.0 | 28.0 | 80.0 | 25.0 | 100.0 | |
| | 2 | 4.2 | 60.0 | 25.0 | 80.0 | 23.0 | 100.0 | |
| | 3 | 1.3 | 30.0 | 15.0 | 35.0 | 10.0 | 115.0 | |
| | 4 | 0.5 | 20.0 | 10.0 | 25.0 | 10.0 | 130.0 | |
| | 5 | 3.5 | 65.0 | 35.0 | 85.0 | 30.0 | 100.0 | |
| | 6 | 2.5 | 65.0 | 35.0 | 85.0 | 35.0 | 100.0 | |
| Inert Soil | | 1.5 | 25.0 | 10.0 | 10.0 | 1.0 | 130 | |
| | | | | | | | | % Lime |
| Stabilized Soil | | 1.5 | 60.0 | 28.0 | 80.0 | 25.0 | 120 | 8 |

**Table E-3. Vertical Moisture Barrier and Wheel Path for Section A, Fort Worth North Loop IH 820.**

| | |
|---|---|
| Depth of Vertical Moisture Barrier | 0 and 8 (ft) |
| Width of Pavement (5 lanes) | 83 (ft) |
| Number of Wheel Path | 1 |
| Distance from the Center of Pavement | 27 (ft) |

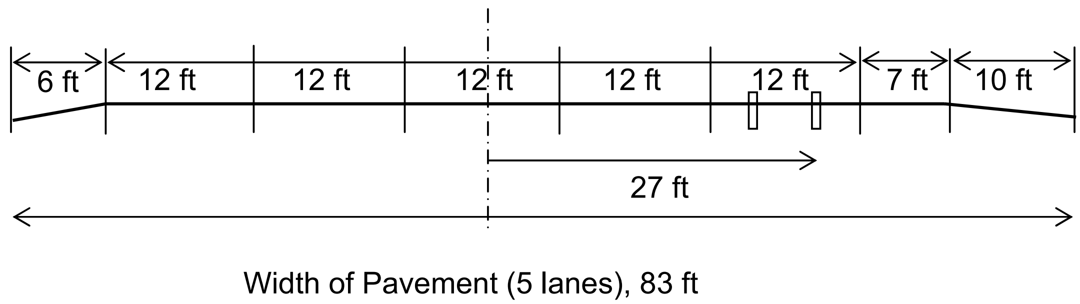



**Figure E-1. Dimension of Cross Section of the Pavement for Section A, Fort Worth North Loop IH 820.**

**Table E-4. Structural Properties of the Flexible Pavement for Section A, Fort Worth North Loop IH 820.**

| SN | FWD | SN = Structural Number, in |
|---|---|---|
| (inches) | (psi) | FWD = Falling Weight Deflectometer Modulus of |
| 4.00-5.28 | 10,000 | Subgrade Soil (from drop weight closest to 9k load, psi) |

**Table E-5. Structural Properties of the Rigid Pavement for Section A, Fort Worth North Loop IH 820.**

| D (inches) | fc (psi) | Sc (psi) | Cd | J | FWD (psi) | $P_t$ |
|---|---|---|---|---|---|---|
| 11.5-12.0 | 4,000 | 650 | 0.90 | 3.2 | 10,000 | 3.0 |

D = Thickness of Concrete Layer, in
fc = 28-day Compressive Strength of Concrete, psi, Ec = 57000 $(fc)^{0.5}$ , psi
Sc = Mean Modulus of Rupture of Concrete, psi
Cd = Drainage Coefficient
J = Load Transfer Coefficient
FWD=Falling Weight Deflectometer Modulus of Subgrade Soil (from drop weight closest to 9000 lb load, psi, k (pci) =$M_R$ / 19.4
Pt = Terminal Serviceability Index for the Concrete Pavement

**Table E-6. Traffic and Reliability Data for Section A, Fort Worth North Loop IH 820.**

| | |
|---|---|
| Traffic Analysis Period, C | 30 (yrs) |
| Average Daily Traffic of Outer Lane (T=0) | 13,712 |
| Average Daily Traffic of Outer Lane (T=C) | 21,744 |
| No of 18kip ESAL in the 30th years | 8,415,520 |
| Reliability for Traffic | 50, 90, and 95 (%) |
| Reliability for Soil | 50, 90, and 95 (%) |

**Table E-7. Initial and Terminal Serviceability Index and Roughness Data for Section A, Fort Worth North Loop IH 820.**

| | Flexible | | Rigid | |
|---|---|---|---|---|
| | Initial | Terminal | Initial | Terminal |
| SI | 4.2 | 2.5 | 4.5 | 3.0 |
| IRI (in/miles) | 75.2 | 166.2 | 65.4 | 131.7 |

IRI (inch/mile) = 63.36×8.4193×exp(-0.4664×SI)

**Input Data for Section B, Fort Worth North Loop IH 820**

**Table E-8. Environmental and Geometry Conditions for Section B, Fort Worth North Loop IH 820.**

| | |
|---|---|
| TMI | -10.0 |
| Lateral Slope | Fill |
| Longitudinal Drainage | Slope |
| Root Zone | 0.0 (ft) |
| Depth of Moisture Active Zone, Zm | 15.0 (ft) |
| Equilibrium Suction | 3.45 (pF) |

**Table E-9. Soil Properties for Each Layer for Section B, Fort Worth North Loop IH 820.**

| Soil Type | Layer | Thickness (ft) | LL (%) | PI (%) | -#200 (%) | -2μm (%) | $\gamma_d$ (pcf) | |
|---|---|---|---|---|---|---|---|---|
| Natural Soil | 1 | 3.5 | 60.0 | 36.0 | 85.0 | 30.0 | 100.0 | |
| | 2 | 1.5 | 55.0 | 30.0 | 80.0 | 25.0 | 105.0 | |
| | 3 | 4.0 | 65.0 | 38.0 | 85.0 | 30.0 | 100.0 | |
| | 4 | 0.5 | 30.0 | 15.0 | 35.0 | 10.0 | 115.0 | |
| | 5 | 1.5 | 53.0 | 32.0 | 80.0 | 25.0 | 100.0 | |
| | 6 | 4.0 | 45.0 | 15.0 | 99.4 | 37.0 | 100.0 | |
| Inert Soil | | 1.5 | 25.0 | 10.0 | 10.0 | 1.0 | 130 | |
| | | | | | | | | % Lime |
| Stabilized Soil | | 1.5 | 60.0 | 28.0 | 80.0 | 25.0 | 120 | 8 |

**Table E-10. Vertical Moisture Barrier and Wheel Path for Section B, Fort Worth North Loop IH 820.**

| | |
|---|---|
| Depth of Vertical Moisture Barrier | 0 and 8 (ft) |
| Width of Pavement (5 lanes) | 83 (ft) |
| Number of Wheel Path | 1 |
| Distance from the Center of Pavement | 27 (ft) |
| | |

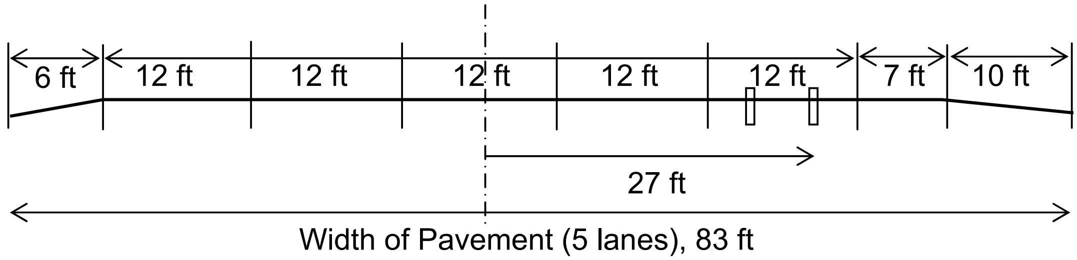



**Figure E-2. Dimension of Cross Section of the Pavement for Section B, Fort Worth North Loop IH 820.**

**Table E-11. Structural Properties of the Flexible Pavement for Section B, Fort Worth North Loop IH 820.**

| SN | FWD | SN = Structural Number, in |
|---|---|---|
| (inches) | (psi) | FWD = Falling Weight Deflectometer Modulus of |
| 4.40-5.72 | 10,000 | Subgrade Soil (from drop weight closest to 9k load, psi) |

**Table E-12. Structural Properties of the Rigid Pavement for Section B, Fort Worth North Loop IH 820.**

| D (inches) | fc (psi) | Sc (psi) | Cd | J | FWD (psi) | $P_t$ |
|---|---|---|---|---|---|---|
| 12.0-13.0 | 4,000 | 650 | 1.0 | 3.2 | 10,000 | 3 |

D = Thickness of Concrete Layer, in
fc = 28-day Compressive Strength of Concrete, psi, Ec = 57000 $(fc)^{0.5}$ , psi
Sc = Mean Modulus of Rupture of Concrete, psi
Cd = Drainage Coefficient
J = Load Transfer Coefficient
FWD=Falling Weight Deflectometer Modulus of Subgrade Soil (from drop weight closest to 9000 lb load, psi, k (pci) =$M_R$ / 19.4
Pt = Terminal Serviceability Index for the Concrete Pavement

**Table E-13. Traffic and Reliability Data for Section B, Fort Worth North Loop IH 820.**

| | |
|---|---|
| Traffic Analysis Period, C | 30 (yrs) |
| Average Daily Traffic of Outer Lane (T=0) | 13,712 |
| Average Daily Traffic of Outer Lane (T=C) | 21,744 |
| No of 18 kip ESAL in the 30th years | 8,415,520 |
| Reliability for Traffic | 50, 90, and 95 (%) |
| Reliability for Soil | 50, 90, and 95 (%) |

**Table E-14. Initial and Terminal Serviceability Index and Roughness Data for Section B, Fort Worth North Loop IH 820.**

| | Flexible | | Rigid | |
|---|---|---|---|---|
| | Initial | Terminal | Initial | Terminal |
| SI | 4.2 | 2.5 | 4.5 | 3.0 |
| IRI (in/miles) | 75.2 | 166.2 | 65.4 | 131.7 |

IRI (inch/mile) = 63.36×8.4193×exp(-0.4664×SI)

**Input Data for Section C, Fort Worth North Loop IH 820**

**Table E-15. Environmental and Geometry Conditions for Section C, Fort Worth North Loop IH 820.**

| | |
|---|---|
| TMI | -10.0 |
| Lateral Slope | Fill |
| Longitudinal Drainage | Slope |
| Root Zone | 0.0 (ft) |
| Depth of Moisture Active Zone, Zm | 15.0 (ft) |
| Equilibrium Suction | 3.42 (pF) |

**Table E-16. Soil Properties for Each Layer for Section C, Fort Worth North Loop IH 820.**

| Soil Type | Layer | Thickness (ft) | LL (%) | PI (%) | -#200 (%) | -2μm (%) | $\gamma_d$ (pcf) | |
|---|---|---|---|---|---|---|---|---|
| Natural Soil | 1 | 1.0 | 55.0 | 30.0 | 88.0 | 22.0 | 100.0 | |
| | 2 | 4.0 | 62.0 | 36.0 | 99.7 | 25.0 | 100.0 | |
| | 3 | 3.0 | 50.0 | 31.0 | 90.0 | 23.0 | 100.0 | |
| | 4 | 7.0 | 52.0 | 28.0 | 85.0 | 21.0 | 100.0 | |
| Inert Soil | | 1.5 | 25.0 | 10.0 | 10.0 | 1.0 | 130 | |
| | | | | | | | | % Lime |
| Stabilized Soil | | 1.5 | 60.0 | 28.0 | 80.0 | 25.0 | 120 | 8 |

**Table E-17. Vertical Moisture Barrier and Wheel Path for Section C, Fort Worth North Loop IH 820.**

| | |
|---|---|
| Depth of Vertical Moisture Barrier | 0 and 8 (ft) |
| Width of Pavement (5 lanes) | 83 (ft) |
| Number of Wheel Path | 1 |
| Distance from the Center of Pavement | 27 (ft) |
| | |

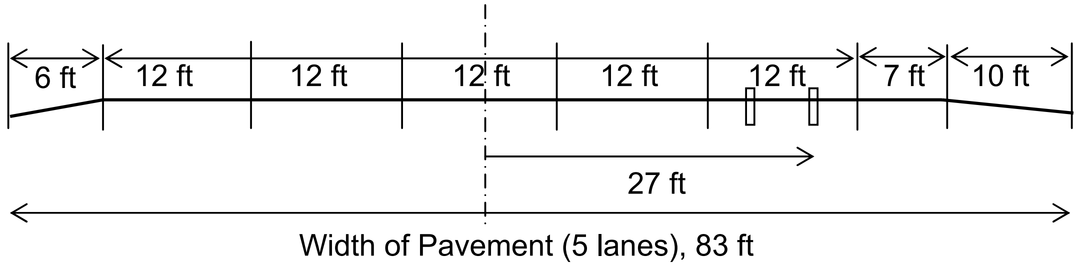



**Figure E-3. Dimension of Cross Section of the Pavement for Section C, Fort Worth North Loop IH 820.**

**Table E-18. Structural Properties of the Flexible Pavement for Section C, Fort Worth North Loop IH 820.**

| SN | FWD | SN = Structural Number, in<br>FWD = Falling Weight Deflectometer Modulus of Subgrade Soil (from drop weight closest to 9k load, psi) |
|---|---|---|
| (inches) | (psi) | |
| 4.40-5.94 | 10,000 | |

**Table E-19. Structural Properties of the Rigid Pavement for Section C, Fort Worth North Loop IH 820.**

| D (inches) | fc (psi) | Sc (psi) | Cd | J | FWD (psi) | $P_t$ |
|---|---|---|---|---|---|---|
| 12.0-13.0 | 4,000 | 650 | 1.0 | 3.2 | 10,000 | 3 |

D = Thickness of Concrete Layer, in
fc = 28-day Compressive Strength of Concrete, psi, Ec = 57000 $(fc)^{0.5}$ , psi
Sc = Mean Modulus of Rupture of Concrete, psi
Cd = Drainage Coefficient
J = Load Transfer Coefficient
FWD=Falling Weight Deflectometer Modulus of Subgrade Soil (from drop weight closest to 9000 lb load, psi, k (pci) =$M_R$ / 19.4
Pt = Terminal Serviceability Index for the Concrete Pavement

**Table E-20. Traffic and Reliability Data for Section C, Fort Worth North Loop IH 820.**

| | |
|---|---|
| Traffic Analysis Period, C | 30 (yrs) |
| Average Daily Traffic of Outer Lane (T=0) | 13,712 |
| Average Daily Traffic of Outer Lane (T=C) | 21,744 |
| No of 18 kip ESAL in the 30th years | 8,415,520 |
| Reliability for Traffic | 50, 90, and 95 (%) |
| Reliability for Soil | 50, 90, and 95 (%) |

**Table E-21. Initial and Terminal Serviceability Index and Roughness Data for Section C, Fort Worth North Loop IH 820.**

| | Flexible | | Rigid | |
|---|---|---|---|---|
| | Initial | Terminal | Initial | Terminal |
| SI | 4.2 | 2.5 | 4.5 | 3.0 |
| IRI (in/miles) | 75.2 | 166.2 | 65.4 | 131.7 |

IRI (inch/mile) = 63.36×8.4193×exp(-0.4664×SI)

**Input Data for the Atlanta US 271 Site**

**Table E-22. Environmental and Geometry Conditions for the Atlanta US 271 Site.**

| | |
|---|---|
| TMI | 30.0 |
| Lateral Slope | Flat |
| Longitudinal Drainage | Slope |
| Root Zone | 11.0 (ft) |
| Depth of Moisture Active Zone, Zm | 17.0 (ft) |
| Equilibrium Suction | 3.09 (pF) |

**Table E-23. Soil Properties for Each Layer for the Atlanta US 271 Site.**

| Soil Type | Layer | Thickness (ft) | LL (%) | PI (%) | -#200 (%) | -2μm (%) | $\gamma_d$ (pcf) | |
|---|---|---|---|---|---|---|---|---|
| Natural Soil | 1 | 5.0 | 48.0 | 26.0 | 90.0 | 14.0 | 100.0 | |
| | 2 | 3.0 | 37.0 | 17.0 | 92.0 | 8.7 | 100.0 | |
| | 3 | 4.0 | 40.0 | 25.0 | 93.4 | 8.6 | 100.0 | |
| | 4 | 5.0 | 37.0 | 15.0 | 93.3 | 7.7 | 100.0 | |
| Inert Soil | | 1.5 | 25.0 | 10.0 | 10.0 | 1.0 | 130 | |
| | | | | | | | | % Lime |
| Stabilized Soil | | 1.5 | 60.0 | 28.0 | 80.0 | 25.0 | 120 | 8 |

**Table E-24. Vertical Moisture Barrier and Wheel Path for the Atlanta US 271 Site.**

| | |
|---|---|
| Depth of Vertical Moisture Barrier | 0 and 8 (ft) |
| Width of Pavement (5 lanes) | 44 (ft) |
| Number of Wheel Path | 1 |
| Distance from the Center of Pavement | 9.0 (ft) |

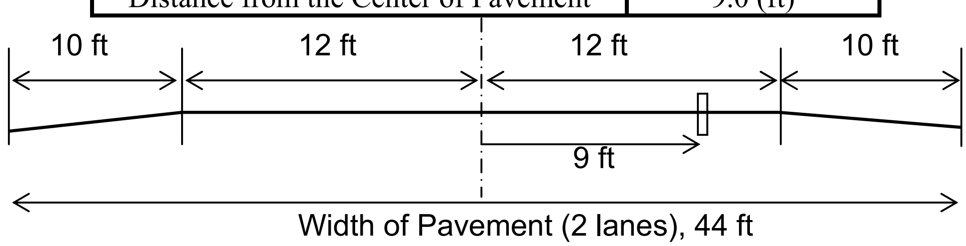



**Figure E-4. Dimension of Cross Section of the Pavement for the Atlanta US 271 Site.**

**Table E-25. Structural Properties of the Flexible Pavement for the Atlanta US 271 Site.**

| SN | FWD | SN = Structural Number, in |
|---|---|---|
| (inches) | (psi) | FWD = Falling Weight Deflectometer Modulus of |
| 3.72-5.06 | 10,000 | Subgrade Soil (from drop weight closest to 9k load, psi) |

**Table E-26. Structural Properties of the Rigid Pavement for the Atlanta US 271 Site.**

| D (inches) | fc (psi) | Sc (psi) | Cd | J | FWD (psi) | $P_t$ |
|---|---|---|---|---|---|---|
| 10.5-12.0 | 4,000 | 650 | 1.0 | 3.2 | 10,000 | 3 |

D = Thickness of Concrete Layer, in
fc = 28-day Compressive Strength of Concrete, psi, Ec = 57000 $(fc)^{0.5}$ , psi
Sc = Mean Modulus of Rupture of Concrete, psi
Cd = Drainage Coefficient
J = Load Transfer Coefficient
FWD=Falling Weight Deflectometer Modulus of Subgrade Soil (from drop weight closest to 9000 lb load, psi, k (pci) =$M_R$ / 19.4
Pt = Terminal Serviceability Index for the Concrete Pavement

**Table E-27. Traffic and Reliability Data for the Atlanta US 271 Site.**

| | |
|---|---|
| Traffic Analysis Period, C | 30 (yrs) |
| Average Daily Traffic in one Direction T=0 | 10,000 |
| Average Daily Traffic in one Direction T=C | 20,000 |
| No of 18 kip ESAL in the 30th year | 2,500,000 |
| Reliability for Traffic | 50, 90, and 95 (%) |
| Reliability for Soil | 50, 90, and 95 (%) |

**Table E-28. Initial and Terminal Serviceability Index and Roughness Data for the Atlanta US 271 Site.**

| | Flexible | | Rigid | |
|---|---|---|---|---|
| | Initial | Terminal | Initial | Terminal |
| SI | 4.2 | 2.5 | 4.5 | 3.0 |
| IRI (in/miles) | 75.2 | 166.2 | 65.4 | 131.7 |

IRI (inch/mile) = 63.36×8.4193×exp(-0.4664×SI)

**Input Data for Austin Loop 1 Site (Main Lane)**

**Table E-29. Environmental and Geometry Conditions for the Austin Loop 1 Site (Main Lane).**

| | |
|---|---|
| TMI | -15.0 |
| Lateral Slope | Fill |
| Longitudinal Drainage | Slope |
| Root Zone | 0.0 (ft) |
| Depth of Moisture Active Zone, Zm | 14.0 (ft) |
| Equilibrium Suction | 3.45 (pF) |

**Table E-30. Soil Properties for Each Layer for the Austin Loop 1 Site (Main Lane).**

| Soil Type | Layer | Thickness (ft) | LL (%) | PI (%) | -#200 (%) | -2μm (%) | $\gamma_d$ (pcf) | |
|---|---|---|---|---|---|---|---|---|
| Natural Soil | 1 | 5.0 | 49.0 | 29.0 | 84.9 | 42.0 | 100.0 | |
| | 2 | 3.0 | 68.0 | 33.0 | 91.8 | 30.0 | 100.0 | |
| | 3 | 6.0 | 68.0 | 35.0 | 90.6 | 18.0 | 105.0 | |
| Inert Soil | | 1.5 | 25.0 | 10.0 | 10.0 | 1.0 | 130 | |
| | | | | | | | | % Lime |
| Stabilized Soil | | 1.5 | 60.0 | 28.0 | 80.0 | 25.0 | 120 | 8 |

**Table E-31. Vertical Moisture Barrier and Wheel Path for the Austin Loop 1 Site (Main Lane).**

| | |
|---|---|
| Depth of Vertical Moisture Barrier | 0 and 8 (ft) |
| Width of Pavement (4 lanes) | 62 (ft) |
| Number of Wheel Path | 1 |
| Distance from the Center of Pavement | 21 (ft) |

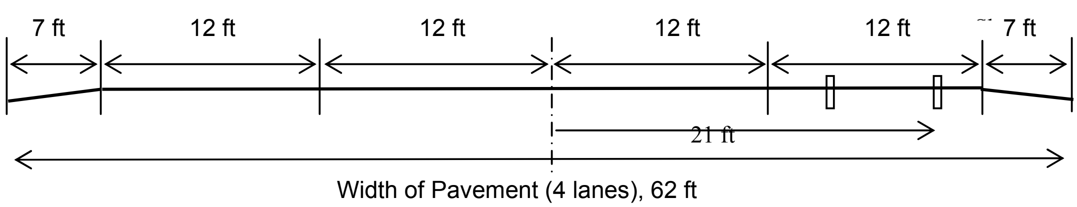



**Figure E-5. Dimension of Cross Section of the Pavement for the Austin Loop 1 Site (Main Lane).**

**Table E-32. Structural Properties of the Flexible Pavement for the Austin Loop 1 Site (Main Lane).**

| SN (inches) | FWD (psi) | SN = Structural Number, in<br>FWD = Falling Weight Deflectometer Modulus of Subgrade Soil (from drop weight closest to 9k load, psi) |
|---|---|---|
| 4.66-5.72 | 10,000 | |

**Table E-33. Structural Properties of the Rigid Pavement for the Austin Loop 1 Site (Main Lane).**

| D (inches) | fc (psi) | Sc (psi) | Cd | J | FWD (psi) | $P_t$ |
|---|---|---|---|---|---|---|
| 12.0-13.2 | 4,000 | 650 | 1.0 | 3.2 | 10,000 | 3 |

D = Thickness of Concrete Layer, in
fc = 28-day Compressive Strength of Concrete, psi, $Ec = 57000\ (fc)^{0.5}$ , psi
Sc = Mean Modulus of Rupture of Concrete, psi
Cd = Drainage Coefficient
J = Load Transfer Coefficient
FWD=Falling Weight Deflectometer Modulus of Subgrade Soil (from drop weight closest to 9000 lb load, psi, k (pci) $= M_R / 19.4$
Pt = Terminal Serviceability Index for the Concrete Pavement

**Table E-34. Traffic and Reliability Data for the Austin Loop 1 Site (Main Lane).**

| | |
|---|---|
| Traffic Analysis Period, C | 30 (yrs) |
| Average Daily Traffic of Outer Lane (T=0) | 16,283 |
| Average Daily Traffic of Outer Lane (T=C) | 25,821 |
| No of 18 kip ESAL in the 30th year | 9,993,430 |
| Reliability for Traffic | 50, 90, and 95 (%) |
| Reliability for Soil | 50, 90, and 95 (%) |

**Table E-35. Initial and Terminal Serviceability Index and Roughness Data for the Austin Loop 1 Site (Main Lane).**

| | Flexible | | Rigid | |
|---|---|---|---|---|
| | Initial | Terminal | Initial | Terminal |
| SI | 4.2 | 2.5 | 4.5 | 3.0 |
| IRI (in/miles) | 75.2 | 166.2 | 65.4 | 131.7 |

IRI (inch/mile) = $63.36 \times 8.4193 \times \exp(-0.4664 \times SI)$

**Input Data for the Austin Loop 1 Site (Frontage Road)**

**Table E-36. Environmental and Geometry Conditions for the Austin Loop 1 Site (Frontage Road).**

| | |
|---|---|
| TMI | -15.0 |
| Lateral Slope | Fill |
| Longitudinal Drainage | Slope |
| Root Zone | 0.0 (ft) |
| Depth of Moisture Active Zone, Zm | 14.0 (ft) |
| Equilibrium Suction | 3.45 (pF) |

**Table E-37. Soil Properties for Each Layer for the Austin Loop 1 Site (Frontage Road).**

| Soil Type | Layer | Thickness (ft) | LL (%) | PI (%) | -#200 (%) | -2μm (%) | $\gamma_d$ (pcf) | |
|---|---|---|---|---|---|---|---|---|
| Natural Soil | 1 | 5.0 | 49.0 | 29.0 | 84.9 | 42.0 | 100.0 | |
| | 2 | 3.0 | 68.0 | 33.0 | 91.8 | 30.0 | 100.0 | |
| | 3 | 6.0 | 68.0 | 35.0 | 90.6 | 18.0 | 105.0 | |
| Inert Soil | | 1.5 | 25.0 | 10.0 | 10.0 | 1.0 | 130 | |
| | | | | | | | | % Lime |
| Stabilized Soil | | 1.5 | 60.0 | 28.0 | 80.0 | 25.0 | 120 | 8 |

**Table E-38. Vertical Moisture Barrier and Wheel Path for the Austin Loop 1 Site (Frontage Road).**

| | |
|---|---|
| Depth of Vertical Moisture Barrier | 0 and 8 (ft) |
| Width of Pavement (3 lanes) | 50 (ft) |
| Number of Wheel Path | 1 |
| Distance from the Center of Pavement | 15 (ft) |

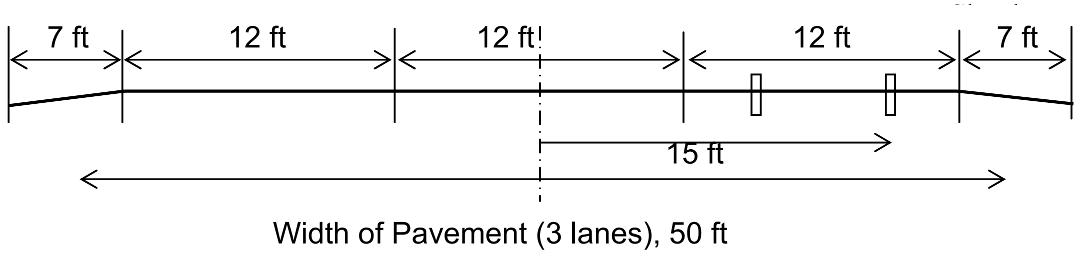



**Figure E-6. Dimension of Cross Section of the Pavement for the Austin Loop 1 Site (Frontage Road).**

**Table E-39. Structural Properties of the Flexible Pavement for the Austin Loop 1 Site (Frontage Road).**

| SN (inches) | FWD (psi) | |
|---|---|---|
| 3.74-5.06 | 10,000 | SN = Structural Number, in<br>FWD = Falling Weight Deflectometer Modulus of Subgrade Soil (from drop weight closest to 9k load, psi) |

**Table E-40. Structural Properties of the Rigid Pavement for the Austin Loop 1 Site (Frontage Road).**

| D (inches) | fc (psi) | Sc (psi) | Cd | J | FWD (psi) | $P_t$ |
|---|---|---|---|---|---|---|
| 11.0-12.0 | 4,000 | 650 | 0.90 | 3.2 | 10,000 | 3 |

D = Thickness of Concrete Layer, in
fc = 28-day Compressive Strength of Concrete, psi, Ec = 57000 $(fc)^{0.5}$ , psi
Sc = Mean Modulus of Rupture of Concrete, psi
Cd = Drainage Coefficient
J = Load Transfer Coefficient
FWD=Falling Weight Deflectometer Modulus of Subgrade Soil (from drop weight closest to 9000 lb load, psi, k (pci) =$M_R$ / 19.4
Pt = Terminal Serviceability Index for the Concrete Pavement

**Table E-41. Traffic and Reliability Data for the Austin Loop 1 Site (Frontage Road).**

| | |
|---|---|
| Traffic Analysis Period, C | 30 (yrs) |
| Average Daily Traffic of Outer Lane (T=0) | 4,028 |
| Average Daily Traffic of Outer Lane (T=C) | 6,837 |
| No of 18 kip ESAL in the 30th year | 2,472,059 |
| Reliability for Traffic | 50, 90, and 95 (%) |
| Reliability for Soil | 50, 90, and 95 (%) |

**Table E-42. Initial and Terminal Serviceability Index and Roughness Data for the Austin Loop 1 Site (Frontage Road).**

| | Flexible | | Rigid | |
|---|---|---|---|---|
| | Initial | Terminal | Initial | Terminal |
| SI | 4.2 | 2.5 | 4.5 | 3.0 |
| IRI (in/miles) | 75.2 | 166.2 | 65.4 | 131.7 |

IRI (inch/mile) = 63.36×8.4193×exp(-0.4664×SI)

## OUTPUT DATA FOR ANALYSIS OF SIX STUDY SECTIONS USING THE NEW METHOD

The results of analysis of the six study sections are presented in Tables E-43 to E-60.

### Output Data for Section A, Fort Worth North Loop IH 820

**Table E-43. Results of Analysis of Section A with Reliability of 50 % for the Flexible Pavement.**

| Case | Barrier (ft) | ACP (in) | Stab. Soil (ft) | Inert Soil (ft) | SN (in) | Movement(in) at the Edge | | | Movement (in) at the Outer Wheel Path | SI | | IRI (in/mile) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Swelling | Shrinkage | Total | | After 20yrs | After 30yrs | After 20yrs | After 30yrs |
| 1 | 8.00 | 4.00 | - | - | 4.00 | 0.07 | 1.39 | 1.46 | 0.56 | 2.10 | 1.99 | 201 | 213 |
| 2 | - | 4.00 | 1.8 | - | 4.14 | 0.04 | 1.22 | 1.26 | 0.50 | 2.86 | 2.62 | 141 | 157 |
| 3 | - | 4.00 | 2.0 | - | 4.40 | 0.02 | 1.21 | 1.24 | 0.49 | 3.32 | 3.05 | 114 | 126 |

**Table E-44. Results of Analysis of Section A with Reliability of 90 % for the Flexible Pavement.**

| Case | Barrier (ft) | ACP (in) | Stab. Soil (ft) | Inert Soil (ft) | SN (in) | Movement(in) at the Edge | | | Movement (in) at the Outer Wheel Path | SI | | IRI (in/mile) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Swelling | Shrinkage | Total | | After 20yrs | After 30yrs | After 20yrs | After 30yrs |
| 1 | - | 4.00 | 2.5 | - | 5.06 | 0.02 | 1.16 | 1.19 | 0.45 | 2.91 | 2.67 | 137 | 153 |
| 2 | - | 4.00 | 2.5 | 1.5 | 5.06 | 0.01 | 1.04 | 1.07 | 0.40 | 3.03 | 2.78 | 130 | 146 |
| 3 | - | 4.50 | 2.5 | 1.5 | 5.28 | 0.01 | 1.04 | 1.07 | 0.40 | 3.30 | 3.03 | 114 | 129 |

**Table E-45. Results of Analysis of Section A with Reliability of 95 % for the Rigid Pavement.**

| Case | Barrier (ft) | D (in) | Stab. Soil (ft) | Inert Soil (ft) | | Movement(in) at the Edge | | | Movement (in) at the Outer Wheel Path | SI | | IRI (in/miles) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Swelling | Shrinkage | Total | | After 20yrs | After 30yrs | After 20yrs | After 30yrs |
| 1 | - | 11.50 | 0.67 | - | | 0.05 | 1.33 | 1.38 | 0.57 | 2.39 | 2.20 | 137 | 154 |
| 2 | - | 12.00 | - | - | | 0.07 | 1.39 | 1.46 | 0.61 | 3.30 | 3.02 | 103 | 118 |
| 3 | - | 12.00 | 0.67 | - | | 0.05 | 1.33 | 1.38 | 0.57 | 3.39 | 3.09 | 100 | 115 |
| 4 | | 12.00 | 1.00 | - | | 0.05 | 1.30 | 1.34 | 0.55 | 3.43 | 3.14 | 98 | 113 |

## Output Data for Section B, Fort Worth North Loop IH 820

### Table E-46. Results of Analysis of Section B with Reliability of 50 % for the Flexible Pavement.

| Case | Barrier (ft) | ACP (in) | Stab. Soil (ft) | Inert Soil (ft) | SN (in) | Movement(in) at the Edge | | | Movement (in) at the Outer Wheel Path | SI | | IRI (in/mile) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Swelling | Shrinkage | Total | | After 20yrs | After 30yrs | After 20yrs | After 30yrs |
| 1 | - | 4.00 | 2.0 | - | 4.40 | 1.51 | 1.10 | 2.63 | 1.05 | 2.05 | 1.93 | 207 | 217 |
| 2 | - | 4.00 | 2.0 | 1.5 | 4.40 | 1.08 | 0.82 | 1.90 | 0.80 | 2.85 | 2.61 | 142 | 158 |
| 3 | - | 4.00 | 2.2 | - | 4.66 | 1.43 | 1.07 | 2.50 | 1.00 | 3.01 | 2.76 | 132 | 147 |
| 4 | - | 4.00 | 2.5 | - | 5.06 | 1.22 | 1.02 | 2.24 | 0.90 | 3.55 | 3.29 | 102 | 115 |

### Table E-47. Results of Analysis of Section B with Reliability of 90 % for the Flexible Pavement.

| Case | Barrier (ft) | ACP (in) | Stab. Soil (ft) | Inert Soil (ft) | SN (in) | Movement(in) at the Edge | | | Movement (in) at the Outer Wheel Path | SI | | IRI (in/mile) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Swelling | Shrinkage | Total | | After 20yrs | After 30yrs | After 20yrs | After 30yrs |
| 1 | - | 4.00 | 2.5 | 2.5 | 5.06 | 0.72 | 0.66 | 1.37 | 0.59 | 2.48 | 2.29 | 167 | 182 |
| 2 | - | 4.50 | 2.5 | 1.5 | 5.28 | 0.90 | 0.77 | 1.67 | 0.70 | 2.65 | 2.43 | 154 | 170 |
| 3 | - | 5.00 | 2.5 | 1.5 | 5.50 | 0.90 | 0.77 | 1.67 | 0.70 | 3.06 | 2.80 | 128 | 144 |
| 4 | - | 4.00 | 3.0 | 1.5 | 5.72 | 0.61 | 0.67 | 1.28 | 0.53 | 3.52 | 3.26 | 103 | 117 |

### Table E-48. Results of Analysis of Section B with Reliability of 95 % for the Rigid Pavement.

| Case | Barrier (ft) | D (in) | Stab. Soil (ft) | Inert Soil (ft) | | Movement(in) at the Edge | | | Movement (in) at the Outer Wheel Path | SI | | IRI (in/miles) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Swelling | Shrinkage | Total | | After 20yrs | After 30yrs | After 20yrs | After 30yrs |
| 1 | - | 12.60 | - | - | | 3.19 | 1.49 | 4.68 | 1.80 | 2.13 | 2.00 | 135 | 151 |
| 2 | - | 12.00 | 0.67 | - | | 2.36 | 1.36 | 3.72 | 1.48 | 2.41 | 2.22 | 125 | 142 |
| 3 | - | 12.00 | 1.00 | - | | 2.08 | 1.26 | 3.35 | 1.33 | 1.33 | 2.77 | 108 | 124 |
| 4 | | 13.00 | - | - | | 3.19 | 1.49 | 4.68 | 1.80 | 1.80 | 2.91 | 106 | 119 |

## Output Data for Section C, Fort Worth North Loop IH 820

### Table E-49. Results of Analysis of Section C with Reliability of 50 % for the Flexible Pavement.

| Case | Barrier (ft) | ACP (in) | Stab. Soil (ft) | Inert Soil (ft) | SN (in) | Movement(in) at the Edge | | | Movement (in) at the Outer Wheel Path | SI | | IRI (in/mile) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Swelling | Shrinkage | Total | | After 20yrs | After 30yrs | After 20yrs | After 30yrs |
| 1 | - | 4.00 | 2.0 | - | 4.40 | 1.37 | 1.01 | 2.38 | 0.97 | 2.40 | 2.22 | 175 | 189 |
| 2 | - | 4.00 | 2.0 | 1.0 | 4.40 | 1.20 | 0.84 | 2.03 | 0.84 | 2.77 | 2.54 | 147 | 163 |
| 3 | - | 4.00 | 2.2 | - | 4.66 | 1.27 | 0.97 | 2.24 | 0.92 | 3.14 | 2.88 | 124 | 140 |
| 4 | - | 4.00 | 2.5 | - | 5.06 | 1.12 | 0.91 | 2.03 | 0.83 | 3.60 | 3.35 | 172 | 187 |

### Table E-50. Results of Analysis of Section C with Reliability of 90 % for the Flexible Pavement.

| Case | Barrier (ft) | ACP (in) | Stab. Soil (ft) | Inert Soil (ft) | SN (in) | Movement(in) at the Edge | | | Movement (in) at the Outer Wheel Path | SI | | IRI (in/mile) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Swelling | Shrinkage | Total | | After 20yrs | After 30yrs | After 20yrs | After 30yrs |
| 1 | - | 4.00 | 2.5 | 1.5 | 5.06 | 0.78 | 0.66 | 1.44 | 0.60 | 2.41 | 2.23 | 172 | 187 |
| 2 | - | 4.50 | 2.5 | 1.0 | 5.28 | 0.96 | 0.74 | 1.70 | 0.70 | 2.65 | 2.44 | 154 | 170 |
| 3 | - | 4.50 | 2.5 | 1.5 | 5.28 | 0.78 | 0.66 | 1.44 | 0.60 | 2.93 | 2.68 | 136 | 152 |
| 4 | - | 4.00 | 3.0 | - | 5.72 | 0.89 | 0.82 | 1.70 | 0.69 | 3.33 | 3.07 | 113 | 127 |
| 5 | - | 4.50 | 3.0 | - | 5.94 | 0.89 | 0.82 | 1.70 | 0.69 | 3.51 | 3.51 | 104 | 117 |



### Table E-51. Results of Analysis of Section C with Reliability of 95 % for the Rigid Pavement.

| Case | Barrier (ft) | D (in) | Stab. Soil (ft) | Inert Soil (ft) | | Movement(in) at the Edge | | | Movement (in) at the Outer Wheel Path | SI | | IRI (in/miles) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Swelling | Shrinkage | Total | | After 20yrs | After 30yrs | After 20yrs | After 30yrs |
| 1 | - | 12.00 | 1.0 | - | | 1.90 | 1.21 | 3.10 | 1.29 | 2.46 | 2.27 | 129 | 145 |
| 2 | - | 12.50 | - | - | | 2.58 | 1.33 | 3.91 | 1.62 | 2.75 | 2.52 | 115 | 132 |
| 3 | - | 12.00 | 1.50 | - | | 1.62 | 1.10 | 2.72 | 1.13 | 2.99 | 2.74 | 113 | 128 |
| 4 | 8.0 | 12.50 | - | - | | 2.58 | 1.33 | 3.91 | 1.42 | 3.35 | 3.06 | 98 | 112 |
| 5 | | 13.00 | - | - | | 2.58 | 1.33 | 3.91 | 1.62 | 3.65 | 3.35 | 89 | 120 |

## Output Data for the Atlanta US 271 Site

### Table E-52. Results of Analysis of the Atlanta US 271 Site with Reliability of 50 % for the Flexible Pavement.

| Case | Barrier (ft) | ACP (in) | Stab. Soil (ft) | Inert Soil (ft) | SN (in) | Movement(in) at the Edge | | | Movement (in) at the Outer Wheel Path | SI | | IRI (in/mile) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Swelling | Shrinkage | Total | | After 20yrs | After 30yrs | After 20yrs | After 30yrs |
| 1 | - | 4.00 | - | - | 4.00 | 0.58 | 1.03 | 1.61 | 1.26 | 2.81 | 2.58 | 145 | 161 |
| 2 | 8.0 | 4.00 | - | - | 4.00 | 0.58 | 1.03 | 1.61 | 1.04 | 3.18 | 2.92 | 122 | 137 |
| 3 | - | 4.00 | 2.0 | - | 4.00 | 0.32 | 0.97 | 1.30 | 1.04 | 3.22 | 2.95 | 120 | 135 |

### Table E-53. Results of Analysis of the Atlanta US 271 Site with Reliability of 90 % for the Flexible Pavement.

| Case | Barrier (ft) | ACP (in) | Stab. Soil (ft) | Inert Soil (ft) | SN (in) | Movement(in) at the Edge | | | Movement (in) at the Outer Wheel Path | SI | | IRI (in/mile) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Swelling | Shrinkage | Total | | After 20yrs | After 30yrs | After 20yrs | After 30yrs |
| 1 | - | 4.50 | 2.0 | - | 4.62 | 0.32 | 0.97 | 1.30 | 1.04 | 2.39 | 2.22 | 174 | 188 |
| 2 | - | 4.00 | 2.2 | - | 4.66 | 0.30 | 0.97 | 1.27 | 1.02 | 2.61 | 2.40 | 157 | 173 |
| 3 | - | 4.50 | 2.0 | 1.5 | 4.62 | 0.23 | 0.85 | 1.08 | 0.88 | 0.88 | 2.93 | 136 | 152 |
| 4 | - | 4.50 | 2.2 | - | 4.88 | 0.30 | 0.97 | 1.27 | 1.02 | 1.02 | 3.08 | 127 | 143 |
| 5 | - | 4.00 | 1.5 | - | 5.06 | 0.28 | 0.96 | 1.24 | 1.00 | 1.00 | 3.35 | 112 | 127 |



### Table E-54. Results of Analysis of the Atlanta US 271 Site with Reliability of 95 % for the Rigid Pavement.

| Case | Barrier (ft) | D (in) | Stab. Soil (ft) | Inert Soil (ft) | | Movement(in) at the Edge | | | Movement (in) at the Outer Wheel Path | SI | | IRI (in/miles) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Swelling | Shrinkage | Total | | After 20yrs | After 30yrs | After 20yrs | After 30yrs |
| 1 | - | 10.50 | - | - | | 0.58 | 1.03 | 1.61 | 1.26 | 2.56 | 2.35 | 127 | 145 |
| 2 | - | 11.00 | - | - | | 0.58 | 1.03 | 1.61 | 1.26 | 3.63 | 3.33 | 92 | 107 |
| 3 | - | 12.00 | - | - | | 0.58 | 1.03 | 1.61 | 1.26 | 4.22 | 4.01 | 74 | 81 |

## Output Data for the Austin Loop 1 Site (Main Lane)

**Table E-55. Results of Analysis of the Austin Loop 1 Site (Main Lane) with Reliability of 50 % for the Flexible Pavement.**

| Case | Barrier (ft) | ACP (in) | Stab. Soil (ft) | Inert Soil (ft) | SN (in) | Movement(in) at the Edge | | | Movement (in) at the Outer Wheel Path | SI | | IRI (in/mile) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Swelling | Shrinkage | Total | | After 20yrs | After 30yrs | After 20yrs | After 30yrs |
| 1 | - | 4.00 | 2.2 | 1.0 | 4.66 | 0.85 | 0.62 | 1.48 | 0.99 | 2.72 | 2.50 | 151 | 166 |
| 2 | - | 4.00 | 2.2 | 1.5 | 4.66 | 0.73 | 0.56 | 1.31 | 0.89 | 2.93 | 2.68 | 137 | 153 |
| 3 | - | 4.00 | 2.5 | - | 5.06 | 0.86 | 0.70 | 1.56 | 1.01 | 3.32 | 3.06 | 114 | 129 |

**Table E-56. Results of Analysis of the Austin Loop 1 Site (Main Lane) with Reliability of 90 % for the Flexible Pavement.**

| Case | Barrier (ft) | ACP (in) | Stab. Soil (ft) | Inert Soil (ft) | SN (in) | Movement(in) at the Edge | | | Movement (in) at the Outer Wheel Path | SI | | IRI (in/mile) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Swelling | Shrinkage | Total | | After 20yrs | After 30yrs | After 20yrs | After 30yrs |
| 1 | - | 4.50 | 2.8 | - | 5.68 | 0.78 | 0.66 | 1.44 | 0.93 | 2.48 | 2.29 | 167 | 182 |
| 2 | - | 4.00 | 2.8 | 1.5 | 5.46 | 0.55 | 0.50 | 1.06 | 0.70 | 2.74 | 2.51 | 149 | 164 |
| 3 | - | 4.00 | 3.0 | - | 5.72 | 0.70 | 0.64 | 1.33 | 0.85 | 2.83 | 2.59 | 143 | 158 |
| 4 | - | 4.00 | 3.0 | 1.5 | 5.72 | 0.50 | 0.48 | 0.98 | 0.65 | 3.25 | 2.98 | 118 | 133 |

**Table E-57. Results of Analysis of the Austin Loop 1 Site (Main Lane) with Reliability of 95 % for the Rigid Pavement.**

| Case | Barrier (ft) | D (in) | Stab. Soil (ft) | Inert Soil (ft) | | Movement(in) at the Edge | | | Movement (in) at the Outer Wheel Path | SI | | IRI (in/mile) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Swelling | Shrinkage | Total | | After 20yrs | After 30yrs | After 20yrs | After 30yrs |
| 1 | - | 13.20 | - | - | | 2.03 | 1.00 | 3.01 | 2.10 | 3.25 | 2.98 | 121 | 138 |
| 2 | 13.0 | 12.00 | - | - | | 2.03 | 1.00 | 3.01 | 1.19 | 2.46 | 2.27 | 121 | 138 |
| 3 | - | 12.00 | 2.0 | - | | 1.03 | 0.76 | 1.79 | 1.19 | 2.61 | 2.39 | 122 | 138 |
| 4 | - | 12.00 | 1.5 | 1.5 | | 0.98 | 0.65 | 1.63 | 1.15 | 2.81 | 2.57 | 116 | 132 |
| 5 | 10.0 | 12.50 | - | - | | 2.03 | 1.00 | 3.01 | 1.47 | 2.93 | 2.67 | 111 | 127 |
| 6 | - | 12.00 | 2.0 | 1.5 | | 0.82 | 0.59 | 1.40 | 0.96 | 3.33 | 3.04 | 100 | 115 |

## Output Data for the Austin Loop 1 Site (Frontage Road)

### Table E-58. Results of Analysis of the Austin Loop 1 Site (Frontage Road) with Reliability of 50 % for the Flexible Pavement.

| Case | Barrier (ft) | ACP (in) | Stab. Soil (ft) | Inert Soil (ft) | SN (in) | Movement(in) at the Edge | | | Movement (in) at the Outer Wheel Path | SI | | IRI (in/mile) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Swelling | Shrinkage | Total | | After 20yrs | After 30yrs | After 20yrs | After 30yrs |
| 1 | - | 4.00 | 1.5 | - | 3.74 | 2.03 | 1.00 | 3.01 | 1.80 | 2.55 | 2.35 | 166 | 181 |
| 2 | 8.0 | 4.00 | - | - | 4.00 | 1.12 | 0.78 | 1.88 | 1.39 | 3.44 | 3.17 | 108 | 122 |
| 3 | - | 4.00 | 1.8 | - | 4.14 | 1.21 | 0.82 | 2.03 | 1.51 | 2.36 | 2.19 | 179 | 193 |
| 4 | - | 4.00 | 1.5 | 1.5 | 3.74 | 0.98 | 0.65 | 1.63 | 1.24 | 3.02 | 2.77 | 131 | 147 |

### Table E-59. Results of Analysis of the Austin Loop 1 Site (Frontage Road) with Reliability of 90 % for the Flexible Pavement.

| Case | Barrier (ft) | ACP (in) | Stab. Soil (ft) | Inert Soil (ft) | SN (in) | Movement(in) at the Edge | | | Movement (in) at the Outer Wheel Path | SI | | IRI (in/mile) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Swelling | Shrinkage | Total | | After 20yrs | After 30yrs | After 20yrs | After 30yrs |
| 1 | - | 4.00 | 2.0 | 2.5 | 4.40 | 0.61 | 0.49 | 1.10 | 0.83 | 2.63 | 2.42 | 156 | 171 |
| 2 | - | 4.00 | 2.2 | 1.5 | 4.66 | 0.73 | 0.56 | 1.31 | 0.96 | 2.90 | 2.65 | 138 | 154 |
| 3 | - | 4.00 | 2.5 | - | 5.06 | 0.86 | 0.70 | 3.01 | 1.11 | 3.23 | 2.97 | 119 | 134 |

### Table E-60. Results of Analysis of the Austin Loop 1 Site (Frontage Road) with Reliability of 95 % for the Rigid Pavement.

| Case | Barrier (ft) | D (in) | Stab. Soil (ft) | Inert Soil (ft) | | Movement(in) at the Edge | | | Movement (in) at the Outer Wheel Path | SI | | IRI (in/mile) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Swelling | Shrinkage | Total | | After 20yrs | After 30yrs | After 20yrs | After 30yrs |
| 1 | - | 11.00 | - | - | | 2.03 | 1.00 | 3.01 | 2.28 | 3.54 | 3.25 | 92 | 105 |
| 2 | - | 11.50 | - | - | | 2.03 | 1.00 | 3.01 | 2.28 | 4.01 | 3.75 | 78 | 88 |
| 3 | - | 12.00 | - | - | | 2.03 | 1.00 | 3.01 | 2.28 | 4.22 | 4.02 | 73 | 80 |

## RESULTS OF ANALYSIS FOR SIX STUDY SECTIONS USING PVR METHOD (TEX-124-E)

The results of calculations using the Tex-124-E method for several cases on the six study sections are presented in Tables E-61 through E-94.

### Analysis of the Case with No Surcharge and No Treatment

**Table E-61. Calculations with No Surcharge and No Treatment for Section A, Fort Worth North Loop IH 820.**

| Depth (ft.) | Avg. Load (psi) | LL (%) | Dry 0.2LL+9 (%) | Wet 0.47LL+2 (%) | Moisture (%) | Dry/ Avg/Wet | No. 40 (%) | PI (%) | Volume Swell (%) | Free Swell (%) | PVR, Top of Layer (in) | PVR, Bottom of Layer (in) | Diff. (in) | Mod.- No.40 Factor | Mod. Density Factor | PVR in Layer (in.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0-2.0 | 1 | 60 | 22.2 | 30.2 | 25.4 | dry | 100 | 28 | 7.5 | 10.6 | 0.00 | 0.62 | 0.62 | 1 | 1 | 0.62 |
| 2.0-4.0 | 3 | 60 | 22.2 | 30.2 | 25.4 | dry | 100 | 28 | 7.5 | 10.6 | 0.62 | 1.15 | 0.53 | 1 | 1 | 0.53 |
| 4.0-6.0 | 5 | 60 | 22.2 | 30.2 | 25.4 | dry | 100 | 25 | 6.5 | 9.6 | 1.06 | 1.45 | 0.39 | 1 | 1 | 0.39 |
| 6.0-8.0 | 7 | 60 | 22.2 | 30.2 | 27.0 | wet | 100 | 25 | 6.5 | 9.6 | 1.45 | 1.55 | 0.1 | 1 | 1 | 0.10 |
| 8.0-10.0 | 9 | 60 | 22.2 | 30.2 | 23.8 | dry | 100 | 25 | 6.5 | 9.6 | 1.55 | 1.72 | 0.17 | 1 | 1 | 0.17 |
| 10.0-12.0 | 11 | 65 | 23.3 | 32.55 | 23.8 | dry | 100 | 35 | 10 | 13.3 | 2.90 | 3.00 | 0.1 | 1 | 1 | 0.10 |
| 12.0-14.0 | 13 | 65 | 23.3 | 32.55 | 24.8 | dry | 100 | 35 | 10 | 13.3 | 3.00 | 3.20 | 0.2 | 1 | 1 | 0.20 |
| 14.0-16.0 | 15 | 65 | 23.3 | 32.55 | 24.8 | dry | 100 | 35 | 10 | 13.3 | 3.20 | 3.31 | 0.11 | 1 | 1 | 0.11 |
| NOTE: no surcharge and no treatment on subgrade soil | | | | | | | | | | | | | | Total PVR (in) = | | 2.22 |

## Table E-62. Calculations with No Surcharge and No Treatment for Section B, Fort Worth North Loop IH 820.

| Depth (ft.) | Avg. Load (psi) | LL (%) | Dry 0.2LL+9 (%) | Wet 0.47LL+2 (%) | Moisture (%) | Dry/ Avg/Wet | No. 40 (%) | PI (%) | Volume Swell (%) | Free Swell (%) | PVR, Top of Layer (in) | PVR, Bottom of Layer (in) | Diff. (in) | Mod.-No.40 Factor | Mod. Density Factor | PVR in Layer (in.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0-2.0 | 1.00 | 60 | 22.2 | 30.2 | 12.8 | dry | 100 | 36 | 10.5 | 13.8 | 0.00 | 0.62 | 0.62 | 1 | 1 | 0.62 |
| 2.0-4.0 | 3.00 | 55 | 21.1 | 27.85 | 20.2 | dry | 100 | 30 | 8.4 | 11.6 | 0.60 | 1.28 | 0.68 | 1 | 1 | 0.68 |
| 4.0-6.0 | 5.00 | 55 | 21.1 | 27.85 | 11.35 | dry | 100 | 30 | 8.4 | 11.6 | 1.28 | 1.75 | 0.47 | 1 | 1 | 0.47 |
| 6.0-8.0 | 7.00 | 65 | 23.3 | 32.55 | 11.35 | dry | 100 | 38 | 11.1 | 14.5 | 2.22 | 2.70 | 0.48 | 1 | 1 | 0.48 |
| 8.0-10.0 | 9.00 | 65 | 23.3 | 32.55 | 18.41 | dry | 100 | 38 | 11.1 | 14.5 | 2.70 | 3.08 | 0.38 | 1 | 1 | 0.38 |
| 10.0-12.0 | 11.00 | 53 | 20.66 | 26.91 | 18.41 | dry | 100 | 32 | 9.0 | 12.2 | 2.38 | 2.69 | 0.31 | 1 | 1 | 0.31 |
| 12.0-14.0 | 13.00 | 45 | 18.9 | 23.15 | 18.41 | dry | 100 | 25 | 6.5 | 9.6 | 1.80 | 1.90 | 0.1 | 1 | 1 | 0.1 |
| 14.0-16.0 | 15.00 | 45 | 18.9 | 23.15 | 24.9 | dry | 100 | 15 | 3.0 | 5.8 | 0.58 | 0.61 | 0.03 | 1 | 1 | 0.03 |
| NOTE: no surcharge and no treatment on subgrade soil | | | | | | | | | | | | | | Total PVR (in) = | | 3.07 |



## Table E-63. Calculations with No Surcharge and No Treatment for Section C, Fort Worth North Loop IH 820.

| Depth (ft.) | Avg. Load (psi) | LL (%) | Dry 0.2LL+9 (%) | Wet 0.47LL+2 (%) | Moisture (%) | Dry/ Avg/Wet | No. 40 (%) | PI (%) | Volume Swell (%) | Free Swell (%) | PVR, Top of Layer (in) | PVR, Bottom of Layer (in) | Diff. (in) | Mod.-No.40 Factor | Mod. Density Factor | PVR in Layer (in.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0-2.0 | 1.00 | 55 | 21.1 | 27.85 | 22.8 | dry | 100 | 30 | 8.3 | 11.5 | 0.00 | 0.61 | 0.61 | 1 | 1 | 0.61 |
| 2.0-4.0 | 3.00 | 62 | 22.64 | 31.14 | 22.8 | dry | 100 | 36 | 10.5 | 13.8 | 0.60 | 1.41 | 0.81 | 1 | 1 | 0.81 |
| 4.0-6.0 | 5.00 | 62 | 22.64 | 31.14 | 25.0 | dry | 100 | 36 | 10.5 | 13.8 | 1.41 | 2.08 | 0.67 | 1 | 1 | 0.67 |
| 6.0-8.0 | 7.00 | 50 | 20 | 25.5 | 24.8 | wet | 100 | 31 | 4.0 | 6.9 | 0.72 | 0.82 | 0.1 | 1 | 1 | 0.1 |
| 8.0-10.0 | 9.00 | 50 | 20 | 25.5 | 25.2 | wet | 100 | 31 | 4 | 6.9 | 0.82 | 0.91 | 0.09 | 1 | 1 | 0.09 |
| 10.0-12.0 | 11.00 | 52 | 20.44 | 26.44 | 25.2 | wet | 100 | 28 | 3.5 | 6.3 | 0.72 | 0.78 | 0.06 | 1 | 1 | 0.06 |
| 12.0-14.0 | 13.00 | 52 | 20.44 | 26.44 | 25.2 | wet | 100 | 28 | 3.5 | 6.3 | 0.78 | 0.8 | 0.02 | 1 | 1 | 0.02 |
| 14.0-16.0 | 15.00 | 52 | 20.44 | 26.44 | 25.2 | wet | 100 | 28 | 3.5 | 6.3 | 0.8 | 0.8 | 0 | 1 | 1 | 0 |
| NOTE: no surcharge and no treatment on subgrade soil | | | | | | | | | | | | | | Total PVR (in) = | | 2.36 |

## Table E-64. Calculations with No Surcharge and No Treatment for the Atlanta US 271 Site.

| Depth (ft.) | Avg. Load (psi) | LL (%) | Dry 0.2LL+9 (%) | Wet 0.47LL+2 (%) | Moisture (%) | Dry/ Avg/Wet | No. 40 (%) | PI (%) | Volume Swell (%) | Free Swell (%) | PVR, Top of Layer (in) | PVR, Bottom of Layer (in) | Diff. (in) | Mod.- No.40 Factor | Mod. Density Factor | PVR in Layer (in.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0-2.0 | 1.00 | 48 | 19.56 | 24.56 | 16.1 | dry | 100 | 26 | 6.8 | 9.9 | 0.00 | 0.58 | 0.58 | 1 | 1 | 0.58 |
| 2.0-4.0 | 3.00 | 48 | 19.56 | 24.56 | 16.1 | dry | 100 | 26 | 6.8 | 9.9 | 0.58 | 1.10 | 0.52 | 1 | 1 | 0.52 |
| 4.0-6.0 | 5.00 | 37 | 17.14 | 19.39 | 17 | dry | 100 | 17 | 3.5 | 6.3 | 0.50 | 0.65 | 0.15 | 1 | 1 | 0.15 |
| 6.0-8.0 | 7.00 | 37 | 17.14 | 19.39 | 17 | dry | 100 | 17 | 3.5 | 6.3 | 0.65 | 0.72 | 0.07 | 1 | 1 | 0.07 |
| 8.0-10.0 | 9.00 | 40 | 17.8 | 20.8 | 16.7 | dry | 100 | 25 | 6.5 | 9.6 | 1.60 | 1.75 | 0.15 | 1 | 1 | 0.15 |
| 10.0-12.0 | 11.00 | 40 | 17.8 | 20.8 | 16.7 | dry | 100 | 25 | 6.5 | 9.6 | 1.75 | 1.82 | 0.07 | 1 | 1 | 0.07 |
| 12.0-14.0 | 13.00 | 37 | 17.14 | 19.39 | 15.8 | dry | 100 | 15 | 2.8 | 5.6 | 0.51 | 0.56 | 0.05 | 1 | 1 | 0.05 |
| 14.0-16.0 | 15.00 | 37 | 17.14 | 19.39 | 15.8 | dry | 100 | 15 | 2.8 | 5.6 | 0.56 | 0.58 | 0.02 | 1 | 1 | 0.02 |
| 16.0-18.0 | 17.00 | 37 | 17.14 | 19.39 | 15.8 | dry | 100 | 15 | 2.8 | 5.6 | 0.58 | 0.59 | 0.01 | 1 | 1 | 0.01 |
| NOTE: no surcharge and no treatment on subgrade soil | | | | | | | | | | | | | | Total PVR (in) = | | 1.62 |

## Table E-65. Calculations with No Surcharge and No Treatment for the Austin Loop 1 Site.

| Depth (ft.) | Avg. Load (psi) | LL (%) | Dry 0.2LL+9 (%) | Wet 0.47LL+2 (%) | Moisture (%) | Dry/ Avg/Wet | No. 40 (%) | PI (%) | Volume Swell (%) | Free Swell (%) | PVR, Top of Layer (in) | PVR, Bottom of Layer (in) | Diff. (in) | Mod.- No.40 Factor | Mod. Density Factor | PVR in Layer (in.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0-2.0 | 1.00 | 49 | 19.78 | 25.03 | 19.03 | dry | 100 | 29 | 8.0 | 11.2 | 0.00 | 0.60 | 0.6 | 1 | 1 | 0.6 |
| 2.0-4.0 | 3.00 | 49 | 19.78 | 25.03 | 19.03 | dry | 100 | 29 | 8.0 | 11.2 | 0.60 | 1.14 | 0.54 | 1 | 1 | 0.54 |
| 4.0-6.0 | 5.00 | 68 | 23.96 | 33.96 | 23.11 | dry | 100 | 33 | 9.4 | 12.7 | 1.35 | 1.94 | 0.59 | 1 | 1 | 0.59 |
| 6.0-8.0 | 7.00 | 68 | 23.96 | 33.96 | 23.11 | dry | 100 | 33 | 9.4 | 12.7 | 1.94 | 2.30 | 0.36 | 1 | 1 | 0.36 |
| 8.0-10.0 | 9.00 | 68 | 23.96 | 33.96 | 23.00 | dry | 100 | 33 | 9.4 | 12.7 | 2.30 | 2.58 | 0.28 | 1 | 1 | 0.28 |
| 10.0-12.0 | 11.00 | 68 | 23.96 | 33.96 | 23.00 | dry | 100 | 35 | 10.5 | 13.8 | 2.85 | 3.12 | 0.27 | 1 | 1 | 0.27 |
| 12.0-14.0 | 13.00 | 68 | 23.96 | 33.96 | 24.09 | dry | 100 | 35 | 10.5 | 13.8 | 3.12 | 3.30 | 0.18 | 1 | 1 | 0.18 |
| 14.0-16.0 | 15.00 | 68 | 23.96 | 33.96 | 24.09 | dry | 100 | 35 | 10.5 | 13.8 | 3.30 | 3.45 | 0.15 | 1 | 1 | 0.15 |
| NOTE: no surcharge and no treatment on subgrade, assume the same soil profile for a Main Lanes and a Frontage Road | | | | | | | | | | | | | | Total PVR (in) = | | 2.97 |

## Analysis of the Case with the Surcharge of 1 psi and No Treatment

### Table E-66. Calculations with the Surcharge of 1 psi and No Treatment for Section A, Fort Worth North Loop IH 820.

| Depth (ft.) | Avg. Load (psi) | LL (%) | Dry 0.2LL+9 (%) | Wet 0.47LL+2 (%) | Moisture (%) | Dry/ Avg/Wet | No. 40 (%) | PI (%) | Volume Swell (%) | Free swell (%) | PVR, Top of Layer (in) | PVR, Bottom of Layer (in) | Diff. (in) | Mod.- No.40 factor | Mod. Density factor | PVR in Layer (in.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0-2.0 | 2 | 60 | 22.2 | 30.2 | 25.4 | dry | 100 | 28 | 7.5 | 10.6 | 0.60 | 0.95 | 0.35 | 1 | 1 | 0.35 |
| 2.0-4.0 | 4 | 60 | 22.2 | 30.2 | 25.4 | dry | 100 | 28 | 7.5 | 10.6 | 0.95 | 1.40 | 0.45 | 1 | 1 | 0.45 |
| 4.0-6.0 | 6 | 60 | 22.2 | 30.2 | 25.4 | dry | 100 | 25 | 6.5 | 9.6 | 1.25 | 1.50 | 0.25 | 1 | 1 | 0.25 |
| 6.0-8.0 | 8 | 60 | 22.2 | 30.2 | 27 | wet | 100 | 25 | 6.5 | 9.6 | 1.50 | 1.68 | 0.18 | 1 | 1 | 0.18 |
| 8.0-10.0 | 10 | 60 | 22.2 | 30.2 | 23.8 | dry | 100 | 25 | 6.5 | 9.6 | 1.68 | 1.80 | 0.12 | 1 | 1 | 0.12 |
| 10.0-12.0 | 12 | 65 | 23.3 | 32.55 | 23.8 | dry | 100 | 35 | 10 | 13.3 | 2.90 | 3.12 | 0.22 | 1 | 1 | 0.22 |
| 12.0-14.0 | 14 | 65 | 23.3 | 32.55 | 24.8 | dry | 100 | 35 | 10 | 13.3 | 3.12 | 3.29 | 0.17 | 1 | 1 | 0.17 |
| 14.0-16.0 | 16 | 65 | 23.3 | 32.55 | 24.8 | dry | 100 | 35 | 10 | 13.3 | 3.29 | 3.42 | 0.13 | 1 | 1 | 0.13 |
| NOTE: assume a surcharge load of 1 psi beneath pavement within a pavement, no treatment on sugrade soil | | | | | | | | | | | | | | Total PVR (in) = | | 1.87 |



### Table E-67. Calculations with the Surcharge of 1 psi and No Treatment for Section B, Fort Worth North Loop IH 820.

| Depth (ft.) | Avg. Load (psi) | LL (%) | Dry 0.2LL+9 (%) | Wet 0.47LL+2 (%) | Moisture (%) | Dry/ Avg/Wet | No. 40 (%) | PI (%) | Volume Swell (%) | Free swell (%) | PVR, Top of Layer (in) | PVR, Bottom of Layer (in) | Diff. (in) | Mod.- No.40 factor | Mod. Density factor | PVR in Layer (in.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0-2.0 | 2 | 60 | 22.2 | 30.2 | 12.8 | dry | 100 | 36 | 10.5 | 13.8 | 0.60 | 1.00 | 0.4 | 1 | 1 | 0.4 |
| 2.0-4.0 | 4 | 55 | 21.1 | 27.85 | 20.2 | dry | 100 | 30 | 8.4 | 11.6 | 0.98 | 1.55 | 0.57 | 1 | 1 | 0.57 |
| 4.0-6.0 | 6 | 55 | 21.1 | 27.85 | 11.35 | dry | 100 | 30 | 8.4 | 11.6 | 1.55 | 1.91 | 0.36 | 1 | 1 | 0.36 |
| 6.0-8.0 | 8 | 65 | 23.3 | 32.55 | 11.35 | dry | 100 | 38 | 11.1 | 14.5 | 2.45 | 2.90 | 0.45 | 1 | 1 | 0.45 |
| 8.0-10.0 | 10 | 65 | 23.3 | 32.55 | 18.41 | dry | 100 | 38 | 11.1 | 14.5 | 2.90 | 3.24 | 0.34 | 1 | 1 | 0.34 |
| 10.0-12.0 | 12 | 53 | 20.66 | 26.91 | 18.41 | dry | 100 | 32 | 9.0 | 12.2 | 2.61 | 2.80 | 0.19 | 1 | 1 | 0.19 |
| 12.0-14.0 | 14 | 45 | 18.9 | 23.15 | 18.41 | dry | 100 | 25 | 6.5 | 9.6 | 1.85 | 1.92 | 0.07 | 1 | 1 | 0.07 |
| 14.0-16.0 | 16 | 45 | 18.9 | 23.15 | 24.9 | dry | 100 | 15 | 3.0 | 5.8 | 0.61 | 0.62 | 0.01 | 1 | 1 | 0.01 |
| NOTE: assume a surcharge load of 1 psi beneath pavement within a pavement, no treatment on sugrade soil | | | | | | | | | | | | | | Total PVR (in) = | | 2.39 |

## Table E-68. Calculations with the Surcharge of 1 psi and No Treatment for Section C, Fort Worth North Loop IH 820.

| Depth (ft.) | Avg. Load (psi) | LL (%) | Dry 0.2LL+9 (%) | Wet 0.47LL+2 (%) | Moisture (%) | Dry/ Avg/Wet | No. 40 (%) | PI (%) | Volume Swell (%) | Free Swell (%) | PVR, Top of Layer (in) | PVR, Bottom of Layer (in) | Diff. (in) | Mod.- No.40 Factor | Mod. Density Factor | PVR in Layer (in.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0-2.0 | 2 | 55 | 21.1 | 27.85 | 22.8 | dry | 100 | 30 | 8.3 | 11.5 | 0.60 | 0.78 | 0.18 | 1 | 1 | 0.18 |
| 2.0-4.0 | 4 | 62 | 22.64 | 31.14 | 22.8 | dry | 100 | 36 | 10.5 | 13.8 | 1.02 | 1.79 | 0.77 | 1 | 1 | 0.77 |
| 4.0-6.0 | 6 | 62 | 22.64 | 31.14 | 25.0 | dry | 100 | 36 | 10.5 | 13.8 | 1.79 | 2.31 | 0.52 | 1 | 1 | 0.52 |
| 6.0-8.0 | 8 | 50 | 20 | 25.5 | 24.8 | wet | 100 | 31 | 4.0 | 6.9 | 1.05 | 1.17 | 0.12 | 1 | 1 | 0.12 |
| 8.0-10.0 | 10 | 50 | 20 | 25.5 | 25.2 | wet | 100 | 31 | 4.0 | 6.9 | 1.17 | 1.21 | 0.04 | 1 | 1 | 0.04 |
| 10.0-12.0 | 12 | 52 | 20.44 | 26.44 | 25.2 | wet | 100 | 28 | 3.5 | 6.3 | 1.03 | 1.08 | 0.05 | 1 | 1 | 0.05 |
| 12.0-14.0 | 14 | 52 | 20.44 | 26.44 | 25.2 | wet | 100 | 28 | 3.5 | 6.3 | 1.08 | 1.09 | 0.01 | 1 | 1 | 0.01 |
| 14.0-16.0 | 16 | 52 | 20.44 | 26.44 | 25.2 | wet | 100 | 28 | 3.5 | 6.3 | 1.09 | 1.1 | 0.01 | 1 | 1 | 0.01 |
| NOTE: assume a surcharge load of 1 psi beneath pavement within a pavement, no treatment on subgrade soil | | | | | | | | | | | | | | Total PVR (in) = | | 1.70 |

## Table E-69. Calculations with the Surcharge of 1 psi and No Treatment for the Atlanta US 271 Site.

| Depth (ft.) | Avg. Load (psi) | LL (%) | Dry 0.2LL+9 (%) | Wet 0.47LL+2 (%) | Moisture (%) | Dry/ Avg/Wet | No. 40 (%) | PI (%) | Volume Swell (%) | Free Swell (%) | PVR, Top of Layer (in) | PVR, Bottom of Layer (in) | Diff. (in) | Mod.- No.40 Factor | Mod. Density Factor | PVR in Layer (in.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0-2.0 | 2 | 48 | 19.56 | 24.56 | 16.1 | dry | 100 | 26 | 6.8 | 9.9 | 0.55 | 0.90 | 0.35 | 1 | 1 | 0.35 |
| 2.0-4.0 | 4 | 48 | 19.56 | 24.56 | 16.1 | dry | 100 | 26 | 6.8 | 9.9 | 0.90 | 1.30 | 0.4 | 1 | 1 | 0.4 |
| 4.0-6.0 | 6 | 37 | 17.14 | 19.39 | 17 | dry | 100 | 17 | 3.5 | 6.3 | 0.61 | 0.70 | 0.09 | 1 | 1 | 0.09 |
| 6.0-8.0 | 8 | 37 | 17.14 | 19.39 | 17 | dry | 100 | 17 | 3.5 | 6.3 | 0.70 | 0.72 | 0.02 | 1 | 1 | 0.02 |
| 8.0-10.0 | 10 | 40 | 17.8 | 20.8 | 16.7 | dry | 100 | 25 | 6.5 | 9.6 | 1.70 | 1.82 | 0.12 | 1 | 1 | 0.12 |
| 10.0-12.0 | 12 | 40 | 17.8 | 20.8 | 16.7 | dry | 100 | 25 | 6.5 | 9.6 | 1.82 | 1.93 | 0.11 | 1 | 1 | 0.11 |
| 12.0-14.0 | 14 | 37 | 17.14 | 19.39 | 15.8 | dry | 100 | 15 | 2.8 | 5.6 | 0.55 | 0.58 | 0.03 | 1 | 1 | 0.03 |
| 14.0-16.0 | 16 | 37 | 17.14 | 19.39 | 15.8 | dry | 100 | 15 | 2.8 | 5.6 | 0.58 | 0.60 | 0.02 | 1 | 1 | 0.02 |
| 16.0-18.0 | 18 | 37 | 17.14 | 19.39 | 15.8 | dry | 100 | 15 | 2.8 | 5.6 | 0.60 | 0.62 | 0.02 | 1 | 1 | 0.02 |
| NOTE: assume a surcharge load of 1 psi beneath pavement within a pavement, no treatment on subgrade soil | | | | | | | | | | | | | | Total PVR (in) = | | 1.16 |

**Table E-70. Calculations with the Surcharge of 1 psi and No Treatment for the Austin Loop 1 Site.**

| Depth (ft.) | Avg. Load (psi) | LL (%) | Dry 0.2LL+9 (%) | Wet 0.47LL+2 (%) | Moisture (%) | Dry/ Avg/Wet | No. 40 (%) | PI (%) | Volume Swell (%) | Free Swell (%) | PVR, Top of Layer (in) | PVR, Bottom of Layer (in) | Diff. (in) | Mod.- No.40 Factor | Mod. Density Factor | PVR in Layer (in.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0-2.0 | 2 | 49 | 19.78 | 25.03 | 19.03 | dry | 100 | 29 | 8.0 | 11.2 | 0.61 | 0.98 | 0.37 | 1 | 1 | 0.37 |
| 2.0-4.0 | 4 | 49 | 19.78 | 25.03 | 19.03 | dry | 100 | 29 | 8.0 | 11.2 | 0.98 | 1.35 | 0.37 | 1 | 1 | 0.37 |
| 4.0-6.0 | 6 | 68 | 23.96 | 33.96 | 23.11 | dry | 100 | 33 | 9.4 | 12.7 | 1.65 | 2.12 | 0.47 | 1 | 1 | 0.47 |
| 6.0-8.0 | 8 | 68 | 23.96 | 33.96 | 23.11 | dry | 100 | 33 | 9.4 | 12.7 | 2.12 | 2.43 | 0.31 | 1 | 1 | 0.31 |
| 8.0-10.0 | 10 | 68 | 23.96 | 33.96 | 23.00 | dry | 100 | 33 | 9.4 | 12.7 | 2.43 | 2.72 | 0.29 | 1 | 1 | 0.29 |
| 10.0-12.0 | 12 | 68 | 23.96 | 33.96 | 23.00 | dry | 100 | 35 | 10.5 | 13.8 | 3.00 | 3.21 | 0.21 | 1 | 1 | 0.21 |
| 12.0-14.0 | 14 | 68 | 23.96 | 33.96 | 24.09 | dry | 100 | 35 | 10.5 | 13.8 | 3.21 | 3.43 | 0.22 | 1 | 1 | 0.22 |
| 14.0-16.0 | 16 | 68 | 23.96 | 33.96 | 24.09 | dry | 100 | 35 | 10.5 | 13.8 | 3.43 | 3.56 | 0.13 | 1 | 1 | 0.13 |
| , | | | | | | | | | | | | | | Total PVR (in) = | | 2.37 |
| NOTE: assume a surcharge load of 1 psi beneath pavement within a pavement, no treatment on subgrade soil, assume the same soil profile for a Main Lanes and a Frontage Road | | | | | | | | | | | | | | | | |

## Analysis of the Case with No Surcharge and Treatment for the Pavement Acceptable Predicted Performance at the Edge.

**Table E-71. Calculations with No Surcharge and Treatment for the Flexible Pavement for Section A, Fort Worth North Loop IH 820.**

| Depth (ft.) | Avg. Load (psi) | LL (%) | Dry 0.2LL+9 (%) | Wet 0.47LL+2 (%) | Moisture (%) | Dry/ Avg/Wet | No. 40 (%) | PI (%) | Volume Swell (%) | Free Swell (%) | PVR, Top of Layer (in) | PVR, Bottom of Layer (in) | Diff. (in) | Mod.- No.40 Factor | Mod. Density Factor | PVR in Layer (in.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0-2.0 | 1 | 30 | 15.6 | 16.1 | 15 | dry | 100 | 15 | 3.0 | 5.8 | 0.00 | 0.20 | 0.2 | 1 | 0.85 | 0.17 |
| 2.0-4.0 | 3 | 60 | 22.2 | 30.2 | 25.4 | dry | 100 | 28 | 7.5 | 10.6 | 0.62 | 1.15 | 0.53 | 1 | 1 | 0.53 |
| 4.0-6.0 | 5 | 60 | 22.2 | 30.2 | 25.4 | dry | 100 | 25 | 6.5 | 9.6 | 1.06 | 1.45 | 0.39 | 1 | 1 | 0.39 |
| 6.0-8.0 | 7 | 60 | 22.2 | 30.2 | 27.0 | wet | 100 | 25 | 6.5 | 9.6 | 1.45 | 1.55 | 0.1 | 1 | 1 | 0.1 |
| 8.0-10.0 | 9 | 60 | 22.2 | 30.2 | 23.8 | dry | 100 | 25 | 6.5 | 9.6 | 1.55 | 1.72 | 0.17 | 1 | 1 | 0.17 |
| 10.0-12.0 | 11 | 65 | 23.3 | 32.55 | 23.8 | dry | 100 | 35 | 10 | 13.3 | 2.90 | 3.00 | 0.1 | 1 | 1 | 0.1 |
| 12.0-14.0 | 13 | 65 | 23.3 | 32.55 | 24.8 | dry | 100 | 35 | 10 | 13.3 | 3.00 | 3.20 | 0.2 | 1 | 1 | 0.2 |
| 14.0-16.0 | 15 | 65 | 23.3 | 32.55 | 24.8 | dry | 100 | 35 | 10 | 13.3 | 3.20 | 3.31 | 0.11 | 1 | 1 | 0.11 |
| NOTE: :no surcharge, LTS 2.5 ft thick (LL=30%, PI=15%, w=15%, mod. density factor =0.85) | | | | | | | | | | | | | | Total PVR (in) = | | 1.77 |

## Table E-72. Calculations with No Surcharge and Treatment for the Rigid Pavement for Section A, Fort Worth North Loop IH 820.

| Depth (ft.) | Avg. Load (psi) | LL (%) | Dry 0.2LL+9 (%) | Wet 0.47LL+2 (%) | Moisture (%) | Dry/ Avg/Wet | No. 40 (%) | PI (%) | Volume Swell (%) | Free Swell (%) | PVR, Top of Layer (in) | PVR, Bottom of Layer (in) | Diff. (in) | Mod.- No.40 Factor | Mod. Density Factor | PVR in Layer (in.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0-2.0 | 1 | 60 | 22.2 | 30.2 | 25.4 | dry | 100 | 28 | 7.5 | 10.6 | 0.00 | 0.62 | 0.62 | 1 | 1 | 0.62 |
| 2.0-4.0 | 3 | 60 | 22.2 | 30.2 | 25.4 | dry | 100 | 28 | 7.5 | 10.6 | 0.62 | 1.15 | 0.53 | 1 | 1 | 0.53 |
| 4.0-6.0 | 5 | 60 | 22.2 | 30.2 | 25.4 | dry | 100 | 25 | 6.5 | 9.6 | 1.06 | 1.45 | 0.39 | 1 | 1 | 0.39 |
| 6.0-8.0 | 7 | 60 | 22.2 | 30.2 | 27 | wet | 100 | 25 | 6.5 | 9.6 | 1.45 | 1.55 | 0.1 | 1 | 1 | 0.1 |
| 8.0-10.0 | 9 | 60 | 22.2 | 30.2 | 23.8 | dry | 100 | 25 | 6.5 | 9.6 | 1.55 | 1.72 | 0.17 | 1 | 1 | 0.17 |
| 10.0-12.0 | 11 | 65 | 23.3 | 32.55 | 23.8 | dry | 100 | 35 | 10 | 13.3 | 2.90 | 3.00 | 0.1 | 1 | 1 | 0.1 |
| 12.0-14.0 | 13 | 65 | 23.3 | 32.55 | 24.8 | dry | 100 | 35 | 10 | 13.3 | 3.00 | 3.20 | 0.2 | 1 | 1 | 0.2 |
| 14.0-16.0 | 15 | 65 | 23.3 | 32.55 | 24.8 | dry | 100 | 35 | 10 | 13.3 | 3.20 | 3.31 | 0.11 | 1 | 1 | 0.11 |
| NOTE: no surcharge, no treatment on subgrade soil | | | | | | | | | | | | | | Total PVR (in) = | | 2.22 |

## Table E-73. Calculations with No Surcharge and Treatment for the Flexible Pavement for Section B, Fort Worth North Loop IH 820.

| Depth (ft.) | Avg. Load (psi) | LL (%) | Dry 0.2LL+9 (%) | Wet 0.47LL+2 (%) | Moisture (%) | Dry/ Avg/Wet | No. 40 (%) | PI (%) | Volume Swell (%) | Free Swell (%) | PVR, Top of Layer (in) | PVR, Bottom of Layer (in) | Diff. (in) | Mod.- No.40 Factor | Mod. Density Factor | PVR in Layer (in.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0-2.0 | 1 | 30 | 15.6 | 16.1 | 15 | dry | 100 | 15 | 3 | 5.8 | 0.00 | 0.20 | 0.2 | 1 | 0.85 | 0.17 |
| 2.0-4.0 | 3.00 | 20 | 13.4 | 11.4 | 20 | dry | 100 | 10 | 1.0 | 3.7 | 0.12 | 0.22 | 0.1 | 1 | 0.8 | 0.08 |
| 4.0-6.0 | 5.00 | 55 | 21.1 | 27.85 | 11.35 | dry | 100 | 30 | 8.4 | 11.6 | 1.28 | 1.75 | 0.47 | 1 | 1 | 0.47 |
| 6.0-8.0 | 7.00 | 65 | 23.3 | 32.55 | 11.35 | dry | 100 | 38 | 11.1 | 14.5 | 2.22 | 2.70 | 0.48 | 1 | 1 | 0.48 |
| 8.0-10.0 | 9.00 | 65 | 23.3 | 32.55 | 18.41 | dry | 100 | 38 | 11.1 | 14.5 | 2.70 | 3.08 | 0.38 | 1 | 1 | 0.38 |
| 10.0-12.0 | 11.00 | 53 | 20.66 | 26.91 | 18.41 | dry | 100 | 32 | 9.0 | 12.2 | 2.38 | 2.69 | 0.31 | 1 | 1 | 0.31 |
| 12.0-14.0 | 13.00 | 45 | 18.9 | 23.15 | 18.41 | dry | 100 | 25 | 6.5 | 9.6 | 1.80 | 1.90 | 0.1 | 1 | 1 | 0.1 |
| 14.0-16.0 | 15.00 | 45 | 18.9 | 23.15 | 24.9 | dry | 100 | 15 | 3.0 | 5.8 | 0.58 | 0.61 | 0.03 | 1 | 1 | 0.03 |
| | | | | | | | | | | | | | | Total PVR (in) = | | 2.02 |
| NOTE: :no surcharge, LTS 2.5 ft thick (LL = 30%, PI = 15%, w = 15%, mod. density factor =0.85), Inert 1.5 ft (LL = 25%, PI = 10%, w = 20%, mod. density factor=0.8) | | | | | | | | | | | | | | | | |

**Table E-74. Calculations with No Surcharge and Treatment for the Rigid Pavement for Section B, Fort Worth North Loop IH 820.**

| Depth (ft.) | Avg. Load (psi) | LL (%) | Dry 0.2LL+9 (%) | Wet 0.47LL+2 (%) | Moisture (%) | Dry/ Avg/Wet | No. 40 (%) | PI (%) | Volume Swell (%) | Free Swell (%) | PVR, Top of Layer (in) | PVR, Bottom of Layer (in) | Diff. (in) | Mod.- No.40 Factor | Mod. Density Factor | PVR in Layer (in.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0-2.0 | 1.00 | 40 | 17.8 | 20.8 | 20 | dry | 100 | 25 | 3 | 6.5 | 0.00 | 0.28 | 0.28 | 1 | 0.85 | 0.238 |
| 2.0-4.0 | 3.00 | 55 | 21.1 | 27.85 | 20.2 | dry | 100 | 30 | 8.4 | 11.6 | 0.60 | 1.28 | 0.68 | 1 | 1 | 0.68 |
| 4.0-6.0 | 5.00 | 55 | 21.1 | 27.85 | 11.35 | dry | 100 | 30 | 8.4 | 11.6 | 1.28 | 1.75 | 0.47 | 1 | 1 | 0.47 |
| 6.0-8.0 | 7.00 | 65 | 23.3 | 32.55 | 11.35 | dry | 100 | 38 | 11.1 | 14.5 | 2.22 | 2.70 | 0.48 | 1 | 1 | 0.48 |
| 8.0-10.0 | 9.00 | 65 | 23.3 | 32.55 | 18.41 | dry | 100 | 38 | 11.1 | 14.5 | 2.70 | 3.08 | 0.38 | 1 | 1 | 0.38 |
| 10.0-12.0 | 11.00 | 53 | 20.66 | 26.91 | 18.41 | dry | 100 | 32 | 9.0 | 12.2 | 2.38 | 2.69 | 0.31 | 1 | 1 | 0.31 |
| 12.0-14.0 | 13.00 | 45 | 18.9 | 23.15 | 18.41 | dry | 100 | 25 | 6.5 | 9.6 | 1.80 | 1.90 | 0.1 | 1 | 1 | 0.1 |
| 14.0-16.0 | 15.00 | 45 | 18.9 | 23.15 | 24.9 | dry | 100 | 15 | 3.0 | 5.8 | 0.58 | 0.61 | 0.03 | 1 | 1 | 0.03 |
| NOTE: :no surcharge, LTS 8.0 in thick (LL = 30%, PI = 15%, w = 15%, mod. density factor = 0.85) | | | | | | | | | | | | | | Total PVR (in) = | | 2.69 |

**Table E-75. Calculations with No Surcharge and Treatment for the Flexible Pavement for Section C, Fort Worth North Loop IH 820.**

| Depth (ft.) | Avg. Load (psi) | LL (%) | Dry 0.2LL+9 (%) | Wet 0.47LL+2 (%) | Moisture (%) | Dry/ Avg/Wet | No. 40 (%) | PI (%) | Volume Swell (%) | Free Swell (%) | PVR, Top of Layer (in) | PVR, Bottom of Layer (in) | Diff. (in) | Mod.- No.40 Factor | Mod. Density Factor | PVR in Layer (in.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0-2.0 | 1 | 30 | 15.6 | 16.1 | 15 | dry | 100 | 15 | 3 | 5.8 | 0.00 | 0.20 | 0.2 | 1 | 0.85 | 0.17 |
| 2.0-4.0 | 3.00 | 20 | 13.4 | 11.4 | 20 | dry | 100 | 10 | 1.0 | 3.7 | 0.12 | 0.22 | 0.1 | 1 | 0.8 | 0.08 |
| 4.0-6.0 | 5.00 | 62 | 22.64 | 31.14 | 25.0 | dry | 100 | 36 | 10.5 | 13.8 | 1.41 | 2.08 | 0.67 | 1 | 1 | 0.67 |
| 6.0-8.0 | 7.00 | 50 | 20 | 25.5 | 24.8 | wet | 100 | 31 | 4.0 | 6.9 | 0.72 | 0.82 | 0.1 | 1 | 1 | 0.1 |
| 8.0-10.0 | 9.00 | 50 | 20 | 25.5 | 25.2 | wet | 100 | 31 | 4 | 6.9 | 0.82 | 0.91 | 0.09 | 1 | 1 | 0.09 |
| 10.0-12.0 | 11.00 | 52 | 20.44 | 26.44 | 25.2 | wet | 100 | 28 | 3.5 | 6.3 | 0.72 | 0.78 | 0.06 | 1 | 1 | 0.06 |
| 12.0-14.0 | 13.00 | 52 | 20.44 | 26.44 | 25.2 | wet | 100 | 28 | 3.5 | 6.3 | 0.78 | 0.8 | 0.02 | 1 | 1 | 0.02 |
| 14.0-16.0 | 15.00 | 52 | 20.44 | 26.44 | 25.2 | wet | 100 | 28 | 3.5 | 6.3 | 0.8 | 0.8 | 0 | 1 | 1 | 0 |
| | | | | | | | | | | | | | | Total PVR (in) = | | 1.19 |
| NOTE: :no surcharge, LTS 2.5 ft thick (LL = 30%, PI = 15%, w = 15%, mod. density factor = 0.85), Inert 1.0 ft (LL = 25%, PI = 10%, w = 20%, mod .density factor = 0.8) | | | | | | | | | | | | | | | | |

## Table E-76. Calculations with No Surcharge and Treatment for the Rigid Pavement for Section C, Fort Worth North Loop IH 820.

| Depth (ft.) | Avg. Load (psi) | LL (%) | Dry 0.2LL+9 (%) | Wet 0.47LL+2 (%) | Moisture (%) | Dry/ Avg/Wet | No. 40 (%) | PI (%) | Volume Swell (%) | Free Swell (%) | PVR, Top of Layer (in) | PVR, Bottom of Layer (in) | Diff. (in) | Mod.- No.40 Factor | Mod. Density Factor | PVR in Layer (in.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0-2.0 | 1 | 40 | 17.8 | 20.8 | 20 | dry | 100 | 25 | 3 | 6.5 | 0.00 | 0.28 | 0.28 | 1 | 0.85 | 0.238 |
| 2.0-4.0 | 3.00 | 62 | 22.64 | 31.14 | 22.8 | dry | 100 | 36 | 10.5 | 13.8 | 0.60 | 1.41 | 0.81 | 1 | 1 | 0.81 |
| 4.0-6.0 | 5.00 | 62 | 22.64 | 31.14 | 25.0 | dry | 100 | 36 | 10.5 | 13.8 | 1.41 | 2.08 | 0.67 | 1 | 1 | 0.67 |
| 6.0-8.0 | 7.00 | 50 | 20 | 25.5 | 24.8 | wet | 100 | 31 | 4.0 | 6.9 | 0.72 | 0.82 | 0.1 | 1 | 1 | 0.1 |
| 8.0-10.0 | 9.00 | 50 | 20 | 25.5 | 25.2 | wet | 100 | 31 | 4 | 6.9 | 0.82 | 0.91 | 0.09 | 1 | 1 | 0.09 |
| 10.0-12.0 | 11.00 | 52 | 20.44 | 26.44 | 25.2 | wet | 100 | 28 | 3.5 | 6.3 | 0.72 | 0.78 | 0.06 | 1 | 1 | 0.06 |
| 12.0-14.0 | 13.00 | 52 | 20.44 | 26.44 | 25.2 | wet | 100 | 28 | 3.5 | 6.3 | 0.78 | 0.8 | 0.02 | 1 | 1 | 0.02 |
| 14.0-16.0 | 15.00 | 52 | 20.44 | 26.44 | 25.2 | wet | 100 | 28 | 3.5 | 6.3 | 0.8 | 0.8 | 0 | 1 | 1 | 0 |
| NOTE: :no surcharge, LTS 1.0 ft thick (LL = 30%, PI = 15%, w = 15%, mod. density factor = 0.85) | | | | | | | | | | | | | | Total PVR (in) = | | 1.99 |

## Table E-77. Calculations with No Surcharge and Treatment for the Flexible Pavement, Atlanta US 271.

| Depth (ft.) | Avg. Load (psi) | LL (%) | Dry 0.2LL+9 (%) | Wet 0.47LL+2 (%) | Moisture (%) | Dry/ Avg/Wet | No. 40 (%) | PI (%) | Volume Swell (%) | Free Swell (%) | PVR, Top of Layer (in) | PVR, Bottom of Layer (in) | Diff. (in) | Mod.- No.40 Factor | Mod. Density Factor | PVR in Layer (in.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0-2.0 | 1 | 30 | 15.6 | 16.1 | 15 | dry | 100 | 15 | 3 | 5.8 | 0.00 | 0.20 | 0.2 | 1 | 0.85 | 0.17 |
| 2.0-4.0 | 3.00 | 48 | 19.56 | 24.56 | 16.1 | dry | 100 | 26 | 6.8 | 9.9 | 0.58 | 1.10 | 0.52 | 1 | 1 | 0.52 |
| 4.0-6.0 | 5.00 | 37 | 17.14 | 19.39 | 17 | dry | 100 | 17 | 3.5 | 6.3 | 0.50 | 0.65 | 0.15 | 1 | 1 | 0.15 |
| 6.0-8.0 | 7.00 | 37 | 17.14 | 19.39 | 17 | dry | 100 | 17 | 3.5 | 6.3 | 0.65 | 0.72 | 0.07 | 1 | 1 | 0.07 |
| 8.0-10.0 | 9.00 | 40 | 17.8 | 20.8 | 16.7 | dry | 100 | 25 | 6.5 | 9.6 | 1.60 | 1.75 | 0.15 | 1 | 1 | 0.15 |
| 10.0-12.0 | 11.00 | 40 | 17.8 | 20.8 | 16.7 | dry | 100 | 25 | 6.5 | 9.6 | 1.75 | 1.82 | 0.07 | 1 | 1 | 0.07 |
| 12.0-14.0 | 13.00 | 37 | 17.14 | 19.39 | 15.8 | dry | 100 | 15 | 2.8 | 5.6 | 0.51 | 0.56 | 0.05 | 1 | 1 | 0.05 |
| 14.0-16.0 | 15.00 | 37 | 17.14 | 19.39 | 15.8 | dry | 100 | 15 | 2.8 | 5.6 | 0.56 | 0.58 | 0.02 | 1 | 1 | 0.02 |
| 16.0-18.0 | 17.00 | 37 | 17.14 | 19.39 | 15.8 | dry | 100 | 15 | 2.8 | 5.6 | 0.58 | 0.59 | 0.01 | 1 | 1 | 0.01 |
| NOTE: :no surcharge, LTS 2.2 ft thick (LL = 30%, PI = 15%, w = 15%, mod. density factor = 0.85) | | | | | | | | | | | | | | Total PVR (in) = | | 1.21 |

## Table E-78. Calculations with No Surcharge and Treatment for the Rigid Pavement, Atlanta US 271.

| Depth (ft.) | Avg. Load (psi) | LL (%) | Dry 0.2LL+9 (%) | Wet 0.47LL+2 (%) | Moisture (%) | Dry/ Avg/Wet | No. 40 (%) | PI (%) | Volume Swell (%) | Free Swell (%) | PVR, Top of Layer (in) | PVR, Bottom of Layer (in) | Diff. (in) | Mod.- No.40 Factor | Mod. Density Factor | PVR in Layer (in.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0-2.0 | 1.00 | 48 | 19.56 | 24.56 | 16.1 | dry | 100 | 26 | 6.8 | 9.9 | 0.00 | 0.58 | 0.58 | 1 | 1 | 0.58 |
| 2.0-4.0 | 3.00 | 48 | 19.56 | 24.56 | 16.1 | dry | 100 | 26 | 6.8 | 9.9 | 0.58 | 1.10 | 0.52 | 1 | 1 | 0.52 |
| 4.0-6.0 | 5.00 | 37 | 17.14 | 19.39 | 17 | dry | 100 | 17 | 3.5 | 6.3 | 0.50 | 0.65 | 0.15 | 1 | 1 | 0.15 |
| 6.0-8.0 | 7.00 | 37 | 17.14 | 19.39 | 17 | dry | 100 | 17 | 3.5 | 6.3 | 0.65 | 0.72 | 0.07 | 1 | 1 | 0.07 |
| 8.0-10.0 | 9.00 | 40 | 17.8 | 20.8 | 16.7 | dry | 100 | 25 | 6.5 | 9.6 | 1.60 | 1.75 | 0.15 | 1 | 1 | 0.15 |
| 10.0-12.0 | 11.00 | 40 | 17.8 | 20.8 | 16.7 | dry | 100 | 25 | 6.5 | 9.6 | 1.75 | 1.82 | 0.07 | 1 | 1 | 0.07 |
| 12.0-14.0 | 13.00 | 37 | 17.14 | 19.39 | 15.8 | dry | 100 | 15 | 2.8 | 5.6 | 0.51 | 0.56 | 0.05 | 1 | 1 | 0.05 |
| 14.0-16.0 | 15.00 | 37 | 17.14 | 19.39 | 15.8 | dry | 100 | 15 | 2.8 | 5.6 | 0.56 | 0.58 | 0.02 | 1 | 1 | 0.02 |
| 16.0-18.0 | 17.00 | 37 | 17.14 | 19.39 | 15.8 | dry | 100 | 15 | 2.8 | 5.6 | 0.58 | 0.59 | 0.01 | 1 | 1 | 0.01 |
| NOTE: no surcharge, no treatment on subgrade soil | | | | | | | | | | | | | | Total PVR (in) = | | 1.62 |

## Table E-79. Calculations with No Surcharge and Treatment for the Flexible Pavement, Austin Loop 1, Main Lane.

| Depth (ft.) | Avg. Load (psi) | LL (%) | Dry 0.2LL+9 (%) | Wet 0.47LL+2 (%) | Moisture (%) | Dry/ Avg/Wet | No. 40 (%) | PI (%) | Volume Swell (%) | Free Swell (%) | PVR, Top of Layer (in) | PVR, Bottom of Layer (in) | Diff. (in) | Mod.- No.40 Factor | Mod. Density Factor | PVR in Layer (in.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0-2.0 | 1 | 30 | 15.6 | 16.1 | 15 | dry | 100 | 15 | 3 | 5.8 | 0.00 | 0.20 | 0.2 | 1 | 0.85 | 0.17 |
| 2.0-4.0 | 3.00 | 40 | 17.8 | 20.8 | 18.00 | dry | 100 | 25 | 6.5 | 9.6 | 0.60 | 1.00 | 0.4 | 1 | 1 | 0.4 |
| 4.0-6.0 | 5.00 | 68 | 23.96 | 33.96 | 23.11 | dry | 100 | 33 | 9.4 | 12.7 | 1.35 | 1.94 | 0.59 | 1 | 1 | 0.59 |
| 6.0-8.0 | 7.00 | 68 | 23.96 | 33.96 | 23.11 | dry | 100 | 33 | 9.4 | 12.7 | 1.94 | 2.30 | 0.36 | 1 | 1 | 0.36 |
| 8.0-10.0 | 9.00 | 68 | 23.96 | 33.96 | 23.00 | dry | 100 | 33 | 9.4 | 12.7 | 2.30 | 2.58 | 0.28 | 1 | 1 | 0.28 |
| 10.0-12.0 | 11.00 | 68 | 23.96 | 33.96 | 23.00 | dry | 100 | 35 | 10.5 | 13.8 | 2.85 | 3.12 | 0.27 | 1 | 1 | 0.27 |
| 12.0-14.0 | 13.00 | 68 | 23.96 | 33.96 | 24.09 | dry | 100 | 35 | 10.5 | 13.8 | 3.12 | 3.30 | 0.18 | 1 | 1 | 0.18 |
| 14.0-16.0 | 15.00 | 68 | 23.96 | 33.96 | 24.09 | dry | 100 | 35 | 10.5 | 13.8 | 3.30 | 3.45 | 0.15 | 1 | 1 | 0.15 |
| NOTE: no surcharge, LTS 2.8 ft (LL = 30%, PI = 15%, w = 15%, mod. density factor = 0.85) | | | | | | | | | | | | | | Total PVR (in) = | | 2.40 |

### Table E-80. Calculations with No Surcharge and Treatment for the Rigid Pavement, Austin Loop 1, Main Lane.

| Depth (ft.) | Avg. Load (psi) | LL (%) | Dry 0.2LL+9 (%) | Wet 0.47LL+2 (%) | Moisture (%) | Dry/ Avg/Wet | No. 40 (%) | PI (%) | Volume Swell (%) | Free Swell (%) | PVR, Top of Layer (in) | PVR, Bottom of Layer (in) | Diff. (in) | Mod.- No.40 Factor | Mod. Density Factor | PVR in Layer (in.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0-2.0 | 1 | 30 | 15.6 | 16.1 | 15 | dry | 100 | 15 | 3 | 5.8 | 0.00 | 0.20 | 0.2 | 1 | 0.85 | 0.17 |
| 2.0-4.0 | 3.00 | 49 | 19.78 | 25.03 | 19.03 | dry | 100 | 29 | 8.0 | 11.2 | 0.60 | 1.14 | 0.54 | 1 | 1 | 0.54 |
| 4.0-6.0 | 5.00 | 68 | 23.96 | 33.96 | 23.11 | dry | 100 | 33 | 9.4 | 12.7 | 1.35 | 1.94 | 0.59 | 1 | 1 | 0.59 |
| 6.0-8.0 | 7.00 | 68 | 23.96 | 33.96 | 23.11 | dry | 100 | 33 | 9.4 | 12.7 | 1.94 | 2.30 | 0.36 | 1 | 1 | 0.36 |
| 8.0-10.0 | 9.00 | 68 | 23.96 | 33.96 | 23.00 | dry | 100 | 33 | 9.4 | 12.7 | 2.30 | 2.58 | 0.28 | 1 | 1 | 0.28 |
| 10.0-12.0 | 11.00 | 68 | 23.96 | 33.96 | 23.00 | dry | 100 | 35 | 10.5 | 13.8 | 2.85 | 3.12 | 0.27 | 1 | 1 | 0.27 |
| 12.0-14.0 | 13.00 | 68 | 23.96 | 33.96 | 24.09 | dry | 100 | 35 | 10.5 | 13.8 | 3.12 | 3.30 | 0.18 | 1 | 1 | 0.18 |
| 14.0-16.0 | 15.00 | 68 | 23.96 | 33.96 | 24.09 | dry | 100 | 35 | 10.5 | 13.8 | 3.30 | 3.45 | 0.15 | 1 | 1 | 0.15 |
| NOTE: no surcharge, LTS 2.0 ft (LL = 30%, PI = 15%, w = 15%, mod. density factor = 0.85) | | | | | | | | | | | | | | Total PVR (in) = | | 2.54 |

### Table E-81. Calculations with No Surcharge and Treatment for the Flexible Pavement, Austin Loop 1, Frontage Road.

| Depth (ft.) | Avg. Load (psi) | LL (%) | Dry 0.2LL+9 (%) | Wet 0.47LL+2 (%) | Moisture (%) | Dry/ Avg/Wet | No. 40 (%) | PI (%) | Volume Swell (%) | Free Swell (%) | PVR, Top of Layer (in) | PVR, Bottom of Layer (in) | Diff. (in) | Mod.- No.40 Factor | Mod. Density Factor | PVR in Layer (in.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0-2.0 | 1 | 30 | 15.6 | 16.1 | 15 | dry | 100 | 15 | 3 | 5.8 | 0.00 | 0.20 | 0.2 | 1 | 0.85 | 0.17 |
| 2.0-4.0 | 3.00 | 20 | 13.4 | 11.4 | 20 | dry | 100 | 10 | 1.0 | 3.7 | 0.12 | 0.22 | 0.1 | 1 | 0.8 | 0.08 |
| 4.0-6.0 | 5.00 | 68 | 23.96 | 33.96 | 23.11 | dry | 100 | 33 | 9.4 | 12.7 | 1.35 | 1.94 | 0.59 | 1 | 1 | 0.59 |
| 6.0-8.0 | 7.00 | 68 | 23.96 | 33.96 | 23.11 | dry | 100 | 33 | 9.4 | 12.7 | 1.94 | 2.30 | 0.36 | 1 | 1 | 0.36 |
| 8.0-10.0 | 9.00 | 68 | 23.96 | 33.96 | 23.00 | dry | 100 | 33 | 9.4 | 12.7 | 2.30 | 2.58 | 0.28 | 1 | 1 | 0.28 |
| 10.0-12.0 | 11.00 | 68 | 23.96 | 33.96 | 23.00 | dry | 100 | 35 | 10.5 | 13.8 | 2.85 | 3.12 | 0.27 | 1 | 1 | 0.27 |
| 12.0-14.0 | 13.00 | 68 | 23.96 | 33.96 | 24.09 | dry | 100 | 35 | 10.5 | 13.8 | 3.12 | 3.30 | 0.18 | 1 | 1 | 0.18 |
| 14.0-16.0 | 15.00 | 68 | 23.96 | 33.96 | 24.09 | dry | 100 | 35 | 10.5 | 13.8 | 3.30 | 3.45 | 0.15 | 1 | 1 | 0.15 |
| | | | | | | | | | | | | | | Total PVR (in) = | | 2.08 |
| NOTE: no surcharge, LTS 2.0 ft (LL = 30%, PI = 15%, w = 15%, mod. density factor = 0.85), Inert 2.0 ft (LL = 25%, PI = 10%, w = 20%, mod. density factor = 0.8) | | | | | | | | | | | | | | | | |

**Table E-82. Calculations with No Surcharge and Treatment for the Rigid Pavement, Austin Loop 1, Frontage Road.**

| Depth (ft.) | Avg. Load (psi) | LL (%) | Dry 0.2LL+9 (%) | Wet 0.47LL+2 (%) | Moisture (%) | Dry/ Avg/Wet | No. 40 (%) | PI (%) | Volume Swell (%) | Free Swell (%) | PVR, Top of Layer (in) | PVR, Bottom of Layer (in) | Diff. (in) | Mod.- No.40 Factor | Mod. Density Factor | PVR in Layer (in.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0-2.0 | 1.00 | 49 | 19.78 | 25.03 | 19.03 | dry | 100 | 29 | 8.0 | 11.2 | 0.00 | 0.60 | 0.6 | 1 | 1 | 0.6 |
| 2.0-4.0 | 3.00 | 49 | 19.78 | 25.03 | 19.03 | dry | 100 | 29 | 8.0 | 11.2 | 0.60 | 1.14 | 0.54 | 1 | 1 | 0.54 |
| 4.0-6.0 | 5.00 | 68 | 23.96 | 33.96 | 23.11 | dry | 100 | 33 | 9.4 | 12.7 | 1.35 | 1.94 | 0.59 | 1 | 1 | 0.59 |
| 6.0-8.0 | 7.00 | 68 | 23.96 | 33.96 | 23.11 | dry | 100 | 33 | 9.4 | 12.7 | 1.94 | 2.30 | 0.36 | 1 | 1 | 0.36 |
| 8.0-10.0 | 9.00 | 68 | 23.96 | 33.96 | 23.00 | dry | 100 | 33 | 9.4 | 12.7 | 2.30 | 2.58 | 0.28 | 1 | 1 | 0.28 |
| 10.0-12.0 | 11.00 | 68 | 23.96 | 33.96 | 23.00 | dry | 100 | 35 | 10.5 | 13.8 | 2.85 | 3.12 | 0.27 | 1 | 1 | 0.27 |
| 12.0-14.0 | 13.00 | 68 | 23.96 | 33.96 | 24.09 | dry | 100 | 35 | 10.5 | 13.8 | 3.12 | 3.30 | 0.18 | 1 | 1 | 0.18 |
| 14.0-16.0 | 15.00 | 68 | 23.96 | 33.96 | 24.09 | dry | 100 | 35 | 10.5 | 13.8 | 3.30 | 3.45 | 0.15 | 1 | 1 | 0.15 |
| NOTE : no surcharge, no treatment on subgrade soil | | | | | | | | | | | | | | Total PVR (in) = | | 2.97 |

## Analysis of the Case with the Surcharge of 1 psi and Treatment for the Pavement Acceptable Predicted Performance at the Outer Wheel Path.

**Table E-83. Calculations with the Surcharge of 1 psi and Treatment for the Flexible Pavement for Section A, Fort Worth North Loop IH 820.**

| Depth (ft.) | Avg. Load (psi) | LL (%) | Dry 0.2LL+9 (%) | Wet 0.47LL+2 (%) | Moisture (%) | Dry/ Avg/Wet | No. 40 (%) | PI (%) | Volume Swell (%) | Free Swell (%) | PVR, Top of Layer (in) | PVR, Bottom of Layer (in) | Diff. (in) | Mod.- No.40 Factor | Mod. Density Factor | PVR in Layer (in.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0-2.0 | 2 | 30 | 15.6 | 16.1 | 15 | dry | 100 | 15 | 3 | 5.8 | 0.20 | 0.32 | 0.12 | 1 | 0.85 | 0.102 |
| 2.0-4.0 | 4 | 60 | 22.2 | 30.2 | 25.4 | dry | 100 | 28 | 7.5 | 10.6 | 0.95 | 1.40 | 0.45 | 1 | 1 | 0.45 |
| 4.0-6.0 | 6 | 60 | 22.2 | 30.2 | 25.4 | dry | 100 | 25 | 6.5 | 9.6 | 1.25 | 1.50 | 0.25 | 1 | 1 | 0.25 |
| 6.0-8.0 | 8 | 60 | 22.2 | 30.2 | 27 | wet | 100 | 25 | 6.5 | 9.6 | 1.50 | 1.68 | 0.18 | 1 | 1 | 0.18 |
| 8.0-10.0 | 10 | 60 | 22.2 | 30.2 | 23.8 | dry | 100 | 25 | 6.5 | 9.6 | 1.68 | 1.80 | 0.12 | 1 | 1 | 0.12 |
| 10.0-12.0 | 12 | 65 | 23.3 | 32.55 | 23.8 | dry | 100 | 35 | 10 | 13.3 | 2.90 | 3.12 | 0.22 | 1 | 1 | 0.22 |
| 12.0-14.0 | 14 | 65 | 23.3 | 32.55 | 24.8 | dry | 100 | 35 | 10 | 13.3 | 3.12 | 3.29 | 0.17 | 1 | 1 | 0.17 |
| 14.0-16.0 | 16 | 65 | 23.3 | 32.55 | 24.8 | dry | 100 | 35 | 10 | 13.3 | 3.29 | 3.42 | 0.13 | 1 | 1 | 0.13 |
| NOTE: surcharge load of 1 psi, LTS 2.5 ft thick (LL = 30%, PI = 15%, w = 15%, mod. density factor = 0.85) | | | | | | | | | | | | | | Total PVR (in) = | | 1.62 |

## Table E-84. Calculations with the Surcharge of 1 psi and Treatment for the Rigid Pavement for Section A, Fort Worth North Loop IH 820.

| Depth (ft.) | Avg. Load (psi) | LL (%) | Dry 0.2LL+9 (%) | Wet 0.47LL+2 (%) | Moisture (%) | Dry/ Avg/Wet | No. 40 (%) | PI (%) | Volume Swell (%) | Free Swell (%) | PVR, Top of Layer (in) | PVR, Bottom of Layer (in) | Diff. (in) | Mod.- No.40 Factor | Mod. Density Factor | PVR in Layer (in.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0-2.0 | 2 | 60 | 22.2 | 30.2 | 25.4 | dry | 100 | 28 | 7.5 | 10.6 | 0.60 | 0.95 | 0.35 | 1 | 1 | 0.35 |
| 2.0-4.0 | 4 | 60 | 22.2 | 30.2 | 25.4 | dry | 100 | 28 | 7.5 | 10.6 | 0.95 | 1.40 | 0.45 | 1 | 1 | 0.45 |
| 4.0-6.0 | 6 | 60 | 22.2 | 30.2 | 25.4 | dry | 100 | 25 | 6.5 | 9.6 | 1.25 | 1.50 | 0.25 | 1 | 1 | 0.25 |
| 6.0-8.0 | 8 | 60 | 22.2 | 30.2 | 27 | wet | 100 | 25 | 6.5 | 9.6 | 1.50 | 1.68 | 0.18 | 1 | 1 | 0.18 |
| 8.0-10.0 | 10 | 60 | 22.2 | 30.2 | 23.8 | dry | 100 | 25 | 6.5 | 9.6 | 1.68 | 1.80 | 0.12 | 1 | 1 | 0.12 |
| 10.0-12.0 | 12 | 65 | 23.3 | 32.55 | 23.8 | dry | 100 | 35 | 10 | 13.3 | 2.90 | 3.12 | 0.22 | 1 | 1 | 0.22 |
| 12.0-14.0 | 14 | 65 | 23.3 | 32.55 | 24.8 | dry | 100 | 35 | 10 | 13.3 | 3.12 | 3.29 | 0.17 | 1 | 1 | 0.17 |
| 14.0-16.0 | 16 | 65 | 23.3 | 32.55 | 24.8 | dry | 100 | 35 | 10 | 13.3 | 3.29 | 3.42 | 0.13 | 1 | 1 | 0.13 |
| NOTE: surcharge load of 1 psi, no treatment on subgrade soil | | | | | | | | | | | | | | Total PVR (in) = | | 1.87 |

## Table E-85. Calculations with the Surcharge of 1 psi and Treatment for the Flexible Pavement for Section B, Fort Worth North Loop IH 820.

| Depth (ft.) | Avg. Load (psi) | LL (%) | Dry 0.2LL+9 (%) | Wet 0.47LL+2 (%) | Moisture (%) | Dry/ Avg/Wet | No. 40 (%) | PI (%) | Volume Swell (%) | Free Swell (%) | PVR, Top of Layer (in) | PVR, Bottom of Layer (in) | Diff. (in) | Mod.- No.40 Factor | Mod. Density Factor | PVR in Layer (in.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0-2.0 | 2 | 30 | 15.6 | 16.1 | 15 | dry | 100 | 15 | 3 | 5.8 | 0.20 | 0.32 | 0.12 | 1 | 0.85 | 0.102 |
| 2.0-4.0 | 4 | 20 | 13.4 | 11.4 | 20 | dry | 100 | 10 | 1.0 | 3.7 | 0.18 | 0.22 | 0.04 | 1 | 0.8 | 0.032 |
| 4.0-6.0 | 6 | 55 | 21.1 | 27.85 | 11.35 | dry | 100 | 30 | 8.4 | 11.6 | 1.55 | 1.91 | 0.36 | 1 | 1 | 0.36 |
| 6.0-8.0 | 8 | 65 | 23.3 | 32.55 | 11.35 | dry | 100 | 38 | 11.1 | 14.5 | 2.45 | 2.90 | 0.45 | 1 | 1 | 0.45 |
| 8.0-10.0 | 10 | 65 | 23.3 | 32.55 | 18.41 | dry | 100 | 38 | 11.1 | 14.5 | 2.90 | 3.24 | 0.34 | 1 | 1 | 0.34 |
| 10.0-12.0 | 12 | 53 | 20.66 | 26.91 | 18.41 | dry | 100 | 32 | 9.0 | 12.2 | 2.61 | 2.80 | 0.19 | 1 | 1 | 0.19 |
| 12.0-14.0 | 14 | 45 | 18.9 | 23.15 | 18.41 | dry | 100 | 25 | 6.5 | 9.6 | 1.85 | 1.92 | 0.07 | 1 | 1 | 0.07 |
| 14.0-16.0 | 16 | 45 | 18.9 | 23.15 | 24.9 | dry | 100 | 15 | 3.0 | 5.8 | 0.61 | 0.62 | 0.01 | 1 | 1 | 0.01 |
| | | | | | | | | | | | | | | Total PVR (in) = | | 1.55 |
| NOTE: surcharge load of 1 psi, LTS 2.5 ft thick (LL = 30%, PI = 15%, w = 15%, mod. density factor = 0.85), Inert 1.5 ft (LL = 25%, PI = 10%, w = 20%, mod. density factor = 0.8) | | | | | | | | | | | | | | | | |

**Table E-86. Calculations with the Surcharge of 1 psi and Treatment for the Rigid Pavement for Section B, Fort Worth North Loop IH 820.**

| Depth (ft.) | Avg. Load (psi) | LL (%) | Dry 0.2LL+9 (%) | Wet 0.47LL+2 (%) | Moisture (%) | Dry/ Avg/Wet | No. 40 (%) | PI (%) | Volume Swell (%) | Free Swell (%) | PVR, Top of Layer (in) | PVR, Bottom of Layer (in) | Diff. (in) | Mod.- No.40 Factor | Mod. Density Factor | PVR in Layer (in.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0-2.0 | 2 | 40 | 17.8 | 20.8 | 20 | dry | 100 | 25 | 3 | 6.5 | 0.27 | 0.35 | 0.08 | 1 | 0.85 | 0.068 |
| 2.0-4.0 | 4 | 55 | 21.1 | 27.85 | 20.2 | dry | 100 | 30 | 8.4 | 11.6 | 0.98 | 1.55 | 0.57 | 1 | 1 | 0.57 |
| 4.0-6.0 | 6 | 55 | 21.1 | 27.85 | 11.35 | dry | 100 | 30 | 8.4 | 11.6 | 1.55 | 1.91 | 0.36 | 1 | 1 | 0.36 |
| 6.0-8.0 | 8 | 65 | 23.3 | 32.55 | 11.35 | dry | 100 | 38 | 11.1 | 14.5 | 2.45 | 2.90 | 0.45 | 1 | 1 | 0.45 |
| 8.0-10.0 | 10 | 65 | 23.3 | 32.55 | 18.41 | dry | 100 | 38 | 11.1 | 14.5 | 2.90 | 3.24 | 0.34 | 1 | 1 | 0.34 |
| 10.0-12.0 | 12 | 53 | 20.66 | 26.91 | 18.41 | dry | 100 | 32 | 9.0 | 12.2 | 2.61 | 2.80 | 0.19 | 1 | 1 | 0.19 |
| 12.0-14.0 | 14 | 45 | 18.9 | 23.15 | 18.41 | dry | 100 | 25 | 6.5 | 9.6 | 1.85 | 1.92 | 0.07 | 1 | 1 | 0.07 |
| 14.0-16.0 | 16 | 45 | 18.9 | 23.15 | 24.9 | dry | 100 | 15 | 3.0 | 5.8 | 0.61 | 0.62 | 0.01 | 1 | 1 | 0.01 |
| NOTE: surcharge load of 1 psi, LTS 8.0 in thick (LL = 30%, PI = 15%, w = 15%, mod. density factor = 0.85) | | | | | | | | | | | | | | Total PVR (in) = | | 2.06 |

**Table E-87. Calculations with the Surcharge of 1 psi and Treatment for the Flexible Pavement for Section C, Fort Worth North Loop IH 820.**

| Depth (ft.) | Avg. Load (psi) | LL (%) | Dry 0.2LL+9 (%) | Wet 0.47LL+2 (%) | Moisture (%) | Dry/ Avg/Wet | No. 40 (%) | PI (%) | Volume Swell (%) | Free Swell (%) | PVR, Top of Layer (in) | PVR, Bottom of Layer (in) | Diff. (in) | Mod.- No.40 Factor | Mod. Density Factor | PVR in Layer (in.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0-2.0 | 2 | 30 | 15.6 | 16.1 | 15 | dry | 100 | 15 | 3 | 5.8 | 0.00 | 0.20 | 0.2 | 1 | 0.85 | 0.17 |
| 2.0-4.0 | 4 | 20 | 13.4 | 11.4 | 20 | dry | 100 | 10 | 1.0 | 3.7 | 0.18 | 0.22 | 0.04 | 1 | 0.8 | 0.032 |
| 4.0-6.0 | 6 | 62 | 22.64 | 31.14 | 25.0 | dry | 100 | 36 | 10.5 | 13.8 | 1.79 | 2.31 | 0.52 | 1 | 1 | 0.52 |
| 6.0-8.0 | 8 | 50 | 20 | 25.5 | 24.8 | wet | 100 | 31 | 4.0 | 6.9 | 1.05 | 1.17 | 0.12 | 1 | 1 | 0.12 |
| 8.0-10.0 | 10 | 50 | 20 | 25.5 | 25.2 | wet | 100 | 31 | 4 | 6.9 | 1.17 | 1.21 | 0.04 | 1 | 1 | 0.04 |
| 10.0-12.0 | 12 | 52 | 20.44 | 26.44 | 25.2 | wet | 100 | 28 | 3.5 | 6.3 | 1.03 | 1.08 | 0.05 | 1 | 1 | 0.05 |
| 12.0-14.0 | 14 | 52 | 20.44 | 26.44 | 25.2 | wet | 100 | 28 | 3.5 | 6.3 | 1.08 | 1.09 | 0.01 | 1 | 1 | 0.01 |
| 14.0-16.0 | 16 | 52 | 20.44 | 26.44 | 25.2 | wet | 100 | 28 | 3.5 | 6.3 | 1.09 | 1.1 | 0.01 | 1 | 1 | 0.01 |
| NOTE: surcharge load of 1 psi, LTS 2.5 ft thick (LL = 30%, PI = 15%, w = 15%, mod. density factor = 0.85), Inert 1.0 ft (LL = 25%, PI = 10%, w = 20%, mod. density factor = 0.8) | | | | | | | | | | | | | | Total PVR (in) = | | 0.95 |

**Table E-88. Calculations with the Surcharge of 1 psi and Treatment for the Rigid Pavement for Section C, Fort Worth North Loop IH 820.**

| Depth (ft.) | Avg. Load (psi) | LL (%) | Dry 0.2LL+9 (%) | Wet 0.47LL+2 (%) | Moisture (%) | Dry/ Avg/Wet | No. 40 (%) | PI (%) | Volume Swell (%) | Free Swell (%) | PVR, Top of Layer (in) | PVR, Bottom of Layer (in) | Diff. (in) | Mod.- No.40 Factor | Mod. Density Factor | PVR in Layer (in.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0-2.0 | 2 | 40 | 17.8 | 20.8 | 20 | dry | 100 | 25 | 3 | 6.5 | 0.28 | 0.42 | 0.14 | 1 | 0.85 | 0.119 |
| 2.0-4.0 | 4 | 62 | 22.64 | 31.14 | 22.8 | dry | 100 | 36 | 10.5 | 13.8 | 1.02 | 1.79 | 0.77 | 1 | 1 | 0.77 |
| 4.0-6.0 | 6 | 62 | 22.64 | 31.14 | 25.0 | dry | 100 | 36 | 10.5 | 13.8 | 1.79 | 2.31 | 0.52 | 1 | 1 | 0.52 |
| 6.0-8.0 | 8 | 50 | 20 | 25.5 | 24.8 | wet | 100 | 31 | 4.0 | 6.9 | 1.05 | 1.17 | 0.12 | 1 | 1 | 0.12 |
| 8.0-10.0 | 10 | 50 | 20 | 25.5 | 25.2 | wet | 100 | 31 | 4 | 6.9 | 1.17 | 1.21 | 0.04 | 1 | 1 | 0.04 |
| 10.0-12.0 | 12 | 52 | 20.44 | 26.44 | 25.2 | wet | 100 | 28 | 3.5 | 6.3 | 1.03 | 1.08 | 0.05 | 1 | 1 | 0.05 |
| 12.0-14.0 | 14 | 52 | 20.44 | 26.44 | 25.2 | wet | 100 | 28 | 3.5 | 6.3 | 1.08 | 1.09 | 0.01 | 1 | 1 | 0.01 |
| 14.0-16.0 | 16 | 52 | 20.44 | 26.44 | 25.2 | wet | 100 | 28 | 3.5 | 6.3 | 1.09 | 1.1 | 0.01 | 1 | 1 | 0.01 |
| NOTE :surcharge load of 1 psi, LTS 1.0 ft thick (LL = 30%, PI = 15%, w = 15%, mod. density factor = 0.85) | | | | | | | | | | | | | | Total PVR (in) = | | 1.64 |

**Table E-89. Calculations with the Surcharge of 1 psi and Treatment for the Flexible Pavement, Atlanta US 271.**

| Depth (ft.) | Avg. Load (psi) | LL (%) | Dry 0.2LL+9 (%) | Wet 0.47LL+2 (%) | Moisture (%) | Dry/ Avg/Wet | No. 40 (%) | PI (%) | Volume Swell (%) | Free Swell (%) | PVR, Top of Layer (in) | PVR, Bottom of Layer (in) | Diff. (in) | Mod.- No.40 Factor | Mod. Density Factor | PVR in Layer (in.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0-2.0 | 2 | 30 | 15.6 | 16.1 | 15 | dry | 100 | 15 | 3 | 5.8 | 0.20 | 0.32 | 0.12 | 1 | 0.85 | 0.102 |
| 2.0-4.0 | 4 | 48 | 19.56 | 24.56 | 16.1 | dry | 100 | 26 | 6.8 | 9.9 | 0.90 | 1.30 | 0.4 | 1 | 1 | 0.4 |
| 4.0-6.0 | 6 | 37 | 17.14 | 19.39 | 17 | dry | 100 | 17 | 3.5 | 6.3 | 0.61 | 0.70 | 0.09 | 1 | 1 | 0.09 |
| 6.0-8.0 | 8 | 37 | 17.14 | 19.39 | 17 | dry | 100 | 17 | 3.5 | 6.3 | 0.70 | 0.72 | 0.02 | 1 | 1 | 0.02 |
| 8.0-10.0 | 10 | 40 | 17.8 | 20.8 | 16.7 | dry | 100 | 25 | 6.5 | 9.6 | 1.70 | 1.82 | 0.12 | 1 | 1 | 0.12 |
| 10.0-12.0 | 12 | 40 | 17.8 | 20.8 | 16.7 | dry | 100 | 25 | 6.5 | 9.6 | 1.82 | 1.93 | 0.11 | 1 | 1 | 0.11 |
| 12.0-14.0 | 14 | 37 | 17.14 | 19.39 | 15.8 | dry | 100 | 15 | 2.8 | 5.6 | 0.55 | 0.58 | 0.03 | 1 | 1 | 0.03 |
| 14.0-16.0 | 16 | 37 | 17.14 | 19.39 | 15.8 | dry | 100 | 15 | 2.8 | 5.6 | 0.58 | 0.60 | 0.02 | 1 | 1 | 0.02 |
| 16.0-18.0 | 18 | 37 | 17.14 | 19.39 | 15.8 | dry | 100 | 15 | 2.8 | 5.6 | 0.60 | 0.62 | 0.02 | 1 | 1 | 0.02 |
| NOTE: surcharge load of 1 psi, LTS 2.2 ft thick (LL = 30%, PI = 15%, w = 15%, mod. density factor = 0.85) | | | | | | | | | | | | | | Total PVR (in) = | | 0.91 |

## Table E-90. Calculations with the Surcharge of 1 psi and Treatment for the Rigid Pavement, Atlanta US 271.

| Depth (ft.) | Avg. Load (psi) | LL (%) | Dry 0.2LL+9 (%) | Wet 0.47LL+2 (%) | Moisture (%) | Dry/ Avg/Wet | No. 40 (%) | PI (%) | Volume Swell (%) | Free Swell (%) | PVR, Top of Layer (in) | PVR, Bottom of Layer (in) | Diff. (in) | Mod.- No.40 Factor | Mod. Density Factor | PVR in Layer (in.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0-2.0 | 2 | 48 | 19.56 | 24.56 | 16.1 | dry | 100 | 26 | 6.8 | 9.9 | 0.55 | 0.90 | 0.35 | 1 | 1 | 0.35 |
| 2.0-4.0 | 4 | 48 | 19.56 | 24.56 | 16.1 | dry | 100 | 26 | 6.8 | 9.9 | 0.90 | 1.30 | 0.4 | 1 | 1 | 0.4 |
| 4.0-6.0 | 6 | 37 | 17.14 | 19.39 | 17 | dry | 100 | 17 | 3.5 | 6.3 | 0.61 | 0.70 | 0.09 | 1 | 1 | 0.09 |
| 6.0-8.0 | 8 | 37 | 17.14 | 19.39 | 17 | dry | 100 | 17 | 3.5 | 6.3 | 0.70 | 0.72 | 0.02 | 1 | 1 | 0.02 |
| 8.0-10.0 | 10 | 40 | 17.8 | 20.8 | 16.7 | dry | 100 | 25 | 6.5 | 9.6 | 1.70 | 1.82 | 0.12 | 1 | 1 | 0.12 |
| 10.0-12.0 | 12 | 40 | 17.8 | 20.8 | 16.7 | dry | 100 | 25 | 6.5 | 9.6 | 1.82 | 1.93 | 0.11 | 1 | 1 | 0.11 |
| 12.0-14.0 | 14 | 37 | 17.14 | 19.39 | 15.8 | dry | 100 | 15 | 2.8 | 5.6 | 0.55 | 0.58 | 0.03 | 1 | 1 | 0.03 |
| 14.0-16.0 | 16 | 37 | 17.14 | 19.39 | 15.8 | dry | 100 | 15 | 2.8 | 5.6 | 0.58 | 0.60 | 0.02 | 1 | 1 | 0.02 |
| 16.0-18.0 | 18 | 37 | 17.14 | 19.39 | 15.8 | dry | 100 | 15 | 2.8 | 5.6 | 0.60 | 0.62 | 0.02 | 1 | 1 | 0.02 |
| NOTE: surcharge load of 1 psi, no treatment on subgrade soil | | | | | | | | | | | | | | Total PVR (in) = | | 1.16 |

## Table E-91. Calculations with the Surcharge of 1 psi and Treatment for the Flexible Pavement, Austin Loop 1, Main Lane.

| Depth (ft.) | Avg. Load (psi) | LL (%) | Dry 0.2LL+9 (%) | Wet 0.47LL+2 (%) | Moisture (%) | Dry/ Avg/Wet | No. 40 (%) | PI (%) | Volume Swell (%) | Free Swell (%) | PVR, Top of Layer (in) | PVR, Bottom of Layer (in) | Diff. (in) | Mod.- No.40 Factor | Mod. Density Factor | PVR in Layer (in.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0-2.0 | 2 | 30 | 15.6 | 16.1 | 15 | dry | 100 | 15 | 3 | 5.8 | 0.20 | 0.32 | 0.12 | 1 | 0.85 | 0.102 |
| 2.0-4.0 | 4 | 40 | 17.8 | 20.8 | 19.03 | dry | 100 | 20 | 4.7 | 7.6 | 0.60 | 0.80 | 0.2 | 1 | 1 | 0.2 |
| 4.0-6.0 | 6 | 68 | 23.96 | 33.96 | 23.11 | dry | 100 | 33 | 9.4 | 12.7 | 1.65 | 2.12 | 0.47 | 1 | 1 | 0.47 |
| 6.0-8.0 | 8 | 68 | 23.96 | 33.96 | 23.11 | dry | 100 | 33 | 9.4 | 12.7 | 2.12 | 2.43 | 0.31 | 1 | 1 | 0.31 |
| 8.0-10.0 | 10 | 68 | 23.96 | 33.96 | 23.00 | dry | 100 | 33 | 9.4 | 12.7 | 2.43 | 2.72 | 0.29 | 1 | 1 | 0.29 |
| 10.0-12.0 | 12 | 68 | 23.96 | 33.96 | 23.00 | dry | 100 | 35 | 10.5 | 13.8 | 3.00 | 3.21 | 0.21 | 1 | 1 | 0.21 |
| 12.0-14.0 | 14 | 68 | 23.96 | 33.96 | 24.09 | dry | 100 | 35 | 10.5 | 13.8 | 3.21 | 3.43 | 0.22 | 1 | 1 | 0.22 |
| 14.0-16.0 | 16 | 68 | 23.96 | 33.96 | 24.09 | dry | 100 | 35 | 10.5 | 13.8 | 3.43 | 3.56 | 0.13 | 1 | 1 | 0.13 |
| NOTE: surcharge load of 1 psi, LTS 2.8 ft (LL = 30%, PI = 15%, w =15%, mod. density factor = 0.85) | | | | | | | | | | | | | | Total PVR (in) = | | 1.93 |

## Table E-92. Calculations with the Surcharge of 1 psi and Treatment for the Rigid Pavement, Austin Loop 1, Main Lane.

| Depth (ft.) | Avg. Load (psi) | LL (%) | Dry 0.2LL+9 (%) | Wet 0.47LL+2 (%) | Moisture (%) | Dry/ Avg/Wet | No. 40 (%) | PI (%) | Volume Swell (%) | Free Swell (%) | PVR, Top of Layer (in) | PVR, Bottom of Layer (in) | Diff. (in) | Mod.- No.40 Factor | Mod. Density Factor | PVR in Layer (in.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0-2.0 | 2 | 30 | 15.6 | 16.1 | 15 | dry | 100 | 15 | 3 | 5.8 | 0.20 | 0.32 | 0.12 | 1 | 0.85 | 0.102 |
| 2.0-4.0 | 4 | 49 | 19.78 | 25.03 | 19.03 | dry | 100 | 29 | 8.0 | 11.2 | 0.98 | 1.35 | 0.37 | 1 | 1 | 0.37 |
| 4.0-6.0 | 6 | 68 | 23.96 | 33.96 | 23.11 | dry | 100 | 33 | 9.4 | 12.7 | 1.65 | 2.12 | 0.47 | 1 | 1 | 0.47 |
| 6.0-8.0 | 8 | 68 | 23.96 | 33.96 | 23.11 | dry | 100 | 33 | 9.4 | 12.7 | 2.12 | 2.43 | 0.31 | 1 | 1 | 0.31 |
| 8.0-10.0 | 10 | 68 | 23.96 | 33.96 | 23.00 | dry | 100 | 33 | 9.4 | 12.7 | 2.43 | 2.72 | 0.29 | 1 | 1 | 0.29 |
| 10.0-12.0 | 12 | 68 | 23.96 | 33.96 | 23.00 | dry | 100 | 35 | 10.5 | 13.8 | 3.00 | 3.21 | 0.21 | 1 | 1 | 0.21 |
| 12.0-14.0 | 14 | 68 | 23.96 | 33.96 | 24.09 | dry | 100 | 35 | 10.5 | 13.8 | 3.21 | 3.43 | 0.22 | 1 | 1 | 0.22 |
| 14.0-16.0 | 16 | 68 | 23.96 | 33.96 | 24.09 | dry | 100 | 35 | 10.5 | 13.8 | 3.43 | 3.56 | 0.13 | 1 | 1 | 0.13 |
| NOTE: surcharge load of 1 psi, LTS 2.0 ft (LL = 30%, PI = 15%, w = 15%, mod. density factor = 0.85) | | | | | | | | | | | | | | Total PVR (in) = | | 2.10 |

## Table E-93. Calculations with the Surcharge of 1 psi and Treatment for the Flexible Pavement, Austin Loop 1, Frontage Road.

| Depth (ft.) | Avg. Load (psi) | LL (%) | Dry 0.2LL+9 (%) | Wet 0.47LL+2 (%) | Moisture (%) | Dry/ Avg/Wet | No. 40 (%) | PI (%) | Volume Swell (%) | Free Swell (%) | PVR, Top of Layer (in) | PVR, Bottom of Layer (in) | Diff. (in) | Mod.- No.40 Factor | Mod. Density Factor | PVR in Layer (in.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0-2.0 | 2 | 30 | 15.6 | 16.1 | 15 | dry | 100 | 15 | 3 | 5.8 | 0.20 | 0.32 | 0.12 | 1 | 0.85 | 0.102 |
| 2.0-4.0 | 4 | 20 | 13.4 | 11.4 | 20 | dry | 100 | 10 | 1.0 | 3.7 | 0.18 | 0.22 | 0.04 | 1 | 0.8 | 0.032 |
| 4.0-6.0 | 6 | 68 | 23.96 | 33.96 | 23.11 | dry | 100 | 33 | 9.4 | 12.7 | 1.65 | 2.12 | 0.47 | 1 | 1 | 0.47 |
| 6.0-8.0 | 8 | 68 | 23.96 | 33.96 | 23.11 | dry | 100 | 33 | 9.4 | 12.7 | 2.12 | 2.43 | 0.31 | 1 | 1 | 0.31 |
| 8.0-10.0 | 10 | 68 | 23.96 | 33.96 | 23.00 | dry | 100 | 33 | 9.4 | 12.7 | 2.43 | 2.72 | 0.29 | 1 | 1 | 0.29 |
| 10.0-12.0 | 12 | 68 | 23.96 | 33.96 | 23.00 | dry | 100 | 35 | 10.5 | 13.8 | 3.00 | 3.21 | 0.21 | 1 | 1 | 0.21 |
| 12.0-14.0 | 14 | 68 | 23.96 | 33.96 | 24.09 | dry | 100 | 35 | 10.5 | 13.8 | 3.21 | 3.43 | 0.22 | 1 | 1 | 0.22 |
| 14.0-16.0 | 16 | 68 | 23.96 | 33.96 | 24.09 | dry | 100 | 35 | 10.5 | 13.8 | 3.43 | 3.56 | 0.13 | 1 | 1 | 0.13 |
| | | | | | | | | | | | | | | Total PVR (in) = | | 1.76 |
| NOTE: surcharge load of 1 psi, LTS 2.0 ft (LL = 30%, PI = 15%, w = 15%, mod. density factor = 0.85), Inert 2.0 ft (LL = 25%, PI = 10%, w = 20%, mod. density factor = 0.8) | | | | | | | | | | | | | | | | |

## Table E-94. Calculations with the Surcharge of 1 psi and Treatment for the Rigid Pavement, Austin Loop 1, Frontage Road.

| Depth (ft.) | Avg. Load (psi) | LL (%) | Dry 0.2LL+9 (%) | Wet 0.47LL+2 (%) | Moisture (%) | Dry/ Avg/Wet | No. 40 (%) | PI (%) | Volume Swell (%) | Free Swell (%) | PVR, Top of Layer (in) | PVR, Bottom of Layer (in) | Diff. (in) | Mod.- No.40 Factor | Mod. Density Factor | PVR in Layer (in.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0-2.0 | 2 | 49 | 19.78 | 25.03 | 19.03 | dry | 100 | 29 | 8.0 | 11.2 | 0.61 | 0.98 | 0.37 | 1 | 1 | 0.37 |
| 2.0-4.0 | 4 | 49 | 19.78 | 25.03 | 19.03 | dry | 100 | 29 | 8.0 | 11.2 | 0.98 | 1.35 | 0.37 | 1 | 1 | 0.37 |
| 4.0-6.0 | 6 | 68 | 23.96 | 33.96 | 23.11 | dry | 100 | 33 | 9.4 | 12.7 | 1.65 | 2.12 | 0.47 | 1 | 1 | 0.47 |
| 6.0-8.0 | 8 | 68 | 23.96 | 33.96 | 23.11 | dry | 100 | 33 | 9.4 | 12.7 | 2.12 | 2.43 | 0.31 | 1 | 1 | 0.31 |
| 8.0-10.0 | 10 | 68 | 23.96 | 33.96 | 23.00 | dry | 100 | 33 | 9.4 | 12.7 | 2.43 | 2.72 | 0.29 | 1 | 1 | 0.29 |
| 10.0-12.0 | 12 | 68 | 23.96 | 33.96 | 23.00 | dry | 100 | 35 | 10.5 | 13.8 | 3.00 | 3.21 | 0.21 | 1 | 1 | 0.21 |
| 12.0-14.0 | 14 | 68 | 23.96 | 33.96 | 24.09 | dry | 100 | 35 | 10.5 | 13.8 | 3.21 | 3.43 | 0.22 | 1 | 1 | 0.22 |
| 14.0-16.0 | 16 | 68 | 23.96 | 33.96 | 24.09 | dry | 100 | 35 | 10.5 | 13.8 | 3.43 | 3.56 | 0.13 | 1 | 1 | 0.13 |
| NOTE: surcharge load of 1 psi, no treatment on subgrade soil | | | | | | | | | | | | | | Total PVR (in) = | | 2.37 |

# APPENDIX F

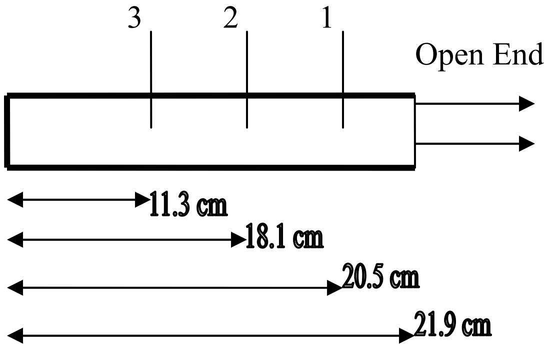
This chapter includes the diffusion coefficient values and curves of different soil samples obtained from the testing carried out at Texas A&M University. There are three subparts in this chapter APPENDIX F-1, APPENDIX F-2, and APPENDIX F-3, which show the data of Fort Worth, Atlanta, and Austin Districts, respectively.

## APPENDIX F-1

**Project: Fort Worth District**

**Borehole: A1**

**Sample Depth: 5'-6'**




Total Length of the sample, L = 21.9 cm

Distance of psychrometer 1 from closed end, x = 20.5cm

Initial Suction, $u_0$ = 3.28 pF

Relative Humidity = 31%

Atmospheric Suction, $u_a$ = 6.21 pF

Diffusion Coefficient, $\alpha = 8.93E^{-5}$ $cm^2/sec$

Psychrometer 1:

No.: 43447, $\pi_{v0}$ = 58 @ 25ºC

Setup Time & Date: 5:23 PM, 12/20/03

| No. | T | $\pi_v$ | µV | Total Suction (bar) | Total Suction (pF) | Time (minutes) | Time | Date |
|---|---|---|---|---|---|---|---|---|
| 1 | 21.0 | 55.20 | 12.5 | 15.7 | 4.20 | 416 | 12:19 AM | 12/21/2003 |
| 2 | 22.5 | 56.25 | 26.0 | 36.0 | 4.57 | 1560 | 7:23 PM | 12/21/2003 |
| 3 | 22.5 | 56.25 | 42.0 | 60.2 | 4.79 | 2975 | 6:58 PM | 12/22/2003 |

| Project: Fort Worth District |
|---|
| Borehole: A1 |
| Sample Depth: 5'-6' |

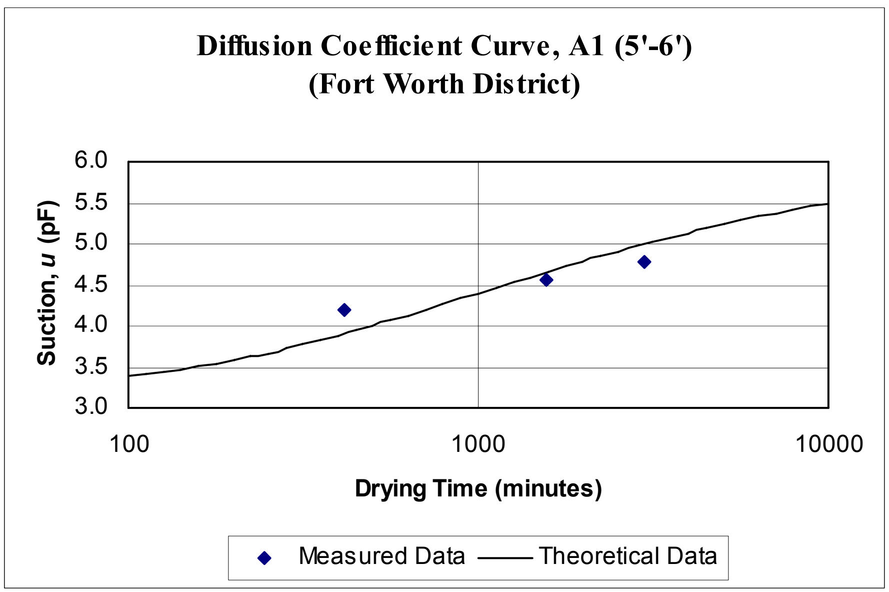
Psychrometer 2:

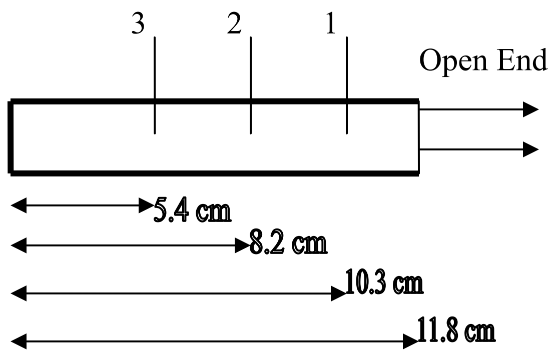
No.: 40305, $\pi_{v0}$ = 60 @ 25ºC

Setup Time & Date: 5:23 PM, 12/20/03

| No. | T | $\pi_v$ | μV | Total Suction (bar) | Total Suction (pF) | Time (minutes) | Time | Date |
|---|---|---|---|---|---|---|---|---|
| 1 | 22.0 | 57.90 | 3.0 | 3.3 | 3.52 | 419 | 12:22 AM | 12/21/2003 |
| 2 | 23.0 | 58.60 | 9.5 | 12.4 | 4.10 | 1561 | 7:24 PM | 12/21/2003 |
| 3 | 23.0 | 58.60 | 11.0 | 14.5 | 4.17 | 2977 | 7:00 PM | 12/22/2003 |
| 4 | 23.0 | 58.60 | 16.0 | 21.6 | 4.34 | 4448 | 7:31 PM | 12/232003 |
| 5 | 23.5 | 58.95 | 23.0 | 31.5 | 4.51 | 5838 | 6:21 PM | 12/24/2003 |
| 6 | 24.0 | 59.30 | 35.0 | 48.4 | 4.69 | 7298 | 6:41 PM | 12/26/2003 |

Diffusion Coefficient Curve for Psychrometer 1:






**Project: Fort Worth District**

**Borehole: A1**

**Sample Depth: 11'-12'**

Total Length of the sample, L = 11.8 cm

Distance of psychrometer 1 from closed end, x = 10.3cm

Initial Suction, $u_0$ = 3.38 pF

Relative Humidity = 44%

Atmospheric Suction, $u_a$ = 6.06 pF

Diffusion Coefficient, $\alpha = 5.90E^{-5}$ $cm^2$/sec

Psychrometer 1:

No.: 40332, $\pi_{v0}$ = 50 @ 25ºC

Setup Time & Date: 4:00 PM, 11/19/03

| No. | T | $\pi_v$ | μV | Total Suction (bar) | Total Suction (pF) | Time (minutes) | Time | Date |
|---|---|---|---|---|---|---|---|---|
| 1 | 22.5 | 48.25 | 15.5 | 22.8 | 4.37 | 1419 | 3:39 PM | 11/20/2003 |
| 2 | 22.5 | 48.25 | 31.0 | 46.2 | 4.67 | 2890 | 4:10 PM | 11/22/2003 |

Psychrometer 2:

No.: 40336, $\pi_{v0}$ = 50 @ 25ºC

Setup Time & Date: 4:00 PM, 11/19/03

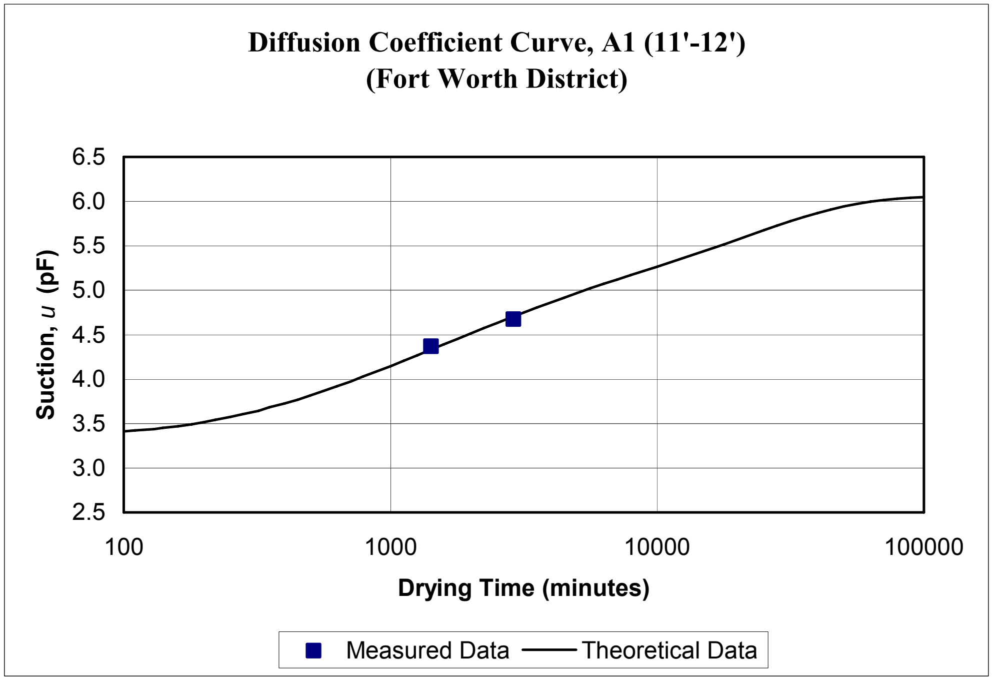
**Project: Fort Worth District**

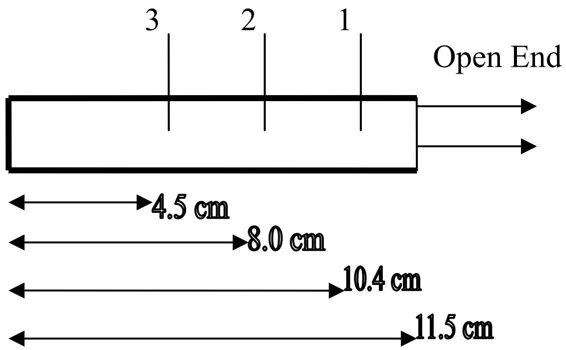
**Borehole: A1**

**Sample Depth: 11'-12'**

| No. | T | $\pi_v$ | µV | Total Suction (bar) | Total Suction (pF) | Time (minutes) | Time | Date |
|---|---|---|---|---|---|---|---|---|
| 1 | 23.0 | 48.60 | 9.0 | 12.8 | 4.12 | 1422 | 3:42 PM | 11/20/2003 |
| 2 | 23.0 | 48.60 | 18.0 | 26.3 | 4.43 | 2894 | 4:14 PM | 11/22/2003 |
| 3 | 23.5 | 48.95 | 22.5 | 33.0 | 4.53 | 5730 | 3:30 PM | 11/24/2003 |
| 4 | 23.5 | 48.95 | 38.0 | 56.2 | 4.76 | 8638 | 3:58 PM | 11/27/2003 |

Diffusion Coefficient Curve for Psychrometer 1:






**Project: Fort Worth District**

**Borehole: A2**

**Sample Depth: 2’-3’**

Total Length of the sample, L = 11.5 cm

Distance of psychrometer 2 from closed end, x = 8 cm

Initial Suction, $u_0$ = 4.56 pF

Relative Humidity = 31%

Atmospheric Suction, $u_a$ = 6.21 pF

Diffusion Coefficient, $\alpha = 3.06E^{-5}$ $cm^2/sec$

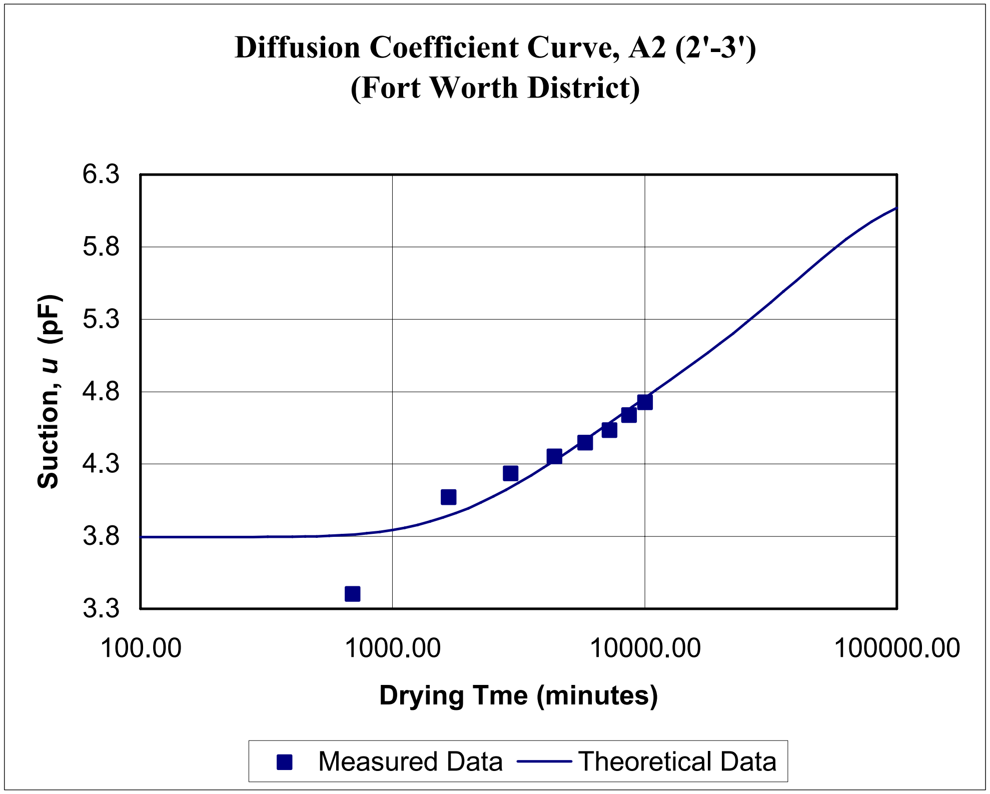
Psychrometer 2:

No.: 40322, $\pi_{v0}$ = 50 @ 25ºC

Setup Time & Date: 2:52 PM, 12/18/03

| No. | T | $\pi_v$ | μV | Total Suction (bar) | Total Suction (pF) | Time (minutes) | Time | Date |
|---|---|---|---|---|---|---|---|---|
| 1 | 20.5 | 46.85 | 2.0 | 2.5 | 3.40 | 695 | 1:17 AM | 12/19/2003 |
| 2 | 22.0 | 47.90 | 8.0 | 11.5 | 4.07 | 1670 | 5:02 PM | 12/19/2003 |
| 3 | 22.0 | 47.90 | 11.5 | 16.8 | 4.23 | 2948 | 2:20 PM | 12/20/2003 |
| 4 | 22.5 | 48.25 | 15.0 | 22.1 | 4.35 | 4395 | 7:27 PM | 12/21/2003 |
| 5 | 23.0 | 48.60 | 18.5 | 27.4 | 4.45 | 5818 | 7:10 PM | 12/22/2003 |
| 6 | 22.5 | 48.25 | 22.5 | 33.4 | 4.53 | 7251 | 7:03 PM | 12/23/2003 |
| 7 | 23.5 | 48.95 | 28.5 | 42.5 | 4.64 | 8676 | 6:48 PM | 12/24/2003 |
| 8 | 23.5 | 48.95 | 35.0 | 52.3 | 4.73 | 10049 | 5:41 PM | 12/26/2003 |

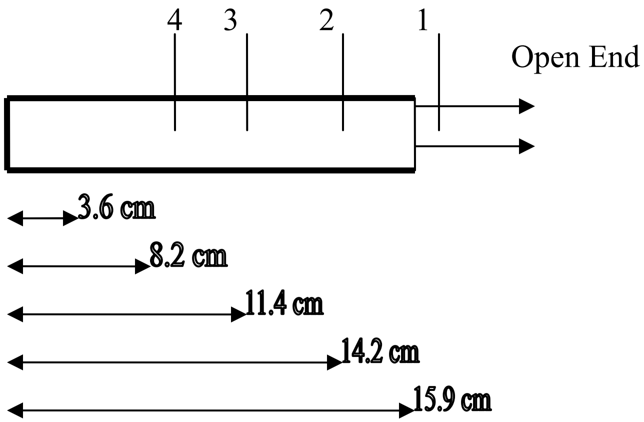
Diffusion Coefficient Curve for Psychrometer 2:




**Project: Fort Worth District**

**Borehole: A2**

**Sample Depth: 2’-3’**




**Project: Fort Worth District**

**Borehole: A2**

**Sample Depth: 12'-13'**

Total Length of the sample, L = 15.9 cm

Distance of psychrometer 1 from closed end, x = 14.2 cm

Initial Suction, $u_0$ = 3.51 pF

Relative Humidity = 56%

Atmospheric Suction, $u_a$ = 5.91 pF

Diffusion Coefficient, $\alpha = 2.00E^{-5}$ $cm^2$/sec

Psychrometer 1:

No.: 40307, $\pi_{v0}$ = 56 @ 25ºC

Setup Time & Date: 3:30 PM, 10/07/03

| No. | T | $\pi_v$ | μV | Total Suction (bar) | Total Suction (pF) | Time (minutes) | Time | Date |
|---|---|---|---|---|---|---|---|---|
| 5 | 21.5 | 53.55 | 45.0 | 62.9 | 4.81 | 11217 | 10:27 AM | 10/15/03 |
| 1 | 22.5 | 54.25 | 9.0 | 9.1 | 3.97 | 1515 | 4:45 PM | 10/8/03 |
| 2 | 22.0 | 53.90 | 11.5 | 12.9 | 4.12 | 2800 | 2:10 PM | 10/9/03 |
| 3 | 21.5 | 53.55 | 16.0 | 19.6 | 4.30 | 4335 | 3:45 PM | 10/10/03 |
| 4 | 21.5 | 53.55 | 29.0 | 39.0 | 4.60 | 8540 | 1:50 PM | 10/13/03 |
| 5 | 21.5 | 53.55 | 33.0 | 45.0 | 4.66 | 9812 | 11:02 AM | 10/14/03 |
| 6 | 22.0 | 53.90 | 35.5 | 48.7 | 4.70 | 10094 | 3:44 PM | 10/14/03 |

**Project: Fort Worth District**

**Borehole: A2**

**Sample Depth: 12'-13'**

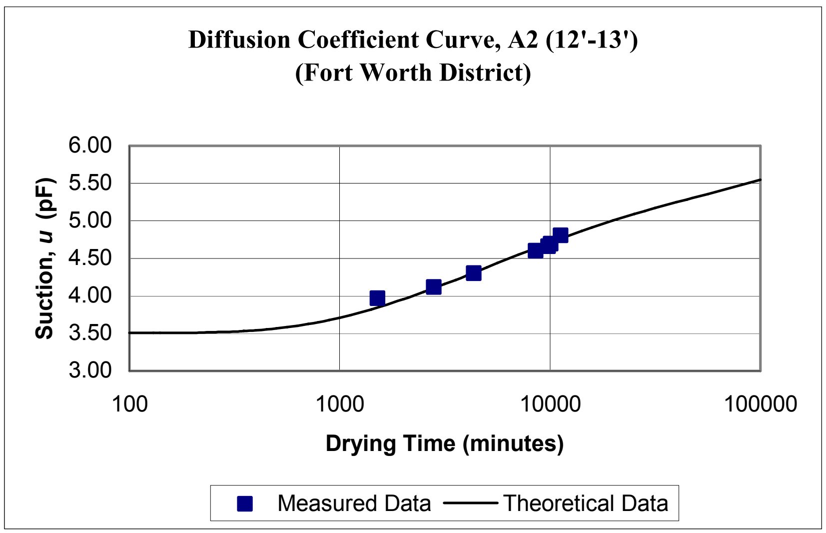
Psychrometer 2:

No.: 40326, $\pi_{v0} = 49$ @ 25ºC

Setup Time & Date: 3:30 PM, 10/07/03

| No. | T | $\pi_v$ | μV | Total Suction (bar) | Total Suction (pF) | Time (minutes) | Time | Date |
|---|---|---|---|---|---|---|---|---|
| 1 | 22.5 | 47.25 | 5.5 | 3.8 | 3.58 | 1520 | 4:50 PM | 10/8/03 |
| 2 | 22.0 | 46.90 | 6.5 | 5.2 | 3.73 | 2805 | 2:15 PM | 10/9/03 |
| 3 | 21.5 | 46.55 | 8.0 | 7.4 | 3.88 | 4338 | 3:48 PM | 10/10/03 |
| 4 | 21.5 | 46.55 | 14.0 | 16.3 | 4.22 | 8558 | 2:08 PM | 10/13/03 |
| 5 | 22.0 | 46.90 | 15.5 | 18.5 | 4.28 | 9815 | 11:05 AM | 10/14/03 |
| 6 | 22.0 | 46.90 | 17.0 | 20.7 | 4.32 | 10095 | 3:45 PM | 10/14/03 |
| 7 | 21.5 | 46.55 | 19.5 | 24.4 | 4.40 | 11223 | 10:30 AM | 10/15/03 |

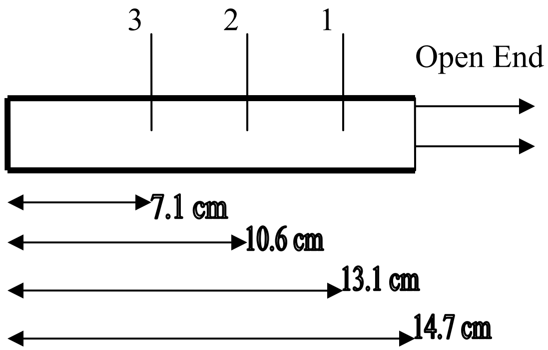
Diffusion Coefficient Curve for Psychrometer 1:



**Project: Fort Worth District**

**Borehole: A3**

**Sample Depth: 0'-1'**




Total Length of the sample, L = 14.7 cm

Distance of psychrometer 2 from closed end, x = 10.6 cm

Initial Suction, $u_0$ = 4.10 pF

Relative Humidity = 30%

Atmospheric Suction, $u_a$ = 6.22 pF

Diffusion Coefficient, $\alpha = 8.66E^{-5}$ $cm^2$/sec

Psychrometer 1:

No.: 43450, $\pi_{v0}$ = 52 @ 25ºC

Setup Time & Date: 5:30 PM, 12/20/03

| No. | T | $\pi_v$ | µV | Total Suction (bar) | Total Suction (pF) | Time (minutes) | Time | Date |
|---|---|---|---|---|---|---|---|---|
| 1 | 22.0 | 49.90 | 20.5 | 28.1 | 4.46 | 395 | 12:05 AM | 12/21/2003 |

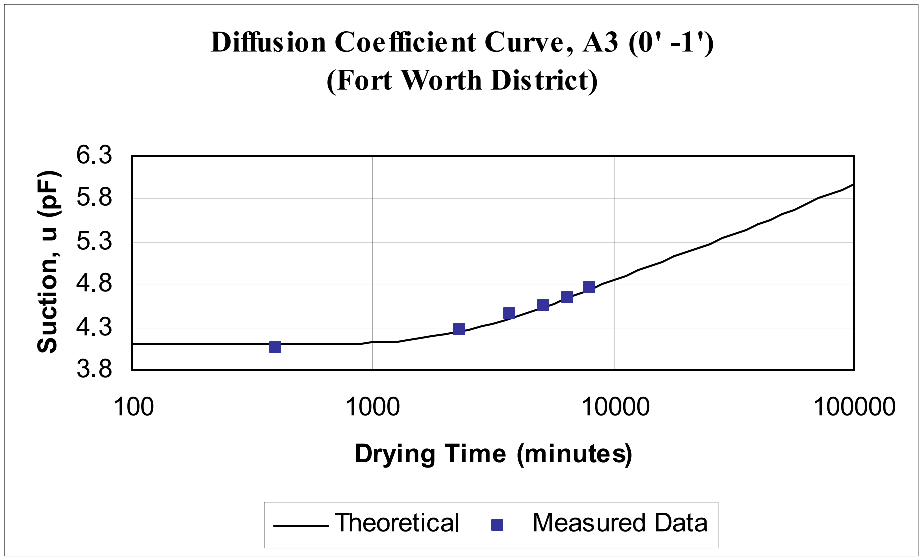
Psychrometer 2:

No.: 40325, $\pi_{v0}$ = 49 @ 25ºC

Setup Time & Date: 5:30 PM, 12/20/0

| No. | T | $\pi_v$ | μV | Total Suction (bar) | Total Suction (pF) | Time (minutes) | Time | Date |
|---|---|---|---|---|---|---|---|---|
| 1 | 23.0 | 47.60 | 8.5 | 11.2 | 4.06 | 398 | 12:08 AM | 12/21/2003 |
| 2 | 24.5 | 48.65 | 13.0 | 17.8 | 4.26 | 2288 | 7:38 PM | 12/21/2003 |
| 3 | 24.5 | 48.65 | 19.5 | 27.3 | 4.44 | 3738 | 7:28 PM | 12/22/2003 |
| 4 | 24.0 | 48.30 | 24.5 | 34.5 | 4.55 | 5184 | 7:34 PM | 12/23/2003 |
| 5 | 24.0 | 48.30 | 31.0 | 44.0 | 4.65 | 6536 | 6:10 PM | 12/24/2003 |
| 6 | 24.5 | 48.65 | 40.0 | 57.1 | 4.77 | 8010 | 6:44 PM | 12/26/2003 |

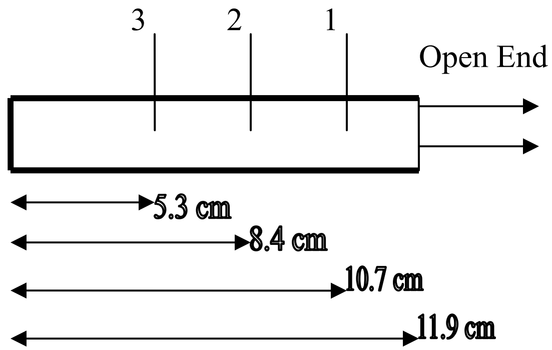
Diffusion Coefficient Curve for Psychrometer 2:




**Project: Fort Worth District**

**Borehole: A3**

**Sample Depth: 0'-1'**




**Project: Fort Worth District**

**Borehole: A3**

**Sample Depth: 9'-10'**

Total Length of the sample, L = 11.9 cm

Distance of psychrometer 2 from closed end, x = 10.7 cm

Initial Suction, $u_0$ = 3.25 pF

Relative Humidity = 31%

Atmospheric Suction, $u_a$ = 6.21 pF

Diffusion Coefficient, $\alpha = 5.05E^{-5}$ $cm^2/sec$

Psychrometer 1:

No.: 40333, $\pi_{v0}$ = 53 @ 25ºC

Setup Time & Date: 6:35 PM, 12/19/03

| No. | T | $\pi_v$ | µV | Total Suction (bar) | Total Suction (pF) | Time (minutes) | Time | Date |
|---|---|---|---|---|---|---|---|---|
| 1 | 21.5 | 50.55 | 18.5 | 26.7 | 4.44 | 1195 | 2:30 PM | 12/20/2003 |
| 2 | 21.0 | 50.20 | 26.0 | 37.9 | 4.59 | 2455 | 11:40 PM | 12/20/2003 |
| 3 | 23.0 | 51.60 | 35.0 | 51.4 | 4.72 | 3671 | 7:56 PM | 12/21/2003 |

**Project: Fort Worth District**

**Borehole: A3**

**Sample Depth: 9'-10'**

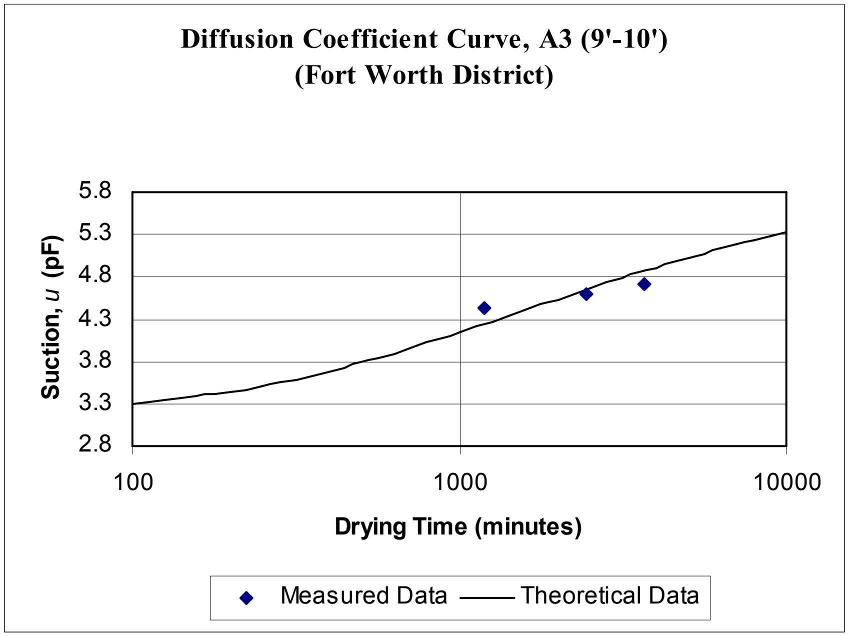
Psychrometer 2:

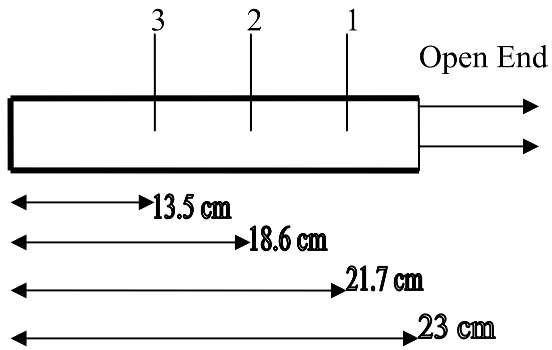
No.: 40312, $\pi_{v0}$ = 56 @ 25ºC

Setup Time & Date: 6:35 PM, 12/19/03

| No. | T | $\pi_v$ | μV | Total Suction (bar) | Total Suction (pF) | Time (minutes) | Time | Date |
|---|---|---|---|---|---|---|---|---|
| 1 | 22.0 | 53.90 | 9.5 | 10.4 | 4.03 | 1196 | 2:31 PM | 12/20/2003 |
| 2 | 22.0 | 53.90 | 12.5 | 14.9 | 4.18 | 2456 | 11:41 PM | 12/20/2003 |
| 3 | 23.5 | 54.95 | 12.5 | 14.9 | 4.18 | 3675 | 8:00 PM | 12/21/2003 |
| 4 | 23.5 | 54.95 | 21.5 | 28.4 | 4.46 | 5108 | 7:53 PM | 12/22/2003 |
| 5 | 22.5 | 54.25 | 30.0 | 41.1 | 4.62 | 6592 | 7:09 PM | 12/23/2003 |

Diffusion Coefficient Curve for Psychrometer 1:






**Project: Fort Worth District**

**Borehole: A4**

**Sample Depth: 5’-6’**

Total Length of the sample, L = 23 cm

Distance of psychrometer 2 from closed end, x = 21.7 cm

Initial Suction, $u_0$ = 3.22 pF

Relative Humidity = 31%

Atmospheric Suction, $u_a$ = 6.21 pF

Diffusion Coefficient, $\alpha = 9.88E^{-5}$ $cm^2$/sec

Psychrometer 1:

No.: 40320, $\pi_{v0}$ = 53 @ 25ºC

Setup Time & Date: 7:20 PM, 12/19/03

| No. | T | $\pi_v$ | μV | Total Suction (bar) | Total Suction (pF) | Time (minutes) | Time | Date |
|---|---|---|---|---|---|---|---|---|
| 1 | 22.0 | 50.90 | 25.5 | 35.0 | 4.55 | 1194 | 3:26 PM | 12/20/2003 |
| 2 | 22.0 | 50.90 | 39.0 | 55.1 | 4.75 | 1733 | 12:25 AM | 12/21/2003 |

Psychrometer 2:

No.: 43311, $\pi_{v0}$ = 52 @ 25ºC

Setup Time & Date: 7:20 PM, 12/19/03

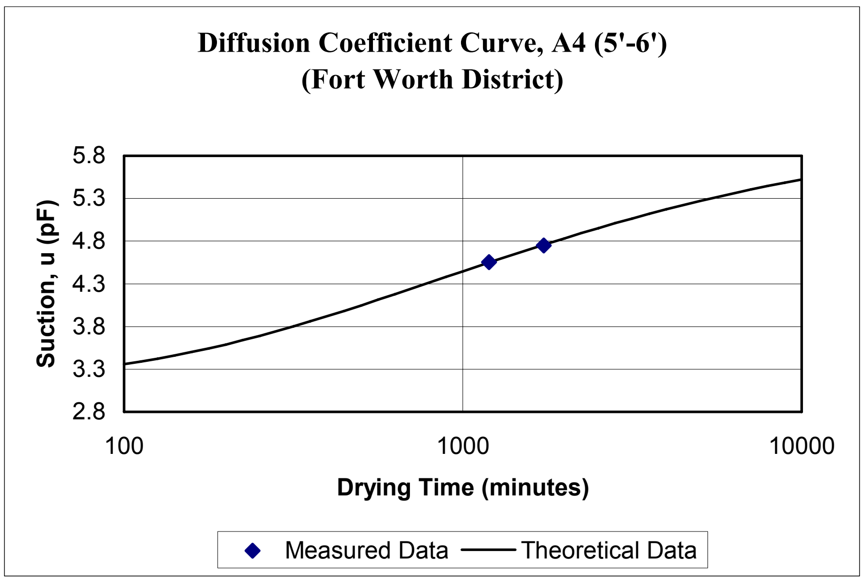
**Project: Fort Worth District**

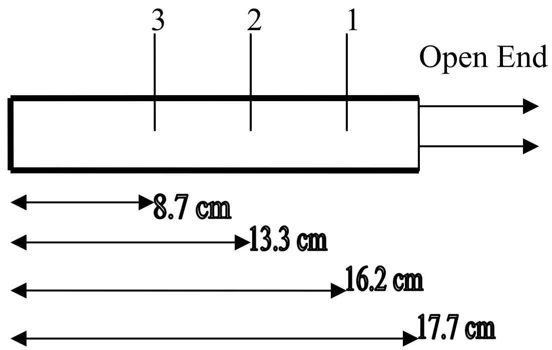
**Borehole: A4**

**Sample Depth: 5'-6'**

| No. | T | $\pi_v$ | µV | Total Suction (bar) | Total Suction (pF) | Time (minutes) | Time | Date |
|---|---|---|---|---|---|---|---|---|
| 1 | 22.5 | 50.25 | 4.0 | 3.8 | 3.59 | 1220 | 3:40 PM | 12/20/2003 |
| 2 | 23.0 | 50.60 | 4.0 | 3.8 | 3.59 | 2492 | 12:28 AM | 12/21/2003 |
| 3 | 23.5 | 50.95 | 4.0 | 3.8 | 3.59 | 3647 | 7:13 PM | 12/21/2003 |
| 4 | 23.0 | 50.60 | 5.5 | 6.0 | 3.79 | 5078 | 7:04 PM | 12/22/2003 |
| 5 | 23.5 | 50.95 | 8.0 | 9.6 | 3.99 | 6534 | 7:20 PM | 12/23/2003 |
| 6 | 23.5 | 50.95 | 14.0 | 18.1 | 4.27 | 7923 | 6:29 PM | 12/24/2003 |
| 7 | 23.5 | 50.95 | 15.0 | 19.6 | 4.30 | 9362 | 6:28 PM | 12/26/2003 |
| 8 | 24.0 | 51.30 | 25.0 | 33.9 | 4.54 | 10778 | 7:04 PM | 12/27/2003 |
| 9 | 24.0 | 51.30 | 32.0 | 43.9 | 4.65 | 12124 | 5:30 PM | 12/29/2003 |

Diffusion Coefficient Curve for Psychrometer 1:






Total Length of the sample, L = 17.7 cm

Distance of psychrometer 2 from closed end, x = 16.2 cm

Initial Suction, $u_0$ = 4.26 pF

Relative Humidity = 30%

Atmospheric Suction, $u_a$ = 6.22 pF

Diffusion Coefficient, $\alpha = 0.33E^{-5}$ $cm^2/sec$

Psychrometer 1:

No.: 40331, $\pi_{v0}$ = 50 @ 25ºC

Setup Time & Date: 2:20 PM, 12/20/03

| No. | T | $\pi_v$ | µV | Total Suction (bar) | Total Suction (pF) | Time (minutes) | Time | Date |
|---|---|---|---|---|---|---|---|---|
| 1 | 20.5 | 46.85 | 5.5 | 7.3 | 3.87 | 569 | 11:49 AM | 12/20/2003 |
| 2 | 22.0 | 47.90 | 7.5 | 10.2 | 4.02 | 1771 | 7:47 PM | 12/21/2003 |
| 3 | 23.0 | 48.60 | 9.0 | 12.4 | 4.10 | 3199 | 7:35 PM | 12/22/2003 |
| 4 | 23.0 | 48.60 | 14.5 | 20.5 | 4.32 | 4661 | 7:13 PM | 12/23/2003 |
| 5 | 23.0 | 48.60 | 21.5 | 30.7 | 4.50 | 6063 | 6:35 PM | 12/24/2003 |
| 6 | 23.5 | 48.95 | 27.5 | 39.4 | 4.60 | 7459 | 5:51 PM | 12/26/2003 |
| 7 | 24.0 | 49.30 | 31.0 | 44.5 | 4.66 | 8857 | 7:09 PM | 12/27/2003 |

**Project: Fort Worth District**

**Borehole: A4**

**Sample Depth: 10’-11’**

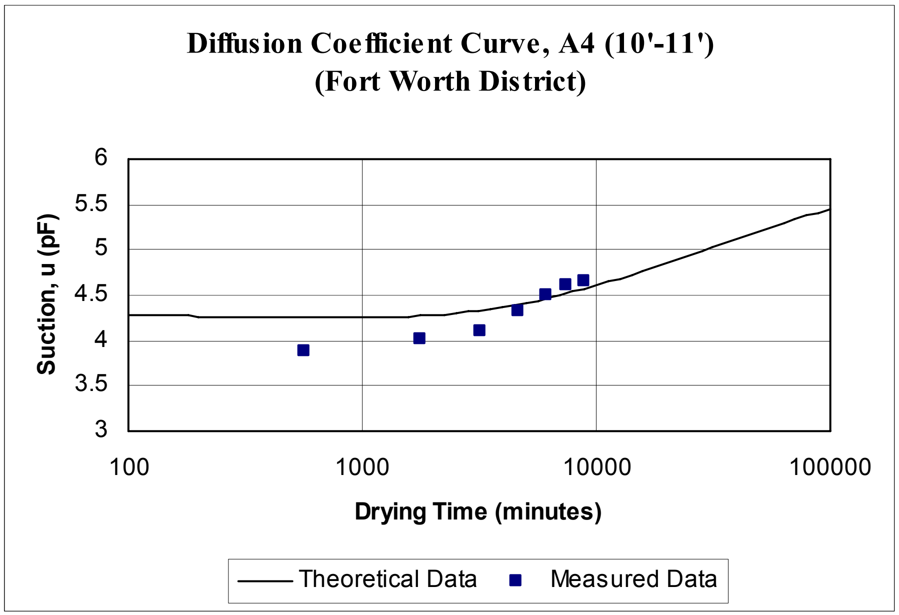
Psychrometer 2:

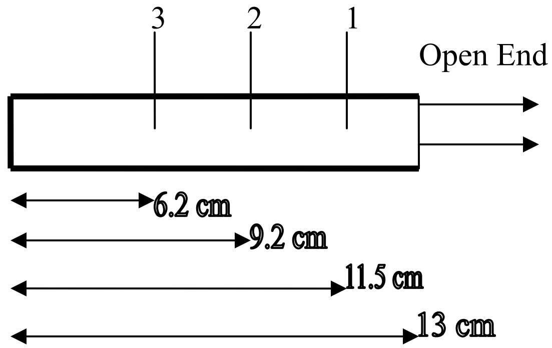
No.: 40321, $\pi_{v0}$ = 51 @ 25ºC

Setup Time & Date: 2:20 PM, 12/20/03

| No. | T | $\pi_v$ | μV | Total Suction (bar) | Total Suction (pF) | Time (minutes) | Time | Date |
|---|---|---|---|---|---|---|---|---|
| 1 | 22.0 | 48.90 | 4.0 | 5.0 | 3.71 | 572 | 11:52 AM | 12/20/2003 |
| 2 | 23.0 | 49.60 | 4.0 | 5.0 | 3.71 | 1778 | 7:51 PM | 12/21/2003 |
| 3 | 23.5 | 49.95 | 4.0 | 5.0 | 3.71 | 3211 | 7:40 PM | 12/22/2003 |
| 4 | 23.0 | 49.60 | 5.5 | 7.2 | 3.87 | 4676 | 7:16 PM | 12/23/2003 |
| 5 | 23.5 | 49.95 | 7.0 | 9.4 | 3.98 | 6080 | 6:37 PM | 12/24/2003 |
| 6 | 23.5 | 49.95 | 9.0 | 12.4 | 4.10 | 7479 | 5:54 PM | 12/26/2003 |
| 7 | 23.5 | 49.95 | 11.5 | 16.0 | 4.21 | 8880 | 7:12 PM | 12/27/2003 |
| 8 | 23.5 | 49.95 | 16.0 | 22.6 | 4.36 | 10215 | 5:24 PM | 12/29/2003 |

Diffusion Coefficient Curve for Psychrometer 1:






**Project: Fort Worth District**

**Borehole: A5**

**Sample Depth: 3'-4'**

Total Length of the sample, L = 13.0 cm

Distance of psychrometer 2 from closed end, x = 11.5 cm

Initial Suction, $u_0$ = 3.02 pF

Relative Humidity = 31%

Atmospheric Suction, $u_a$ = 6.21 pF

Diffusion Coefficient, $\alpha = 7.86E^{-5}\ cm^2/sec$

Psychrometer 1:

No.: 40316, $\pi_{v0}$ = 58 @ 25ºC

Setup Time & Date: 2:30 PM, 12/18/03

| No. | T | $\pi_v$ | µV | Total Suction (bar) | Total Suction (pF) | Time (minutes) | Time | Date |
|---|---|---|---|---|---|---|---|---|
| 1 | 21.0 | 55.20 | 16.0 | 19.0 | 4.29 | 618 | 1:00 AM | 12/19/2003 |
| 2 | 22.5 | 56.25 | 27.0 | 35.1 | 4.55 | 1587 | 5:09 PM | 12/19/2003 |
| 3 | 22.5 | 56.25 | 30.0 | 39.4 | 4.60 | 3174 | 7:36 PM | 12/19/2003 |
| 4 | 22.5 | 56.25 | 48.0 | 65.7 | 4.83 | 4298 | 2:10 PM | 12/20/2003 |

Psychrometer 2:

No.: 40363, $\pi_{v0} = 49$ @ 25ºC

Setup Time & Date: 2:30 PM, 12/18/03

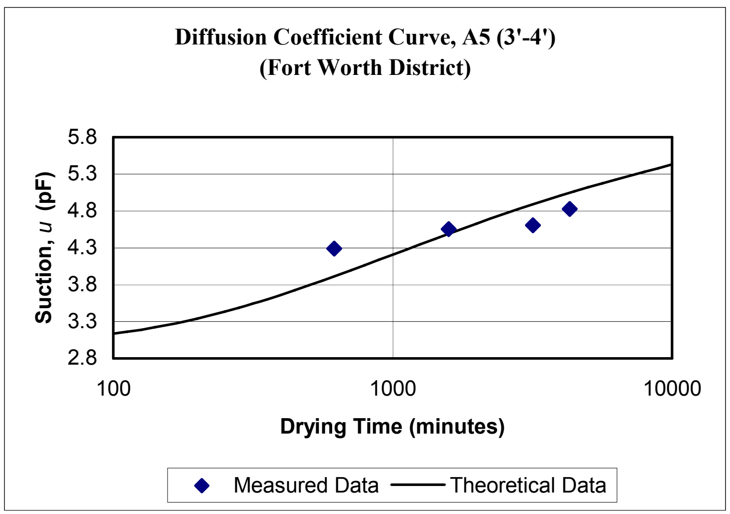
**Project: Fort Worth District**

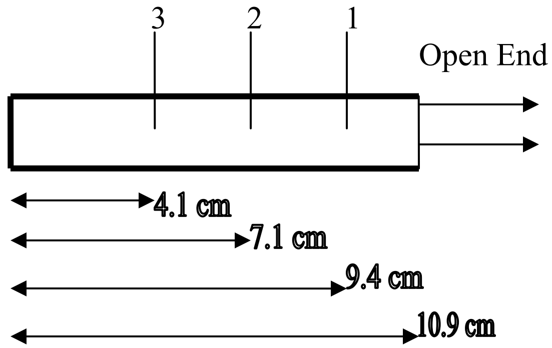
**Borehole: A5**

**Sample Depth: 3’-4’**

| No. | T | $\pi_v$ | μV | Total Suction (bar) | Total Suction (pF) | Time (minutes) | Time | Date |
|---|---|---|---|---|---|---|---|---|
| 1 | 22.0 | 46.90 | 6.0 | 4.7 | 3.68 | 635 | 1:05 AM | 12/19/2003 |
| 2 | 23.0 | 47.60 | 5.5 | 3.9 | 3.60 | 1600 | 5:10 PM | 12/19/2003 |
| 3 | 23.0 | 47.60 | 6.0 | 4.7 | 3.68 | 2861 | 2:11 PM | 12/20/2003 |
| 4 | 23.5 | 47.95 | 10.5 | 11.9 | 4.08 | 4658 | 8:08 PM | 12/21/2003 |
| 5 | 24.0 | 48.30 | 12.0 | 14.3 | 4.16 | 6046 | 7:59 PM | 12/22/2003 |
| 6 | 23.5 | 47.95 | 15.0 | 19.1 | 4.29 | 7519 | 7:26 PM | 12/23/2003 |
| 7 | 23.5 | 47.95 | 18.0 | 23.9 | 4.39 | 8898 | 6:25 PM | 12/24/2003 |
| 8 | 24.0 | 48.30 | 25.0 | 35.0 | 4.55 | 10348 | 6:35 PM | 12/26/2003 |
| 9 | 23.5 | 47.95 | 28.0 | 39.8 | 4.61 | 11813 | 7:00 PM | 12/27/2003 |
| 10 | 23.5 | 47.95 | 37.0 | 54.2 | 4.74 | 13168 | 5:35 PM | 12/29/2003 |

Diffusion Coefficient Curve for Psychrometer 1:






**Project: Fort Worth District**

**Borehole: A5**

**Sample Depth: 8’-9’**

Total Length of the sample, L = 10.9 cm

Distance of psychrometer 2 from closed end, x = 9.4 cm

Initial Suction, $u_0$ = 3.09 pF

Relative Humidity = 31%

Atmospheric Suction, $u_a$ = 6.21 pF

Diffusion Coefficient, $\alpha = 10.3E^{-5}$ $cm^2/sec$

Psychrometer 1:

No.: 40338, $\pi_{v0}$ = 49 @ 25ºC

Setup Time & Date: 3:00 PM, 12/18/03

| No. | T | $\pi_v$ | μV | Total Suction (bar) | Total Suction (pF) | Time (minutes) | Time | Date |
|---|---|---|---|---|---|---|---|---|
| 1 | 21.0 | 46.20 | 12.5 | 18.1 | 4.27 | 630 | 12:30 AM | 12/19/2003 |
| 2 | 22.5 | 47.25 | 23.0 | 33.7 | 4.54 | 1645 | 4:55 PM | 12/19/2003 |
| 3 | 22.0 | 46.90 | 24.8 | 36.4 | 4.57 | 1875 | 7:32 PM | 12/19/2003 |

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Psychrometer 2:

No.: 40321, $\pi_{v0} = 51$ @ 25ºC

Setup Time & Date: 3:00 PM, 12/18/03

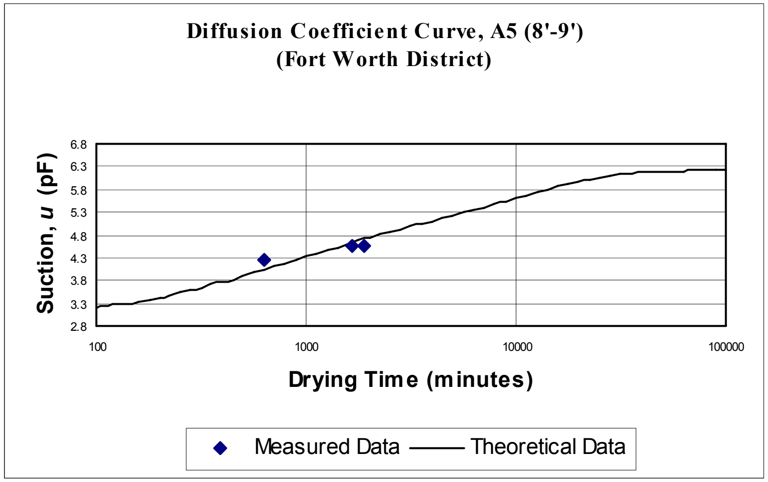
**Project: Fort Worth District**

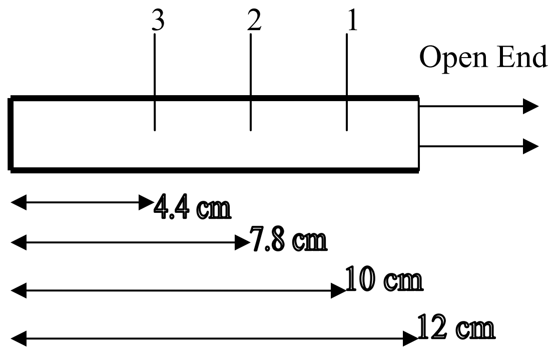
**Borehole: A5**

**Sample Depth: 8'-9'**

| No. | T | $\pi_v$ | μV | Total Suction (bar) | Total Suction (pF) | Time (minutes) | Time | Date |
|---|---|---|---|---|---|---|---|---|
| 1 | 22.0 | 48.90 | 5.5 | 7.2 | 3.87 | 655 | 12:55 AM | 12/19/2003 |
| 2 | 22.5 | 49.25 | 5.0 | 6.5 | 3.82 | 1648 | 4:58 PM | 12/19/2003 |
| 3 | 23.0 | 49.60 | 6.0 | 8.0 | 3.91 | 2939 | 1:59 PM | 12/20/2003 |
| 4 | 24.5 | 50.65 | 7.5 | 10.2 | 4.02 | 3055 | 11:33 PM | 12/20/2003 |
| 5 | 24.5 | 50.65 | 9.5 | 13.1 | 4.13 | 4323 | 8:11 PM | 12/21/2003 |
| 6 | 24.5 | 50.65 | 11.5 | 16.0 | 4.21 | 5785 | 8:03 PM | 12/22/2003 |
| 7 | 23.0 | 49.60 | 13.0 | 18.2 | 4.27 | 7190 | 6:58 PM | 12/23/2003 |
| 8 | 24.0 | 50.30 | 17.5 | 24.8 | 4.40 | 8654 | 6:52 PM | 12/24/2003 |
| 9 | 24 | 50.30 | 22 | 31.4 | 4.51 | 10082 | 5:34 PM | 12/26/2003 |
| 10 | 24.5 | 50.65 | 25.0 | 35.8 | 4.56 | 11655 | 7:17 PM | 12/27/2003 |
| 11 | 23.5 | 49.95 | 32.0 | 46.1 | 4.67 | 13003 | 5:15 PM | 12/29/2003 |

Diffusion Coefficient Curve for Psychrometer 1:






**Project: Fort Worth District**

**Borehole: B1**

**Sample Depth: 6'-7'**

Total Length of the sample, L = 12.0 cm

Distance of psychrometer 2 from closed end, x = 10.0 cm

Initial Suction, $u_0$ = 3.38 pF

Relative Humidity = 39.2%

Atmospheric Suction, $u_a$ = 6.11 pF

Diffusion Coefficient, $\alpha = 8.26E^{-5}$ $cm^2/sec$

Psychrometer 1:

No.: 40307, $\pi_{v0}$ = 56 @ 25ºC

Setup Time & Date: 6:10 PM, 01/21/04

| No. | T | $\pi_v$ | μV | Total Suction (bar) | Total Suction (pF) | Time (minutes) | Time | Date |
|---|---|---|---|---|---|---|---|---|
| 1 | 21.0 | 53.20 | 8.5 | 8.4 | 3.93 | 220 | 9:50 PM | 1/21/2004 |
| 2 | 21.5 | 53.55 | 18.0 | 22.6 | 4.36 | 1309 | 3:59 PM | 1/22/2004 |
| 3 | 21.5 | 53.55 | 19.5 | 24.8 | 4.40 | 1429 | 5:59 PM | 1/22/2004 |
| 4 | 21.5 | 53.55 | 22.0 | 28.5 | 4.46 | 1740 | 11:10 PM | 1/22/2004 |
| 5 | 22.0 | 53.90 | 35.0 | 47.9 | 4.69 | 2749 | 3:59 PM | 1/23/2004 |
| 6 | 23.0 | 54.60 | 41.0 | 56.9 | 4.76 | 4145 | 3:15 PM | 1/24/2004 |
| 7 | 23.0 | 54.60 | 50.0 | 70.3 | 4.86 | 5787 | 6:27 PM | 1/25/2004 |

Psychrometer 2:

No.: 40336, $\pi_{v0}$ = 50 @ 25ºC

Setup Time & Date: 6:10 PM, 01/21/04

**Project: Fort Worth District**

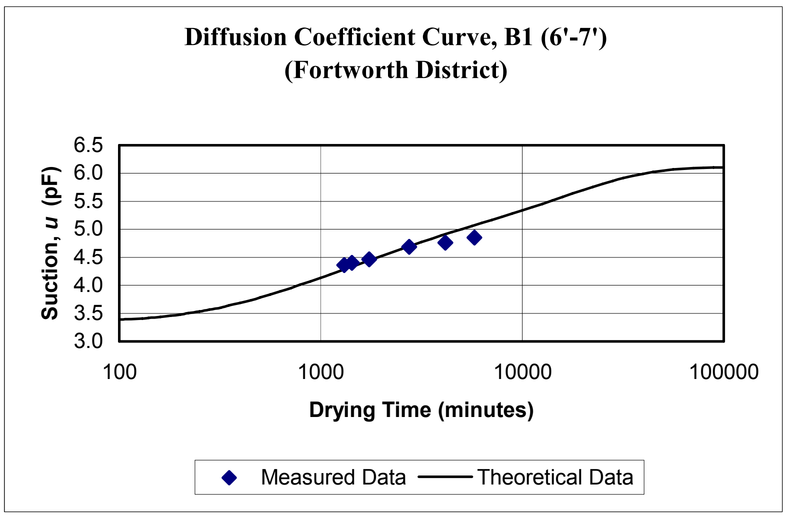
**Borehole: B1**

**Sample Depth: 6'-7'**

| No. | T | $\pi_v$ | μV | Total Suction (bar) | Total Suction (pF) | Time (minutes) | Time | Date |
|---|---|---|---|---|---|---|---|---|
| 1 | 22.5 | 48.25 | 4.0 | 5.4 | 3.74 | 1310 | 4:00 PM | 1/22/2004 |
| 2 | 22.5 | 48.25 | 5.0 | 6.9 | 3.84 | 1430 | 6:00 PM | 1/22/2004 |
| 3 | 22.5 | 48.25 | 15.0 | 21.8 | 4.35 | 2752 | 4:02 PM | 1/23/2004 |
| 4 | 22.5 | 48.25 | 20.0 | 29.3 | 4.47 | 4147 | 3:17 PM | 1/24/2004 |
| 5 | 23.5 | 48.95 | 21.5 | 31.5 | 4.51 | 4420 | 7:50 PM | 1/24/2004 |
| 6 | 23.5 | 48.95 | 25.0 | 36.7 | 4.57 | 5790 | 6:30 PM | 1/25/2004 |
| 7 | 23.5 | 48.95 | 26.0 | 38.2 | 4.59 | 5920 | 8:40 PM | 1/25/2004 |
| 8 | 23.5 | 48.95 | 28.0 | 41.2 | 4.62 | 7030 | 3:10 PM | 1/26/2004 |
| 9 | 23.5 | 48.95 | 30.0 | 44.2 | 4.65 | 8515 | 3:55 PM | 1/27/2004 |



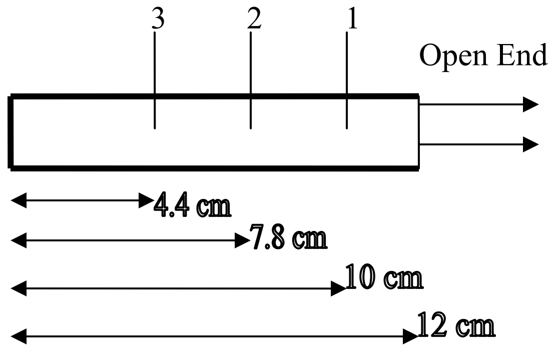
Diffusion Coefficient Curve for Psychrometer 1:



**Project: Fort Worth District**

**Borehole: B1**

**Sample Depth: 9'-10'**




Total Length of the sample, L = 12.0 cm

Distance of psychrometer 2 from closed end, x = 10.0 cm

Initial Suction, $u_0$ = 3.38 pF

Relative Humidity = 39.2%

Atmospheric Suction, $u_a$ = 6.11 pF

Diffusion Coefficient, $\alpha = 8.26E^{-5}$ $cm^2/sec$

Psychrometer 1:

No.: 40307, $\pi_{v0}$ = 56 @ 25ºC

Setup Time & Date: 6:10 PM, 01/21/04

| No. | T | $\pi_v$ | μV | Total Suction (bar) | Total Suction (pF) | Time (minutes) | Time | Date |
|---|---|---|---|---|---|---|---|---|
| 1 | 21.0 | 53.20 | 8.5 | 8.4 | 3.93 | 220 | 9:50 PM | 1/21/2004 |
| 2 | 21.5 | 53.55 | 18.0 | 22.6 | 4.36 | 1309 | 3:59 PM | 1/22/2004 |
| 3 | 21.5 | 53.55 | 19.5 | 24.8 | 4.40 | 1429 | 5:59 PM | 1/22/2004 |
| 4 | 21.5 | 53.55 | 22.0 | 28.5 | 4.46 | 1740 | 11:10 PM | 1/22/2004 |
| 5 | 22.0 | 53.90 | 35.0 | 47.9 | 4.69 | 2749 | 3:59 PM | 1/23/2004 |
| 6 | 23.0 | 54.60 | 41.0 | 56.9 | 4.76 | 4145 | 3:15 PM | 1/24/2004 |
| 7 | 23.0 | 54.60 | 50.0 | 70.3 | 4.86 | 5787 | 6:27 PM | 1/25/2004 |

Psychrometer 2:

No.: 40336, πv0 = 50 @ 25ºC

Setup Time & Date: 6:10 PM, 01/21/04

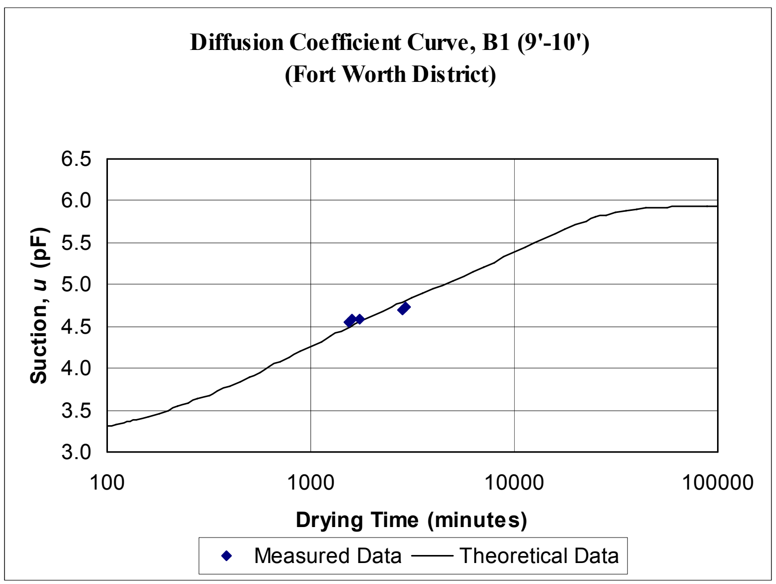
**Project: Fort Worth District**

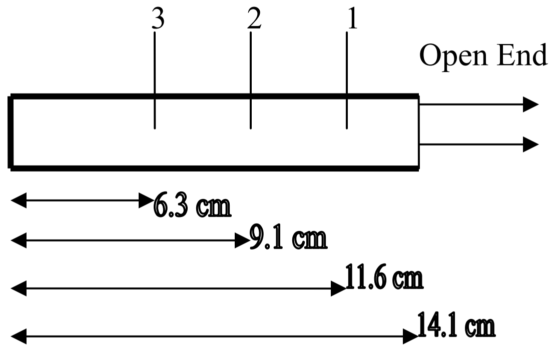
**Borehole: B1**

**Sample Depth: 9'-10'**

| No. | T | $\pi_v$ | μV | Total Suction (bar) | Total Suction (pF) | Time (minutes) | Time | Date |
|---|---|---|---|---|---|---|---|---|
| 1 | 22.5 | 48.25 | 4.0 | 5.4 | 3.74 | 1310 | 4:00 PM | 1/22/2004 |
| 2 | 22.5 | 48.25 | 5.0 | 6.9 | 3.84 | 1430 | 6:00 PM | 1/22/2004 |
| 3 | 22.5 | 48.25 | 15.0 | 21.8 | 4.35 | 2752 | 4:02 PM | 1/23/2004 |
| 4 | 22.5 | 48.25 | 20.0 | 29.3 | 4.47 | 4147 | 3:17 PM | 1/24/2004 |
| 5 | 23.5 | 48.95 | 21.5 | 31.5 | 4.51 | 4420 | 7:50 PM | 1/24/2004 |
| 6 | 23.5 | 48.95 | 25.0 | 36.7 | 4.57 | 5790 | 6:30 PM | 1/25/2004 |
| 7 | 23.5 | 48.95 | 26.0 | 38.2 | 4.59 | 5920 | 8:40 PM | 1/25/2004 |
| 8 | 23.5 | 48.95 | 28.0 | 41.2 | 4.62 | 7030 | 3:10 PM | 1/26/2004 |
| 9 | 23.5 | 48.95 | 30.0 | 44.2 | 4.65 | 8515 | 3:55 PM | 1/27/2004 |

Diffusion Coefficient Curve for Psychrometer 1:






**Project: Fort Worth District**

**Borehole: B2**

**Sample Depth: 3'- 4'**

Total Length of the sample, L = 14.1 cm

Distance of psychrometer 2 from closed end, x = 11.6 cm

Initial Suction, $u_0$ = 3.24 pF

Relative Humidity = 39.2%

Atmospheric Suction, $u_a$ = 6.11 pF

Diffusion Coefficient, $\alpha = 0.106E^{-5}$ $cm^2$/sec

Psychrometer 1:

No.: 40363, $\pi_{v0}$ = 49 @ 25ºC

Setup Time & Date: 5:32 PM, 01/22/04

| No. | T | $\pi_v$ | μV | Total Suction (bar) | Total Suction (pF) | Time (minutes) | Time | Date |
|---|---|---|---|---|---|---|---|---|
| 1 | 21.5 | 46.55 | 8.0 | 11.9 | 4.08 | 378 | 11:14:00 PM | 1/22/2004 |
| 2 | 23.0 | 47.60 | 9.5 | 14.2 | 4.16 | 1406 | 4:22:00 PM | 1/23/2004 |
| 3 | 23.5 | 47.95 | 21.0 | 32.2 | 4.52 | 2804 | 3:04:00 PM | 1/24/2004 |
| 4 | 23.0 | 47.60 | 24.0 | 36.9 | 4.58 | 3104 | 8:00:00 PM | 1/24/2004 |
| 5 | 23.0 | 47.60 | 36.0 | 55.6 | 4.75 | 4409 | 6:15:00 PM | 1/25/2004 |
| 6 | 24.0 | 48.30 | 42.0 | 65.0 | 4.82 | 4544 | 8:30:00 PM | 1/25/2004 |

Psychrometer 2:

No.: 40333, $\pi_{v0} = 53$ @ 25ºC

Setup Time & Date: 5:32 PM, 01/22/04

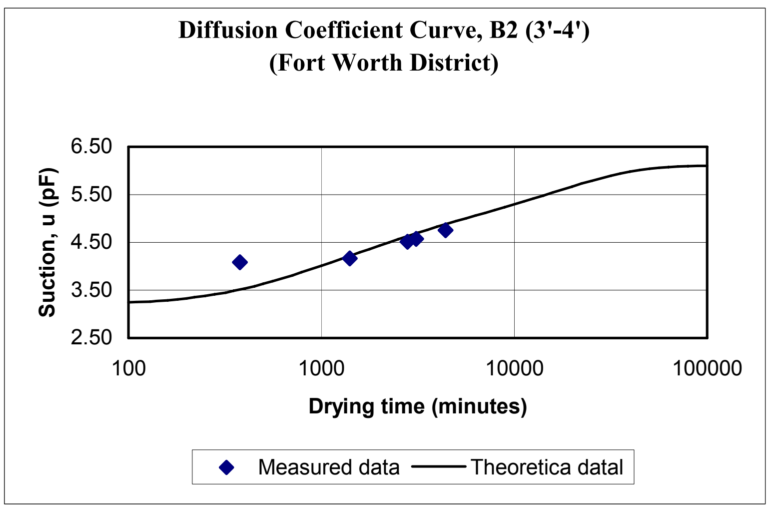
**Project: Fort Worth District**

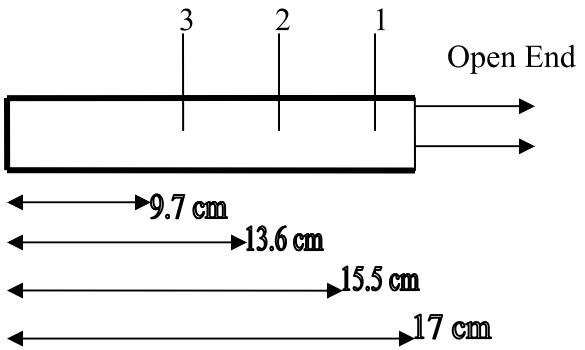
**Borehole: B2**

**Sample Depth: 3'- 4'**

| No. | T | $\pi_v$ | μV | Total Suction (bar) | Total Suction (pF) | Time (minutes) | Time | Date |
|---|---|---|---|---|---|---|---|---|
| 1 | 24.0 | 52.30 | 3.0 | 3.3 | 3.53 | 1409 | 4:25:00 PM | 1/23/2004 |
| 2 | 24.0 | 52.30 | 3.5 | 4.1 | 3.62 | 2806 | 3:06:00 PM | 1/24/2004 |
| 3 | 24.0 | 52.30 | 3.5 | 4.1 | 3.62 | 3108 | 8:04:00 PM | 1/24/2004 |
| 4 | 24.0 | 52.30 | 4.5 | 5.5 | 3.75 | 4431 | 6:17:00 PM | 1/25/2004 |
| 5 | 24.5 | 52.65 | 4.5 | 5.5 | 3.75 | 4548 | 8:34:00 PM | 1/25/2004 |
| 6 | 24.5 | 52.65 | 4.5 | 5.5 | 3.75 | 5704 | 3:50:00 PM | 1/26/2004 |
| 7 | 24.0 | 52.30 | 8.0 | 10.5 | 4.03 | 7205 | 4:51:00 PM | 1/27/2004 |
| 8 | 24.5 | 52.65 | 11.5 | 15.5 | 4.20 | 8636 | 4:40:00 PM | 1/28/2004 |
| 9 | 24 | 52.30 | 13.5 | 18.4 | 4.27 | 10496 | 11:40:00 PM | 1/29/2004 |

Diffusion Coefficient Curve for Psychrometer 1:






**Project: Fort Worth District**

**Borehole: B2**

**Sample Depth: 11’-12’**

Total Length of the sample, L = 17.0 cm

Distance of psychrometer 2 from closed end, x = 15.5 cm

Initial Suction, $u_0$ = 3.18 pF

Relative Humidity = 54.2%

Atmospheric Suction, $u_a$ = 5.93 pF

Diffusion Coefficient, $\alpha = 9.66E^{-5}$ $cm^2$/sec

Psychrometer 1:

No.: 40325, $\pi_{v0}$ = 49 @ 25ºC

Setup Time & Date: 3:05 PM, 01/11/04

| No. | T | $\pi_v$ | µV | Total Suction (bar) | Total Suction (pF) | Time (minutes) | Time | Date |
|---|---|---|---|---|---|---|---|---|
| 1 | 23.0 | 47.60 | 24.5 | 34.5 | 4.55 | 1503 | 4:08 PM | 1/12/2004 |
| 2 | 22.5 | 47.25 | 25.5 | 36.0 | 4.56 | 1567 | 5:12 PM | 1/12/2004 |
| 3 | 22.0 | 46.90 | 27.0 | 38.2 | 4.59 | 1700 | 7:25 PM | 1/12/2004 |
| 4 | 23.0 | 47.60 | 31.0 | 44.0 | 4.65 | 2789 | 1:34 PM | 1/13/2004 |
| 5 | 22.5 | 47.25 | 40.0 | 57.1 | 4.77 | 4255 | 2:00 PM | 1/14/2004 |

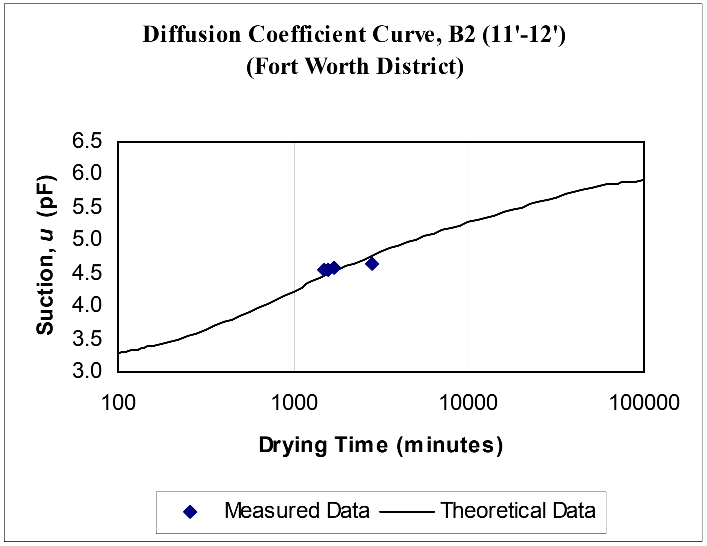
Psychrometer 2:

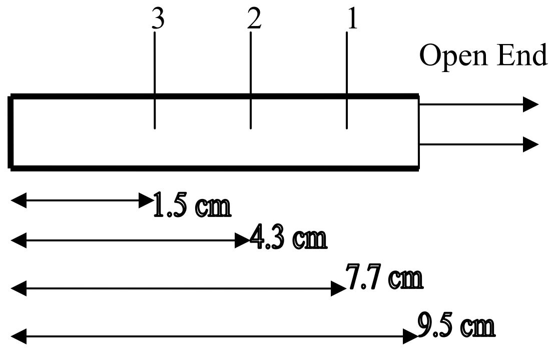
No.: 40362, $\pi_{v0}$ = 50 @ 25ºC

Setup Time & Date: 3:05 PM, 01/11/04

| No. | T | $\pi_v$ | µV | Total Suction (bar) | Total Suction (pF) | Time (minutes) | Time | Date |
|---|---|---|---|---|---|---|---|---|
| 1 | 22.0 | 47.90 | 7.0 | 10.3 | 4.02 | 1509 | 4:14 PM | 1/12/2004 |
| 2 | 23.0 | 48.60 | 11.0 | 16.6 | 4.23 | 2900 | 3:25 PM | 1/13/2004 |
| 3 | 24.5 | 49.65 | 14.5 | 22.1 | 4.35 | 4260 | 2:05 PM | 1/14/2004 |
| 4 | 24.0 | 49.30 | 27.0 | 41.6 | 4.63 | 8666 | 3:31 PM | 1/17/2004 |
| 5 | 24.0 | 49.30 | 33.0 | 50.9 | 4.72 | 10275 | 6:20 PM | 1/18/2004 |
| 6 | 23.5 | 48.95 | 34.0 | 52.5 | 4.73 | 11589 | 4:14 PM | 1/19/2004 |

Diffusion Coefficient Curve for Psychrometer 1:






Project: Fort Worth District

Borehole: B3

Sample Depth: 0'-1'

Total Length of the sample, L = 9.5 cm

Distance of psychrometer 2 from closed end, x = 7.7 cm

Initial Suction, $u_0$ = 4.2 pF

Relative Humidity = 44%

Atmospheric Suction, $u_a$ = 6.06 pF

Diffusion Coefficient, $\alpha = 6.20E^{-5}\ cm^2/sec$

Psychrometer 1:

No.: 40324, $\pi_{v0}$ = 53 @ 25ºC

Setup Time & Date: 4:30 PM, 11/17/03

| No. | T | $\pi_v$ | μV | Total Suction (bar) | Total Suction (pF) | Time (minutes) | Time | Date |
|---|---|---|---|---|---|---|---|---|
| 1 | 24.5 | 52.65 | 13.5 | 17.1 | 4.24 | 1472 | 5:02:00 PM | 11/18/2003 |
| 2 | 23.5 | 51.95 | 0.0 | | | | 4:38:00 AM | 11/19/2003 |

**Project: Fort Worth District**

**Borehole: B3**

**Sample Depth: 0’-1’**

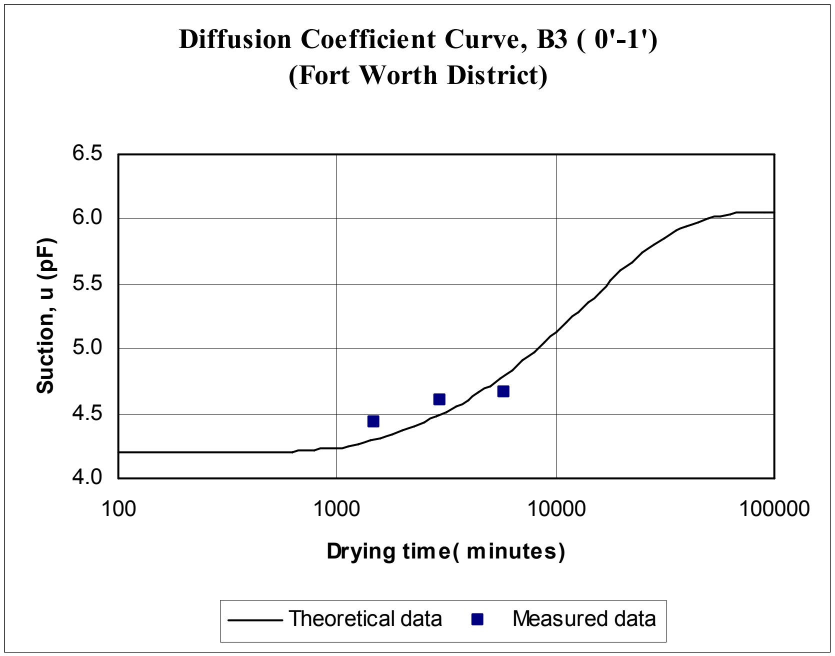
Psychrometer 2:

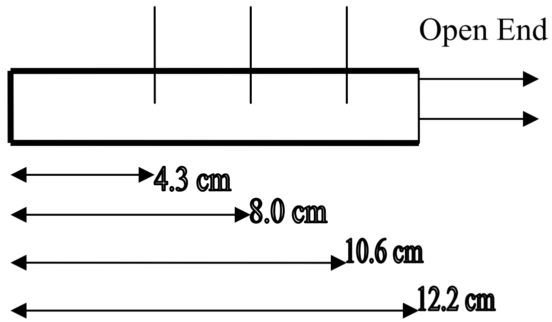
No.: 40316, $\pi_{v0}$ = 58 @ 25ºC

Setup Time & Date: 4:30 PM, 11/17/03

| No. | T | $\pi_v$ | μV | Total Suction (bar) | Total Suction (pF) | Time (minutes) | Time | Date |
|---|---|---|---|---|---|---|---|---|
| 1 | 24.5 | 57.65 | 20.5 | 27.0 | 4.44 | 1474 | 5:04 PM | 11/20/2003 |
| 2 | 24.5 | 57.65 | 28.5 | 39.2 | 4.60 | 2974 | 4:40 PM | 11/22/2003 |
| 3 | 24.5 | 57.65 | 32.5 | 45.2 | 4.66 | 5783 | 3:29 PM | 11/24/2003 |

Diffusion Coefficient Curve for Psychrometer 2:






**Project: Fort Worth District**

**Borehole: B4**

**Sample Depth: 1'-2'**

Total Length of the sample, L = 12.2 cm

Distance of psychrometer 2 from closed end, x = 10.6 cm

Initial Suction, $u_0$ = 3.59 pF

Relative Humidity = 39.2%

Atmospheric Suction, $u_a$ = 6.11 pF

Diffusion Coefficient, $\alpha = 8.40E^{-5}$ $cm^2/sec$

Psychrometer 1:

No.: 40322, $\pi_{v0}$ = 50 @ 25ºC

Setup Time & Date: 5:35 PM, 01/21/04

| No. | T | $\pi_v$ | μV | Total Suction (bar) | Total Suction (pF) | Time (minutes) | Time | Date |
|---|---|---|---|---|---|---|---|---|
| 1 | 21.0 | 47.20 | 6.0 | 8.5 | 3.94 | 265 | 10:00 PM | 1/21/2004 |
| 2 | 22.0 | 47.90 | 24.5 | 36.4 | 4.57 | 1331 | 3:46 PM | 1/22/2004 |
| 3 | 22.0 | 47.90 | 27.0 | 40.2 | 4.61 | 1455 | 5:50 PM | 1/22/2004 |
| 4 | 23.0 | 48.60 | 32.0 | 47.7 | 4.69 | 1768 | 11:03 PM | 1/22/2004 |

Psychrometer 2:

No.: 43447, $\pi_{v0}$ = 58 @ 25ºC

Setup Time & Date: 5:35 PM, 01/21/04

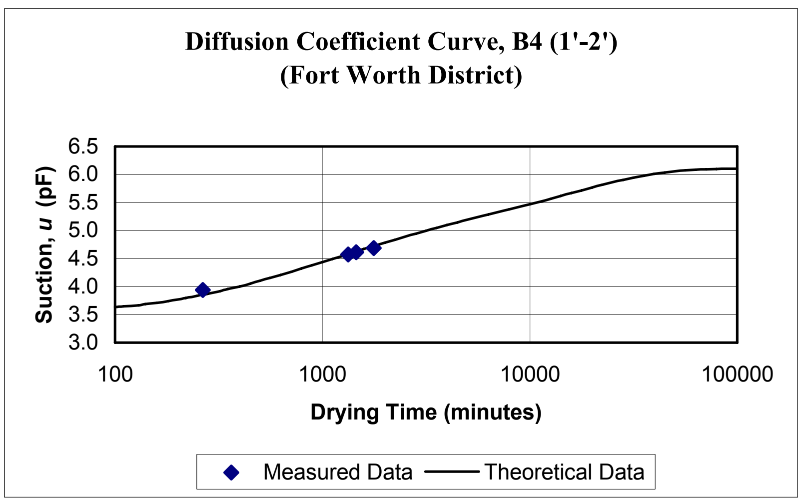
**Project: Fort Worth District**

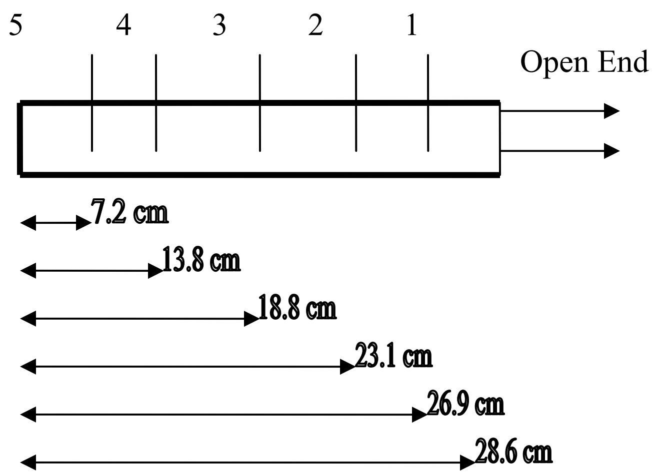
**Borehole: B4**

**Sample Depth: 1'-2'**

| No. | T | $\pi_v$ | μV | Total Suction (bar) | Total Suction (pF) | Time (minutes) | Time | Date |
|---|---|---|---|---|---|---|---|---|
| 1 | 22.5 | 56.25 | 5.0 | 4.4 | 3.65 | 1335 | 3:50 PM | 1/22/2004 |
| 2 | 22.5 | 56.25 | 6.5 | 6.6 | 3.83 | 1456 | 5:51 PM | 1/22/2004 |
| 3 | 23.0 | 56.60 | 9.5 | 11.2 | 4.06 | 2802 | 4:17 PM | 1/23/2004 |
| 4 | 24.0 | 57.30 | 13.0 | 16.4 | 4.22 | 4175 | 3:10 PM | 1/24/2004 |
| 5 | 23.5 | 56.95 | 14.0 | 17.9 | 4.26 | 5180 | 7:55 PM | 1/24/2004 |
| 6 | 23.5 | 56.95 | 18.5 | 24.7 | 4.40 | 6529 | 6:24 PM | 1/25/2004 |
| 7 | 24.0 | 57.30 | 19.0 | 25.5 | 4.41 | 6661 | 8:36 PM | 1/25/2004 |
| 8 | 24.0 | 57.30 | 23.5 | 32.3 | 4.52 | 7790 | 3:25 PM | 1/26/2004 |
| 9 | 23.5 | 56.95 | 30.0 | 42.1 | 4.63 | 9327 | 5:02 PM | 1/27/2004 |
| 10 | 23.5 | 56.95 | 38.0 | 54.1 | 4.74 | 10733 | 4:28 PM | 1/28/2004 |

Diffusion Coefficient Curve for Psychrometer 1:






**Project: Fort Worth District**

**Borehole: B4**

**Sample Depth: 13’-14’**

Total Length of the sample, L = 28.6 cm

Distance of psychrometer 2 from closed end, x = 26.9 cm

Initial Suction, $u_0$ = 3.56 pF

Relative Humidity = 54.6%

Atmospheric Suction, $u_a$ = 5.92 pF

Diffusion Coefficient, $\alpha = 1.08E^{-5}$ $cm^2$/sec

Psychrometer 1:

No.: 43311, $\pi_{v0}$ = 52 @ 25ºC

Setup Time & Date: 4:25 PM, 09/10/03

**Project: Fort Worth District**

**Borehole: B4**

**Sample Depth: 13'-14'**

| No. | T | $\pi_v$ | μV | Total Suction (bar) | Total Suction (pF) | Time (minutes) | Time | Date |
|---|---|---|---|---|---|---|---|---|
| 1 | 22.5 | 50.25 | 5.5 | 6.0 | 3.79 | 1010 | 9:35 AM | 9/11/03 |
| 2 | 23.0 | 50.60 | 6.0 | 6.7 | 3.83 | 1490 | 5:35 PM | 9/11/03 |
| 3 | 22.5 | 50.25 | 6.5 | 7.4 | 3.88 | 2465 | 9:50 AM | 9/12/03 |
| 4 | 22.5 | 50.25 | 7.5 | 8.8 | 3.96 | 2895 | 5:00 PM | 9/12/03 |
| 5 | 22.5 | 50.25 | 8.0 | 9.6 | 3.99 | 4270 | 3:55 PM | 9/13/03 |
| 6 | 22.0 | 49.90 | 10.5 | 13.1 | 4.13 | 5515 | 12:40 PM | 9/14/03 |
| 7 | 22.0 | 49.90 | 12.0 | 15.3 | 4.19 | 6766 | 9:31 AM | 9/15/03 |
| 8 | 22.0 | 49.90 | 13.0 | 16.7 | 4.23 | 7238 | 5:23 PM | 9/15/03 |
| 9 | 22.5 | 50.25 | 15.5 | 20.3 | 4.32 | 8539 | 3:04 PM | 9/16/03 |
| 10 | 23.0 | 50.60 | 15.0 | 19.6 | 4.30 | 8713 | 5:58 PM | 9/16/03 |
| 11 | 22.3 | 50.08 | 18.0 | 23.9 | 4.39 | 9625 | 9:10 AM | 9/17/03 |
| 12 | 22.5 | 50.25 | 21.0 | 28.2 | 4.46 | 11195 | 11:20 AM | 9/18/03 |
| 13 | 23.0 | 50.60 | 21.0 | 28.2 | 4.46 | 11430 | 3:15 PM | 9/18/03 |

Psychrometer 2:

No.: 43450, $\pi_{v0}$ = 52 @ 25ºC

Setup Time & Date: 4:25 PM, 09/10/03

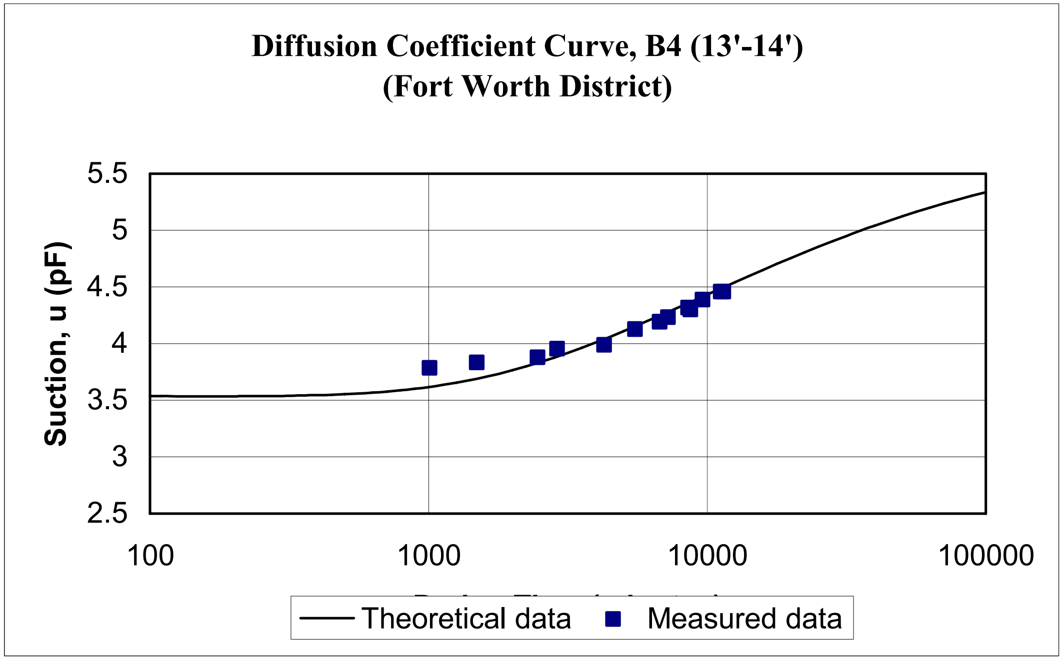
**Project: Fort Worth District**

**Borehole: B4**

**Sample Depth: 13'-14'**

| No. | T | $\pi_v$ | μV | Total Suction (bar) | Total Suction (pF) | Time (minutes) | Time | Date |
|---|---|---|---|---|---|---|---|---|
| 1 | 22.5 | 50.25 | 5.0 | 4.9 | 3.7 | 1015 | 9:40 AM | 9/11/03 |
| 2 | 23.0 | 50.60 | 5.0 | 4.9 | 3.7 | 1495 | 5:40 PM | 9/11/03 |
| 3 | 22.5 | 50.25 | 5.5 | 5.7 | 3.8 | 2468 | 9:53 AM | 9/12/03 |
| 4 | 22.5 | 50.25 | 5.5 | 5.7 | 3.8 | 2895 | 5:00 PM | 9/12/03 |
| 5 | 23.0 | 50.60 | 7.0 | 7.9 | 3.9 | 4273 | 3:58 PM | 9/13/03 |
| 6 | 22.5 | 50.25 | 7.0 | 7.9 | 3.9 | 5517 | 12:42 PM | 9/14/03 |
| 7 | 22.0 | 49.90 | 8.0 | 9.4 | 4.0 | 6770 | 9:35 AM | 9/15/03 |
| 8 | 22.0 | 49.90 | 8.5 | 10.2 | 4.0 | 7251 | 5:36 PM | 9/15/03 |
| 9 | 22.5 | 50.25 | 9.5 | 11.7 | 4.1 | 8542 | 3:07 PM | 9/16/03 |
| 10 | 23.0 | 50.60 | 10.0 | 12.4 | 4.1 | 8715 | 6:00 PM | 9/16/03 |
| 11 | 22.5 | 50.25 | 10.0 | 12.4 | 4.1 | 9629 | 9:14 AM | 9/17/03 |
| 12 | 22.5 | 50.25 | 11.0 | 13.9 | 4.2 | 11199 | 11:24 AM | 9/18/03 |
| 13 | 23.0 | 50.60 | 11.0 | 13.9 | 4.2 | 11436 | 3:21 AM | 9/18/03 |

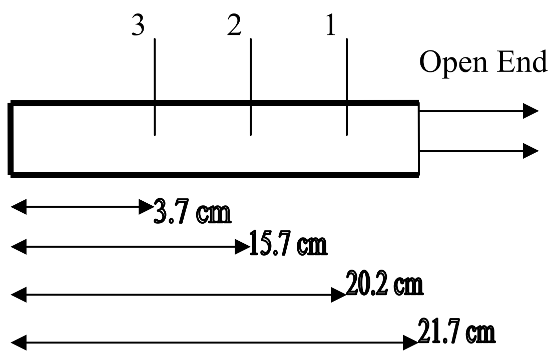
Diffusion Coefficient Curve for Psychrometer 1:




**Project: Fort Worth District**

**Borehole: B4**

**Sample Depth: 13’-14’**




**Project: Fort Worth District**

**Borehole: B5**

**Sample Depth: 6'-7'**

Total Length of the sample, L = 21.7 cm

Distance of psychrometer 2 from closed end, x = 20.2 cm

Initial Suction, $u_0$ = 2.67 pF

Relative Humidity = 44%

Atmospheric Suction, $u_a$ = 6.06 pF

Diffusion Coefficient, $\alpha = 13.7E^{-5}$ $cm^2$/sec

Psychrometer 1:

No.: 40305, $\pi_{v0}$ = 60 @ 25ºC

Setup Time & Date: 4:10 PM, 11/18/03

| No. | T | $\pi_v$ | µV | Total Suction (bar) | Total Suction (pF) | Time (minutes) | Time | Date |
|---|---|---|---|---|---|---|---|---|
| 1 | 23.0 | 58.60 | 20.0 | 27.2 | 4.44 | 1475 | 4:45 PM | 11/19/03 |
| 2 | 22.5 | 58.25 | 44.0 | 61.0 | 4.79 | 2770 | 2:20 PM | 11/20/03 |

Psychrometer 2:

No.: 40330, $\pi_{v0}$ = 51 @ 25ºC

Setup Time & Date: 4:10 PM, 11/18/03

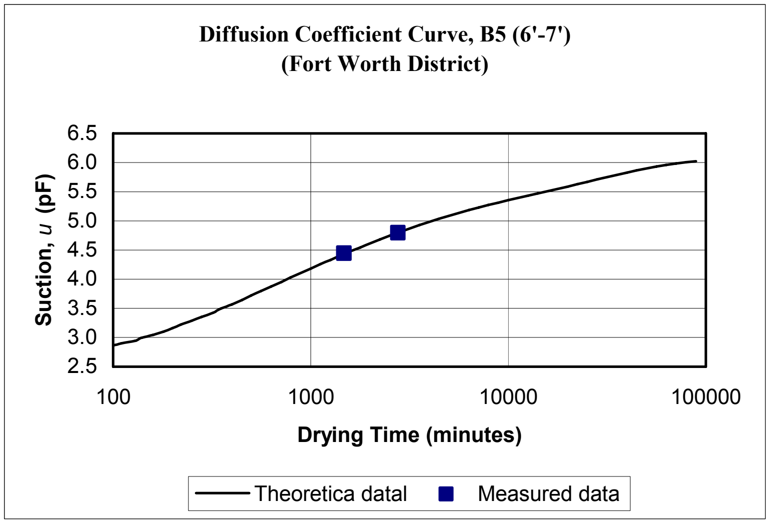
**Project: Fort Worth District**

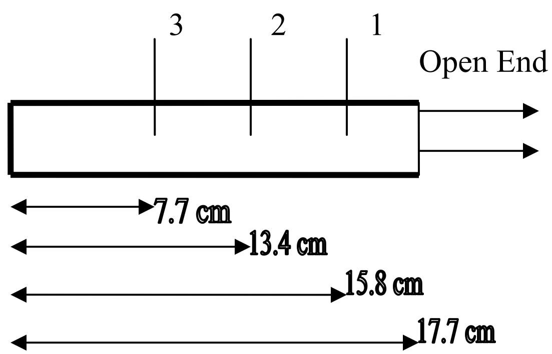
**Borehole: B5**

**Sample Depth: 6'-7'**

| No. | T | $\pi_v$ | μV | Total Suction (bar) | Total Suction (pF) | Time (minutes) | Time | Date |
|---|---|---|---|---|---|---|---|---|
| 1 | 22.5 | 49.25 | 7.5 | 10.0 | 4.01 | 1480 | 4:50 PM | 11/19/03 |
| 2 | 23.0 | 49.60 | 12.0 | 16.7 | 4.23 | 2772 | 2:22 PM | 11/20/03 |
| 3 | 24.0 | 50.30 | 17.5 | 24.9 | 4.40 | 5775 | 4:25 PM | 11/22/03 |
| 4 | 24.0 | 50.30 | 23.5 | 33.8 | 4.54 | 8575 | 3:05 PM | 11/24/03 |
| 5 | 24.0 | 50.30 | 26.0 | 37.6 | 4.58 | 12955 | 4:05 PM | 11/27/03 |
| 6 | 24.0 | 50.30 | 30.0 | 43.5 | 4.65 | 14390 | 4:10 PM | 11/28/03 |
| 7 | 24.0 | 50.30 | 34.0 | 49.5 | 4.70 | 15955 | 6:15 PM | 11/29/03 |

Diffusion Coefficient Curve for Psychrometer 1:






**Project: Fort Worth District**

**Borehole: B5**

**Sample Depth: 11’-12’**

Total Length of the sample, L = 17.7 cm

Distance of psychrometer 2 from closed end, x = 15.8 cm

Initial Suction, $u_0$ = 3.49 pF

Relative Humidity = 44%

Atmospheric Suction, $u_a$ = 6.06 pF

Diffusion Coefficient, $\alpha = 7.61E^{-5}$ $cm^2/sec$

Psychrometer 1:

No.: 40362, $\pi_{v0}$ = 50 @ 25ºC

Setup Time & Date: 3:00 PM, 11/19/03

| No. | T | $\pi_v$ | μV | Total Suction (bar) | Total Suction (pF) | Time (minutes) | Time | Date |
|---|---|---|---|---|---|---|---|---|
| 1 | 22.5 | 48.25 | 26.5 | 40.8 | 4.62 | 1409 | 2:29:00 PM | 11/20/2003 |

Psychrometer 2:

No.: 40348, $\pi_{v0}$ = 51 @ 25ºC

Setup Time & Date: 3:00 PM, 11/19/03

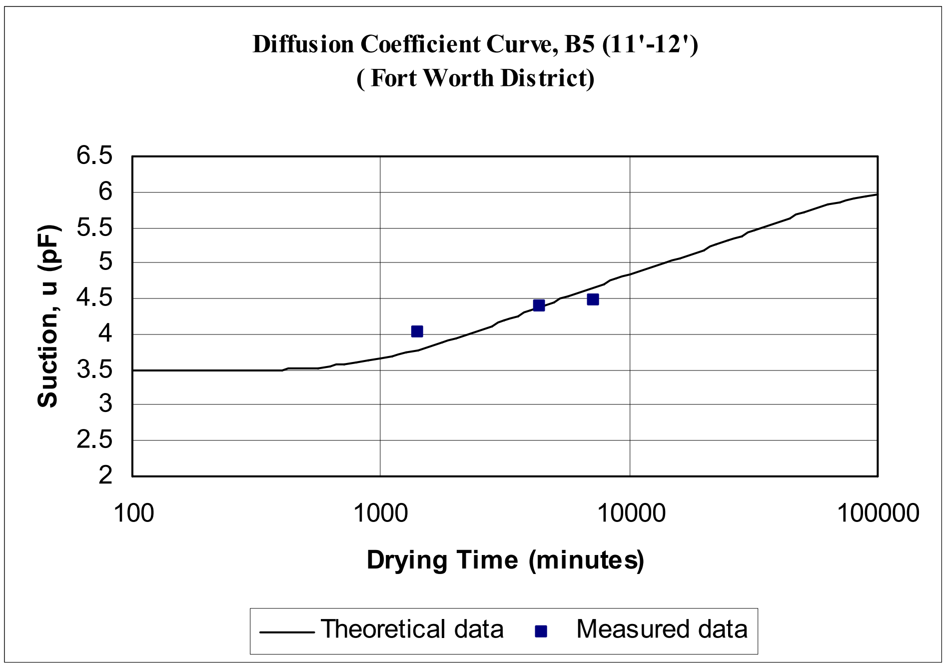
**Project: Fort Worth District**

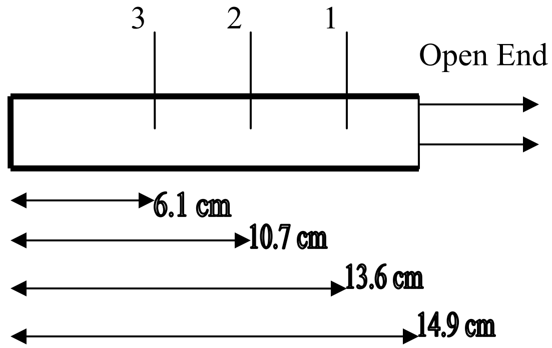
**Borehole: B5**

**Sample Depth: 11'-12'**

| No. | T | $\pi_v$ | μV | Total Suction (bar) | Total Suction (pF) | Time (minutes) | Time | Date |
|---|---|---|---|---|---|---|---|---|
| 1 | 23.0 | 49.60 | 8.0 | 10.5 | 4.03 | 1412 | 2:32 PM | 11/20/2003 |
| 2 | 24.0 | 50.30 | 17.0 | 23.4 | 4.38 | 4412 | 4:31 PM | 11/22/2003 |
| 3 | 23.5 | 49.95 | 21.0 | 29.1 | 4.47 | 7196 | 2:55 PM | 11/24/2003 |

Diffusion Coefficient Curve for Psychrometer 2:






**Project: Fort Worth District**

**Borehole: C1**

**Sample Depth: 2’-3’**

Total Length of the sample, L = 14.9 cm

Distance of psychrometer 2 from closed end, x = 13.6 cm

Initial Suction, $u_0$ = 3.28 pF

Relative Humidity = 30%

Atmospheric Suction, $u_a$ = 6.22 pF

Diffusion Coefficient, $\alpha = 3.73E^{-5}$ $cm^2$/sec

Psychrometer 1:

No.: 40324, $\pi_{v0}$ = 50 @ 25ºC

Setup Time & Date: 8:05 PM, 12/30/03

| No. | T | $\pi_v$ | μV | Total Suction (bar) | Total Suction (pF) | Time (minutes) | Time | Date |
|---|---|---|---|---|---|---|---|---|
| 1 | 22.0 | 47.90 | 22.0 | 29.7 | 4.48 | 1305 | 5:50 PM | 12/31/03 |
| 2 | 23.0 | 48.60 | 28.0 | 38.6 | 4.60 | 2733 | 5:38 PM | 01/01/04 |
| 3 | 23.5 | 48.95 | 35.0 | 49.0 | 4.70 | 4213 | 6:08 PM | 01/02/04 |
| 4 | 23.5 | 48.95 | 38.0 | 53.5 | 4.74 | 5665 | 6:20 PM | 01/03/04 |
| 5 | 23.5 | 48.95 | 41.0 | 57.9 | 4.77 | 7122 | 6:37 PM | 01/04/04 |

Psychrometer 2:

No.: 40312, $\pi_{v0}$ = 56 @ 25ºC

Setup Time & Date: 8:05 PM, 12/30/03

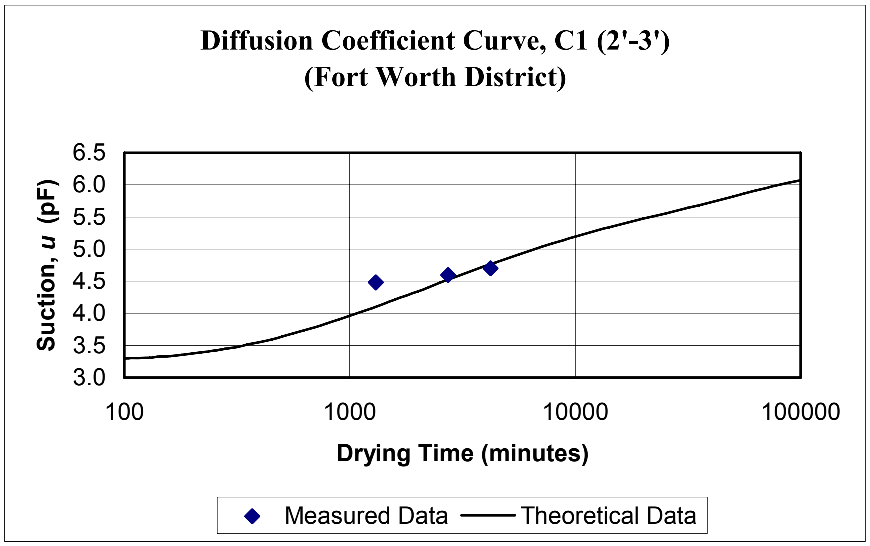
| No. | T | $\pi_v$ | μV | Total Suction (bar) | Total Suction (pF) | Time (minutes) | Time | Date |
|---|---|---|---|---|---|---|---|---|
| 1 | 23.0 | 54.60 | 11.5 | 13.4 | 4.14 | 1306 | 5:51 PM | 12/31/03 |
| 2 | 24.0 | 55.30 | 14.5 | 17.9 | 4.26 | 2735 | 5:40 PM | 01/01/04 |
| 3 | 24.0 | 55.30 | 17.5 | 22.4 | 4.36 | 4215 | 6:10 PM | 01/02/04 |
| 4 | 24.0 | 55.30 | 20.0 | 26.2 | 4.43 | 5669 | 6:24 PM | 01/03/04 |
| 5 | 24.0 | 55.30 | 23.5 | 31.4 | 4.51 | 7125 | 6:40 PM | 01/04/04 |
| 6 | 23.5 | 54.95 | 27.0 | 36.6 | 4.57 | 8543 | 6:18 PM | 01/05/04 |
| 7 | 23.0 | 54.60 | 34.0 | 47.1 | 4.68 | 9987 | 6:22 PM | 01/06/04 |
| 8 | 24.0 | 55.30 | 35.0 | 48.6 | 4.70 | 11267 | 3:42 PM | 01/07/04 |

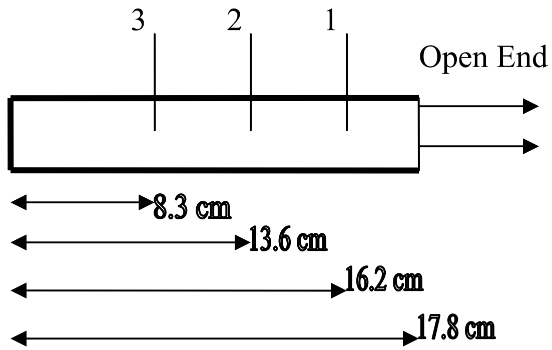
**Project: Fort Worth District**

**Borehole: C1**

**Sample Depth: 2'-3'**

Diffusion Coefficient Curve for Psychrometer 1:






**Project: Fort Worth District**

**Borehole: C1**

**Sample Depth: 6'-7'**

Total Length of the sample, L = 17.8 cm

Distance of psychrometer 2 from closed end, x = 16.2 cm

Initial Suction, $u_0$ = 3.76 pF

Relative Humidity = 30%

Atmospheric Suction, $u_a$ = 6.22 pF

Diffusion Coefficient, $\alpha = 3.06E^{-5}$ $cm^2$/sec

Psychrometer 1:

No.: 43450, $\pi_{v0}$ = 52 @ 25ºC

Setup Time & Date: 7:00 PM, 12/30/03

| No. | T | $\pi_v$ | μV | Total Suction (bar) | Total Suction (pF) | Time (minutes) | Time | Date |
|---|---|---|---|---|---|---|---|---|
| 1 | 22.0 | 49.90 | 23.5 | 32.6 | 4.52 | 1380 | 6:00 PM | 12/31/2003 |
| 2 | 22.0 | 49.90 | 30.0 | 42.3 | 4.64 | 2790 | 5:30 PM | 1/1/2004 |
| 3 | 23.0 | 50.60 | 32.0 | 45.3 | 4.66 | 4275 | 6:15 PM | 1/2/2004 |
| 4 | 22.5 | 50.25 | 43.0 | 61.8 | 4.80 | 5715 | 6:15 PM | 1/3/2004 |

Psychrometer 2:

No.: 43448, $\pi_{v0}$ = 54 @ 25ºC

Setup Time & Date: 7:00 PM, 12/30/03

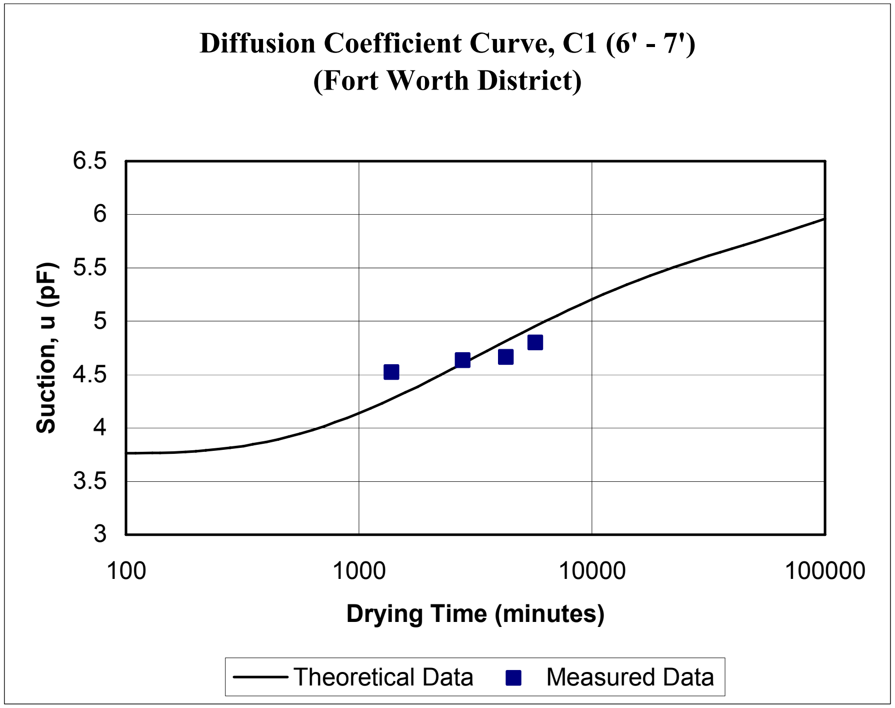
**Project: Fort Worth District**

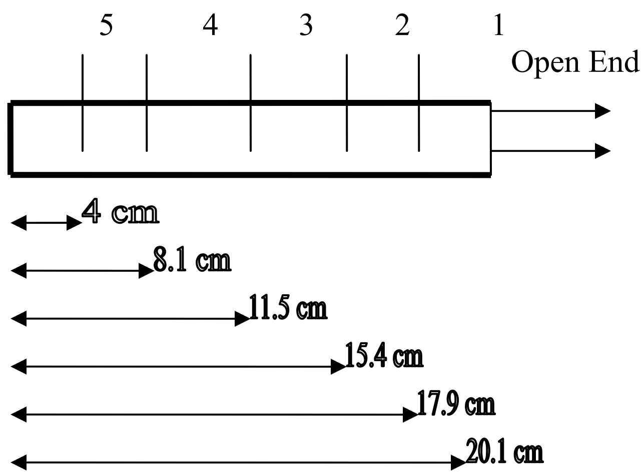
**Borehole: C1**

**Sample Depth: 6'-7'**

| No. | T | $\pi_v$ | μV | Total Suction (bar) | Total Suction (pF) | Time (minutes) | Time | Date |
|---|---|---|---|---|---|---|---|---|
| 1 | 22.5 | 52.25 | 7.5 | 8.2 | 3.92 | 1383 | 6:03 PM | 12/31/2003 |

Diffusion Coefficient Curve for Psychrometer 1:






**Project: Fort Worth District**

**Borehole: C2**

**Sample Depth: 4’-5’**

Total Length of the sample, L = 20.1 cm

Distance of psychrometer 2 from closed end, x = 17.9 cm

Initial Suction, $u_0$ = 3.74 pF

Relative Humidity = 56%

Atmospheric Suction, $u_a$ = 5.91 pF

Diffusion Coefficient, $\alpha = 1.53E^{-5}$ $cm^2/sec$

Psychrometer 1:

No.: 43450, $\pi_{v0}$ = 52 @ 25ºC

Setup Time & Date: 2:30 PM, 10/08/03

| No. | T | $\pi_v$ | μV | Total Suction (bar) | Total Suction (pF) | Time (minutes) | Time | Date |
|---|---|---|---|---|---|---|---|---|
| 1 | 22.0 | 49.90 | 7.0 | 7.9 | 3.91 | 1435 | 2:25 PM | 10/9/03 |
| 2 | 22.0 | 49.90 | 8.5 | 10.2 | 4.02 | 2965 | 3:55 PM | 10/10/03 |
| 3 | 22.0 | 49.90 | 19.0 | 25.9 | 4.42 | 7192 | 2:22 PM | 10/13/03 |
| 4 | 22.0 | 49.90 | 21.5 | 29.6 | 4.48 | 8443 | 11:13 AM | 10/14/03 |
| 5 | 22.0 | 49.90 | 23.0 | 31.9 | 4.51 | 8724 | 3:54 PM | 10/14/03 |
| 6 | 21.5 | 49.55 | 28.0 | 39.3 | 4.60 | 9823 | 10:15 AM | 10/15/03 |
| 7 | 22.0 | 49.90 | 33.0 | 46.8 | 4.68 | 10868 | 3:40 PM | 10/16/03 |
| 8 | 22.5 | 50.25 | 37.0 | 52.8 | 4.73 | 11952 | 9:44 AM | 10/17/03 |

Psychrometer 2:

No.: 43447, $\pi_{v0}$ = 58 @ 25ºC

Setup Time & Date: 2:30 PM, 10/08/03

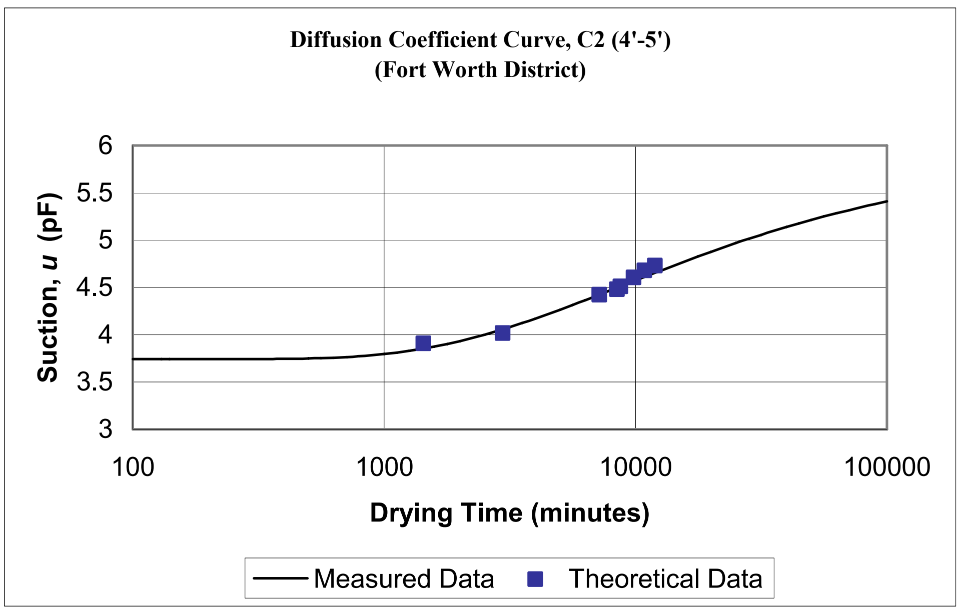
| No. | T | $\pi_v$ | μV | Total Suction (bar) | Total Suction (pF) | Time (minutes) | Time | Date |
|---|---|---|---|---|---|---|---|---|
| 1 | 22.5 | 56.25 | 6.0 | 5.9 | 3.78 | 1439 | 2:29 PM | 10/9/03 |
| 2 | 22.0 | 55.90 | 7.0 | 7.4 | 3.88 | 2966 | 3:56 PM | 10/10/03 |
| 3 | 22.5 | 56.25 | 9.5 | 11.2 | 4.06 | 7195 | 2:25 PM | 10/13/03 |
| 4 | 22.0 | 55.90 | 10.8 | 13.0 | 4.12 | 8445 | 11:15 AM | 10/14/03 |
| 5 | 22.0 | 55.90 | 11.5 | 14.2 | 4.16 | 8725 | 3:55 PM | 10/14/03 |
| 6 | 21.5 | 55.55 | 12.5 | 15.7 | 4.20 | 9825 | 10:17 AM | 10/15/03 |
| 7 | 22.0 | 55.90 | 14.5 | 18.7 | 4.28 | 10874 | 3:46 PM | 10/16/03 |
| 8 | 22.5 | 56.25 | 16.0 | 21.0 | 4.33 | 11954 | 9:46 AM | 10/17/03 |

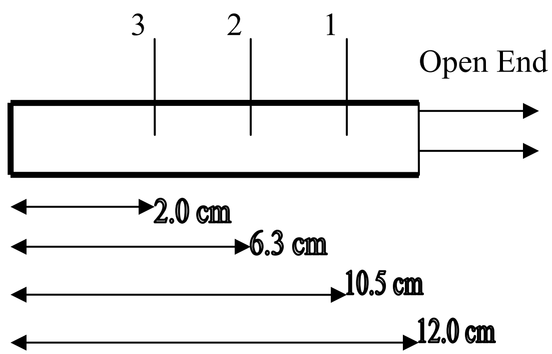
**Project: Fort Worth District**

**Borehole: C2**

**Sample Depth: 4'-5'**

Diffusion Coefficient Curve for Psychrometer 1:






**Project: Fort Worth District**

**Borehole: C2**

**Sample Depth: 5’-6’**

Total Length of the sample, L = 12.0 cm

Distance of psychrometer 2 from closed end, x = 10.5 cm

Initial Suction, $u_0$ = 3.57 pF

Relative Humidity = 44%

Atmospheric Suction, $u_a$ = 6.06 pF

Diffusion Coefficient, $\alpha = 6.10E^{-5}$ $cm^2/sec$

Psychrometer 1:

No.: 40307, $\pi_{v0}$ = 56 @ 25ºC

Setup Time & Date: 4:00 PM, 12/02/03

| No. | T | $\pi_v$ | µV | Total Suction (bar) | Total Suction (pF) | Time (minutes) | Time | Date |
|---|---|---|---|---|---|---|---|---|
| 1 | 22.0 | 53.90 | 20.5 | 26.3 | 4.43 | 1397 | 3:17 PM | 12/3/03 |
| 2 | 22.0 | 53.90 | 44.0 | 61.4 | 4.80 | 2809 | 2:49 PM | 12/4/03 |

Psychrometer 2:

No.: 40293, $\pi_{v0} = 57$ @ 25ºC

Setup Time & Date: 4:00 PM, 12/02/03

**Project: Fort Worth District**

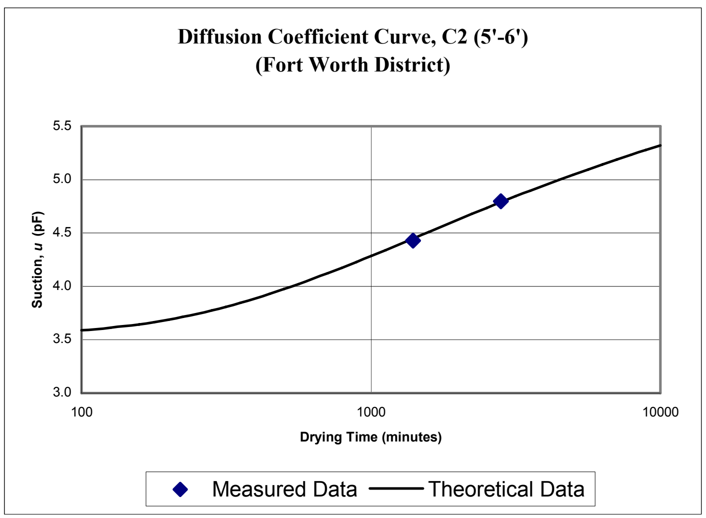
**Borehole: C2**

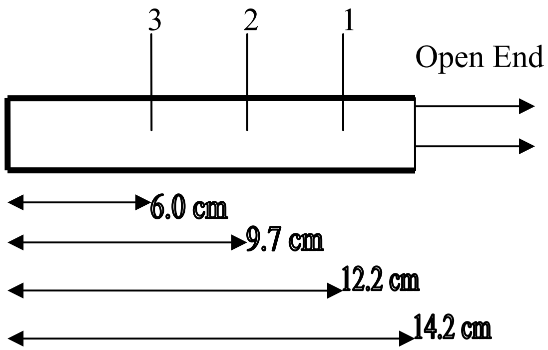
**Sample Depth: 5’-6’**

| No. | T | $\pi_v$ | µV | Total Suction (bar) | Total Suction (pF) | Time (minutes) | Time | Date |
|---|---|---|---|---|---|---|---|---|
| 1 | 23.0 | 55.60 | 7.0 | 7.9 | 3.91 | 1405 | 3:25 PM | 12/3/03 |
| 2 | 22.0 | 54.90 | 10.5 | 12.9 | 4.12 | 2806 | 2:46 PM | 12/4/03 |
| 3 | 22.0 | 54.90 | 13.5 | 17.1 | 4.24 | 4300 | 3:40 PM | 12/5/03 |
| 4 | 22.0 | 54.90 | 20.0 | 26.3 | 4.43 | 5950 | 7:10 PM | 12/6/03 |
| 5 | 23.0 | 55.60 | 23.5 | 31.3 | 4.50 | 7380 | 7:00 PM | 12/7/03 |
| 6 | 23.0 | 55.60 | 27.0 | 36.2 | 4.57 | 8385 | 11:45 AM | 12/8/03 |
| 7 | 23.0 | 55.60 | 29.5 | 39.8 | 4.61 | 10220 | 6:20 PM | 12/9/03 |
| 8 | 23.0 | 55.60 | 35.0 | 47.6 | 4.69 | 11350 | 1:10 PM | 12/10/03 |



Diffusion Coefficient Curve for Psychrometer 1:






**Project: Fort Worth District**

**Borehole: C3**

**Sample Depth: 6'-7'**

Total Length of the sample, L = 14.2 cm

Distance of psychrometer 2 from closed end, x = 12.2 cm

Initial Suction, $u_0$ = 4.03 pF

Relative Humidity = 39.2%

Atmospheric Suction, $u_a$ = 6.11 pF

Diffusion Coefficient, $\alpha = 9.20E^{-5}$ $cm^2$/sec

Psychrometer 1:

No.: 40321, $\pi_{v0}$ = 51 @ 25ºC

Setup Time & Date: 6:02 PM, 01/22/04

| No. | T | $\pi_v$ | µV | Total Suction (bar) | Total Suction (pF) | Time (minutes) | Time | Date |
|---|---|---|---|---|---|---|---|---|
| 1 | 22.0 | 48.90 | 15.0 | 21.1 | 4.33 | 298 | 11:00 PM | 1/22/04 |
| 2 | 23.0 | 49.60 | 33.0 | 47.5 | 4.69 | 1308 | 3:50 PM | 1/23/04 |

Psychrometer 2:

No.: 40320, $\pi_{v0} = 48$ @ 25ºC

Setup Time & Date: 6:02 PM, 01/22/04

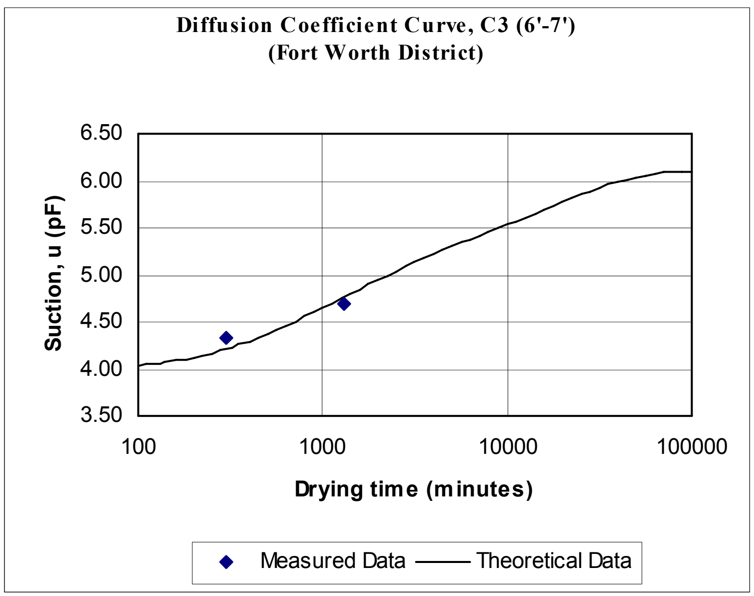
| No. | T | $\pi_v$ | μV | Total Suction (bar) | Total Suction (pF) | Time (minutes) | Time | Date |
|---|---|---|---|---|---|---|---|---|
| 1 | 23.0 | 46.60 | 9.0 | 10.4 | 4.03 | 1371 | 3:53 PM | 1/23/04 |
| 2 | 24.0 | 47.30 | 18.0 | 23.8 | 4.39 | 2756 | 2:58 PM | 1/24/04 |
| 3 | 24.0 | 47.30 | 20.0 | 26.8 | 4.44 | 3066 | 8:08 PM | 1/24/04 |
| 4 | 23.5 | 46.95 | 24.5 | 33.5 | 4.53 | 4394 | 6:41 PM | 1/25/04 |
| 5 | 24.5 | 47.65 | 25.0 | 34.3 | 4.54 | 4518 | 8:45 PM | 1/25/04 |
| 6 | 24.5 | 47.65 | 29.0 | 40.2 | 4.61 | 5671 | 3:58 PM | 1/26/04 |

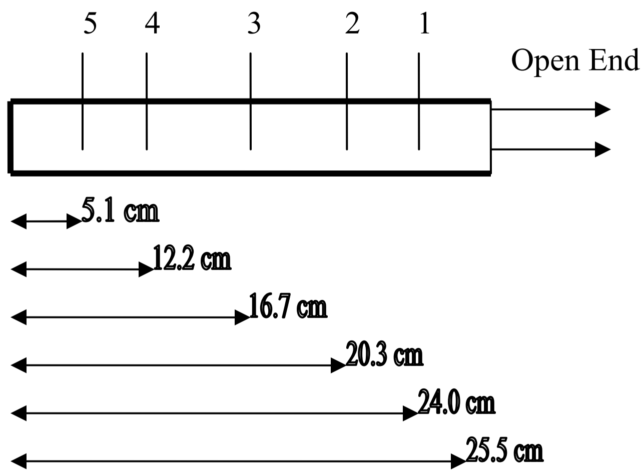
**Project: Fort Worth District**

**Borehole: C3**

**Sample Depth: 6'-7'**

Diffusion Coefficient Curve for Psychrometer 1:






**Project: Fort Worth District**

**Borehole: C3**

**Sample Depth: 9’-10’**



Total Length of the sample, L = 25.5 cm

Distance of psychrometer 2 from closed end, x = 24.0 cm

Initial Suction, $u_0$ = 3.38 pF

Relative Humidity = 54.3%

Atmospheric Suction, $u_a$ = 6.75 pF

Diffusion Coefficient, $\alpha = 0.93E^{-5}$ $cm^2/sec$

Psychrometer 1:

No.: 43311, $\pi_{v0}$ = 52 @ 25ºC

Setup Time & Date: 1:00 PM, 09/19/03

**Project: Fort Worth District**

**Borehole: C3**

**Sample Depth: 9'-10'**

| No. | T | $\pi_v$ | μV | Total Suction (bar) | Total Suction (pF) | Time (minutes) | Time | Date |
|---|---|---|---|---|---|---|---|---|
| 1 | 21.5 | 49.55 | 6.5 | 7.4 | 3.88 | 1539 | 2:39 PM | 9/20/03 |
| 2 | 21.5 | 49.55 | 9.0 | 11.0 | 4.05 | 4125 | 9:45 AM | 9/22/03 |
| 3 | 22.0 | 49.90 | 10.0 | 12.4 | 4.10 | 4360 | 3:30 PM | 9/22/03 |
| 4 | 21.5 | 49.55 | 12.0 | 15.3 | 4.19 | 5690 | 1:40 PM | 9/23/03 |
| 5 | 22.0 | 49.90 | 16.0 | 21.0 | 4.33 | 6875 | 10:25 AM | 9/24/03 |
| 6 | 22.0 | 49.90 | 16.5 | 21.7 | 4.35 | 7235 | 4:25 PM | 9/24/03 |
| 7 | 22.0 | 49.90 | 20.5 | 27.5 | 4.45 | 8302 | 10:12 AM | 9/25/03 |
| 8 | 22.0 | 49.90 | 22.0 | 29.6 | 4.48 | 8715 | 5:05 PM | 9/25/03 |
| 9 | 21.5 | 49.55 | 26.5 | 36.0 | 4.57 | 9815 | 11:25 AM | 9/26/03 |
| 10 | 21.0 | 49.20 | 33.5 | 46.1 | 4.67 | 10690 | 2:00 PM | 9/27/03 |
| 11 | 21.0 | 49.20 | 40.0 | 55.4 | 4.75 | 12080 | 2:10 PM | 9/28/03 |

Psychrometer 2:

No.: 43450, $\pi_{v0}$ = 52 @ 25ºC

Setup Time & Date: 1:00 PM, 09/19/03

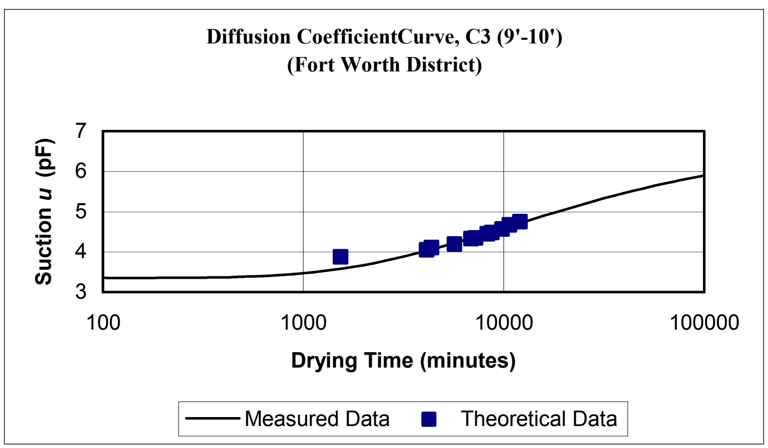
**Project: Fort Worth District**

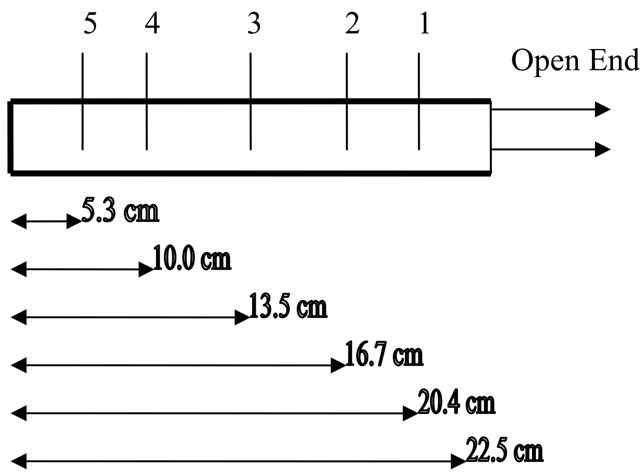
**Borehole: C3**

**Sample Depth: 9’-10’**

| No. | T | $\pi_v$ | µV | Total Suction (bar) | Total Suction (pF) | Time (minutes) | Time | Date |
|---|---|---|---|---|---|---|---|---|
| 1 | 22.5 | 50.25 | 4.5 | 4.2 | 3.63 | 1541 | 2:41 PM | 9/20/03 |
| 2 | 21.5 | 49.55 | 4.5 | 4.2 | 3.63 | 4128 | 9:48 AM | 9/22/03 |
| 3 | 22.0 | 49.90 | 4.5 | 4.2 | 3.63 | 4363 | 3:33 PM | 9/22/03 |
| 4 | 21.5 | 49.55 | 5.0 | 4.9 | 3.70 | 5694 | 1:44 PM | 9/23/03 |
| 5 | 22.5 | 50.25 | 6.3 | 6.8 | 3.84 | 6878 | 10:28 AM | 9/24/03 |
| 6 | 22.5 | 50.25 | 6.0 | 6.4 | 3.82 | 7236 | 4:26 PM | 9/24/03 |
| 7 | 22.5 | 50.25 | 7.0 | 7.9 | 3.91 | 8304 | 10:14 AM | 9/25/03 |
| 8 | 22.5 | 50.25 | 7.5 | 8.7 | 3.95 | 8717 | 5:07 PM | 9/25/03 |
| 9 | 21.5 | 49.55 | 8.0 | 9.4 | 3.98 | 9816 | 11:26 AM | 9/26/03 |
| 10 | 21.5 | 49.55 | 9.0 | 10.9 | 4.05 | 10691 | 2:01 PM | 9/27/03 |
| 11 | 21.5 | 49.55 | 10.0 | 12.4 | 4.10 | 10705 | 2:15 PM | 9/28/03 |
| 12 | 22.0 | 49.90 | 12.0 | 15.4 | 4.20 | 12167 | 2:37 PM | 9/29/03 |

Diffusion Coefficient Curve for Psychrometer 1:






**Project: Fort Worth District**

**Borehole: C4**

**Sample Depth: 5'-6'**

Total Length of the sample, L = 22.5 cm

Distance of psychrometer 2 from closed end, x = 20.4 cm

Initial Suction, $u_0$ = 3.38 pF

Relative Humidity = 54.3%

Atmospheric Suction, $u_a$ = 5.93 pF

Diffusion Coefficient, $\alpha = 1.93E^{-5}$ $cm^2$/sec

Psychrometer 1:

No.: 40293, $\pi_{v0}$ = 57 @ 25ºC

Setup Time & Date: 1:00 PM, 09/19/03

**Project: Fort Worth District**

**Borehole: C4**

**Sample Depth: 5'-6'**

| No. | T | $\pi_v$ | μV | Total Suction (bar) | Total Suction (pF) | Time (minutes) | Time | Date |
|---|---|---|---|---|---|---|---|---|
| 1 | 22.5 | 55.25 | 7.5 | 8.6 | 3.94 | 1555 | 2:55 PM | 09/20/03 |
| 2 | 22.0 | 54.90 | 8.5 | 10.1 | 4.01 | 2700 | 10:00 AM | 09/22/03 |
| 3 | 22.0 | 54.90 | 10.0 | 12.2 | 4.09 | 2986 | 3:46 PM | 09/22/03 |
| 4 | 21.5 | 54.55 | 10.5 | 12.9 | 4.12 | 4407 | 1:55 PM | 09/23/03 |
| 5 | 22.0 | 54.90 | 12.0 | 15.0 | 4.18 | 5645 | 10:38 AM | 09/24/03 |
| 6 | 22.5 | 55.25 | 13.0 | 16.4 | 4.22 | 5944 | 4:39 PM | 09/24/03 |
| 7 | 22.5 | 55.25 | 14.0 | 17.8 | 4.26 | 7006 | 10:21 AM | 09/25/03 |
| 8 | 22.5 | 55.25 | 15.0 | 19.3 | 4.29 | 7425 | 5:20 PM | 09/25/03 |
| 9 | 21.5 | 54.55 | 17.5 | 22.8 | 4.36 | 8523 | 11:38 AM | 09/26/03 |
| 10 | 21.5 | 54.55 | 21.0 | 27.8 | 4.45 | 10115 | 2:10 PM | 09/27/03 |
| 11 | 21.5 | 54.55 | 25.0 | 33.4 | 4.53 | 11567 | 2:22 PM | 09/28/03 |
| 12 | 22.0 | 54.90 | 29.0 | 39.1 | 4.60 | 13043 | 2:58 PM | 09/29/03 |

Psychrometer 2:

No.: 40320, $\pi_{v0}$ = 48 @ 25ºC

Setup Time & Date: 1:00 PM, 09/19/03

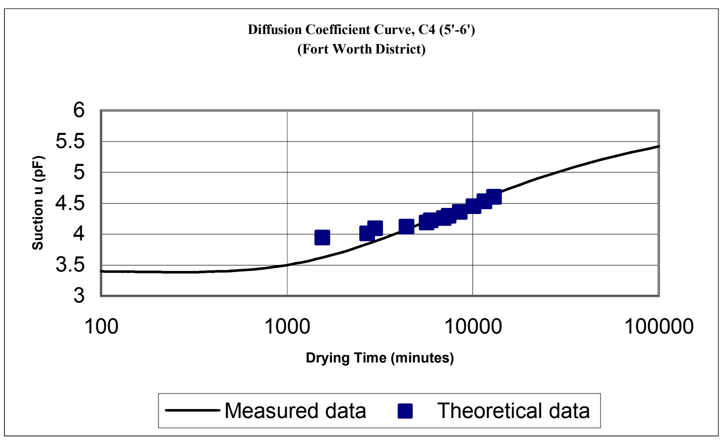
**Project: Fort Worth District**

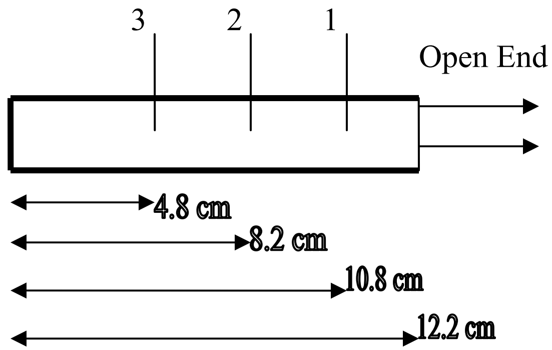
**Borehole: C4**

**Sample Depth: 5’-6’**

| No. | T | $\pi_v$ | µV | Total Suction (bar) | Total Suction (pF) | Time (minutes) | Time | Date |
|---|---|---|---|---|---|---|---|---|
| 1 | 23.0 | 46.60 | 5.5 | 5.2 | 3.72 | 1565 | 3:05 PM | 09/20/03 |
| 2 | 22.0 | 45.90 | 6.5 | 6.7 | 3.83 | 2705 | 10:05 AM | 09/22/03 |
| 3 | 22.5 | 46.25 | 7.0 | 7.5 | 3.88 | 2990 | 3:50 PM | 09/22/03 |
| 4 | 21.5 | 45.55 | 8.0 | 8.9 | 3.96 | 4412 | 2:00 PM | 09/23/03 |
| 5 | 22.5 | 46.25 | 9.0 | 10.4 | 4.03 | 5649 | 10:42 AM | 09/24/03 |
| 6 | 22.5 | 46.25 | 9.0 | 10.4 | 4.03 | 5945 | 4:40 PM | 09/24/03 |
| 7 | 22.5 | 46.25 | 10.0 | 11.9 | 4.08 | 7008 | 10:23 AM | 09/25/03 |
| 8 | 22.5 | 46.25 | 10.0 | 11.9 | 4.08 | 7428 | 5:23 AM | 09/25/03 |
| 9 | 21.5 | 45.55 | 12.0 | 14.9 | 4.18 | 8526 | 11:41 AM | 09/26/03 |
| 10 | 21.5 | 45.55 | 13.5 | 17.1 | 4.24 | 10119 | 2:14 PM | 09/27/03 |
| 11 | 21.5 | 45.55 | 15.0 | 19.4 | 4.30 | 11568 | 2:23 PM | 09/28/03 |
| 12 | 22.0 | 45.90 | 17.0 | 22.4 | 4.36 | 13045 | 3:00 PM | 09/29/03 |

Diffusion Coefficient Curve for Psychrometer 1:






**Project: Fort Worth District**

**Borehole: C4**

**Sample Depth: 9'-9.5'**

Total Length of the sample, L = 12.2 cm

Distance of psychrometer 2 from closed end, x = 10.8 cm

Initial Suction, $u_0$ = 4.57 pF

Relative Humidity = 30%

Atmospheric Suction, $u_a$ = 6.22 pF

Diffusion Coefficient, $\alpha = 1.93E^{-5}$ $cm^2/sec$

Psychrometer 1:

No.: 40336, $\pi_{v0}$ = 50 @ 25ºC

Setup Time & Date: 7:20 PM, 01/06/04

| No. | T | $\pi_v$ | μV | Total Suction (bar) | Total Suction (pF) | Time (minutes) | Time | Date |
|---|---|---|---|---|---|---|---|---|
| 1 | 20.0 | 46.50 | 9.5 | 13.6 | 4.14 | 1614 | 10:14 PM | 1/6/2004 |
| 2 | 21.0 | 47.90 | 26.5 | 39.0 | 4.60 | 2645 | 3:25 PM | 1/7/2004 |

Psychrometer 2:

No.: 40338, $\pi_{v0}$ = 49 @ 25ºC

Setup Time & Date: 7:20 PM, 01/06/04

**Project: Fort Worth District**

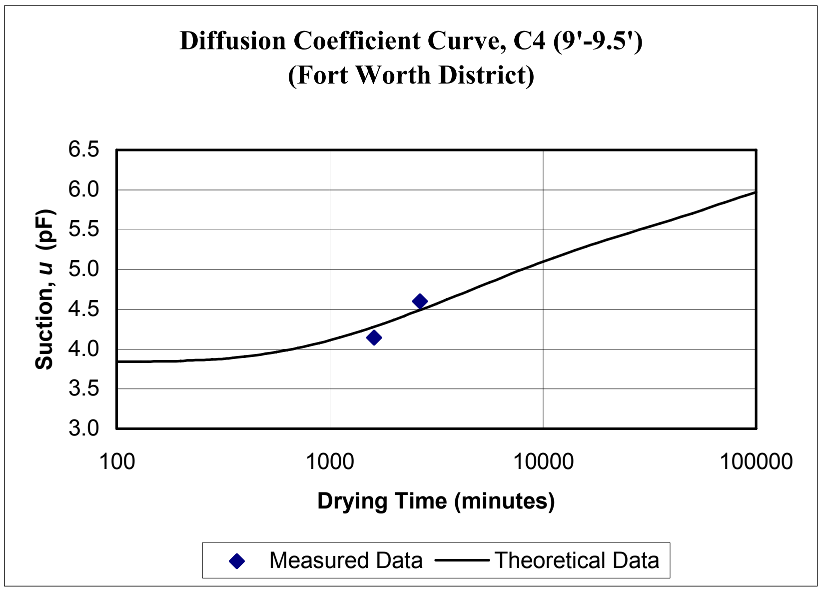
**Borehole: C4**

**Sample Depth: 9'-9.5'**

| No. | T | $\pi_v$ | μV | Total Suction (bar) | Total Suction (pF) | Time (minutes) | Time | Date |
|---|---|---|---|---|---|---|---|---|
| 1 | 21.0 | 46.20 | 6.0 | 8.4 | 3.93 | 1615 | 10:15 PM | 1/6/2004 |
| 2 | 21.5 | 46.55 | 8.0 | 11.4 | 4.07 | 2650 | 3:30 PM | 1/7/2004 |
| 3 | 22.5 | 47.25 | 9.0 | 13.0 | 4.12 | 3915 | 12:35 PM | 1/8/2004 |
| 4 | 22.5 | 47.25 | 19.0 | 28.1 | 4.46 | 5588 | 4:28 PM | 1/9/2004 |
| 5 | 22.5 | 47.25 | 24.0 | 35.7 | 4.56 | 6995 | 3:55 PM | 1/10/2004 |
| 6 | 23.0 | 47.60 | 30.0 | 44.8 | 4.66 | 8302 | 1:42 PM | 1/11/2004 |
| 7 | 24.0 | 48.30 | 35.0 | 52.4 | 4.73 | 9868 | 3:48 PM | 1/12/2004 |



Diffusion Coefficient Curve for Psychrometer 1:

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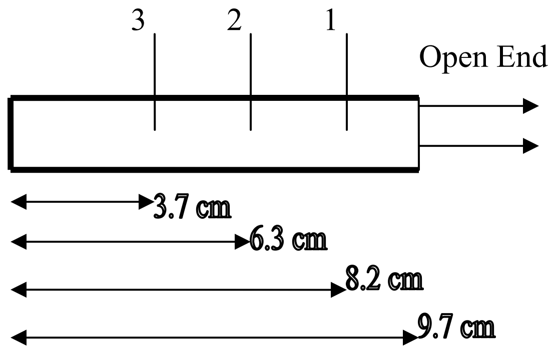



**Project: Fort Worth District**

**Borehole: C5**

**Sample Depth: 4'-5'**

Total Length of the sample, L = 9.7 cm

Distance of psychrometer 2 from closed end, x = 8.2 cm

Initial Suction, $u_0$ = 3.61 pF

Relative Humidity = 30%

Atmospheric Suction, $u_a$ = 6.22 pF

Diffusion Coefficient, $\alpha = 2.93E^{-5}$ $cm^2/sec$

Psychrometer 1:

No.: 40348, $\pi_{v0}$ = 51 @ 25ºC

Setup Time & Date: 8:35 PM, 01/03/04

| No. | T | $\pi_v$ | μV | Total Suction (bar) | Total Suction (pF) | Time (minutes) | Time | Date |
|---|---|---|---|---|---|---|---|---|
| 1 | 21.5 | 48.55 | 8.0 | 10.5 | 4.03 | 1313 | 6:28 PM | 01/04/04 |
| 2 | 21.0 | 48.20 | 25.5 | 35.6 | 4.56 | 2735 | 6:10 PM | 01/05/04 |
| 3 | 21.5 | 48.55 | 41.0 | 57.8 | 4.77 | 4196 | 6:31 PM | 01/06/04 |

**Project: Fort Worth District**

**Borehole: C5**

**Sample Depth: 4'-5'**

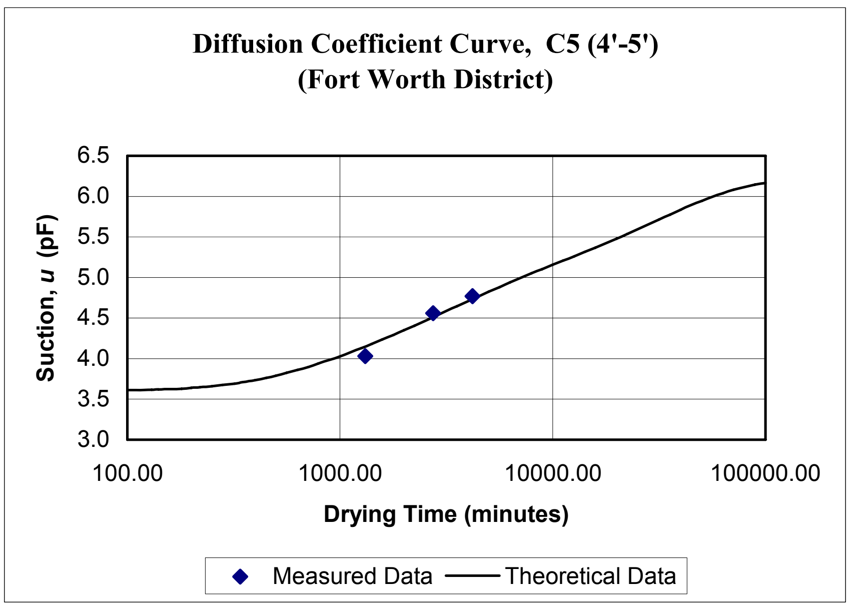
Psychrometer 2:

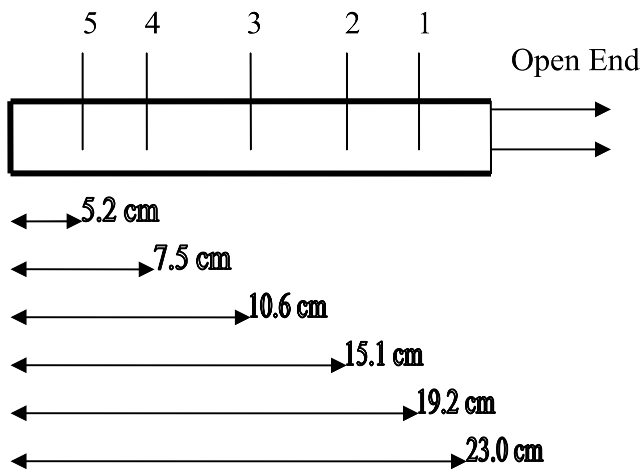
No.: 40331, $\pi_{v0} = 50$ @ 25ºC

Setup Time & Date: 8:35 PM, 01/03/04

| No. | T | $\pi_v$ | µV | Total Suction (bar) | Total Suction (pF) | Time (minutes) | Time | Date |
|---|---|---|---|---|---|---|---|---|
| 1 | 22.5 | 48.25 | 5.0 | 6.6 | 3.83 | 1315 | 6:30 PM | 01/04/04 |
| 2 | 22.0 | 47.90 | 11.0 | 15.3 | 4.19 | 2740 | 6:15 PM | 01/05/04 |
| 3 | 22.0 | 47.90 | 20.5 | 29.2 | 4.47 | 4200 | 6:35 PM | 01/06/04 |
| 4 | 22.5 | 48.25 | 26.0 | 37.2 | 4.58 | 5460 | 3:35 PM | 01/07/04 |
| 5 | 23.0 | 48.60 | 31.0 | 44.5 | 4.66 | 6727 | 12:42 PM | 01/08/04 |
| 6 | 23.0 | 48.60 | 36.0 | 51.8 | 4.72 | 8405 | 4:40 PM | 01/09/04 |

Diffusion Coefficient Curve for Psychrometer 1:






**Project: Fort Worth District**

**Borehole: C5**

**Sample Depth: 7'-8'**

Total Length of the sample, L = 23.0 cm

Distance of psychrometer 2 from closed end, x = 19.2 cm

Initial Suction, $u_0$ = 3.81 pF

Relative Humidity = 54.3%

Atmospheric Suction, $u_a$ = 5.93 pF

Diffusion Coefficient, $\alpha = 1.73E^{-5}$ $cm^2/sec$

**Project: Fort Worth District**

**Borehole: C5**

**Sample Depth: 7'-8'**

Psychrometer 1:

No.: 40334, $\pi_{v0}$ = 53 @ 25ºC

Setup Time & Date: 2:35 PM, 09/20/03

| No. | T | $\pi_v$ | μV | Total Suction (bar) | Total Suction (pF) | Time (minutes) | Time | Date |
|---|---|---|---|---|---|---|---|---|
| 1 | 22.0 | 50.90 | 6.0 | 6.7 | 3.83 | 1185 | 10:30 AM | 9/22/2003 |
| 2 | 22.5 | 51.25 | 6.5 | 7.4 | 3.88 | 1526 | 4:01 PM | 9/22/2003 |
| 3 | 22.0 | 50.90 | 7.0 | 8.1 | 3.92 | 2860 | 2:15 PM | 9/23/2003 |
| 4 | 23.0 | 51.60 | 8.0 | 9.6 | 3.99 | 4098 | 10:53 AM | 9/24/2003 |
| 5 | 23.0 | 51.60 | 8.5 | 10.3 | 4.02 | 4577 | 4:52 PM | 9/24/2003 |
| 6 | 22.5 | 51.25 | 9.5 | 11.7 | 4.08 | 5637 | 10:32 AM | 9/25/2003 |
| 7 | 22.5 | 51.25 | 10.5 | 13.1 | 4.13 | 6055 | 5:30 PM | 9/25/2003 |
| 8 | 22.0 | 50.90 | 12.0 | 15.3 | 4.19 | 7159 | 11:54 AM | 9/26/2003 |
| 9 | 22 | 50.90 | 14 | 18.1 | 4.27 | 8811 | 2:22 PM | 9/27/2003 |
| 10 | 21.5 | 50.55 | 17.0 | 22.4 | 4.36 | 10463 | 2:28 PM | 9/28/2003 |
| 11 | 22.0 | 50.90 | 23.0 | 31.0 | 4.50 | 11945 | 3:10 PM | 9/29/2003 |
| 12 | 22 | 50.90 | 27.0 | 36.8 | 4.57 | 13406 | 3:31 PM | 9/30/2003 |

Psychrometer 2:

No.: 40316, $\pi_{v0}$ = 58 @ 25ºC

Setup Time & Date: 2:35 PM, 09/20/03

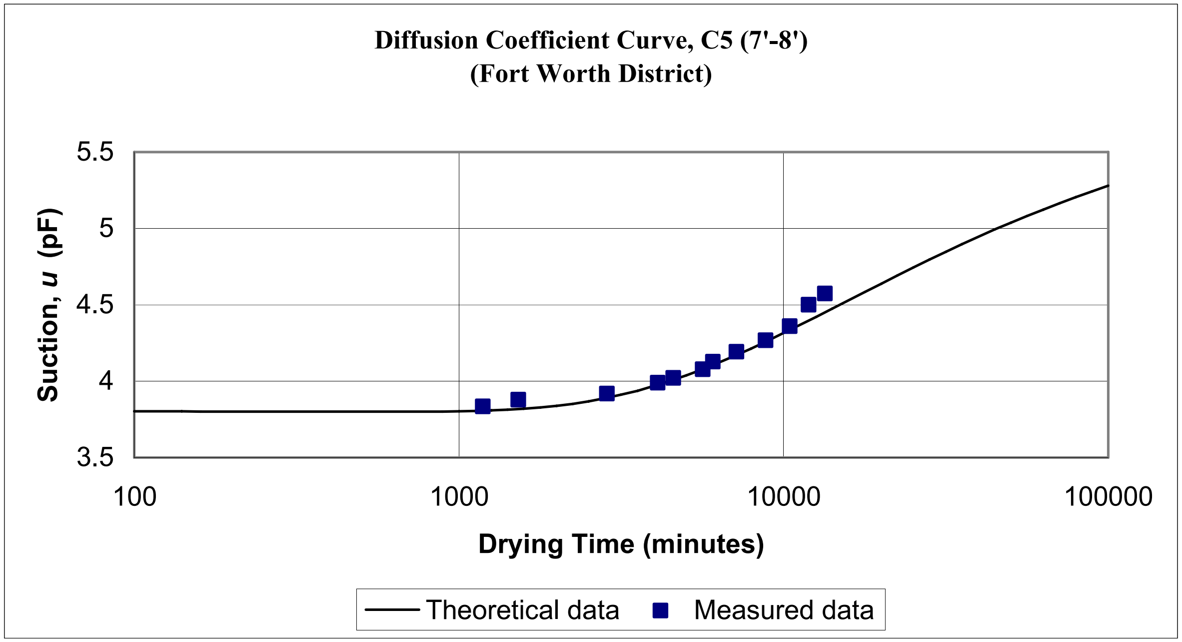
**Project: Fort Worth District**

**Borehole: C5**

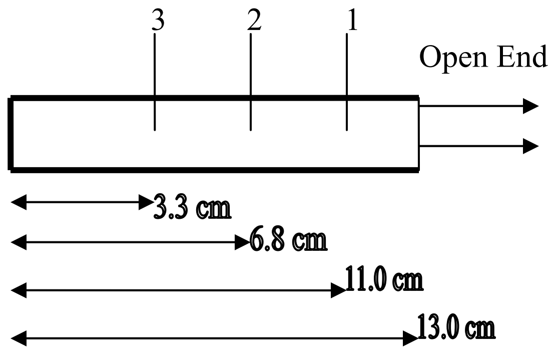
**Sample Depth: 7'-8'**

| No. | T | $\pi_v$ | μV | Total Suction (bar) | Total Suction (pF) | Time (minutes) | Time | Date |
|---|---|---|---|---|---|---|---|---|
| 1 | 22.5 | 56.25 | 5.0 | 5.3 | 3.73 | 1195 | 10:20 AM | 9/22/2003 |
| 2 | 22.5 | 56.25 | 5.5 | 6.0 | 3.79 | 1528 | 4:03 PM | 9/22/2003 |
| 3 | 22.0 | 55.90 | 6.5 | 7.4 | 3.88 | 2905 | 3:00 PM | 9/23/2003 |
| 4 | 23.0 | 56.60 | 6.0 | 6.7 | 3.83 | 4100 | 10:55 AM | 9/24/2003 |
| 5 | 23.0 | 56.60 | 8.5 | 10.3 | 4.02 | 4580 | 4:55 PM | 9/24/2003 |
| 6 | 22.5 | 56.25 | 7.0 | 8.1 | 3.92 | 5639 | 10:34 AM | 9/25/2003 |
| 7 | 23.0 | 56.60 | 7.8 | 9.3 | 3.98 | 6056 | 5:31 PM | 9/25/2003 |
| 8 | 22.5 | 56.25 | 8.0 | 9.6 | 3.99 | 7163 | 11:58 AM | 9/26/2003 |
| 9 | 22 | 55.90 | 9.5 | 11.7 | 4.08 | 8814 | 2:25 PM | 9/27/2003 |
| 10 | 21.5 | 55.55 | 11.0 | 13.9 | 4.15 | 10464 | 2:29 PM | 9/28/2003 |
| 11 | 22.0 | 55.90 | 14.0 | 18.1 | 4.27 | 11949 | 3:14 PM | 9/29/2003 |
| 12 | 22 | 55.90 | 16.0 | 21.0 | 4.33 | 13409 | 3:34 PM | 9/30/2003 |

Diffusion Coefficient Curve for Psychrometer 1:



# APPENDIX F-2




**Project: Atlanta District**

**Borehole: A1**

**Sample Depth: 5’-5.5’**

Total Length of the sample, L = 13.0 cm

Distance of psychrometer 2 from closed end, x = 11.0 cm

Initial Suction, $u_0$ = 2.84 pF

Relative Humidity = 44%

Atmospheric Suction, $u_a$ = 6.06 pF

Diffusion Coefficient, $\alpha = 4.83E^{-5}$ $cm^2/sec$

**Project: Atlanta District**

**Borehole: A1**

**Sample Depth: 5’-5.5’**

Psychrometer 1:

No.: 40293, $\pi_{v0}$ = 57 @ 25ºC

Setup Time & Date: 12:45 PM, 11/14/03

| No. | T | $\pi_v$ | μV | Total Suction (bar) | Total Suction (pF) | Time (minutes) | Time | Date |
|---|---|---|---|---|---|---|---|---|
| 1 | 23.0 | 55.60 | 5.0 | 5.1 | 3.72 | 1834 | 6:11:00 PM | 11/15/2003 |
| 2 | 23.5 | 55.95 | 10.5 | 12.9 | 4.12 | 3278 | 6:15:00 AM | 11/16/2003 |
| 3 | 23.0 | 55.60 | 15.0 | 19.3 | 4.29 | 4486 | 2:33:00 PM | 11/17/2003 |
| 4 | 23.0 | 55.60 | 24.0 | 32.0 | 4.51 | 5113 | 4:30:00 PM | 11/18/2003 |
| 5 | 24.0 | 56.30 | 36.5 | 49.7 | 4.70 | 6533 | 4:10:00 PM | 11/19/2003 |
| 6 | 24.0 | 56.30 | 45.0 | 61.7 | 4.80 | 7828 | 2:45:00 PM | 11/20/2003 |

Psychrometer 2:

No.: 40334, $\pi_{v0}$ = 53 @ 25ºC

Setup Time & Date: 12:45 PM, 11/14/03

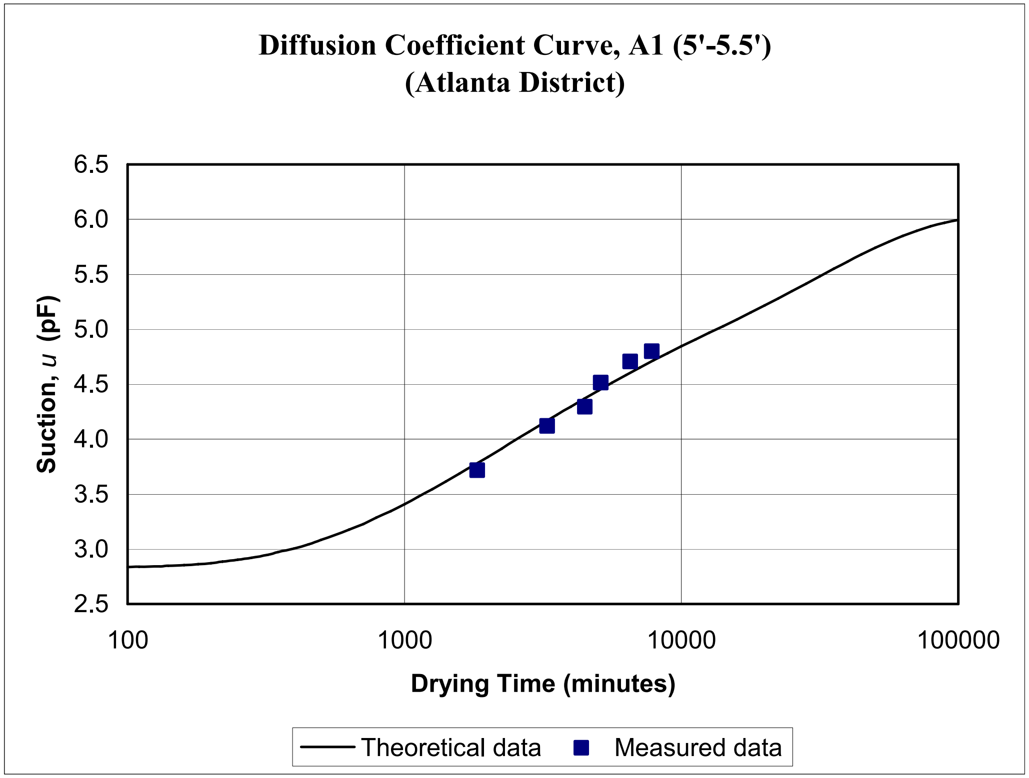
| No. | T | $\pi_v$ | μV | Total Suction (bar) | Total Suction (pF) | Time (minutes) | Time | Date |
|---|---|---|---|---|---|---|---|---|
| 1 | 23.0 | 51.60 | 3.0 | 0.1 | 1.79 | 1837 | 6:14 PM | 11/15/2003 |
| 2 | 23.5 | 51.95 | 3.0 | 0.1 | 1.79 | 3280 | 6:17 AM | 11/16/2003 |
| 3 | 23.0 | 51.60 | 3.0 | 0.1 | 1.79 | 4488 | 2:35 PM | 11/17/2003 |
| 4 | 23.0 | 51.60 | 3.5 | 0.8 | 2.92 | 5114 | 4:31 PM | 11/18/2003 |
| 5 | 24.0 | 52.30 | 5.0 | 3.1 | 3.50 | 6536 | 4:13 AM | 11/19/2003 |
| 6 | 24.0 | 52.30 | 6.5 | 5.4 | 3.74 | 7830 | 2:47 PM | 11/20/2003 |

Diffusion Coefficient Curve for Psychrometer 1:

**Project: Atlanta District**

**Borehole: A1**

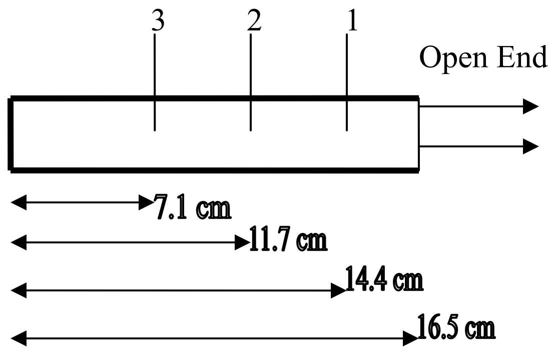
**Sample Depth: 5'-5.5'**



**Project: Atlanta District**

**Borehole: A2**

**Sample Depth: 9'-11'**




Total Length of the sample, L = 16.5 cm

Distance of psychrometer 2 from closed end, x = 14.4 cm

Initial Suction, $u_0$ = 3.13 pF

Relative Humidity = 44%

Atmospheric Suction, $u_a$ = 6.06 pF

Diffusion Coefficient, $\alpha = 3.93E^{-5}$ $cm^2/sec$

Psychrometer 1:

No.: 43450, $\pi_{v0}$ = 52 @ 25ºC

Setup Time & Date: 12:05 PM, 11/14/03

| No. | T | $\pi_v$ | μV | Total Suction (bar) | Total Suction (pF) | Time (minutes) | Time | Date |
|---|---|---|---|---|---|---|---|---|
| 1 | 22.5 | 50.25 | 6.0 | 6.4 | 3.82 | 1797 | 6:02 PM | 11/15/2003 |
| 2 | 22.5 | 50.25 | 10.5 | 13.2 | 4.13 | 3235 | 6:00 PM | 11/16/2003 |
| 3 | 23.0 | 50.60 | 15.0 | 19.9 | 4.31 | 4460 | 2:25 PM | 11/17/2003 |
| 4 | 23.0 | 50.60 | 23.5 | 32.6 | 4.52 | 6030 | 4:35 PM | 11/18/2003 |
| 5 | 24.0 | 51.30 | 34.0 | 48.3 | 4.69 | 7451 | 4:16 PM | 11/19/2003 |

Project: Atlanta District

Borehole: A2

Sample Depth: 9’-11’

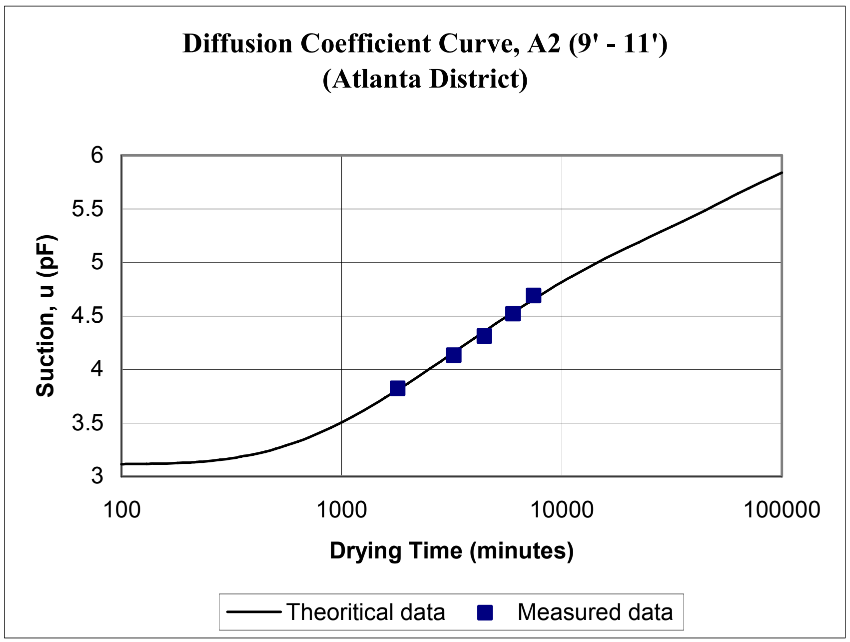
Psychrometer 2:

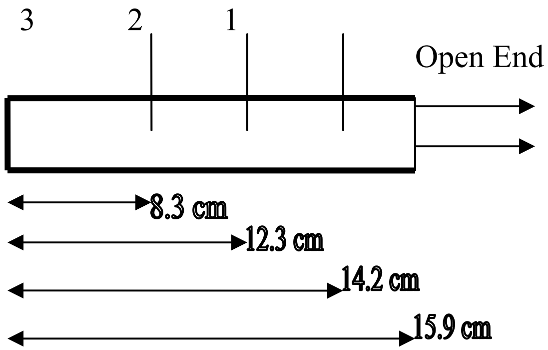
No.: 43447, $\pi_{v0}$ = 58 @ 25ºC

Setup Time & Date: 12:05 PM, 11/14/03

| No. | T | $\pi_v$ | μV | Total Suction (bar) | Total Suction (pF) | Time (minutes) | Time | Date |
|---|---|---|---|---|---|---|---|---|
| 1 | 23.0 | 56.60 | 3.8 | 2.5 | 3.40 | 1800 | 6:05 PM | 11/15/2003 |
| 2 | 23.5 | 56.95 | 3.5 | 2.1 | 3.33 | 3238 | 6:03 PM | 11/16/2003 |
| 3 | 23.5 | 56.95 | 4.0 | 2.9 | 3.46 | 4462 | 2:27 PM | 11/17/2003 |
| 4 | 23.5 | 56.95 | 6.0 | 5.9 | 3.78 | 6035 | 4:40 PM | 11/18/2003 |
| 5 | 24.5 | 57.65 | 11.0 | 13.4 | 4.14 | 7452 | 4:17 AM | 11/19/2003 |
| 6 | 24.5 | 57.65 | 13.0 | 16.4 | 4.22 | 8810 | 2:55 PM | 11/20/2003 |

Diffusion Coefficient Curve for Psychrometer 1:






**Project: Atlanta District**

**Borehole: A3**

**Sample Depth: 11'-13'**

Total Length of the sample, L = 15.9 cm

Distance of psychrometer 2 from closed end, x = 14.2 cm

Initial Suction, $u_0$ = 3.21 pF

Relative Humidity = 44%

Atmospheric Suction, $u_a$ = 6.06 pF

Diffusion Coefficient, $\alpha = 1.23E^{-5}$ $cm^2/sec$

Psychrometer 1:

No.: 42448, $\pi_{v0}$ = 54 @ 25ºC

Setup Time & Date: 12:00 PM, 11/14/03

| No. | T | $\pi_v$ | µV | Total Suction (bar) | Total Suction (pF) | Time (minutes) | Time | Date |
|---|---|---|---|---|---|---|---|---|
| 1 | 22.0 | 51.90 | 4.0 | 3.15 | 3.51 | 1798 | 5:59 PM | 11/15/2003 |
| 2 | 23.0 | 52.60 | 5.5 | 5.32 | 3.73 | 3250 | 6:12 PM | 11/16/2003 |
| 3 | 23.0 | 52.60 | 6.5 | 6.77 | 3.84 | 4455 | 2:16 PM | 11/17/2003 |
| 4 | 23.5 | 52.95 | 10.0 | 11.83 | 4.08 | 6044 | 4:46 PM | 11/18/2003 |
| 5 | 24.0 | 53.30 | 14.5 | 18.35 | 4.27 | 7505 | 4:25 PM | 11/19/2003 |
| 6 | 24.0 | 53.30 | 18.5 | 24.13 | 4.39 | 8892 | 3:18 PM | 11/20/2003 |
| 7 | 24.0 | 53.30 | 24 | 32.09 | 4.51 | 11714 | 4:20 PM | 11/22/2003 |
| 8 | 23.0 | 52.60 | 36 | 49.46 | 4.70 | 14537 | 3:20 PM | 11/24/2003 |

Psychrometer 2:

No.: 43316, $\pi_{v0}$ = 53 @ 25ºC

Setup Time & Date: 12:00 PM, 11/14/03

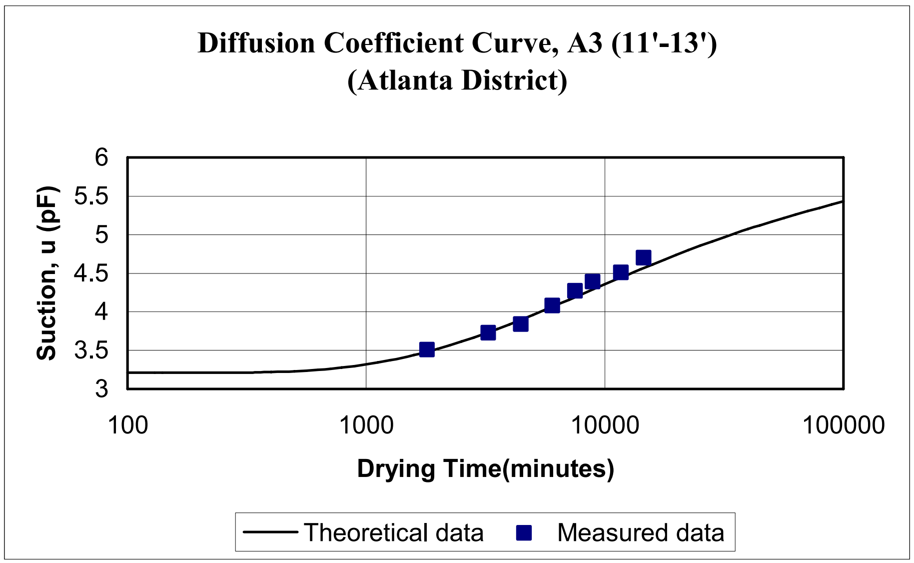
**Project: Atlanta District**

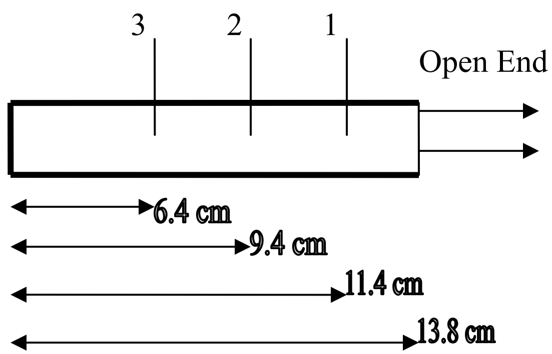
**Borehole: A3**

**Sample Depth: 11'-13'**

| No. | T | $\pi_v$ | μV | Total Suction (bar) | Total Suction (pF) | Time (minutes) | Time | Date |
|---|---|---|---|---|---|---|---|---|
| 1 | 23.0 | 51.60 | 3.5 | 1.13 | 3.06 | 1799 | 5:58 PM | 11/15/2003 |
| 2 | 23.5 | 51.95 | 4.0 | 1.89 | 3.28 | 3252 | 6:10 PM | 11/16/2003 |
| 3 | 23.0 | 51.60 | 4.0 | 1.89 | 3.28 | 4456 | 2:15 PM | 11/17/2003 |
| 4 | 24.0 | 52.30 | 5.5 | 4.17 | 3.63 | 6046 | 4:44 PM | 11/18/2003 |
| 5 | 24.0 | 52.30 | 5.5 | 4.17 | 3.63 | 7507 | 4:23 PM | 11/19/2003 |
| 6 | 24.0 | 52.30 | 5.5 | 4.17 | 3.63 | 8894 | 3:16 PM | 11/20/2003 |
| 7 | 24.0 | 52.30 | 7.5 | 7.21 | 3.87 | 11716 | 4:18 PM | 11/22/2003 |
| 8 | 23.5 | 51.95 | 9.5 | 10.26 | 4.02 | 14542 | 3:15 PM | 11/24/2003 |

Diffusion Coefficient Curve for Psychrometer 1:






**Project: Atlanta District**

**Borehole: B1**

**Sample Depth: 5'-7'**

Total Length of the sample, L = 13.8 cm

Distance of psychrometer 2 from closed end, x = 11.4 cm

Initial Suction, $u_0$ = 3.38 pF

Relative Humidity = 64.2%

Atmospheric Suction, $u_a$ = 5.79 pF

Diffusion Coefficient, $\alpha = 5.66E^{-5}$ $cm^2/sec$

Psychrometer 1:

No.: 40312, $\pi_{v0}$ = 56 @ 25ºC

Setup Time & Date: 12:35 PM, 10/31/03

| No. | T | $\pi_v$ | μV | Total Suction (bar) | Total Suction (pF) | Time (minutes) | Time | Date |
|---|---|---|---|---|---|---|---|---|
| 1 | 22.0 | 53.90 | 3.5 | 1.4 | 3.16 | 302 | 5:37 PM | 10/31/03 |
| 2 | 21.0 | 53.20 | 6.8 | 6.3 | 3.81 | 1556 | 2:31 PM | 11/1/03 |
| 3 | 21.5 | 53.55 | 13.0 | 15.7 | 4.20 | 3121 | 4:36 PM | 11/2/03 |
| 4 | 21.5 | 53.55 | 28.5 | 38.9 | 4.60 | 4247 | 11:22 AM | 11/4/03 |
| 5 | 22.0 | 53.90 | 37.0 | 51.6 | 4.72 | 5880 | 2:35 PM | 11/5/03 |
| 6 | 21.0 | 53.20 | 46.0 | 65.1 | 4.82 | 7315 | 2:30 PM | 11/6/03 |

Psychrometer 2:

No.: 40334, $\pi_{v0} = 53$ @ 25ºC

Setup Time & Date: 12:35 PM, 10/31/03

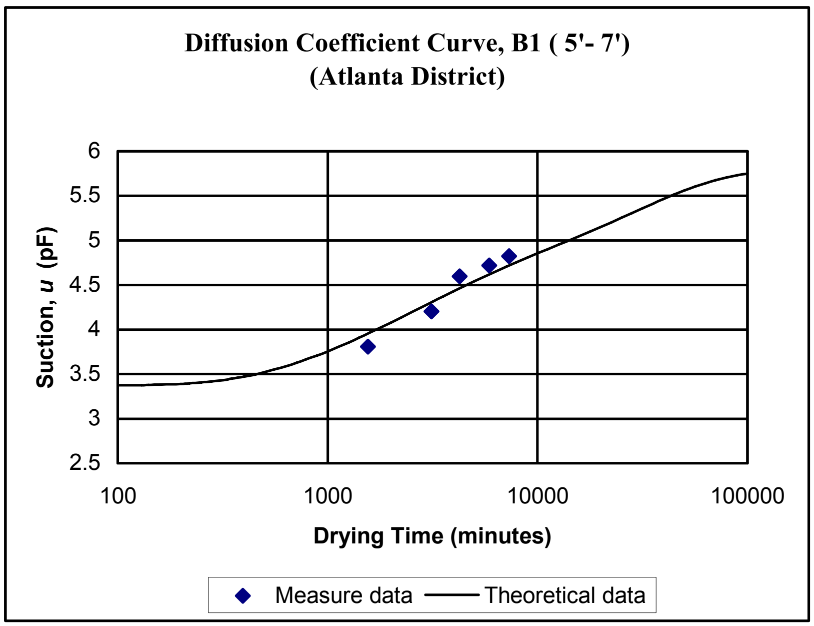
**Project: Atlanta District**

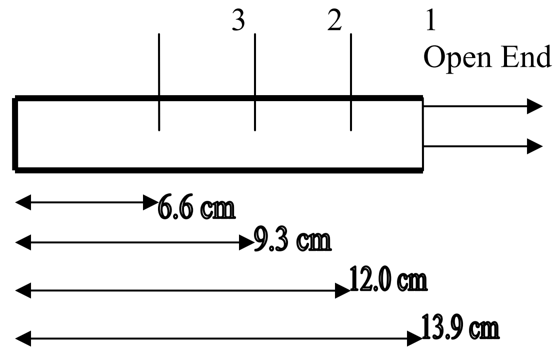
**Borehole: B1**

**Sample Depth: 5'-7'**

| No. | T | $\pi_v$ | μV | Total Suction (bar) | Total Suction (pF) | Time (minutes) | Time | Date |
|---|---|---|---|---|---|---|---|---|
| 1 | 21.0 | 55.20 | 4.0 | 2.9 | 3.46 | 1558 | 2:33 PM | 10/31/03 |
| 2 | 21.5 | 55.55 | 4.5 | 3.6 | 3.57 | 3123 | 4:38 PM | 11/1/03 |
| 3 | 21.5 | 55.55 | 8.0 | 8.9 | 3.96 | 4250 | 11:25 AM | 11/2/03 |
| 4 | 22.0 | 55.90 | 10.5 | 12.7 | 4.11 | 5885 | 2:40 PM | 11/4/03 |
| 5 | 21.0 | 55.20 | 13.0 | 16.4 | 4.22 | 7318 | 2:33 PM | 11/5/03 |

Diffusion Coefficient Curve for Psychrometer 1:






**Project: Atlanta District**

**Borehole: B2**

**Sample Depth: 9'-11'**

Total Length of the sample, L = 13.9 cm

Distance of psychrometer 2 from closed end, x = 12.0 cm

Initial Suction, $u_0$ = 3.22 pF

Relative Humidity = 64.2%

Atmospheric Suction, $u_a$ = 5.79 pF

Diffusion Coefficient, $\alpha = 3.07E^{-5}$ $cm^2/sec$

Psychrometer 1:

No.: 43316, $\pi_{v0}$ = 53 @ 25ºC

Setup Time & Date: 12:00 PM, 10/31/03

| No. | T | $\pi_v$ | μV | Total Suction (bar) | Total Suction (pF) | Time (minutes) | Time | Date |
|---|---|---|---|---|---|---|---|---|
| 1 | 21.0 | 50.20 | 5.0 | 3.4 | 3.54 | 1524 | 2:24 PM | 11/1/03 |
| 2 | 21.5 | 50.55 | 8.0 | 8.0 | 3.91 | 3105 | 4:45 PM | 11/2/03 |
| 3 | 21.5 | 50.55 | 15.0 | 18.6 | 4.28 | 4215 | 11:15 AM | 11/4/03 |
| 4 | 22.0 | 50.90 | 20.0 | 26.2 | 4.43 | 5875 | 2:55 PM | 11/5/03 |
| 5 | 21.5 | 50.55 | 24.0 | 32.3 | 4.52 | 7300 | 2:40 PM | 11/6/03 |
| 6 | 21.0 | 50.20 | 29.0 | 39.9 | 4.61 | 8625 | 12:45 PM | 11/7/03 |
| 7 | 21.0 | 50.20 | 33.0 | 46.0 | 4.67 | 10270 | 4:10 PM | 11/8/03 |
| 8 | 21.5 | 50.55 | 38.0 | 53.6 | 4.74 | 11655 | 3:15 PM | 11/9/03 |

Psychrometer 2:

No.: 40334, $\pi_{v0}$ = 53 @ 25ºC

Setup Time & Date: 12:00 PM, 10/31/03

**Project: Atlanta District**

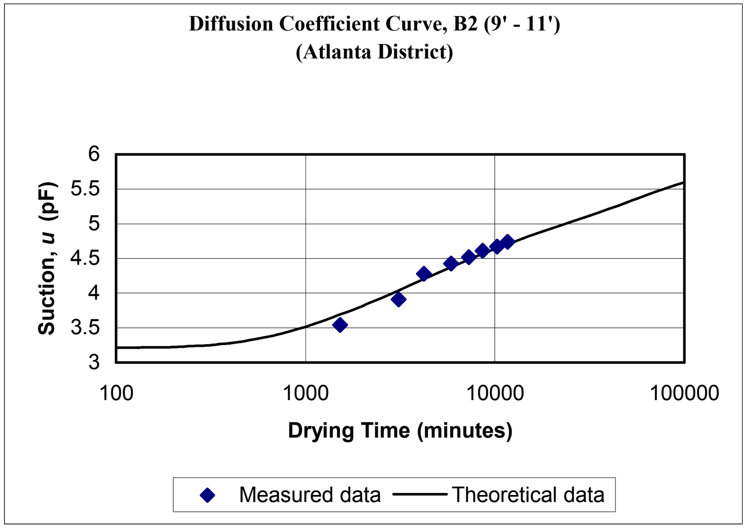
**Borehole: B2**

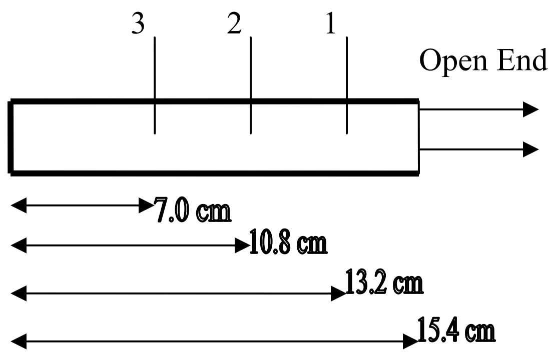
**Sample Depth: 9'-11'**

| No. | T | $\pi_v$ | μV | Total Suction (bar) | Total Suction (pF) | Time (minutes) | Time | Date |
|---|---|---|---|---|---|---|---|---|
| 1 | 21.0 | 51.20 | 2.5 | 1.0 | 3.00 | 1526 | 2:26 PM | 11/1/03 |
| 2 | 21.5 | 51.55 | 3.0 | 1.7 | 3.24 | 3107 | 4:47 PM | 11/2/03 |
| 3 | 21.5 | 51.55 | 3.5 | 2.4 | 3.39 | 4216 | 11:16 AM | 11/4/03 |
| 4 | 22.0 | 51.90 | 5.0 | 4.6 | 3.67 | 5878 | 2:58 PM | 11/5/03 |
| 5 | 21.5 | 51.55 | 6.0 | 6.0 | 3.79 | 7304 | 2:44 PM | 11/6/03 |
| 6 | 21.0 | 51.20 | 7.0 | 7.5 | 3.88 | 8626 | 12:46 PM | 11/7/03 |
| 7 | 21.0 | 51.20 | 7.5 | 8.2 | 3.92 | 10272 | 4:12 PM | 11/8/03 |
| 8 | 21.5 | 51.55 | 8.0 | 8.9 | 3.96 | 11657 | 3:17 PM | 11/9/03 |



Diffusion Coefficient Curve for Psychrometer 1:






**Project: Atlanta District**

**Borehole: B3**

**Sample Depth: 13'-14'**

Total Length of the sample, L = 15.4 cm

Distance of psychrometer 2 from closed end, x = 13.2 cm

Initial Suction, $u_0$ = 3.96 pF

Relative Humidity = 64.2%

Atmospheric Suction, $u_a$ = 5.79 pF

Diffusion Coefficient, $\alpha = 8.33E^{-5}$ $cm^2/sec$

Psychrometer 1:

No.: 40293, $\pi_{v0}$ = 57 @ 25ºC

Setup Time & Date: 3:35 PM, 10/30/03

| No. | T | $\pi_v$ | μV | Total Suction (bar) | Total Suction (pF) | Time (minutes) | Time | Date |
|---|---|---|---|---|---|---|---|---|
| 1 | 22.5 | 55.25 | 12.0 | 15.0 | 4.18 | 344 | 9:19 PM | 10/30/03 |
| 2 | 22.0 | 54.90 | 23.0 | 30.6 | 4.49 | 1153 | 10:50 AM | 10/31/03 |
| 3 | 22.0 | 54.90 | 42.0 | 57.5 | 4.77 | 2823 | 2:40 PM | 11/1/03 |

Psychrometer 2:

No.: 40334, $\pi_{v0}$ = 53 @ 25ºC

Setup Time & Date: 3:35 PM, 10/30/03

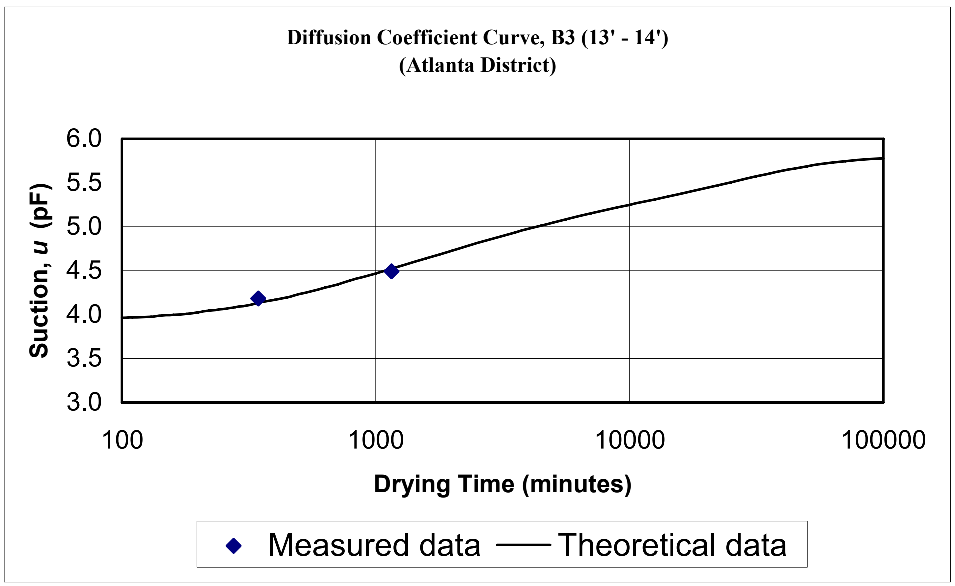
**Project: Atlanta District**

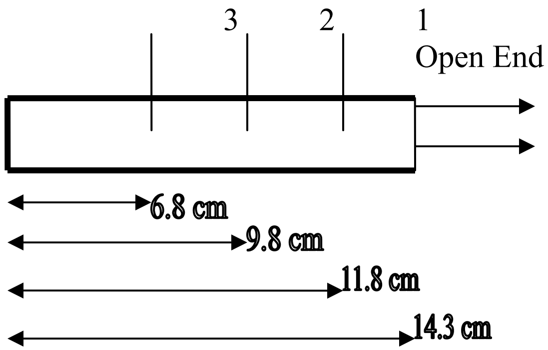
**Borehole: B3**

**Sample Depth: 13'-14'**

| No. | T | $\pi_v$ | μV | Total Suction (bar) | Total Suction (pF) | Time (minutes) | Time | Date |
|---|---|---|---|---|---|---|---|---|
| 1 | 22.5 | 46.25 | 7.5 | 8.2 | 3.92 | 346 | 9:21 PM | 10/30/03 |
| 2 | 22.0 | 45.90 | 9.0 | 10.4 | 4.03 | 1158 | 10:55 AM | 10/31/03 |
| 3 | 22.5 | 46.25 | 12.5 | 15.6 | 4.20 | 2828 | 2:45 PM | 11/1/03 |
| 4 | 22.5 | 46.25 | 17.0 | 22.3 | 4.36 | 4388 | 4:35 PM | 11/2/03 |
| 5 | 22.0 | 45.90 | 23.0 | 31.3 | 4.50 | 5500 | 11:07 AM | 11/3/03 |
| 6 | 22.5 | 46.25 | 29.0 | 40.2 | 4.61 | 7163 | 2:50 PM | 11/4/03 |

Diffusion Coefficient Curve for Psychrometer 1:






**Project: Atlanta District**

**Borehole: C1**

**Sample Depth: 2’-4’**

Total Length of the sample, L = 14.3 cm

Distance of psychrometer 2 from closed end, x = 11.8 cm

Initial Suction, $u_0$ = 3.07 pF

Relative Humidity = 66.4%

Atmospheric Suction, $u_a$ = 5.76 pF

Diffusion Coefficient, $\alpha = 9.16E^{-5}$ $cm^2/sec$

Psychrometer 1:

No.: 43447, $\pi_{v0}$ = 58 @ 25ºC

Setup Time & Date: 5:05 PM, 10/23/03

| No. | T | $\pi_v$ | µV | Total Suction (bar) | Total Suction (pF) | Time (minutes) | Time | Date |
|---|---|---|---|---|---|---|---|---|
| 1 | 22.0 | 55.90 | 3.5 | 2.1 | 3.33 | 330 | 11:35 PM | 10/23/2003 |
| 2 | 22.0 | 55.90 | 6.5 | 6.6 | 3.83 | 1754 | 11:19 AM | 10/24/2003 |
| 3 | 21.5 | 55.55 | 15.0 | 19.4 | 4.30 | 2808 | 5:45 AM | 10/26/2003 |
| 4 | 21.5 | 55.55 | 26.0 | 36.0 | 4.57 | 3370 | 2:23 PM | 10/27/2003 |
| 5 | 21.5 | 55.55 | 32.0 | 45.1 | 4.66 | 4812 | 2:25 PM | 10/28/2003 |
| 6 | 22.0 | 55.90 | 36.0 | 51.1 | 4.72 | 6056 | 11:09 AM | 10/29/2003 |

Psychrometer 2:

No.: 43448, $\pi_{v0}$ = 54 @ 25ºC

Setup Time & Date: 5:05 PM, 10/23/03

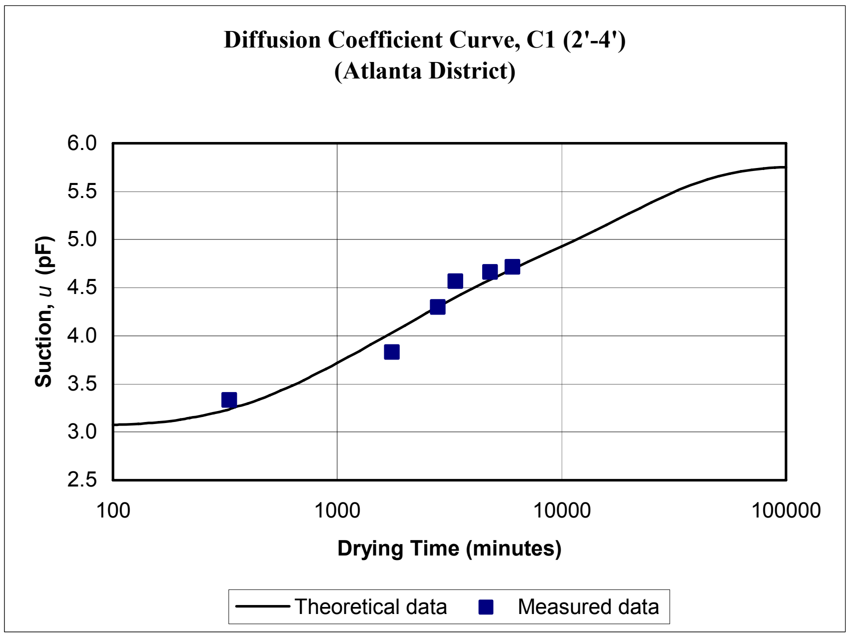
**Project: Atlanta District**

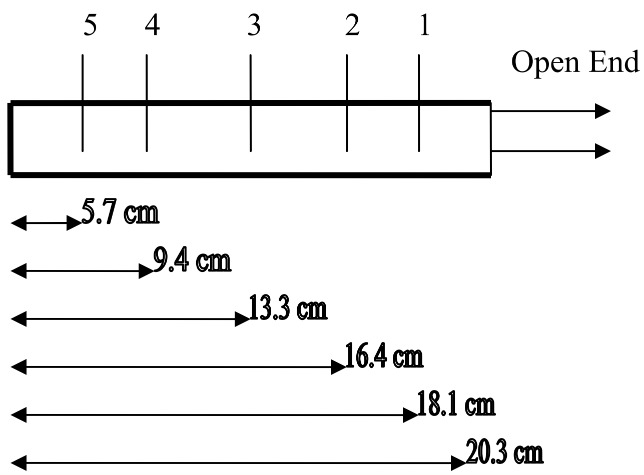
**Borehole: C1**

**Sample Depth: 2'-4'**

| No. | T | $\pi_v$ | μV | Total Suction (bar) | Total Suction (pF) | Time (minutes) | Time | Date |
|---|---|---|---|---|---|---|---|---|
| 1 | 21.5 | 51.55 | 7.5 | 8.2 | 3.92 | 1037 | 11:20 AM | 10/23/2003 |
| 2 | 21.5 | 51.55 | 12.5 | 15.5 | 4.20 | 2143 | 5:48 AM | 10/26/2003 |
| 3 | 21.0 | 51.20 | 9.0 | 10.4 | 4.03 | 2660 | 2:25 PM | 10/27/2003 |
| 4 | 21.5 | 51.55 | 10.0 | 11.8 | 4.08 | 4093 | 2:30 PM | 10/28/2003 |
| 5 | 21.5 | 51.55 | 12.0 | 14.7 | 4.18 | 5319 | 11:11 AM | 10/29/2003 |

Diffusion Coefficient Curve for Psychrometer 1:






**Project: Atlanta District**

**Borehole: C2**

**Sample Depth: 9'-11'**

Total Length of the sample, L = 20.3 cm

Distance of psychrometer 2 from closed end, x = 18.1 cm

Initial Suction, $u_0$ = 3.43 pF

Relative Humidity = 66.4%

Atmospheric Suction, $u_a$ = 5.76 pF

Diffusion Coefficient, $\alpha = 13.10E^{-5}\ cm^2/sec$

Psychrometer 1:

No.: 40316, $\pi_{v0}$ = 53 @ 25ºC

Setup Time & Date: 5:05 PM, 10/23/03

| No. | T | $\pi_v$ | µV | Total Suction (bar) | Total Suction (pF) | Time (minutes) | Time | Date |
|---|---|---|---|---|---|---|---|---|
| 1 | 22.0 | 50.90 | 2.5 | 0.7 | 2.88 | 337 | 11:42 PM | 10/23/2003 |
| 2 | 22.0 | 50.90 | 11.0 | 13.4 | 4.13 | 1045 | 11:30 AM | 10/24/2003 |
| 3 | 21.5 | 50.55 | 24.0 | 32.7 | 4.52 | 2160 | 6:05 AM | 10/26/2003 |
| 4 | 21.5 | 50.55 | 39.0 | 55.0 | 4.75 | 2958 | 2:35 PM | 10/27/2003 |

Psychrometer 2:

No.: 40316, $\pi_{v0}$ = 58 @ 25ºC

Setup Time & Date: 5:05 PM, 10/23/03

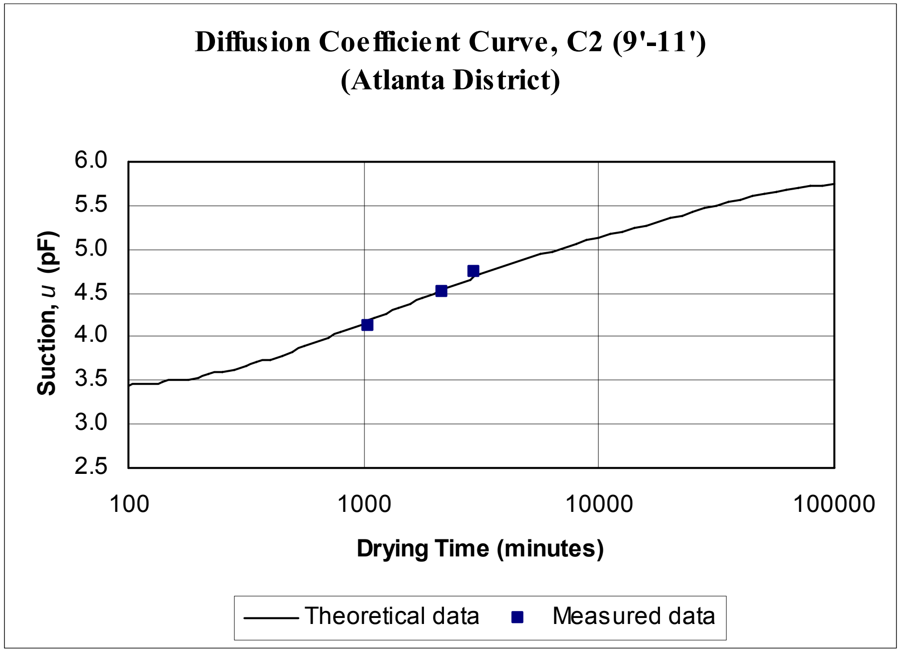
**Project: Atlanta District**

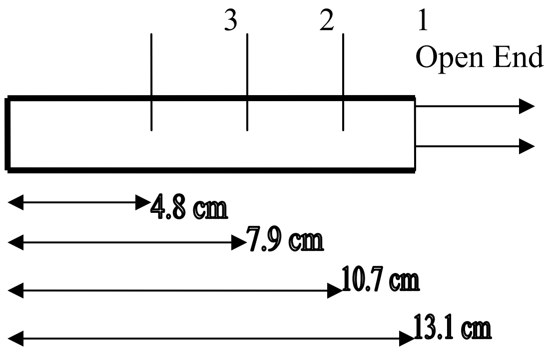
**Borehole: C2**

**Sample Depth: 9’-11’**

| No. | T | $\pi_v$ | µV | Total Suction (bar) | Total Suction (pF) | Time (minutes) | Time | Date |
|---|---|---|---|---|---|---|---|---|
| 1 | 22.0 | 53.90 | 7.5 | 6.9 | 3.85 | 1048 | 11:31 AM | 10/23/2003 |
| 2 | 22.0 | 53.90 | 12.5 | 14.3 | 4.17 | 2163 | 6:08 AM | 10/26/2003 |
| 3 | 21.5 | 53.55 | 9.0 | 9.1 | 3.97 | 2672 | 2:37 PM | 10/27/2003 |
| 4 | 22.0 | 53.90 | 10.0 | 10.6 | 4.03 | 4120 | 2:45 PM | 10/28/2003 |
| 5 | 22.0 | 53.90 | 12.0 | 13.6 | 4.14 | 5355 | 11:20 AM | 10/29/2003 |

Diffusion Coefficient Curve for Psychrometer 1:






**Project: Atlanta District**

**Borehole: C3**

**Sample Depth: 11’-13’**

Total Length of the sample, L = 13.1 cm

Distance of psychrometer 2 from closed end, x = 10.7 cm

Initial Suction, $u_0$ = 3.99 pF

Relative Humidity = 66.4%

Atmospheric Suction, $u_a$ = 5.76 pF

Diffusion Coefficient, $\alpha = 4.26E^{-5}$ $cm^2/sec$

Psychrometer 1:

No.: 40334, $\pi_{v0}$ = 53 @ 25ºC

Setup Time & Date: 5:25 PM, 10/23/03

| No. | T | $\pi_v$ | μV | Total Suction (bar) | Total Suction (pF) | Time (minutes) | Time | Date |
|---|---|---|---|---|---|---|---|---|
| 1 | 22.5 | 51.25 | 8.0 | 7.7 | 3.89 | 380 | 11:45 PM | 10/23/2003 |
| 2 | 22.0 | 50.90 | 14.5 | 17.5 | 4.25 | 1065 | 11:10 AM | 10/24/2003 |
| 3 | 22.0 | 50.90 | 30.0 | 41.1 | 4.62 | 3635 | 6:15 AM | 10/26/2003 |

Psychrometer 2:

No.: 40337, $\pi_{v0} = 49$ @ 25ºC

Setup Time & Date: 5:25 PM, 10/23/03

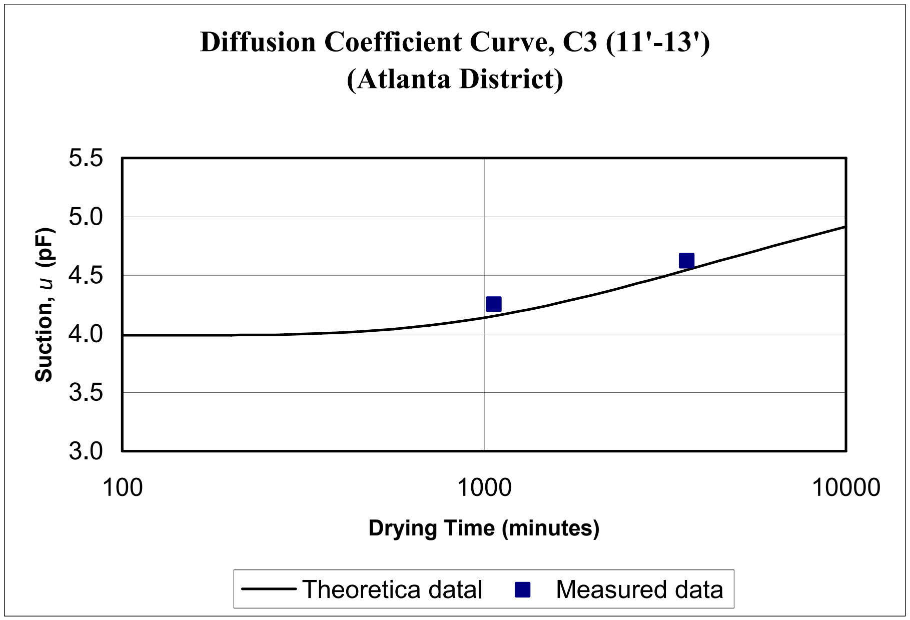
**Project: Atlanta District**

**Borehole: C3**

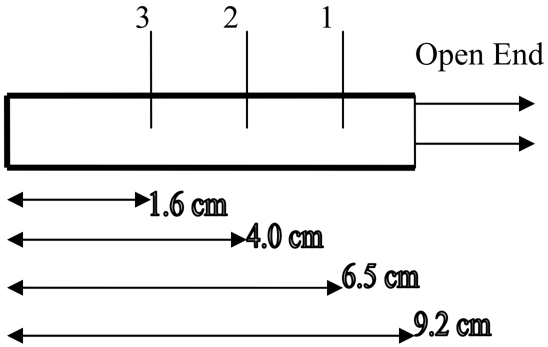
**Sample Depth: 11'-13'**

| No. | T | $\pi_v$ | μV | Total Suction (bar) | Total Suction (pF) | Time (minutes) | Time | Date |
|---|---|---|---|---|---|---|---|---|
| 1 | 22.0 | 46.90 | 7.3 | 10.4 | 4.03 | 1069 | 11:14 AM | 10/24/2003 |
| 2 | 22.0 | 46.90 | 10.5 | 14.8 | 4.18 | 3640 | 6:20 AM | 10/26/2003 |
| 3 | 21.5 | 46.55 | 12.5 | 17.5 | 4.25 | 4836 | 2:16 PM | 10/27/2003 |
| 4 | 21.5 | 46.55 | 14.5 | 20.2 | 4.31 | 6280 | 2:20 PM | 10/28/2003 |
| 5 | 22.0 | 46.90 | 17.0 | 23.6 | 4.38 | 7525 | 11:05 AM | 10/29/2003 |

Diffusion Coefficient Curve for Psychrometer 1:



# APPENDIX F-3




**Project: Austin District**

**Borehole: B1**

**Sample Depth: 2'-3.5'**

Total Length of the sample, L = 9.2 cm

Distance of psychrometer 2 from closed end, x = 6.5 cm

Initial Suction, $u_0$ = 3.45 pF

Relative Humidity = 60.9%

Atmospheric Suction, $u_a$ = 5.84 pF

Diffusion Coefficient, $\alpha = 10.60E^{-5}\ cm^2/sec$

Psychrometer 1:

No.: 40362, $\pi_{v0}$ = 50 @ 25ºC

Setup Time & Date: 4:35 PM, 02/26/04

| No. | T | $\pi_v$ | µV | Total Suction (bar) | Total Suction (pF) | Time (minutes) | Time | Date |
|---|---|---|---|---|---|---|---|---|
| 1 | 22.0 | 47.90 | 12.0 | 18.1 | 4.27 | 950 | 12:45 PM | 2/27/04 |
| 2 | 22.0 | 47.90 | 12.0 | 18.1 | 4.27 | 1431 | 4:46 PM | 2/27/04 |
| 3 | 22.5 | 48.25 | 21.5 | 33.0 | 4.53 | 2714 | 2:09 PM | 2/28/04 |
| 4 | 22.0 | 47.90 | 25.5 | 39.2 | 4.60 | 3040 | 7:33 PM | 2/28/04 |
| 5 | 22.5 | 48.25 | 31.5 | 48.6 | 4.70 | 4187 | 2:40 PM | 2/29/04 |
| 6 | 22.5 | 48.25 | 33.0 | 50.9 | 4.72 | 4527 | 8:20 PM | 2/29/04 |

Psychrometer 2:

No.: 40325, $\pi_{v0}$ = 49 @ 25ºC

Setup Time & Date: 4:35 PM, 02/26/04

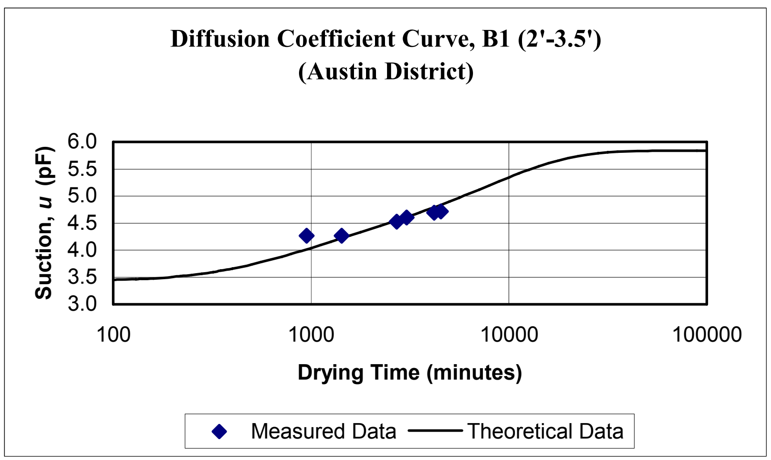
**Project: Austin District**

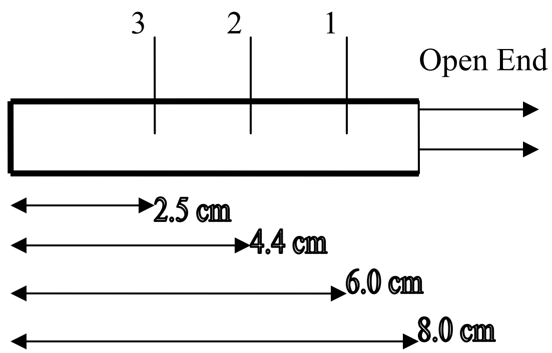
**Borehole: B1**

**Sample Depth: 2'-3.5'**

| No. | T | $\pi_v$ | μV | Total Suction (bar) | Total Suction (pF) | Time (minutes) | Time | Date |
|---|---|---|---|---|---|---|---|---|
| 1 | 22.5 | 47.25 | 4.5 | 5.4 | 3.74 | 951 | 12:46 PM | 2/27/04 |
| 2 | 23.0 | 47.60 | 4.5 | 5.4 | 3.74 | 1435 | 4:50 PM | 2/27/04 |
| 3 | 23.0 | 47.60 | 11.0 | 14.9 | 4.18 | 2716 | 2:11 PM | 2/28/04 |
| 4 | 23.0 | 47.60 | 11.5 | 15.6 | 4.20 | 3043 | 7:36 PM | 2/28/04 |
| 5 | 23.0 | 47.60 | 15.5 | 21.4 | 4.34 | 4191 | 2:44 PM | 2/29/04 |
| 6 | 23.0 | 47.60 | 18.0 | 25.1 | 4.41 | 4532 | 8:25 PM | 2/29/04 |
| 7 | 23.0 | 47.60 | 24.0 | 33.8 | 4.54 | 5504 | 12:37 PM | 3/1/04 |
| 8 | 23.5 | 47.95 | 31.0 | 44.0 | 4.65 | 6122 | 10:55 AM | 3/2/04 |
| 9 | 22.5 | 47.25 | 32.0 | 45.5 | 4.67 | 6443 | 4:16 PM | 3/2/04 |
| 10 | 23.0 | 47.60 | 41.0 | 58.6 | 4.78 | 7692 | 1:05 PM | 3/3/04 |

Diffusion Coefficient Curve for Psychrometer 1:






**Project: Austin District**

**Borehole: B1**

**Sample Depth: 3.5'-5'**

Total Length of the sample, L = 8.0 cm

Distance of psychrometer 2 from closed end, x = 6.0 cm

Initial Suction, $u_0$ = 3.53 pF

Relative Humidity = 60.9%

Atmospheric Suction, $u_a$ = 5.84 pF

Diffusion Coefficient, $\alpha = 5.65E^{-5}$ $cm^2/sec$

Psychrometer 1:

No.: 40293, $\pi_{v0}$ = 57 @ 25ºC

Setup Time & Date: 4:33 PM, 02/27/04

| No. | T | $\pi_v$ | µV | Total Suction (bar) | Total Suction (pF) | Time (minutes) | Time | Date |
|---|---|---|---|---|---|---|---|---|
| 1 | 22.0 | 54.90 | 10.5 | 12.9 | 4.12 | 1293 | 2:16 PM | 2/28/04 |
| 2 | 22.5 | 55.25 | 17.0 | 22.1 | 4.35 | 1617 | 7:40 PM | 2/28/04 |
| 3 | 22.0 | 54.90 | 23.0 | 30.6 | 4.49 | 2688 | 2:31 PM | 2/29/04 |
| 4 | 22.0 | 54.90 | 28.0 | 37.7 | 4.58 | 3046 | 8:29 PM | 2/29/04 |
| 5 | 23.0 | 55.60 | 33.0 | 44.7 | 4.66 | 4742 | 12:45 PM | 3/1/04 |
| 6 | 23.0 | 55.60 | 37.0 | 50.4 | 4.71 | 5342 | 10:45 AM | 3/2/04 |

Psychrometer 2:

No.: 40305, $\pi_{v0}$ = 60 @ 25ºC

Setup Time & Date: 4:33 PM, 02/27/04

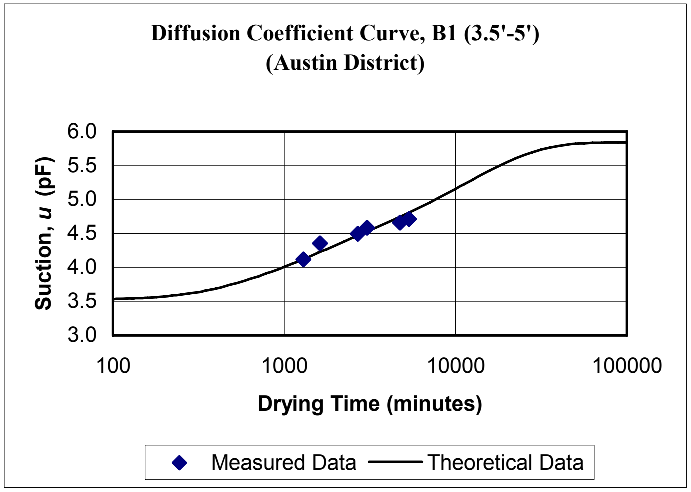
**Project: Austin District**

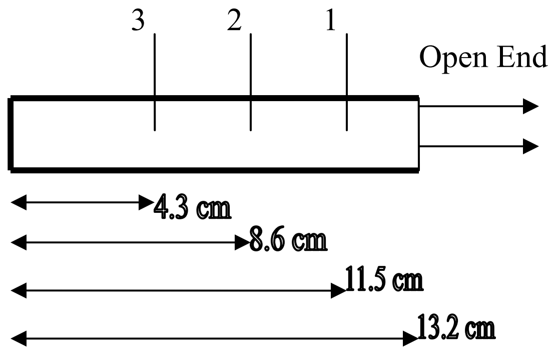
**Borehole: B1**

**Sample Depth: 3.5'-5'**

| No. | T | $\pi_v$ | μV | Total Suction (bar) | Total Suction (pF) | Time (minutes) | Time | Date |
|---|---|---|---|---|---|---|---|---|
| 1 | 22.5 | 58.25 | 5.0 | 6.1 | 3.79 | 1301 | 2:24 PM | 2/28/04 |
| 2 | 23.0 | 58.60 | 9.5 | 12.4 | 4.10 | 1622 | 7:45 PM | 2/28/04 |
| 3 | 22.5 | 58.25 | 13.0 | 17.4 | 4.25 | 2691 | 2:34 PM | 2/29/04 |
| 4 | 22.5 | 58.25 | 14.5 | 19.5 | 4.30 | 3049 | 8:32 PM | 2/29/04 |
| 5 | 23.0 | 58.60 | 22.0 | 30.0 | 4.49 | 4747 | 12:50 PM | 3/1/04 |
| 6 | 23.0 | 58.60 | 28.0 | 38.5 | 4.59 | 5347 | 10:50 AM | 3/2/04 |
| 7 | 23.5 | 58.95 | 30.0 | 41.3 | 4.62 | 5682 | 4:25 PM | 3/2/04 |
| 8 | 23.0 | 58.60 | 35.0 | 48.4 | 4.69 | 6917 | 1:00 PM | 3/3/04 |

Diffusion Coefficient Curve for Psychrometer 1:






**Project: Austin District**

**Borehole: B2**

**Sample Depth: 3.5’-5’**

Total Length of the sample, L = 13.2 cm

Distance of psychrometer 2 from closed end, x = 11.5 cm

Initial Suction, $u_0$ = 3.21 pF

Relative Humidity = 66.4%

Atmospheric Suction, $u_a$ = 5.76 pF

Diffusion Coefficient, $\alpha = 8.33E^{-5}$ $cm^2$/sec

Psychrometer 1:

No.: 40321, $\pi_{v0}$ = 51 @ 25ºC

Setup Time & Date: 6:12 PM, 04/20/04

| No. | T | $\pi_v$ | µV | Total Suction (bar) | Total Suction (pF) | Time (minutes) | Time | Date |
|---|---|---|---|---|---|---|---|---|
| 1 | 23.5 | 49.95 | 9.0 | 12.4 | 4.10 | 1123 | 12:55 PM | 4/21/2004 |
| 2 | 23.0 | 49.60 | 11.0 | 15.3 | 4.19 | 1413 | 5:45 PM | 4/21/2004 |
| 3 | 23.5 | 49.95 | 22.5 | 32.1 | 4.52 | 2473 | 11:25 AM | 4/22/2004 |
| 4 | 23.5 | 49.95 | 24.5 | 35.1 | 4.55 | 2996 | 8:09 PM | 4/22/2004 |
| 5 | 23.5 | 49.95 | 37.0 | 53.4 | 4.74 | 4173 | 3:46 PM | 4/23/2004 |
| 6 | 24.0 | 50.30 | 39.0 | 56.3 | 4.76 | 4327 | 6:20 PM | 4/23/2004 |

Psychrometer 2:

No.: 40338, $\pi_{v0}$ = 50 @ 25ºC

Setup Time & Date: 6:12 PM, 04/20/04

**Project: Austin District**

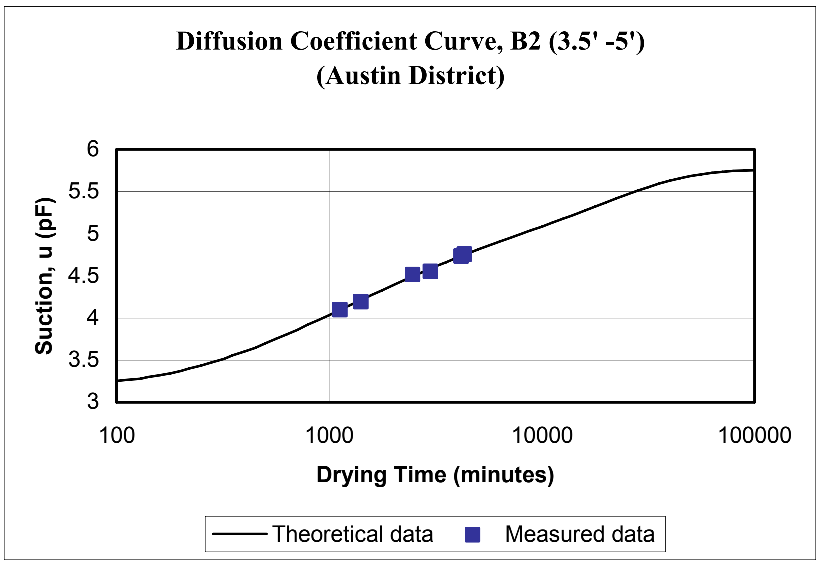
**Borehole: B2**

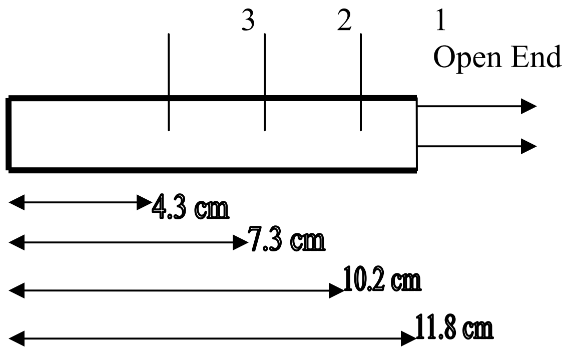
**Sample Depth: 3.5'-5'**

| No. | T | $\pi_v$ | μV | Total Suction (bar) | Total Suction (pF) | Time (minutes) | Time | Date |
|---|---|---|---|---|---|---|---|---|
| 1 | 24.0 | 49.30 | 5.0 | 6.9 | 3.85 | 1128 | 1:00 PM | 4/21/2004 |
| 2 | 23.5 | 48.95 | 6.5 | 9.2 | 3.97 | 1415 | 5:47 PM | 4/21/2004 |
| 3 | 24.5 | 49.65 | 10.0 | 14.5 | 4.17 | 2477 | 11:29 AM | 4/22/2004 |
| 4 | 24.0 | 49.30 | 11.5 | 16.8 | 4.23 | 2998 | 8:11 PM | 4/22/2004 |
| 5 | 24.5 | 49.65 | 18.0 | 26.6 | 4.43 | 4174 | 3:47 AM | 4/23/2004 |
| 6 | 24.5 | 49.65 | 18.5 | 27.4 | 4.45 | 4329 | 6:22 PM | 4/23/2004 |
| 7 | 24.0 | 49.30 | 26.5 | 39.5 | 4.61 | 5648 | 4:21 PM | 4/24/2004 |



Diffusion Coefficient Curve for Psychrometer 1:






**Project: Austin District**

**Borehole: B2**

**Sample Depth: 6.5'-8'**

Total Length of the sample, L = 11.8 cm

Distance of psychrometer 2 from closed end, x = 10.2 cm

Initial Suction, $u_0$ = 3.27 pF

Relative Humidity = 66.4%

Atmospheric Suction, $u_a$ = 5.76 pF

Diffusion Coefficient, $\alpha = 5.66E^{-5}$ $cm^2/sec$

Psychrometer 1:

No.: 43311, $\pi_{v0}$ = 52 @ 25ºC

Setup Time & Date: 6:52 PM, 04/20/04

| No. | T | $\pi_v$ | μV | Total Suction (bar) | Total Suction (pF) | Time (minutes) | Time | Date |
|---|---|---|---|---|---|---|---|---|
| 1 | 23.0 | 50.60 | 6.5 | 7.4 | 3.88 | 1113 | 12:45 PM | 4/21/2004 |
| 2 | 23.0 | 50.60 | 8.5 | 10.3 | 4.02 | 1418 | 5:50 PM | 4/21/2004 |
| 3 | 23.0 | 50.60 | 19.5 | 26.0 | 4.42 | 2464 | 11:16 AM | 4/22/2004 |
| 4 | 23.5 | 50.95 | 22.5 | 30.3 | 4.49 | 2984 | 8:13 PM | 4/22/2004 |
| 5 | 23.5 | 50.95 | 35.0 | 48.2 | 4.69 | 4155 | 3:40 PM | 4/23/2004 |
| 6 | 24.0 | 51.30 | 37.0 | 51.1 | 4.72 | 4309 | 9:20 PM | 4/23/2004 |
| 7 | 23.0 | 50.60 | 45.0 | 62.5 | 4.80 | 5441 | 4:14 PM | 4/24/2004 |

Psychrometer 2:

No.: 40321, $\pi_{v0} = 49$ @ 25ºC

Setup Time & Date: 6:52 PM, 04/20/04

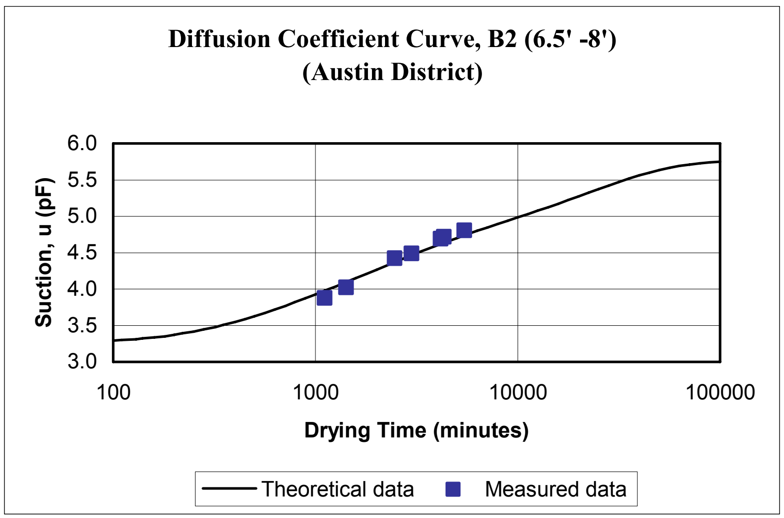
**Project: Austin District**

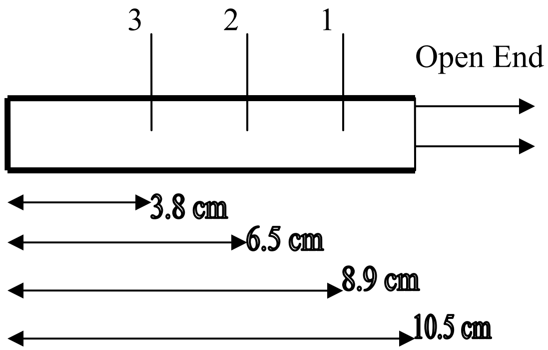
**Bore hole: B2**

**Sample Depth: 6.5'-8'**

| No. | T | $\pi_v$ | μV | Total Suction (bar) | Total Suction (pF) | Time (minutes) | Time | Date |
|---|---|---|---|---|---|---|---|---|
| 1 | 23.5 | 47.95 | 3.5 | 4.6 | 3.67 | 1115 | 12:47 PM | 4/21/2004 |
| 2 | 23.5 | 47.95 | 3.5 | 4.6 | 3.67 | 1421 | 5:53 PM | 4/21/2004 |
| 3 | 24.0 | 48.30 | 6.0 | 8.4 | 3.93 | 2468 | 11:20 AM | 4/22/2004 |
| 4 | 24.0 | 48.30 | 9.0 | 13.0 | 4.12 | 2986 | 8:15 PM | 4/22/2004 |
| 5 | 24.0 | 48.30 | 9.5 | 13.7 | 4.15 | 4159 | 3:44 PM | 4/23/2004 |
| 6 | 24.0 | 48.30 | 10.0 | 14.5 | 4.17 | 4320 | 9:31 PM | 4/23/2004 |
| 7 | 24.0 | 48.30 | 13.0 | 19.0 | 4.29 | 5442 | 4:15 PM | 4/24/2004 |

Diffusion Coefficient Curve for Psychrometer 1:






**Project: Austin District**

**Borehole: B2**

**Sample Depth: 9.5'-10.7'**

Total Length of the sample, L = 10.5 cm

Distance of psychrometer 2 from closed end, x = 8.9 cm

Initial Suction, $u_0$ = 3.21 pF

Relative Humidity = 66.4%

Atmospheric Suction, $u_a$ = 5.76 pF

Diffusion Coefficient, $\alpha = 10.70E^{-5}$ $cm^2/sec$

Psychrometer 1:

No.: 43450, $\pi_{v0}$ = 52 @ 25ºC

Setup Time & Date: 2:00 PM, 04/07/04

| No. | T | $\pi_v$ | µV | Total Suction (bar) | Total Suction (pF) | Time (minutes) | Time | Date |
|---|---|---|---|---|---|---|---|---|
| 1 | 23.0 | 50.60 | 7.0 | 8.1 | 3.92 | 510 | 10:30 PM | 4/7/2004 |
| 2 | 23.0 | 50.60 | 16.5 | 21.7 | 4.35 | 1268 | 11:08 AM | 4/8/2004 |
| 3 | 23.0 | 50.60 | 19.0 | 25.3 | 4.41 | 1545 | 3:45 PM | 4/8/2004 |
| 4 | 23.5 | 50.95 | 24.0 | 32.5 | 4.52 | 2140 | 1:40 AM | 4/9/2004 |
| 5 | 23.5 | 50.95 | 32.0 | 43.9 | 4.65 | 2784 | 12:56 PM | 4/9/2004 |
| 6 | 24.0 | 51.30 | 34.0 | 46.8 | 4.68 | 3174 | 7:26 PM | 4/9/2004 |
| 7 | 24.0 | 51.30 | 38.0 | 52.5 | 4.73 | 3472 | 12:24 PM | 4/10/2004 |

**Project: Austin District**

**Borehole: B2**

**Sample Depth: 9.5'-10.7'**

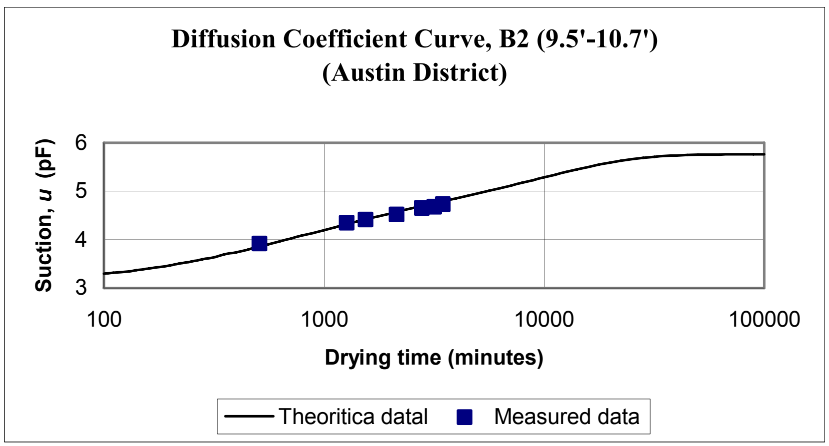
Psychrometer 2:

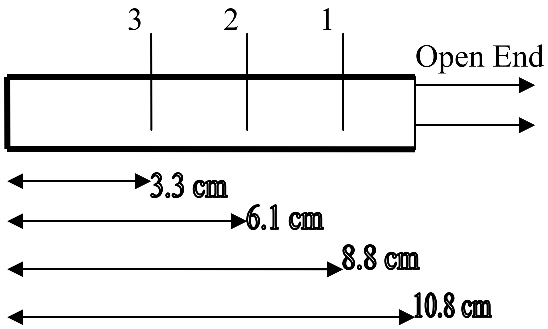
No.: 40321, $\pi_{v0}$ = 51 @ 25ºC

Setup Time & Date: 2:00 PM, 04/07/04

| No. | T | $\pi_v$ | μV | Total Suction (bar) | Total Suction (pF) | Time (minutes) | Time | Date |
|---|---|---|---|---|---|---|---|---|
| 1 | 23.5 | 49.95 | 6.5 | 8.7 | 3.95 | 512 | 10:32 PM | 4/7/2004 |
| 2 | 23.5 | 49.95 | 12.5 | 17.5 | 4.25 | 1270 | 11:10 AM | 4/8/2004 |
| 3 | 23.5 | 49.95 | 13.0 | 18.2 | 4.27 | 1555 | 3:55 PM | 4/8/2004 |
| 4 | 23.0 | 49.60 | 19.0 | 27.0 | 4.44 | 2143 | 1:43 AM | 4/9/2004 |
| 5 | 24.0 | 50.30 | 23.0 | 32.9 | 4.53 | 2786 | 12:58 PM | 4/9/2004 |
| 6 | 24.0 | 50.30 | 23.0 | 32.9 | 4.53 | 3176 | 7:28 PM | 4/9/2004 |
| 7 | 23.0 | 49.60 | 29.0 | 41.7 | 4.63 | 3478 | 12:30 PM | 4/10/2004 |
| 8 | 24.0 | 50.30 | 30.0 | 43.1 | 4.64 | 3891 | 7:23 PM | 4/10/2004 |
| 9 | 23.5 | 49.95 | 35.0 | 50.5 | 4.71 | 5029 | 2:21 PM | 4/11/2004 |
| 10 | 23.5 | 49.95 | 38.0 | 54.9 | 4.75 | 5504 | 10:16 PM | 4/11/2004 |

Diffusion Coefficient Curve for Psychrometer 1:






**Project: Austin District**

**Borehole: B3**

**Sample Depth: 3.5’-5’**

Total Length of the sample, L = 10.8 cm

Distance of psychrometer 2 from closed end, x = 8.8 cm

Initial Suction, $u_0$ = 3.46 pF

Relative Humidity = 56.8%

Atmospheric Suction, $u_a$ = 5.9 pF

Diffusion Coefficient, $\alpha = 3.20E^{-5}$ $cm^2/sec$

Psychrometer 1:

No.: 40316, $\pi_{v0}$ = 58 @ 25ºC

Setup Time & Date: 5:30 PM, 03/24/04

| No. | T | $\pi_v$ | μV | Total Suction (bar) | Total Suction (pF) | Time (minutes) | Time | Date |
|---|---|---|---|---|---|---|---|---|
| 1 | 22.5 | 56.25 | 10.5 | 11.0 | 4.05 | 1380 | 4:30 PM | 3/25/2004 |
| 2 | 22.5 | 56.25 | 13.5 | 15.4 | 4.19 | 1865 | 12:35 AM | 3/26/2004 |
| 3 | 22.5 | 56.25 | 21.5 | 27.0 | 4.44 | 2612 | 1:02 PM | 3/26/2004 |
| 4 | 23.5 | 56.95 | 16.0 | 19.0 | 4.29 | 2962 | 6:52 PM | 3/26/2004 |
| 5 | 23.0 | 56.60 | 18.5 | 22.7 | 4.36 | 4731 | 12:21 AM | 3/27/2004 |
| 6 | 23.5 | 56.95 | 23.0 | 29.2 | 4.47 | 5725 | 5:47 PM | 3/27/2004 |
| 7 | 23.5 | 56.95 | 26.5 | 34.3 | 4.54 | 7128 | 5:10 PM | 3/28/2004 |
| 8 | 23.5 | 56.95 | 28.0 | 36.5 | 4.57 | 8821 | 9:23 PM | 3/28/2004 |
| 9 | 22.5 | 56.25 | 37.0 | 49.6 | 4.70 | 9887 | 3:09 PM | 3/29/2004 |

**Project: Austin District**

**Borehole: B3**

**Sample Depth: 3.5'-5'**

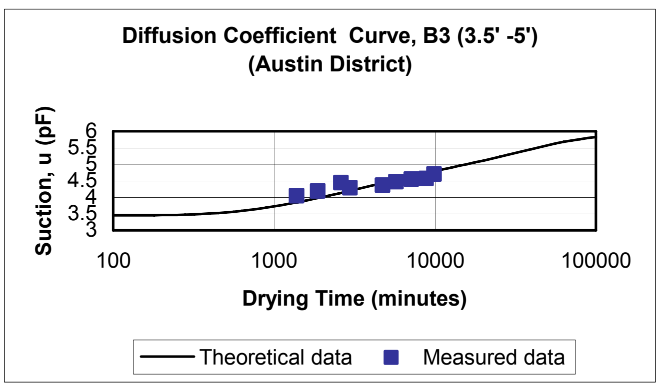
Psychrometer 2:

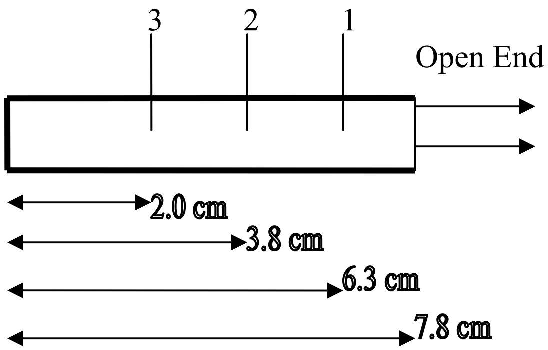
No.: 40325, $\pi_{v0} = 49$ @ 25ºC

Setup Time & Date: 5:30 PM, 03/24/04

| No. | T | $\pi_v$ | μV | Total Suction (bar) | Total Suction (pF) | Time (minutes) | Time | Date |
|---|---|---|---|---|---|---|---|---|
| 1 | 23.0 | 47.60 | 3.0 | 3.2 | 3.52 | 1385 | 4:35 PM | 3/25/2004 |
| 2 | 23.5 | 47.95 | 3.0 | 3.2 | 3.52 | 1870 | 12:40 AM | 3/26/2004 |
| 3 | 23.5 | 47.95 | 9.0 | 12.0 | 4.09 | 2616 | 1:06 PM | 3/26/2004 |
| 4 | 24.5 | 48.65 | 10.5 | 14.2 | 4.16 | 2968 | 6:58 PM | 3/26/2004 |
| 5 | 23.5 | 47.95 | 10.5 | 14.2 | 4.16 | 4733 | 12:23 AM | 3/27/2004 |
| 6 | 24.0 | 48.30 | 15.0 | 20.7 | 4.32 | 5728 | 5:50 PM | 3/27/2004 |
| 7 | 24.0 | 48.30 | 15.0 | 20.7 | 4.32 | 7130 | 5:12 PM | 3/28/2004 |
| 8 | 24.0 | 48.30 | 17.0 | 23.6 | 4.38 | 8823 | 9:25 PM | 3/28/2004 |
| 9 | 23.5 | 47.95 | 20.5 | 28.7 | 4.47 | 9890 | 3:12 PM | 3/29/2004 |
| 10 | 23.5 | 47.95 | 25.0 | 35.3 | 4.56 | 11141 | 1:03 PM | 3/30/2004 |
| 11 | 23.5 | 47.95 | 33.0 | 46.9 | 4.68 | 11680 | 10:02 PM | 3/30/2004 |
| 12 | 24.0 | 48.30 | 38.0 | 54.2 | 4.74 | 12555 | 12:37 PM | 3/31/2004 |

Diffusion Coefficient Curve for Psychrometer 1:






**Project: Austin District**

**Borehole: B3**

**Sample Depth: 6.5’-8’**

Total Length of the sample, L = 7.8 cm

Distance of psychrometer 2 from closed end, x = 6.3 cm

Initial Suction, $u_0$ = 3.64 pF

Relative Humidity = 56.8%

Atmospheric Suction, $u_a$ = 5.9 pF

Diffusion Coefficient, $\alpha = 1.56E^{-5}$ $cm^2/sec$

Psychrometer 1:

No.: 40293, $\pi_{v0}$ = 57@ 25ºC

Setup Time & Date: 5:00 PM, 03/24/04

| No. | T | $\pi_v$ | µV | Total Suction (bar) | Total Suction (pF) | Time (minutes) | Time | Date |
|---|---|---|---|---|---|---|---|---|
| 1 | 23.0 | 55.60 | 9.0 | 10.8 | 4.04 | 1192 | 4:52 PM | 3/25/2004 |
| 2 | 23.0 | 55.60 | 11.0 | 13.6 | 4.14 | 2385 | 12:45 PM | 3/26/2004 |
| 3 | 23.0 | 55.60 | 16.5 | 21.4 | 4.34 | 3855 | 1:15 PM | 3/26/2004 |
| 4 | 24.0 | 56.30 | 20.0 | 26.3 | 4.43 | 5625 | 6:45 PM | 3/26/2004 |
| 5 | 23.5 | 55.95 | 23.5 | 31.3 | 4.50 | 5839 | 12:11 AM | 3/27/2004 |
| 6 | 23.5 | 55.95 | 24.0 | 32.0 | 4.51 | 6918 | 6:10 PM | 3/27/2004 |
| 7 | 24.0 | 56.30 | 25.0 | 33.4 | 4.53 | 8288 | 5:00 PM | 3/28/2004 |

**Project: Austin District**

**Borehole: B3**

**Sample Depth: 6.5'-8'**

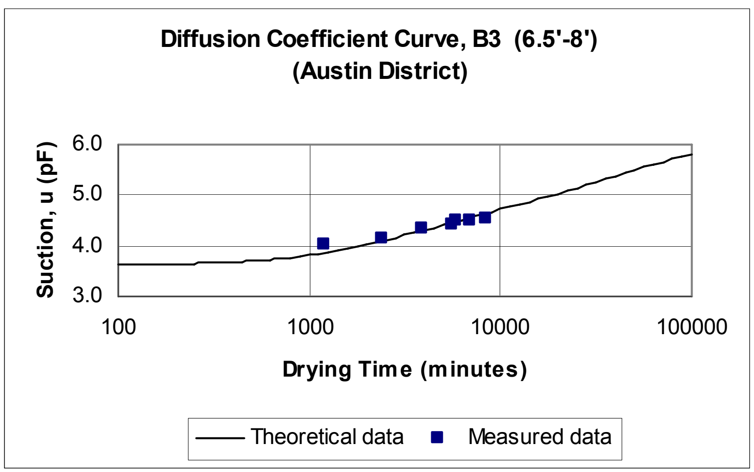
Psychrometer 2:

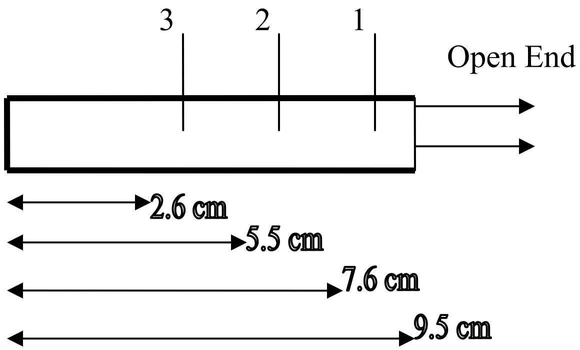
No.: 40325, $\pi_{v0} = 49$ @ 25°C

Setup Time & Date: 5:00 PM, 03/24/04

| No. | T | $\pi_v$ | μV | Total Suction (bar) | Total Suction (pF) | Time (minutes) | Time | Date |
|---|---|---|---|---|---|---|---|---|
| 1 | 24.0 | 59.30 | 8.0 | 10.3 | 4.02 | 1198 | 4:58 PM | 3/25/2004 |
| 2 | 24.0 | 59.30 | 12.0 | 16.0 | 4.21 | 2390 | 12:50 PM | 3/26/2004 |
| 3 | 24.0 | 59.30 | 25.0 | 34.3 | 4.54 | 3890 | 1:20 PM | 3/26/2004 |
| 4 | 24.0 | 59.30 | 20.0 | 27.2 | 4.44 | 5636 | 6:46 PM | 3/26/2004 |
| 5 | 23.5 | 58.95 | 18.5 | 25.1 | 4.41 | 5842 | 12:14 AM | 3/27/2004 |
| 6 | 24.0 | 59.30 | 26.0 | 35.7 | 4.56 | 6919 | 6:11 PM | 3/27/2004 |
| 7 | 24.0 | 59.30 | 34.0 | 47.0 | 4.68 | 8290 | 5:02 PM | 3/28/2004 |
| 8 | 24.0 | 59.30 | 36.0 | 49.8 | 4.71 | 8562 | 9:34 PM | 3/28/2004 |
| 9 | 23.5 | 58.95 | 40.0 | 55.4 | 4.75 | 9611 | 3:03 PM | 3/29/2004 |

Diffusion Coefficient Curve for Psychrometer 1:






**Project: Austin District**

**Borehole: B3**

**Sample Depth: 9.5’-11’**

Total Length of the sample, L = 9.5 cm

Distance of psychrometer 2 from closed end, x = 7.6 cm

Initial Suction, $u_0$ = 3.77 pF

Relative Humidity = 60.87%

Atmospheric Suction, $u_a$ = 5.84 pF

Diffusion Coefficient, $\alpha$ = 4.66E$^{-5}$ cm$^2$/sec

**Project: Austin District**

**Borehole: B3**

**Sample Depth: 9.5'-11'**

Psychrometer 1:

No.: 40338, $\pi_{v0}$ = 49@ 25ºC

Setup Time & Date: 2:10 PM, 04/07/04

| No. | T | $\pi_v$ | µV | Total Suction (bar) | Total Suction (pF) | Time (minutes) | Time | Date |
|---|---|---|---|---|---|---|---|---|
| 1 | 22.5 | 47.25 | 10.0 | 14.5 | 4.17 | 492 | 10:22 PM | 4/7/04 |
| 2 | 23.5 | 47.95 | 15.5 | 22.8 | 4.37 | 1250 | 11:00 AM | 4/8/04 |
| 3 | 23.5 | 47.95 | 19.0 | 28.1 | 4.46 | 1525 | 3:35 PM | 4/8/04 |
| 4 | 23.0 | 47.60 | 20.5 | 30.4 | 4.49 | 2126 | 1:36 AM | 4/9/04 |
| 5 | 23.5 | 47.95 | 22.5 | 33.4 | 4.53 | 2811 | 1:01 PM | 4/9/04 |
| 6 | 24.5 | 48.65 | 26.5 | 39.5 | 4.61 | 3505 | 12:35 PM | 4/10/04 |
| 7 | 24.0 | 48.30 | 28.0 | 41.8 | 4.63 | 3967 | 7:17 PM | 4/10/04 |
| 8 | 23.0 | 47.60 | 34.0 | 50.9 | 4.72 | 5124 | 2:34 PM | 4/11/04 |
| 9 | 24.0 | 48.30 | 38.0 | 56.9 | 4.76 | 5580 | 10:10 PM | 4/11/04 |

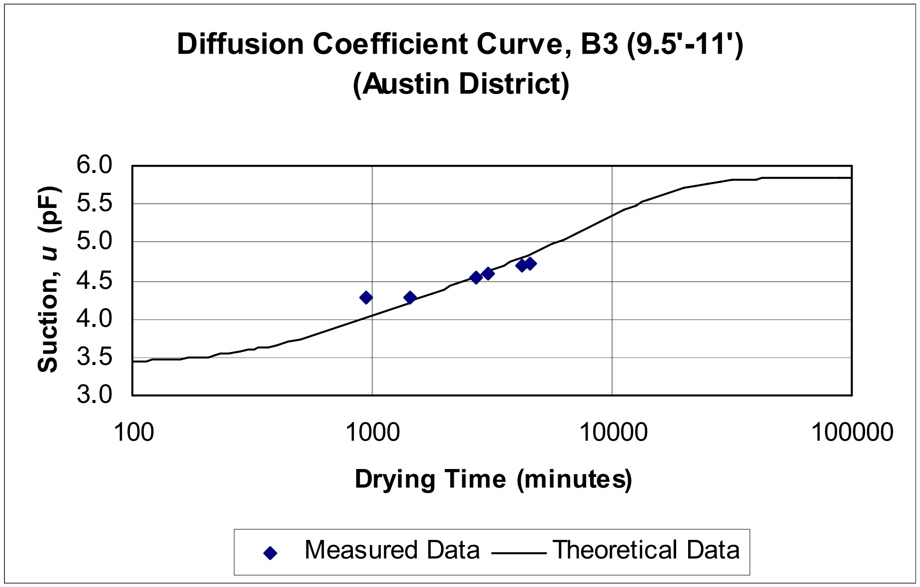
Psychrometer 2:

No.: 40330, $\pi_{v0}$ = 51 @ 25ºC

Setup Time & Date: 2:10 PM, 04/07/04

| No. | T | $\pi_v$ | µV | Total Suction (bar) | Total Suction (pF) | Time (minutes) | Time | Date |
|---|---|---|---|---|---|---|---|---|
| 1 | 23.5 | 49.95 | 7.5 | 10.0 | 4.01 | 495 | 10:25 PM | 4/7/04 |
| 2 | 24.0 | 50.30 | 11.5 | 15.9 | 4.21 | 1252 | 11:02 AM | 4/8/04 |
| 3 | 23.5 | 49.95 | 12.0 | 16.7 | 4.23 | 1530 | 3:40 PM | 4/8/04 |
| 4 | 23.5 | 49.95 | 16.0 | 22.6 | 4.36 | 2125 | 1:35 AM | 4/9/04 |
| 5 | 24.0 | 50.30 | 16.5 | 23.4 | 4.38 | 2814 | 1:04 PM | 4/9/04 |
| 6 | 24.5 | 50.65 | 20.0 | 28.6 | 4.47 | 3510 | 12:40 PM | 4/10/04 |
| 7 | 24.5 | 50.65 | 22.0 | 31.6 | 4.51 | 3970 | 7:20 PM | 4/10/04 |
| 8 | 24.0 | 50.30 | 29.0 | 42.1 | 4.63 | 5127 | 2:37 PM | 4/11/04 |
| 9 | 24.5 | 50.65 | 30.0 | 43.5 | 4.65 | 5584 | 10:14 PM | 4/11/04 |

Diffusion Coefficient Curve for Psychrometer 1:



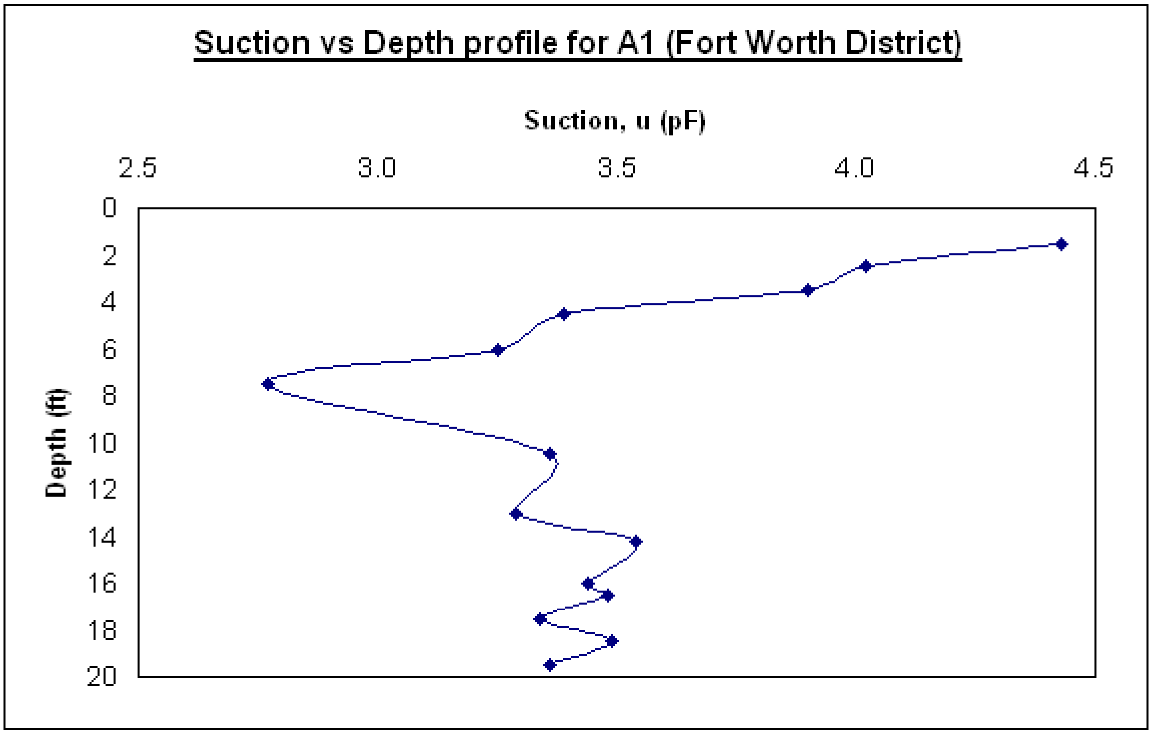
# APPENDIX G

This chapter includes the suction profile of the soil samples obtained from testing carried out at Texas A&M University. There are three subparts in this chapter APPENDIX-G1, APPENDIX-G2, and APPENDIX-G3, which show the data of the Fort Worth, Atlanta, and Austin Districts, respectively.

## APPENDIX G-1

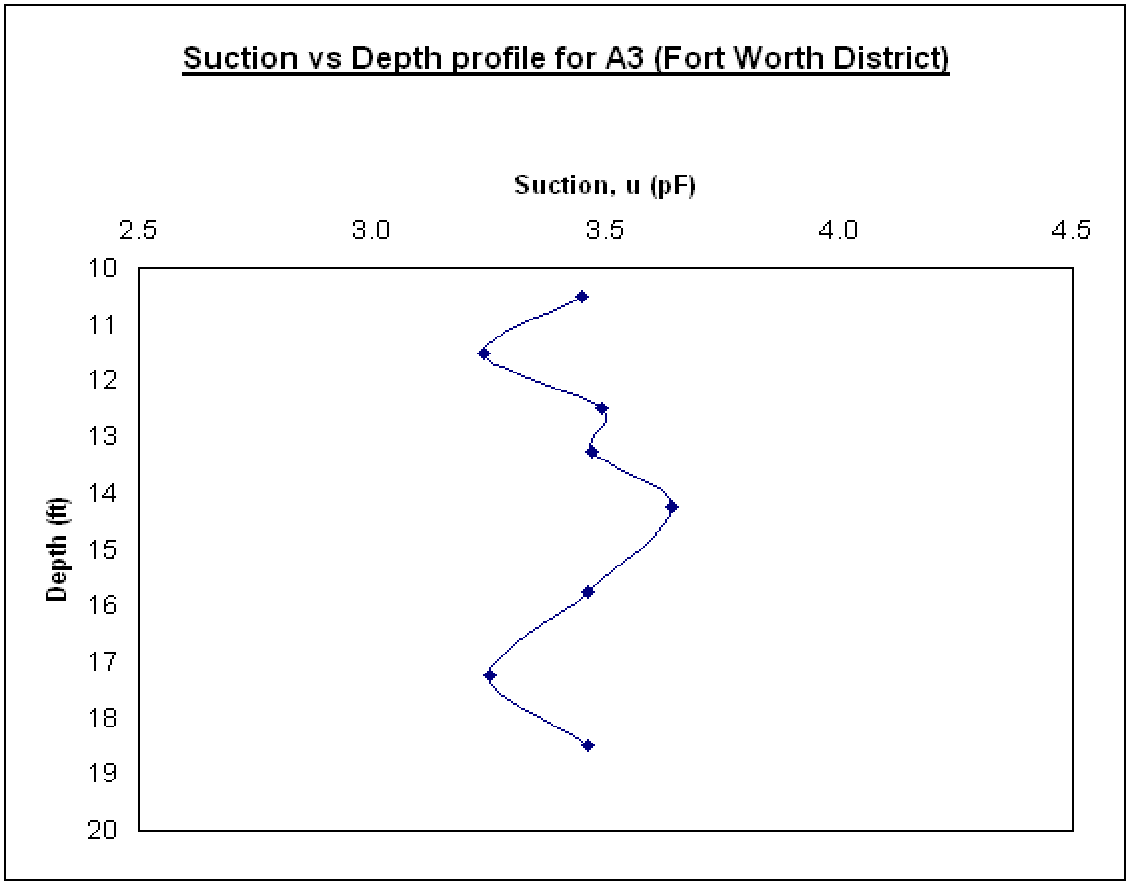
### BOREHOLE A1 (Fort Worth District)

| No. | Depth (ft) | Suction (pF) | Water Content (%) | Mean Depth (ft) |
|---|---|---|---|---|
| 1 | 1-2 | 4.43 | 17.64 | 1.5 |
| 2 | 2-3 | 4.02 | 30.75 | 2.5 |
| 3 | 3-4 | 3.90 | 19.84 | 3.5 |
| 4 | 4-5 | 3.39 | 19.25 | 4.5 |
| 5 | 5-7 | 3.25 | 18.69 | 6.0 |
| 6 | 7-8 | 2.77 | 19.82 | 7.5 |
| 7 | 10-11 | 3.36 | 17.34 | 10.5 |
| 8 | 12.5-13.5 | 3.29 | 16.44 | 13.0 |
| 9 | 13.5-15 | 3.54 | 21.77 | 14.3 |
| 10 | 15-16 | 3.44 | 21.91 | 16.0 |
| 11 | 16-17 | 3.48 | 21.77 | 16.5 |
| 12 | 17-18 | 3.34 | 21.66 | 17.5 |
| 13 | 18-19 | 3.49 | 20.87 | 18.5 |
| 14 | 19-20 | 3.36 | 22.43 | 19.5 |



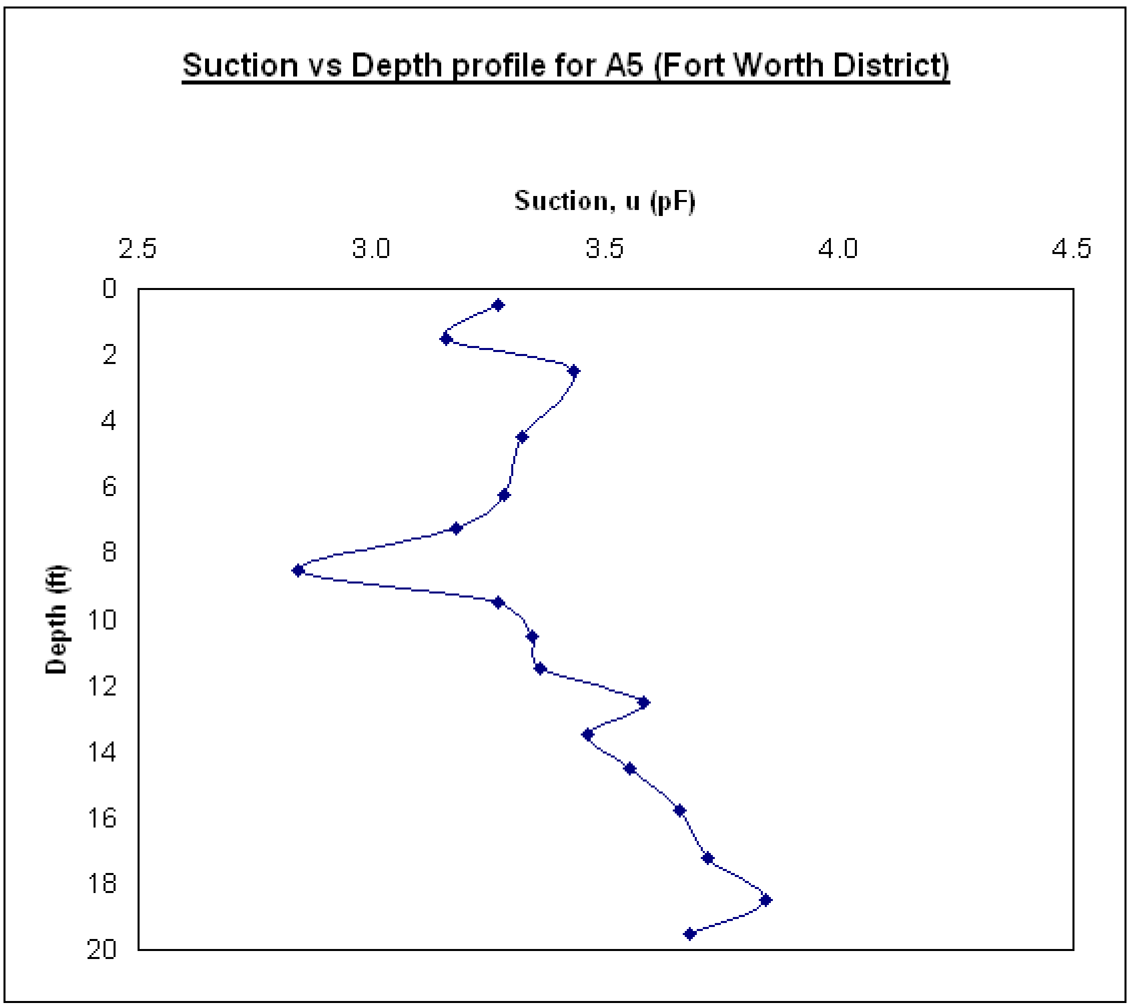
**BOREHOLE A3 (Fort Worth District)**

| No. | Depth (ft) | Suction (pF) | Water Content (%) | Mean Depth (ft) |
|---|---|---|---|---|
| 1 | 0-1 | 4.10 | 15.32 | 0.5 |
| 2 | 9-10 | 3.25 | 23.80 | 9.5 |
| 3 | 10-11 | 3.45 | 17.79 | 10.5 |
| 4 | 11-12 | 3.24 | 12.58 | 11.5 |
| 5 | 12-13 | 3.49 | 24.97 | 12.5 |
| 6 | 13-13.5 | 3.47 | 28.79 | 13.3 |
| 7 | 13.5-15 | 3.64 | 28.89 | 14.3 |
| 8 | 15-16.5 | 3.46 | 25.37 | 15.8 |
| 9 | 16.5-18 | 3.25 | 22.67 | 17.3 |
| 10 | 18-19 | 3.46 | 23.21 | 18.5 |
| 11 | 19-20 | 3.20 | 15.14 | 19.5 |



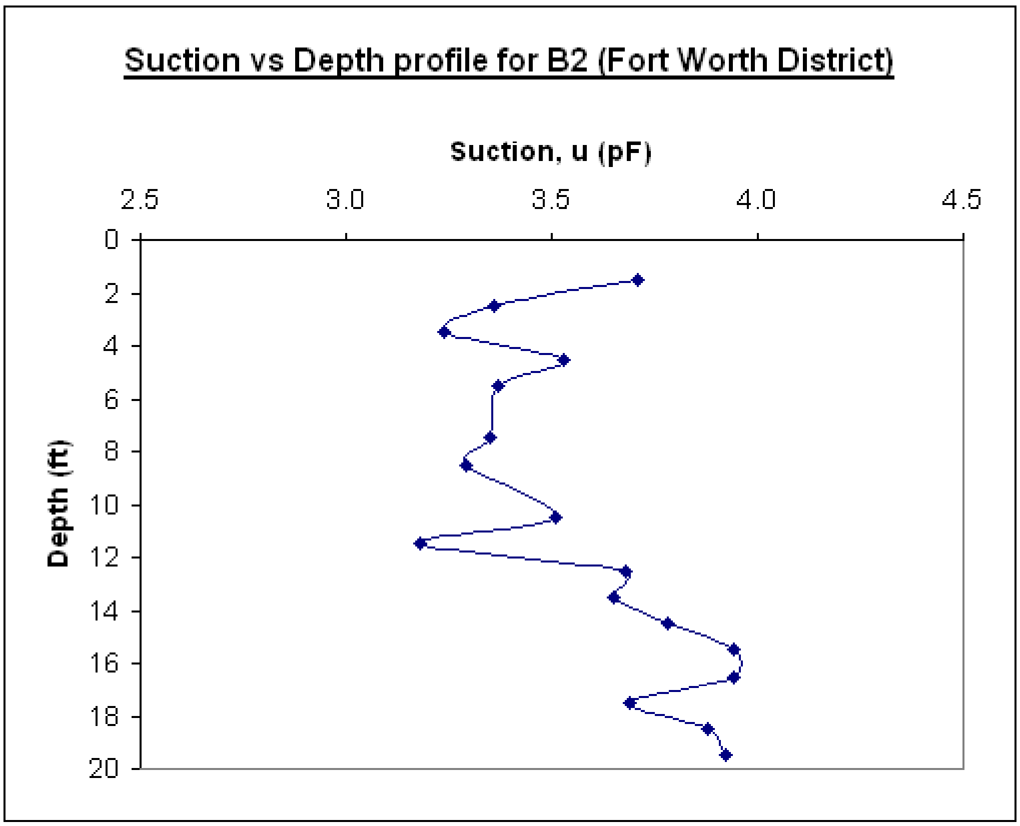
**BOREHOLE A5 (Fort Worth District)**

| No. | Depth (ft) | Suction (pF) | Water Content (%) | Mean Depth (ft) |
|---|---|---|---|---|
| 1 | 0-1 | 3.27 | 22.56 | 0.5 |
| 2 | 1-2 | 3.16 | 26.11 | 1.5 |
| 3 | 2-3 | 3.43 | 26.44 | 2.5 |
| 4 | 4-5 | 3.32 | 22.51 | 4.5 |
| 5 | 6-6.5 | 3.28 | 12.57 | 6.3 |
| 6 | 6.5-8 | 3.18 | 14.91 | 7.3 |
| 7 | 8-9 | 2.84 | 12.35 | 8.5 |
| 8 | 9-10 | 3.27 | 15.96 | 9.5 |
| 9 | 10-11 | 3.34 | 14.00 | 10.5 |
| 10 | 11-12 | 3.36 | 18.68 | 11.5 |
| 11 | 12-13 | 3.58 | 20.75 | 12.5 |
| 12 | 13-14 | 3.46 | 22.93 | 13.5 |
| 13 | 14-15 | 3.55 | 22.69 | 14.5 |
| 14 | 15-16.5 | 3.66 | 20.1 | 15.8 |
| 15 | 16.5-18 | 3.72 | 17.76 | 17.3 |
| 16 | 18-19 | 3.84 | 13.21 | 18.5 |
| 17 | 19-20 | 3.68 | 16.57 | 19.5 |



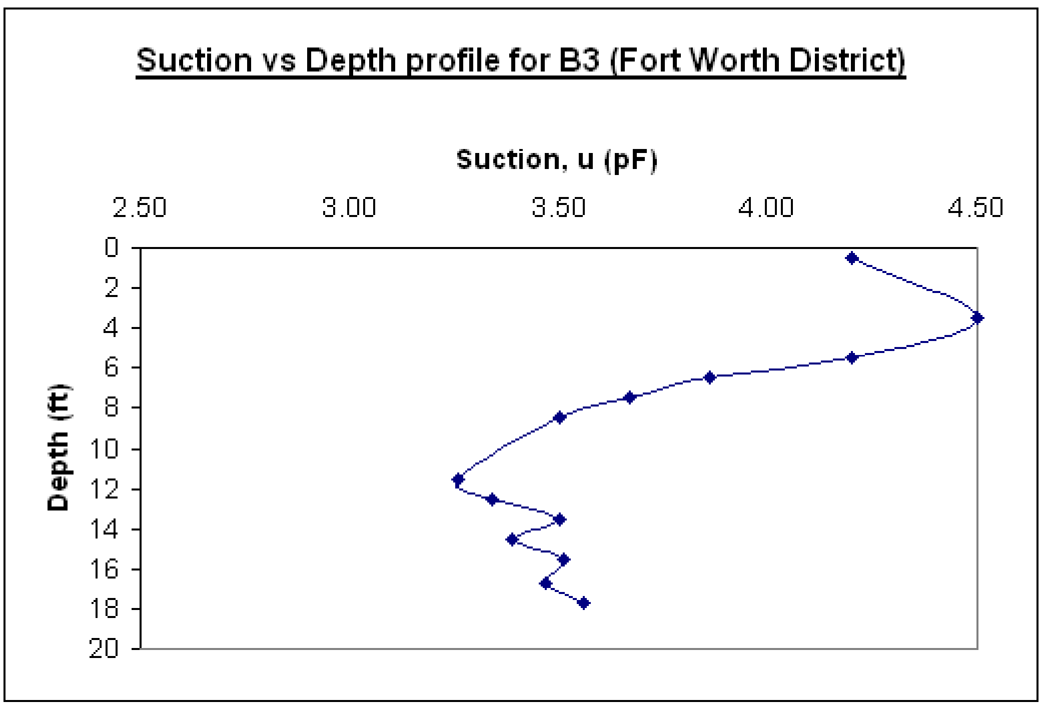
**BOREHOLE B2 (Fort Worth District)**

| No. | Depth (ft) | Suction (pF) | Water Content (%) | Mean Depth (ft) |
|---|---|---|---|---|
| 1 | 1-2 | 3.71 | 17.11 | 1.5 |
| 2 | 2-3 | 3.36 | 19.28 | 2.5 |
| 3 | 3-4 | 3.24 | 21.03 | 3.5 |
| 4 | 4-5 | 3.53 | 25.20 | 4.5 |
| 5 | 5-6 | 3.37 | 15.26 | 5.5 |
| 6 | 7-8 | 3.35 | 17.52 | 7.5 |
| 7 | 8-9 | 3.29 | 13.78 | 8.5 |
| 8 | 10-11 | 3.51 | 22.21 | 10.5 |
| 9 | 11-12 | 3.18 | 20.61 | 11.5 |
| 10 | 12-13 | 3.68 | 19.50 | 12.5 |
| 11 | 13-14 | 3.65 | 19.17 | 13.5 |
| 12 | 14-15 | 3.78 | 20.81 | 14.5 |
| 13 | 15-16 | 3.94 | 20.83 | 15.5 |
| 14 | 16-17 | 3.94 | 20.47 | 16.5 |
| 15 | 17-18 | 3.69 | 20.03 | 17.5 |
| 16 | 18-19 | 3.88 | 21.77 | 18.5 |
| 17 | 19-20 | 3.92 | 21.99 | 19.5 |



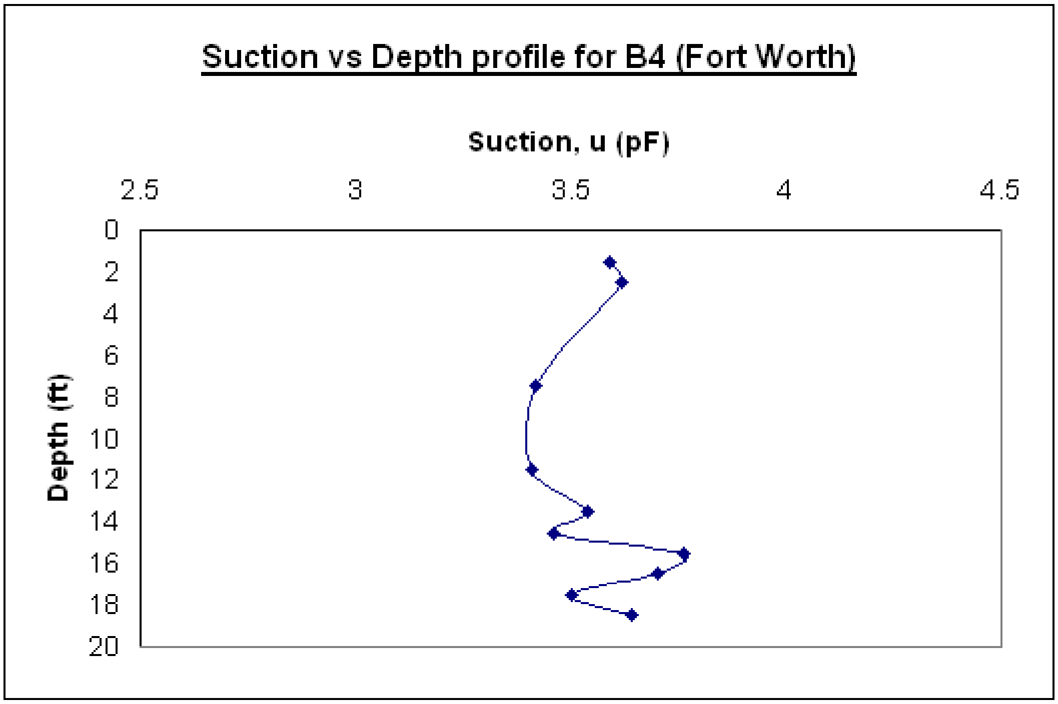
**BOREHOLE B3 (Fort Worth District)**

| No. | Depth (ft) | Suction (pF) | Water Content (%) | Mean Depth (ft) |
|---|---|---|---|---|
| 1 | 0-1 | 4.20 | 11.10 | 0.5 |
| 2 | 3-4 | 4.50 | 11.35 | 3.5 |
| 3 | 5-6 | 4.20 | 14.50 | 5.5 |
| 4 | 6-7 | 3.86 | 24.74 | 6.5 |
| 5 | 7-8 | 3.67 | 17.19 | 7.5 |
| 6 | 8-9 | 3.50 | 16.85 | 8.5 |
| 7 | 11-12 | 3.26 | 15.46 | 11.5 |
| 8 | 12-13 | 3.34 | 20.91 | 12.5 |
| 9 | 13-14 | 3.50 | 19.93 | 13.5 |
| 10 | 14-15 | 3.39 | 19.69 | 14.5 |
| 11 | 15-16 | 3.51 | 20.74 | 15.5 |
| 12 | 16-17.5 | 3.47 | 20.96 | 16.8 |
| 13 | 17.5-18 | 3.56 | 19.97 | 17.8 |



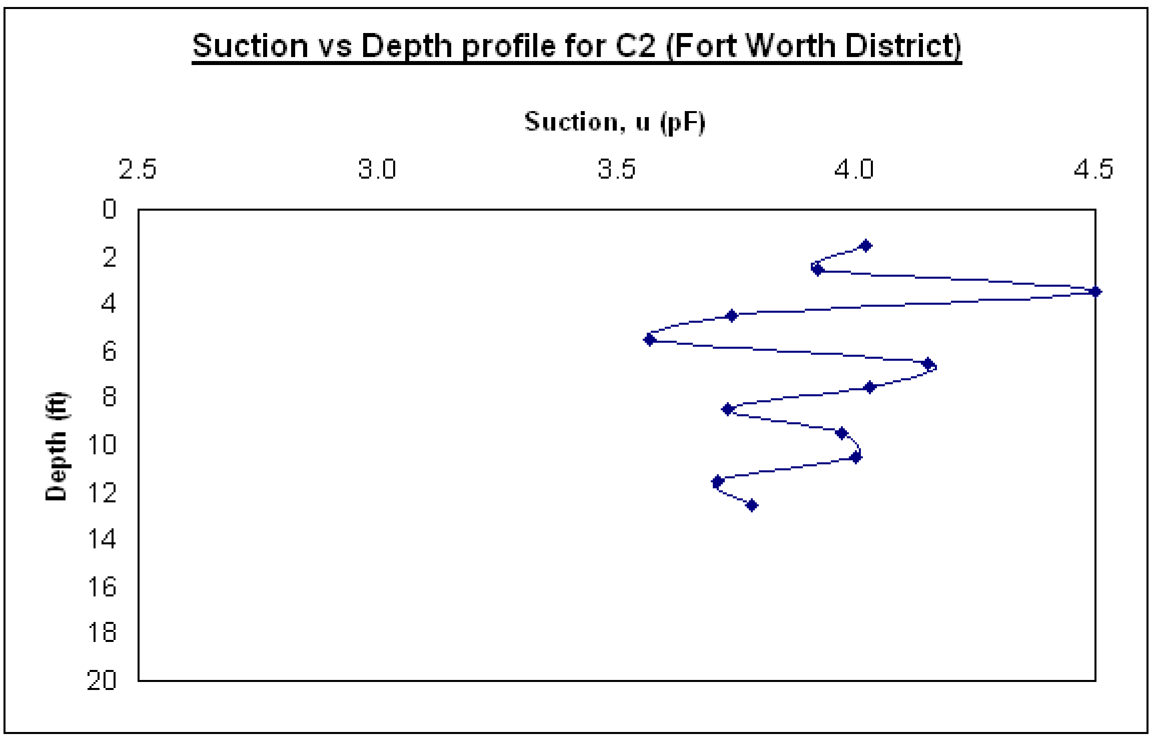
**BOREHOLE B4 (Fort Worth District)**

| No. | Depth (ft) | Suction (pF) | Water Content (%) | Mean Depth (ft) |
|---|---|---|---|---|
| 1 | 1-2 | 3.59 | 19.13 | 1.5 |
| 2 | 2-3 | 3.62 | 20.54 | 2.5 |
| 3 | 7-8 | 3.42 | 16.62 | 7.5 |
| 4 | 11-12 | 3.41 | 21.78 | 11.5 |
| 5 | 13-14 | 3.54 | 24.86 | 13.5 |
| 6 | 14-15 | 3.46 | 21.47 | 14.5 |
| 7 | 15-16 | 3.76 | 20.49 | 15.5 |
| 8 | 16-17 | 3.70 | 22.29 | 16.5 |
| 9 | 17-18 | 3.50 | 21.75 | 17.5 |
| 10 | 18-19 | 3.64 | 13.47 | 18.5 |



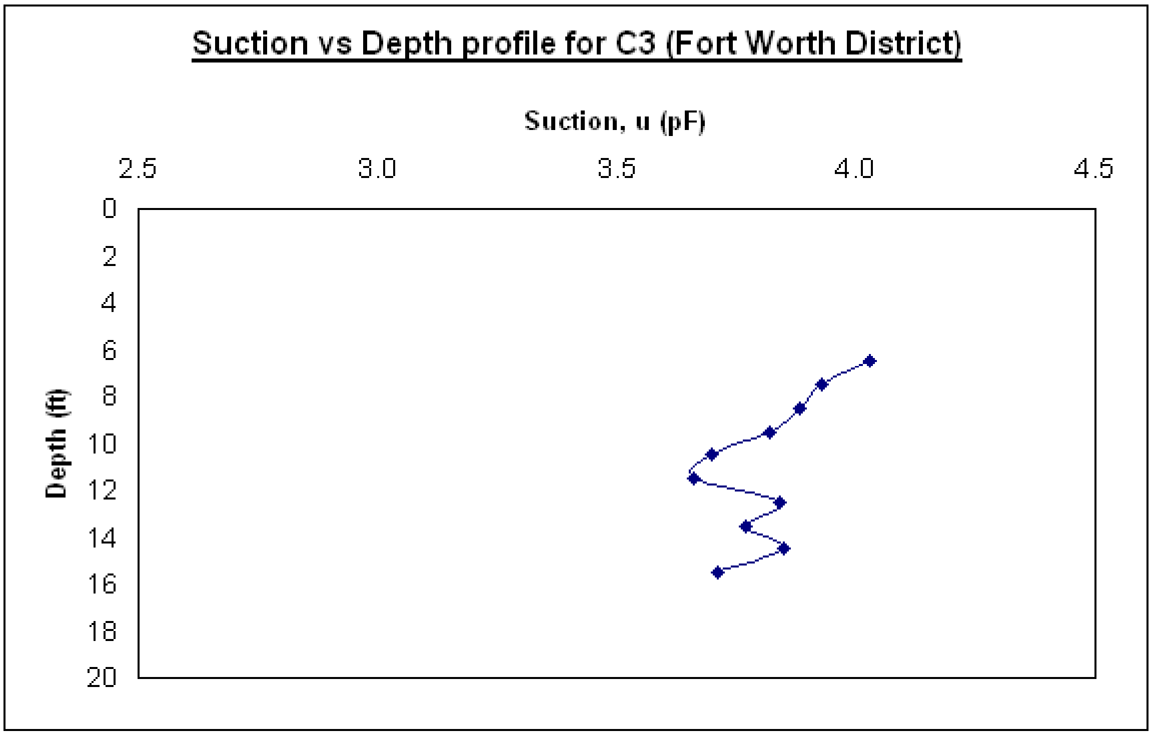
**BOREHOLE C2 (Fort Worth District)**

| No. | Depth (ft) | Suction (pF) | Water Content (%) | Mean Depth (ft) |
|---|---|---|---|---|
| 1 | 1-2 | 4.02 | 16.67 | 1.5 |
| 2 | 2-3 | 3.92 | 16.01 | 2.5 |
| 3 | 3-4 | 4.50 | 6.74 | 3.5 |
| 4 | 4-5 | 3.74 | 24.98 | 4.5 |
| 5 | 5-6 | 3.57 | 26.93 | 5.5 |
| 6 | 6-7 | 4.15 | 22.81 | 6.5 |
| 7 | 7-8 | 4.03 | 22.87 | 7.5 |
| 8 | 8-9 | 3.73 | 20.80 | 8.5 |
| 9 | 9-10 | 3.97 | 22.16 | 9.5 |
| 10 | 10-11 | 4.00 | 21.68 | 10.5 |
| 11 | 11-12 | 3.71 | 20.62 | 11.5 |
| 12 | 12-13 | 3.78 | 24.10 | 12.5 |



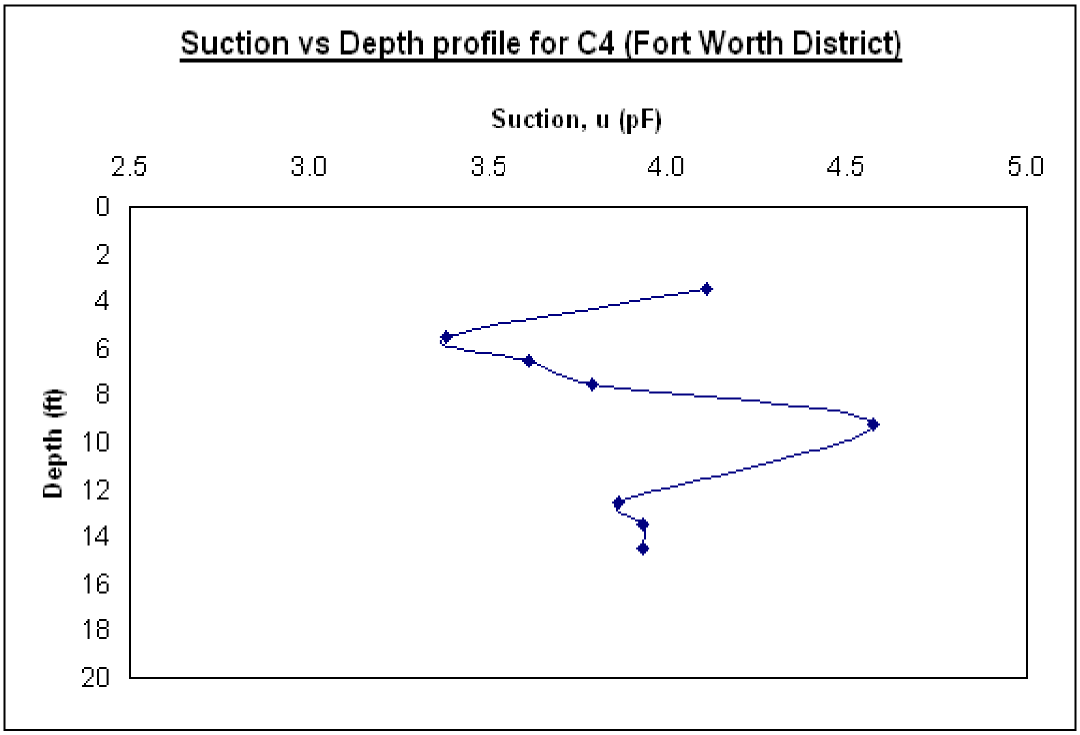
**BOREHOLE C3 (Fort Worth District)**

| No. | Depth (ft) | Suction (pF) | Water Content (%) | Mean Depth (ft) |
|---|---|---|---|---|
| 1 | 6-7 | 4.03 | 18.04 | 6.5 |
| 2 | 7-8 | 3.93 | 19.98 | 7.5 |
| 3 | 8-9 | 3.88 | 20.51 | 8.5 |
| 4 | 9-10 | 3.82 | 25.24 | 9.5 |
| 5 | 10-11 | 3.70 | 24.07 | 10.5 |
| 6 | 11-12 | 3.66 | 22.79 | 11.5 |
| 7 | 12-13 | 3.84 | 22.16 | 12.5 |
| 8 | 13-14 | 3.77 | 21.82 | 13.5 |
| 9 | 14-15 | 3.85 | 21.57 | 14.5 |
| 10 | 15-16 | 3.71 | 20.81 | 15.5 |



**BOREHOLE C4 (Fort Worth District)**

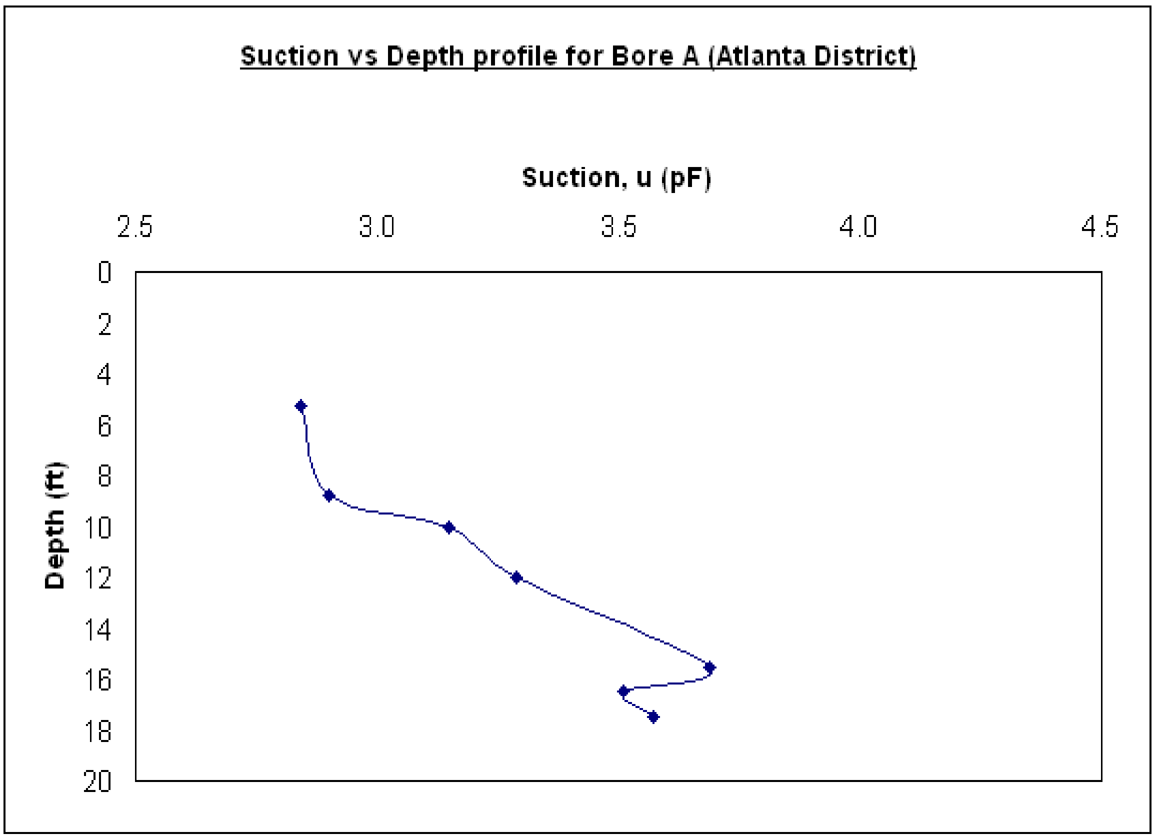
| No. | Depth (ft) | Suction (pF) | Water Content (%) | Mean Depth (ft) |
|---|---|---|---|---|
| 1 | 3-4 | 4.11 | 12.24 | 3.5 |
| 2 | 5-6 | 3.38 | 15.50 | 5.5 |
| 3 | 6-7 | 3.61 | 20.94 | 6.5 |
| 4 | 7-8 | 3.79 | 16.40 | 7.5 |
| 5 | 9-9.5 | 4.57 | 22.11 | 9.3 |
| 6 | 12-13 | 3.86 | 17.18 | 12.5 |
| 7 | 13-14 | 3.93 | 21.61 | 13.5 |
| 8 | 14-15 | 3.93 | 20.14 | 14.5 |



## APPENDIX G-2

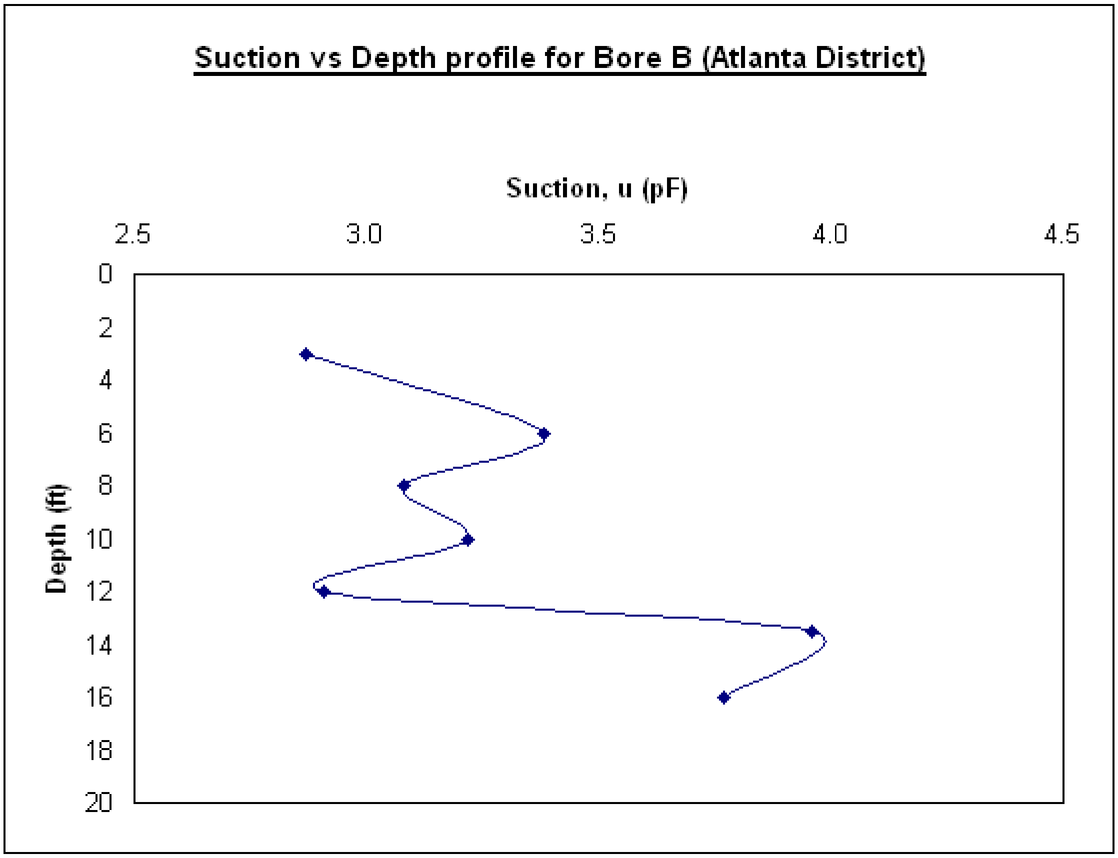
### BOREHOLE A (Atlanta District)

| No. | Depth (ft) | Suction (pF) | Water Content (%) | Mean Depth (ft) |
|---|---|---|---|---|
| 1 | 5-5.5 | 2.84 | 17.64 | 5.3 |
| 2 | 8.5-9 | 2.90 | 30.75 | 8.8 |
| 3 | 9-11 | 3.15 | 19.84 | 10.0 |
| 4 | 11-13 | 3.29 | 19.25 | 12.0 |
| 5 | 15-16 | 3.69 | 18.69 | 15.5 |
| 6 | 16-17 | 3.51 | 19.82 | 16.5 |
| 7 | 17-18 | 3.57 | 17.34 | 17.5 |



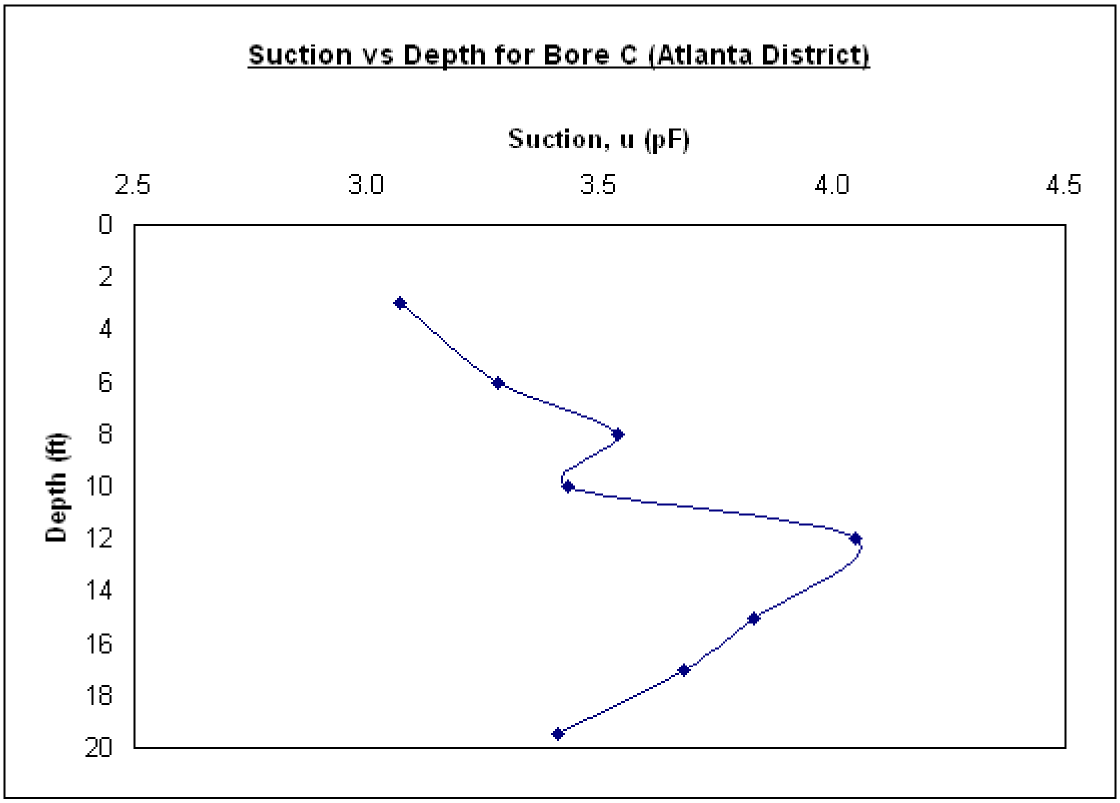
**BOREHOLE B (Atlanta District)**

| No. | Depth (ft) | Suction (pF) | Water Content (%) | Mean Depth (ft) |
|---|---|---|---|---|
| 1 | 3-5 | 2.87 | 22.87 | 3.0 |
| 2 | 5-7 | 3.38 | 17.89 | 6.0 |
| 3 | 7-9 | 3.08 | 19.04 | 8.0 |
| 4 | 9-11 | 3.22 | 20.73 | 10.0 |
| 5 | 11-13 | 2.91 | 20.45 | 12.0 |
| 6 | 13-14 | 3.96 | 13.73 | 13.5 |
| 7 | 15-17 | 3.77 | 17.14 | 16.0 |



## BOREHOLE C (Atlanta District)

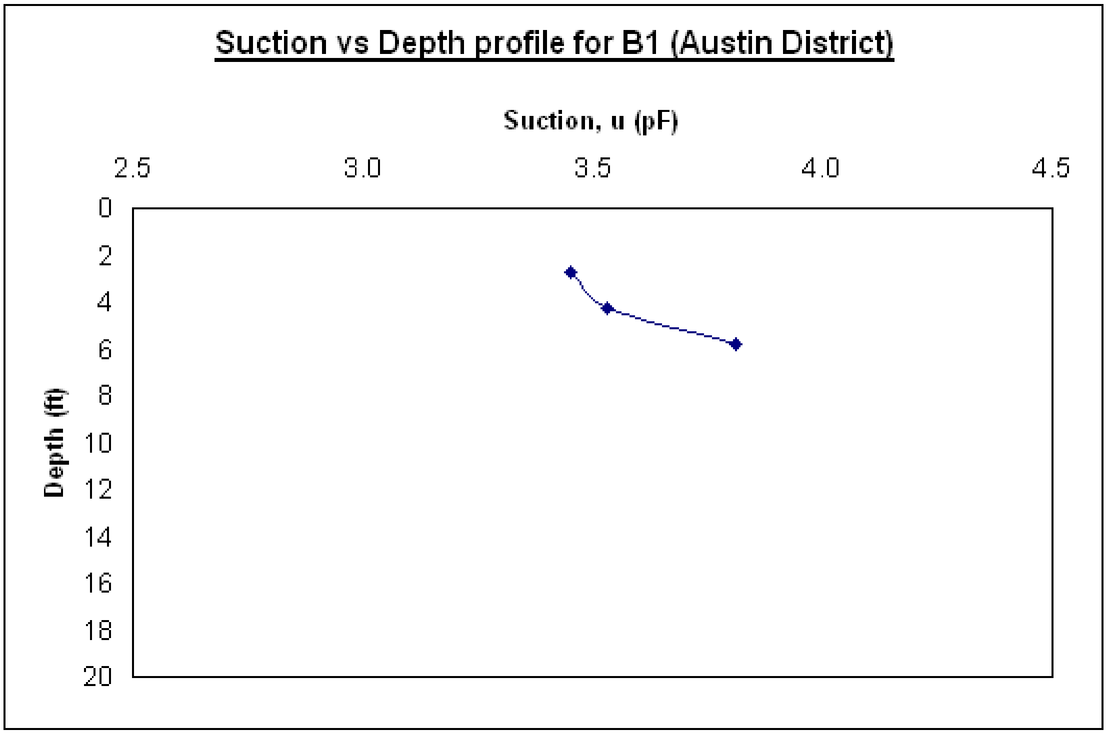
| No. | Depth (ft) | Suction (pF) | Water Content (%) | Mean Depth (ft) |
|---|---|---|---|---|
| 1 | 2-4 | 3.07 | 19.08 | 3.0 |
| 2 | 5-7 | 3.28 | 19.53 | 6.0 |
| 3 | 7-9 | 3.54 | 20.24 | 8.0 |
| 4 | 9-11 | 3.43 | 19.01 | 10.0 |
| 5 | 11-13 | 4.05 | 13.13 | 12.0 |
| 6 | 14-16 | 3.83 | 17.03 | 15.0 |
| 7 | 16-18 | 3.68 | 14.70 | 17.0 |
| 8 | 19-20 | 3.41 | 13.21 | 19.5 |



## APPENDIX G-3

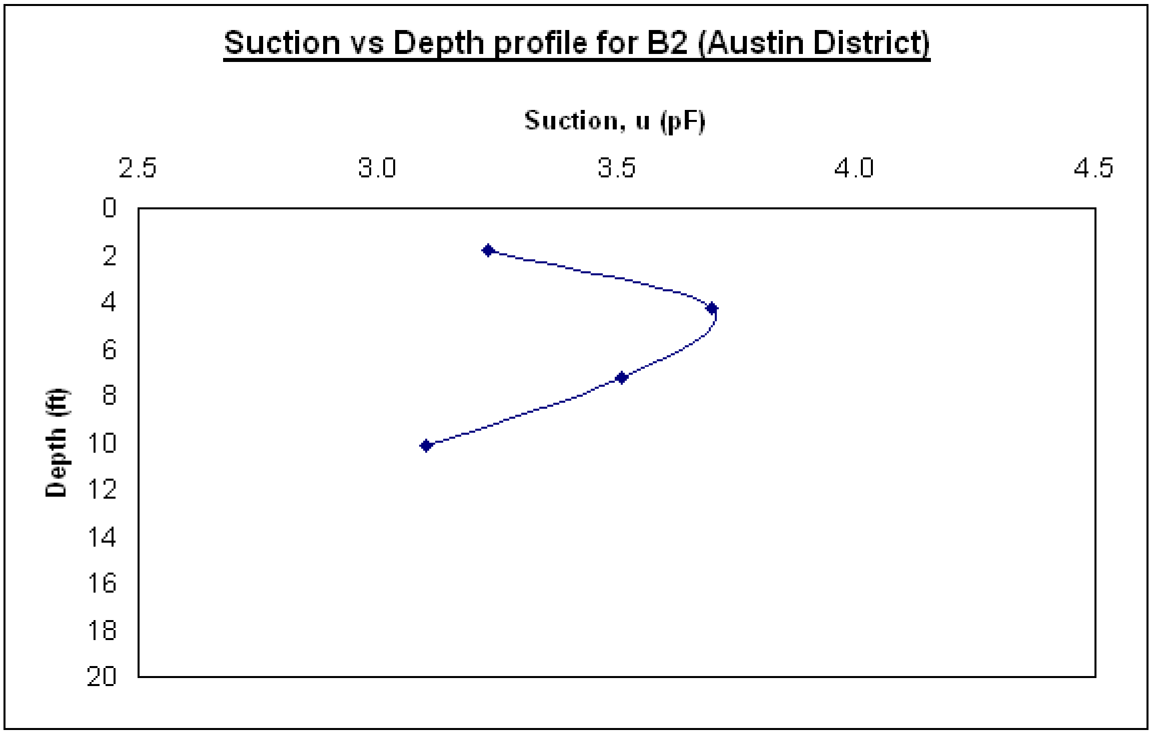
### BOREHOLE B1 (Austin District)

| No. | Depth (ft) | Suction (pF) | Water Content (%) | Mean Depth (ft) |
|---|---|---|---|---|
| 1 | 2-3.5 | 3.45 | 21.46 | 2.8 |
| 2 | 3.5-5 | 3.53 | 19.95 | 4.3 |
| 3 | 5-6.5 | 3.81 | 12.84 | 5.8 |



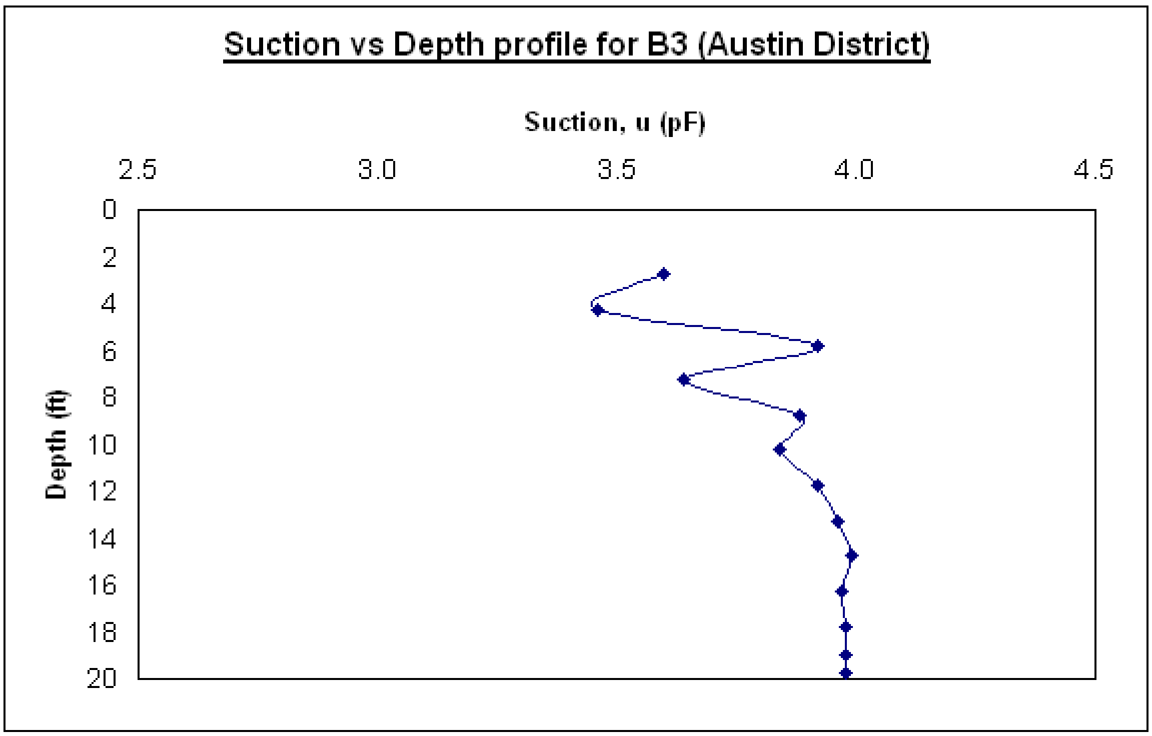
**BOREHOLE B2 (Austin District)**

| No. | Depth (ft) | Suction (pF) | Water Content (%) | Mean Depth (ft) |
|---|---|---|---|---|
| 1 | 1.5-2 | 3.23 | 19.03 | 1.8 |
| 2 | 3.5-5 | 3.70 | 12.89 | 4.3 |
| 3 | 6.5-8 | 3.51 | 14.99 | 7.3 |
| 4 | 9.5-10.7 | 3.10 | 11.68 | 10.1 |



**BOREHOLE B3 (Austin District)**

| No. | Depth (ft) | Suction (pF) | Water Content (%) | Mean Depth (ft) |
|---|---|---|---|---|
| 1 | 2-3.5 | 3.60 | 17.97 | 2.8 |
| 2 | 3.5-5 | 3.46 | 21.23 | 4.3 |
| 3 | 5-6.5 | 3.92 | 15.20 | 5.8 |
| 4 | 6.5-8 | 3.64 | 20.29 | 7.3 |
| 5 | 8-9.5 | 3.88 | 20.44 | 8.8 |
| 6 | 9.5-11 | 3.84 | 19.17 | 10.3 |
| 7 | 11-12.5 | 3.92 | 11.79 | 11.8 |
| 8 | 12.5-14 | 3.96 | 18.57 | 13.3 |
| 9 | 14-15.5 | 3.99 | 5.33 | 14.8 |
| 10 | 15.5-17 | 3.97 | 20.36 | 16.3 |
| 11 | 17-18.5 | 3.98 | 17.18 | 17.8 |
| 12 | 18.5-19.5 | 3.98 | 19.37 | 19.0 |
| 13 | 19.5-20 | 3.98 | 17.50 | 19.8 |



# REFERENCES


1. Bulut, R., Lytton, R.L., and Wray, W.K. (2001). "Soil Suction Measurements by Filter Paper," Expansive Clay Soils and Vegetative Influence on Shallow Foundations, ASCE Geotechnical Special Publication No. 115 (eds. C. Vipulanandan, M. B. Addison, & M. Hasen), Houston, Texas, pp. 243-261.
2. "HR 33T, Dew Point, Microvoltmeter, Instruction/Service Manual," 1978, 1986, 2001, Wescor, Inc.
3. Fredlund, D.G. and Rahardjo H. (1993). Soil Mechanics for Unsaturated Soils, John Wiley and Sons, New York.
4. "CR 7 Measurement and Control System Instruction Manual," 1991-1997, Campbell Scientific, Inc.
5. Mitchell, P.W. (1979). "The Structural Analysis of Footings on Expansive Soils," Research Report No. 1, K.W.G. Smith and Assoc. Pty. Ltd., Newton, South Australia.
6. Aubeny, C. and Lytton, R. L. (2003). "Estimating Strength Versus Location and Time in High Plasticity Clays," Research Report No. FHWA/TX-03/2100-PI, Texas Transportation Institute, College Station, Texas.
7. Reynolds, W.C. and Perkins, H.C. (1970). Engineering Thermodynamics, McGraw-Hill, New York.