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DYNAFLECT FIELD VERIFICATION

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16. Abstract

The Dynaflect is used by the Colorado Division of Highways for structural evaluation of asphalt pavements to determine the needed overlay thickness. This research addresses various aspects of Dynaflect data analysis including temperature correction, seasonal adjustment, and five sensor analyses to determine roadway layer strengths.

Analysis of data indicated that:

1. The current temperature correction is more effective than either no correction or a larger correction.
2. The amount of seasonal variation of Dynaflect deflections was found to vary with the severity of local conditions. A chart was constructed for the determination of "critical factor" for seasonal adjustment of deflections.
3. Dynaflect deflections were analyzed to determine subgrade strength. These strengths did not agree with R-values of sampled subgrade soil.

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INTRODUCTION

The Dynaflect is used by Colorado Division of Highways (CDOH) for structural evaluation of pavements. Photograph 1 shows the Dynaflect trailer and tow vehicle. This device applies a known cyclic force and measures the resulting deflection of the pavement. Stiffer pavements result in lower deflection readings. In general, stiffer pavements can better handle traffic loadings without cracking or failure. CDOH uses Dynaflect testing to determine overlay thicknesses and to survey highways to provide input for the pavement sufficiency rating system. The sufficiency rating system is used to establish priorities for construction funding. This research examines several aspects of Dynaflect data analysis. Areas examined include temperature correction, seasonal correction, and analysis of five sensor deflections to determine pavement and subgrade layer strengths.

Dynaflect Operation

The cyclic force is produced by a pair of counter-rotating unbalanced flywheels. Vertical component of this force is transmitted to the pavement through two steel wheels attached to the flywheels by a heavy frame. Horizontal components of force from the flywheels cancel out. A lift mechanism moves the force wheels in or out of contact with the ground. With the steel wheels up, the Dynaflect trailer is supported by conventional tires allowing travel at highway speeds. The magnitude of the cyclic force on the steel wheels is plus or minus 500 pounds at a frequency of eight cycles per second. Dead weight on the steel wheels is 2060 pounds.

Geophones measure the deflection of the pavement under the applied load. Each geophone consists of a coil, spring suspended for vertical

Photograph 1 - Dynaflect Trailer and Tow Vehicle

Photograph 2 - Control and Readout Devices

motion with the road. The coil tends to remain stationary in the moving field of the magnet producing an electrical signal with a voltage proportional to the amplitude of the motion. These geophones are usually referred to as sensors. Five sensors are used, with the first sensor located midway between the steel wheels and the other four sensors located forward at one foot intervals along the tongue. A motorized lift mechanism lowers the sensors for measurement and raises them for travel. In the raised position, the sensors are inverted so the coils are solidly supported within the geophone.

A control panel is located in the vehicle which tows the Dynaflect trailer. Photograph 2 shows the control panel and other equipment used by the operator. By use of this panel, the operator may raise and lower the steel wheels and sensors, adjust the frequency of the applied load, calibrate the sensors and monitor the output of the sensors. The electrical output of the sensors is filtered and amplified within the control panel. Narrow band filters reject all but the desired eight cycle per second signal created by the applied load thus reducing the effect of traffic and other sources of extraneous vibrations.

Sensors are calibrated using a cam activated platform which applies a .005 inch vertical motion at eight cycles per second. Sensitivity for each sensor is adjusted to produce a reading of .005 inch with the sensor on the platform. A dial gauge is used to check the amplitude of the platform motion. Frequency of the calibration platform and the flywheels are checked using a strobe light.

Dynaflect Use for Overlay Design

Deflection analysis is a widely used method for determining the thickness of overlay needed to rehabilitate an existing roadway.

Experience has shown that in general the more an asphalt pavement deflects under a given load, the fewer loadings it takes to cause failure. It is also well known that the addition of a layer of asphalt pavement will reduce deflections. The amount of deflection reduction can be calculated using multi-layer computer programs. Using these principles, charts have been developed with which overlay thickness required can be calculated from measured deflections and projected traffic.

The Colorado Department of Highways (CDOH) uses the Dynaflect to make deflection measurements for overlay design. For two-lane highways, deflection is measured every 0.1 mile on alternate sides of the road in the outer wheel path. Various testing patterns are used for multi-lane roads. All readings are corrected for temperature. This is necessary since the stiffness of an asphalt pavement is dependent on temperature. At each test stop, the surface temperature of the pavement is measured using an infrared thermometer. The Dynaflect operator points this gunlike device at the pavement, pulls the trigger, and gets an immediate temperature reading without leaving the vehicle.

Charts developed by H. F. Southgate at the Kentucky Department of Highways [1] are used to estimate the temperature within the pavement. These charts were developed by taking numerous temperature readings within pavements each hour throughout the day using thermocouples. Surface temperature, air temperature, and other weather data was also recorded. The method based on this data works as follows. For thin pavements, 2" or less, the chart for the time of day of the deflection reading is entered with the surface temperature to obtain the temperature within the pavement at the depth required. For thick pavements, greater than 2", the chart for the time of day of the deflection reading is entered with the sum of the surface temperature and the mean air temperature for the previous five days to obtain the temperature within the pavement at the depth required. Figures 1 and 2 are examples of the charts for thin and thick pavement.

For temperature correction, the charts are used to estimate the temperature at the middle and bottom of the pavement. The temperatures at the top, middle, and bottom of the pavement are averaged to obtain the mean pavement temperature. Mean pavement temperature is used with curve A in a Temperature Adjustment Chart[2] developed by the Asphalt Institute (Figure 3) to find the temperature correction factor. The measured deflection is multiplied by this factor to get a corrected deflection. Calculations to this point are done by computer. Corrected deflections are now grouped for statistical treatment. Groups usually contain ten readings, but substantial changes in readings should be placed at the divisions between groups. The mean and standard deviation are calculated for each group of corrected deflections.

Mean plus two standard deviations for a group of deflections is called the representative deflection for the section of highway tested. Deflections measured in the section should exceed this deflection only 2% of the time. This statistical treatment is done because the weakest areas have been found to be most closely associated with performance.

If the pavement is substantially weaker during one period of the year, during the spring thaw for example, the deflection readings should be taken at this time. If this cannot be done, the readings should be increased by a critical factor.

A Thickness Design Chart (Figure 4) developed by the Asphalt Institute is used to determine the overlay thickness needed. This chart is entered with the representative deflection and the projected traffic to

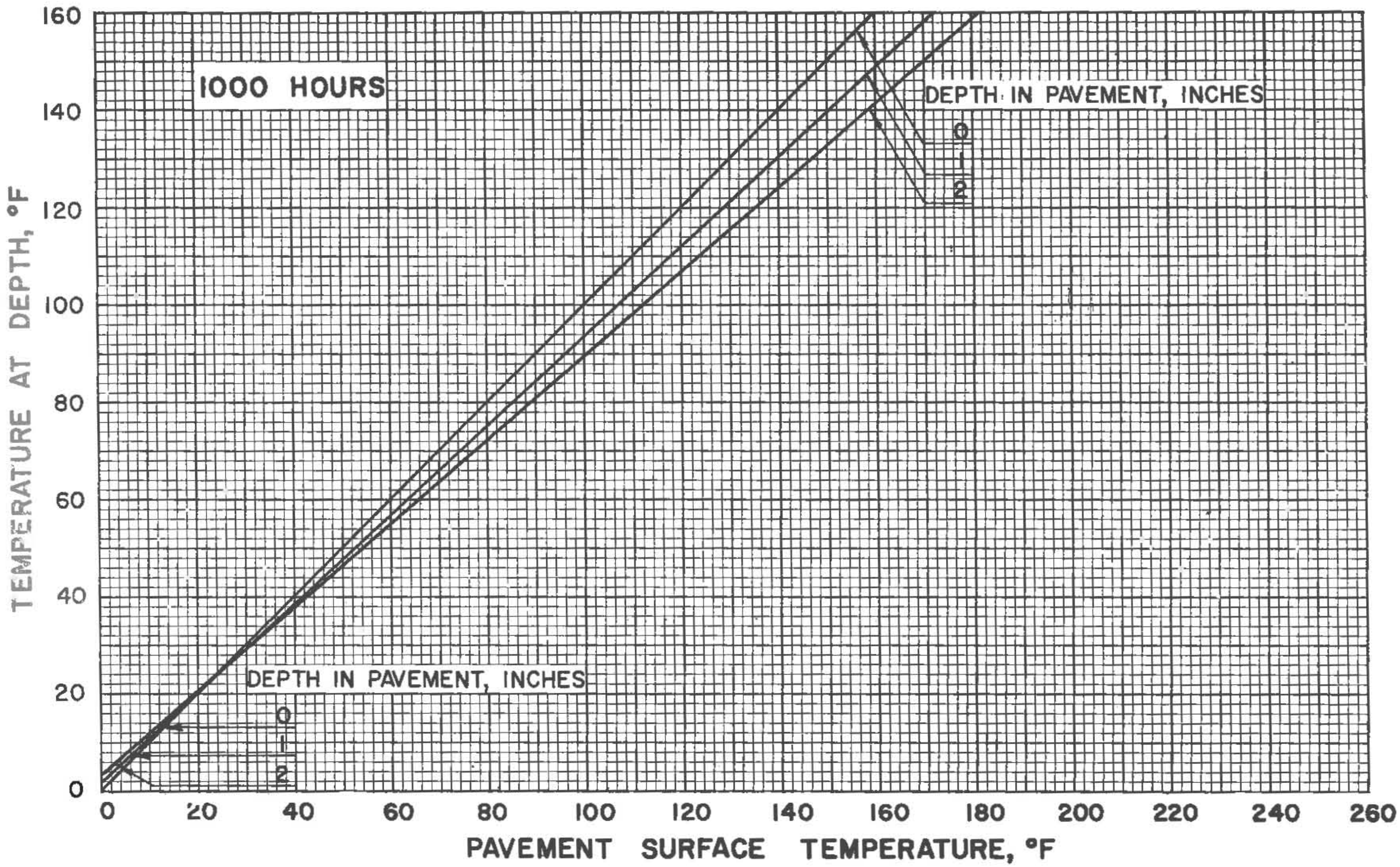


Figure 1 : Temperature Prediction Graphs for Pavements Equal To or Less Than 2 Inches Thick

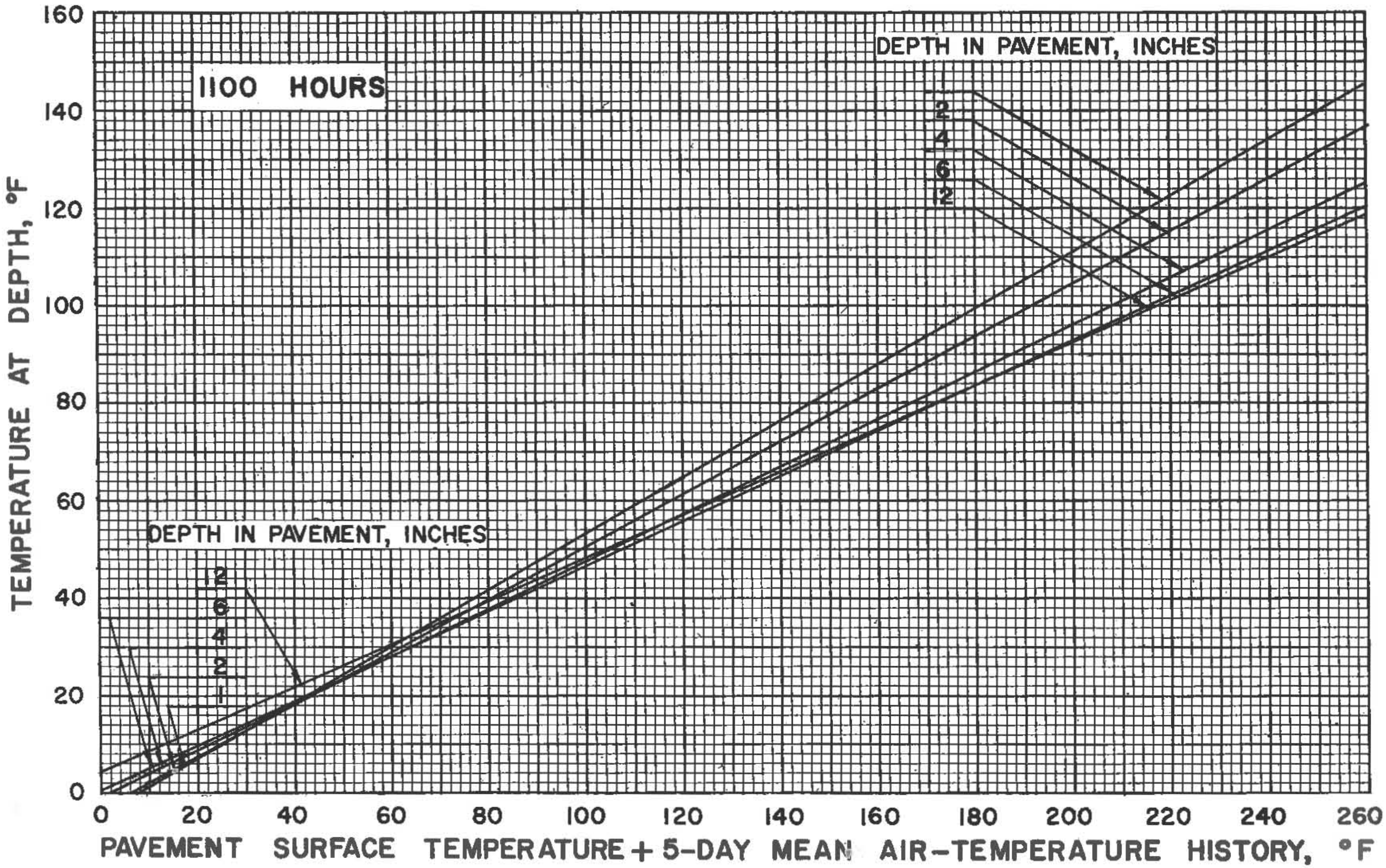


Figure 2 : Temperature Prediction Graph for Pavement Greater Than 2 Inches Thick

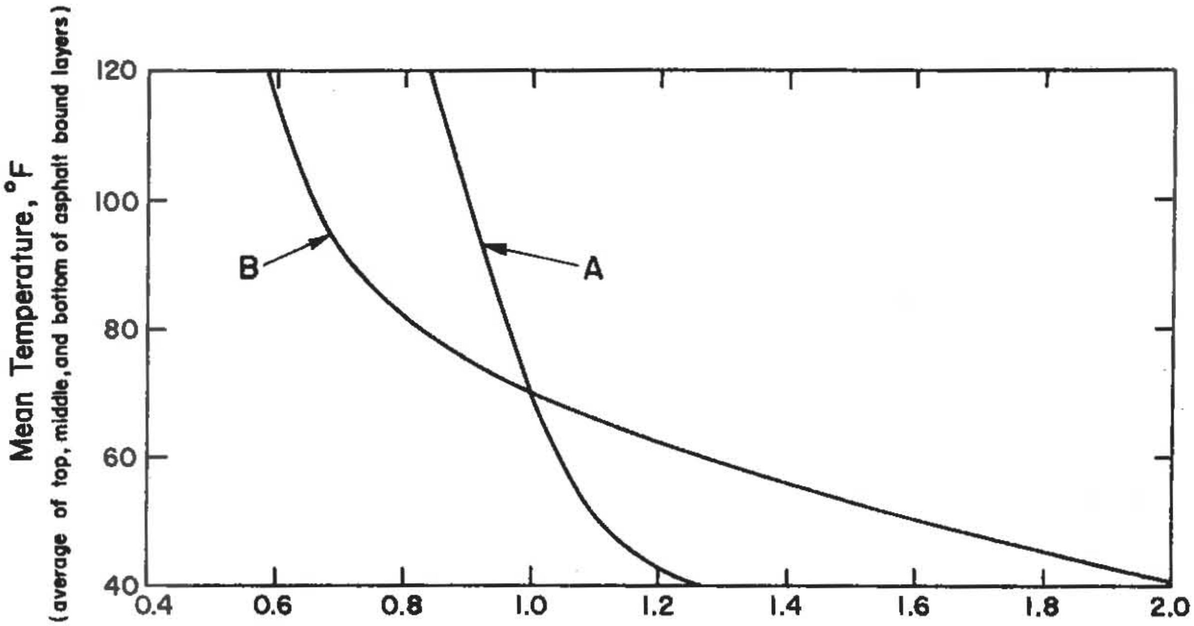


Figure 3 — Temperature Adjustment Factors to 70°F. for Benkelman Beam Deflections

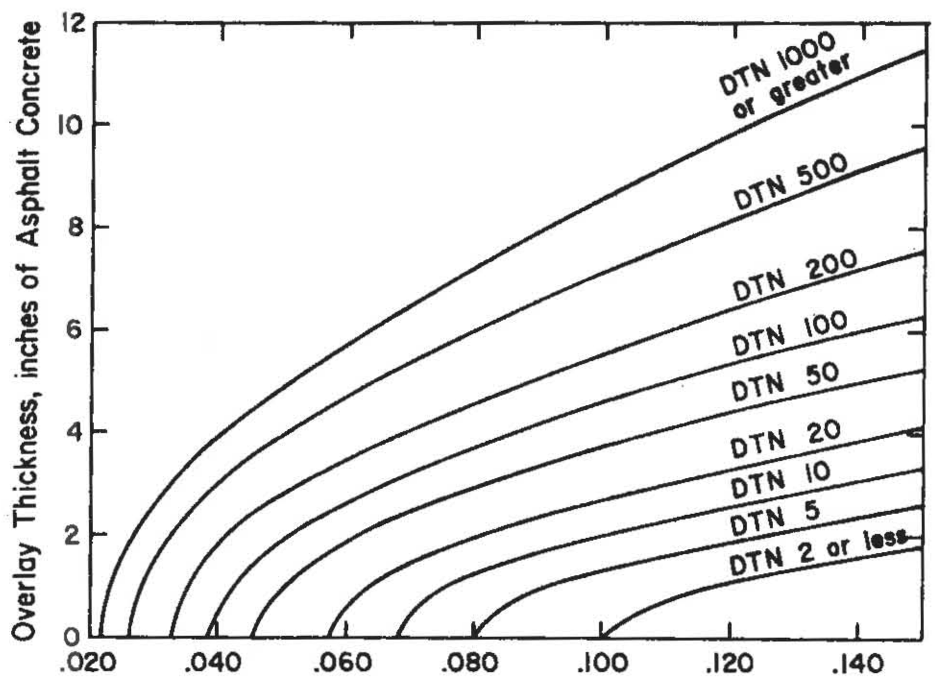


Figure 4 — Thickness Design Chart

obtain the thickness of the needed overlay. CDOH has substituted structural number for thickness on this chart. This structural number is divided by the strength coefficient of the paving material to be used to find the inches of overlay required.

RESEARCH NEEDED FOR DYNAFLECT DATA ANALYSIS

Additional research was needed on the following aspects of data analysis to refine the overlay design procedure.

Temperature Correction

Temperature correction of Dynaflect data is required because the stiffness of the asphaltic component of flexible pavement is dependent on temperature. In general, the stiffness of untreated roadway components such as, base, subbase, and subgrade are not temperature dependent. Thus, it would be expected that the amount of temperature correction required would depend on the relative contributions of the treated and untreated layers to the overall stiffness. For thick full depth asphalt pavement over a weak subgrade a large correction should be required. For a thin asphalt pavement over a strong combination of untreated based, subbase, and subgrade, only a small correction should be required.

The chart used to find the temperature correction factor (Figure 3) contains two correction curves. Curve A applies a smaller correction and is intended for most situations. Curve B applies a much larger correction and is intended for use in only a few special situations. These situations are described as "pavements with four inches or more of total asphalt thickness on a weak foundation, i.e., the support to the asphalt layers contributed by all materials directly underneath." CDOH uses only curve A for temperature corrections due to uncertainty about when to use curve B. The effectiveness of these curves for various pavements needed examination.

To estimate temperatures within a pavement, charts developed by H. F. Southgate at the Kentucky DOH are used. These charts are based on data collected by the Asphalt Institute's Laboratory at College Park, Maryland.

It is not clear how accurate these charts are in Colorado where the climate is considerably different. A comparison of temperatures predicted by these charts to measured temperatures should indicate how appropriate these charts are.

The charts developed by Southgate and the Asphalt Institute charts (Figures 3 and 4) were developed for use with the Benkelman Beam. It is not apparent how appropriate these charts are for use with the Dynaflect.

Seasonal Variation

Dynaflect readings should be taken at the time of the year when the pavement is weakest. In Colorado, this is usually in the spring when an abundance of moisture is available to weaken supporting layers. Experience has shown that these periods of higher deflection are critical to pavement performance.

Obviously, Dynaflect readings cannot all be obtained at the time of highest deflections. Therefore, it is necessary to adjust readings in many cases by multiplying by a "critical factor". This factor increases the deflections to what they would be if they had been measured at the time of highest deflections.

Before this research, the choice of a critical factor was largely guesswork due to a lack of supporting data. Deflections measured throughout the year at selected sites, should provide valuable guidance for selecting critical factors.

Five Sensor Analysis

For asphalt overlay thickness design, CDOH uses the deflections of the first sensor only. This sensor, located midway between the steel wheels, gives an indication of the overall ability of the pavement-subgrade combination to support loads. However, the first sensor deflection does not provide the stiffness of each pavement layer nor does it establish the amount of bending the pavement suffers. When deciding how to rehabilitate a roadway, it would be useful to know the stiffness of each pavement layer and the subgrade. For example, a severe weakness in the subgrade may indicate a need for improved drainage or reconstruction rather than an overlay.

Fatigue failure of asphalt pavements is more closely related to the amount of bending of the pavement than to maximum deflection under an applied load. For this reason, it is important to know the distribution of deflections in addition to the maximum.

The Dynaflect measures deflections directly between the steel wheels and at points 1, 2, 3, and 4 feet ahead of this point. Geophones at these locations are referred to as the 1st, 2nd, 3rd, 4th, and 5th sensors respectively. A plot of deflection versus sensor location is called the deflection basin. The shape of this basin is determined by the relative stiffness of the pavement layers and subgrade. Surface Curvature Index (SCI) is the difference between the first sensor deflection and the second sensor deflection. SCI is strongly dependent on the stiffness of the surface layer and indicates the amount of bend of the surface layer. Base Curvature Index (BCI) is the difference of the 4th sensor deflection and the 5th sensor deflection. BCI is strongly dependent on the stiffness of the supporting layers.

In theory, the five sensor deflections can be analyzed to find the stiffness of the pavement layers and subgrade. It would be useful to know how accurate such determinations are in actual field applications.

The stiffness of the top layer of the pavement does not affect all sensors equally. It has the greatest effect on the first sensor and successively less effect on sensors 2 through 5. For this reason, less temperature correction should be applied to deflection readings from sensors 2 through 5 than to readings from sensor 1. It would be useful to know what temperature correction is appropriate for all sensors.

DESCRIPTION OF PROJECT

This research project seeks answers to the following questions.

1. Is CDOH's current method of temperature correcting Dynaflect deflections for use in overlay thickness design effective? What temperature corrections are appropriate for sensors 2 through 5?

2. How much do temperature corrected deflections vary with the season in selected locations in Colorado? What seasonal correction is appropriate for various times of year and locations?

3. How effectively can pavement and subgrade strengths be predicted by analysis of deflections measured by the five Dynaflect sensors?

Temperature Correction Sites

Four sites were selected for use in examining the temperature correction method. Two of these sites were on driveways entering the parking lot north of the CDOH Materials Lab, one was on State Highway 58 east of Golden and one was on McIntyre Street near State Highway 58, both in Northwestern Denver. These sites were chosen for convenient location and because of the wide variation of pavement thicknesses. Pavement thicknesses for sites 1 through 4 are 5", 3", 9" and 3" respectively. Thermocouples were implanted at the midpoint and bottom of the pavement of the sites at the lab. No thermocouples were implanted at the sites on and near State Highway 58. These thermocouples allowed measurement of temperatures within the pavements in addition to the surface temperatures. Each site was monitored on each of three days. Monitoring consisted of measuring Dynaflect deflections and pavement temperatures each hour throughout the workday. Data and calculated results from the Temperature Correction Sites may be found in Tables 1 through 10.

Seasonal Variation Sites

Six sites were Dynaflected to determine the seasonal variation of deflections. Site locations were chosen to provide a wide variation in climate and elevation. Site locations are shown on Figure 5. Each site was tested six times starting in the spring and ending in the fall. Testing of a site consisted of measuring Dynaflect deflections at ten locations in a 500' test section. These ten readings were averaged and the results recorded in Table 11 and shown in Figures 6 through 11. The original test site 6 was overlayed so a new test site 6 was established. This is why the April 14th results are missing for test site 6.

<u>Five Sensor Test Sites</u>

Fifteen sites (Figure 12) were Dynaflected for analysis of five sensor deflections to predict pavement and subgrade layer strengths. At these sites, the pavement was drilled through and soil samples taken as a part of an ongoing soils research project.[5] Thus, test results on the in-place soil were available. It was originally planned for pavement cores to be taken and tested but this was not done for the following reasons. All pavements were less than ten years old and in good condition so pavement strengths should be similar. In addition, cores would not reflect pavement weakness resulting from cracks surrounding the core. At each site, ten Dynaflect readings were taken. These deflections and the site averages can be found in Tables 12 through 19.

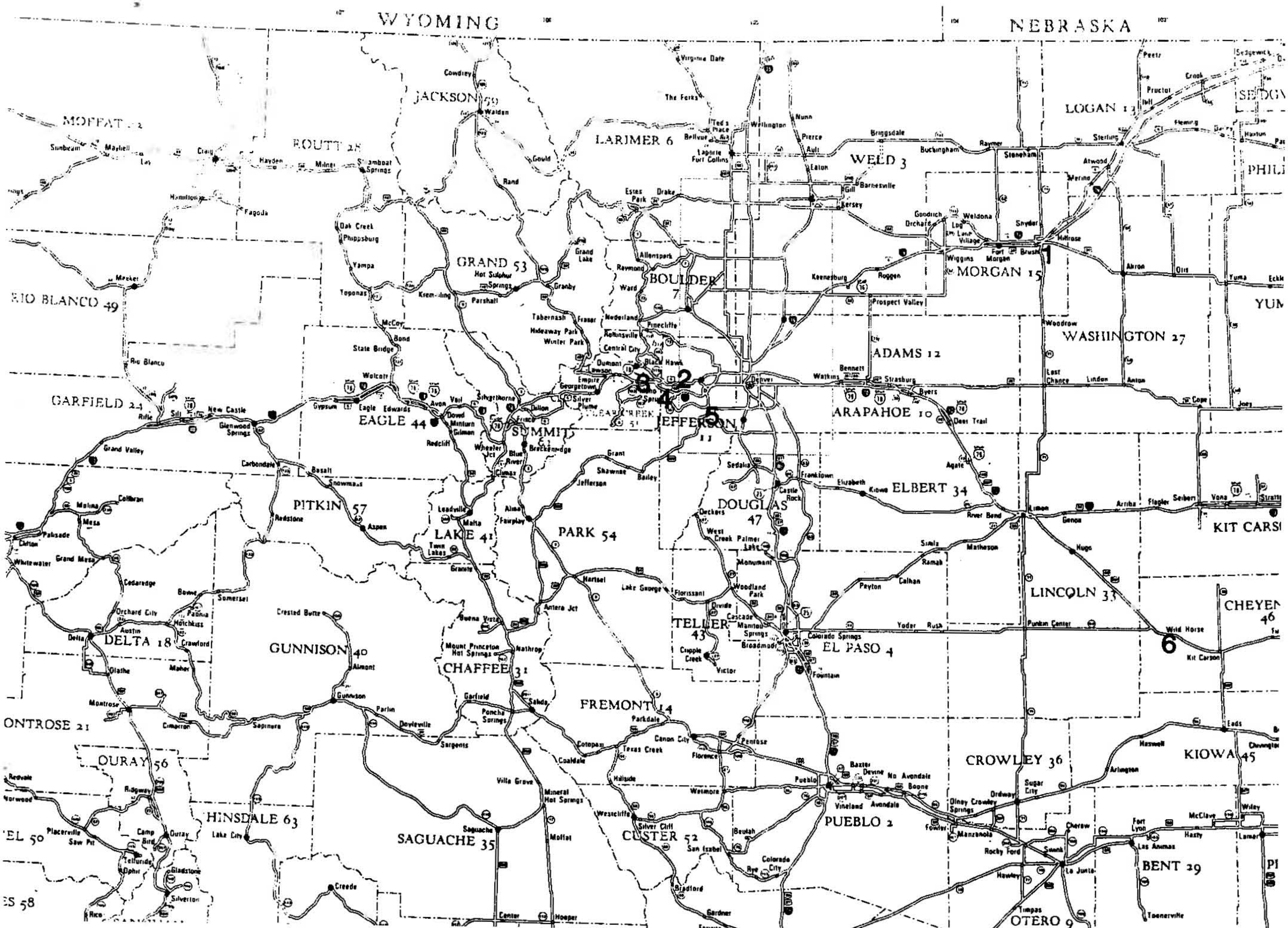


Figure 5 Seasonal Variation Site Location

FIGURE 6 SEASONAL VARIATION

SITE 1 STATE HIGHWAY 71 SOUTH OF BRUSH

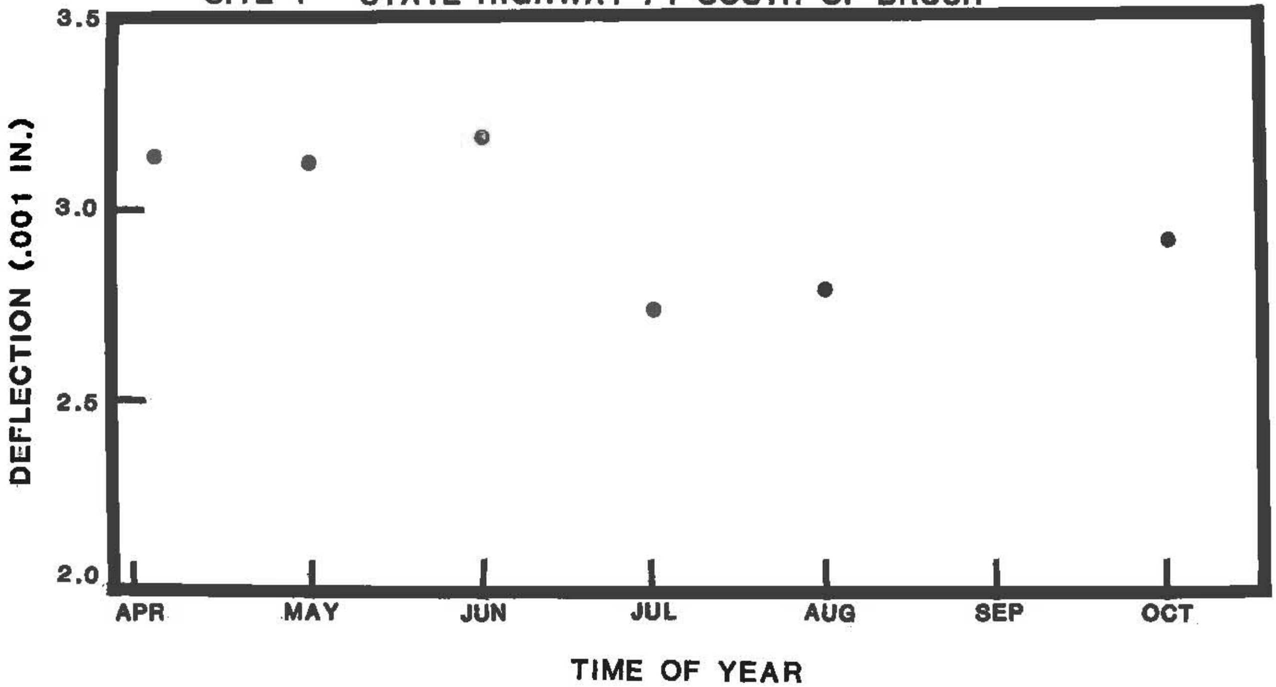


FIGURE 7 SEASONAL VARIATION

SITE 2 STATE HIGHWAY 58 GOLDEN

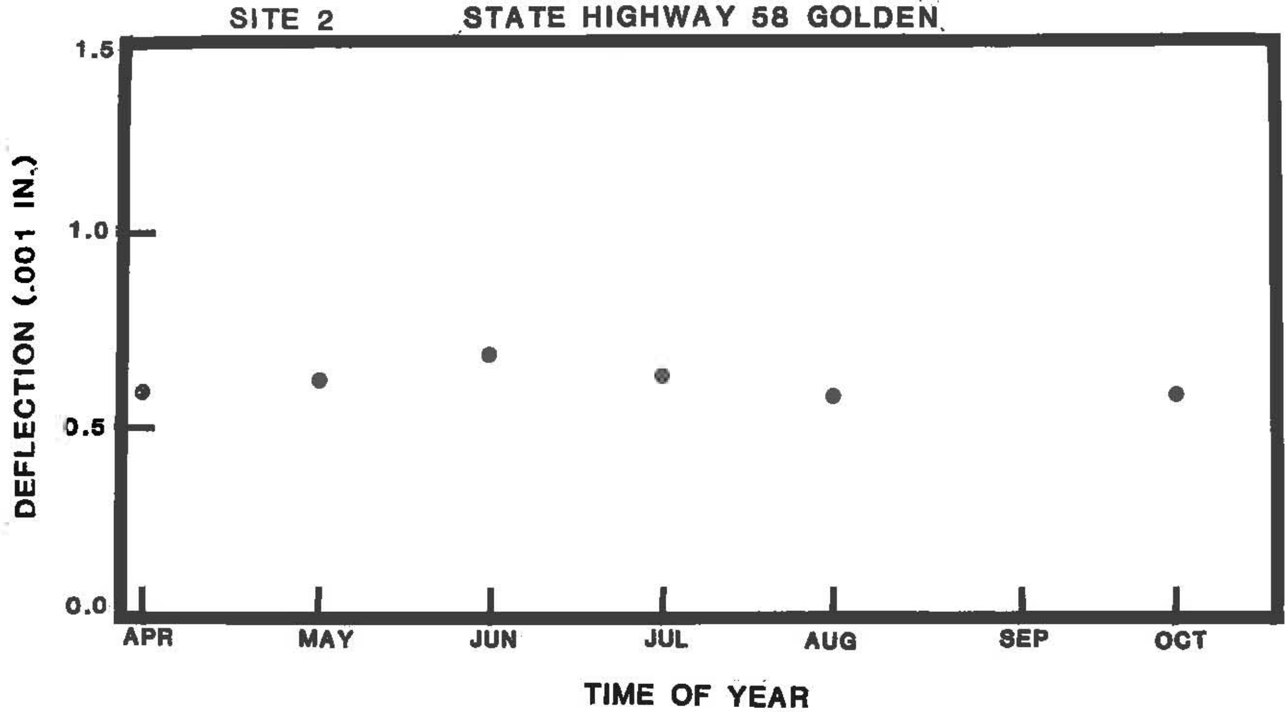


FIGURE 8 SEASONAL VARIATION

SITE 3 STATE HIGHWAY 103 SQUAW PASS

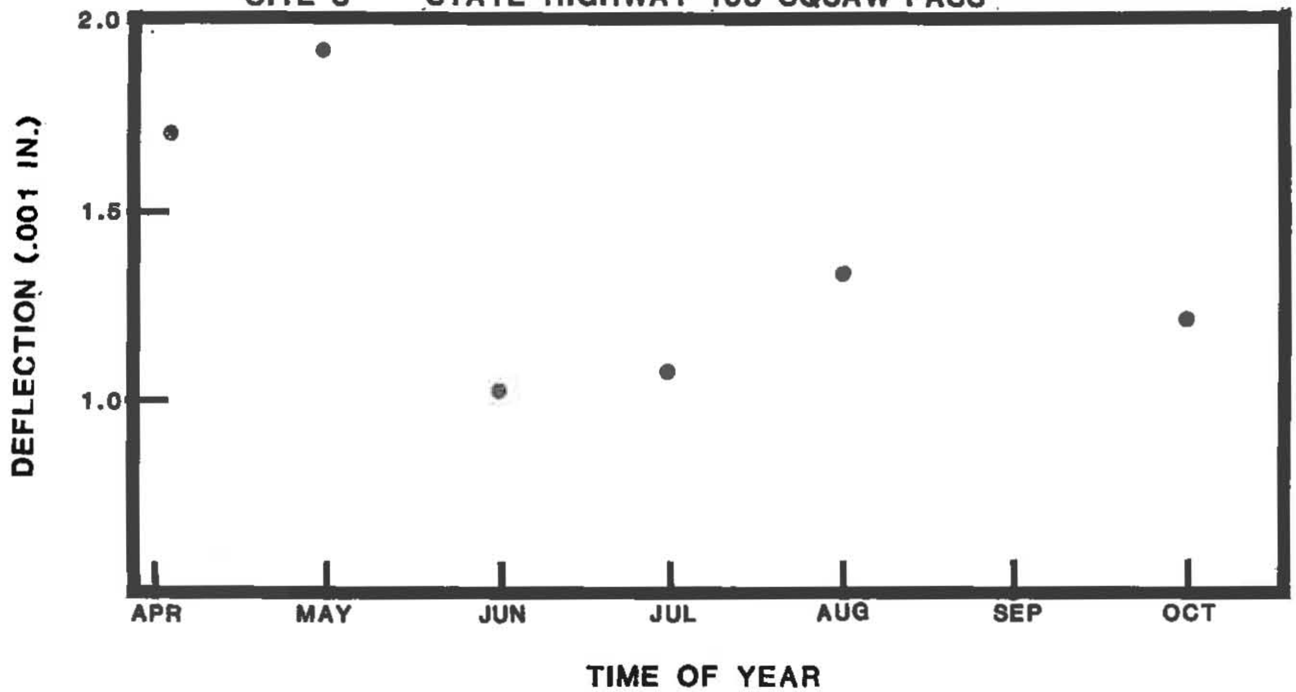


FIGURE 9 SEASONAL VARIATION

SITE 4 STATE HIGHWAY 74 WEST OF EVERGREEN

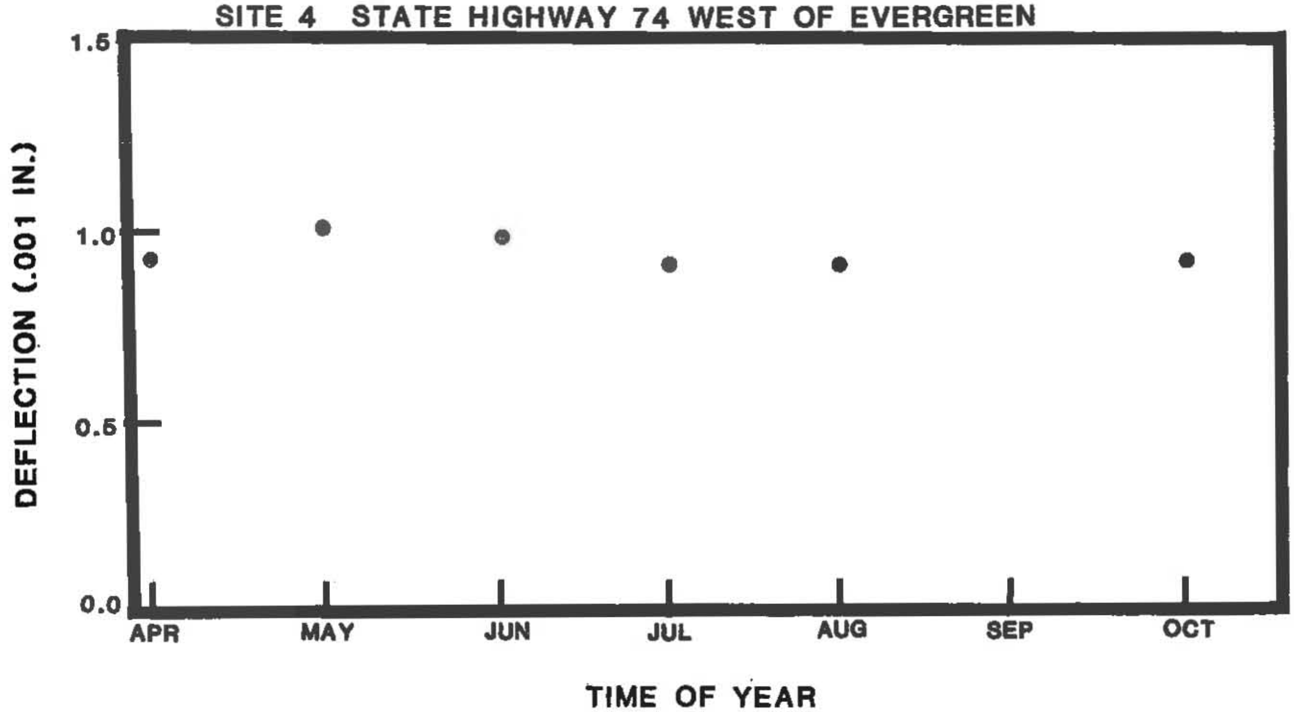


FIGURE 10 SEASONAL VARIATION

SITE 5 STATE HIGHWAY 121 WADSWORTH BLVD.

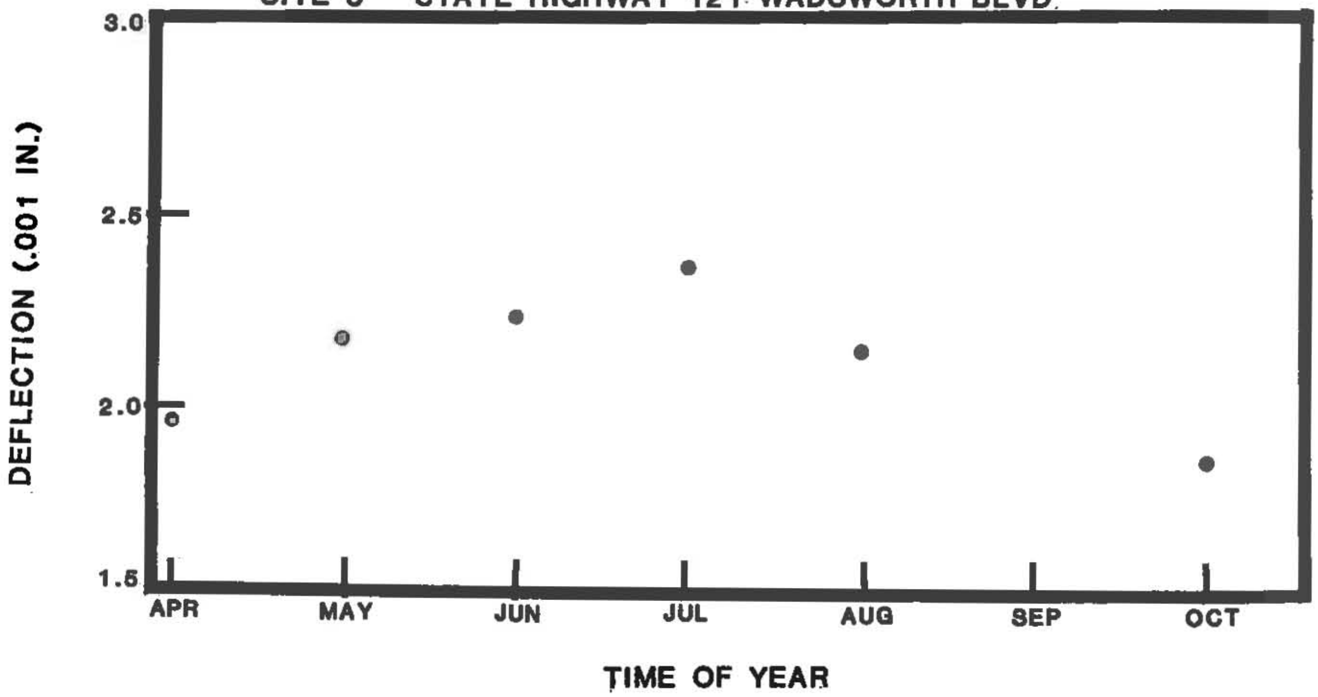
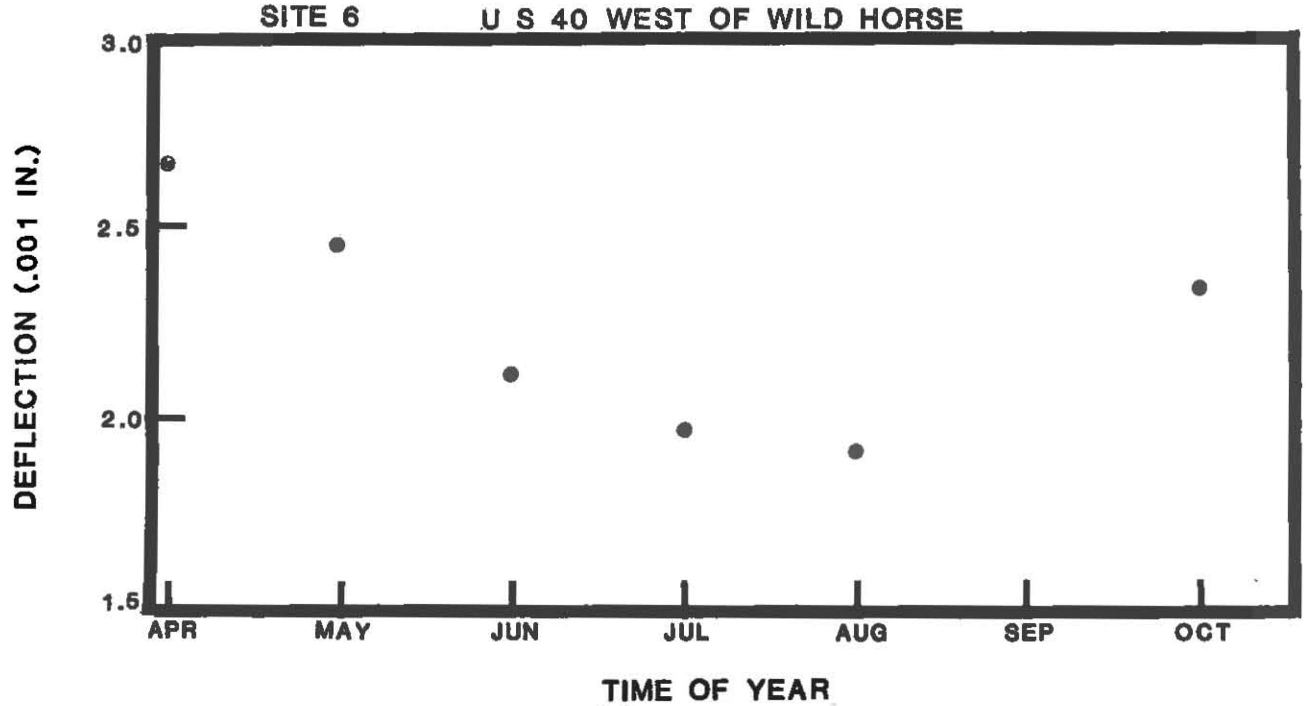
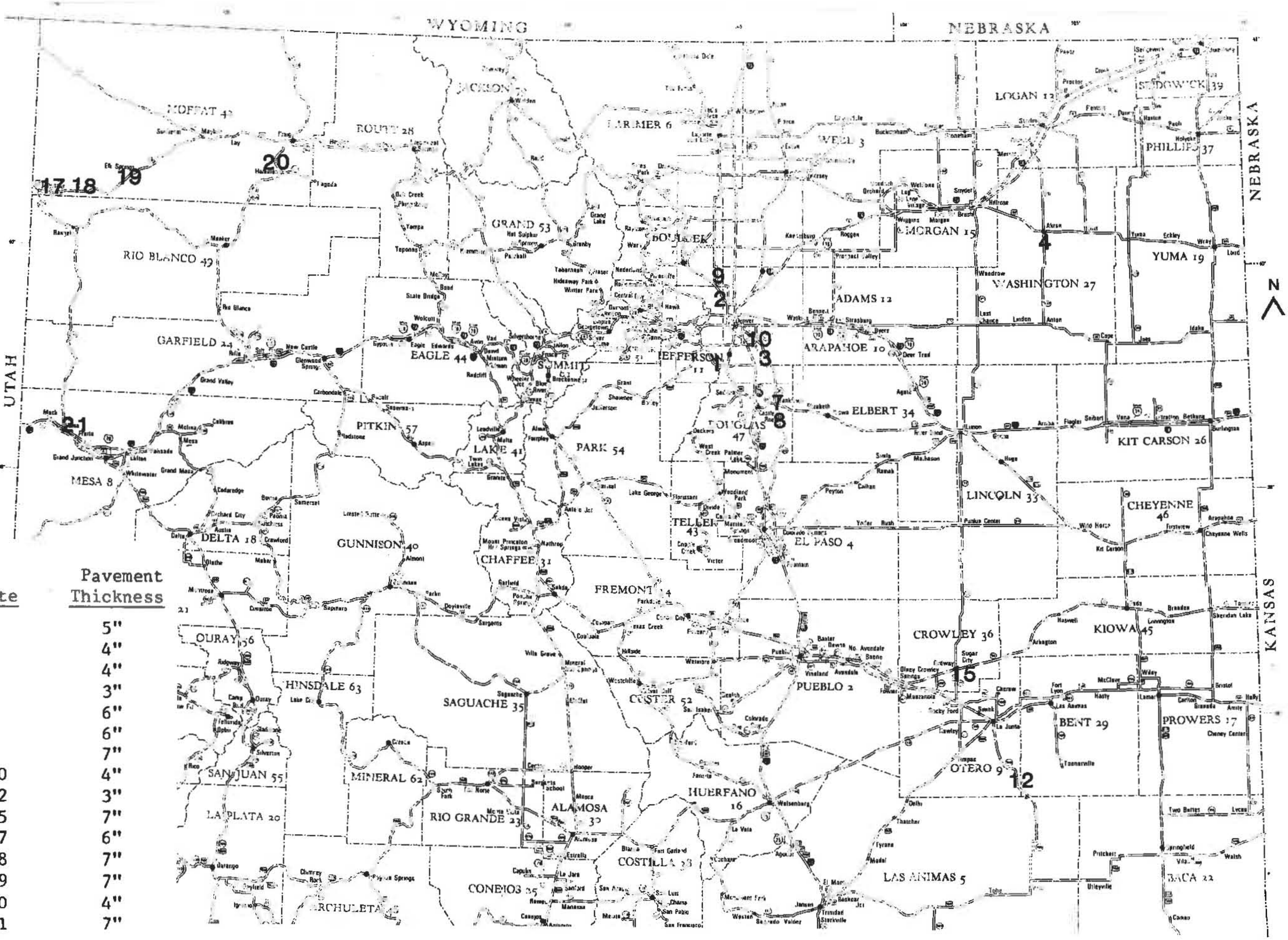


FIGURE 11 SEASONAL VARIATION

SITE 6 U S 40 WEST OF WILD HORSE





Site	Pavement Thickness
1	5"
2	4"
3	4"
4	3"
7	6"
8	6"
9	7"
10	4"
12	3"
15	7"
17	6"
18	7"
19	7"
20	4"
21	7"

Figure 12 Five Sensor Site Location

DATA ANALYSIS AND DISCUSSION OF RESULTS

The following is a description of the analysis approach for each subject area examined and an interpretation of the meaning of the analyzed results.

Temperatures Correction Sites

Tables 1 and 2 contain the raw data from sensor 1 on the Temperature Correction Sites. This data is listed on the line labeled none, meaning no temperature correction has been applied. Also included in these tables is data corrected for temperature using curve A or curve B of the chart on page 11 of Research Report 69-3 from the Asphalt Institute.[2] Examples of these curves are shown in Figures 13 and 14. The report states that "Curve A, derived mostly from granular base pavements, has the greatest data support and hence should be used for all but a few special situations. The special situations calling for use of curve B are those pavements with four inches or more of total asphalt thickness on a weak foundation;". For overlay design temperature correction, CDOH uses only curve A due to uncertainty on when to use curve B and because of the large correction applied by curve B.

Table 3 contains statistical results for sensor 1 Temperature Correction Site data. The mean, standard deviation and coefficient of variation were calculated for each day a site was tested. A low coefficient of variation was assumed to indicate that the corresponding temperature correction method is effective. For seven site-days correction A was most effective, for three site-days correction B was most effective and for two site-days no correction was most effective. No correlation was apparent between the most effective correction approach and pavement thickness.

FIGURE 13 UNCORRECTED DEFLECTION

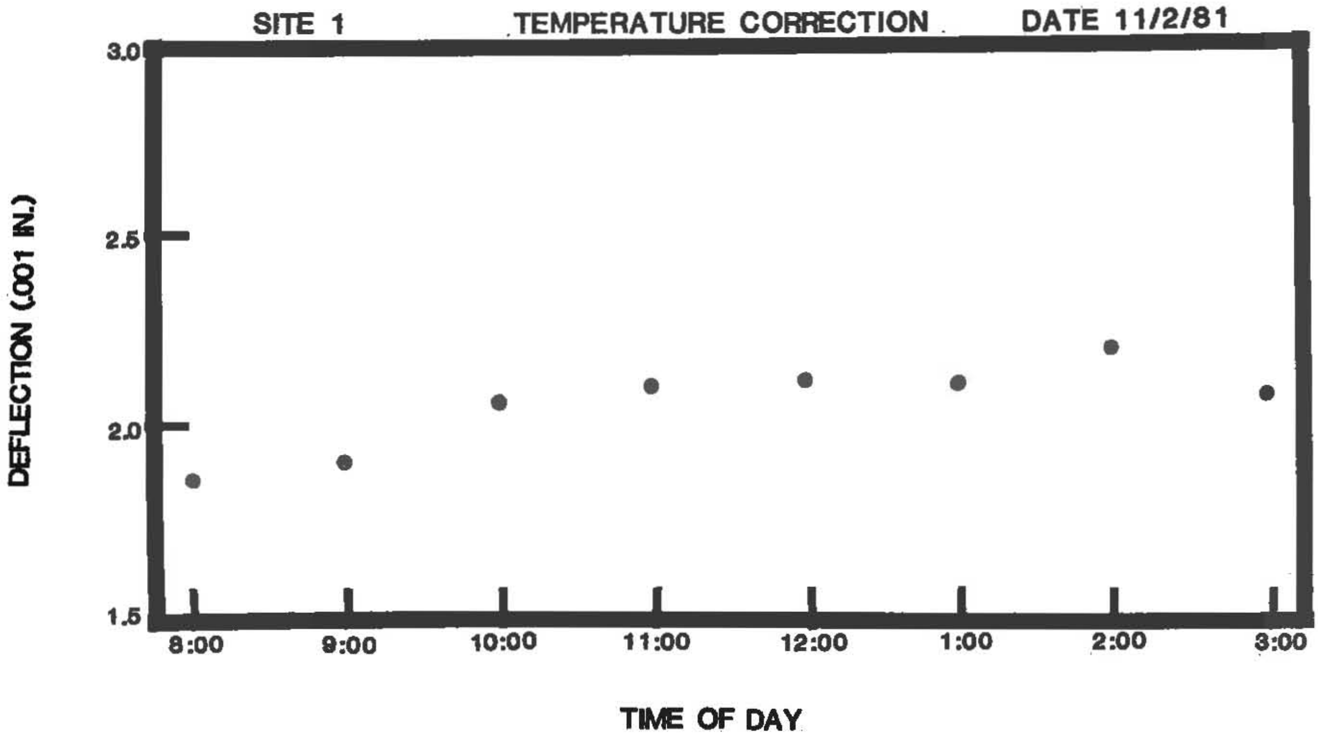
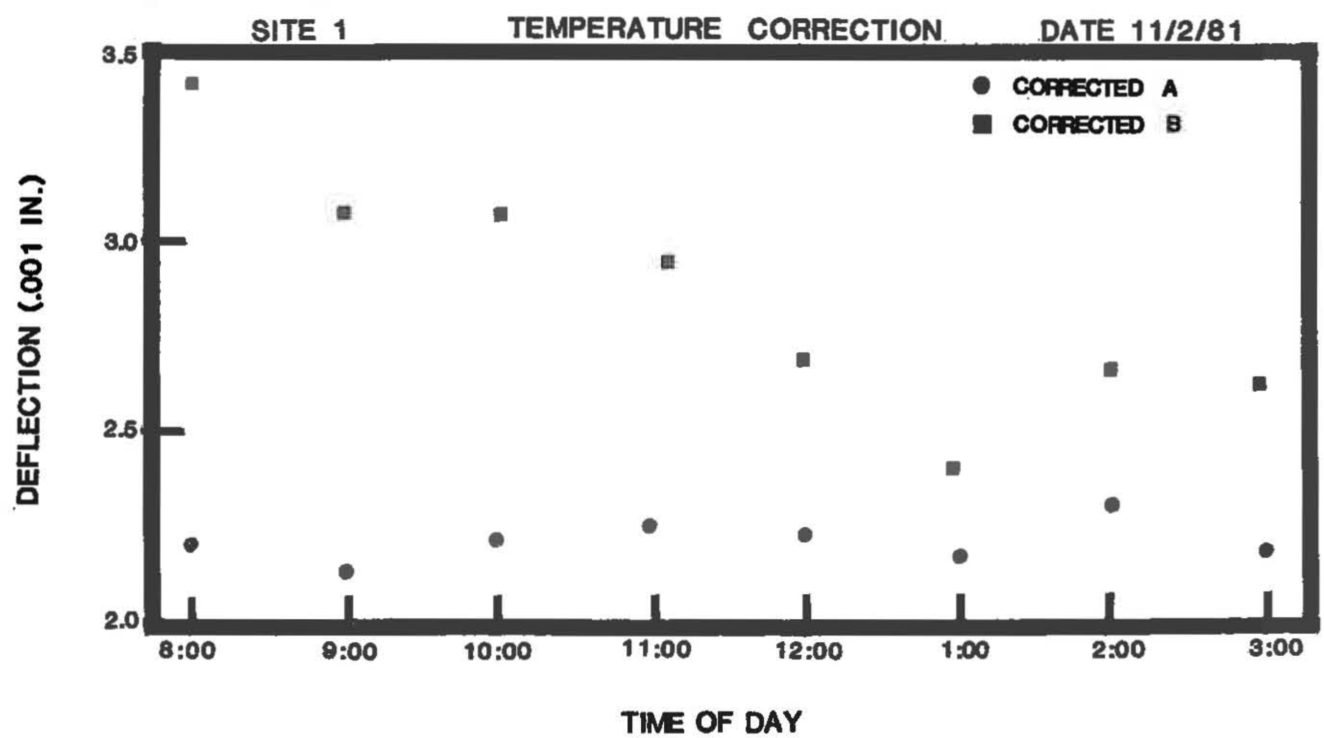


FIGURE 14 CORRECTED DEFLECTION



Tables 4, 5, 6, and 7 contain the uncorrected deflections versus time of day on the Temperature Correction Sites for sensors 2 through 5. It can be calculated from these tables that there is less than 10% variation in deflections for sensors 3, 4, and 5 throughout each day. From this reason it is concluded that these sensors do not need temperature correction. This is expected since the more distant sensors from the force wheels are affected more by the subgrade than the pavement.

Sensor 2 shows up to 18% variation of deflection throughout the day and thus merits further examination. Table 8 shows deflection versus time of day for sensor 2 with no correction and with corrections A and B applied. Table 9 contains statistical results from Table 8. The statistical results indicate that correction B does a poor job of correcting for sensor 2. In all cases, correction B creates greater variation than either no correction or correction A. For five site-days no correction had least variation, for six site-days correction A was most effective and for one site-day no correction and correction A were equally effective. It appears that a correction curve between curve A and no correction would be most effective for sensor 2.

Table 10 contains temperature data from sites 1 and 2. For each site, date, time of day, the measured temperatures at the surface, middle, and bottom of the pavement are listed on the left of the appropriate space. The calculated temperatures for the middle and bottom are listed on the right of each space after the dash. These temperatures were calculated using surface temperature and five-day mean with the charts developed by Southgate. Some temperatures are missing for the first day of testing because of an error in connecting the thermocouples. In almost all cases, the calculated temperatures were less than the actual measured temperatures.

Seasonal Variation Sites

Table 11 contains the test results from the Seasonal Variation Sites. For each site on each test date, the mean and standard deviation for the ten readings were calculated and recorded in this table. For each site the ratio of the highest average deflection to the lowest is recorded on the right. This ratio provides an indication of the maximum amount of seasonal variation to be expected at these sites.

Site 3 is just east of Squaw Pass on State Highway 103. This site is subject to very severe conditions in the winter and spring due to the altitude (about 9000'). These conditions include high precipitation, temperature extremes, a large amount of spring runoff and many freeze thaw cycles. Due to the large amount of moisture present in the spring and considerably milder conditions in the summer and fall a large seasonal variation was expected for this site. This expectation proved true as the deflection average decreased from 1.97 mils in April to 1.12 mils in June for a ratio of 1.76.

The sites other than site 3 showed much less variation in average deflection. This is expected since these sites experience much less variation in moisture conditions than site 3. The ratios of high average deflection to low, excluding site 3, ranged from 1.17 to 1.30 with an average of 1.21. For sites 3, 4, and 6, the deflections tend to be high in the spring and decrease into the summer and fall. For sites 1, 2, and 5 the trend is not clear.

Regional factor is a number used to adjust flexible pavement thickness designs for local conditions. This number is determined by summing assigned values based on annual precipitation, elevation, drainage, frost, and other special conditions. Appendix B contains an excerpt from the CDOH Design Manual describing the use and calculation of regional factor.

The seasonal variation data described above indicates that a larger seasonal adjustment (critical factor) is needed for severe local conditions than for normal conditions. The regional factor is an appropriate number to describe local conditions for critical factor determination since the same conditions which increase regional factor generally result in a higher seasonal variation. For example, a site with high annual precipitation, high elevation, poor drainage, and deep frost penetration would have a large regional factor and also a large seasonal variation.

Regional factor for site 3 near Squaw Pass was estimated to be 3. All other seasonal variation sites had regional factors of 1 or less.

Based on the considerations and data discussed above, the following table (Figure 15) was constructed for use in determining critical factor. In choosing the subgrade condition category, weather conditions prior to testing should be considered in addition to time of year.

Figure 15
Critical Factor

Regional Factor	Subgrade Condition			
	Wettest (March-April)	Transition (May-June)	Driest (July-Dec.)	Ground Frozen (Jan.-Feb.)
1	1.0	1.1	1.2	No Testing
2	1.0	1.2	1.5	
3	1.0	1.4	1.8	
4	1.0	1.5	2.0	

Five Sensor Analysis

Figures 16, 17, and 18 show the Colorado method of analyzing the deflections from the five sensors to evaluate the condition of the pavement structure and subgrade in addition to the overall roadway condition. This chart is patterned after charts used by Utah one of which is described below. To use this chart, the DMD, SCI', and BCI' must be calculated from

Figure 16 - CDOH Method of Five Sensor Analysis

ADT VOLUME 0 TO 1000

use temperature corrected sensor no. 1

DMD sensor no.1	SCI sensor no.1 minus sensor no.3	BCI sensor no.3 minus sensor no.5	ANALYSIS OF ROADWAY CONDITION OVERALL	 STRUCTURE	 SUBGRADE
GT 2.00	GT $\frac{DMD}{2}$	GT $\frac{DMD}{7.5}$	-POOR-	-POOR-	-POOR-
		LE $\frac{DMD}{7.5}$	-POOR-	-POOR-	GOOD
	LE $\frac{DMD}{2}$	GT $\frac{DMD}{7.5}$	-POOR-	GOOD	-POOR-
		LE $\frac{DMD}{7.5}$	-POOR-	GOOD	GOOD
LE 2.00	GT $\frac{DMD}{2}$ * or 0.75	GT $\frac{DMD}{7.5}$ * or 0.20	GOOD	-POOR-	-POOR-
		LE $\frac{DMD}{7.5}$ * or 0.20	GOOD	-POOR-	GOOD
	LE $\frac{DMD}{2}$ * or 0.75	GT $\frac{DMD}{7.5}$ * or 0.20	GOOD	GOOD	-POOR-
		LE $\frac{DMD}{7.5}$ * or 0.20	GOOD	GOOD	GOOD

Note: * = use the larger of the two values — the number will be larger when DMD is less than 1.50

G T = greater than

L E = less than or equal to

Figure 17 - CDOH Method of Five Sensor Analysis

ADT VOLUME 1001 TO 5000

use temperature corrected sensor no. 1

DMD sensor no.1	SCI sensor no.1 minus sensor no.3	BCI sensor no.3 minus sensor no.5	ANALYSIS OF ROADWAY CONDITION OVERALL	STRUCTURE	SUBGRADE
GT 1.50	GT DMD/2	GT DMD/7.5	-POOR-	-POOR-	-POOR-
		LE DMD/7.5	-POOR-	-POOR-	GOOD
	LE DMD/2	GT DMD/7.5	-POOR-	GOOD	-POOR-
		LE DMD/7.5	-POOR-	GOOD	GOOD
LE 1.50	GT DMD/2 * or 0.5575	GT DMD/7.5 * or 0.15	GOOD	-POOR-	-POOR-
		LE DMD/7.5 * or 0.15	GOOD	-POOR-	GOOD
	LE DMD/2 * or 0.5575	GT DMD/7.5 * or 0.15	GOOD	GOOD	-POOR-
		LE DMD/7.5 * or 0.15	GOOD	GOOD	GOOD

Note: * = use the larger of the two values — the number will be larger when DMD is less than 1.115

G T = greater than

L E = less than or equal to

Figure 18 - CDOH Method of Five Sensor Analysis

ADT VOLUME 5001 +

use temperature corrected sensor no. 1

DMD sensor no.1	SCI sensor no.1 minus sensor no.3	BCI sensor no.3 minus sensor no.5	ANALYSIS OF ROADWAY CONDITION		
			OVERALL	STRUCTURE	SUBGRADE
GT 1.00	GT DMD/2	GT DMD/7.5	-POOR-	-POOR-	-POOR-
		LE DMD/7.5	-POOR-	-POOR-	GOOD
	LE DMD/2	GT DMD/7.5	-POOR-	GOOD	-POOR-
		LE DMD/7.5	-POOR-	GOOD	GOOD
LE 1.00	GT DMD/2 * or 0.375	GT DMD/7.5 * or 0.10	GOOD	-POOR-	-POOR-
		LE DMD/7.5 * or 0.10	GOOD	-POOR-	GOOD
	LE DMD/2 * or 0.375	GT DMD/7.5 * or 0.10	GOOD	GOOD	-POOR-
		LE DMD/7.5 * or 0.10	GOOD	GOOD	GOOD

Note: * = use the larger of the two values — the number will be larger when DMD is less than 0.75

G T = greater than

L E = less than or equal to

the deflections of sensors 1, 3, and 5. DMD is the first sensor deflection. SCI' is the difference of sensors 1 and 3 and BCI' is the difference of sensors 3 and 5. This unconventional method of determining SCI and BCI was chosen for the following reason. SCI is normally the difference between sensors 1 and 2. However, the Temperature Correction Site results indicate that temperature correction is needed for sensor 2 but not for sensor 3. Since the appropriate correction for sensor 2 has not been established using the difference of sensor 1 and sensor 3, for SCI avoids a problem. Colorado's method uses three charts for each of three traffic categories. These categories are an Average Daily Traffic (ADT) of 0 to 1000, 1001 to 5000, and 5001 or above. The higher traffic categories have more stringent deflection requirements. ADT is used because this number is easier to obtain than 18^K. In each chart, the evaluation of overall condition is based on DMD, evaluation of the pavement structure condition is based on SCI' and subgrade condition evaluation is based on the BCI'. The thresholds for SCI' and BCI' are based on the DMD or in some cases a fixed minimum.

Figure 19 shows the Utah DOT method of five sensor analysis. This chart was included in information sent by Doug Anderson, Utah DOT, in April, 1982. In this chart, SCI and BCI are defined traditionally. SCI is the difference of sensor 1 and sensor 2 deflections and BCI is the difference of sensor 4 and sensor 5 deflections. This chart also bases overall condition on DMD, pavement structure condition on SCI, and subgrade condition on BCI.

Tables 12 through 19 show deflections measured on the 15 five sensor sites. The first sensor deflections have been temperature corrected, but not deflections from sensors two through five. The two analysis methods

Figure 19 UTAH METHOD OF FIVE SENSOR ANALYSIS

DEFLECTION CRITERIA FOR DYNAFLECT			
DMD	SCI	BCI	Condition of Pavement Structure
Greater Than 1.25	Greater Than 0.25	Greater than 0.15	Pavement and Subgrade Weak
		Less than 0.15	Weak Structure, Pavement is Cause
	Less Than 0.25	Greater than 0.15	Weak Structure, Subgrade is Cause
		Less than 0.15	Condition not likely to exist
Less Than 1.25	Greater Than 0.25	Greater than 0.15	Condition not likely to exist
		Less than 0.15	Pavement weak, But not critical
	Less Than 0.25	Greater than 0.15	Subgrade weak, More study advised
		Less than 0.15	Pavement and Subgrade strong

described above have been applied to these deflections and the results are shown in Tables 20 through 35. As part of a soils research project, soil samples were taken at each site and tested. Table 36 shows soil classification and average R-value at field moisture for each site. Also shown in this table are the results of applying the CDOH and Utah analysis methods to the average site deflections. Site numbers shown were those used in the soils research. Not all soil research sites were Dynaflected so there are gaps in the site numbering.

To facilitate comparison soils with R-values of 50 or higher was considered good and soils with R-values of less than 50 was considered poor. Using this criteria with Table 35 it is found that CDOH five sensor analysis results agree with subgrade R-values in eight cases and disagree in seven cases. Comparing results of Utah's method of analysis with R-value results shows agreement in three cases and disagreement in five cases. Comparison is not possible where the Utah method does not make a definitive statement about subgrade condition.

Deflection Basin Examination

The five sensors measure a four-foot cross-section of the deflection basin. It is of interest to compare this cross-section with the entire three dimensional deflection basin. To accomplish this, the remote sensor was used to measure deflections on a one-foot grid extending five feet ahead, behind, right and left of the first sensor. The results are shown on Figure 20.

Figure 20 - Extended Deflection Basin

TOW VEHICLE

.20	.23	.27	.29	.32	.32	.31	.29	.26	.23	.20
.23	.28	.33	.37	.41	.42	.41	.37	.32	.27	.23
.27	.34	.42	.51	.56	.61	.56	.48	.41	.33	.26
.30	.39	.52	.68	.84	.91	.80	.64	.49	.37	.29
.32	.44	.62	.99	1.36	1.44	1.22	.84	.57	.41	.31
.34	.47	.69	1.20		1.87		.97	.63	.44	.33
.33	.45	.65	.97	1.34	1.35	1.15	.80	.54	.39	.29
.30	.40	.52	.68	.80	.84	.77	.61	.47	.36	.27
.27	.33	.41	.49	.56	.57	.54	.46	.38	.31	.25
.23	.27	.32	.37	.39	.42	.39	.36	.31	.25	.21
.19	.22	.26	.28	.30	.30	.29	.27	.24	.22	.18

CONCLUSIONS AND IMPLEMENTATION

Temperature Correction

Test results from the four temperature correction sites indicate that for sensor 1 correction A is more effective than correction B or no correction. Correction A is currently being applied to all sensor 1 deflections used in overlay design so no change in procedure is needed.

Test results indicate that for sensor 2 correction A and no correction were equally effective. Correction B was very ineffective. For sensor 2 a correction of the form of curve A but of reduced magnitude would be appropriate. Determination of a correction curve for sensor 2 is beyond the scope of this study.

Data indicates that deflections of sensors 3, 4, and 5 are not substantially affected by temperature so no correction is required.

Seasonal Variation

Data indicates that seasonal variation of Dynaflect deflections is dependent on time of year, recent weather prior to testing, and local conditions relating to climate and drainage. Based on these findings, a chart (Figure 13) was constructed for determining critical factors for seasonal correction of deflections. Inputs for this chart are the subgrade moisture condition and local conditions as expressed by the regional factor for the site. Time of year and recent weather should both be considered in choosing the subgrade condition category.

The critical factor chart has been distributed for use and will be included in the next revision of the CDOH Design Manual.

Five Sensor Analysis

On fifteen sites soil samples were obtained and tested and Dynaflect deflections were measured. The five sensor deflections were analyzed using a Colorado method and a Utah method to yield an evaluation of the subgrade condition. Results of Colorado method of evaluation agreed with R-value test results for eight of the fifteen sites. Results of Utah's method of evaluation agreed with R-values for three out of eight sites where comparison is possible.

The following are several plausible explanations of the lack of agreement between five sensor analysis results and R-values.

1. Because of the lack of uniformity of the subgrade and pavement layers, it may be impossible to accurately calculate the strengths of the layers from the five sensor deflections.

2. A more effective method of analyzing the five sensor deflections may be needed.

3. The R-value test as conducted in this study may not be effective for evaluating the condition of the subgrade. For R-value testing, remolded specimens were compacted at field moisture following the standard R-value compaction method (AASHTO T190). Remolding or a difference between specimen and field density could affect results. In addition, results could be affected by the difference between the nature of the loading applied in Dynaflect testing versus R-value testing. The Dynaflect applies a cyclic load at eight cycles per second whereas in the R-value test, the load is applied at a constant strain of .05 inches per minute.

4. The Dynaflect may not generate sufficient load to stress the subgrade to the extent that appreciable deflections occur at the surface, i.e., deflections at sensors 4 and 5 are too small to give a dependable indication of subgrade strength.

Given the uncertainties which exist with respect to five sensor analysis, it would be unwise to base rehabilitation decisions on the results of such analysis.

Additional Research Needs

This study was a low level effort which addressed a few specific aspects of Dynaflect data analysis. A major in depth study by NCHRP is underway which will address broader questions relating to non-destructive testing of pavements.

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5. Keith W. Berry and Charles R. Hines, "R-Value Test Modification", Colorado Department of Highways, April, 1983.

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Appendix A

Data Tables

Table 1 TEMPERATURE CORRECTION SITE DEFLECTIONS Sensor 1

Site	Date Tested	Correction	Deflection (.001 in.) Vs. Time of Day							
			8:00	9:00	10:00	11:00	12:00	1:00	2:00	3:00
1	9-9-81	None	1.73	1.90	2.00	2.13	2.12	2.25	2.20	2.21
		A	1.71	1.84	1.89	1.99	1.93	2.02	1.99	2.01
		B	1.63	1.63	1.56	1.60	1.46	1.51	1.50	1.50
1	9-22-81	None	1.74	1.83	1.94	2.03	2.11	2.21	2.14	2.11
		A	1.74	1.77	1.83	1.87	1.92	2.03	1.98	1.94
		B	1.77	1.57	1.51	1.46	1.43	1.55	1.54	1.48
1	11-2-81	None	1.86	1.91	2.04	2.10	2.12	2.10	2.21	2.08
		A	2.19	2.10	2.21	2.24	2.22	2.16	2.29	2.18
		B	3.35	3.06	3.06	2.94	2.67	2.39	2.65	2.62
2	9-9-81	None	2.52	2.53	2.61	2.72	2.74	2.78	2.88	2.68
		A	2.50	2.41	2.45	2.45	2.43	2.46	2.56	2.40
		B	2.42	2.02	2.01	1.85	1.78	1.78	1.87	1.77
2	9-22-81	None	2.57	2.71	2.80	2.79	2.71	2.75	2.77	2.65
		A	2.58	2.62	2.63	2.55	2.44	2.46	2.49	2.37
		B	2.62	2.33	2.13	1.95	1.79	1.82	1.88	1.75
2	11-2-81	None	2.88	2.97	2.96	2.92	3.00	3.19	3.23	3.07
		A	3.28	3.27	3.20	3.09	3.11	3.24	3.37	3.19
		B	4.95	4.75	4.32	3.85	3.60	3.38	4.07	3.80

Table 2 TEMPERATURE CORRECTION SITE DEFLECTIONS Sensor 1

Site	Date Tested	Correction	Deflection (.001 in.) Vs. Time of Day							
			8:00	9:00	10:00	11:00	12:00	1:00	2:00	3:00
3	10-9-81	None	.52	.53	.55	.58	.60	.62	.62	
		A	.55	.56	.58	.59	.60	.61	.61	
		B	.71	.70	.69	.64	.58	.58	.57	
3	10-30-81	None	.51	.52	.52	.54	.55	.54	.55	.54
		A	.56	.57	.56	.59	.59	.58	.59	.58
		B	.82	.82	.78	.81	.77	.73	.80	.76
3	11-20-81	None	.45	.47	.49	.49	.50	.53	.54	.54
		A	.52	.56	.59	.59	.56	.57	.56	.59
		B	.81	.86	.92	.92	.82	.74	.65	.83
4	10-9-81	None	.99	1.02	1.01	.94	1.06	1.01	.95	
		A	1.06	1.08	1.03	.93	1.05	1.01	.93	
		B	1.42	1.35	1.13	.90	1.00	.99	.84	
4	10-30-81	None	1.13	1.00	.96	1.04	1.00	.95	1.07	1.00
		A	1.24	1.08	1.02	1.12	1.07	1.01	1.15	1.07
		B	1.79	1.46	1.27	1.48	1.40	1.29	1.56	1.42
4	11-20-81	None	.99	1.02	.98	.94	1.12	1.03	1.08	1.10
		A	1.18	1.22	1.17	1.11	1.22	1.08	1.11	1.16
		B	1.82	1.92	1.84	1.73	1.72	1.30	1.23	1.45

Table 3 TEMPERATURE CORRECTION SITE STATISTICS Sensor 1

Site	Date Tested	Correction	Mean (.001 in.)	Standard Deviation (.001 in.)	Coefficient of Variation (%)
1	9-9-81	None A B	2.07 1.92 1.55	.179 .106 .066	8.7 5.5 4.2
1	9-22-81	None A B	2.01 1.89 1.54	.164 .101 .105	8.1 5.4 6.8
1	11-2-81	None A B	2.05 2.20 2.84	.115 .056 .312	5.6 2.6 11.0
2	9-9-81	None A B	2.68 2.46 1.94	.124 .052 .219	4.6 2.1 11.3
2	9-22-81	None A B	2.72 2.52 2.03	.078 .093 .031	2.9 3.7 15.1
2	11-2-81	None A B	3.03 3.22 4.09	.126 .092 .550	4.2 2.9 1.3
3	10-9-81	None A B	.57 .59 .64	.042 .024 .062	7.2 4.0 9.7
3	10-30-81	None A B	.53 .58 .79	.015 .013 .032	2.8 2.2 4.1
3	11-20-81	None A B	.50 .57 .82	.033 .024 .090	6.6 4.2 11.0
4	10-9-81	None A B	1.00 1.01 1.09	.042 .061 .222	4.2 6.0 2.0
4	10-30-81	None A B	1.02 1.10 1.46	.059 .075 .165	5.8 6.8 11.3
4	11-20-81	None A B	1.03 1.16 1.63	.063 .052 .263	6.1 4.5 16.2

Table 4 TEMPERATURE CORRECTION SITE 1 Sensors 2, 3, 4 and 5

Site No.	Date Tested	Time of Day	Deflection (.001 in.) Vs. Sensor No.			
			2	3	4	5
1	9-9-81	8:00	1.44	1.02	0.72	0.48
		9:00	1.56	1.05	0.73	0.48
		10:00	1.59	1.03	0.71	0.47
		11:00	1.67	1.07	0.72	0.47
		12:00	1.63	1.02	0.69	0.46
		1:00	1.70	1.06	0.70	0.46
		2:00	1.65	1.01	0.68	0.45
		3:00	1.66	1.01	0.68	0.45
1	9-22-81	8:00	1.46	1.03	0.70	0.48
		9:00	1.51	1.03	0.69	0.48
		10:00	1.54	1.02	0.68	0.47
		11:00	1.62	1.05	0.69	0.47
		12:00	1.64	1.02	0.66	0.45
		1:00	1.69	1.05	0.67	0.46
		2:00	1.62	1.00	0.65	0.44
		3:00	1.59	1.00	0.64	0.45
1	11-2-81	8:00	1.59	1.20	0.87	0.59
		9:00	1.64	1.20	0.86	0.58
		10:00	1.74	1.26	0.88	0.60
		11:00	1.80	1.30	0.91	0.61
		12:00	1.80	1.28	0.88	0.59
		1:00	1.78	1.24	0.85	0.56
		2:00	1.86	1.31	0.90	0.60
		3:00	1.73	1.23	0.85	0.56

Table 5 TEMPERATURE CORRECTION SITE 2 SENSORS 2, 3, 4 and 5

Site No.	Date Tested	Time of Day	Deflection (.001 in.) Vs. Sensor No.			
			2	3	4	5
2	9-9-81	8:00	1.75	1.00	0.66	0.45
		9:00	1.72	0.96	0.65	0.44
		10:00	1.74	0.94	0.64	0.44
		11:00	1.74	0.96	0.64	0.45
		12:00	1.74	0.94	0.64	0.45
		1:00	1.75	0.95	0.65	0.45
		2:00	1.80	0.96	0.65	0.45
		3:00	1.74	0.95	0.64	0.44
2	9-22-81	8:00	1.81	1.03	0.64	0.44
		9:00	1.85	1.02	0.64	0.45
		10:00	1.87	1.02	0.64	0.45
		11:00	1.81	0.98	0.62	0.45
		12:00	1.74	0.94	0.60	0.43
		1:00	1.75	0.96	0.62	0.45
		2:00	1.76	0.95	0.60	0.44
		3:00	1.70	0.95	0.61	0.44
2	11-2-81	8:00	2.04	1.24	0.78	0.52
		9:00	2.10	1.23	0.77	0.51
		10:00	2.06	1.20	0.75	0.50
		11:00	2.03	1.16	0.72	0.49
		12:00	2.15	1.19	0.74	0.50
		1:00	2.23	1.24	0.76	0.51
		2:00	2.29	1.30	0.80	0.53
		3:00	2.14	1.21	0.76	0.51

Table 6 TEMPERATURE CORRECTION SITE 3 Sensors 2, 3, 4 and 5

Site No.	Date Tested	Time of Day	Deflection (.001 in.) Vs. Sensor No.			
			2	3	4	5
3	10-9-81	8:00	0.44	0.31	0.23	0.16
		9:00	0.45	0.30	0.22	0.15
		10:00	0.46	0.30	0.22	0.15
		11:00	0.47	0.31	0.22	0.16
		12:00	0.48	0.31	0.19	0.16
		1:00	0.49	0.31	0.19	0.16
		2:00	0.49	0.31	0.19	0.16
3	10-30-81	8:00	0.43	0.32	0.24	0.17
		9:00	0.45	0.33	0.24	0.17
		10:00	0.44	0.32	0.24	0.17
		11:00	0.46	0.33	0.24	0.17
		12:00	0.47	0.34	0.25	0.17
		1:00	0.45	0.32	0.24	0.17
		2:00	0.46	0.33	0.24	0.17
		3:00	0.46	0.33	0.24	0.17
3	11-20-81	8:00	0.40	0.30	0.24	0.17
		9:00	0.42	0.31	0.24	0.17
		10:00	0.43	0.32	0.25	0.18
		11:00	0.43	0.31	0.25	0.17
		12:00	0.44	0.32	0.25	0.17
		1:00	0.46	0.33	0.25	0.18
		2:00	0.47	0.33	0.25	0.17
		3:00	0.46	0.33	0.25	0.18

Table 7 TEMPERATURE CORRECTION SITE 4 Sensors 2, 3, 4 and 5

Site No.	Date Tested	Time of Day	Deflection (.001 in.) Vs. Sensor No.			
			2	3	4	5
4	10-9-81	8:00	0.62	0.27	0.14	0.08
		9:00	0.66	0.30	0.16	0.09
		10:00	0.61	0.26	0.14	0.08
		11:00	0.57	0.25	0.14	0.08
		12:00	0.62	0.25	0.14	0.09
		1:00	0.58	0.25	0.13	0.09
		2:00	0.53	0.23	0.13	0.08
4	10-30-81	8:00	0.74	0.35	0.17	0.09
		9:00	0.66	0.33	0.16	0.09
		10:00	0.64	0.30	0.16	0.09
		11:00	0.66	0.32	0.16	0.09
		12:00	0.64	0.32	0.16	0.09
		1:00	0.61	0.29	0.15	0.09
		2:00	0.68	0.33	0.17	0.09
		3:00	0.66	0.31	0.16	0.09
4	11-20-81	8:00	0.67	0.32	0.18	0.10
		9:00	0.68	0.32	0.18	0.10
		10:00	0.67	0.32	0.18	0.09
		11:00	0.63	0.29	0.17	0.09
		12:00	0.73	0.33	0.18	0.10
		1:00	0.67	0.31	0.17	0.09
		2:00	0.69	0.30	0.16	0.10
		3:00	0.70	0.31	0.16	0.09

Table 8 TEMPERATURE CORRECTION SITE DEFLECTIONS Sensor 2

Site	Date Tested	Correction	Deflection (.001 in.) Vs. Time of Day							
			8:00	9:00	10:00	11:00	12:00	1:00	2:00	3:00
1	9-9-81	None	1.44	1.56	1.59	1.67	1.63	1.70	1.65	1.66
		A	1.42	1.51	1.50	1.56	1.48	1.52	1.49	1.51
		B	1.35	1.34	1.24	1.25	1.12	1.14	1.13	1.13
1	9-22-81	None	1.46	1.51	1.54	1.62	1.64	1.69	1.62	1.59
		A	1.46	1.46	1.46	1.50	1.49	1.55	1.50	1.46
		B	1.49	1.30	1.20	1.17	1.11	1.18	1.17	1.12
1	11-2-81	None	1.59	1.64	1.74	1.80	1.80	1.78	1.86	1.73
		A	1.87	1.80	1.89	1.92	1.88	1.83	1.93	1.81
		B	2.86	2.62	2.61	2.52	2.27	2.03	2.23	2.18
2	9-9-81	None	1.75	1.72	1.74	1.74	1.74	1.75	1.80	1.74
		A	1.73	1.64	1.63	1.57	1.55	1.55	1.60	1.56
		B	1.68	1.38	1.34	1.18	1.13	1.12	1.17	1.15
2	9-22-81	None	1.81	1.85	1.87	1.81	1.74	1.75	1.76	1.70
		A	1.82	1.79	1.76	1.65	1.56	1.56	1.58	1.52
		B	1.85	1.60	1.42	1.27	1.15	1.16	1.20	1.12
2	11-2-81	None	2.04	2.10	2.06	2.03	2.15	2.23	2.29	2.14
		A	2.33	2.31	2.23	2.15	2.23	2.26	2.39	2.23
		B	3.51	3.35	3.00	2.68	2.58	2.36	2.89	2.65

Table 8 (Cont'd) TEMPERATURE CORRECTION SITE DEFLECTIONS - Sensor 2

Site	Date Tested	Correction	Deflection (.001 in.) Vs. Time of Day							
			8:00	9:00	10:00	11:00	12:00	1:00	2:00	3:00
3	10-9-81	None	0.44	0.45	0.46	0.47	0.48	0.49	0.49	
		A	0.47	0.48	0.48	0.48	0.48	0.48	0.48	
		B	0.60	0.59	0.58	0.52	0.46	0.46	0.45	
3	10-30-81	None	0.43	0.45	0.44	0.46	0.47	0.45	0.46	0.46
		A	0.48	0.49	0.48	0.50	0.50	0.49	0.49	0.49
		B	0.69	0.71	0.66	0.69	0.66	0.61	0.67	0.64
3	11-20-81	None	0.40	0.42	0.43	0.43	0.44	0.46	0.47	0.46
		A	0.47	0.50	0.52	0.52	0.49	0.49	0.49	0.50
		B	0.72	0.77	0.81	0.81	0.72	0.64	0.57	0.70
4	10-9-81	None	0.62	0.66	0.61	0.57	0.62	0.58	0.53	
		A	0.67	0.70	0.62	0.56	0.61	0.58	0.52	
		B	0.88	0.87	0.68	0.55	0.58	0.57	0.47	
4	10-30-81	None	0.74	0.66	0.64	0.66	0.64	0.61	0.68	0.66
		A	0.81	0.71	0.68	0.71	0.68	0.65	0.73	0.71
		B	1.17	0.96	0.84	0.94	0.90	0.83	0.99	0.94
4	11-20-81	None	0.67	0.68	0.67	0.63	0.73	0.67	0.69	0.70
		A	0.80	0.81	0.80	0.75	0.80	0.70	0.71	0.74
		B	1.23	1.28	1.26	1.16	1.12	0.84	0.79	0.92

Table 9 TEMPERATURE CORRECTION SITE STATISTICS Sensor 2

Site	Date Tested	Correction	Mean (.001 in.)	Standard Deviation (.001 in.)	Coefficient Variation (%)
1	9-9-81	None A B	1.61 1.50 1.21	.083 .040 .096	5.1 2.7 7.9
1	9-22-81	None A B	1.58 1.49 1.22	.075 .032 .124	4.6 2.2 10.2
1	11-22-81	None A B	1.74 1.87 2.41	.089 .049 .028	5.1 2.6 11.5
2	9-9-81	None A B	1.75 1.60 1.27	.023 .062 .192	1.3 3.9 15.2
2	9-22-81	None A B	1.79 1.66 1.35	.058 .119 .261	3.3 7.1 19.3
2	11-22-81	None A B	2.13 2.27 2.88	.093 .074 .394	4.3 3.3 13.7
3	10-9-81	None A B	.47 .48 .52	.020 .004 .067	4.2 .8 12.9
3	10-30-81	None A B	.45 .49 .67	.013 .008 .032	2.85 1.5 4.7
3	11-20-81	None A B	.50 .50 .72	.017 .017 .083	3.3 3.3 11.5
4	10-9-81	None A B	.60 .61 .66	.042 .062 .161	7.0 10.2 24.4
4	10-30-81	None A B	.66 .69 .95	.038 .049 .106	5.8 7.0 11.2
4	11-20-81	None A B	.68 .76 1.08	.029 .044 .196	4.2 5.8 18.2

Table 10 - PAVEMENT TEMPERATURES OF TEMPERATURE CORRECTION SITES 1 AND 2

Site	Date Tested	Location of Temperature	Pavement Temperature in °F Vs. Time of Day *							
			8:00	9:00	10:00	11:00	12:00	1:00	2:00	3:00
1	9-9-81	Surface Middle Bottom	75	85	95	100	110	115	110 109-96 102-88	105 110-96 103-88
1	9-22-81	Surface Middle Bottom	70 69-67 70-69	85 77-75 76-74	95 84-81 78-79	105 92-88 84-81	110 99-92 90-84	105 104-95 99-86	100 106-91 98-83	100 105-94 98-86
1	11-2-81	Surface Middle Bottom	45 51-43 50-45	55 65-49 52-47	60 60-49 56-48	65 63-55 58-51	70 69-58 63-54	75 72-64 65-60	70 73-61 71-57	65 71-60 67-57
2	9-9-81	Surface Middle Bottom	75	90	95	110	115	115	110 115-102 106-96	105 114-100 103-96
2	9-22-81	Surface Middle Bottom	70 73-68 70-68	85 83-75 76-74	95 93-84 83-81	105 100- 88 90-92	110 107-98 95-92	110 110-102 99-98	105 110-99 102-94	105 108-101 101-96
2	11-2-81	Surface Middle Bottom	50 49-44 49-44	55 54-48 52-47	60 63-52 57-50	65 65-57 59-54	70 72-62 64-58	75 75-64 66-62	65 65-61 68-58	65 65-62 66-59

* Measured Temperature - Predicted Temperature

Table 11 SEASONAL VARIATION SITE DEFLECTIONS (.001 inches)

Site	Statistic	Approximate Date of Testing *						Ratio of High to Low
		April 14	May 12	June 9	July 14	August 26	October 8	
1	Average	3.12	3.12	3.18	2.72	2.77	2.81	1.17
	Std. Dev.	.29	.24	.29	.22	.26	.30	
2	Average	.59	.61	.67	.63	.57	.58	1.18
	Std. Dev.	.09	.09	.09	.09	.07	.07	
3	Average	1.97	1.81	1.12	1.17	1.32	1.20	1.76
	Std. Dev.	.71	.30	.17	.18	.26	.20	
4	Average	.92	1.05	.99	.89	.89	.90	1.18
	Std. Dev.	.05	.06	.05	.04	.04	.05	
5	Average	1.97	2.18	2.21	2.35	2.12	1.83	1.19
	Std. Dev.	.24	.26	.31	.36	.33	.20	
6	Average		2.49	2.10	1.97	1.91	1.91	1.30
	Std. Dev.		.19	.14	.17	.15	.15	

* Site tested over three days. Middle date given.

Table 12 FIVE SENSOR SITE DEFL Y

Site	Test Number	Deflections (.001 in.) vs. Sensor Number				
		1	2	3	4	5
1	1	.94	.59	.33	.23	.18
	2	1.07	.65	.35	.21	.18
	3	.94	.61	.35	.21	.18
	4	.98	.63	.37	.26	.19
	5	.91	.60	.36	.26	.20
	6	1.08	.70	.41	.29	.22
	7	1.08	.70	.41	.28	.21
	8	1.09	.70	.40	.28	.21
	9	1.06	.62	.34	.24	.19
	10	1.05	.69	.41	.29	.22
	Ave.	1.02	.65	.37	.26	.20
2	1	1.49	1.03	.64	.45	.32
	2	1.46	1.03	.64	.46	.32
	3	1.46	1.03	.65	.46	.33
	4	1.43	.99	.61	.43	.31
	5	1.33	.92	.59	.42	.30
	6	1.36	.98	.62	.45	.32
	7	1.43	.97	.57	.39	.27
	8	1.53	1.02	.61	.43	.31
	9	1.23	.83	.51	.36	.26
	10	1.36	.98	.65	.48	.35
	Ave.	1.41	.98	.61	.39	.31

Table 13 FIVE SENSOR SITE DEFLECTIONS

Site	Test Number	Deflections (.001 in.) vs. Sensor Number				
		1	2	3	4	5
3	1	1.13	.80	.51	.39	.30
	2	1.03	.74	.49	.39	.31
	3	1.00	.71	.48	.37	.31
	4	.99	.70	.48	.38	.31
	5	.97	.71	.49	.40	.33
	6	.99	.72	.50	.41	.33
	7	1.16	.83	.57	.44	.36
	8	1.16	.83	.56	.44	.35
	9	1.16	.85	.57	.46	.37
	10	1.34	.96	.63	.42	.38
	Ave.	1.09	.78	.53	.41	.34
4	1	1.08	.69	.36	.21	.12
	2	1.26	.77	.39	.22	.12
	3	.94	.59	.29	.18	.10
	4	1.14	.62	.29	.17	.10
	5	.86	.55	.28	.17	.10
	6	.92	.60	.32	.19	.12
	7	1.19	.80	.42	.24	.14
	8	1.34	.86	.43	.23	.13
	9	1.33	.80	.39	.20	.10
	10	1.07	.73	.42	.26	.16
	Ave.	1.11	.70	.36	.21	.12

Table 14 FIVE SENSOR SITE DEFLECTIONS

Site	Test Number	Deflections (.001 in.) vs. Sensor Number				
		1	2	3	4	5
6	1	1.02	.85	.63	.56	.36
	2	1.14	.94	.71	.63	.42
	3	1.09	.87	.66	.59	.38
	4	.94	.75	.57	.52	.35
	5	.79	.65	.49	.45	.30
	6	.74	.59	.44	.41	.28
	7	.91	.66	.44	.40	.27
	8	.85	.61	.39	.36	.24
	9	.83	.57	.37	.34	.23
	10	.82	.55	.33	.29	.19
	Ave.	.91	.70	.50	.48	.30
7	1	1.33	.95	.57	.38	.26
	2	1.42	1.07	.65	.44	.30
	3	1.24	.85	.44	.27	.17
	4	1.22	.84	.45	.29	.19
	5	1.33	.95	.53	.35	.23
	6	1.36	.93	.50	.32	.21
	7	1.39	.97	.54	.35	.24
	8	1.19	.83	.47	.32	.22
	9	1.21	.89	.53	.37	.25
	10	1.25	.84	.46	.32	.22
	Ave.	1.29	.91	.51	.34	.23

Table 15 FIVE SENSOR SITE DEFLECTIONS

Site	Test Number	Deflections (.001 in.) vs. Sensor Number				
		1	2	3	4	5
8	1	.85	.56	.36	.28	.23
	2	.86	.59	.36	.23	.21
	3	.87	.60	.38	.29	.23
	4	1.11	.69	.41	.31	.25
	5	1.03	.64	.39	.26	.23
	6	1.07	.69	.40	.30	.23
	7	.94	.60	.36	.28	.22
	8	1.03	.66	.36	.25	.22
	9	1.10	.68	.36	.27	.21
	10	1.03	.66	.36	.26	.20
	Ave.	.99	.63	.37	.27	.22
9	1	.81	.73	.57	.45	.33
	2	.84	.75	.57	.44	.31
	3	.85	.76	.58	.44	.31
	4	.77	.68	.54	.42	.31
	5	.73	.64	.48	.36	.25
	6	.76	.64	.47	.34	.23
	7	.82	.68	.49	.35	.25
	8	.89	.74	.52	.31	.25
	9	.97	.81	.56	.39	.25
	10	1.09	.86	.56	.37	.24
	Ave.	.85	.73	.53	.39	.27

Table 16 FIVE SENSOR SITE DEFLECTIONS

Site	Test Number	Deflections (.001 in.) vs. Sensor Number				
		1	2	3	4	5
10	1	1.03	.70	.45	.33	.24
	2	1.03	.72	.47	.35	.25
	3	.97	.69	.43	.31	.22
	4	1.01	.71	.44	.32	.23
	5	1.08	.76	.48	.35	.26
	6	1.15	.79	.50	.36	.27
	7	1.01	.71	.45	.34	.25
	8	1.03	.72	.45	.33	.24
	9	1.04	.74	.46	.33	.25
	10	1.10	.78	.46	.33	.25
	Ave.	1.05	.73	.46	.34	.25
12	1	2.56	1.77	1.05	.69	.51
	2	3.12	2.21	1.29	.81	.61
	3	3.46	2.36	1.35	.88	.69
	4	3.16	2.11	1.26	.87	.70
	5	2.90	1.98	1.21	.88	.73
	6	2.99	2.07	1.23	.86	.69
	7	3.30	2.09	1.12	.73	.60
	8	3.47	2.21	1.20	.81	.64
	9	3.05	2.06	1.22	.84	.63
	10	2.50	1.73	1.10	.80	.65
	Ave.	3.05	2.06	1.20	.82	.65

Table 17 FIVE SENSOR SITE DEFLECTIONS

Site	Test Number	Deflections (.001 in.) vs. Sensor Number				
		1	2	3	4	5
15	1	1.38	1.04	.71	.52	.40
	2	1.28	.99	.68	.51	.40
	3	1.28	1.02	.71	.54	.42
	4	1.22	.98	.70	.52	.40
	5	1.42	1.13	.80	.52	.46
	6	1.50	1.16	.77	.56	.42
	7	1.44	1.13	.76	.49	.42
	8	1.57	1.24	.86	.64	.48
	9	1.48	1.23	.89	.62	.53
	10	1.54	1.24	.90	.69	.53
	Ave.	1.41	1.12	.78	.56	.45
17	1	1.64	1.06	.56	.35	.25
	2	1.59	1.05	.55	.37	.27
	3	1.67	1.14	.64	.43	.30
	4	1.66	1.19	.67	.45	.32
	5	1.45	1.01	.57	.39	.38
	6	1.39	.99	.54	.36	.26
	7	1.24	.86	.49	.34	.25
	8	1.34	.93	.51	.34	.25
	9	1.36	.87	.47	.32	.24
	10	1.45	1.00	.54	.35	.26
	Ave.	1.48	1.01	.55	.37	.27

Table 18 FIVE SENSOR SITE DEFLECTIONS

Site	Test Number	Deflection (.001 in.) vs. Sensor Number				
		1	2	3	4	5
18	1	2.51	1.84	1.11	.70	.52
	2	2.51	1.89	1.13	.73	.54
	3	1.98	1.46	.88	.58	.44
	4	2.11	1.52	.91	.55	.38
	5	2.02	1.26	.62	.35	.26
	6	2.12	1.39	.60	.29	.19
	7	1.97	1.21	.47	.19	.12
	8	2.07	1.37	.60	.27	.16
	9	1.84	1.28	.58	.23	.10
	10	1.83	1.29	.64	.28	.11
	Ave.	2.10	1.45	.65	.42	.28
19	1	2.17	1.50	.70	.35	.18
	2	2.14	1.51	.66	.31	.18
	3	2.00	1.42	.68	.32	.19
	4	1.83	1.36	.68	.31	.17
	5	1.63	1.15	.57	.27	.13
	6	1.50	1.11	.59	.30	.14
	7	1.81	1.32	.66	.32	.16
	8	1.77	1.29	.64	.30	.15
	9	1.44	1.08	.56	.27	.15
	10	1.24	.99	.59	.33	.18
	Ave.	1.78	1.27	.63	.31	.16

Table 19 FIVE SENSOR SITE DEFLECTIONS

Site	Test Number	Deflection (.001 in.) vs. Sensor Number 1	2	3	4	5
20	1	1.02	.67	.42	.31	.24
	2	1.08	.72	.45	.29	.25
	3	1.16	.72	.37	.21	.15
	4	1.06	.65	.33	.21	.14
	5	1.11	.70	.37	.25	.17
	6	1.11	.68	.36	.24	.17
	7	.92	.60	.34	.24	.17
	8	.98	.62	.35	.24	.16
	9	.84	.55	.33	.23	.16
	10	.99	.62	.35	.24	.17
	Ave.	1.03	.65	.37	.25	.18
21	1	1.25	.90	.49	.28	.17
	2	2.08	1.44	.63	.30	.15
	3	1.66	1.32	.84	.53	.33
	4	1.80	1.49	.98	.62	.37
	5	1.51	1.19	.70	.39	.21
	6	1.61	1.28	.74	.37	.19
	7	1.82	1.40	.81	.48	.28
	8	1.96	1.59	.97	.56	.31
	9	1.66	1.32	.75	.41	.22
	10	1.58	1.23	.73	.40	.22
	Ave.	1.69	1.32	.76	.43	.25

Date Tested 8-31-79

Table 20 FIVE SENSOR SITE 1 ANALYSIS LOCATION - WADSWORTH AT CHATFIELD AVE.

Test Number	Tentative CDOH Method of Analysis of Roadway Cond			Utah Method of Analysis of Roadway Condition
	Overall	Structure	Subgrade	
1	Good	Good	Good	Pavement weak - but not critical
2	Good	Good	Good	Pavement weak - but not critical
3	Good	Good	Good	Weak structure - pavement is cause
4	Good	Good	Good	Pavement weak - but not critical
5	Good	Good	Good	Weak structure - pavement is cause
6	Good	Good	Good	Pavement weak - but not critical
7	Good	Good	Good	Pavement weak - but not critical
8	Good	Good	Good	Pavement weak - but not critical
9	Good	Good	Good	Pavement weak - but not critical
10	Good	Good	Good	Pavement weak - but not critical
Ave.	Good	Good	Good	Pavement weak - but not critical

Date Tested 9-7-79

Table 21 FIVE SENSOR SITE 2 ANALYSIS   LOCATION - WADSWORTH BLVD. AT 108th

Test Number	Tentative CDOH Method of Analysis of Roadway Cond.			Utah Method of Analysis of Roadway Condition
	Overall	Structure	Subgrade	
1	Good	Poor	Poor	Weak Structure - Subgrade is cause
2	Good	Poor	Poor	Subgrade weak - Investigation recommended
3	Good	Poor	Poor	Subgrade weak - Investigation recommended
4	Good	Poor	Poor	Subgrade weak - Investigation recommended
5	Good	Good	Poor	Pavement and subgrade weak
6	Good	Good	Poor	Subgrade weak - Investigation recommended
7	Good	Poor	Poor	Subgrade weak - Investigation recommended
8	Good	Poor	Poor	Pavement and subgrade weak
9	Good	Good	Poor	Pavement and subgrade weak
10	Good	Good	Poor	Subgrade weak - Investigation recommended
Ave.	Good	Poor	Poor	Pavement and subgrade strong

Date Tested 9-7-79

Table 22 FIVE SENSOR SITE 3 ANALYSIS LOCATION - SERVICE ROAD AT I 225 and ILIFF

Test Number	Tentative CDOH Method of Analysis of Roadway Cond.			Utah Method of Analysis of Roadway Condition
	Overall	Structure	Subgrade	
1	Good	Good	Poor	No Comment
2	Good	Good	Good	Pavement and subgrade strong
3	Good	Good	Good	Pavement and subgrade strong
4	Good	Good	Good	Pavement and subgrade strong
5	Good	Good	Good	Weak structure - subgrade is cause
6	Good	Good	Good	Pavement and subgrade strong
7	Good	Good	Poor	No Comment
8	Good	Good	Poor	No Comment
9	Good	Good	Good	No Comment
10	Good	Good	Poor	Pavement and subgrade strong
Ave.	Good	Good	Good	Pavement and subgrade strong

Date Tested 9-27-79

Table 23 FIVE SENSOR SITE 4 ANALYSIS LOCATION - SOUTH OF AKRON

Test Number	Tentative CDOH Method of Analysis of Roadway Cond			Utah Method of Analysis of Roadway Condition
	Overall	Structure	Subgrade	
1	Good	Good	Poor	Pavement weak - but not critical
2	Good	Poor	Poor	Pavement and subgrade weak
3	Good	Good	Good	Pavement and subgrade weak
4	Good	Poor	Good	Weak structure - pavement is cause
5	Good	Good	Good	Pavement and subgrade weak
6	Good	Good	Good	Pavement and subgrade weak
7	Good	Poor	Poor	Pavement and subgrade weak
8	Good	Poor	Poor	Pavement and subgrade strong
9	Good	Poor	Poor	Pavement weak - but not critical
10	Good	Good	Poor	Subgrade weak - Investigation recommended
Ave.	Good	Good	Poor	Pavement weak - but not critical

Date Tested 9-27-79

Table 24 FIVE SENSOR SITE 6 ANALYSIS LOCATION - EAST OF WRAY

Test Number	Tentative CDOH Method of Analysis of Roadway Cond.			Utah Method of Analysis of Roadway Condition
	Overall	Structure	Subgrade	
1	Good	Good	Poor	Subgrade weak - Investigation recommended
2	Good	Good	Poor	Subgrade weak - Investigation recommended
3	Good	Good	Poor	Subgrade weak - Investigation recommended
4	Good	Good	Poor	Weak structure - Subgrade is cause
5	Good	Good	Good	Subgrade weak - Investigation recommended
6	Good	Good	Good	Subgrade weak - Investigation recommended
7	Good	Good	Good	Weak structure - Subgrade is cause
8	Good	Good	Good	Weak structure - Subgrade is cause
9	Good	Good	Good	Weak structure - Subgrade is cause
10	Good	Good	Good	No comment
Ave.	Good	Good	Good	Weak structure - subgrade is cause

Date Tested 10-15-79

Table 25 FIVE SENSOR SITE 7 ANALYSIS LOCATION - STATE HIGHWAY 83 - SOUTH OF FRANKTOWN MILESPOST 41.4

Test Number	Tentative CDOH Method of Analysis of Roadway Cond.			Utah Method of Analysis of Roadway Condition
	Overall	Structure	Subgrade	
1	Good	Poor	Poor	Subgrade weak - Investigation recommended
2	Good	Poor	Poor	Subgrade weak - Investigation recommended
3	Good	Poor	Poor	Pavement and subgrade weak
4	Good	Poor	Poor	Pavement and subgrade weak
5	Good	Poor	Poor	Subgrade weak - Investigation recommended
6	Good	Poor	Poor	Pavement and subgrade strong
7	Good	Poor	Poor	Pavement and subgrade strong
8	Good	Good	Poor	Pavement and subgrade weak
9	Good	Good	Poor	Weak structure - Subgrade is cause
10	Good	Poor	Poor	Pavement and subgrade weak
Ave.	Good	Poor	Poor	Pavement and subgrade weak

Date Tested 19-15-79

Table 26 FIVE SENSOR SITE 8 ANALYSIS LOCATION - STATE HIGHWAY 83 SOUTH OF FRANKTOWN MILESPOST 37.9

Test Number	Tentative CDOH Method of Analysis of Roadway Cond			Utah Method of Analysis of Roadway Condition
	Overall	Structure	Subgrade	
1	Good	Good	Good	Weak structure - Pavement is cause
2	Good	Good	Good	Pavement and subgrade strong
3	Good	Good	Good	Pavement and subgrade strong
4	Good	Good	Good	Weak structure - Pavement is cause
5	Good	Good	Good	Weak structure - Pavement is cause
6	Good	Good	Good	Weak structure - Pavement is cause
7	Good	Good	Good	Pavement and subgrade strong
8	Good	Good	Good	Weak structure - Pavement is cause
9	Good	Good	Good	Weak structure - Pavement is cause
10	Good	Good	Good	Weak structure - Pavement is cause
Ave.	Good	Good	Good	Pavement weak - But not critical

Date Tested 11-7-79

Table 27 FIVE SENSOR SITE 9 ANALYSIS LOCATION - 108th AT WADSWORTH

Test Number	Tentative CDOH Method of Analysis of Roadway Cond			Utah Method of Analysis of Roadway Condition
	Overall	Structure	Subgrade	
1	Good	Good	Poor	Weak structure - Subgrade is cause
2	Good	Good	Poor	Subgrade weak - Investigation recommended
3	Good	Good	Poor	Subgrade weak - Investigation recommended
4	Good	Good	Poor	Weak structure - Subgrade is cause
5	Good	Good	Poor	Weak structure - Subgrade is cause
6	Good	Good	Poor	Weak structure - Subgrade is cause
7	Good	Good	Poor	Weak structure - Subgrade is cause
8	Good	Good	Poor	Pavement and subgrade strong
9	Good	Good	Poor	Weak structure - Subgrade is cause
10	Good	Good	Poor	Weak structure - Subgrade is cause
Ave.	Good	Good	Poor	Subgrade weak - Investigation recommended

Date Tested 11-7-79

Table 28 FIVE SENSOR SITE 10 ANALYSIS LOCATION - SERVICE ROAD AT I 225 AND ILIFF

Test Number	Tentative CDOH Method of Analysis of Roadway Cond.			Utah Method of Analysis of Roadway Condition
	Overall	Structure	Subgrade	
1	Good	Good	Poor	No Comment
2	Good	Good	Poor	Weak structure - Subgrade is cause
3	Good	Good	Poor	Pavement and subgrade strong
4	Good	Good	Poor	No comment
5	Good	Good	Poor	No comment
6	Good	Good	Poor	Pavement and subgrade strong
7	Good	Good	Poor	No comment
8	Good	Good	Poor	No comment
9	Good	Good	Poor	No comment
10	Good	Good	Poor	No comment
Ave.	Good	Good	Poor	No comment

Date Tested 5-15-80

Table 29 FIVE SENSOR SITE 12 ANALYSIS LOCATION - STATE HIGHWAY 109 SOUTH OF PURGATORY RIVER

Test Number	Tentative CDOH Method of Analysis of Roadway Cond.			Utah Method of Analysis of Roadway Condition
	Overall	Structure	Subgrade	
1	Poor	Poor	Poor	No comment
2	Poor	Poor	Poor	No comment
3	Poor	Poor	Poor	No comment
4	Poor	Poor	Poor	No comment
5	Poor	Poor	Poor	Pavement and subgrade strong
6	Poor	Poor	Poor	Pavement and subgrade strong
7	Poor	Poor	Poor	No comment
8	Poor	Poor	Poor	No comment
9	Poor	Poor	Poor	No comment
10	Poor	Good	Poor	No comment
Ave.	Poor	Poor	Poor	No comment

Date Tested 5-15-80

Table 30 **FIVE SENSOR SITE 15 ANALYSIS LOCATION - STATE HIGHWAY 71 ORDWAY SOUTH MILEPOST 22.4**

Test Number	Tentative CDOH Method of Analysis of Roadway Cond.			Utah Method of Analysis of Roadway Condition
	Overall	Structure	Subgrade	
1	Good	Good	Poor	Weak structure - Subgrade is cause
2	Good	Good	Poor	Pavement and subgrade strong
3	Good	Good	Poor	Subgrade weak - Investigation recommended
4	Good	Good	Poor	Subgrade weak - Investigation recommended
5	Good	Good	Poor	No comment
6	Good	Good	Poor	Subgrade weak - Investigation recommended
7	Good	Good	Poor	No comment
8	Good	Good	Poor	Subgrade weak - Investigation recommended
9	Good	Good	Poor	Pavement and subgrade strong
10	Good	Good	Poor	Pavement weak - Investigation recommended
Ave.	Good	Good	Poor	No comment

Date Tested 8-12-80

Table 31 FIVE SENSOR SITE 17 ANALYSIS LOCATION - MASSADONA WEST MILEPOST 15.3

Test Number	Tentative CDOH Method of Analysis of Roadway Cond.			Utah Method of Analysis of Roadway Condition
	Overall	Structure	Subgrade	
1	Good	Poor	Poor	Weak structure - Pavement is cause
2	Good	Poor	Poor	Weak structure - Pavement is cause
3	Good	Poor	Poor	Pavement and subgrade weak
4	Good	Poor	Poor	Weak structure - subgrade is cause
5	Good	Poor	Poor	Pavement and subgrade strong
6	Good	Poor	Poor	Pavement and subgrade strong
7	Good	Good	Poor	Weak structure - Pavement is cause
8	Good	Poor	Poor	Weak structure - Pavement is cause
9	Good	Poor	Poor	Pavement weak - But not critical
10	Good	Poor	Poor	Pavement and subgrade strong
Ave.	Good	Poor	Poor	Pavement and subgrade strong

Date Tested 8-12-80

Table 32 FIVE SENSOR SITE 18 ANALYSIS LOCATION - WEST OF ELK SPRINGS MILEPOST 27.4

Test Number	Tentative CDOH Method of Analysis of Roadway Cond.			Utah Method of Analysis of Roadway Condition
	Overall	Structure	Subgrade	
1	Poor	Good	Poor	Weak structure - Subgrade is cause
2	Poor	Good	Poor	Weak structure - Subgrade is cause
3	Good	Poor	Poor	Pavement and subgrade strong
4	Good	Poor	Poor	Subgrade weak - Investigation recommended
5	Good	Poor	Poor	Pavement weak - But not critical
6	Good	Poor	Poor	Pavement weak - But not critical
7	Good	Poor	Poor	Pavement weak - But not critical
8	Good	Poor	Poor	Pavement weak - But not critical
9	Good	Poor	Poor	No comment
10	Good	Poor	Poor	Weak structure - Subgrade is cause
Ave.	Good	Poor	Poor	Pavement and subgrade strong

Date Tested 8-12-80

Table 33 FIVE SENSOR SITE 19 ANALYSIS LOCATION - WEST OF ELK SPRINGS MILEPOST 29.8

Test Number	Tentative CDOH Method of Analysis of Roadway Cond.			Utah Method of Analysis of Roadway Condition
	Overall	Structure	Subgrade	
1	Good	Poor	Poor	Weak structure - Subgrade is cause
2	Poor	Poor	Poor	Pavement weak - But not critical
3	Good	Poor	Poor	Pavement and subgrade strong
4	Good	Poor	Poor	Weak structure - Subgrade is cause
5	Good	Poor	Poor	Weak structure - Subgrade is cause
6	Good	Poor	Poor	Weak structure - Subgrade is cause
7	Good	Poor	Poor	Subgrade weak - Investigation recommended
8	Good	Poor	Poor	Subgrade weak - Investigation recommended
9	Good	Poor	Poor	Subgrade weak - Investigation recommended
10	Good	Good	Poor	Weak structure - Subgrade is cause
Ave.	Good	Poor	Poor	Subgrade weak - Investigation recommended

Date Tested 8-13-80

Table 34 FIVE SENSOR SITE 20 ANALYSIS LOCATION - NORTH OF HAMILTON MILEPOST 77.9

Test Number	Tentative CEOH Method of Analysis of Roadway Cond.			Utah Method of Analysis of Roadway Condition
	Overall	Structure	Subgrade	
1	Good	Good	Good	Pavement weak - But not critical
2	Good	Good	Good	Pavement weak - But not critical
3	Good	Poor	Poor	Pavement weak - But not critical
4	Good	Good	Good	Pavement weak - But not critical
5	Good	Good	Good	Pavement weak - But not critical
6	Good	Good	Good	Pavement weak - But not critical
7	Good	Good	Good	Pavement and subgrade weak
8	Good	Good	Good	Pavement and subgrade weak
9	Good	Good	Good	No comment
10	Good	Good	Good	Pavement and subgrade weak
Ave.	Good	Good	Good	Pavement weak - But not critical

Date Tested 8-14-82

Table 35 FIVE SENSOR SITE 21 ANALYSIS LOCATION - SOUTH OF LOMA ON STATE HIGHWAY 139 MILEPOST 0.5

Test Number	Tentative CDOH Method of Analysis of Roadway Cond.			Utah Method of Analysis of Roadway Condition
	Overall	Structure	Subgrade	
1	Good	Poor	Poor	Pavement and subgrade weak
2	Good	Poor	Poor	No comment
3	Good	Poor	Poor	Subgrade weak - Investigation recommended
4	Good	Poor	Poor	Weak structure - Subgrade is cause
5	Good	Poor	Poor	Weak structure - Subgrade is cause
6	Good	Poor	Poor	Subgrade weak - Investigation recommended
7	Good	Poor	Poor	Weak structure - Subgrade is cause
8	Good	Poor	Poor	Subgrade weak - Investigation recommended
9	Good	Poor	Poor	Subgrade weak - Investigation recommended
10	Good	Poor	Poor	Weak structure - Subgrade is cause
Ave.	Good	Poor	Poor	Subgrade weak - Investigation recommended

Table 36 FIVE SENSOR SITE COMPARISONS

Site	CDOH Method of Analysis for Subgrade	Utah Method of Analysis of Roadway Condition	Subgrade Soil Classification	Subgrade R-Value
1	Good	Pavement weak, but not critical	A-6(4)	53
2	Poor	Pavement and subgrade strong	A-6(7)	16
3	Good	Pavement and subgrade strong	A-6(6)	20
4	Poor	Pavement weak, but not critical	A-2-6(0)	81
7	Poor	Pavement and subgrade weak	A-1-b(0)	82
8	Good	Pavement weak, but not critical	A-7-6(12)	22
9	Poor	Subgrade weak - Investigation recommended	A-7-6(19)	21
10	Poor	No comment	A-2-4(0)	60
12	Poor	No comment	A-6(12)	23
15	Poor	No comment	A-7-6(19)	50
17	Poor	Pavement and subgrade strong	A-4(0)	45
18	Poor	Pavement and subgrade strong	A-6(20)	18
19	Poor	Subgrade weak - Investigation recommended	A-7-6(21)	26
20	Good	Pavement weak, but not critical	A-2-4(0)	26
21	Poor	Subgrade weak - Investigation recommended	A-6(12)	28

Appendix B
Excerpts from CDOH Design Manual on

1.Regional Factor

2.Asphalt Pavement Overlay Design

C. Environmental Conditions (Regional Factor)

A regional factor has been included in the design procedure to permit an adjustment in design due to variations in the climatic and other environmental conditions. The adjustment is made by modifying the structural number (SN) to reflect conditions that vary throughout the State.

The regional factor is determined by assigning values to the following categories. The summation of these assigned values will be the regional factor to be used for the project. Normally this factor will be supplied by the District personnel who are most familiar with local conditions.

REGIONAL FACTOR

Annual Precipitation	
Over 34"	1.00
24" - 34"	0.50
18" - 23"	0.00
14" = 17"	-0.25
Less than 14"	-0.50
Elevation	
Over 9500	1.50
8500-9500	1.00
6500-8500	0.50
Less than 6500	0.25
Drainage	
*Very poor	1.00
Poor	0.50
Fair	0.25
Good	-0.25

* High ground water table

Frost

** Frost boils in area	3.00
** Frost susceptible soil, frost penetration over 28"	1.00
Frost susceptible soil, frost penetration under 28"	0.25

** Moisture available when subject to frost action

Minimum of 0.50 R.F. should be used.

Other conditions that may influence the choice of regional factors are:

(1) Elevation of the grade line, expecially in swampy areas where the roadbed soils may be saturated for long time periods.

(2) Number of freezing and thawing cycles during the winter and early spring.

(3) Steep grades on sections carrying a large volume of heavy truck traffic. (Slow moving vehicles cause greater damage than fast moving vehicles.)

(4) Areas of concentrated turning and stopping movements, such as bus stops, etc.

Adjustments in the factor for these conditions can only be made on the basis of judgment.

Theoretically, conditions would require the use of different factors for various portions of a project; however, the design will normally be based on the highest regional factor that prevails for a substantial portion of the project. In extreme cases, two or more regional factors may be used.