COMMONWEALTH OF KENTUCKY
DEPARTMENT OF TRANSPORTATION
FRANKFORT, KENTUCKY 40601

Billy Paxton
SECRETARY

WENDELL H. FORD
GOVERNOR

July 19, 1974

H.3.17

MEMORANDUM TO: J. R. Harbison
State Highway Engineer
Chairman, Research Committee

SUBJECT: Research Report No. 396; "Temperature Distributions in Asphaltic Concrete Pavements;" KYP-69-17; HPR-PL-1(10), Part III.

In 1967 and '68, when we began new studies of bituminous concrete pavement performance and their responses to loads, it became evident that a method of estimating temperatures at depths in pavements was needed. Nearly a full year of continuous recordings had been made previously by the Asphalt Institute at their facilities at the University of Maryland. We undertook an analysis of the data and found that, if the surface temperature were known, a fairly accurate estimate of the temperature at any depth and at any time of day could be made if the previous 5-day air temperature history was considered -- more than 5 days of previous air temperatures did not improve the estimate significantly. Similar recordings were made later at Clarkson College in New York and at the University of Arizona. We resolved to analyze those data sets also if and when they could be made available to us. The analysis proceeded as other, ranking priorities would permit. The report submitted now is final, and the project is concluded.

These findings will benefit other studies here and elsewhere involving field evaluations of pavements. Road Rater tests, deflections, Dynaflect tests, etc., depend upon pavement temperature.

No specific implementation action is requested.

Respectfully submitted,

Jas. H. Havens
Director of Research

JHH:gd
Attachment
cc's: Research Committee

TECHNICAL REPORT STANDARD TITLE PAGE

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4. Title and Subtitle	5. Report Date
Temperature Distributions in Asphaltic Concrete Pavements	July 1974
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Division of Research Kentucky Bureau of Highways 533 South Limestone Lexington, Kentucky 40508	11. Contract or Grant No. KYP-69-17
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Study Title: Analysis of Pavement Temperatures

16. Abstract

The straight-line relationship between temperatures at a given depth and the surface temperatures combined with 5-day average air temperatures appears to be as valid for upper New York State and Arizona as it was for Maryland. The main differences were in the ranges and mean temperatures. Values given herein are for straight-line equations for all 24 hours and for the depths of 2, 4, 6, 8, 10, and 12 inches (5.1, 10.2, 15.2, 20.3, 25.4, and 30.5 cm). The original concept appears to be valid and may be used with confidence for estimating pavement temperatures at other latitudes and longitudes.

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Pavement Temperature Distribution Surface deflections Longitude, latitude, clock time, sun time	

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Research Report
396

TEMPERATURE DISTRIBUTIONS IN ASPHALTIC CONCRETE PAVEMENTS

KYP-69-17; HPR-PL-1(10), Part III

by

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Division of Research
Bureau of Highways
DEPARTMENT OF TRANSPORTATION
Commonwealth of Kentucky

July 1974

INTRODUCTION

Structural responses of bituminous concrete pavement systems vary greatly with temperature. Many investigators *(1, 2, 3)* have analyzed pavement temperatures for several purposes. Kallas *(1)*, Straub, et al. *(2)*, and Rumney and Jimenez *(3)* studied pavement temperatures for duration of temperature levels and for influences of solar radiation upon pavement temperatures. Kentucky developed a method *(4, 5)* whereby the temperature at depths could be estimated so that deflections measured at some pavement surface temperature could be adjusted to an equivalent deflection at a reference, or standard, mean pavement temperature. This method was simplified by the Asphalt Institute and incorporated in their manual on pavement rehabilitation *(6)*.

The method of estimating pavement temperatures at depths *(4, 5)* raised several questions:

1. What is the effect upon the accuracy of the temperature estimating system by such variables as altitude, latitude, longitude, and solar exposure?
2. Does the straight-line relationship developed using Kallas' *(1)* data (Maryland) hold true for data from other locations?
3. If other data sets are combined with the Maryland data, does the accuracy of the estimate increase, decrease, or remain the same?
4. Can graphs developed from the Maryland data set be used with confidence for other locations not having similar weather conditions?

Answers to the above questions required the acquisition and analysis of additional data sets. Professors Arthur Straub of Clarkson College in upper New York state and Rudolph Jimenez of the University of Arizona at Tucson supplied data sets for this analysis. Their cooperation is greatly appreciated. These two additional locations were thought to be sufficiently variant from the Maryland site so that questions of latitude, longitude, and altitude effects could be adequately investigated. This report is the result of analyses of the various data sets, both individually and combined.

ANALYSES AND RESULTS

The original analyses of the Maryland *(4, 5)* data set were completed for the hours of 0600 through 1900. The remaining hours have been analyzed to complete the entire 24-hour period. Both the 0- and 5-day average air temperature approaches were completed. Results are summarized in Table 1.

The New York and Arizona data sets were analyzed individually using the same computer program used for the Maryland data set. The analyses indicated that a straight-line relationship was equally valid for all data sets; however, the equations were not identical (see Table 1). The major differences between the data sets were in the ranges and mean temperatures. Inspection of the data and least-squares fits showed that, for a given hour, depth, and surface plus 5-day average air temperature history, there could be an apparent difference in temperatures of as much as 5 to 10 F (2.8 to 5.6 C) in the upper ranges (see Figure 1). Closer inspection showed that, when the equation was solved for temperatures within the temperature range for the respective sites, the discrepancies were minimal and generally within the limits of scatter of the Maryland data set.

The scatter (standard error of estimate) for the New York and Arizona data sets was generally less than the scatter for the Maryland data for corresponding depths. However, the number of observations were considerably less. Figure 2 shows the results for 1300 hours and 4-inch (10.2-cm) depth. A slight rotation and horizontal shift appears in the New York and Arizona data compared to the Maryland data.

From the standpoint of longitudes, the New York site was eight clock minutes earlier or ahead of the Maryland site. However, the Arizona site was 16 clock minutes later or behind the equivalent Maryland clock time. To adjust for these longitudinal effects, New York and Arizona clock times were determined for the appropriate Maryland sun times. Interpolated pavement temperatures for those adjusted clock times were plotted. Figure 3 shows the same data as in Figure 2 but adjusted for longitude. A threefold net effect of the longitudinal adjustment could be noted:

1. The rotational shifts in the fitted straight line were less.
2. The horizontal shifts between the data sets were less.
3. Longitudinal adjustments for depths from the surface down to the 2-inch (5.1-cm) depth are very slight and are likely to be unnecessary. Longitudinal adjustments appear to begin to be effective for depths equal to and greater than 4 inches (10.2 cm).

The net result of adjustments for longitude is a closer grouping of the data which then fit within the outer limits of the Maryland data. The increased number of observations within the same limits has the statistical result of a reduced standard error of estimate and an increased correlation coefficient.

The New York and Arizona pavement temperature data had been analyzed and correlated with recorded solar radiation data *(2, 3)*. The question, "Could the scatter of pavement temperature data be reduced if the data were analyzed on the basis of daytime exposure to solar radiation?" was investigated. Analyses were made for sunrise, midmorning, midday, midafternoon, and sunset. After clock times for these five points in time were determined for each day, pavement temperatures were interpolated, recorded, plotted, and analyzed. The results are summarized in Table 2. The procedure is valid, and the scatter reduced for sunrise, midmorning, and sunset but increased for midday and midafternoon. The wider variations at midday and midafternoon appear to be caused by summer afternoon showers and variable cloud cover. While this last investigation was of academic interest and needed to be investigated, the system is very awkward to use, does not provide better accuracy, is not recommended for general use; but it does lend credence to the original system *(4, 5)*.

DISCUSSION AND IMPLEMENTATION

Air temperature history appears to account for differences in latitude and altitude. Adjustments can be made for differences in longitude by interpolating between hourly graphs, which can be prepared from data given in Table 1. If the purpose of estimating pavement temperatures is to determine the magnitude of the asphaltic tensile strain, adjustments may well be worth the effort. If the objective is to adjust deflection data *(4, 5, 6)*, such refinements may not be justified. The Asphalt Institute *(6)* has proposed the use of one graph for estimating temperatures at various depths in order to calculate an average pavement temperature which can be used to adjust measured deflections to equivalent deflections at a "standard" temperature. The use of one temperature distribution graph will produce greater discrepancies than those caused by not adjusting for longitude. Furthermore, the choice of adjustment curves for deflection measurements will have a more pronounced effect than making no adjustment for longitude or exposure to solar radiation. Therefore, the set of equations based upon Maryland data may be used with confidence for other latitudes and longitudes.

SUMMARY

1. The addition of a 5-day average air temperature history to the surface temperature results in a straight-line correlation with temperature at a given depth. This relationship appears to be equally valid for data sets recorded in upper New York state, Maryland, and Arizona.

2. The equations originally developed from the Maryland data set appear to be reasonably accurate for other locations.

3. The effects of changes in altitude and latitude are accounted for in the air temperature history. The net result is a shift up or down the temperature scale.

4. The second factor affecting the accuracy is longitude.

5. The data from Maryland, New York, and Arizona combined into one data set resulted in slightly more scatter than the Maryland set alone.

6. Adjusting the New York and Arizona data to equivalent Maryland times reduced the scatter and slightly improved the accuracy.

7. Analyzing all data sets in terms of daytime exposure to solar radiation also resulted in a straight-line correlation between surface temperature plus air temperature history and temperature at a given depth. The accuracy was improved over the Maryland graphs for sunrise, midmorning, and sunset but worsened for the midday and midafternoon times.

8. The analysis of the data on the basis of daytime exposure to solar radiation was a nice academic exercise which validated the method of analysis used for the Maryland graphs but is too cumbersome to use as a practical method.

9. The Maryland set of graphs are recommended for use in other latitudes and longitudes. More accurate results may be obtained if the clock time at any site is adjusted to a longitude within that time zone that is equivalent to the College Park, Maryland, longitude of 76° 56' in the Eastern Standard Time zone.

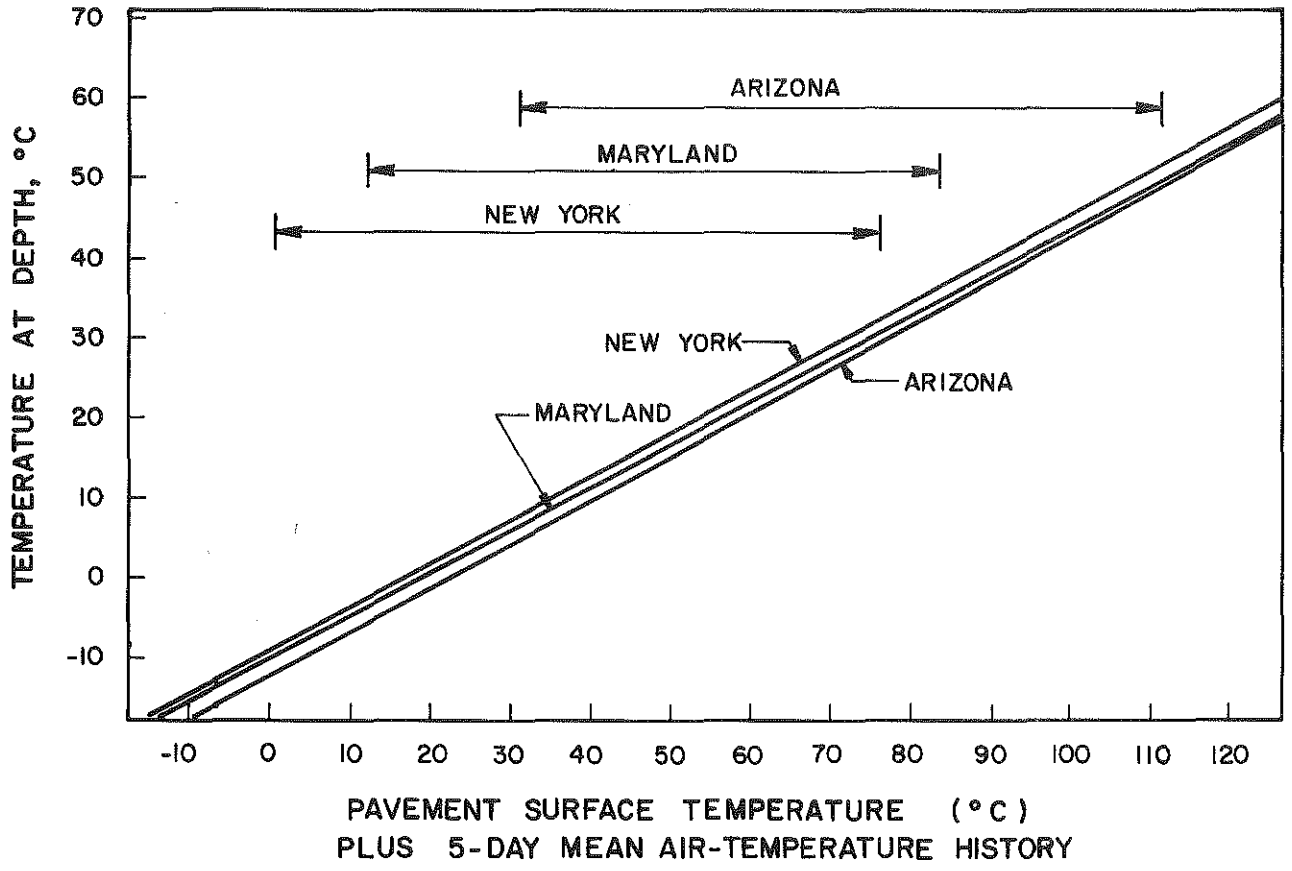

Figure 1. Temperature at 2-inch (51-mm) Depth at 1100 Hours.

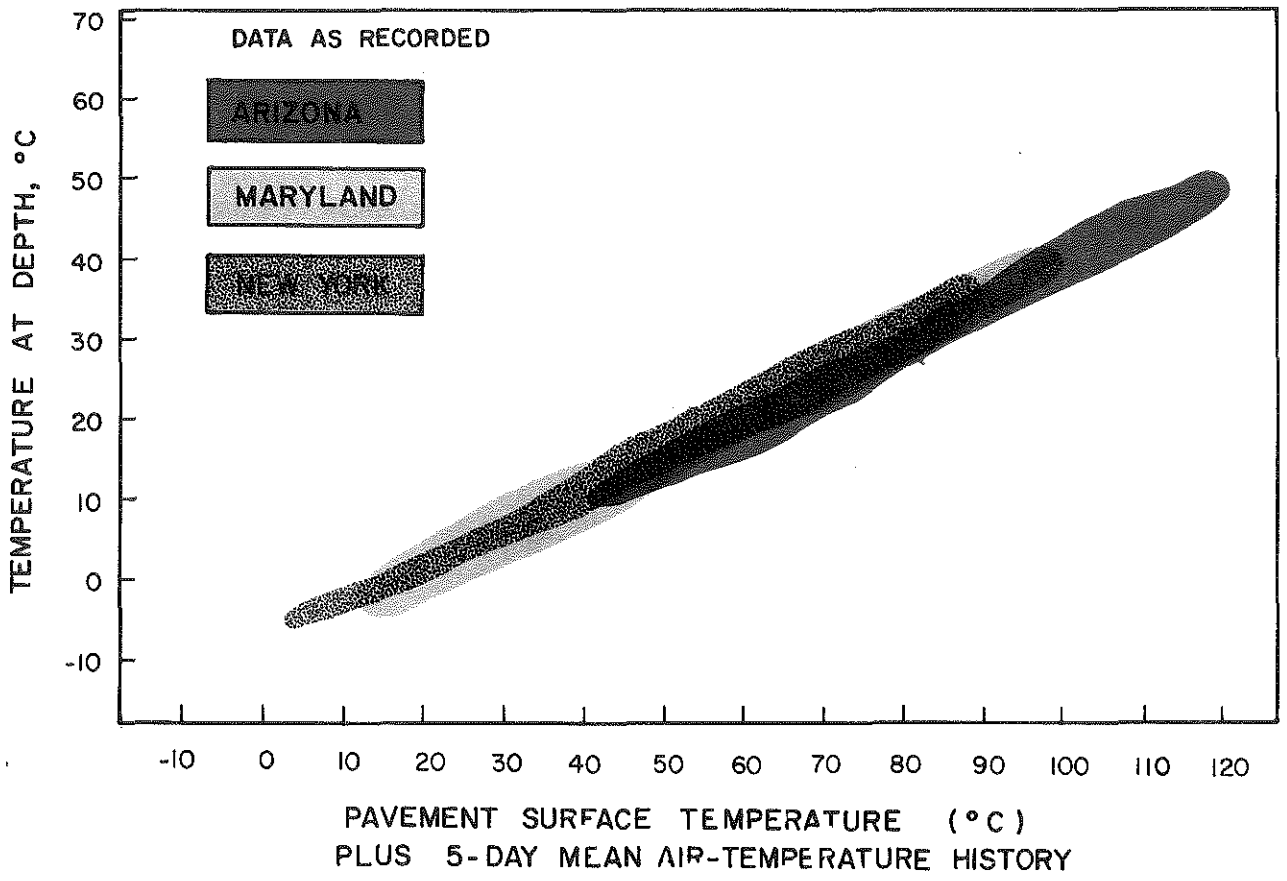

Figure 2. Temperatures as Recorded at 4-inch (102-mm) Depth, 1300 Hours.

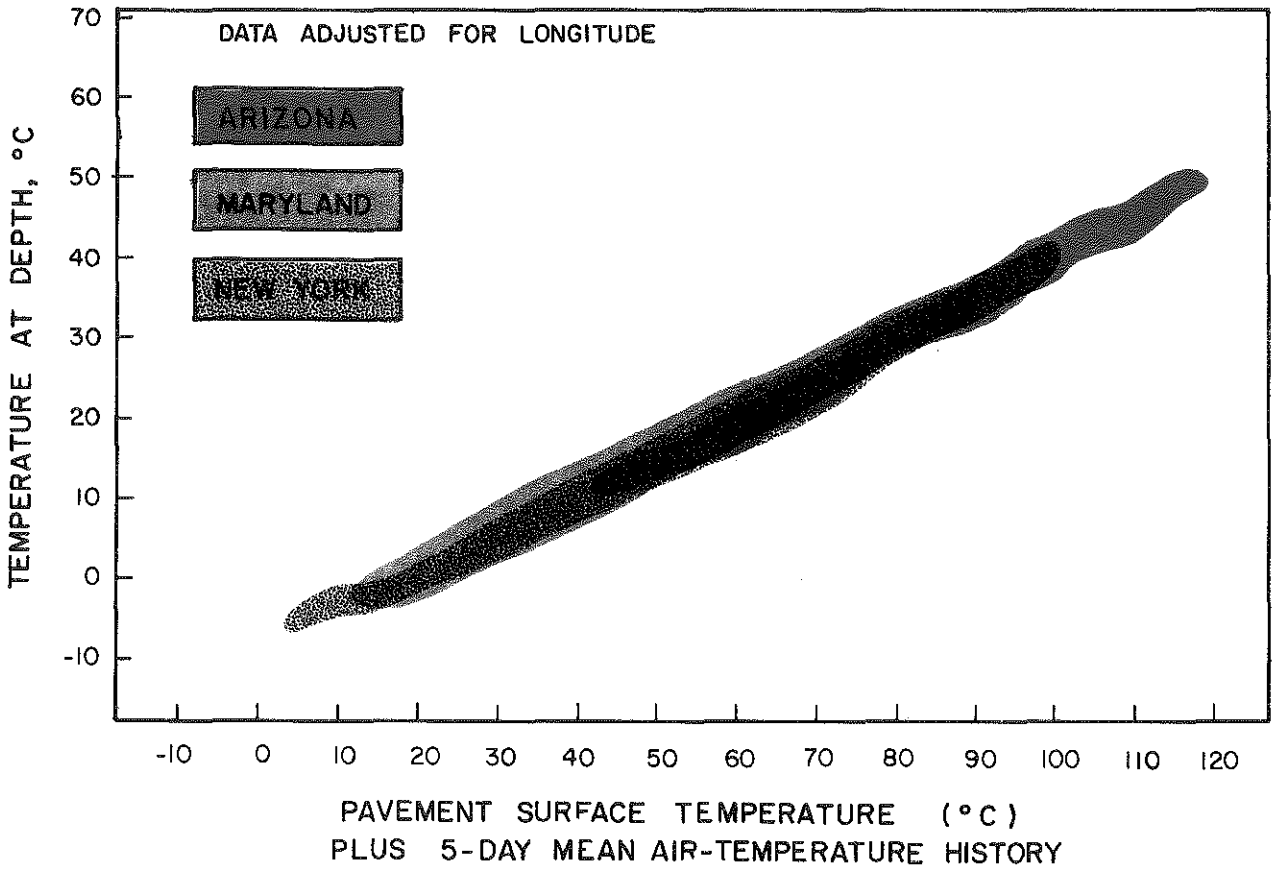

Figure 3. Temperatures at 4-inch (102-mm) Depth, 1300 Hours, Adjusted to an Equivalent Maryland Longitude.

TABLE 1

TEMPERATURE DISTRIBUTIONS[a] IN ASPHALTIC CONCRETE PAVEMENTS AS A FUNCTION OF TIME

[a]X = surface temperature plus 5-day average air-temperature history
Y = temperature at depth

0100

DEPTH (in.)	DEPTH (cm)	STATISTICAL PARAMETERS FOR Y = A + BX	NUMBER OF DATA POINTS IN ANALYSES: 314 COLLEGE PARK, MARYLAND	254 CLARKSON COLLEGE, NEW YORK	36 UNIV OF ARIZ TUCSON, ARIZONA	604 COMBINED DATA SETS	596 LONGITUDINALLY ADJUSTED DATA
2	5.1	Constant A	-4.1	-0.7	-3.3	-2.5	-2.8
		Coefficient B	0.573	0.551	0.560	0.561	0.561
		Correlation Coefficient R	0.988	0.982	0.997	0.986	0.985
		Standard Error of Estimate	2.9	3.3	1.6	3.1	3.2
4	10.2	Constant A	-2.6	-0.5	-1.3	-1.5	-1.5
		Coefficient B	0.586	0.572	0.572	0.579	0.580
		Correlation Coefficient R	0.987	0.980	0.997	0.985	0.985
		Standard Error of Estimate	3.1	3.7	1.5	3.3	3.3
6	15.2	Constant A	-0.9	0.0	0.4	-0.4	-0.5
		Coefficient B	0.590	0.584	0.577	0.586	0.585
		Correlation Coefficient R	0.985	0.978	0.996	0.983	0.983
		Standard Error of Estimate	3.4	4.0	1.7	3.6	3.6
8	20.3	Constant A	0.6	0.8	2.2	0.7	0.6
		Coefficient B	0.588	0.584	0.576	0.586	0.585
		Correlation Coefficient R	0.982	0.977	0.995	0.982	0.983
		Standard Error of Estimate	3.6	4.0	1.9	3.7	3.6
10	25.4	Constant A	1.9	2.1	4.2	1.9	2.0
		Coefficient B	0.581	0.572	0.570	0.579	0.578
		Correlation Coefficient R	0.981	0.978	0.993	0.981	0.982
		Standard Error of Estimate	3.8	3.9	2.2	3.8	3.7
12	30.5	Constant A	3.7	3.7	5.9	3.5	3.5
		Coefficient B	0.566	0.557	0.561	0.565	0.564
		Correlation Coefficient R	0.979	0.977	0.992	0.980	0.981
		Standard Error of Estimate	3.8	3.8	2.3	3.8	3.6

0200

DEPTH (in.)	DEPTH (cm)	STATISTICAL PARAMETERS FOR Y = A + BX	NUMBER OF DATA POINTS IN ANALYSES: 316 COLLEGE PARK, MARYLAND	254 CLARKSON COLLEGE, NEW YORK	36 UNIV OF ARIZ TUCSON, ARIZONA	606 COMBINED DATA SETS	606 LONGITUDINALLY ADJUSTED DATA
2	5.1	Constant A	-4.0	-0.6	-3.5	-2.4	-2.5
		Coefficient B	0.567	0.545	0.558	0.556	0.554
		Correlation Coefficient R	0.989	0.983	0.996	0.987	0.986
		Standard Error of Estimate	2.7	3.2	1.7	3.0	3.0
4	10.2	Constant A	-2.3	-0.3	-1.4	-1.3	-1.2
		Coefficient B	0.580	0.566	0.569	0.572	0.573
		Correlation Coefficient R	0.988	0.981	0.997	0.986	0.986
		Standard Error of Estimate	3.0	3.5	1.5	3.2	3.2
6	15.2	Constant A	-0.7	0.2	0.4	-0.2	-0.3
		Coefficient B	0.585	0.578	0.574	0.581	0.580
		Correlation Coefficient R	0.985	0.978	0.996	0.984	0.984
		Standard Error of Estimate	3.3	3.8	1.6	3.5	3.5
8	20.3	Constant A	0.7	0.9	2.3	0.8	0.7
		Coefficient B	0.586	0.580	0.574	0.583	0.582
		Correlation Coefficient R	0.983	0.977	0.995	0.982	0.983
		Standard Error of Estimate	3.6	3.9	1.8	3.6	3.5
10	25.4	Constant A	1.9	2.0	4.2	1.9	1.9
		Coefficient B	0.580	0.572	0.569	0.578	0.578
		Correlation Coefficient R	0.981	0.977	0.994	0.981	0.981
		Standard Error of Estimate	3.7	3.9	2.1	3.8	3.7
12	30.5	Constant A	3.8	3.7	5.8	3.6	3.5
		Coefficient B	0.566	0.559	0.562	0.566	0.565
		Correlation Coefficient R	0.978	0.976	0.992	0.979	0.980
		Standard Error of Estimate	3.9	3.9	2.3	3.8	3.8

0300

DEPTH (in.)	DEPTH (cm)	STATISTICAL PARAMETERS FOR Y = A + BX	NUMBER OF DATA POINTS IN ANALYSES: 316 COLLEGE PARK, MARYLAND	254 CLARKSON COLLEGE, NEW YORK	36 UNIV OF ARIZ TUCSON, ARIZONA	606 COMBINED DATA SETS	605 LONGITUDINALLY ADJUSTED DATA
2	5.1	Constant A	-4.0	-0.6	-4.6	-2.5	-2.5
		Coefficient B	0.562	0.540	0.563	0.552	0.550
		Correlation Coefficient R	0.989	0.983	0.995	0.987	0.986
		Standard Error of Estimate	2.7	3.1	1.8	2.9	3.0
4	10.2	Constant A	-2.3	-0.1	-2.5	-1.3	-1.2
		Coefficient B	0.576	0.559	0.574	0.568	0.568
		Correlation Coefficient R	0.989	0.982	0.997	0.987	0.987
		Standard Error of Estimate	2.8	3.3	1.6	3.0	3.0
6	15.2	Constant A	-0.6	0.5	-0.2	-0.1	-0.1
		Coefficient B	0.581	0.571	0.576	0.577	0.575
		Correlation Coefficient R	0.986	0.979	0.996	0.985	0.984
		Standard Error of Estimate	3.1	3.6	1.6	3.3	3.3
8	20.3	Constant A	0.6	1.2	2.0	0.9	0.8
		Coefficient B	0.583	0.574	0.574	0.580	0.578
		Correlation Coefficient R	0.983	0.978	0.995	0.983	0.983
		Standard Error of Estimate	3.4	3.8	1.8	3.5	3.4
10	25.4	Constant A	1.7	2.2	3.9	1.8	1.9
		Coefficient B	0.581	0.569	0.570	0.577	0.516
		Correlation Coefficient R	0.981	0.977	0.994	0.981	0.981
		Standard Error of Estimate	3.7	3.8	2.0	3.7	3.7
12	30.5	Constant A	3.4	3.8	5.2	3.4	3.4
		Coefficient B	0.571	0.558	0.567	0.568	0.567
		Correlation Coefficient R	0.979	0.975	0.992	0.979	0.979
		Standard Error of Estimate	3.8	3.9	2.4	3.8	3.8

0400

DEPTH (in.)	DEPTH (cm)	STATISTICAL PARAMETERS FOR Y = A + BX	NUMBER OF DATA POINTS IN ANALYSES: 316 COLLEGE PARK, MARYLAND	254 CLARKSON COLLEGE, NEW YORK	35 UNIV OF ARIZ TUCSON, ARIZONA	605 COMBINED DATA SETS	605 LONGITUDINALLY ADJUSTED DATA
2	5.1	Constant A	-4.1	-0.2	-3.6	-2.3	-2.4
		Coefficient B	0.559	0.533	0.550	0.547	0.545
		Correlation Coefficient R	0.989	0.984	0.996	0.987	0.986
		Standard Error of Estimate	2.7	3.0	1.6	2.9	2.9
4	10.2	Constant A	-2.3	0.4	-1.3	-1.0	-0.9
		Coefficient B	0.572	0.551	0.561	0.562	0.562
		Correlation Coefficient R	0.989	0.983	0.996	0.987	0.987
		Standard Error of Estimate	2.7	3.2	1.5	2.9	2.9
6	15.2	Constant A	-0.6	1.0	0.6	0.2	0.0
		Coefficient B	0.578	0.563	0.567	0.571	0.570
		Correlation Coefficient R	0.987	0.981	0.996	0.985	0.985
		Standard Error of Estimate	3.0	3.5	1.7	3.2	3.2
8	20.3	Constant A	0.6	1.6	2.6	1.0	0.9
		Coefficient B	0.581	0.569	0.569	0.576	0.575
		Correlation Coefficient R	0.984	0.978	0.995	0.983	0.984
		Standard Error of Estimate	3.3	3.7	1.9	3.4	3.3
10	25.4	Constant A	1.6	2.4	4.5	1.9	1.9
		Coefficient B	0.581	0.565	0.567	0.576	0.575
		Correlation Coefficient R	0.981	0.977	0.993	0.981	0.981
		Standard Error of Estimate	3.6	3.8	2.2	3.7	3.6
12	30.5	Constant A	3.4	4.2	5.9	3.6	3.5
		Coefficient B	0.571	0.555	0.562	0.567	0.566
		Correlation Coefficient R	0.979	0.975	0.991	0.978	0.979
		Standard Error of Estimate	3.8	3.9	2.4	3.8	3.8

0500

DEPTH (in.)	DEPTH (cm)	STATISTICAL PARAMETERS FOR Y = A + BX	NUMBER OF DATA POINTS IN ANALYSES: 316 COLLEGE PARK, MARYLAND	254 CLARKSON COLLEGE, NEW YORK	35 UNIV OF ARIZ TUCSON, ARIZONA	605 COMBINED DATA SETS	605 LONGITUDINALLY ADJUSTED DATA
2	5.1	Constant A	-4.0	-0.2	-2.7	-2.2	-2.4
		Coefficient B	0.555	0.529	0.542	0.543	0.541
		Correlation Coefficient R	0.989	0.984	0.991	0.987	0.986
		Standard Error of Estimate	2.6	2.9	2.3	2.8	2.9
4	10.2	Constant A	-2.2	0.5	-0.8	-1.0	-0.7
		Coefficient B	0.568	0.547	0.555	0.558	0.557
		Correlation Coefficient R	0.990	0.984	0.996	0.988	0.988
		Standard Error of Estimate	2.6	3.0	1.7	2.8	2.8
6	15.2	Constant A	-0.5	1.1	0.7	0.2	0.1
		Coefficient B	0.574	0.559	0.564	0.568	0.566
		Correlation Coefficient R	0.987	0.982	0.996	0.986	0.986
		Standard Error of Estimate	2.9	3.3	1.6	3.0	3.1
8	20.3	Constant A	0.7	1.8	2.6	1.1	1.0
		Coefficient B	0.578	0.564	0.566	0.573	0.572
		Correlation Coefficient R	0.985	0.979	0.995	0.983	0.984
		Standard Error of Estimate	3.2	3.6	1.9	3.3	3.3
10	25.4	Constant A	1.7	2.7	4.6	2.0	2.1
		Coefficient B	0.579	0.562	0.565	0.573	0.573
		Correlation Coefficient R	0.982	0.977	0.993	0.981	0.981
		Standard Error of Estimate	3.5	3.7	2.2	3.6	3.6
12	30.5	Constant A	3.5	4.1	5.5	3.6	3.6
		Coefficient B	0.570	0.554	0.565	0.566	0.565
		Correlation Coefficient R	0.979	0.975	0.993	0.978	0.979
		Standard Error of Estimate	3.8	3.8	2.2	3.8	3.7

0600

DEPTH (in.)	DEPTH (cm)	STATISTICAL PARAMETERS FOR Y = A + BX	NUMBER OF DATA POINTS IN ANALYSES: 316 COLLEGE PARK, MARYLAND	254 CLARKSON COLLEGE, NEW YORK	35 UNIV OF ARIZ TUCSON, ARIZONA	605 COMBINED DATA SETS	605 LONGITUDINALLY ADJUSTED DATA
2	5.1	Constant A	-4.1	0.0	-3.5	-2.2	-2.3
		Coefficient B	0.553	0.524	0.543	0.538	0.537
		Correlation Coefficient R	0.989	0.985	0.995	0.987	0.986
		Standard Error of Estimate	2.6	2.8	1.7	2.8	2.8
4	10.2	Constant A	-2.2	0.6	-1.1	-0.9	-0.7
		Coefficient B	0.564	0.541	0.552	0.553	0.553
		Correlation Coefficient R	0.990	0.985	0.997	0.988	0.989
		Standard Error of Estimate	2.5	2.9	1.5	2.7	2.7
6	15.2	Constant A	-0.5	1.2	0.9	0.3	0.3
		Coefficient B	0.570	0.555	0.558	0.563	0.560
		Correlation Coefficient R	0.989	0.983	0.997	0.987	0.987
		Standard Error of Estimate	2.7	3.2	1.5	2.9	2.9
8	20.3	Constant A	0.6	1.8	3.0	1.2	1.1
		Coefficient B	0.576	0.561	0.561	0.569	0.568
		Correlation Coefficient R	0.986	0.981	0.996	0.985	0.986
		Standard Error of Estimate	3.0	3.4	1.7	3.2	3.1
10	25.4	Constant A	1.5	2.7	5.2	2.0	2.1
		Coefficient B	0.578	0.559	0.559	0.571	0.570
		Correlation Coefficient R	0.983	0.979	0.994	0.982	0.982
		Standard Error of Estimate	3.4	3.6	2.0	3.5	3.4
12	30.5	Constant A	3.2	4.2	6.7	3.6	3.6
		Coefficient B	0.572	0.552	0.553	0.565	0.563
		Correlation Coefficient R	0.980	0.976	0.992	0.979	0.980
		Standard Error of Estimate	3.6	3.8	2.3	3.7	3.6

0700

DEPTH (in.)	DEPTH (cm)	STATISTICAL PARAMETERS FOR Y = A + BX	NUMBER OF DATA POINTS IN ANALYSES: 316 COLLEGE PARK, MARYLAND	254 CLARKSON COLLEGE, NEW YORK	111 UNIV OF ARIZ TUCSON, ARIZONA	681 COMBINED DATA SETS	678 LONGITUDINALLY ADJUSTED DATA
2	5.1	Constant A	-3.8	-0.1	-0.8	-1.9	-2.0
		Coefficient B	0.543	0.552	0.521	0.531	0.530
		Correlation Coefficient R	0.988	0.985	0.993	0.987	0.987
		Standard Error of Estimate	2.7	2.8	1.8	2.7	2.8
4	10.2	Constant A	-1.8	0.5	3.1	-0.2	0.0
		Coefficient B	0.550	0.536	0.513	0.539	0.538
		Correlation Coefficient R	0.991	0.987	0.994	0.989	0.989
		Standard Error of Estimate	2.4	2.7	1.7	2.5	2.5
6	15.2	Constant A	-0.9	1.0	5.5	1.1	1.1
		Coefficient B	0.557	0.548	0.513	0.547	0.545
		Correlation Coefficient R	0.990	0.986	0.993	0.988	0.988
		Standard Error of Estimate	2.5	2.9	1.8	2.6	2.7
8	20.3	Constant A	1.1	1.7	7.5	2.1	2.1
		Coefficient B	0.562	0.554	0.514	0.553	0.551
		Correlation Coefficient R	0.988	0.984	0.991	0.986	0.987
		Standard Error of Estimate	2.8	3.1	2.1	2.9	2.8
10	25.4	Constant A	2.1	2.6	9.3	3.1	3.2
		Coefficient B	0.564	0.553	0.515	0.555	0.553
		Correlation Coefficient R	0.985	0.982	0.988	0.983	0.984
		Standard Error of Estimate	3.1	3.3	2.5	3.2	3.2
12	30.5	Constant A	3.8	4.1	9.8	4.5	4.6
		Coefficient B	0.559	0.548	0.517	0.551	0.548
		Correlation Coefficient R	0.982	0.979	0.986	0.981	0.982
		Standard Error of Estimate	3.5	3.5	2.6	3.4	3.4

0800

DEPTH (in.)	DEPTH (cm)	STATISTICAL PARAMETERS FOR Y = A + BX	NUMBER OF DATA POINTS IN ANALYSES: 316 COLLEGE PARK, MARYLAND	254 CLARKSON COLLEGE, NEW YORK	160 UNIV OF ARIZ TUCSON, ARIZONA	730 COMBINED DATA SETS	728 LONGITUDINALLY ADJUSTED DATA
2	5.1	Constant A	-3.6	-0.5	-1.9	-2.2	-2.3
		Coefficient B	0.533	0.520	0.525	0.527	0.527
		Correlation Coefficient R	0.985	0.985	0.995	0.988	0.988
		Standard Error of Estimate	3.0	2.8	2.0	2.9	3.0
4	10.2	Constant A	-1.4	0.3	2.3	0.0	0.5
		Coefficient B	0.528	0.523	0.504	0.520	0.516
		Correlation Coefficient R	0.987	0.986	0.994	0.989	0.990
		Standard Error of Estimate	2.8	2.8	2.0	2.7	2.7
6	15.2	Constant A	0.3	1.0	5.2	1.5	1.7
		Coefficient B	0.531	0.530	0.497	0.523	0.519
		Correlation Coefficient R	0.988	0.986	0.994	0.990	0.989
		Standard Error of Estimate	2.7	2.8	1.9	2.7	2.7
8	20.3	Constant A	1.6	1.4	7.9	2.5	2.9
		Coefficient B	0.535	0.537	0.494	0.529	0.523
		Correlation Coefficient R	0.987	0.986	0.994	0.989	0.990
		Standard Error of Estimate	2.9	2.9	2.0	2.8	2.7
10	25.4	Constant A	2.7	2.0	10.5	3.4	3.8
		Coefficient B	0.536	0.540	0.489	0.532	0.526
		Correlation Coefficient R	0.985	0.985	0.992	0.987	0.988
		Standard Error of Estimate	3.1	2.9	2.2	3.0	2.9
12	30.5	Constant A	4.3	3.8	11.3	5.1	5.5
		Coefficient B	0.532	0.532	0.486	0.526	0.520
		Correlation Coefficient R	0.983	0.982	0.992	0.985	0.986
		Standard Error of Estimate	3.3	3.2	2.2	3.2	3.1

0900

DEPTH (in.)	DEPTH (cm)	STATISTICAL PARAMETERS FOR Y = A + BX	NUMBER OF DATA POINTS IN ANALYSES: 316 COLLEGE PARK, MARYLAND	253 CLARKSON COLLEGE, NEW YORK	184 UNIV OF ARIZ TUCSON, ARIZONA	753 COMBINED DATA SETS	752 LONGITUDINALLY ADJUSTED DATA
2	5.1	Constant A	-3.2	-0.5	-4.1	-1.9	-2.2
		Coefficient B	0.526	0.520	0.530	0.520	0.523
		Correlation Coefficient R	0.984	0.985	0.995	0.988	0.988
		Standard Error of Estimate	3.2	3.1	2.0	3.1	3.2
4	10.2	Constant A	-1.4	1.0	-0.3	0.2	0.6
		Coefficient B	0.508	0.501	0.497	0.498	0.496
		Correlation Coefficient R	0.982	0.982	0.993	0.986	0.987
		Standard Error of Estimate	3.4	3.2	2.3	3.2	3.1
6	15.2	Constant A	-0.1	2.0	2.6	1.6	1.7
		Coefficient B	0.506	0.495	0.484	0.493	0.492
		Correlation Coefficient R	0.981	0.978	0.992	0.985	0.985
		Standard Error of Estimate	3.4	3.5	2.4	3.2	3.3
8	20.3	Constant A	1.1	2.6	5.5	2.7	3.2
		Coefficient B	0.508	0.498	0.476	0.495	0.491
		Correlation Coefficient R	0.981	0.976	0.992	0.985	0.986
		Standard Error of Estimate	3.5	3.6	2.3	0.3	3.2
10	25.4	Constant A	2.3	3.2	8.2	3.8	4.2
		Coefficient B	0.508	0.501	0.467	0.496	0.492
		Correlation Coefficient R	0.980	0.977	0.991	0.985	0.985
		Standard Error of Estimate	3.6	3.6	2.4	3.3	3.3
12	30.5	Constant A	3.9	4.7	9.1	5.4	5.8
		Coefficient B	0.504	0.495	0.465	0.490	0.485
		Correlation Coefficient R	0.978	0.975	0.991	0.983	0.984
		Standard Error of Estimate	3.7	3.7	2.5	3.4	3.4

1000

DEPTH (in.)	DEPTH (cm)	STATISTICAL PARAMETERS FOR Y = A + BX	NUMBER OF DATA POINTS IN ANALYSES: 316 COLLEGE PARK, MARYLAND	253 CLARKSON COLLEGE, NEW YORK	196 UNIV OF ARIZ TUCSON, ARIZONA	765 COMBINED DATA SETS	762 LONGITUDINALLY ADJUSTED DATA
2	5.1	Constant A	-3.5	-1.1	-6.4	-1.8	-2.1
		Coefficient B	0.532	0.531	0.540	0.522	0.527
		Correlation Coefficient R	0.987	0.984	0.995	0.988	0.988
		Standard Error of Estimate	3.1	3.3	2.2	3.3	3.3
4	10.2	Constant A	-2.2	1.3	-4.2	0.0	0.2
		Coefficient B	0.501	0.489	0.502	0.485	0.486
		Correlation Coefficient R	0.978	0.979	0.991	0.982	0.984
		Standard Error of Estimate	3.8	3.5	2.8	3.7	3.6
6	15.2	Constant A	-1.0	3.0	-1.9	1.2	1.2
		Coefficient B	0.488	0.467	0.485	0.472	0.473
		Correlation Coefficient R	0.970	0.968	0.988	0.977	0.978
		Standard Error of Estimate	4.3	4.3	3.0	4.1	4.1
8	20.3	Constant A	0.2	3.8	0.6	2.2	2.8
		Coefficient B	0.484	0.462	0.474	0.468	0.464
		Correlation Coefficient R	0.967	0.962	0.987	0.975	0.976
		Standard Error of Estimate	4.5	4.6	3.1	4.2	4.2
10	25.4	Constant A	1.4	4.2	3.1	3.5	3.9
		Coefficient B	0.482	0.465	0.463	0.465	0.463
		Correlation Coefficient R	0.966	0.963	0.985	0.975	0.975
		Standard Error of Estimate	4.6	4.5	3.2	4.3	4.3
12	30.5	Constant A	2.8	5.8	4.7	4.9	5.4
		Coefficient B	0.479	0.456	0.457	0.460	0.457
		Correlation Coefficient R	0.965	0.960	0.986	0.974	0.974
		Standard Error of Estimate	4.6	4.7	3.1	4.3	4.3

1100

DEPTH (in.)	DEPTH (cm)	STATISTICAL PARAMETERS FOR Y = A + BX	COLLEGE PARK, MARYLAND	CLARKSON COLLEGE, NEW YORK	UNIV OF ARIZ TUCSON, ARIZONA	COMBINED DATA SETS	LONGITUDINALLY ADJUSTED DATA
		NUMBER OF DATA POINTS IN ANALYSES	316	254	198	768	767
2	5.1	Constant A	-3.0	-1.7	-7.6	-1.6	-1.9
		Coefficient B	0.537	0.547	0.553	0.529	0.536
		Correlation Coefficient R	0.988	0.986	0.994	0.987	0.988
		Standard Error of Estimate	3.2	3.5	2.5	3.6	3.6
4	10.2	Constant A	-0.9	1.3	-7.2	0.6	0.4
		Coefficient B	0.486	0.487	0.510	0.476	0.480
		Correlation Coefficient R	0.979	0.981	0.990	0.981	0.983
		Standard Error of Estimate	3.9	3.6	3.0	4.0	3.9
6	15.2	Constant A	0.7	3.6	-5.8	1.9	1.6
		Coefficient B	0.461	0.449	0.486	0.451	0.456
		Correlation Coefficient R	0.965	0.963	0.986	0.972	0.974
		Standard Error of Estimate	4.7	4.7	3.4	4.6	4.5
8	20.3	Constant A	1.8	4.7	-3.4	3.0	3.2
		Coefficient B	0.451	0.436	0.470	0.440	0.441
		Correlation Coefficient R	0.956	0.951	0.983	0.967	0.968
		Standard Error of Estimate	5.2	5.3	3.6	5.0	4.8
10	25.4	Constant A	2.8	5.3	-1.0	4.2	4.3
		Coefficient B	0.447	0.434	0.456	0.434	0.435
		Correlation Coefficient R	0.952	0.949	0.981	0.964	0.964
		Standard Error of Estimate	5.4	5.4	3.7	5.1	5.1
12	30.5	Constant A	4.3	7.0	0.4	5.6	5.8
		Coefficient B	0.441	0.422	0.450	0.428	0.428
		Correlation Coefficient R	0.949	0.942	0.980	0.962	0.963
		Standard Error of Estimate	5.5	5.6	3.7	5.2	5.1

1200

DEPTH (in.)	DEPTH (cm)	STATISTICAL PARAMETERS FOR Y = A + BX	COLLEGE PARK, MARYLAND	CLARKSON COLLEGE, NEW YORK	UNIV OF ARIZ TUCSON, ARIZONA	COMBINED DATA SETS	LONGITUDINALLY ADJUSTED DATA
		NUMBER OF DATA POINTS IN ANALYSES	316	256	200	772	769
2	5.1	Constant A	-2.5	-2.4	-7.4	-1.4	-1.7
		Coefficient B	0.546	0.565	0.563	0.541	0.547
		Correlation Coefficient R	0.989	0.986	0.993	0.988	0.988
		Standard Error of Estimate	3.2	3.8	2.7	3.8	3.7
4	10.2	Constant A	0.1	1.1	-9.3	0.6	0.1
		Coefficient B	0.482	0.493	0.524	0.480	0.486
		Correlation Coefficient R	0.983	0.985	0.986	0.982	0.985
		Standard Error of Estimate	3.6	3.4	3.6	4.0	3.8
6	15.2	Constant A	1.7	3.8	-9.1	1.9	1.4
		Coefficient B	0.447	0.444	0.498	0.446	0.453
		Correlation Coefficient R	0.966	0.969	0.980	0.971	0.984
		Standard Error of Estimate	4.8	4.4	4.2	4.8	4.6
8	20.3	Constant A	2.8	5.3	-6.5	3.2	3.4
		Coefficient B	0.430	0.421	0.473	0.427	0.429
		Correlation Coefficient R	0.952	0.954	0.976	0.963	0.965
		Standard Error of Estimate	0.6	5.1	4.4	5.3	5.1
10	25.4	Constant A	4.0	6.0	-3.2	4.7	4.4
		Coefficient B	0.422	0.415	0.451	0.415	0.419
		Correlation Coefficient R	0.944	0.948	0.972	0.958	0.959
		Standard Error of Estimate	5.8	5.4	4.5	5.5	5.4
12	30.5	Constant A	5.5	7.8	-2.3	5.8	5.7
		Coefficient B	0.413	0.398	0.447	0.408	0.411
		Correlation Coefficient R	0.937	0.937	0.971	0.953	0.955
		Standard Error of Estimate	6.1	5.8	4.5	5.7	5.6

1300

DEPTH (in.)	DEPTH (cm)	STATISTICAL PARAMETERS FOR Y = A + BX	NUMBER OF DATA POINTS IN ANALYSES: 316 COLLEGE PARK, MARYLAND	256 CLARKSON COLLEGE, NEW YORK	199 UNIV OF ARIZ TUCSON, ARIZONA	771 COMBINED DATA SETS	769 LONGITUDINALLY ADJUSTED DATA
2	5.1	Constant A	-2.4	-3.0	-6.6	-1.4	-1.7
		Coefficient B	0.559	0.582	0.570	0.553	0.560
		Correlation Coefficient R	0.987	0.985	0.994	0.987	0.987
		Standard Error of Estimate	3.7	4.1	2.5	4.1	4.1
4	10.2	Constant A	0.671	1.1	-9.1	1.0	0.2
		Coefficient B	0.489	0.503	0.532	0.488	0.496
		Correlation Coefficient R	0.985	0.987	0.990	0.985	0.987
		Standard Error of Estimate	3.5	3.3	3.2	3.4	3.6
6	15.2	Constant A	2.6	4.4	-9.6	2.4	1.7
		Coefficient B	0.445	0.445	0.504	0.447	0.456
		Correlation Coefficient R	0.970	0.973	0.984	0.975	0.978
		Standard Error of Estimate	4.6	4.3	3.8	4.6	4.4
8	20.3	Constant A	4.1	6.1	-8.0	3.9	3.9
		Coefficient B	0.427	0.415	0.479	0.422	0.425
		Correlation Coefficient R	0.954	0.957	0.978	0.964	0.968
		Standard Error of Estimate	5.4	5.1	4.2	5.3	5.0
10	25.4	Constant A	5.5	7.0	-5.5	5.3	4.6
		Coefficient B	0.407	0.403	0.457	0.406	0.414
		Correlation Coefficient R	0.943	0.948	0.973	0.957	0.959
		Standard Error of Estimate	5.9	5.5	4.5	5.6	5.5
12	30.5	Constant A	6.7	8.8	-4.9	6.0	5.8
		Coefficient B	0.396	0.384	0.454	0.399	0.404
		Correlation Coefficient R	0.932	0.934	0.972	0.951	0.954
		Standard Error of Estimate	6.3	5.9	4.5	5.9	5.7

1400

DEPTH (in.)	DEPTH (cm)	STATISTICAL PARAMETERS FOR Y = A + BX	NUMBER OF DATA POINTS IN ANALYSES: 316 COLLEGE PARK, MARYLAND	256 CLARKSON COLLEGE, NEW YORK	197 UNIV OF ARIZ TUCSON, ARIZONA	769 COMBINED DATA SETS	768 LONGITUDINALLY ADJUSTED DATA
2	5.1	Constant A	-2.7	-3.2	-5.6	-1.7	-2.1
		Coefficient B	0.574	0.595	0.580	0.569	0.576
		Correlation Coefficient R	0.986	0.984	0.992	0.987	0.987
		Standard Error of Estimate	4.0	4.4	3.1	4.3	4.3
4	10.2	Constant A	1.1	1.4	-7.1	1.1	0.4
		Coefficient B	0.501	0.514	0.539	0.503	0.511
		Correlation Coefficient R	0.987	0.988	0.987	0.986	0.989
		Standard Error of Estimate	3.5	3.4	3.6	3.8	3.5
6	15.2	Constant A	3.6	4.9	-7.4	3.0	2.1
		Coefficient B	0.451	0.452	0.508	0.457	0.467
		Correlation Coefficient R	0.976	0.977	0.983	0.979	0.981
		Standard Error of Estimate	4.2	4.1	3.9	4.4	4.2
8	20.3	Constant A	5.2	6.8	-6.9	4.4	4.1
		Coefficient B	0.422	0.417	0.484	0.428	0.433
		Correlation Coefficient R	0.962	0.961	0.979	0.969	0.972
		Standard Error of Estimate	5.1	5.0	4.1	5.0	4.7
10	25.4	Constant A	6.3	7.9	-5.7	5.6	4.8
		Coefficient B	0.406	0.400	0.466	0.410	0.418
		Correlation Coefficient R	0.950	0.952	0.974	0.961	0.963
		Standard Error of Estimate	5.6	5.3	4.4	5.4	5.3
12	30.5	Constant A	7.4	10.0	-4.5	6.4	6.0
		Coefficient B	0.392	0.375	0.457	0.399	0.405
		Correlation Coefficient R	0.937	0.935	0.973	0.953	0.956
		Standard Error of Estimate	6.2	5.9	4.5	5.8	5.6

1500

DEPTH (in.)	DEPTH (cm)	STATISTICAL PARAMETERS FOR Y = A + BX	NUMBER OF DATA POINTS IN ANALYSES: 316 COLLEGE PARK, MARYLAND	256 CLARKSON COLLEGE, NEW YORK	197 UNIV OF ARIZ TUCSON, ARIZONA	769 COMBINED DATA SETS	766 LONGITUDINALLY ADJUSTED DATA
2	5.1	Constant A	-2.7	-3.6	-3.0	-2.1	-2.4
		Coefficient B	0.585	0.606	0.582	0.584	0.589
		Correlation Coefficient R	0.986	0.983	0.991	0.987	0.986
		Standard Error of Estimate	4.3	4.7	3.2	4.4	4.4
4	10.2	Constant A	1.7	1.1	-3.3	1.0	0.5
		Coefficient B	0.513	0.529	0.543	0.522	0.527
		Correlation Coefficient R	0.987	0.988	0.984	0.987	0.989
		Standard Error of Estimate	3.6	3.5	4.0	3.8	3.5
6	15.2	Constant A	4.4	4.8	-3.8	3.1	2.3
		Coefficient B	0.462	0.467	0.512	0.474	0.483
		Correlation Coefficient R	0.981	0.982	0.979	0.982	0.984
		Standard Error of Estimate	3.9	3.8	4.3	4.1	4.0
8	20.3	Constant A	6.0	7.0	-3.4	4.7	4.3
		Coefficient B	0.431	0.427	0.487	0.442	0.447
		Correlation Coefficient R	0.971	0.970	0.975	0.974	0.977
		Standard Error of Estimate	4.5	4.5	4.5	4.6	4.4
10	25.4	Constant A	7.1	8.3	-2.1	5.9	5.2
		Coefficient B	0.412	0.404	0.465	0.421	0.427
		Correlation Coefficient R	0.961	0.960	0.968	0.967	0.968
		Standard Error of Estimate	5.1	5.0	4.9	5.1	5.0
12	30.5	Constant A	8.5	10.4	-0.8	6.9	6.5
		Coefficient B	0.393	0.377	0.453	0.406	0.411
		Correlation Coefficient R	0.947	0.943	0.967	0.957	0.959
		Standard Error of Estimate	5.7	5.6	4.9	5.6	5.4

1600

DEPTH (in.)	DEPTH (cm)	STATISTICAL PARAMETERS FOR Y = A + BX	NUMBER OF DATA POINTS IN ANALYSES: 316 COLLEGE PARK, MARYLAND	255 CLARKSON COLLEGE, NEW YORK	196 UNIV OF ARIZ TUCSON, ARIZONA	767 COMBINED DATA SETS	739 LONGITUDINALLY ADJUSTED DATA
2	5.1	Constant A	-2.7	-3.7	-0.2	-2.1	-2.8
		Coefficient B	0.595	0.613	0.577	0.593	0.600
		Correlation Coefficient R	0.985	0.982	0.991	0.986	0.985
		Standard Error of Estimate	4.4	5.0	3.1	4.5	4.6
4	10.2	Constant A	2.5	1.2	0.5	1.4	1.2
		Coefficient B	0.526	0.542	0.544	0.537	0.539
		Correlation Coefficient R	0.988	0.987	0.986	0.988	0.989
		Standard Error of Estimate	3.6	3.8	3.7	3.7	3.5
6	15.2	Constant A	5.8	4.9	0.0	3.8	3.4
		Coefficient B	0.474	0.482	0.519	0.491	0.496
		Correlation Coefficient R	0.987	0.984	0.982	0.986	0.986
		Standard Error of Estimate	3.4	3.6	4.1	3.7	3.7
8	20.3	Constant A	7.5	7.1	0.3	5.5	5.3
		Coefficient B	0.441	0.442	0.493	0.458	0.460
		Correlation Coefficient R	0.981	0.977	0.978	0.980	0.981
		Standard Error of Estimate	3.8	4.0	4.3	4.1	3.9
10	25.4	Constant A	8.5	8.5	1.7	6.6	6.4
		Coefficient B	0.420	0.416	0.468	0.434	0.437
		Correlation Coefficient R	0.972	0.970	0.973	0.974	0.973
		Standard Error of Estimate	4.3	4.4	4.5	4.5	4.5
12	30.5	Constant A	9.9	10.7	2.6	7.7	7.7
		Coefficient B	0.399	0.386	0.456	0.416	0.417
		Correlation Coefficient R	0.961	0.955	0.969	0.964	0.963
		Standard Error of Estimate	5.0	5.0	4.7	5.1	5.1

1700

DEPTH (in.)	DEPTH (cm)	STATISTICAL PARAMETERS FOR Y = A + BX	NUMBER OF DATA POINTS IN ANALYSIS: 316 COLLEGE PARK, MARYLAND	256 CLARKSON COLLEGE, NEW YORK	170 UNIV OF ARIZ TUCSON, ARIZONA	742 COMBINED DATA SETS	645 LONGITUDINALLY ADJUSTED DATA
2	5.1	Constant A	-3.8	-3.7	-3.0	-3.3	-4.0
		Coefficient B	0.608	0.618	0.599	0.607	0.614
		Correlation Coefficient R	0.984	0.980	0.991	0.984	0.982
		Standard Error of Estimate	4.7	5.2	3.1	4.7	4.9
4	10.2	Constant A	1.9	1.0	-0.8	0.8	1.1
		Coefficient B	0.547	0.558	0.573	0.558	0.556
		Correlation Coefficient R	0.986	0.985	0.990	0.987	0.987
		Standard Error of Estimate	3.9	4.1	3.1	3.9	3.8
6	15.2	Constant A	5.9	4.7	0.3	4.0	4.2
		Coefficient B	0.495	0.503	0.545	0.513	0.510
		Correlation Coefficient R	0.987	0.986	0.989	0.987	0.985
		Standard Error of Estimate	3.4	3.5	3.1	3.5	3.7
8	20.3	Constant A	8.1	6.9	1.0	5.9	6.2
		Coefficient B	0.460	0.463	0.519	0.478	0.474
		Correlation Coefficient R	0.985	0.983	0.986	0.984	0.984
		Standard Error of Estimate	3.4	3.5	3.4	3.6	3.6
10	25.4	Constant A	9.2	8.3	1.7	7.0	7.7
		Coefficient B	0.437	0.435	0.498	0.454	0.447
		Correlation Coefficient R	0.980	0.979	0.981	0.980	0.977
		Standard Error of Estimate	3.7	3.7	3.7	3.9	4.0
12	30.5	Constant A	10.7	10.6	2.9	8.4	9.2
		Coefficient B	0.413	0.403	0.483	0.431	0.423
		Correlation Coefficient R	0.971	0.968	0.978	0.970	0.968
		Standard Error of Estimate	4.3	4.3	3.9	4.6	4.6

1800

DEPTH (in.)	DEPTH (cm)	STATISTICAL PARAMETERS FOR Y = A + BX	NUMBER OF DATA POINTS IN ANALYSES: 316 COLLEGE PARK, MARYLAND	256 CLARKSON COLLEGE, NEW YORK	74 UNIV OF ARIZ TUCSON, ARIZONA	646 COMBINED DATA SETS	615 LONGITUDINALLY ADJUSTED DATA
2	5.1	Constant A	-5.0	-3.9	-2.7	-4.3	-4.7
		Coefficient B	0.619	0.621	0.603	0.618	0.619
		Correlation Coefficient R	0.984	0.979	0.989	0.982	0.982
		Standard Error of Estimate	4.6	5.2	2.9	4.8	4.9
4	10.2	Constant A	0.6	0.2	-0.8	0.1	0.3
		Coefficient B	0.570	0.577	0.594	0.577	0.574
		Correlation Coefficient R	0.985	0.983	0.984	0.984	0.985
		Standard Error of Estimate	4.1	4.3	3.3	4.2	4.0
6	15.2	Constant A	4.9	3.7	0.0	3.7	3 6
		Coefficient B	0.523	0.531	0.576	0.534	0.532
		Correlation Coefficient R	0.986	0.986	0.982	0.985	0.986
		Standard Error of Estimate	3.6	3.6	3.5	3.7	3.7
8	20.3	Constant A	7.4	6.0	0.5	5.9	5.9
		Coefficient B	0.488	0.492	0.557	0.500	0.498
		Correlation Coefficient R	0.986	0.987	0.980	0.985	0.986
		Standard Error of Estimate	3.3	3.2	3.6	3.5	3.4
10	25.4	Constant A	8.6	7.6	1.1	7.2	7.4
		Coefficient B	0.465	0.461	0.538	0.474	0.470
		Correlation Coefficient R	0.985	0.986	0.976	0.982	0.982
		Standard Error of Estimate	3.4	3.1	3.8	3.6	3.6
12	30.5	Constant A	10.2	9.8	2.7	9.0	9.0
		Coefficient B	0.439	0.429	0.518	0.448	0.444
		Correlation Coefficient R	0.979	0.980	0.974	0.975	0.976
		Standard Error of Estimate	3.7	3.5	3.8	4.0	4.0

1900

DEPTH (in.)	DEPTH (cm)	STATISTICAL PARAMETERS FOR Y = A + BX	NUMBER OF DATA POINTS IN ANALYSES: 316 COLLEGE PARK, MARYLAND	256 CLARKSON COLLEGE, NEW YORK	44 UNIV OF ARIZ TUCSON, ARIZONA	616 COMBINED DATA SETS	613 LONGITUDINALLY ADJUSTED DATA
2	5.1	Constant A	-6.3	-4.0	-3.8	-5.0	-5.2
		Coefficient B	0.627	0.620	0.599	0.620	0.620
		Correlation Coefficient R	0.983	0.978	0.992	0.981	0.981
		Standard Error of Estimate	4.4	5.1	2.6	4.7	4.8
4	10.2	Constant A	-2.1	-0.8	-2.6	-1.5	-1.3
		Coefficient B	0.601	0.594	0.602	0.598	0.596
		Correlation Coefficient R	0.984	0.981	0.986	0.983	0.984
		Standard Error of Estimate	4.1	4.5	3.4	4.3	4.1
6	15.2	Constant A	1.9	2.2	-1.8	1.7	1.6
		Coefficient B	0.564	0.560	0.593	0.565	0.563
		Correlation Coefficient R	0.986	0.984	0.981	0.985	0.985
		Standard Error of Estimate	3.7	3.8	3.9	3.8	3.7
8	20.3	Constant A	4.6	4.4	-0.7	4.0	3.9
		Coefficient B	0.533	0.525	0.576	0.534	0.533
		Correlation Coefficient R	0.987	0.987	0.976	0.986	0.987
		Standard Error of Estimate	3.3	3.2	4.3	3.5	3.3
10	25.4	Constant A	6.1	6.2	0.6	5.6	5.7
		Coefficient B	0.507	0.492	0.557	0.507	0.505
		Correlation Coefficient R	0.986	0.988	0.972	0.985	0.985
		Standard Error of Estimate	3.2	2.9	4.5	3.4	3.3
12	30.5	Constant A	8.2	8.7	2.0	7.7	7.6
		Coefficient B	0.478	0.459	0.538	0.478	0.476
		Correlation Coefficient R	0.984	0.985	0.973	0.981	0.981
		Standard Error of Estimate	3.3	3.1	4.3	3.6	3.6

2000

DEPTH (in.)	DEPTH (cm)	STATISTICAL PARAMETERS FOR Y = A + BX	NUMBER OF DATA POINTS IN ANALYSES: 316 COLLEGE PARK, MARYLAND	256 CLARKSON COLLEGE, NEW YORK	41 UNIV OF ARIZ TUCSON, ARIZONA	613 COMBINED DATA SETS	610 LONGITUDINALLY ADJUSTED DATA
2	5.1	Constant A	-6.3	-4.0	-3.8	-4.9	-5.0
		Coefficient B	0.621	0.615	0.593	0.614	0.611
		Correlation Coefficient R	0.983	0.976	0.993	0.980	0.980
		Standard Error of Estimate	4.2	5.0	2.3	4.5	4.6
4	10.2	Constant A	-3.4	-2.0	-2.4	-2.7	-2.4
		Coefficient B	0.613	0.609	0.602	0.609	0.607
		Correlation Coefficient R	0.984	0.978	0.994	0.982	0.982
		Standard Error of Estimate	4.0	4.7	2.2	4.3	4.2
6	15.2	Constant A	-0.2	0.4	-1.2	-0.1	0.0
		Coefficient B	0.591	0.587	0.598	0.590	0.586
		Correlation Coefficient R	0.985	0.982	0.994	0.984	0.985
		Standard Error of Estimate	3.8	4.1	2.2	3.8	3.8
8	20.3	Constant A	2.2	2.5	-0.1	2.1	2.1
		Coefficient B	0.565	0.557	0.587	0.565	0.562
		Correlation Coefficient R	0.986	0.986	0.992	0.986	0.987
		Standard Error of Estimate	3.4	3.4	2.5	3.4	3.3
10	25.4	Constant A	4.0	4.4	1.1	3.7	3.9
		Coefficient B	0.541	0.526	0.573	0.540	0.537
		Correlation Coefficient R	0.987	0.988	0.990	0.987	0.987
		Standard Error of Estimate	3.2	2.9	2.7	3.2	3.2
12	30.5	Constant A	6.1	6.7	2.4	5.7	5.8
		Coefficient B	0.513	0.495	0.558	0.512	0.590
		Correlation Coefficient R	0.986	0.988	0.988	0.986	0.985
		Standard Error of Estimate	3.1	2.8	2.9	3.2	3.2

2100

DEPTH (in.)	DEPTH (cm)	STATISTICAL PARAMETERS FOR Y = A + BX	NUMBER OF DATA POINTS IN ANALYSES: 316 COLLEGE PARK, MARYLAND	256 CLARKSON COLLEGE, NEW YORK	38 UNIV OF ARIZ TUCSON, ARIZONA	610 COMBINED DATA SETS	609 LONGITUDINALLY ADJUSTED DATA
2	5.1	Constant A	-6.1	-3.4	-3.8	-4.5	-4.6
		Coefficient B	0.612	0.602	0.585	0.603	0.600
		Correlation Coefficient R	0.982	0.975	0.993	0.980	0.979
		Standard Error of Estimate	4.0	4.7	2.3	4.3	4.3
4	10.2	Constant A	-4.0	-2.3	-2.2	-2.9	-2.7
		Coefficient B	0.615	0.610	0.596	0.610	0.609
		Correlation Coefficient R	0.982	0.976	0.993	0.980	0.981
		Standard Error of Estimate	4.0	4.7	2.4	4.3	4.3
6	15.2	Constant A	-1.3	-0.7	-0.7	-0.9	-0.8
		Coefficient B	0.602	0.601	0.595	0.600	0.596
		Correlation Coefficient R	0.983	0.978	0.994	0.982	0.982
		Standard Error of Estimate	3.9	4.3	2.2	4.0	4.0
8	20.3	Constant A	0.9	1.0	0.5	0.8	0.9
		Coefficient B	0.584	0.580	0.588	0.583	0.580
		Correlation Coefficient R	0.984	0.982	0.994	0.985	0.986
		Standard Error of Estimate	3.6	3.8	2.3	3.6	3.5
10	25.4	Constant A	2.5	2.8	1.6	2.3	2.5
		Coefficient B	0.564	0.553	0.579	0.563	0.560
		Correlation Coefficient R	0.986	0.986	0.992	0.986	0.986
		Standard Error of Estimate	3.3	3.2	2.5	3.3	3.3
12	30.5	Constant A	4.6	5.1	3.1	4.3	4.4
		Coefficient B	0.538	0.523	0.564	0.538	0.534
		Correlation Coefficient R	0.986	0.987	0.991	0.986	0.986
		Standard Error of Estimate	3.1	2.9	2.6	3.1	3.1

2200

DEPTH (in.)	DEPTH (cm)	STATISTICAL PARAMETERS FOR Y = A + BX	NUMBER OF DATA POINTS IN ANALYSES: 316 COLLEGE PARK, MARYLAND	255 CLARKSON COLLEGE, NEW YORK	37 UNIV OF ARIZ TUCSON, ARIZONA	608 COMBINED DATA SETS	607 LONGITUDINALLY ADJUSTED DATA
2	5.1	Constant A	-5.3	-2.7	-3.1	-3.9	-3.9
		Coefficient B	0.598	0.588	0.575	0.590	0.588
		Correlation Coefficient R	0.983	0.975	0.995	0.980	0.980
		Standard Error of Estimate	3.8	4.4	2.0	4.1	4.1
4	10.2	Constant A	-3.5	-2.0	-0.8	-2.6	-2.5
		Coefficient B	0.607	0.603	0.582	0.602	0.602
		Correlation Coefficient R	0.983	0.974	0.996	0.980	0.980
		Standard Error of Estimate	3.9	4.6	1.8	4.2	4.2
6	15.2	Constant A	-1.3	-0.9	1.0	-0.9	-0.9
		Coefficient B	0.601	0.603	0.581	0.600	0.597
		Correlation Coefficient R	0.982	0.976	0.996	0.981	0.981
		Standard Error of Estimate	3.9	4.5	1.9	4.0	4.1
8	20.3	Constant A	0.6	0.5	2.5	0.6	0.6
		Coefficient B	0.590	0.589	0.577	0.589	0.587
		Correlation Coefficient R	0.983	0.979	0.994	0.983	0.984
		Standard Error of Estimate	3.7	4.0	2.1	3.8	3.7
10	25.4	Constant A	2.1	2.2	3.7	2.0	2.0
		Coefficient B	0.573	0.566	0.570	0.572	0.571
		Correlation Coefficient R	0.984	0.983	0.992	0.984	0.985
		Standard Error of Estimate	3.5	3.5	2.4	3.5	3.4
12	30.5	Constant A	4.2	4.4	5.0	3.9	4.0
		Coefficient B	0.550	0.539	0.559	0.550	0.547
		Correlation Coefficient R	0.985	0.985	0.992	0.985	0.986
		Standard Error of Estimate	3.3	3.1	2.4	3.3	3.2

2300

DEPTH (in.)	DEPTH (cm)	STATISTICAL PARAMETERS FOR Y = A + BX	COLLEGE PARK, MARYLAND	CLARKSON COLLEGE, NEW YORK	UNIV OF ARIZ TUCSON, ARIZONA	COMBINED DATA SETS	LONGITUDINALLY ADJUSTED DATA
		NUMBER OF DATA POINTS IN ANALYSES	316	254	36	606	606
2	5.1	Constant A	-5.1	-2.2	-3.1	-3.5	-3.6
		Coefficient B	0.590	0.576	0.567	0.581	0.578
		Correlation Coefficient R	0.983	0.975	0.994	0.980	0.980
		Standard Error of Estimate	3.7	4.2	2.1	3.9	3.9
4	10.2	Constant A	-3.4	-1.7	-1.0	-2.4	-2.3
		Coefficient B	0.601	0.595	0.578	0.595	0.596
		Correlation Coefficient R	0.983	0.975	0.995	0.980	0.980
		Standard Error of Estimate	3.8	4.4	1.9	4.0	4.0
6	15.2	Constant A	-1.4	-0.8	0.9	-0.9	-0.9
		Coefficient B	0.599	0.600	0.580	0.597	0.595
		Correlation Coefficient R	0.982	0.975	0.995	0.980	0.980
		Standard Error of Estimate	3.8	4.4	1.9	4.0	4.0
8	20.3	Constant A	0.3	0.2	2.7	0.3	0.3
		Coefficient B	0.592	0.592	0.576	0.591	0.589
		Correlation Coefficient R	0.982	0.978	0.994	0.981	0.983
		Standard Error of Estimate	3.8	4.1	2.0	3.8	3.7
10	25.4	Constant A	1.6	1.6	4.3	1.6	1.7
		Coefficient B	0.580	0.575	0.568	0.579	0.578
		Correlation Coefficient R	0.982	0.981	0.993	0.983	0.983
		Standard Error of Estimate	3.7	3.7	2.3	3.6	3.6
12	30.5	Constant A	3.6	3.8	5.4	3.5	3.5
		Coefficient B	0.560	0.552	0.559	0.560	0.558
		Correlation Coefficient R	0.983	0.983	0.993	0.984	0.985
		Standard Error of Estimate	3.4	3.3	2.2	3.4	3.3

2400

DEPTH (in.)	DEPTH (cm)	STATISTICAL PARAMETERS FOR Y = A + BX	COLLEGE PARK, MARYLAND	CLARKSON COLLEGE, NEW YORK	UNIV OF ARIZ TUCSON, ARIZONA	COMBINED DATA SETS	LONGITUDINALLY ADJUSTED DATA
		NUMBER OF DATA POINTS IN ANALYSES	316	246	36	598	562
2	5.1	Constant A	-4.7	1.4	-3.4	-3.1	-3.3
		Coefficient B	0.582	0.540	0.567	0.572	0.571
		Correlation Coefficient R	0.983	0.969	0.994	0.981	0.979
		Standard Error of Estimate	3.6	4.5	2.1	3.7	3.8
4	10.2	Constant A	-3.1	1.7	-1.5	-2.1	-2.1
		Coefficient B	0.594	0.560	0.579	0.588	0.590
		Correlation Coefficient R	0.983	0.969	0.995	0.981	0.980
		Standard Error of Estimate	3.6	4.7	2.0	3.8	3.9
6	15.2	Constant A	-1.2	2.3	0.4	-0.8	0.9
		Coefficient B	0.595	0.570	0.581	0.593	0.592
		Correlation Coefficient R	0.982	0.969	0.995	0.981	0.979
		Standard Error of Estimate	3.7	4.7	2.0	3.9	4.0
8	20.3	Constant A	0.3	3.1	2.4	0.4	0.2
		Coefficient B	0.592	0.567	0.577	0.590	0.589
		Correlation Coefficient R	0.981	0.971	0.994	0.981	0.981
		Standard Error of Estimate	3.8	4.6	2.1	3.8	3.8
10	25.4	Constant A	1.5	4.3	4.2	1.5	1.6
		Coefficient B	0.583	0.555	0.571	0.582	0.580
		Correlation Coefficient R	0.981	0.973	0.993	0.982	0.981
		Standard Error of Estimate	3.7	4.3	2.3	3.7	3.7
12	30.5	Constant A	3.2	6.0	5.1	3.2	3.4
		Coefficient B	0.568	0.538	0.567	0.567	0.562
		Correlation Coefficient R	0.982	0.975	0.993	0.982	0.982
		Standard Error of Estimate	3.6	4.0	2.3	3.5	3.5

TABLE 2

TEMPERATURE DISTRIBUTIONS[a] IN ASPHALTIC CONCRETE PAVEMENTS AS A FUNCTION OF DAYTIME EXPOSURE TO SOLAR RADIATION

[a]X = surface temperature plus 5-day average air-temperature history
Y = temperature at depth

SUNRISE

DEPTH (in.)	DEPTH (cm)	STATISTICAL PARAMETERS FOR Y = A + BX	COLLEGE PARK, MARYLAND	CLARKSON COLLEGE, NEW YORK	UNIV OF ARIZ TUCSON, ARIZONA	COMBINED DATA SETS
2	5.1	Constant A	-5.2	-0.7	-2.0	-3.1
		Coefficient B	0.561	0.532	0.534	0.547
		Correlation Coefficient R	0.988	0.982	0.993	0.985
		Standard Error of Estimate	2.8	3.1	2.2	3.0
4	10.2	Constant A	-2.8	-0.3	-0.2	-1.5
		Coefficient B	0.573	0.555	0.546	0.563
		Correlation Coefficient R	0.990	0.982	0.996	0.987
		Standard Error of Estimate	2.6	3.3	1.8	2.9
6	15.2	Constant A	-1.7	0.5	1.4	-0.5
		Coefficient B	0.579	0.565	0.554	0.571
		Correlation Coefficient R	0.988	0.981	0.995	0.986
		Standard Error of Estimate	2.9	3.5	1.8	3.1
8	20.3	Constant A	-0.3	1.4	3.3	0.6
		Coefficient B	0.585	0.565	0.557	0.576
		Correlation Coefficient R	0.987	0.980	0.994	0.985
		Standard Error of Estimate	3.1	3.6	2.1	3.2

MIDMORNING

DEPTH (in.)	DEPTH (cm)	STATISTICAL PARAMETERS FOR Y = A + BX	COLLEGE PARK, MARYLAND	CLARKSON COLLEGE, NEW YORK	UNIV OF ARIZ TUCSON, ARIZONA	COMBINED DATA SETS
2	5.1	Constant A	-3.1	-0.1	-6.0	-2.0
		Coefficient B	0.525	0.516	0.544	0.521
		Correlation Coefficient R	0.980	0.983	0.994	0.985
		Standard Error of Estimate	3.3	3.0	2.1	3.1
4	10.2	Constant A	-4.4	-0.8	-5.2	-1.6
		Coefficient B	0.541	0.525	0.530	0.518
		Correlation Coefficient R	0.983	0.983	0.992	0.983
		Standard Error of Estimate	3.2	3.1	2.4	3.3
6	15.2	Constant A	-5.2	-0.7	-4.3	-1.6
		Coefficient B	0.553	0.534	0.529	0.525
		Correlation Coefficient R	0.982	0.982	0.991	0.982
		Standard Error of Estimate	3.4	3.2	2.5	3.5
8	20.3	Constant A	-4.5	-0.3	-2.1	-0.9
		Coefficient B	0.562	0.537	0.526	0.531
		Correlation Coefficient R	0.984	0.983	0.990	0.984
		Standard Error of Estimate	3.3	3.1	2.6	3.4

MIDDAY

DEPTH (in.)	DEPTH (cm)	STATISTICAL PARAMETERS FOR Y = A + BX	COLLEGE PARK, MARYLAND	CLARKSON COLLEGE, NEW YORK	UNIV OF ARIZ TUCSON, ARIZONA	COMBINED DATA SETS
2	5.1	Constant A	-2.4	-2.7	-6.8	-1.3
		Coefficient B	0.548	0.571	0.563	0.543
		Correlation Coefficient R	0.986	0.984	0.993	0.986
		Standard Error of Estimate	3.7	4.0	2.8	4.0
4	10.2	Constant A	0.4	1.1	-9.9	0.4
		Coefficient B	0.482	0.493	0.531	0.484
		Correlation Coefficient R	0.982	0.984	0.988	0.983
		Standard Error of Estimate	3.7	3.5	3.5	4.0
6	15.2	Constant A	1.5	3.8	-9.7	1.7
		Coefficient B	0.451	0.448	0.506	0.451
		Correlation Coefficient R	0.970	0.972	0.981	0.973
		Standard Error of Estimate	4.5	4.2	4.1	4.7
8	20.3	Constant A	2.8	5.0	-6.1	3.4
		Coefficient B	0.434	0.427	0.473	0.429
		Correlation Coefficient R	0.957	0.960	0.977	0.965
		Standard Error of Estimate	5.2	4.8	4.3	5.1

MIDAFTERNOON

DEPTH (in.)	DEPTH (cm)	STATISTICAL PARAMETERS FOR Y = A + BX	COLLEGE PARK, MARYLAND	CLARKSON COLLEGE, NEW YORK	UNIV OF ARIZ TUCSON, ARIZONA	COMBINED DATA SETS
2	5.1	Constant A	-4.9	-4.5	-5.9	-3.4
		Coefficient B	0.603	0.618	0.599	0.595
		Correlation Coefficient R	0.984	0.981	0.992	0.984
		Standard Error of Estimate	4.6	5.1	3.0	4.7
4	10.2	Constant A	-1.4	-0.8	-8.4	-1.4
		Coefficient B	0.536	0.548	0.574	0.540
		Correlation Coefficient R	0.985	0.985	0.987	0.986
		Standard Error of Estimate	4.0	3.9	3.7	4.1
6	15.2	Constant A	0.7	2.7	-9.3	0.4
		Coefficient B	0.491	0.491	0.547	0.497
		Correlation Coefficient R	0.982	0.982	0.981	0.982
		Standard Error of Estimate	3.9	3.8	4.2	4.2
8	20.3	Constant A	2.9	4.8	-8.1	2.6
		Coefficient B	0.458	0.452	0.514	0.460
		Correlation Coefficient R	0.975	0.974	0.975	0.975
		Standard Error of Estimate	4.3	4.4	4.6	4.6

SUNSET

DEPTH (in.)	DEPTH (cm)	STATISTICAL PARAMETERS FOR Y = A + BX	COLLEGE PARK, MARYLAND	CLARKSON COLLEGE, NEW YORK	UNIV OF ARIZ TUCSON, ARIZONA	COMBINED DATA SETS
2	5.1	Constant A	-4.4	-2.6	-2.6	-3.4
		Coefficient B	0.613	0.607	0.596	0.607
		Correlation Coefficient R	0.979	0.972	0.987	0.977
		Standard Error of Estimate	4.7	5.3	2.8	4.8
4	10.2	Constant A	-2.4	-1.9	-5.7	-2.1
		Coefficient B	0.602	0.603	0.616	0.600
		Correlation Coefficient R	0.983	0.977	0.988	0.981
		Standard Error of Estimate	4.0	4.8	2.7	4.3
6	15.2	Constant A	-1.2	-0.1	-8.1	-1.0
		Coefficient B	0.578	0.576	0.622	0.578
		Correlation Coefficient R	0.985	0.981	0.986	0.983
		Standard Error of Estimate	3.7	4.1	3.0	3.9
8	20.3	Constant A	0.0	1.2	-9.7	0.2
		Coefficient B	0.557	0.548	0.614	0.555
		Correlation Coefficient R	0.987	0.984	0.983	0.985
		Standard Error of Estimate	3.3	3.6	3.2	3.5

REFERENCES

1. B. F. Kallas, *Asphalt Pavement Temperatures,* **Record 150**, Highway Research Board, 1966, pp. 1-11.
2. A. L. Straub, H. N. Schenck, Jr. and F. E. Przybycien, *Bituminous Pavement Temperature Related to Climate,* **Record 256**, Highway Research Board, 1968, pp. 53-77.
3. T. N. Rumney, and R. A. Jimenez, *Pavement Temperatures in the Southwest,* **Record 361**, Highway Research Board, 1971, pp. 1-13.
4. H. F. Southgate, *An Evaluation of Temperature Distribution within Asphalt Pavements and Its Relationship to Pavement Deflection,* Kentucky Department of Highways, 1968.
5. H. F. Southgate and R. C. Deen, *Temperature Distribution within Asphalt Pavements and Its Relationship to Pavement Deflection,* **Record 291**, Highway Research Board, 1969, pp. 116-131.
6. *Asphalt Overlays and Pavement Rehabilitation,* **Manual Series No. 17 (MS-17)**, The Asphalt Institute, First Edition, 1969.