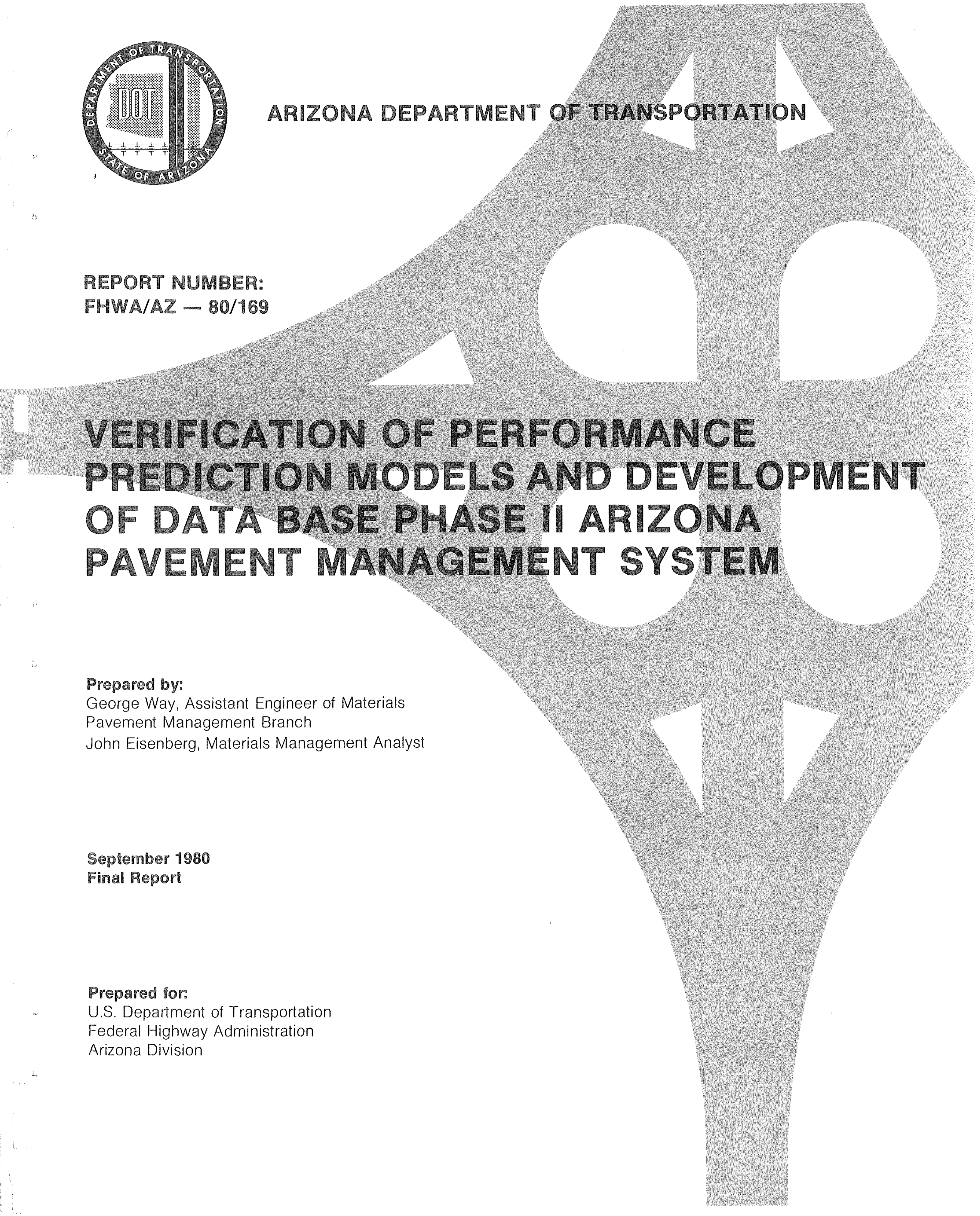

ARIZONA DEPARTMENT OF TRANSPORTATION

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VERIFICATION OF PERFORMANCE PREDICTION MODELS AND DEVELOPMENT OF DATA BASE PHASE II ARIZONA PAVEMENT MANAGEMENT SYSTEM

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September 1980
Final Report

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Federal Highway Administration
Arizona Division

PAVEMENT MANAGEMENT SYSTEM
FOR
ARIZONA PHASE II

VERIFICATION OF PERFORMANCE PREDICTION MODELS
AND
DEVELOPMENT OF DATA BASE

By

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April 21, 1980

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16. Abstract

A pavement management system (PMS) has been defined as "the systematic development of information and procedures in optimizing the design and maintenance of pavements" (1). The purpose of this research was to verify and adjust models (equations) developed in phase I, II and III of the PMS. This verification process involved testing models against real data and determining the correlation. Appropriate adjustments were made to enhance the final predictions. Results of this work indicate that the prediction models can reasonably predict the future ride and cracking condition for newly constructed, in-service and overlaid asphaltic concrete pavements, as well as, plain concrete pavements.

The second purpose of this project was to develop a PMS data base. Such a data base was developed through a cooperative effort between Research Section, Materials Services and Information System Groups. The data base contains over 250,000 records which are stored in an information management system (IMS) file. Data is stored hierarchially which facilitates the retrieval of data via a remote terminal. Computer programs which allow various users (Designers, Maintenance Engineers, District staff, Researchers, Planners and others) to retrieve data in less than one minute have been implemented and have been in use for six months within the department.

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PAVEMENT MANAGEMENT SYSTEM (PMS)

ADOT is currently engaged in implementing PMS. At present, no state has been able to make a complete PMS operational. ADOT is very close to creating a fully functional operational PMS; however, one basic element of such a system is not currently present and that is a PMS Operations Group.

Before defining the exact size or structure of a PMS Operations Group, a brief history of how ADOT has managed to come this far is in order. In June 1978, ADOT, through the State Engineer, made a commitment to develop a PMS and make it functional. A group of knowledgeable co-principals was charged with literally creating the PMS within ADOT. To help this group, six temporary positions were furnished. Over the months, additional help was obtained from Information Systems. Virtually all of the work effort up until now has been done on a cooperative level. In all, 21 positions have dedicated more than 50 percent of their time to completing this project as shown below.

Positions Working on PMS

Research Section	1	
Materials Services	10	(Includes Inventory)
Information Systems	4	
Temporary	6	
Total	21	

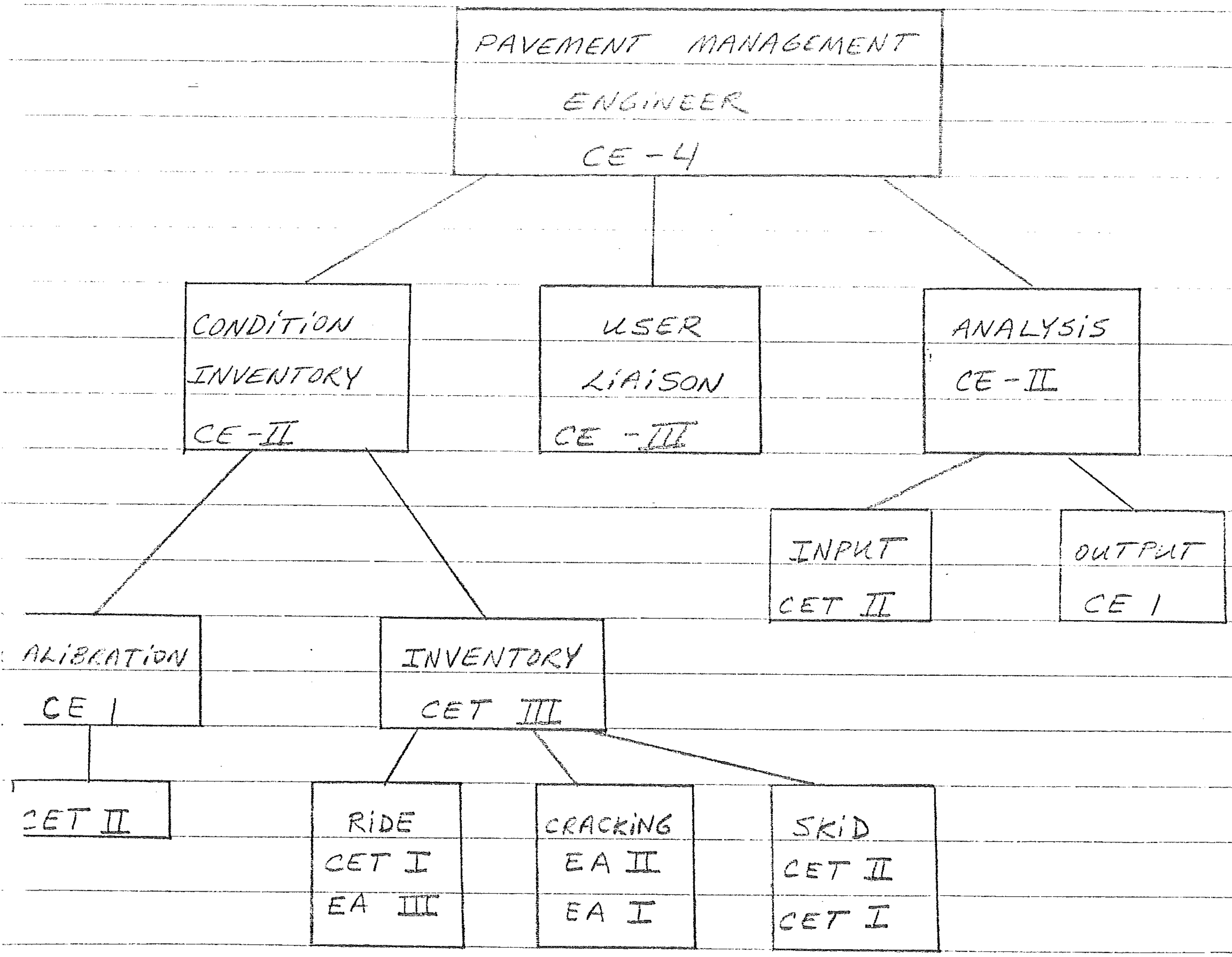
Since different lines of authority have been involved, some time has naturally been spent in working out priorities and solving personnel problems. Two of the temporary positions soon will be terminated. In addition, work by the consultant will be complete by January 1980. Findings by both the consultant and the ADOT staff indicate that the inventory work effort will change in the future. Greater emphasis should be placed on obtaining the most current ride, percent cracking and skid number. Deflection measurements most likely would be performed as a design test on an as-needed basis. Considering the above, an attempt has been made at visualizing the PMS Group of the future (1980).

Attached is an organizational chart representing a future 1980 PMS Group. Since PMS would furnish both information to a variety of users (Traffic, Planning, Operations, Districts and Research) and create a future preservation plan of action, it would be advantageous that it report to the Chief Deputy or State Engineer. The top position could be either a CE-4 or 5. Supporting the top position would be two functional areas denoted as condition inventory and analysis. Both areas would be headed up by a CE-2 or equivalent management position in the case of analysis. The role of the condition inventory arm would be to collect inventory ride, cracking and skid data in the field. This area would not perform deflection test as this would be a design function and could be performed by a design crew or District on an as-needed basis. Those persons working in the inventory area would be responsible for equipment upkeep, standardization and maintenance. In addition, until that time when all tests are automated, they would perform manual coding.

The analysis area would consist of those office personnel needed to input and output all data for the PMS data base. Input data would consist of condition data, highway history (new construction, overlay, seal coats, etc.) and construction data. In addition, data from other existing files such as PECOS, Traffic ADT and ADL would be updated and input. In the future, other files might be created such as construction costs, geometrics, etc. Output work would involve providing most current data to users (updating), future preservation action plan, reports to Highways Division management, annual summary condition report, priority planning report, three R study, interstate needs study and other special studies aimed at improving design, construction and maintenance. The liaison feedback position would be responsible for answering user questions and needs. Questions from users such as Districts, design, etc., would be fed back to the inventory or analysis area to see where errors were made or to make improvements. Likewise, this position would be responsible for explaining new innovations in the system to user groups as well as passing results of studies back to each group.

In all, 17 positions, including two typists, would be needed.

FUTURE
PAVEMENT MANAGEMENT GROUP



ABSTRACT

A pavement management system (PMS) has been defined as "the systematic development of information and procedures in optimizing the design and maintenance of pavements" (1). The purpose of this research was to verify and adjust models (equations) developed in phase I, II and III of the PMS. This verification process involved testing models against real data and determining the correlation. Appropriate adjustments were made to enhance the final predictions. Results of this work indicate that the prediction models can reasonably predict the future ride and cracking condition for newly constructed, in-service and overlaid asphaltic concrete pavements, as well as, plain concrete pavements.

The second purpose of this project was to develop a PMS data base. Such a data base was developed through a cooperative effort between Research Section, Materials Services and Information System Groups. The data base contains over 250,000 records which are stored in an information management system (IMS) file. Data is stored hierarchially which facilitaters the retrieval of data via a remote terminal. Computer programs which allow various users (Designers, Maintenance Engineers, District staff, Researchers, Planners and others) to retrieve data in less than one minute have been implemented and have been in use for six months within the department.

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Pavement Management System for Arizona Phase II Verification of Performance Prediction Models and Development of Data Base.

INTRODUCTION

A pavement management system (PMS) has been defined as "the systematic development of information and procedures necessary in optimizing the design and maintenance of pavements" (1). As ADOT's highway network has grown and reached completion, the concern of highway engineers and managers has shifted from new construction to preserving the existing highway network. At present, ADOT has over 6,000 miles of highways within its system. The cumulative cost to construct the present system was about $2.1 billion. To replace the existing highways at today's dollars would amount to $4.0 billion; however, to overlay the entire system would cost about $500 million. The idea behind PMS is that it is possible through a systematic management methodology to preserve the condition of ADOT's highways at or above an acceptable level at a reduced cost.

To implement PMS within ADOT has involved three phases:

Phase I	Develop program to optimize the design of new construction and major maintenance completed by Woodward-Clyde Consultants in 1976 (1).
Phase II	A. Verify prediction models with actual data and create computerized data base. B. Develop a functional PMS within ADOT. To be accomplished by ADOT staff by March 1981.
Phase III	Develop a network optimization system. To be developed by Woodward-Clyde Consultants and tested by ADOT staff.

Phase II and III projects represent a joint effort between ADOT and Woodward-Clyde Consultants. Information, highway condition data and general overall direction of both projects was managed by a series of meetings between principal investigators. In addition to this ADOT created a management steering committee composed of the following positions.:

Chief Deputy Engineer - Chairman
Assistant State Engineer Traffic
Priority Program Manager
Maintenance Engineer
Materials Engineer
Information Systems Project Manager

This committee addressed important operational problems and recommended appropriate actions to be taken to the State Engineer.

The purpose of this part of the Phase II project was to verify and adjust existing models and develop a suitable data base for the use of the Phase III program as well as design, maintenance and management.

Model Verification

In Phase I Woodward-Clyde developed pavement performance prediction models by using the Bayesian method (1). Models were created by interviewing knowledgeable highway engineers about their expectations of future pavement performance in terms of several variables. From these values mathematical models (equations) were developed and are shown below.

1976 MODELS

New and In-Service Construction

$$\mathrm{LN\ CRI} = 0.8815\ \mathrm{LN\ RGN} + 0.6965\ \mathrm{LN\ DEFL} + 0.1901\ \mathrm{LN\ TRAF} + 0.4217\ \mathrm{LN\ AGE} + 1.6638$$

Where
CRI = Change in Roughness Index in Two Years
RGN = Environmental Region
  1 = 0 to 5000 feet elevation
  2 = Greater than 5000 feet
  3 = Greater than 5000 feet with swelling clay foundation

DEFL = Equivalent Benkelman Beam (BB) Deflection Obtained From Correlations with Dynaflect Deflection (.001 inch Dynaflect = .0224 inch BB)

TRAF = Average Annual Equivalent 18 Kip (8 kn) Single Axle Loads Estimated for the Specific Roadway

AGE = Age of Pavement In Years

For an overlay plus an asphalt concrete friction course without an asphalt-rubber inner-layer or heater-scarification

$$\mathrm{LN\ CRI} = 0.8744\ \ln \mathrm{RGN} + 0.3281\ \ln \mathrm{DEFL} + 0.0718\ \ln \mathrm{TRAF} - 0.0375\ \ln \mathrm{THIK} + 0.4618\ \ln \mathrm{AGE} + 1.2736$$

Where
CRI, RGN, DEFL, TRAF, and AGE are the same as used in equation (1) and

THIK = thickness of the overlay

For new construction or overlays

$$\mathrm{LN\ CSN} = 0.2940\ \ln \mathrm{RGN} - 1.0046\ \mathrm{AGE} + 0.6949\ \ln \mathrm{AGT} + 0.0594\ \ln \mathrm{TRAF} + 1.9420$$

Where
CSN = annual change in skid number
RGN, AGE, and TRAF are the same as used in equation (1) and AGT = type of aggregate; 1 for basalt, 2 for gravel, and 3 for limestone.

Ride index immediately after overlay was related to the ride index before and thickness.

$$LN\ (RI_a) = 1.628 + 0.309\ LN\ (RI_b) - 0.237\ LN\ (THIK)$$

Where
RI_a = Ride Index After Overlay
RI_b = Ride Index Before Overlay
THIK= Thickness of Overlay

When an overlay was built with asphalt rubber or heater scarification a correction factor called CRH was used to reduce the amount of change in ride per year. Since completion of the 1976 project a CRH of .7 was used for heater scarification and .6 for asphalt rubber.

Roughness index was defined as the Mays meter roughness, however, in 1976 this value was interpreted differently than at present. To convert the 1976 value to the correct value it must be multiplied by 6.4.

The above represented ADOT and Woodward-Clyde's best approximation of future ride and skid number. During two and one half years of using these equations it became obvious that a percent cracking prediction model was needed as well as an improved ride model based on real data. The skid number prediction model, although technically correct, was always predicting no future problem due to aggregate abrasion, nevertheless serious low skid numbers did occur evidently for other reasons. Generally these reasons were of an uncontrollable nature at the construction site or maintenance activity. With these historical experiences in mind it was decided in this project to develop prediction models for both roughness and percent cracking. Skid numbers would not be predicted, but rather monitored closely to determine those miles of highway in need of fix up. It is hoped that historical construction and maintenance data accumulated as part of this project will in the future be able to identify and correct the reasons for low skid number.

Factorial Design

Since results of the Phase II work would be incorporated into the Phase III, discussions were held to set guidelines for the new prediction models. These guidelines included the following:

1. Models (equations) should be able to predict next years ride and percent cracking very accurately. This was necessary because those highways to be overlayed next year will be in next year condition at the time of overlay, also annual monitoring of condition would insure that next years values would be known.
2. Models should be able to predict reasonably well for a four to five year time frame. This would fit into the five year plan which ADOT must compile and present to the ADOT commission and Governor for approval each year.
3. Models should contain no more than five independent variables; preferrably less. In this way the size of the network problem could be kept within reason.
4. Models should predict in one year increments.

With these guidelines, an incomplete factorial experiment was designed by Woodward-Clyde and is shown on Figure 1. Originally only projects built since 1969 were going to be incorporated into the project. 1969 represented a year when a new set of specifications were published, also the design of

FIGURE 1

1/3 FACTORIAL DESIGN: FILL THE CELLS WHICH ARE MARKED.
(Requires a total of 27 units.)

	Environment	1			2			3		
Ride Index	Deflection / Age in Years	3 to 7	8 to 12	13 to 17	3 to 7	8 to 12	13 to 17	3 to 7	8 to 12	13 to 17
H	H		X		X					X
	M	X					X		X	
	L			X		X		X		
M	H	X					✓		X	
	M			X		✓		X		
	L		X		X					X
L	H			✓		X		X		
	M		✓		X					✓
	L	X					X		✓	

X = Main Experiment ✓ = Replicates

asphaltic concrete (AC) changed. It was not possible to fill more than half of the cells, the sample was changed to increase the time frame from 1963 to the present. 1963 was selected because it represented that time when the AASHTO Interim Guidelines (2) were put into practice. The selection process was widened to include any mile of highway built since 1963 and a mile could represent more than one cell, as its condition changed with time. Unfortunately the cell design was unsatisfactory in solving the problem due to the use of ride index and deflection as factors that were constrained or bracheted into region. A substitute factorial scheme was devised. In this new scheme region and time were divided into three levels as shown below.

Regional factor (AASHTO)	0 - 1.6	Desert
	1.7 - 3.0	Transition
	3.1 - 5.0	Mountains
Age of AC Pavement	0 - 5.0	Years
	5.1 -10.0	Years
	10.1 -15.0	Years

This produced nine combinations. For each combination 15 different miles were randomly selected, giving a total of 135 miles of new construction and 135 miles of overlays. Thus each sample represented about 2.3 percent of the miles in the system. Woodward-Clyde advised that this was a more than adequate sample size. In addition those miles where all data were present were also included. That is if roughness, cracking and deflection data were present for years 1973, 1975 and 1979, all of these years of data were included under the same milepost. Appendix A gives a description of the data as well as all the data used to generate future correlations. Basically this data included the following.

- Route number
- Direction
- Milepost
- Cell number
- Record year - year condition tests performed
- Regional factor - AASHTO regional factor, derived from elevation, rainfall and climate zone.
  .1 of a point for each 1000 feet of elevation,
  .1 of a point for each inch of average annual rainfall and .1 for climate zones as shown on Figure 2.

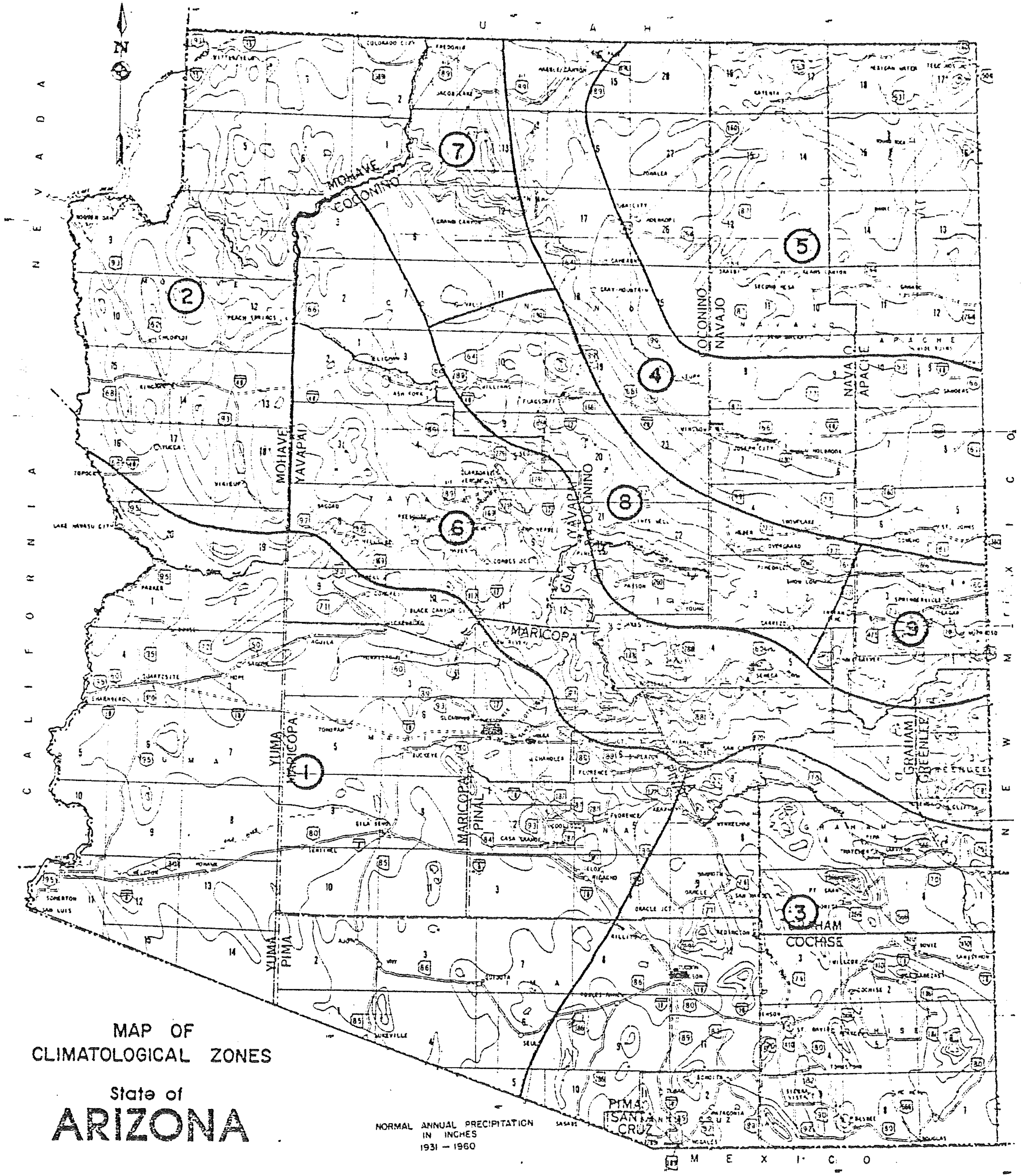
- Thickness of original AC surfacing in inches
- Thickness of AC overlay in inches
- Number of single axle equivalent 18 kip (80 kn) traffic in year of record

- % cracking in year of record
- % cracking one year after year of record

- Mays meter inches of roughness in year of record
- Mays meter inches of roughness one year after year of record

- Dynaflect deflections in milliinches (1.0 is equal to .001 inches of deflection) for all five geophones. All deflections were

FIGURE 2



MAP OF CLIMATOLOGICAL ZONES

State of

ARIZONA

NORMAL ANNUAL PRECIPITATION IN INCHES 1931 – 1960 temperature corrected according to the Asphalt Institute method (3).

- Age of pavement according to the year of record. If year of record 1976 and age 8 years, then pavement was built in 1968.

Consideration was given to other variables such as soil support, unbound base thickness, density, moisture, grading, asphalt content and asphalt type, however, either values for these variables were missing or too much uncertainty surrounded their determination. That is new construction or overlay asphalt content and type might have been found, a question would arise as to how applicable they would be to pavements 10 years old which have been flushed or seal coated, thus they were not investigated.

A number of regression runs were made to determine correlation to either the roughness or percent cracking directly from the other variables. New variables were created which included spreadability index, surface curvative index, base curvative index to name a few. Direct correlation of all variables to either the magnitude of roughness or percent cracking gave very poor results. An approach similar to the 1976 equation was attempted, which included the use of the change in roughness (ΔR) and change in percent cracking ($\Delta\ \%C$) per year. This approach developed equations which represent the new predictive equations based on real data.

New Models (Equations)

The models developed represent prediction of future roughness and percent cracking conditions based upon past experience. These models are intended to be used in conjuction with annual pavement condition surveys. These models are not design equations because they do not give any insight into what caused the new future distressed condition. Rather they represent a what system of examination and prediction. That is given what happened they predict what will happen. Design equations are why systems which represent why particular failures occur and develop design strategies to prevent or delay such occurrence. The following predictive models were developed and represent ADOT's future predictive models

New and In-Service Construction

Percent Cracking

$$\Delta\%C_n = 0.55(\Delta\%C_p) + 0.031(\%C_p * \%C) + 0.01(R_g)^2 + 0.05(R_g * \%C) - 0.0059(\%C)^2 + 0.186$$

$R^2 = 0.70$; Standard Error = 0.64, F Value = 84

Where

$\Delta\%C_n$ = Change in Amount of Cracking During Next Year
$\Delta\%C_p$ = Change in Amount of Cracking During Previous Year
$\%C$ = Present Amount of Cracking
R_g = Regional Factor

As an Example, Given:

1976 Percent Cracking = 10
1977 Percent Cracking = 15

Change in Percent Cracking = 5
Regional Factor = 2.0

Find the 1978, 1979 and 1980 Percent Cracking

Year	% Cracking	Change In % Cracking
1976	10	5
1977	15	5
1978	20	7
1979	27	7
1980	34	

Roughness

$$R_n = 0.138(R) + 2.65(Rg)^2 - 0.047(Rg*R) - 0.125$$

$R^2 = 0.54$, Standard Error = 10.4, F-Value = 38

Where

R_n = Change in Roughness During Next Year
R = Present Roughness
R_g = Regional Factor

Example, Given:

1976 Roughness = 100 inches/mile
Regional Factor= 2.0
Find the 1977, 1978, 1979 Roughness

Year	Roughness	Change in Roughness
1976	100	15
1977	115	15
1978	130	17
1979	147	

Naturally each year new roughness and cracking values would be measured in the field thus the starting value or seed value would change to reflect the real world value.

Percent Cracking — Overlay

$$\Delta\%C_n = 0.51 + 0.069(\%C) + 0.52(\Delta\%C_p) - 0.0034(D_L)^2 - 0.003(\%C)^2 + 0.068(\Delta\%C_p)^2$$

$R^2 = 0.68$, Standard Error = 0.71

Where

All symbols mean the same as before except one new term has been added.

D_L = Index to first year of cracking. Factor which represents the relative amount that each overlay and overlay plus treatment delays the first crack. Appendix B gives the index values for all treatments.

It should be noted that immediately after an overlay, both %C and $\Delta\%C_p$ are set equal to zero to predict the change in cracking in one year. The term D_L accounts for benefit derived by using various treatments to prevent reflective cracking and is similar to the use of CRH in the 1976 Woodward-Clyde model.

EXAMPLE:
Given 1976 existing highway with

Regional Factor	= 2.0
Traffic	= 4000 ADT
Present Cracking	= 20 Percent
Change in Cracking in last year	= 3

2.5 inch AC overlay would have an index to first crack of 6.5.

Find Percent Cracking In Years 1977 to 1984

Overlay One Year	Year	Percent Cracking	Change In Percent Cracking
	1976	20	3
Overlay	1976	0	0
(1)	1977	0	0
(2)	1978	1	1
(3)	1979	2	1
(4)	1980	3	1
(5)	1981	4	1
(6)	1982	5	1
(7)	1983	6	1
(8)	1984	8	2
(9)	1985	9	1

Roughness

For an overlay the roughness change was found to be related to the roughness before overlay.

$$R_N = 65.29 - .78(R_B) - 7.76(TH)$$

$R^2 = .9379$

Where

R_N = Change in roughness one year following an overlay in inches/mile

TH = Thickness of overlay in inches

R_B = Roughness before overlay

Note: If calculated roughness after overlay less than 50, roughness set to 50.

After overlay at which time the in-service equation is used to perform future calculations.

EXAMPLE:

Given a 1976 pavement with the following conditions

Roughness = 200 inches/mile
Regional Factor = 2.0
Overlay thickness of 2.5 inches of AC

Find Roughness for 1977 Through 1985

	Year	Roughness	Change In Roughness	Overlay
	1976	200		Roughness Model
One Year	1976	Overlay		
After	1977	90	110	
(2)	1978	104	14	In-Service Roughness Model
(3)	1979	120	16	
(4)	1980	135	15	
(5)	1981	152	17	
(6)	1982	169	17	
(7)	1983	187	18	
(8)	1984	205	18	
(9)	1985	225	20	

For both roughness and percent cracking the actual amount one year after construction will be monitored. In order to test the accuracy of future predictions a verification process were undertaken.

Verification

Twenty nine miles of new construction or in-service pavements as well twenty four miles of overlays were randomly selected from the ADOT file.

Appendix C gives each mile, as well as pertinent data about each mile. A verification test was conducted by comparing expected future predicted roughness and percent cracking to actual measurements. In addition the predicted 1976 roughness derived from Woodward-Clydes original equation was also calculated. Since many projects were designed using the AASHTO equation the predicted present serviceability values were also calculated.

To test the equations it was necessary to conduct two separate calculations.

1). Given some starting roughness value (50 inches per mile) and cracking value (0 percent cracking) representative of the pavement immediately after new construction or overlay calculate the expected future ride and cracking and compare to the actual value.

Examples:
Case 1 - Given a mile of highway built in 1970 assume the new ride equals 50 inches per mile and 0 percent cracking.

Year	Actual Ride	Calculated Ride	Actual % Cracking	Calculated % Cracking
1970	42	50*	0	0*
1971	57	55	0	1
1972	63	60	1	2
1973	70	65	1	3

* 50 and 0 assumed.

Case 2 - Given some existing ride or % cracking condition calculate ride or % cracking in a future year.

Example: Given a mile of highway find the actual measured ride and % cracking for a given year. Use this measured value to calculate the ride or % cracking in a future year.

Ride			Calculated	Ride
	Actual			
Year	Ride	Given		
1972	69	1972	Given	
1973	75	77	1973	Given
1974	86	90	87	1974
1975	103	110	105	100

% Cracking

Year	Actual % Cracking		Calculated	% Cracking
1973	5	Given 1973		
1974	7	8	Given 1974	
1975	9	12	10	Given 1975
1976	15	16	14	13

To interpret results of the above analysis regressions between the actual and calculate ride and percent cracking were performed. This is quite straightforward for case 1, however, for case 2 actual and calculated values were grouped by year. Thus all one year predictions were grouped together. likewise all two year, three year and so forth.

To thoroughly examine the worth of the prediction equations, similar analysis were performed with the old SOMSAC equations and the present servicability (PSI) equation. Appendix D gives a summary of information for each site by site number, Information includes:

- Site location - Route, milepost, direction
- 18 kip single axle Equivalents in 1978
- Structual numbers
- Soil support
- Regional factor
- Beginning PSI
- Traffic Growth factor
- Year built
- % cracking
- Rut depth   By year
- Ride
- PSI

To derive structual number for new construction AC was given a coefficient of .40 and base .12 per inch of thickness. For overlays the new AC was given a coefficient of .40 per inch and the old AC a coefficient of .20 or half the new value per inch. Existing PSI values were derived by using correlations determined in an earlier report (4). These correlations relates ride roughness to slope variance and Arizona percent cracking to ADOT class 2 and 3 cracking. Figures 3 and 4 show these relationships. Calculations from the raw data represented about 180 pages of values, therefore, summaries of the calculations are reprinted here Appendix D. Predicted versus actual roughness and percent cracking figures with correlations, standard errors and coefficient of variation are shown in Appendix E by site number.

FIGURE 3

MAYS RIDE METER ROUGHNESS VS. SLOPE VARIANCE

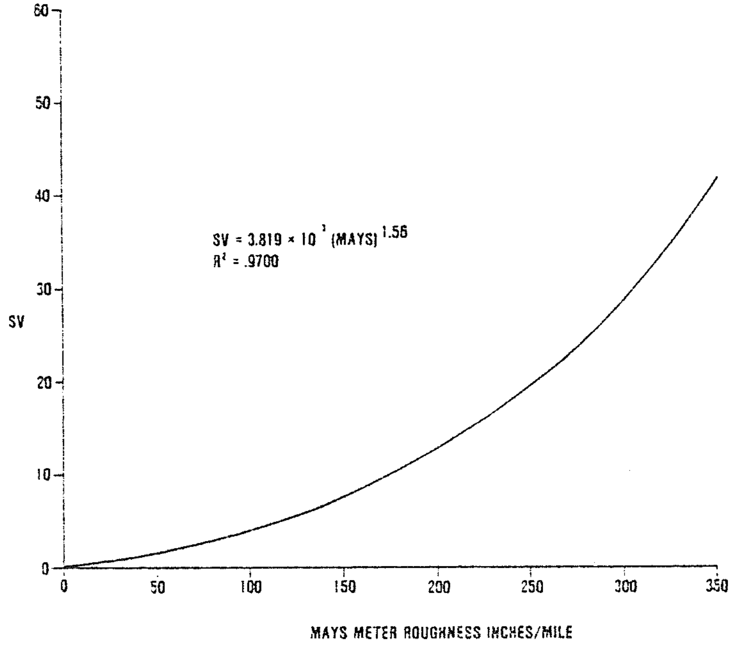
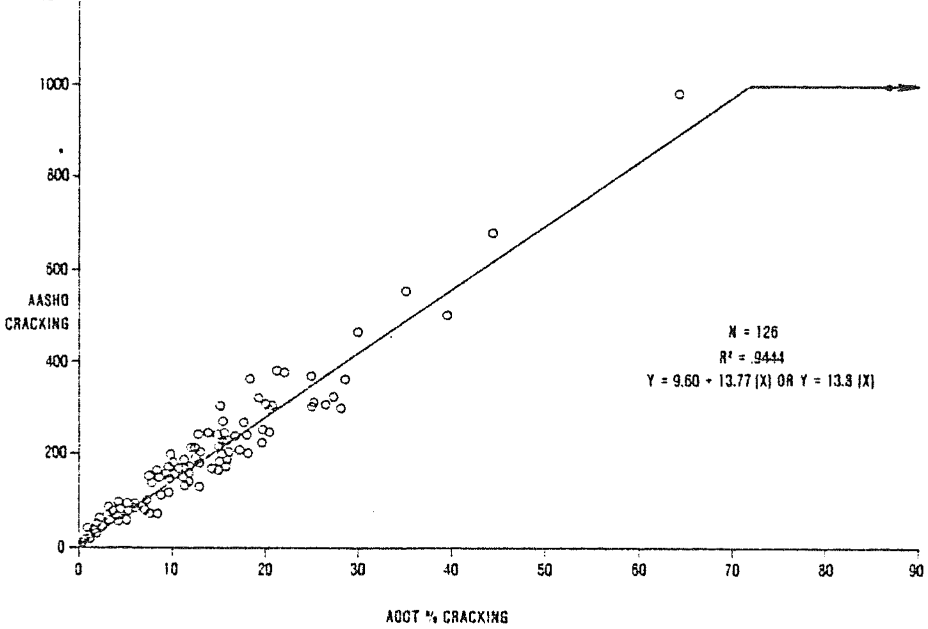


FIGURE 4

ADOT % CRACKING VS. AASHO ROAD TEST CRACKING



Interpretation - New Construction

Two cases of predicted future performance were examined and will be interpreted.

Case 1: Prediction at design stage.

For all miles of highway a predicted expected future roughness or cracking was determined and a correlation between actual and predicted values was performed. By examining Appendix D and E values it was possible to determine if there were and relationships between the correlation, standard error or the slope of the correlation line (B) and time in years. Thus making it possible to establish inferences about the equations ability to predict the future.

Roughness

Figure 5 shows the relationship between the correlation squared and time in years. No trend is observed indicating the equations ability to predict future performance reasonably well over a time period of 32 years.

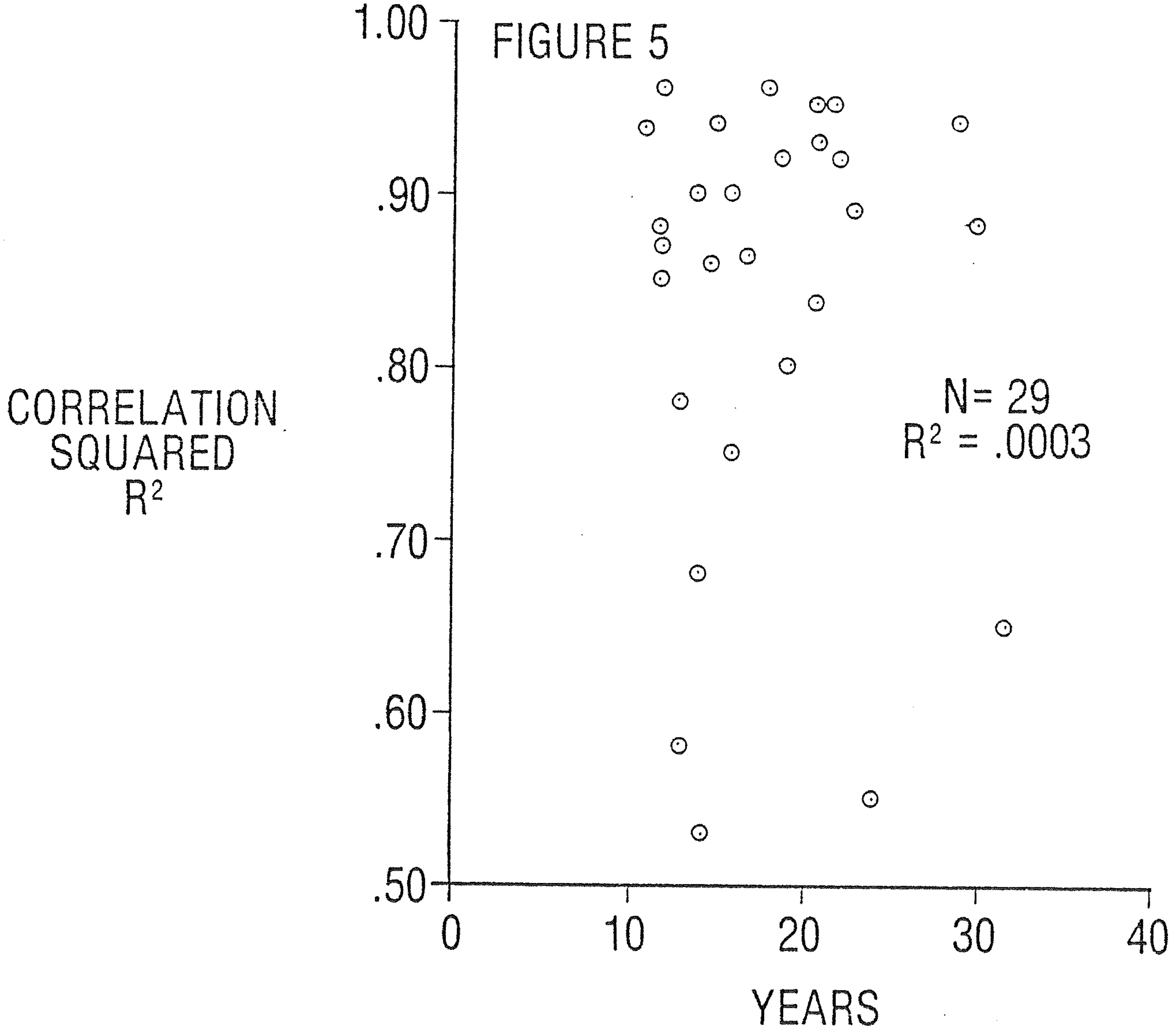


Figure 6 shows the standard error versus time in years. Although the correlation squared value is low, the trend does indicate increasing standard error with time. Hence as the equation predicts into future years the error in prediction increases which is to be expected. Correlations for both Figures 6 and 7 although low are nonetheless good since they represent results expected by project participants.

FIGURE 6

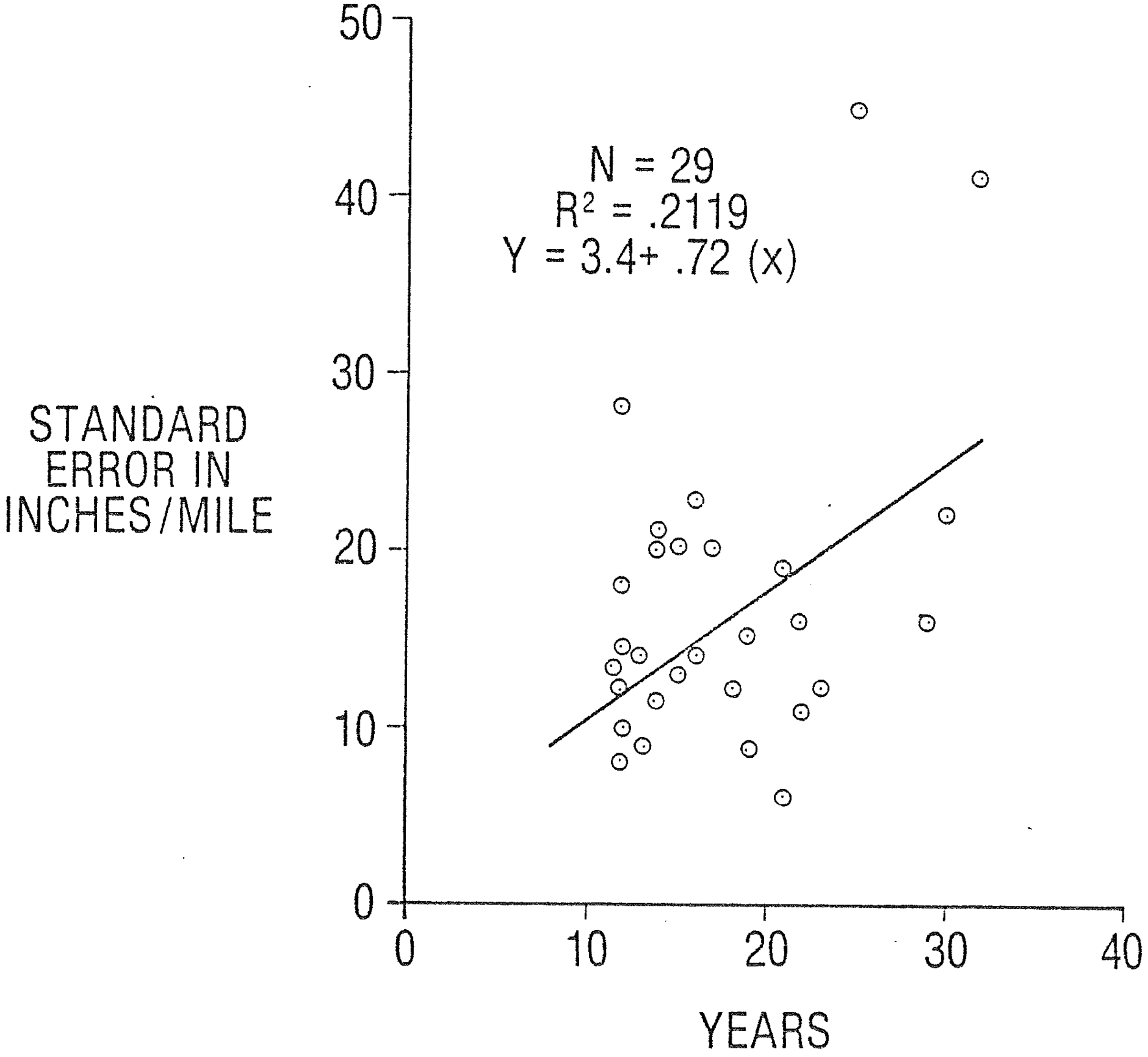


Figure 7 shows the slope of the line (B) versus time. The slope of the line becomes shallower with time. This indicates that as years go by the equation will predict more roughness than actually occurred. It would be most desirable if the slope were close to 1.00. To account for this it is suggested that the average slope of .48 be multiplied times the results from the equation, thus giving an average slope closer to 1.00 and predicted values closer to the acutal magnitude of measured values.

The intercept value (A) was not related to time thus the average value of 19 represents a reasonable correction value, however, this number is small and it is suggested no correction be made to the A coefficient.

Since most highway engineers are very concerned with the life of the pavement the design phase equation gives an opportunity of looking at expected life. Table 1 gives a comparison between the PMS predicted life to a very rough condition and the adjusted PMS predicted life (slope B = .48).

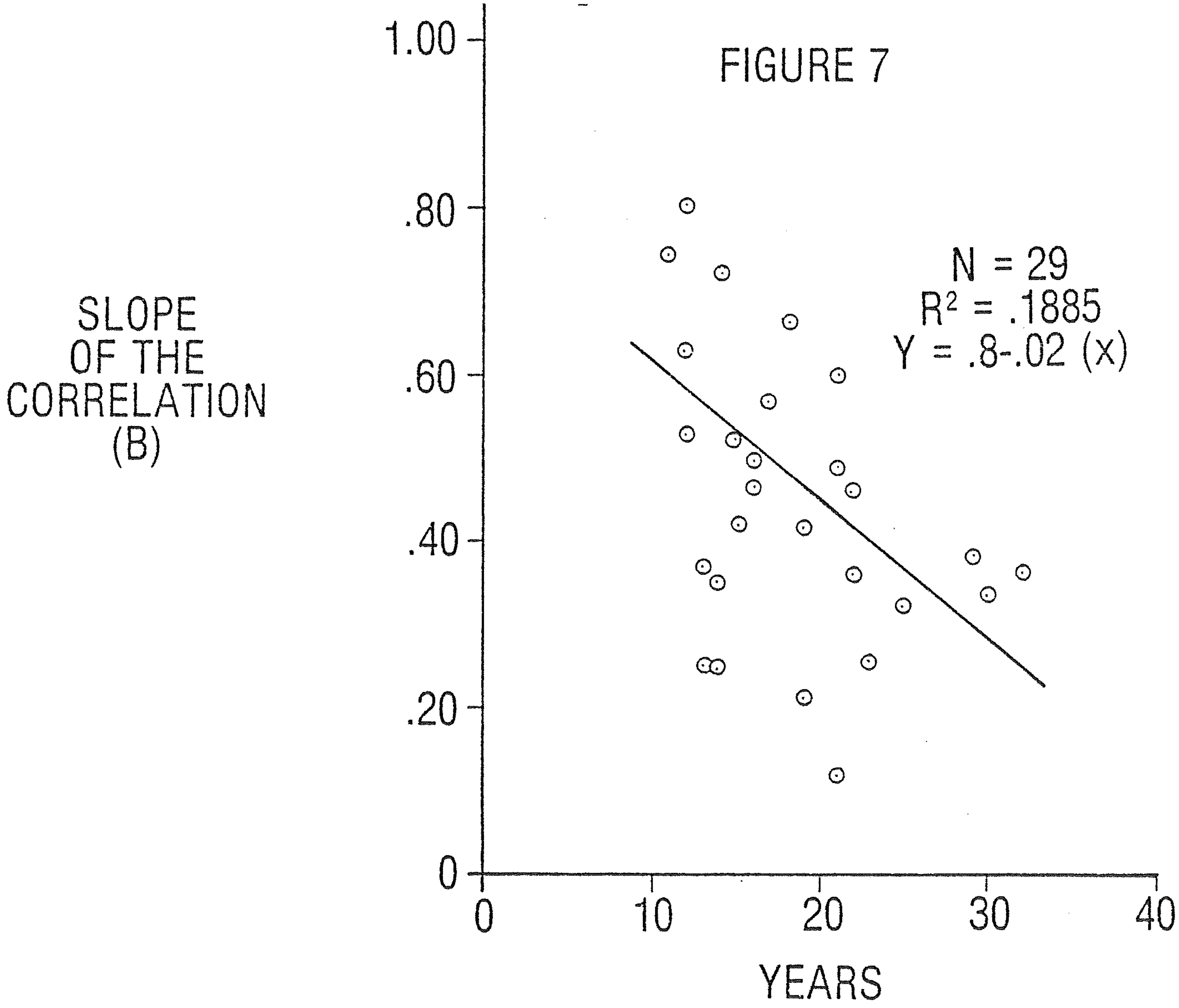


FIGURE 7

Table 1

Years to 256 inches/mile Roughness

	Region	PMS Prediction	Adjusted PMS Prediction
Desert	.5	15	21
	1.0	15	23
	1.5	14	23
Transition	2.0	13	23
	2.5	11	22
Mountains	3.0	9	21
	3.5	7	19
	4.0	6	17
	4.5	5	15

To further substantiate the adjustment sites 12, 14, 19, 21, 24, 28 and 29 all reached the 256 inch/mile value during their life. The average years to this condition was 19 years. The PMS average predicted years to the same condition was 10, whereas the adjusted average predicted years was 21. The adjusted value is much closer to the real world experience.

It was stated earlier in the report that the PMS equations are not design equations, however, they should reasonably well predict future expected distress conditions. In this respect the PMS equations can serve to alert the designer to the expectation that a design will most likely perform in the predicted manner. Given this prediction the designer may choose to reexamine the design to determine if additional structual components (more thickness, stabilization, different asphalt etc.) might be necessary to compensate for future expected distress. Therefore the PMS equations can serve as useful guides to the designer.

Cracking

Figure 8 shows the correlation squared versus time. A strong correlation exists indicating that predictions beyond 20 years should be interpreted as generally poor.

FIGURE 8
% CRACKING

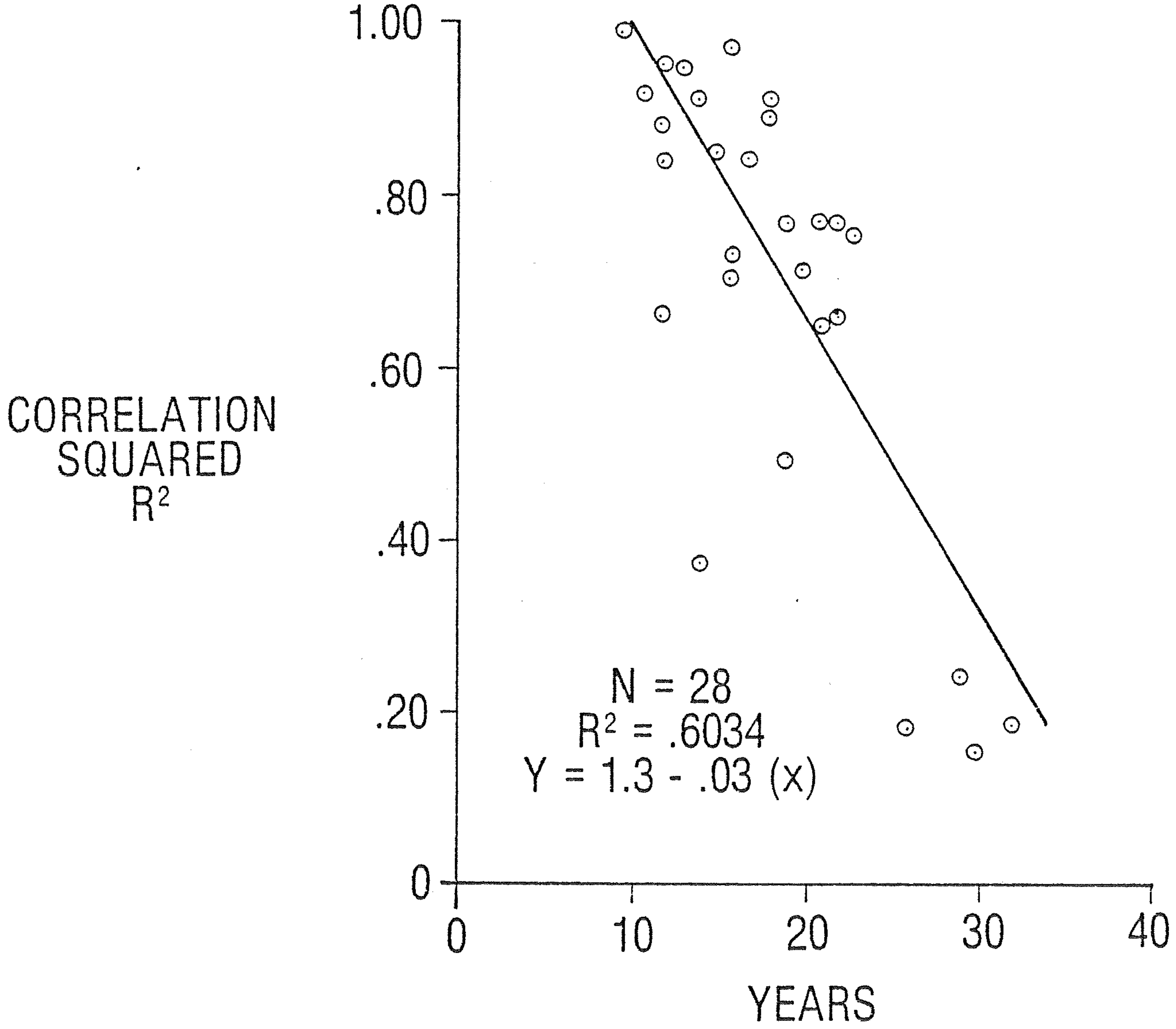


Figure 9 shows that standard error for cracking, like roughness, increases over time. Hence greater error occurs with attempts to predict future cracking.

FIGURE 9
% CRACKING

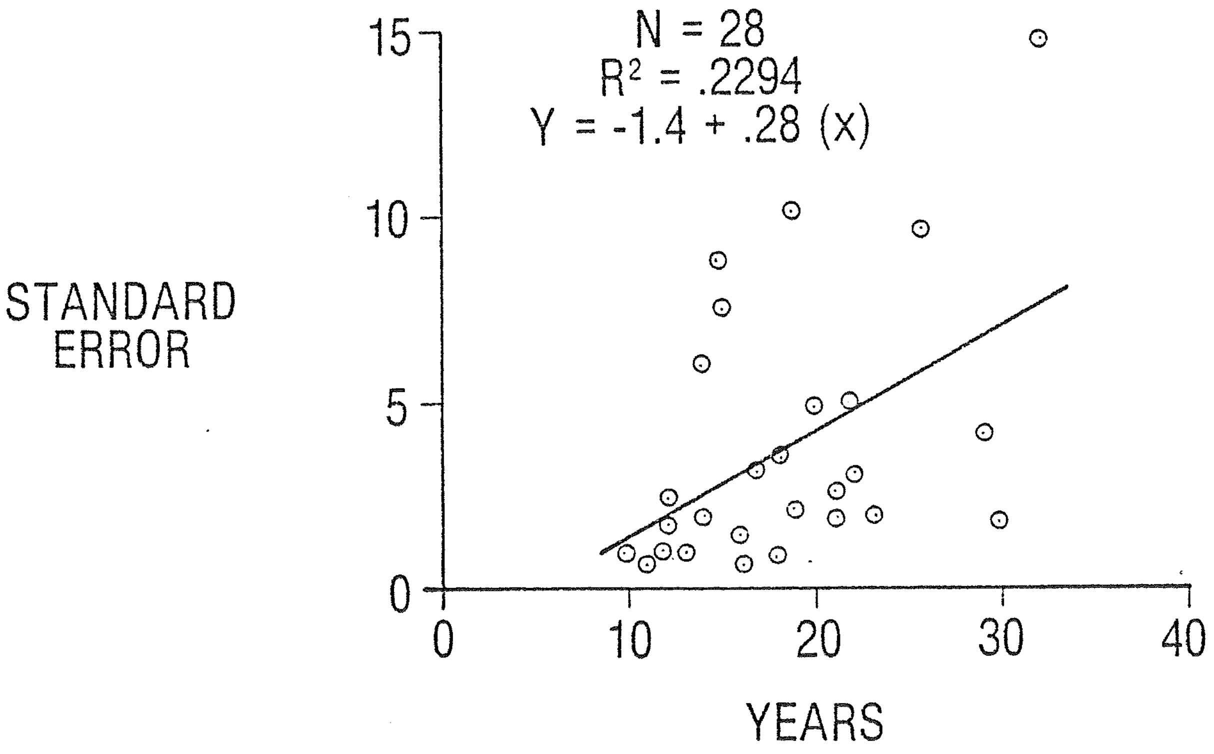
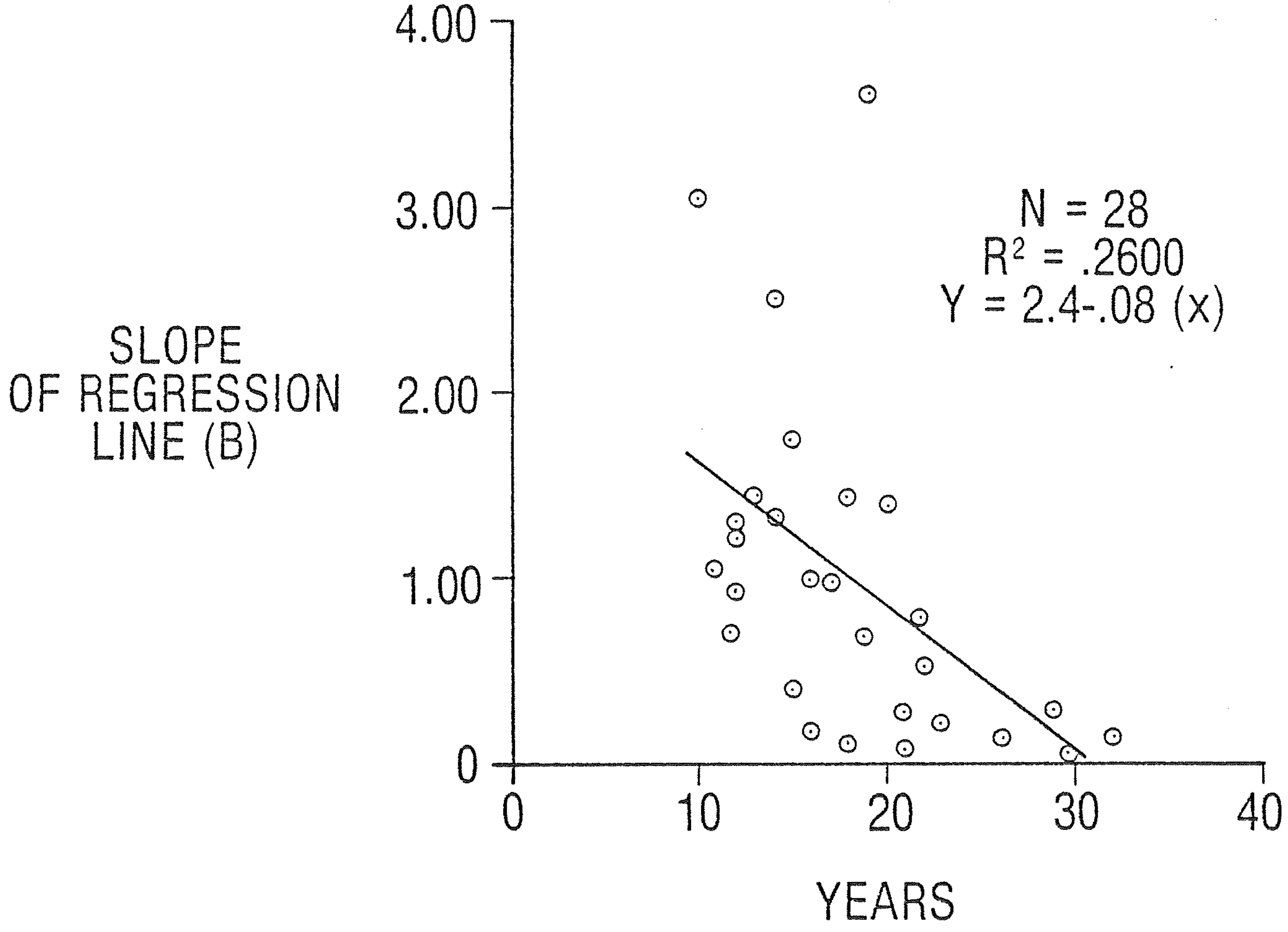


Figure 10 gives the slope (B) versus time. Like roughness slope (B) decreases with time. Over long periods of time greater cracking than occurred will be predicted. Unlike roughness, however, the average slope is close to 1.00, which is of course very disirable. Therefore no correction in slope (B) is suggested. Within the Phase III network optimization system (NOS) only one year predictions are necessary thus no adjustments are needed for NOS.

FIGURE 10
% CRACKING



One of the problems in predicting cracking is the non-continuous nature of cracking. That is the occurrence of the first crack is often delayed many years as shown on Figure II. This figure indicates that pavements built in 1949 first cracked in 1968, 1959 first cracked in 1970 and 1969 first cracked in 1971. There are several possible explanations for this behavior, which include the following:

A). Pavements of 20 years or more of age represent those few remaining structures which exhibited superior performance and would thus indicate exceptionally long crack lives.

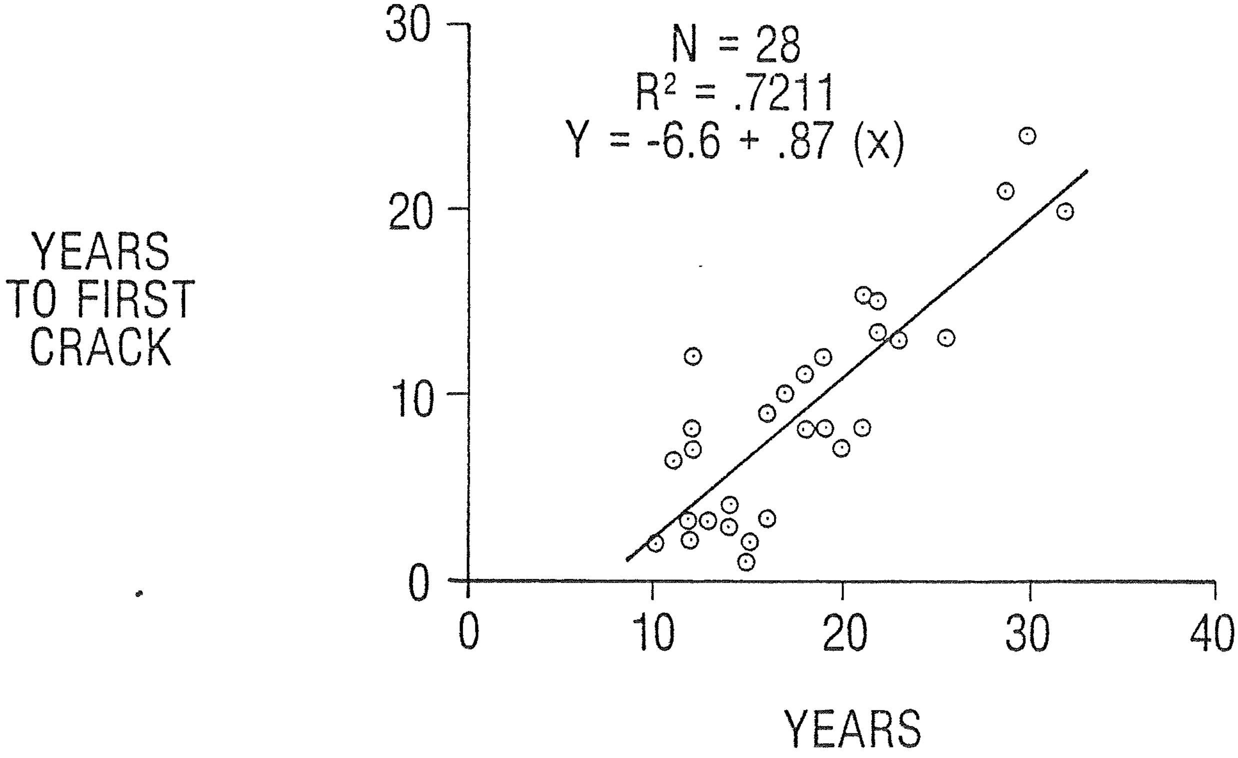
B). Pavements of 20 years or more of age were built to be very flexible, with generally two inches or less of original surfacing. Orginal surfaces generally contained high penetration (200/300) or liquid asphalt (SC-3000).

C). Pavements of 20 years or more of age originally received very light traffic in comparison to todays traffic.

D). Maintenance (seal coats and patches) has tended to cover up cracks, hence masking the true cracking, such that the initial crack survey in 1973 did not see any cracks.

For all the above reasons it is difficult to fairly interpret projects built more than 20 years ago, however, even considering these uncertainties the cracking model in its present form represents a valuable tool to predicting cracking for individual miles of highway up to 20 years.

FIGURE 11



Using the equation it is possible to predict the numbers of years to some future cracking, such as 10 percent. Table 2 shows these values.

Table 2

Years to 10 Percent Cracking

	Region	PMS Prediction
Desert	.5	22
	1.0	16
	1.5	13
Transistion	2.0	12
	2.5	11
Mountains	3.0	10
	3.5	9
	4.0	8
	4.5	8

Comparing those sites which reached 10 percent cracking to the predicted number of years gave the following.

26 sites reached 10 percent cracking

Actual Average Number of Years to 10 Percent	Predicted Average Number of Years to 10 Percent
15	12

Considering all the uncertainties in predicting cracking this is very good agreement. For sites built in the last 20 years the agreement is even better with the actual average number of years being 12 years and predicted 13 years.

In summary the PMS prediction models for both roughness and cracking for case 1, prediction at the design stage, is remarkably good considering the uncertainties in site specific prediction.

Case 2: Prediction given an existing condition in the field.

For all miles of highway a predicted expected future roughness or cracking was determined for each future year based upon an existing condition.

Roughness

Roughness measurements have been taken since 1972, hence only those actually measured values were used in this part of the interpretation. Table 3 summarizes results of this work.

Table 3

Correlation Between Predicted Future Ride in Years 1 Thru 7 Based on a Measured Ride Now. Case 2

Future Year Ride Predicted	N	R^2	Standard Error	A	B	Coefficient of Variation C.V.
1	195	.8922	25.4	9.2	.90	12%
2	169	.8622	28.7	12.6	.84	14
3	139	.8327	31.4	12.9	.80	16
4	111	.8144	33.4	15.8	.75	17
5	82	.8047	34.8	16.0	.73	18
6	53	.8066	34.6	19.7	.70	17
7	25	.8085	36.6	5.9	.74	18

The values in this table clearly show that the PMS equation is very good in predicting the future roughness condition given the present existing pavement condition. The coefficient of variation is below 20 percent from 1 year to 7 years which is also very good, considering the uncertainty of the future. It should be noted that the slope (B) decreases with time. This is similar to the case 1 trend. In order to equate the predicted values more closely to the actual values in terms of magnitude it is suggested that an adjustment factor be used, which is equal to the slope (B) up to four years and then set equal to .70 for five or more years.

In general the PMS equation is capable of predicting future roughness extremely well given the existing condition of the highway.

Preditions of cracking with small standard errors (below 20 percent coefficient of variation) are at best very difficult to make due to large increases in cracking that can and do occur in one year. With this in mind the present PMS equation is considered to be a very good prediction model.

Table 4

Correlation Between Predicted Percent Cracking in Years 1 Thru 6 Based on a Measured Percent Cracking Now

Future Year % Cracking	N	R^2	Standard Error	A	B	Coefficient Of Variation
1	163	.9186	4.0	1.8	.89	12%
2	136	.8266	6.0	4.5	.72	18
3	107	.6435	9.0	8.0	.55	28
4	79	.6158	9.7	10.2	.53	30
5	49	.6068	10.0	12.8	.45	31
6	20	.7091	8.5	13.2	.42	26

Correlation squared (R^2) values, although lower than the roughness values, are still quite good. The standard error and coefficient of variation are above 20 percent an indication of how dramatic increases in cracking can occur in the field. The slope (B) value decreases with time and should be used to adjust the predicted cracking values back down to magnitudes closer to those observed in the field. For those years beyond five or more an adjustment factor of .40 is suggested.

In summary the new PMS equations for both roughness and cracking for both case 1 and 2 can do a very good job of predicting future pavement distress conditions.

This is possible because the models (equations) are of a recursive form. The logic behind a recursive model is that a future condition is dependent upon a past condition. Thus more roughness or cracking accelerater the rate of progression to still more and more roughness and cracking until the pavement has lost its desirable serviceability and structual characteristics. To demonstrate still further how the recursive model emulates the real world additional investigations were performed.

SOMSAC

In the first PMS project Woodward-Clyde developed a model to predict future ride through a Bayesian statistical approach using extensive interviews with knowledgeable highway engineers (1). To further compliment this report a similar set of predicted future roughness values was developed by using the SOMSAC equation in a recursive mode. Results of this comparison can be found on Appendix D and E. In terms of case 1 (Prediction at design stage) the SOMSAC correlations compared on the average as shown in Table 5.

Table 5

PMS - SOMSAC Comparison for Case 1 - Same Sites; Same Time Frame

Average	PMS	SOMSAC
Correlation Squared R^2	.8431	.8111
Standard Error	16.4	18.5
A	18.8	30.4
B	.48	.33
Coefficient of Variation	14%	15%

Even though the PMS model contains fewer terms than SOMSAC, it does a better job of predicting. This is not too surprising because PMS was developed with real observations whereas SOMSAC was developed by guessing. What is surprising is how well SOMSAC predicted considering that no data or observations were used. Evidently highway engineers tended to feel that pavements would last a considerably shorter length of time than actually observed. This can be seen in the two slope (B) values. To understand this three equivalent examples were selected to portray the differences between PMS and SOMSAC predictions in terms of years to an objectionable roughness (256 inches/mile).

Predicted Years to 256 inches/mile Case 1

AASHO REGION	SOMSAC REGION	AJUSTED PMS	PMS	SOMSAC*
1.0	1.0	23	15	11
2.0	2.0	23	13	7
3.0	2.0	21	9	7

* Deflection .001 inch
Traffic 50,000 18 kip per year
Thickness 6 inches of AC
Traffic Growth 1.05

The SOMSAC model predicts an objectionable ride will occur sooner then it actually does by as many as 12 to 14 years.

Case 2 (Prediction given on existing condition in the field) comparisons are shown on table 6. Detailed values by year are shown Appendix D.

Table 6

PMS - SOMSAC Comparison for Case 2 Same Sites; Same Time Frame Years 1 Thru 7

Average	PMS	SOMSAC
Correlation Squared R^2	.8316	.6639
Standard Error	32.1	44.5
A	32.2	28.4
B	.78	.73
Coefficient of Variation	68%	22%

Not surprisingly the PMS equation is again better than the SOMSAC equation. Interestingly though, in this mode the SOMSAC slope (B) is quite close to the PMS value, however, the correlation and scatter are not as good. Examining both Case 1 and 2 the PMS equation is better than the SOMSAC equation.

Present Serviceability Index - PSI

In addition to trying SOMSAC, the PSI design equation for flexible pavements (2) was also tried in the recursive mode. By incrementing traffic it was possible to calculate future expected PSI values and compare them to measured values. Table 7 shows results of this comparison.

Table 7

PMS - PSI Comparison for Case 1

Average	PMS	PSI
Correlation Squared R^2	.8431	.8677
Standard Error	16.4	.7
A	18.8	-14.7
B	.48	4.6
Coefficient of Variation	14%	5%

Using the recursive approach the PSI equation can do a good job of predicting the future PSI, however, the equation is not applicable to all cases. Of the 29 sites it was possible to use the PSI equation on 16, for the other 13, irrational values were calculated. This was primarily due to the low structural numbers (S_N). Such numbers when combined with the 18 kip traffic loading gave ridiculous answers. Therefore the use of the PSI equations for the entire network would be very difficult. In addition using PSI equation routinely would mean the annual collection of considerable more data than is currently collected.

Examining the PSI prediction equations per each site a very large slope (B) value is determined. This equates to predicting much longer lives than actually occurred. To see this table 8 was created. Generally predicted years to 2.5 PSI tend to be more than observed. Another indication can be seen by looking at pavements built since 1963 (year AASHTO interim guides came into use in Arizona). Table 9 shows that 33 percent of the sites have already reached the 2.5 PSI level. This is yet another indication that the PSI equation tends to predict longer lives than are actually observed.

Table 8

AASHTO Region	Actual Years* To 2.5 PSI	Predicted Years to** 2.5 PSI
1.0	18	36
2.0	14	25
3.0	12	20

*Rough average of actual sites
**Traffic 50,000 18 kip per year beginning
SN = 3.88 (6 inch AC, 14 inch base)
SS = 5.00
PSI at beginning = 4.20
Traffic growth = 1.05

Table 9

Number of Sites Built Since 1963 = 15

Sites which Reached 2.5 PSI Since Construction		Sites which did not reach 2.5 PSI Since Construction	
Years of age	No.	Years of age	No.
6	1	8	1
7	1	10	2
14	2	12	5
16	1	14	2
Total	5	Total	10

The PSI equation could also be used in a recursive mode for Case 2 (Prediction given an existing PSI condition in the field). Table 10 shows a comparison between the PMS and PSI for a Case 2 mode. The PSI does not predict as well as the PMS equation in this mode. This is not too surprising since the PSI equation was not developed with this use in mind. In addition the equation is based on AASHTO road test data not Arizona data. Even with these stipulations the recursive mode isn't totally bad.

Table 10

PMS - PSI Comparison for Case 2

Years 1 Thru 7

Average	PMS	PSI
Correlation Squared R^2	.8316	.6959
Standard Error	32.1	.33
A	13.2	.56
B	.78	.76
Coefficient of Variation	16%	10%

In summary two additional approaches to predicting future pavement conditions using a recursive form of the equations were tried. Both approaches give reasonably good approximations given the fact that neither one was specifically designed using Arizona data. In examining both the SCMSAC and PSI equations several trends were observed and adjustments suggested. The PMS equation for roughness appear to be a very useful inventory predictor of future roughness. For purposes of design either SCMSAC of AASHTO should be adjusted to give closer approximations.

Overlays

Both Case 1 and 2 were similarly examined for overlay sites. Appendix A, D and E give detailed data for overlay sites. In all 24 overlay sites were examined.

Roughness

Case 1

Unlike the new construction Case 1 very little correlation was found between years and correlation squared (R^2), standard error or slope (B) as can be seen in Table II. These values are good since they indicate no bias with time.

Table 11

Correlation to Future Years

x=years

Y	N	R^2
R^2	24	.0576
Standard Error	24	.0477
Slope (B)	24	.0332

Hence average of all site values appear to be reasonable indicators. Average values are as follows for the 24 sites.

Average Values

Correlation squared (R^2) = .7193
Standard error = 13.04
A intercept = 20.68
Slope (B) = .42
Coefficient of Variation = 18%

Of note again is the low slope (B) value, which as in the new construction work, indicates an overprediction of future roughness. It is suggested an adjustment of .42 be made to the equation thus giving more reasonable answers. The overlay PMS equation is the same as the new construction equation except a second equation adjusts the future predicted roughness based upon the existing highways present roughness. To demonstrate this, plus the adjustment, Table 12 was developed.

Table 12

Overlay* Years to 256 Inches/Mile

Present Roughness Inches/Mile Before Overlay	ASHTO Region	Roughness PMS	Adjusted PMS
250	1.0	15	25
	3.0	9	25
350	1.0	11	20
	3.0	8	20

*2 inch overlay

Since the slope (B) is .42 for overlays and .48 for new construction this would indicate that even thin overlays are capable of maintaining the ride for about the same number of years as the new construction.

Cracking - Case 1

Correlations between years and correlation squared (R^2), standard error or slope (B) shows no trend as the figures below show. As in roughness the average site values can be used as reasonable indicators. Since there is no bias with time.

Correlation to Future Years

Y	N	R^2
R^2	24	.0398
Standard Error	24	.0320
Slope (B)	24	.0162

Average Values

Correlation squared (R^2) = .8414
Standard Error = .75
A Intercept = .78
Slope (B) = 1.04
Coefficient of Variation = 22%

The correlation is quite good, standard error low and slope (B) very close to 1.00, which makes this an excellent predictive equation. To enhance the meaning of these numbers table 13 was prepared to show the number of years to 10 percent cracking for various thicknesses of overlay and differing regions. Time to 10 percent cracking is much shorter than the time to 256 inches/mile roughness.

Table 13

Years to 10 Percent Cracking

Overlay	Region	
Thickness	1.0	3.0
1.5 inch	10	9
2.5 inch	12	9
3.5	16	10

ADT = 5000

Years to 10 percent cracking for overlays, compared to new construction (Table 2) show that overlays tend to perform in a manner very similar to the new construction.

In summary both the roughness and percent cracking PMS equations for overlays do a very good job of predicting future conditions.

Roughness

Case 2 - Prediction given an existing condition.

Table 14 summarizes results of the calculations. Although the correlation squared (R^2) is lower than for new construction, the other values would indicate a good correlation.

Since the slope (B) changes with time it is suggested the average slope (B) (.66) be used as an adjustment factor.

Table 14

Correlation Between Predicted Future Ride in Years 1 Thru 7 Based On A Measured Ride Now.

Future Year Ride Predicted	N	R^2	Standard Error	A	B	Coefficient of Variation
1	161	.6555	20.9	16.5	.75	22
2	138	.6107	22.6	16.7	.71	24
3	115	.6607	21.7	8.7	.74	22
4	92	.5777	25.1	11.7	.66	26
5	69	.5944	25.8	10.9	.66	26
6	44	.5952	23.5	25.6	.54	21
7	23	.6760	22.4	11.6	.56	21

Cracking

Case 2 - Prediction given an existing condition.

Table 15 summarizes the various correlation statistics for this care. Although the correlation values fall off by year four, the error terms are not excessively large and the slope (B) value is still good. Predictions for four or more years should be adjusted by using a .75 value to give more reasonable answers.

In summary both the roughness and cracking PMS equations for routine overlays appear to do a good job of predicting the future expected conditions. As an additional reinforcement of the recursive equation mode two additional overlay equations were examined.

Table 15

Correlation Between Predicted Future Percent Cracking In Years 1 Thru 5 Based On A Measured Percent Cracking Now.

Future Year Percent Cracking Predicted	N	R^2	Standard Error	A	B	Coefficient of Variation
1	124	.7520	1.82	.3	.98	15
2	103	.6810	2.14	.4	.96	17
3	79	.5316	2.74	.8	.91	22
4	57	.3587	3.49	1.8	.74	28
5	34	.3514	4.04	1.9	.76	32

SOMSAC

Case 1 and 2

Using the SOMSAC overlay equation for overlay sites in Appendix C, it was possible to do a similar investigation and compare it to the PMS equation. Table 16 shows comparisons for both Case 1 and 2 for PMS and SOMSAC. This table shows that PMS and SOMSAC give surprisingly similar values in terms of correlation, standard error and slope (B). Either PMS or SOMSAC could be used for prediction, however, SOMSAC like PMS would need to have an adjustment factor to account for the differences in slope (B). For Case 1, an adjustment factor of .46 should be multiplied times the SOMSAC value to give reasonable results. To demonstrate this adjustment is shown in the following table.

Table 16

Case 1

PMS - SOMSAC Comparison; Overlays

Average Values	PMS	SOMSAC
Correlation Squared (R^2)	.7193	.7214
Standard Error	13.04	11.32
A Intercept	20.68	22.08
Slope (B)	.42	.46
Coefficient of Variation	18%	15%

Case 2

Average Values	PMS	SOMSAC
Correlation Squared (R^2)	.6243	.5358
Standard Error	23.1	25.8
A Intercept	14.5	.7
Slope (B)	.66	.77
Coefficient of Variation	23%	26%

In summary either PMS or SOMSAC could be used to predict the future roughness of overlays.

Present Serviceability Index (PSI)

Table 17 gives a comparison of PSI to PMS statistics for both Case 1 and 2. Detailed PSI statistics can be found in Appendix D and E.

Years to 256 inches/mile

Overlay, Case 1

SOMSAC Region	SOMSAC*	Adjusted SOMSAC
1.0	15	25
2.0	9	21

*.001 inch deflection
50,000 18 kip single axle EQ./year
2.0 inch AC overlay
50 inches/mile roughness after overlay
1.05 growth in traffic/year

Table 17

Case 1

PMS - PSI Comparison; Overlays

Average Values	PMS	PSI
Correlation Squared (R^2)	.7193	.7750
Standard Error	23.1	.36
A Intercept	14.5	1.82
Slope (B)	.66	.47
Coefficient of Variation	23%	10%

PMS and PSI both do a good job of predicting the case 1 future condition, however, PMS is much better than PSI for case 2. The good showing is additional testimony to the premise that a recursive form of a pavement prediction equation is a reasonable model of what really occurs in the field. Interestingly for case 2 PSI has a slope (B) of 5.01 and for case 2 a slope (B) of .47. This is very similar to the new construction case 1 and 2 results shown on Table 7 and 10. The 5.01 value would indicate that the PSI equation for overlays predicts more years of service than actually occurs by values similar to Table 8.

By examining both SOMSAC and PSI equations in a recursive mode it has been demonstrated that the PMS equation can give comparably good predictions of future performance. All three equations need some adjustment for either case 1 or 2 or both in order to more closely approximate actual performance. This section has dealt with conventional overlays, however, overlays with special treatments (asphalt rubber, heater scarification) have also been built and will be examined.

Special Treatments with Overlays

Over the years ADOT has used either heater scarification or asphalt rubber to improve roughness and cracking performance of overlays. Generally such treatments have been employed when unusual amounts of cracking (greater than 10 percent) have been present in the existing road. In addition they have been employed when no other conventional material or process short of reconstruction appeared capable of providing satisfactory performance. Therefore when either conventional overlays or special treatment performance is observed it should be recalled that generally both heater scarification and asphalt rubber were used where the degree of difficulty in improving performance was indeed much higher than a routine conventional overlay. It should also be mentioned that extensive use of special treatments as part of the routine overlay design strategies is relatively new, which means the data base of field performance is limited. Numerous special research reports have been issued documenting performance (4) (5) (6) (7). Indeed reference (7) reports on the performance of all asphalt rubber projects. A similar report will be forthcoming next year or all heater scarification projects. With these thoughts in mind nine miles of heater scarification and nine miles of asphalt rubber were selected from different projects and are listed on Appendix F.

Results of this analysis are grouped by treatment and case.

Asphalt Rubber

Case 1 and 2 - Ride and Cracking

Both the ride and cracking statistics for case 1 and 2 are shown on table 17. The ride values are not too good primarily due to the limited nature of the data. Only five years of data have been collected up until now. The range of ride values is very limted. The standard error and coefficient of variation values are reasonable and are indication that the model is performing as intended. Slope (B) values are smaller than one indicating a longer than expected life, however, current expected lives already are predicted to be 20 years. Given that the current performance trend represents only five years of actual data it is felt that adjustments at this time would be unwise. The cracking predictions for the five year period is remarkably good. The cracking equation predicted no cracking and up until now there has been no cracking.

Table 18

Asphalt Rubber Case 1

Average	Ride	Cracking
Correlation Squared (R^2)	.5777	1.0000
Standard Error	12.6	0.0
A Intercept	44.3	0.0
B Slope	.70	1.00
Coefficient of Variation	17	0.0

Asphalt Rubber Case 2

Average	Ride	Cracking
Correlation Squared (R^2)	.3238	1.0000
Standard Error	31.3	0.0
A Intercept	39.0	0.0
B Slope	.53	1.00
Coefficient of Variation	33	0

Heater Scarification

Case 1 and 2 - Ride and Cracking

Statistics for both cases are shown on Table 18. As in the cracking case the ride values are not too good, however, a maximum of only 9 years of ride history is known. In addition virtually all the ride values are still in the good range, thus restricting the size of numbers considerably. At present the PMS equation seems capable of giving good ride correlation in the future. Cracking statistics are very good for both cases indicating that the PMS cracking equation has good prediction capabilities.

Table 19

Heater Scarification Case 1

Average	Ride	Cracking
Correlation Squared (R^2)	.6239	.8993
Standard Error	13.6	.4
A Intercept	-7.2	.1
B Slope	1.23	.95
Coefficient of Variation	17	18

Heater Scarification Case 2

Average	Ride	Cracking
Correlation Squared (R^2)	.4489	.9257
Standard Error	22.3	1.2
A Intercept	35.6	-.7
B Slope	.57	1.1
Coefficient of Variation	23	16

In summary the special treatments portion of the PMS overlay equations appears to be a reasonably good approximation of the future performance of these materials. As additional ride and cracking data is collected in future years the equations can be updated and certainly improved.

Concrete - PCCP

Although ADOT has only about 250 miles of concrete highways in its system, it was agreed some prediction model was needed. Historically the ride of concrete pavements has been of major concern, thus a prediction equation using the same approach as the new design and existing flexible pavement equation was utilized. A small sample set of 12 miles of concrete highway was used to generate the predictive equation. The derived equation had poor correlation, however, it was thought that even a poor equation was better than no equation.

PCCP - Ride Equation

$$R_N = 14.73 + .04(R) = 3.00(R_g)$$

R_N = Change in roughness during next year
R = Present roughness
R_g = Regional factor

Correlation Squared (R^2) = .0258

Appendix G gives the raw data used to develop this equation. In addition the raw data and correlations for six other miles of highway are shown. These six additional miles of highway were used to verify the degree of agreement. Table 19 gives the statistical measurements for both case 1 and 2 for the ride prediction. Results show a good correlation with small coefficients of variation. Slope (B) values should be slightly adjusted to .58 for case 1 and .78 for case 2. Considering the above adjustments a comparison of AC to PCCP can be made by using Table 1. Table 19 indicates that plain jointed PCCP (9" slabs) would reach the 256 inch/mile roughness (very rough pavement) in about 60 percent of the time that it would take an AC pavement (or about eight years sooner).

Table 20

Concrete Highways; Jointed PCCP Ride

Average	Case 1	Case 2
Correlation Squared (R^2)	.9028	.7905
Standard Error	21.4	35.9
A Intercept	12.5	10.8
B Slope	.58	.78
Coefficient of Variation	15	16

The PCCP PMS equation appears to be a reasonably good predictor of future performance for both case 1 and 2. This concludes the mathematical verification interpretation.

Table 21

Years to 256 Inches/Mile Roughness AC and PCCP; Case 1

	Region	AC Adjusted PMS	PCCP Adjusted PMS
Desert	1.0	23	15
Transistion	2.0	23	14
Mountains	3.0	21	13

Conclusions

It has been demonstrated that the PMS models (equations) can reasonably predict both the future ride and cracking for AC pavements (new, existing and overlays) and PCCP pavements. Many suggested minor adjustments should be made to produce a reasonable set of models. It should be recalled that this is a start, no doubt future verification calculations will make additional adjustments which will improve the models ability to predict the future.

It appears that both new AC pavements and overlays are capable of providing a comfortable ride up to and beyond 20 years. Generally cracking will start and progress to objectional values in about 10 years unless some special treatment is used which can extend the period of low cracking beyond 10 years.

Concrete highways built out of plain jointed concrete of no more than 9 inches thickness generally reach a rough condition in about 15 years or about 60 percent of the time that AC pavements reach the same condition. Additional work on characterizing the performance of ground PCCP and overlayed PCCP needs to be done in the future.

In terms of Present Serviceability Index (PSI) for AC pavements objectionable levels of service (below 2.5) is reached in less than 20 years. This appears to be due in part to the overprediction of performance which should be further investigated.

The SOMSAC equations are capable of producing reasonably good predictions of future performance. These equations contain terms for deflection and traffic and could be used to check the design of new highways and overlays.

Recommendations

The new PMS prediction models with adjustments should become past of the PMS network optimization program.

The SOMSAC ride equations with adjustments and the PMS, overlay cracking equations contain terms which make them useful as equations to check the designs of both new and overlayed pavements.

Such equations should be incorporated into the SOMSAC program.

A similar verification process should be repeated about once every four years for purposes of testing the equations and evaluating new designs or construction techniques; such of recycling, sulfer asphalt, overlays with special treatment, grinding of concrete and overlaying of concrete.

Additional special investigations which would determine why some miles of highway have not performed as expected are also encouraged.

In closing ADOT has available to it a valuable prediction tool not available in any other state at this time. This valuable tool should be implemented and used as much as possible within the context of management, design and research of pavements within Arizona.

REFERENCES

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2. "AASHTO Interim Guide for Design of Pavement Structures 1972," 1974, American Association of State Highway and Transportation Officials.

3. "Asphalt Overlays and Pavement Rehabilitation," The Asphalt Institute, MS-17, November 1977.

4. Way, George, "Prevention of Reflective Cracking Minnetonka-East (1979 Addendum Report)", Arizona Dept. of Transportation Report 1979-GWI, August 1979.

5. Way, George, "Tests on Treatments for Reflective Cracking," Transportation Research Record 647.

6. Forstie, D., Walsh, H., Way, G., "Membrane Technique for Control of Expansive Clays," Transportation Research Board, January 1979.

7. Gonsalves, G.F.D., "Evaluation of Road Surfaces Utilizing Asphalt Rubber 1978," Arizona Dept. Of Transportation Report Number 1979-663, November 1979.

APPENDIX A

DATA DESCRIPTION

Column	
1.	Route Number (Interstate, US, State)
2.	Route Number Alpha Code (A for Alternate)
3.	Direction
4.	District
5.	Milepost (006 is Milepost 6)
6.	Cell Number
7.	Year That Condition Data was Obtained
8.	Regional Factor (21 = 2.1)
9.	Thickness of AC (020 = 2.0 inches of Oringinal AC)
10.	Thickness of AC Overlay (15 = 1.5 inches)
11.	Daily 18 kip Single Axle Equivalents in Year of Data (15 ADL or 5475 18 kip Loads In A Year)
12.	Percent Cracking In Year of Data (04 = 4%)
13.	Percent Cracking in Year Following The Year of Record (05 = 5%)
14.	Mays Meter Roughness in Inches/Mile for Year of Data (093 = 93 Inches/Mile)
15.	Mays Meter Roughness In Year Following the Year of Record (102 = 102 Inches/Mile)
16.	Dynaflect 1st Geophone Deflection for Year of Data (181 = .00181 Inches Deflection)
17.	Dynaflect 2nd Geophone Deflection (085 = .00085 Inches Deflection)
18.	Dynaflect 3rd Geophone Deflection (045 = .00045 Inches Deflection)
19.	Dynaflect 4th Geophone Deflection (023 = .00023 Inches Deflection)

Column

20. Dynaflect 5th Geophone Deflection (011 = .0011 Inches Deflection)

21. Age of AC Pavement In Years (Since Year of Record 1975 and Age 11 Years; AC Built in 1964).

APPENDIX A

NEW CONSTRUCTION

DATA FOR REGRESSION

```
1 |2|3|4| 5 |    6| 7| 8| 9 |10 |    11|12|13| 14| 15| 16| 17 |18 |19 |20|21
63  N4  55     47521  20         150405  93102191  55  45  23  1111
63  N4  55   157721  20          1507     99111134  76  35  20  1313
63  N4  60     67521  20         15010110612621213  52  30  1711
63  N4  40   157721  21          1502   120134126  75  27  20  1013
63  N4  42     67521  20         150202  73  80123  32  40  24  1411
63  N4  42   247721  20          1504     97  91  99  57  20  14  0713
66  E6  44   107415  20          800306  33  60124  70  41  23  17  3
66  E6  14   207715  20          9713   110146  73  49  22  15  11  6
68  E6  14   117515  20           80101  79  61143  93  23  16  11  9
68  E6  14   217715  20           90202  71  90  93  46  20  11  0911
69  E6  15   207515  20           301012101951911 05  34  20  13  9
69  E6  15   307715  20           902    175222121  70  25  13  1211
70  E3  43   127415  30           20101  84  74110  26  50  33  2411
70  E33 49   127515  30           20202  71  12711  89  55  34  2515
70  E33 49   217215  30           30300  99  92  71  51  31  22  1915
70  E33 49   127415  30           70000  73  71114  33  57  37  2511
70  E3350    127615  30           40000  60112131104  50  36  2213
70  E3350    217615  30           90000  74  78  74  41  32  27  1815
70  E3353    217415  30           70000  76  59  94  52  35  21  1311
70  E3353    217415  30           80000  63120111  90  55  35  2313
70  E3353    217815  30           900    98       73  57  70  17  1115
75  N3337    237419  20           70000  84  97  33  56  26  19  13  9
75  N3337     37618  20           80100  851471611107  45  30  2111
75  N3337    157319  20           90005106  97115  62  25  16  1013
82  E2  25   147426  20           20102  84107113  52  25  14  10  9
82  E2  25   247626  20           20304  92  86  74  35  17  11  0911
83  N2  56    57421  20           10102  92  91158  70  27  15  10  9
83  N2  56   237621  20           10304  93  99  72  20  13  07  0410
83  N2  57   147421  20           10102  94  26155  61  26  16  11  3
83  N2  57   277421  20           10304  93105  67  30  15  11  0710
86  E2163    137417  40           40000  54  67105  35  21  11  09  2
86  E2163    227617  40           40000  70  79  44  20  17  11  03  2
86  E2163    237917  40           500    92       35  22  11  03  05  2
86  E2165    137417  40           40000  53  38115  44  25  17  12  2
86  E2165    227617  40           40000  95  93  56  36  25  16  12  4
86  E2165    237317  40           500    95       46  32  20  14  10  6
87  N  221   167429  30           50000  70  55112  62  27  15  12  2
87  N  291   257733  30           600     97117  37  31  21  15  12  5
87  N4276    277443  15           50101117103  97  45  21  11  0911
87  N4276    277743  15           602    122151  69  32  15  09  0714
87  N4293    547440  15           50001143139  84  42  27  14  1111
87  N4293    547740  15           602    141210  74  33  14  08  0714
87  N4293    547440  15           50001126114  69  31  20  11  0911
87  N4299    277740  15           602    122172  55  24  13  09  0514
87  N4310    547333  10           60506245179  35  29  13  06  0411
87  N4310    547733  10           608    235273  62  29  13  07  0413
87  N4312    547533  10           60405193143  66  35  19  10  0711
87  N4312    547733  10           607    195242  65  32  17  09  0613
87  N4315    547533  10           60203192145  63  22  10  05  0311
87  N4315    547733  10           605    190230  77  33  13  08  0413
87  N4351     57517  20          40304  63  76205119  72  45  33  9
87  N4351    157717  20          406     93112101  58  30  21  1711
87  N4353     57517  20          40304117121279161  91  55  42  9
87  N4353    427717  20          405    145152109  64  36  25  1911
87  N4354     57517  20          40203  74  83252147  74  42  32  9
87  N4354    157717  20          404     90105101  55  29  22  1311
87  N4359     57517  20          403041031033071 72  91  53  36  9
87  N4359    427717  20          409    131141119  65  41  26  1811
87  N4361    327517  20          40407154131212140  92  51  36  9
87  N4361    427717  20          414    176167110  70  45  33  2011
87  N4386     67518  10           20304  66  79172  35  51  29  2412
87  N4386    247718  10           305    84  90  93  67  25  19  1414
87  N4391     67518  10           20303  91  91229103  74  42  2012
87  N4391    157718  10           303    102124110  36  34  23  2014
87  N4397     67518  10           20303  79  95204119  62  34  2412
87  N4397    157718  10           303     97124127  59  30  21  1414
87  N7224    247433  40          440000  85  76  65  45  22  17  14  5
87  N7224    267633  40          4500     93105  44  39  23  16  12  8
87  N7224    247333  40          4501   106       50  35  10  14  1110
87  N7225    537433  40          440000116  79  54  37  25  19  15  6
87  N7225    177333  40          4500   136       57  39  22  18  1310
```

APPENDIX A

NEW CONSTRUCTION

DATA FOR REGRESSION

```
  1 |2|3|4| 5 |  6| 7| 8| 9 |10|   11|12|13| 14| 15| 16| 17|18|19|2021
 89 N1269 227423 40          50000 43 67 88 54 28 18 13 5
 89 N1269 147623 40          50000 32 53116 71 29 19 15 7
 89 N1269 237823 40          50000 85 51 73 46 17 15 10 9
 90 E3300 157421 30          80102 68 69100 57 23 14 1011
 90 E3300 247721 30          903   83 93 87 48 24 15 1014
 92 E3343 147423 25          40101 77119102 53 23 13 10 8
 92 E3348 247723 25          40203113106 97 50 18 11 0711
 92 E3350 147423 25          40001 39 80107 52 24 16 12 8
 92 E3350 247723 25          402   74 75 64 36 16 09 0711
 93 N2238 197610 30         310101 32 22 32 52 31 22 16 3
 93 N2238  17810 30         3202   58   195101 61 32 26 5
 95 N1 10 207403 30         130000120142 91 80 70 60 48 6
 95 N1 10 477603 30         190000135148 77 68 56 47 39 8
 95 N1 10 207803 30         250002109 88 71 60 49 43 3510
 95 N1 85 117409 30          80101 51 62104 65 30 17 12 6
 95 N1 85 117609 30          80202 61 69105 68 29 14 10 8
 95 N1 85 387809 30          904  136   108 58 23 13 0810
 98 E5306 137519 20          40203 30 55123 83 44 31 21 3
 98 E5306 227719 20          50506 43 83 63 45 26 17 11 5
 98 E5307 137519 20          40203 41 59122 74 38 26 17 3
 98 E5307 227719 20          50506 62 89 66 44 23 14 08 5
 98 E5308 137519 20          40203 30 60113 73 41 28 19 3
 98 E5308 227719 20          50506 58 69 63 43 24 15 09 5
 98 E5310 137519 20          40203 42 68131 74 35 24 17 3
 98 E5310 227719 20          50506 63 83 65 45 25 16 09 5
 98 E5312 137519 20          40203 71 94143 83 44 27 20 3
 98 E5312 137719 20          50506 95106106 68 35 19 10 5
 98 E5315 137519 20          40203 71 96136 79 49 25 15 3
 98 E5315 227719 20          50506 93115 89 53 25 13 07 5
 98 E5318  47519 20          40304 48 63157 94 47 29 18 3
 98 E5318 137719 20          50506 61 75108 52 35 15 11 5
 98 E5320 227519 20          40203 37 49 97 63 30 18 11 3
 98 E5320 227719 20          50506 53 69 54 32 18 10 07 5
 98 E5323 137519 20          40203 33 50125 77 39 25 16 3
 98 E5323 137719 20          50506 51 71100 57 33 19 13 5
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I 8 E2161 117510 40        1400102 33 30109 67 35 20 15 6
I 8 E2161 207710 40        1530202 17 57 75 55 27 18 14 8
I 8 E2161 117810 40        16002   57   119 70 35 22 14 9
I 8 E2163 107210 40        1210000 25 28125 96 63 37 25 3
I 8 E2163  27510 40        1400102 48 48169110 65 39 29 6
I 8 E2163 117710 40        1530512 32 67147 87 60 40 29 8
I 8 E2163  27810 40        16008   67   161 93 61 37 27 9
I 8 W1 58 487305 30        13302   63 74 80 51 31 22 1711
I10 E   4 207305 20        1720103 47 44 98 58 27 17 12 8
I10 E   4 117505 20        1850507 71 61137 35 42 24 1610
I10 E   4 127305 20        20510  101   121 61 29 16 0913
I10 E 302 227219 35        1790000 21 41 82 49 24 15 11 5
I10 F 302 237319 35        1350002 41 69 98 60 28 17 12 6
I10 E 302 147519 35        1980406 85 79144 74 32 20 12 8
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I10 E1 48 197308 60        1360000 26 33 79 56 28 18 10 1
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I10 E1161 207810 35        2130502 58 72 85 59 36 22 1610
I10 E1162 197310 35        1820001 30 30 55 35 23 15 11 5
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APPENDIX A

NEW CONSTRUCTION

DATA FOR REGRESSION

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I10  E2177  197310 40        1820303 20 33 50 32 21 16 13 5
I10  E2177  117510 40        1940404 18 39104 68 39 25 17 7
I10  E2177  207810 40        21305   27    93 71 31 24 1710
I10  E2178  197310 40        1820000 16 33 43 28 20 14 11 5
I10  E2178  207510 40        1940101 19 39 93 59 35 24 17 7
I10  E2178  207810 40        21303   29    78 53 26 22 1710
I10  E2182  197310 40        1820505 27 39 54 34 21 14 09 5
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I10  E2182  207810 40        21306   31    98 77 29 19 1110
I10  E2183  197310 40        1820102 19 33 49 32 19 13 08 5
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I10  E2183  207810 40        21303   24    97 73 28 17 0910
I10  E2190  197310 45        1820505 21 34 49 33 21 14 11 5
I10  E2190  117510 45        1940505 30 44111 89 47 29 18 7
I10  E2190  117810 45        21306   54   107 80 41 24 1510
I10  E2194  197310 45        1820001 29 47 74 51 30 20 15 5
I10  E2194  117510 45        1940203 44 50133107 68 48 29 7
I10  E2194  117810 45        21305   64   112 91 51 38 2310
I10  E2196  197310 45        1820001 29 39 43 32 23 16 13 5
I10  E2196  207510 45        1940203 35 52 96 75 55 42 26 7
I10  E2196  117810 45        21304   65   120 98 60 39 2410
I10  E2237  207315 30        2910404 76 86 59 41 31 26 2010
I10  E2237  127515 30        3130505 94 98103 73 50 41 3012
I10  E2237  487815 30        34606  136    64 51 34 24 1915
I10  E2252  117316 30        2280406 83 92100 79 59 49 35 8
I10  E2252   27516 30        2870810 90119185135 95 71 5010
I10  E2252  397816 30        37414  153   116 81 57 41 2713
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I10  W1 10  397508 30        1851413130124137 86 36 20 1412
I10  W1 10  397808 30        20525  171   122 64 25 16 0915
I10  W1 12  207306 30        1720002 85 85 60 31 15 09 0710
I10  W1 12  217506 30        1850406 98 96 86 48 21 11 0812
I10  W1 12  487306 30        20509  143    85 42 17 09 0615
I10  W1159    7410 40        2801110 46 50124 90 51 36 28 7
I10  W1159  117510 40        2881418 50 62122 83 44 29 22 8
I10  W1159    7810 40        31423   73    75 53 23 19 1311
I10  W1166  197310 35        1820000 32 45 85 58 35 21 17 5
I10  W1166  117510 35        1940000 43 56141112 70 42 31 7
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I10  W2238  207315 30        2910002 83 86 86 63 42 29 2210
I10  W2238  127515 30        3130305109130149101 70 48 3712
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I10  W2241  117516 35        3130505 62 79116 84 57 39 29 8
I10  W2241  487816 35        34607  181    69 59 36 23 1911
I10  W3338  137318 40        1760305 65 51133 97 62 42 34 5
I10  W3338   57518 40        1880709 81 83204138100 77 49 7
I10  W3338  327818 40        2071406123107232161 99 89 5710
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APPENDIX A

NEW CONSTRUCTION

DATA FOR REGRESSION

```
 1 |2|3|4| 5 |  6| 7| 8| 9 |10|  11|12|13| 14| 15| 16| 17 |18 |19 |20|21
I10 W3343 137318 40       1760203 36 43 98 65 37 22 13 5
I10 W3343 147518 40       1880303 48 54118 89 58 38 26 7
I10 W3343 237818 40       2070410 86 67 90 77 41 24 1810
I10 W3344 227318 40       1760404 48 48 89 61 33 20 15 5
I10 W3344 147518 40       1380404 59 62111 82 41 34 20 7
I10 W3344 237818 40       2070406 63 78 77 62 37 22 1410
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I17 N1219 217510 34       1480708 56 80 98 54 28 19 1211
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I17 N1224 207311 30       1380204116104 63 40 23 14 10 9
I17 N1224 217511 30       1480609106115 93 52 24 14 0911
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I19 S2  13  57621 40       470101 79 79154 85 41 23 17 9
I19 S2  13 157821 40       520212 78 80136 76 30 18 1211
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I40 E5181 637835 20       25261  300   226 90 30 15 1015
I40 E5182 357335 20       2134040170180190 34 33 16 0910
I40 E5182 367535 20       2285560207242209 91 30 13 0912
I40 F5182 637835 20       25265  276   219113 45 18 1115
I40 E6   9 197309 50       1470000 38 52 64 43 25 16 12 1
I40 E6   9 107509 50       1650000 46 52131 80 43 25 17 3
I40 E6   9 207809 50       1910000 94 76 98 62 32 20 15 6
I40 W4352 497221 20       2070202183210 54 47 37 26 20 5
I40 W4352 507321 20       2150204210213 61 55 43 30 22 6
I40 W4352 507521 20       2300603179211 97 82 62 47 34 8
I40 W4352 787821 20       25211  273    84 69 51 40 2811
I40 W5182 357335 20       2155560238285202 93 38 19 1110
I40 W5182 637535 20       2317075303329263135 64 25 1512
I40 W5182 637835 20       25280  310   225 92 39 19 1215
I40 W6130  47327 35       1870006 46 45151 93 50 28 18 4
I40 W6130  57527 35       2051218 68113164 99 53 24 15 6
I40 W6130 327827 35       23229  143   173 79 41 19 12 9
I40 W6131  47327 35       1870004 63 54168100 54 31 21 4
I40 W6131  57527 35       2050812 78111198118 63 31 20 6
I40 W6131 327827 35       23220  181   168 89 46 23 18 9
I40 W6139 137327 35       1870405 64 57134 67 28 16 11 4
I40 W6139 147527 35       2050607 74 80128 76 35 17 10 6
I40 W6139 417827 35       23211  143   111 64 23 13 08 9
180 E7412 357535 30        370304118130166122 75 64 57 8
180 E7412 357738 30        4208  194188173 92 66 51 4510
180 E7414  87538 30        370404 78103174123 77 60 52 8
180 E7414 357738 30        4204  155142173 96 61 53 4510
180 E7423 257537 90        370000 69 93 88 68 33 19 14 1
180 E7423 527737 90        4200  129115 76 56 28 20 16 3
180 E7427 257537 60        140101 83 79 75 53 21 11 08 5
180 F7427 267737 60        1602  121114 63 38 15 08 05 7
186 E 345 777524 10         20203327229 93 48 21 11 0610
186 E 345 787724 10         205  281309 64 43 17 10 0612
186 E 347 507524 10         20304147124 76 40 17 10 0610
186 E 347 517724 10         205  163211 69 38 14 08 0512
260 E 283 267445 30        620203 84 65 68 31 14 06 03 8
260 E 283 267645 30        6305   78124 73 37 14 07 0510
260 E 293 267445 30        620203 77 68 54 22 10 04 03 8
260 E 293 267645 30        6305   74131 80 40 17 10 0710
260 E7272 257442 30        600000 70 66 66 30 15 07 04 3
260 E7272 257642 30        620000 80130 85 50 16 10 07 5
260 E7272 267842 30        6300   81    84 45 18 08 06 7
260 E7285 267445 30        620000 77 70 75 42 22 15 11 8
260 E7285 267645 30        630101 78121 80 39 18 11 0810
260 E7285 277845 30        6302   96    64 34 14 11 0812
260 E7287 267445 30        600000 89 82 99 61 35 26 19 8
260 E7287 177645 30        620000 90131110 66 31 23 1510
260 E7287 277845 30        6301  104    86 56 29 22 1612
260 E7290 267445 30        600001 81 71 69 42 26 19 14 3
260 E7290 267645 30        620204 80125 95 54 28 21 1610
260 E7290 277845 30        6303   91    79 46 25 15 1212
```

APPENDIX A

NEW CONSTRUCTION

DATA FOR REGRESSION

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 1 |2|3|4| 5 |  6| 7| 8| 9 |10 |  11|12|13| 14| 15| 16| 17 |18 |19 |20|21
260 E7291 267445 30            620000 87 82 71 37 20 12 09 8
260 E7291 267645 30            63     81135102 57 28 18 1310
260 E7291 277345 30            6302  108    90 57 27 16 1112
260 E7294 267445 30            620000 83 78 74 39 18 09 06 8
260 E7294 267645 30            630000 87134 75 36 17 11 0810
260 E7294 277845 30            6301  106    70 36 18 10 0512
260 E7295 267445 30            620000106 98 76 44 23 15 11 8
260 E7295 267645 30            630000100147100 56 27 18 1210
260 E7295 277845 30            6301  113    80 44 23 13 0612
260 E7297 547438 15            620000137118 91 56 29 17 1111
260 E7297 277638 15            630000103142102 56 24 15 1013
260 E7297 547338 15            6300  123    80 52 20 13 0715
260 E7298 277438 15            620000120105 89 53 27 16 1011
260 E7298 277638 15            630000 95140 92 51 24 15 1113
260 E7298 277838 15            6300  112    78 51 22 15 1015
260 E7306 267433 30            130000 67 50 31 49 25 15 11 7
260 E7306 267733 30            140001112 82 53 32 20 10 0810
260 E7306 277333 30            1401   82    69 36 24 15 1111
260 E7309 257433 50            140000 52 44 97 60 28 20 15 3
260 E7309 267733 50            150102109 74 62 38 21 14 09 6
260 E7309 267333 50            1502   74    32 64 30 20 14 7
260 E7313 257433 50            140000 52 43 81 50 29 18 15 3
260 E7313 267733 50            150101 95 60 52 30 16 13 09 6
260 E7313 267833 50            1501   60    77 49 22 17 12 7
260 E7318 257433 50            140101 65 58 84 55 31 21 16 3
260 E7318 267733 50            150202115 81 57 37 23 14 12 6
260 E7318 267833 50            1502   81    76 48 28 18 14 7
260 E7319 167433 50            140001108106104 77 49 36 27 3
260 E7319 537733 50            150307162136 81 61 40 27 21 6
260 E7319 447833 50            1507  136   115 79 56 38 27 7
260 E7320 257433 80            140000 73 60 62 50 28 18 12 0
260 E7320 257733 90            150202110 77 63 48 27 15 10 3
260 E7320 257833 80            1502   77    76 60 41 24 15 4
260 E7321 257433 80            140000 96 82 61 49 31 21 15 0
260 E7321 257733 80            150101113 97 51 40 21 14 08 3
260 E7321 257833 80            1501   97    63 49 30 19 13 4
260 E7322 257433 80            140000 77 65 56 46 32 25 20 0
260 E7322 437733 80            150202140132106 82 54 31 19 3
260 E7322 437833 80            1502  132   100 86 63 35 28 4
260 E7324 257433 80            140000 76106 63 49 32 24 17 0
260 E7324 437733 30            150101201152104 72 53 26 18 3
260 E7324 437833 80            1501  152   111 81 65 39 24 4
260 E7325 257431 65            140000 94 69 52 40 27 20 14 0
260 E7325 527731 65            150101123102 83 60 36 20 14 3
260 E7325 257831 65            1501  102    99 76 55 28 20 4
260 E7327 257431 65            140000 54 50 57 39 28 18 14 0
260 E7327 257731 65            150101119103 54 47 27 19 13 3
260 E7327 257831 65            1501  103    70 59 37 23 16 4
260 E7329 257431 65            140000 62 50 96 70 44 30 20 0
260 E7329 257731 65            150000108 73 70 50 18 08 05 3
260 E7329 257831 65            1500   73    84 61 29 16 09 4
260 E7331  77432 30            140000111 93161 69 44 30 20 4
260 E7331 537732 30            150105143121 59 40 20 14 09 7
260 E7331 267832 30            1505  121    82 57 30 18 15 8
260 E7334 267732 30            230203118 95 53 39 21 17 11 7
260 E7334 267832 30            2403   95    84 58 32 20 16 8
279 N6294 507422 30            200404133178 86 59 42 27 2010
279 N6294 427622 30            210404143158122 69 35 27 1912
279 N6294 517822 30            2304  163    89 74 42 28 2214
289 W2   5 597423 10            14545291319171 82 41 23 17 8
289 W2   5 607723 10            150   291308160 88 35 22 1511
289 W2   6 597423 10            14550269297179 86 35 18 11 8
289 W2   6 517723 10            15560245267 37 50 22 15 1111
389 E5   8 147519 20            30203106106117 82 46 27 21 8
389 E5   8 237719 20            305    99119 70 40 24 16 1210
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APPENDIX A

OVERLAY

DATA FOR REGRESSION

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1 |2|3|4| 5 |   6| 7| 8| 9 |10 |   11|12|13| 14| 15| 16| 17 |18 |19 |20|21
60 E1 51  117410 2015     440000 69 77101 53 23 15 10 0
60 E1 51  207610 2015     480000 43 98 77 49 26 13 09 2
60 E1 51  207810 2015     5200   78    23 17 10 07 0604
60 E1174   17410 2530     890000 92137159110 71 50 33 2
60 E1174  197610 2530     930000116103 94 63 38 26 18 4
60 E1174  477810 2530     9800   165    56 42 25 20 14 6
60 E7242  147420 2540     490001 56 43105 75 41 24 13 7
60 F7242  237620 2540     510203 69 46 90 58 36 18 10 9
60 E7299  407420 2030      140000131125109 91 55 34 21 4
60 E7299  237620 2030      160000108175 70 45 19 09 05 6
60 E7299  507320 2030   .  1801   139    78 52 26 16 08 8
60 E7303  137420 2030      140000 91 91120 97 63 40 27 4
60 E7303  147620 2030      160000 90124102 68 36 21 14 6
60 E7303  507820 2030      1801   131    82 60 40 25 14 8
60 W1159  477810 3507   23415    160     86 55 42 28 23 7
64 E5188  167433 2040       70001 48 53146115 78 50 31 3
64 E5188  167633 2040       90203 42 43145118 63 41 22 5
64 E5192  667433 2040       70001 49 55135104 70 45 28 3
64 E5192  667623 2040       90203 41 45134107 61 35 22 5
64 E5226  227626 2030      130000100109 97 59 27 16 11 1
64 E5226  497326 2030      1500   136    72 49 28 16 12 3
64 E5234  497626 2030      130000124128 47 27 12 06 04 1
64 E5234  497826 2030      1500   154    30 14 07 04 03 3
66 E6119  227424 2038       70000 33 41 82 51 29 17 12 1
66 E6119  237724 2038       70204 38 63 55 31 16 10 06 4
66 E6124  227424 2038      930001 29 39 98 60 41 28 20 1
66 E6124  237724 2038   1100203 35 75 70 42 24 15 15 4
66 E6129  137424 2038       70001 28 38120 69 50 33 25 1
66 E6129  237724 2038       70203 68124 80 50 31 21 16 4
66 E6130  137424 2039       70000 36 33123 76 57 41 31 1
66 E6130  237724 2038       70204 61 86 83 55 39 27 20 4
66 W4257  197516 2530      430203 90 91 78 66 51 29 24 5
66 W4257  207716 2530      480505107144 93 74 53 42 32 7
70 E3339   17614 3525      890203 76120170142 96 73 53 2
70 E3339  107814 3525      9104   115    134104 65 57 42 4
70 E3366   57418 2025       70505 78 81167105 55 31 1913
70 E3366   57618 2025       80606 79135220120 60 31 1915
70 E3366  427818 2025       908   128    127 79 27 22 1317
70 E3368   57418 2035       71314 82117155 94 43 22 12 8
70 E3368   57618 2035       81416 82121155 94 36 17 0910
70 E3368  427818 2035       918   149    126 65 23 13 0812
70 E3370  147418 2035       70204 80106149 96 39 21 11 8
70 E3370   57618 2035       80608 91133169109 61 27 1410
70 E3370  427818 2035       910   139    130 90 33 19 0812
70 E3371   57418 2035       70203 92140157 98 40 25 17 8
70 E3371  147618 2035       80405100148162 82 47 25 1810
70 E3371  427818 2035       907   143    111 68 28 17 0912
70 E3373  237418 2035       70606 59126 83 61 31 20 13 8
70 E3373  147618 2035       80606 82130101 75 36 21 1310
70 E3373  517818 2035       906   125    68 47 19 15 0912
73 E7354   77741 1030      100000122 92155 88 54 28 18 2
85 S1 25  377310 1010       20004218211102 57 33 22 15 3
85 S1 25  387610 1010       21216201215143 82 43 27 19 6
85 S1 25  477810 1010       219   233     75 39 26 15 12 8
85 S1 26  377310 1010       22222207207104 58 33 22 14 3
85 S1 26  297610 1010       22222190215153 75 39 26 17 6
85 S1 26  477810 1010       222   235     65 37 26 15 12 8
85 S1 29  197310 1010       21212 82 86 75 41 19 10 06 3
85 S1 29  117610 1010       21212 91107124 64 25 13 08 6
85 S1 29  207810 1010       212   114     62 32 15 09 06 8
85 S1 30  197310 1010       21111 62 70 89 48 24 15 10 3
85 S1 30  117610 1010       21212 71 84143 78 34 19 13 6
85 S1 30  207810 1010       213   108     54 27 16 11 08 8
87 N2119  107311 2010       30103 69 71128 34 52 29 22 4
87 N2119   27611 2010       30507 64 60198112 67 41 28 7
87 N2119  117811 2010       310    95    122 58 42 26 19 9
89 N2118  297613 2505       31919147164174 94 44 26 17 7
89 N2118  387813 2505       319   174    116 57 24 16 11 9
```

APPENDIX A

OVERLAY

DATA FOR REGRESSION

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1 |2|3|4| 5 |   6| 7| 8| 9 |10 |   11|12|13| 14| 15| 16| 17 |18 |19 |20|21
 89 N6293 527835 2530   1900  123    43 32 14 08 06 1
 89 N6308 257432 2025   190000109128 74 41 20 09 06 1
 89 N6308 167632 2025   190000 98129124 30 42 21 10 3
 89 N6308 527832 2025   1900  125    51 28 13 09 06 5
 89 N6341 147427 1040   110000 91 98113 69 29 13 09 6
 89 N6341 147627 1040   120000 87 89105 74 49 22 10 8
 89 N6341 237827 1040   1300   97    89 60 29 15 0810
 89 N6346 147427 1040   110000109133121 77 42 19 13 6
 89 N6346 417627 1040   120000127136116 79 55 24 09 8
 89 N6346 507827 1040   1301  129    76 67 23 12 0610
 89 N6356 137427 2540   110000 62 77144 99 62 29 17 5
 89 N6356 147627 2540   120000 76 89144 96 64 34 16 7
 89 N6356 147827 2540   1300   80   100 72 33 19 07 9
 89 N6357 137427 5540   110000 64 72126 90 56 33 18 5
 89 N6357 147627 5540   120000 71 73132100 73 46 24 7
 89 N6357 147827 5540   1300   65   101 83 41 27 15 9
 89AN5385 257837 1520    600  108    52 27 14 08 05 0
 89AN5392 527735 2020    60202171204 65 41 21 14 09 5
 89AN5392 537835 2020    602  204    83 44 30 17 10 6
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 89AN5393 447835 2020    601  207   103 50 29 18 11 6
 89AN5394 527735 2020    60201151177 55 30 12 06 03 5
 89AN5394 537835 2020    601  177    95 44 19 12 07 6
 89AN5395 527735 2020    60100157173 56 38 14 09 05 5
 89AN5395 537835 2020    600  173    70 51 23 17 07 6
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 89AN5396 537635 2020    601  172    68 47 21 13 06 6
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 89AN5397 537835 2020    601  148    80 66 29 19 11 6
 89AN5398 527735 2020    60101138172 65 41 17 13 08 5
 89AN5398 537835 2020    601  172    85 66 30 19 14 6
 89AN5399 527735 2020    50204144172 65 39 14 06 04 5
 89AN5399 537835 2020    504  172    88 53 24 14 06 6
 95 N1 14 197803 2505   4302  105    77 48 30 21 16 0
 95 N1 16 197803 2505   4302  106    67 47 32 24 19 0
 95 N6221 197707 2030   650000120168 75 48 26 19 13 0
 95 N6224  17707 2030   6512  103147151 93 57 36 23 0
 95 N6226 107707 2030   650708105147135 77 57 38 29 0
 95 N6229 107707 2025   650000 42 86108 75 56 38 26 1
 95 N6230 107707 2025   650000 42 85103 70 56 41 30 1
I 8 E1 56 207305 2020  1330507122 56 87 59 31 19 14 8
I 8 E1 56 117505 2020  1440911 70 65107 61 31 17 1110
I 8 E1 56 217705 2020  1551341 60101 88 51 24 13 1012
I 8 E1 56 127805 2020  16141  101   104 62 27 17 1113
I 8 E1 58 207305 2020  1330101 49 50 89 66 43 29 22 8
I 8 E1 58 207505 2020  1440203 64 59 80 55 34 22 1610
I 8 E1 58 217705 2020  1550435 64 97 75 47 32 20 1612
I 8 E1 58 217805 2020  16135   97    92 57 32 22 1813
I 8 E1 59 207305 2020  1330203 61 55 66 46 34 25 20 8
I 8 E1 59 207505 2020  1440405 70 69 66 47 33 23 1710
I 8 E1 59 217705 2020  1550626 70114 65 43 30 20 1512
I 8 E1 59 217805 2020  16126  114    98 70 38 23 2013
I 8 E1 61 207305 2020  1330204 46 51 99 69 42 28 22 8
I 8 E1 61 207505 2020  1440608 76 75 95 59 40 24 1810
I 8 E1 61 127705 2020  1551040 66104102 55 34 20 1612
I 8 E1 61 127805 2020  16140  104   109 69 34 23 1813
I 8 E1 63 207305 2015  1330304 61 66 68 46 29 20 16 8
I 8 E1 63 207505 2015  1440603104126 66 53 34 21 1510
I 8 E1 63 217705 2015  1551043117145 77 48 30 17 1612
I 8 E1 63 397805 2015  16143  145   130 73 40 23 1813
I 8 E1 65 207305 2015  1330603 66 68 60 43 28 20 16 8
I 8 E1 65 207505 2015  1441012107131 89 67 40 23 1710
I 8 E1 65 217705 2015  1551635122147 91 60 35 21 1512
I 8 E1 65 397805 2015  16135  147   113 67 35 23 1913
I 8 E1 74 207305 2015  1330506 46 53 66 41 23 13 09 8
I 8 E1 74 207505 2015  1440708 74 88 64 47 26 15 1010
I 8 E1 74 127705 2015  1551133 97143107 54 31 18 1312
I 8 E1 74 397805 2015  16133  143   100 59 30 18 1113
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APPENDIX A

OVERLAY

DATA FOR REGRESSION

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 1 |2|3|4| 5 |   6| 7| 8| 9 |10 |  11|12|13| 14| 15| 16| 17 |18 |19 |20|21
I  8 E1  76  207305  2015  1330101  34  38  63  44  24  13  08 8
I  8 E1  76  207505  2015  1440204  52  69  50  35  20  10  0610
I  8 E1  76  217705  2015  1550724  81154   59  40  18  13  0812
I  8 E1  76  487805  2015  16124   154      59  38  19  11  0713
I  8 E1  77  207305  2015  1333030  52  58  54  35  21  11  08 8
I  8 E1  77  207505  2015  1443030  81  91  44  30  19  10  0610
I  8 E1  77  217705  2015  1553030102133   49  29  17  10  0712
I  8 E1  77  487805  2015  16130   133      59  37  18  10  0713
I  8 E1  80  207306  2515  1330506  38  42  72  40  17  09  06 8
I  8 E1  80  207506  2515  1440708  47  58  66  37  18  09  0610
I  8 E1  80  217706  2515  1551133  52105   92  44  20  09  0612
I  8 E1  80  217806  2515  16133   105      90  43  18  10  0513
I  8 E1  81  117306  2520  1332224  41  53107  63  31  19  13 3
I  8 E1  81  207506  2520  1442623  46  60  75  45  24  14  0910
I  8 E1  81  217706  2520  1553030  37  89  96  56  27  14  1112
I  8 E1  81  127806  2520  16130    89     104  51  22  14  0913
I  8 E1  84  207306  2520  1330001  48  43  72  44  20  08  05 8
I  8 E1  84  207506  2520  1440203  52  59  60  34  13  04  0210
I  8 E1  84  217706  2520  1550413  50105   76  40  15  05  0412
I  8 E1  84  217806  2520  16113   105      67  37  13  04  0213
I  8 E1  85  207306  2520  1330001  43  44  54  31  16  08  05 8
I  8 E1  85  207506  2520  1440202  53  56  43  25  12  06  0310
I  8 E1  85  217706  2520  1550305  41  90  57  30  13  07  0512
I  8 E1  85  217806  2520  16105    90      46  22  10  04  0313
I10 E3334     47319  3045  1760004  32  41258161  87  56  42 0
I10 E3334     47519  3045  1880812  46  54260155  91  64  39 2
I10 E3334     47819  3045  20723    77     238155  74  57  38 5
I10 E3385   107316  3040  1660000  40  54108  72  41  22  13 4
I10 E3385   207516  3040  1780000  64  52  80  62  38  26  15 6
I10 E3385   207816  3040  19501    74      83  70  36  22  12 9
I10 E3388   197316  3040  1660404  48  65  89  61  37  22  12 4
I10 E3388   207516  3040  1780303  66  66  74  61  40  26  16 6
I10 E3388   207816  3040  19503    74      72  61  35  20  13 9
I10 W3385   197316  3040  1660001  45  52  77  59  36  22  15 4
I10 W3385   207516  3040  1780203  61  58  98  74  47  31  19 6
I10 W3385   207816  3040  19505    74      79  63  31  21  11 9
I10 W3386   197316  3040  1660000  43  45  79  59  36  21  14 4
I10 W3386   207516  3040  1780101  51  57  95  74  48  33  20 6
I10 W3386   207816  3040  19503    75      80  65  37  26  14 9
I10 W3390   197316  3040  1660101  64  76  75  52  31  20  11 4
I10 W3390   207516  3040  1780203104  86  85  64  44  29  16 6
I10 W3390   207816  3040  19505    83      80  57  29  21  12 9
I17 N5305   137529  4060  1120000  33  40146  72  27  11  07 8
I17 N5305   137829  4060  12300    56     114  76  39  18  0811
I17 N5337   257335  4060  1050003  93  54  49  36  24  15  08 5
I17 N5337   167535  4060  1120609  92100118  85  44  23  13 7
I17 N5337   447835  4060  12314   142     102  60  31  15  0810
I17 N5338   257335  4060  1050002  58  92  60  44  27  15  07 5
I17 N5338   257535  4050  1120406  71  80  93  80  47  30  17 7
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I17 N6248   227225  4005  1160000  31  32  44  29  19  13  09 3
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I17 N6248   237725  4005  1370105  50  49  76  46  23  14  09 8
I17 N6248   237825  4005  14105    49      65  34  17  12  07 9
I17 N6252   227225  6005  1160000  34  52  50  33  19  11  07 3
I17 N6252   227325  6005  1200000  52  64  55  38  20  11  07 4
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I17 S1214   207310  2030  1380001  50  65  69  52  32  18  14 9
I17 S1214   217510  2030  1480203  84  80  76  57  31  20  1411
I17 S1214   217810  2030  16406   116      99  80  42  23  1914
I17 S1215   207310  2030  1380001  37  49  53  41  28  15  12 9
I17 S1215   217510  2030  1480202  50  62  75  59  32  18  1111
I17 S1215   487810  2030  16403   128      94  68  43  22  1414
I17 S1217   207310  2034  1380000  29  38  58  44  26  14  11 9
I17 S1217   217510  2034  1480102  39  52  80  61  33  19  1211
I17 S1217   217810  2034  16403   101      90  82  39  24  1614
```

APPENDIX A

OVERLAY

DATA FOR REGRESSION

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 1 |2|3|4| 5 |  6| 7| 8| 9 |10|  11|12|13| 14| 15| 16| 17|18|19|20|21
I17 S1219 207310 2034 1380304 42 58 50 39 25 16 11 9
I17 S1219 217510 2034 1480506 63 71 47 36 23 15 1011
I17 S1219 217810 2034 16408  100    73 54 34 23 1314
I17 S1221 207311 2030 1380305 55 72 63 42 26 17 12 9
I17 S1221 217511 2030 1480709 78 87 62 49 27 17 1111
I17 S1221 217811 2030 16411   99    85 61 28 20 1314
I17 S1224 207311 2030 1380208 62 73 73 43 24 16 10 9
I17 S1224 217511 2030 1481420 80 94 78 57 31 18 1311
I17 S1224 127811 2030 16433   91   112 76 40 26 1914
I17 S1225 207313 2030 1380205 51 56 75 41 20 12 07 7
I17 S1225 207513 2030 1480811 63 89 80 55 24 12 07 9
I17 S1225 127813 2030 16415   76   118 82 31 19 1212
I17 S1228 207313 2030 1380001 41 45 55 32 17 10 06 7
I17 S1228 207513 2030 1480203 70 73 63 42 20 11 07 9
I17 S1228 217813 2030 16405   99    80 45 27 13 0812
I17 S1229 207313 2030 1380001 42 60 64 38 21 13 08 7
I17 S1229 207513 2030 1480305 70 78 64 41 21 11 07 9
I17 S1229 127813 2030 16409   93   112 61 30 16 1112
I17 S5338 257335 4060 1050002 53 38 60 43 26 15 08 3
I17 S5338 257535 4060 1120405 73 86 83 65 37 23 14 5
I17 S5338 177835 4060 12311  119   131109 58 31 17 8
I17 S6256 237325 2030 1200000 63 65 66 42 23 15 0910
I17 S6256 247525 2030 1290000 75 82 66 35 20 10 0612
I17 S6256 247825 2030 14100   76    98 56 28 15 0815
I17 S6264 237226 2030 1000000 32 54 76 52 30 18 10 9
I17 S6264 147326 2030 1100003 54 62105 64 34 22 1610
I17 S6264 247526 2030 1290609 67 79 99 49 35 25 1712
I17 S6264 157826 2030 15714  121   133 32 40 30 2115
I17 S6267 237226 2030 1000000 82 80 97 72 39 23 14 9
I17 S6267 147326 2030 1100001 80 93121 80 44 28 1910
I17 S6267 157526 2030 1290203107113123 74 35 26 1612
I17 S6267 427826 2030 15706  169   135 75 43 24 1815
I17 S6268 237226 2030 1000000 71 88 80 55 28 19 15 9
I17 S6268 147326 2030 1100000 88101113 75 46 36 2810
I17 S6268 157526 2030 1290102104116123 68 36 28 2012
I17 S6268 517826 2030 15703  130    90 52 27 16 1215
I19 S2  15 237320 2040  440000 72 67 60 40 23 15 12 6
I19 S2  15 147620 2040  490102 85 86146 96 62 25 15 9
I19 S2  15 157920 2040  5203   83   147 97 52 26 1711
I40 E4238 227319 2548 2280000 79 37 68 47 26 14 07 3
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I40 E4238 237819 2548 26000   47    63 42 21 14 08 8
I40 E4244 227317 2548 2280000 37 23 72 48 27 15 10 5
I40 E4244 237517 2548 2410000 28 26 54 42 24 14 09 7
I40 E4244 237817 2548 26000   29    52 37 21 15 0910
I40 E4299 227217 4040 2070000 44 80 41 30 21 15 12 5
I40 E4299 237317 4040 2150101 80 81 58 45 27 21 16 6
I40 E4299 237517 4040 2300101 83 74 73 60 46 30 24 8
I40 E4299 247817 4040 25202  116    76 66 42 24 2111
I40 E4300 227217 4040 2070001 56 78 37 29 21 17 13 5
I40 E4300 237317 4040 2150101 78 12 59 45 29 22 17 6
I40 E4300 237517 4040 2300101 85 77 86 68 49 31 21 8
I40 E4300 247817 4040 25202  118    77 62 35 21 1711
I40 E4301 227217 4040 2070000 29 44 52 42 30 21 16 5
I40 E4301 237317 4040 2150101 44 45 76 57 37 23 17 6
I40 E4301 237517 4040 2300101 47 48 75 59 45 30 16 8
I40 E4301 247817 4040 25202   71    75 54 37 26 1911
I40 E4302 227217 4040 2070000 28 41 53 47 33 23 17 5
I40 E4302 237317 4040 2150000 41 40 79 55 34 22 17 6
I40 E4302 147517 4040 2300000 57 40111 88 71 45 21 8
```

APPENDIX A

OVERLAY

DATA FOR REGRESSION

```
 1 |2|3|4| 5 |  6| 7| 8| 9 |10|  11|12|13| 14| 15| 16| 17 |18 |19 |20|21
I40 E4302 157317 4040 25201    66    107 77 58 35 2311
I40 E4303 227217 4040 2070000 46 69 52 43 27 19 13 5
I40 E4303 237317 4040 2150004 69 60 92 67 41 26 18 6
I40 E4303 237517 4040 2300812 85 83 96 77 62 42 26 8
I40 E4303 157817 4040 25220  113   118 85 63 41 2911
I40 E4306 227217 4040 2070000 16 39 56 42 26 17 12 5
I40 E4306 237317 4040 2150004 39 46 76 54 30 19 14 6
I40 E4306 237517 4040 2300812 50 47 87 69 49 29 21 8
I40 E4306 157817 4040 25220   96   105 72 49 25 1911
I40 E4337 237220 2040 2070000 72134 94 75 56 36 26 8
I40 E4337 417320 2040 2150202134 93102 69 43 27 21 9
I40 E4337  67520 2040 2300303108116172138 95 76 5211
I40 E4337 427820 2040 25204  170   149 97 57 32 2814
I40 E4339 237220 2040 2070000 89128 34 30 24 17 12 8
I40 E4339 507220 2040 2150001123135 48 42 33 24 18 9
I40 E4339 517520 2040 2300202142134 84 72 60 47 3611
I40 E4339 517820 2040 25203  169    61 51 40 28 1914
I40 E4340 237220 2040 2070102 95126 76 53 39 24 19 8
I40 E4340 507320 2040 2150202126122 99 68 46 28 22 9
I40 E4340  67520 2040 2300202120110157117 86 60 4111
I40 E4340 427820 2040 25203  139   134 93 56 37 2514
I40 E4341 237220 2040 2070102121222 80 52 28 15 11 8
I40 E4341 417320 2040 2150202222170104 62 34 20 15 9
I40 E4341 337520 2040 2300203179158192135 80 46 3111
I40 E4341 337820 2040 25203  181   167 93 47 26 1814
I40 W4331 237220 4540 2070000 85111 76 55 36 23 12 8
I40 W4331 237320 4540 2150001111123 92 68 43 28 19 9
I40 W4331 427520 4540 2300101135134108 92 73 56 3711
I40 W4331 427820 4540 25202  170   125 93 52 41 3014
180 W5219 167835 2030  1300   87   112 77 49 29 21 1
180 W5229  77639 2025  100000 71 73165 67 23 09 05 0
180 W5229 257839 2025  1000   94    97 59 27 16 08 2
260 E7253 257636 1015  840000 92139 73 40 17 11 07 2
260 E7253 257836 1015  8701  105    91 41 17 11 07 4
260 E7254 167636 1015  840000 78112113 68 29 15 10 2
260 E7254 167836 1015  8700   89   101 46 19 13 08 4
260 E7257 167636 1015  840000 73126102 66 27 11 08 2
260 E7257 257836 1015  8702   95    90 43 17 10 06 4
260 E7263 257638 2015  840000 93114 99 73 46 30 25 1
260 E7263 257838 2015  8701   86    96 62 43 27 20 3
264 E4354 407719 2020   40000144165104 76 49 35 21 1
666 N3157 227524 2030  410203 89 98 97 68 36 20 10 5
666 N3157 507724 2030  430405147141 59 43 21 13 07 7
```

APPENDIX B

Index to First Year of Cracking

Traffic	≤2000 ADT	Low
	2001 - 10,000 ADT	Medium
	10,001 + ADT	High
Region	0.0 - 1.7	Desert
	1.8 - 2.7	Transition
	2.8 +	Mountains

SC = Seal Coat
ACFC = Asphaltic Concrete Friction Course
AC = Asphaltic Concrete
HS = Heater Scarification
AR = Asphalt Rubber
Recycle = Represents Combination of Recycled AC Plus New AC Overlay. Total AC Thickness of Nominal 4 Inches.

Index To First Year of Cracking

Traffic ADT

	≤2000 Low			2001-10,000 Medium			10,001 + High		
	Region			Region			Region		
	0.0 1.7	1.8 2.7	2.8+	0.0 1.7	1.8 2.7	2.8+	0.0 1.7	1.8 2.7	2.8+
SC	1.67	1.17	1.00	1.17	1.00	1.00	1.00	1.00	1.00
ACFC	3.00	2.50	2.00	2.83	2.50	2.00	2.83	2.50	2.00
ACFC + AR	7.50	6.50	5.50	6.50	4.50	3.50	5.50	4.50	4.50
ACFC + HS	5.50	4.50	3.50	4.50	3.50	3.00	3.50	3.00	2.50
1.5" AC	7.50	6.50	5.50	6.50	4.50	3.50	5.50	4.50	4.50
1.5" AC + AR	11.50	10.50	9.50	10.50	8.50	7.50	9.50	7.50	7.00
1.5" AC + HS	7.50	6.50	5.50	6.50	4.83	4.00	5.50	5.00	5.00
2.5" AC	9.50	8.50	7.50	8.50	6.50	5.50	6.00	6.00	5.50
2.5" AC + AR	12.50	11.50	10.50	11.50	9.50	8.50	11.50	9.00	7.17
2.5" AC + HS	10.83	9.83	8.83	9.83	7.83	6.83	7.17	6.50	6.17
3.5" AC	11.67	10.50	9.50	10.50	9.50	6.83	8.50	8.00	7.50
3.5" AC + AR	13.50	12.83	11.83	12.83	11.83	10.83	12.50	10.83	9.83
3.5" AC + HS	11.83	10.83	9.83	10.83	9.83	8.83	9.50	8.83	8.00
4.5" AC	12.50	11.50	10.50	11.50	10.50	9.50	9.50	9.00	8.50
5.5" AC	13.83	12.83	11.83	12.83	11.50	10.50	11.83	10.50	9.50
RECYCLE	16.50	15.50	14.50	15.50	14.50	13.50	14.50	13.50	12.50

APPENDIX C

New Construction and Overlay Data For Verification

Route number, mile post and direction of each site is given.

Rut depth in inches
Ride in inches/mile

Beginning traffic is the 18 kip single axle loads applied in the first year.

SN is the AASHTO structural number which was estimated by multiplying the coefficient .40 times the inches of AC and .12 times the inches of unbound base and adding the two numbers together.

SS is the AASHTO soil support number

REG. is the AASHTO regional factor

BEG. PSI is the beginning PSI which was assumed to be 4.20.

Growth is the growth factor for traffic. Thus traffic in any year was computed using a compound interest formula traffic = BEG. Traffic (Growth Factor)**year

SITE NO. 1

NEW CONSTRUCTION
PSI CALCULATION
I-8, M.P. 12, E.B.
Region=.5

YEAR	% CRACKING	RUT DEPTH	RIDE	PSI
1967	0	0	25	4.65
1968	0	0	27	4.61
1969	0	0	30	4.56
1970	0	.1	32	4.51
1971	0	.1	34	4.47
1972	0	.1	36	4.43
1973	0	.1	37	4.41
1974	0	.2	38	4.35
1975	0	.2	53	4.10
1976	0	.2	54	4.08
1977	0	.2	41	4.30
1978	0	.2	85	3.66
1979	0	.20	46	4.22

Beg. Traffic = 94,000
SN = 2.38
SS = 6.92
Reg. = .5
Beg. PSI = 4.20
Growth = 1.033

SITE NO. 2

NEW CONSTRUCTION
PSI CALCULATION
I-8, M.P. 64, E.B.
Region=.5

YEAR	% CRACKING	RUT DEPTH	RIDE	PSI
1965	0	0	20	4.75
1966	0	.10	20	4.73
1967	0	.10	21	4.71
1968	1	.10	22	4.66
1969	2	.10	24	4.60
1970	3	.10	25	4.57
1971	3	.10	25	4.57
1972	4	.15	28	4.49
1973	5	.15	52	4.06
1974	5	.15	55	4.01
1975	4	.20	84	3.59
1976	4	.20	121	3.20
1977	4	.20	112	3.29
1978	33	.20	128	3.00

Beg. Traffic = 70,000
SN = 2.24
SS = 6.92
Reg. = .5
Beg. PSI = 4.20
Growth = 1.042

SITE NO. 3

NEW CONSTRUCTION
PSI CALCULATION
I-8, M.P. 92, E.B.
Region=.7

YEAR	% CRACKING	RUT DEPTH	RIDE	PSI
1960	0	0	30	4.56
1961	0	0	34	4.48
1962	0	.10	40	4.36
1963	0	.10	43	4.31
1964	0	.10	47	4.24
1965	0	.10	51	4.17
1966	0	.10	60	4.03
1967	0	.10	68	3.92
1968	0	.10	72	3.86
1969	1	.10	79	3.37
1970	1	.10	85	3.66
1971	2	.10	92	3.56
1972	3	.10	101	3.45
1973	3	.10	163	2.91
1974	5	.10	142	3.05
1975	15	.15	188	2.66
1976	25	.15	188	2.61
1977	35	.15	196	2.51

Beg. Traffic = 49,000
SN = 3.34
SS = 7.01
Reg. = .7
Beg. PSI = 4.20
Growth = 1.047

SITE NO. 4

NEW CONSTRUCTION
PSI CALCULATION
I-8, M.P. 140, E.B.
Region=1.2

YEAR	% CRACKING	RUT DEPTH	RIDE	PSI
1959	0	0	30	4.56
1960	0	0	32	4.52
1961	0	0	36	4.45
1962	0	.10	41	4.34
1963	0	.10	43	4.31
1964	0	.10	47	4.24
1965	0	.10	50	4.19
1966	0	.10	51	4.17
1967	1	.10	53	4.10
1968	2	.10	55	4.06
1969	3	.10	60	3.97
1970	4	.10	65	3.89
1971	5	.10	69	3.82
1972	7	.10	74	3.74
1973	9	.10	125	3.17
1974	11	.10	131	3.10
1975	13	.15	167	2.79
1976	15	.15	167	2.78
1977	17	.15	163	2.80
1978	38	.15	195	2.51

Beg. Traffic = 66,000
SN = 3.00
SS = 7.01
Reg. = 1.2
Beg. PSI = 4.20
Growth = 1.057

SITE NO. 5

NEW CONSTRUCTION
PSI CALCULATION
I-10, M.P. 294, E.B.
Region=1.9

YEAR	% CRACKING	RUT DEPTH	RIDE	PSI
1963	0	0	35	4.46
1964	0	0	42	4.34
1965	0	0	50	4.20
1966	0	0	57	4.09
1967	0	0	69	3.92
1968	0	0	80	3.77
1969	0	0	84	3.72
1970	0	0	93	3.62
1971	0	0	100	3.54
1972	0	0	118	3.36
1973	0	0	134	3.21
1974	2	0	89	3.61
1975	5	.10	112	3.32
1976	10	.10	117	3.23
1977	15	.10	159	2.96
1978	24	.10	192	2.59
1979	25	.10	237	2.33

Beg. Traffic = 239,000
SN = 3.32
SS = 5.98
Reg. = 1.9
Beg. PSI = 4.20
Growth = 1.013

SITE NO. 6

NEW CONSTRUCTION
PSI CALCULATION
I-10, M.P. 338, E.B.
Region=1.8

YEAR	% CRACKING	RUT DEPTH	RIDE	PSI
1968	0	0	20	4.75
1969	0	.10	22	4.69
1970	1	.15	26	4.56
1971	1	.20	28	4.50
1972	2	.25	30	4.42
1973	3	.30	73	3.67
1974	5	.30	69	3.71
1975	6	.35	73	3.60
1976	8	.35	78	3.52
1977	10	.40	97	3.23
1978	12	.40	127	2.92
1979	11	.40	94	3.35

Beg. Traffic = 205,000
SN = 3.40
SS = 6.83
Reg. = 1.8
Beg. PSI = 4.20
Growth = 1.025

SITE NO. 7

NEW CONSTRUCTION
PSI CALCULATION
I-10, M.P. 378, E.B.
Region=1.7

YEAR	% CRACKING	RUT DEPTH	RIDE	PSI
1966	0	0	30	4.56
1967	0	0	34	4.48
1968	0	.10	42	4.33
1969	1	.10	54	4.09
1970	1	.10	63	3.95
1971	1	.10	70	3.85
1972	2	.10	77	3.76
1973	2	.10	98	3.51
1974	4	.10	132	3.14
1975	7	.15	101	3.40
1976	10	.15	86	3.55
1977	12	.15	86	3.54
1978	15	.15	116	3.20

Beg. Traffic = 146,000
SN = 5.56
SS = 5.00
Reg. = 1.7
Beg. PSI = 4.20
Growth = 1.011

SITE NO. 8

NEW CONSTRUCTION
PSI CALCULATION
I-17, M.P. 243, N.B.
Region=2.4

YEAR	% CRACKING	RUT DEPTH	RIDE	PSI
1967	0	.00	25	4.65
1968	0	0	27	4.61
1969	0	.10	29	4.56
1970	0	.10	33	4.49
1971	0	.15	39	4.36
1972	0	.15	43	4.29
1973	0	.15	76	3.79
1974	0	.15	81	3.73
1975	1	.20	33	4.41
1976	2	.20	90	3.54
1977	4	.20	90	3.52
1978	15	.20	93	3.42
1979			100	

Beg. Traffic = 102,000
SN = 3.12
SS = 9.08
Reg. = 2.4
Beg. PSI = 4.20
Growth = 1.018

SITE NO. 9

PSI CALCULATION
I-17, M.P. 298, S.B.
Region=2.6

YEAR	% CRACKING	RUT DEPTH	RIDE	PSI
1961	0	0	30	4.56
1962	0	.10	33	4.49
1963	0	.10	40	4.36
1964	0	.10	42	4.33
1965	0	.15	49	4.19
1966	0	.15	52	4.14
1967	0	.15	57	4.06
1968	0	.20	65	3.92
1969	0	.20	76	3.77
1970	0	.20	83	3.68
1971	0	.25	90	3.56
1972	0	.25	95	3.51
1973	.4	.25	120	3.25
1974	1	.25	158	2.90
1975	2	.30	158	2.84
1976	4	.30	144	2.93
1977	7	.30	174	2.68
1978	12	.30	195	2.52
1979			145	

Beg. Traffic = 70,000
SN = 4.84
SS = 4.76
Reg. = 2.6
Beg. PSI = 4.20
Growth = 1.023

SITE NO. 10

NEW CONSTRUCTION
PSI CALCULATION
I-40, M.P. 64, E.B.
Region=1.8

YEAR	% CRACKING	RUT DEPTH	RIDE	PSI
1966	0	.00	20	4.75
1967	0	.00	21	4.73
1968	0	.10	22	4.69
1969	0	.10	20	4.73
1970	0	.10	20	4.73
1971	1	.10	25	4.60
1972	2	.10	19	4.70
1973	4	.10	34	4.39
1974	5	.10	36	4.35
1975	5	.10	41	4.26
1976	7	.15	49	4.09
1977	9	.15	24	4.53
1978	13	.20	64	3.80
1979	23	.20	83	3.50

Beg. Traffic = 63,000
SN = 4.24
SS = 5.93
Reg. = 1.8
Beg. PSI = 4.20
Growth = 1.037

SITE NO. 11

NEW CONSTRUCTION
PSI CALCULATION
I-40, M.P. 134, E.B.
Region=2.7

YEAR	% CRACKING	RUT DEPTH	RIDE	PSI
1969	0	.00	20	4.75
1970	0	.10	23	4.68
1971	1	.20	20	4.65
1972	2	.25	21	4.59
1973	4	.35	54	3.90
1974	7	.40	59	3.74
1975	12	.40	90	3.30
1976	18	.45	119	2.91
1977	23	.45	108	3.00
1978	30	.45	141	2.67
1979			162	

Beg. Traffic = 46,000
SN = 3.40
SS = 5.93
Reg. = 2.7
Beg. PSI = 4.20
Growth = 1.044

SITE NO. 12

NEW CONSTRUCTION
PSI CALCULATION
I-40, M.P. 142, E.B.
Region=2.7

YEAR	% CRACKING	RUT DEPTH	RIDE	PSI
1965	0	.00	100	3.54
1966	1	.00	122	3.28
1967	3	.10	140	3.08
1968	5	.10	151	2.98
1969	8	.10	163	2.86
1970	13	.10	185	2.68
1971	20	.10	190	2.62
1972	27	.10	205	2.50
1973	33	.10	218	2.41
1974	40	.15	247	2.21
1975	43	.15	217	2.36
1976	51	.15	227	2.29
1977	57	.15	236	2.22
1978	65	.15	258	2.10
1979	65	.15	272	2.03

Beg. Traffic = 34,000
SN = 3.32
SS = 7.67
Reg. = 2.7
Beg. PSI = 4.20
Growth = 1.053

SITE NO. 13

NEW CONSTRUCTION
PSI CALCULATION
I-40, M.P. 183, E.B.
Region=3.7

YEAR	% CRACKING	RUT DEPTH	RIDE	PSI
1965	0	.00	65	3.97
1966	0	.10	71	3.88
1967	1	.10	73	3.81
1968	3	.10	81	3.68
1969	6	.10	84	3.62
1970	10	.10	85	3.58
1971	13	.10	91	3.49
1972	20	.10	96	3.40
1973	23	.10	133	3.17
1974	25	.15	156	2.82
1975	30	.15	178	2.64
1976	33	.15	177	2.64
1977	37	.15	172	2.66
1978	40	.15	233	2.29
1979	40	.15	203	2.45

Beg. Traffic = 123,000
SN = 5.04
SS =6.07
Reg. = 3.7
Beg. PSI = 4.20
Growth = 1.029

SITE NO. 14

NEW CONSTRUCTION
PSI CALCULATION
I-40, M.P. 350, W.B.
Region=2.1

YEAR	% CRACKING	RUT DEPTH	RIDE	PSI
1967	0	.00	100	3.54
1968	0	.00	109	3.44
1969	0	.00	123	3.31
1970	1	.00	141	3.12
1971	3	.00	172	2.86
1972	5	.00	212	2.58
1973	7	.00	283	2.21
1974	9	.00	250	2.35
1975	11	.10	258	2.29
1976	12	.10	221	2.47
1977	12	.10	296	2.11
1978	13	.10	317	2.02

Beg. Traffic = 176,000
SN = 6.64
SS = 6.73
Reg. = 2.1
Beg. PSI = 4.20
Growth = 1.028

SITE NO. 15

PSI CALCULATION
U.S. 60, M.P. 110
Region=1.4

YEAR	% CRACKING	RUT DEPTH	RIDE	PSI
1968	0	.00	50	4.20
1969	0	.00	52	4.17
1970	0	.05	60	4.04
1971	0	.05	65	3.97
1972	0	.05	70	3.90
1973	0	.05	80	3.77
1974	1	.05	86	3.66
1975	3	.10	118	3.28
1976	4	.10	111	3.34
1977	6	.10	131	3.13
1978	7	.10	163	2.87
1979	10	.10	170	2.80

Beg. 18 kip = 247,000
SN = 3.16
SS = 5.30
Reg. = 1.4
Beg. PSI = 4.20
Growth = 1.011

SITE NO. 16

PSI CALCULATION
S.R. 63, M.P. 32
Region=2.2

YEAR	% CRACKING	RUT DEPTH	RIDE	PSI
1964	0	.00	80	3.77
1965	0	.10	86	3.68
1966	0	.10	95	3.58
1967	1	.10	107	3.41
1968	1	.15	121	3.26
1969	2	.15	136	3.13
1970	2	.15	142	3.08
1971	3	.20	161	2.91
1972	3	.20	183	2.75
1973	4	.20	234	2.42
1974	8	.20	192	2.63
1975	12	.20	187	2.64
1976	17	.25	163	2.74
1977	21	.25	187	2.56
1978	23	.25	200	2.47
1979	26	.25	211	2.40

Beg. Traffic = 4,600
SN = .8
SS = 5.00
Reg. = 2.2
Beg. PSI = 4.20
Growth =1.032

SITE NO. 17

PSI CALCULATION
U.S. 70, M.P. 266
Region=2.0

YEAR	% CRACKING	RUT DEPTH	RIDE	PSI
1957	0	0	50	4.20
1958	0	0	52	4.17
1959	0	0	54	4.14
1960	0	0	59	4.06
1961	0	0	61	4.03
1962	0	0	63	4.00
1963	0	0	65	3.96
1964	0	0	68	3.93
1965	0	0	71	3.89
1966	0	0	73	3.86
1967	0	.00	75	3.84
1968	0	.05	82	3.74
1969	0	.05	86	3.70
1970	1	.05	91	3.60
1971	1	.05	93	3.58
1972	2	.05	97	3.52
1973	3	.05	111	3.36
1974	4	.10	99	3.46
1975	6	.10	97	3.47
1976	7	.10	128	3.15
1977	9	.10	164	2.85
1978	11	.10	154	2.91
1979	15	.10	183	2.69

Beg. Traffic = 22,000
SN = 2.96
SS = 4.50
Reg. = 2.0
Beg. PSI = 4.20
Growth = 1.011

SITE NO. 18

NEW CONSTRUCTION
PSI CALCULATION
S.R. 73, M.P. 316
Region=3.2

YEAR	% CRACKING	RUT DEPTH	RIDE	PSI
1959	0	.00	100	3.54
1960	0	.00	115	3.39
1961	0	.10	129	3.24
1962	0	.10	137	3.17
1963	0	.10	156	3.02
1964	0	.15	167	2.92
1965	0	.15	179	2.84
1966	0	.20	191	2.74
1967	1	.20	212	2.58
1968	1	.25	231	2.44
1969	1	.25	250	2.34
1970	2	.25	273	2.22
1971	2	.30	291	2.10
1972	3	.30	311	2.00
1973	3	.30	332	1.92
1974	5	.30	365	1.79
1975	8	.35	330	1.84
1976	11	.35	293	1.98
1977	13	.35	358	1.71
1978	15	.35	343	1.76
1979	17	.40	363	1.63

Beg. Traffic = 3,500
SN = .4
SS = 3.50
Reg. = 3.2
Beg. PSI = 4.20
Growth = 1.008

SITE NO. 19

NEW CONSTRUCTION
PSI CALCULATION
S.R. 86, M.P. 108
Region=1.5

YEAR	% CRACKING	RUT DEPTH	RIDE	PSI
1951	0	0	50	4.20
1952	0	0	53	4.16
1953	0	0	55	4.12
1954	0	.10	59	4.05
1955	0	.10	66	3.95
1956	0	.10	75	3.82
1957	0	.10	82	3.73
1958	0	.10	91	3.63
1959	0	.15	93	3.59
1960	0	.15	100	3.51
1961	0	.15	111	3.39
1962	0	.20	125	3.24
1963	0	.20	146	3.06
1964	0	.20	152	3.01
1965	0	.20	160	2.95
1966	0	.25	170	2.85
1967	0	.25	175	2.81
1968	0	.25	180	2.78
1969	0	.25	191	2.71
1970	0	.25	200	2.65
1971	0	.25	211	2.59
1972	1	.25	232	2.43
1973	1	.25	237	2.41
1974	3	.25	228	2.43
1975	6	.30	243	2.28
1976	9	.30	197	2.52
1977	12	.30	239	2.27
1978	15	.30	261	2.14
1979	18	.30	256	2.15

Beg. Traffic = 12,000
SN = 1.12
SS = 6.00
Reg. = 1.5
Beg. PSI = 4.20
Growth = 1.001

SITE NO. 20

PSI CALCULATION
U.S. 89, M.P. 134
Region=1.3

YEAR	% CRACKING	RUT DEPTH	RIDE	PSI
1961	0	.00	55	4.12
1962	0	.00	60	4.05
1963	0	.10	63	3.99
1964	0	.10	69	3.90
1965	0	.10	73	3.85
1966	0	.10	78	3.78
1967	0	.10	85	3.70
1968	0	.10	91	3.63
1969	0	.10	93	3.60
1970	0	.10	95	3.58
1971	0	.10	96	3.57
1972	0	.10	102	3.50
1973	1	.10	109	3.39
1974	2	.10	125	3.23
1975	4	.15	103	3.40
1976	7	.15	96	3.45
1977	9	.15	108	3.31
1978	11	.15	117	3.21
1979	14	.15	126	3.11

Beg. Traffic = 13,000
SN = .8
SS = 6.00
Reg. = 1.3
Beg..PSI = 4.20
Growth = 1.041

SITE NO. 21

PSI CALCULATION
U.S. 89, M.P. 496
Region=1.6

YEAR	% CRACKING	RUT DEPTH	RIDE	PSI
1958	0	0	45	4.29
1959	0	0	52	4.17
1960	0	0	57	4.09
1961	0	0	64	3.99
1962	0	0	69	3.92
1963	0	0	72	3.88
1964	0	0	78	3.80
1965	0	0	83	3.73
1966	0	0	89	3.66
1967	0	0	94	3.61
1968	0	8	96	3.58
1969	0	0	107	3.47
1970	0	0	121	3.33
1971	0	0	123	3.31
1972	0	0	134	3.21
1973	1	.00	173	2.88
1974	5	.00	172	2.84
1975	9	.10	196	2.64
1976	15	.10	184	2.68
1977	21	.10	259	2.24
1978	23	.10	198	2.56
1979	27	.10	200	2.53

Beg. Traffic = 16,000
SN = 1.00
SS = 3.50
Reg. = 1.6
Beg. PSI = 4.20
Growth = 1.027

SITE NO. 22

NEW CONSTRUCTION
PSI CALCULATION
S.R. 92, M.P. 342
Region=1.9

YEAR	% CRACKING	RUT DEPTH	RIDE	PSI
1968	0	.00	41	4.36
1969	0	.10	46	4.26
1970	0	.10	52	4.16
1971	0	.10	57	4.08
1972	0	.10	65	3.96
1973	0	.10	98	3.55
1974	0	.10	76	3.81
1975	1	.10	113	3.35
1976	2	.15	107	3.38
1977	3	.15	101	3.43
1978	9	.20	109	3.28
1979	11	.20	136	3.02

Beg. Traffic = 3,600
SN = 1.20
SS = 5.00
Reg. = 1.9
Beg. PSI = 4.2
Growth = 1.027

SITE NO. 23

PSI CALCULATION
U.S. 160, M.P. 414
Region=1.8

YEAR	% CRACKING	RUT DEPTH	RIDE	PSI
1962	0	.00	60	4.05
1963	0	.00	66	3.96
1964	0	.10	75	3.82
1965	0	.10	89	3.65
1966	0	.10	103	3.49
1967	0	.10	112	3.40
1968	0	.15	119	3.32
1969	0	.15	123	3.28
1970	1	.15	137	3.12
1971	2	.15	159	2.93
1972	2	.15	185	2.75
1973	4	.20	205	2.58
1974	8	.20	196	2.60
1975	13	.20	204	2.53
1976	21	.20	205	2.48
1977	30	.25	230	2.28
1978	33	.25	247	2.18
1979	35	.25	243	2.19

Begin. Traffic =10,000
SN = .80
SS = 4.00
Reg. = 1.8
Beg. PSI = 4.20
Growth = 1.025

SITE NO. 25

NEW CONSTRUCTION
PSI CALCULATION
S.R. 366, M.P. 116
Region = 2.0

YEAR	% CRACKING	RUT DEPTH	RIDE	PSI
1964	0	.00	56	4.11
1965	0	.10	59	4.05
1966	0	.10	64	3.97
1967	0	.10	70	3.89
1968	0	.10	73	3.85
1969	0	.15	76	3.79
1970	0	.15	78	3.77
1971	0	.15	89	3.63
1972	0	.15	97	3.54
1973	1	.15	118	3.29
1974	1	.15	165	2.90
1975	1	.15	152	3.00
1976	1	.15	163	2.92
1977	2	.20	151	2.97
1978	2	.20	170	2.83
1979	7	.20	161	2.84

Beg. Traffic = 2,600
SN = .80
SS = 5.00
Reg. = 2.0
Beg. PSI = 4.20
Growth = 1.022

SITE NO. 26

PSI CALCULATION
U.S. 93, M.P. 169
Region=1.6

YEAR	% CRACKING	RUT DEPTH	RIDE	PSI
1959	0	.00	40	4.37
1960	0	.00	40	4.37
1961	0	.05	41	4.35
1962	0	.05	41	4.35
1963	0	.05	42	4.34
1964	0	.05	43	4.32
1965	0	.05	43	4.32
1966	0	.05	43	4.32
1967	0	.05	44	4.30
1968	0	.05	44	4.30
1969	0	.05	45	4.28
1970	0	.05	50	4.20
1971	0	.05	52	4.17
1972	0	.05	55	4.12
1973	0	.05	66	3.96
1974	1	.10	65	3.92
1975	2	.10	74	3.78
1976	3	.10	67	3.87
1977	7	.10	60	3.94
1978	8	.10	90	3.53
1979	10	.10	74	3.72

Beg. Traffic = 23,000
SN = .80
SS = 6.00
Reg. = 1.6
Beg. PSI = 4.20
Growth =1.008

SITE NO. 27

PSI CALCULATION
U.S. 163, M.P. 398
Region=1.9

YEAR	% CRACKING	RUT DEPTH	RIDE	PSI
1958	0	.00	45	4.29
1959	0	.00	50	4.20
1960	0	.10	56	4.09
1961	0	.10	63	3.99
1962	0	.10	69	3.90
1963	0	.10	73	3.85
1964	0	.10	79	3.77
1965	0	.10	82	3.37
1966	0	.10	86	3.68
1967	0	.10	91	3.63
1968	0	.10	93	3.60
1969	0	.10	97	3.56
1970	0	.10	111	3.41
1971	1	.10	130	3.20
1972	2	.10	145	3.05
1973	3	.10	158	2.94
1974	6	.10	138	3.07
1975	9	.10	146	2.99
1976	14	.15	138	3.01
1977	17	.15	162	2.81
1978	20	.15	201	2.54
1979	24	.15	217	2.43

Beg. Traffic = 1,200
SN = .80
SS = 3.00
Reg. = 1.9
Beg. PSI = 4.20
Growth = 1.047

SITE NO. 28

PSI CALCULATION
U.S. 180, M.P. 406
Region=3.5

YEAR	% CRACKING	RUT DEPTH	RIDE	PSI
1948	0	0	75	3.84
1949	0	.10	80	3.76
1950	0	.10	84	3.71
1951	0	.10	88	3.66
1952	0	.10	93	3.60
1953	0	.10	99	3.54
1954	0	.10	107	3.45
1955	0	.10	115	3.37
1956	0	.10	120	3.32
1957	0	.10	121	3.31
1958	0	.10	121	3.31
1959	0	.10	125	3.28
1960	0	.10	133	3.21
1961	0	.10	141	3.14
1962	0	.10	149	3.08
1963	0	.10	152	3.05
1964	0	.10	161	2.98
1965	0	.10	165	2.96
1966	0	.10	169	2.93
1967	0	.10	170	2.92
1968	1	.10	173	2.86
1969	3	.10	181	2.78
1970	4	.10	190	2.71
1971	5	.10	192	2.69
1972	7	.10	193	2.67
1973	9	.10	210	2.55
1974	14	.10	233	2.40
1975	23	.10	227	2.39
1976	36	.10	256	2.20
1977	50	.10	330	1.84
1978	53	.10	281	2.04
1979	57	.10	371	1.68

Beg. Traffic = 229
SN = .40
SS = 3.72
Reg. = 3.5
Beg. PSI = 4.20
Growth = 1.083

SITE NO. 29

NEW CONSTRUCTION
PSI CALCULATION
U.S. 666, M.P. 144
Region=1.9

YEAR	% CRACKING	RUT DEPTH	RIDE	PSI
1950	0	0	71	3.89
1951	0	.00	73	3.86
1952	0	.10	79	3.79
1953	0	.10	85	3.71
1954	0	.10	89	3.66
1955	0	.10	91	3.64
1956	0	.10	95	3.59
1957	0	.10	97	3.57
1958	0	.10	100	3.54
1959	0	.10	101	3.53
1960	0	.10	102	3.52
1961	0	.15	104	3.47
1962	0	.15	107	3.43
1963	0	.15	115	3.35
1964	0	.15	129	3.22
1965	0	.15	133	3.19
1966	0	.15	137	3.16
1967	0	.15	140	3.13
1968	0	.15	141	3.12
1969	0	.15	141	3.12
1970	0	.15	152	3.03
1971	0	.15	176	2.86
1972	0	.15	201	2.70
1973	0	.15	222	2.58
1974	1	.20	232	2.46
1975	1	.20	241	2.42
1976	2	.20	211	2.57
1977	3	.20	281	2.20
1978	6	.20	255	2.29
1979	10	.20	282	2.14

Beg. Traffic = 5,300
SN = .40
SS = 3.00
Reg. = 1.9
Beg. PSI = 4.20
Growth = 1.069

SITE NO. 1
OVERLAY
PSI CALCULATION
U.S. 95, M.P. 12
Region=.3

YEAR	% CRACKING	RUT DEPTH	RIDE	PSI
1968	0	.00	65	3.97
1969	0	.00	73	3.86
1970	0	.05	82	3.74
1971	0	.05	90	3.65
1972	1	.05	99	3.51
1973	1	.05	102	3.48
1974	2	.05	105	3.43
1975	2	.10	127	3.21
1976	2	.10	86	3.63
1977	3	.10	48	4.16
1978	3	.10	128	3.19
1979			122	

Beg. Traffic = 37,000
SN = 3.38
SS = 6.00
Reg. = .3
Beg. PSI = 4.20
Growth = 1.024

SITE NO. 2
PSI CALCULATION
I-8, M.P. 60, E.B.
Region=.5
OVERLAY

YEAR	% CRACKING	RUT DEPTH	RIDE	PSI
1965	0	.00	25	4.65
1966	0	.00	27	4.61
1967	0	.05	28	4.59
1968	0	.10	29	4.56
1969	0	.10	29	4.56
1970	1	.10	30	4.51
1971	1	.10	30	4.51
1972	2	.10	31	4.47
1973	2	.10	43	4.26
1974	3	.10	42	4.26
1975	4	.15	61	3.93
1976	5	.15	62	3.90
1977	6	.15	49	4.10
1978	25	.15	95	3.47
1979			40	

Beg. Traffic = 70,000
SN = 2.24
SS = 6.92
Reg. = .5
Beg. PSI = 4.20
Growth = 1.042

SITE NO. 3
PSI CALCULATION
S.R. 95, M.P. 132
Region=.6
OVERLAY

YEAR	% CRACKING	RUT DEPTH	RIDE	PSI
1970	0	.00	65	3.97
1971	0	.00	72	3.88
1972	1	.00	82	3.71
1973	1	.00	97	3.53
1974	2	.00	102	3.47
1975	3	.05	113	3.34
1976	5	.05	111	3.34
1977	7	.05	100	3.44
1978	8	.05	175	2.79
1979			152	

Beg. Traffic = 14,000
SN = 1.52
SS = 7.00
Reg. = .6
Beg. PSI = 4.20
Growth = 1.099

SITE NO. 5
OVERLAY
PSI CALCULATION
I-8, M.P. 112, W.B.
Region=.7

YEAR	% CRACKING	RUT DEPTH	RIDE	PSI
1970	0	.00	25	4.65
1971	0	.10	30	4.54
1972	0	.10	33	4.49
1973	0	.10	31	4.52
1974	1	.10	46	4.22
1975	1	.10	49	4.17
1976	1	.15	51	4.12
1977	2	.15	61	3.95
1978	2	.15	74	3.77
1979			55	

Beg. Traffic = 159,000
SN = 2.38
SS = 7.01
Reg. = .7
Beg. PSI = 4.20
Growth = 1.043

SITE NO. 7
OVERLAY
PSI CALCULATION
S.R. 87, M.P. 118
Region=1.1

YEAR	% CRACKING	RUT DEPTH	RIDE	PSI
1969	0	.00	41	4.36
1970	0	.00	46	4.27
1971	0	.00	52	4.17
1972	1	.00	63	3.97
1973	1	.00	76	3.79
1974	3	.05	73	3.80
1975	5	.05	55	4.04
1976	7	.05	65	3.37
1977	10	.05	60	3.93
1978	14	.05	90	3.51
1979			79	

Beg. Traffic = 1,700
SN = 2.36
SS = 6.00
Reg. = 1.1
Beg. PSI = 4.20
Growth = 1.016

SITE NO. 8
OVERLAY
PSI CALCULATION
I-40, M.P. 38, E.B.
Region=1.2

YEAR	% CRACKING	RUT DEPTH	RIDE	PSI
1966	0	.00	15	4.84
1967	0	.00	20	4.75
1968	0	.05	21	4.72
1969	0	.05	24	4.67
1970	0	.10	22	4.69
1971	0	.10	23	4.68
1972	0	.10	23	4.68
1973	0	.15	46	4.24
1974	0	.15	46	4.24
1975	0	.15	38	4.38
1976	0	.15	48	4.21
1977	0	.15	36	4.41
1978	0	.15	83	3.70
1979	2	.15	61	3.95

Beg. Traffic = 186,000
SN = 3.08
SS = 8.99
Reg. = 1.2
Beg. PSI = 4.20
Growth = 1.025

SITE NO. 9
OVERLAY
PSI CALCULATION
I-40, M.P. 23, W.B.
Region=1.2

YEAR	% CRACKING	RUT DEPTH	RIDE	PSI
1970	0	.00	15	4.84
1971	0	.00	17	4.80
1972	0	.05	14	4.85
1973	0	.05	26	4.63
1974	0	.05	35	4.46
1975	1	.10	56	4.06
1976	1	.10	26	4.58
1977	1	.10	20	4.69
1978	1	.10	65	3.92
1979	5	.10	41	4.26

Beg. Traffic = 160,000
SN = 2.46
SS = 8.99
Reg. = 1.2
Beg. PSI = 4.20
Growth = 1.036

SITE NO. 10
OVERLAY
PSI CALCULATION
U.S. 93, M.P. 59
Region=1.4

YEAR	% CRACKING	RUT DEPTH	RIDE	PSI
1961	0	.00	25	4.65
1962	0	.00	31	4.54
1963	0	.05	39	4.39
1964	0	.05	47	4.25
1965	0	.05	49	4.22
1966	0	.10	52	4.16
1967	1	.10	52	4.12
1968	1	.10	63	3.95
1969	2	.15	69	3.83
1970	3	.15	75	3.74
1971	5	.15	82	3.63
1972	6	.15	90	3.53
1973	8	.15	113	3.27
1974	9	.15	90	3.51
1975	10	.20	117	3.19
1976	10	.20	116	3.20
1977	11	.20	107	3.29
1978	12	.20	163	2.80
1979	14	.20	138	2.98

Beg. Traffic = 21,000
SN = 2.58
SS = 6.00
Reg. = 1.4
Beg. PSI = 4.20
Growth = 1.023

SITE NO. 11
OVERLAY
PSI CALCULATION
I-10, M.P. 390, E.B.
Region=1.6

YEAR	% CRACKING	RUT DEPTH	RIDE	PSI
1969	0	.00	35	4.46
1970	0	.05	41	4.35
1971	1	.05	45	4.25
1972	1	.10	51	4.14
1973	2	.10	52	4.11
1974	2	.10	64	3.92
1975	3	.10	70	3.83
1976	3	.15	67	3.83
1977	7	.15	73	3.73
1978	9	.15	83	3.59
1979			58	

Beg. Traffic = 145,000
SN = 5.16
SS = 5.00
Reg. = 1.6
Beg. PSI = 4.2
Growth = 1.017

SITE NO. 12
OVERLAY
PSI CALCULATION
U.S. 60, M.P. 252
Region=1.6

YEAR	% CRACKING	RUT DEPTH	RIDE	PSI
1970	0	.00	65	3.97
1971	1	.05	77	3.77
1972	3	.10	98	3.48
1973	6	.10	113	3.30
1974	6	.10	119	3.24
1975	6	.10	119	3.24
1976	7	.10	123	3.20
1977	7	.15	122	3.19
1978	8	.15	143	3.00
1979			166	

Beg. Traffic = 15,000
SN = 4.46
SS = 7.00
Reg. = 1.6
Beg. PSI = 4.20
Growth = 1.051

SITE NO. 14
OVERLAY
PSI CALCULATION
I-40, M.P. 304, E.B.
Region=1.7

YEAR	% CRACKING	RUT DEPTH	RIDE	PSI
1967	0	.00	20	4.73
1968	0	.10	22	4.69
1969	0	.10	24	4.66
1970	0	.15	27	4.58
1971	1	.20	31	4.45
1972	1	.25	34	4.36
1973	1	.30	68	3.69
1974	1	.30	74	3.69
1975	1	.35	71	3.68
1976	2	.35	69	3.70
1977	2	.35	130	3.03
1978	2	.35	101	3.31
1979			127	

Beg. Traffic = 183,000
SN = 3.22
SS = 6.07
Reg. = 1.7
Beg. PSI = 4.20
Growth = 1.024

SITE NO. 15
OVERLAY
PSI CALCULATION
U.S. 70, M.P. 370
Region=1.8

YEAR	% CRACKING	RUT DEPTH	RIDE	PSI
1966	0	.00	40	4.37
1967	0	.00	43	4.32
1968	0	.10	47	4.24
1969	0	.10	51	4.17
1970	1	.10	58	4.03
1971	1	.15	60	3.98
1972	2	.15	64	3.90
1973	2	.20	89	3.56
1974	3	.20	80	3.65
1975	3	.20	106	3.34
1976	7	.20	91	3.49
1977	9	.20	133	3.05
1978	10	.20	139	3.00
1979			123	

Beg. Traffic = 5,400
SN = 2.88
SS = 6.00
Reg. = 1.8
Beg. PSI = 4.20
Growth = 1.061

SITE NO. 16
OVERLAY
PSI CALCULATION
I-19, M.P. 42, N.
Region=1.8

YEAR	% CRACKING	RUT DEPTH	RIDE	PSI
1969	0	.00	30	4.36
1970	0	.05	35	4.46
1971	0	.10	40	4.36
1972	0	.15	44	4.27
1973	0	.20	77	3.76
1974	1	.25	67	3.82
1975	2	.25	78	3.66
1976	3	.25	69	3.77
1977	5	.25	72	3.71
1978	6	.25	76	3.65
1979			80	

Beg. Traffic = 64,000
SN = 3.12
SS = 8.80
Reg. = 1.8
Beg. PSI = 4.20
Growth = 1.032

SITE NO. 17
OVERLAY
PSI CALCULATION
S.R. 389, M.P. 1.0
Region=1.9

YEAR	% CRACKING	RUT DEPTH	RIDE	PSI
1967	0	.00	40	4.37
1968	0	.00	43	4.32
1969	0	.10	51	4.17
1970	0	.10	56	4.09
1971	0	.10	59	4.05
1972	0	.20	62	3.96
1973	0	.20	68	3.88
1974	1	.20	66	3.87
1975	1	.20	79	3.69
1976	2	.25	72	3.74
1977	2	.25	88	3.54
1978	3	.25	103	3.36
1979	5	.25	118	3.19

Beg. Traffic = 4,000
SN = 3.04
SS = 4.50
Reg. = 1.9
Beg. PSI = 4.20
Growth = 1.001

SITE NO. 18
OVERLAY
PSI CALCULATION
I-19, M.P. 12, N.B.
Region=2.0

YEAR	% CRACKING	RUT DEPTH	RIDE	PSI
1967	0	.00	25	4.65
1968	0	.00	31	4.54
1969	0	.10	32	4.51
1970	0	.10	34	4.47
1971	0	.10	36	4.43
1972	1	.20	41	4.26
1973	1	.20	51	4.10
1974	1	.20	48	4.14
1975	1	.20	65	3.88
1976	2	.20	64	3.88
1977	2	.25	65	3.84
1978	3	.25	74	3.70
1979	4	.25	102	3.36

Beg. Traffic =53,000
SN = 2.72
SS = 5.00
Reg. = 2.0
Beg. PSI = 4.20
Growth = 1.035

SITE NO. 19
OVERLAY
PSI CALCULATION
I-10, M.P. 326, E.B.
Region=2.0

YEAR	% CRACKING	RUT DEPTH	RIDE	PSI
1971	0	.00	20	4.75
1972	0	.10	24	4.66
1973	0	.20	42	4.28
1974	0	.20	52	4.12
1975	1	.20	49	4.13
1976	1	.25	55	4.00
1977	1	.25	51	4.06
1978	1	.25	50	4.06
1979	2	.25	57	3.95

Beg. Traffic = 270,000
SN = 3.14
SS = 6.83
Reg. = 2.0
Beg. PSI = 4.20
Growth = 1.017

SITE NO. 20
OVERLAY
PSI CALCULATION
I-10, M.P. 327, E.B.
Region=2.0

YEAR	% CRACKING	RUT DEPTH	RIDE	PSI
1971	0	.00	25	4.65
1972	0	.10	28	4.58
1973	0	.20	53	4.10
1974	0	.20	54	4.08
1975	1	.20	57	4.00
1976	1	.25	59	3.94
1977	1	.25	59	3.94
1978	1	.25	62	3.89
1979	3	.30	64	3.80

Beg. Traffic = 270,000
SN = 2.78
SS = 6.83
Reg. = 2.0
Beg. PSI = 4.20
Growth = 1.017

SITE NO. 22
OVERLAY
PSI CALCULATION
U.S. 60, M.P. 354
Region=2.0

YEAR	% CRACKING	RUT DEPTH	RIDE	PSI
1971	0	.00	58	4.08
1972	0	.10	65	3.96
1973	0	.10	87	3.67
1974	1	.10	114	3.34
1975	2	.10	122	3.25
1976	3	.15	142	3.05
1977	5	.15	163	2.87
1978	5	.15	152	2.95
1979	7	.15	141	3.02

Beg. Traffic = 8,400
SN = 1.84
SS = 3.50
Reg. 2.0
Beg. PSI = 4.20
Growth = 1.025

SITE NO. 23
OVERLAY
PSI CALCULATION
I-40, M.P. 230, E.B.
Region=2.3

YEAR	% CRACKING	RUT DEPTH	RIDE	PSI
1970	0	.00	65	3.97
1971	0	.00	69	3.92
1972	0	.10	77	3.80
1973	0	.10	126	3.27
1974	1	.10	53	4.10
1975	3	.10	77	3.73
1976	5	.10	91	3.54
1977	7	.15	127	3.14
1978	8	.15	119	3.21
1979			133	

Beg. Traffic = 172,000
SN = 3.92
SS = 8.42
Reg. = 2.3
Beg. PSI = 4.20
Growth = 1.025

SITE NO. 24
OVERLAY
PSI CALCULATION
U.S. 66, M.P. 136, E.B.
Region=2.4

YEAR	% CRACKING	RUT DEPTH	RIDE	PSI
1971	0	.00	65	3.97
1972	0	.20	71	3.84
1973	1	.40	76	3.57
1974	2	.40	95	3.32
1975	2	.40	101	3.25
1976	3	.45	92	3.28
1977	5	.50	91	3.21
1978	5	.50	147	2.68
1979	6	.50	127	2.84

Beg. Traffic = 36,000
SN = 3.48
SS = 4.50
Reg. = 2.4
Beg. PSI = 4.20
Growth = 1.001

SITE NO. 25
OVERLAY
PSI CALCULATION
U.S. 666, M.P. 155
Region=2.4

YEAR	% CRACKING	RUT DEPTH	RIDE	PSI
1970	0	.00	65	3.97
1971	0	.00	80	3.77
1972	0	.00	88	3.67
1973	0	.00	70	3.90
1974	1	.00	92	3.59
1975	2	.10	118	3.29
1976	2	.10	121	3.26
1977	3	.10	173	2.83
1978			126	
1979			102	

Beg. Traffic = 25,000
SN = 2.32
SS = 6.75
Reg. = 2.4
Beg. PSI = 4.20
Growth = 1.005

SITE NO. 27
OVERLAY
PSI CALCULATION
S.R. 77, M.P. 344
Region=2.8

YEAR	% CRACKING	RUT DEPTH	RIDE	PSI
1971	0	.00	60	4.05
1972	0	.10	67	3.93
1973	0	.15	73	3.83
1974	1	.15	81	3.69
1975	3	.15	73	3.77
1976	5	.15	92	3.51
1977	6	.15	132	3.11
1978	8	.20	113	3.24
1979			113	

Beg. Traffic = 24,000
SN = 2.56
SS = 4.00
Reg. = 2.8
Beg. PSI = 4.20
Growth = 1.020

SITE NO. 29
OVERLAY
PSI CALCULATION
U.S. 89A, M.P. 399
Region=3.5

YEAR	% CRACKING	RUT DEPTH	RIDE	PSI
1972	0	.00	99	3.55
1973	0	.15	101	3.50
1974	1	.15	117	3.30
1975	1	.20	141	3.06
1976	2	.20	132	3.12
1977	2	.20	144	3.02
1978	3	.25	172	2.77
1979			171	

Beg. Traffic = 4,700
SN = 2.64
SS = 4.00
Reg. = 3.5
Beg. PSI = 4.20
Growth = 1.037

APPENDIX D

Summary of Verification Correlations

PMS - Ride - New PMS Prediction Equation

SOMSAC - Previously Used Prediction Equation

PSI - Modified PSI Prediction Equation

N/A Not Applicable

Case 1

TABLE R^2

New Construction

Site Project	N	PMS-Ride	SOMSAC	PSI
1	13	.5767	.5881	.5865
2	14	.9040	.8764	.9203
3	18	.9585	.9415	.9518
4	21	.9330	.9141	.9653
5	17	.8584	.8546	.9200
6	12	.8702	.8701	.9026
7	14	.5347	.5303	.8565
8	13	.7763	.7760	.7681
9	19	.9155	.9081	.8951
10	14	.6798	.6881	.6471
11	11	.9350	.9582	.9435
12	15	.9348	.9137	.8889
13	15	.8677	.8052	.8598
14	12	.8543	.8526	.8556
15	12	.9641	.9641	.9735
16	16	.7508	.7575	N/A
17	23	.8908	.8518	.9484
18	21	.9504	.9109	N/A
19	29	.9448	.9490	N/A
20	19	.8025	.8242	N/A
21	22	.9220	.5335	N/A
22	12	.8797	.8733	N/A
23	18	.9608	.9700	N/A
24	25	.5464	.5473	N/A
25	16	.8991	.9012	N/A
26	21	.8441	.8149	N/A
27	22	.9455	.9431	N/A
28	32	.6646	.5623	N/A
29	30	.8843	.6419	N/A
$\bar{x}$	18.1	.8431	.8111	.8677
σ	5.7	.1270	.1432	.1113

N/A - Not Applicable

Case 1

TABLE

Std. Error

New Construction

Site Project	N	PMS-Ride	SOMSAC	PSI
1	13	9.92	9.79	.17
2	14	12.25	13.90	.17
3	18	11.27	13.38	.14
4	21	14.32	16.22	.12
5	17	19.59	19.85	.16
6	12	12.24	12.25	.19
7	14	19.78	19.88	.17
8	13	13.52	13.52	.22
9	19	14.98	15.62	.21
10	14	10.57	10.43	.22
11	11	12.76	10.23	.19
12	15	12.66	14.57	.15
13	15	19.45	23.60	.21
14	12	27.91	28.07	.20
15	12	7.59	7.59	.08
16	16	22.90	22.59	N/A
17	23	11.78	13.72	.10
18	21	19.48	26.11	N/A
19	29	16.19	15.57	N/A
20	19	9.15	8.70	N/A
21	22	16.32	39.92	N/A
22	12	10.33	10.60	N/A
23	18	12.01	10.54	N/A
24	25	45.46	45.42	N/A
25	16	13.50	13.36	N/A
26	21	5.51	6.01	N/A
27	22	10.95	11.18	N/A
28	32	40.58	46.36	N/A
29	30	21.55	37.91	N/A
$\bar{x}$	--	16.36	18.51	.71
σ	--	8.89	11.16	.04

N/A - Not Applicable

Case 1

TABLE

A Coefficient

New Construction

Site Project	N	PMS-Ride	SOMSAC	PSI
1	13	13.66	11.95	- 2.64
2	14	-31.29	-13.94	-10.49
3	18	- 6.50	.27	-54.09
4	21	- 5.18	- 1.00	- 8.26
5	17	6.08	21.19	1.96
6	12	-16.16	2.25	- 4.66
7	14	28.28	38.92	- 9.23
8	13	2.15	7.32	-55.06
9	19	- 3.56	11.44	- 7.04
10	14	- .46	5.39	- 5.44
11	11	-37.84	-10.64	-13.17
12	15	93.40	108.59	-25.19
13	15	18.40	33.06	- 9.27
14	12	46.64	82.60	-37.15
15	12	- 4.49	11.23	2.43
16	16	72.39	85.47	N/A
17	23	30.16	33.92	2.62
18	21	67.70	89.72	N/A
19	29	43.38	28.73	N/A
20	19	57.20	59.64	N/A
21	22	22.89	16.66	N/A
22	12	15.75	29.98	N/A
23	18	36.88	46.96	N/A
24	25	-17.71	9.14	N/A
25	16	24.52	13.98	N/A
26	21	30.19	31.58	N/A
27	22	28.31	32.84	N/A
28	32	26.32	49.44	N/A
29	30	41.22	43.42	N/A
$\bar{x}$	--	18.78	30.35	-14.67
σ	--	30.09	30.89	18.58

N/A - Not Applicable

Case 1

TABLE

B Coefficient

New Construction

Site Project	N	PMS-Ride	SOMSAC	PSI
1	13	.25	.27	1.70
2	14	.72	.33	3.60
3	18	.66	.40	14.03
4	21	.49	.34	3.05
5	17	.57	.32	.59
6	12	.63	.31	2.26
7	14	.35	.16	3.34
8	13	.36	.32	14.23
9	19	.42	.31	2.88
10	14	.25	.15	2.49
11	11	.74	.36	4.32
12	15	.52	.26	6.76
13	15	.42	.26	3.25
14	12	1.19	.37	9.76
15	12	.90	.61	.45
16	16	.47	.23	N/A
17	23	.25	.20	.38
18	21	.60	.77	N/A
19	29	.38	.62	N/A
20	19	.21	.11	N/A
21	22	.46	.25	N/A
22	12	.53	.30	N/A
23	18	.66	.34	N/A
24	25	.32	.27	N/A
25	16	.50	.79	N/A
26	21	.12	.07	N/A
27	22	.36	.32	N/A
28	32	.36	.29	N/A
29	30	.34	.27	N/A
$\bar{x}$	--	.48	.33	4.57
σ	--	.22	.17	4.41

N/A - Not Applicable

Case 1

Coefficient of Variation

Site	N	PMS - RIDE	SOMSAC	PSI
1	13	18%	18%	4%
2	14	17	19	5
3	18	10	12	4
4	21	13	14	3
5	17	14	15	5
6	12	17	17	5
7	14	27	27	4
8	13	22	22	5
9	19	13	14	6
10	14	21	20	5
11	11	14	11	5
12	15	7	8	5
13	15	13	16	7
14	12	13	13	7
15	12	7	7	3
16	16	16	16	N/A
17	23	10	12	3
18	21	8	11	N/A
19	29	11	10	N/A
20	19	10	10	N/A
21	22	13	26	N/A
22	12	12	12	N/A
23	18	8	7	N/A
24	25	27	27	N/A
25	16	12	12	N/A
26	21	9	9	N/A
27	22	8	9	N/A
28	32	18	21	N/A
29	30	12	21	N/A
$\bar{X}$	--	15	15	5
	--	5	6	1

N/A - Not Applicable

Case 2

TABLE

Correlation Between Predicted Future Ride in Years 1-7 Based on a Measured Ride Now

Future Year Ride Predicted	R^2 New Construction		
	PMS	SOMSAC	PSI
1	.8922	.8831	.8372
2	.8622	.8366	.7891
3	.8327	.7476	.6845
4	.8144	.7106	.6524
5	.8047	.6266	.6565
6	.8066	.5778	.5544
7	.8085	.2647	--
$\bar{x}$	.8316	.6639	.6959
σ	.0336	.2062	.1021

Case 2

TABLE

Correlation Between Predicted Future Ride in Years 1-7 Based on a Measured Ride Now

		Standard Error New Construction	
Future Year Ride Predicted	PMS	SOMSAC	PSI
1	25.36	26.28	.25
2	28.68	31.70	.28
3	31.43	38.00	.35
4	33.41	41.86	.35
5	34.80	49.92	.36
6	34.64	51.68	.38
7	36.55	71.74	---
$\bar{x}$	32.12	44.45	.33
σ	3.93	15.10	.05

Case 2

TABLE

Correlation Between Predicted Future Ride in Years 1-7 Based on a Measured Ride Now

Future Year Ride Predicted	PMS	A Coefficient New Construction SOMSAC	PSI
1	9.24	5.94	.28
2	12.56	1.39	.36
3	12.86	14.64	.54
4	15.81	18.32	.64
5	16.04	27.47	.61
6	19.67	39.48	.91
7	5.89	91.45	--
$\bar{x}$	13.15	28.38	.56
σ	4.59	30.62	.22

Case 2

TABLE

Correlation Between Predicted Future Ride in Years 1-7 Based on a Measured Ride Now

Future Year Ride Predicted		Slope B New Construction	
	PMS	SOMSAC	PSI
1	.90	.92	.89
2	.84	.91	.84
3	.80	.76	.78
4	.75	.69	.72
5	.73	.62	.71
6	.70	.53	.59
7	.74	.38	---
$\bar{x}$	.78	.73	.76
σ	.07	.21	.11

Case 2

Correlation Between Predicted Future Ride in Years 1-7 Based On a Measured Ride Now

Future Year Ride Predicted	PMS	SOMSAC	PSI
1	13%	13%	8%
2	15	16	9
3	16	19	11
4	17	21	11
5	18	25	11
6	18	25	12
7	19	32	--
$\overline{X}$	17	22	10
	2	6	2

Case 1

New Construction or In - Service

Project	N	PMS R^2	A	B	% Cracking	
1	13	-----	---		Std. Error	C.V.
2	14	.3733	-1.84	2.47	6.33	38
3	19	.4939	-8.48	3.58	10.14	38
4	20	.7072	-3.58	1.36	4.92	26
5	17	.8444	-3.21	.96	3.27	26
6	12	.9471	.23	1.31	.97	8
7	13	.9522	-1.33	1.39	1.07	15
8	12	.6614	-1.69	.72	2.41	32
9	18	.8934	- .94	.12	1.02	17
10	14	.9129	-1.68	1.32	1.86	17
11	10	.9930	-1.03	3.06	.85	6
12	15	.8503	9.95	1.73	8.85	27
13	15	.7324	9.22	.38	7.51	38
14	12	.8835	.88	1.22	1.70	26
15	11	.9170	- .92	1.07	.73	20
16	16	.9731	- .96	.96	1.44	11
17	23	.7532	-1.33	.23	2.05	27
18	21	.7723	- .67	.11	2.55	31
19	29	.2445	-1.21	.28	4.18	47
20	19	.7712	-1.92	.67	2.04	29
21	22	.6623	-3.61	.77	4.90	36
22	12	.8347	-1.50	.96	1.48	27
23	18	.9116	-4.17	1.44	3.63	21
24	26	.1826	-1.11	.11	9.75	49
25	16	.7063	- .56	.20	.93	26
26	21	.6372	-1.26	.27	1.77	36
27	22	.7666	-2.71	.50	3.53	29
28	32	.1752	-1.76	.16	14.90	52
29	30	.1522	- .37	.06	1.94	38
	$\bar{x}$	.7038	- .98	.98	3.81	28
		.2568	.34	.89	3.51	12

Existing Construction In - Service

Correlation Between Predicted Future % Cracking In Years 1-6 Based On A Measured % Cracking Now.

Case 2

Future Year % Cracking Predicted	N	R^2	Error	A	B	C.V.
1	163	.9136	4.03	1.84	.89	12%
2	136	.8266	6.04	4.49	.72	19
3	107	.6435	9.03	7.95	.55	28
4	79	.6158	9.66	10.23	.53	30
5	49	.6068	10.04	12.84	.45	31
6	20	.7091	8.53	13.17	.45	26
$\bar{x}$		.7201	7.89	8.42	.60	24
		.1268	2.36	4.56	.17	7

Case 1

TABLE

Ride Overlay

R^2

Project	N	PMS	SOMSAC	PSI
1	12	.2039	.2101	.1802
2	15	.5501	.5213	.8811
3	10	.7314	.7911	.6138
4	--	--	--	--
5	10	.8078	.8308	.9646
6	--	--	--	--
7	11	.5495	.5495	N/A
8	14	.7481	.7279	.7969
9	9	.4004	.4136	.5279
10	19	.9274	.9252	.8716
11	11	.6739	.7059	.9290
12	10	.8904	.8887	.9568
13	--	--	--	--
14	13	.8867	.8805	.9062
15	14	.9163	.9152	.9531
16	11	.7267	.7472	.8564
17	13	.9297	.9122	.9779
18	13	.9154	.9030	.8696
19	9	.6699	.6649	.7332
20	9	.7209	.7184	.6730
21	--	--	--	--
22	9	.8269	.8306	.5638
23	10	.4961	.4907	.4704
24	9	.7551	.7538	.9114
25	10	.4996	.5007	.8979
26	--	--	--	--
27	9	.7904	.7845	.6556
28	--	-	--	--
29	8	.9263	.9256	.8587
$\bar{x}$	11.2	.7193	.7214	.7750
σ	2.6	.1930	.1918	.2029

Case 1

TABLE

Ride Overlay
Std. Error

Project	N	PMS	SOMSAC	PSI
1	12	21.33	21.25	.26
2	15	51.08	12.57	.12
3	10	16.78	14.80	.20
4	--	--	--	--
5	10	6.52	6.12	.05
6	--	--	--	--
7	11	9.54	9.54	N/A
8	14	9.28	9.64	.15
9	9	12.97	12.83	.21
10	19	9.99	10.14	.19
11	11	8.04	7.64	.07
12	10	9.22	9.30	.06
13	--	--	--	--
14	13	12.68	13.02	.17
15	14	9.48	9.55	.26
16	11	9.61	9.24	.13
17	13	5.79	6.47	.05
18	13	6.12	6.55	.13
19	9	7.27	7.33	.14
20	9	7.20	7.23	.16
21	--	--	--	--
22	9	14.97	14.81	.28
23	10	20.07	20.18	.24
24	9	12.36	12.39	.12
25	10	21.67	21.65	.11
26	--	--	--	--
27	9	10.69	10.84	.18
28	--	--	--	--
29	8	7.16	7.19	.10
$\bar{x}$	--	13.04	11.32	.15
σ	--	9.55	4.63	.07

Case 1

TABLE

Ride Overlay

A Coefficient

Project	N	PMS	SOMSAC	PSI
1	12	67.05	64.43	-18.68
2	15	12.75	9.29	- 3.56
3	10	34.06	21.93	1.53
4	--	--	--	--
5	10	3.80	6.41	- 9.84
6	--	--	--	--
7	11	34.03	32.81	N/A
8	14	- 1.06	- 1.81	-30.66
9	9	- .35	3.36	-41.31
10	19	12.54	6.81	- 3.90
11	11	27.49	26.57	- 3.55
12	10	40.50	37.47	-53.31
13	--	--	--	--
14	13	-22.33	-23.37	.59
15	14	9.77	3.90	-76.44
16	11	20.42	18.08	-90.47
17	13	20.87	13.91	-31.22
18	13	5.05	3.51	3.75
19	9	15.51	11.57	2.00
20	9	18.91	16.67	3.44
21	--	--	--	--
22	9	24.63	21.05	3.21
23	10	43.82	49.99	-13.69
24	9	40.15	34.02	- .28
25	10	50.24	38.25	- 8.68
26	--	--	--	--
27	9	10.69	43.52	3.41
28	--	--	--	--
29	8	7.16	69.45	- 1.31
$\bar{x}$	--	20.68	22.08	-16.77
σ	--	19.78	21.93	26.82

Case 1

TABLE

Ride Overlay

B Coefficient

Project	N	PMS	SOMSAC	PSI
1	12	.26	.28	5.36
2	15	.23	.22	1.93
3	10	.80	.88	.50
4	--	--	--	--
5	10	.47	.39	3.44
6	--	--	--	--
7	11	.30	.31	N/A
8	14	.31	.28	8.46
9	9	.34	.24	10.96
10	19	.39	.35	1.94
11	11	.28	.28	1.94
12	10	.72	.77	13.63
13	--	--	--	--
14	13	.65	.62	1.02
15	14	.50	.57	19.22
16	11	.35	.38	22.60
17	13	.36	.49	8.48
18	13	.33	.35	.21
19	9	.27	.35	.61
20	9	.30	.35	.23
21	--	--	--	--
22	9	.86	.95	.24
23	10	.40	.29	4.23
24	9	.47	.61	1.01
25	10	.41	.67	2.98
26	--	--	--	--
27	9	.33	.31	.14
28	00	00	00	00
29	8	.39	.58	1.13
$\bar{x}$	--	.42	.46	5.01
σ	--	.17	.21	6.40

Ride Overlays Coefficient of Variation

Project	N	PMS	SOMSAC	PSI
1	12	22%	22%	7%
2	15	21	21	3
3	10	14	12	6
4	--	--	--	-
5	10	13	12	1
6	--	--	--	-
7	11	15	15	N/A
8	14	19	20	4
9	9	16	32	5
10	19	11	11	5
11	11	14	13	2
12	10	8	8	2
13	--	--	--	-
14	13	17	17	4
15	14	11	11	7
16	11	17	17	3
17	13	7	8	1
18	13	10	10	3
19	9	19	19	3
20	9	16	16	4
21	--	--	--	-
22	9	14	13	8
23	10	20	20	7
24	9	12	12	4
25	10	18	18	3
26	--	--	--	-
27	9	11	11	5
28	-	--	--	-
29	8	5	5	3
	$\bar{x}$	14	15	4
		5	6	2

Case 2

TABLE

Correlation Between Predicted Future Ride in Years 1-7 Based on a Measured Ride Now

Future Year Ride Predicted	Overlay R^2			
	PMS	SOMSAC	PSI	N
1	.6555	.6565	.-674	161
2	.6107	.5782	.4971	138
3	.6607	.5462	.4055	115
4	.5777	.5286	.2673	92
5	.5944	.4713	.1354	69
6	.5952	.4970	.0342	44
7	.6760	.4731	--	23
$\bar{x}$	.6243	.5358	.3345	---
σ	.0389	.0660	.2352	---

Case 2

TABLE

Correlation Between Predicted Future Ride in Years 1-7 Based on a Measured Ride Now

Future Year Ride Predicted			Overlays Std. Error
	PMS	SOMSAC	PSI
1	20.92	20.99	.25
2	22.58	23.48	.30
3	21.67	25.71	.33
4	25.14	26.38	.39
5	25.76	28.63	.45
6	23.45	26.97	.42
7	22.35	28.50	---
$\bar{x}$	23.12	25.81	.36
σ	1.78	2.75	.08

Case 2

TABLE

Correlation Between Predicted Future Ride in Years 1-7 Based on a Measured Ride Now

Future Year Ride Predicted	PMS	Overlay A Coefficient SOMSAC	PSI
1	16.53	10.10	.60
2	16.73	5.62	1.26
3	8.73	- 6.33	1.39
4	11.66	- 6.90	1.97
5	10.92	- .81	2.61
6	25.64	5.39	3.11
7	14.59	- 2.41	--
$\bar{x}$	14.97	.67	1.82
σ	5.57	6.50	.93

Case 2

TABLE

Correlation Between Predicted Future Ride in Years 1-7 Based on a Measured Ride Now

Future Year Ride Predicted	PMS	Overlay B Coefficient SOMSAC	PSI
1	.75	.83	.82
2	.71	.84	.65
3	.74	.88	.60
4	.66	.83	.44
5	.66	.75	.25
6	.54	.66	.08
7	.56	.63	---
$\bar{x}$	.66	.77	.47
σ	.08	.10	.27

Case 2

Correlation Between Predicted Future Ride in Years 1-7 Based on A Measured Ride Now

Overlays

Future Year Ride Predicted		Coefficient of Variation		
		PMS	SOMSAC	PSI
1		22	22	7
2		24	24	8
3		23	27	9
4		26	27	11
5		27	30	12
6		24	25	11
7		23	27	-
	$\bar{x}$	24	26	10
		2	3	2

Case 1

TABLE

Overlay % Cracking

Project		N	R^2	Std. Error	A	B
1		10	.9557	.23	- .09	.24
2		13	.5837	4.14	-2.43	1.17
3		9	.9753	.44	- .21	.83
4		--	--	--	--	--
5		9	.9224	.22	- .14	.27
6		--	--	--	--	--
7		10	.9524	1.01	-1.16	1.12
8		14	.2367	.22	- .13	.14
9		10	.6437	.86	- .45	.29
10		19	.9772	.72	- .97	.79
11		10	.9042	.90	- .21	2.92
12		9	.7264	1.40	2.17	1.11
13		--	--	--	--	--
14		12	.9009	.24	.14	.55
15		13	.9396	.84	- .75	1.71
16		10	.8677	.78	- .30	2.00
17		13	.8347	.61	- .62	.38
18		13	.9351	.31	- .21	.48
19		9	.7584	.33	- .03	.24
20		9	.7044	.50	- .14	.32
21		--	--	--	--	--
22		9	.9116	.73	- .50	1.62
23		9	.8800	1.06	.34	4.18
24		9	.9242	.58	.09	1.22
25		8	.9375	.28	- .25	.63
26		--	--	--	--	--
27		8	.9643	.55	- .52	1.24
28		--	--	--	--	--
29		7	.9156	.30	.19	.45
30	$\bar{x}$	10.6	.8414	.75	- .27	1.04
	σ	2.7	.1716	.81	.78	.97

Case 1

Overlay % Cracking

	Coefficient of Variation	
Project	N	C.V.
1	10	15%
2	13	33
3	9	11
4	-	-
5	9	22
6	-	-
7	10	14
8	14	22
9	10	34
10	19	10
11	10	20
12	9	35
13	-	-
14	12	24
15	13	17
16	10	26
17	13	24
18	13	16
19	9	33
20	9	33
21	-	-
22	9	21
23	9	27
24	9	19
25	8	19
26	-	-
27	8	14
28	-	-
29	7	20
$\bar{x}$		22
		8

Case 2

TABLE

Correlation Between Predicted Future % Cracking In Years 1-5 Based on a Measured % Cracking Now

Overlay

Future Year % Cracking Predicted	R^2	Std. Error
	Olay PMS	Olay PMS
1	.7520	1.82
2	.6810	2.14
3	.5316	2.74
4	.3587	3.49
5	.3514	4.04
$\bar{x}$	.5349	2.85
σ	.1825	.92

	Olay A	Olay B
1	.30	.98
2	.36	.96
3	.76	.91
4	1.76	.74
5	1.85	.76
$\bar{x}$	1.01	.87
σ	.75	.11

Case 2

Correlation Between Predicted Future % Cracking in Years 1-5 Based On A Measured %Cracking Now

Coefficient of Variation

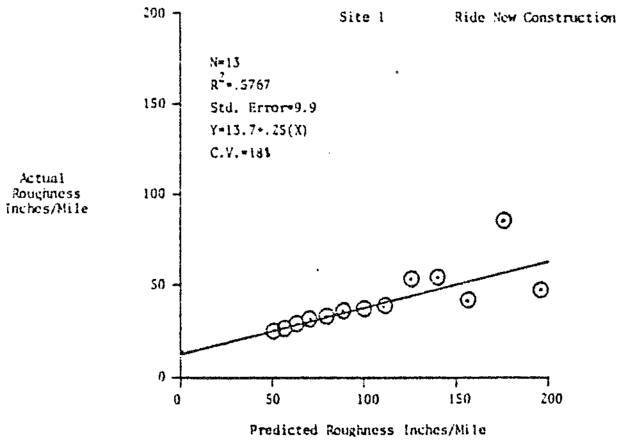
Overlay

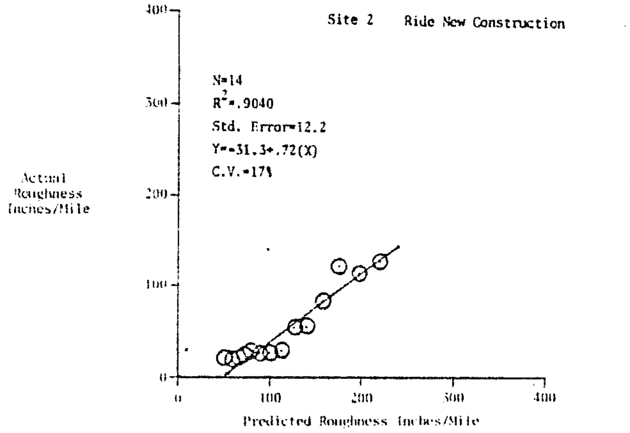
Future Year % Cracking Predicted	C.V.
1	15%
2	17
3	22
4	28
5	32
$\overline{x}$	23
	7

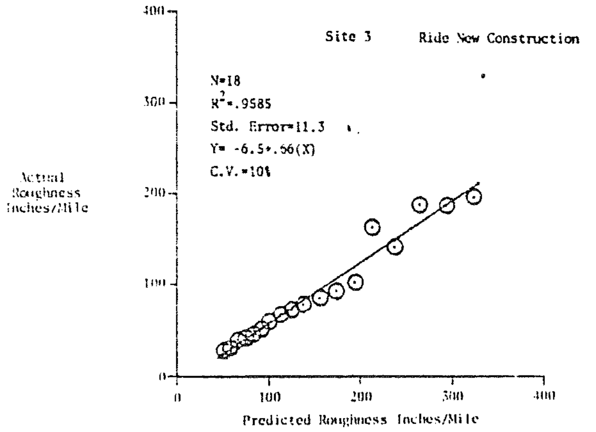
APPENDIX E

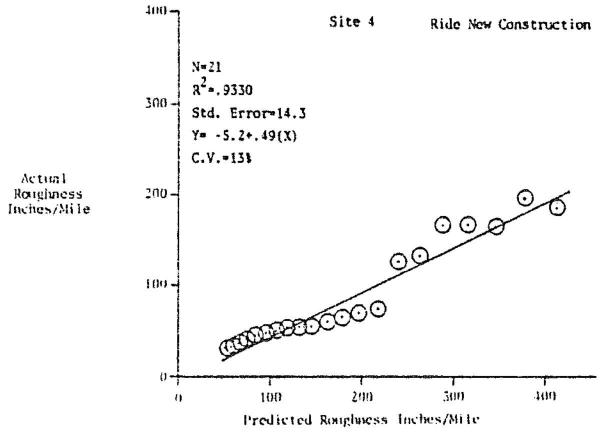
Figures Depicting Actual Roughness or % Cracking Versus Predicted Values

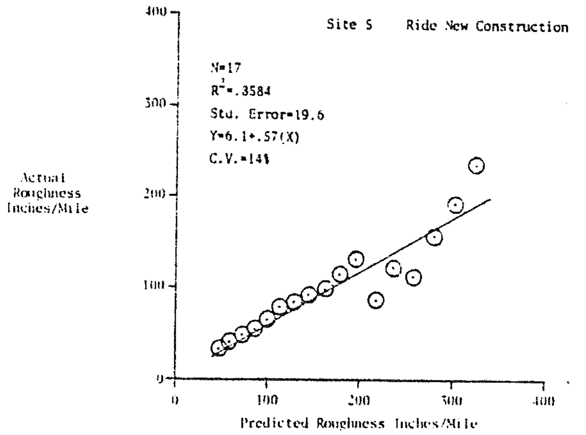
For Case 1

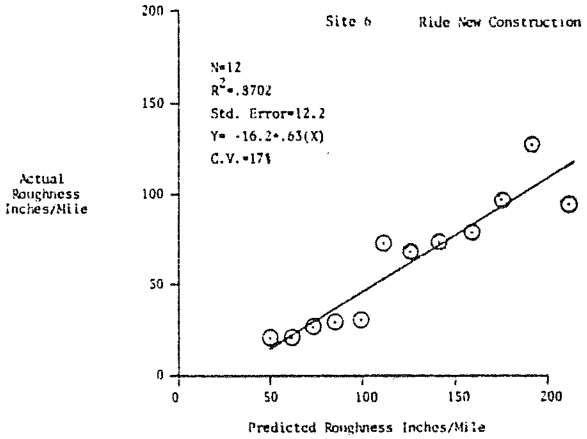

Site 1
Ride New Construction
N=13
R^2=.5767
Std. Error=9.9
Y=13.7+.25(X)
C.V.=18%
Actual Roughness Inches/Mile
0
50
100
150
200
Predicted Roughness Inches/Mile
0
50
100
150
200

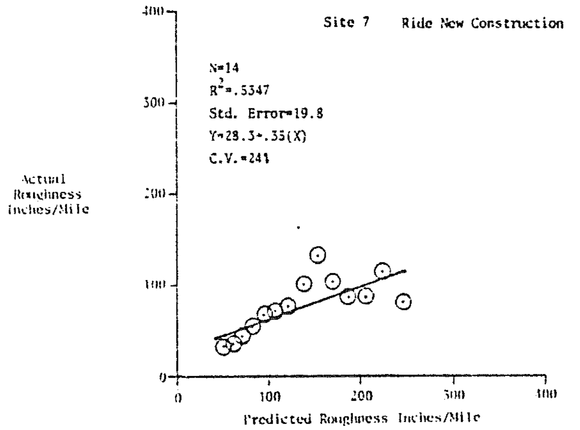

Site 2
Ride New Construction
N=14
R^2=.9040
Std. Error=12.2
Y=-31.3+.72(X)
C.V.=17%
Actual Roughness Inches/Mile
0
100
200
300
400
Predicted Roughness Inches/Mile
0
100
200
300
400

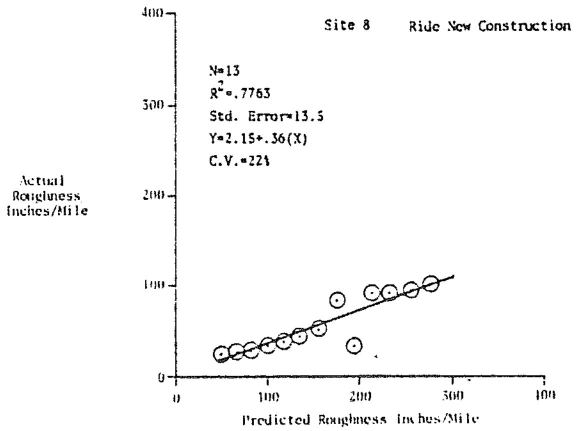

Site 3
Ride New Construction
N=18
R^2=.9585
Std. Error=11.3
Y= -6.5+.56(X)
C.V.=10%
Actual Roughness Inches/Mile
0
100
200
300
400
Predicted Roughness Inches/Mile
0
100
200
300
400

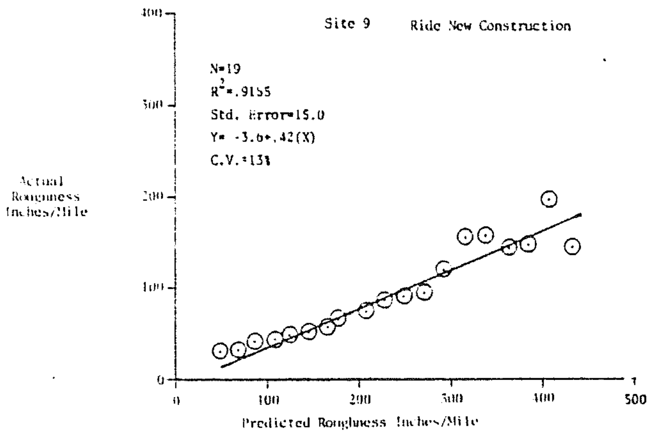

Site 4
Ride New Construction
N=21
R^2=.9330
Std. Error=14.3
Y= -5.2+.49(X)
C.V.=13%
Actual Roughness Inches/Mile
0
100
200
300
400
Predicted Roughness Inches/Mile
0
100
200
300
400

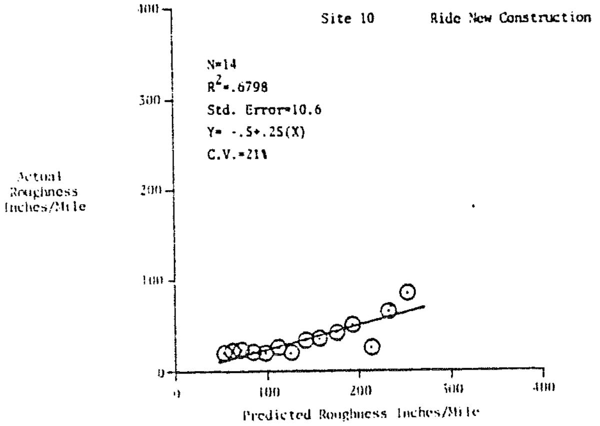

Site 5
Ride New Construction
N=17
R^2=.3584
Stu. Error=19.6
Y=6.1+.57(X)
C.V.=14%
Actual Roughness Inches/Mile
0
100
200
300
400
Predicted Roughness Inches/Mile
0
100
200
300
400

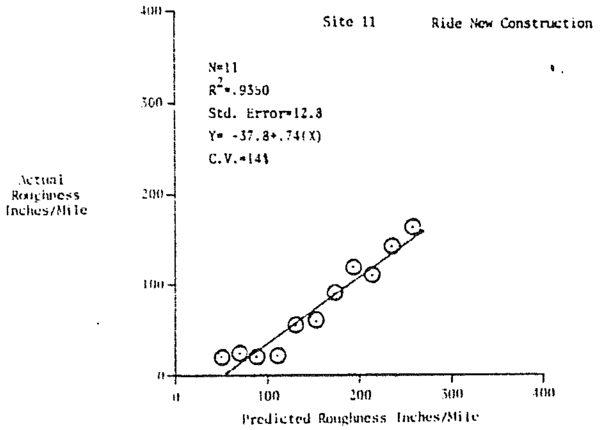

Site 6
Ride New Construction
N=12
R^2=.8702
Std. Error=12.2
Y= -16.2+.63(X)
C.V.=17%
Actual Roughness Inches/Mile
0
50
100
150
200
Predicted Roughness Inches/Mile
0
50
100
150
200

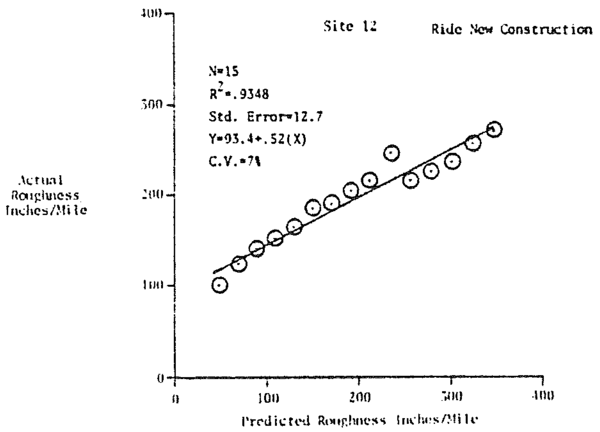

Site 7
Ride New Construction
N=14
R^2=.5347
Std. Error=19.8
Y=28.3+.35(X)
C.V.=24%
Actual Roughness Inches/Mile
0
100
200
300
400
Predicted Roughness Inches/Mile
0
100
200
300
400

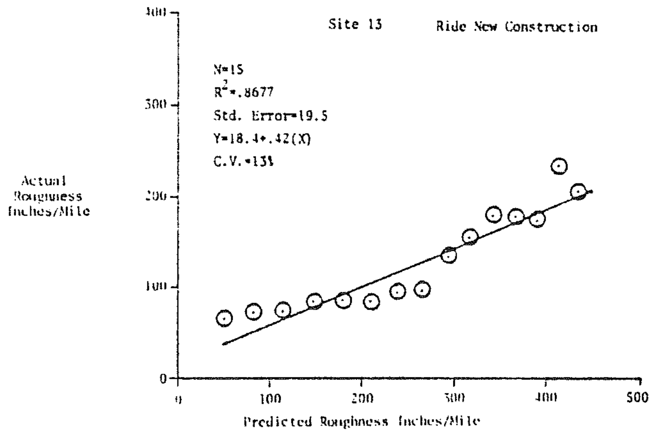

Site 8
Ride New Construction
N=13
R^2=.7763
Std. Error=13.5
Y=2.15+.36(X)
C.V.=22%
Actual Roughness Inches/Mile
0
100
200
300
400
Predicted Roughness Inches/Mile
0
100
200
300
400

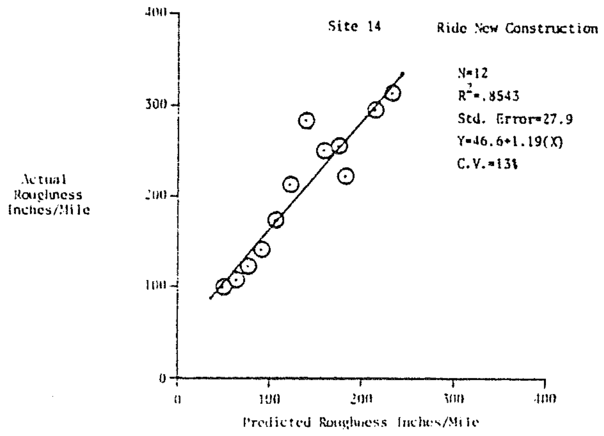

Site 9
Ride New Construction
N=19
R^2=.9155
Std. Error=15.0
Y= -3.6+.42(X)
C.V.=13%
Actual Roughness Inches/Mile
400
300
200
100
0
0
100
200
300
400
500
Predicted Roughness Inches/Mile

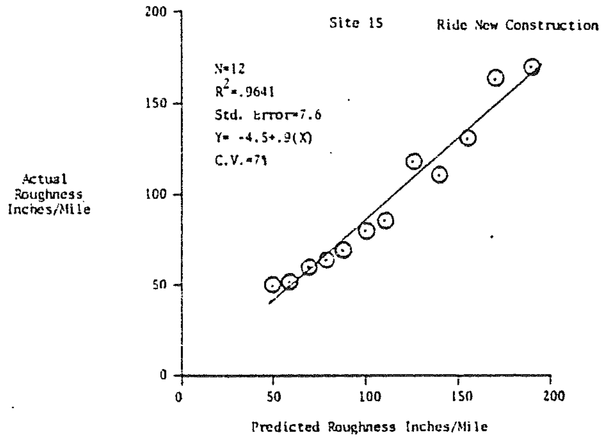

Site 10
Ride New Construction
N=14
R^2=.6798
Std. Error=10.6
Y= -.5+.25(X)
C.V.=21%
Actual Roughness Inches/Mile
400
300
200
100
0
0
100
200
300
400
Predicted Roughness Inches/Mile

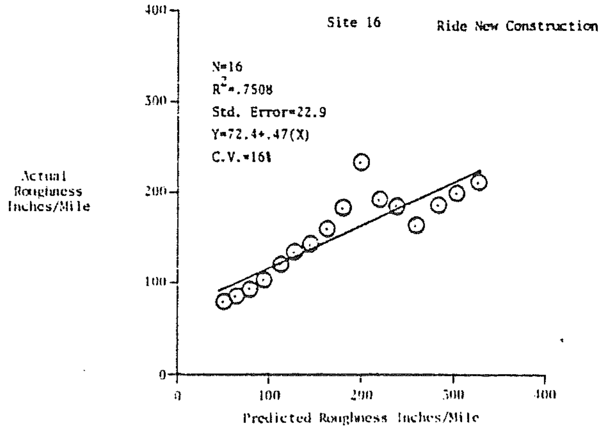

Site 11
Ride New Construction
N=11
R^2=.9350
Std. Error=12.8
Y= -37.8+.74(X)
C.V.=14%
Actual Roughness Inches/Mile
400
300
200
100
0
0
100
200
300
400
Predicted Roughness Inches/Mile

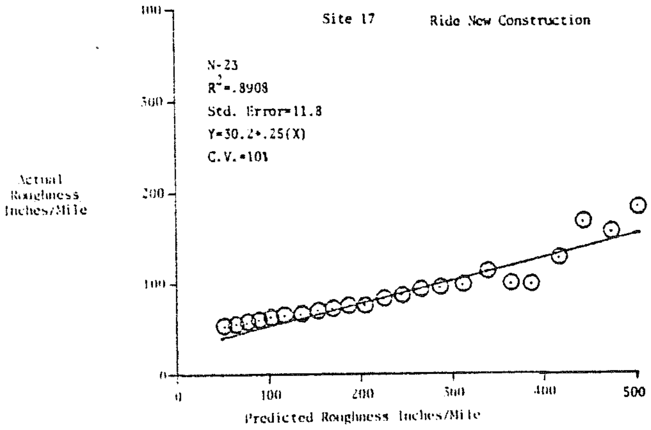

Site 12
Ride New Construction
N=15
R^2=.9348
Std. Error=12.7
Y=93.4+.52(X)
C.V.=7%
Actual Roughness Inches/Mile
400
300
200
100
0
0
100
200
300
400
Predicted Roughness Inches/Mile

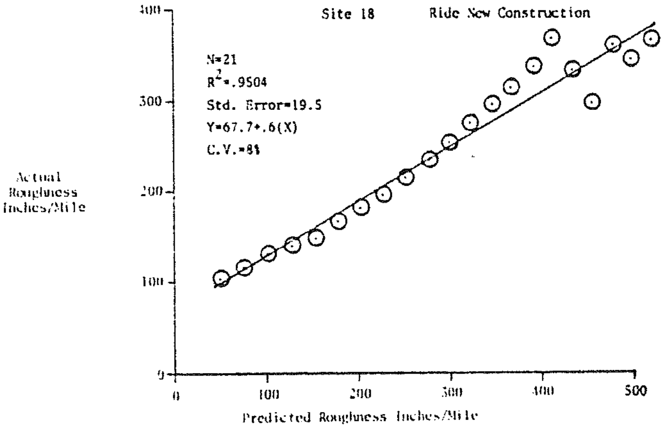

Site 13
Ride New Construction
N=15
R^2=.8677
Std. Error=19.5
Y=18.4+.42(X)
C.V.=13%
Actual Roughness Inches/Mile
400
300
200
100
0
0
100
200
300
400
500
Predicted Roughness Inches/Mile

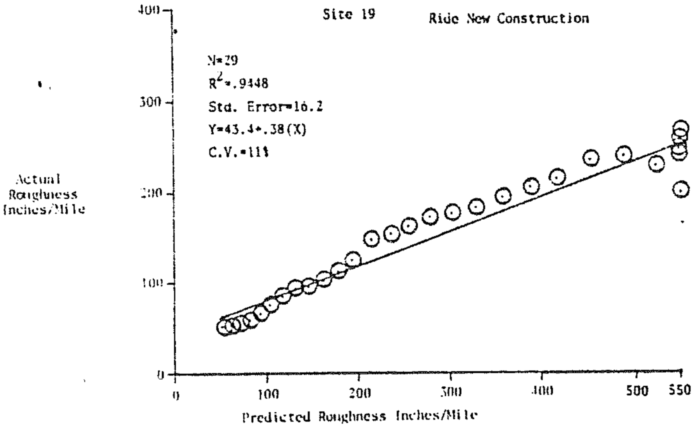

Site 14
Ride New Construction
N=12
R^2=.8543
Std. Error=27.9
Y=46.6+1.19(X)
C.V.=13%
Actual Roughness Inches/Mile
400
300
200
100
0
0
100
200
300
400
Predicted Roughness Inches/Mile

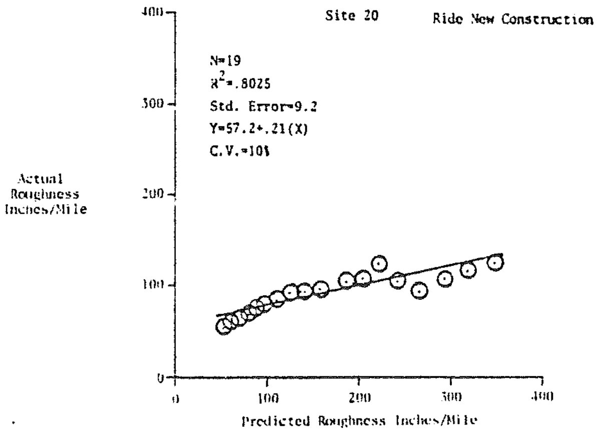

Site 15
Ride New Construction
N=12
R^2=.9641
Std. Error=7.6
Y= -4.5+.9(X)
C.V.=7%
Actual Roughness Inches/Mile
200
150
100
50
0
0
50
100
150
200
Predicted Roughness Inches/Mile

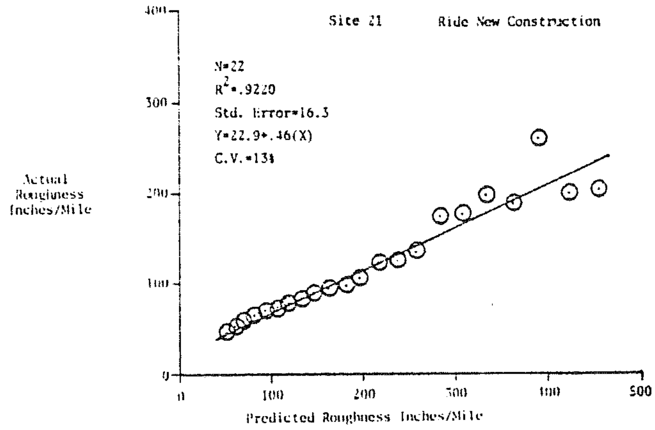

Site 16
Ride New Construction
N=16
R^2=.7508
Std. Error=22.9
Y=72.4+.47(X)
C.V.=16%
Actual Roughness Inches/Mile
400
300
200
100
0
0
100
200
300
400
Predicted Roughness Inches/Mile

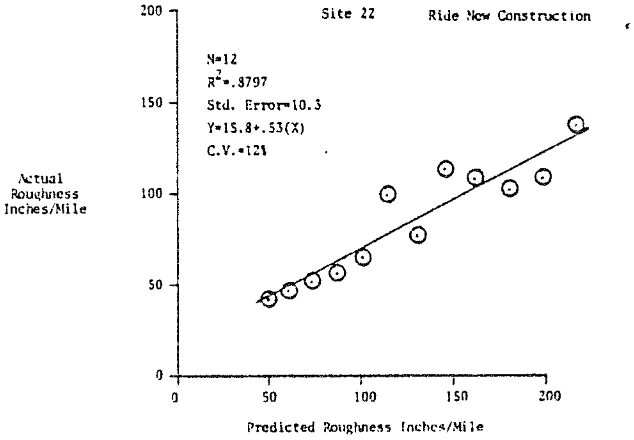

Site 17
Ride New Construction
N=23
R^2=.8908
Std. Error=11.8
Y=30.2+.25(X)
C.V.=10%
Actual Roughness Inches/Mile
0
100
200
300
400
500
Predicted Roughness Inches/Mile

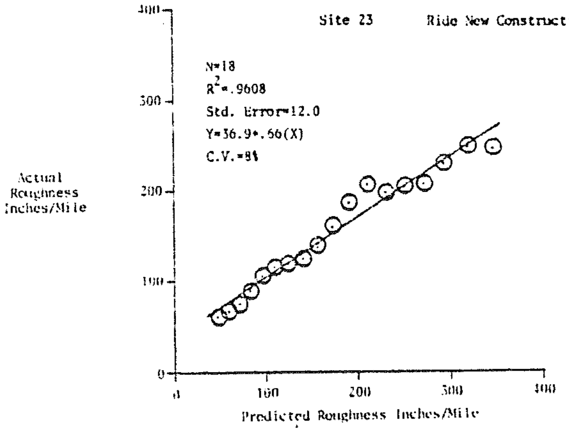

Site 18
Ride New Construction
N=21
R^2=.9504
Std. Error=19.5
Y=67.7+.6(X)
C.V.=8%
Actual Roughness Inches/Mile
0
100
200
300
400
500
Predicted Roughness Inches/Mile

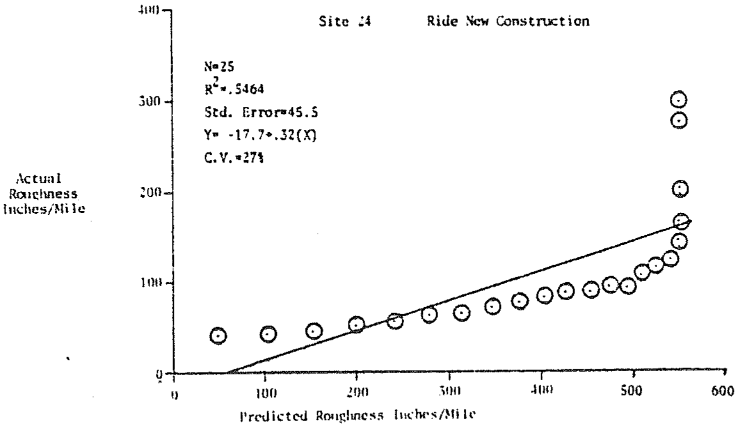

Site 19
Ride New Construction
N=29
R^2=.9448
Std. Error=16.2
Y=43.4+.38(X)
C.V.=11%
Actual Roughness Inches/Mile
0
100
200
300
400
500
550
Predicted Roughness Inches/Mile

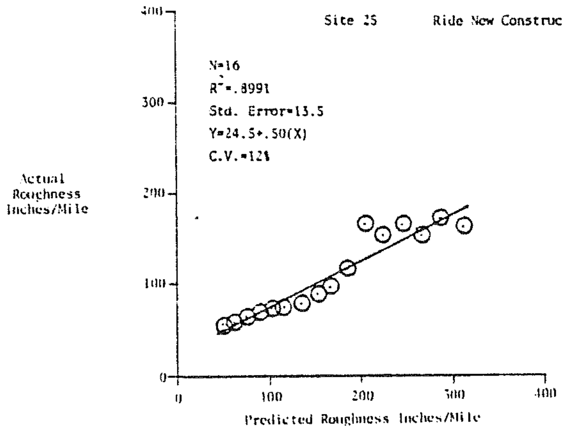

Site 20
Ride New Construction
N=19
R^2=.8025
Std. Error=9.2
Y=57.2+.21(X)
C.V.=10%
Actual Roughness Inches/Mile
0
100
200
300
400
Predicted Roughness Inches/Mile

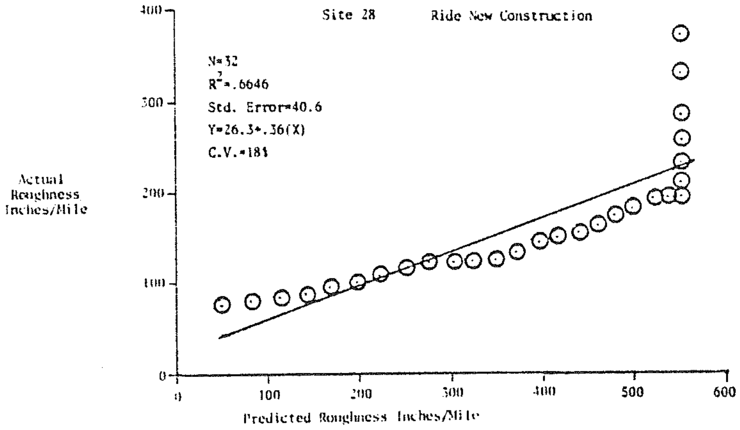

Site 21
Ride New Construction
N=22
R^2=.9220
Std. Error=16.3
Y=22.9+.46(X)
C.V.=13%
Actual Roughness Inches/Mile
0
100
200
300
400
500
Predicted Roughness Inches/Mile

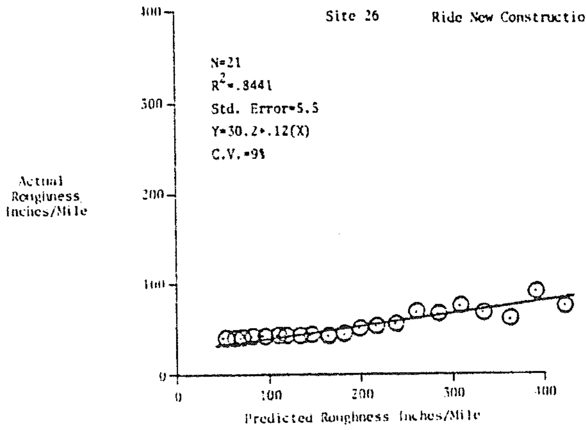

Site 22
Ride New Construction
N=12
R^2=.8797
Std. Error=10.3
Y=15.8+.53(X)
C.V.=12%
Actual Roughness Inches/Mile
0
50
100
150
200
Predicted Roughness Inches/Mile

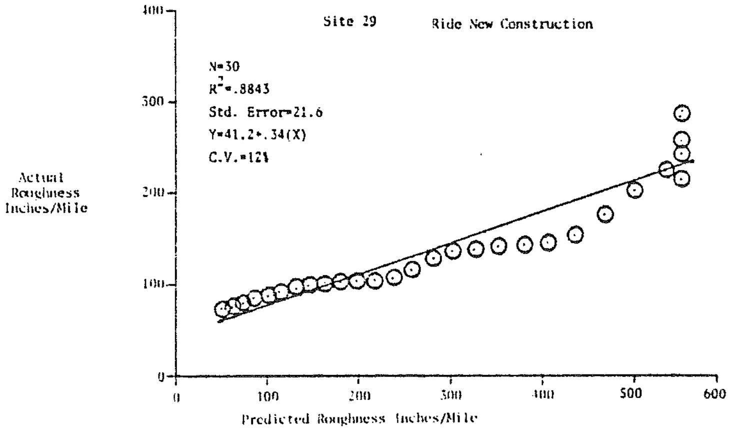

Site 23
Ride New Construction
N=18
R^2=.9608
Std. Error=12.0
Y=36.9+.66(X)
C.V.=8%
Actual Roughness Inches/Mile
0
100
200
300
400
Predicted Roughness Inches/Mile

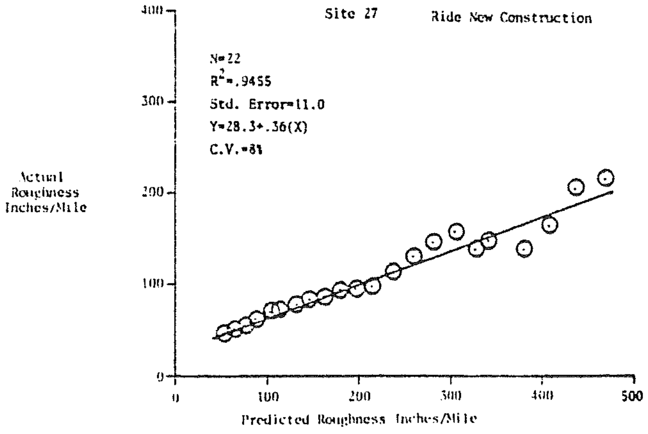

Site 24
Ride New Construction
N=25
R^2=.5464
Std. Error=45.5
Y= -17.7+.32(X)
C.V.=27%
Actual Roughness Inches/Mile
0
100
200
300
400
500
600
Predicted Roughness Inches/Mile

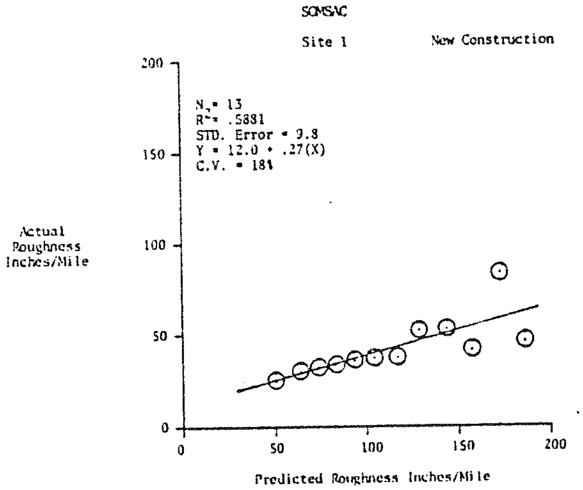

Site 25
Ride New Construction
N=16
R^2=.8991
Std. Error=13.5
Y=24.5+.50(X)
C.V.=12%
Actual Roughness Inches/Mile
0
100
200
300
400
Predicted Roughness Inches/Mile

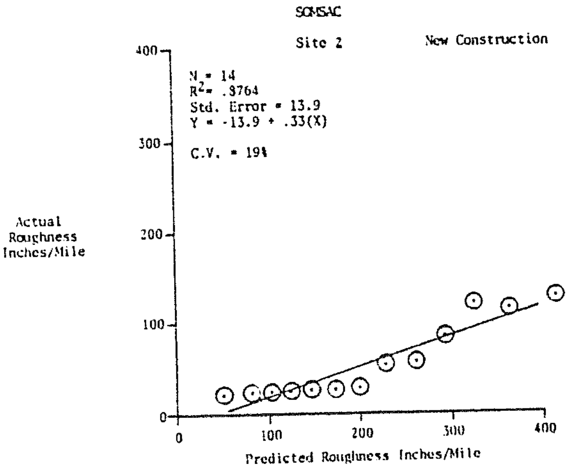

Site 28
Ride New Construction
N=32
R^2=.6646
Std. Error=40.6
Y=26.3+.36(X)
C.V.=18%
Actual Roughness Inches/Mile
0
100
200
300
400
500
600
Predicted Roughness Inches/Mile

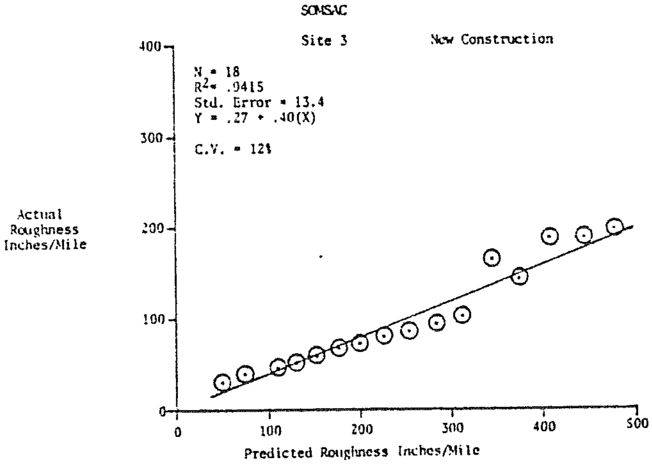

Site 26
Ride New Construction
N=21
R^2=.8441
Std. Error=5.5
Y=30.2+.12(X)
C.V.=9%
Actual Roughness Inches/Mile
0
100
200
300
400
Predicted Roughness Inches/Mile

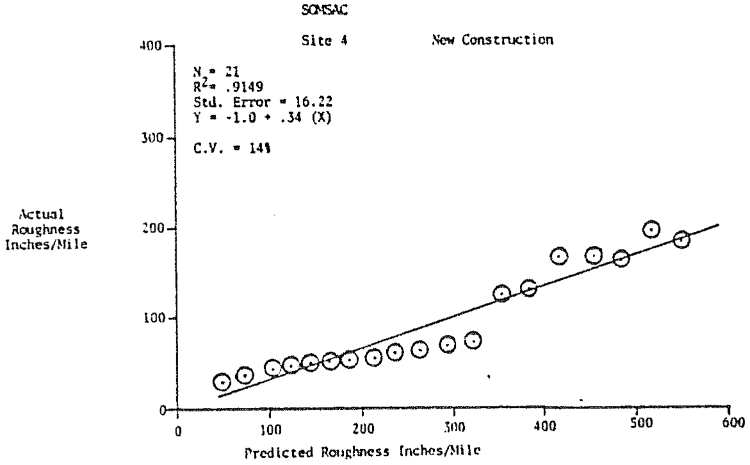

Site 29
Ride New Construction
N=30
R^2=.8843
Std. Error=21.6
Y=41.2+.34(X)
C.V.=12%
Actual Roughness Inches/Mile
0
100
200
300
400
500
600
Predicted Roughness Inches/Mile

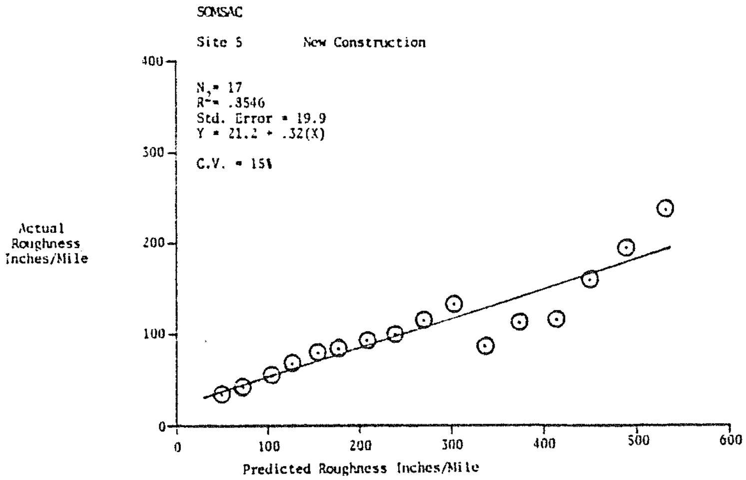

Site 27
Ride New Construction
N=22
R^2=.9455
Std. Error=11.0
Y=28.3+.36(X)
C.V.=8%
Actual Roughness Inches/Mile
0
100
200
300
400
500
Predicted Roughness Inches/Mile

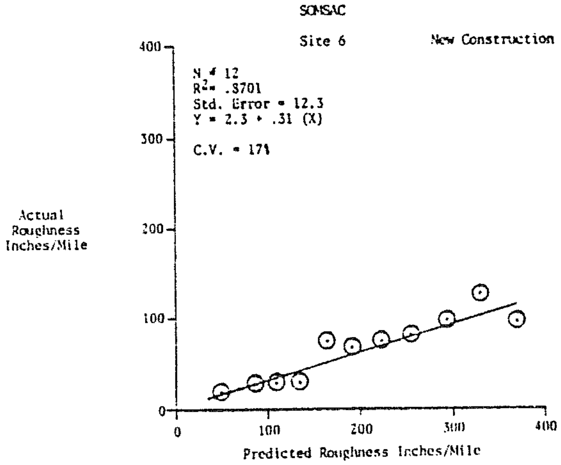

SOMSAC
Site 1
New Construction
N = 13
R² = .5881
STD. Error = 9.8
Y = 12.0 + .27(X)
C.V. = 18%
Actual Roughness Inches/Mile
0
50
100
150
200
Predicted Roughness Inches/Mile
0
50
100
150
200

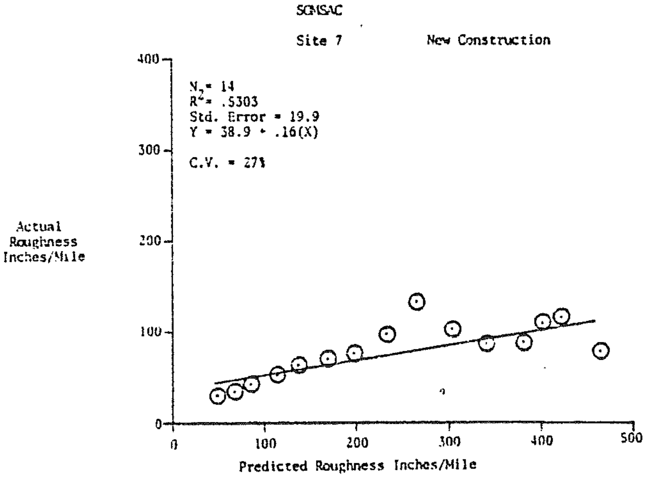

SOMSAC
Site 2
New Construction
N = 14
R² = .8764
Std. Error = 13.9
Y = -13.9 + .33(X)
C.V. = 19%
Actual Roughness Inches/Mile
0
100
200
300
400
Predicted Roughness Inches/Mile
0
100
200
300
400

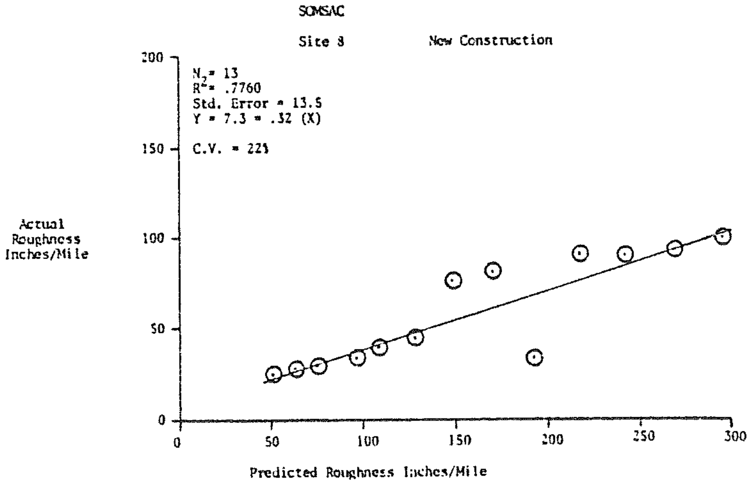

SOMSAC
Site 3
New Construction
N = 18
R² = .9415
Std. Error = 13.4
Y = .27 + .40(X)
C.V. = 12%
Actual Roughness Inches/Mile
0
100
200
300
400
Predicted Roughness Inches/Mile
0
100
200
300
400
500


SOMSAC
Site 4
New Construction
N = 21
R² = .9149
Std. Error = 16.22
Y = -1.0 + .34 (X)
C.V. = 14%
Actual Roughness Inches/Mile
0
100
200
300
400
Predicted Roughness Inches/Mile
0
100
200
300
400
500
600


SOMSAC
Site 5
New Construction
N = 17
R² = .8546
Std. Error = 19.9
Y = 21.2 + .32(X)
C.V. = 15%
Actual Roughness Inches/Mile
0
100
200
300
400
Predicted Roughness Inches/Mile
0
100
200
300
400
500
600

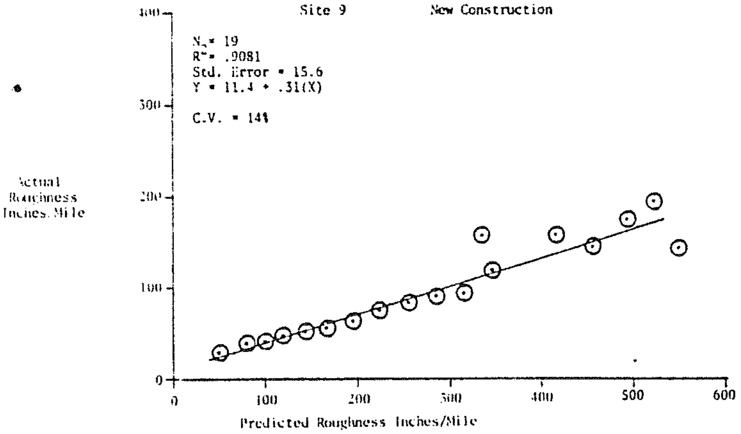

SOMSAC
Site 6
New Construction
N = 12
R² = .8701
Std. Error = 12.3
Y = 2.3 + .31 (X)
C.V. = 17%
Actual Roughness Inches/Mile
0
100
200
300
400
Predicted Roughness Inches/Mile
0
100
200
300
400


SOMSAC
Site 7
New Construction
N = 14
R² = .5303
Std. Error = 19.9
Y = 38.9 + .16(X)
C.V. = 27%
Actual Roughness Inches/Mile
0
100
200
300
400
Predicted Roughness Inches/Mile
0
100
200
300
400
500


SOMSAC
Site 8
New Construction
N = 13
R² = .7760
Std. Error = 13.5
Y = 7.3 = .32 (X)
C.V. = 22%
Actual Roughness Inches/Mile
0
50
100
150
200
Predicted Roughness Inches/Mile
0
50
100
150
200
250
300

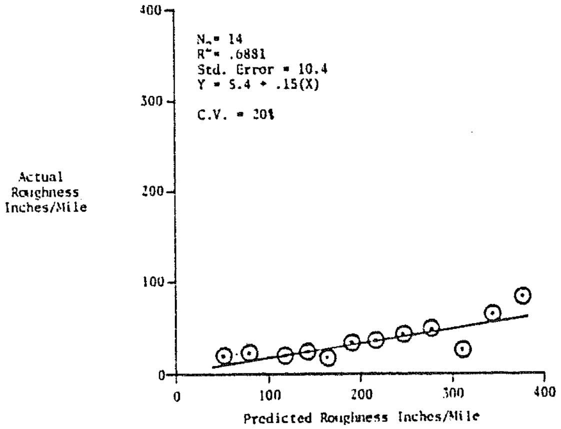
SOMSAC

Site 9 New Construction



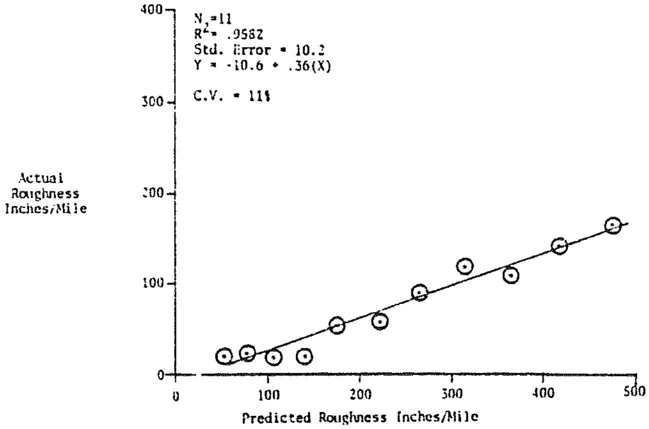
SOMSAC

Site 10 New Construction



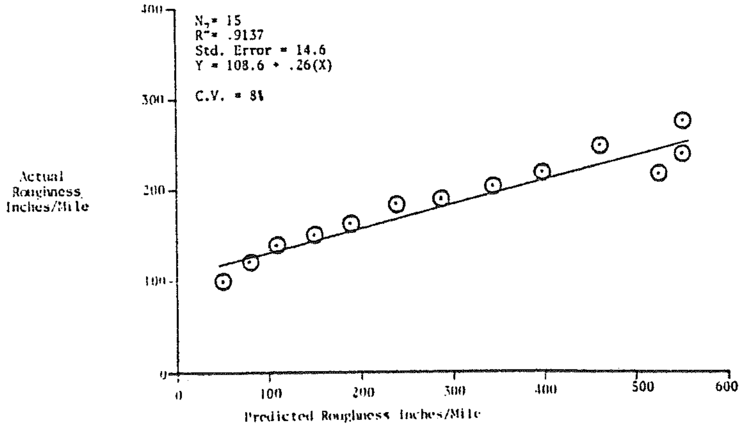
SOMSAC

Site 11 New Construction



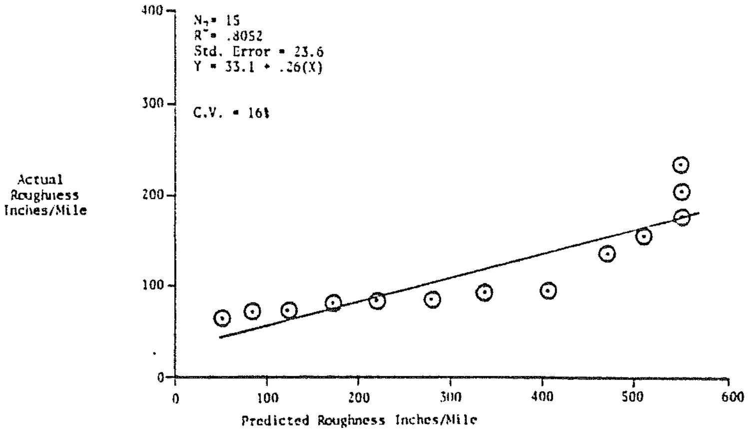
SOMSAC

Site 12 New Construction



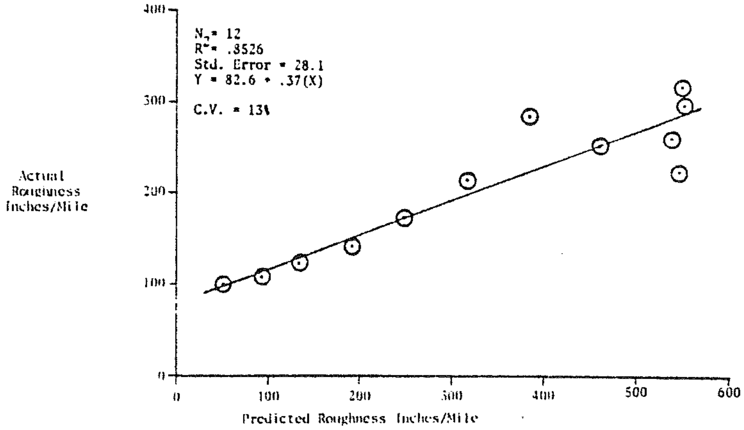
SOMSAC

Site 13 New Construction



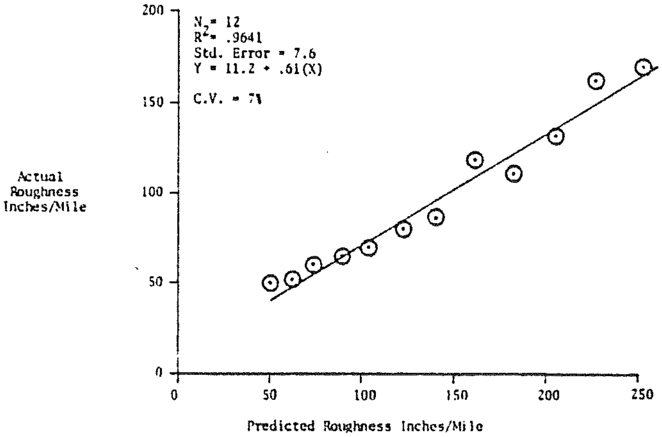
SOMSAC

Site 14 New Construction

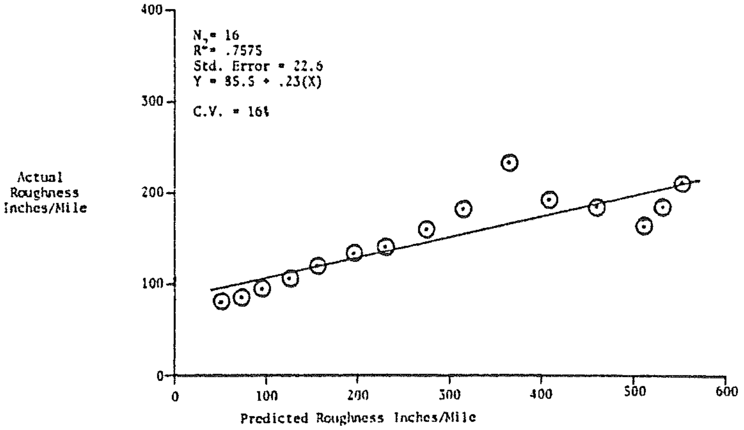


SOMSAC

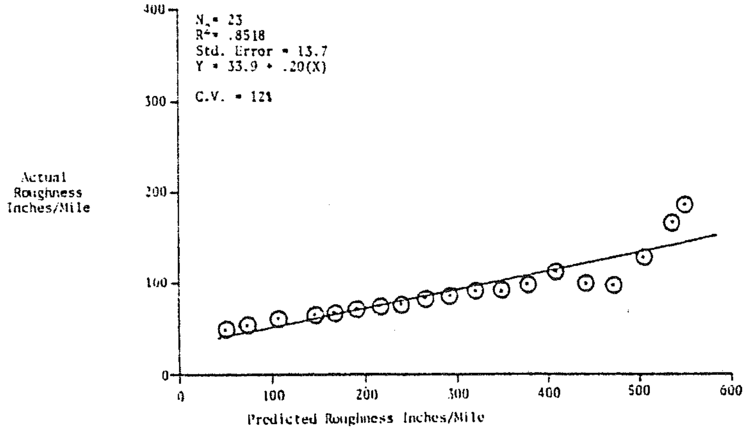
Site 15 New Construction



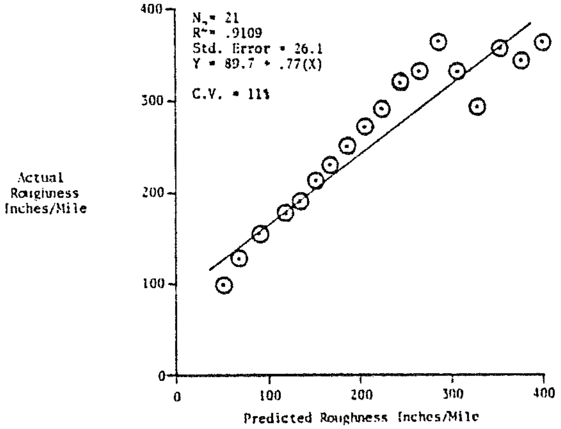
SOMDAC
Site 16 New Construction



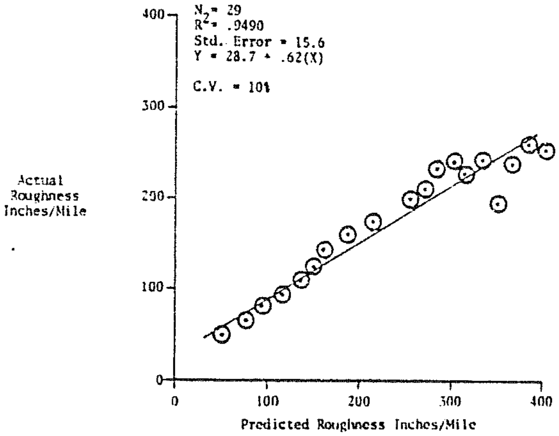
SOMSAC
Site 17 New Construction



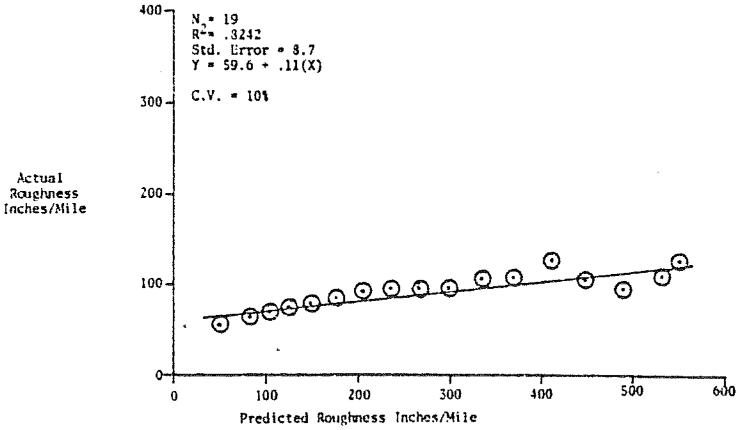
SOMSAC
Site 18 New Construction



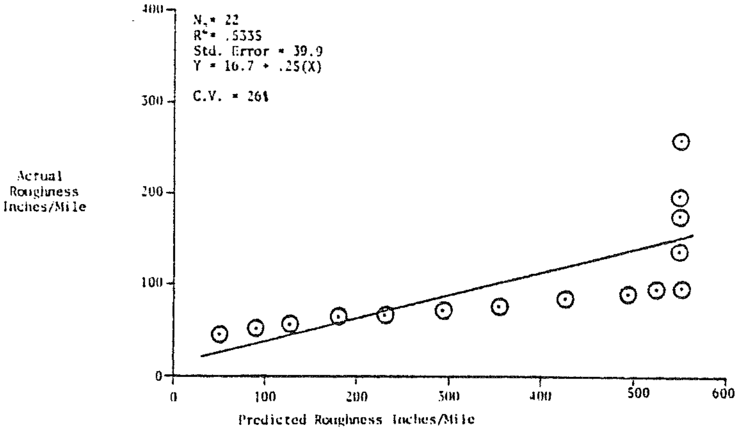
SOMSAC
Site 19 New Construction



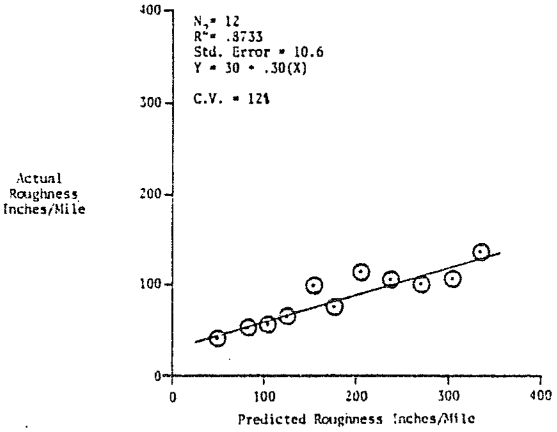
SOMSAC
Site 20 New Construction



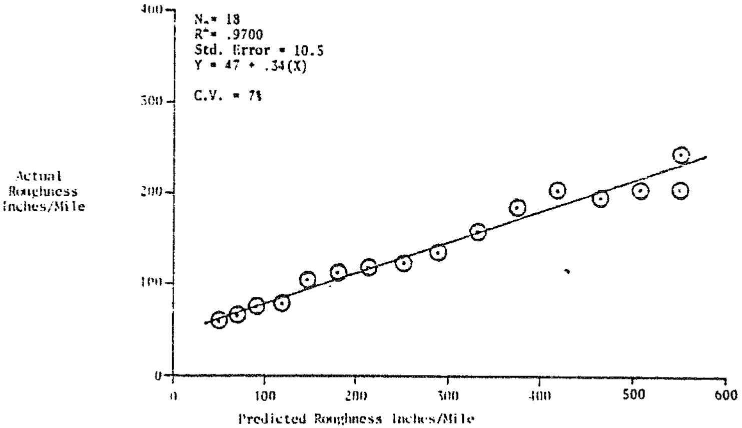
SOMSAC
Site 21 New Construction



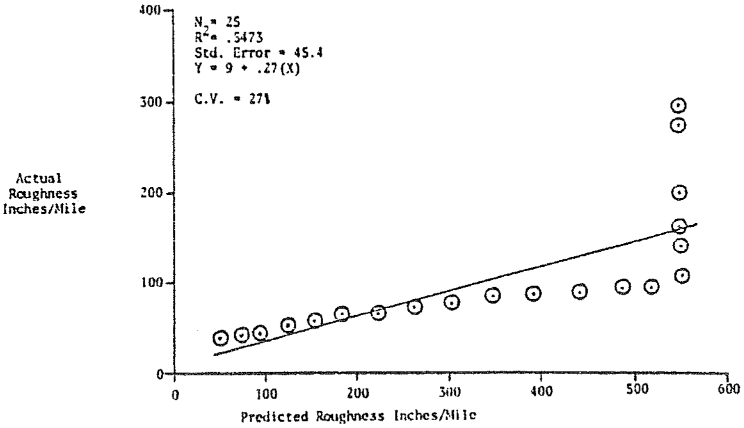
SOMSAC
Site 22 New Construction

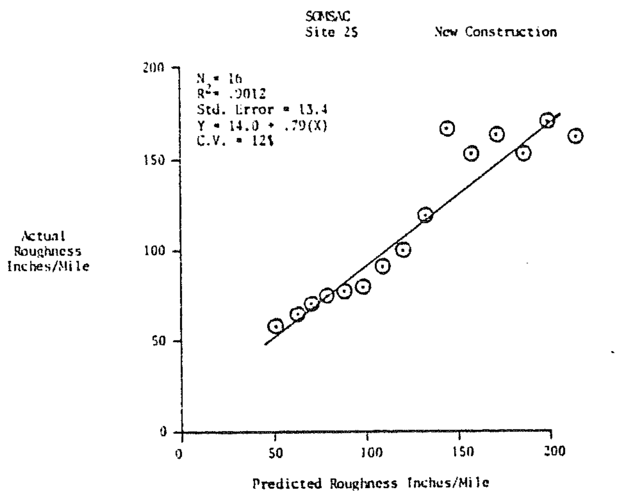


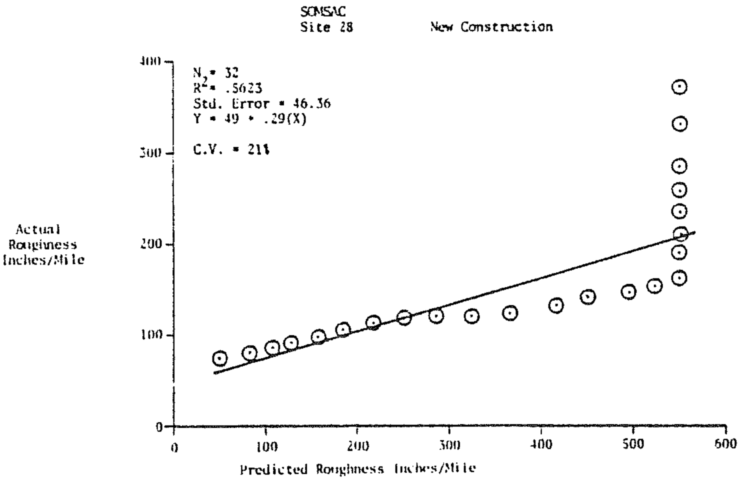
SOMSAC
Site 23 New Construction

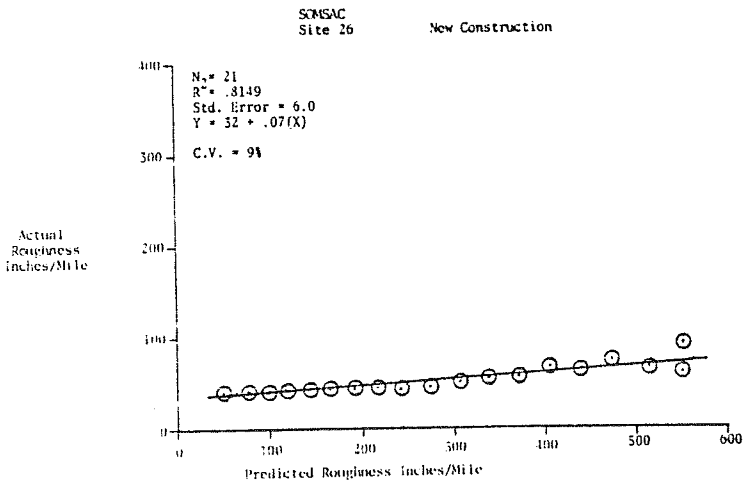


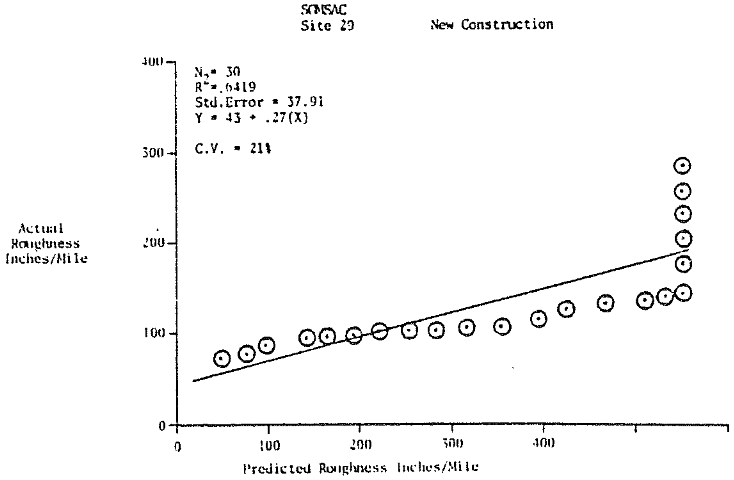
SOMSAC
Site 24 New Construction

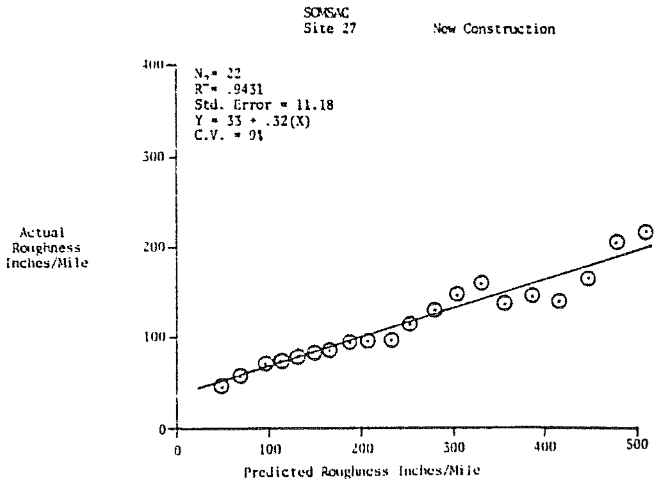


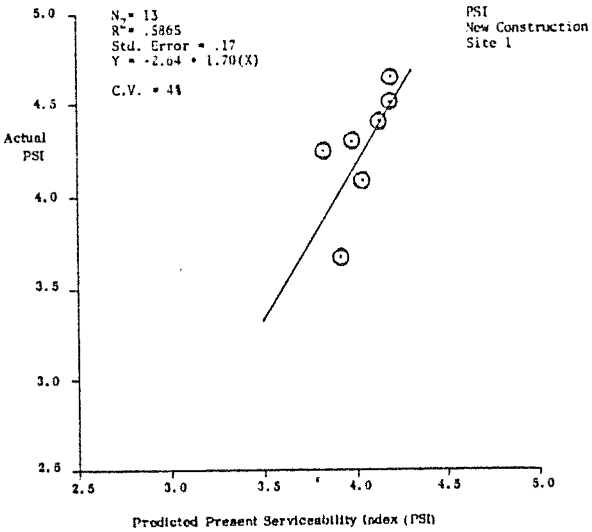

SCMSAC
Site 25
New Construction
N = 16
R^2= .9012
Std. Error = 13.4
Y = 14.0 + .79(X)
C.V. = 12%
Actual Roughness Inches/Mile
200
150
100
50
0
0
50
100
150
200
Predicted Roughness Inches/Mile

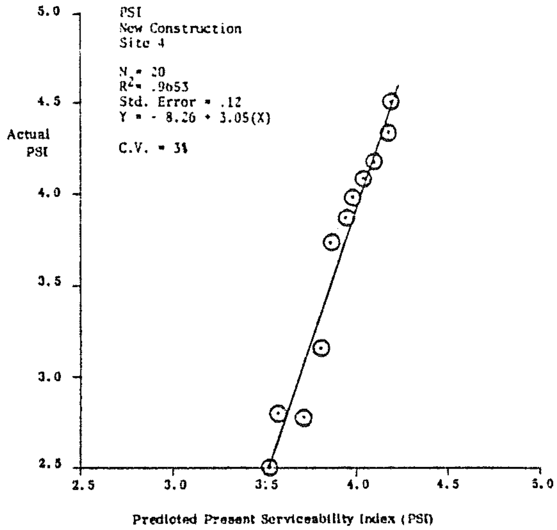

SCMSAC
Site 28
New Construction
N = 32
R^2= .5623
Std. Error = 46.36
Y = 49 + .29(X)
C.V. = 21%
Actual Roughness Inches/Mile
400
300
200
100
0
0
100
200
300
400
500
600
Predicted Roughness Inches/Mile

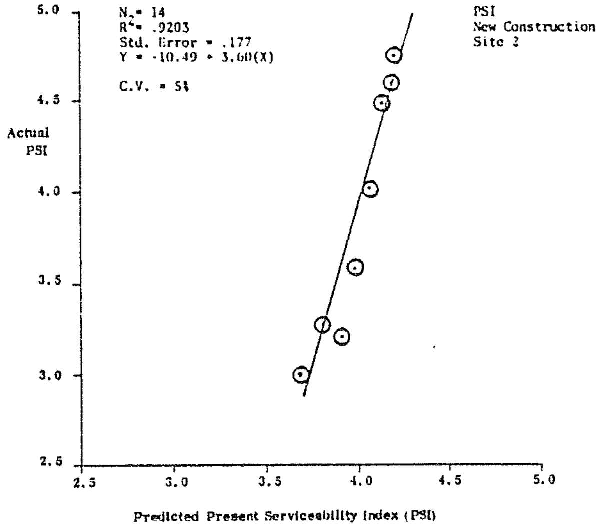

SCMSAC
Site 26
New Construction
N = 21
R^2= .8149
Std. Error = 6.0
Y = 32 + .07(X)
C.V. = 9%
Actual Roughness Inches/Mile
400
300
200
100
0
0
100
200
300
400
500
600
Predicted Roughness Inches/Mile

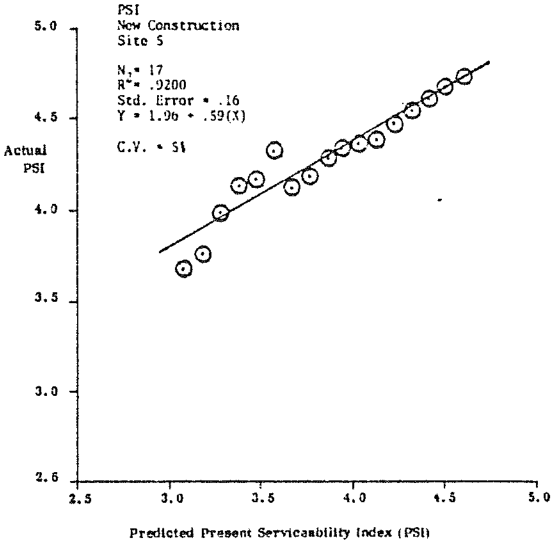

SCMSAC
Site 29
New Construction
N = 30
R^2=.6419
Std.Error = 37.91
Y = 43 + .27(X)
C.V. = 21%
Actual Roughness Inches/Mile
400
300
200
100
0
0
100
200
300
400
Predicted Roughness Inches/Mile

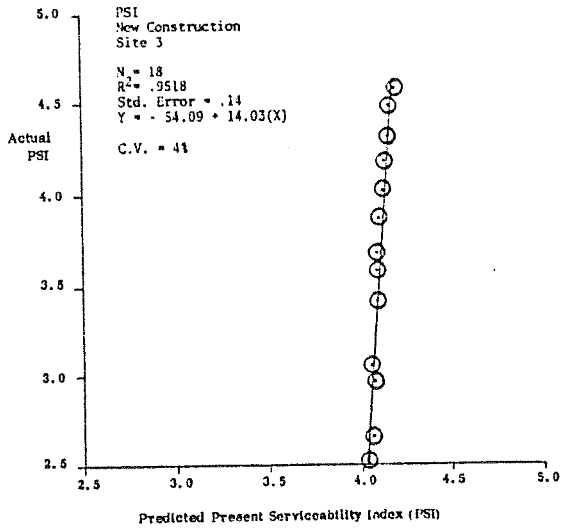

SCMSAC
Site 27
New Construction
N = 22
R^2= .9431
Std. Error = 11.18
Y = 33 + .32(X)
C.V. = 9%
Actual Roughness Inches/Mile
400
300
200
100
0
0
100
200
300
400
500
Predicted Roughness Inches/Mile

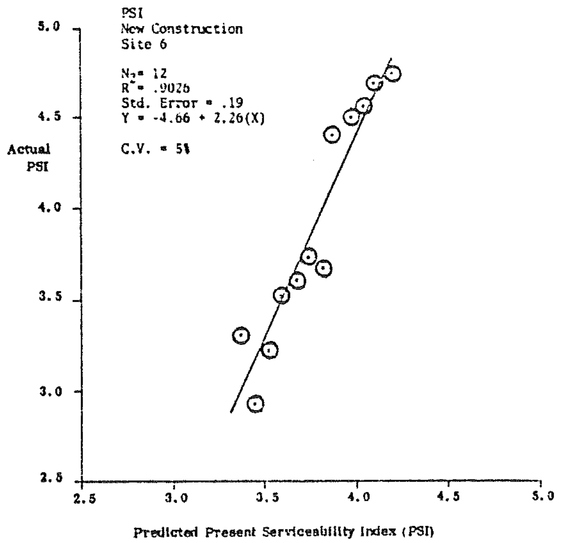

N_2= 13
R^2= .5865
Std. Error = .17
Y = -2.64 + 1.70(X)
C.V. = 4%
PSI
New Construction
Site 1
Actual PSI
5.0
4.5
4.0
3.5
3.0
2.5
2.5
3.0
3.5
4.0
4.5
5.0
Predicted Present Serviceability Index (PSI)

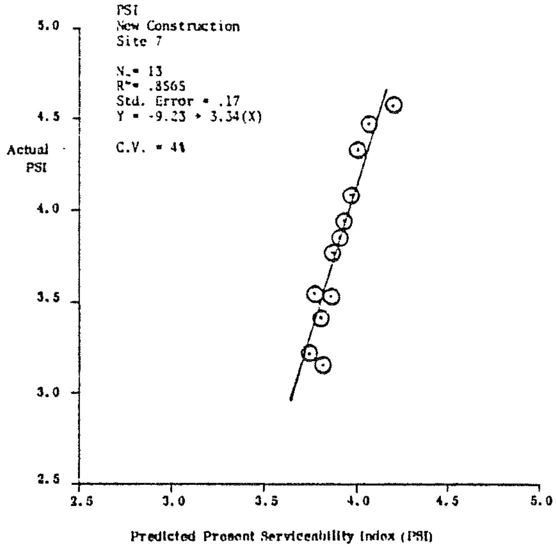

PSI
New Construction
Site 4
N_2= 20
R^2= .9653
Std. Error = .12
Y = - 8.26 + 3.05(X)
C.V. = 3%
Actual PSI
5.0
4.5
4.0
3.5
3.0
2.5
2.5
3.0
3.5
4.0
4.5
5.0
Predicted Present Serviceability Index (PSI)

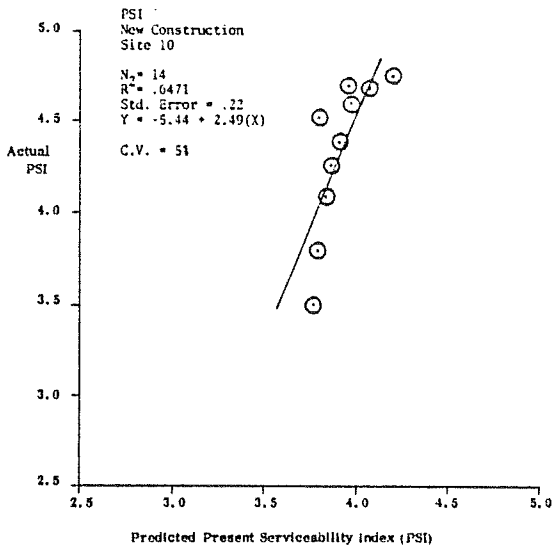

N_2= 14
R^2= .9203
Std. Error = .177
Y = -10.49 + 3.60(X)
C.V. = 5%
PSI
New Construction
Site 2
Actual PSI
5.0
4.5
4.0
3.5
3.0
2.5
2.5
3.0
3.5
4.0
4.5
5.0
Predicted Present Serviceability Index (PSI)

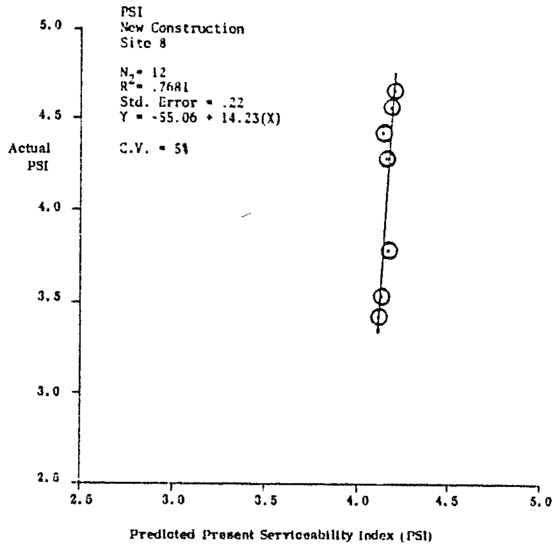

PSI
New Construction
Site 5
N_2= 17
R^2= .9200
Std. Error = .16
Y = 1.96 + .59(X)
C.V. = 5%
Actual PSI
5.0
4.5
4.0
3.5
3.0
2.5
2.5
3.0
3.5
4.0
4.5
5.0
Predicted Present Serviceability Index (PSI)

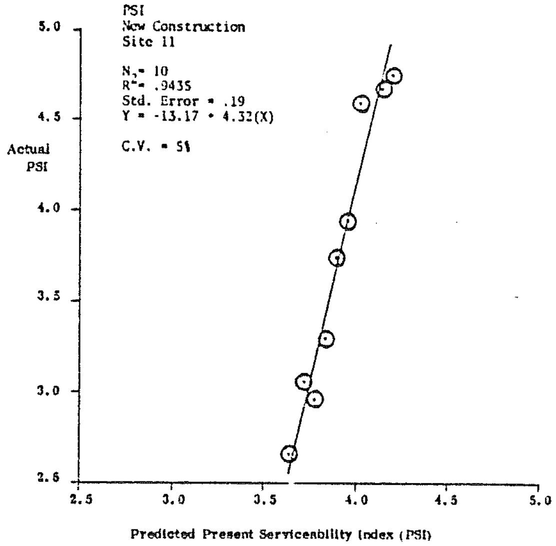

PSI
New Construction
Site 3
N_2= 18
R^2= .9518
Std. Error = .14
Y = - 54.09 + 14.03(X)
C.V. = 4%
Actual PSI
5.0
4.5
4.0
3.5
3.0
2.5
2.5
3.0
3.5
4.0
4.5
5.0
Predicted Present Serviceability Index (PSI)

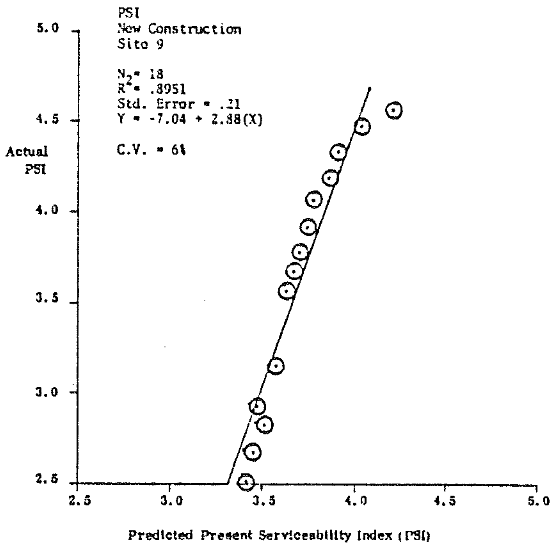

PSI
New Construction
Site 6
N_2= 12
R^2= .9026
Std. Error = .19
Y = -4.66 + 2.26(X)
C.V. = 5%
Actual PSI
5.0
4.5
4.0
3.5
3.0
2.5
2.5
3.0
3.5
4.0
4.5
5.0
Predicted Present Serviceability Index (PSI)

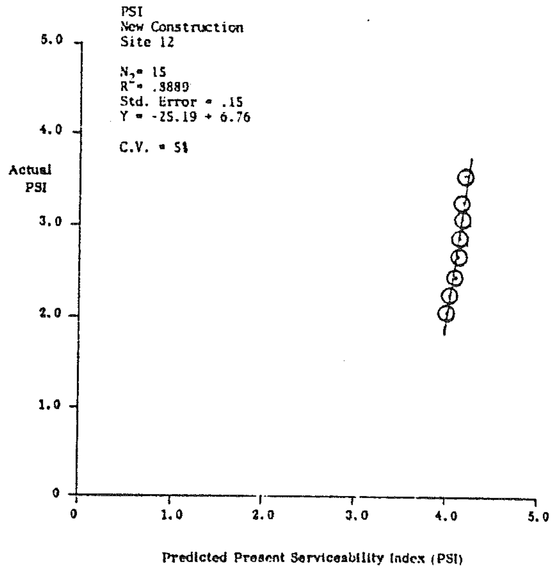

PSI
New Construction
Site 7
N_2 = 13
R^2 = .8565
Std. Error = .17
Y = -9.23 + 3.34(X)
C.V. = 4%
Actual PSI
5.0
4.5
4.0
3.5
3.0
2.5
2.5
3.0
3.5
4.0
4.5
5.0
Predicted Present Serviceability Index (PSI)

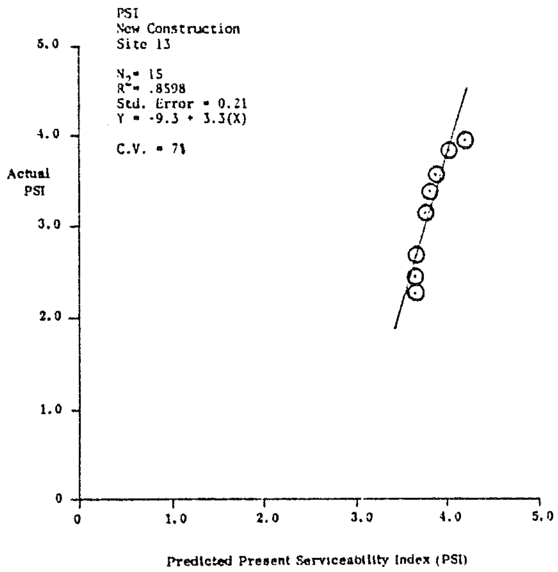

PSI
New Construction
Site 10
N_2 = 14
R^2 = .6471
Std. Error = .22
Y = -5.44 + 2.49(X)
C.V. = 5%
Actual PSI
5.0
4.5
4.0
3.5
3.0
2.5
2.5
3.0
3.5
4.0
4.5
5.0
Predicted Present Serviceability Index (PSI)

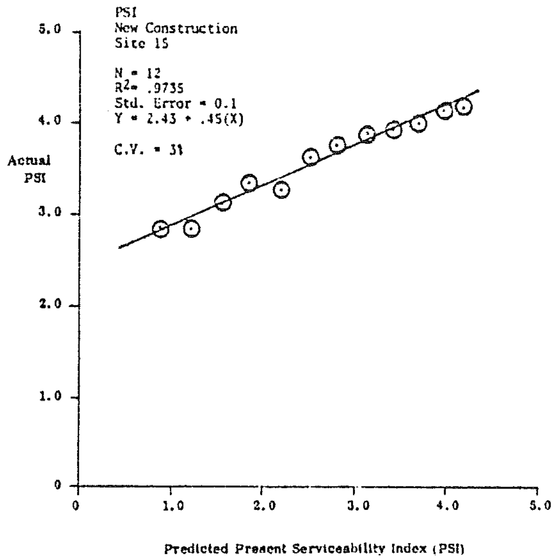

PSI
New Construction
Site 8
N_2 = 12
R^2 = .7681
Std. Error = .22
Y = -55.06 + 14.23(X)
C.V. = 5%
Actual PSI
5.0
4.5
4.0
3.5
3.0
2.5
2.5
3.0
3.5
4.0
4.5
5.0
Predicted Present Serviceability Index (PSI)

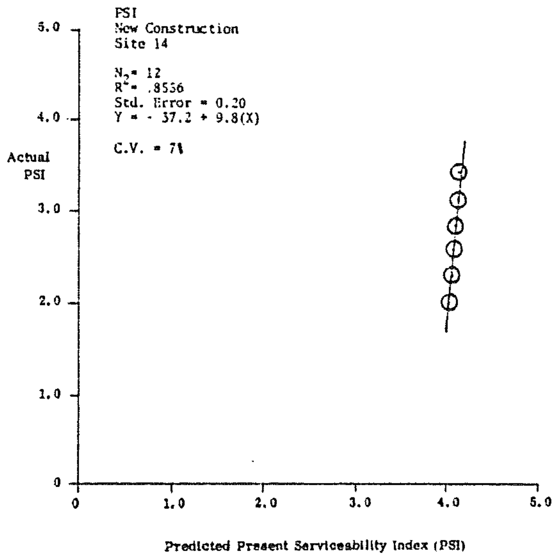

PSI
New Construction
Site 11
N_2 = 10
R^2 = .9435
Std. Error = .19
Y = -13.17 + 4.32(X)
C.V. = 5%
Actual PSI
5.0
4.5
4.0
3.5
3.0
2.5
2.5
3.0
3.5
4.0
4.5
5.0
Predicted Present Serviceability Index (PSI)

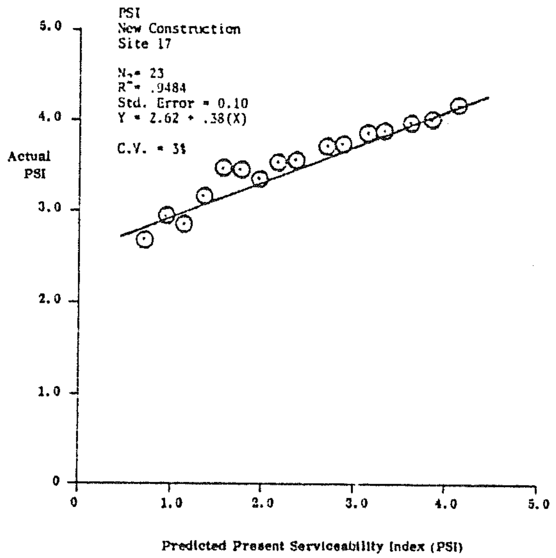

PSI
New Construction
Site 9
N_2 = 18
R^2 = .8951
Std. Error = .21
Y = -7.04 + 2.88(X)
C.V. = 6%
Actual PSI
5.0
4.5
4.0
3.5
3.0
2.5
2.5
3.0
3.5
4.0
4.5
5.0
Predicted Present Serviceability Index (PSI)

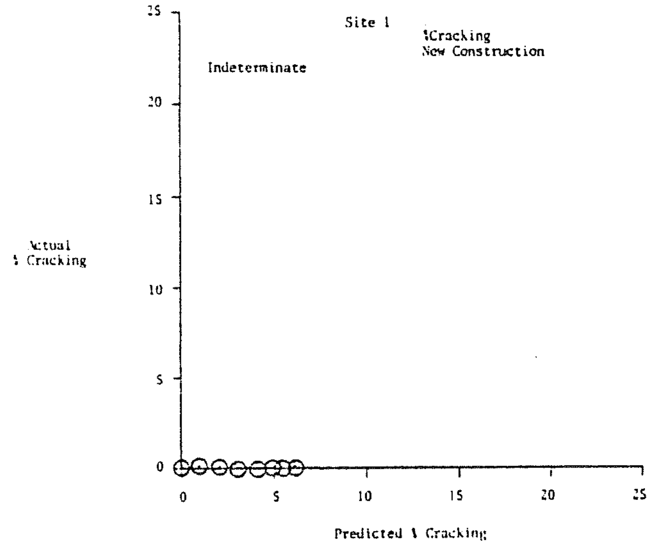

PSI
New Construction
Site 12
N_2 = 15
R^2 = .8889
Std. Error = .15
Y = -25.19 + 6.76
C.V. = 5%
Actual PSI
5.0
4.0
3.0
2.0
1.0
0
0
1.0
2.0
3.0
4.0
5.0
Predicted Present Serviceability Index (PSI)

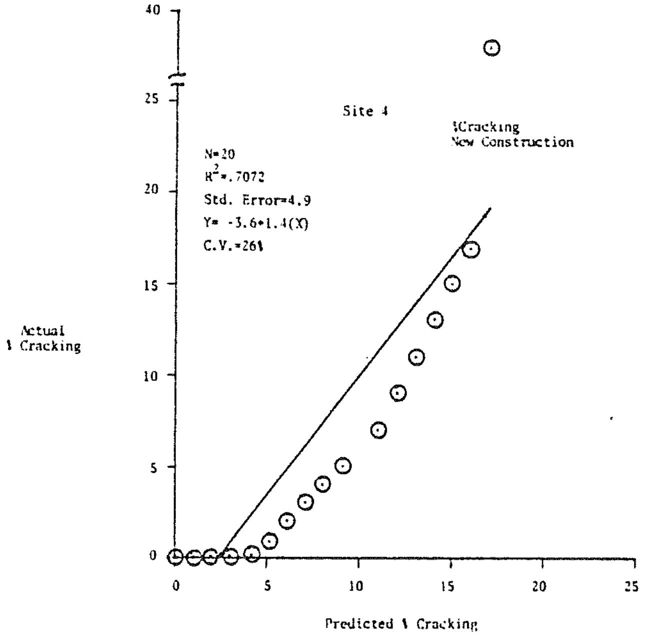

PSI
New Construction
Site 13
N_2= 15
R^2= .8598
Std. Error = 0.21
Y = -9.3 + 3.3(X)
C.V. = 7%
Actual PSI
5.0
4.0
3.0
2.0
1.0
0
1.0
2.0
3.0
4.0
5.0
Predicted Present Serviceability Index (PSI)

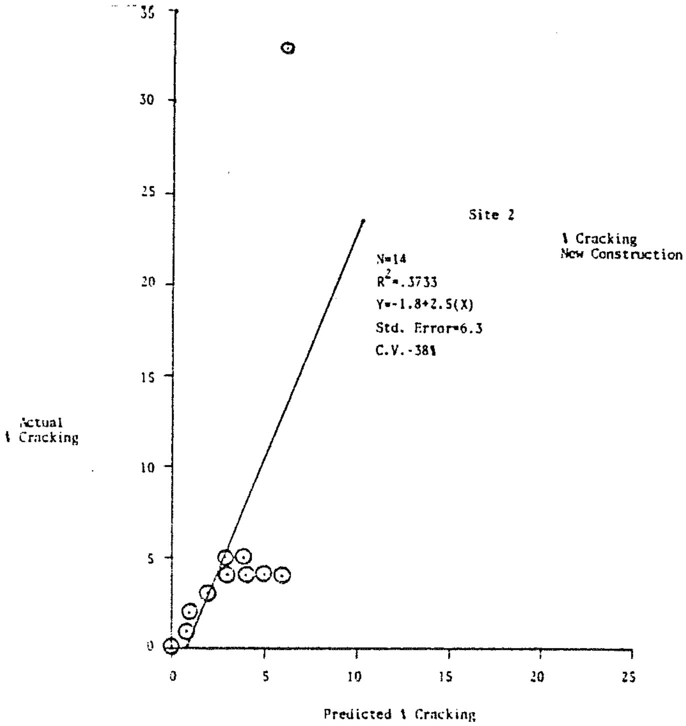

PSI
New Construction
Site 15
N = 12
R^2= .9735
Std. Error = 0.1
Y = 2.43 + .45(X)
C.V. = 3%
Actual PSI
5.0
4.0
3.0
2.0
1.0
0
1.0
2.0
3.0
4.0
5.0
Predicted Present Serviceability Index (PSI)

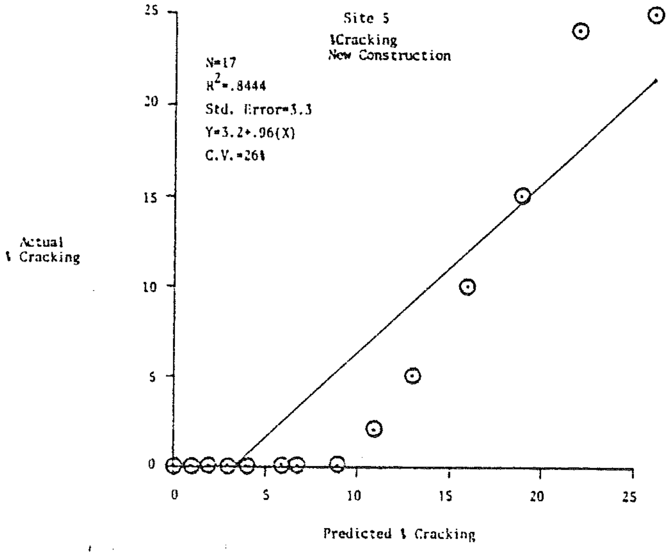

PSI
New Construction
Site 14
N_2= 12
R^2= .8556
Std. Error = 0.20
Y = - 37.2 + 9.8(X)
C.V. = 7%
Actual PSI
5.0
4.0
3.0
2.0
1.0
0
1.0
2.0
3.0
4.0
5.0
Predicted Present Serviceability Index (PSI)

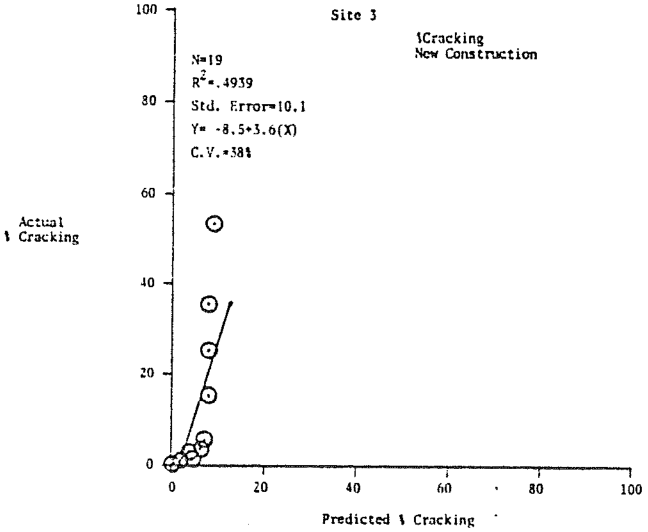

PSI
New Construction
Site 17
N_2= 23
R^2= .9484
Std. Error = 0.10
Y = 2.62 + .38(X)
C.V. = 3%
Actual PSI
5.0
4.0
3.0
2.0
1.0
0
1.0
2.0
3.0
4.0
5.0
Predicted Present Serviceability Index (PSI)

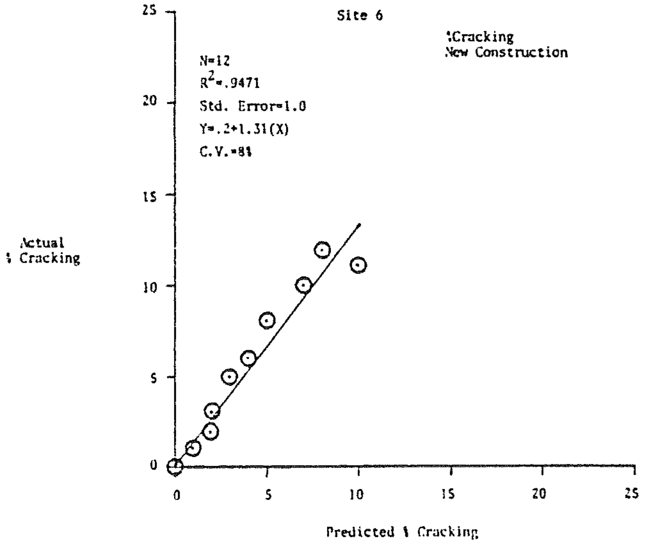

Site 1
%Cracking
New Construction
Indeterminate
Actual
% Cracking
Predicted % Cracking
0
5
10
15
20
25

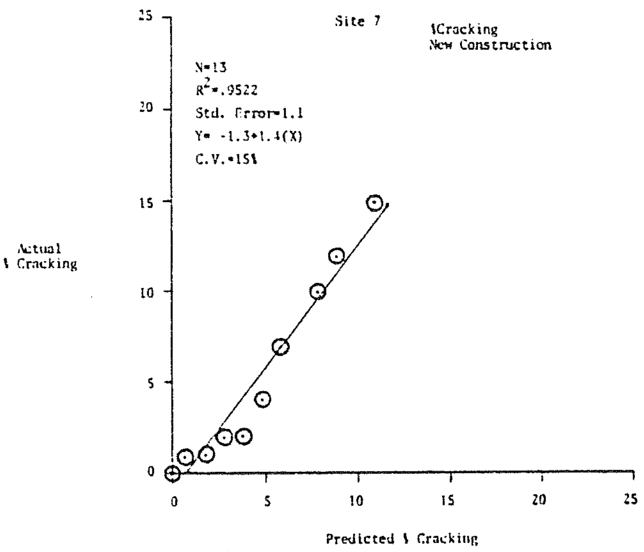

Site 4
%Cracking
New Construction
N=20
R^2=.7072
Std. Error=4.9
Y= -3.6+1.4(X)
C.V.=26%
Actual
% Cracking
Predicted % Cracking
0
5
10
15
20
25
40

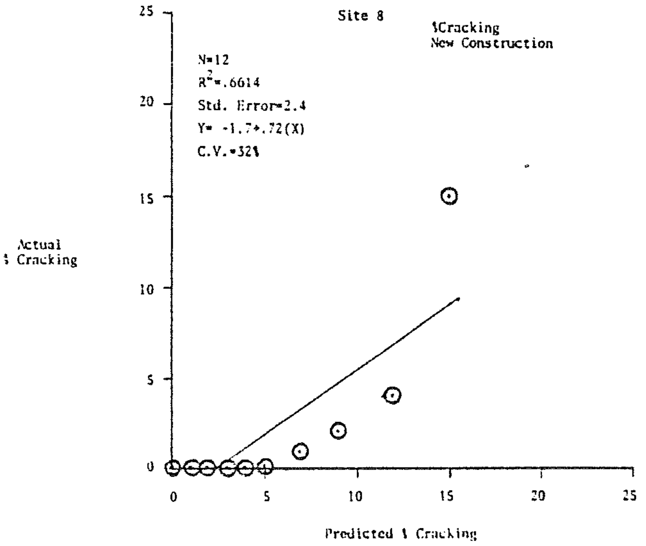

Site 2
% Cracking
New Construction
N=14
R^2=.3733
Y=-1.8+2.5(X)
Std. Error=6.3
C.V.-38%
Actual
% Cracking
Predicted % Cracking
0
5
10
15
20
25
30
35

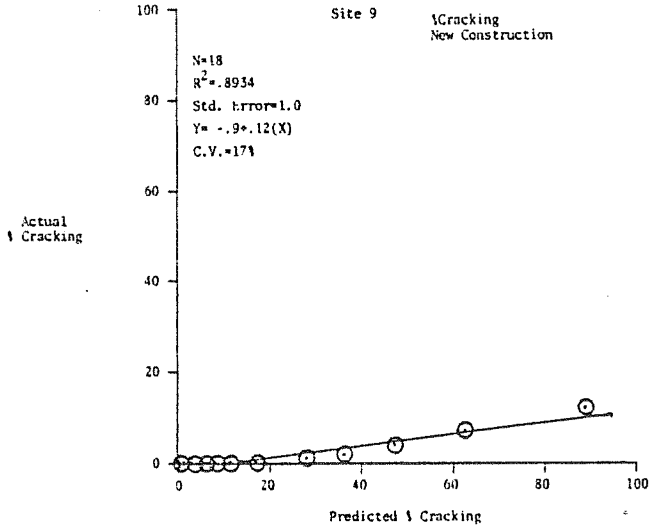

Site 5
%Cracking
New Construction
N=17
R^2=.8444
Std. Error=3.3
Y=3.2+.96(X)
C.V.=26%
Actual
% Cracking
Predicted % Cracking
0
5
10
15
20
25

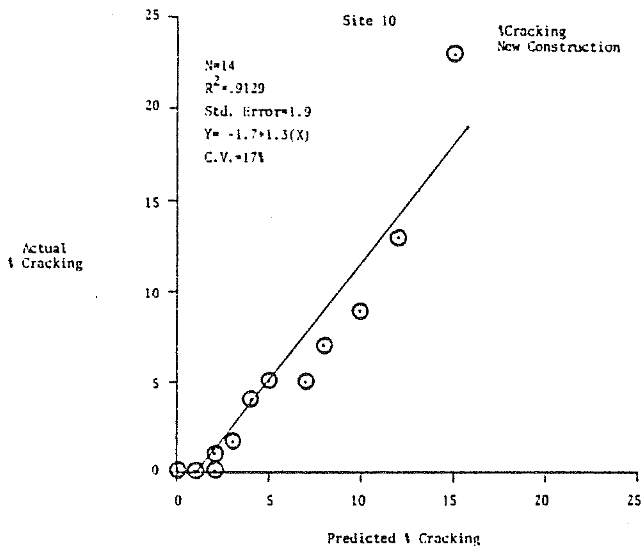

Site 3
%Cracking
New Construction
N=19
R^2=.4939
Std. Error=10.1
Y= -8.5+3.6(X)
C.V.=38%
Actual
% Cracking
Predicted % Cracking
0
20
40
60
80
100

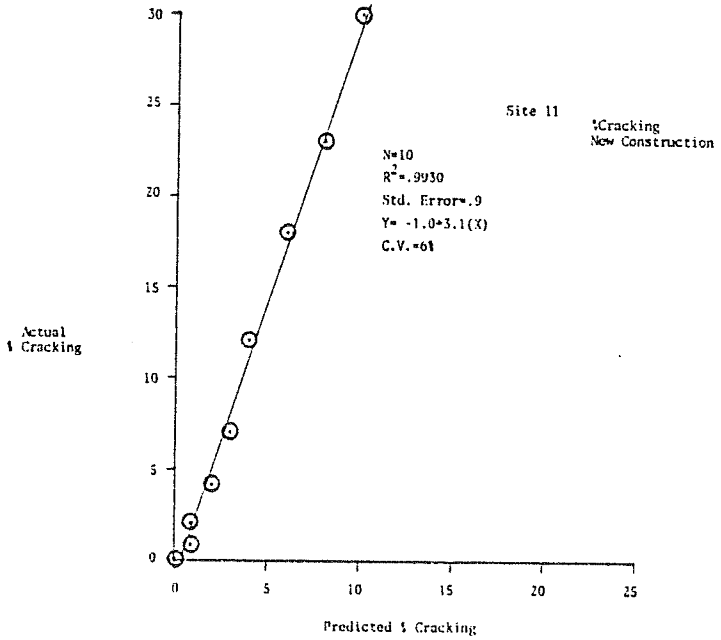

Site 6
%Cracking
New Construction
N=12
R^2=.9471
Std. Error=1.0
Y=.2+1.31(X)
C.V.=8%
Actual
% Cracking
Predicted % Cracking
0
5
10
15
20
25

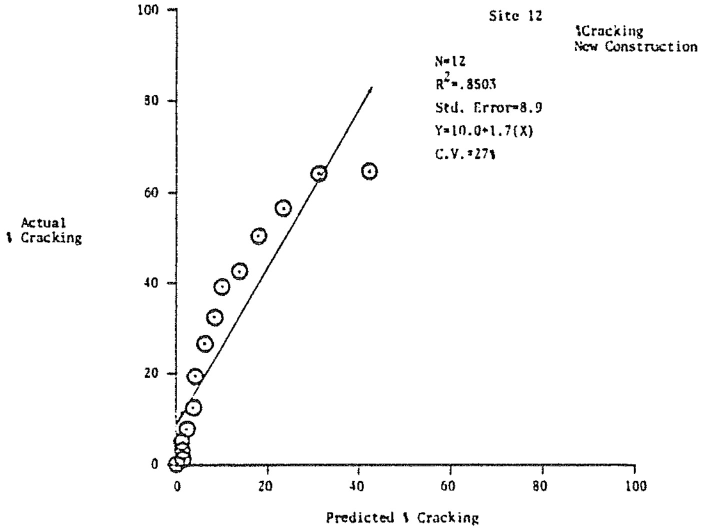

Site 7
%Cracking
New Construction
N=13
R^2=.9522
Std. Error=1.1
Y= -1.3+1.4(X)
C.V.=15%
Actual
% Cracking
Predicted % Cracking
0
5
10
15
20
25

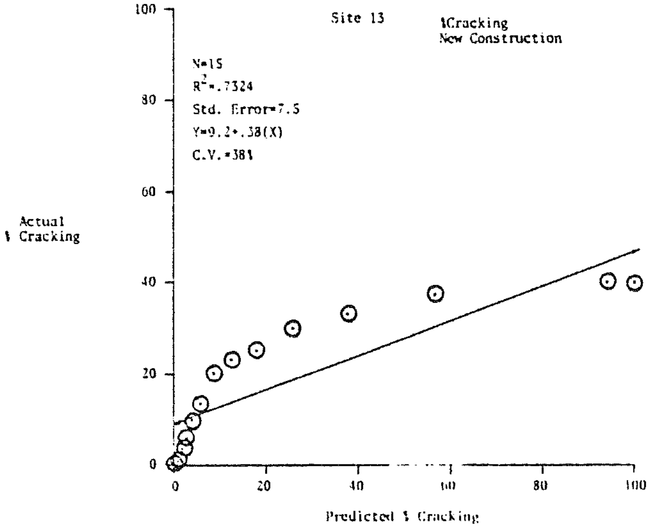

Site 8
%Cracking
New Construction
N=12
R^2=.6614
Std. Error=2.4
Y= -1.7+.72(X)
C.V.=32%
Actual
% Cracking
Predicted % Cracking
0
5
10
15
20
25

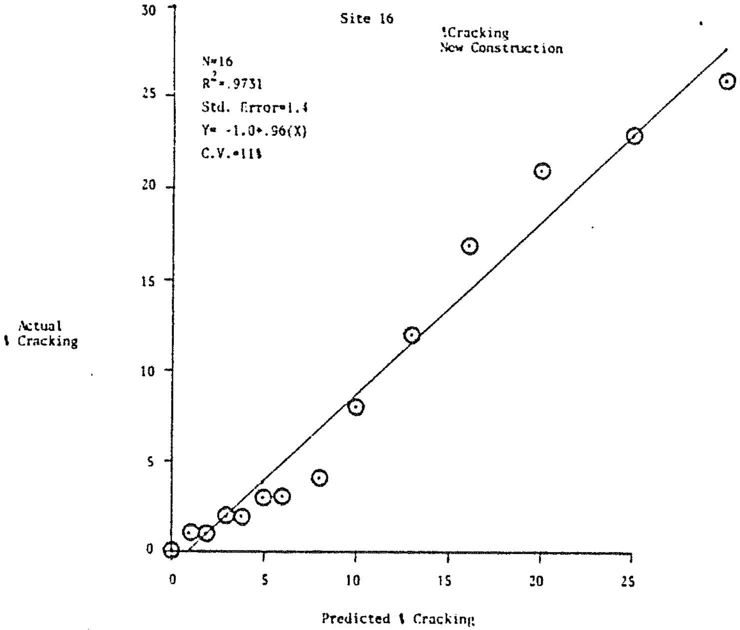

Site 9
%Cracking
New Construction
N=18
R^2=.8934
Std. Error=1.0
Y= -.9+.12(X)
C.V.=17%
Actual
% Cracking
Predicted % Cracking
0
20
40
60
80
100

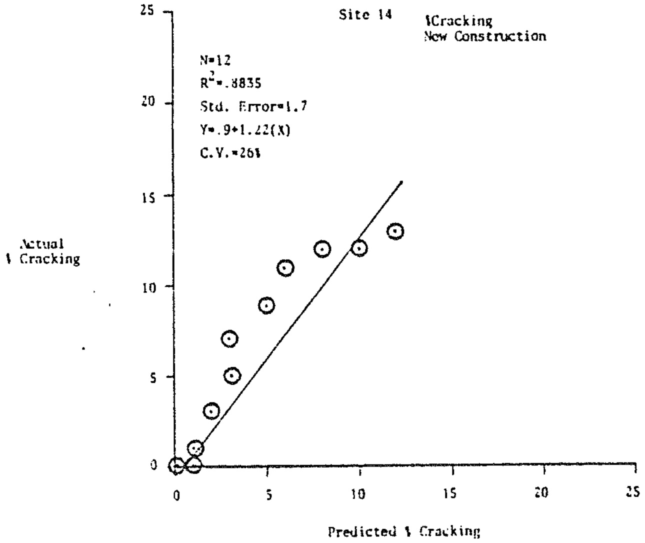

Site 10
%Cracking
New Construction
N=14
R^2=.9129
Std. Error=1.9
Y= -1.7+1.3(X)
C.V.=17%
Actual
% Cracking
Predicted % Cracking
0
5
10
15
20
25

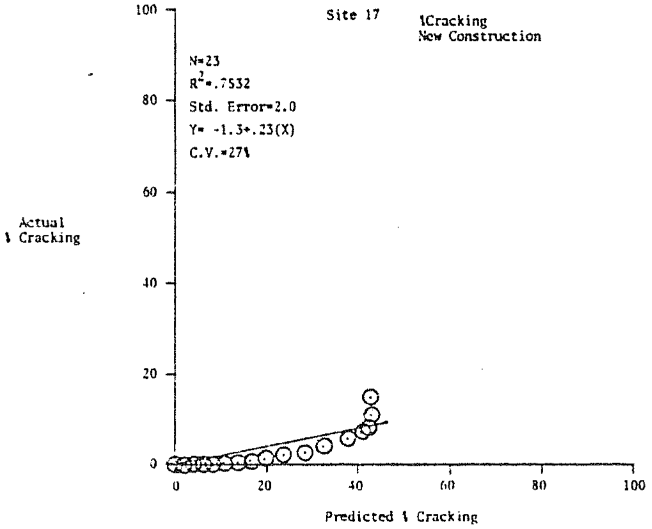

Site 11
%Cracking
New Construction
N=10
R^2=.9930
Std. Error=.9
Y= -1.0+3.1(X)
C.V.=6%
Actual
% Cracking
Predicted % Cracking
0
5
10
15
20
25
30

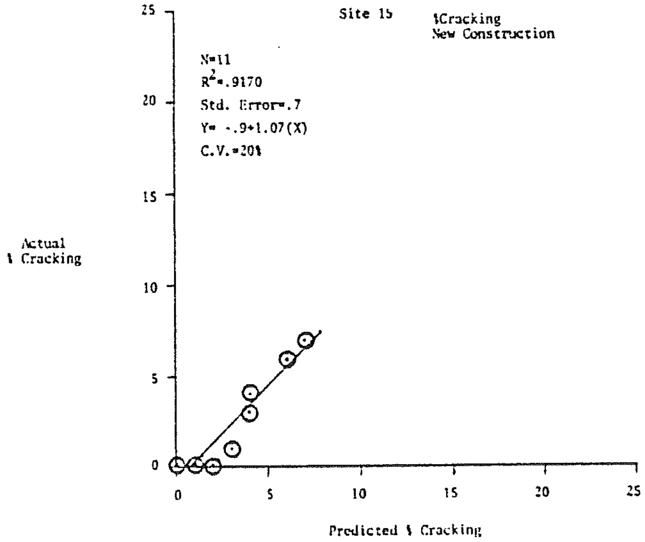

Site 12
%Cracking
New Construction
N=12
R^2=.8503
Std. Error=8.9
Y=10.0+1.7(X)
C.V.=27%
Actual
% Cracking
Predicted % Cracking
0
20
40
60
80
100

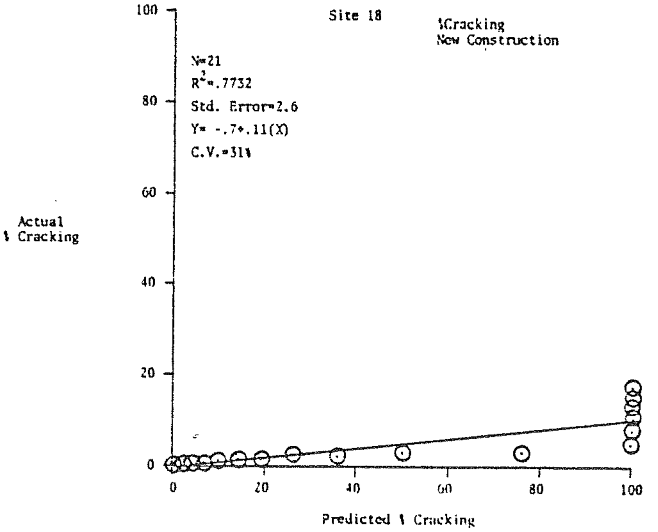

Site 13
%Cracking
New Construction
N=15
R²=.7324
Std. Error=7.5
Y=9.2+.38(X)
C.V.=38%
Actual
% Cracking
Predicted % Cracking
0
20
40
60
80
100

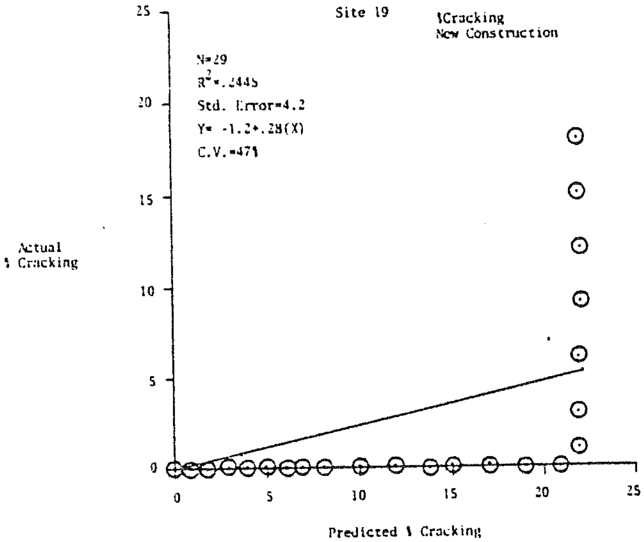

Site 16
%Cracking
New Construction
N=16
R²=.9731
Std. Error=1.4
Y= -1.0+.96(X)
C.V.=11%
Actual
% Cracking
Predicted % Cracking
0
5
10
15
20
25
30

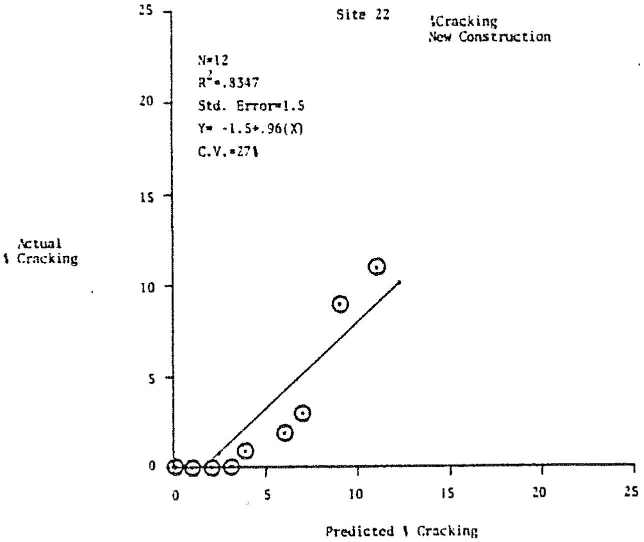

Site 14
%Cracking
New Construction
N=12
R²=.8835
Std. Error=1.7
Y=.9+1.22(X)
C.V.=26%
Actual
% Cracking
Predicted % Cracking
0
5
10
15
20
25

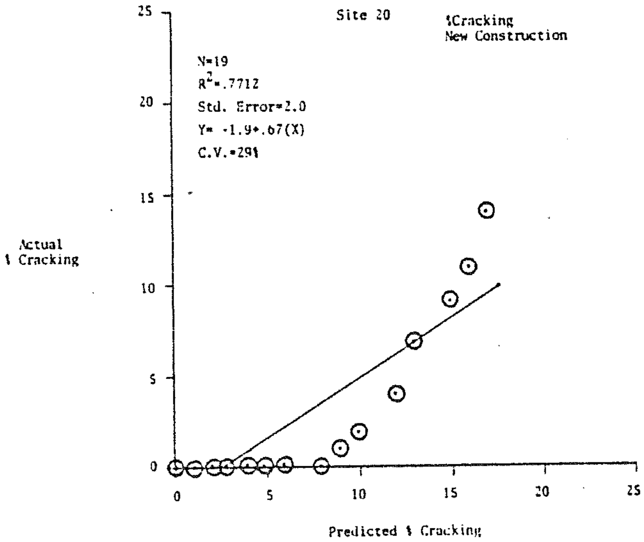

Site 17
%Cracking
New Construction
N=23
R²=.7532
Std. Error=2.0
Y= -1.3+.23(X)
C.V.=27%
Actual
% Cracking
Predicted % Cracking
0
20
40
60
80
100

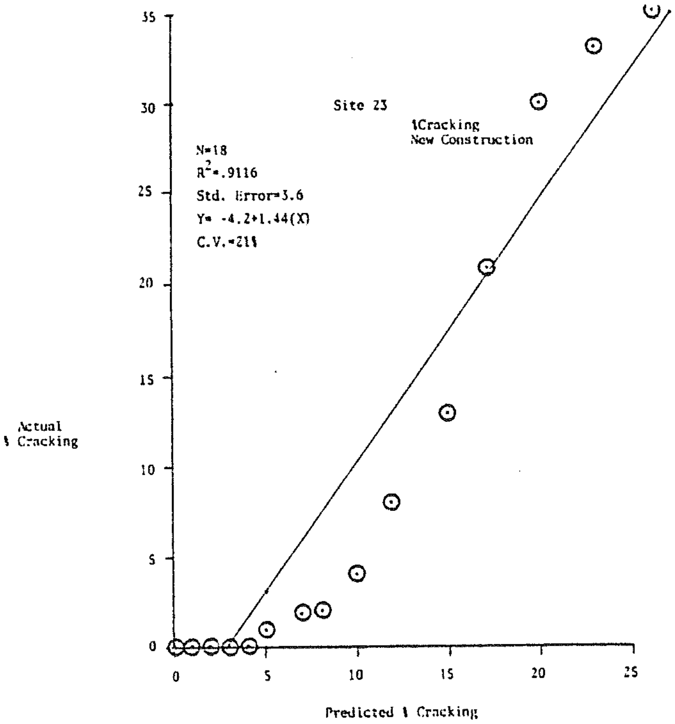

Site 15
%Cracking
New Construction
N=11
R²=.9170
Std. Error=.7
Y= -.9+1.07(X)
C.V.=20%
Actual
% Cracking
Predicted % Cracking
0
5
10
15
20
25

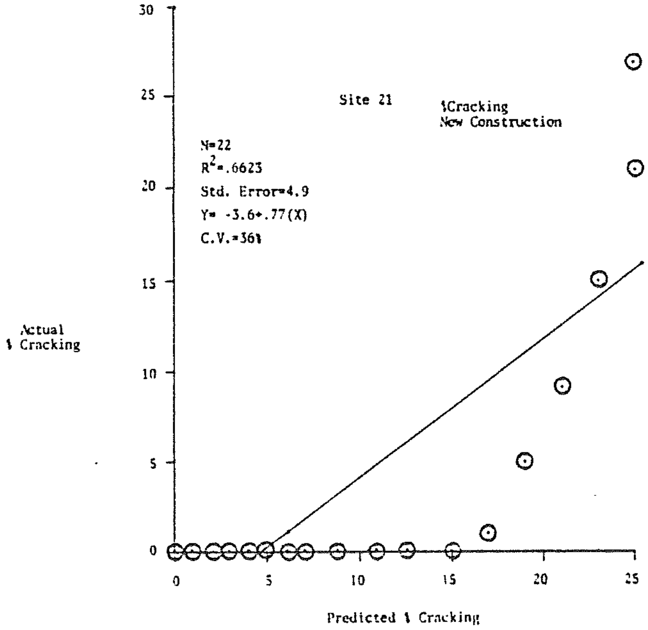

Site 18
%Cracking
New Construction
N=21
R²=.7732
Std. Error=2.6
Y= -.7+.11(X)
C.V.=31%
Actual
% Cracking
Predicted % Cracking
0
20
40
60
80
100

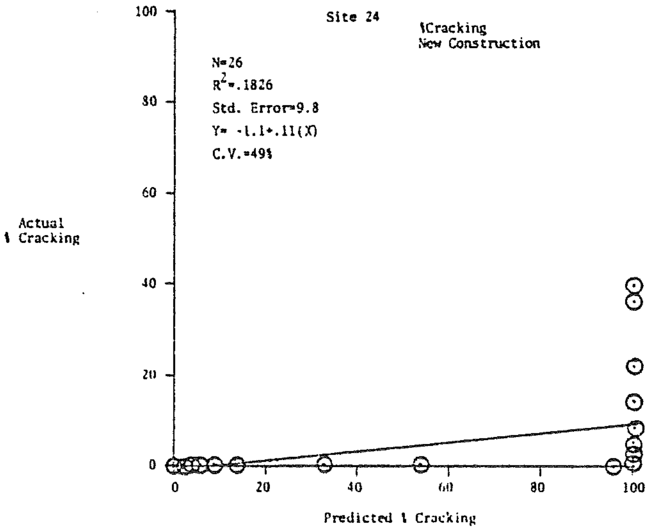

Site 19
%Cracking
New Construction
N=29
R^2=.2445
Std. Error=4.2
Y= -1.2+.28(X)
C.V.=47%
Actual % Cracking
Predicted % Cracking
0
5
10
15
20
25

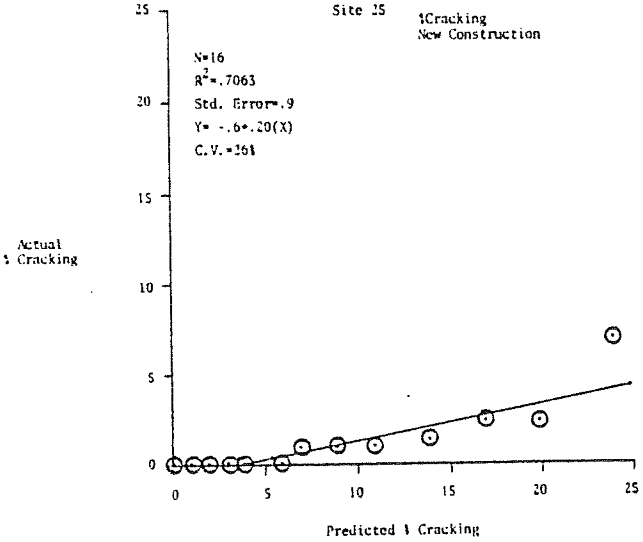

Site 22
%Cracking
New Construction
N=12
R^2=.8347
Std. Error=1.5
Y= -1.5+.96(X)
C.V.=27%
Actual % Cracking
Predicted % Cracking
0
5
10
15
20
25

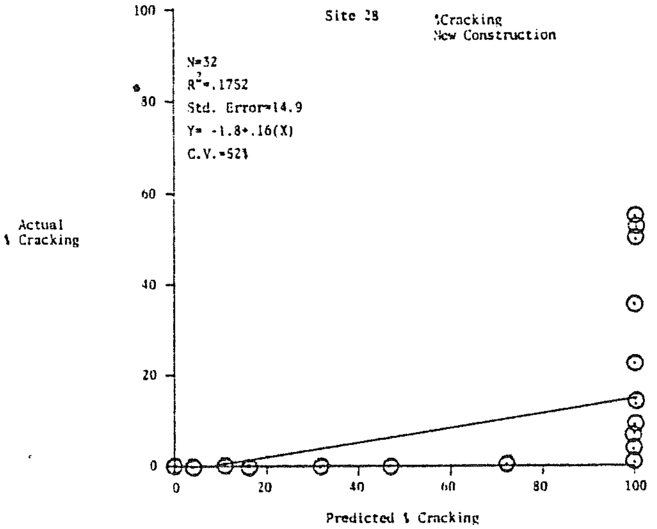

Site 20
%Cracking
New Construction
N=19
R^2=.7712
Std. Error=2.0
Y= -1.9+.67(X)
C.V.=29%
Actual % Cracking
Predicted % Cracking
0
5
10
15
20
25

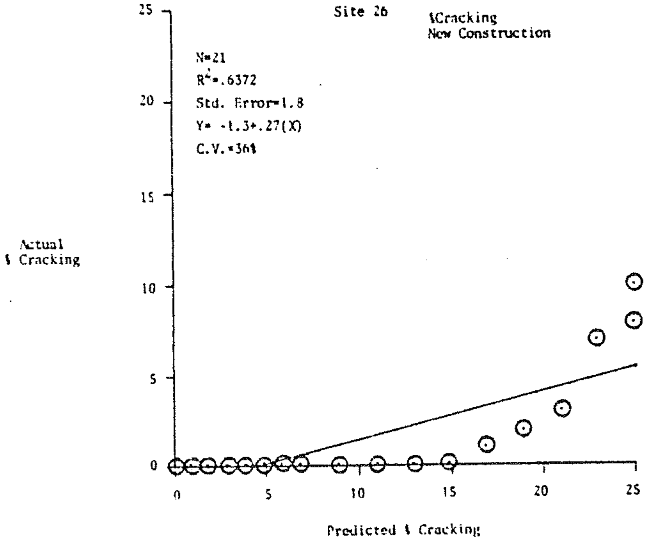

Site 23
%Cracking
New Construction
N=18
R^2=.9116
Std. Error=3.6
Y= -4.2+1.44(X)
C.V.=21%
Actual % Cracking
Predicted % Cracking
0
5
10
15
20
25
30
35

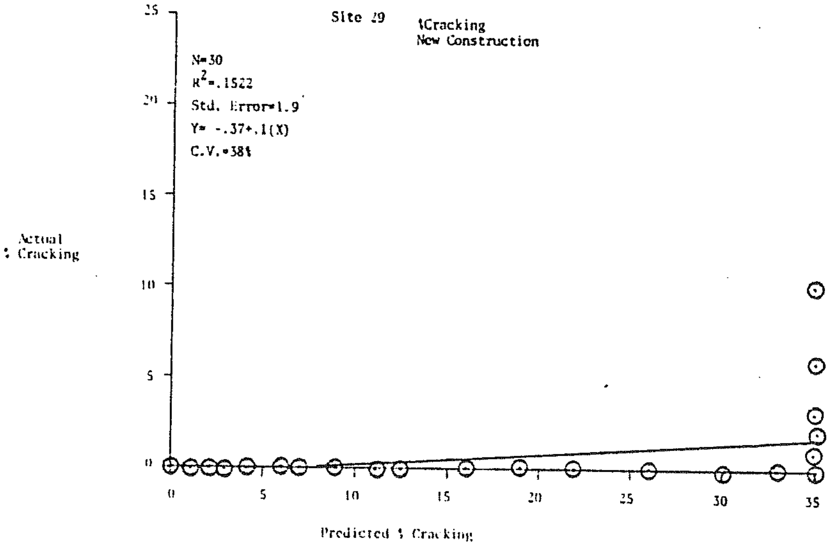

Site 21
%Cracking
New Construction
N=22
R^2=.6623
Std. Error=4.9
Y= -3.6+.77(X)
C.V.=36%
Actual % Cracking
Predicted % Cracking
0
5
10
15
20
25
30

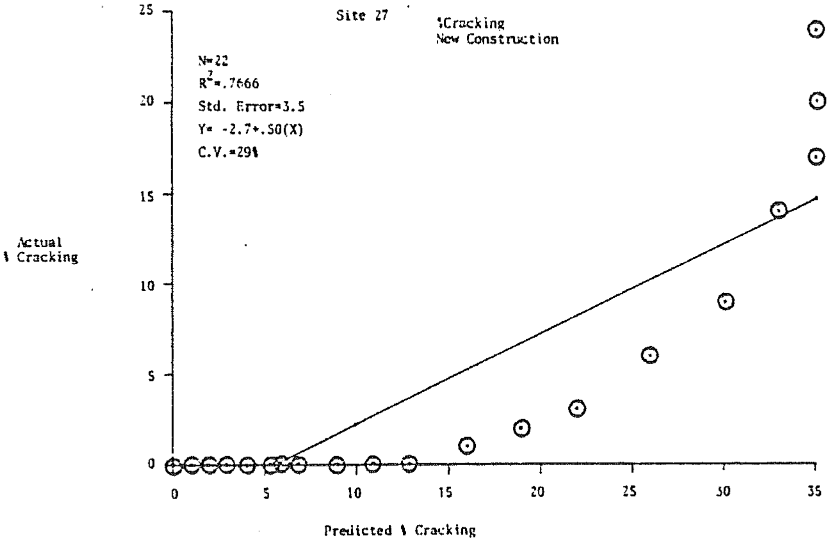

Site 24
%Cracking
New Construction
N=26
R^2=.1826
Std. Error=9.8
Y= -1.1+.11(X)
C.V.=49%
Actual % Cracking
Predicted % Cracking
0
20
40
60
80
100

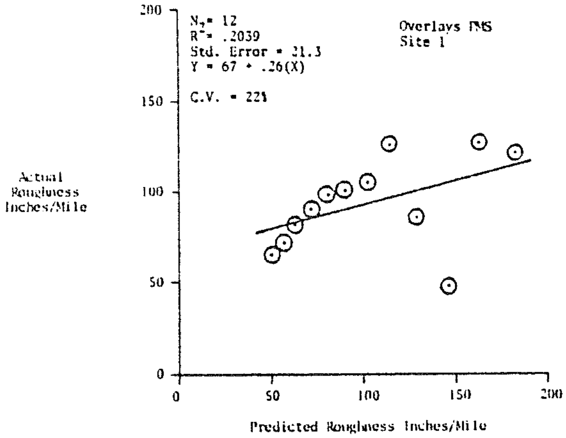

Site 25
%Cracking
New Construction
N=16
R^2=.7063
Std. Error=.9
Y= -.6+.20(X)
C.V.=26%
Actual
% Cracking
25
20
15
10
5
0
0
5
10
15
20
25
Predicted % Cracking


Site 28
%Cracking
New Construction
N=32
R^2=.1752
Std. Error=14.9
Y= -1.8+.16(X)
C.V.=52%
Actual
% Cracking
100
80
60
40
20
0
0
20
40
60
80
100
Predicted % Cracking


Site 26
%Cracking
New Construction
N=21
R^2=.6372
Std. Error=1.8
Y= -1.3+.27(X)
C.V.=36%
Actual
% Cracking
25
20
15
10
5
0
0
5
10
15
20
25
Predicted % Cracking

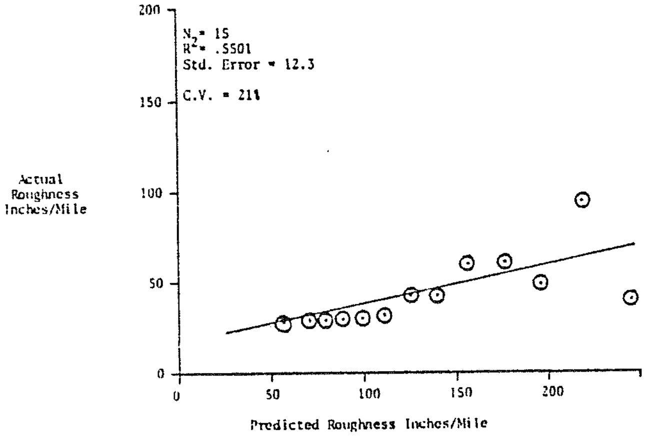

Site 29
%Cracking
New Construction
N=30
R^2=.1522
Std. Error=1.9
Y= -.37+.1(X)
C.V.=38%
Actual
% Cracking
25
20
15
10
5
0
0
5
10
15
20
25
30
35
Predicted % Cracking


Site 27
%Cracking
New Construction
N=22
R^2=.7666
Std. Error=3.5
Y= -2.7+.50(X)
C.V.=29%
Actual
% Cracking
25
20
15
10
5
0
0
5
10
15
20
25
30
35
Predicted % Cracking



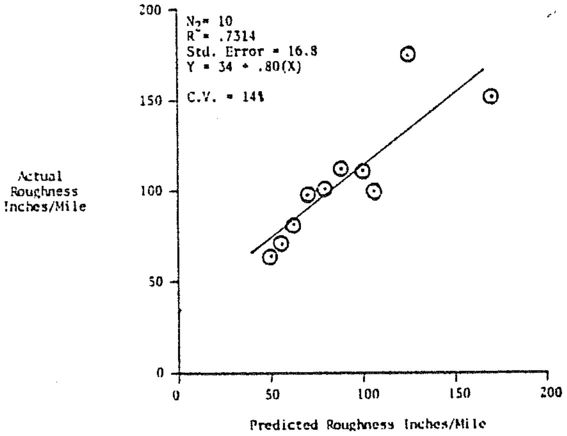
Overlays PMS

Site 2

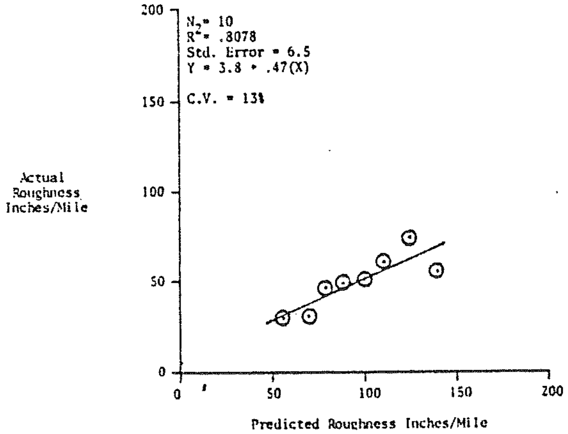


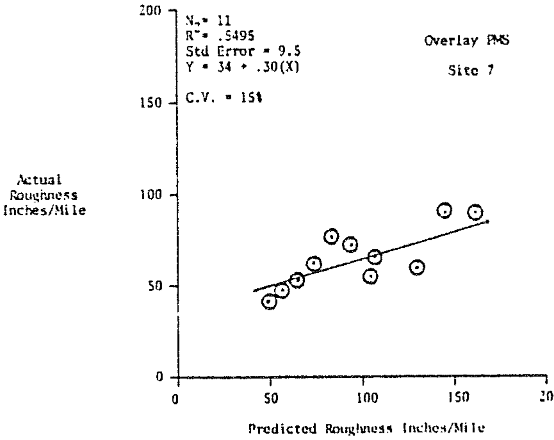
Overlays PMS

Site 3



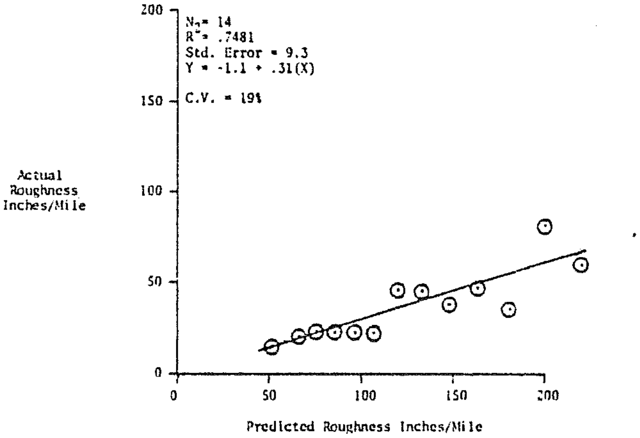
Overlays PMS
Site 5





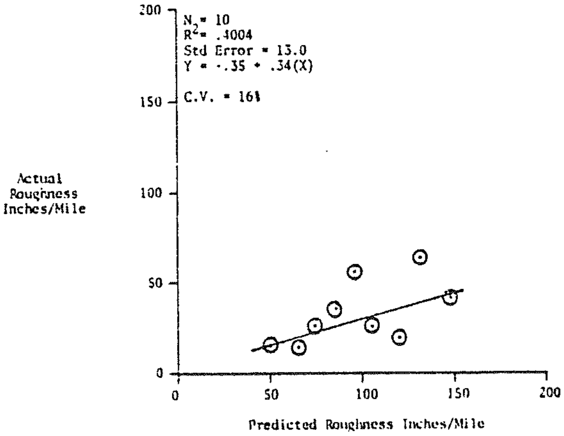
Overlay PMS

Site 8



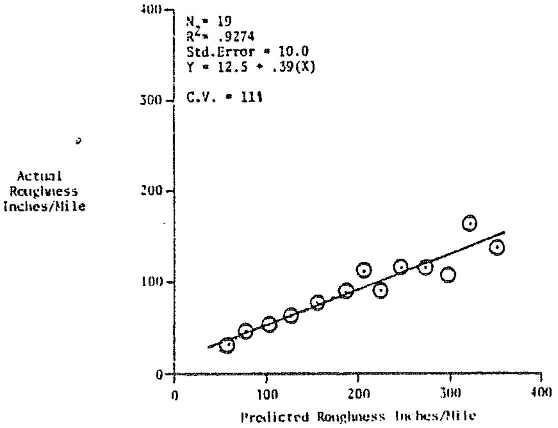
Overlay PMS

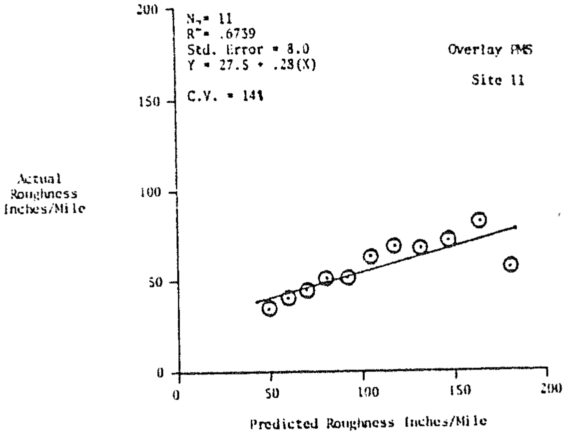
Site 9



Overlay PMS

Site 10

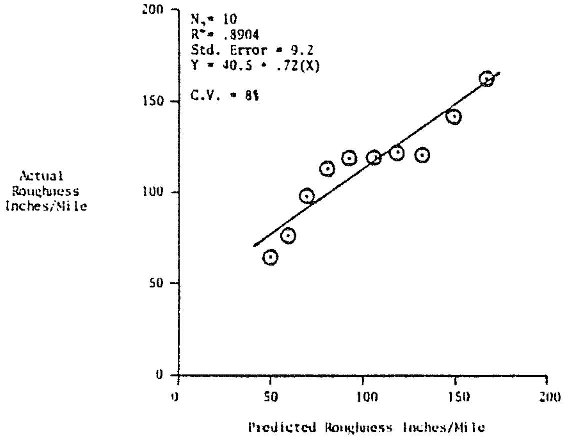



Overlay PMS

Site 11

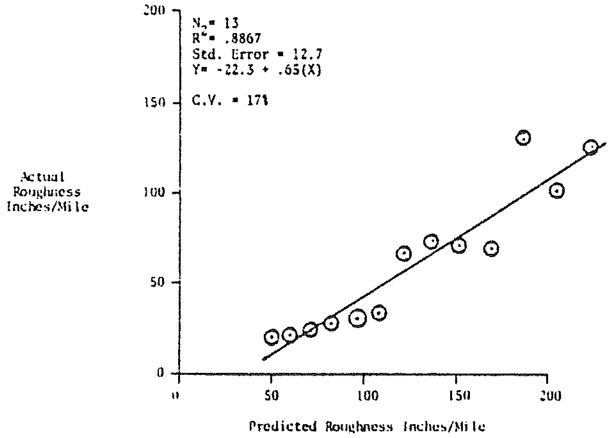
Overlay PMS

Site 12



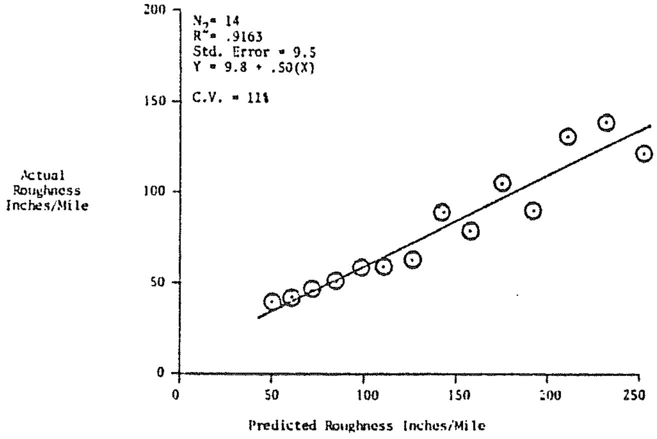
Overlay PMS

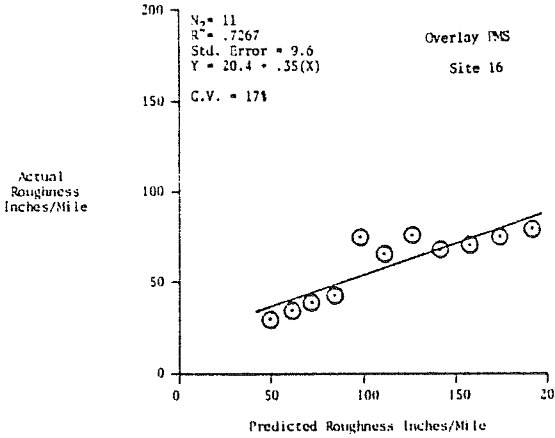
Site 14



Overlay PMS

Site 15

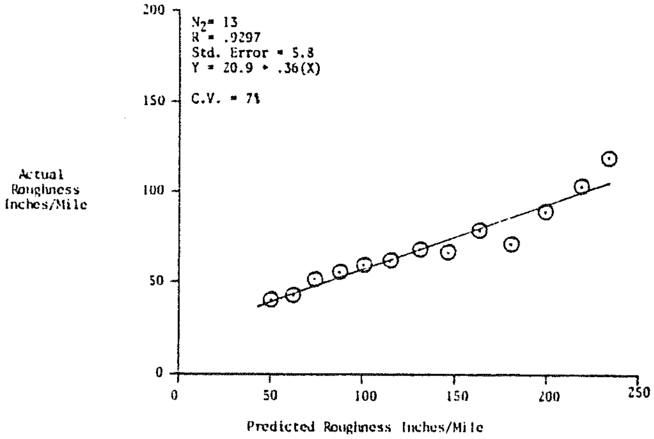



Overlay PMS

Site 16

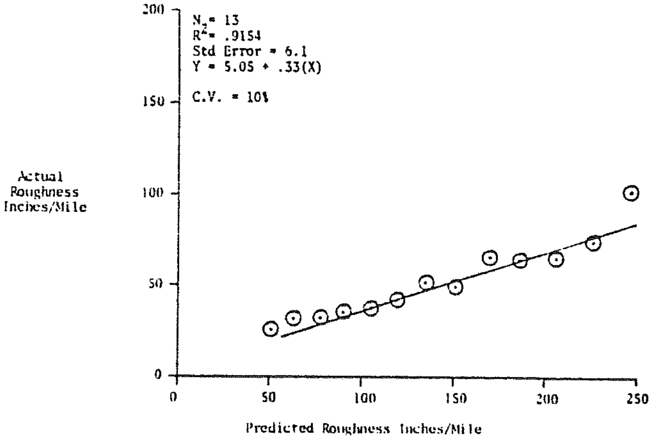
Overlay PMS

Site 17



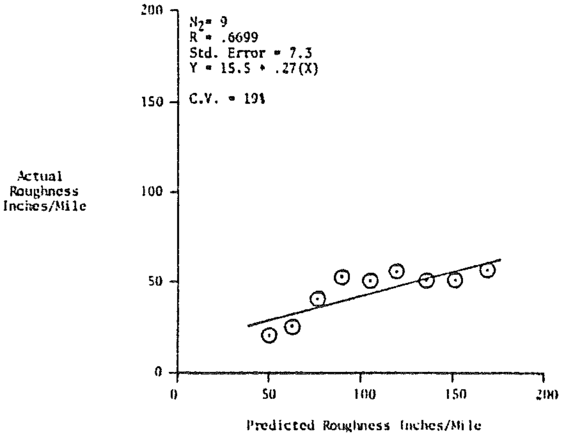
Overlay PMS

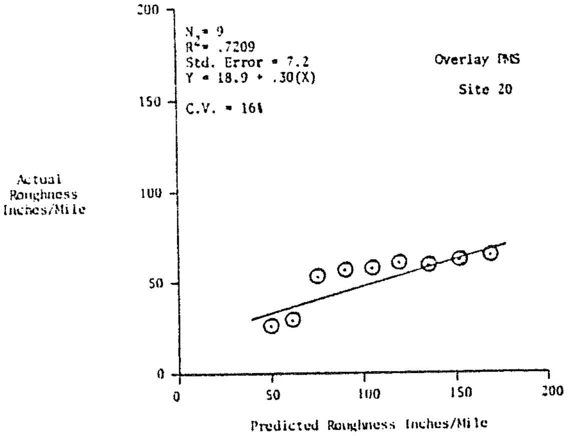
Site 18



Overlay PMS

Site 19

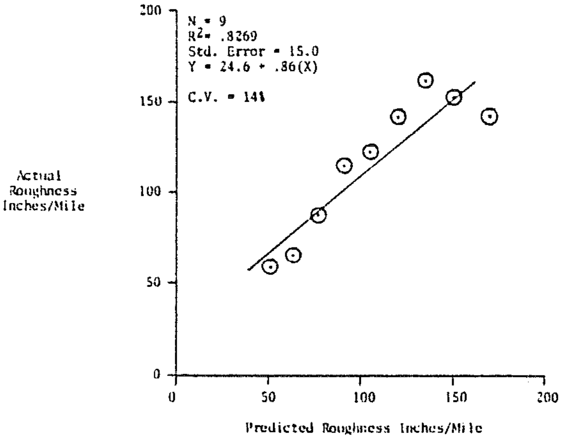



Overlay PMS

Site 20

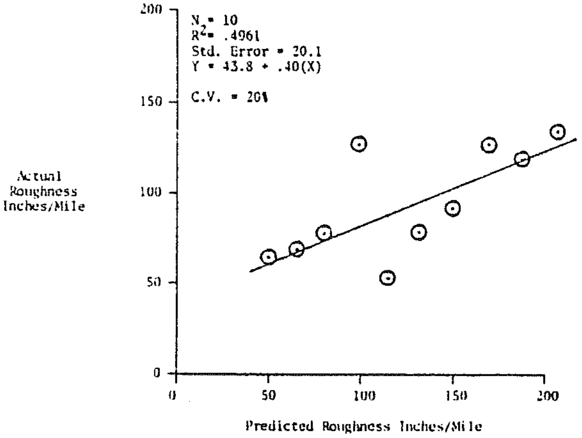
Overlay PMS

Site 22



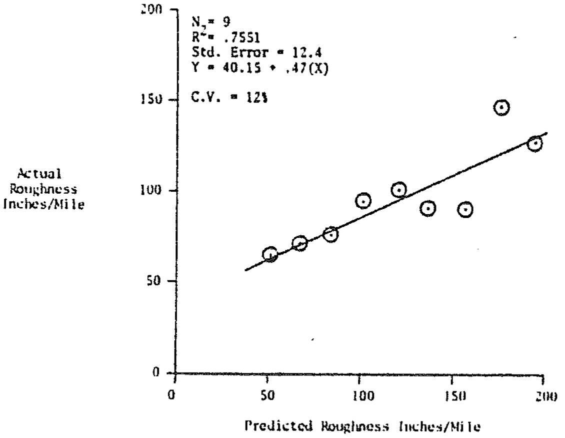
Overlay PMS

Site 23



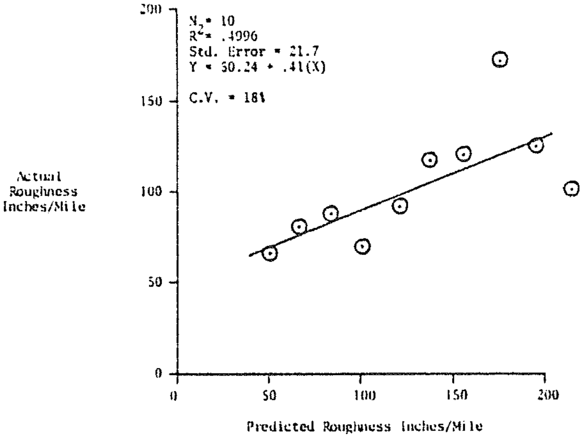
Overlay PMS

Site 24



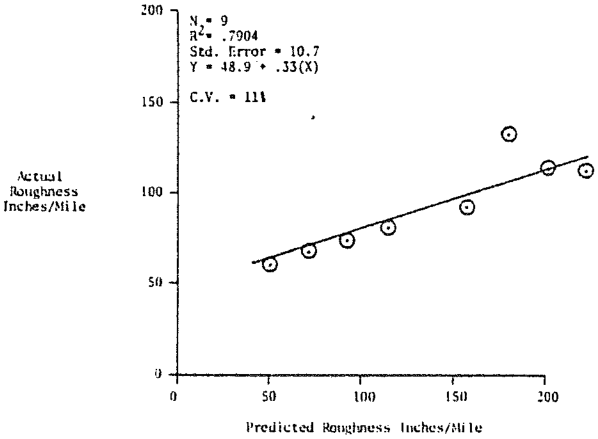
Overlay PMS

Site 25



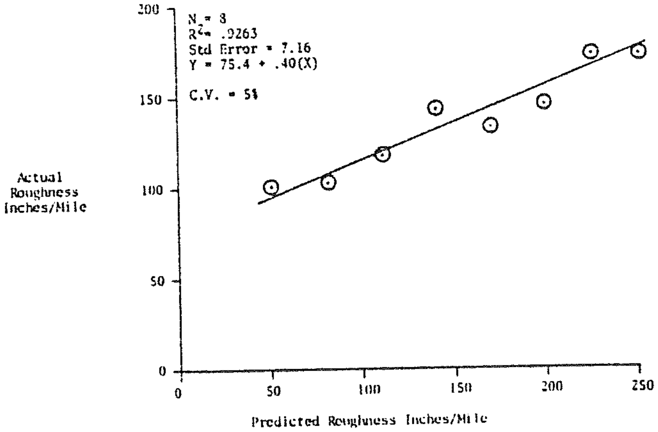
Overlay PMS

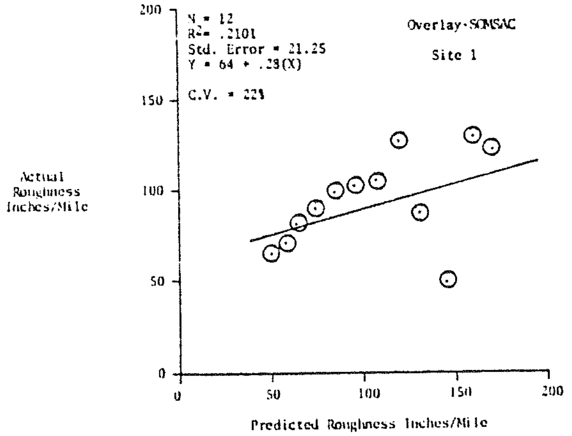
Site 27



Overlay PMS

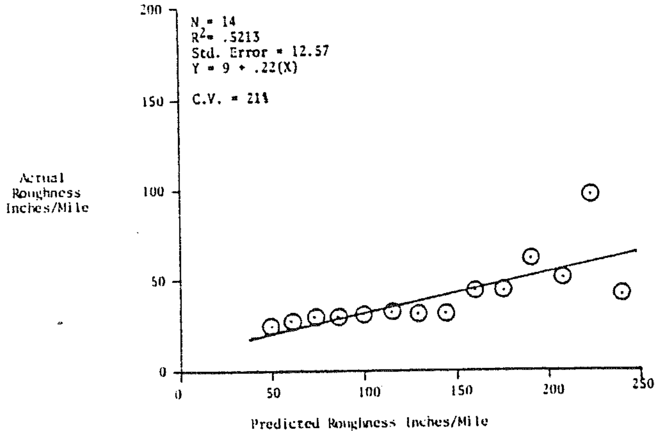
Site 29





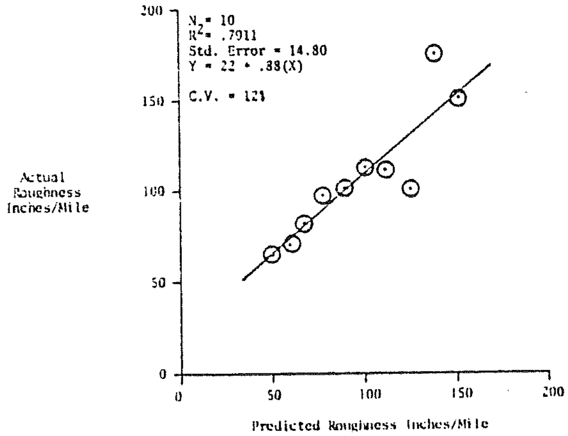
Overlay-SOMSAC

Site 2



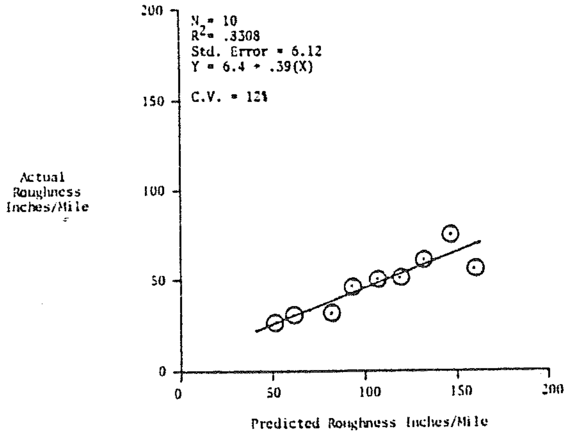
Overlay-SOMSAC

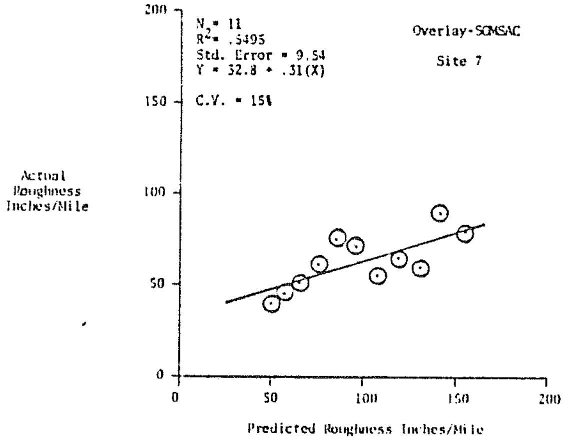
Site 3



Overlay-SOMSAC

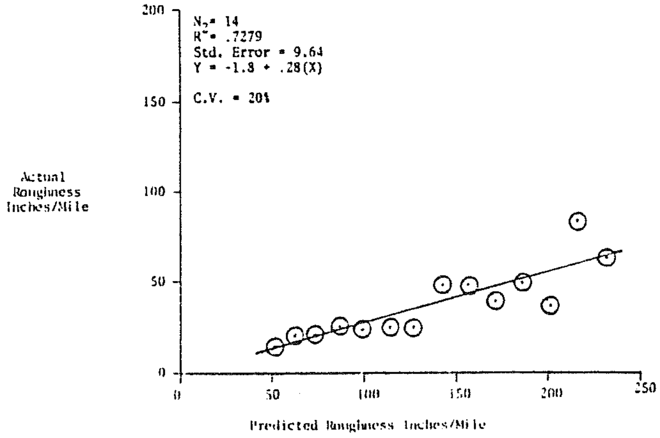
Site 5





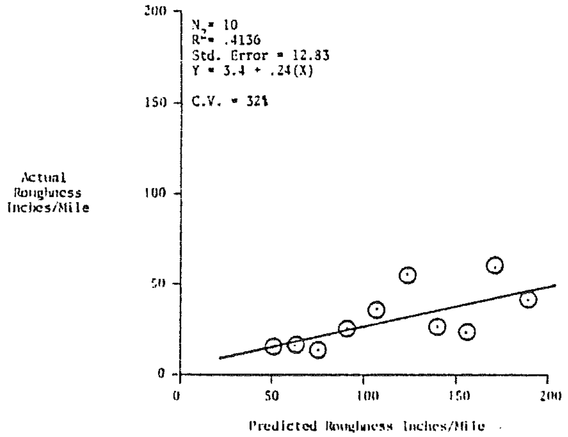
Overlay-SOMSAC

Site 8



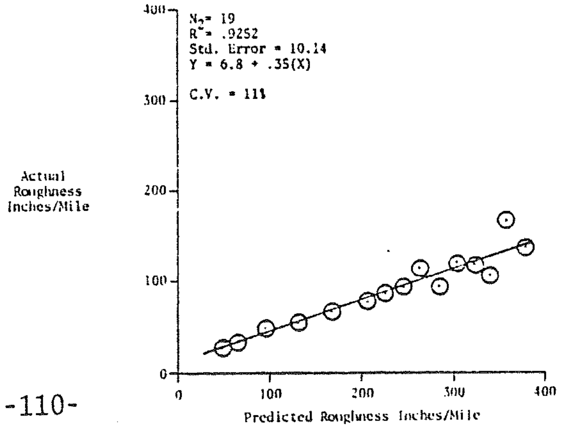
Overlay-SOMSAC

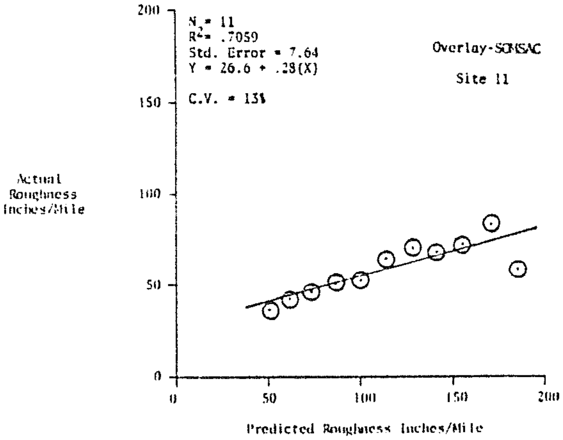
Site 9



Overlay-SOMSAC

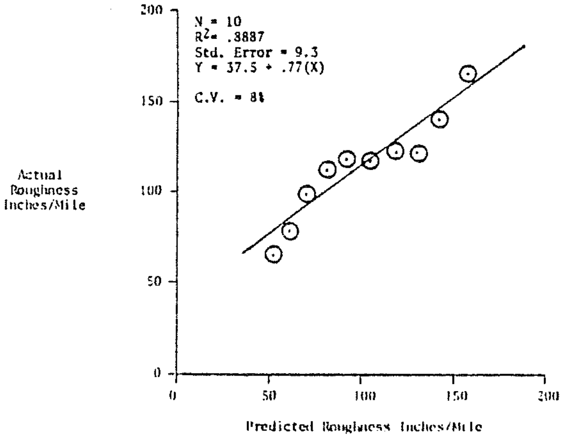
Site 10





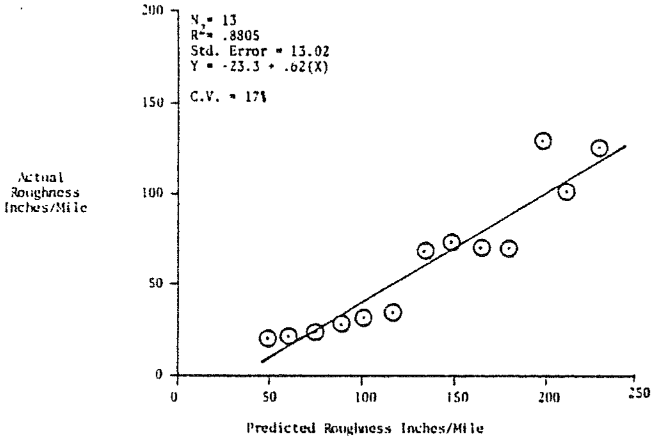
Overlay-SCMSAC

Site 12



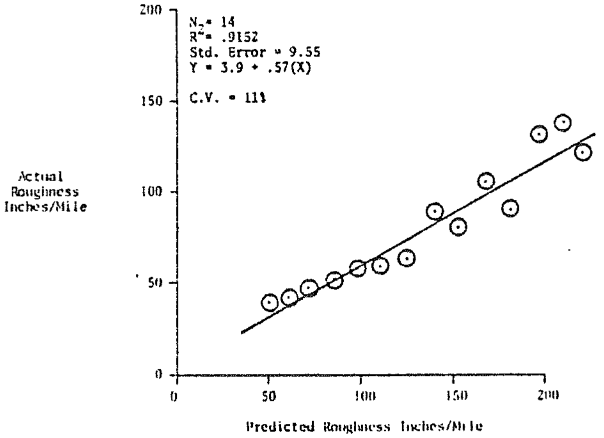
Overlay-SCMSAC

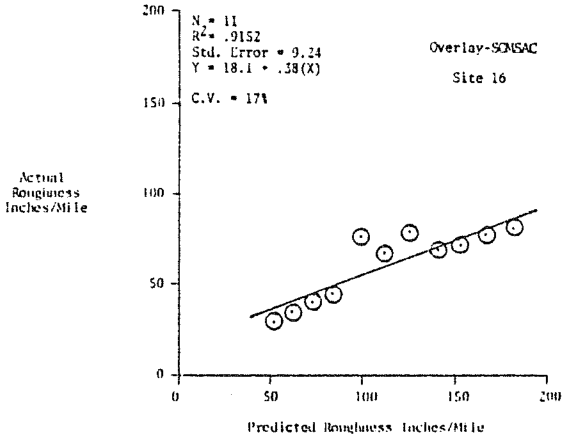
Site 14



Overlay-SCMSAC

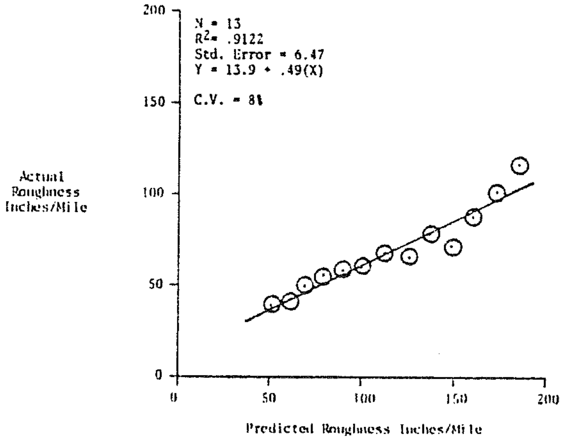
Site 15





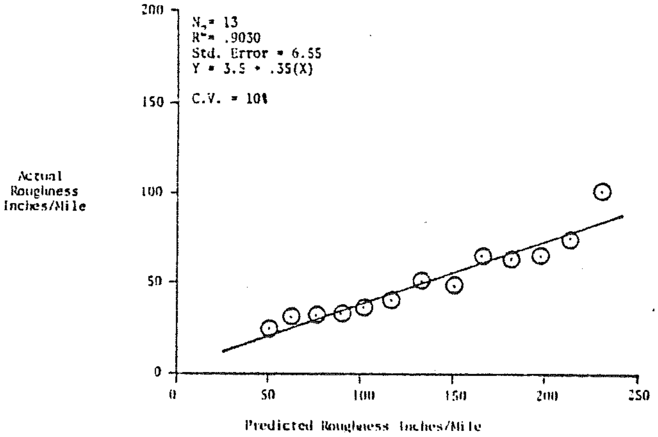
Overlay-SCMSAC

Site 17



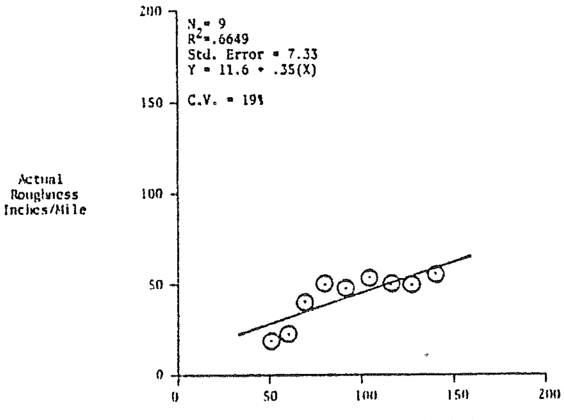
Overlay-SCMSAC

Site 18



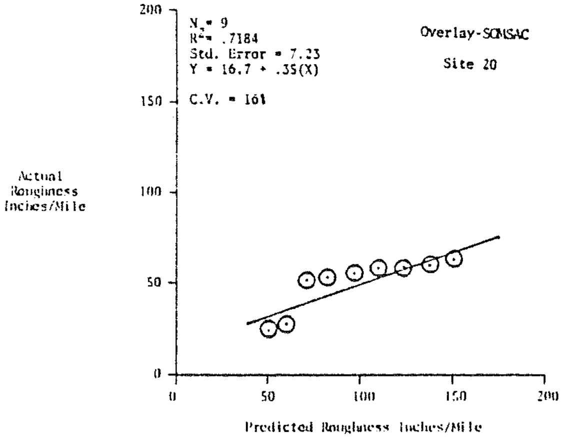
Overlay-SCMSAC

Site 19



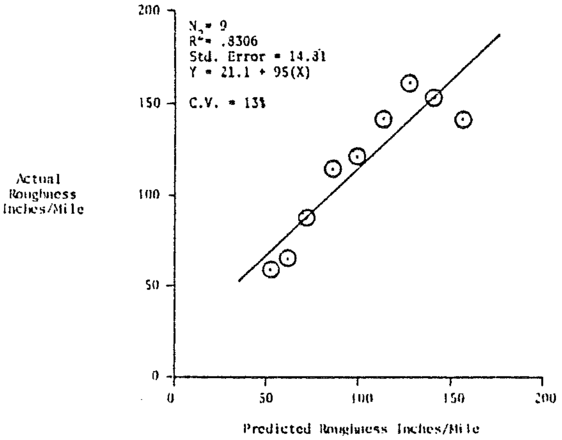
Overlay-SCMSAC

Site 20



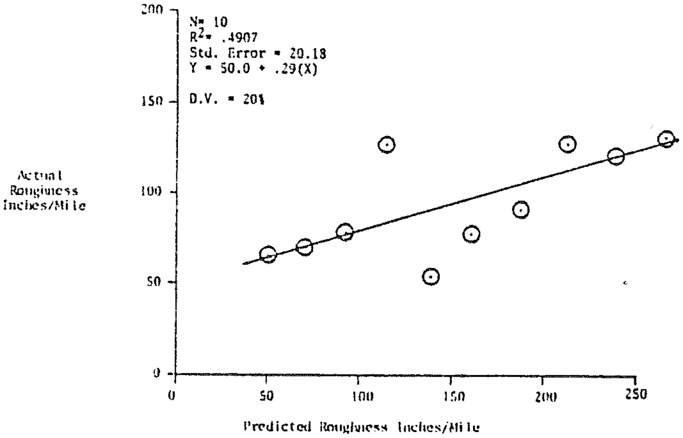
Overlay-SCMSAC

Site 22



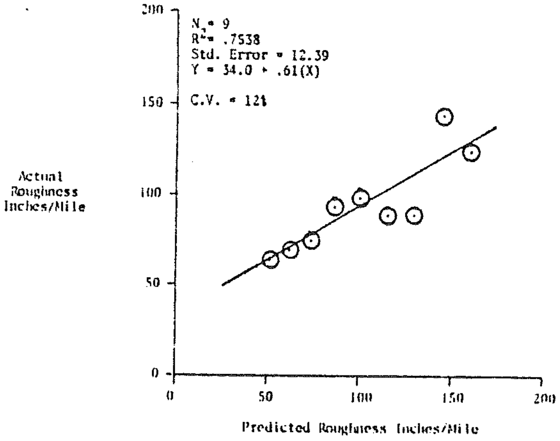
Overlay-SCMSAC

Site 23



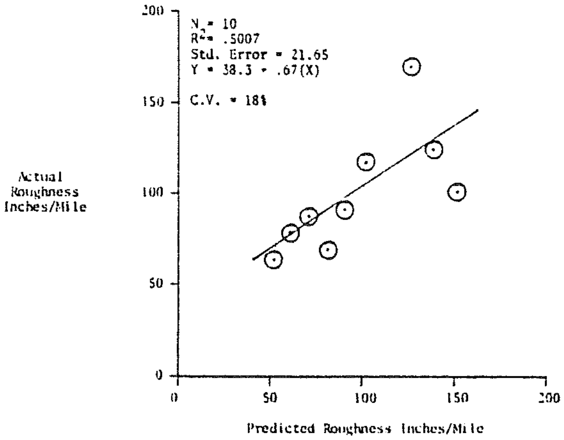
Overlay-SCMSAC

Site 24



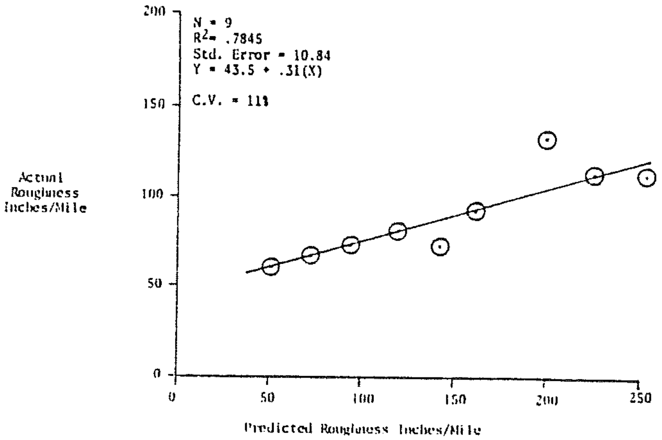
Overlay-SCMSAC

Site 25



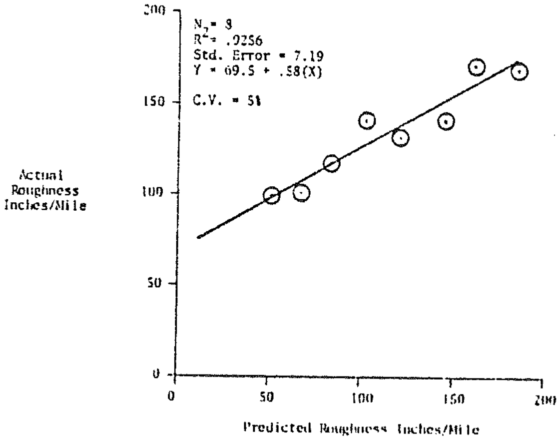
Overlay-SCMSAC

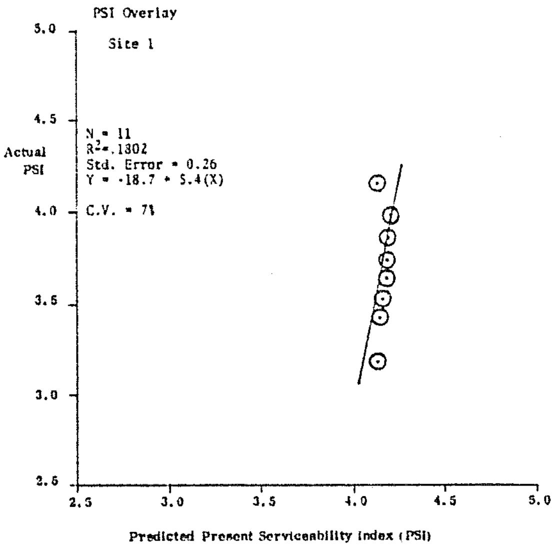
Site 27

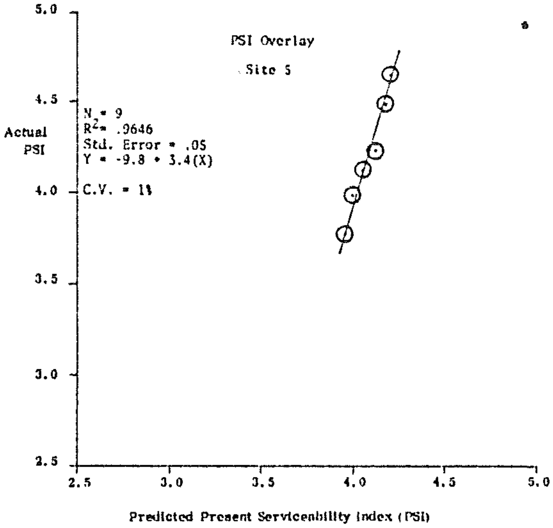


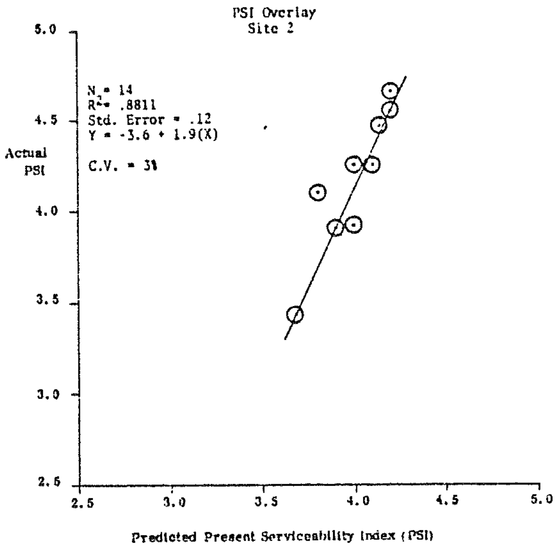
Overlay-SCMSAC

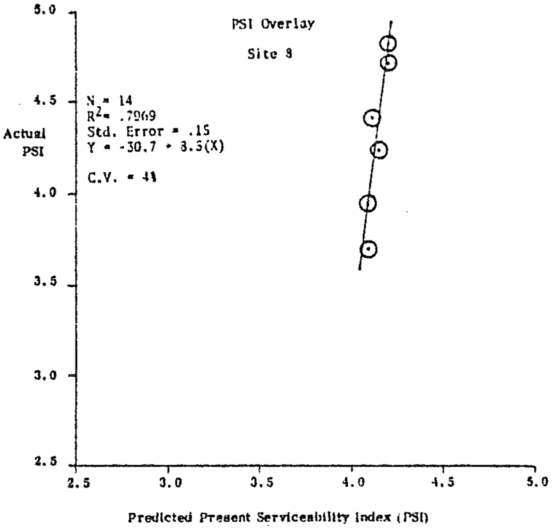
Site 29

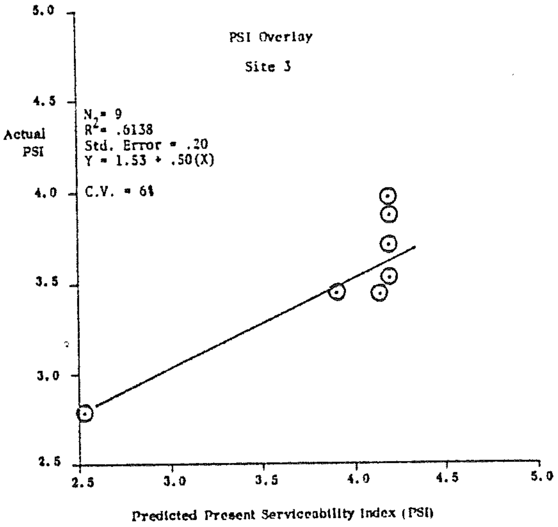


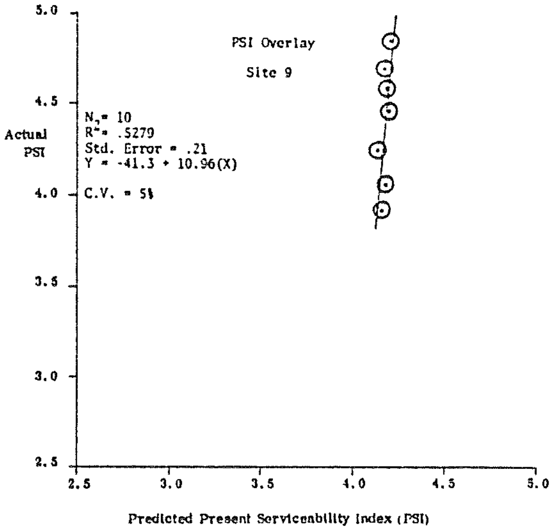

PSI Overlay
Site 1
Actual PSI
N = 11
R^2 = .1302
Std. Error = 0.26
Y = -18.7 + 5.4(X)
C.V. = 7%
5.0
4.5
4.0
3.5
3.0
2.5
2.5
3.0
3.5
4.0
4.5
5.0
Predicted Present Serviceability Index (PSI)

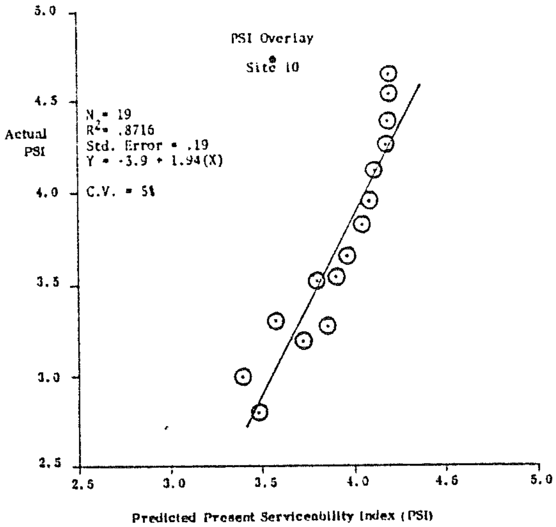

PSI Overlay
Site 5
Actual PSI
N = 9
R^2 = .9646
Std. Error = .05
Y = -9.8 + 3.4(X)
C.V. = 1%
5.0
4.5
4.0
3.5
3.0
2.5
2.5
3.0
3.5
4.0
4.5
5.0
Predicted Present Serviceability Index (PSI)

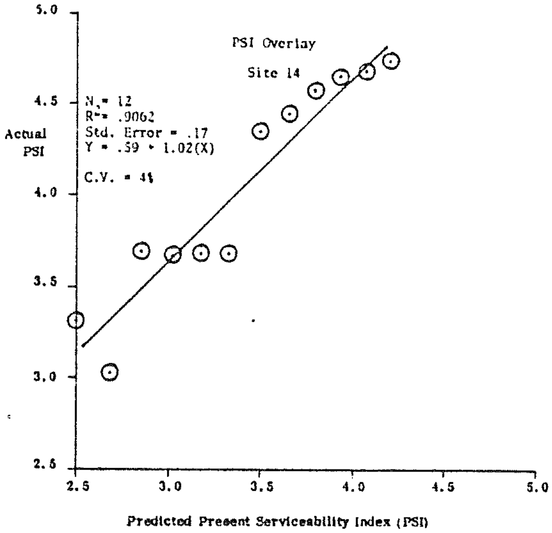

PSI Overlay
Site 2
Actual PSI
N = 14
R^2 = .8811
Std. Error = .12
Y = -3.6 + 1.9(X)
C.V. = 3%
5.0
4.5
4.0
3.5
3.0
2.5
2.5
3.0
3.5
4.0
4.5
5.0
Predicted Present Serviceability Index (PSI)

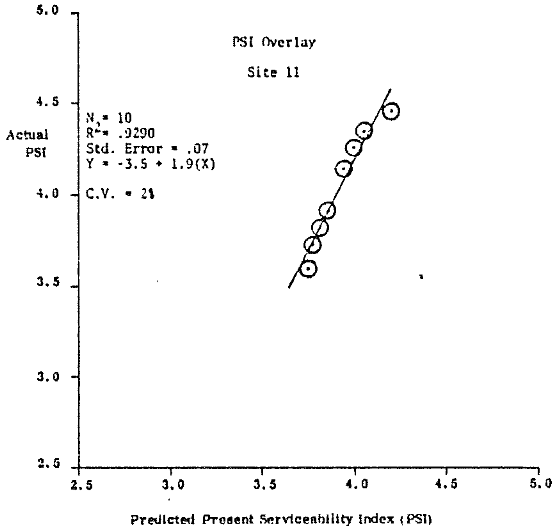

PSI Overlay
Site 8
Actual PSI
N = 14
R^2 = .7969
Std. Error = .15
Y = -30.7 + 8.5(X)
C.V. = 4%
5.0
4.5
4.0
3.5
3.0
2.5
2.5
3.0
3.5
4.0
4.5
5.0
Predicted Present Serviceability Index (PSI)

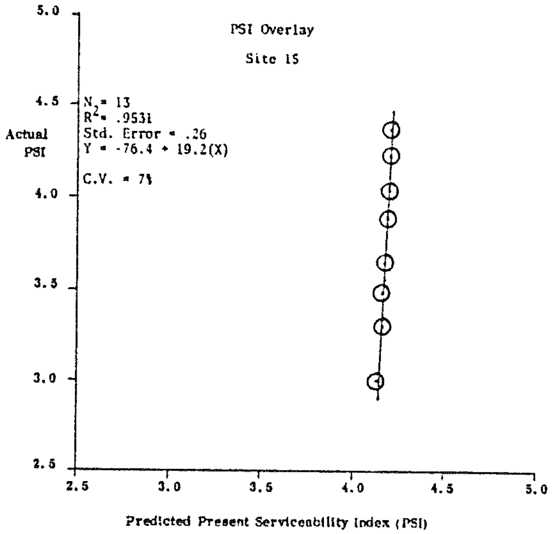

PSI Overlay
Site 3
Actual PSI
N = 9
R^2 = .6138
Std. Error = .20
Y = 1.53 + .50(X)
C.V. = 6%
5.0
4.5
4.0
3.5
3.0
2.5
2.5
3.0
3.5
4.0
4.5
5.0
Predicted Present Serviceability Index (PSI)

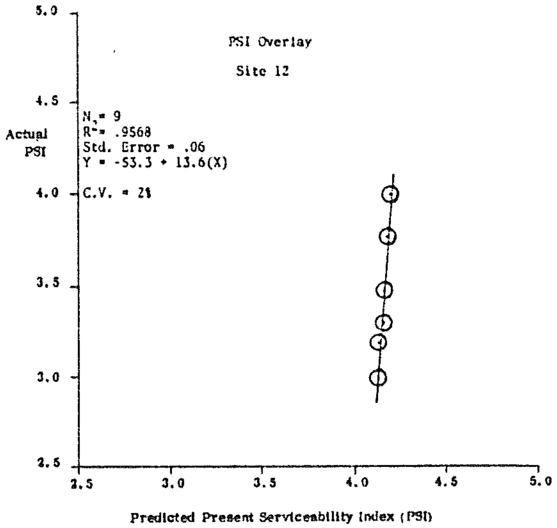

PSI Overlay
Site 9
Actual PSI
N = 10
R^2 = .5279
Std. Error = .21
Y = -41.3 + 10.96(X)
C.V. = 5%
5.0
4.5
4.0
3.5
3.0
2.5
2.5
3.0
3.5
4.0
4.5
5.0
Predicted Present Serviceability Index (PSI)

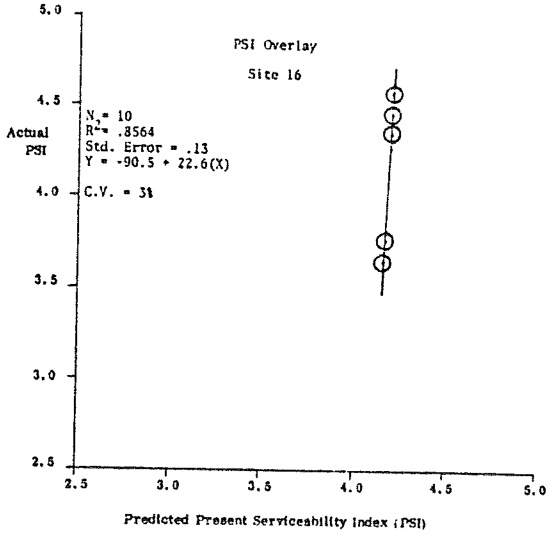

PSI Overlay
Site 10
N = 19
R² = .8716
Std. Error = .19
Y = -3.9 + 1.94(X)
C.V. = 5%
Actual PSI
5.0
4.5
4.0
3.5
3.0
2.5
2.5
3.0
3.5
4.0
4.5
5.0
Predicted Present Serviceability Index (PSI)

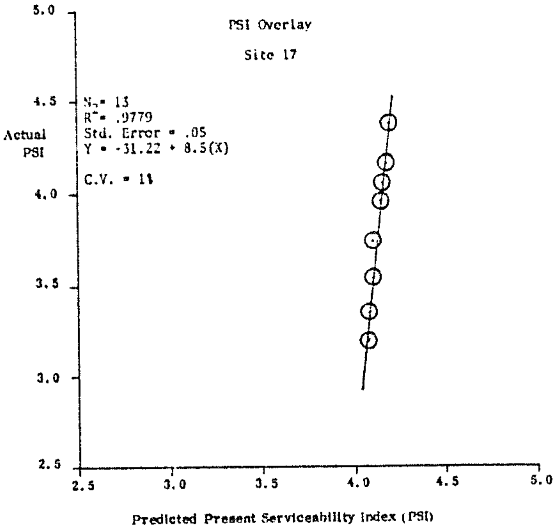

PSI Overlay
Site 14
N = 12
R² = .9062
Std. Error = .17
Y = .59 + 1.02(X)
C.V. = 4%
Actual PSI
5.0
4.5
4.0
3.5
3.0
2.5
2.5
3.0
3.5
4.0
4.5
5.0
Predicted Present Serviceability Index (PSI)

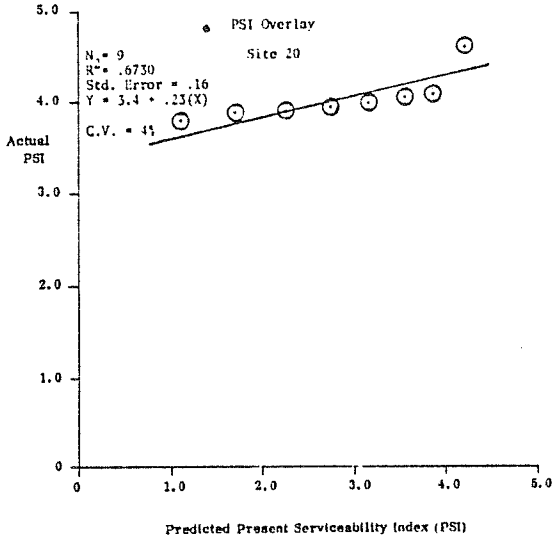

PSI Overlay
Site 11
N = 10
R² = .9290
Std. Error = .07
Y = -3.5 + 1.9(X)
C.V. = 2%
Actual PSI
5.0
4.5
4.0
3.5
3.0
2.5
2.5
3.0
3.5
4.0
4.5
5.0
Predicted Present Serviceability Index (PSI)

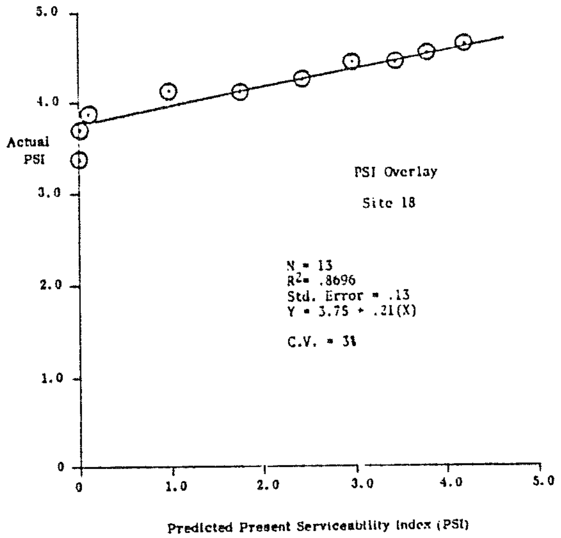

PSI Overlay
Site 15
N = 13
R² = .9531
Std. Error = .26
Y = -76.4 + 19.2(X)
C.V. = 7%
Actual PSI
5.0
4.5
4.0
3.5
3.0
2.5
2.5
3.0
3.5
4.0
4.5
5.0
Predicted Present Serviceability Index (PSI)

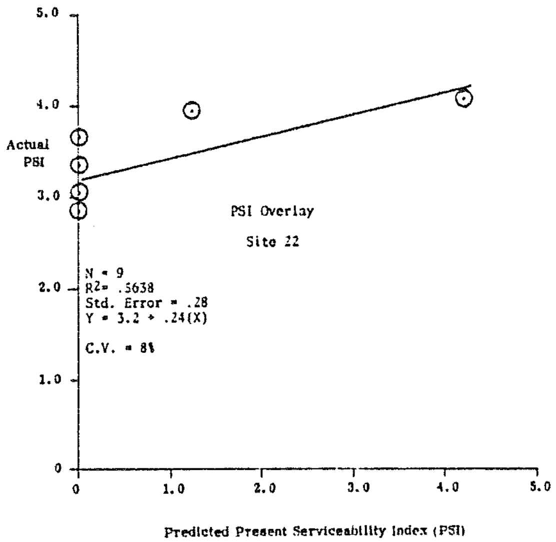

PSI Overlay
Site 12
N = 9
R² = .9568
Std. Error = .06
Y = -53.3 + 13.6(X)
C.V. = 2%
Actual PSI
5.0
4.5
4.0
3.5
3.0
2.5
2.5
3.0
3.5
4.0
4.5
5.0
Predicted Present Serviceability Index (PSI)

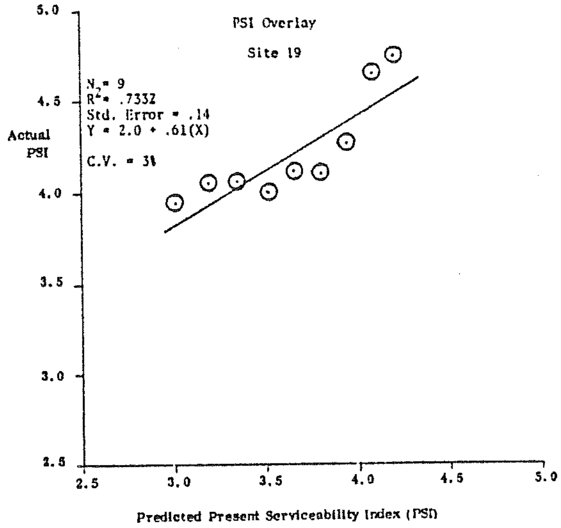

PSI Overlay
Site 16
N = 10
R² = .8564
Std. Error = .13
Y = -90.5 + 22.6(X)
C.V. = 3%
Actual PSI
5.0
4.5
4.0
3.5
3.0
2.5
2.5
3.0
3.5
4.0
4.5
5.0
Predicted Present Serviceability Index (PSI)

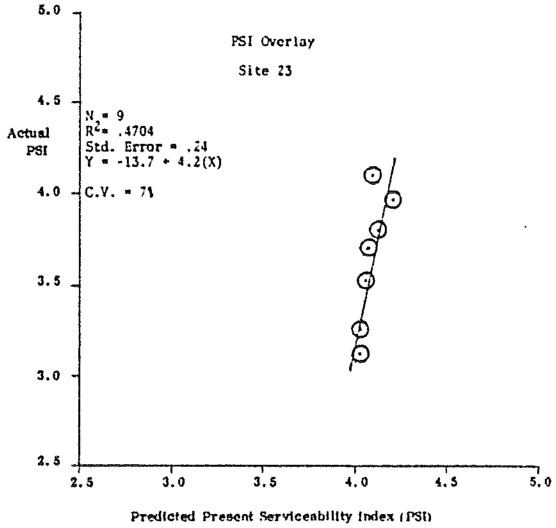

PSI Overlay
Site 17
N,= 13
R^2= .9779
Std. Error = .05
Y = -31.22 + 8.5(X)
C.V. = 1%
Actual PSI
5.0
4.5
4.0
3.5
3.0
2.5
2.5
3.0
3.5
4.0
4.5
5.0
Predicted Present Serviceability Index (PSI)

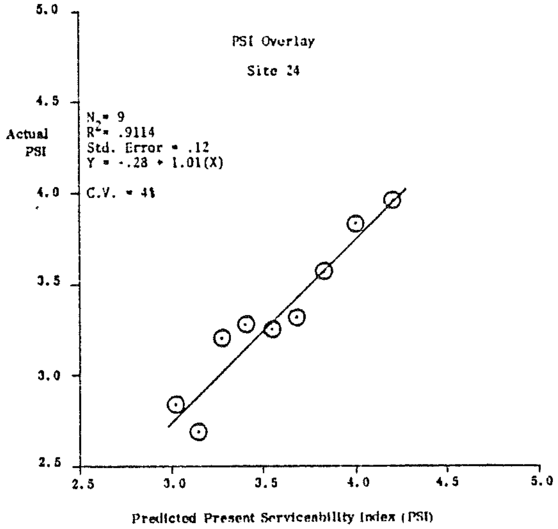

PSI Overlay
Site 20
N,= 9
R^2= .6730
Std. Error = .16
Y = 3.4 + .23(X)
C.V. = 4%
Actual PSI
5.0
4.0
3.0
2.0
1.0
0
0
1.0
2.0
3.0
4.0
5.0
Predicted Present Serviceability Index (PSI)

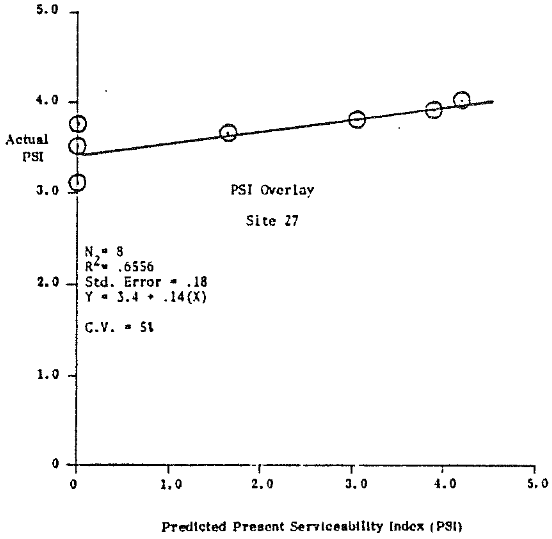

PSI Overlay
Site 18
N = 13
R^2= .8696
Std. Error = .13
Y = 3.75 + .21(X)
C.V. = 3%
Actual PSI
5.0
4.0
3.0
2.0
1.0
0
0
1.0
2.0
3.0
4.0
5.0
Predicted Present Serviceability Index (PSI)

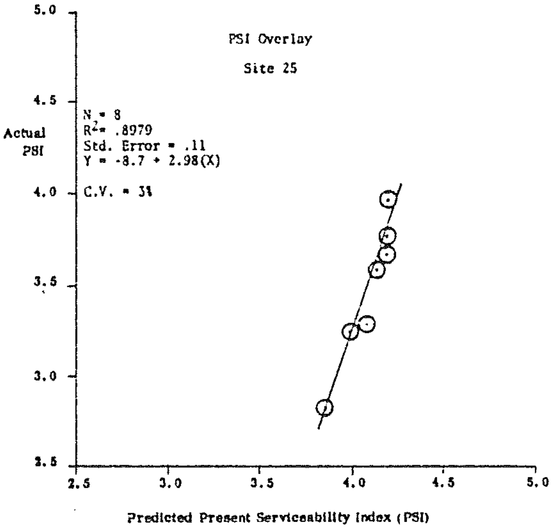

PSI Overlay
Site 22
N = 9
R^2= .5638
Std. Error = .28
Y = 3.2 + .24(X)
C.V. = 8%
Actual PSI
5.0
4.0
3.0
2.0
1.0
0
0
1.0
2.0
3.0
4.0
5.0
Predicted Present Serviceability Index (PSI)

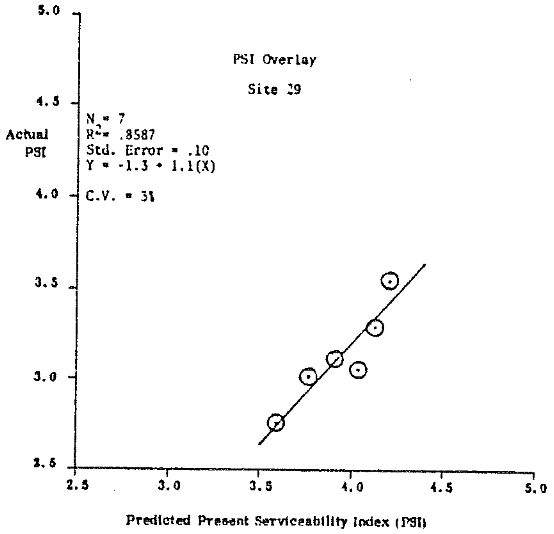

PSI Overlay
Site 19
N,= 9
R^2= .7332
Std. Error = .14
Y = 2.0 + .61(X)
C.V. = 3%
Actual PSI
5.0
4.5
4.0
3.5
3.0
2.5
2.5
3.0
3.5
4.0
4.5
5.0
Predicted Present Serviceability Index (PSI)

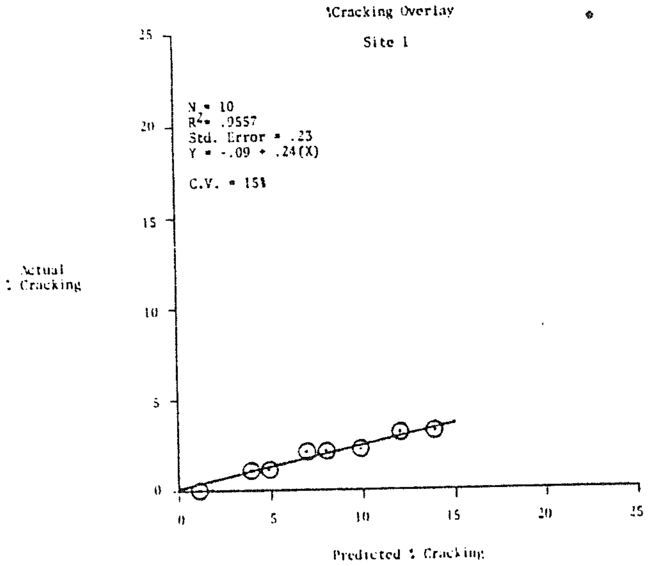

PSI Overlay
Site 23
N,= 9
R^2= .4704
Std. Error = .24
Y = -13.7 + 4.2(X)
C.V. = 7%
Actual PSI
5.0
4.5
4.0
3.5
3.0
2.5
2.5
3.0
3.5
4.0
4.5
5.0
Predicted Present Serviceability Index (PSI)

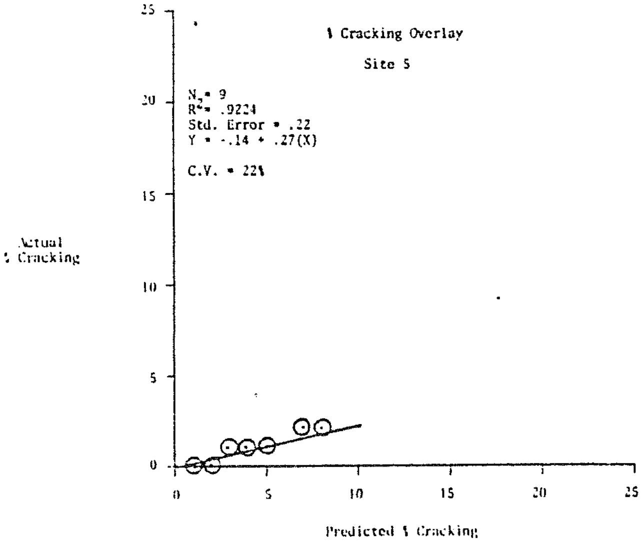

PSI Overlay
Site 24
N = 9
R^2 = .9114
Std. Error = .12
Y = -.28 + 1.01(X)
C.V. = 4%
Actual PSI
5.0
4.5
4.0
3.5
3.0
2.5
2.5
3.0
3.5
4.0
4.5
5.0
Predicted Present Serviceability Index (PSI)

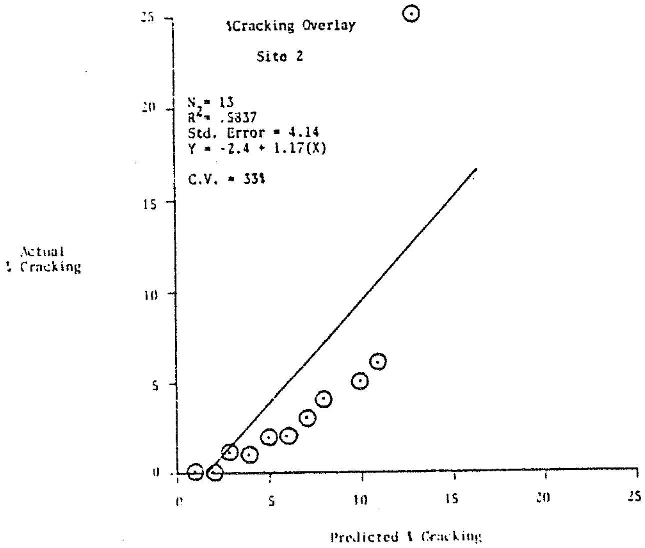

PSI Overlay
Site 27
N = 8
R^2 = .6556
Std. Error = .18
Y = 3.4 + .14(X)
C.V. = 5%
Actual PSI
5.0
4.0
3.0
2.0
1.0
0
0
1.0
2.0
3.0
4.0
5.0
Predicted Present Serviceability Index (PSI)

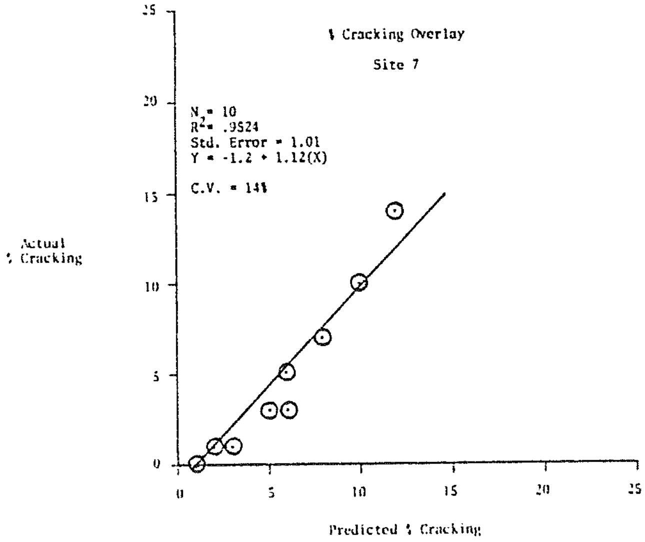

PSI Overlay
Site 25
N = 8
R^2 = .8979
Std. Error = .11
Y = -8.7 + 2.98(X)
C.V. = 3%
Actual PSI
5.0
4.5
4.0
3.5
3.0
2.5
2.5
3.0
3.5
4.0
4.5
5.0
Predicted Present Serviceability Index (PSI)

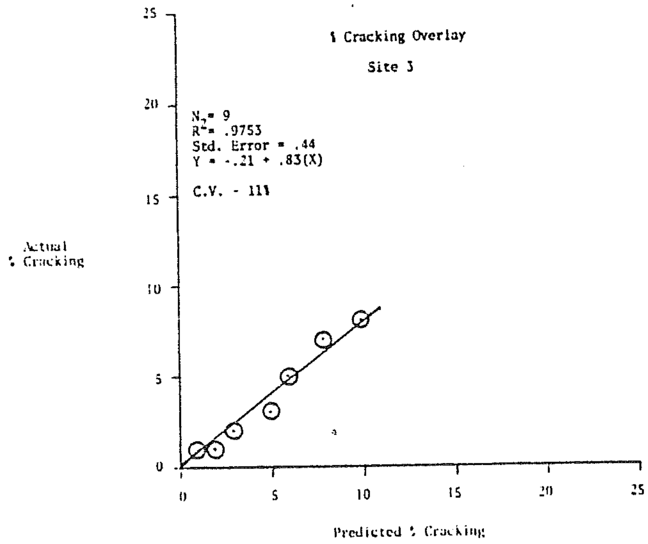

PSI Overlay
Site 29
N = 7
R^2 = .8587
Std. Error = .10
Y = -1.3 + 1.1(X)
C.V. = 3%
Actual PSI
5.0
4.5
4.0
3.5
3.0
2.5
2.5
3.0
3.5
4.0
4.5
5.0
Predicted Present Serviceability Index (PSI)

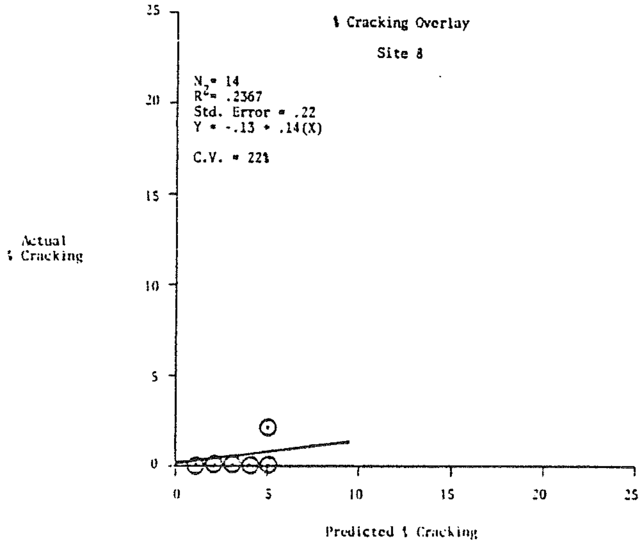

%Cracking Overlay
Site 1
N = 10
R² = .9557
Std. Error = .23
Y = -.09 + .24(X)
C.V. = 15%
Actual % Cracking
Predicted % Cracking
0
5
10
15
20
25

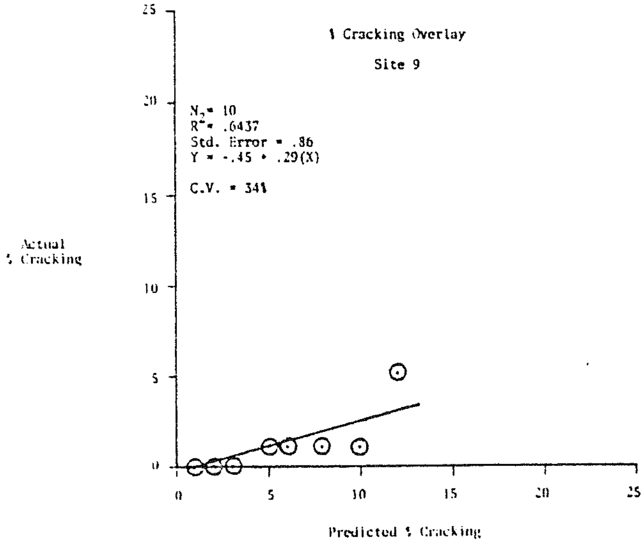

% Cracking Overlay
Site 5
N = 9
R² = .9224
Std. Error = .22
Y = -.14 + .27(X)
C.V. = 22%
Actual % Cracking
Predicted % Cracking
0
5
10
15
20
25

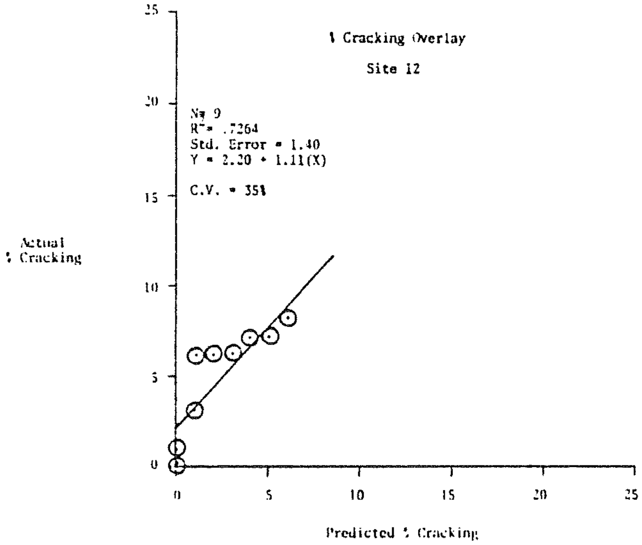

%Cracking Overlay
Site 2
N = 13
R² = .5837
Std. Error = 4.14
Y = -2.4 + 1.17(X)
C.V. = 33%
Actual % Cracking
Predicted % Cracking
0
5
10
15
20
25

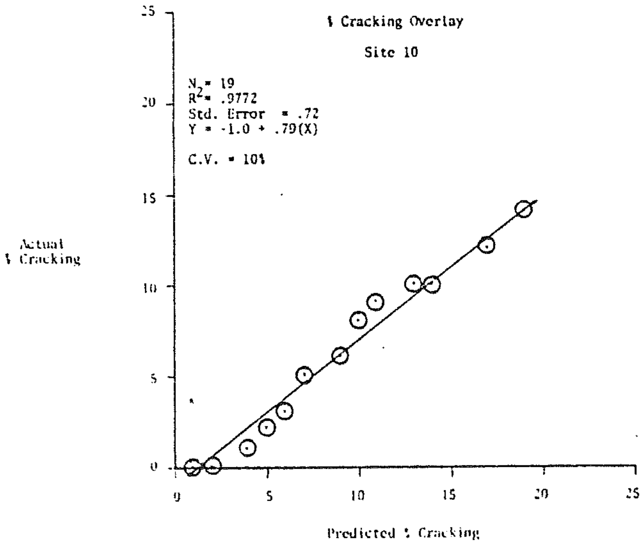

% Cracking Overlay
Site 7
N = 10
R² = .9524
Std. Error = 1.01
Y = -1.2 + 1.12(X)
C.V. = 14%
Actual % Cracking
Predicted % Cracking
0
5
10
15
20
25

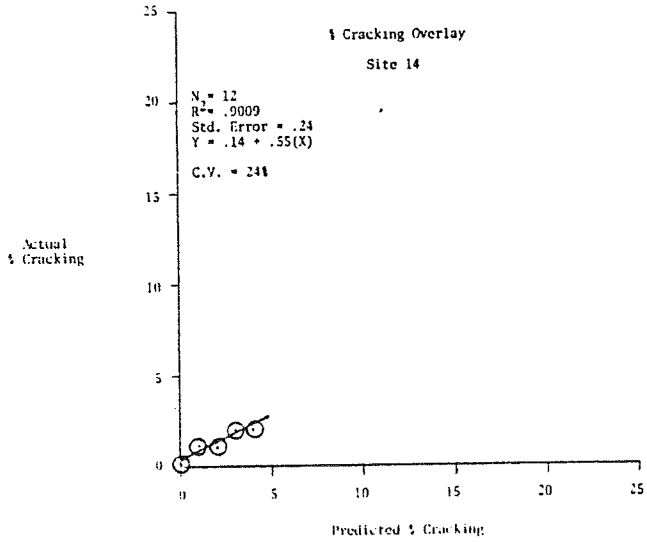

% Cracking Overlay
Site 3
N = 9
R² = .9753
Std. Error = .44
Y = -.21 + .83(X)
C.V. - 11%
Actual % Cracking
Predicted % Cracking
0
5
10
15
20
25

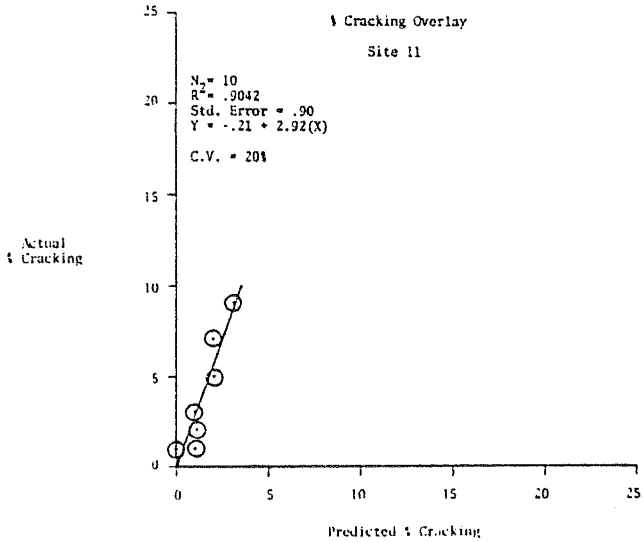

% Cracking Overlay
Site 8
N = 14
R² = .2367
Std. Error = .22
Y = -.13 + .14(X)
C.V. = 22%
Actual % Cracking
Predicted % Cracking
0
5
10
15
20
25

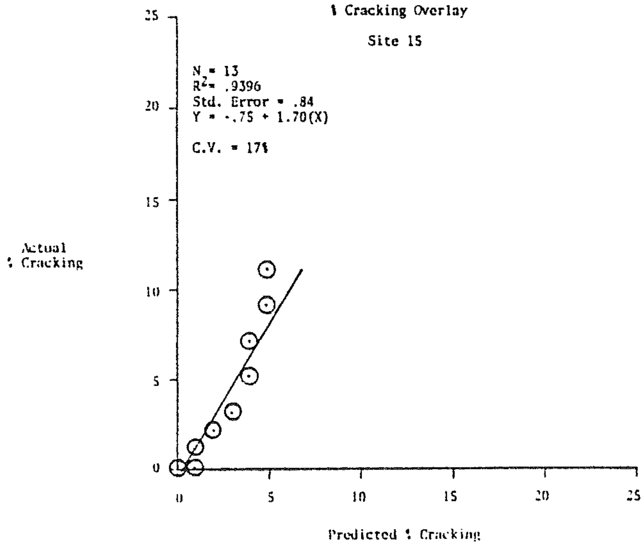

% Cracking Overlay
Site 9
N = 10
R² = .6437
Std. Error = .86
Y = -.45 + .29(X)
C.V. = 34%
Actual % Cracking
Predicted % Cracking
0
5
10
15
20
25

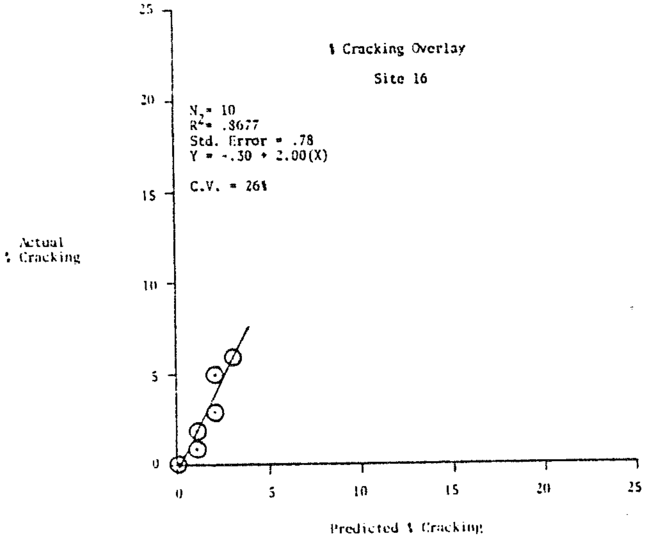

% Cracking Overlay
Site 12
N = 9
R² = .7264
Std. Error = 1.40
Y = 2.20 + 1.11(X)
C.V. = 35%
Actual % Cracking
Predicted % Cracking
0
5
10
15
20
25

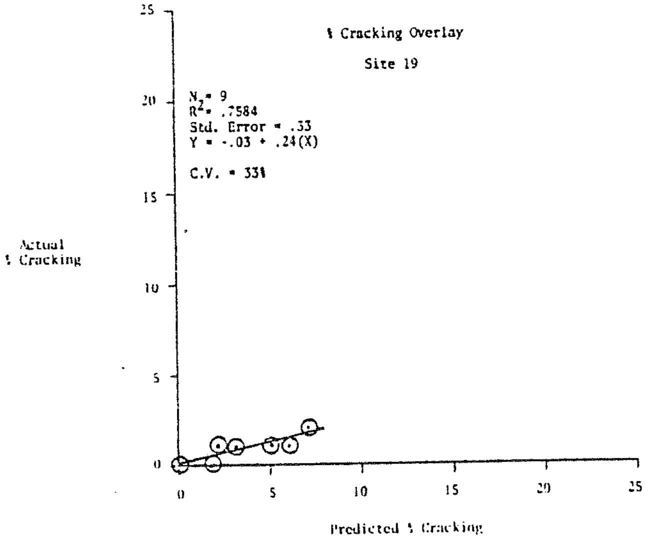

% Cracking Overlay
Site 10
N = 19
R² = .9772
Std. Error = .72
Y = -1.0 + .79(X)
C.V. = 10%
Actual % Cracking
Predicted % Cracking
0
5
10
15
20
25

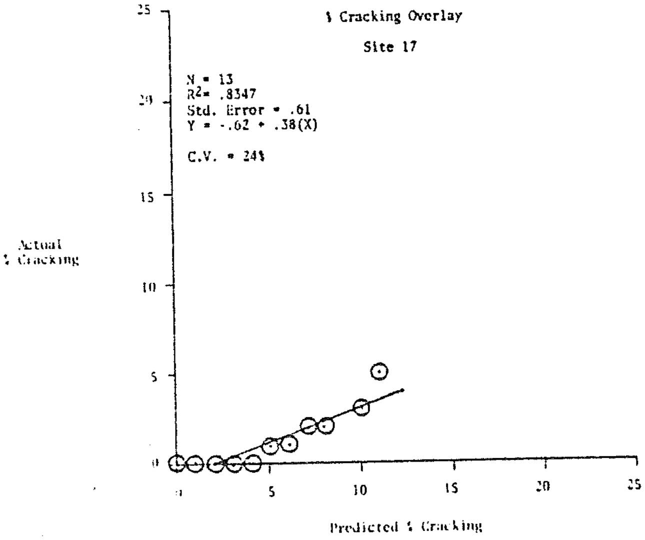

% Cracking Overlay
Site 14
N = 12
R² = .9009
Std. Error = .24
Y = .14 + .55(X)
C.V. = 24%
Actual % Cracking
Predicted % Cracking
0
5
10
15
20
25

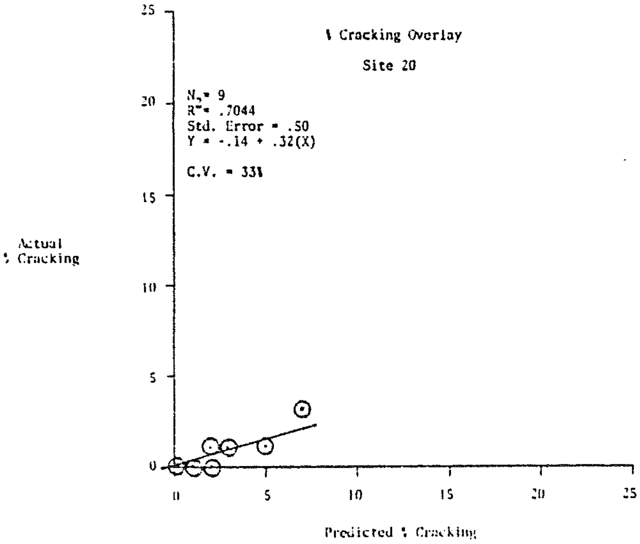

% Cracking Overlay
Site 11
N = 10
R² = .9042
Std. Error = .90
Y = -.21 + 2.92(X)
C.V. = 20%
Actual % Cracking
Predicted % Cracking
0
5
10
15
20
25

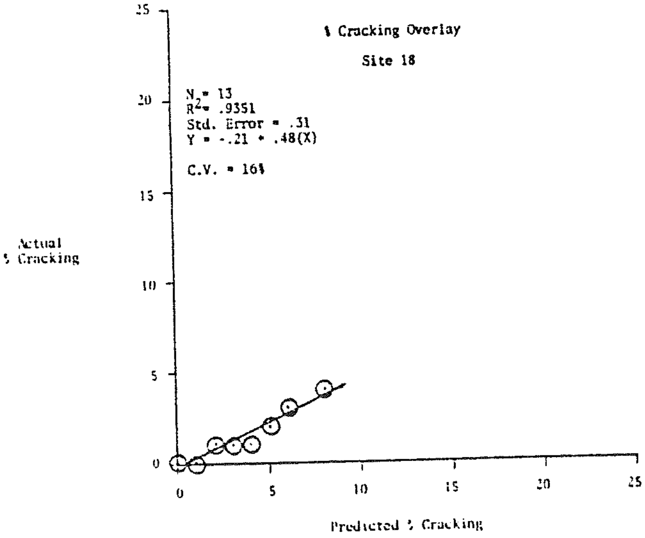

% Cracking Overlay
Site 15
N = 13
R² = .9396
Std. Error = .84
Y = -.75 + 1.70(X)
C.V. = 17%
Actual % Cracking
Predicted % Cracking
0
5
10
15
20
25

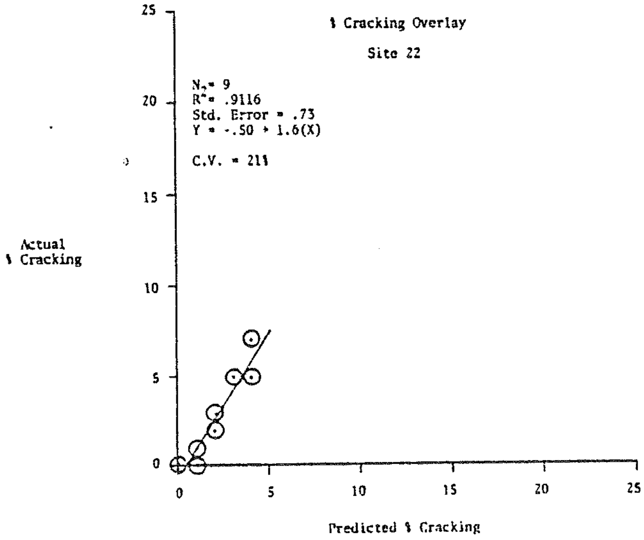

% Cracking Overlay
Site 16
N = 10
R^2 = .8677
Std. Error = .78
Y = -.30 + 2.00(X)
C.V. = 26%
Actual % Cracking
Predicted % Cracking
0
5
10
15
20
25

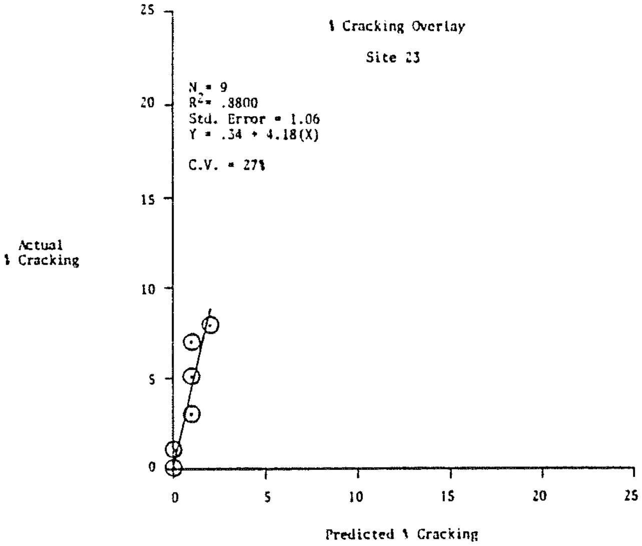

% Cracking Overlay
Site 19
N = 9
R^2 = .7584
Std. Error = .33
Y = -.03 + .24(X)
C.V. = 33%
Actual % Cracking
Predicted % Cracking
0
5
10
15
20
25

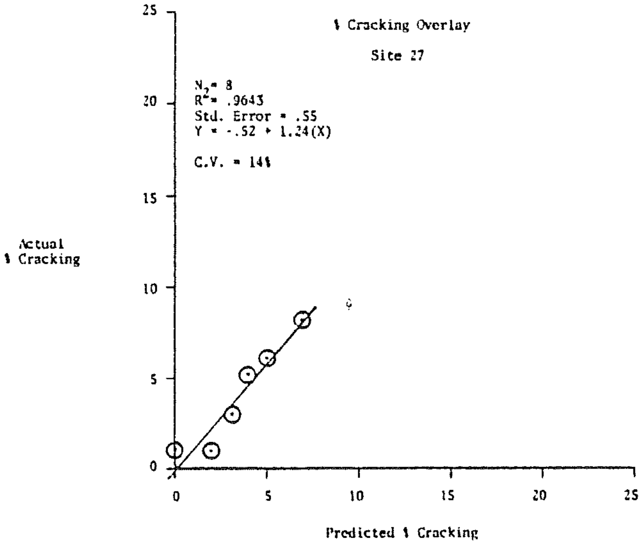

% Cracking Overlay
Site 17
N = 13
R^2 = .8347
Std. Error = .61
Y = -.62 + .38(X)
C.V. = 24%
Actual % Cracking
Predicted % Cracking
0
5
10
15
20
25

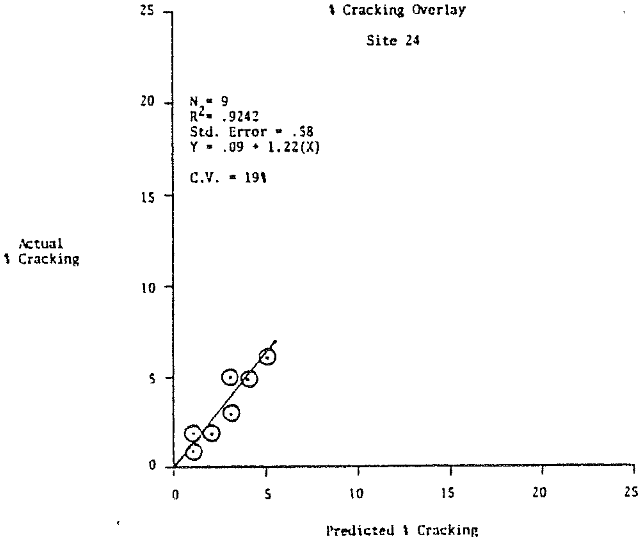

% Cracking Overlay
Site 20
N = 9
R^2 = .7044
Std. Error = .50
Y = -.14 + .32(X)
C.V. = 33%
Actual % Cracking
Predicted % Cracking
0
5
10
15
20
25

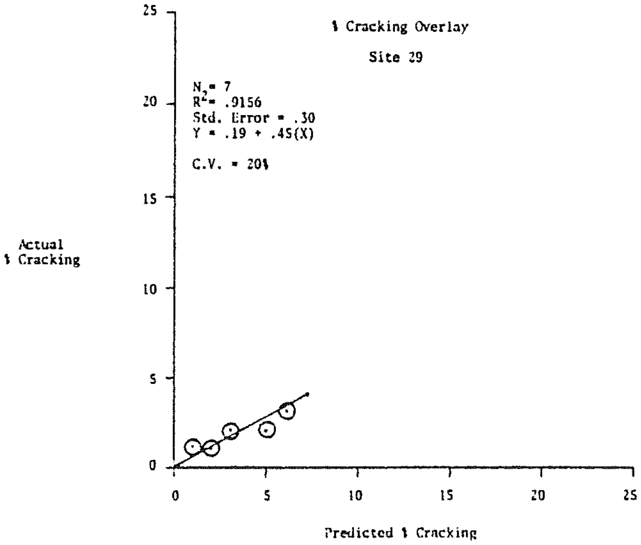

% Cracking Overlay
Site 18
N = 13
R^2 = .9351
Std. Error = .31
Y = -.21 + .48(X)
C.V. = 16%
Actual % Cracking
Predicted % Cracking
0
5
10
15
20
25

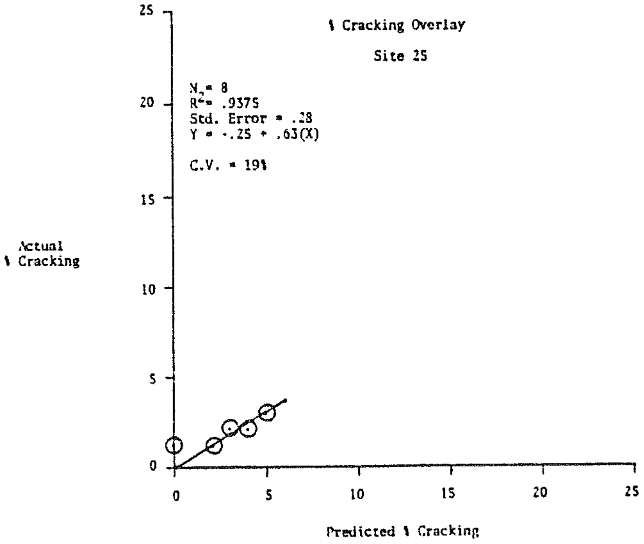

% Cracking Overlay
Site 22
N = 9
R^2 = .9116
Std. Error = .73
Y = -.50 + 1.6(X)
C.V. = 21%
Actual % Cracking
Predicted % Cracking
0
5
10
15
20
25


% Cracking Overlay
Site 23
N = 9
R^2 = .8800
Std. Error = 1.06
Y = .34 + 4.18(X)
C.V. = 27%
Actual
% Cracking
Predicted % Cracking
0
5
10
15
20
25
0
5
10
15
20
25


% Cracking Overlay
Site 27
N = 8
R^2 = .9643
Std. Error = .55
Y = -.52 + 1.24(X)
C.V. = 14%
Actual
% Cracking
Predicted % Cracking
0
5
10
15
20
25
0
5
10
15
20
25


% Cracking Overlay
Site 24
N = 9
R^2 = .9242
Std. Error = .58
Y = .09 + 1.22(X)
C.V. = 19%
Actual
% Cracking
Predicted % Cracking
0
5
10
15
20
25
0
5
10
15
20
25


% Cracking Overlay
Site 29
N = 7
R^2 = .9156
Std. Error = .30
Y = .19 + .45(X)
C.V. = 20%
Actual
% Cracking
Predicted % Cracking
0
5
10
15
20
25
0
5
10
15
20
25


% Cracking Overlay
Site 25
N = 8
R^2 = .9375
Std. Error = .28
Y = -.25 + .63(X)
C.V. = 19%
Actual
% Cracking
Predicted % Cracking
0
5
10
15
20
25
0
5
10
15
20
25

APPENDIX F

Heater Scarification and Asphalt Rubber Data and Correlations for Case 1 and 2 Overlays.

Heater Scarification Data

Site 1

US 60 MP 60 Region = 5.0
5.0" ACFC ADT = 1990
1.2" AC

Year	Ride	% Cracking
1976	54	0
1977	109	0
1978	86	0
1979	68	0

Site 2

US 60 MP 220 Region = 1.9
.7" ACFC ADT = 8700

Year	Ride	% Cracking
1974	72	0
1975	56	0
1976	74	0
1977	61	0
1978	118	0
1979	88	0

Site 3

US 60 WB MP 159 Region = 1.0
.7" ACFC ACT = 39,000

Year	Ride	% Cracking
1971	50	0
1972	65	0
1973	83	3
1974	108	5
1975	113	7
1976	89	9
1977	94	11
1978	156	13
1979	135	15

Site 4

US 60 MP 197 Region = 1.3
.7" ACFC ADT = 3000

Year	Ride	% Cracking
1976	53	0
1977	70	0
1978	110	1
1979	112	2

Site 5

US 95 MP 144 Region = .6
.5" ACFC ACT = 3000

Year	Ride	% Cracking
1973	49	0
1974	46	0
1975	53	0
1976	43	0
1977	36	0
1978	92	1
1979	60	1

Site 6

S 260 MP 254 Regions = 3.6
1.5"AC ADT = 4500

Year	Ride	% Cracking
1974	76	0
1975	65	0
1976	77	0
1977	115	0
1978	87	0
1979	109	0

Heater Scarification Data

Site 7

I 40 MP 263 WB
.5" ACFC
3.0" AC

Region = 1.7
ADT = 14,000

Year	Ride	% Cracking
1972	11	0
1973	30	0
1974	41	0
1975	42	1
1976	45	1
1977	62	1
1978	85	2
1979	78	2

Asphalt Rubber Data

Site 1

S 87 MP 244
.5" ACFC
2.0" AC

Region = 3.0
ADT = 7500

Year	Ride	% Cracking
1977	49	0
1978	48	0
1979		0

Site 2

U 666 MP 322
2.5" AC

Region = 2.1
ADT = 1500

Year	Ride	% Cracking
1977	128	0
1978	124	0
1979	114	0

Site 3

U 89 MP 479
2.8"AC

Region = 1.5
ADT = 5300

Year	Ride	% Cracking
1976	108	0
1977	123	0
1978	128	0
1979	152	0

Site 4

I 40 MP 323 EB
.5" ACFC
3.0" AC

Region = 1.8
ADT = 9400

Year	Ride	% Cracking
1975	49	0
1976	55	0
1977	109	0
1978	80	0
1979	92	0

Site 5

I 40 MP 325 WB
.5"ACFC
3.0"AC

Region = 1.9
ADT = 9400

Year	Ride	% Cracking
1975	24	0
1976	35	0
1977	97	0
1978	43	0
1979	53	0

Site 6

I 40 MP 357 WB
.5"ACFC
3.1"AC

Region = 2.2
ADT = 9000

Year	Ride	% Cracking
1975	80	0
1976	48	0
1977	122	0
1978	58	0
1979	58	0

Asphalt Rubber Data

Site 7

US 180 MP 230
2.5" AC

Region = 3.9
ADT = 1900

Year	Ride	% Cracking
1976	74	0
1977	81	0
1978	105	0
1979	107	0

Case 1

Correlations

Heater Scarification

Ride

Site	N	R^2	Std. Error	A	B	C.V.
1	4	.0068	20.7	63.0	.29	25%
2	6	.3643	16.4	19.4	.83	19
3	9	.7184	16.6	- 20.1	1.61	16
4	4	.9067	7.8	-127.1	3.62	10
5	7	.2258	14.8	5.7	.75	23
6	6	.5268	12.4	51.0	.35	14
7	8	.9186	6.6	- 42.3	1.18	14
$\bar{x}$		.5239	13.6	- 7.2	1.23	17
		.3468	5.0	64.5	1.15	5

Heater Scarification
% Cracking

Site	N	R^2	Std. Error	A	B	C.V.
1	4	-	-	-	-	-
2	6	.9728	.5	- .4	1.57	13%
3	9	.9813	.7	.9	1.48	9
4	-	--	-	-	-	-
5	7	.7835	.2	.8	.18	20
6	-	--	-	-	-	-
7	8	.8596	.3	- .02	.55	30
$\bar{x}$		.8993	.4	.32	.95	18
		.0950	.2	.63	.69	9

Case 2

Correlation Between Predicted Future Ride in Years 1-5 Based on A Measured Now.

Heater Scarification

Ride

Future Year Ride Predicted	N	R^2	Std. Error	A	B	C.V.
1	36	.4000	23.0	32.7	.58	25
2	29	.3145	24.7	40.0	.53	26
3	22	.4737	22.7	28.2	.65	24
4	15	.5698	20.3	30.1	.61	21
5	10	.4865	20.6	46.9	.48	19
$\bar{x}$	22.4	.4489	22.3	35.6	.57	23
	10.5	.0963	1.8	7.8	.07	3

Case 2

Correlation Between Predicted Future Cracking In Years 1-4 Based On A Measured Cracking Now.

Heater Scarification

Cracking

Future Year Cracking Predicted	N	R^2	Std. Error	A	B	C.V.
1	35	.9796	.6	.1	1.0	8
2	29	.9563	.9	- .6	1.1	12
3	21	.9244	1.3	-1.0	1.1	17
4	14	.8425	2.0	-1.3	1.1	27
$\bar{x}$	25	.9257	1.2	- .7	1.1	16
	9	.0599	.6	.6	.1	8

Case 1

Asphalt Rubber

Ride

Site	N	R^2	Error	A	B	C.V.
1	2	--	-	-	-	--
2	3	.9888	.6	162.4	- .68	1%
3	4	.9377	4.0	- 7.0	2.28	3
4	5	.4878	16.0	- 24.5	1.59	20
5	5	.1185	24.0	- 2.3	.82	40
6	5	.0328	26.0	99.2	- .39	30
7	4	.9008	5.0	37.9	.58	5
		.5777	12.6	44.3	.70	17
		.4287	10.9	72.8	1.13	16

Asphalt Rubber

% Cracking

Site	N	R^2	Std. Error	A	B	C.V.
1	-	--	--	-	-	--
2	3	1.0000	.0	.0	1.0	0%
3	4	1.0000	.0	.0	1.0	0%
4	5	1.0000	.0	.0	1.0	0%
5	5	1.0000	.0	.0	1.0	0%
6	5	1.0000	.0	.0	1.0	0%
7	-	--	--	--	-	-
$\overline{x}$		1.0000	.0	.0	1.0	0%

Case 2

Correlation Between Predicted Future Ride In Years 1-3 Based On A Measured Now.

Asphalt Rubber

Future Year Ride Predicted	N	R^2	Error	A	B	C.V.
1	20	.2370	43.9	45.2	.47	47
2	14	.1491	28.4	60.9	.33	29
3	8	.5853	21.7	10.9	.79	22
$\bar{x}$	14	.3238	31.3	39.0	.53	33
	6	.2307	11.4	25.6	.24	13

Case 2

Correlation Between Predicted Future Cracking in Years 1-2 Based On a Measured Cracking Now.

Asphalt Rubber

Ride

Future Year Cracking Predicted	N	R^2	Std. Error	A	B	C.V.
1	23	1.000	0.0	0.0	1.0	0
2	17	1.000	0.0	0.0	1.0	0
$\bar{x}$		1.000	0.0	0.0	1.0	0
		0	0	0	0	0

APPENDIX G

PCCP Data For Regression, Data For Verification and Case 1 and 2 Correlation Results.

PCCP

Data For Regression 12 Locations Selected At Random

Location	Ride Now	Change In Ride	Location	Ride Now	Change In Ride
#1	146	1	#2	55	2
Region = 1.0	147	30	Region = 3.7	57	9
	177	38		66	32
	215	-19		108	-20
	196	33		88	13
	229	8		101	
	237	-24			
	213				

Location	Ride Now	Change In Ride	Location	Ride Now	Change In Ride
#3	180	57	#4	99	5
Region = 1.6	237	21	Region = 1.7	104	4
	258	20		108	26
	278	-43		134	2
	235	35		132	24
	270	17		156	- 5
	287	0		151	
	287				

Location	Ride Now	Change In Ride	Location	Ride Now	Change In Ride
#5	269	32	#6	195	23
Region = 1.0	301	68	Region = 1.0	218	19
	369	16		237	39
	385	- 8		276	-25
	377	26		251	44
	403	- 3		295	- 7
	400	-36		288	-49
	364			239	

PCCP

Data For Regression 12 Locations Selected At Random

Location	Ride Now	Change In Ride
#7	98	18
Region = 1.0	116	11
	127	32
	159	- 6
	153	48
	201	-36
	165	-25
	140	

Location	Ride Now	Change In Ride
#8	107	53
Region = 3.4	160	-14
	146	- 9
	137	

Location	Ride Now	Change In Ride
#9	85	82
Region = 3.1	167	- 5
	162	47
	209	-34
	175	33
	208	44
	252	-57
	195	

Location	Ride Now	Change In Ride
#10	124	23
Region = 1.0	147	-14
	133	22
	155	- 3
	152	

Location	Ride Now	Change In Ride
#11	67	55
Region = 3.1	122	0
	122	31
	153	-11
	142	26
	168	17
	185	- 8
	177	

Location	Ride Now	Change In Ride
#12	99	- 2
Region = 1.0	97	- 2
	95	13
	108	

PCCP Concrete

Verification Data

Site 1

I 40 MP 160 EB Region = 3.3

Year	Ride
1972	50
1973	64
1974	82
1975	99
1976	91
1977	113
1978	159
1979	134

Site 2

I 40 MP 296 EB Region = 3.1

Year	Ride
1969	89
1970	42
1971	44
1972	48
1973	108
1974	106
1975	160
1976	133
1977	175
1978	184
1979	216

Site 3

I 17 MP 202 NB Region = 1.0

Year	Ride
1958	40
1959	45
1960	62
1961	73
1962	86
1963	89
1964	95
1965	99
1966	109
1967	126
1968	151
1969	173
1970	193
1971	205
1972	220
1973	257
1974	313
1975	328
1976	331
1977	341
1978	343
1979	366

Site 4

I 10 MP 150 EB Region = 1.0

Year	Ride
1965	45
1966	59
1967	76
1968	89
1969	102
1970	126
1971	142
1972	158
1973	120
1974	191
1975	217
1976	169
1977	205
1978	220
1979	239

PCCP

Variation Data

Site 5

I 10 MP 257 EB   Region = 1.6

Year	Ride
1963	52
1964	61
1965	67
1966	79
1967	83
1968	87
1969	91
1970	106
1971	125
1972	169
1973	279
1974	271
1975	276
1976	237
1977	288
1978	291
1979	342

Site 6

I 19 MP 59   Region = 1.6

Year	Ride
1965	35
1966	51
1967	65
1968	83
1969	102
1970	143
1971	175
1972	198
1973	242
1974	250
1975	273
1976	245
1977	229
1978	237
1979	258

Case 1

PCCP - Ride

Site	N	R^2	Std. Error	A	B	C.V.
1	8	.8701	12.1	30.3	.45	12
2	11	.9378	15.3	- 4.8	.60	12
3	22	.9743	17.4	-12.7	.63	9
4	15	.9101	18.0	32.8	.52	13
5	17	.9027	31.0	- 2.1	.65	21
6	15	.8218	34.6	31.6	.61	24
$\overline{x}$		.9028	21.4	12.5	.58	15
		.0530	9.1	21.2	.08	6

Case 2

PCCP - Ride

Year	N	R^2	Std. Error	A	B	C.V.
1	42	.8522	31.2	11.4	.90	15
2	36	.8304	32.4	14.1	.84	14
3	30	.7526	38.2	19.8	.76	17
4	24	.8260	32.0	- 4.7	.77	14
5	19	.7473	44.8	14.6	.70	19
6	12	.7342	36.7	9.6	.71	15
$\overline{x}$		.7905	35.9	10.8	.78	16
		.0512	5.2	8.3	.08	2

PAVEMENT MANAGEMENT SYSTEM DATA BASE

By

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PMS Data Base Development

Since 1972 ADOT has collected over 240,000 records which represented the condition of the highway network in terms of ride, cracking, skid number, deflection, rutting and general distress. The purpose of this phase of the research was to develop a workable data base such that important pavement condition data could be stored and retrieved in a timely manner. To develop such a data base a committee representing Research Section, Materials Services and Information Systems Group (ISG) was formed. This committee adopted a decision matrix approach (Appendix A). The matrix consisted of mandatory and desirable attributes that the data base should posses. Four possible options were offered as candidate data base computer systems. These included:

- Information Management System (IMS)
- Physical Sequential
- Index Sequential
- Partition Organization

After lengthy meetings and a final vote it was decided that IMS could perform all mandatory functions and provided the largest number of desirable attributes (Appendix A).

After IMS was selected a detailed design was performed by ISG. Appendix B represents the computer design of the file. The IMS file was designed to be expandable since it is expected additional data sets will be added to it in the future. Originally the file contained five segments which later on was expanded to seven segments which include:

EA 0	Route Segment (location)
EA 1	Synthesized Data
EA 2	Common Data (Descriptive Design Information)
EA 3	Skid Raw Data (Mu Meter)
EA 4	Ride Raw Data (Mays Meter)
EA 5	Dynaflect Raw Data (Deflection)
EA 6	Cracking Raw Data
EA 7	Surface History (Layers, Date of Construction, Thickness, Type)

Such an IMS file is hierarchial in structure with the EA fields representing part of the structure. In the simplest sense an IMS file is a library where records are stored like books in a library. Thus by knowing the Route number, milepost and direction of a particular mile or consecutive miles of highway, it is possible to enter the data base library in the same manner as knowing a book shelf number, book number, chapter and page number. In this way through location keys or pointers (code numbers) the computer can go immediately to the record or pages of data requested without physically reading all sequential data in front of it, thus speeding up retrieval time. Besides data base structure numerous editing programs had to be written to test and validate the data. Those data that failed sensibility tests were kicked out and returned to Materials Services Pavement Evaluation Personnel to check and correct.

Besides edit programs various output programs were written. Both edit and output programs were written so that a cathode ray tube (CRT) and time sharing option (TSO) terminal could be used to execute the results. Appendix C contains the outputs that currently can be obtain via the CRT-TSO retrieval method. Generally engineers and/or technicians can make inquiries and receive results over the tube in less than two minutes. Two CRT-terminals and one fast printer were rented as part of this project and have been in use for over fours months. After some training from ISG several engineers and technicians are using the devices every working day of the week. It is estimated that before this innovation was acquired as part of this project at least two man days of effort was necessary for each individual inquiry. Thus it is conservatively estimated that the PMS file linked to TSO and CRT have saved already one man year of effort in only four months of use. In addition engineers and technicians are able to answer questions that previously they could not answer due to a lack of time.

The data base for PMS is in place, working and being used. This very important element of PMS has made it possible to do the network optimization and verification. The data base represents an evolutionary process. Appendix D shows an idealized PMS data base which should represent the long term goal. In the future new segments will probably be added, also additional output programs will be written and put into use within ADOT.

Appendix A

IMS
WHY CHOSEN?

A task force was intially formed to make recommendations for the PMS file structure. A decision matrix was developed listing "mandatory" and "desirable" features. Each of these was then weighed and IMS was the clear winner. (See attached PMS-DBMS Decision Matrix)

The reasons IMS was chosen as the data base software were several. Of importance was the fact that IMS was already in use in ADOT, both in on-line and batch environments and it supports a hierarchical file structure thereby, reducing data redundancy. The data structure can be changed and added to as required or as new tests and methods are adopted by the Department. Programming expertise was available for instructional purposes thereby shortening the time required to develop the necessary proficiency in a data base management system.

Should the need for an on-line system be developed in the future, conversion from a batch operation could be effected relatively easily.

IMS was chosen also, because it was felt that it would provide the best interface with existing and planned activities. Several different types of data were to be converted and the hierarchical segments allowed each type of data to be loaded individually, occupying no more space than was actually needed.

PMS - DBMS DECISION MATRIX

		OPTIONS							
		IMS		PHY. SEQ.		INDEX SEQ.		PARTIN'D ORG.	
- MANDATORIES -									
NO ADDITIONAL DBMS AT ADOT		YES		YES		YES		YES	
DISK RESIDENT		YES		YES		YES		YES	
DATA UPDATE AUDIT TRAIL		YES		YES		YES		YES	
TSO TERMINAL CASSETTE		YES		YES		YES		YES	
TRS REFERENCE POINT SYSTEM		YES		YES		YES		YES	
DATA BASE IN PLACE BY 07/01/79		YES		YES		YES		YES	
SECURITY		YES		YES		YES		YES	
- DESIRABLES (WEIGHT) -									
ALL SYNTHESIZED DATA ON 1 FILE	(10)	4	40	1	10	3	30	2	20
COMPATIBLE W/EXISTING SOFTWARE	(9)	1	9	4	36	2	18	3	2
MINIMAL REDUNDANCY	(8)	4	32	1	8	3	24	2	16
EASE OF REPORT WRITING	(8)	3	24	1	8	4	32	2	1
EASE OF FILE MAINTENANCE	(8)	4(3)	32	1	8	3(2)	24	2(4)	1
ACCESS TIME	(6)	3	18	1	6	4	24	2	12
EASE OF CONV/ENTRY OF EXIST. DATA	(6)	2	12	4	24	1	6	3	1
LOWEST COST - TIME/PERS. RESOURCE	(6)	3(2)	18	4	24	2(1)	12	1(3)	6
SUPPORT STRUCTURED PROGRAMMING	(4)	4	16	1	4	3	12	2	[illegible]
SECURITY	(4)	4	16	1	4	3	12	2	[illegible]
		217 (203)		132		194 (180)		147 (175)	

Appendix B

PAVEMENT MANAGEMENT SYSTEM
DATA BASE DESIGN

INFORMATION SYSTEMS GROUP
ENGINEERING SYSTEMS SECTION

MARCH 1980

DATA BASE DESCRIPTION STANDARDS

The PMS Data Base is a collection of fixed length data elements, called 'segments', arranged in a two level hierarchical structure relating to a single occurrence of a parent segment, the highway name. It is a single physical IMS/VS data base utilizing HIDAM storage organization methods whereby an indexed sequential file is used to index to the data base records stored in a sequential file. A sequential overflow file is also utilized. The following standards were selected for naming and detailing conversions.

The official PMS data base name is 'EA' which is assigned when the DBDGEN is performed.

The PMS data base consists of eight segment types, the parent segment (EA0) and seven child segments (EA1 - EA7). These names are also assigned with the DBDGEN. In addition, each segment also has a name such as ROUTE, SYNTHESIZED, etc., which is descriptive of the content.

The field names do not follow any special convention other than the DL/I field naming rules which permit from one to eight alphanumeric characters with the first character alphabetic. No special characters and no embedded blanks are permitted. Within these restrictions the attempt was made to assign field names that are descriptive of the contents.

Identical field names may be found in more than one segment. However, if such is the case, the fields will have exactly the same meaning, format, and field length.

The following data base description consists of an illustration of the hierarchical structure of the data base followed by segment descriptions and field names.

The segment descriptions have the following heading:

1) SEGMENT NAME = Official name (Descriptive name)
2) PARENT SEGMENT = Parent segment name or 0
3) LOGICAL PARENT SEGMENT = Logical parent segment name (if applicable)
4) LENGTH = n BYTES
5) SEQUENCE FIELD NAME = Field name ¢,U or M` or NONE
6) ESTIMATED FREQUENCY = n
7) PHYSICAL SOURCE = Source segment name (used only in logical data bases)

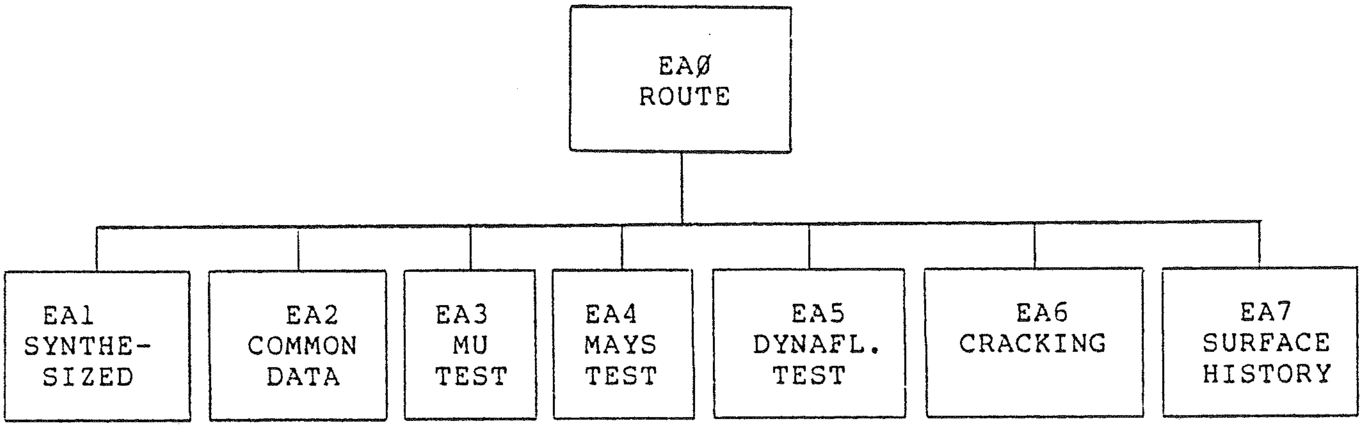
The first item is self-explanatory. In the second item, a 0 is used only if the particular segment is a root segment which, by definition, has no parent. This third item is found only in segments which are logical child segments in a DL/I logical relationship between two segments. The fourth item is self-explanatory. In the fifth item, if the segment has no sequence field, the word 'NONE' is used. If there is a sequence field, the field name is given followed by a comma and then either a 'U' or an 'M'. 'U' indicates that the segment will have only unique values in the sequence field. 'M' indicates that there may be multiple values of the sequence field. The <u>sixth item</u>, ESTIMATED FREQUENCY, is an estimate of the average number of occurrences of the segment being described for each occurrence of its parent segment. If the segment being described is a root segment, this item is an estimate of the total number of root segment occurrences in the data base.

The heading is followed by a tabulation of the field names in the segment in a format from which the segment structure can be inferred. This tabulation is similar to a PL/I data structure declaration. The level number, field name, starting position in the segment, length of the field in bytes and field type are given. So far as field type is concerned the following convention is used:

G - Group item
C - EBCDIC character
Z - Zoned decimal
B - Fullword binary
H - Halfword binary
P - Packed decimal
X - Hexadecimal (includes unsigned binary)
F - Fullword floating point
D - Double word floating point
A - Alphabetic

A group item (G) is one which has elementary items or subfields below it in the segment structure. A field will be declared zoned decimal (Z) if it can have only numeric values (blanks not allowed) and it will be right justified and zero-filled if the value does not fill the field. Binary fields (B and H) mean signed binary whereas if a field uses two bytes with all 16 bits participating in the unsigned value, it will be declared hexadecimal (H). Alphabetic fields (A) will contain only letters or blanks. All other data types are self-explanatory.

PMS EA DATA BASE



DATA BASE NAME EA (PMS)

SEGMENT NAME	=	EA0	EA1	EA2	EA3	EA4	EA5	EA6	EA7
PARENT SEGMENT	=	0	EA0	EA0	EA0	EA0	EA0	EA0	EA0
LENGTH	=	16	70	17	23	36	53	25	75
SEQUENCE FIELD NAME	=	ROUTENAM,U*	*	*	*	*	*	*	*
ESTIMATED FREQUENCY (K = THOUSANDS)	=	200	70K	15K	70K	70K	210K	70K	70K

		*KEY NAME	KEY LENGTH		TOTAL LENGTH
EA0	ROUTE	ROUTENAM	(14)	(14 ROUTE NAME)	16
EA1	SYNTHESIZED	SYNKEY	(5)	(2 YEAR, 3 MILEPOST)	70
EA2	COMMON DATA	COMKEY	(11)	(2 YEAR, 2 CODE, 5 MILEPOST, 2 MONTH)	17
EA3	MU TEST	MUKEY	(8)	(2 YEAR, 5 MILEPOST, 1 DIRECTION)	23
EA4	MAYS TEST	MAYSKEY	(13)	(2 YEAR, 5 MILEPOST FROM, 5 MILEPOST TO, 1 DIRECTION)	36
EA5	DYNAFLECT TEST	DYNAKEY	(8)	(2 YEAR, 5 MILEPOST, 1 DIRECTION)	53
EA6	CRACKING	CRKKEY	(8)	(2 YEAR, 5 MILEPOST, 1 LANE DIR.)	25
EA7	SURFACE HIST.	SURFKEY	(7)	(3 MILEPOST, 2 YEAR, 2 MONTH)	75

SEGMENT NAME EA0 (ROUTE)
PARENT SEGMENT NAME = 0
LENGTH = 16
SEQUENCE FIELD NAME = ROUTENAM, U
ESTIMATED FREQUENCY = 200

FIELD LEVEL	FIELD NAME	START	BYTES	FIELD TYPE
1	ROUTENAM	1	14	G
2	ROUTE	1	6	G
3	TYPE	1	1	C
3	PREFIX	2	1	C
3	ROUTENO	3	4	C
2	AUXMARK	7	5	G
3	MARKER	7	3	C
3	LETTER	10	1	C
3	TISEQ	11	1	C
2	CONNMOVE	12	1	C
2	ROADWAY	13	1	C
2	QUAL	14	1	C
1	DIV_FLG	15	1	C
1	DIR_FLG	16	1	C

EA0: FIELD DEFINITIONS FOR ROUTE SEGMENT (ROOT SEGMENT)

TYPE	I - Interstate Highway S - State Route U - U.S. Highway
PREFIX	A - Alternate B - Business L - Loop S - Spur T - Truck X - Temporary Y - Wye Leg b̸ - None of the above (i.e., regular route)
ROUTENO	This field contains the highway route number. The number is right justified within the field with the leading zeroes. For example, Interstate 8 is carried in this field as '0008'.
MARKER	This field contains the mileage part of the identifier which is marked on the milepost in the field (the number is zero filled to three digits if it is less than 100).
LETTER	This field contains the alphabetic character marked on the milepost on the auxiliary road in the field. This letter serves to distinguish the various ramps, loops, and crossroads at a traffic interchange.
TISEQ	This field contains the traffic interchange sequence number if one is marked on the auxiliary road milepost. Otherwise this field contains a blank. A traffic interchange sequence number serves to distinguish two (or more) traffic interchanges located within the same mile section.
CONMOVE	This field is blank except for those stretches of auxiliary roads (generally ramps in a complex interchange) which are reached through certain movements at forks. The values have the following meaning where the directions indicate the choice that is made at the fork: 0 - Right 1 - Left 2 - Right Right 3 - Left Left 4 - Right Left 5 - Left Right Connecting movements are not signed in the field as are the auxiliary roads from which they branch.

ROADWAY	This field is used to distinguish between portions of roads, frontage roads, and other auxiliary roads: b̸ - Mainline undivided or "Positive Roadway" of divided road 0 - Mainline "Negative Roadway" of divided road 1 - Frontage Road "On the Right" 2 - Frontage Road "On the Left" 3 - Other Auxiliary Roads not identified by AUXMARK field NOTE: The terms "On the Right" and "On the Left" refer to the side of mainline when facing in the positive direction defined for the mainline. Positive direction is defined as the direction of increasing milepost values.
QUAL	This field is blank for all mainline roads, frontage roads, and auxiliary roads defined uniquely by JURIS, ROADNAME, and ROADWAY fields. QUAL contains 1 to 9 if a qualifier is needed to distinguish between two roads having the same JURIS, ROADNAME, and ROADWAY.
DIV_FLG	This field is used to distinguish divided highway types as follows: b̸ - totally divided highway 0 - totally non-divided highway 1 - partially divided highway
DIR_FLG	This field is used to distinguish direction exceptions. These are routes which have mileposts increasing to the south or west. b̸ - no direction exception 0 - total direction exception 1 - partial direction exception

SEGMENT NAME = EA1 (SYNTHESIZED)
PARENT SEGMENT NAME = EA0
LENGTH = 70
SEQUENCE FIELD NAME = SYNKEY
ESTIMATED FREQUENCY = 70,000

FIELD LEVEL	FIELD NAME	START	BYTES	FIELD TYPE
1	SYNKEY	1	5	G
2	YEAR	1	2	C
2	MARKER	3	3	C
1	DISTTOMP	6	3	C
1	MAINTCST (PECOS)	9	5	C
1	SYNDATA	14	37	G
2	RIDE	14	3	C
2	RIDEMO	17	2	C
2	DEFLECT	19	3	C
2	DEFLMO	22	2	C
2	CRACK	24	2	C
2	CRACKMO	26	2	C
2	CRACKCHG	28	2	C
2	RUT	30	3	C
2	RUTMO	33	2	C
2	COND	35	3	C
2	CONDMO	38	2	C
2	SKID	40	2	C
2	SKIDMO	42	2	C
2	REGION	44	2	C
2	ADT	46	5	C
1	RDWY_WIDTH	51	2	C
1	SHLDR_WIDTH	53	2	C
1	DES_LIFE	55	3	C
1	CATAGORY	58	6	C
1	WILDFLD	64	7	C

EA1 - FIELD DEFINITIONS FOR SYNTHESIZED DATA

YEAR		Year test was performed.
MARKER		Test location to the nearest lower M/P
DISTTOMP		Distance between milepost markers
MAINTCST		Maintenance cost per mile for corresponding year (PeCOS)
RIDE		Calculated Ride Index (Index of 0 to 5)
RIDEMO	*	Month of ride test
DEFLECT		Adjusted Dynaflect deflection in MILS
DEFLMO	*	Month of Dynaflect Test
CRACK		Representative percent cracking for test mile
CRACKMO	*	Month of evaluation
CRACKCHG		Change in percent cracking from previous year
RUT		Representative Rut depth (in inches)
RUTMO	*	Month of evaluation
COND		General Overall Cond Rating (Index of 1 to 5)
CONDMO	*	Month of evaluation
SKID		Average Skid Index for Mile (Index of 0 to 100)
SKIDMO	*	Month of Skid Test
REGION		Regional factor
ADT		Average daily traffic
RDWY_WIDTH		Total of driving lane widths for roadway (in feet)
SHLDR_WIDTH		Total of shoulder widths (in feet)
DES_LIFE		Design life of last rehabilitation action
CATAGORY		Highway catagory based on average daily traffic, regional factor, design life, ride index, percent cracking, change in % cracking.
WILDFLD		This field will contain sort fields and other attributes to be defined later.

* If the test was performed during the current year, this field contains the month of test. If the test was performed during a previous year, the field contains the year of the test.

SEGMENT NAME = EA2 (COMMON DATA)
PARENT SEGMENT NAME = EA0
LENGTH = 17
SEQUENCE FIELD NAME = COMKEY
ESTIMATED FREQUENCY = 15,000

FIELD LEVEL	FIELD NAME	START	BYTES	FIELD TYPE
1	COMKEY	1	11	G
2	YEAR	1	2	C
2	CODE	3	2	C
2	MRKR	5	5	C
2	MO	10	2	C

TABLE OF CODES

CODE	NAME	JUST.	TYPE	SIZE
01	ENGINEERING DISTRICT	R	Ƶ	X
02	ADT	R	Ƶ	XXXXX
03	ADL	R	Ƶ	XXXX
05	REGIONAL FACTOR	R	Ƶ	XX
04	GROWTH FACTOR	R	Ƶ	XX.X
06	# LANES	R	Ƶ	X
07	WIDTH	R	Ƶ	XXXXXX
08	YR OF LAST ACTION	R	Ƶ	XX
09	ACTIVITY TYPE	R	Ƶ	XX
10	NOT USED	-	-	-
11	SOIL SUPPORT	R	Ƶ	X.X
12	COUNTY	R	Ƶ	XX
21 TO 40	PECOS INTERFACE*	R	Ƶ	XX

* PeCos Interface
The items under the various PMS Codes/PeCos Activity codes represent the yearly surface maintenance cost per mile.

CODE	PECOS ACTIVITY	
21	101	Hand Patch with Premix
22	102	Level with Premix
23	103	Fill Cracks
24	104	Spot Seal Patching
25	105	Surface/Base Replacement
26	106	Seal Coating (Major)
27	107	Seal Coating (Minor)
28	108	Flush Coating
29	109	Spot Flush Coating
30-38	110-118	Reserved for Future Extension
39	119	Other Paved Surface Maintenance
40	700-709	Non-Routine Surface Maintenance

EA2 - GENERAL DESCRIPTION

This segment contains pertinent common data for a milepost, and will appear in the data base only upon change of said data. Each segment contains only one (1) common attribute defined by its code number (From 1 to 13) definition of codes is found in table EA2-1.

FIELD DEFINITIONS FOR COMMON DATA

YEAR	Year test was performed.
CODE	Attribute Code
MRKR	Test location to the nearest .01 of mile
MO	Month test was performed.
VALUE	Value of the attribute

TABLE EA2-1

CODE	ATTRIBUTE DEFINITION
01	Engineering District pertinent to mile post
02	Average Daily Traffic (Count)
03	Average Daily Loading (18 KIP)
04	ADT and ADL growth factor per year in percent
05	Regional Factor
06	No. of Lanes
07	Roadway Width
08	Yr. of last rehabilitation action
09	Type of rehabilitation
10	Not used
11	Structural quality of subgrade material (Soil Support Value)
12	County code

SEGMENT NAME - EA3 (MU TEST)
PARENT SEGMENT NAME = EA0
LENGTH = 23
SEQUENCE FIELD NAME = MUKEY
ESTIMATED FREQUENCY = 70,000

FIELD LEVEL	FIELD NAME	START	BYTES	FIELD TYPE
1	MUKEY	1	8	G
2	YEAR	1	2	C
2	MRKR	3	5	C
2	LANEDIR	8	1	C
1	TESTDATA	9	15	G
2	HIMU	9	2	C
2	LOMU	11	2	C
2	AVMU	13	2	C
2	MUDAT	15	4	G
3	MUMO	15	2	C
3	MUDAY	17	2	C
2	MUSPEED	19	2	C
2	LANENO	21	1	C
2	REMARKS	22	2	C

EA3 - FIELD DEFINITION FOR MU-METER TEST DATA

YEAR	Year test was performed
MRKR	Test location to the nearest .01 of mile
LANEDIR	Lane direction, relative to cardinal route direction to which the data is applicable
HIMU	Highest singular value at this test location
LOMU	Lowest singular value at this test location
AVMU	Average MU-Meter value for this test location
MUMO	Month of MU-Meter test
MUDAY	Day of MU-Meter test
MUSPEED	Test vehicle speed at time of test
LANENO	Lane number of test
REMARKS	Code

SEGMENT NAME = EA4 (MAYS TEST)
PARENT SEGMENT NAME = EA0
LENGTH = 36
SEQUENCE FIELD NAME = MAYSKEY
ESTIMATED FREQUENCY = 70,000

FIELD LEVEL	FIELD NAME	START	BYTES	FIELD TYPE
1	MAYSKEY	1	13	G
2	YEAR	1	2	C
2	MRKRFM	3	5	C
2	MRKRTO	8	5	C
2	LANEDIR	13	1	C
1	TESTDATA	14	23	G
2	TOTLEN	14	3	C
2	MAYSPEED	17	2	C
2	MAYDAT	19	4	G
3	MAYMO	19	2	C
3	MAYDAY	21	2	C
2	ROUGHIN	23	4	C
2	ROUGHEX	27	4	C
2	ODOEX	31	3	C
2	LANENO	34	1	C
2	REMARKS	35	2	C

EA4 FIELD DEFINITION FOR MAYS METER TEST DATA

YEAR	Year test was performed
MRKRFM	Beginning of test - location to the nearest .01 of mile
MRKRTO	End of test - location to nearest .01 of mile
LANEDIR	Lane direction, relative to cardinal route direction, to which the data is applicable
TOTLEN	Total odometer length (1/20 of mile)
MAYSPEED	Test vehicle speed at time of test
MAYMO	Month of Mays test
MAYDAY	Day of Mays test
ROUGHIN	Total inches of chart paper generated over test Location
ROUGHEX	Exceptional road conditions effecting roughness

	(Examples: Railroad tracks, cattle guards, etc.) to be subtracted from total inches of chart paper.
ODOEX	Exceptions to total odometer length resulting from exceptional road conditions.
LANENO	Lane number of test.
REMARKS	Code

SEGMENT NAME = EA5 (DYNAFLECT TEST)
PARENT SEGMENT NAME = EA0
LENGTH = 53
SEQUENCE FIELD NAME = DYNAKEY
ESTIMATED FREQUENCY = 210,000

FIELD LEVEL	FIELD NAME	START	BYTES	FIELD TYPE
1	DYNAKEY	1	8	G
2	YEAR	1	2	C
2	MRKR	3	5	C
2	LANEDIR	8	1	C
1	TESTDATA	9	41	G
2	SENS1	9	4	G
3	READING	9	2	C
3	MULT	11	2	C
2	SENS2	13	4	G
3	READING	13	2	C
3	MULT	15	2	C
2	SENS3	17	4	G
3	READING	17	2	C
3	MULT	19	2	C
2	SENS4	21	4	G
3	READING	21	2	C
3	MULT	23	2	C
2	SENS5	25	4	G
3	READING	25	2	C
3	MULT	27	2	C
2	DYNADATE	29	4	G
3	DYNAMO	29	2	C
3	DYNADAY	31	2	C
2	TEMPAIR	33	3	C
2	TEMPSURF	36	3	C
2	LANENO	39	1	C
2	PCTCRK	40	2	C
2	PCTPTCH	42	2	C
2	TPCRK	44	1	C
2	FLUSH	45	1	C
2	SEASFACT	46	2	C
2	REMARKA	48	2	C
2	ACTHK	50	4	C

EA5 FIELD DEFINITION FOR DYNAFLECT TEST DATA

YEAR	Year test was performed
MRKR	Test location to nearest .01 of mile

LANEDIR	Lane direction, relative to cardinal route direction to which the data is applicable
SENS1	Deflection at Sensor 1 Reading X.X, Multiplier X.X
SENS2	Deflection at Sensor 2 Reading X.X, Multiplier X.X
SENS3	Deflection at Sensor 3 Reading X.X, Multiplier X.X
SENS4	Deflection at Sensor 4 Reading X.X, Multiplier X.X
SENS5	Deflection at Sensor 5 Reading X.X, Multiplier X.X
DYNAMO	Month of Dynaflect test
DYNADAY	Day of Dynaflect test
TEMPAIR	Average 5 day air temperature at time of test
TEMPSURF	Roadway surface temperature at time of test
LANENO	Lane number of test
PCTCRK	Percent cracking
PCTPTCH	Percent patching
TPCRK	Type cracking code
FLUSH	Flush coat code
SEASFACT	Seasonal factor
REMARKS	Code
ACTHK	Total asphaltic concrete thickness (in inches)

SEGMENT NAME = EA6 (CRACKING)
PARENT SEGMENT NAME = EA0
LENGTH = 25
SEQUENCE FIELD NAME = CRKKEY
ESTIMATED FREQUENCY = 70,000

FIELD LEVEL	FIELD NAME	START	BYTES	FIELD TYPE
1	CRKKEY	1	8	G
2	YEAR	1	2	C
2	MRKR	3	5	C
2	LANEDIR	8	1	C
1	TESTDATA	9	9	G
2	PCT_CRK	9	2	C
2	CODE	11	2	C
2	PCT_PATCH	13	2	C
2	FLUSH	15	2	C
2	LANENO	17	1	C
1	DATE	18	4	G
2	MO	18	2	C
2	DAY	20	2	C
1	WILD	22	4	C

EA6 FIELD DEFINITION FOR CRACKING DATA

YEAR	Year survey was completed.
MRKR	Test location to nearest .01 of mile.
LANEDIR	Lane direction, relative to cardinal route direction to which the data is applicable.
PCT_CRK	Percent cracking from condition survey.
FLUSH	Flush coat code.
LANENO	Lane number where condition survey was taken.
MO	Month of condition survey.
DAY	Day of condition survey.
WILD	This field will contain data to be defined later.

SEGMENT NAME = EA7 (SURFACE HISTORY)
PARENT SEGMENT NAME = EA0
LENGTH = 75
SEQUENCE FIELD NAME = SURFKEY
ESTIMATED FREQUENCY = 70,000

FIELD LEVEL	FIELD NAME	START	BYTES	FIELD TYPE
1	SURFKEY	1	7	G
2	MARKER	1	3	C
2	YEAR	4	2	C
2	MO	6	2	C
1	SURFDATA (5) *	8	65	G
2	LIFT	8,21,34,47,60	2	C
2	TYPE	10,23,36,49,62	2	C
2	MAT_CODE	12,25,38,51,64	3	C
2	GEOM_CODE	15,28,41,54,67	3	C
2	THICK	18,31,44,57,70	3	C
1	WILD	73	3	C

* For more than five lifts an additional segment is used with '99' in the month (MO) Field.

EA7 FIELD DEFINITION FOR SURFACE HISTORY DATA

MARKER	Test location to the nearest lower M/P.
YEAR	Year of lift placement.
MO	Month of lift placement.
LIFT	Lift number.
TYPE	Material type code.
MAT_CODE	Code reflecting material quality
GEOM_CODE	Geometric highway cross-section code.
THICK	Total thickness of lifts.
WILD	This field will contain data to be defined later.

Appendix C

ON-LINE ACCESS TO PMS DATA BASE

1. GENERAL:

The PMS data base contains about 300,000 records, of available information for every lane-mile of state highway in Arizona, collected from 1972 to present.

Various batch programs enable the user to access any desired data/data groups selected by route name, direction, beginning and ending milepost. Turnaround time ranges from one hour to one day, depending upon the amount of data retrieved and the job mix in the computer at execution time.

The work of the maintenance and design engineers, high level management, law enforcement, maintenance crew foreman, contractors, etc. often has to be support by immediate access to pavement data. In response to the need, ADOT ISG developed TSO* on-line access programs for the most often used pavement parameters.

The user enters his request in conversational mode via a TSO (CRT or hard copy) terminal. After program execution concludes, the computer flashes back the requested data to the terminal with an average delay of 60 seconds.

---

* TSO - Time Sharing Option is an extension of the IBM VS2 1.7K operating system. It provides interactive access to the computer from CRT or hard copy terminal.

2. SYSTEM DESCRIPTION:

For each type of access request a TSO command, with the corresponding command procedure (CLIST), was added to the master library.

If the user requests TSO access to the data base by using one of the available commands, an interactive link is established through TCAM (Telecommunication Access Method). Route name, direction, beginning and ending milepost of the road section of interest and any other recorded parameters are entered via TCAM. Upon completion of the conversation, the command procedure invokes the execution of our on-line PL/1 program, which reads the entered data through BSAM (Basic Sequential Access Method).

This program prepares the necessary data base search parameters and issues DL/1 (Data Language/1) commands which convert the search parameters to the data base address of the requested data.

The DL/1 calls are part of the IMS (Information Management System) which, through the Data Base Description module and Program Specification Block, executes the search and retrieval of the requested data. Retrieved data, after the completion of the call, is passed to the PL/1 program which sorts/edits all collected information and then, through TCAM, transmits and displays the results at the requesting terminal.

Since the IMS Supervisory Calls (SVC) are not available in TSO or the PL/1 OS environment, an appropriate linkage was employed to create a DL/1 / PL/1 load module, which if loaded into the user's TSO region (512K bytes), provides the bridge between the various systems and access methods and creates common accessible data storage.

The system executes 100 calls (hundred requested data items or data strings) in less than 1 CPU (Central Processor Unit) second. Thus this method of retrieval for large amounts of coherent data is more efficient than the IMS on-line system, which retrieves one data item in .3 CPU second.

3. OPERATION OF THE ACCESS SYSTEM:

The internal sophistication of the system is totally transparent to the user. The human-computer interface is extremely simple.

After signing on, the appropriate command (See attached User's Guides) initiates conversational mode, which instructs the user regarding the data entry. For more skilled users, a fast data entry option is available, which bypasses the prompted entry.

To insure paging of the tabulated results, the program instructs the user to clear the screen at the beginning of the data retrieval. Subsequent paging is automatic. The pages may be printed on an attached printer, or recalled on the screen if necessary.

For convenience an on-line statistical evaluation program is also available.

For detailed operation and examples, see attached User's Guides.

The data base is accessible through dial-up terminals from any point within the USA.

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USER GUIDE TO
TSO ACCESS OF PMS DATA BASE

PURPOSE:

This guide describes the use of TSO commands, which generate on-line reports of pavement performance from the PMS data base. The reports display on a CRT screen or hard copy terminal all available data for the period 1972 to 1980. The user requests the route number and specifies the beginning and ending mileposts. The commands access:

1. Mu-Meter Data - Average Skid Number
2. Mays Meter Data- Exception corrected and prorated roughness
3. Dynaflect Data - Road Structure Test (Average of Dynaflect Sensor #1 times Multiplier #1 for the first 3 tests within each mile)
4. Cracking Data - Percent Cracking (For Years 1972 through 1980)

OPERATION:

The commands work either in Direct-Entry Mode, or Prompting Mode. The Prompting Mode is easier to use because the procedure inquiries the user for required information. However, with some experience, the Direct-Entry Mode will probably be preferred because it is faster.

PROMPTING MODE:

1. Type in the command for the desired report:
    GETMU - Mu Meter Data (Average Skid Number)
    GETMY - Mays Meter Data (Corrected Roughness)
    GETDY - Dynaflect Test (Road Structure Test)
    GETCK - Cracking Data (Percent Cracking)

2. The system responds with:
    ENTER POSITIONAL PARAMETER RTNAME

3. Type in the route name. The route name must be four (4) characters in length with padded zeros if required. (Example: I008, S085)

4. The system will respond with:
    ENTER POSITIONAL PARAMETER DIR

5. Type in the direction desired. (1 character)
    N - Northbound
    S - Southbound
    E - Eastbound
    W - Westbound

6. The system will then separately request parameters BEGMP and ENDMP. Each of these parameters is three (3) characters in length, and must be padded with zeros if necessary. (Example: 000 for milepost 0, 007 for milepost 7, 012 for milepost 12, etc.)

DIRECT-ENTRY MODE:

To use Direct-Entry Mode enter the name of the desired report and each of the required parameters as described under Prompting Mode. Each parameter must be separated by a blank and must be padded with zeros if necessary to provide the required number of characters.

Examples:

RTNAME (4 CHAR)
DIR (1 CHAR)
BEGMP (3 CHAR)
ENDMP (3 CHAR)

```
GETMU I010 E 080 110
GETMY S087 N 115 135
GETDY I008 E 000 025
GETCK I040 W 325 340
```

NOTE: For example, if a report is desired for Route U89A or for S10B, the Direct-Entry Mode is mandatory. The entry for a request of this type is as follows:

```
GETMY U089 N 320 340 QUAL(A)
GETMU S010 W 250 260 QUAL(B)
```

That is, the route prefix (Alternate - 'A', Business - 'B', etc.) is inserted as the QUAL( ) entry.

STATISTICAL EVALUATION:

The user may request statistical evaluation of the data with PARSTAT command immediately after the completion of a report described above.

Example:

```
GETDY I040 E 000 030
  After GETDY completes running, enter:
PARSTAT
```

The command will respond on CRT or on hard copy terminal with histograms and statistical analysis of the Dynaflect data specified by the GETDY command. Each year appears on a separate screen page.

USER GUIDE TO

TSO ACCESS OF PMS DATA BASE

EXCEPTION REPORT

PURPOSE:

This guide describes how to use the TSO command GETEX, which provides a Data Exception Report on the synthesized data of the PMS data base. The data items checked by this procedure are:

1.	Calculated Ride Index	RIN
2.	Representative Percent Cracking	CRK
3.	Average Skid Index	SKD
4.	Maintenance Cost	MCST
5.	Adjusted Dynaflect Deflection	DEFL

OPERATION:

This procedure can be operated in either Prompting Mode or Direct-Entry Mode. To execute the procedure in Prompting Mode, type in GETEX. The system will then prompt the user for each parameter in turn. A value assignment is mandatory for all parameters. Each parameter must be padded with Zeros if necessary. Data which does not meet the input standard for a given parameter will be flagged with an asterisk (*). For example, if 06 is input for the CRK parameter, then all mileposts having greater than 6 percent pavement cracking will be flagged with an '*'. Refer to Attachment 1 of this Guide for classification of the data. Example for input parameters for the GETEX command:

PARAMETER NAME	NUMBER OF CHARACTERS	EXAMPLES OF PARAMETERS
RTNAME - ROUTE NAME	4	I008, S085
DIR - DIRECTION	1	N, S, E or W
BEGMP - BEGINNING MILEPOST	3	000, 004, 017, 162
ENDMP - ENDING MILEPOST	3	007, 016, 412
RIN - RIDE INDEX	4	2.50, 3.25
CRK - PERCENT CRACKING	2	35, 15
SKD - SKID INDEX	2	45, 62
MCST - MAINTENANCE COST	5	00200, 00550
DEFL - DYNAFLECT DEFLECTION	4	0.73, 1.46

The Direct-Entry Mode is executed by inputting the parameters as a one-line entry. The parameters are input in the order shown for Prompting Mode, each is separated by a blank, and padded with zeros if necessary. Example for direct entry input:

```
GETEX RTNAME DIR BEGMP ENDMP RIN CRK SKD MCST DEFL (PARAMETER NAMES)
         4    1    3     3    4   2   2    5    4  (NO. OF CHARACTER
```

EXAMPLE:

```
GETEX I008 E 000 007 2.50 20 60 00200 0.73
```

NOTE: For an example, if a report is desired for Route U89A or for S10B, the Direct-Entry Mode is <u>mandatory</u>. The entry for a request of this type is as shown below. The route qualifier is the "A" (Alternate) or "B" (Business) in the two routes mentioned above (U89A, S10B). This route qualifier is added as QUAL(A) or QUAL(B) to the end of the parameter string.

```
GETEX U089 N 325 340 2.50 20 55 00300 0.80 QUAL(A)
```

ATTACHMENT 1.
RECOMMENDED DATA CLASSIFICATION FOR EXCEPTION REPORT

RIDE: GETMY - inches/mile

GOOD _ SMOOTH	0 - 122 in/mile
FAIR	123 - 256 in/mile
ROUGH	257 + in/mile

DEFLECTION: GETDY - Mils of an inch; 1.0 mil = .001"

LOW	Less than 1.0
MEDIUM	1.0 - 1.5
HIGH	1.5+

SKID NUMBER: GETMU

GOOD	43 - 99
QUESTIONABLE	35 - 42
BAD	Less than 35

RIDE INDEX: GETEX

GOOD - SMOOTH	3.6 - 5.0
FAIR	2.5 - 3.5
ROUGH	Less than 2.5

PERCENT CRACKING: GETEX

GOOD	Less than 4
FAIR	5 - 11
BAD	Greater than 12

MAINTENANCE COST: GETEX

LOW	$0 - 200
MEDUIM	201 - 500
HIGH	Greater than 500

```
GETMU I010 E 160 175
 PLEASE CLEAR FRAME AND SUBSEQUENTLY HIT 'ENTER'
 INPUT


                    A V E R A G E   M U   V A L U E S
  ROUTE: I010 E  CARDINAL
                   Y E A R   O F   M E A S U R E M E N T
            79    78    77    76    75   74    73    72
  MILEPOST
   160.00   58    62    59    43    52    0    69     0
   161.00   52    73    70    55    67    0     0     0
   162.00   54    73    69    62    71    0    71     0
   163.00   46    68    70    58    65    0     0     0
   164.00   51    71    70    66    72    0    69     0
   165.00   57    72    71    69    72    0     0     0
   166.00   53    70    72    70    76    0    69     0
   167.00   49    66    69    65    76    0     0     0
   168.00   50    68    70    71    70    0    73     0
   169.00   53    67    68    71    71    0     0     0
   170.00   54    70    71    66    74    0    65     0
   171.00   51    65    74    65    78    0     0     0
   172.00   52    68    71    63    76    0    68     0
   173.00   53    71    70    62    79    0     0     0
   174.00   57    72    72    63    77    0    71     0
   175.00   53    72    72    64    70    0     0     0
```

```
GETMY I010 E 160 175
 PLEASE CLEAR FRAME AND SUBSEQUENTLY HIT 'ENTER'
 INPUT


            M A Y S   R O U G H N E S S   I N   I N C H E S
  ROUTE: I010 E  CARDINAL
                   Y E A R   O F   M E A S U R E M E N T
            79    78    77    76    75   74    73    72
  MILEPOST
   160.00   80   102    60    50    60   48    42    23
   161.00   55    56    40    37    50   28    29     9
   162.00   78    66    42    43    42   30    30    10
   163.00   68    51    33    38    46   35    27    14
   164.00   83    74    45    45    53   39    35    23
   165.00   90    77    66    58    50   37    35    18
   166.00  113    94    68    55    48   39    29    24
   167.00  108   105    77    61    52   43    35    27
   168.00   98    93    79    63    55   47    41    29
   169.00   57    61    64    53    60   41    39    27
   170.00   55    42    49    36    34   37    27    25
   171.00   77    66    60    50    39   34    26    24
   172.00   25    34    41    35    26   27    21    20
   173.00   47    56    46    47    44   53    43    29
   174.00   70    78    68    60    58   56    42    31
   175.00  109   105    92    82    75   69    56    32
```

```
GETMY I017 N 200 215

PLEASE CLEAR FRAME AND SUBSEQUENTLY HIT 'ENTER'
INPUT



             M A Y S   R O U G H N E S S   I N   I N C H E S
 ROUTE: I017 N  CARDINAL
                     Y E A R   O F   M E A S U R E M E N T
              79     78     77     76     75     74     73     72
 MILEPOST
   200.00    369    348    339    340    347    325    259    231
   201.00    180    170    172    163    306    299    242    224
   202.00    366    343    341    331    328    313    257    220
   203.00    443    400    403    377    385    369    301    269
   204.00    388    354    354    351    333    328    265    246
   205.00    336    357    350    341    343    320    266    247
   206.00    122    358    347    339    335    322    263    241
   207.00    103    297    294    284    281    264    215    194
   208.00    247    255    241    239    240    213    230    156
   209.00    244    231    221    222    216    194    157    140
   210.00    244    232    222    217    206    196    164    134
   211.00    157    151    142    149    156    117    104     71
   212.00    164    141    134    133    130    109     94     68
   213.00    160    144    124    132    119    114     91     68
   214.00    134    108    112    101     91     79     70     36
   215.00    155    130    111    117    105    105     85     60
IKJ52500I END OF DATA
E
READY


PARSTAT

PLEASE CLEAR FRAME AND SUBSEQUENTLY HIT 'ENTER'
INPUT

                MAYS ROUGHNESS                FOR ROUTE: I017 N  C
                YEAR   1979                   FROM MP 200 TO MP  215
                -------------------------------------------------------
              5 I                 ***                                 I
                I                 ***                                 I
          F     I                 ***                                 I
          R     I                 ***                                 I
          E     I                 ***                                 I
          Q     I                 ***                                 I
          U   3 I            ***  ***  ***            ***             I
          E     I            ***  ***  ***            ***             I
          N     I            ***  ***  ***            ***             I
          C     I            ***  ***  ***            ***             I
          Y     I            ***  ***  ***            ***             I
              1 I            ***  ***  ***       ***  ***  ***        I
                I            ***  ***  ***       ***  ***  ***        I
                -------------------------------------------------------
 CLASS       >        0   50  100  150  200  250  300  350  400  450
 LIMITS:     <=      50  100  150  200  250  300  350  400  450  500
                SAMPLE SIZE =    16          AVG =      238.25
                VAR =    11168.47          ST DEV =   105.68
```

```
GETDY I010 E 160 175
 PLEASE CLEAR FRAME AND SUBSEQUENTLY HIT 'ENTER'
 INPUT

            D Y N A F L E C T   D E F L E C T I O N   I N   M I L S
 ROUTE: I010 E  CARDINAL
                      Y E A R    O F   M E A S U R E M E N T
               79       78       77       76       75       74       73       72
 MILEPOST
   160.00     1.0      0.9      0.0      0.0      1.3      0.9      0.9      0.0
   161.00     1.0      0.9      0.0      0.0      0.9      0.0      0.8      0.0
   162.00     1.0      0.7      0.0      0.0      0.8      0.0      0.6      0.0
   163.00     1.7      0.9      0.0      0.0      1.5      0.0      1.1      0.0
   164.00     1.1      0.7      0.0      0.0      0.9      0.0      1.0      0.0
   165.00     1.3      0.9      0.0      0.0      1.1      0.0      1.1      0.0
   166.00     1.6      1.1      0.0      0.0      1.4      0.0      1.8      0.0
   167.00     1.4      0.7      0.0      0.0      1.0      0.0      1.1      0.0
   168.00     1.5      1.1      0.0      0.0      1.4      0.0      1.6      0.0
   169.00     1.3      0.7      0.0      0.0      1.0      0.0      0.7      0.0
   170.00     1.3      0.9      0.0      0.0      1.0      0.0      0.6      0.0
   171.00     1.2      0.7      0.0      0.0      0.9      0.0      0.6      0.0
   172.00     0.9      0.6      0.0      0.0      0.9      0.0      0.6      0.0
   173.00     1.3      0.9      0.0      0.0      1.1      0.0      0.7      0.0
   174.00     1.4      1.1      0.0      0.0      1.3      0.0      0.8      0.0
   175.00     1.8      1.2      0.0      0.0      1.3      0.0      0.7      0.0
```

```
GETCK I010 E 160 175
 PLEASE CLEAR FRAME AND SUBSEQUENTLY HIT 'ENTER'
 INPUT

                  P E R C E N T   C R A C K I N G
ROUTE: I010 E  CARDINAL
                    Y E A R    O F   M E A S U R E M E N T
             79       78       77       76       75       74       73       72
MILEPOST
  160.00    0.0     21.7     18.0     13.0      9.0      4.0      0.0      0.0
  161.00    7.3      5.7      5.0      4.0      2.0      1.0      0.0      0.0
  162.00    7.0      4.0      3.0      2.0      2.0      1.0      0.0      0.0
  163.00    8.3      4.7      4.0      3.0      2.0      1.0      0.0      0.0
  164.00    4.0      1.3      1.0      1.0      0.0      0.0      0.0      0.0
  165.00    6.3      4.0      3.0      2.0      2.0      1.0      0.0      0.0
  166.00    6.3     10.0      8.0      6.0      4.0      2.0      0.0      0.0
  167.00    8.0      7.3      6.0      4.0      3.0      1.0      0.0      0.0
  168.00    4.3      7.3      6.0      4.0      3.0      1.0      0.0      0.0
  169.00    3.0      0.0      0.0      0.0      0.0      0.0      0.0      0.0
  170.00    5.3      6.3      5.0      4.0      3.0      2.0      1.0      0.0
  171.00    2.7      3.0      3.0      2.0      2.0      1.0      1.0      0.0
  172.00    0.7      1.3      1.0      1.0      0.0      0.0      0.0      0.0
  173.00    0.7      0.7      1.0      1.0      0.0      0.0      0.0      0.0
  174.00    3.0     13.0     10.0      8.0      5.0      3.0      0.0      0.0
  175.00    2.3      3.0      3.0      2.0      2.0      1.0      1.0      0.0
```

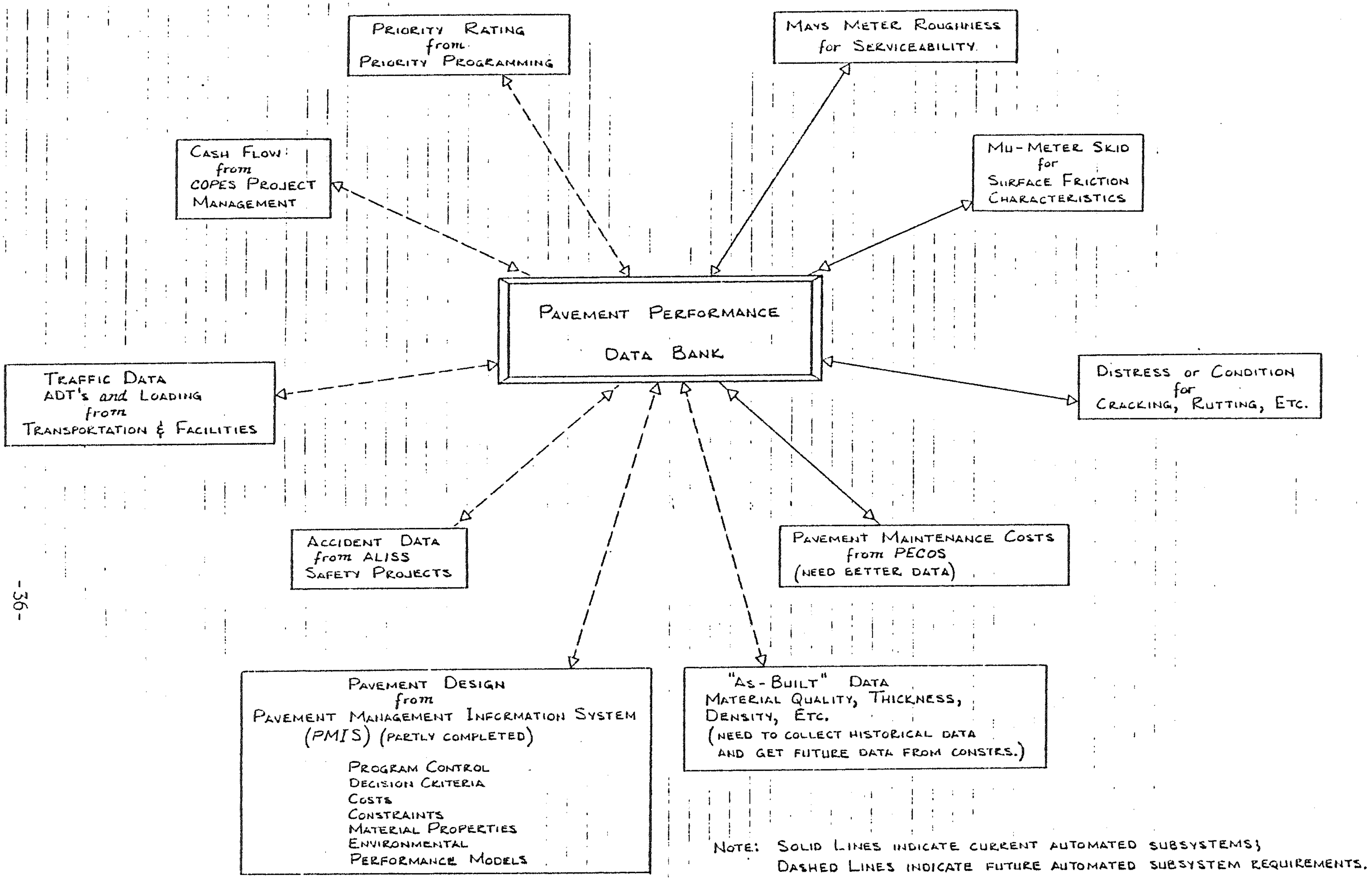
```
GETEX I010 E 160 175 2.50 43 10 01000 1.00
 END OF DATA
 PLEASE CLEAR\FRAME AND SUBSEQUENTLY HIT 'ENTER'
 INPUT
```

```
                     D A T A   E X C E P T I O N   R E P O R T
              ROUTE: I010 C                          FROM MP 160  TO  MP 175
                       RI            SN             DEF           %C                MC
   MILEPOST

    160.00            3.70           58             0.81          0                $1364*
    161.00            4.06           52             0.79          7                $1374*
    162.00            3.73           54             0.78          7                $1545*
    163.00            3.87           46             1.29*         8                $1117*
    164.00            3.67           51             0.83          4                $1204*
    165.00            3.57           57             0.96          6                $1302*
    166.00            3.31           53             1.21*         6                $1124*
    167.00            3.37           49             1.08*         8                 $694
    168.00            3.49           50             1.14*         4                $1201*
    169.00            4.02           53             0.97          3                 $662
    170.00            4.06           54             0.94          5                 $617
    171.00            3.75           51             0.85          3                 $366
    172.00            4.54           52             0.68          1                $1172*
    173.00            4.17           53             0.93          1                $1254*
    174.00            3.83           57             0.98          3                $1063*
    175.00            3.35           53             1.25*         2                 $817
 ***

  TOTAL MAINT COST FOR ROUTE I010 E CARDINAL FROM MP 160 TO MP 175 :   $16876
 END OF DATA
 E
 READY
```

PAVEMENT MANAGEMENT INFORMATION SYSTEM



NOTE: SOLID LINES INDICATE CURRENT AUTOMATED SUBSYSTEMS;
DASHED LINES INDICATE FUTURE AUTOMATED SUBSYSTEM REQUIREMENTS.