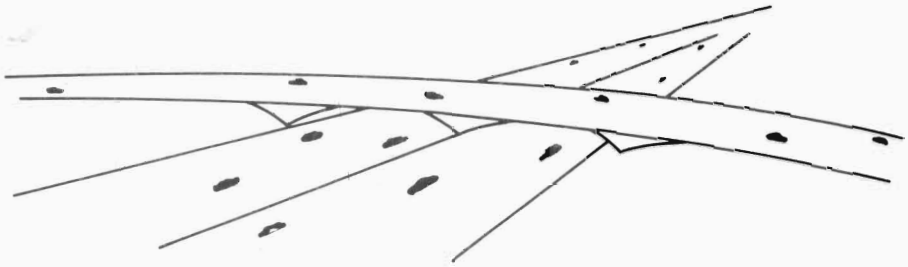

DEPARTMENTAL RESEARCH

Report Number : SS 11.5

MAINTENANCE OPERATIONS OF THE SKID TEST TRAILERS

September 1968—May 1969

TEXAS HIGHWAY DEPARTMENT

MAINTENANCE OPERATIONS OF THE SKID TEST TRAILERS

(September 1968 through May 1969)

by

Jon P. Underwood

Report Number SS 11.5

Conducted by

The Research Section of
The Highway Design Division
The Texas Highway Department

August, 1969

ACKNOWLEDGEMENTS

Acknowledgement is extented to The Texas Highway Department Maintenance Division for directing the operation of these skid test trailers, and to The Texas Highway Department Districts for the valuable information supplied to complete the forms of analysis given in this report. Special thanks are extended to Mr. Joe Young who is responsible for all data analysis by computer.

ABSTRACT

This report covers the results of the skid tests performed by the three Texas skid test trailers from October 1968 to June 1969. This report indicates results for various pavement types and surfaces, and studies the effect of amount of binder and aggregate gradation upon the coefficient of friction. This report will be of specific interest to District, Maintenace, Design, and Resident Engineers and other engineers interested in friction performance of pavements.

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REPORT II

(September 1968-May 1969)

Maintenance Operations of the Skid Test Trailers

Background

In May 1968, the three maintenance skid test trailers began testing operations throughout the state. These trailers were permanently stationed in the districts where the major supply warehouses are located. At this time, the trailers were correlated on several test sections in the Austin and Bryan area and the results of this calibration were used in the computer program prepared by The Highway Design Division in order to obtain consistant skid resistance results regardless of the trailer used. In December 1968, these three trailers were again correlated over the same sections and the necessary changes made in the skid resistance computer program.

The Design Division maintains a state wide file to assist in plan preparation between D-8 and the District.

This is the second report prepared on the state wide status of pavement surfaces in relation to skid resistance. This report will be prepared each year in order to summarize pavement surface information.

General Information

As mentioned in the first report (SS 11.4), the results of this report may be biased due to the manner of selection of the surface to be tested. The District making the skid tests selects the sections to be studied. Some Districts test almost every roadway within their

boundaries, others test only sections considered "slick", and still others test different pavement surface types. Based on this assumption, the statistics given in this report may be biased and may not be a true representation of actual state wide conditions.

Skid tests were performed at 40 mph with standard quantities of test water.

STATE WIDE AVERAGE

In the seven month period covered herein, 2370 pavements were tested. The sections reported include seven pavement types, various coarse aggregate types, binder content and aggregate gradations. The friction values of these sections ranged from 0.14 to 0.80 with an average coefficient of 0.40. The average coefficient for the first five months preceeding the period of this report was 0.39 with a range of 0.15 to 0.80.

Graph 1 indicates approximately 32% of the pavements tested are below a value of 0.32.

Table I and Graphs 2 through 8 presents skid resistance information concerning pavement type.

Table II compares coarse aggregate material types used in Asphaltic Concrete Pavements and Surface Treatments. In this comparison wear and age of surface has not been considered.

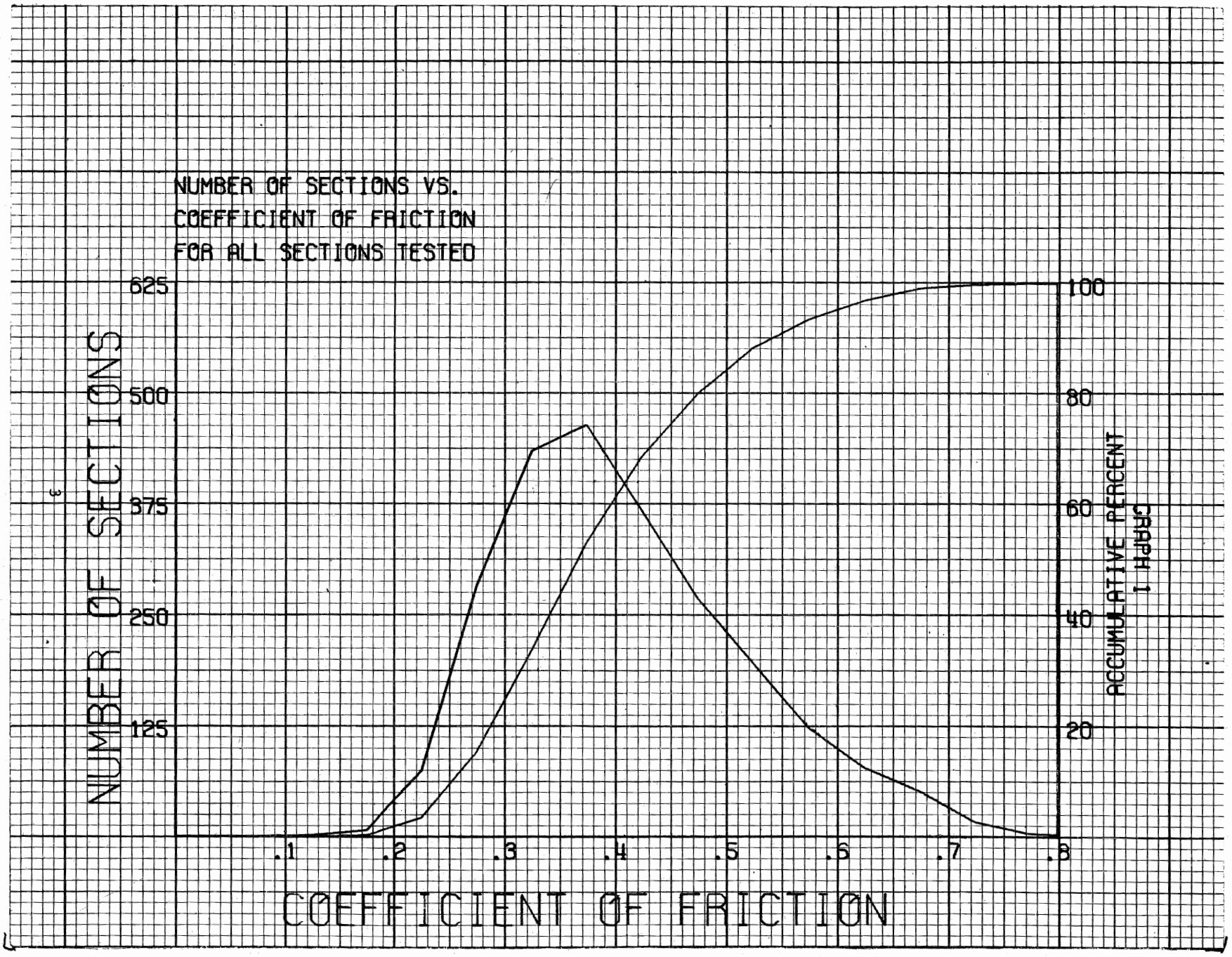

NUMBER OF SECTIONS VS.
COEFFICIENT OF FRICTION
FOR ALL SECTIONS TESTED
NUMBER OF SECTIONS
625
500
375
250
125
100
80
60
40
20
ACCUMULATIVE PERCENT
GRAPH 1
.1
.2
.3
.4
.5
.6
.7
.8
COEFFICIENT OF FRICTION

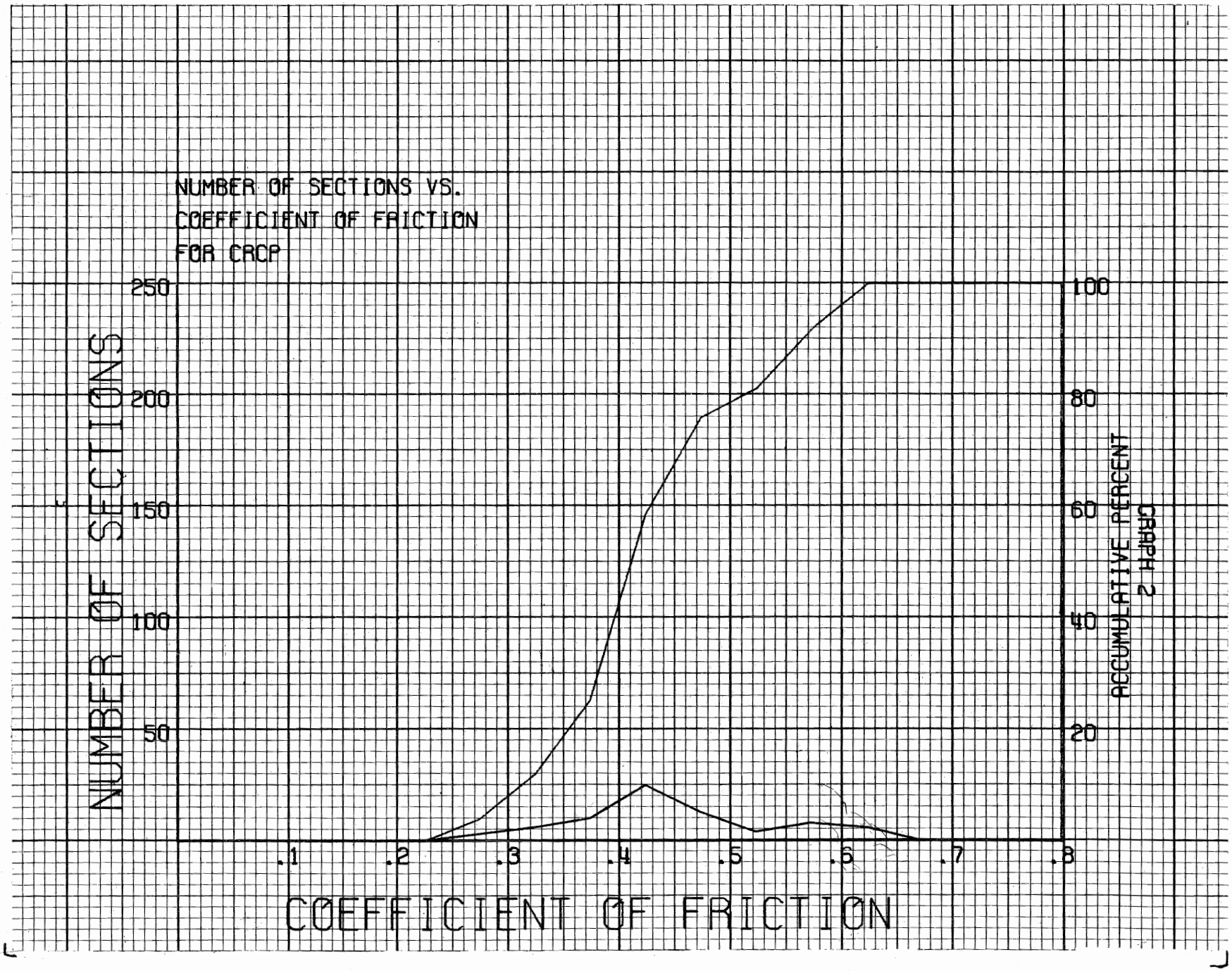
TABLE I

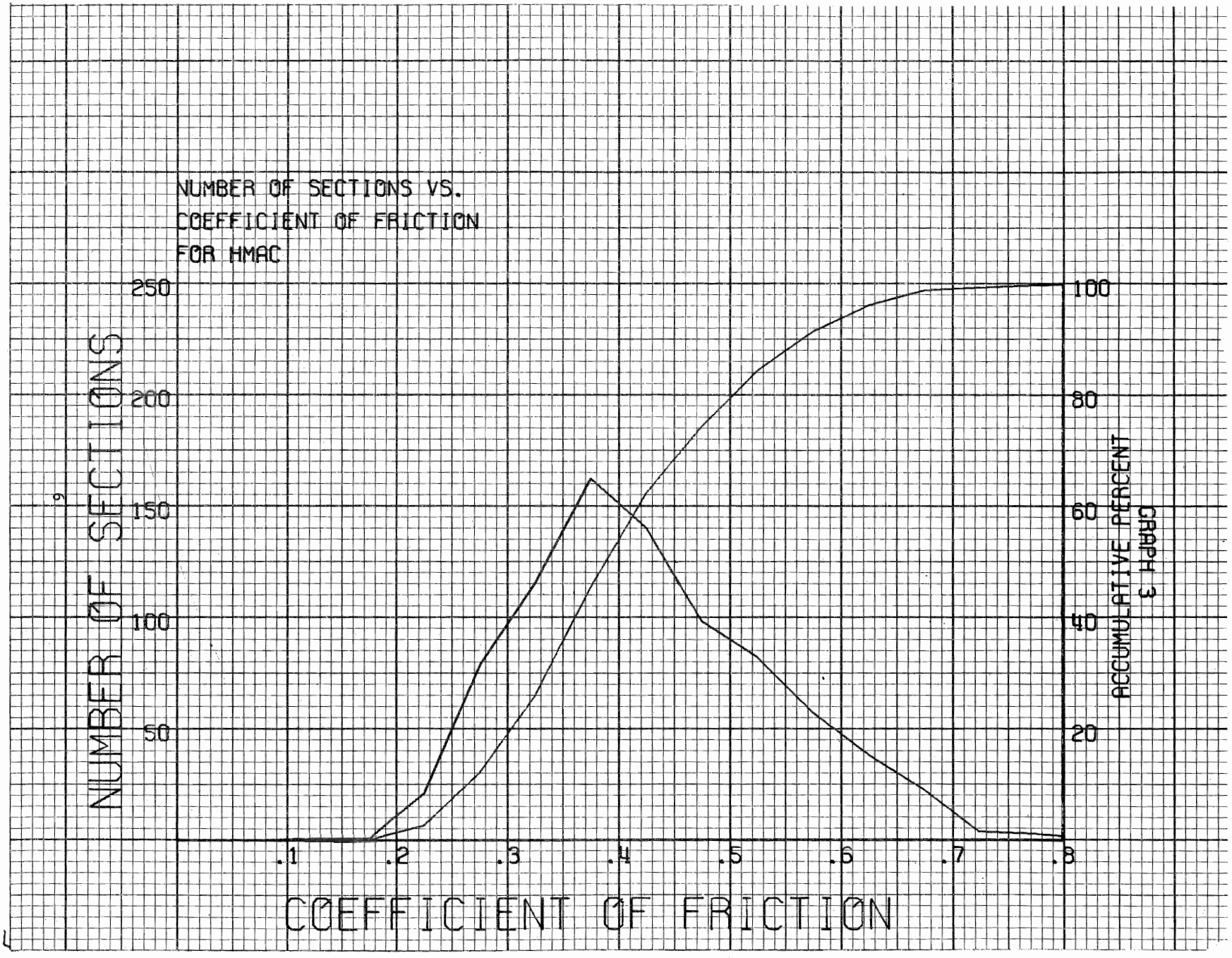
SUMMARY OF GENERAL INFORMATION

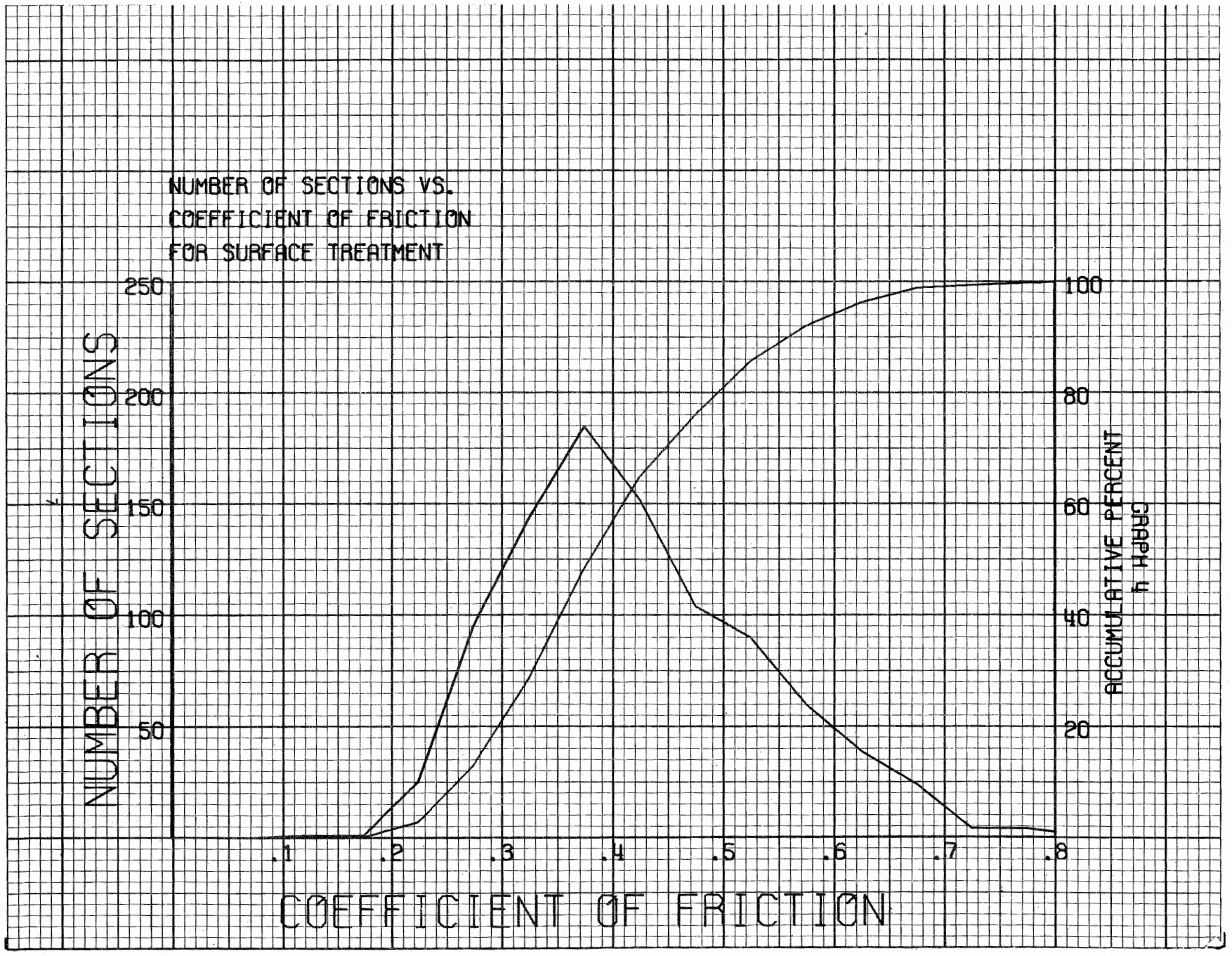
A STUDY - NUMBER OF SECTIONS TESTED VS. COEF. OF FRICTION

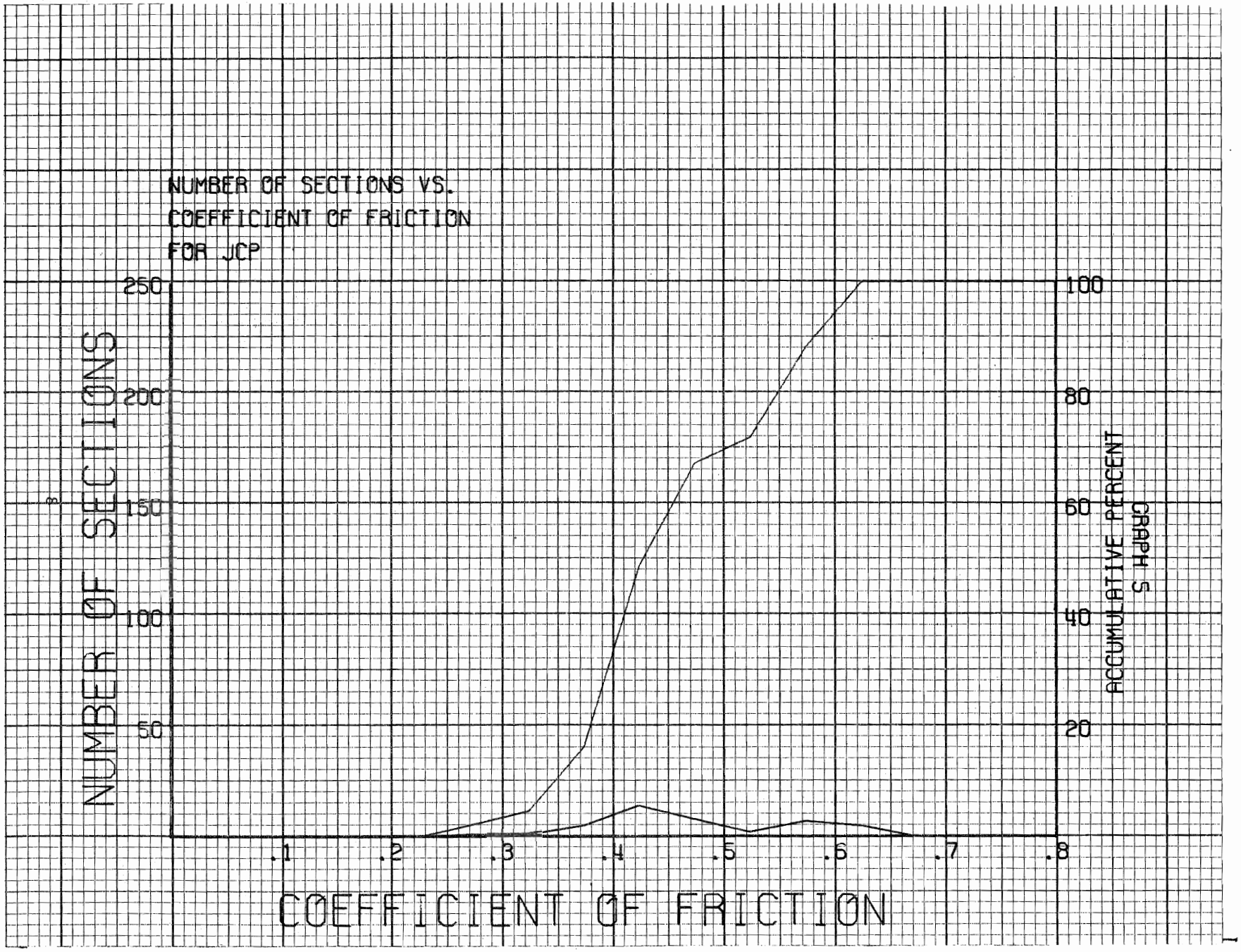
(Correlate to Graphs 1 through 8)

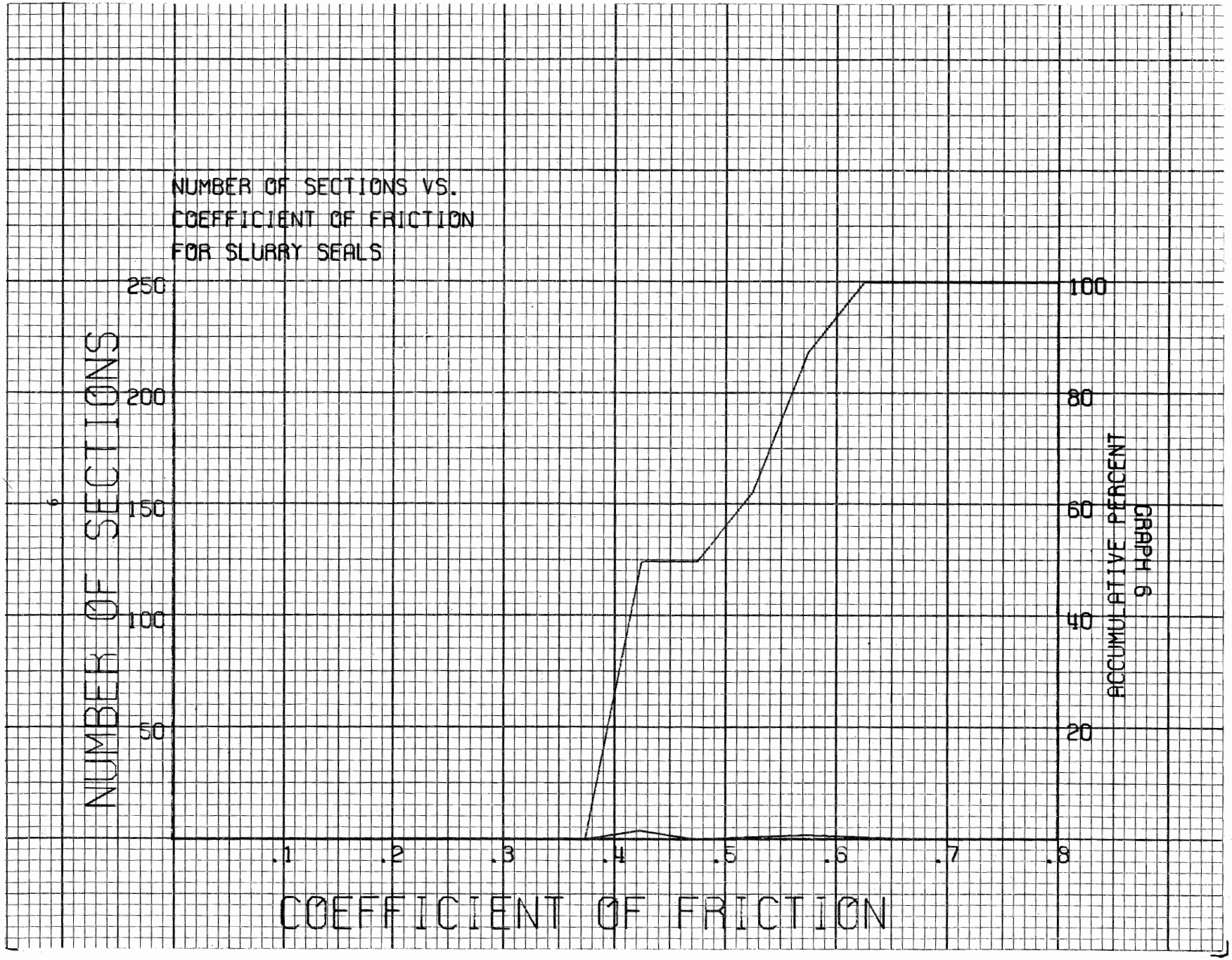
Pavement Type	No. Sec. Tested	Aver. Coef.	Range	Stan. Dev.
All Sections Tested	2370	0.40	.14-.80	0.11
CRCP	75	0.44	.24-.60	0.09
HMAC	832	0.40	.19-.76	0.11
Surface Treatment	928	0.42	.14-.80	0.12
JCP	43	0.36	.26-.47	0.06
Slurry Seals	8	0.38	.31-.50	0.06
Cold Mix Limestone Rock Asphalt	7	0.36	.28-.52	0.08
Hot Mix-Cold Laid A.C.	4	0.50	.37-.64	0.12

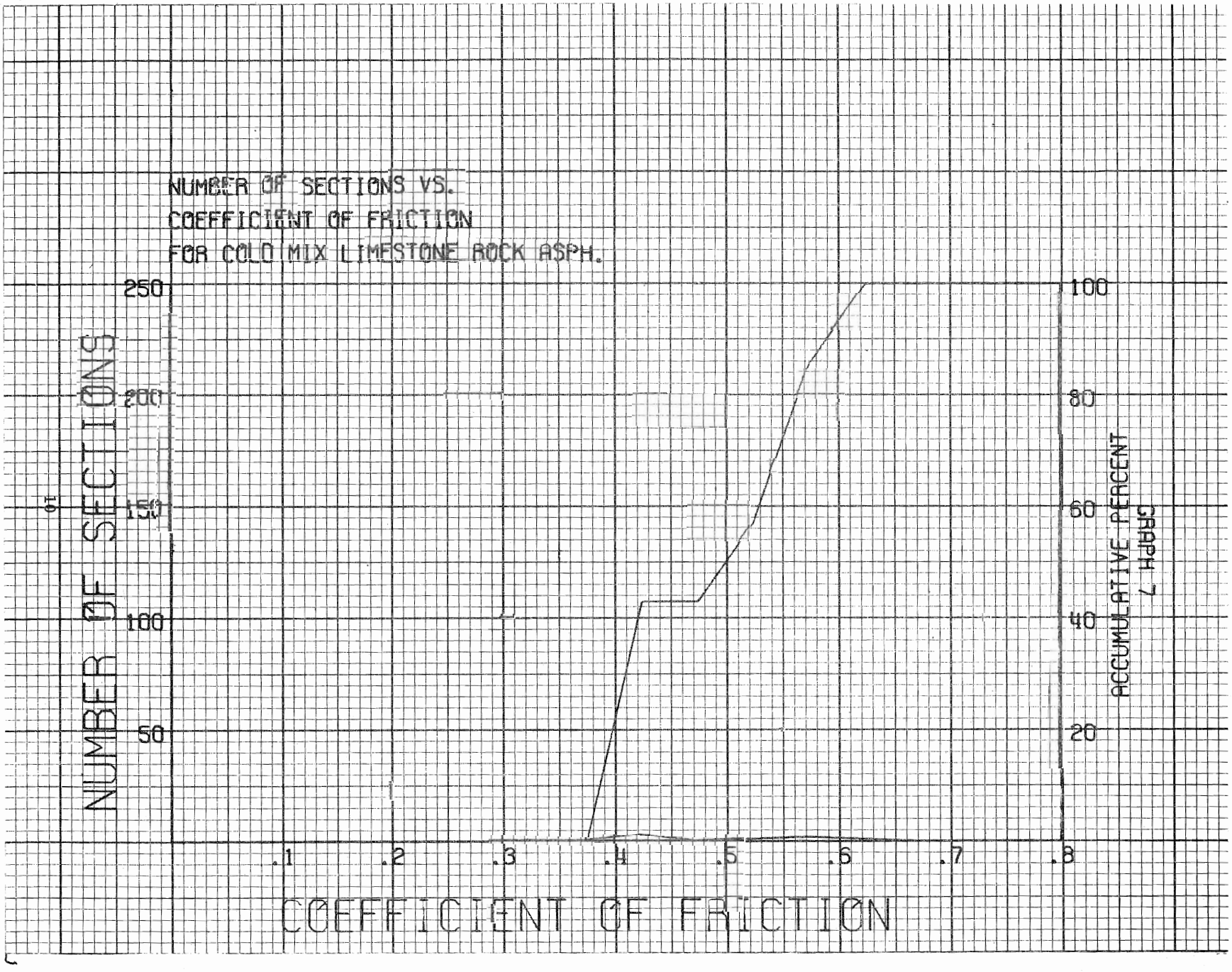

NUMBER OF SECTIONS VS.
COEFFICIENT OF FRICTION
FOR CRCP
NUMBER OF SECTIONS
250
200
150
100
50
.1
.2
.3
.4
.5
.6
.7
.8
COEFFICIENT OF FRICTION
100
80
60
40
20
ACCUMULATIVE PERCENT
GRAPH 2


NUMBER OF SECTIONS VS.
COEFFICIENT OF FRICTION
FOR HMAC
NUMBER OF SECTIONS
250
200
150
100
50
ACCUMULATIVE PERCENT
100
80
60
40
20
.1
.2
.3
.4
.5
.6
.7
.8
COEFFICIENT OF FRICTION
GRAPH 3


NUMBER OF SECTIONS VS.
COEFFICIENT OF FRICTION
FOR SURFACE TREATMENT
NUMBER OF SECTIONS
250
200
150
100
50
.1
.2
.3
.4
.5
.6
.7
.8
COEFFICIENT OF FRICTION
100
80
60
40
20
ACCUMULATIVE PERCENT
GRAPH 4


NUMBER OF SECTIONS VS.
COEFFICIENT OF FRICTION
FOR JCP
NUMBER OF SECTIONS
250
200
150
100
50
.1
.2
.3
.4
.5
.6
.7
.8
COEFFICIENT OF FRICTION
100
80
60
40
20
ACCUMULATIVE PERCENT
GRAPH 5


NUMBER OF SECTIONS VS.
COEFFICIENT OF FRICTION
FOR SLURRY SEALS
NUMBER OF SECTIONS
250
200
150
100
50
100
80
60
40
20
ACCUMULATIVE PERCENT
GRAPH 6
.1
.2
.3
.4
.5
.6
.7
.8
COEFFICIENT OF FRICTION


NUMBER OF SECTIONS VS.
COEFFICIENT OF FRICTION
FOR COLD MIX LIMESTONE ROCK ASPH.
NUMBER OF SECTIONS
250
200
150
100
50
.1
.2
.3
.4
.5
.6
.7
.8
COEFFICIENT OF FRICTION
100
80
60
40
20
ACCUMULATIVE PERCENT
GRAPH 7

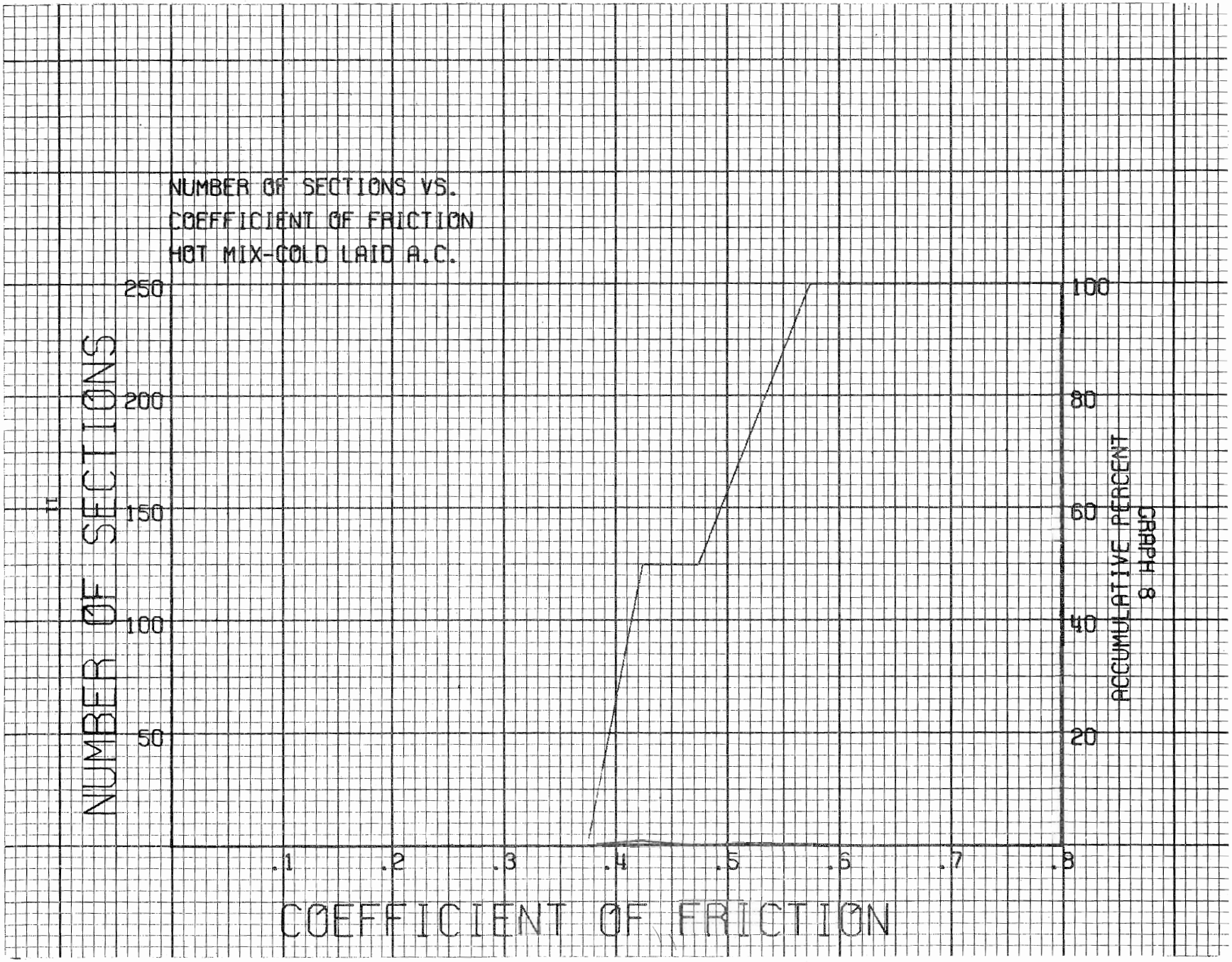

NUMBER OF SECTIONS VS.
COEFFICIENT OF FRICTION
HOT MIX-COLD LAID A.C.
NUMBER OF SECTIONS
250
200
150
100
50
.1
.2
.3
.4
.5
.6
.7
.8
COEFFICIENT OF FRICTION
100
80
60
40
20
ACCUMULATIVE PERCENT
GRAPH 8

TABLE II

SUMMARY OF GENERAL INFORMATION

STUDY OF AGGREGATE MATERIAL TYPES

Material Types	HMAC				SURFACE TREATMENT			
	No. Tested	Aver. Coef.	Range	Stan. Dev.	No. Tested	Aver. Coef.	Range	Stan Dev.
All Sections	832	0.40	.19-.76	0.11	928	0.42	.14-.80	0.12
Silicious	51	0.35	.21-.59	0.10	291	0.42	.20-.80	0.11
Limestone	323	0.45	.21-.73	0.10	171	0.42	.14-.77	0.10
Lightweight	2	0.48	.46-.51	****	36	0.57	.37-.69	0.09
Slag	44	0.49	.30-.67	0.08	27	0.55	.31-.73	0.12
Trap Rock	19	0.45	.29-.56	0.09	15	0.42	.25-.55	0.08
Rock Asphalt	4	0.40	.40-.68	****	30	0.35	.20-.67	0.08
Shell	None							
Rock Asph-Shell	None							

PAVEMENT SURFACE WEAR

The following plots obtained from information completed by the Districts are an attempt to study the relationship of pavement surfacing materials and skid resistance. The information used on these plots was taken from the code sheets completed by the District.

The total traffic has been determined by multiplying the number of days between placement and testing by the ADT. This gives a measure of the number of vehicles polishing or wearing for this section of roadway. This is not an exact method for determing total traffic but other methods require a much more complicated calculation. It is believed that this method is sufficient to reveal the wear characteristic trends of roadway surface materials.

Continuously Reinforced Concrete Pavement

Graph 9 is a plot of coefficient of friction vs total traffic for continuously reinforced concrete pavement. Twenty (20) sections have been tested. This plot shows considerable data scatter but what is believed to be slight decrease in friction with cumulative traffic applications.

Jointed Concrete Pavement

Very little traffic data was available. Graph 10 indicates only one pavement section lies on the total traffic scale with more than three points off scale (greater than 20 million traffic). Little information can be obtained from this plot.

Hot Mix Asphaltic Concrete

Graph 11 is a plot of all surface material types used in HMAC sections. Graphs 12 through 19 are wear plots of several coarse

aggregate materials used in HMAC. These graphs show widely scattered data points but also show the influence of the coarse aggregate on the coefficient of friction.

About the only trend apparent is that silicious material is generally lower in friction than other materials. Limestone is surprisingly high considering the large amount of traffic applications on several surfaces, however, the plots show that the coefficient of friction of surfaces with limestone aggregate can be as low as those with siliceous or as high as those with trap rock.

Surface Treatment

Graph 20 is a general plot for all surface treatment sections tested. Graphs 21 through 26 are plots which study the coarse aggregate material types.

Again a wide data scatter is found. The wear rate of all coarse aggregate material types is approximately the same.

Graph 21 shows only three (3) sections of surface treatment using siliceous coarse aggregate. A considerably larger amount of siliceous aggregate is in use throughout the state, but does not appear due to the incomplete traffic or date data received from the Districts.

The coefficient of friction of lightweight surface treatments, Graph 23, is generally higher than all other surface materials especially at higher total traffic.

Graph 26 is a plot of coefficient of friction vs total traffic for surface treatments using rock asphalt coarse aggregate. Again only five points are shown due to incomplete information reported

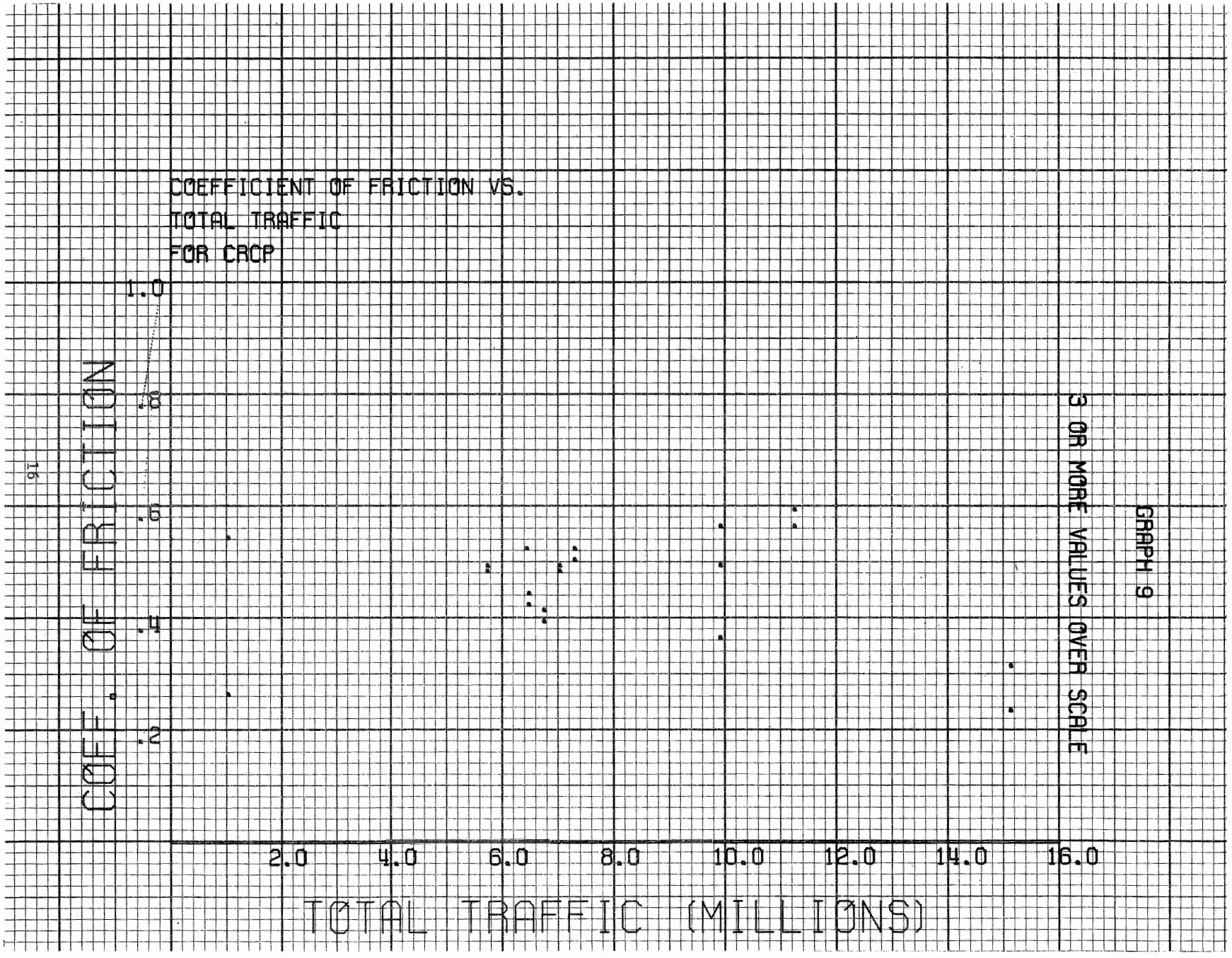
from the Districts.

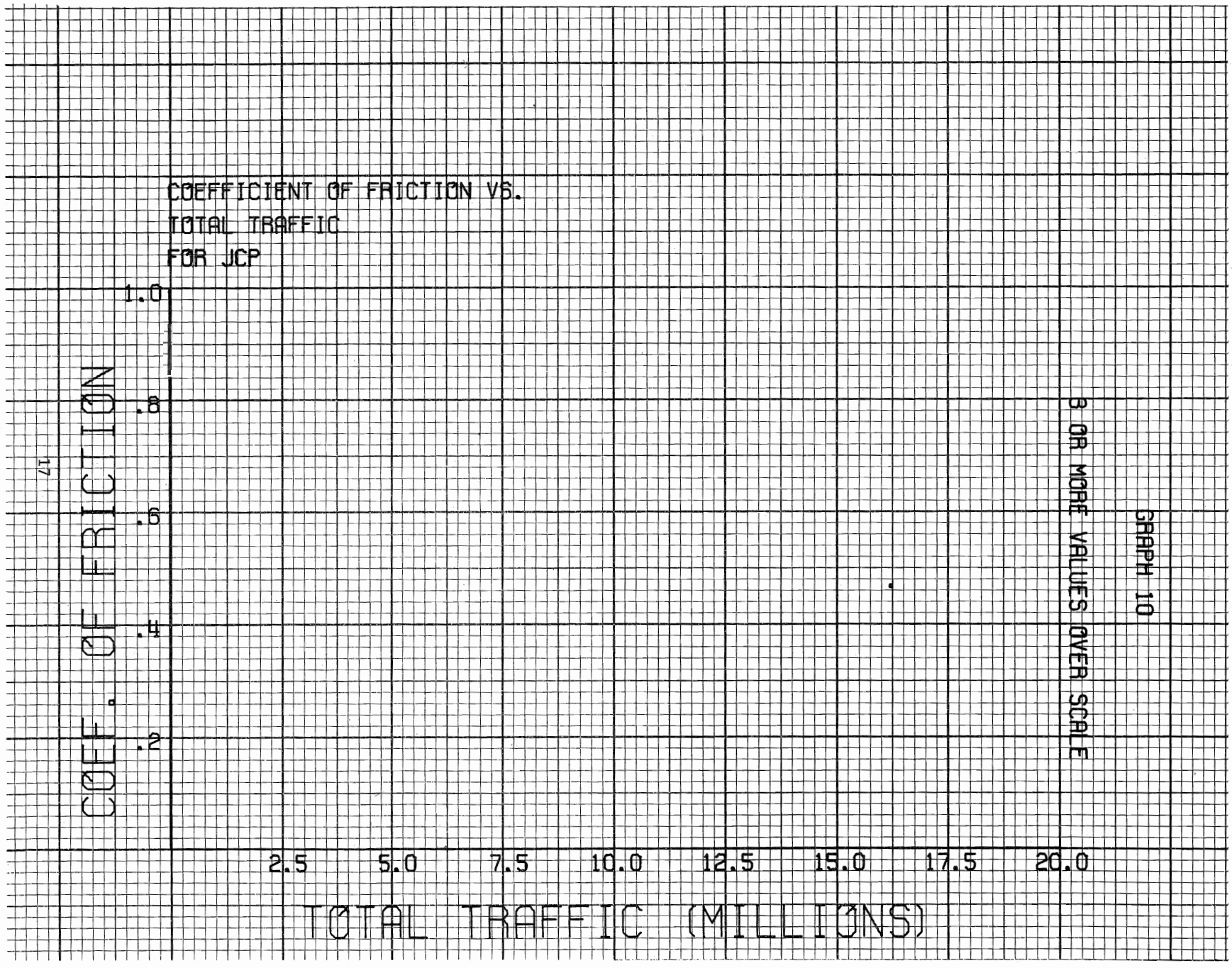
Slurry Seals

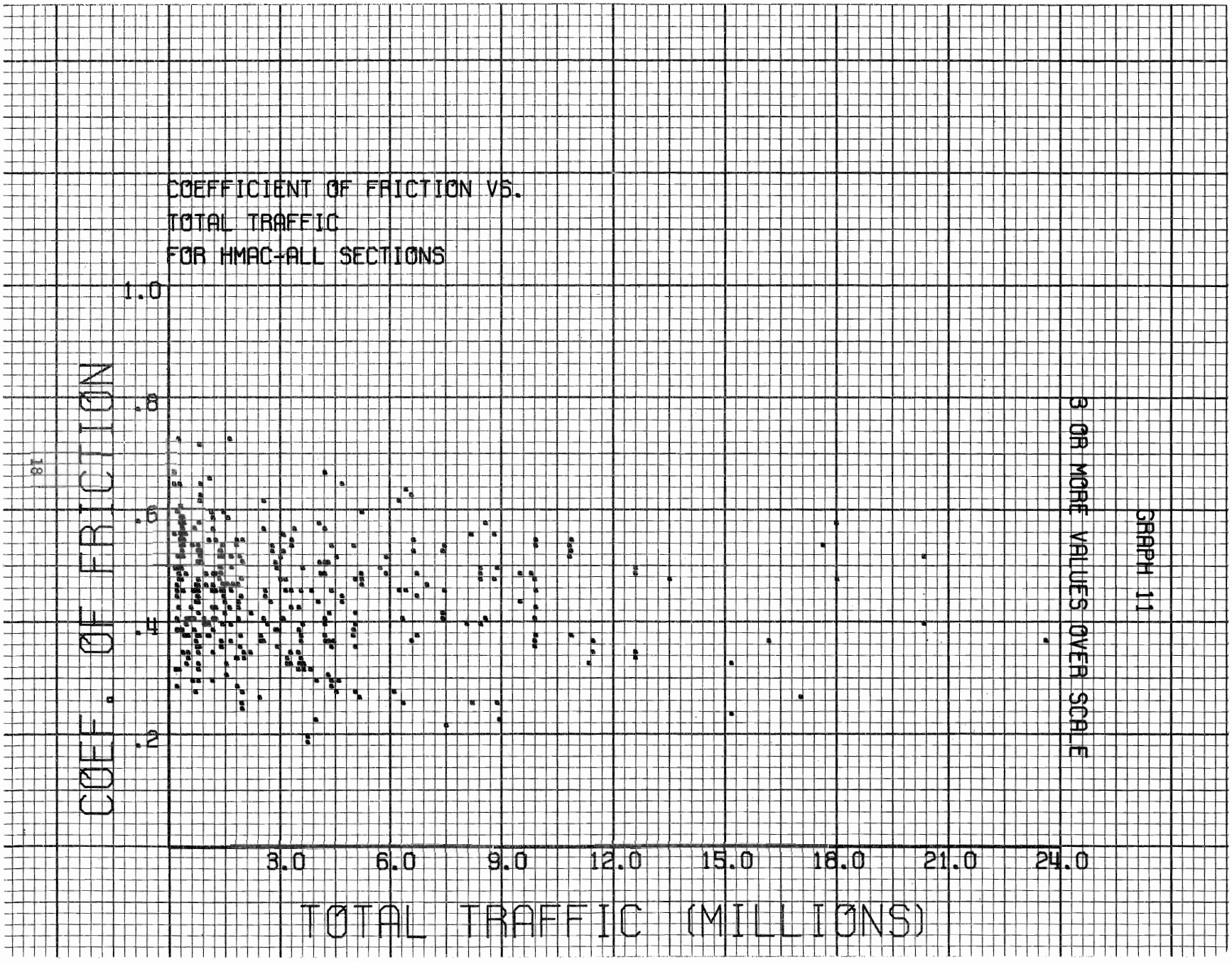
Little judgement and or conclusions can be obtained from the data points in Graph 27. No trend is developed in this plot due to the small number of data points available. Generally, the coarse aggregate material used was Linestone Rock Asphalt.

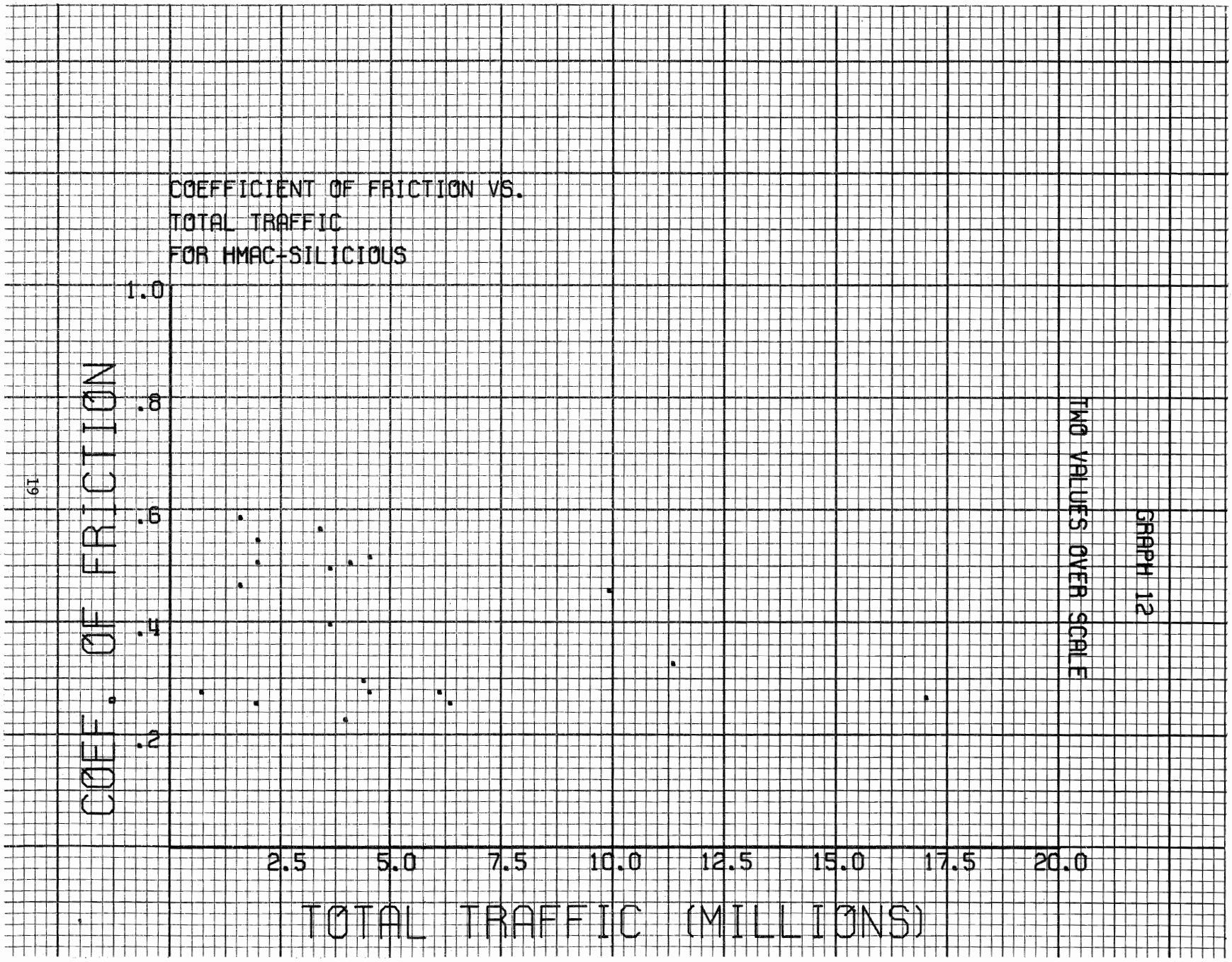
Cold - Laid Limestone Rock Asphalt

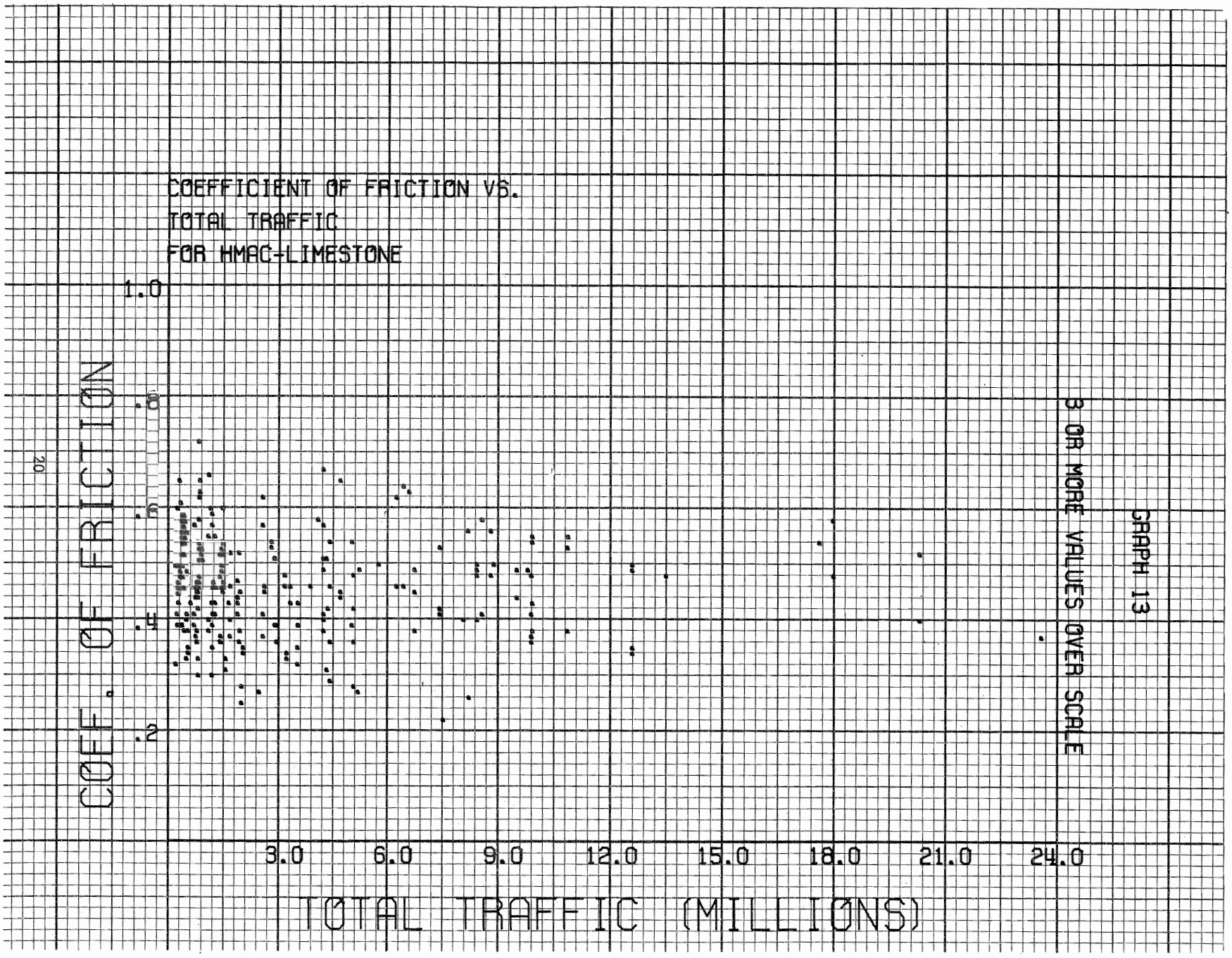
The small number of traffic data points in Graph 28 make any type of analysis difficult. This graph tends to show low coefficent of friction of cold-laid surfaces regardless of any traffic range. A larger number of data points could reverse this trend.

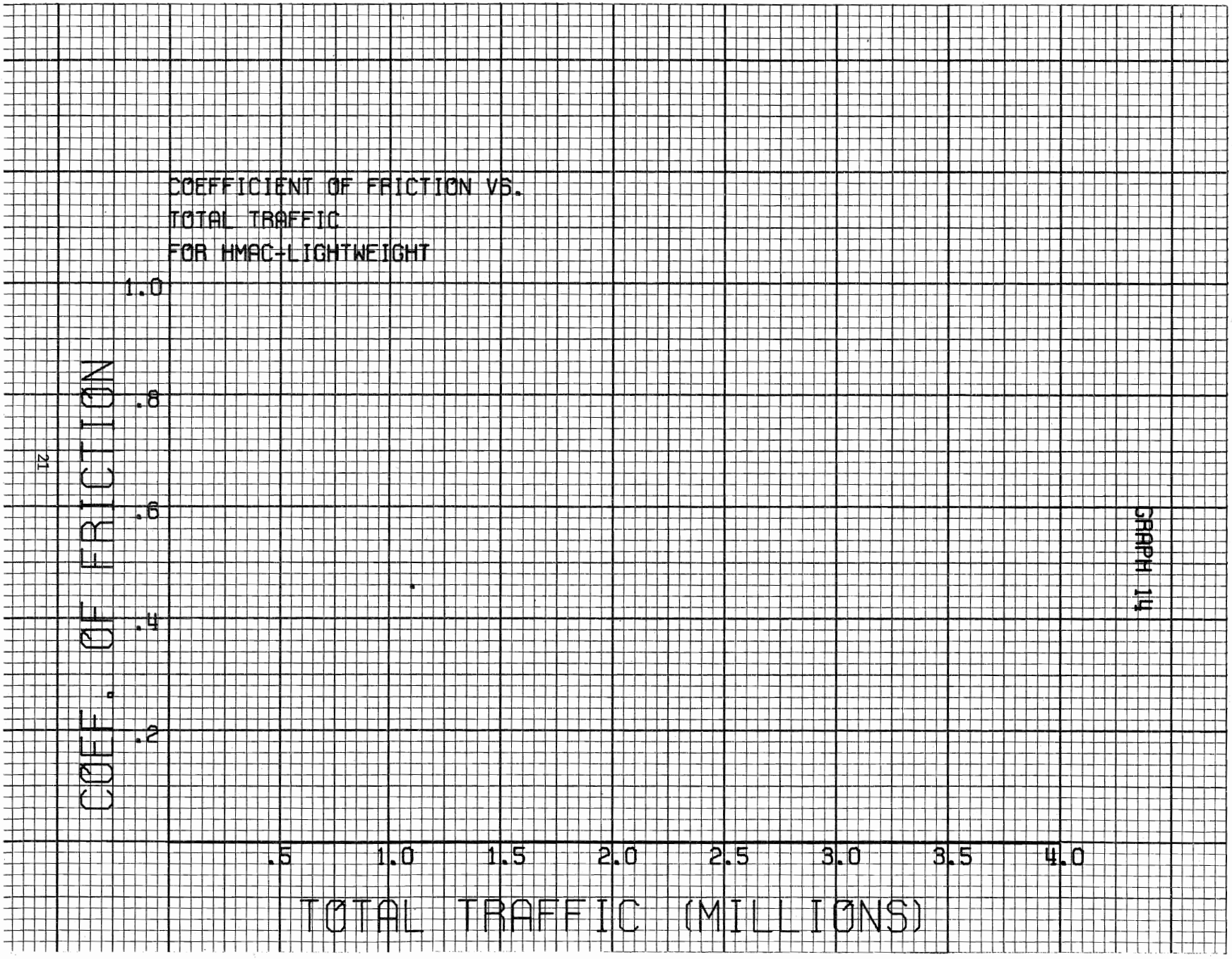

COEFFICIENT OF FRICTION VS.
TOTAL TRAFFIC
FOR CRCP
COEF. OF FRICTION
1.0
.8
.6
.4
.2
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
TOTAL TRAFFIC (MILLIONS)
3 OR MORE VALUES OVER SCALE
GRAPH 9

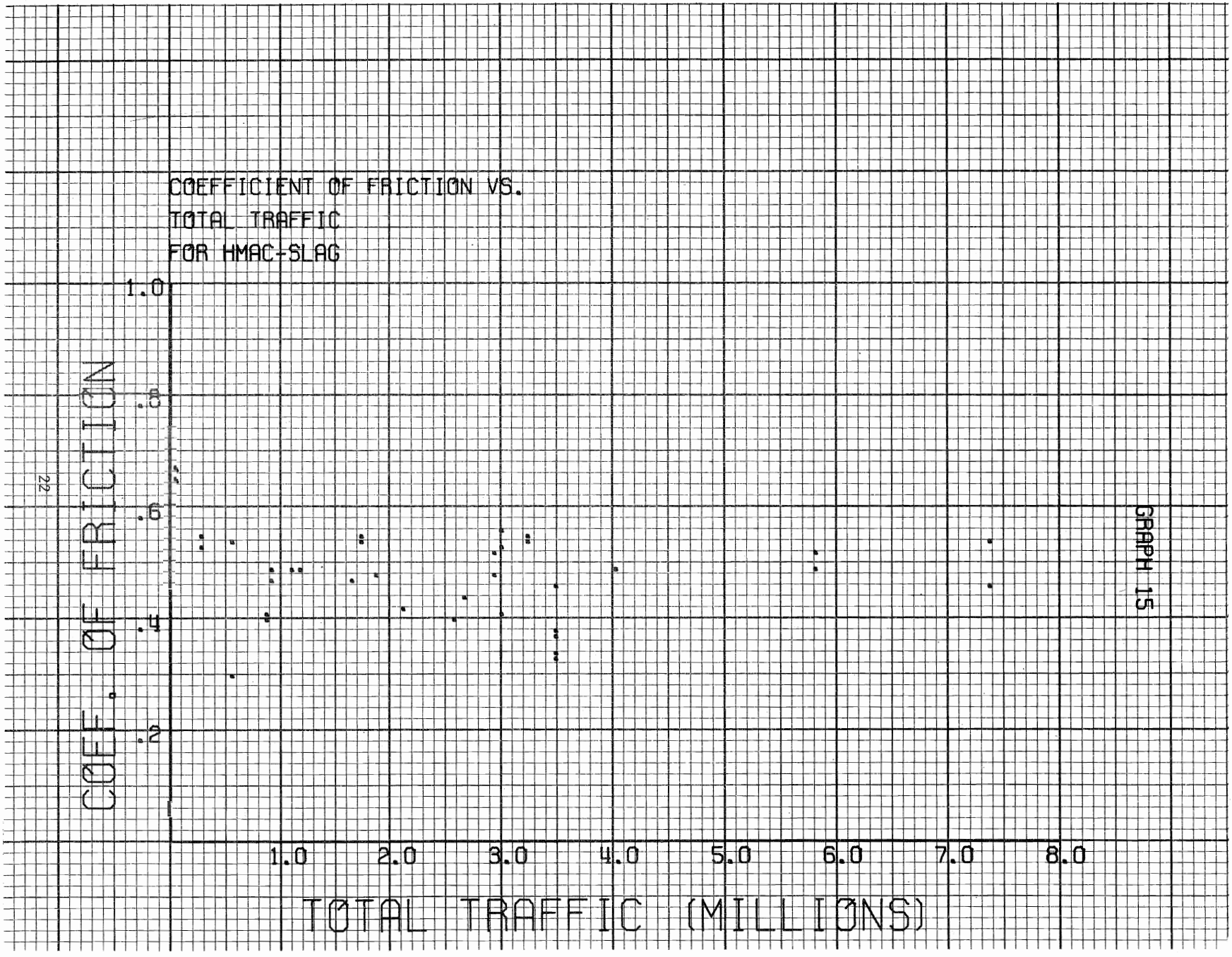

COEFFICIENT OF FRICTION VS.
TOTAL TRAFFIC
FOR JCP
COEF. OF FRICTION
1.0
.8
.6
.4
.2
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
TOTAL TRAFFIC (MILLIONS)
3 OR MORE VALUES OVER SCALE
GRAPH 10

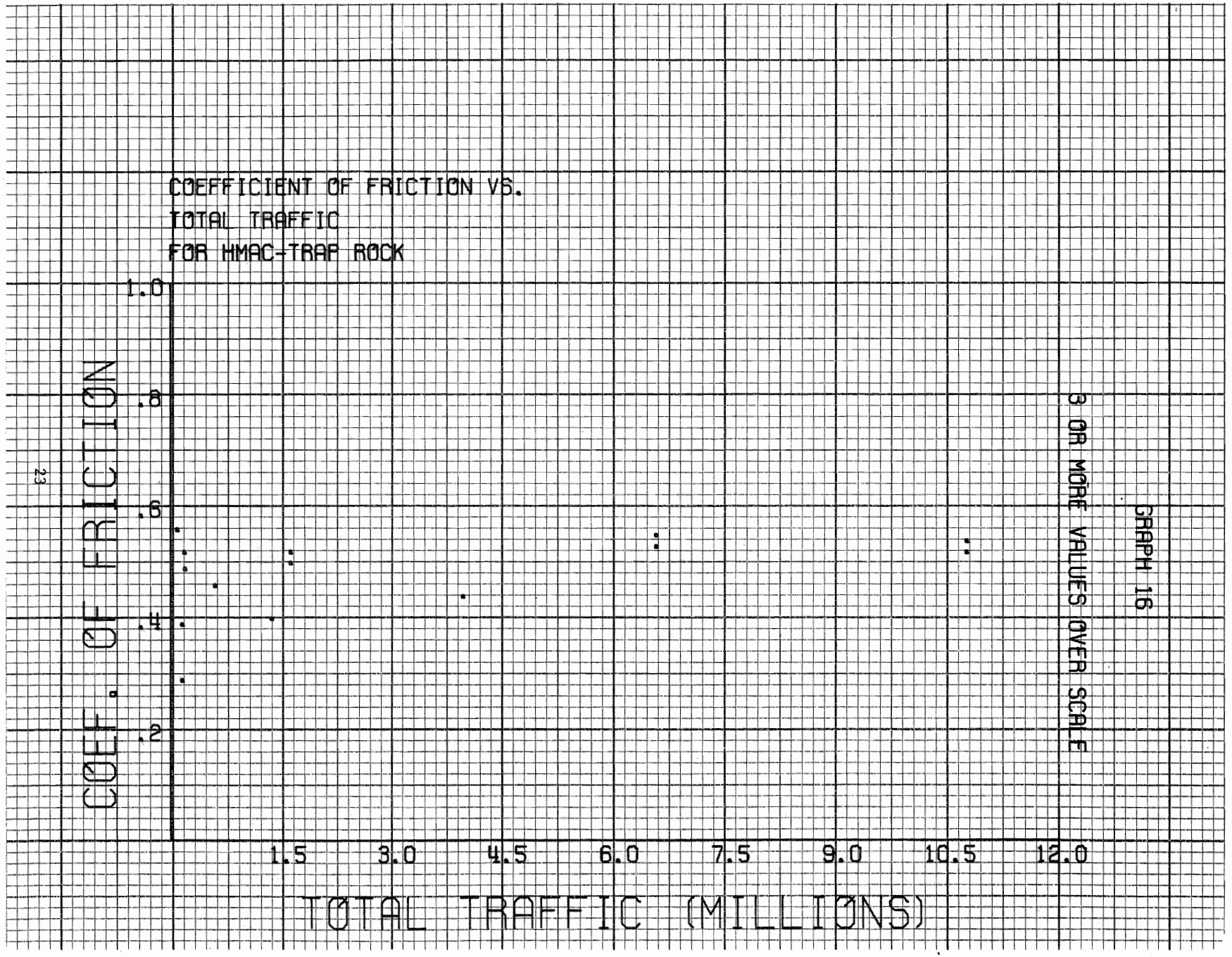

COEFFICIENT OF FRICTION VS.
TOTAL TRAFFIC
FOR HMAC-ALL SECTIONS
1.0
.8
.6
.4
.2
COEF. OF FRICTION
3.0
6.0
9.0
12.0
15.0
18.0
21.0
24.0
TOTAL TRAFFIC (MILLIONS)
3 OR MORE VALUES OVER SCALE
GRAPH 11

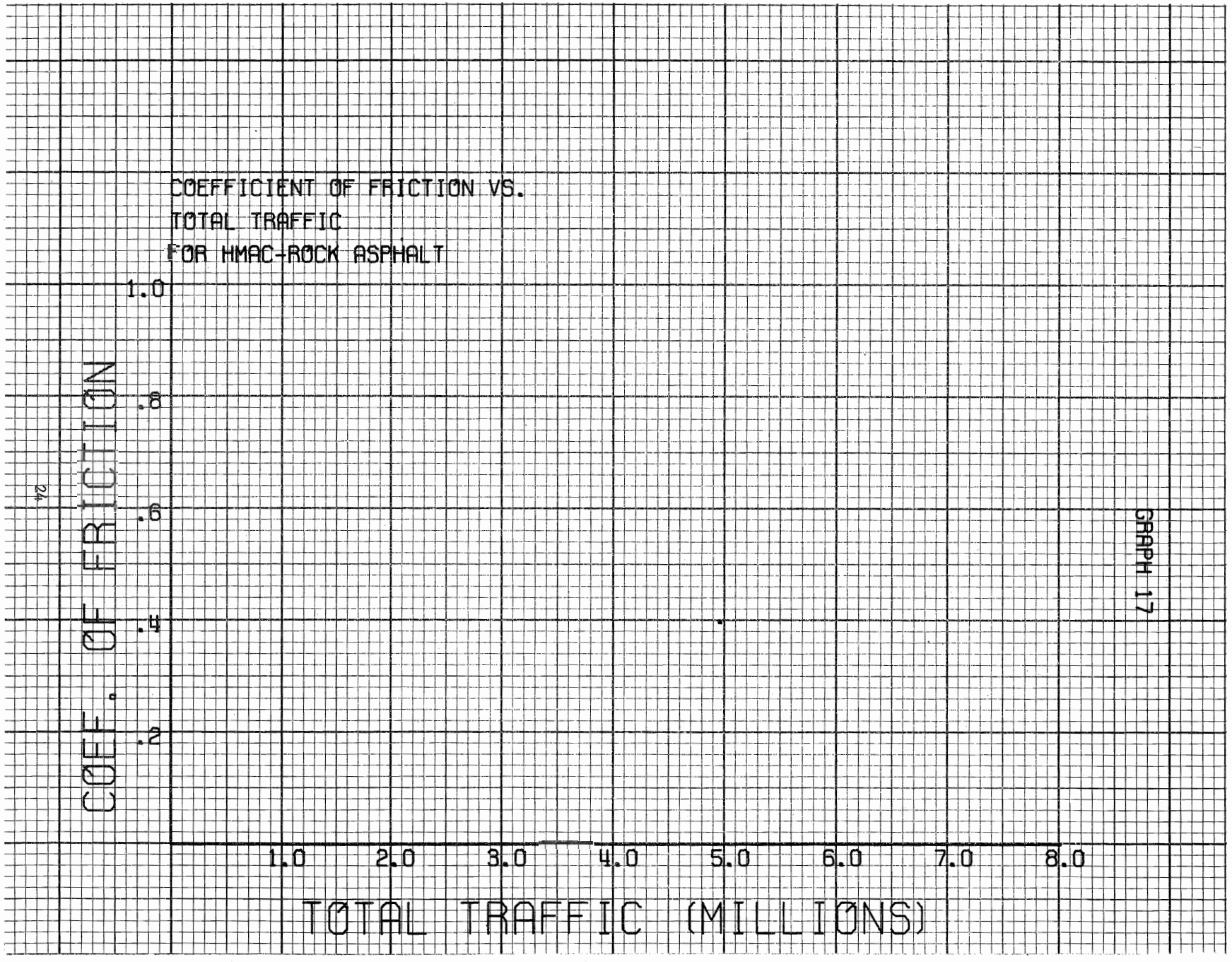

COEFFICIENT OF FRICTION VS.
TOTAL TRAFFIC
FOR HMAC-SILICIOUS
COEF. OF FRICTION
1.0
.8
.6
.4
.2
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
TOTAL TRAFFIC (MILLIONS)
TWO VALUES OVER SCALE
GRAPH 12

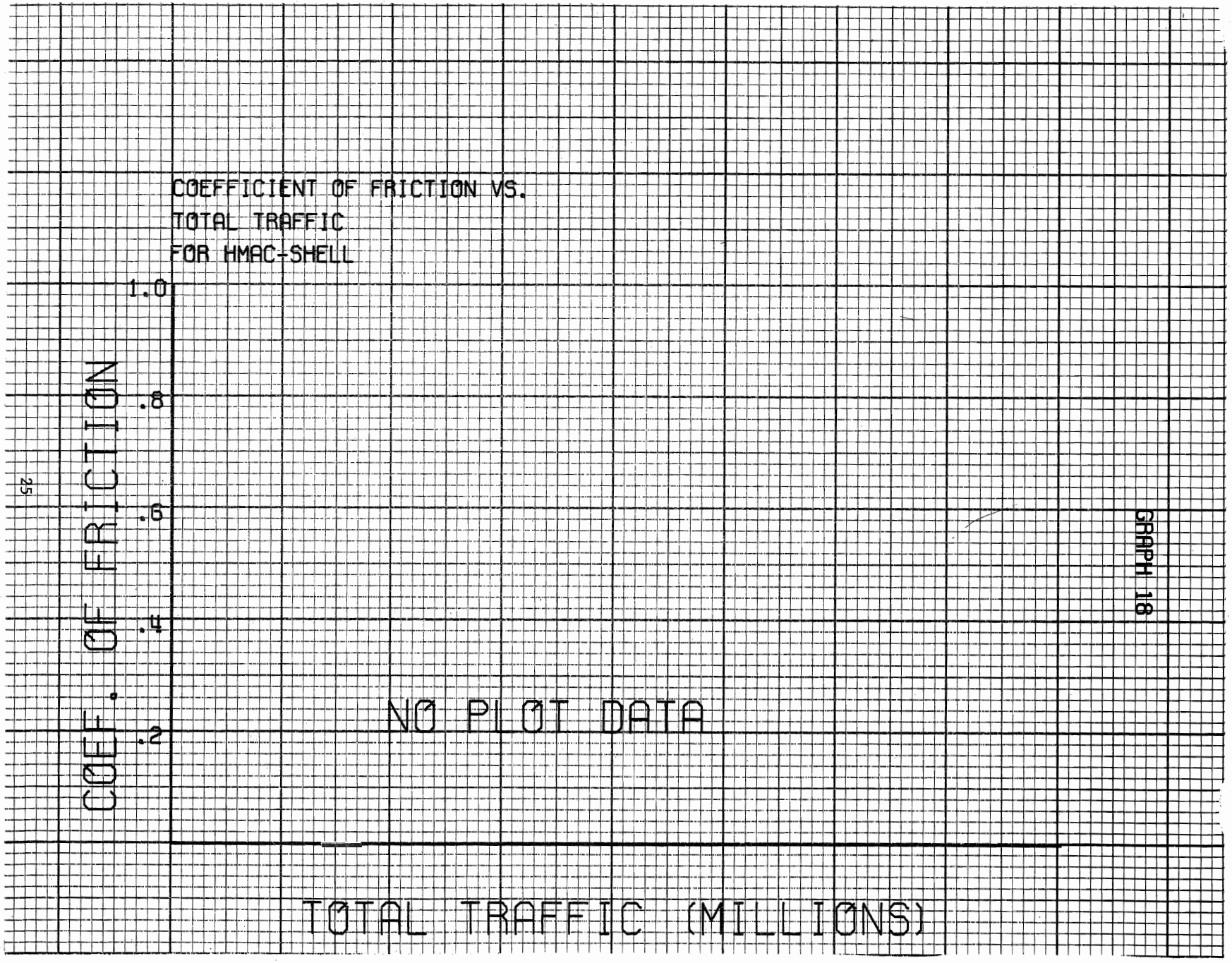

COEFFICIENT OF FRICTION VS.
TOTAL TRAFFIC
FOR HMAC-LIMESTONE
COEF. OF FRICTION
1.0
.8
.6
.4
.2
3.0
6.0
9.0
12.0
15.0
18.0
21.0
24.0
TOTAL TRAFFIC (MILLIONS)
3 OR MORE VALUES OVER SCALE
GRAPH 13

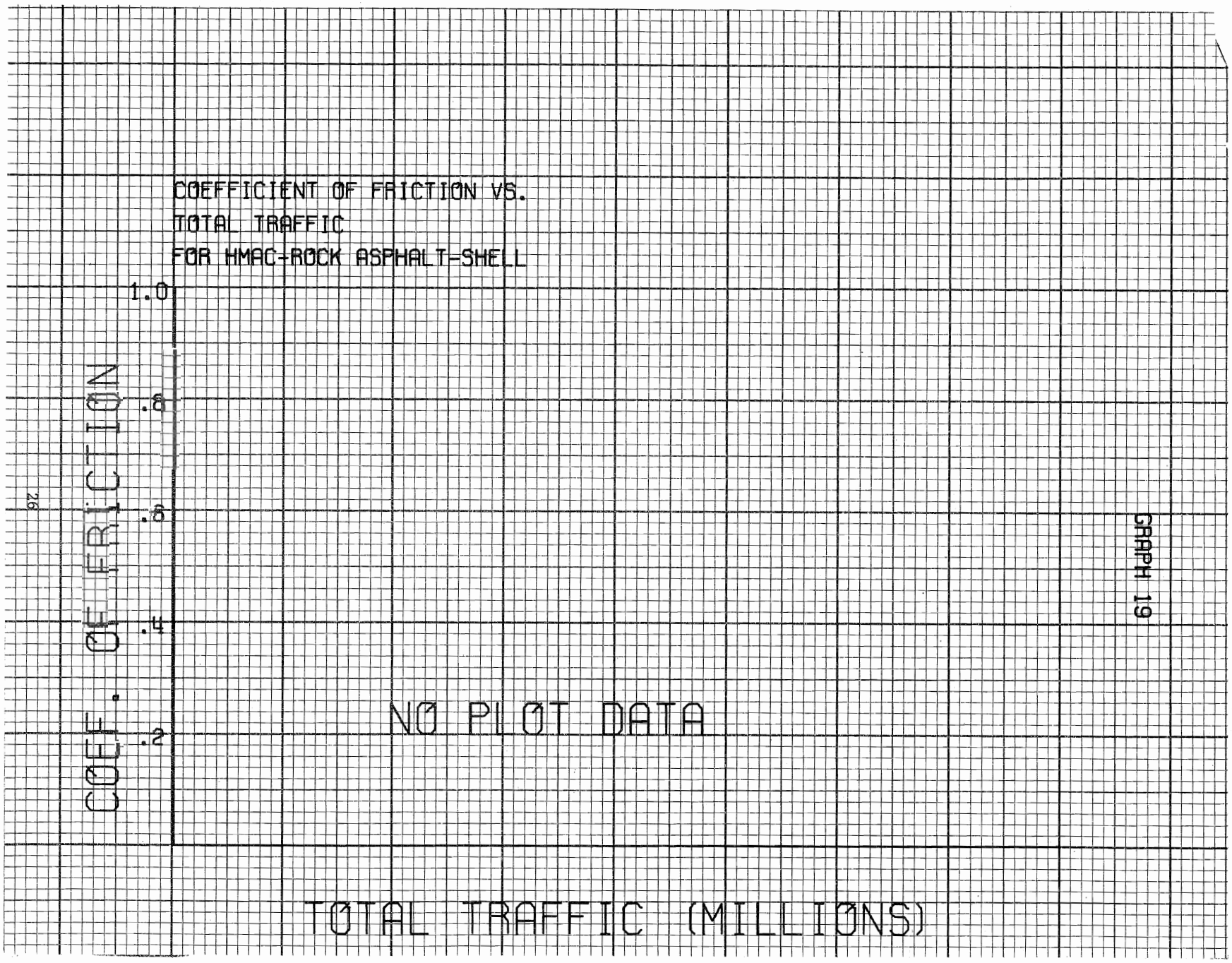

COEFFICIENT OF FRICTION VS.
TOTAL TRAFFIC
FOR HMAC-LIGHTWEIGHT
1.0
.8
.6
.4
.2
COEF. OF FRICTION
.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
TOTAL TRAFFIC (MILLIONS)
GRAPH 14

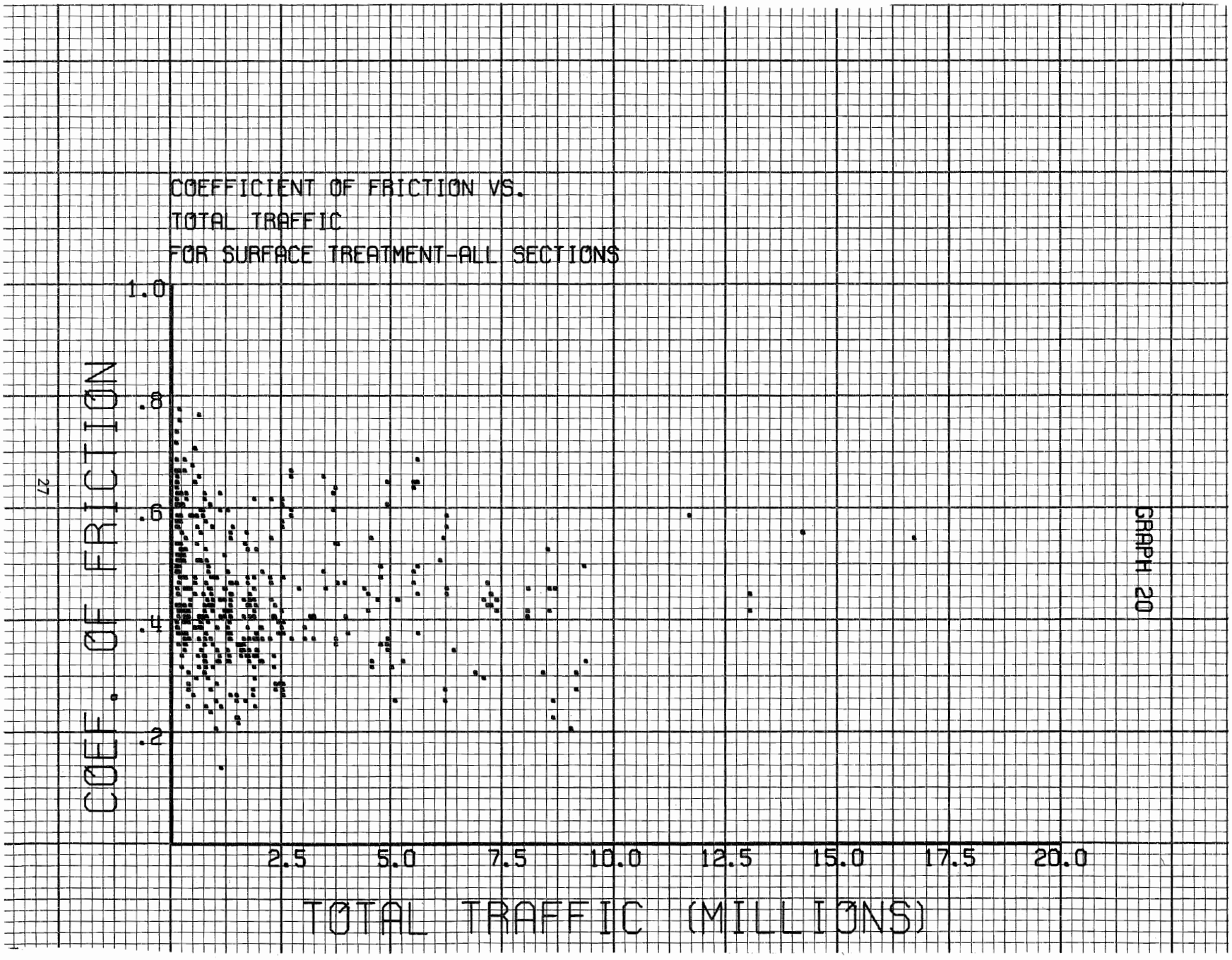

COEFFICIENT OF FRICTION VS.
TOTAL TRAFFIC
FOR HMAC-SLAG
1.0
.8
.6
.4
.2
COEF. OF FRICTION
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
TOTAL TRAFFIC (MILLIONS)
GRAPH 15

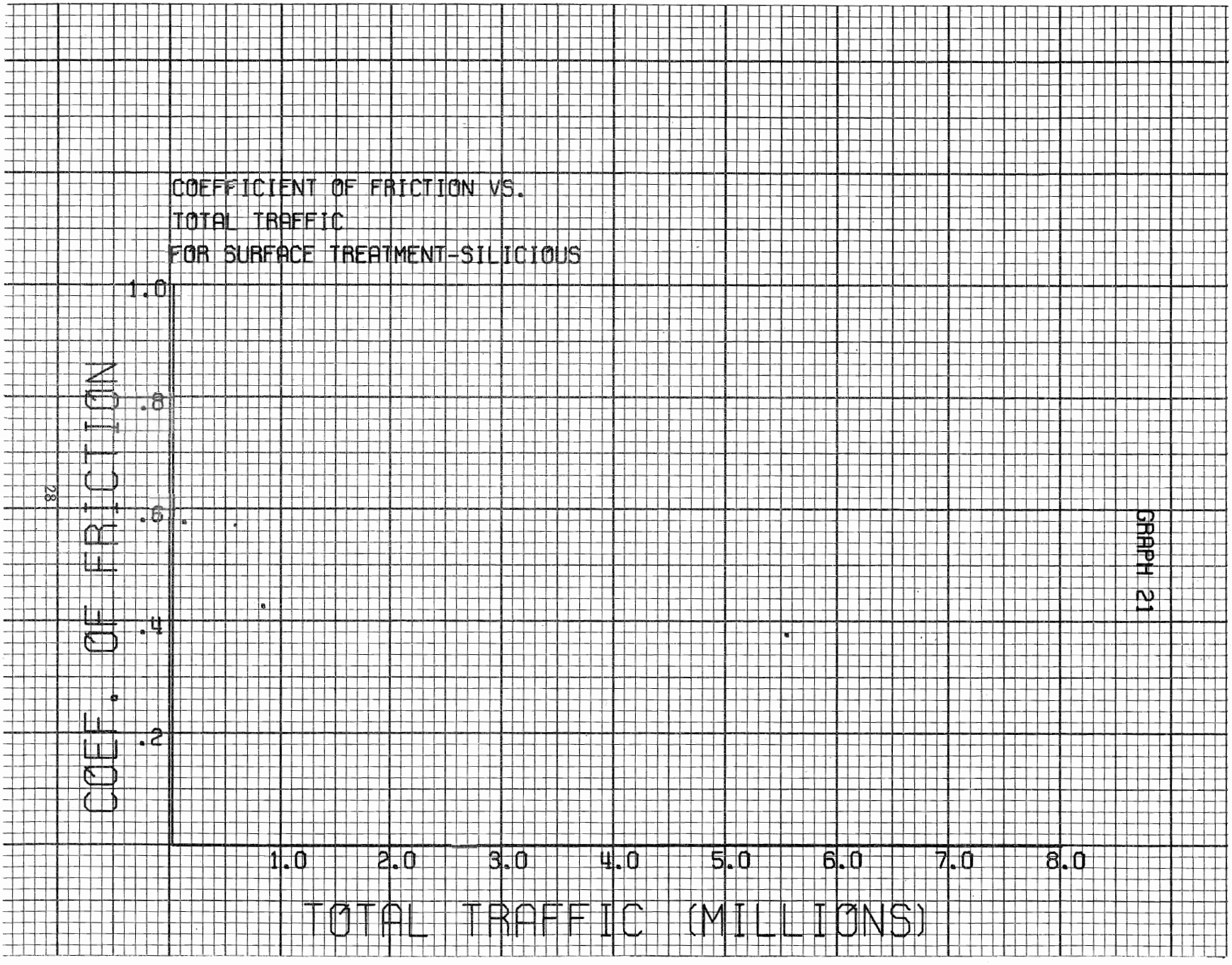

COEFFICIENT OF FRICTION VS.
TOTAL TRAFFIC
FOR HMAC-TRAP ROCK
COEF. OF FRICTION
1.0
.8
.6
.4
.2
1.5
3.0
4.5
6.0
7.5
9.0
10.5
12.0
TOTAL TRAFFIC (MILLIONS)
3 OR MORE VALUES OVER SCALE
GRAPH 16

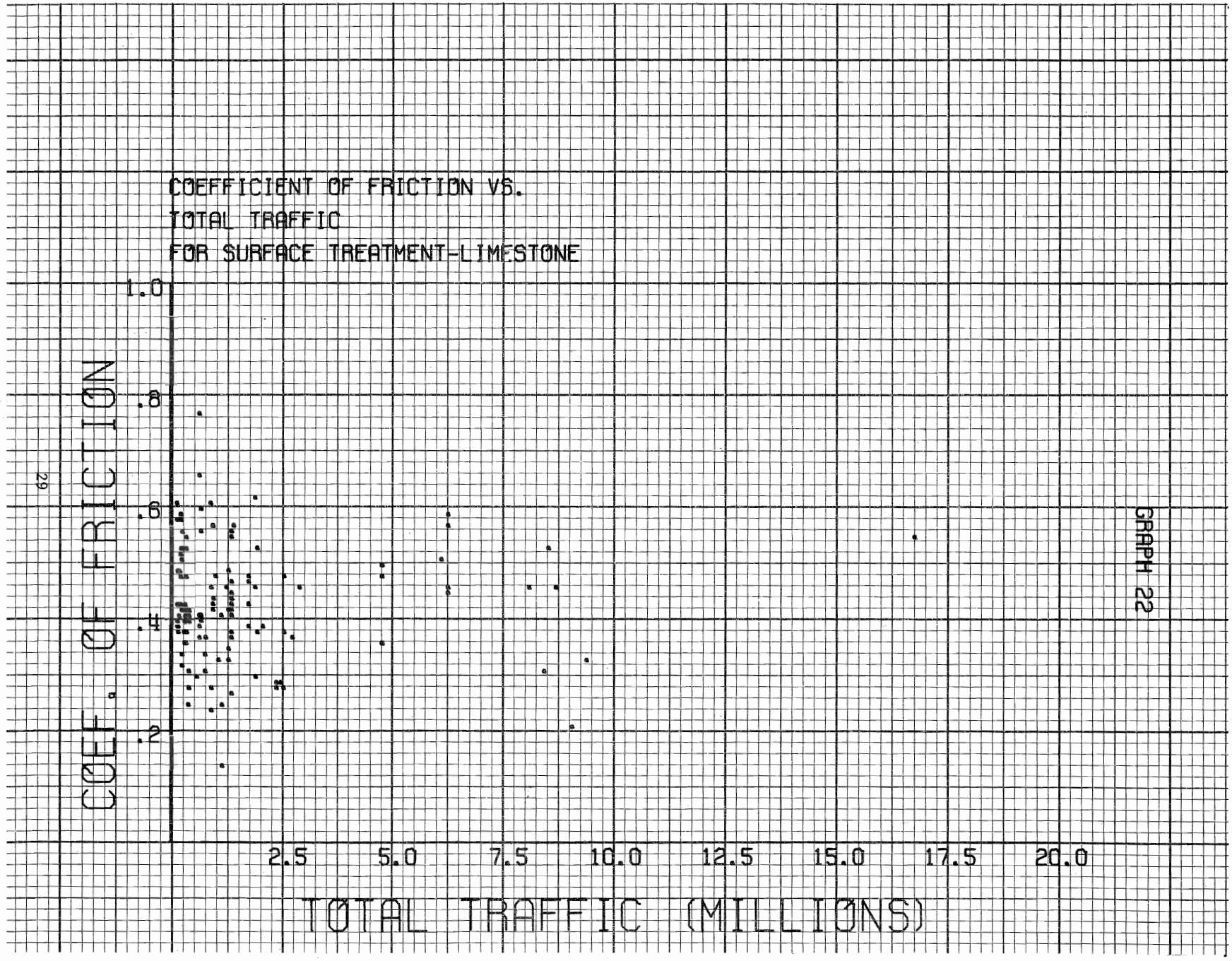

COEFFICIENT OF FRICTION VS.
TOTAL TRAFFIC
FOR HMAC-ROCK ASPHALT
COEF. OF FRICTION
1.0
.8
.6
.4
.2
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
TOTAL TRAFFIC (MILLIONS)
GRAPH 17


COEFFICIENT OF FRICTION VS.
TOTAL TRAFFIC
FOR HMAC-SHELL
1.0
.8
.6
.4
.2
COEF. OF FRICTION
NO PLOT DATA
TOTAL TRAFFIC (MILLIONS)
GRAPH 18

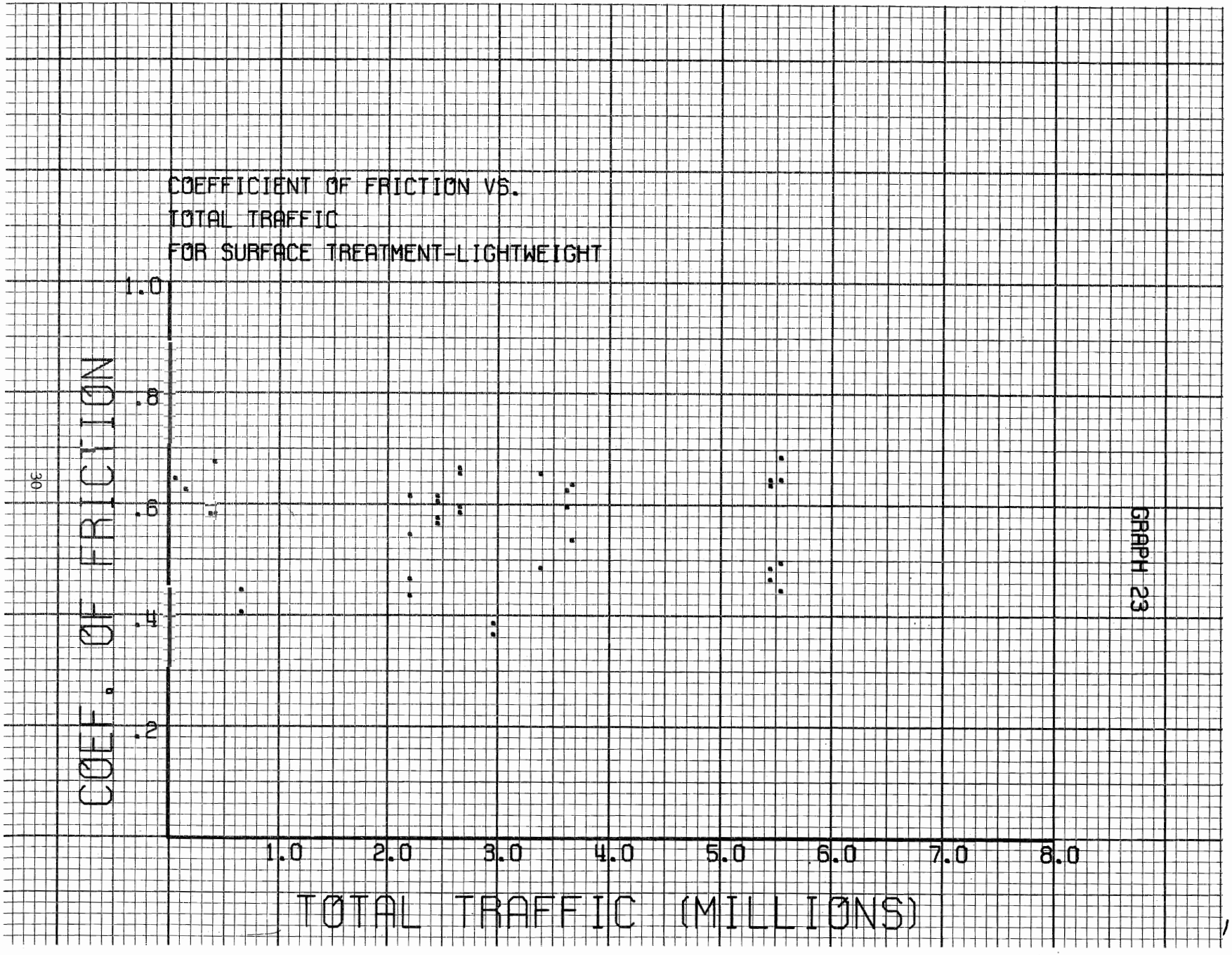

COEFFICIENT OF FRICTION VS.
TOTAL TRAFFIC
FOR HMAC-ROCK ASPHALT-SHELL
1.0
.8
.6
.4
.2
COEF. OF FRICTION
NO PLOT DATA
TOTAL TRAFFIC (MILLIONS)
GRAPH 19

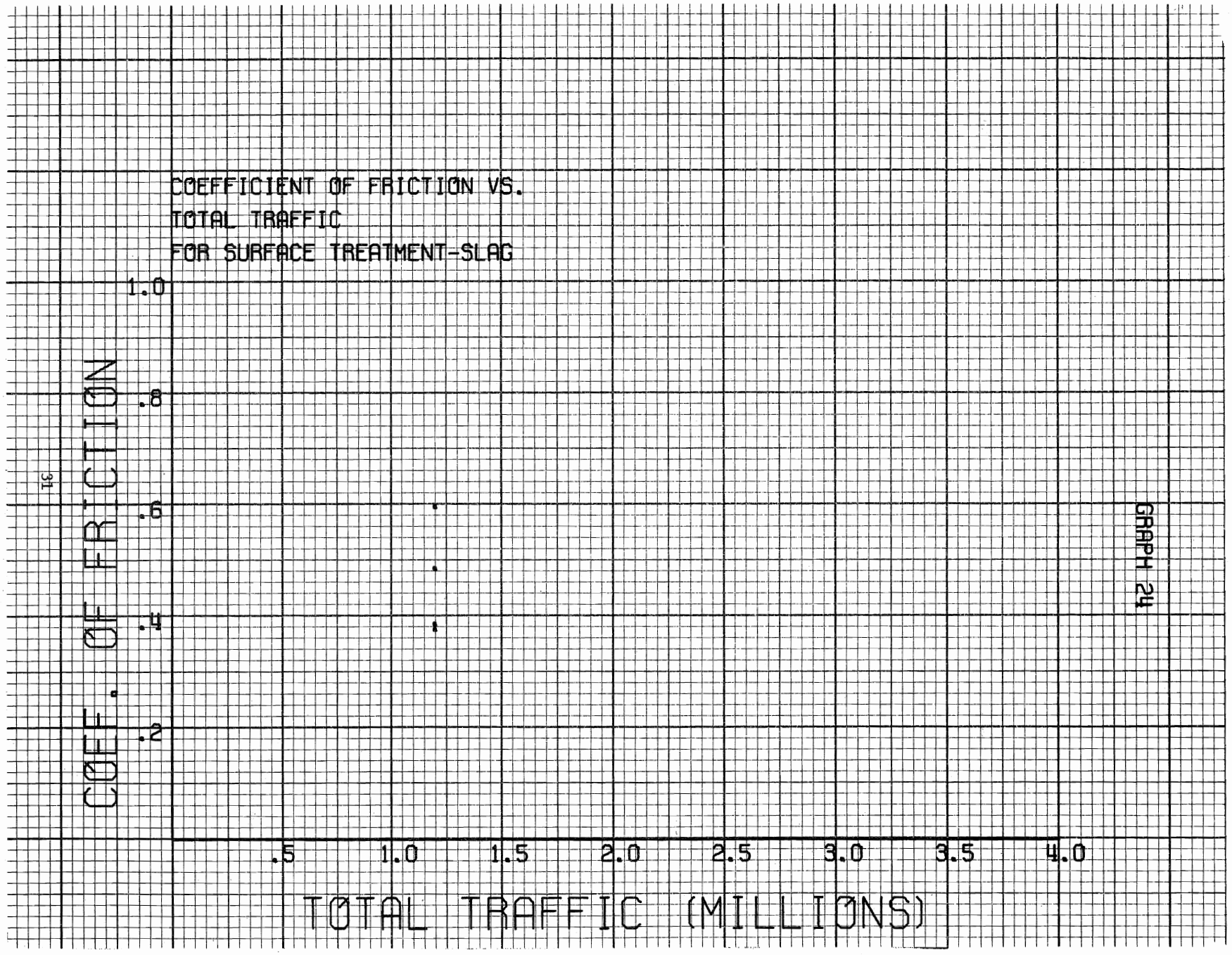

COEFFICIENT OF FRICTION VS.
TOTAL TRAFFIC
FOR SURFACE TREATMENT-ALL SECTIONS
COEF. OF FRICTION
1.0
.8
.6
.4
.2
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
TOTAL TRAFFIC (MILLIONS)
GRAPH 20

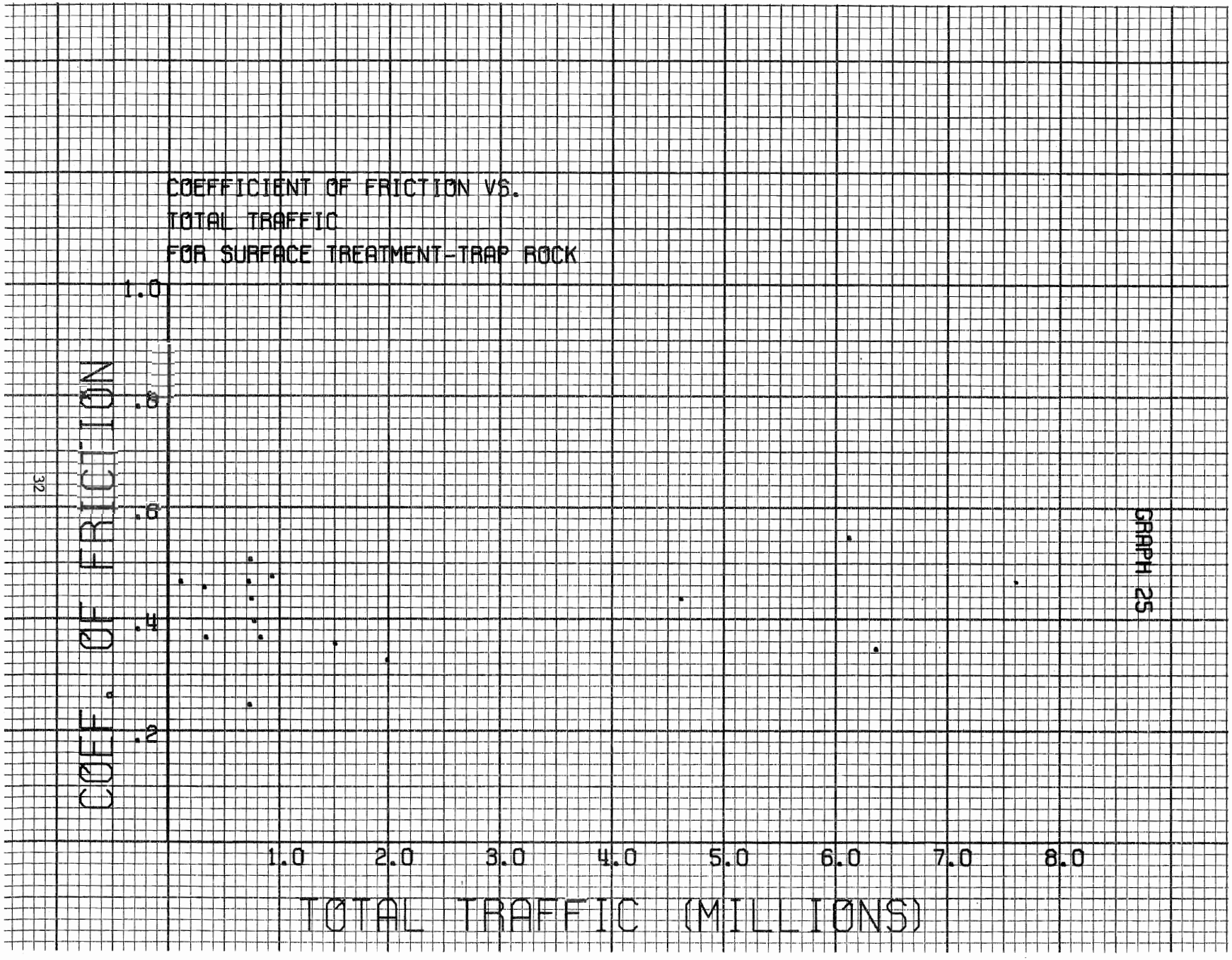

COEFFICIENT OF FRICTION VS.
TOTAL TRAFFIC
FOR SURFACE TREATMENT-SILICIOUS
COEF. OF FRICTION
1.0
.8
.6
.4
.2
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
TOTAL TRAFFIC (MILLIONS)
GRAPH 21

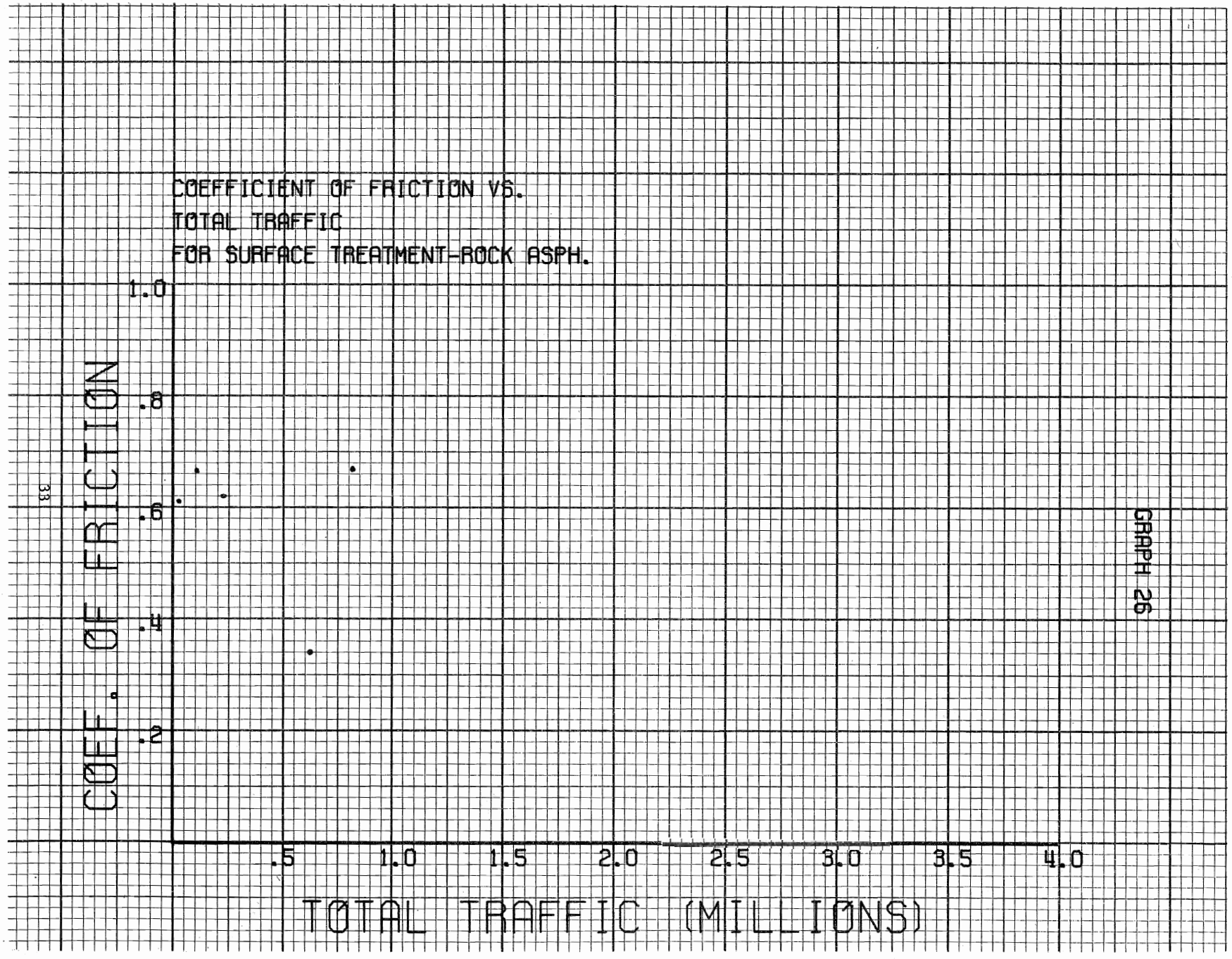

COEFFICIENT OF FRICTION VS.
TOTAL TRAFFIC
FOR SURFACE TREATMENT-LIMESTONE
COEF. OF FRICTION
1.0
.8
.6
.4
.2
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
TOTAL TRAFFIC (MILLIONS)

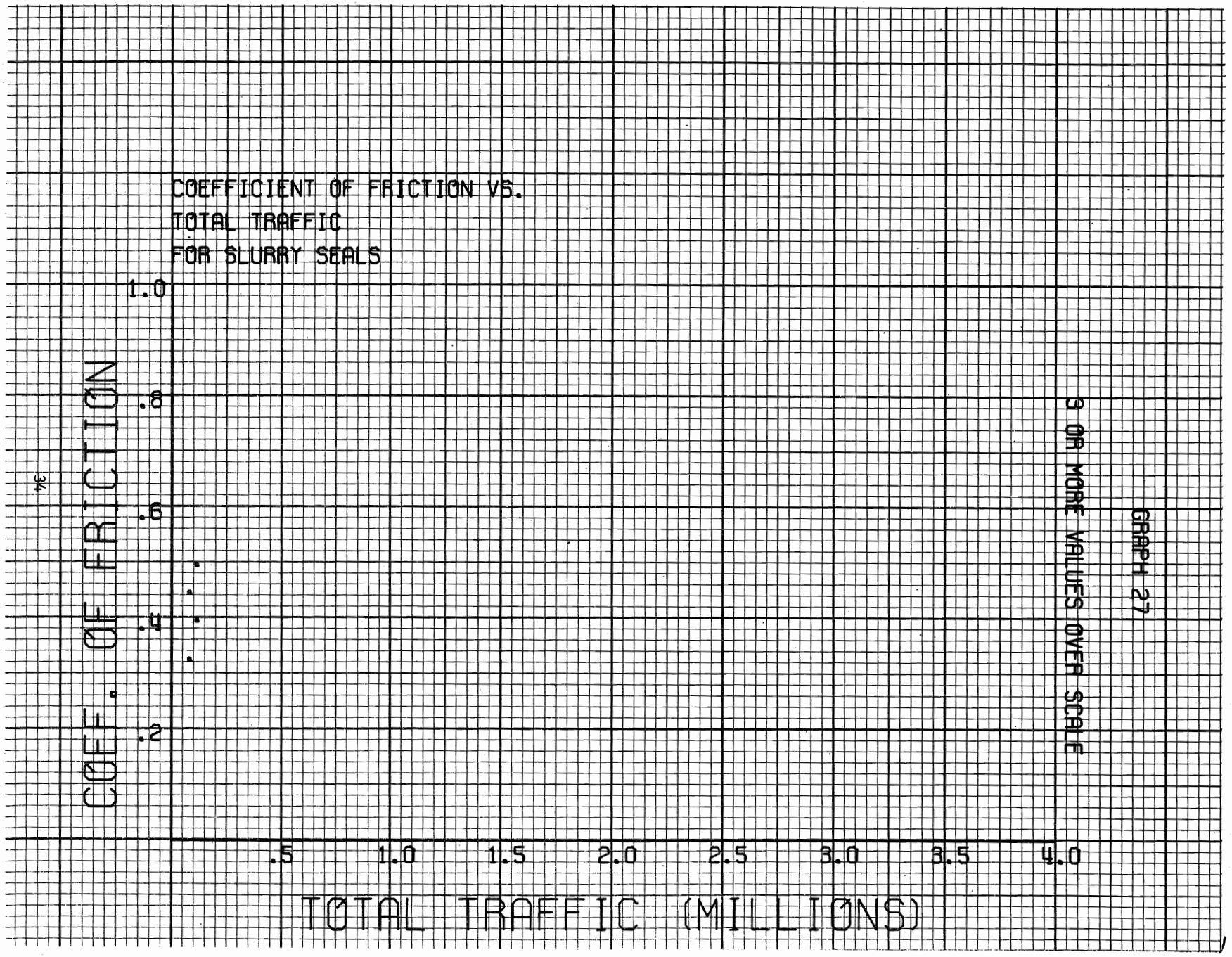
GRAPH 22

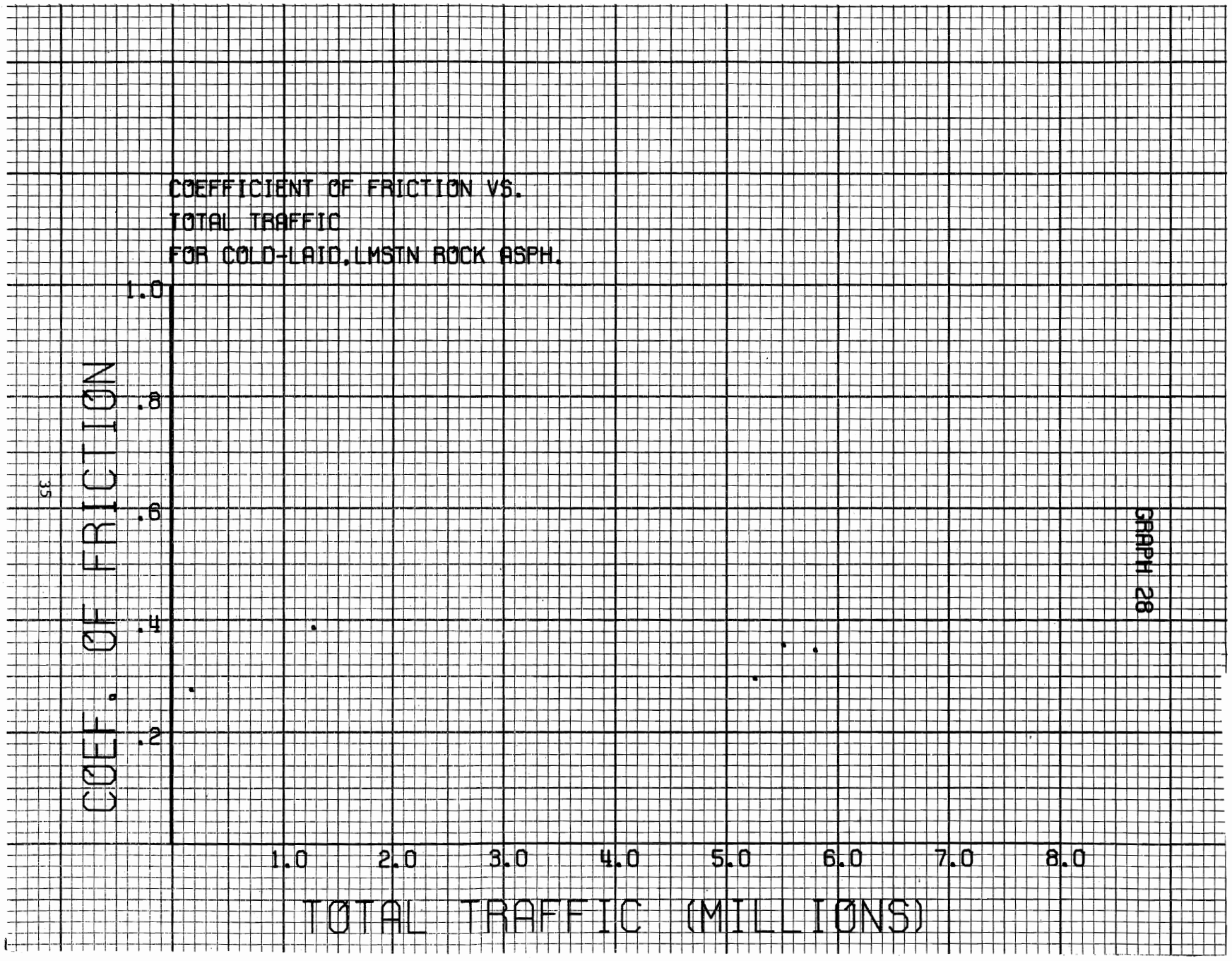

COEFFICIENT OF FRICTION VS.
TOTAL TRAFFIC
FOR SURFACE TREATMENT-LIGHTWEIGHT
COEF. OF FRICTION
1.0
.8
.6
.4
.2
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
TOTAL TRAFFIC (MILLIONS)
GRAPH 23


COEFFICIENT OF FRICTION VS.
TOTAL TRAFFIC
FOR SURFACE TREATMENT-SLAG
COEF. OF FRICTION
1.0
.8
.6
.4
.2
.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
TOTAL TRAFFIC (MILLIONS)
GRAPH 24


COEFFICIENT OF FRICTION VS.
TOTAL TRAFFIC
FOR SURFACE TREATMENT-TRAP ROCK
COEFF. OF FRICTION
1.0
.8
.6
.4
.2
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
TOTAL TRAFFIC (MILLIONS)
GRAPH 25


COEFFICIENT OF FRICTION VS.
TOTAL TRAFFIC
FOR SURFACE TREATMENT-ROCK ASPH.
COEF. OF FRICTION
1.0
.8
.6
.4
.2
.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
TOTAL TRAFFIC (MILLIONS)
GRAPH 26


COEFFICIENT OF FRICTION VS.
TOTAL TRAFFIC
FOR SLURRY SEALS
COEF. OF FRICTION
1.0
.8
.6
.4
.2
.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
TOTAL TRAFFIC (MILLIONS)
3 OR MORE VALUES OVER SCALE
GRAPH 27


COEFFICIENT OF FRICTION VS.
TOTAL TRAFFIC
FOR COLD-LAID.LMSTN ROCK ASPH.
COEF. OF FRICTION
1.0
.8
.6
.4
.2
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
TOTAL TRAFFIC (MILLIONS)
GRAPH 28

PAVEMENT MATERIAL

The following plots attempt to study the pavement surfacing materials more closely. These plots study the effect of the gradation of the aggregate and the amount of binder at a selected traffic range for a given material and pavement type. Graphs 29 through 50 study the effect of the binder and graphs 51 through 61 study the effect of the gradation. Each plot of all information obtained for a pavement type is followed by specific information of the material types used in the pavement type.

The Effect of Binder

In this study two traffic ranges were selected, these being (1) 0-4 million applications and (2) 4-8 million applications for HMAC and (1) 0-2 million (2) greater than 2 million for surface treatments. Please note that the total traffic used in this study is not the actual traffic applications each lane has received because the ADT was used in the calculation of total traffic. It is generally agreed upon by most authorities that all HMAC aggregates polish to some friction level at approximately 4 to 4.5 vehicle applications and remains approximately constant after that. These two traffic ranges were chosen because the aggregate is polishing from 0-4 million applications and the coefficient of friction appears to have leveled off in the 4-8 million range. The different surface treatment traffic ranges were chosen because most surface treatments are resurfaced before they have received two million traffic applications.

Hot Mix Asphaltic Concrete

Graph 29 is a general plot of all HMAC pavements tested. Graphs

30 through 39 are related to specific aggregate types. Again as in report SS 11.4 higher asphalt contents appear not to hinder friction values. There is probably an optimum asphalt content, just as there is an optimum moisture content in base, but this optimum is not appearant from these plots.

Surface Treatments

Graph 40 is a general plot of all surface treatment pavements tested. Graphs 40 through 46 are related to specific aggregate types.

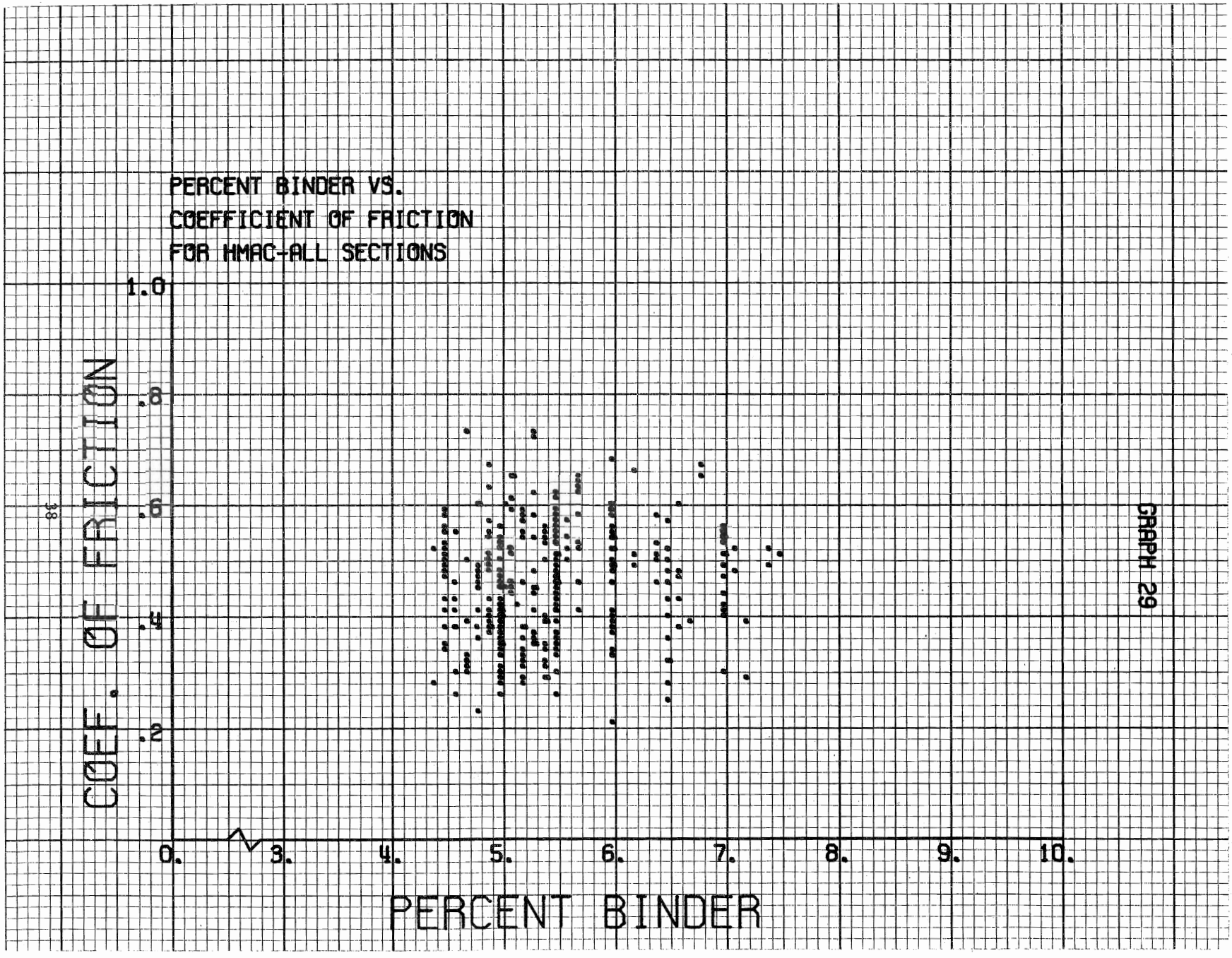
As in the HMAC studied there appears to be no optimum asphalt content. In this analysis it must be remembered that the binder content on some pavements has been varied to match the surface condition before surfacing. The binder contents of greater than 0.7 gal/sq.yd. were checked with the district involved and they are correct.

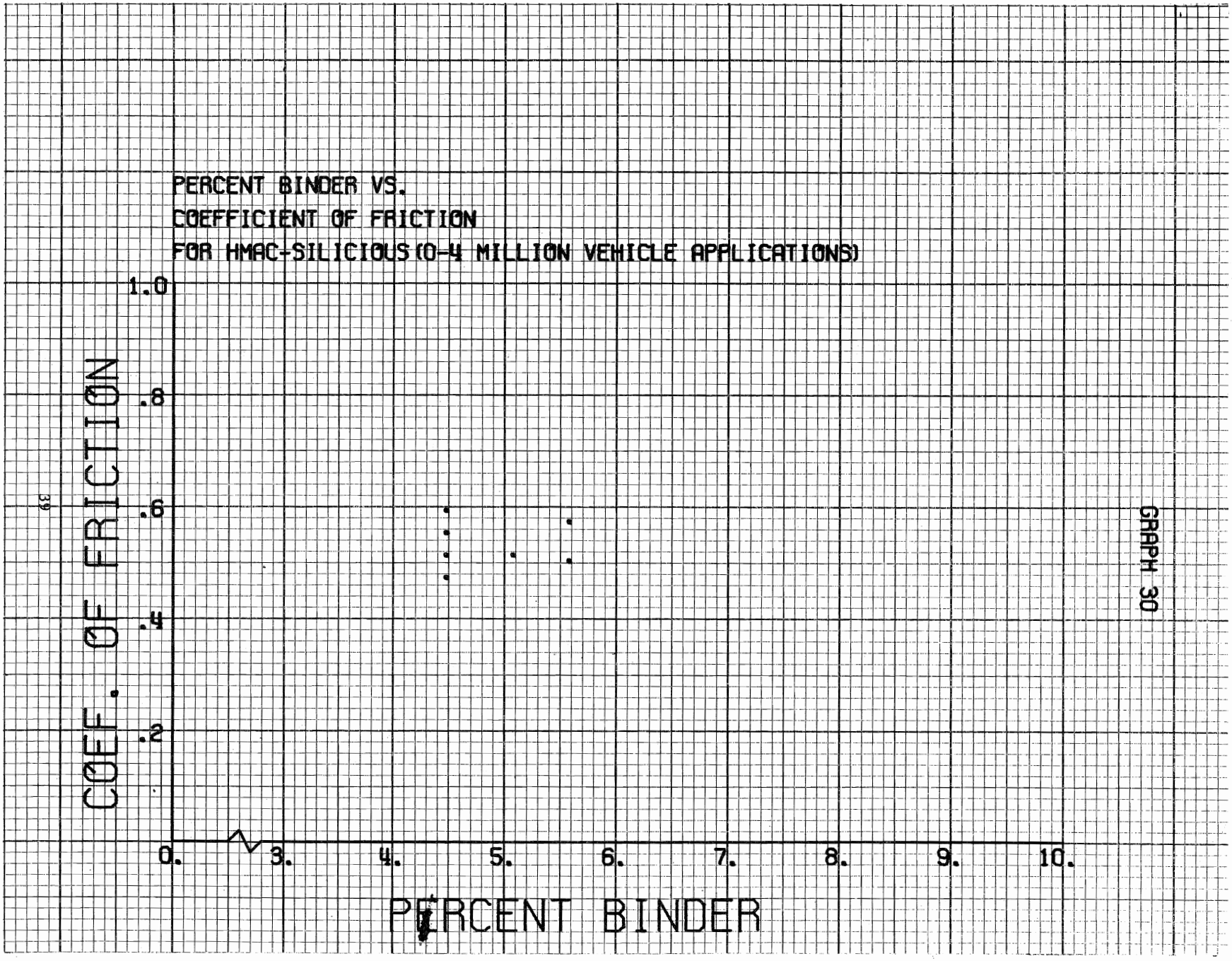
Slurry Seals

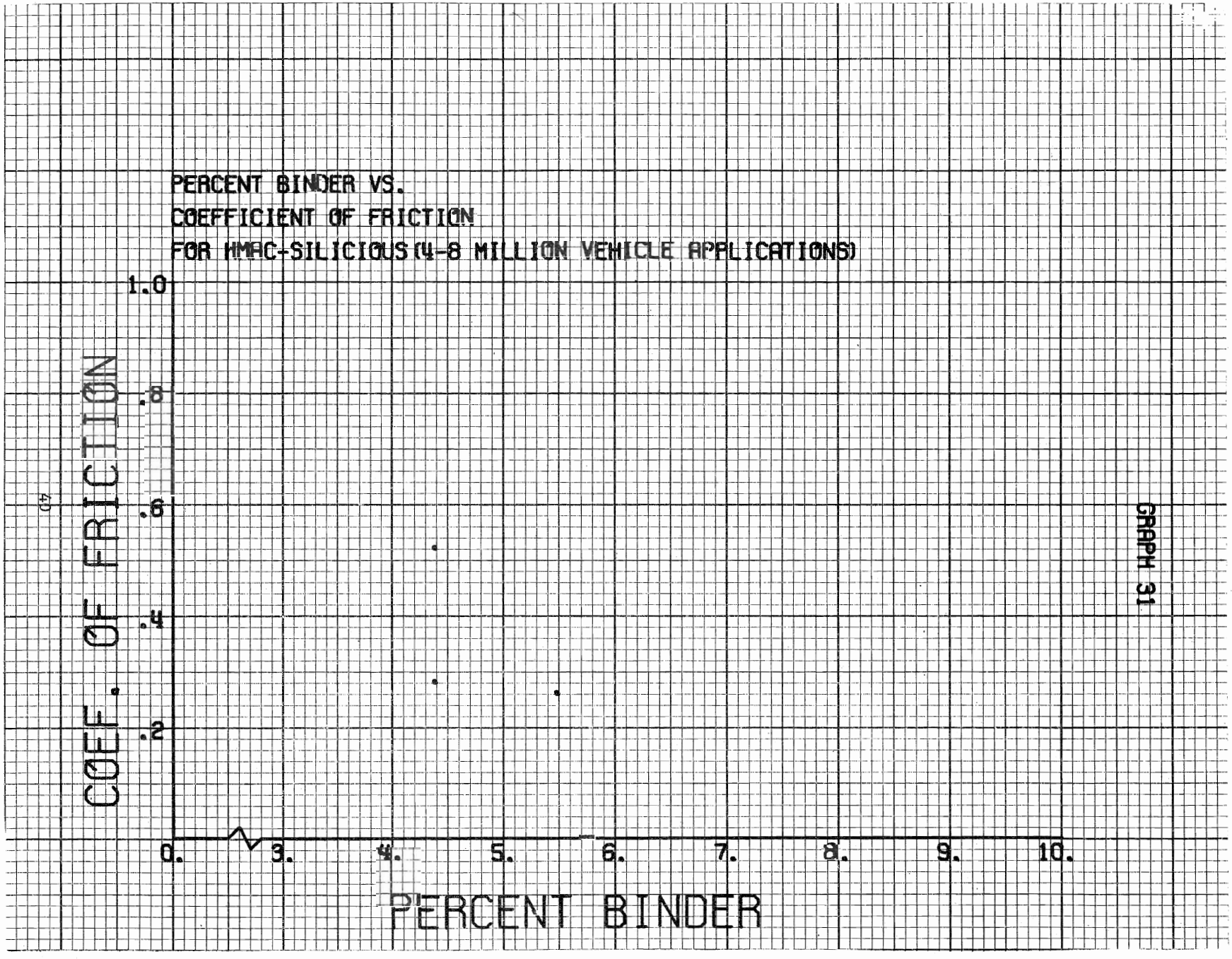
No trends show from Graph 47 due to the small amount of data.

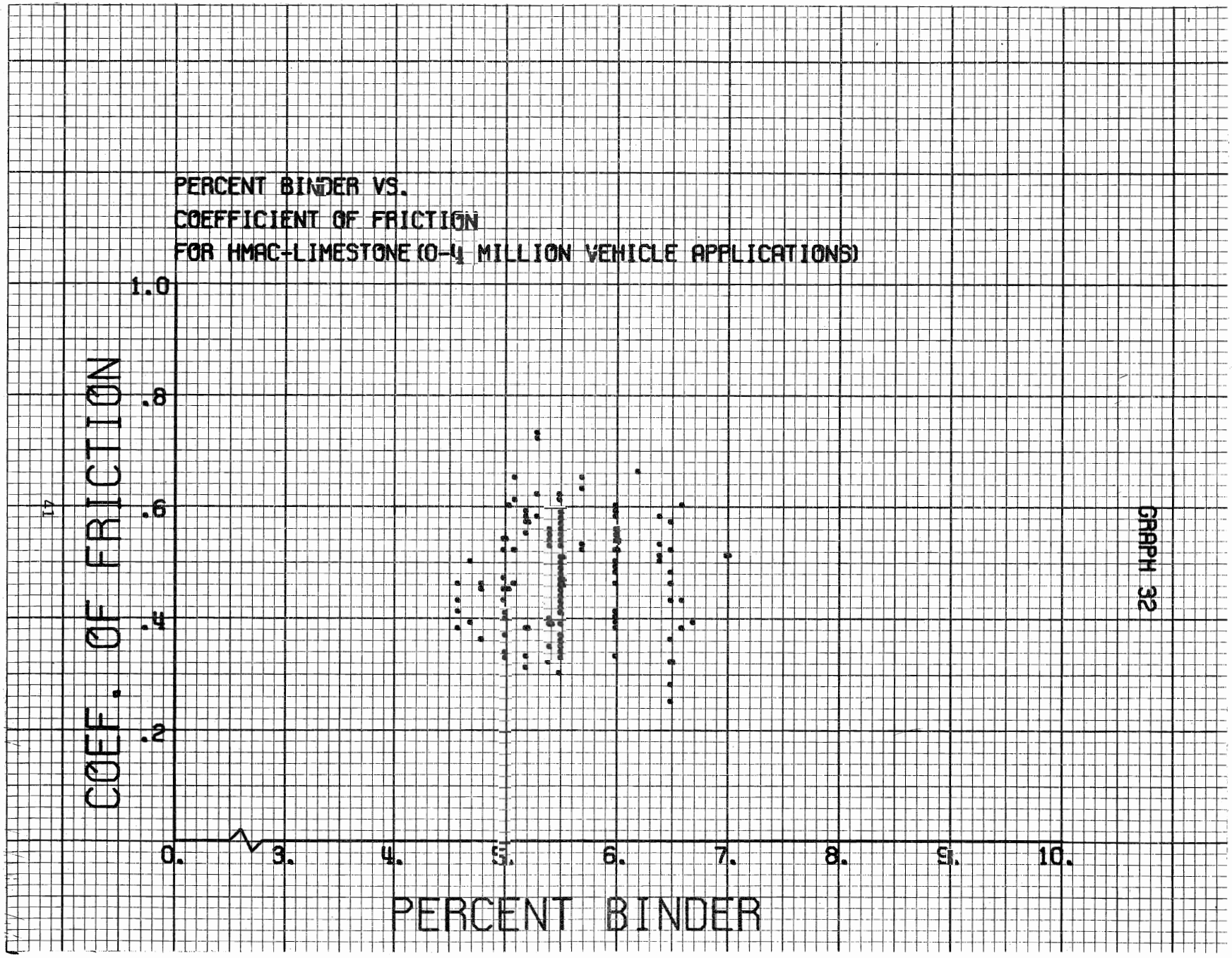
Hot Mix Cold Laid Asphaltic Concrete

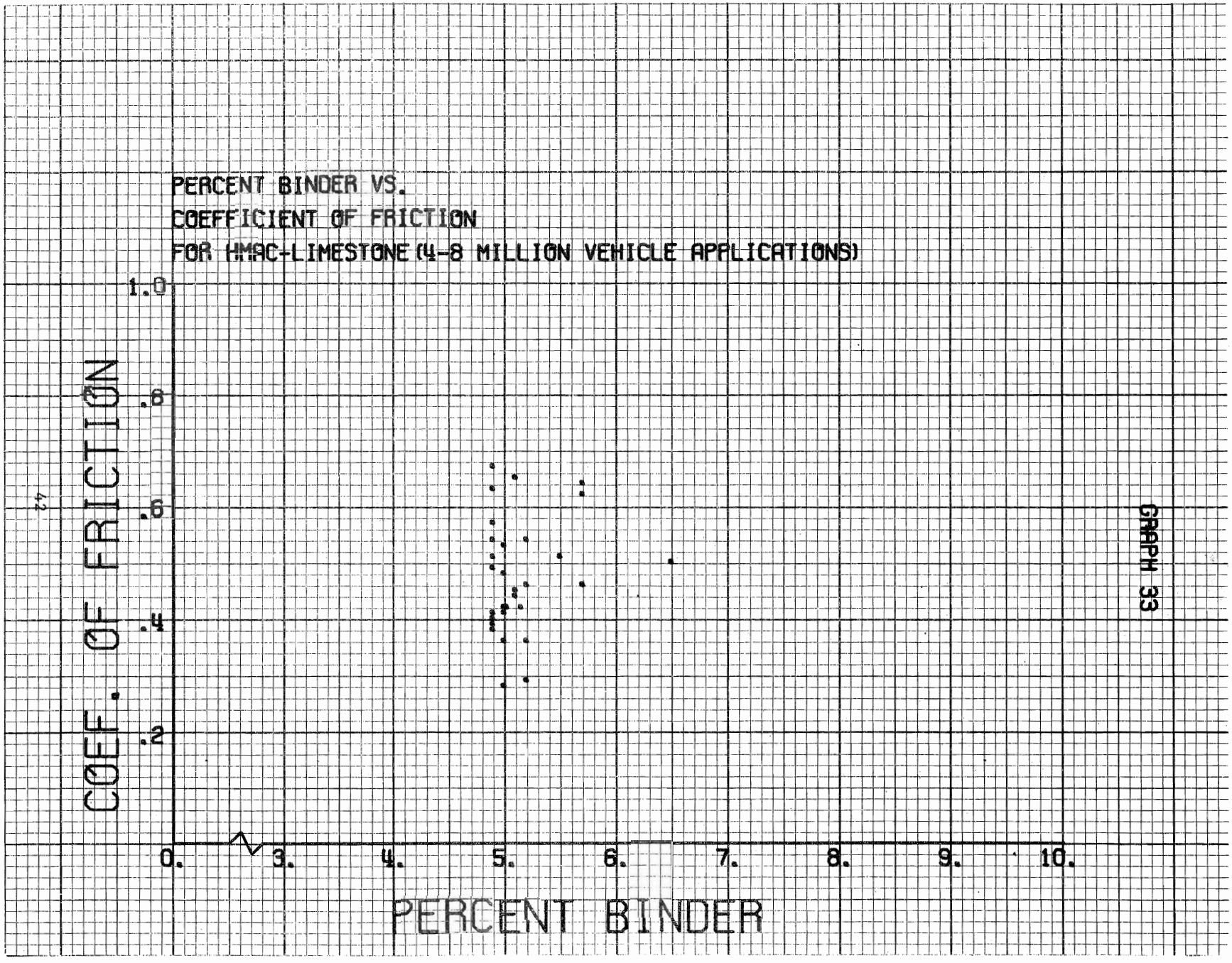
Again there can be no definite trends established due to the small amount of data available. (See Graph 50).

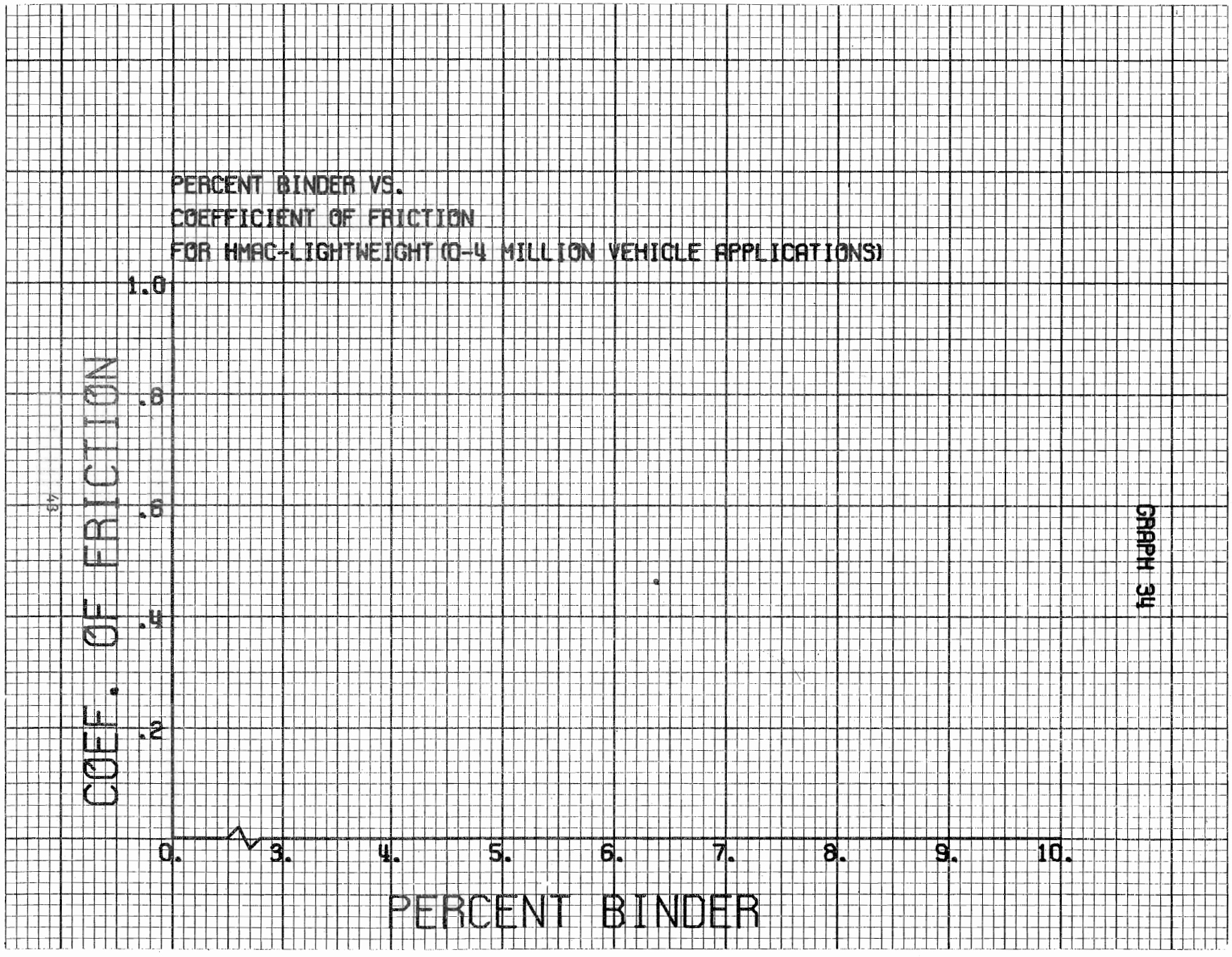

PERCENT BINDER VS.
COEFFICIENT OF FRICTION
FOR HMAC-ALL SECTIONS
1.0
.8
.6
.4
.2
0.
3.
4.
5.
6.
7.
8.
9.
10.
COEF. OF FRICTION
PERCENT BINDER
GRAPH 29

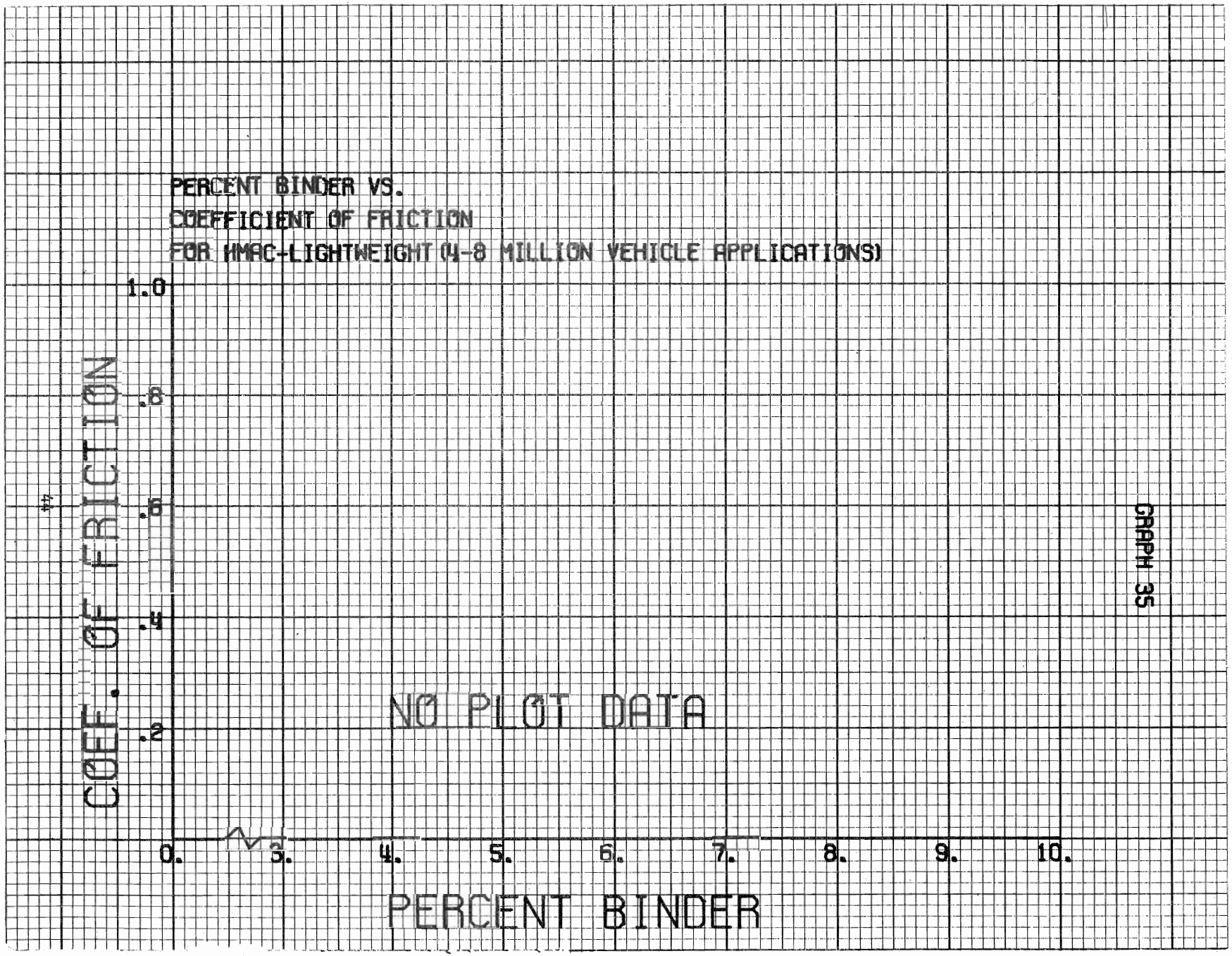

PERCENT BINDER VS.
COEFFICIENT OF FRICTION
FOR HMAC-SILICIOUS (0-4 MILLION VEHICLE APPLICATIONS)
1.0
.8
.6
.4
.2
0.
3.
4.
5.
6.
7.
8.
9.
10.
COEF. OF FRICTION
PERCENT BINDER
GRAPH 30

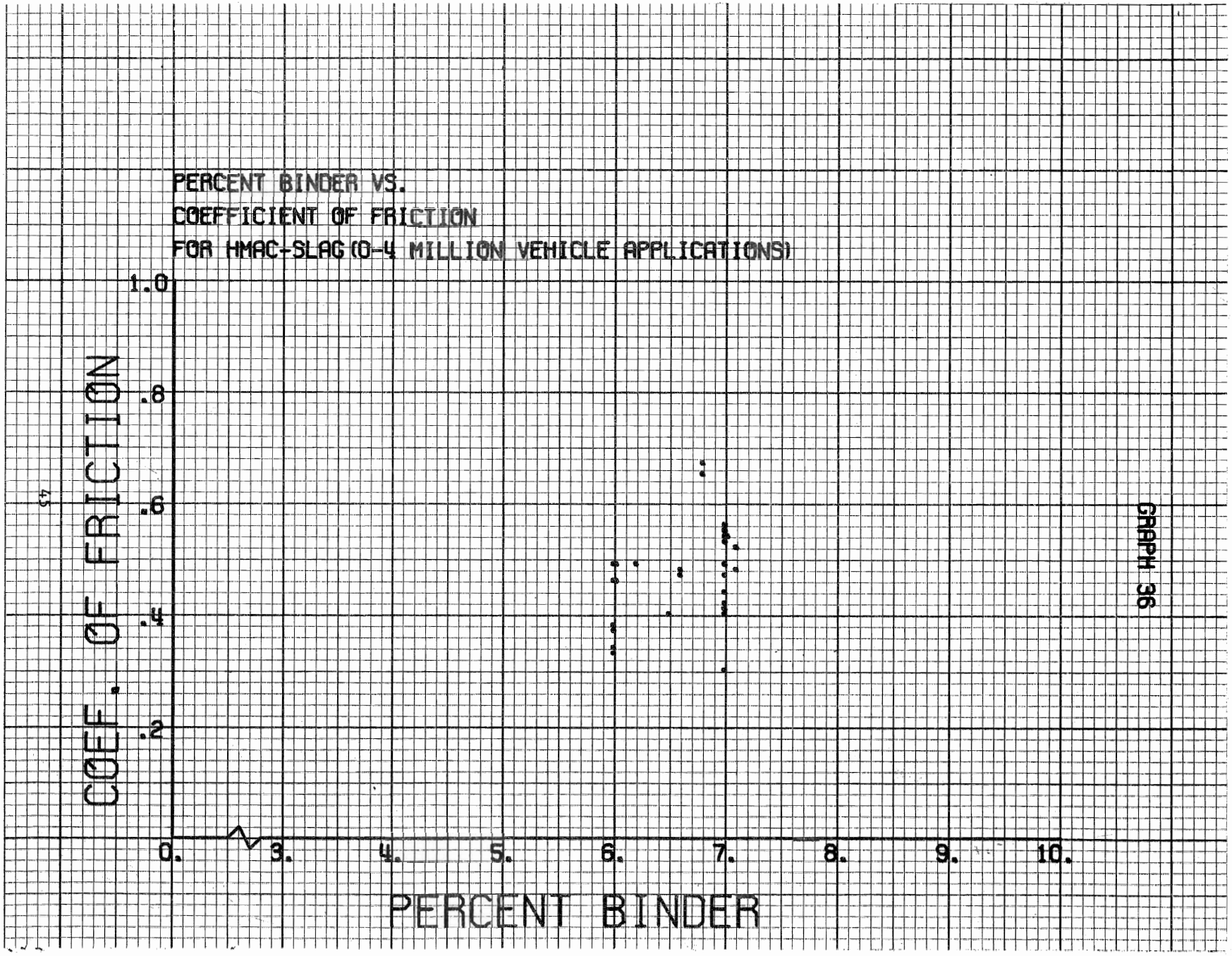

PERCENT BINDER VS.
COEFFICIENT OF FRICTION
FOR HMAC-SILICIOUS (4-8 MILLION VEHICLE APPLICATIONS)
COEF. OF FRICTION
1.0
.8
.6
.4
.2
0.
3.
4.
5.
6.
7.
8.
9.
10.
PERCENT BINDER
GRAPH 31

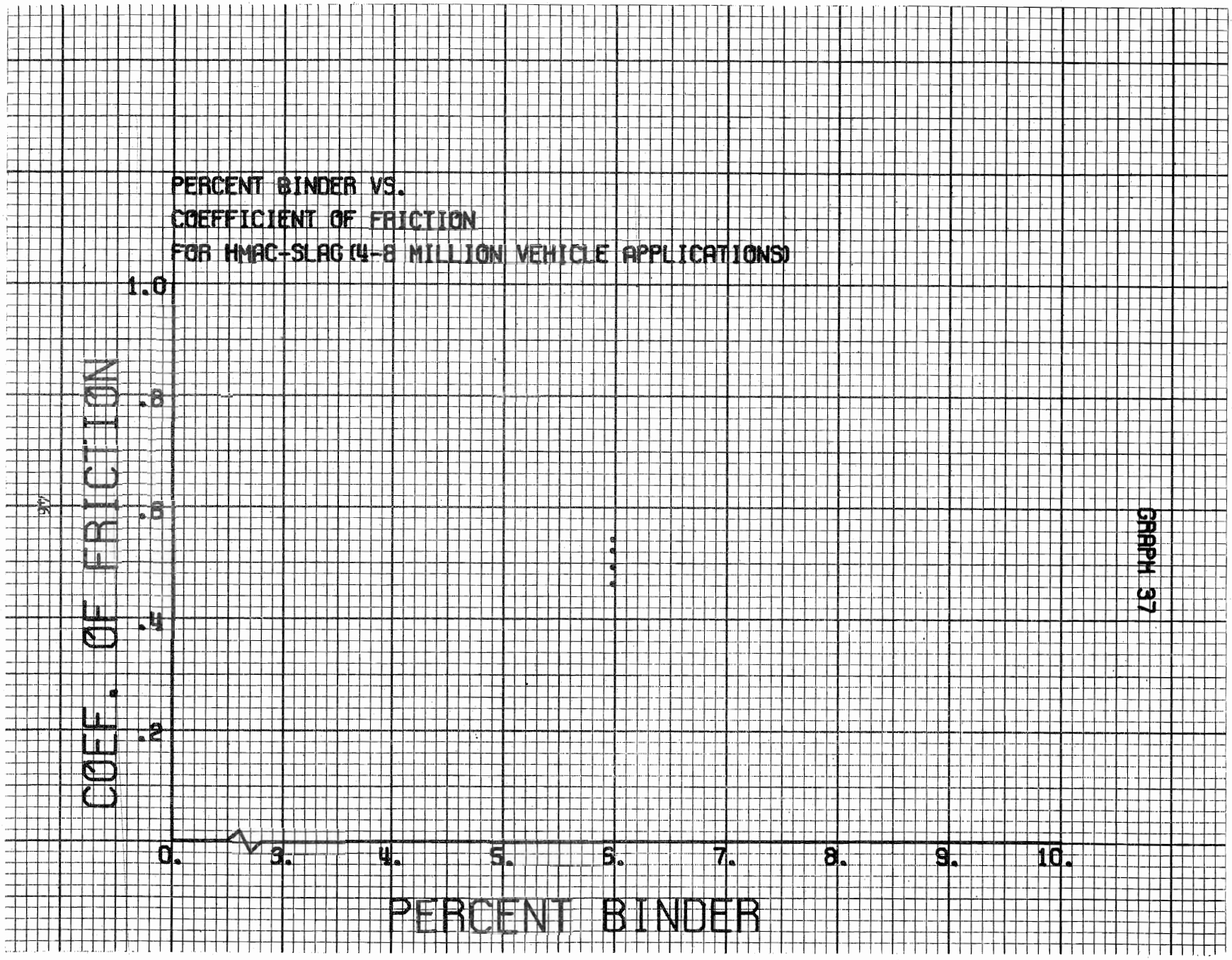

PERCENT BINDER VS.
COEFFICIENT OF FRICTION
FOR HMAC-LIMESTONE (0-4 MILLION VEHICLE APPLICATIONS)
COEF. OF FRICTION
1.0
.8
.6
.4
.2
0.
3.
4.
5.
6.
7.
8.
9.
10.
PERCENT BINDER
GRAPH 32

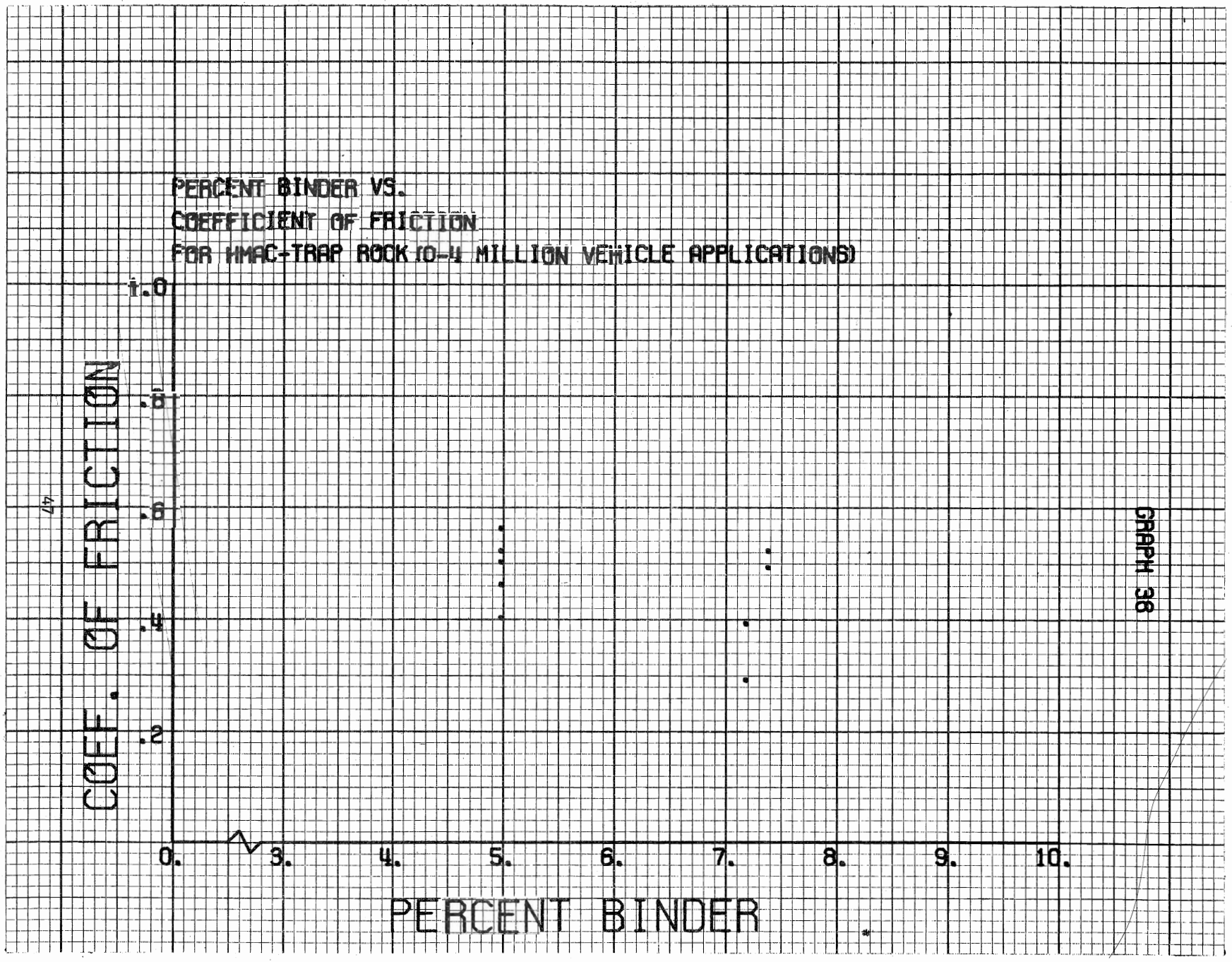

PERCENT BINDER VS.
COEFFICIENT OF FRICTION
FOR HMAC-LIMESTONE (4-8 MILLION VEHICLE APPLICATIONS)
COEF. OF FRICTION
1.0
.8
.6
.4
.2
0.
3.
4.
5.
6.
7.
8.
9.
10.
PERCENT BINDER
GRAPH 33

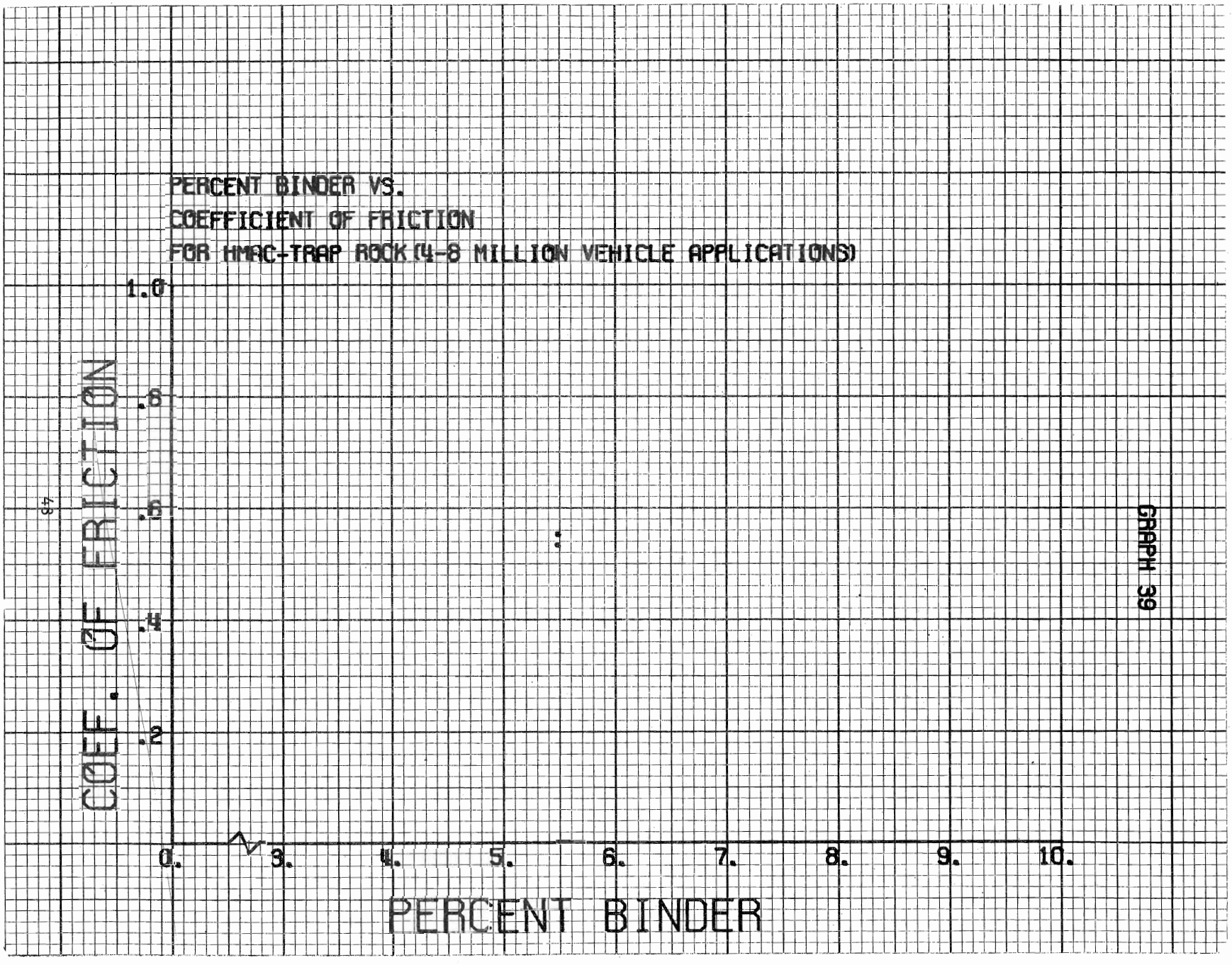

PERCENT BINDER VS.
COEFFICIENT OF FRICTION
FOR HMAC-LIGHTWEIGHT (0-4 MILLION VEHICLE APPLICATIONS)
1.0
.8
.6
.4
.2
0.
3.
4.
5.
6.
7.
8.
9.
10.
COEF. OF FRICTION
PERCENT BINDER
GRAPH 34

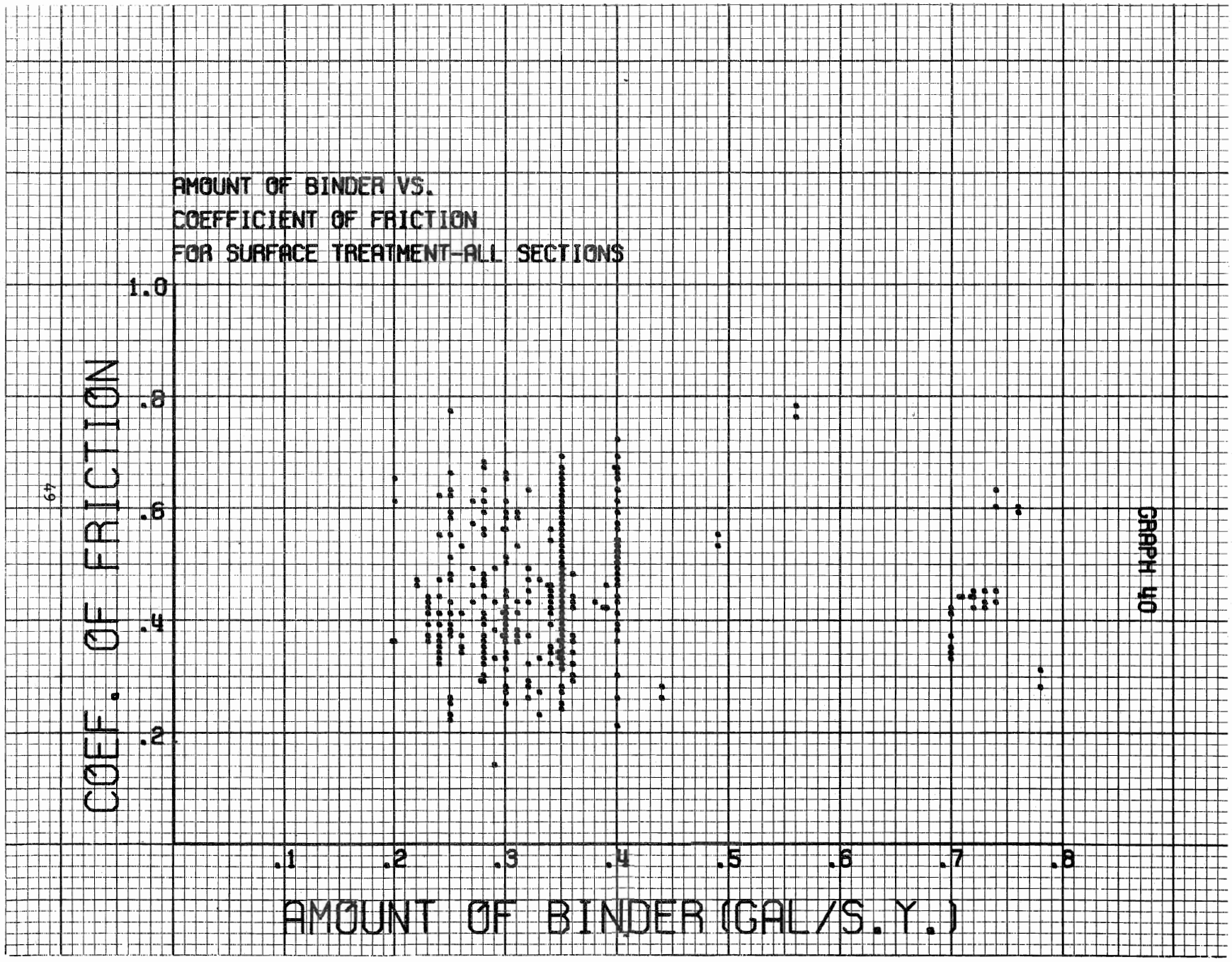

PERCENT BINDER VS.
COEFFICIENT OF FRICTION
FOR HMAC-LIGHTWEIGHT (4-8 MILLION VEHICLE APPLICATIONS)
1.0
.8
.6
.4
.2
0.
3.
4.
5.
6.
7.
8.
9.
10.
COEF. OF FRICTION
NO PLOT DATA
PERCENT BINDER
GRAPH 35

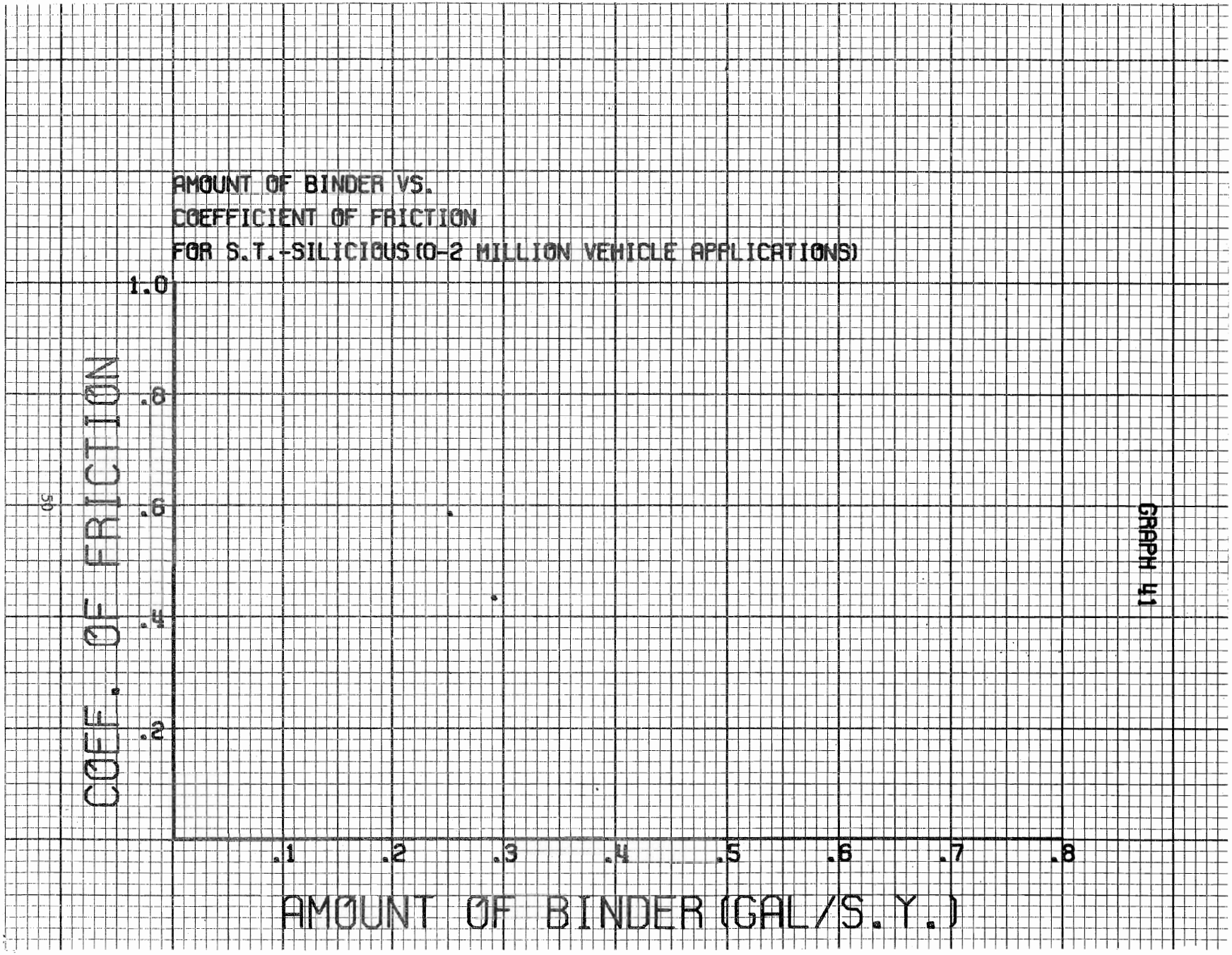

PERCENT BINDER VS.
COEFFICIENT OF FRICTION
FOR HMAC-SLAG (0-4 MILLION VEHICLE APPLICATIONS)
COEF. OF FRICTION
1.0
.8
.6
.4
.2
0.
3.
4.
5.
6.
7.
8.
9.
10.
PERCENT BINDER
GRAPH 36

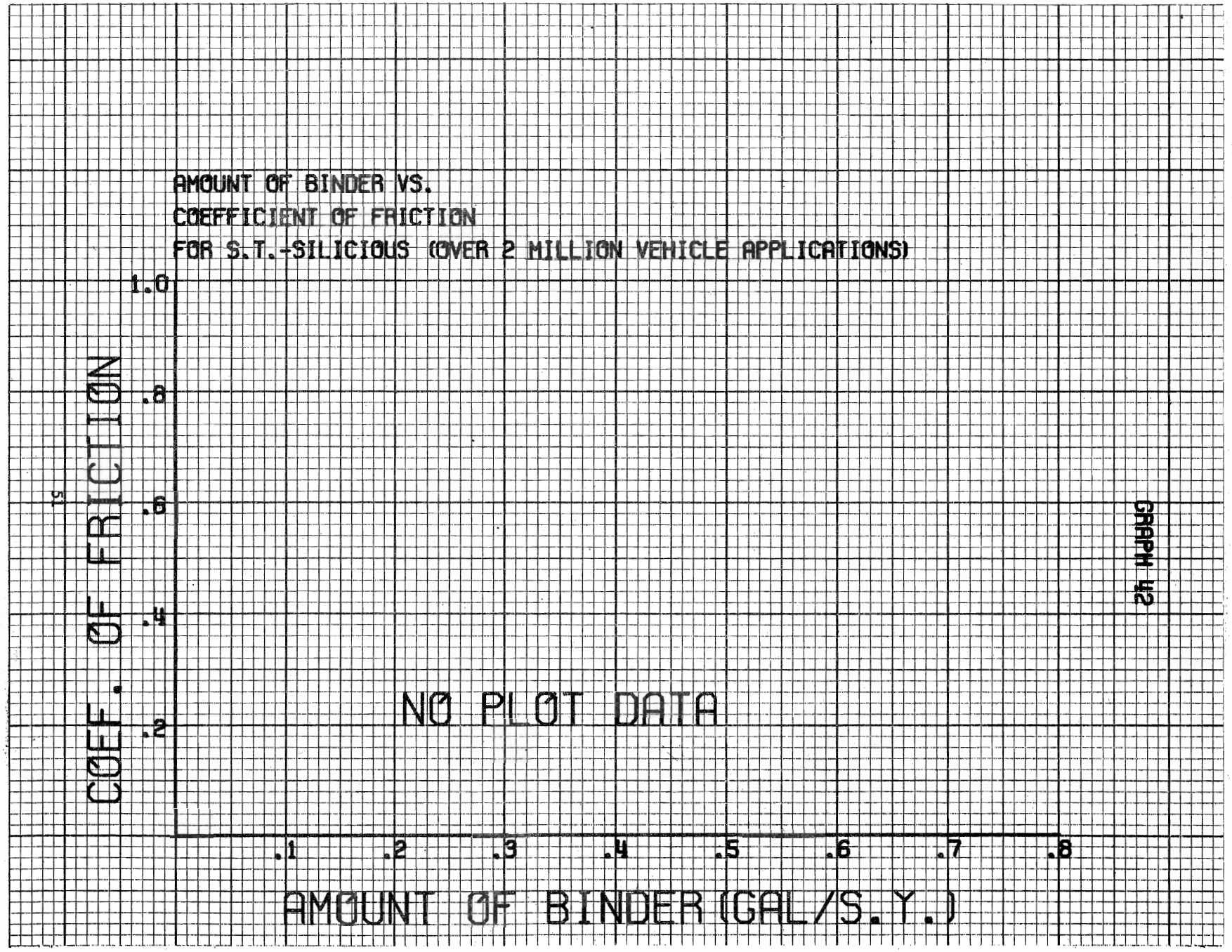

PERCENT BINDER VS.
COEFFICIENT OF FRICTION
FOR HMAC-SLAG (4-8 MILLION VEHICLE APPLICATIONS)
1.0
.8
.6
.4
.2
COEF. OF FRICTION
0.
3.
4.
5.
6.
7.
8.
9.
10.
PERCENT BINDER
GRAPH 37

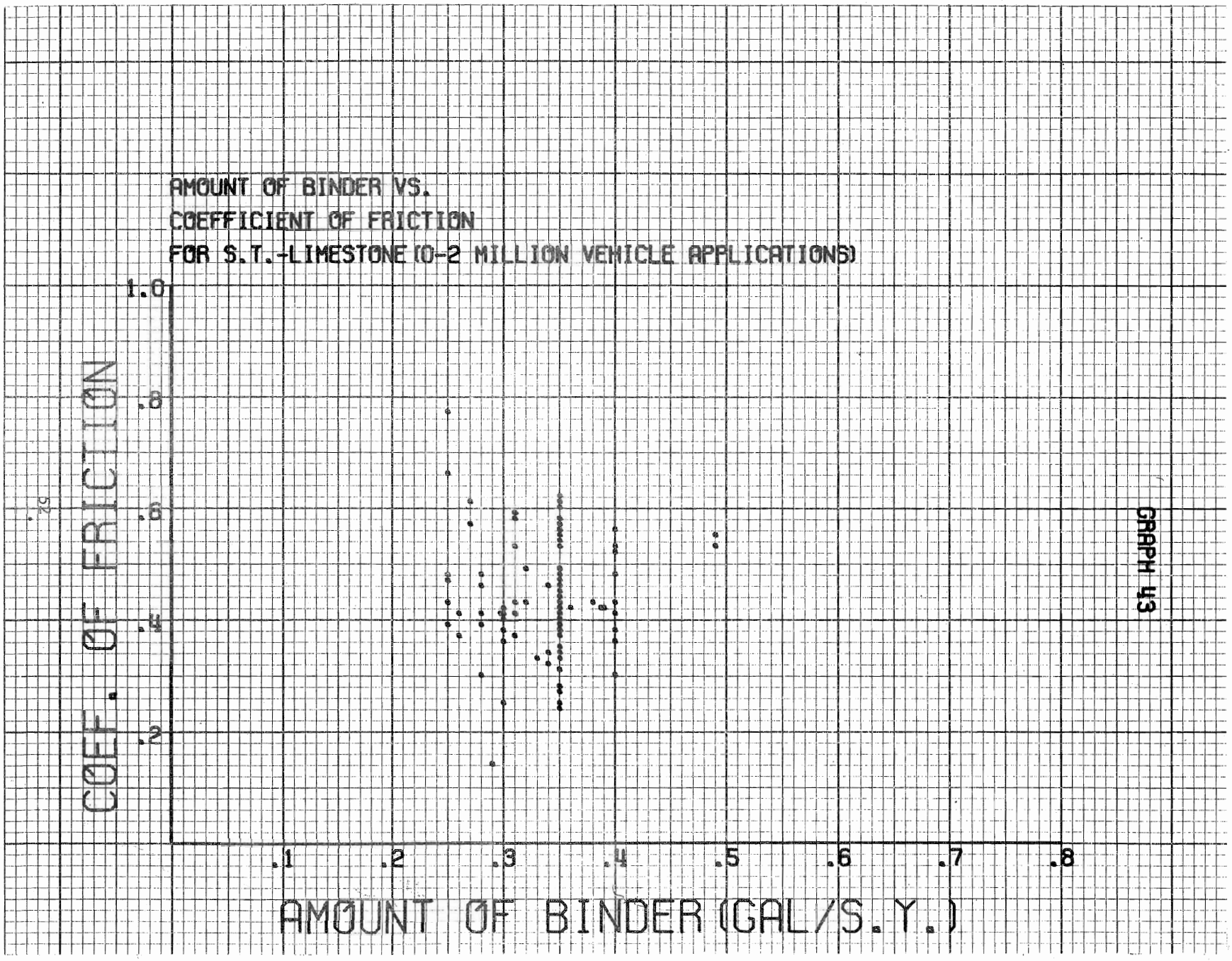

PERCENT BINDER VS.
COEFFICIENT OF FRICTION
FOR HMAC-TRAP ROCK(0-4 MILLION VEHICLE APPLICATIONS)
COEF. OF FRICTION
1.0
.8
.6
.4
.2
0.
3.
4.
5.
6.
7.
8.
9.
10.
PERCENT BINDER
GRAPH 36
47

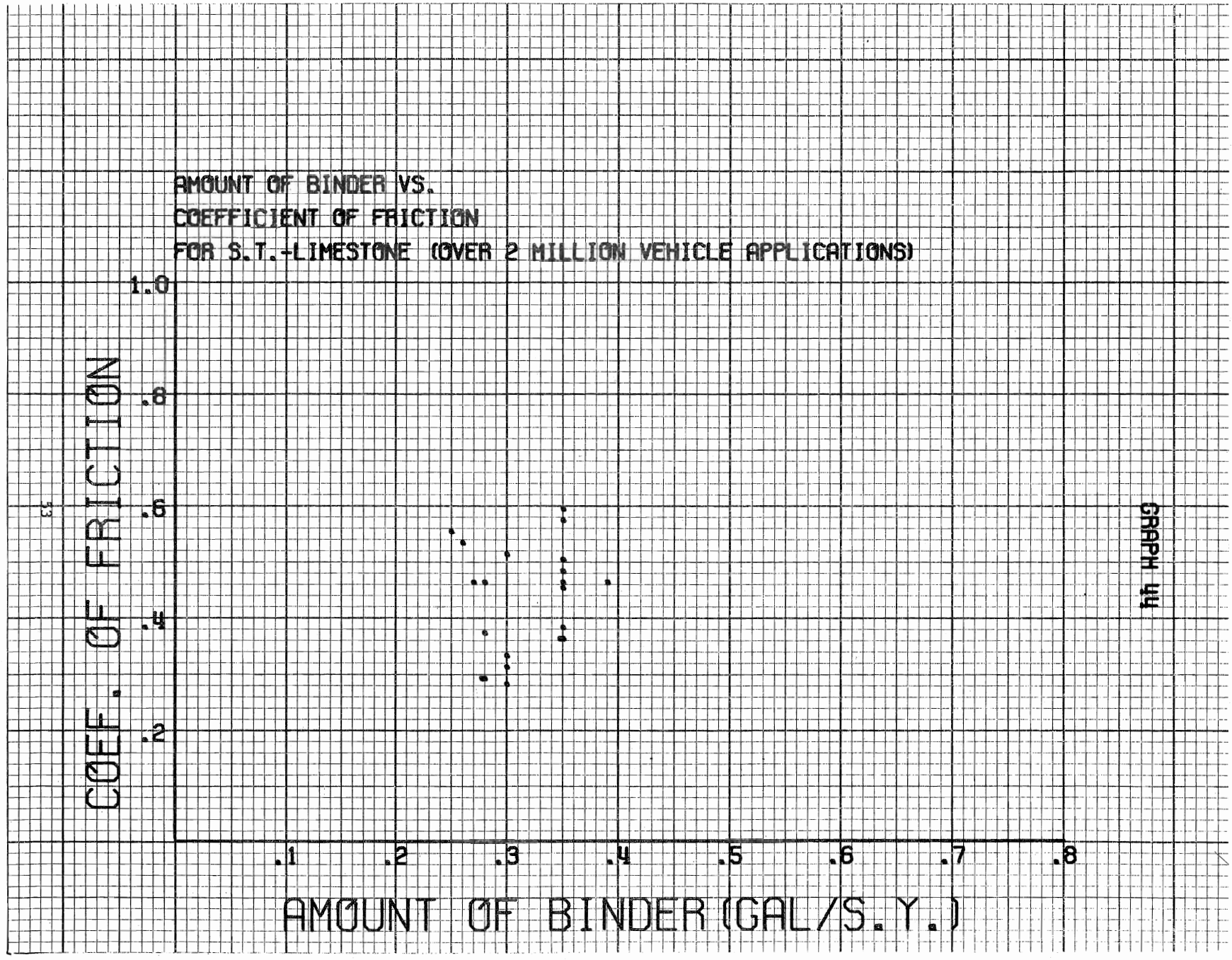

PERCENT BINDER VS.
COEFFICIENT OF FRICTION
FOR HMAC-TRAP ROCK(4-8 MILLION VEHICLE APPLICATIONS)
1.0
.8
.6
.4
.2
COEF. OF FRICTION
0.
3.
4.
5.
6.
7.
8.
9.
10.
PERCENT BINDER
GRAPH 39

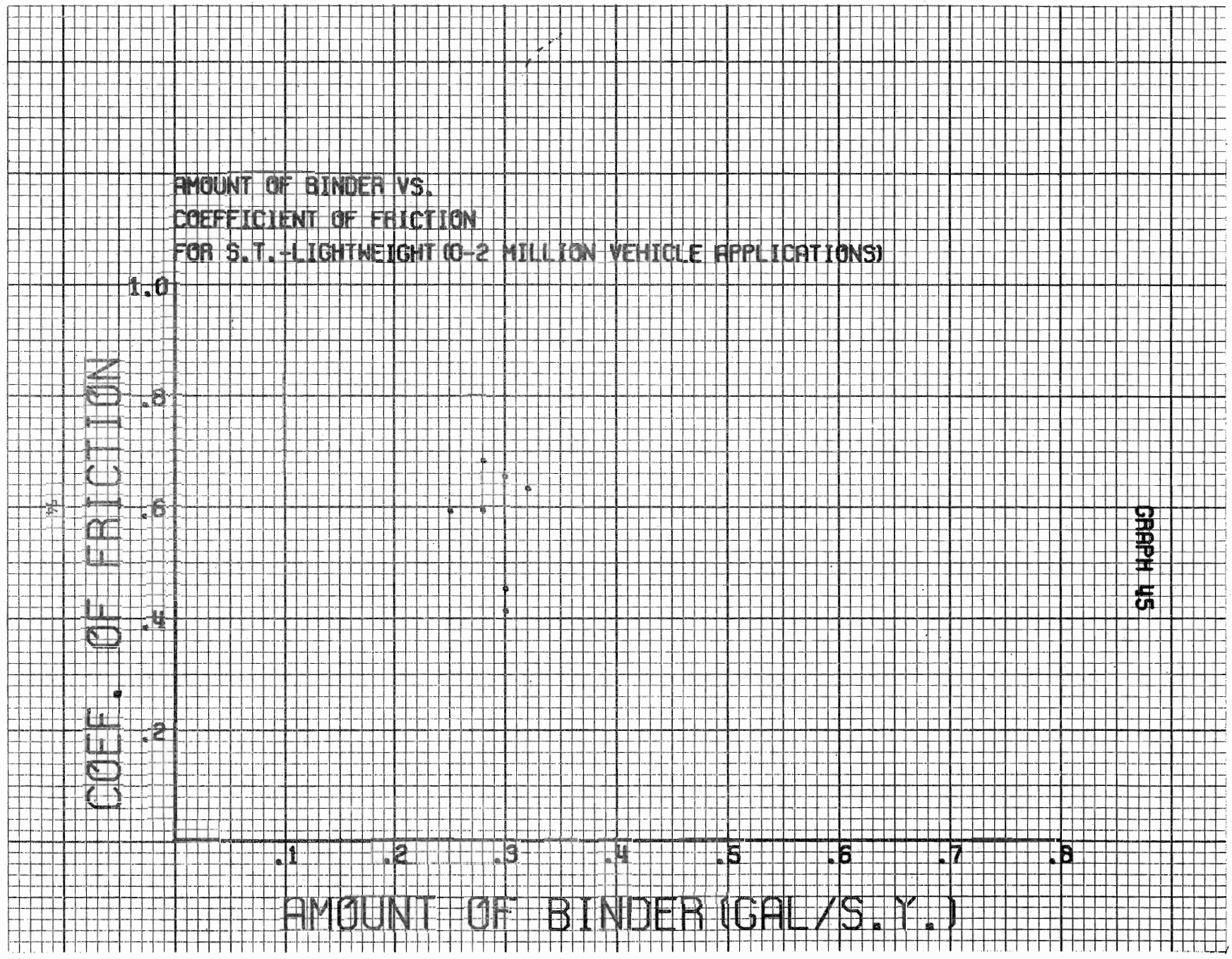

AMOUNT OF BINDER VS.
COEFFICIENT OF FRICTION
FOR SURFACE TREATMENT-ALL SECTIONS
COEF. OF FRICTION
1.0
.8
.6
.4
.2
.1
.2
.3
.4
.5
.6
.7
.8
AMOUNT OF BINDER (GAL/S.Y.)
GRAPH 40

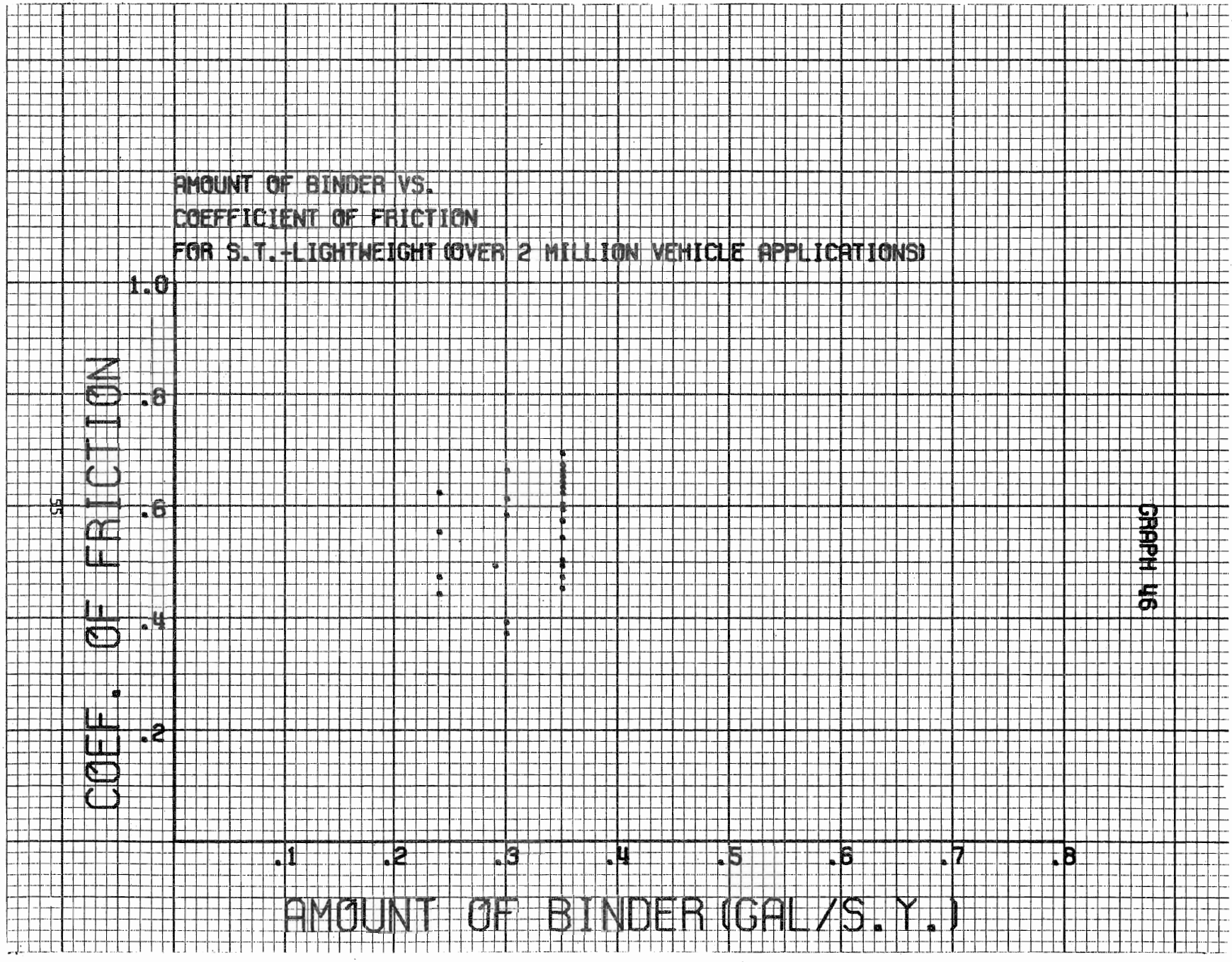

AMOUNT OF BINDER VS.
COEFFICIENT OF FRICTION
FOR S.T.-SILICIOUS (0-2 MILLION VEHICLE APPLICATIONS)
1.0
.8
.6
.4
.2
COEF. OF FRICTION
.1
.2
.3
.4
.5
.6
.7
.8
AMOUNT OF BINDER (GAL/S.Y.)
GRAPH 4.1

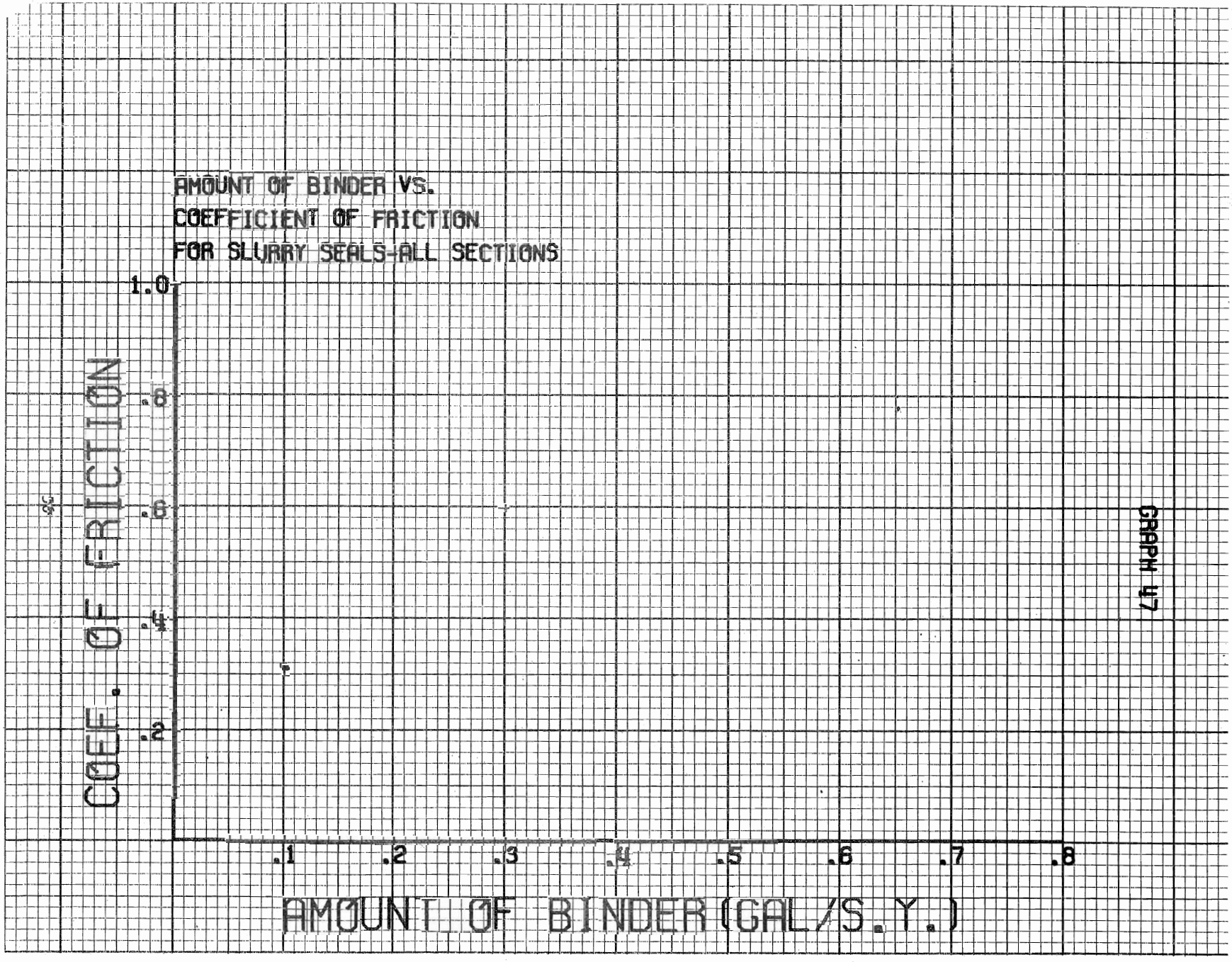

AMOUNT OF BINDER VS.
COEFFICIENT OF FRICTION
FOR S.T.-SILICIOUS (OVER 2 MILLION VEHICLE APPLICATIONS)
1.0
.8
.6
.4
.2
COEF. OF FRICTION
NO PLOT DATA
.1
.2
.3
.4
.5
.6
.7
.8
AMOUNT OF BINDER (GAL/S.Y.)
GRAPH 42

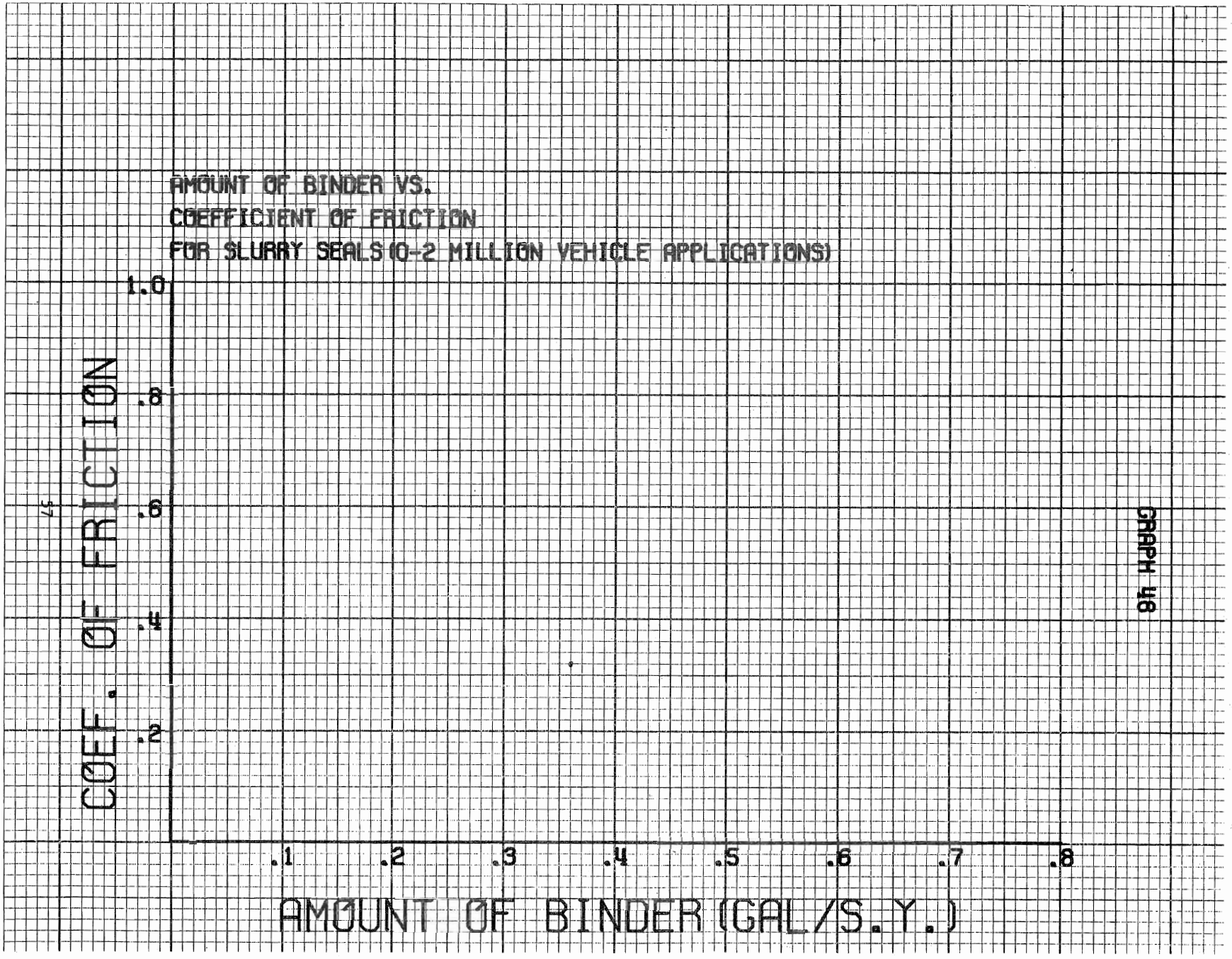

AMOUNT OF BINDER VS.
COEFFICIENT OF FRICTION
FOR S.T.-LIMESTONE (0-2 MILLION VEHICLE APPLICATIONS)
1.0
.8
.6
.4
.2
COEF. OF FRICTION
.1
.2
.3
.4
.5
.6
.7
.8
AMOUNT OF BINDER (GAL/S.Y.)
GRAPH 43

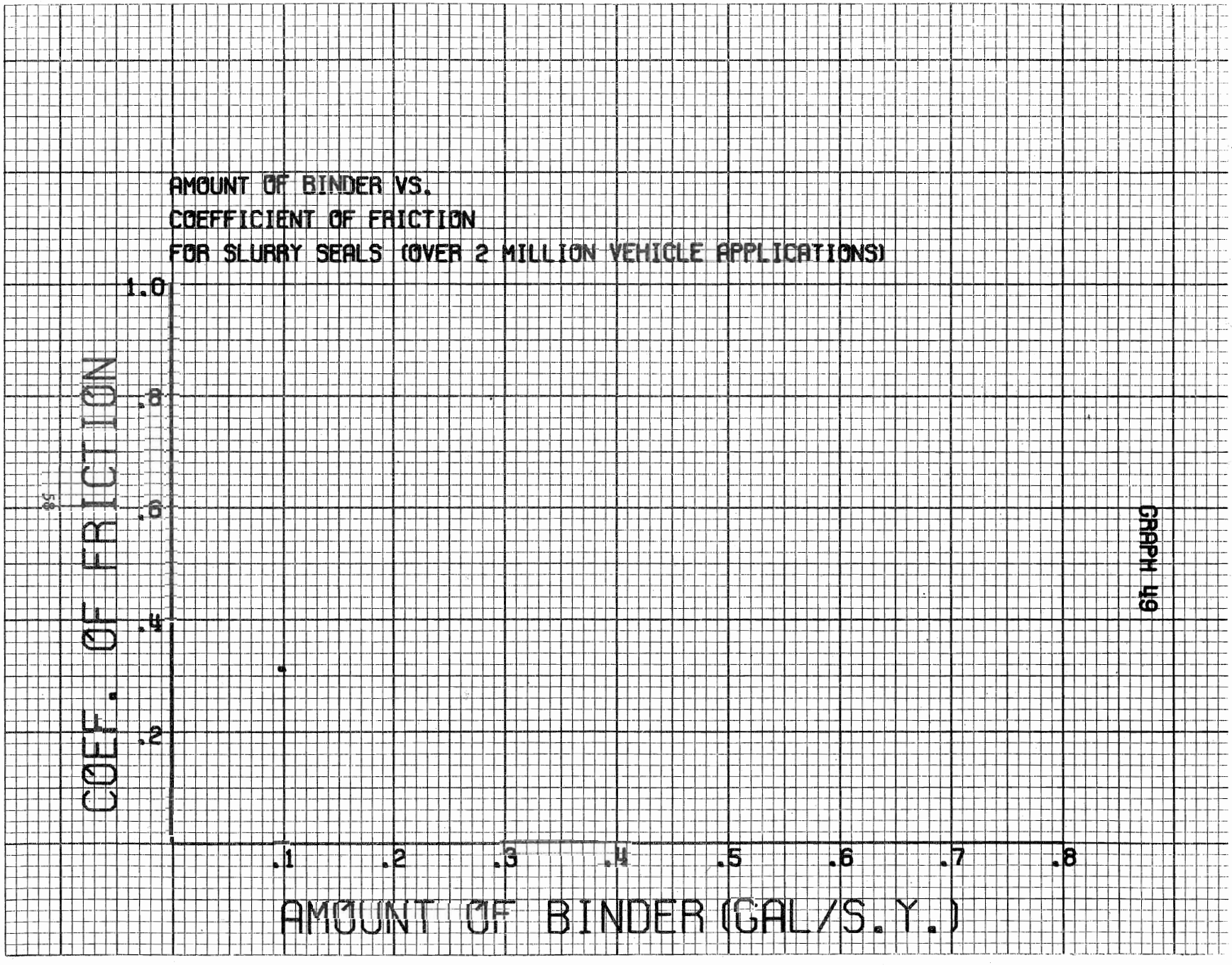

AMOUNT OF BINDER VS.
COEFFICIENT OF FRICTION
FOR S.T.-LIMESTONE (OVER 2 MILLION VEHICLE APPLICATIONS)
COEF. OF FRICTION
1.0
.8
.6
.4
.2
.1
.2
.3
.4
.5
.6
.7
.8
AMOUNT OF BINDER (GAL/S.Y.)
GRAPH by

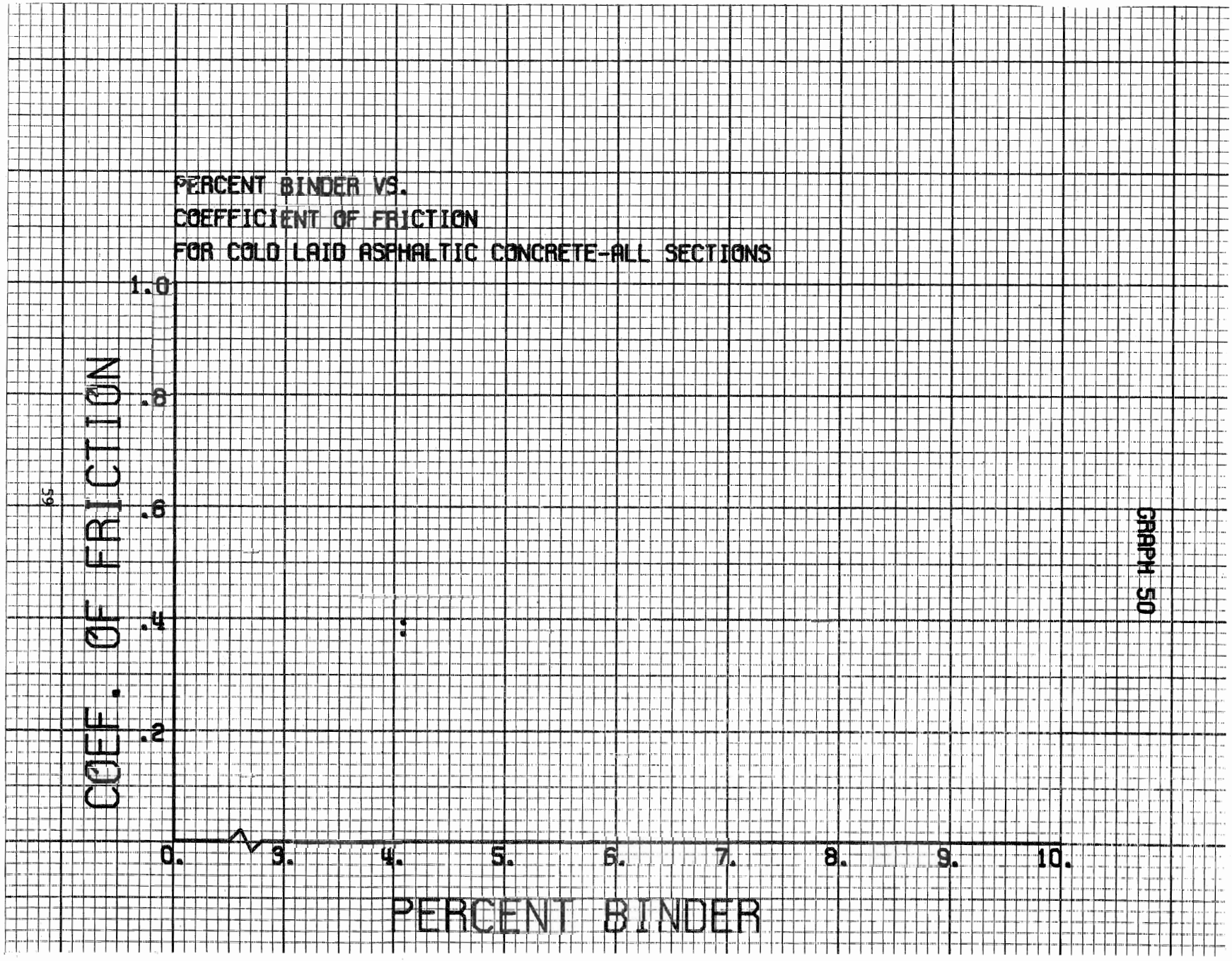

AMOUNT OF BINDER VS.
COEFFICIENT OF FRICTION
FOR S.T.-LIGHTWEIGHT (0-2 MILLION VEHICLE APPLICATIONS)
1.0
.8
.6
.4
.2
COEF. OF FRICTION
.1
.2
.3
.4
.5
.6
.7
.8
AMOUNT OF BINDER (GAL/S.Y.)
GRAPH #5


AMOUNT OF BINDER VS.
COEFFICIENT OF FRICTION
FOR S.T.-LIGHTWEIGHT (OVER 2 MILLION VEHICLE APPLICATIONS)
COEF. OF FRICTION
1.0
.8
.6
.4
.2
.1
.2
.3
.4
.5
.6
.7
.8
AMOUNT OF BINDER (GAL/S.Y.)
GRAPH #6


AMOUNT OF BINDER VS.
COEFFICIENT OF FRICTION
FOR SLURRY SEALS-ALL SECTIONS
1.0
.8
.6
.4
.2
COEF. OF FRICTION
.1
.2
.3
.4
.5
.6
.7
.8
AMOUNT OF BINDER (GAL/S.Y.)
GRAPH 47


AMOUNT OF BINDER VS.
COEFFICIENT OF FRICTION
FOR SLURRY SEALS (0-2 MILLION VEHICLE APPLICATIONS)
COEF. OF FRICTION
1.0
.8
.6
.4
.2
.1
.2
.3
.4
.5
.6
.7
.8
AMOUNT OF BINDER (GAL/S.Y.)
GRAPH 46


AMOUNT OF BINDER VS.
COEFFICIENT OF FRICTION
FOR SLURRY SEALS (OVER 2 MILLION VEHICLE APPLICATIONS)
1.0
.8
.6
.4
.2
COEF. OF FRICTION
.1
.2
.3
.4
.5
.6
.7
.8
AMOUNT OF BINDER (GAL/S.Y.)
GRAPH 49


PERCENT BINDER VS.
COEFFICIENT OF FRICTION
FOR COLD LAID ASPHALTIC CONCRETE-ALL SECTIONS
COEF. OF FRICTION
1.0
.8
.6
.4
.2
0.
3.
4.
5.
6.
7.
8.
9.
10.
PERCENT BINDER
GRAPH 50

The Effect of Gradation

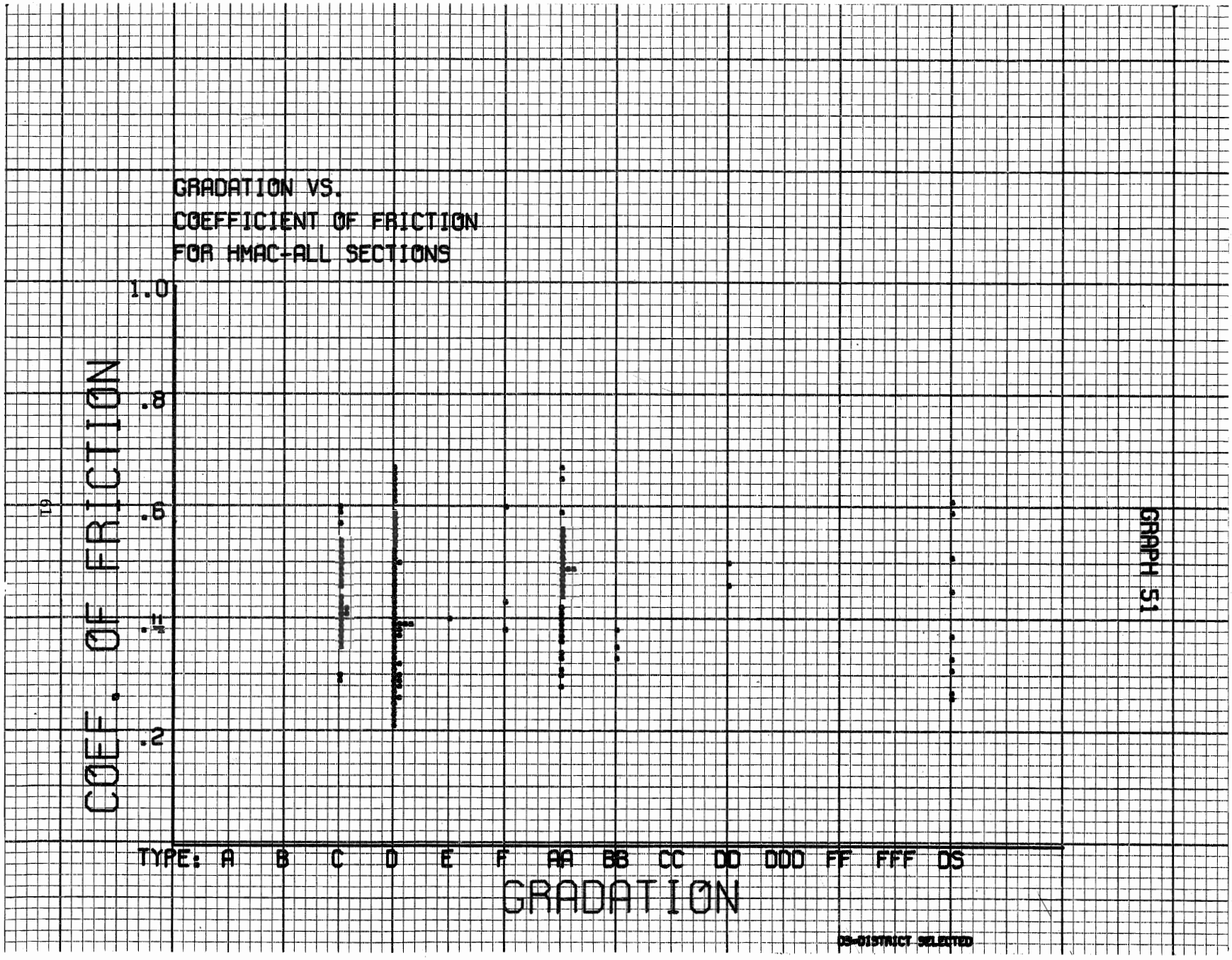
This study of the effects of gradation is similar to the study of the effect of the amount of binder.

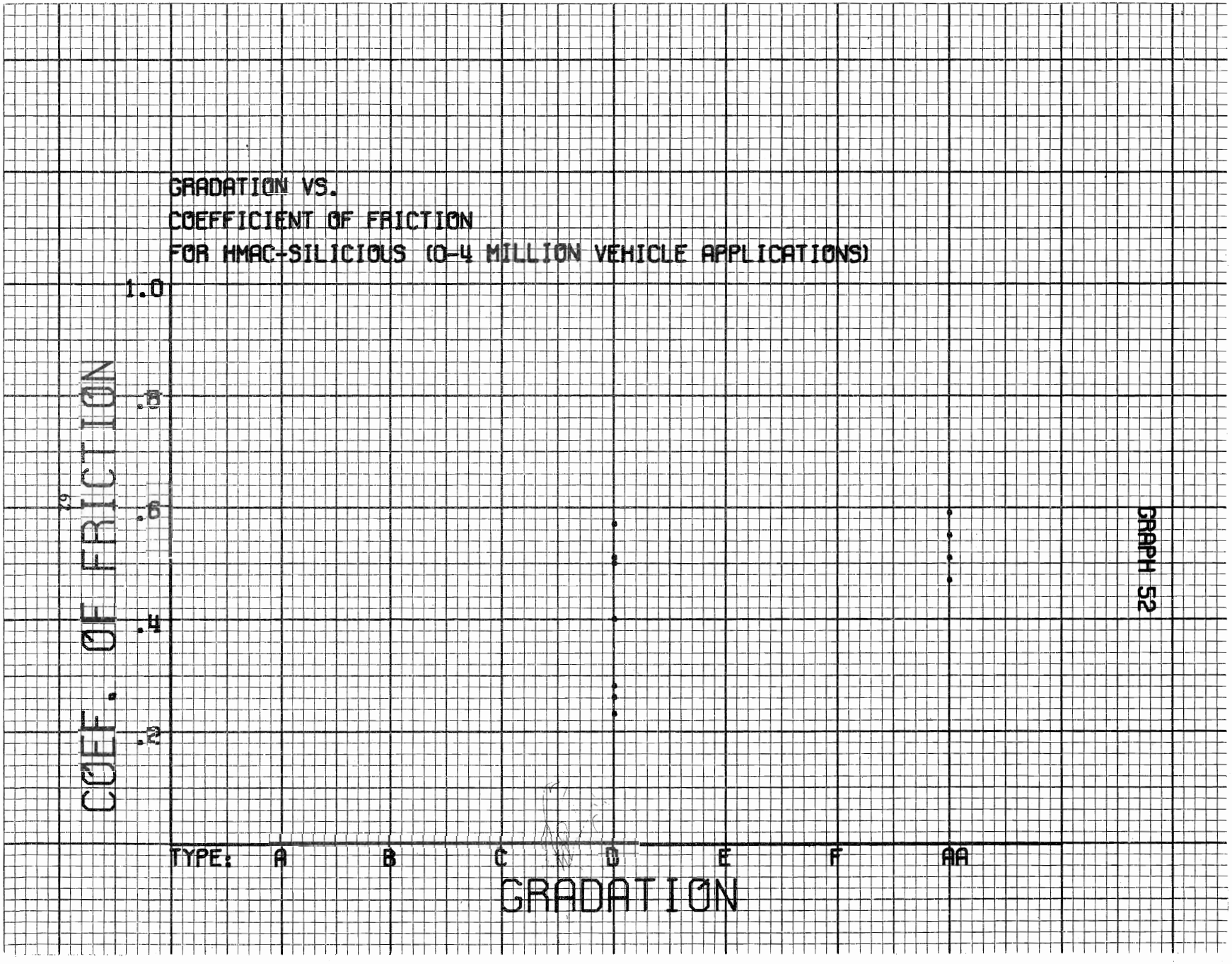
Hot Mix Asphaltic Concrete

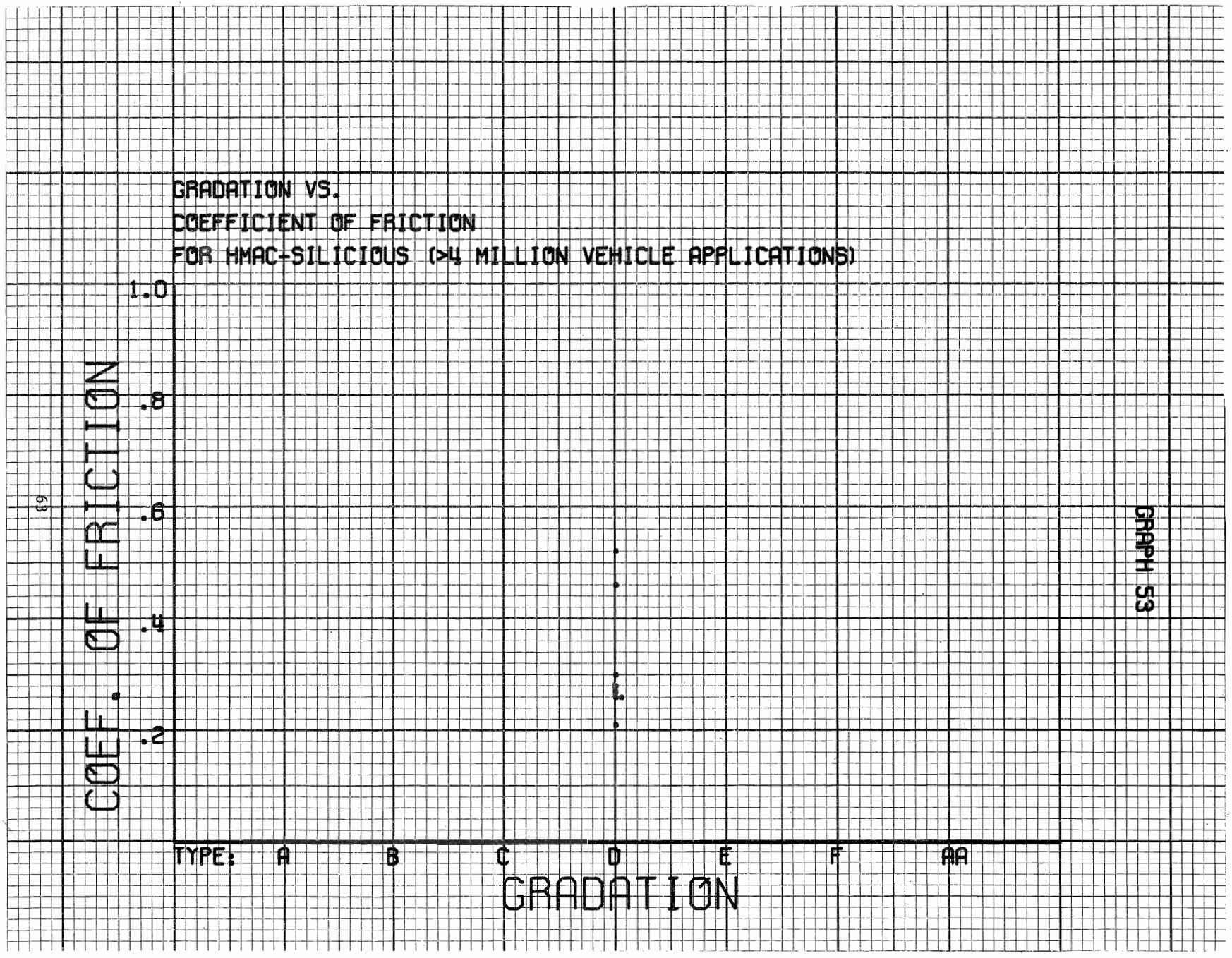
Again the plot (Graph 51) for HMAC, all sections, indicates no optimum gradation to use for optimum coefficient of friction. Graph 52 through Graph 57 are concerned with various material types and traffic ranges.

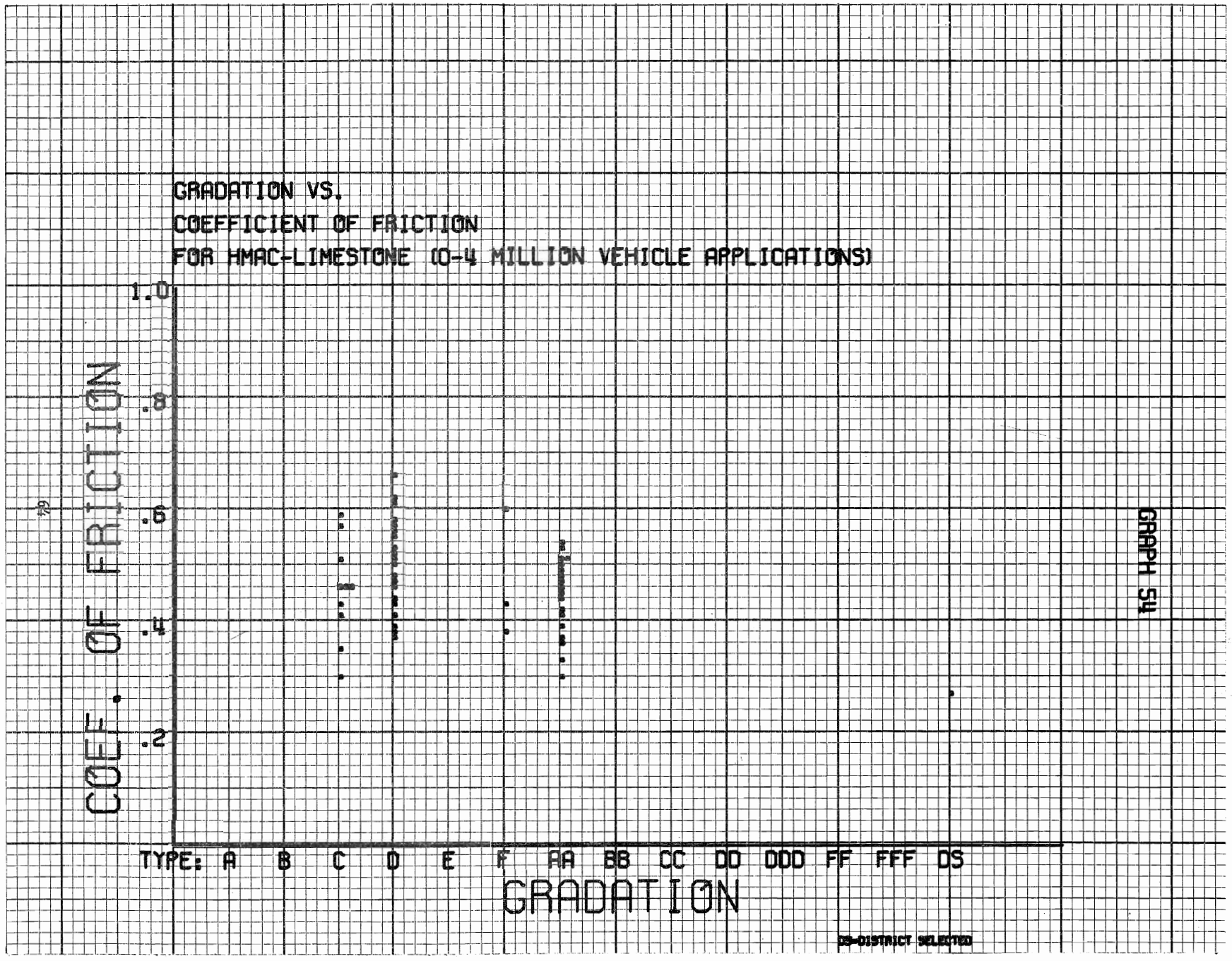
Surface Treatment

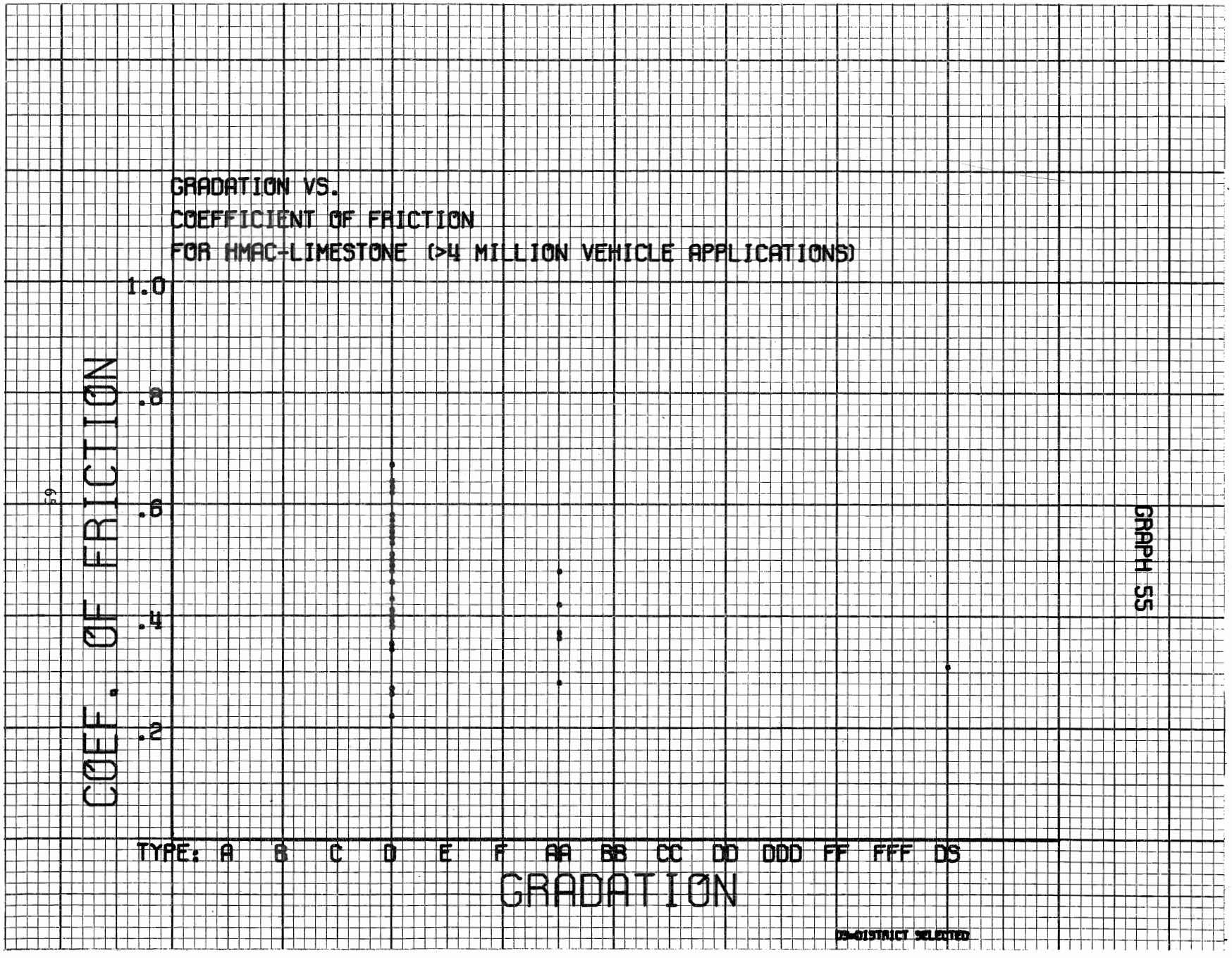
Graph 58 shows the general plot of all surface treatment sections studied. Again no optimum gradation is readily apparent from the plot. Graphs 59 through 61 indicate gradation and percent binder used for the material types and traffic ranges studied. The term "No Plot Data" on Graph 59 indicates there was no complete silicious surface treatment data received from the Districts which was in that traffic range.

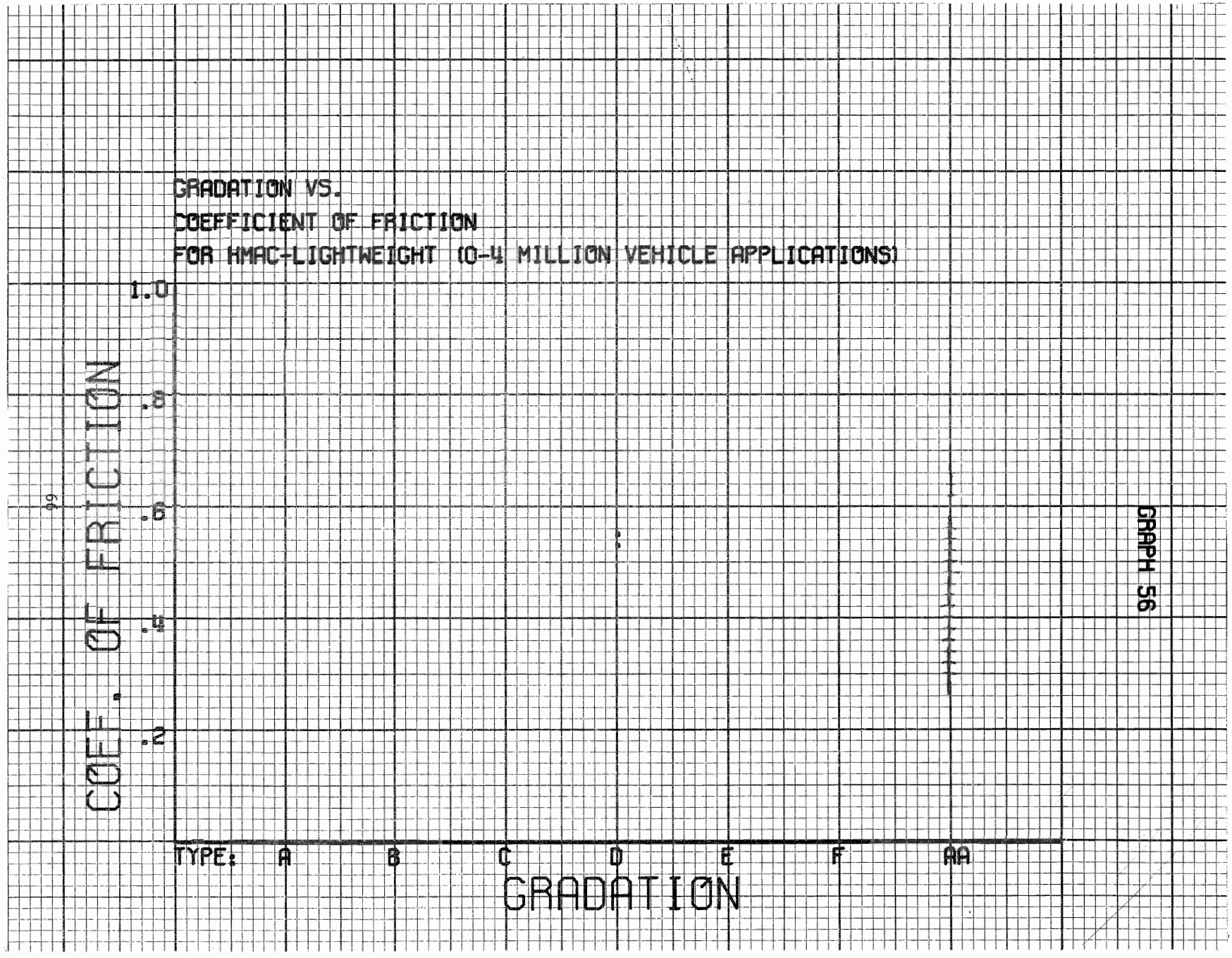

GRADATION VS.
COEFFICIENT OF FRICTION
FOR HMAC-ALL SECTIONS
COE. OF FRICTION
1.0
.8
.6
.4
.2
TYPE: A B C D E F AA BB CC DD DDD FF FFF DS
GRADATION
DS-DISTRICT SELECTED
GRAPH 51

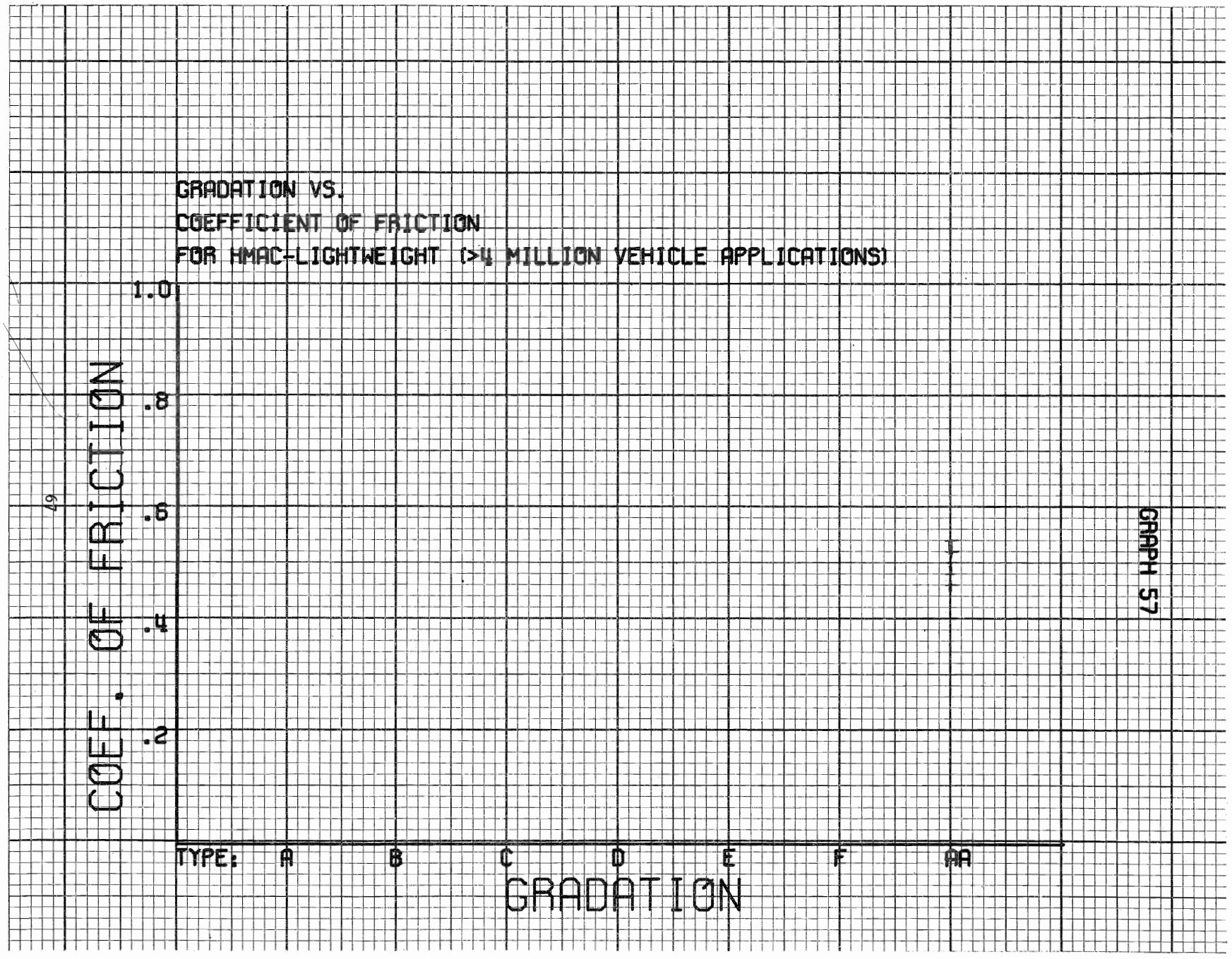

GRADATION VS.
COEFFICIENT OF FRICTION
FOR HMAC-SILICIOUS (0-4 MILLION VEHICLE APPLICATIONS)
1.0
.8
.6
.4
.2
COEF. OF FRICTION
TYPE: A B C D E F AA
GRADATION
GRAPH 52

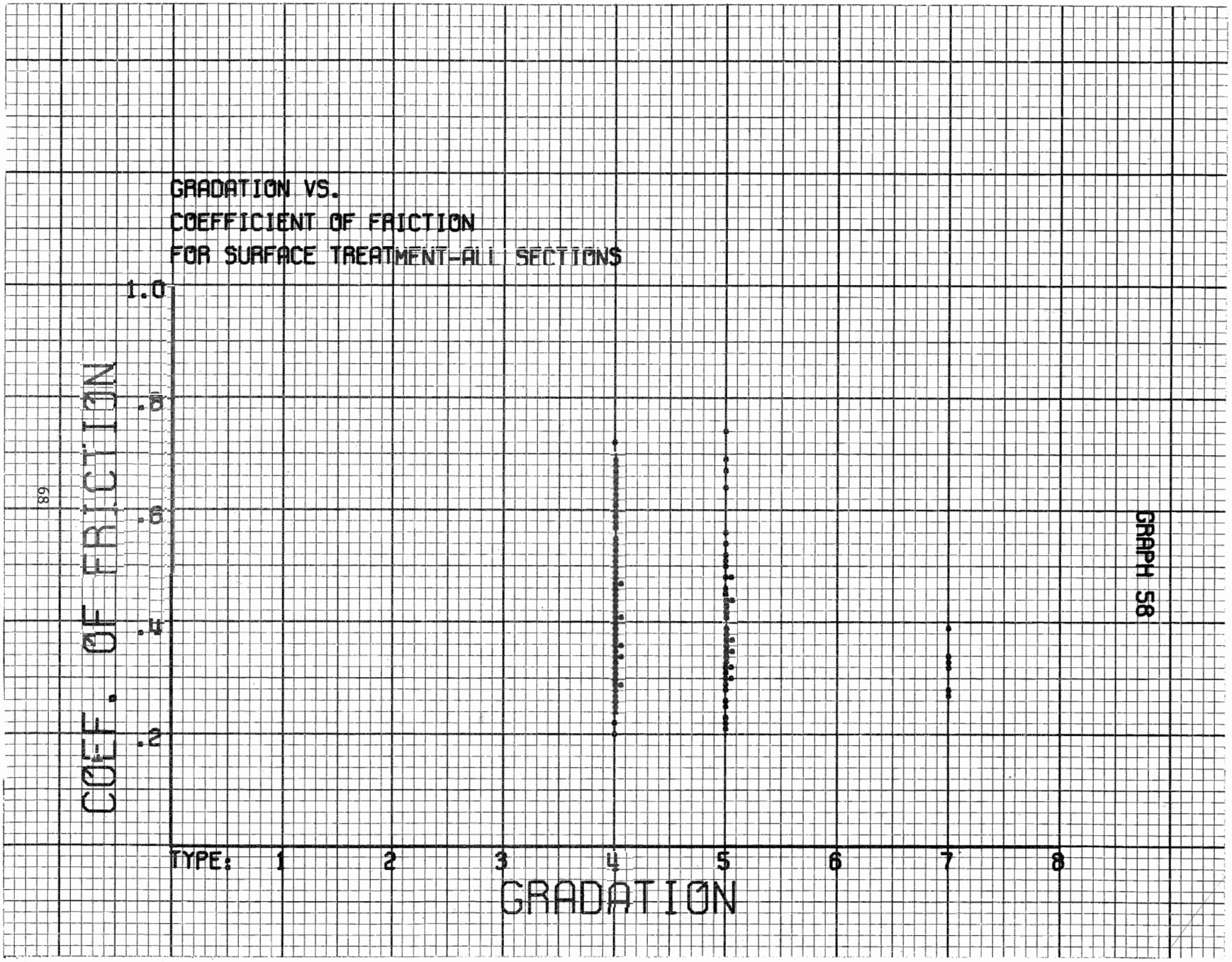

GRADATION VS.
COEFFICIENT OF FRICTION
FOR HMAC-SILICIOUS (>4 MILLION VEHICLE APPLICATIONS)
1.0
.8
.6
.4
.2
COEF. OF FRICTION
TYPE: A B C D E F AA
GRADATION
GRAPH 53

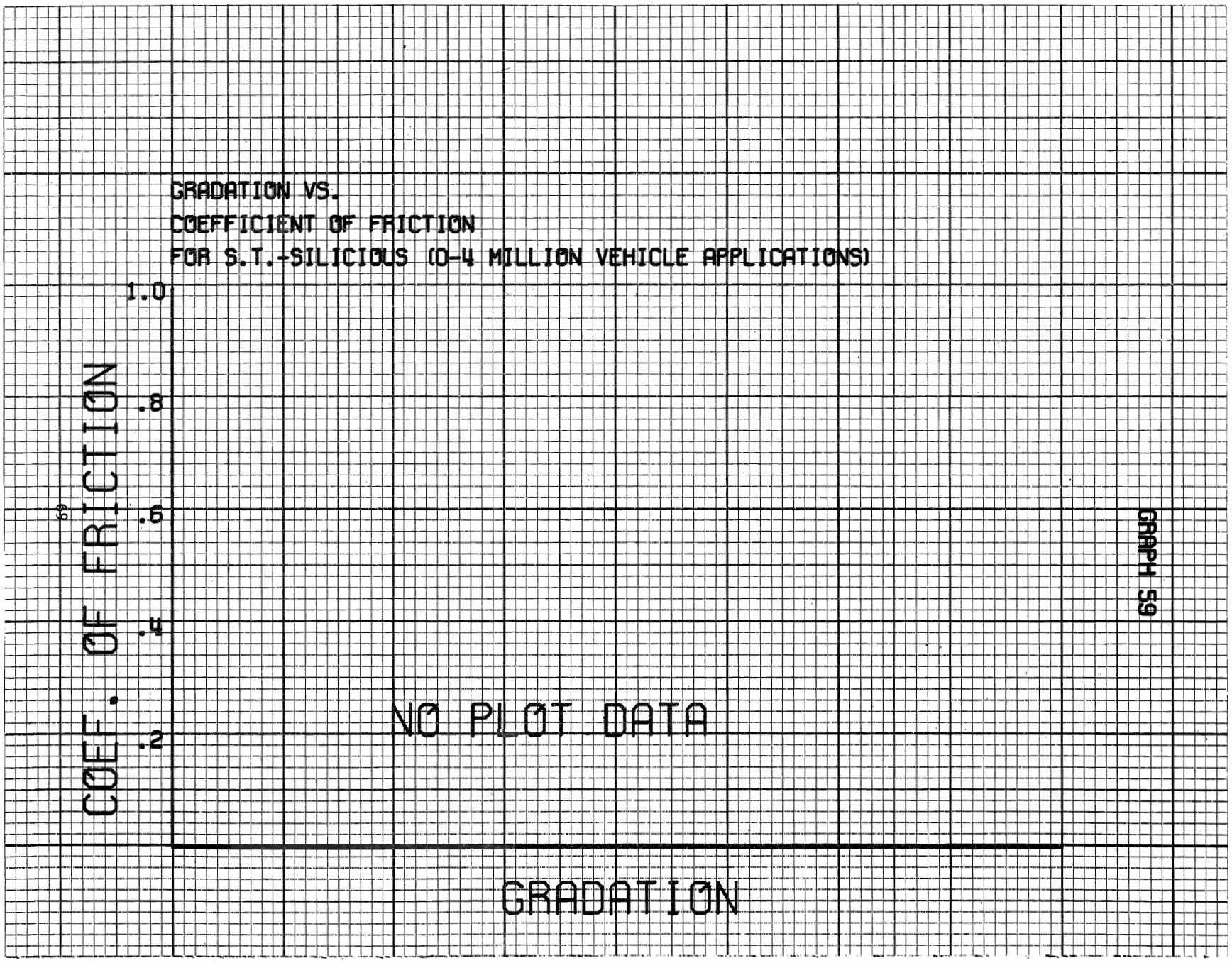

GRADATION VS.
COEFFICIENT OF FRICTION
FOR HMAC-LIMESTONE (0-4 MILLION VEHICLE APPLICATIONS)
COEF. OF FRICTION
1.0
.8
.6
.4
.2
TYPE: A B C D E F RA BB CC DD DDD FF FFF DS
GRADATION
GRAPH 514
DS-DISTRICT SELECTED

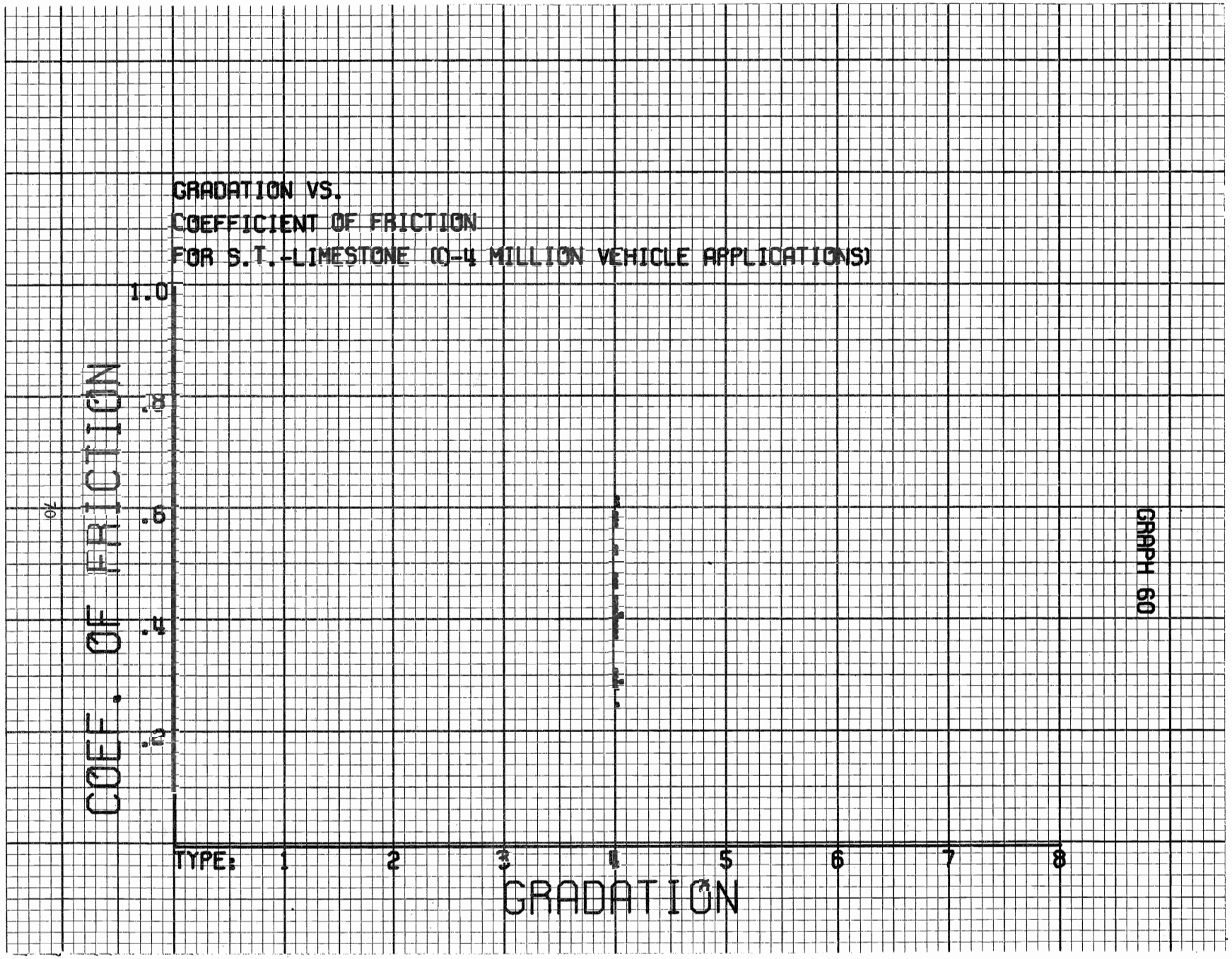

GRADATION VS.
COEFFICIENT OF FRICTION
FOR HMAC-LIMESTONE (>4 MILLION VEHICLE APPLICATIONS)
1.0
.8
.6
.4
.2
COEF. OF FRICTION
TYPE: A B C D E F AA BB CC DD DDD FF FFF DS
GRADATION
09-DISTRICT SELECTED
GRAPH 55

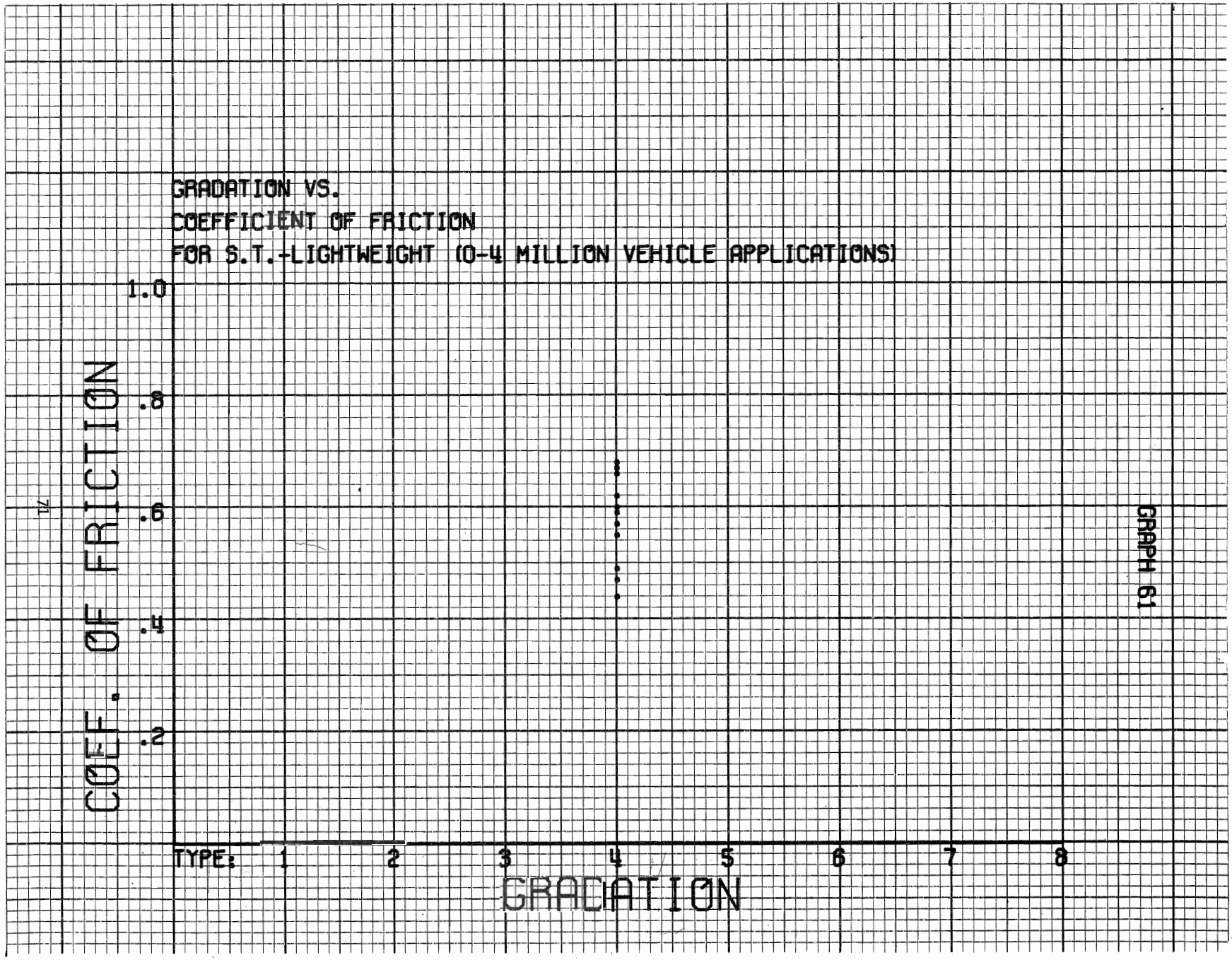

GRADATION VS.
COEFFICIENT OF FRICTION
FOR HMAC-LIGHTWEIGHT (0-4 MILLION VEHICLE APPLICATIONS)
1.0
.8
.6
.4
.2
COEF. OF FRICTION
TYPE: A B C D E F AA
GRADATION
GRAPH 56


GRADATION VS.
COEFFICIENT OF FRICTION
FOR HMAC-LIGHTWEIGHT (>4 MILLION VEHICLE APPLICATIONS)
1.0
.8
.6
.4
.2
COEF. OF FRICTION
TYPE: A B C D E F AA
GRADATION
GRAPH 57


GRADATION VS.
COEFFICIENT OF FRICTION
FOR SURFACE TREATMENT-ALL SECTIONS
1.0
.8
.6
.4
.2
COEF. OF FRICTION
TYPE: 1 2 3 4 5 6 7 8
GRADATION
GRAPH 58


GRADATION VS.
COEFFICIENT OF FRICTION
FOR S.T.+SILICIOUS (0-4 MILLION VEHICLE APPLICATIONS)
1.0
.8
.6
.4
.2
COEF. OF FRICTION
NO PLOT DATA
GRADATION
GRAPH 59


GRADATION VS.
COEFFICIENT OF FRICTION
FOR S.T.-LIMESTONE (0-4 MILLION VEHICLE APPLICATIONS)
1.0
.8
.6
.4
.2
%
COEF. OF FRICTION
TYPE: 1 2 3 4 5 6 7 8
GRADATION
GRAPH 60


GRADATION VS.
COEFFICIENT OF FRICTION
FOR S.T.-LIGHTWEIGHT (0-4 MILLION VEHICLE APPLICATIONS)
COEF. OF FRICTION
1.0
.8
.6
.4
.2
TYPE: 1 2 3 4 5 6 7 8
GRADATION
GRAPH 61