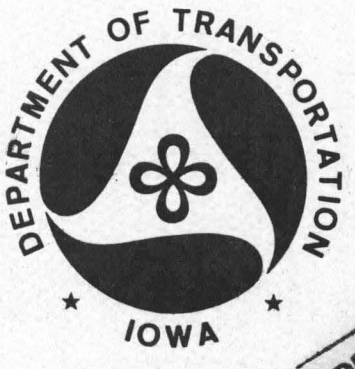
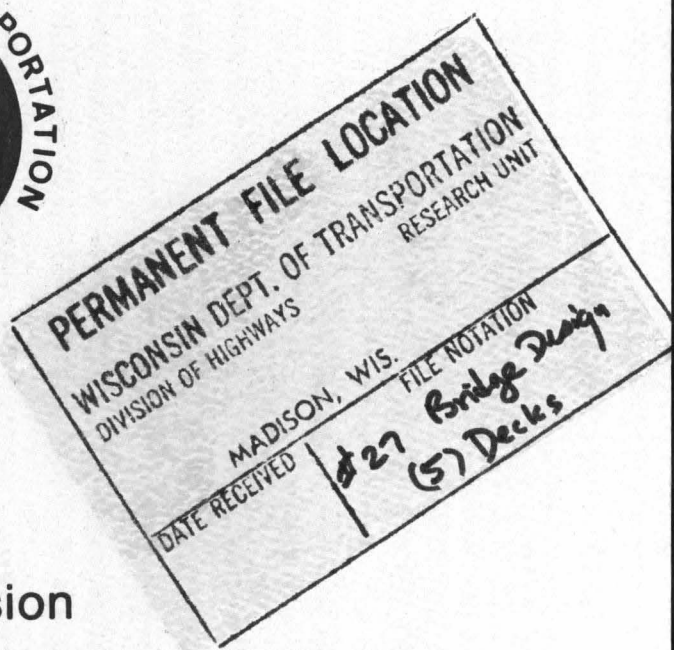
SPECIAL REPORT

A Further Evaluation Of Concrete Bridge Deck Surfacing In Iowa





Highway Division

Office Of Materials

March 1979

DISCLAIMER

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A FURTHER EVALUATION OF CONCRETE BRIDGE DECK SURFACING IN IOWA

by

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March 1979

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ABSTRACT

The Iowa Department of Transportation has overlaid 446 bridge decks with low slump dense concrete from 1964 through October 1978. The overall performance of these decks has been satisfactory.

Nineteen bridges that were resurfaced with either low slump dense concrete (LSDC) or latex-modified concrete were analyzed for chloride content, electrical corrosion potential, delaminations or debonding, and deck surface condition. The resurfacing ages of these bridges range from 5 to 13 years.

None of the bridges showed any evidence of surface distress and the chloride penetration into the resurfacing concrete is relatively low. There are delaminations in the original decks below the resurfacing on the majority of bridges examined. The delaminations are concluded to be caused by either (A) reinforcing steel corrosion, (B) not removing all delaminated concrete prior to placing the resurfacing concrete, or (C) creating an incipient fracture in the top surface of the original deck through the use of scarification equipment.

The active corrosion of the reinforcing steel is predominately in the gutter line on the majority of bridges evaluated.

Recommendations for future deck repairs include removal of concrete to the top layer of reinforcing steel in areas where an electrical corrosion potential of -0.35V or more is detected, providing more positive methods of locating delaminated concrete, and treating the curb and gutter line to reduce the potential damage from salt water.

INTRODUCTION

The Iowa Department of Transportation has been using low-slump, dense concrete for several years as a standard repair and resurfacing technique on bridge decks. From 1964 through October 1978 a total of 446 bridges have been overlaid with the dense concrete system. The overall performance of these overlays has been satisfactory.

In June 1974, a report entitled "An Evaluation of Concrete Bridge Deck Resurfacing in Iowa" was released by the Iowa Depart- of Transportation.[1] This report documented the history, use and performance of low-slump, dense concrete (LSDC)* for bridge deck repair and resurfacing in Iowa from 1964 through 1973.

*LSDC will be the terminology used throughout this report because of the widespread use of term. The reader should be aware that whenever LSDC is used it is considered to be synonymous with the "Iowa Method" which includes specific methods of deck preparation, grouting, curing, etc.

Sixteen bridges were studied for chloride penetration in 1974. Fifteen of the bridges had been resurfaced with LSDC and the other has been resurfaced with latex-modified concrete containing Dow Chemical Corporation's Modifier "B". The age of the resurfacing on the bridges selected for the study ranged from one to nine years. Data was also presented as an indication of the physical properties of the resurfacing concretes as well as the rideability of the finished structure.

Only limited data was presented at that time concerning electrical potential corrosion measurements and no data was presented

to indicate the amount of concrete delamination or debonding that was present in the decks.

In 1978, the bridges detailed in the original report were resurveyed for the purpose of updating the information on the performance of the concrete resurfacing systems. Three additional bridges were also added to the study.

SCOPE

Bridge Selection

Sixteen bridges had decks repaired and resurfaced with the LSDC system. The ages of the resurfacing at the time of the 1978 evaluations were: one deck 13 years old, one 12 years, three 11 years, two 10 years, one 9 years, three 8 years, two 7 years, two 6 years, and one 5 years.

Three bridges included in the study had been repaired and resurfaced with latex-modified concrete. One of these contained a Dow Modifier "B" latex which is no longer used because of a high chloride content. This bridge was included in the 1974 report and has been in service 6 years. The other bridges had been repaired and resurfaced with latex-modified concrete containing Dow Modifier "A" and had been in service 5 years at the time of the 1978 survey.

As previously mentioned three bridges were added to the survey in 1978. These included a set of twin bridges on Interstate 35 over the Raccoon River in Polk County. One of these bridges was was resurfaced in 1973 with the LSDC system and the other bridge

was resurfaced in 1973 with the latex-modified concrete system. Both bridges were inspected by the same personnel and have received similar salt applications since resurfacing. These bridges provide an ideal opportunity to directly compare the performance of the two systems. The other bridge added to the study is on Interstate 235 westbound across the Des Moines River. This bridge was repaired and resurfaced in 1973 with latex-modified concrete. It was selected to provide additional data on the performance of this resurfacing method.

Survey Methods

All bridges were surveyed for chloride content of both the resurfacing concrete and the old deck, delaminations of the concrete in the old deck or debonding of the resurfacing from the old deck, and corrosion of the reinforcing steel in the old deck.

Two-inch diameter cores were drilled on each deck in the approximate locations originally sampled to determine the chloride level of the resurfacing concrete and the old, underlying deck. The cores were drilled wet with a diamond bit, however, the amount of water used in the drilling operation was held to a minimum to minimize the loss of water soluble chloride from the sample.

The cores were dry sawed in 1/2 inch increments with a carborundum blade in the laboratory to establish the chloride profile at each location. Where it was possible, the concrete in the old deck was also sliced for chloride analysis. In some instances, the original deck concrete was not analyzed due to fracturing of

the concrete at or slightly below the original concrete during the core removal operation.

Each concrete slice was coarse ground in a Chipmunk jaw crusher and fine ground to pass the No. 50 sieve in a Micro-pulverizer. After pulverizing each sample was dried in an oven for at least one hour at 105° C.

The chloride concentration was obtained by utilizing the procedure described by Clear & Harrington in Report No. FHWA-RD-77-85.[2] The Gran endpoint determination method was selected due to the relative ease associated with this method. The equipment employed was a Corning Research Model No. 12 pH meter with an Orion chloride electrode Model 96-17.

The chloride content of the concrete sample was converted to pounds of chloride per cubic yard of concrete by assuming a dry-concrete weight of 140 pounds per cubic foot.

Each bridge deck was surveyed with a Delamtect testing device manufactured by S.I.E. Inc. of Fort Worth, Texas. The Delamtect is a small mobile, electronic, acoustical device which imparts a tapping impulse into the surface of the concrete. An oscillating solenoid mounted on two steel wheels generates this impulse. The receivers that "listen" to locate the hollow areas are two oil filled inner tube tires. A hydraphone (pressure transducer) is mounted near the bottom within each of these oil-filled tires and monitors the response from the tapping. A response from each wheel is transmitted to a dual-channel, strip-

chart recorder. Each steel transmitter wheel operates three inches from the receiver tire, thus, evaluating a three inch wide strip. The two three inch wide strips traverse nine inches center to center for each pass. The operation of the testing device in Iowa has been well documented by Marks.[3]

Seventeen of the nineteen bridges surveyed were sounded for delaminations on nine-inch centers for the full width and length of the deck. Only representative deck sections on I-235 in Des Moines and US 20 in Sioux City were tested because of the traffic control problems encountered at these locations.

When unsound areas on a deck were encountered, two-inch diameter cores were drilled to examine the source of the indicated delamination. It was noted whether there was debonding of the resurfacing from the original deck or if there were delaminations of the concrete in the original deck.

Electrical corrosion potential measurements were obtained on sections of all bridges included in the study in accordance with Iowa Test Method 1008. This test method utilizes the copper-copper sulfate half cell in common use for this type of measurement. A four-foot grid system of test points was laid out on each deck section to be tested. If a reading of -0.35 volts or greater was observed, the four-foot grid system was reduced to a two-foot grid to better define the limits of where active corrosion may be occurring. The areas surveyed were selected to include as much delaminated concrete as possible.

Each bridge was also photographed to provide a visual reference as to the surface condition of the deck. Any apparent surface distress was to be noted by the testing crew.

RESULTS

Detailed results of each bridge surveyed are shown in Appendix A. Data from each bridge was plotted to illustrate chloride contents, delamination results and corrosion potential readings. Photographs illustrate general deck condition and delamination locations on the cores obtained for this purpose.

Chloride Penetration

Table No. 1 summarizes the chloride contents at various levels in the LSDC overlay concrete. It is common to find chloride contents of 3-6 lbs. per cubic yard of concrete in the underlying original decks as shown in the Appendix. When these decks were overlaid no effort was made to remove sound concrete with a high chloride content. Because of the high chloride content of the original deck, it is also common to find a relatively high chloride content in the overlay concrete directly in contact with the original. In all likelihood, the chloride migrates from the original deck upward rather than penetrating from the surface due to salting operations.

To present a more meaningful evaluation of chloride penetration properties, the chloride content of the concrete directly

in contact with the original deck was not used in averaging the chloride content of the overlay concrete. Plymouth County Design 169 was not included in Table No. 1 because the thickness of the overlay was not sufficient to plot a meaningful chloride penetration profile.

Table No. 2 summarizes the chloride data available on the latex-modified concrete deck overlays. The latex-concrete overlay on Story County bridge Design 172 contains Modifier "B". This modifier was high in chloride content and was reflected by the high chloride content in the cores from this deck. The concrete on other bridges listed contains Modifier "A".

Table No. 1
Chloride Content of LSDC System

Bridge		Resurfacing	Avg. Chloride Content - lbs/yd^3			
	Design	Age	Resurfacing Depth - In.			
County	No.	Years	0-1/2	1/2-1	1-1-1/2	1-1/2-2
Polk	3265	13	5.0	1.6	-	-
Woodbury	1065	12	14.1	3.2	0.7	0.3
Polk	866	11	11.7	1.9	0.9	-
Clay	267	11	4.0	0.7	0.6	-
Clay	167	11	14.9	5.0	1.5	0.3
Monona	268	10	5.1	1.2	1.2	-
Woodbury	168	10	8.6	2.1	1.2	-
Calhoun	170	8	7.4	1.5	0.9	0.7
Cherokee	370	8	8.9	5.5	0.8	0.4
Woodbury	369	8	6.1	1.3	0.5	0.2
Plymouth	271	7	6.3	2.6	1.0	0.6
Plymouth	171	7	2.6	0.6	0.7	-
Cherokee	172	6	6.6	1.7	-	-
Cherokee	272	6	7.6	2.4	1.0	0.7
Polk	273 NB	5	7.3	1.2	0.7	-
		Avg.	7.7	2.2	0.9	0.5

Table No. 2
Chloride Content of Latex-Modified System

Bridge County	Bridge Design No.	Resurfacing Age Years	Avg. Chloride Content - lbs/yd^3 Resurfacing Depth - In. 0-1/2	1/2-1
Story	172*	6	21.3	18.4
Polk	273 SB**	5	8.4	1.8
Polk	573**	5	8.2	0.6

*Concrete in resurfacing contains Modifier "B"
**Concrete in resurfacing contains Modifier "A"

Delaminations

Unsound areas as detected by the Delamtect have been plotted for each bridge deck and are summarized in Table No. 3 for the LSDC system and in Table No. 4 for the latex-modified concrete system.

Table No. 3
Delamtect Survey Results - LSDC System

Bridge County	Design No.	Resurfacing Age Years	Deck Area-Ft^2	Percent of Deck Area Delaminated
Polk	3265	13	15,444	11.8
Woodbury	1065	12	15,120	15.0*
Polk	866	11	9,436	12.7
Clay	267	11	9,724	11.3
Clay	167	11	20,256	28.5
Monona	268	10	7,410	16.4
Woodbury	168	10	13,891	6.9
Plymouth	169	9	9,828	2.6
Calhoun	170	8	5,496	44.9
Cherokee	370	8	5,376	9.9
Woodbury	369	8	4,200	7.0
Plymouth	271	7	3,250	1.2
Plymouth	171	7	6,240	5.2
Cherokee	172	6	9,600	18.5
Cherokee	272	6	2,448	2.2
Polk	273 NB	5	18,368	0.0
		Total	156,087	

*Representative area surveyed (5,616 Ft^2)

Table No. 4
Delamtect Survey Results
Latex-Modified Concrete System

Bridge County	Bridge Design No.	Resurfacing Age Years	Deck Area-Ft^2	Percent of Deck Area Delaminated
Story	172	6	6,720	9.7*
Polk	273 SB	5	18,368	0.0
Polk	573	5	44,720	4.9**
		Total	69,808	

*Contains Modifier "B"
**Representative area surveyed (13,780 ft^2)

Table No. 3 and 4 contain a column entitled "Percent of Deck Area Delaminated." The Delamtect device does not distinguish the difference between delaminated concrete in the underlying deck or from a lack of bond between the two concretes.

A linear regression analysis was performed utilizing resurfacing age and percentage of deck area delaminated as the independent variables for the LSDC system. A correlation coefficient of 0.265858 indicates no meaningful correlation exists. Due to the limited data a similar analysis was not conducted for the latex-modified concrete system.

Core photographs shown in Appendix A are included to indicate the location in the system which caused the Delamtect to respond. A careful examination of the cores reveals a failure in the concrete from the original deck below the bond line on all bridges surveyed.

It is difficult to ascertain from the photographs in Appendix A whether the failure was debonding or delamination when the fracture plane is close to the interface of the two concretes.

To avoid confusion it would be well to define debonding and delamination as used in this report. Debonding is considered to be an actual failure of the grout to bond the overlay concrete to the prepared surface of the underlying deck. Delamination will be used to describe a fracture in the original deck below the interface of the two concretes.

Most of the delaminations were located in the old concrete within 1/4" of the bonded interface. To better illustrate this type of delamination a core from the Calhoun Co. Design No. 170 bridge is shown in Figures Nos. 1 and 2. Figure No. 1 does not provide sufficient detail to indicate the exact fracture location. Figure No. 2 shows the fracture location in the old deck as evidenced by the separation of the coarse aggregate particle from the old deck.

Electrical Potential

Tables No. 5 and No. 6 summarize the results of the electrical potential measurements on the decks overlaid with LSDC and latex-modified concrete, respectively. The tables indicate: 1) the number and percentage of measurements -0.35V or greater for the total deck area surveyed, 2) the number and percentage of measurements of -0.35V or greater in the delaminated areas only, and 3) the number and percentage of measurements of -0.35V or greater in the gutter line only.

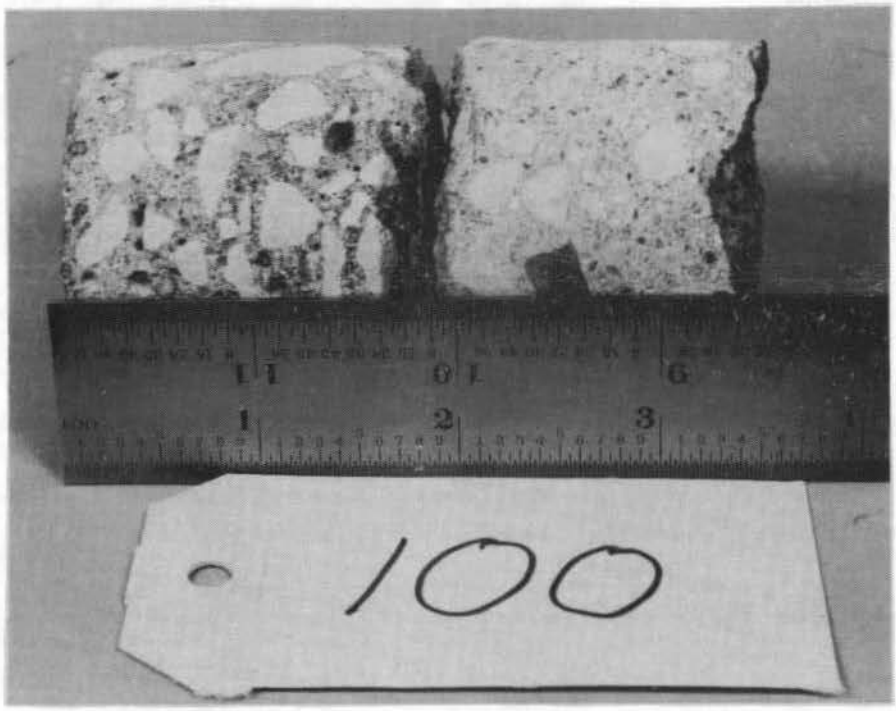


Fig. 1 Delamination core - side view

Fig. 2 Delamination core - end view of fracture

Table No. 5
Electrical Corrosion Potential Results
LSDC System

Bridge		Resurfacing	Total Area Surveyed			Delaminated Area Only			Gutter Line Only		
County	Design No.	Age Years	No. of Readings	No. of Readings -0.35V or More	% -0.35V or More	No. of Readings	No. of Readings -0.35V or More	% -0.35V or More	No. of Readings	No. of Readings -0.35V or More	% -0.35V or More
Polk	3265	13	392	14	3.6	92	12	13.0	52	0	0.0
Woodbury	1065	12	247	62	25.1	66	1	1.5	63	45	71.4
Polk	866	11	222	11	5.0	66	6	9.1	58	6	6.9
Clay	267	11	219	3	1.4	56	1	1.8	55	0	0.0
Clay	167	11	510	129	25.3	198	62	31.3	85	31	36.5
Monona	268	10	237	25	10.5	104	11	10.6	58	6	10.3
Woodbury	168	10	212	4	0.9	36	1	2.8	55	3	5.4
Plymouth	169	9	302	101	33.4	30	11	36.7	141	98	69.5
Calhoun	170	8	256	92	35.9	147	38	25.9	129	73	56.6
Cherokee	370	8	241	51	20.8	50	17	34.0	120	39	32.5
Woodbury	369	8	211	16	7.6	11	0	0.0	74	14	18.9
Plymouth	271	7	364	196	53.8	13	7	53.8	158	148	93.7
Plymouth	171	7	233	48	20.6	42	2	4.8	104	48	46.2
Cherokee	172	6	302	70	23.2	145	23	15.9	108	55	50.9
Cherokee	272	6	331	138	41.7	16	9	56.3	145	76	52.4
Polk	273 N	5	239	14	5.9	0	0	0	79	13	16.5
		Total	4,518	974	21.6%	1,072	201	18.8%	1,484	653	44.0%

Percent of Readings -0.35V or more in non-delaminated area = $\frac{974-201}{4,518-1,072}$ = 22.4%

Percent of Readings -0.35V or more outside gutter line = $\frac{974-653}{4,518-1,484}$ = 10.6%

Table No. 6
Electrical Corrosion Potential Results
Latex-Modified-Concrete System

Bridge		Resurfacing	Total Area Surveyed			Delaminated Area Only			Gutter Line Only		
County	Design No.	Age Years	No. of Readings	No. of Readings -0.35V of More	% -0.35V or More	No. of Readings	No. of Readings -0.35V or More	% -0.35V or More	No. of Readings	No. of Readings -0.35V or More	% -0.35V or More
Story	172	6	317	75	23.7	60	17	28.3	78	24	30.9
Polk	273 SB	5	218	4	1.8	0	0	0	58	3	5.2
Polk	573	5	434	30	6.9	64	4	6.2	85	17	20.5
		Total	969	109	11.2%	124	21	16.9%	221	44	19.9%

Percent of Readings -0.35V or more in non-delaminated area = $\frac{109-21}{969-124}$ = 10.4%

Percent of Readings -0.35V or more outside gutter line = $\frac{109-44}{969-221}$ = 8.7%

A regression analysis was conducted on the LSDC system with the percentage of readings at or exceeding -0.35V for the total deck area surveyed and resurfacing age as the independent variables. A correlation coefficient of -0.405693 indicates no meaningful correlation exists.

Deck Surface Condition

None of the bridges included in the study showed any evidence of surface distress.

DISCUSSION

All of the bridge-deck overlays examined in this investigation were constructed utilizing specifications that are not currently in use, they have since been revised. The main differences in the specifications are:

1. The overlay thickness in the bridges studied was designed at 1-1/4" exclusive of areas which required deeper patching caused by the removal of unsound concrete. The present standard overlay thickness is 1-3/4" with the same exclusions.
2. There were no consolidation requirements for the LSDC placed on these bridges. The current specification requires the concrete be consolidated to a minimum of 98% of rodded unit weight.
3. No criterion concerning electrical corrosion potential had been established to dictate concrete removal

at the time these overlays were placed. The present standard requires that the concrete in the deck be removed to the top layer of reinforcing steel where a corrosion potential measurement of -0.45 volt or more is encountered.

All of the specification changes instituted since the evaluated bridges were resurfaced are designed to increase the service life of the decks.

There has been no significant change in the levels of chloride ions in the LSDC system during the 4-year period since the decks were originally surveyed. The chloride level of the concrete in the majority of original decks under the resurfacing is considerably above the established corrosion threshold level of approximately 1.5 lbs. of chloride per cubic yard of concrete. Why the electrical corrosion potential readings did not indicate active corrosion of the reinforcing steel to a great degree over the entire deck areas surveyed is not fully explainable. A possible reason is that there is not sufficient moisture or oxygen at the reinforcing steel level to initiate corrosion or allow it to continue in any widespread manner.

The delamination survey provided data which indicate the amount of delamination in the original concrete decks is quite variable and is generally more widespread than had originally been thought. Unfortunately, no data is available to indicate whether or not delaminated areas existed immediately after construction; consequently, the progression of the delaminations

cannot be quantitatively analyzed. While some areas of unsound concrete may have remained in the old deck at the time of resurfacing, it is very doubtful that as high a percentage as found by the Delamtect on some bridges could have been overlooked in normal project inspection.

Assuming this is the case, it is probable that the delaminated areas under the resurfacing is increasing. How far this can increase prior to being manifested by surface deterioration is unknown.

Two bridges were void of delaminations. These are twin bridges that were overlaid in 1973 and are located on Interstate 35 across the Raccoon River in Polk County. One bridge was resurfaced with LSDC and the other was resurfaced with latex-modified concrete. It has been reported that the inspector on these bridges did an extremely conscientious job of insuring all unsound concrete was removed prior to resurfacing. The results from these bridges point out the importance of thorough inspection and the removal of <u>all</u> delaminated concrete in the underlying deck. These bridges will be monitored on a yearly basis.

It was intended to establish whether or not delaminated areas of the deck would show more active corrosion of the reinforcing steel than non-delaminated areas.

It is generally agreed that electrical potential measurements at or exceeding -0.35V indicate active corrosion of the reinforcing steel. Readings between -0.20V and -0.35V are generally

concluded to be in the "gray area"; that is, active corrosion may or may not be present.

Since readings of -0.35V or more definitely indicate corrosion, the percentage of readings at this level were tabulated for delaminated and non-delaminated areas. The results exhibited in Table No. 5 show that for the LSDC system the percent of readings of -0.35V or more are nearly equivalent in the delaminated and non-delaminated areas with 18.8% and 22.4%, respectively. It should not be concluded, based upon this tabulation, that the delaminations in the underlying deck concrete are not the result of continued reinforcing steel corrosion. Conversely, it does not provide sufficient evidence to positively conclude that the increase in delaminated areas can solely be attributed to re-bar corrosion.

As mentioned earlier, the majority of the delaminations were located within 1/4" of the bonded interface. It is not unusual to find this type of delamination approximately 2 inches above the reinforcing steel with the concrete between the delamination and the re-bar appearing sound. When these cores were taken directly over the reinforcing steel there was no visual evidence of corrosion on the bar. The exact cause of this type of delamination is not known. There is a distinct possibility that an incipient fracture in the surface of the old concrete may have been created due to the impact of the scarification equipment in use at that time.

There is also a possibility that all delaminated concrete was not removed at the time of resurfacing and this area is increasing due to the mechanical action created by traffic on the bridges.

Table No. 5 also compares corrosion potential measurements in the gutter line with other areas. It is not surprising to observe the high percent (44%) of readings indicating active corrosion in the gutter line since there is a likelihood of more salt and moisture in this area. There is also a distinct possibility of the readings being influenced by corrosion of the reinforcing steel in the curb.

Table No. 6 contains comparable data for the latex-modified concrete system of deck overlays. There is only limited data available on this system; however, it does not appear the analysis of this system would be significantly different than the LSDC system.

CONCLUSIONS

The results from this study would support the following conclusions:

1. The LSDC system of resurfacing over chloride contaminated bridge decks has exhibited adequate performance through 13 years.
2. The performance of the LSDC system and the latex-modified concrete system are equivalent through 6 years.

3. Chloride penetration into the LSDC and latex-modified concrete systems is similar and not significantly changed from the previous survey. Both systems are successful in reducing chloride penetration from surface applied deicing chemicals.
4. Delaminated areas exist in the original deck under the resurfacing on the majority of bridges investigated.
5. The delaminations are probably caused by either; (A) reinforcing steel corrosion, (B) not removing all delaminated concrete prior to resurfacing, or (C) creating an incipient fracture in the top surface of the original deck through the use of scarification equipment.
6. The majority of the delaminations are within 1/4" of the bonded interface and are probably not corrosion related.
7. The areas of delamination are increasing and may eventually result in distress of the resurfacing.
8. The grouting system used to bond the overlay to the original deck is adequate as evidenced by the fact that no bond failures were noted on any of the nineteen bridges studied.
9. Steel corrosion is more prominent in the gutter line than on other areas of the bridges.

10. There is no meaningful correlation between resurfacing age and delaminations or corrosion of the reinforcing steel.
11. Thorough inspection will lessen the likelihood of the formation of delaminated areas.

RECOMMENDATIONS

The following recommendations are being offered for consideration:

1. Increased emphasis should be placed upon intensive inspection to insure all delaminated concrete in the decks being resurfaced is removed. If sufficient funds are available, Delamtect testing devices should be purchased and used on decks just prior to scarification of the deck surface. This would result in more objective determinations in locating areas of unsound concrete that should be removed. Delamtect testing should also be conducted after the placement of the overlay.
2. Concrete should be removed to the top layer of reinforcing steel if an electrical corrosion potential measurement of -0.35V or more is observed.
3. Increased protection of the concrete in the gutter line and curb should be required. This may be done by treating these areas with high quality concrete sealers.

REFERENCES

1. Bergren, J. V. and Brown, B. C., "An Evaluation of Concrete Bridge Deck Surfacing in Iowa", Special Report, Iowa Department of Transportation, June, 1974.

2. Clear, K. C. and Harrigan, E. T., "Sampling and Testing for Chloride Ion in Concrete", Report No. FHWA-RD-77-85, Federal Highway Administration, August, 1977.

3. Marks, V. J., "Bridge Deck Delamination Study" Final Report Research Project HR-179, Iowa Department of Transportation, April, 1978.

APPENDIX A

Bridge Analysis Details

Polk County

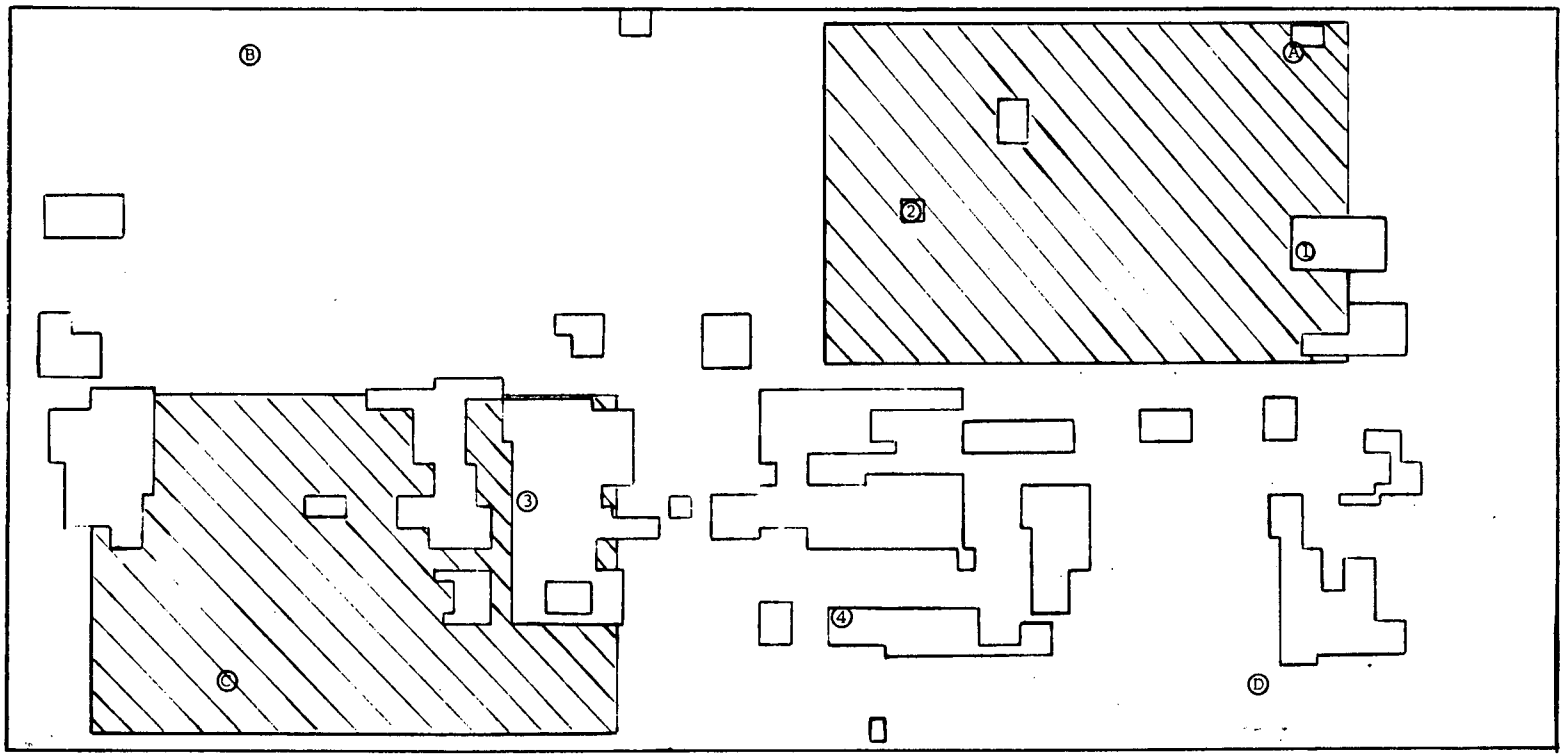
M-1209 Des. No. 3265
Location: 9th St. in Des Moines Over I-235
Year Overlaid 1965

Bridge Deck Dimensions
Width - 52 ft.
Length - 297 ft.

Deck Area - 15,444 ft.^{2}
Delaminated Area - 1,830.63 ft.^{2}
% Delamination - 11.85%

Indicates area where Electrical Potential Readings were taken
Details next page.

Letters indicate chloride cores.
Numbers indicate delamination cores.



Not to scale

Blocked out areas indicate delamination

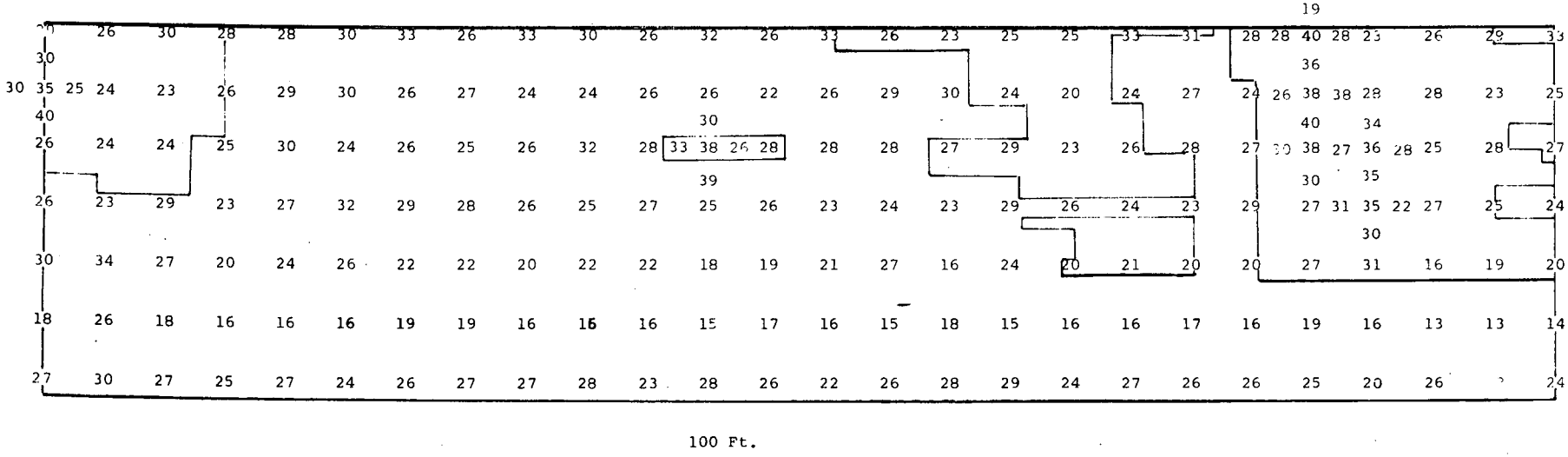
POLK COUNTY

M-1209 Des. No. 3265

Location: 9th St. in Des Moines Over I-235

Year Overlaid 1965

Electrical Potential
Negative Voltage - Copper Sulfate
Half Cell
Detail Sheet No. 1



A-2

Represents S.E. Cross Hatched Area

Blocked out areas indicate delamination

Polk County

M-1209 Des No. 3265
Location: 9th St. in Des Moines Over I-235
Year Overlaid 1965

Electrical Potential
Negative Voltage - Copper Sulfate
Half Cell
Detail Sheet No. 2

24 ft.

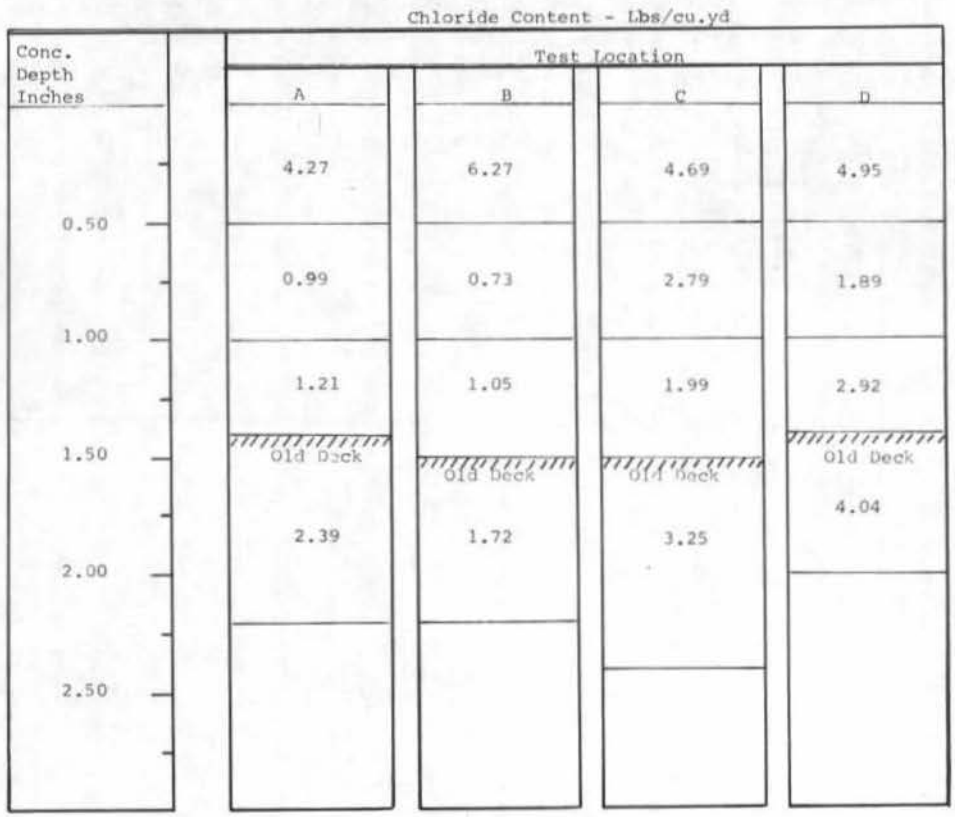
19	18	22	26	22	20	24	24	24	22	26	19	17	20	18	21	16	20	21	20	25	17	18	18	15	14
11	10	11	10	11	10	14	11	12	11	10	10	12	11	09	12	12	16	10	10	08	13	11	12	08	11
16	15	13	12	15	15	19	18	18	21	11	11	15	11	24	20	20	18	17	17	13	16	13	14	16	15
14	13	11	14	12	14	18	22	14	16	17	15	16	15	18	17	14	18	16	18	17	19	16	19	18	15
15	15	14	13	15	16	24	20	15	15	16	12	15	16	14	14	16	18	16	18	17	20	18	24	18	14
17	16	15	14	14	18	16	16	20	17	16	15	14	16	15	16	16	16	17	20	18	19	19	24	27 25 23	43231 7
12	13	19	19	13	18	13	17	18	18	14	14	13	16	17	22	16	13	15	16	17	13	16	20	18	14

100 ft.

Represents N.W. Cross Hatched Area

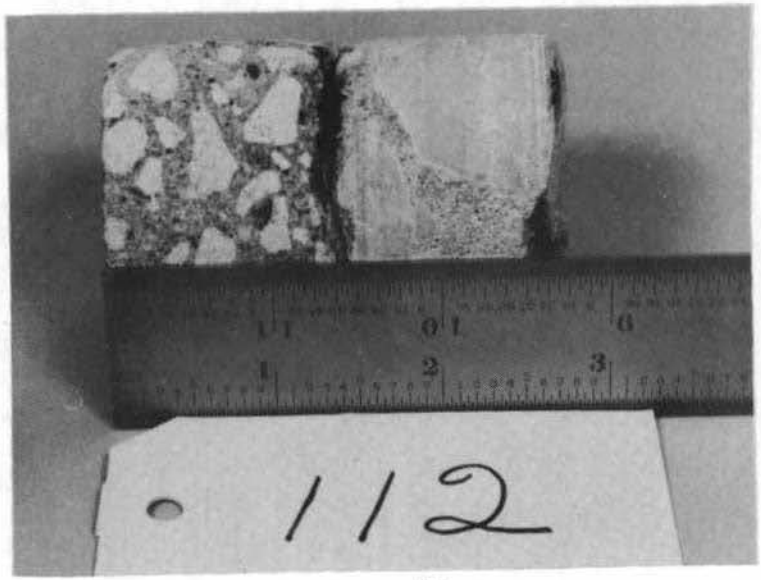
Blocked out areas indicate delamination

Polk County
M-1209 Des. No. 3265
Location: 9th St. in Des Moines over I-235
Year Overlaid: 1965



Polk County
M-1209 Des. No. 3265
Location: 9th St. in Des Moines Over I-235
Year Overlaid: 1965

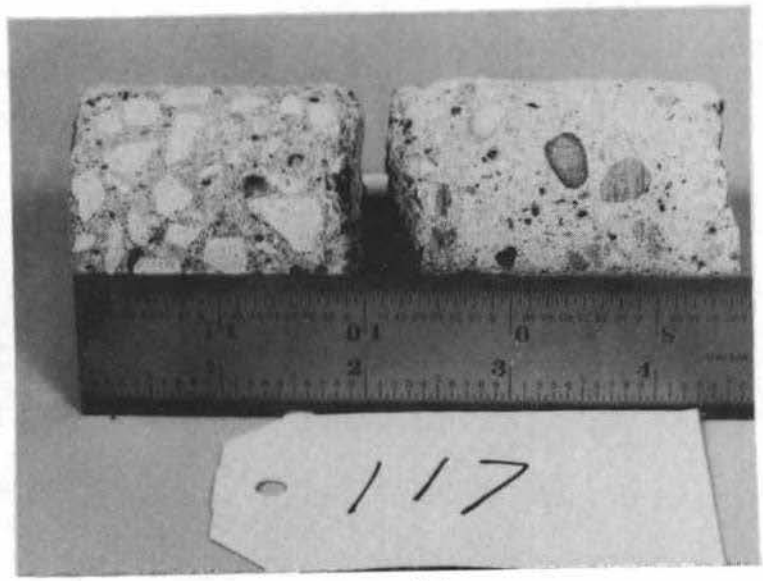
DELAMINATION CORES



Core #1

Core #2

Core #3



Core #4

Woodbury County
UN-20-1(2)--41-97 Des. No. 1065
Location: U.S. 20 Over CM St. P & P RR in Sioux City
Year Overlaid: 1966

Bridge Deck Dimensions
Width - 70 ft.
Length - 216 ft.

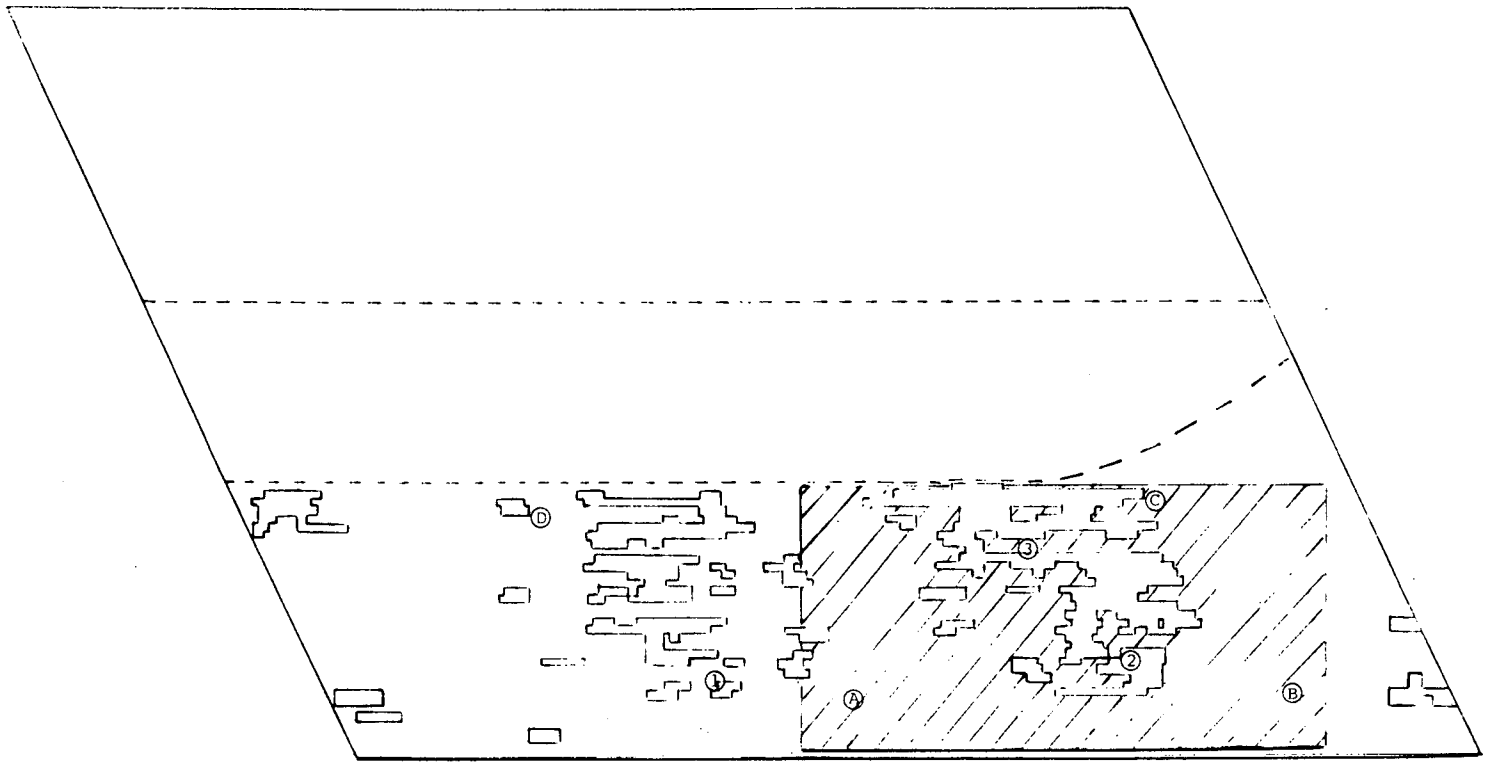
Deck area - 15,120 ft.^{2}
Delaminated Area - 837.75 ft.^{2}
% Delamination - 14.98% *

* 26' x 216' Test Section in EB Lane

N

Indicates areas where Electrical Potential Readings were taken
Details next page

Letters indicate chloride cores.
Numbers indicate delamination cores.

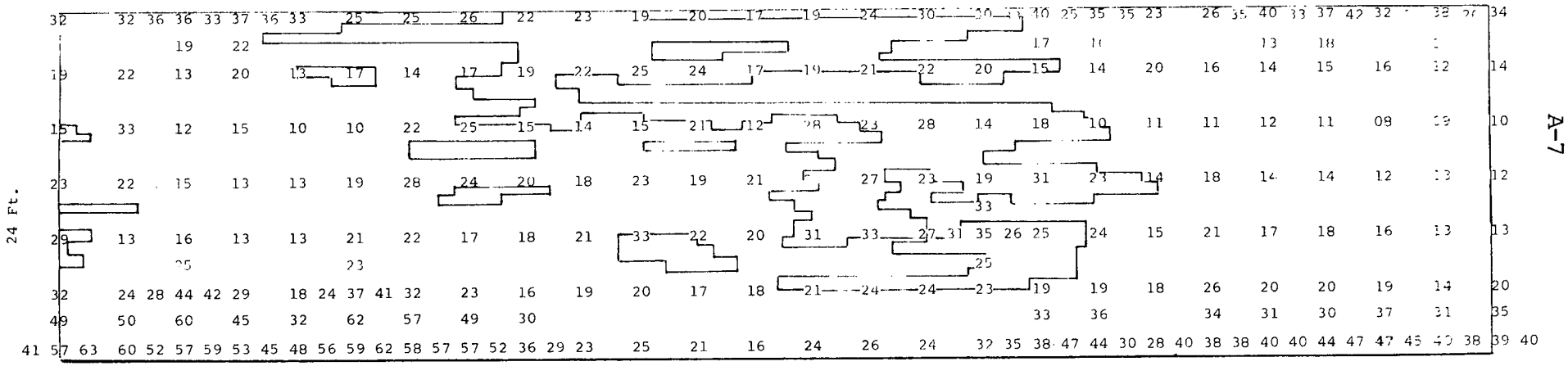


Not to Scale

Blocked out areas indicate delamination

Woodbury County
UN-20-1(2)--41-97 Des. No. 1065
Location: U.S. 20 Over CM St. P & P RR in Sioux City
Year Overlaid: 1966

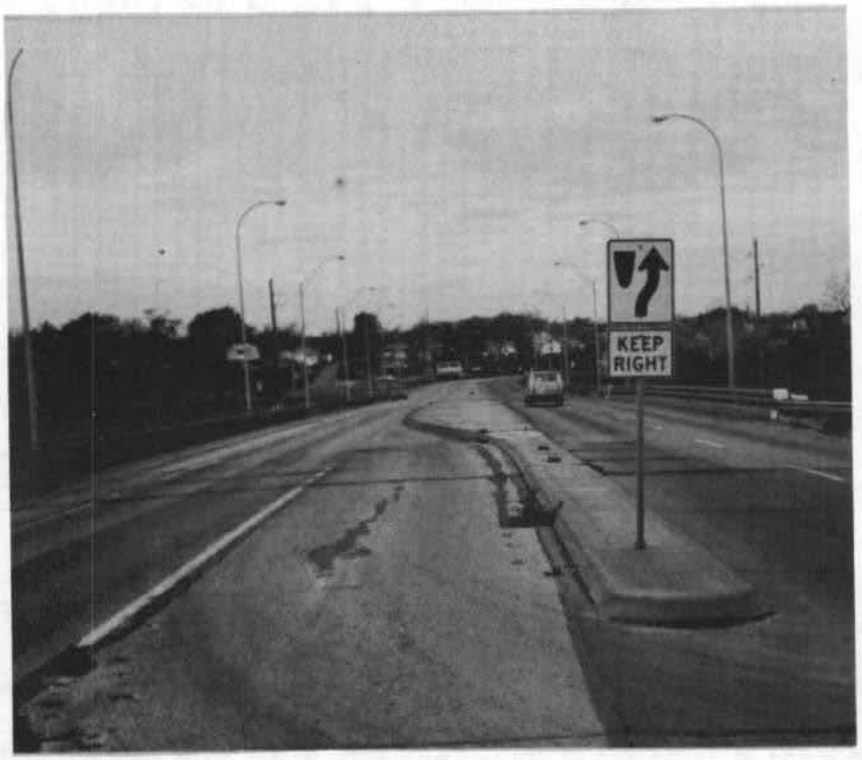
Electrical Potential
Negative Voltage-Copper Sulfate
Half Cell
Detail Sheet

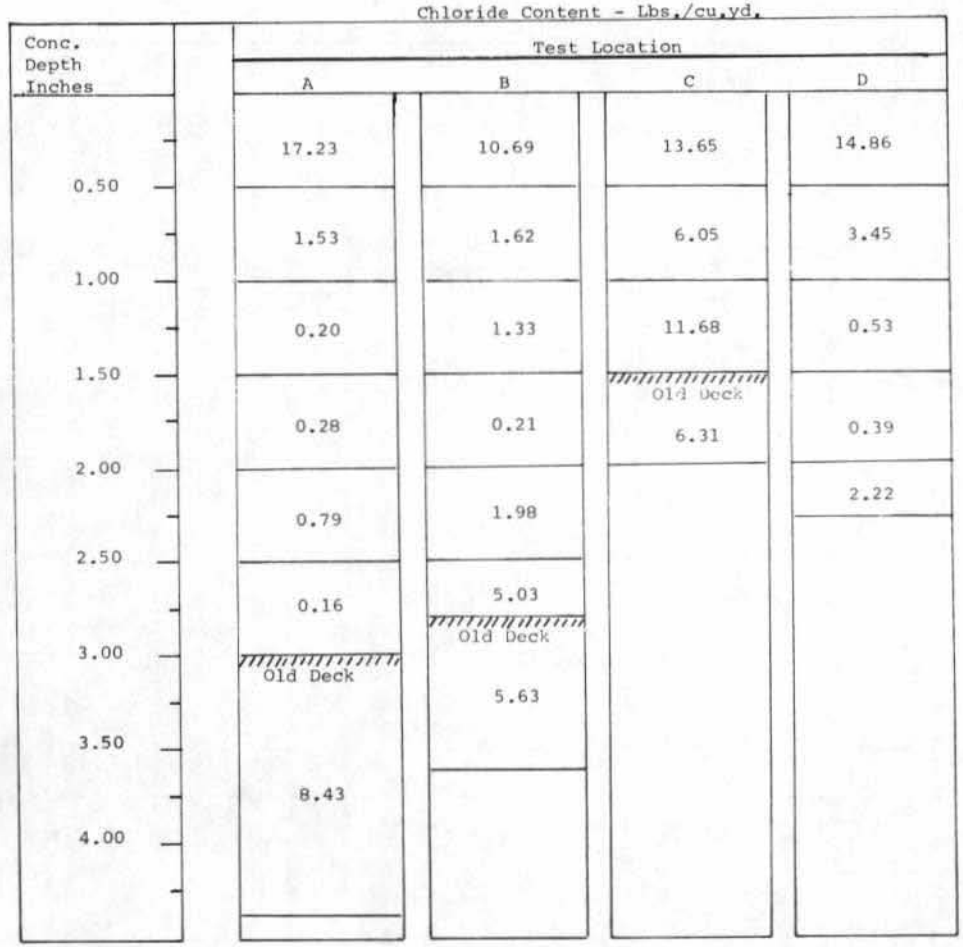


Blocked out areas indicate delamination

A-7

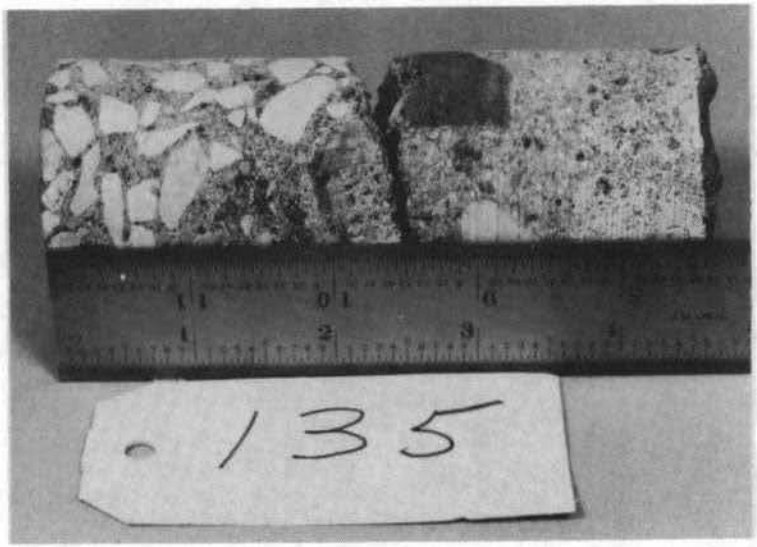
Woodbury County
UN-20-1(2)--41-97 Des. No. 1065
Location: U.S. 20 Over CM St. P & P RR In Sioux City
Year Overlaid: 1966





Woodbury County
UN-20-1(2)--41-97 Des. No. 1065
Location: U.S. 20 Over CM ST. P & P RR In Sioux City
Year Overlaid: 1966

DELAMINATION CORES



Core #1

Core #2

Core #3

Polk County

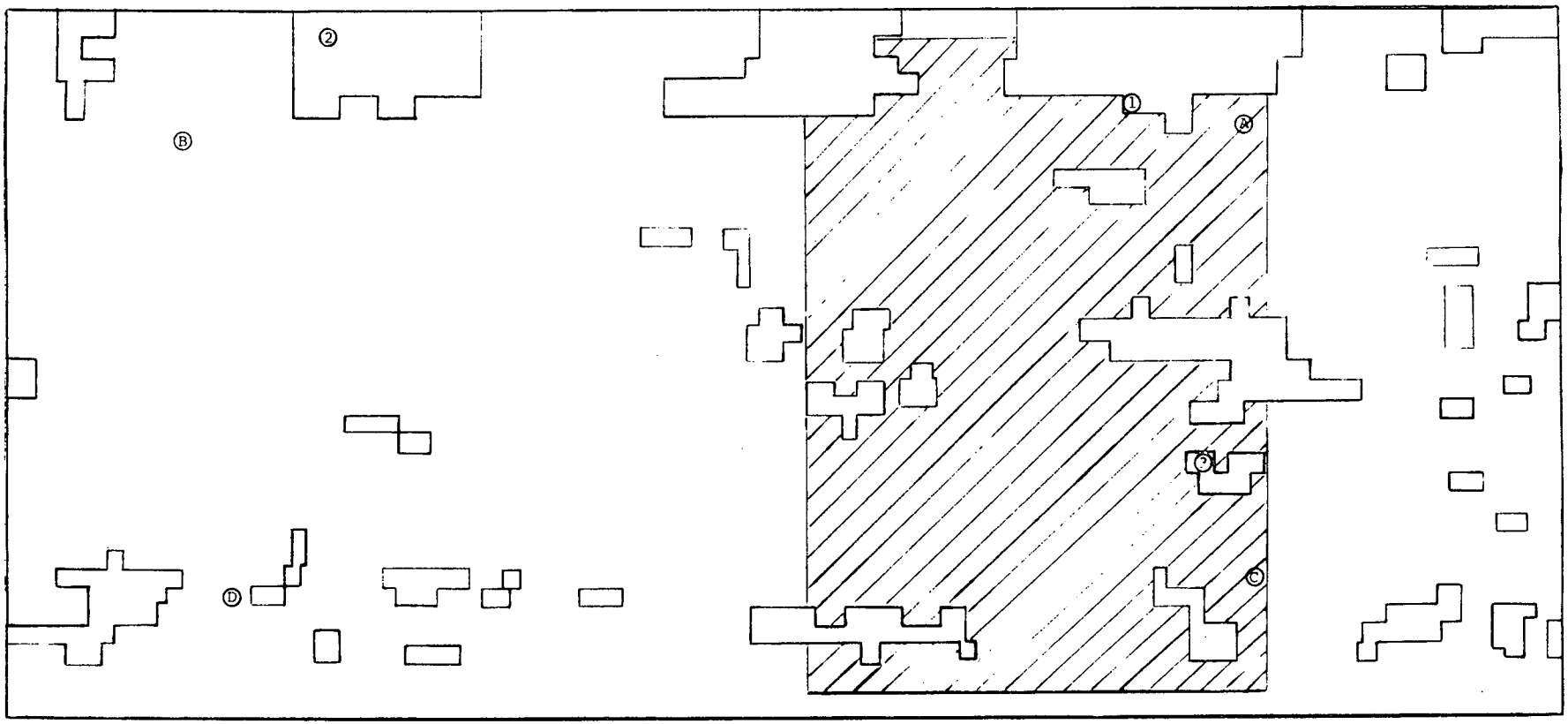
FN-60-4(2)--21-77 Des. No. 866
Location IA. 141 over Little Beaver Creek
Year Overlaid: 1967

Bridge Deck Dimensions
Width - 28 ft.
Length - 337 ft.

Deck Area - 9,436 ft.^{2}
Delaminated Area - 1,200.63
% Delamination - 12.72%

Indicates areas where Electrical Potential Readings were taken. Details next page.

Letters indicate chloride cores.
Numbers indicate delamination cores.

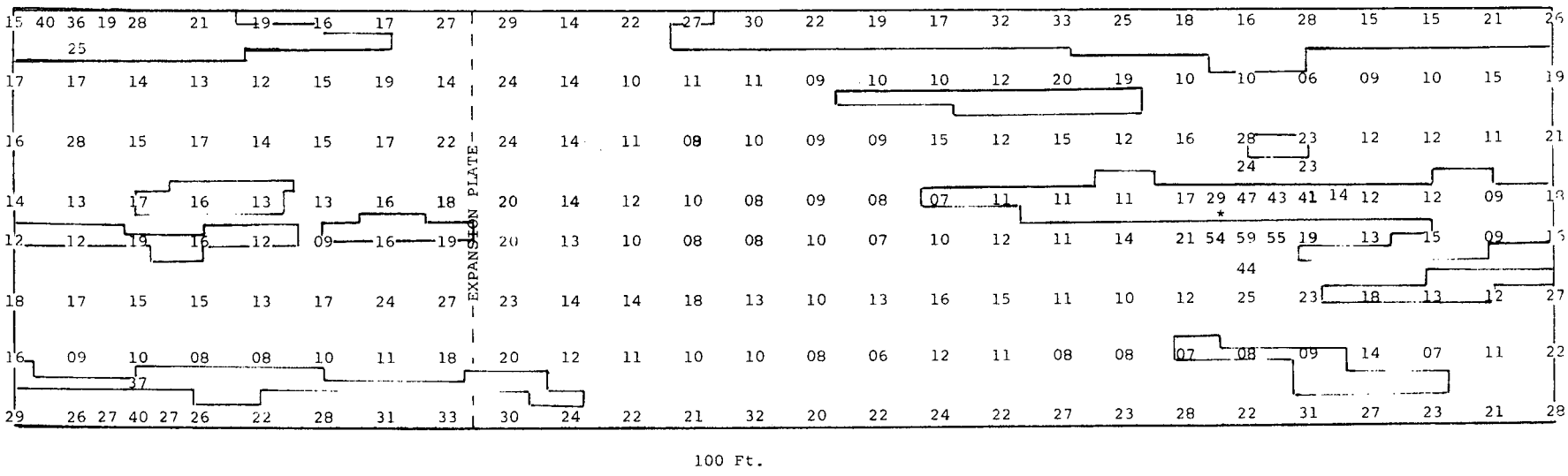


Blocked out areas indicate delamination

Not to scale

Polk County
FN-60-4(2)--21-77 Des. No. 866
Location IA. 141 Over Little Beaver Creek
Year Overlaid: 1967

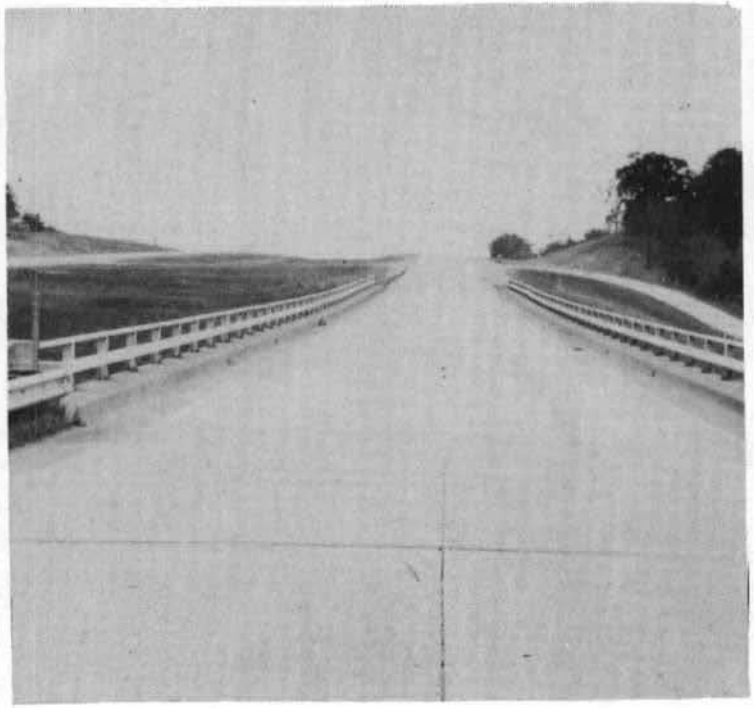
Electrical Potential
Negative Voltage - Copper Sulfate
Half Cell
Detail Sheet

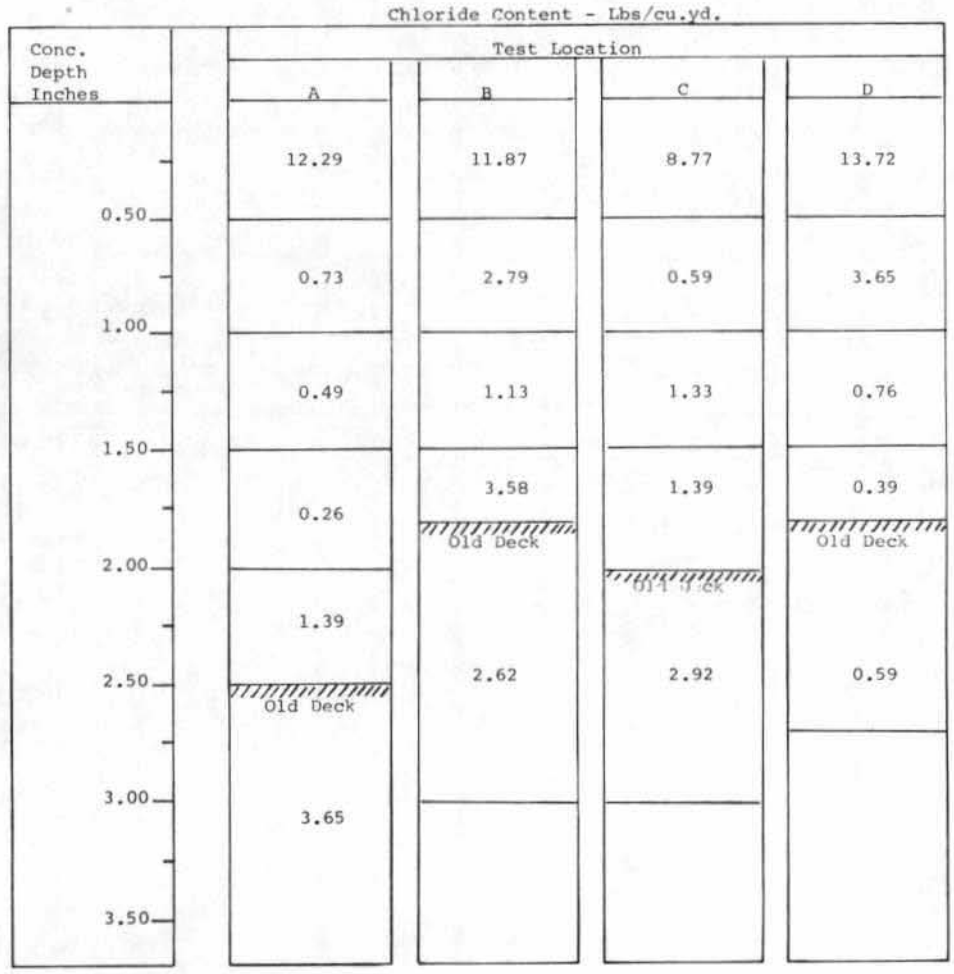


* 4" Core Hole

Blocked out areas indicate delamination

Polk County
FN-60-4(2)--21-77 Des. No. 866
Location: IA. 141 Over Little Beaver Creek
Year Overlaid: 1967

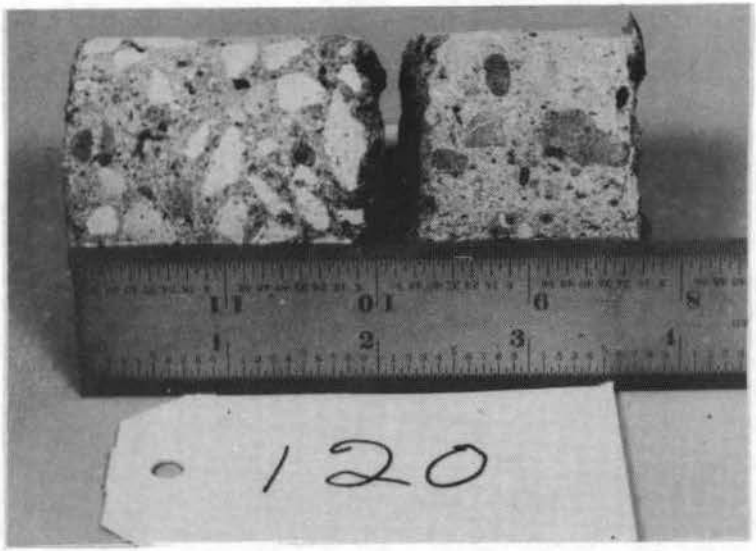




Polk County
FN-60-4(2)--21-77 Des. No. 866
Location: IA. 141 Over Little Beaver Creek
Year Overlaid: 1967

DELAMINATION CORES

Core #1



Core #2

Core #3

Clay County
FN-374-1(1)--21-21 Des. No. 267
Location: IA 374 over Little Sioux River
Year Overlaid: 1967

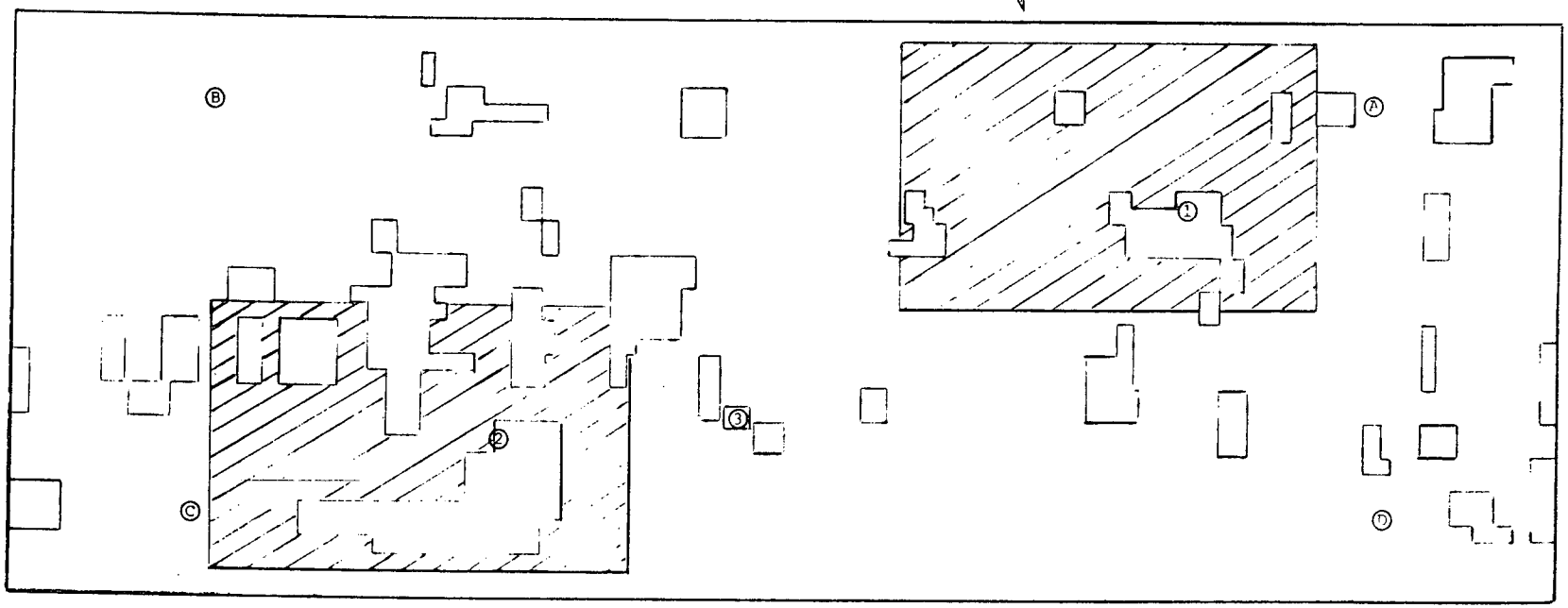
Bridge Deck Dimensions
Width - 26 ft.
Length - 374 ft.

Deck Area - 9,724 ft.^{2}
Delaminated Area - 1,103.13 ft.^{2}
% Delamination - 11.34%

N

Indicate areas where Electrical Potential Readings were taken
Details next page

Letters indicate chloride cores
Numbers indicate delamination cores

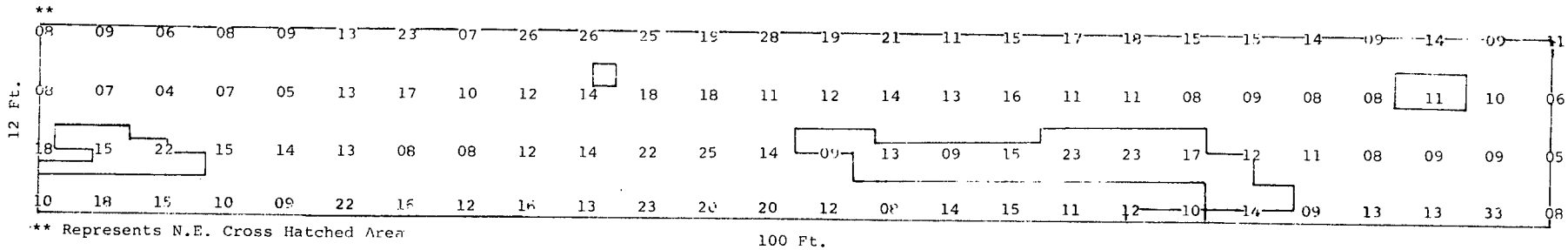


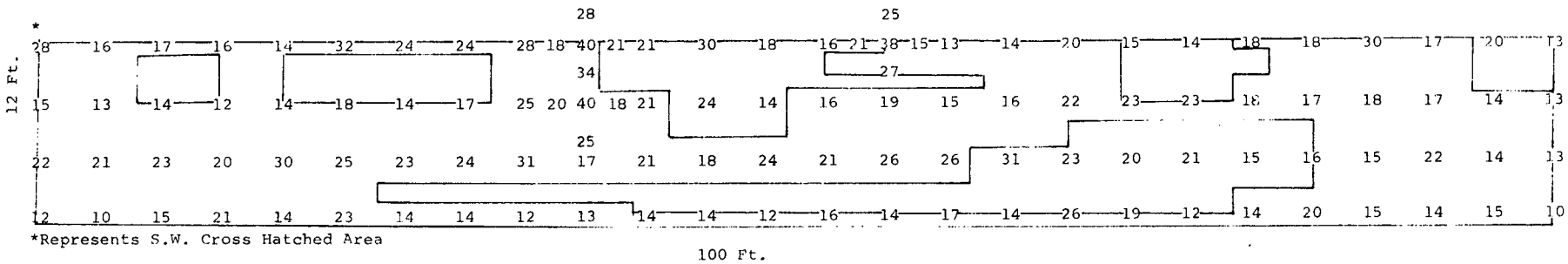
Blocked out areas indicate delamination

Not to scale

Clay County
FN-374-1(1)--21-21 Des. No. 267
Location: IA. 374 Over Little Sioux River
Year Overlaid: 1967

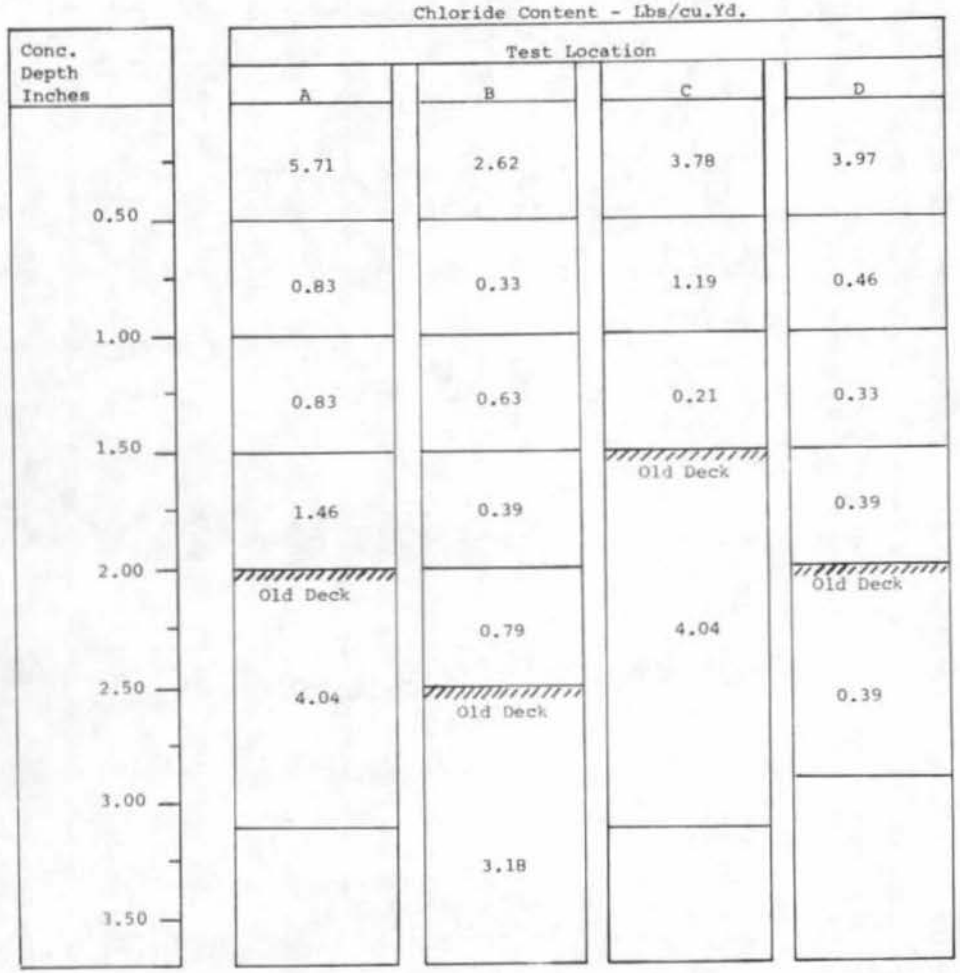
Electrical Potential
Negative Voltage - Copper Sulfate
Half Cell
Detail Sheet





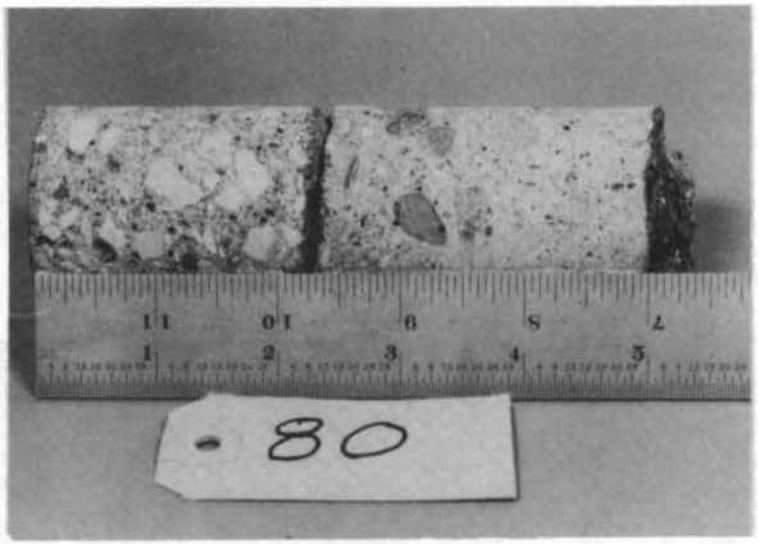
Blocked out areas indicate delamination

Clay County
FN-374-1(1)--21-21 Des. No. 267
Location: IA. 374 Over Little Sioux River
Year Overlaid 1967



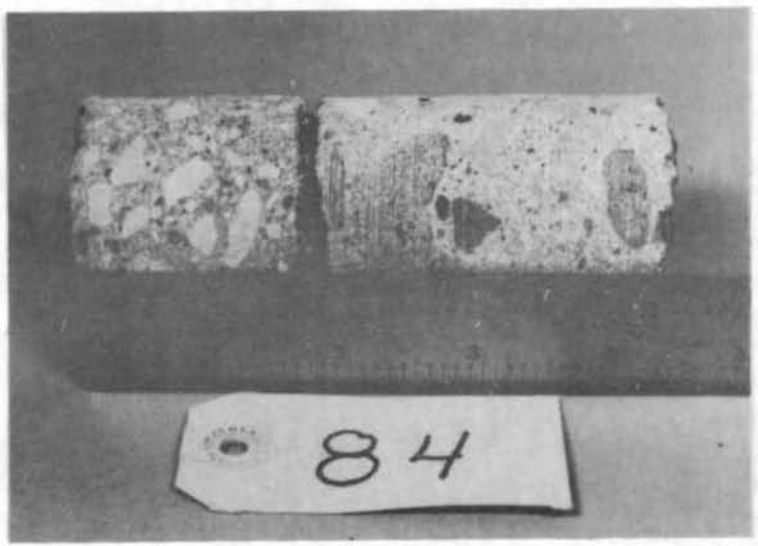
Clay County
FN-374-1(1)--21-21 Des. No. 267
Location: IA 374 Over Little Sioux River
Year Overlaid 1967

DELAMINATION CORES



Core #1

Core #2



Core #3

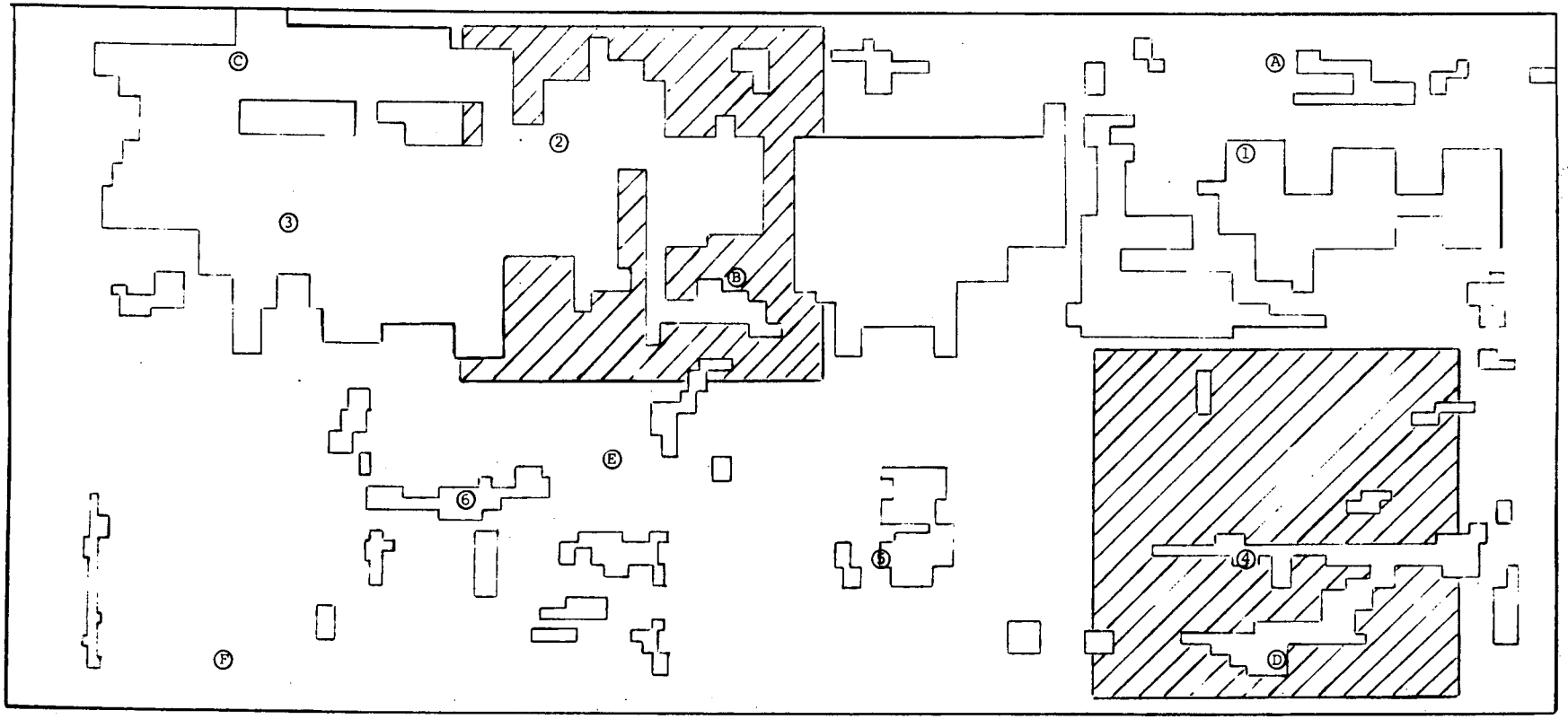
Clay County
UN-18-2(5)--41-21 Des. 167
Location: U.S. 18 Over Little Sioux River in Spencer
Year Overlaid 1967

Bridge Deck Dimensions
Width - 48 Ft.
Length - 422 Ft.

Deck Area 20,256 ft.^{2}
Delaminated Area- 5,780.38 ft^2
% Delamination - 28.54%

Indicates areas where Electrical Potential Readings were taken
Details next page

Letters indicate chloride cores
Numbers indicate delamination cores

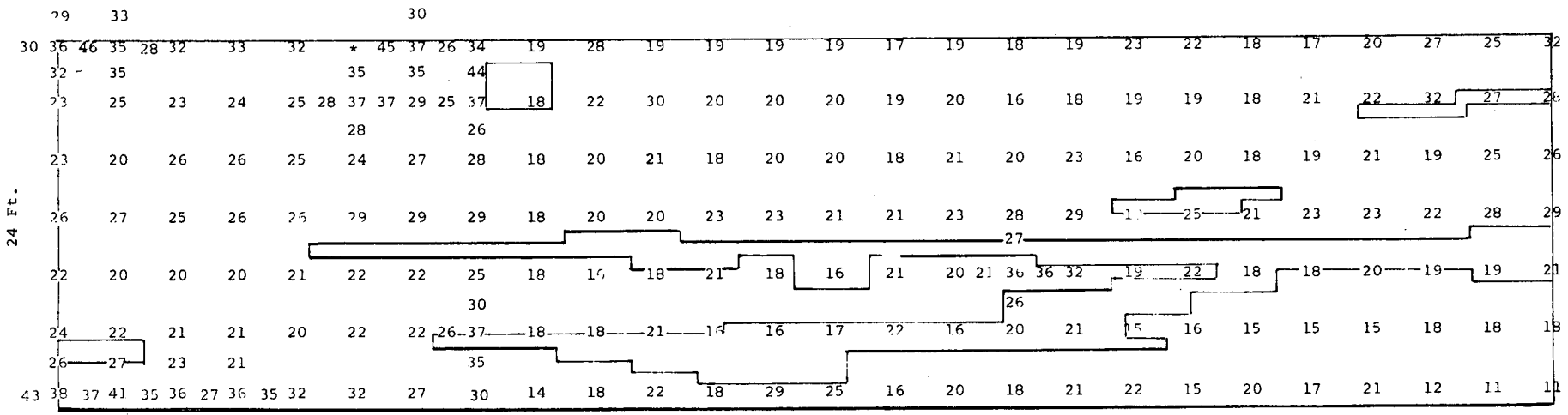


Not to Scale

Blocked out areas indicate delamination

Clay County
UN-18-2(5)--41-21 Des. 167
Location: U.S. 18 Over Little Sioux River in Spencer
Year Overlaid 1967

Electrical Potential
Negative Voltage - Copper Sulfate
Half Cell
Detail Sheet No. 1

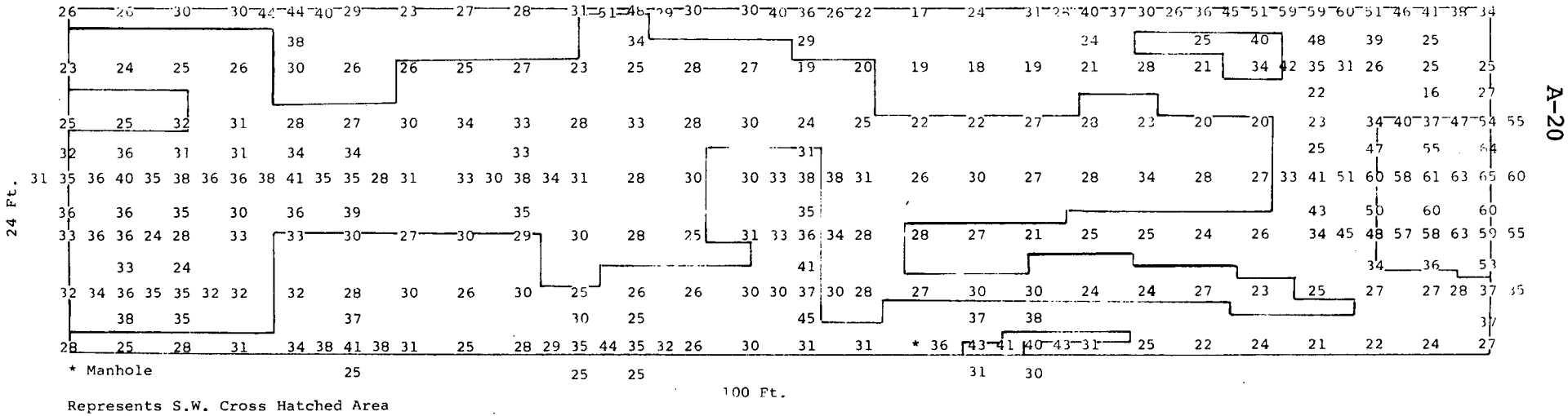


Represents N.E. Cross Hatched Area

Blocked out areas indicate delamination

Clay County
UN-18-2(5)--41-21 Des. 167
Location: U.S. 18 Over Little Sioux River in Spencer
Year Overlaid 1967

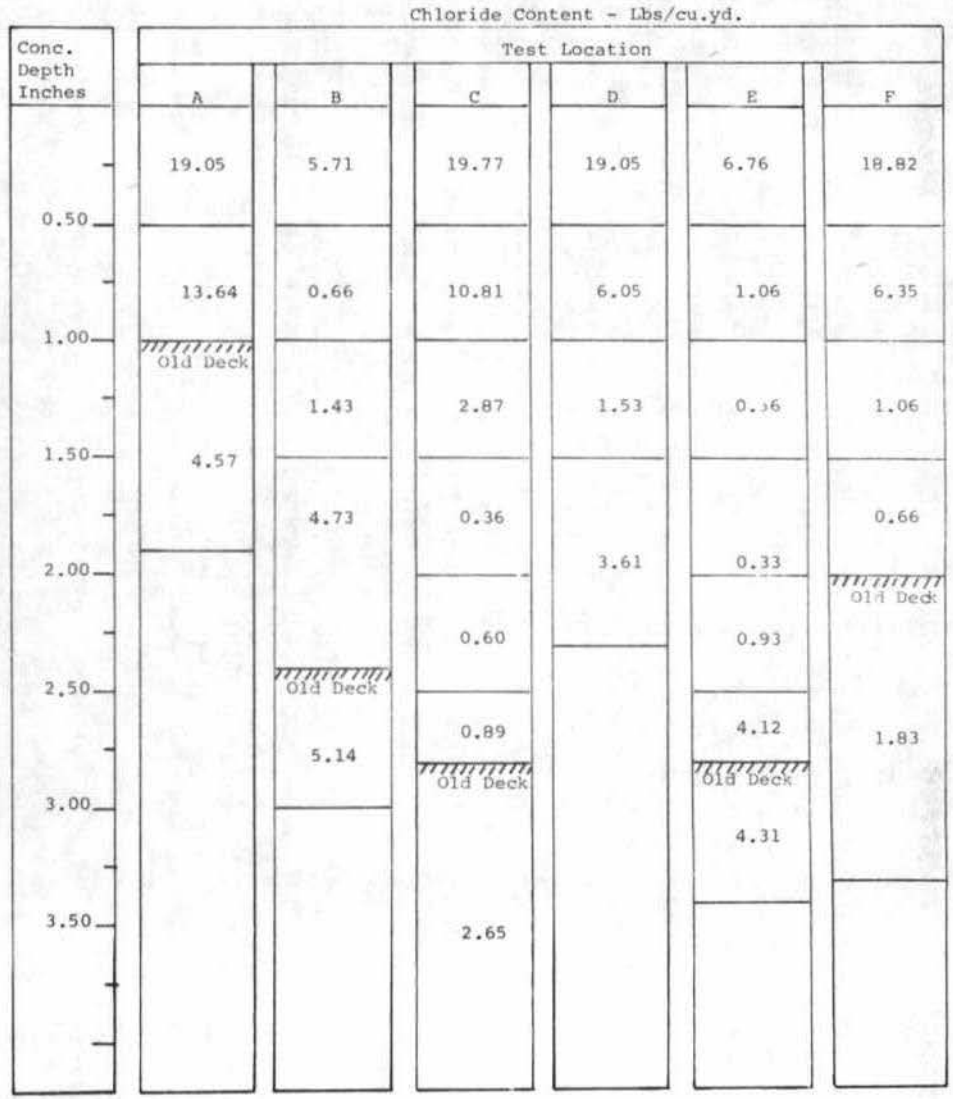
Electrical Potential
Negative Voltage - Copper Sulfate
Half Cell
Detail Sheet No. 2



Represents S.W. Cross Hatched Area

Blocked out areas indicate delamination

Clay County
UN-18-2(5)--41-21 Des. 167
Location: U.S. 18 Over Little Sioux River in Spencer
Year Overlaid: 1967



Clay County
UN-18-2(5)-41-21 Des. No. 167
Location: U.S. 18 Over Little Sioux River in Spencer
Year Overlaid: 1967

DELAMINATION CORES

Core #1

Core #2

Core #3

Core #4

Core #5

Core #6

Monona County
INP-29-6(27)114--15-67 Des. No. 268
Location: IA. 175 Over I-29
Year Overlaid: 1968

Bridge Deck Dimensions
Width - 30 ft.
Length - 247 ft.

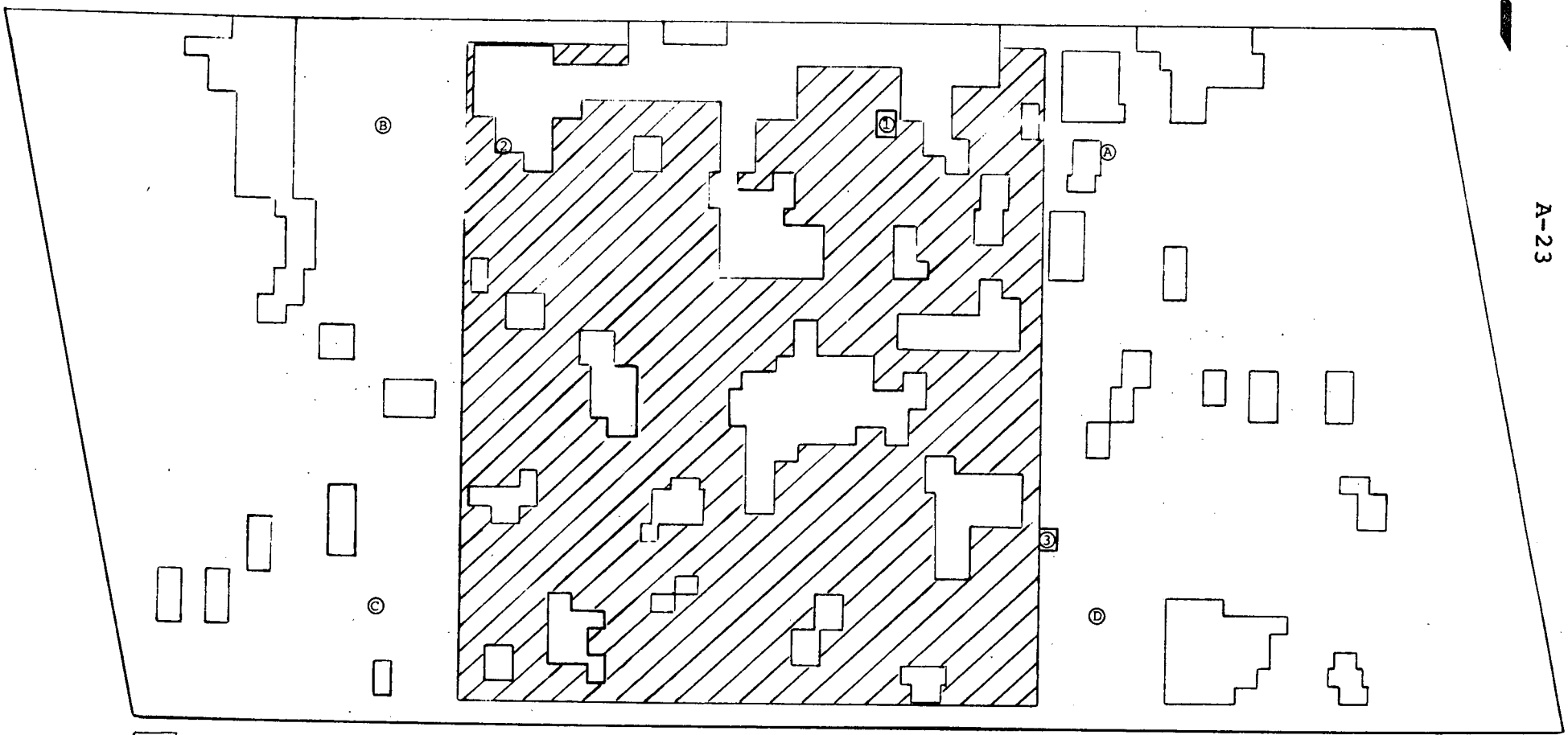
Deck Area - 7,410 ft.^{2}
Delaminated Area - 1,219.25 ft.^{2}
% Delamination - 16.45 %

Monona County
INP-29-6(27)114--15-67 Des. No. 268
Location: IA. 175 Over I-29
Year Overlaid: 1968

Indicates areas where Electrical Potential Readings were taken
Details next page

Letters indicate chloride cores.
Numbers indicate delamination cores.

N



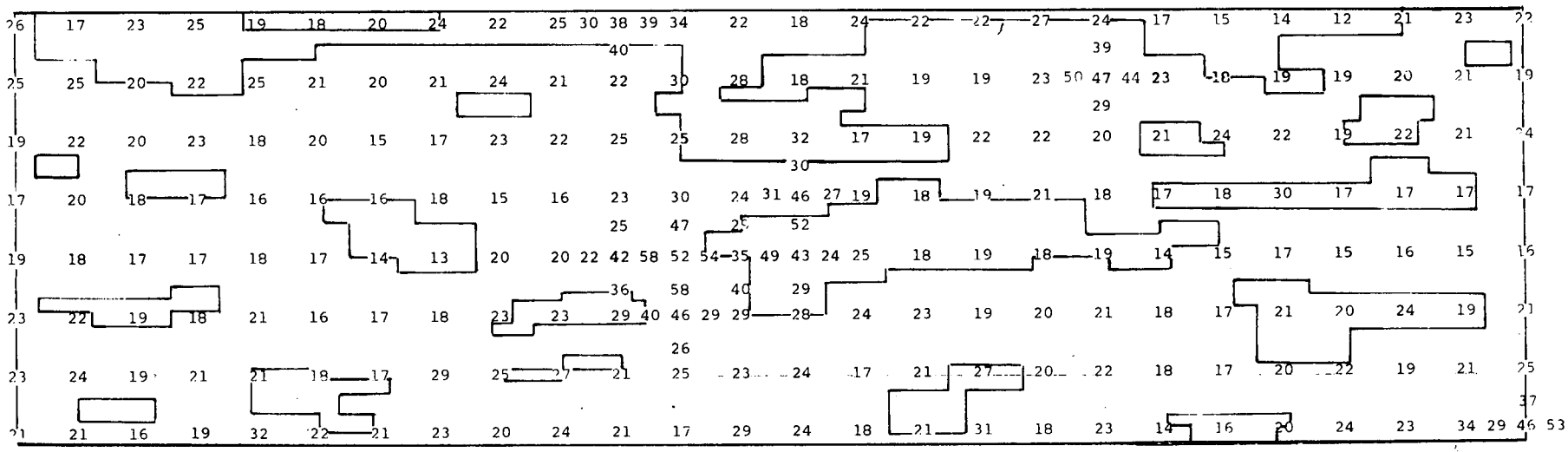
A-23

Blocked out areas indicate delamination

Not to Scale

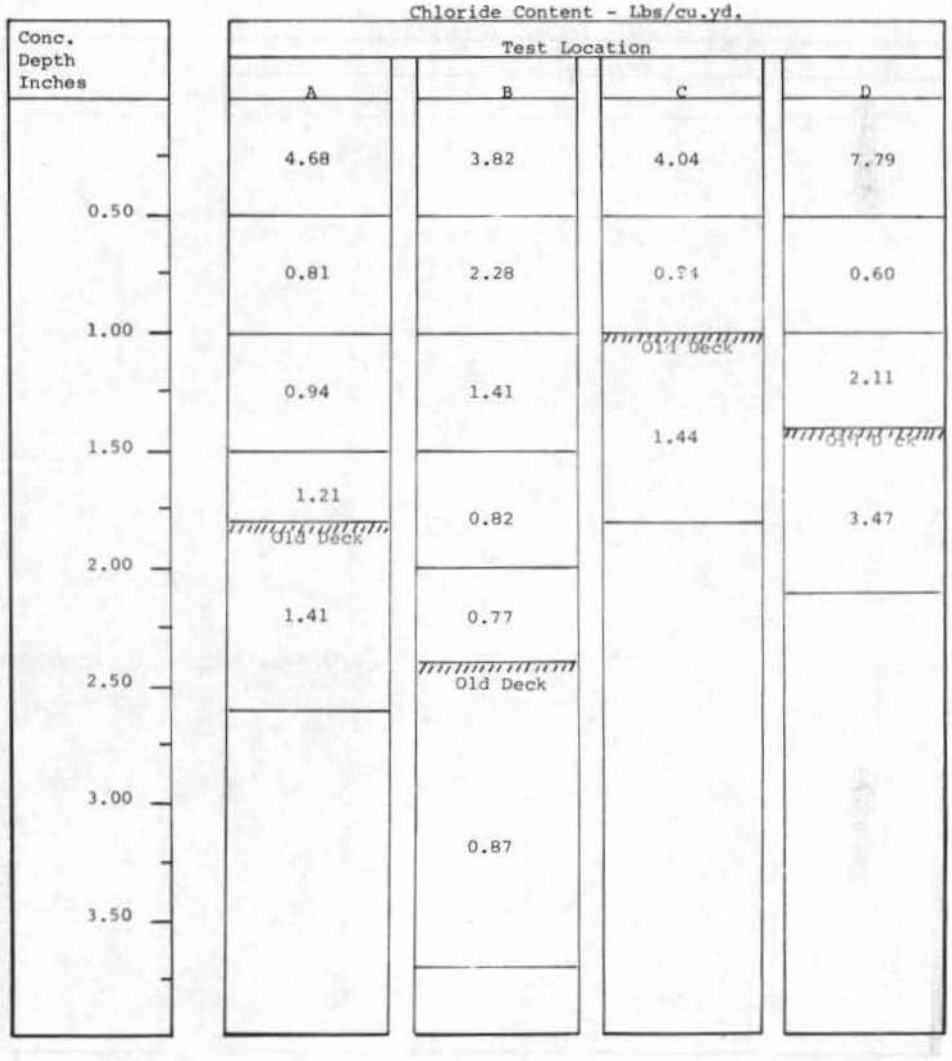
Monona County
INP-29-6(27)114--15-67 Des. No. 268
Location: Ia. 175 Over I-29
Year Overlaid: 1968

Electrical Potential
Negative Voltage - Copper Sulfate
Half Cell
Detail Sheet



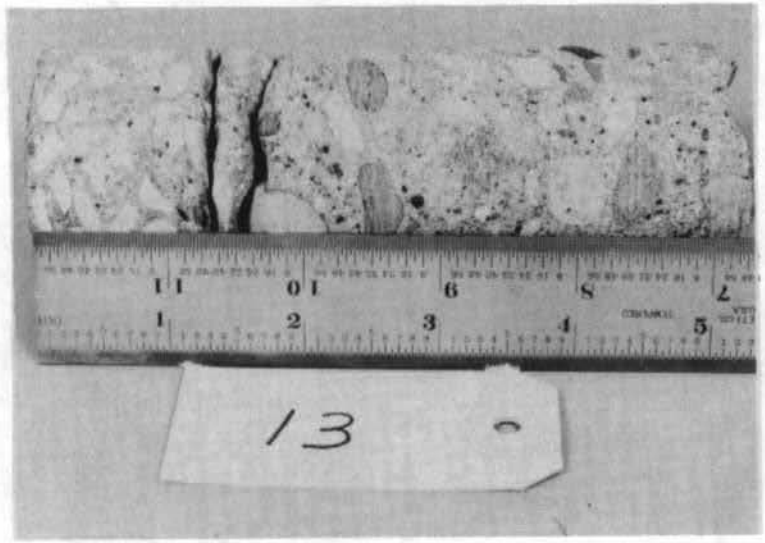
Blocked out areas indicate delamination

Monona County
INP-29-6(27)114--15-67 Des No. 268
Location: IA. 175 Over I-29
Year Overlaid: 1968

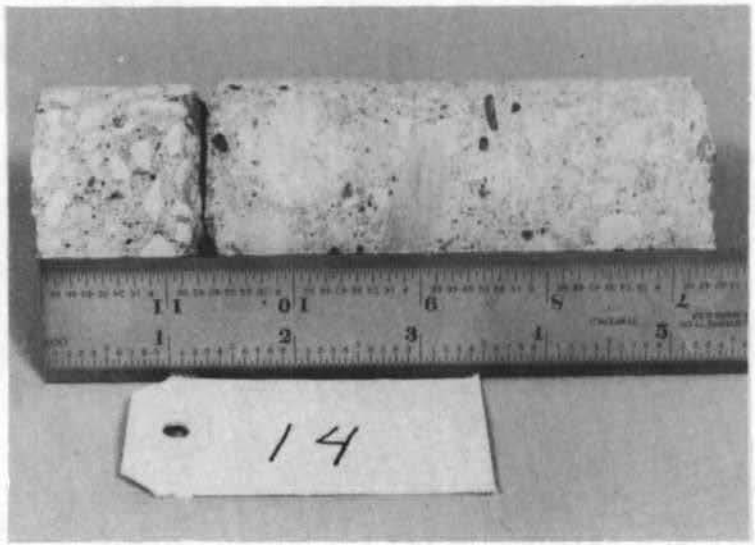


Monona County
INP-29-6(27)114--15-67 Des. No. 268
Location: IA. 175 Over I-29
Year Overlaid: 1968

DELAMINATION CORES



Core #1



Core #2

Core #3

Woodbury County
INP-29-6(28)143--15-97 Des. No. 168
Location: I-29 Over C & NW R.R. & Wall St.
Year Overlaid: 1968

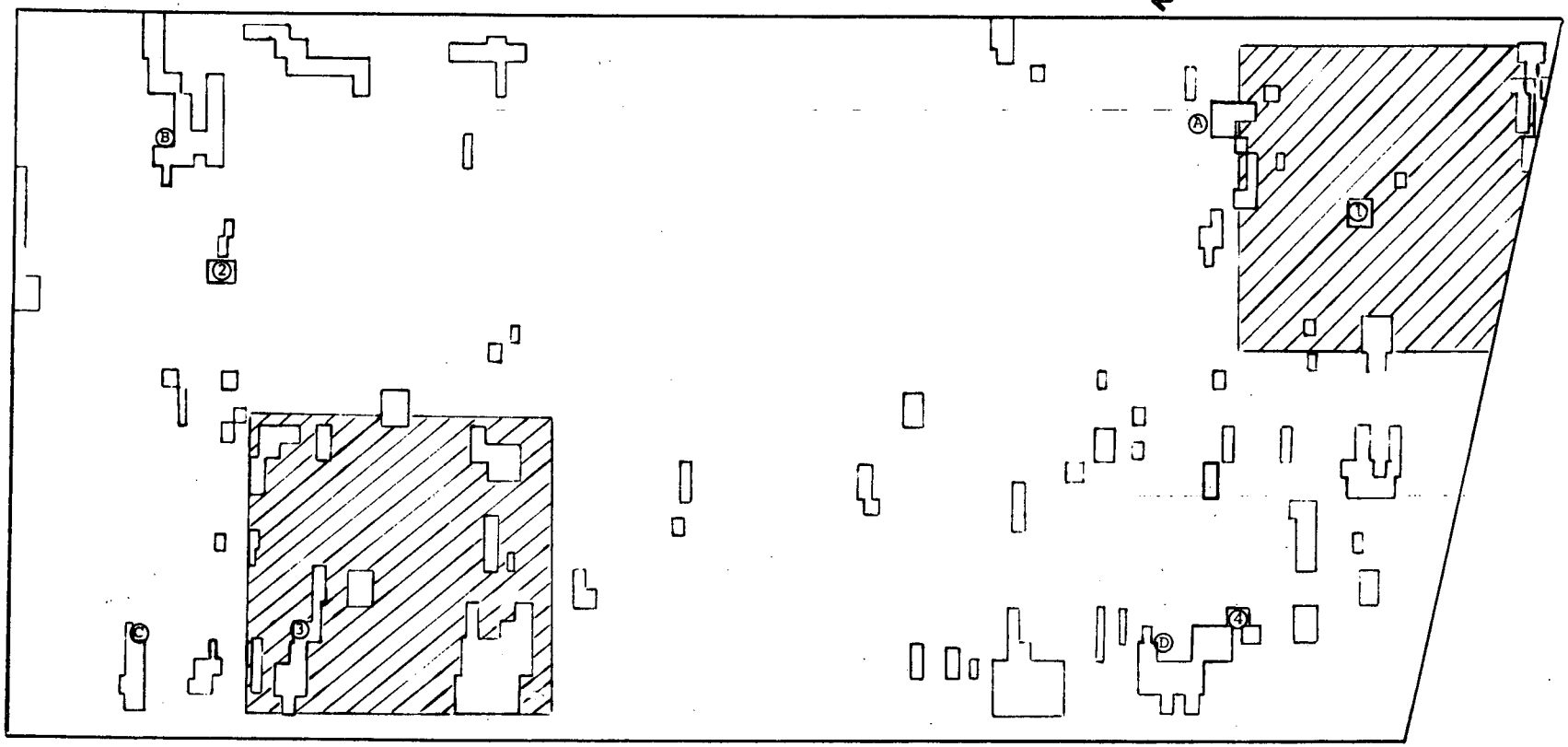
Bridge Deck Dimensions
Width - 29 ft.
Length - 479 ft.

Deck Area - 13,891 ft.^{2}
Delaminated Area - 960.75 ft.^{2}
% Delamination - 6.92 %

Woodbury County
INP-29-6(28)143--15-97 Des. No. 168
Location: I-29 Over C & NW R.R. & Wall St.
Year Overlaid: 1968

Indicates areas where Electrical Potential Readings were taken
Details next page

Letters indicate chloride cores.
Numbers indicate delamination cores.



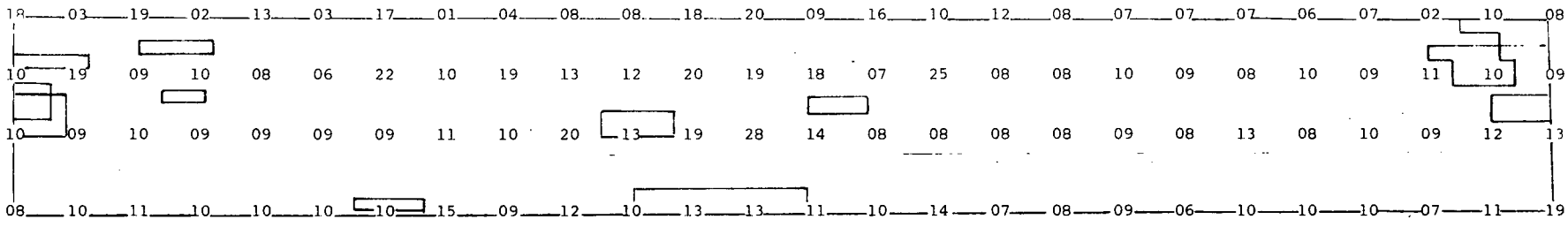
Not to Scale

Blocked out areas indicate delamination

Woodbury County
INP-29-6(28)143--15-97 Des. No. 168
Location: I-29 Over C & NW R.R. & Wall St.
Year Overlaid: 1968

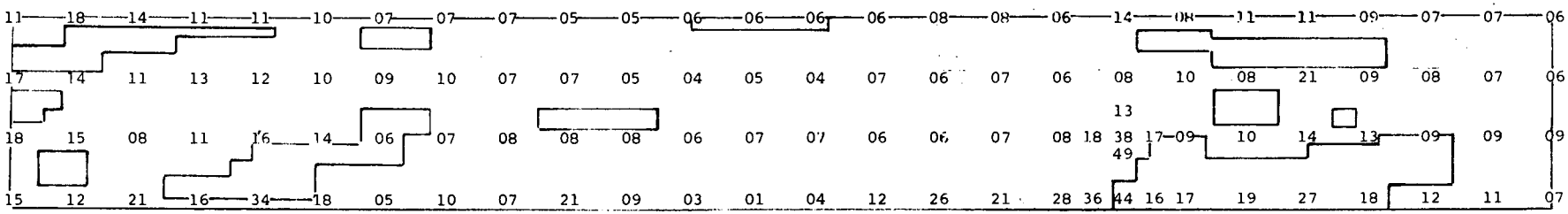
Electrical Potential
Negative Voltage - Copper Sulfate
Half Cell
Detail Sheet

*



* Represents NW Cross Hatched Area

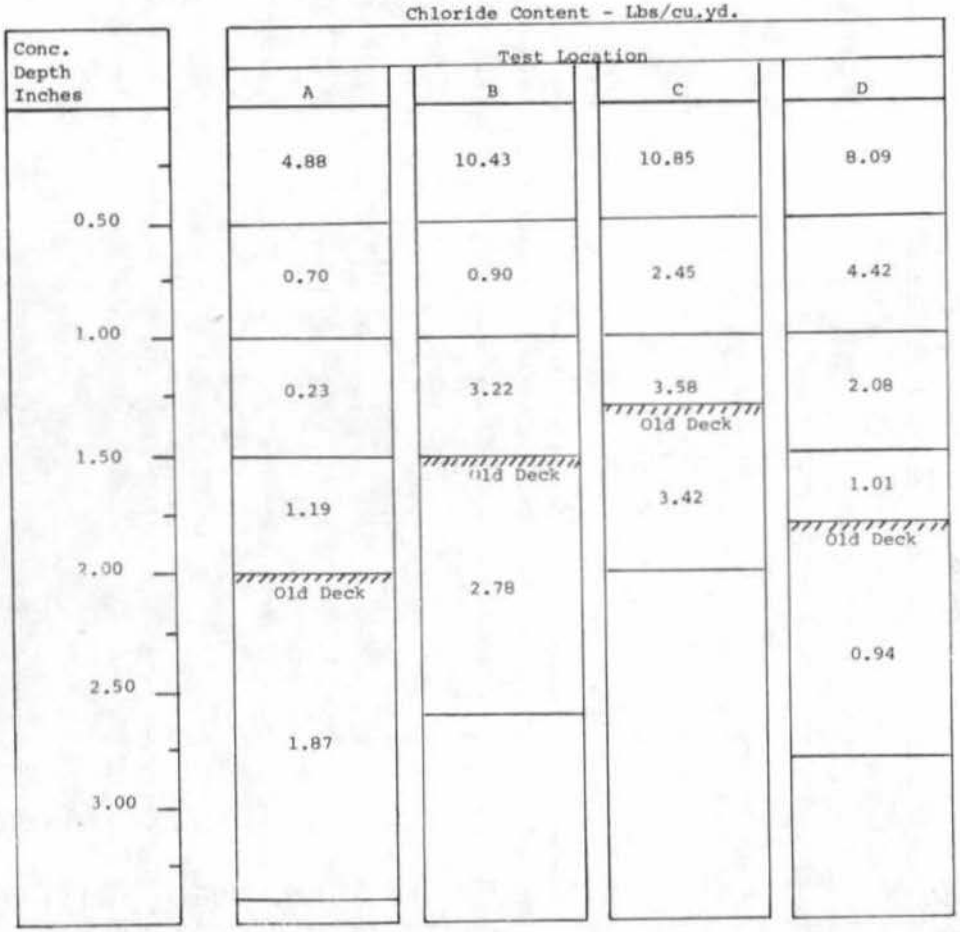
**



** Represents SE Cross Hatched Area

Blocked out areas indicate delamination

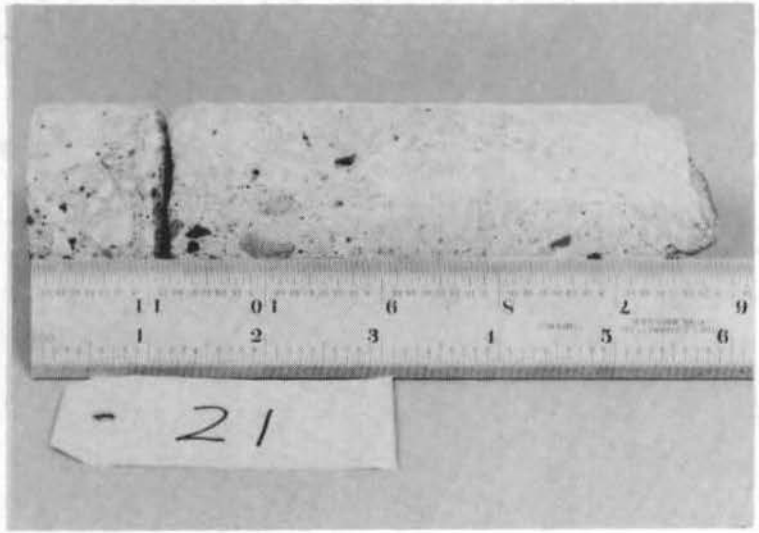
Woodbury County
INP-29-6(28)143--15-97 Des. No. 168
Location: I-29 Over C & NW R.R. & Wall St.
Year Overlaid: 1968



Woodbury County
INP-29-6(28)143-15-97 Des. No. 168
Location: I-29 Over C & NW R.R. & Wall St.
Year Overlaid: 1968

DELAMINATION CORES

Core #1



Core #2

Core #3

Core #4

Plymouth County
FN-75-5(4)--21-75 Des. No. 169
Location: U.S. 75 Southbound Over Floyd River in LeMars
Year Overlaid 1969

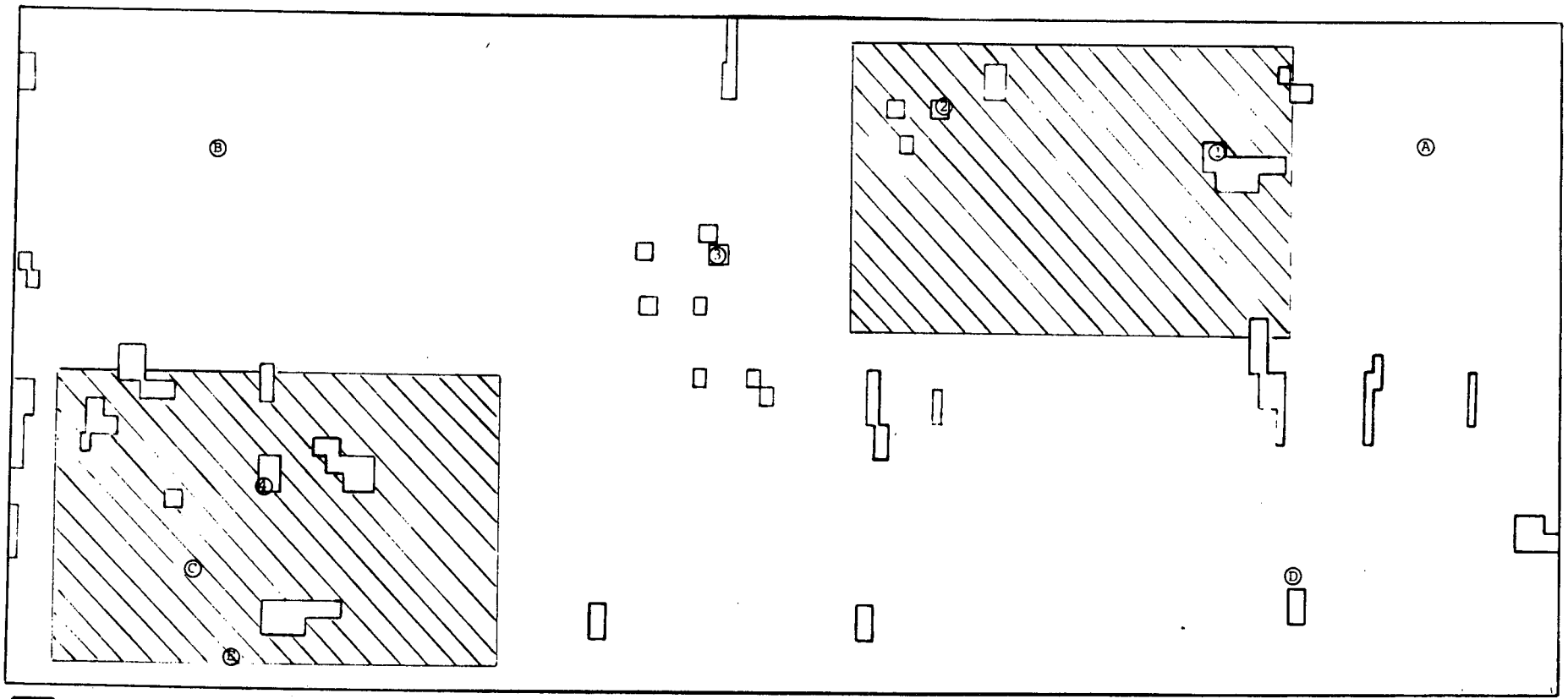
Bridge Deck Dimensions
Width - 28 Ft.
Length - 351 Ft.

Deck Area - 9,828 Ft.^{2}
Delaminated Area 254.50 Ft.^{2}
% Delamination - 2.59 %

N

Indicates areas where Electrical Potential Readings were taken
Details next page

Letters indicate chloride cores.
Numbers indicate delamination cores.

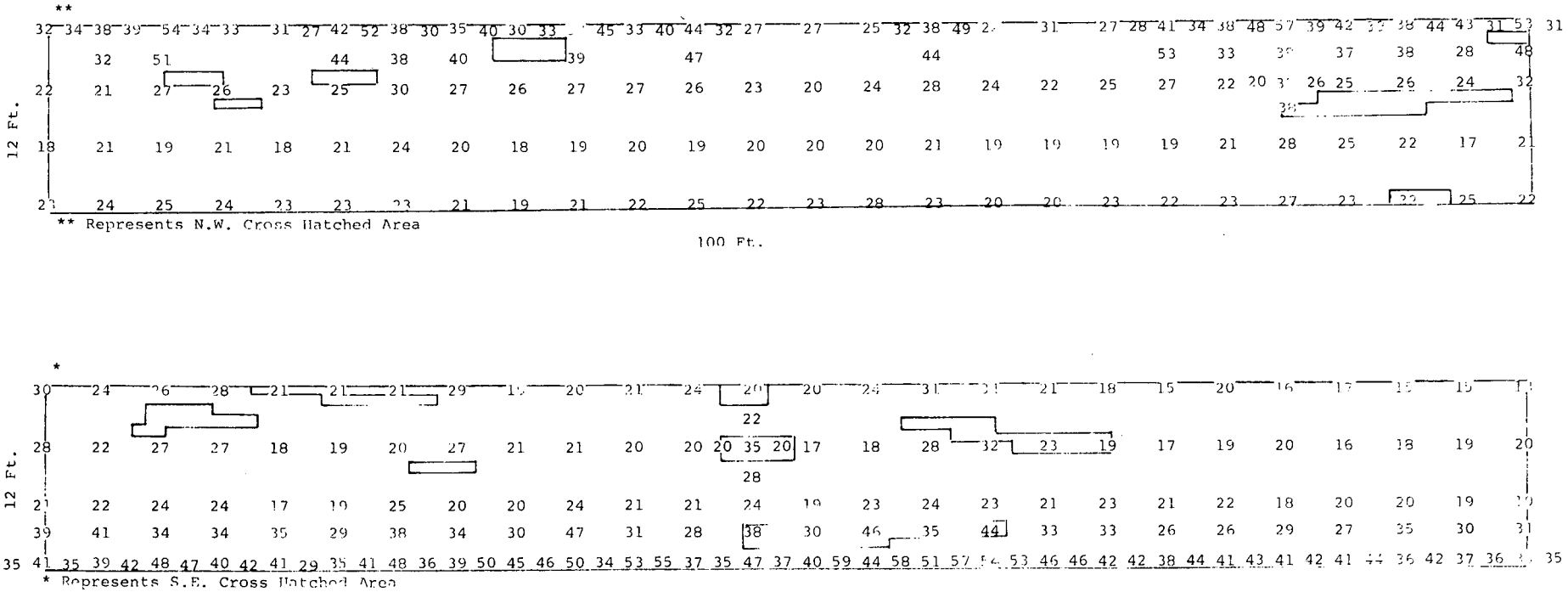


Blocked out areas indicate delamination

Not to Scale

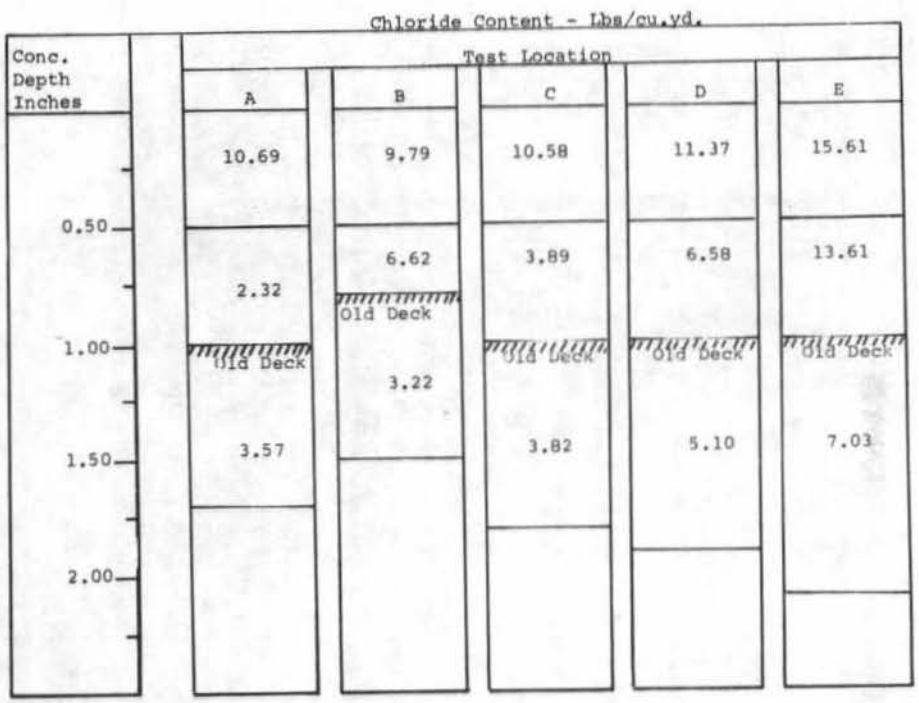
Plymouth County
FN-75-5(4)--21-75 Des. No. 169
Location: U.S. 75 Southbound Over Floyd River in LeMars
Year Overlaid 1969

Electrical Potential
Negative Voltage - Copper Sulfate
Half Cell
Detail Sheet



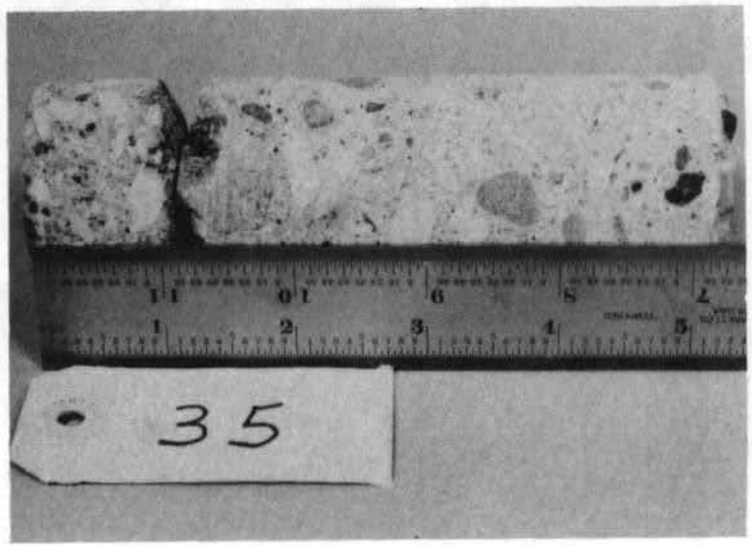
Blocked out areas indicate delamination

Plymouth County
FN-75-5(4)--21-75 Des. No. 169
Location: U.S. 75 Southbound Over Floyd River in LeMars
Year Overlaid: 1969



Plymouth County
FN-75-5(4)--21-75 Des. No. 169
Location: U.S. 75 Southbound Over Floyd River
Year Overlaid: 1969

DELAMINATION CORES



Core #1

Core #2

Core #3

Core #4

Calhoun County
FN-175-5(3)--21-13 Des. No. 170
Location: Ia. 175 Over Raccoon River
Year Overlaid: 1970

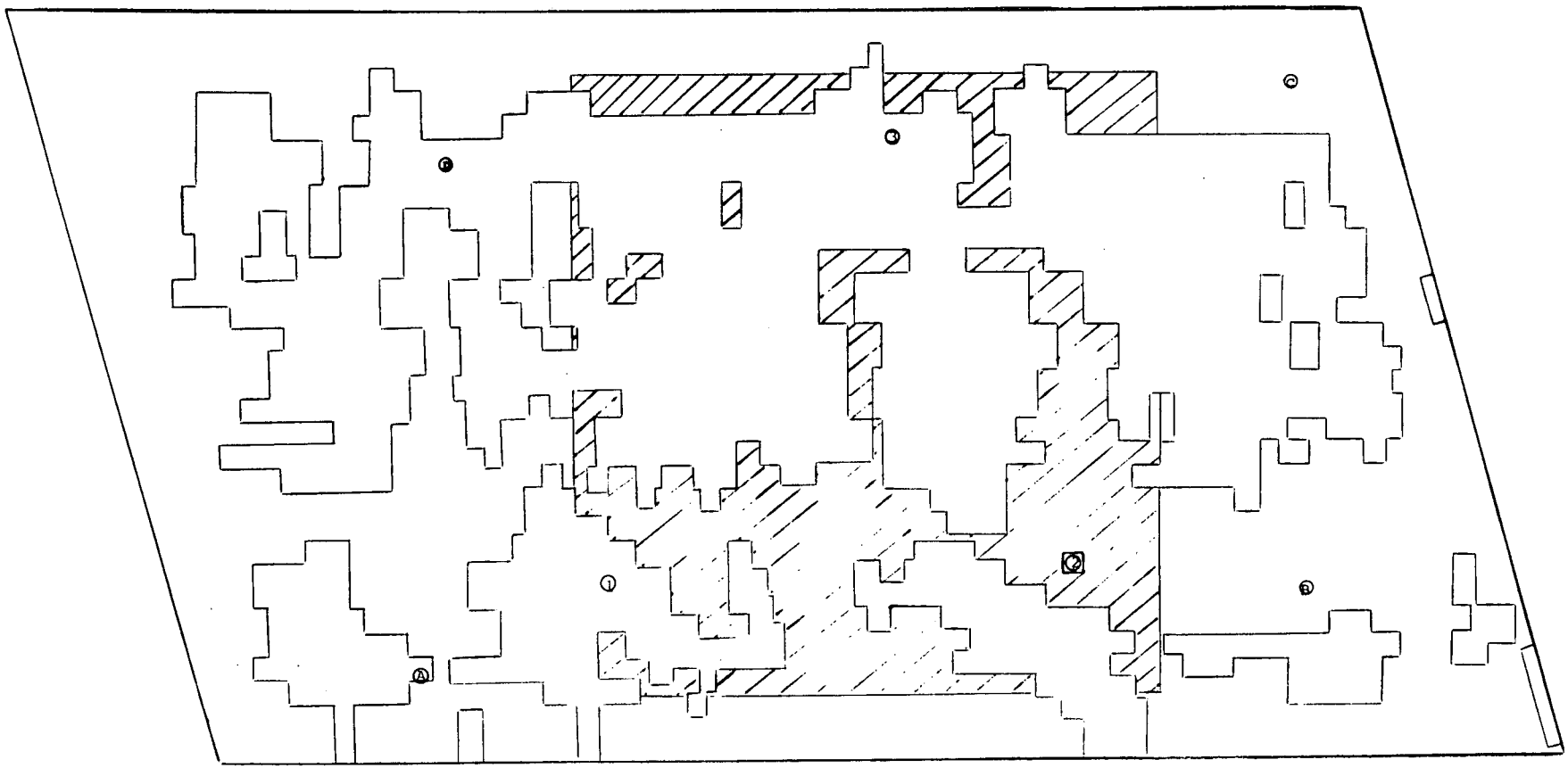
Bridge Deck Dimensions
Width - 24 Ft.
Length - 229 Ft.

Deck Area - 5,496 Ft.^{2}
Delaminated Area - 2,469.25 Ft.^{2}
%Delamination - 44.93 %

N

Indicates areas where Electrical Potential Readings were taken
Details next page

Letters indicate chloride cores.
Numbers indicate delamination cores.

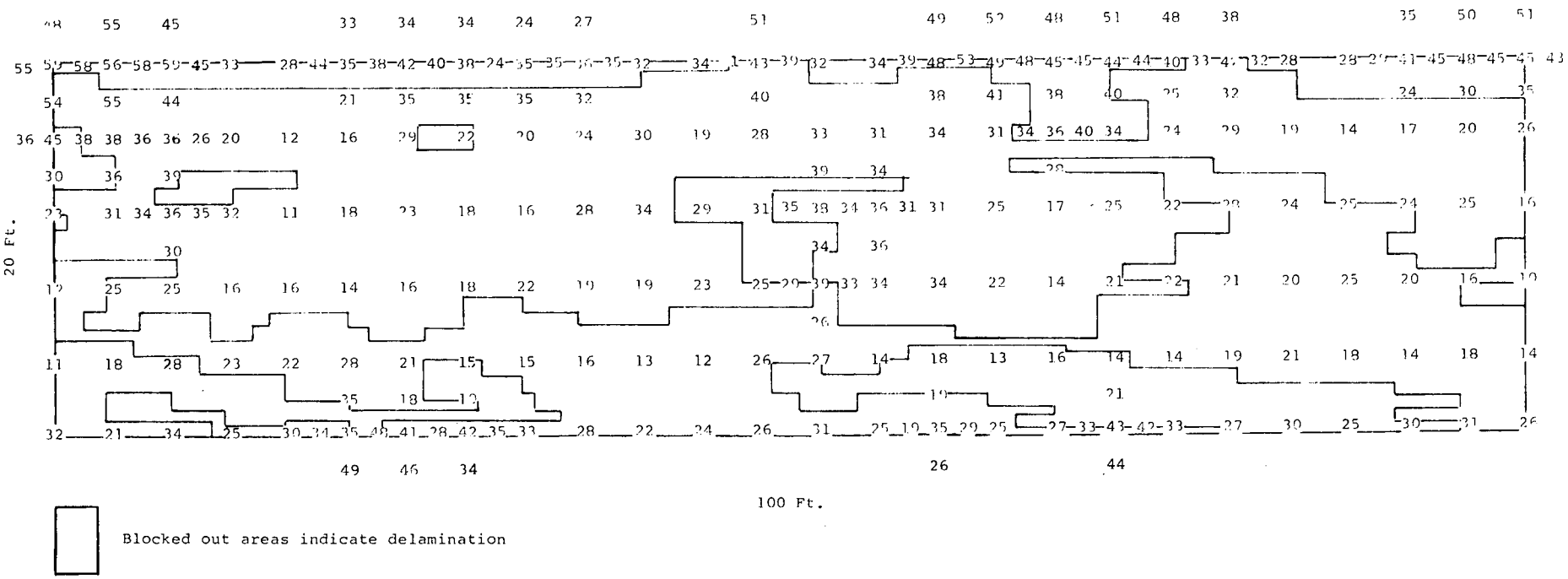


Blocked out areas indicate delamination

Not To Scale

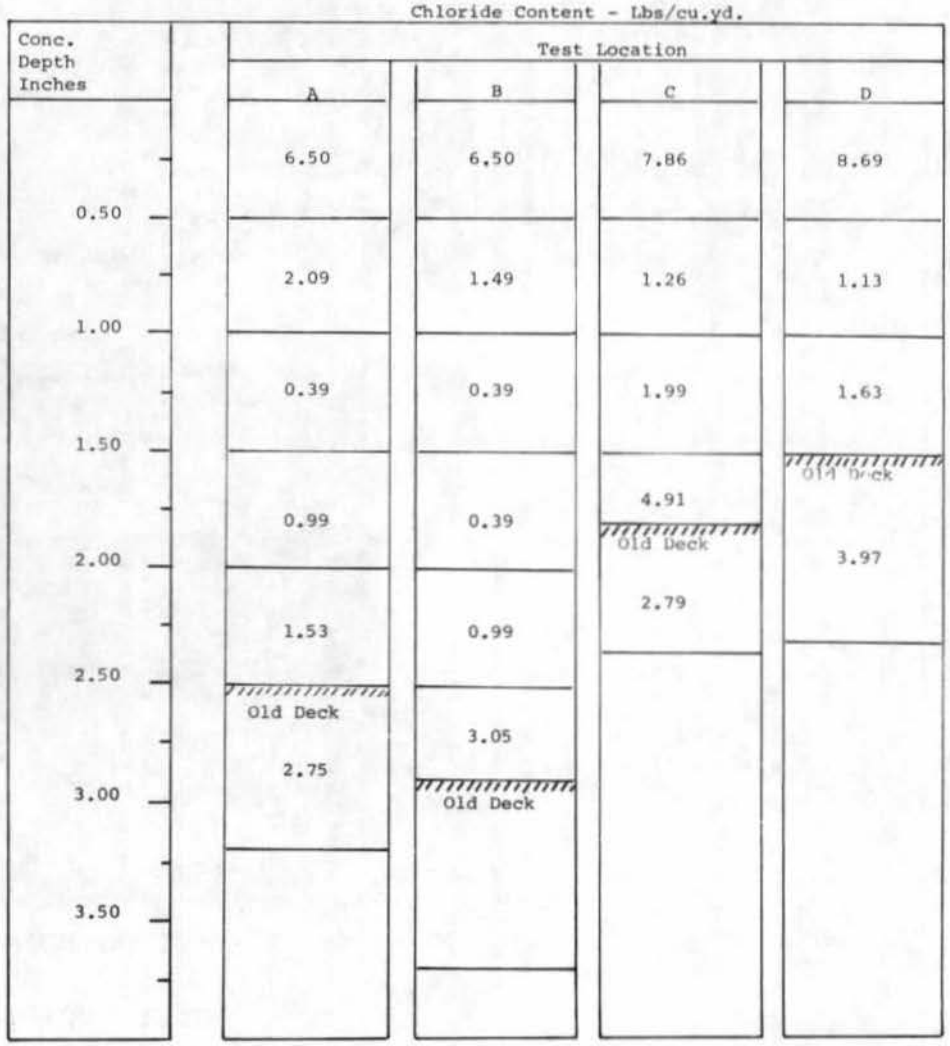
Calhoun County
FN-175-5(3)--21-13 Des. No. 170
Location: IA. 175 Over Raccoon River
Year Overlaid: 1970

Electrical Potential
Negative Voltage - Copper Sulfate
Half Cell
Detail Sheet



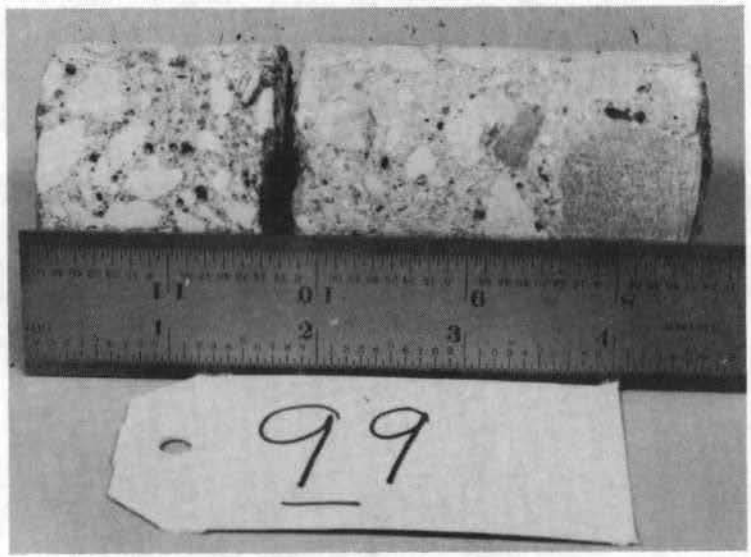
Blocked out areas indicate delamination

Calhoun County
FN-175-5(3)--21-13 Des. No. 170
Location: IA. 175 Over Raccoon River
Year Overlaid: 1970

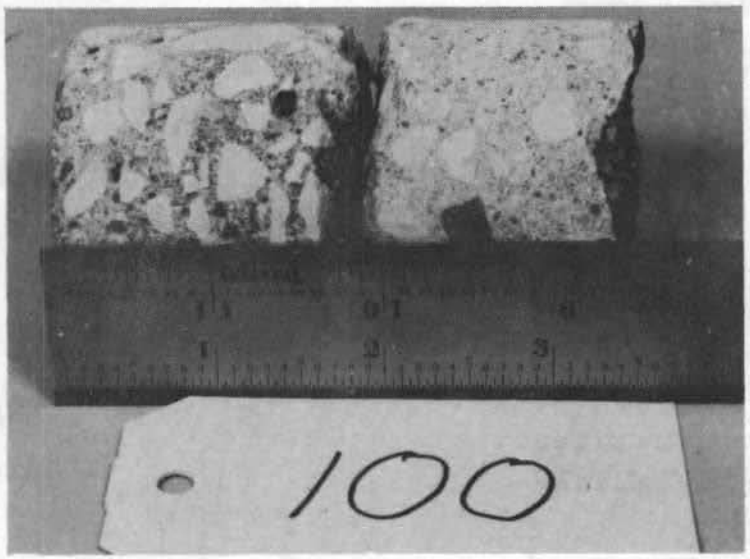


Calhoun County
FN-175-5(3)--21-13 Des. No. 170
Location: IA. 175 Over Raccoon River
Year Overlaid: 1970

DELAMINATION CORES



Core #1



Core #2

Core #3

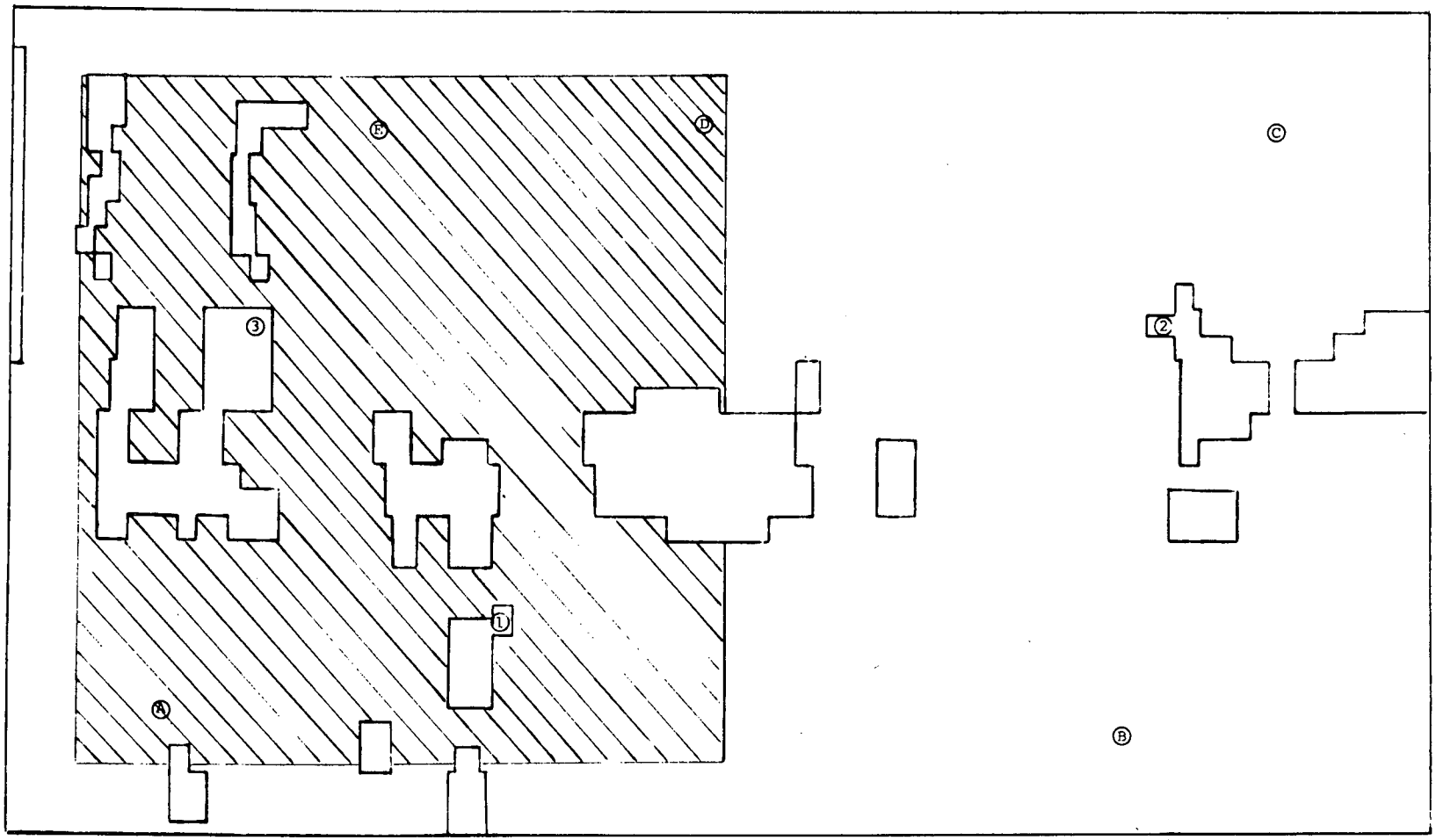
Cherokee County
FN-59-7(11)--21-18 Des. No. 370
Location: U.S. 59 Over Gray Creek
Year Overlaid: 1970

Bridge Deck Dimensions
Width - 24 ft.
Length - 224 Ft.

Deck Area - 5,376 ft.^{2}
Delaminated Area - 531.70 ft.^{2}
% Delamination - 9.89 %

Indicates areas where Electrical Potential Readings were taken
Details next page

Letters indicate chloride cores
Numbers indicate delamination cores

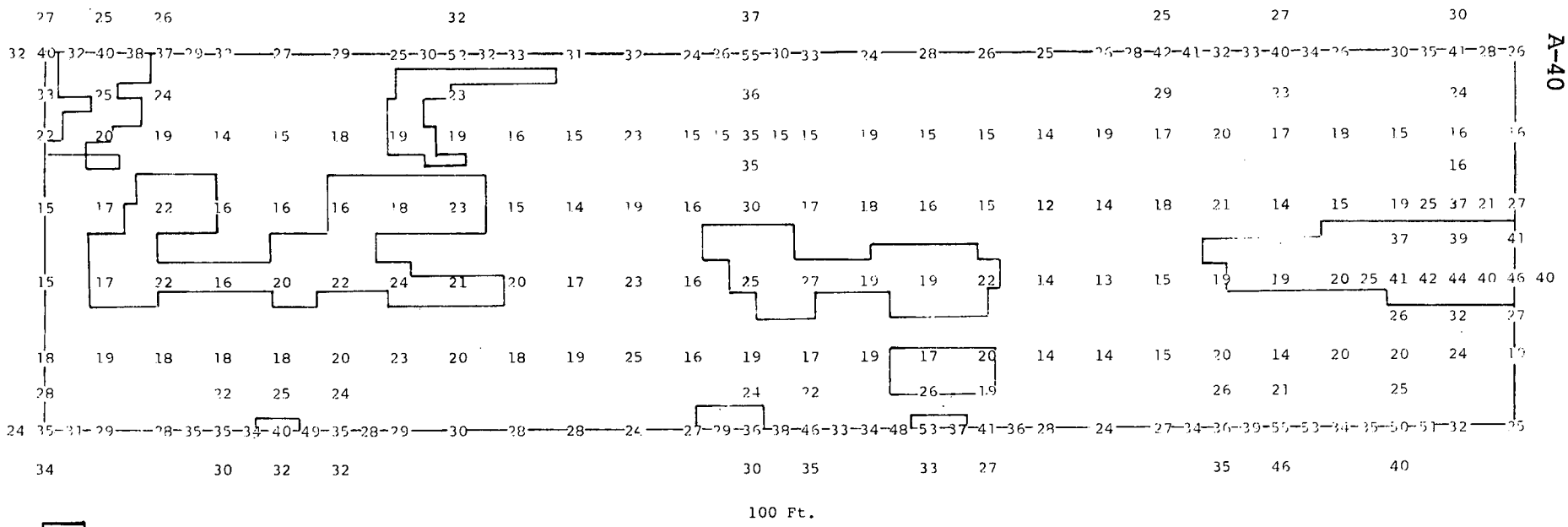


Blocked out areas indicate delamination

Not to scale

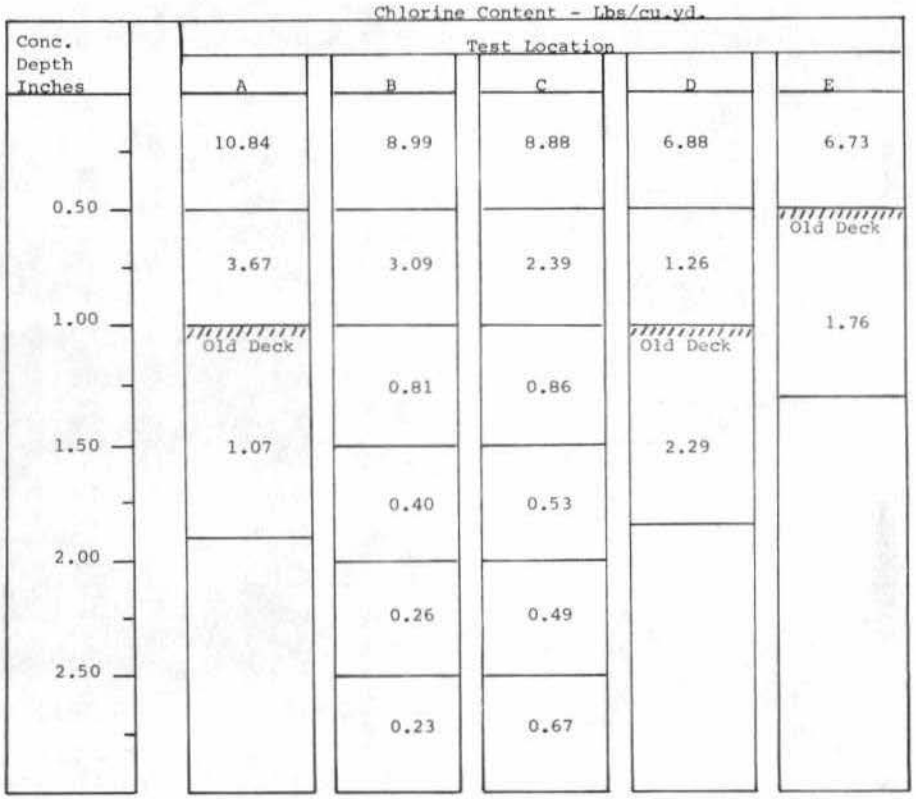
Cherokee County
FN-59-7(11)--21-18 Des. No. 370
Location: U.S. 59 Over Gray Creek
Year Overlaid: 1970

Electrical Potential
Negative Voltage - Copper Sulfate
Half Cell
Detail Sheet



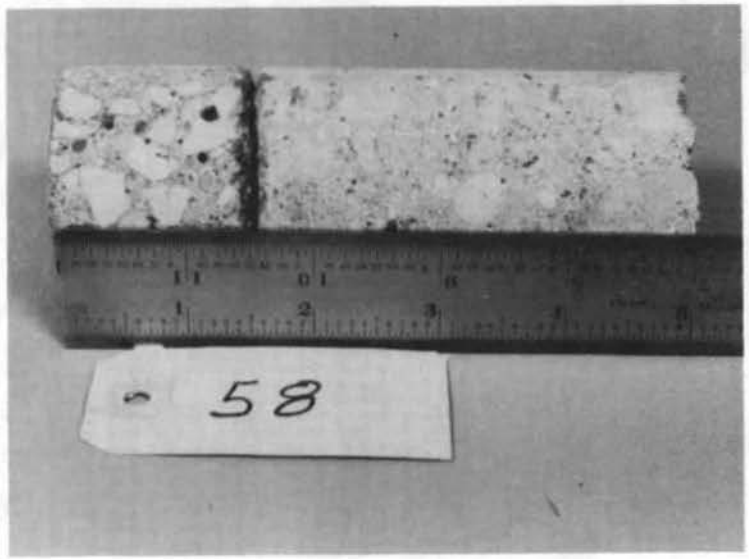
Blocked out areas indicate delamination

Cherokee County
FN-59-7(11)--21-18 Des. No. 370
Location: U.S. 59 Over Gray Creek
Year Overlaid: 1970

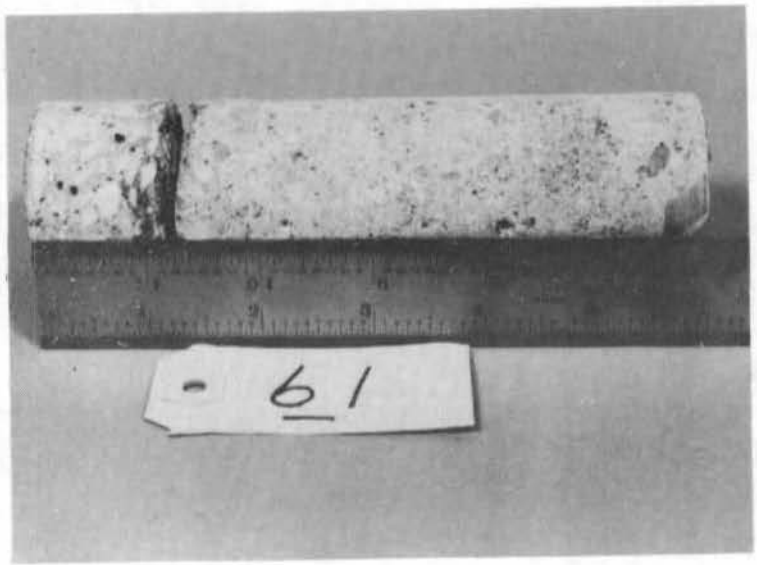


Cherokee County
FN-59-7(11)--21-18 Des. No. 370
Location: U.S. 59 Over Gray Creek
Year Overlaid: 1970

DELAMINATION CORES



Core #1



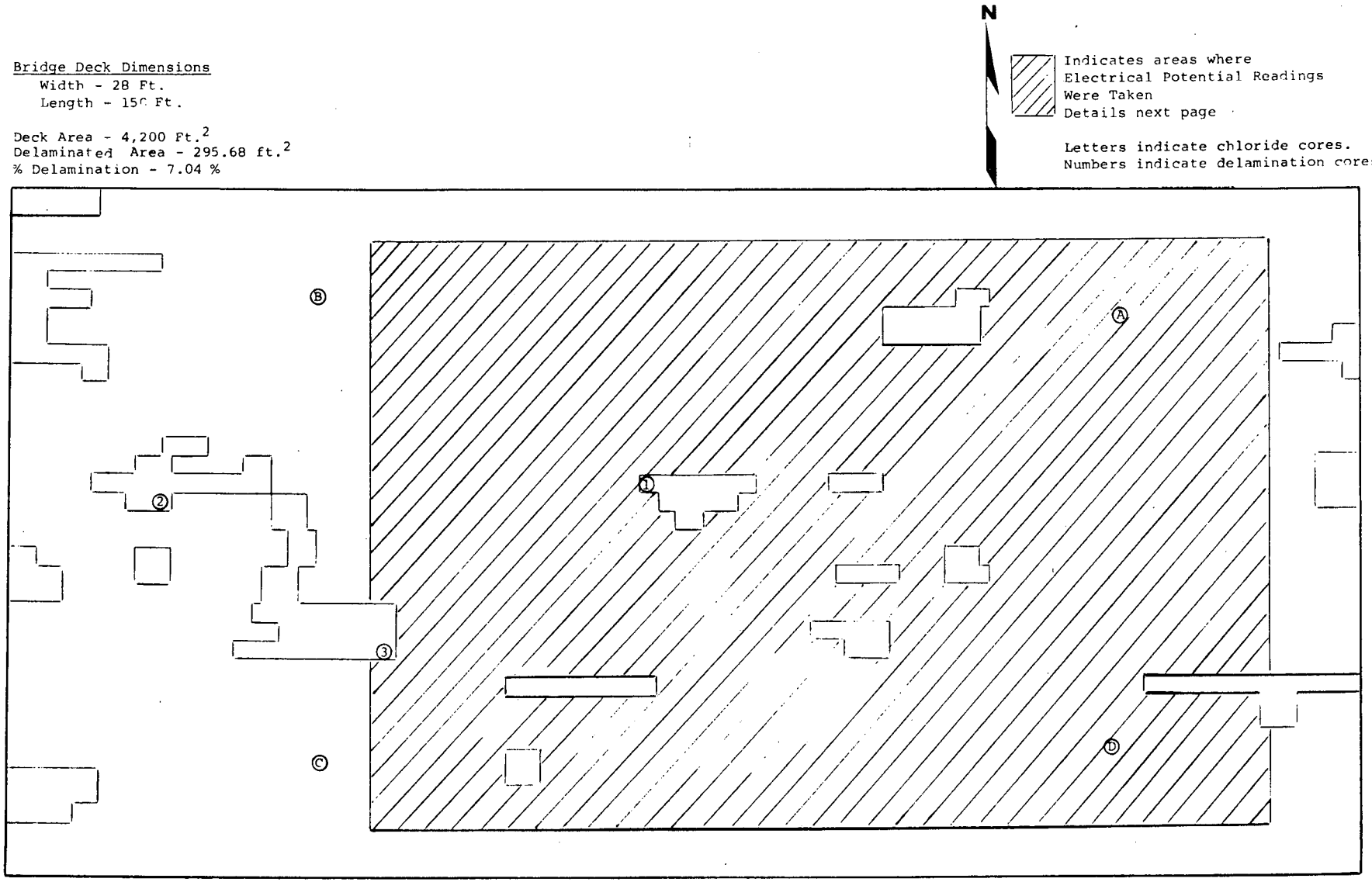
Core #2

Core #3

Woodbury County
FN-20-1(20)--21-97 Des. No. 369
Location: U.S. 20 Over Elliott Creek WB Bridge
Year Overlaid: 1970

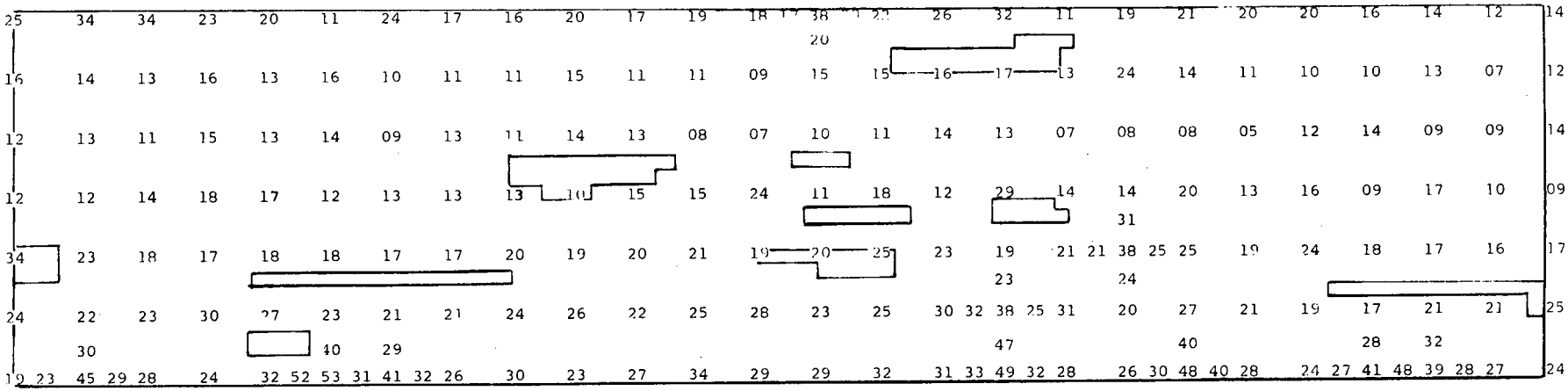
Bridge Deck Dimensions
Width - 28 Ft.
Length - 150 Ft.

Deck Area - 4,200 Ft.^{2}
Delaminated Area - 295.68 ft.^{2}
% Delamination - 7.04 %



Woodbury County
FN-20-1(20)--21-97 Des. No. 369
Location: U.S. 20 Over Elliott Creek W.B. Bridge
Year Overlaid: 1970

Electrical Potential
Negative Voltage - Copper Sulfate
Half Cell
Detail Sheet

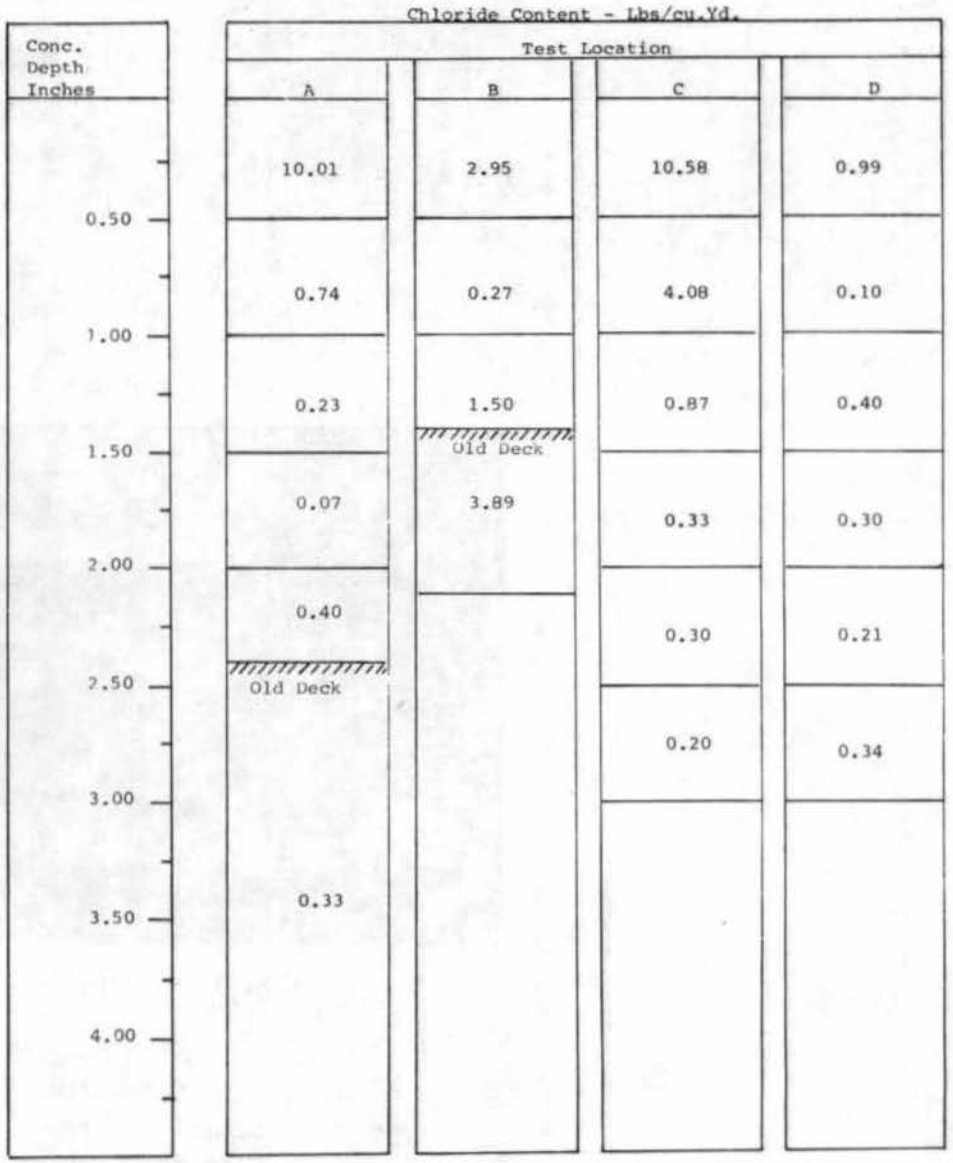


24 Ft.

100 Ft.

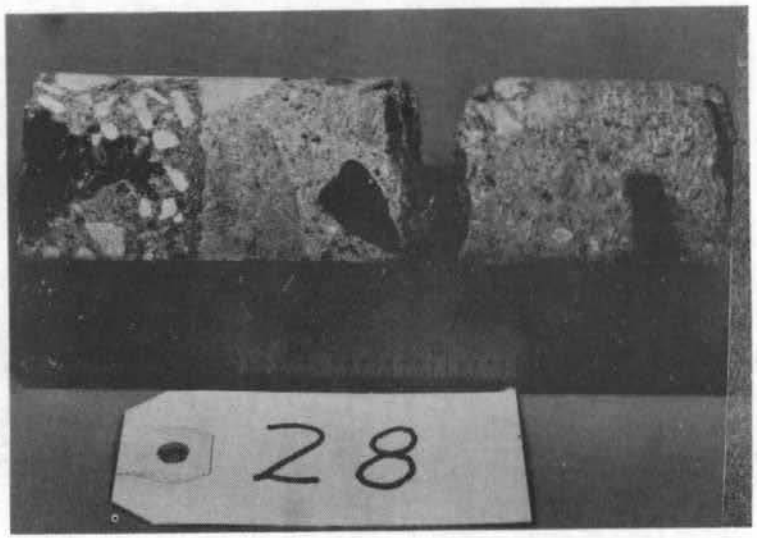
Blocked out areas indicate delamination

Woodbury County
FN-20-1(20)--21-97 Des. No. 369
Location: U.S. 20 Over Elliott Creek WB Bridge
Year Overlaid: 1970



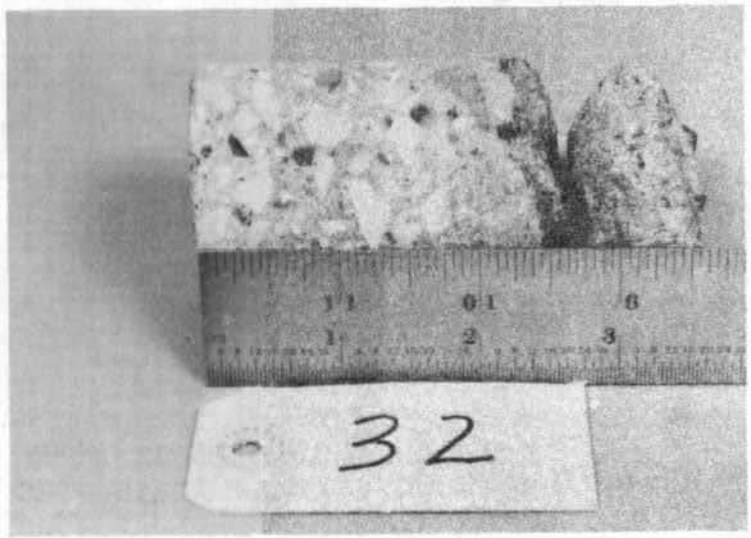
Woodbury County
FN-20-1(20)--21-97 Des. No. 369
Location: U.S. 20 Over Elliott Creek W.B. Bridge
Year Overlaid: 1970

DELAMINATION CORES



Core #1

Core #2



Core #3

Plymouth County
FN-3-1(8)--21-75 Des.No. 271
Location: IA. 3 Over Mink Creek
Year Overlaid: 1971

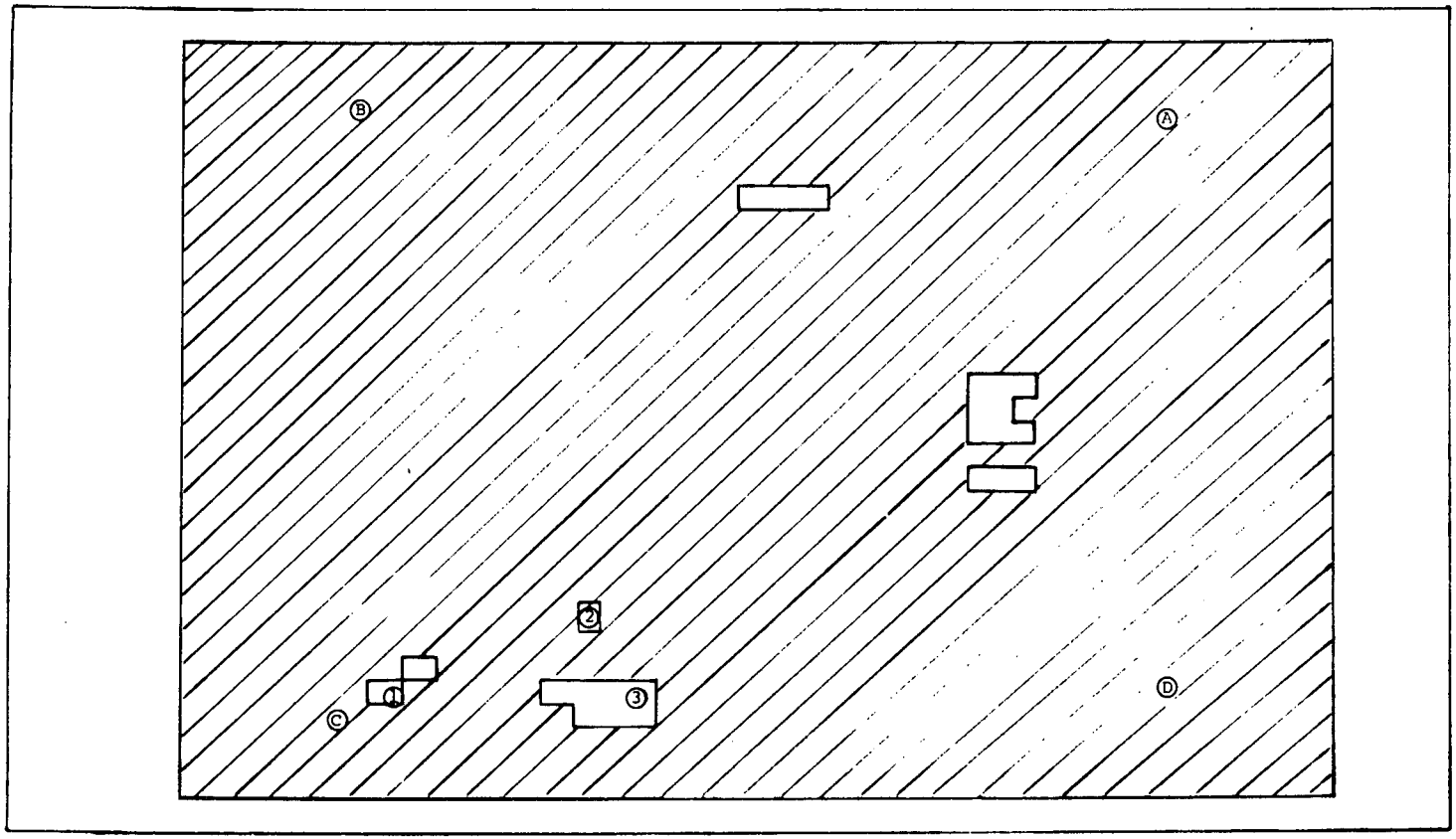
Bridge Deck Dimensions
Width - 26 ft.
Length - 125 ft.

Deck Area - 3,250 ft.^{2}
Delaminated Area - 40.63 ft.^{2}
% Delamination - 1.25%

N

Indicates areas where Electrical Potential Readings were taken
Details next page

Letters indicate chloride cores.
Numbers indicate delamination cores.

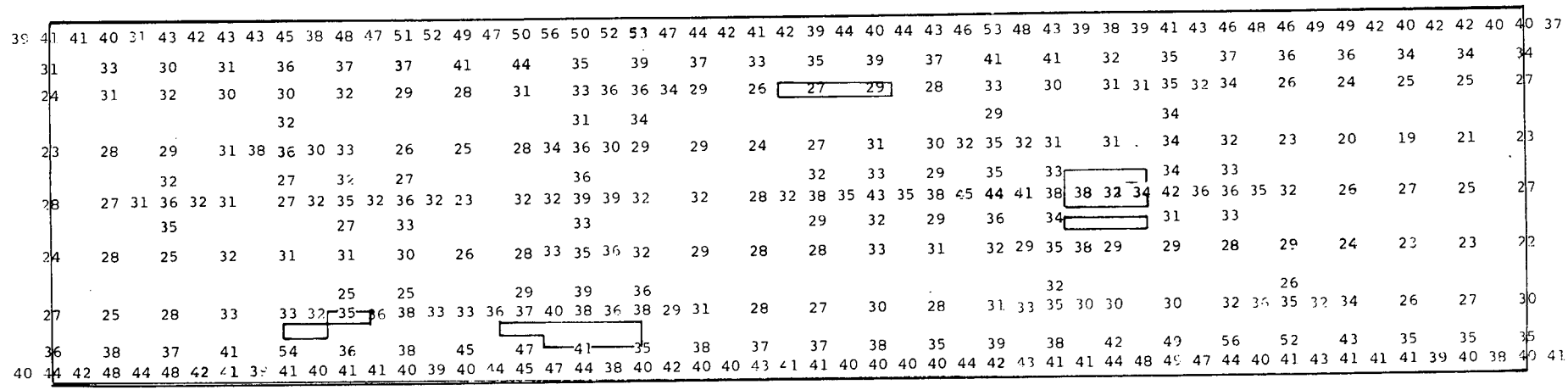


Not To Scale

Blocked out areas indicate delamination

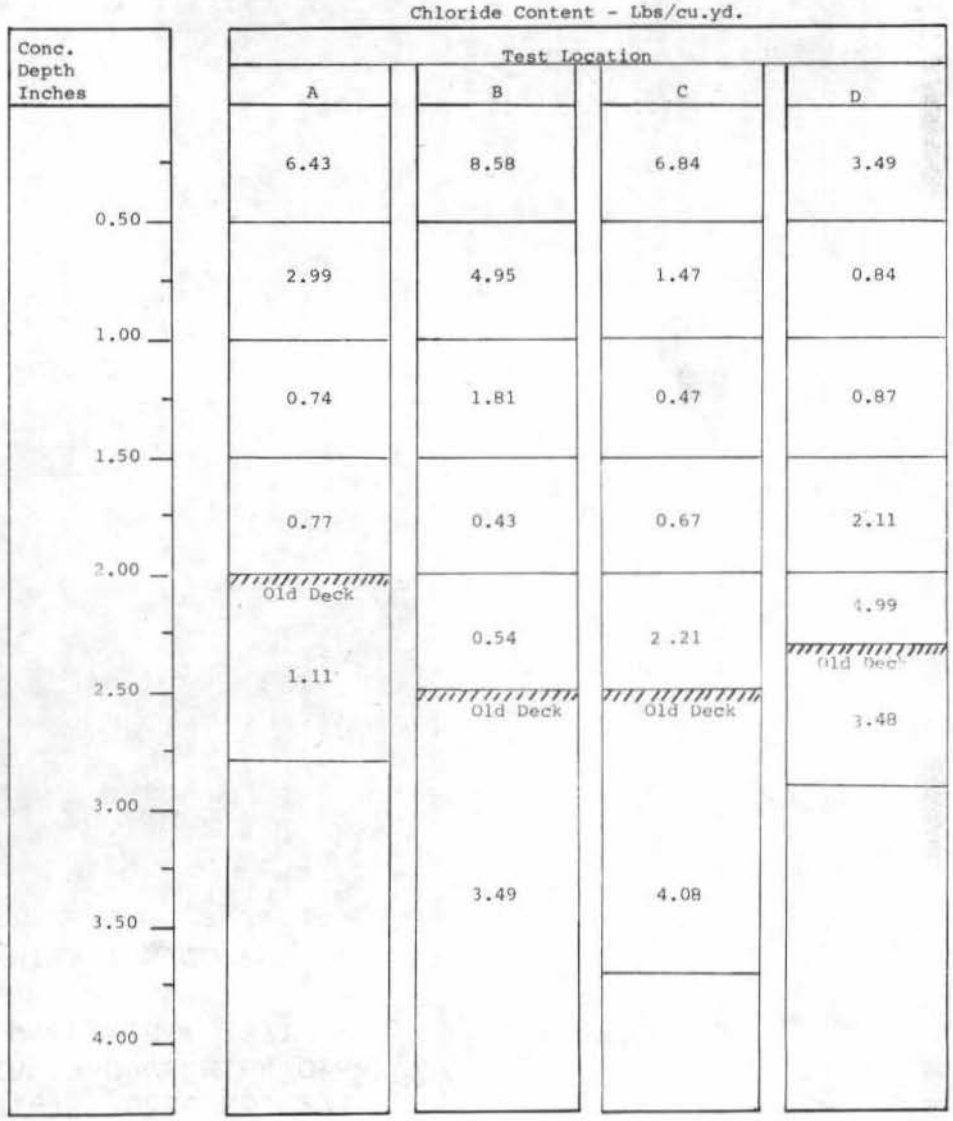
Plymouth County
FN-3-1(8)--21-75 Des. No. 271
Location: Ia. 3 Over Mink Creek
Year Overlaid: 1971

Electrical Potential
Negative Voltage - Copper Sulfate
Half Cell
Detail Sheet



Blocked out areas indicate delamination

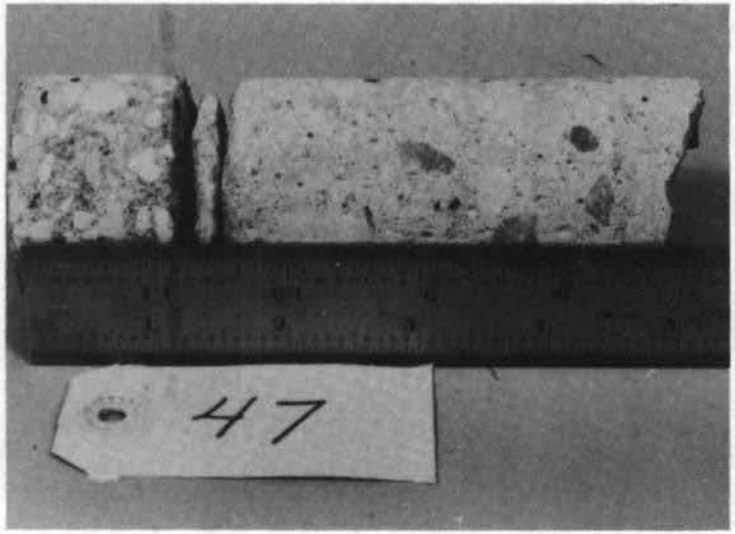
Plymouth County
FN-3-1(8)--21-75 Des. No. 271
Location: Ia. 3 Over Mink Creek
Year Overlaid: 1971



Plymouth County
FN-3-1(8)--21-75 Des. No. 271
Location: IA. 3 Over Mink Creek
Year Overlaid: 1971

DELAMINATION CORES

Core #1



Core #2

Core #3

Plymouth County
FN-3-1(8)--21-75 Des. No. 171
Location: IA. 3 Over W. Branch of Floyd River
Year Overlaid: 1971

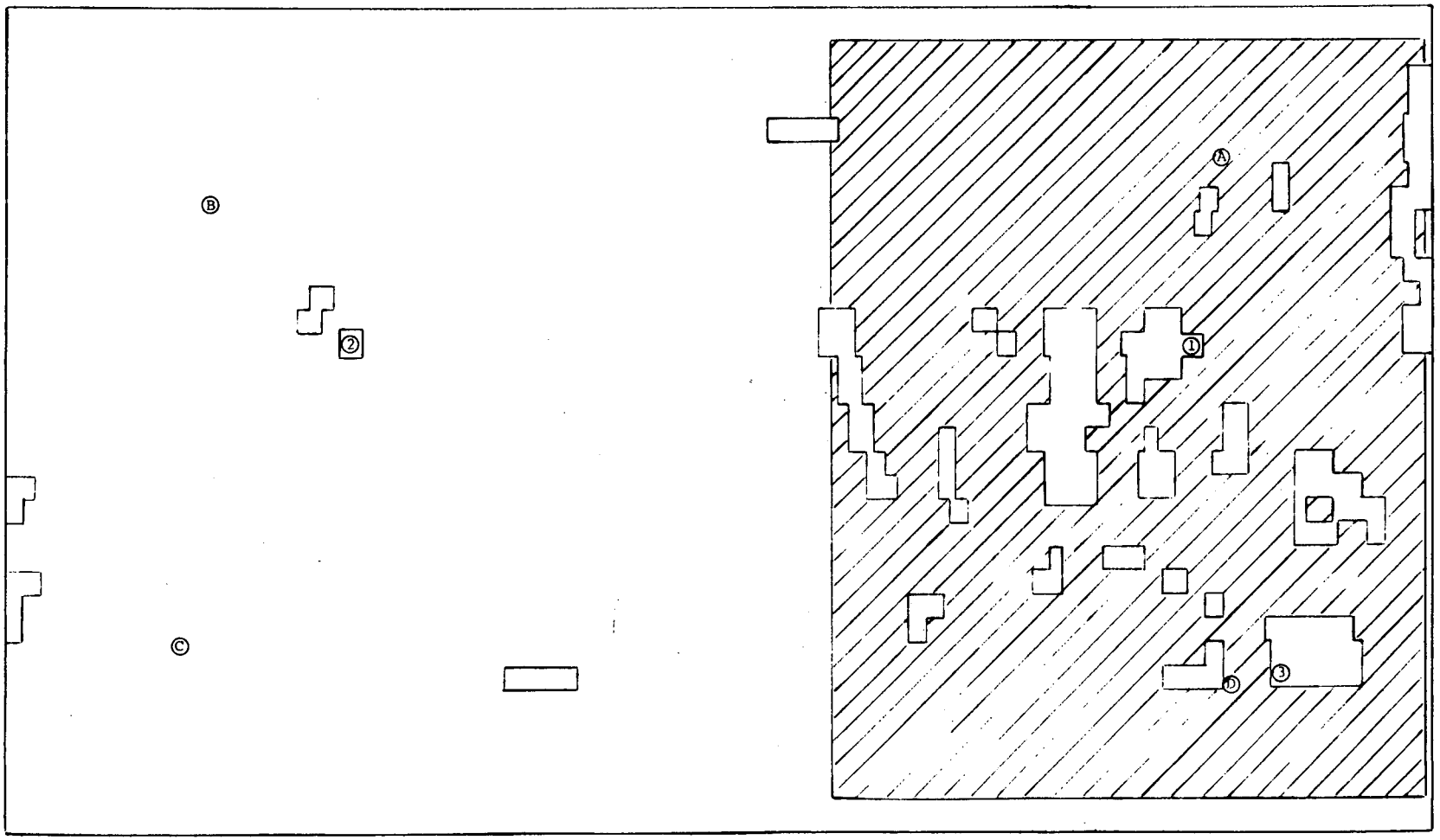
Bridge Deck Dimensions
Width - 26 ft.
Length - 240 ft.

Deck Area - 6,240 ft.^{2}
Delaminated Area - 327.75 ft.^{2}
% Delamination - 5.25 %

Indicates areas where Electrical Potential Readings were taken
Details next page

Letters indicate chloride cores.
Numbers indicate delamination cores.

N

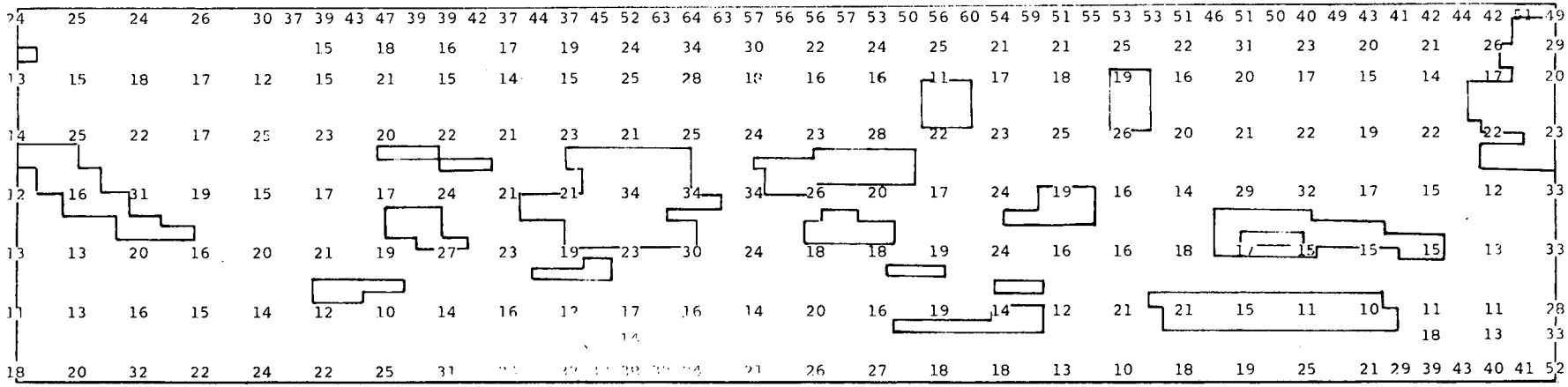


Blocked out areas indicate delamination

Not to Scale

Plymouth County
FN-3-1(8)--21-75 Des. No. 171
Location: Ia. 3 Over W. Branch of Floyd River
Year Overlaid: 1971

Electrical Potential
Negative Voltage - Copper Sulfate
Half Cell
Detail Sheet



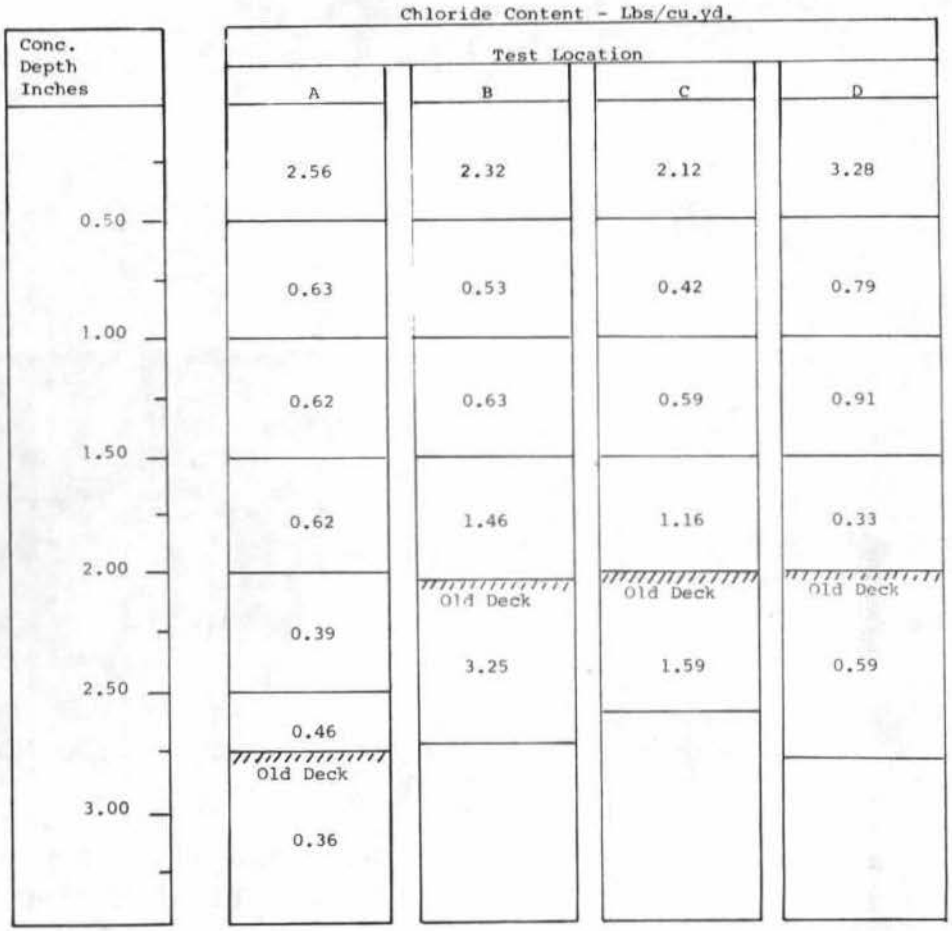
24 Ft.

100 Ft.

Blocked out areas indicate delamination

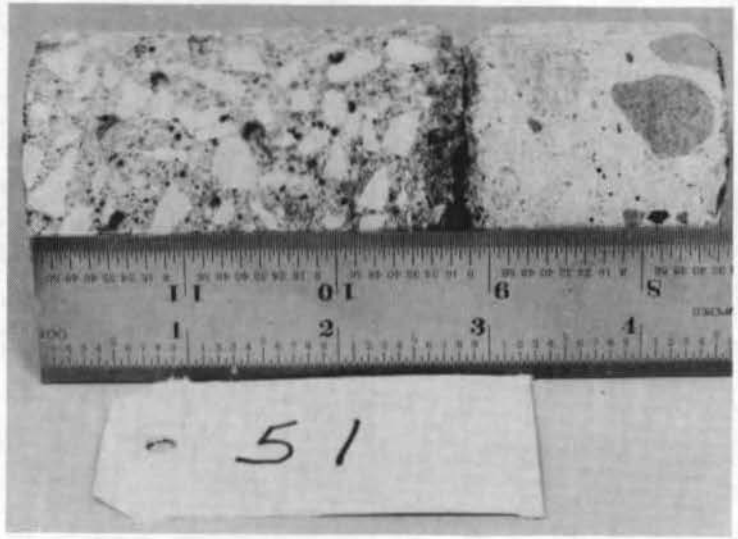
A-52

Plymouth County
FN-3-1(8)--21-75 Des. No. 171
Location: Ia. 3 Over W. Branch of Floyd River
Year Overlaid: 1971



Plymouth County
FN-3-1(8)--21-75 Des. No. 171
Location: IA. 3 Over W. Branch of Floyd River
Year Overlaid: 1971

DELAMINATION CORES



Core #1

Core #2

Core #3

Cherokee County

FN-3-2(7)--21-18 Des. No. 172
Location: Ia. 3 over Little Sioux River
Year Overlaid: 1972

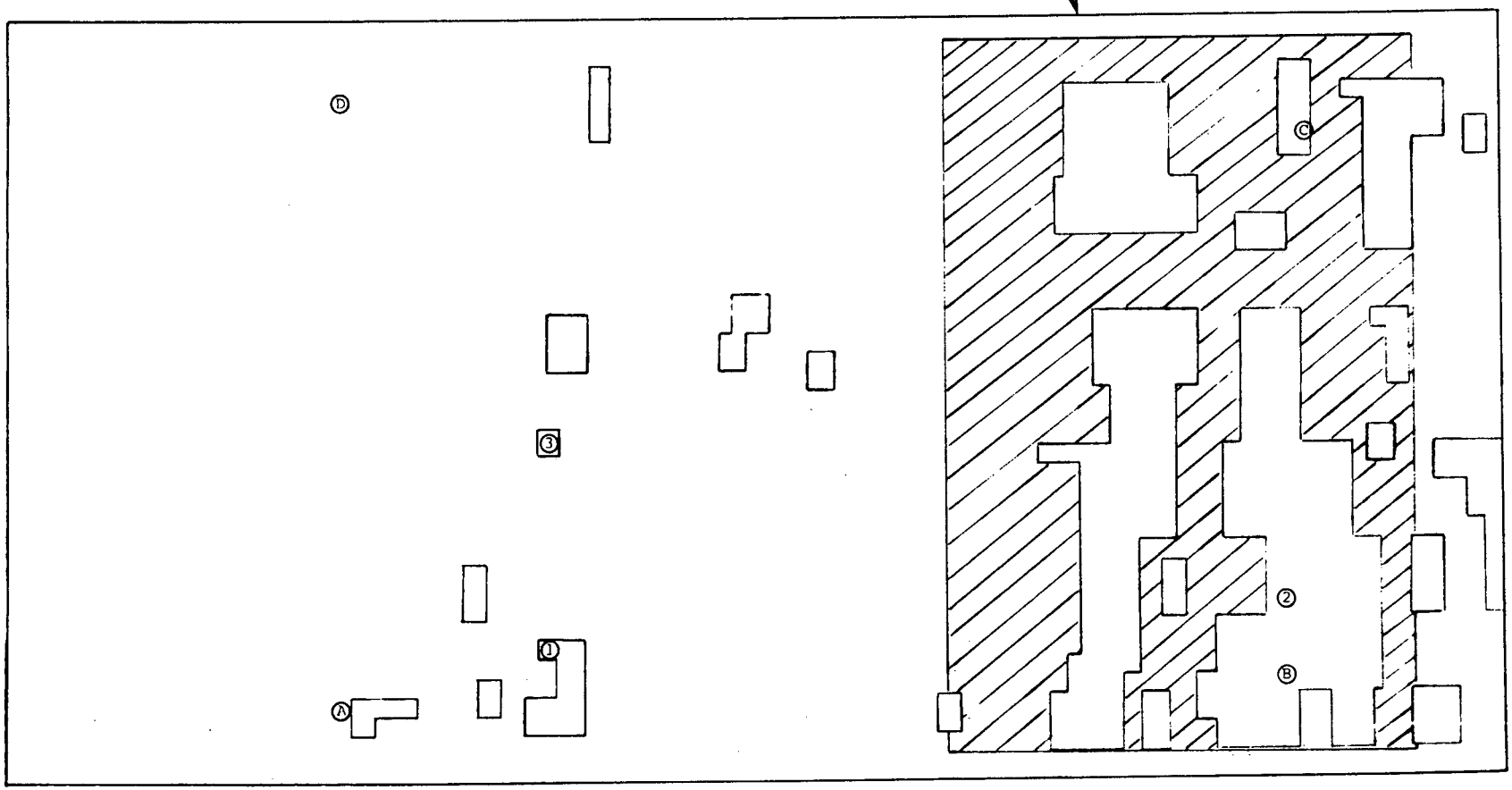
Bridge Deck Dimensions
Width - 30 ft.
Length - 320 ft.

Deck Area - 9,600 ft.^{2}
Delaminated Area - 1,296 ft.^{2}
% Delamination - 13.5%

N

Indicate areas where Electrical Potential Readings were taken
Details next page

Letters indicate chloride cores
Numbers indicate delamination cores.



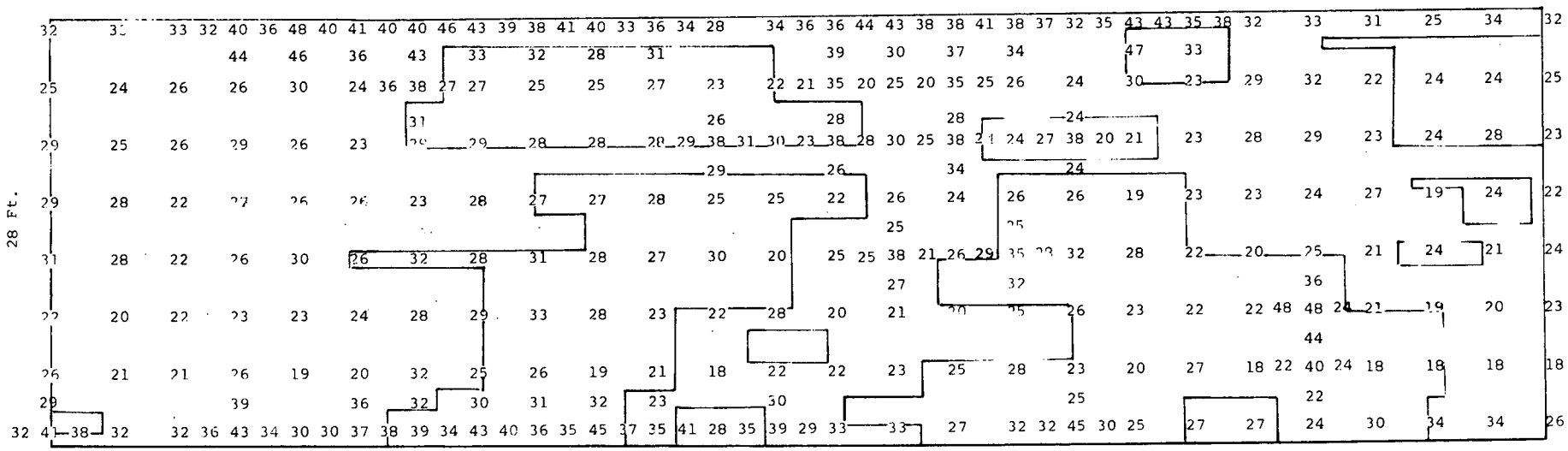
Not to scale

Blocked out areas indicate delamination

Cherokee County
FN-3-2(7)--21-18 Des. No. 172
Location: IA. 3 Over Little Sioux River
Year Overlaid: 1972

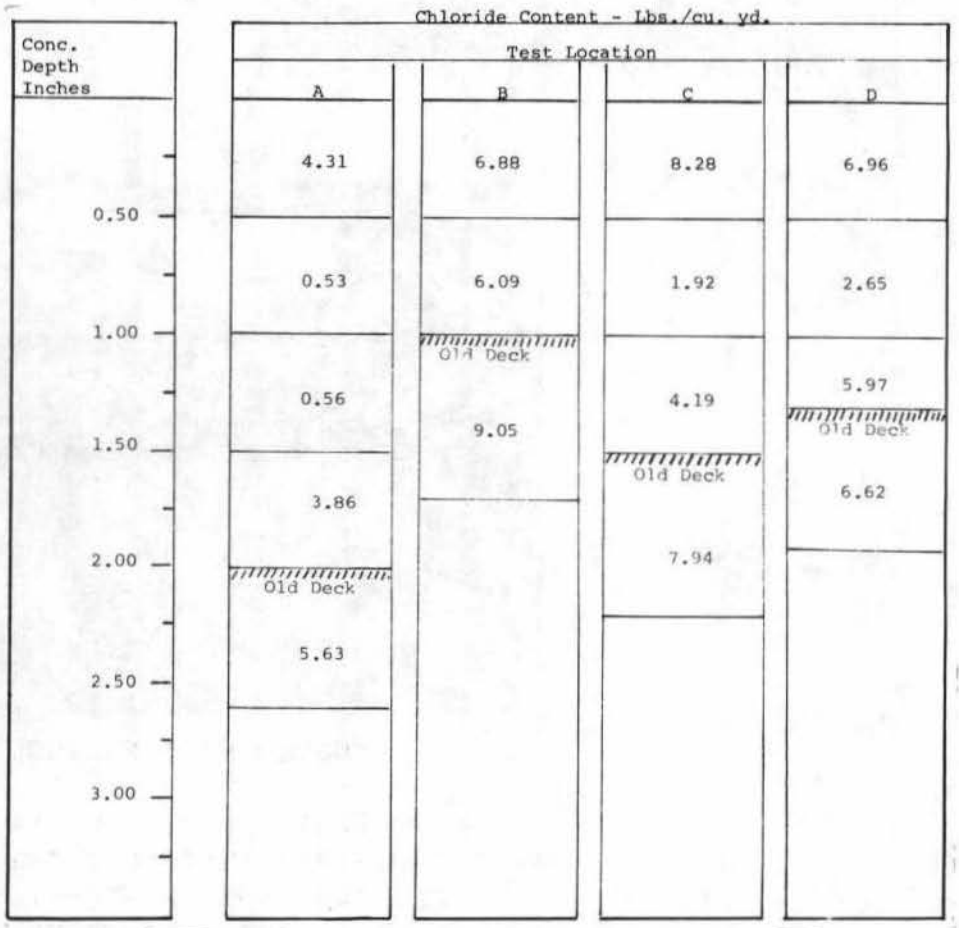
Electrical Potential

Negative Voltage - Copper Sulfate
Half Cell
Detail Sheet



Blocked out areas indicate delamination

Cherokee County
FN-3-2(7)--21-18 Des No. 172
Location: Ia. 3 Over Little Sioux River
Year Overlaid: 1972

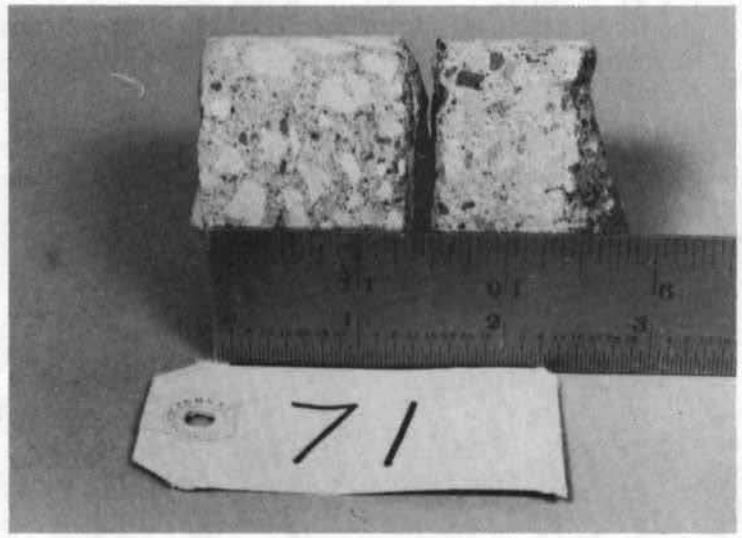


Cherokee County
FN-3-2(7)--21-18 Des. No. 172
Location: IA. 3 Over Little Sioux River
Year Overlaid: 1972

DELAMINATION CORES

Core #1

Core #2



Core #3

Cherokee County
FN-59-7(14)--21-18 Des. No. 272
Location U.S. 59 Over Gray Creek
Year Overlaid 1972

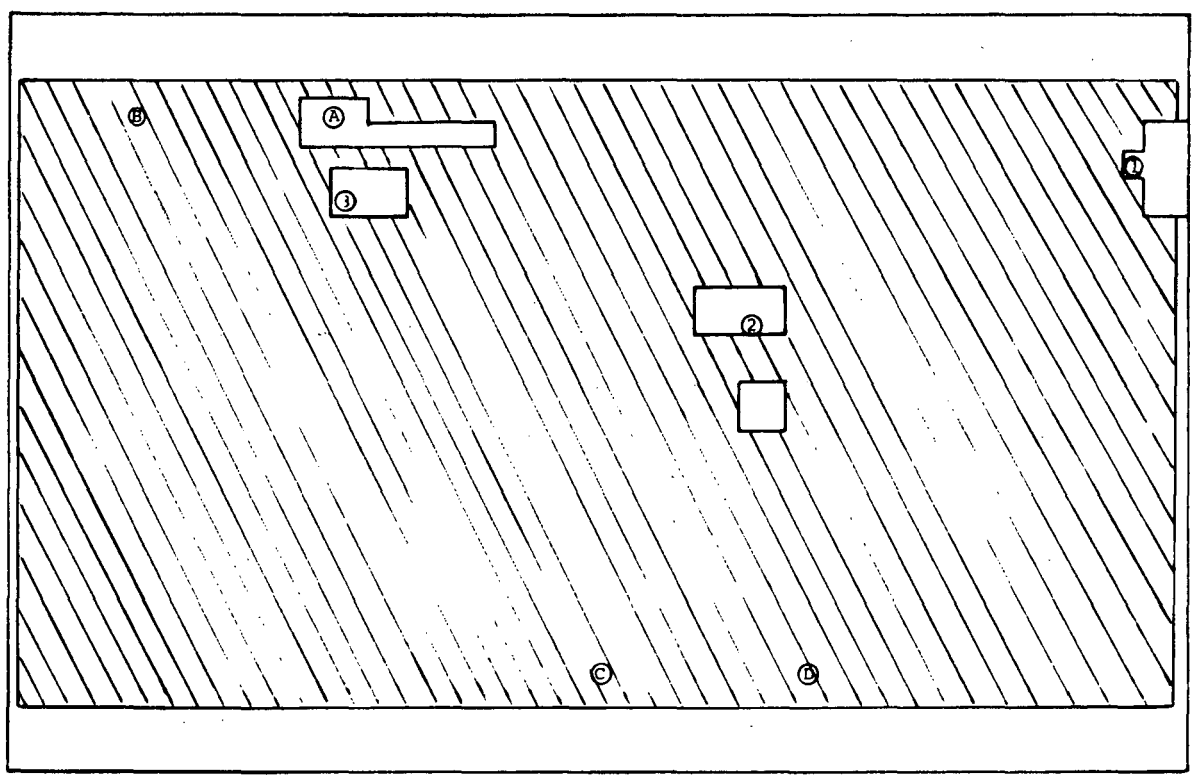
Cherokee County
FN-59-7(14)--21-18 Des. No. 272
Location U.S. 59 Over Gray Creek
Year Overlaid 1972

Bridge Deck Dimensions
Width - 24 ft.
Length - 102 ft.

Deck Area - 2,448 ft.^{2}
Delaminated Area - 53.25 ft.^{2}
% Delamination - 2.18%

Indicates areas where Electrical Potential Readings were taken
Details next page

Letters indicate chloride cores.
Numbers indicate delamination cores.

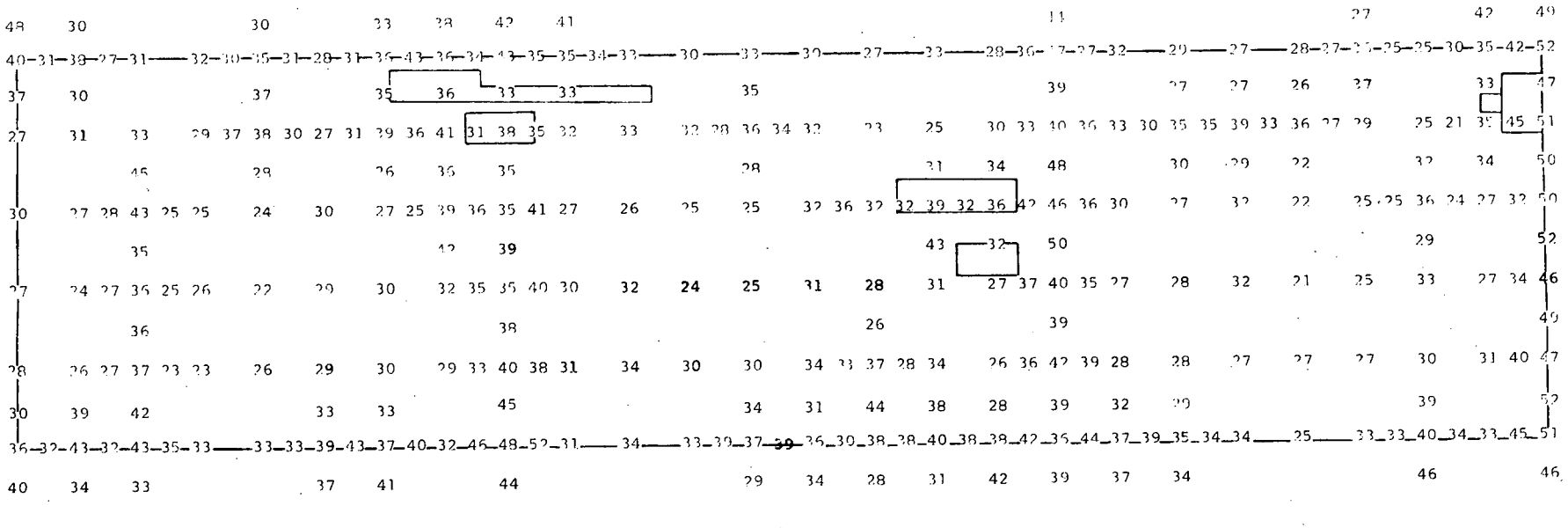


Not to scale

Blocked out areas indicate delamination

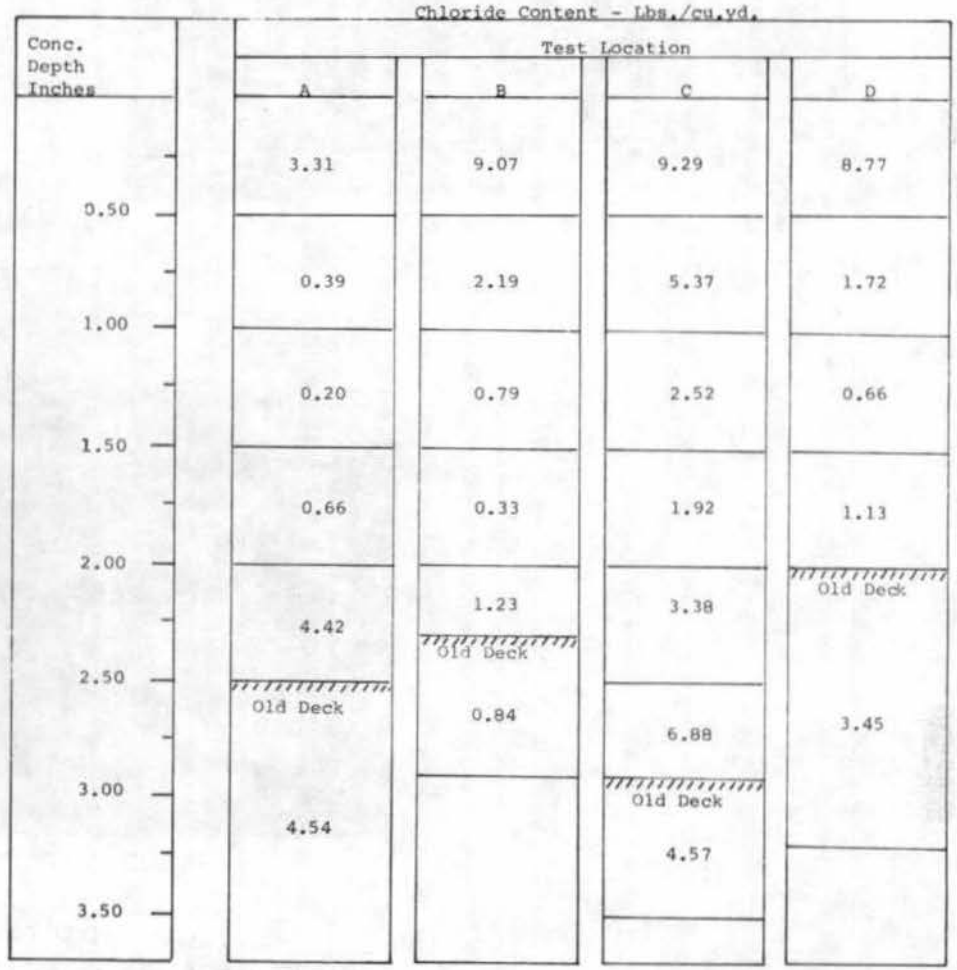
Cherokee County
FN-59-7(14)--21-18 Des. No. 272
Location: US 59 Over Gray Creek
Year Overlaid: 1972

Electrical Potential
Negative Voltage - Copper Sulfate
Half Cell
Detail Sheet



Blocked out areas indicate delamination

Cherokee County
FN-59-7(14)--21-18 Des. No. 272
Location U.S. 59 Over Gray Creek
Year Overlaid 1972



Cherokee County
FN-59-7(14)--21-18 Des. No. 272
Location: U.S. 59 Over Gray Creek
Year Overlaid: 1972

DELAMINATION CORES

Core #1

Core #2

Core #3

Polk County
I-35-2(129)69--01-77 Des. No. 273
Location: I-35 Over Raccoon River Northbound
Year Overlaid: 1973

Bridge Deck Dimensions
Width - 28 Ft.
Length - 656 Ft.

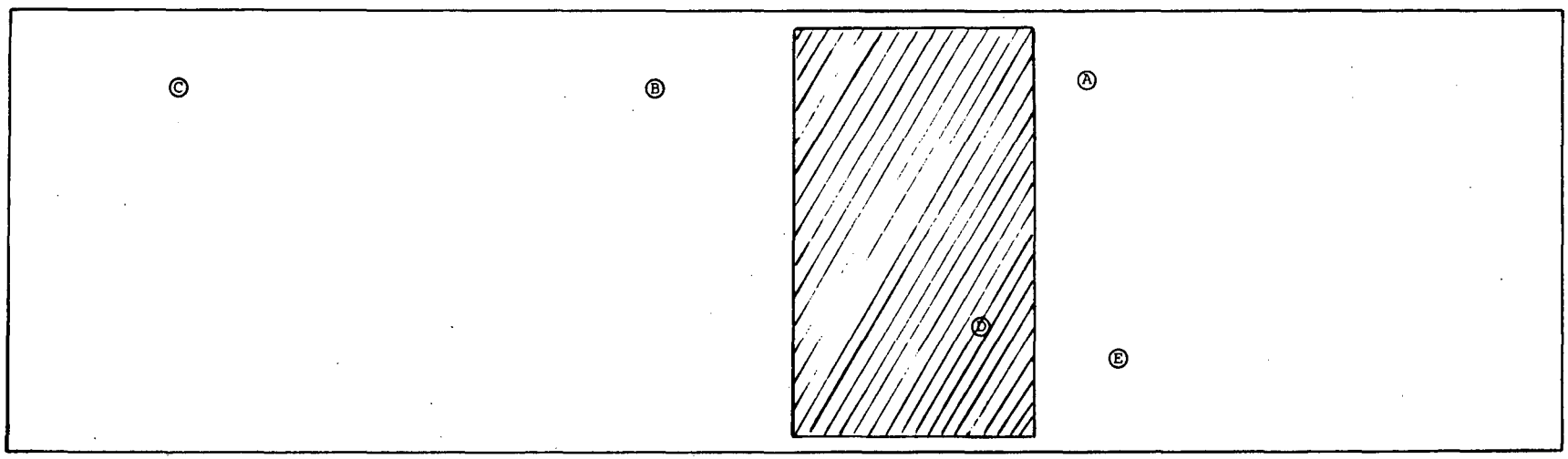
Deck Area - 18,368 $ft.^2$
Delaminated Area - 0.00 $ft.^2$
% Delamination - 0.00 %

Polk County
I-35-2(129)69--01-77 Des. No. 273
Location: I-35 Over Raccoon River Northbound
Year Overlaid: 1973

N

Indicates areas where Electrical Potential Readings were taken
Details next page

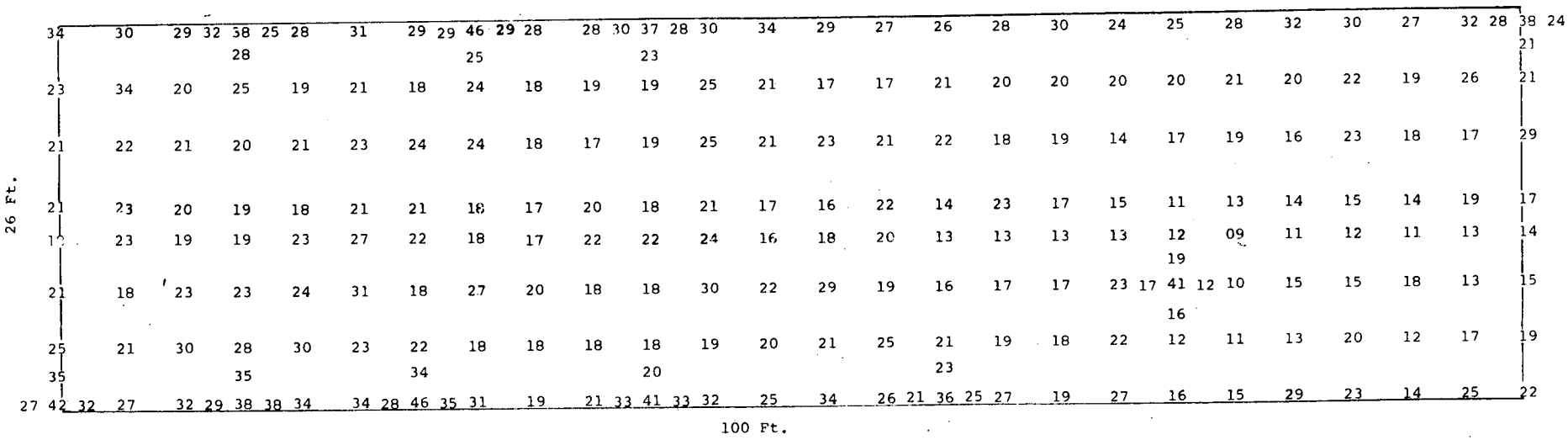
Letters indicate chloride cores.



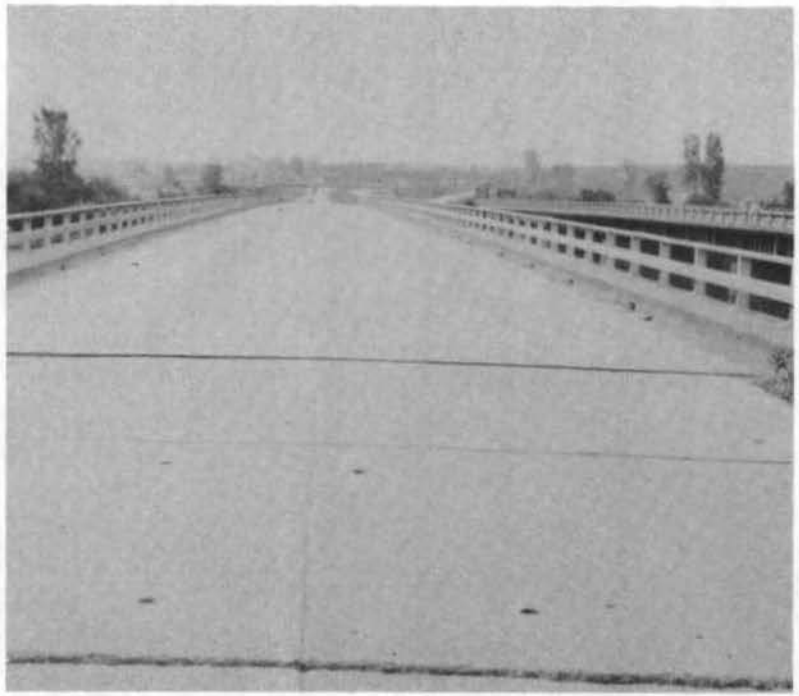
Not to Scale

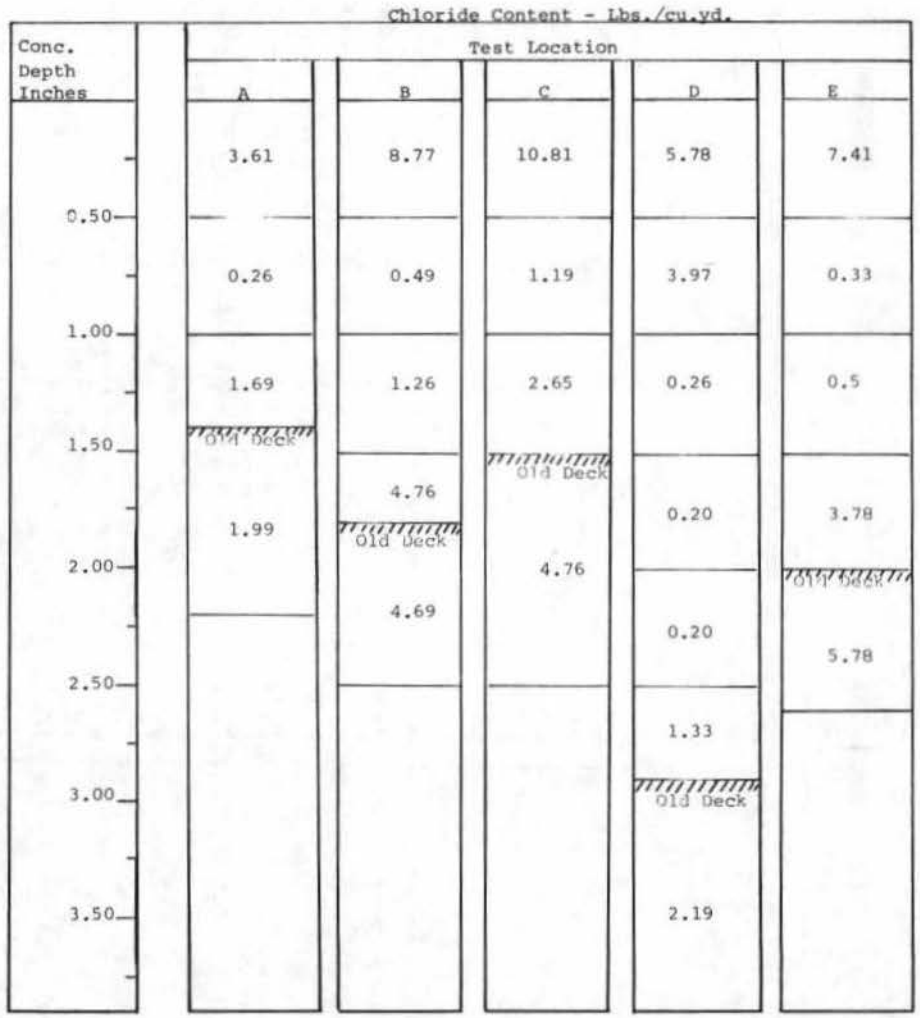
Polk County
I-35-2(129)69--01-77 Des. No. 273
Location: I-35 Over Raccoon River Northbound
Year Overlaid: 1973

Electrical Potential
Negative Voltage - Copper Sulfate
Half Cell
Detail Sheet



Polk County
I-35-2(129)69--01-77 Des. No. 273
Location: I-35 Over Raccoon River Northbound
Year Overlaid: 1973





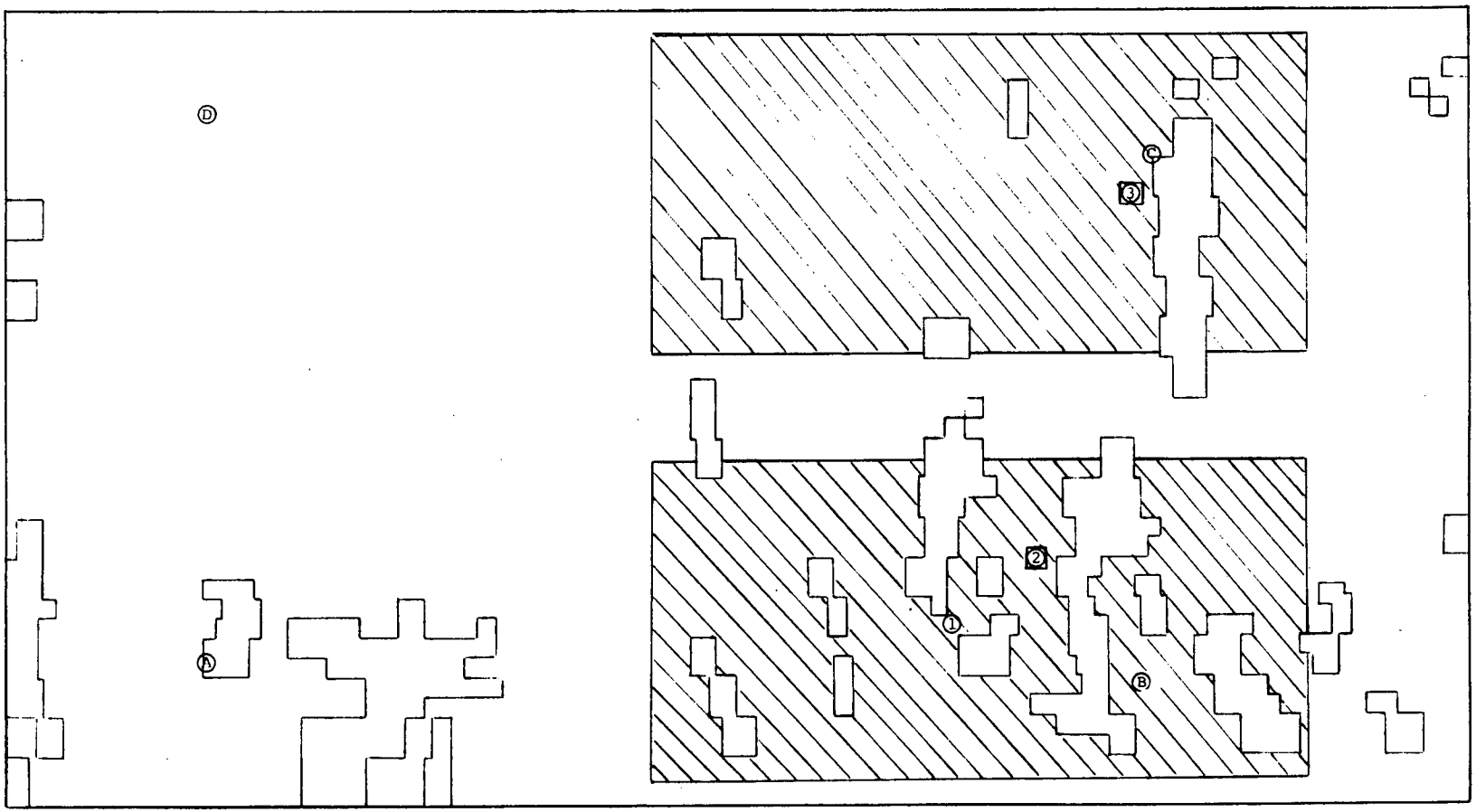
Story County
FN-65-5(5)--21-85 Des. No. 172
Location: U.S. 65 Over U.S. 30
Year Overlaid: 1972

Bridge Deck Dimension
Width - 30 ft.
Length - 224 ft.

Deck Area - 6,720 ft.^{2}
Delaminated Area - 650.13 ft.^{2}
% Delamination - 9.67%

Indicates areas where Electrical Potential Readings were taken
Details next page

Letters indicate chloride cores.
Numbers indicate delamination cores.

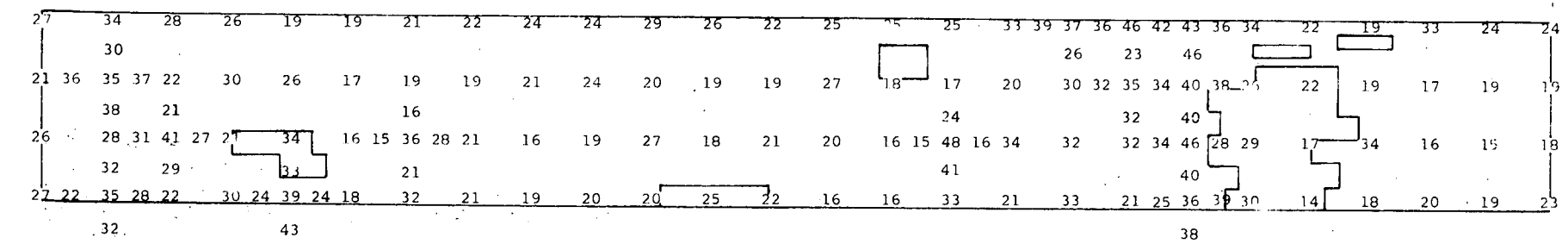


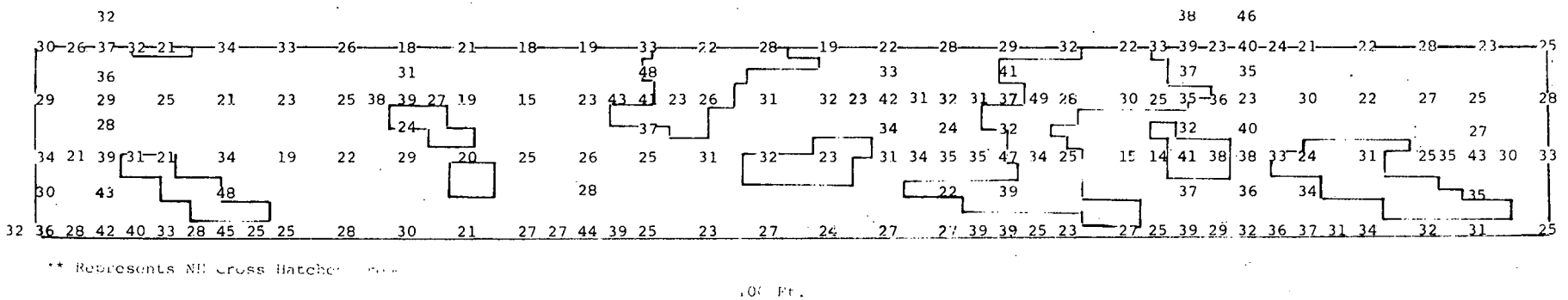
Blocked out areas indicate delamination

Not to Scale

Story County
FN-65-5(5)--21-85 Des. No. 172
Location: US. 65 Over US 30
Year Overlaid: 1972

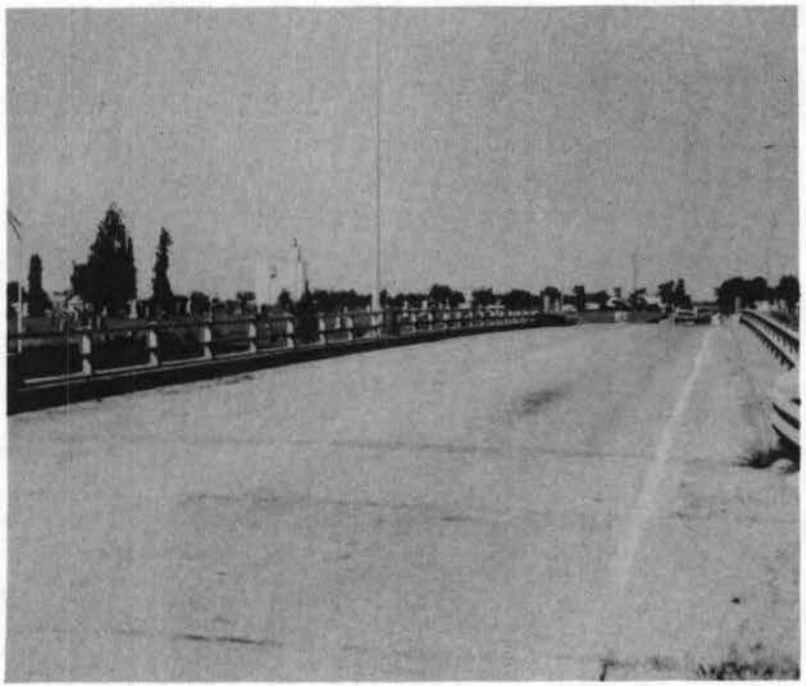
Electrical Potential
Negative Voltage-Copper Sulfate
Half Cell
Detail Sheet

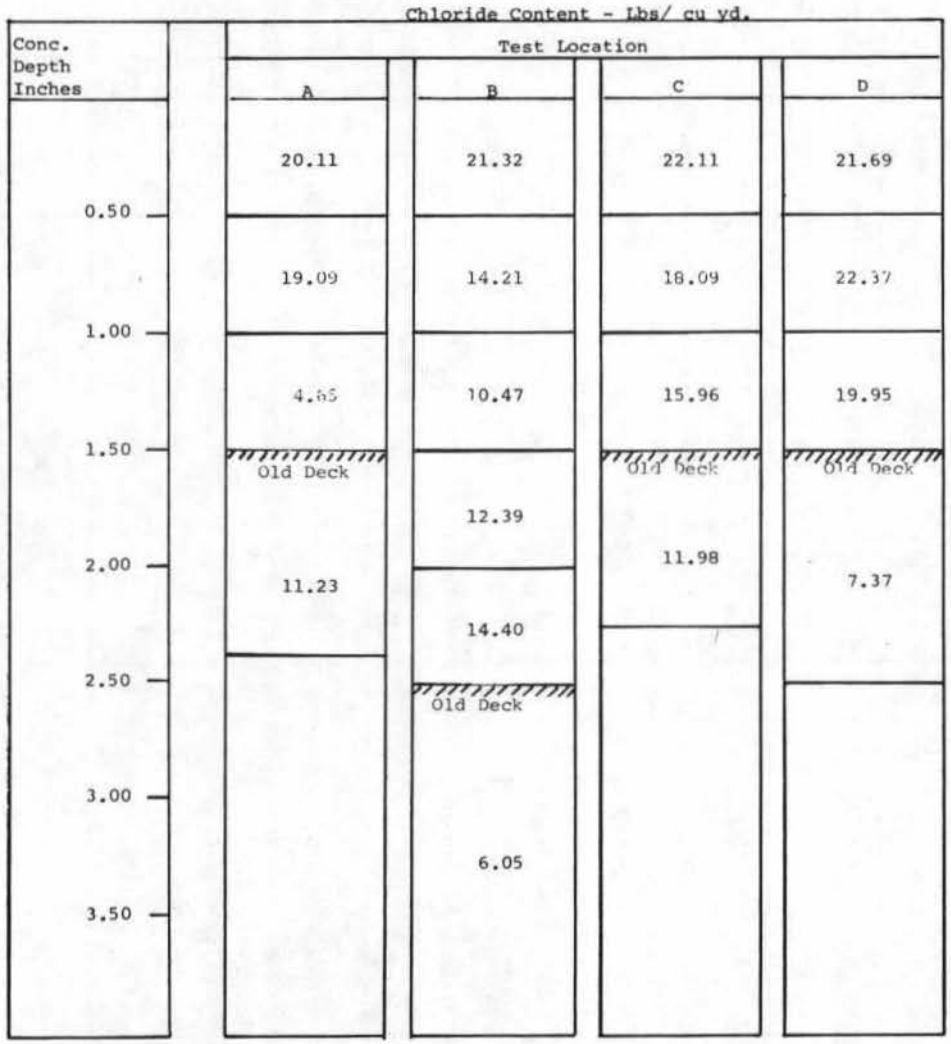




Blocked out areas indicate delamination

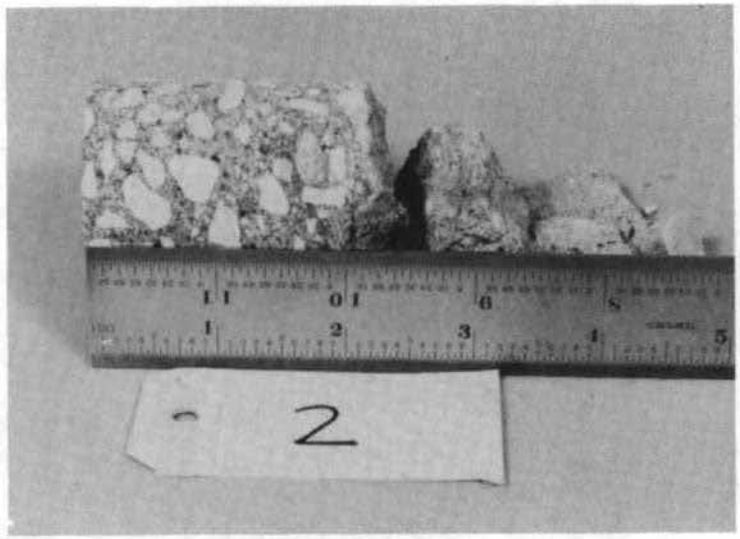
Story County
FN-65-5(5)--21-85 Des. No. 172
Location: U.S. 65 Over U.S. 30
Year Overlaid: 1972



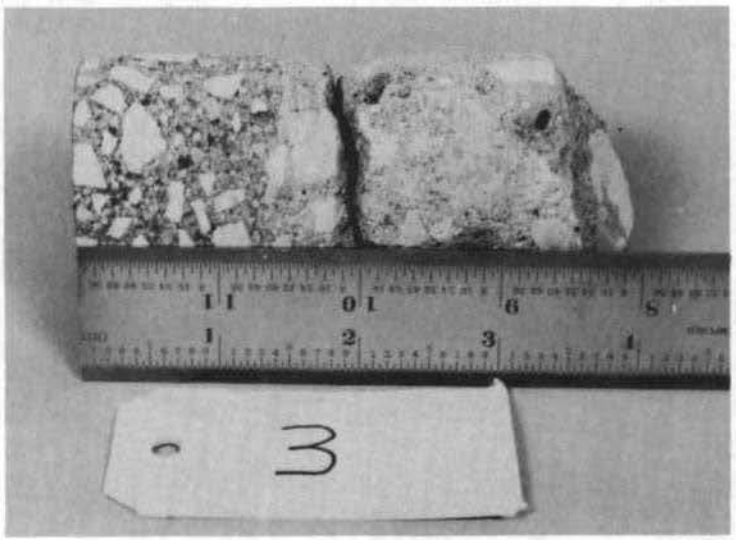


Story County
FN-65-5(5)--21-85 Des. No. 172
Location: U.S. 65 Over U.S. 30
Year Overlaid: 1972

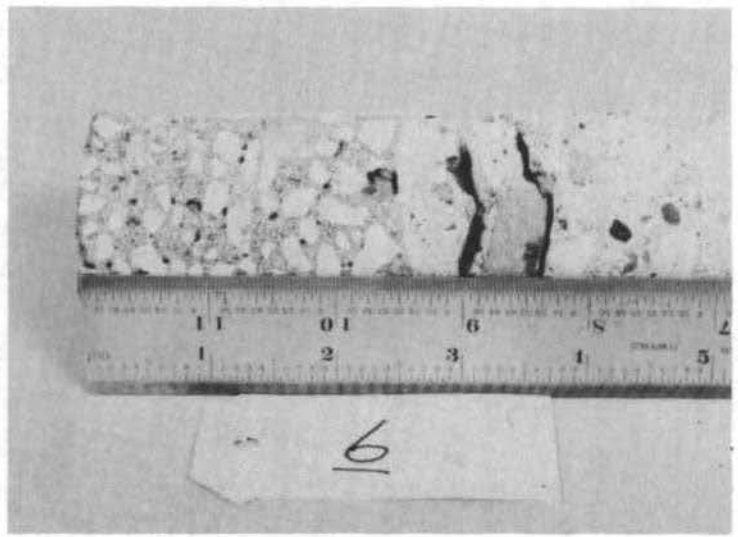
DELAMINATION CORES



Core #1



Core #2



Core #3

Polk County
I-35-2(129)69--01-77 Des. No. 273
Location: I-35 Over Raccoon River Southbound
Year Overlaid: 1973

Bridge Deck Dimensions
Width - 28 ft.
Length - 656 ft.

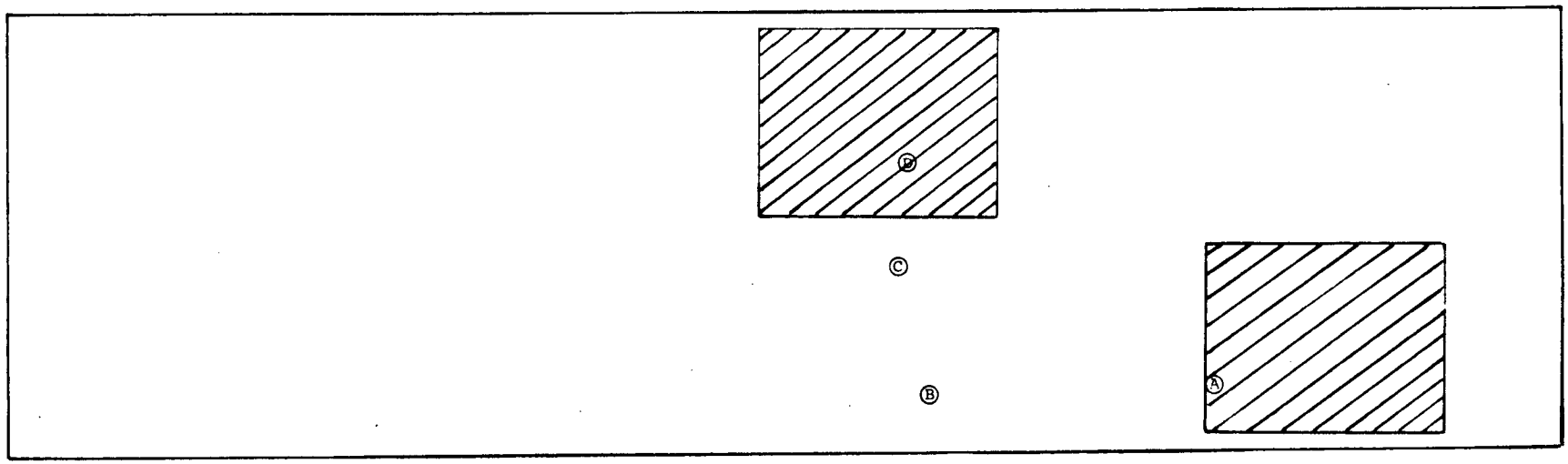
Deck Area - 18,368 ft.^{2}
Delaminated Area - 0.00 ft.^{2}
% Delamination - 0.00 %

Polk County
I-35-2(129)69--01-77 Des. No. 273
Location: I-35 Over Raccoon River Southbound
Year Overlaid: 1973

N

Indicates areas where Electrical Potential Readings were taken
Details next page

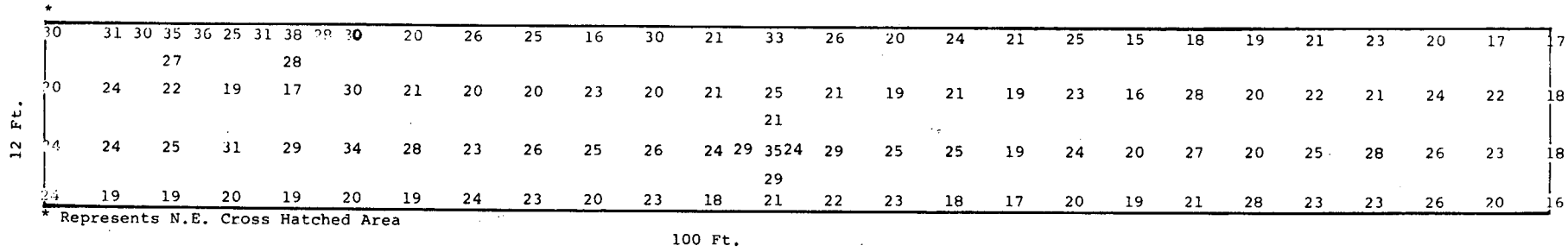
Letters indicate chloride cores.



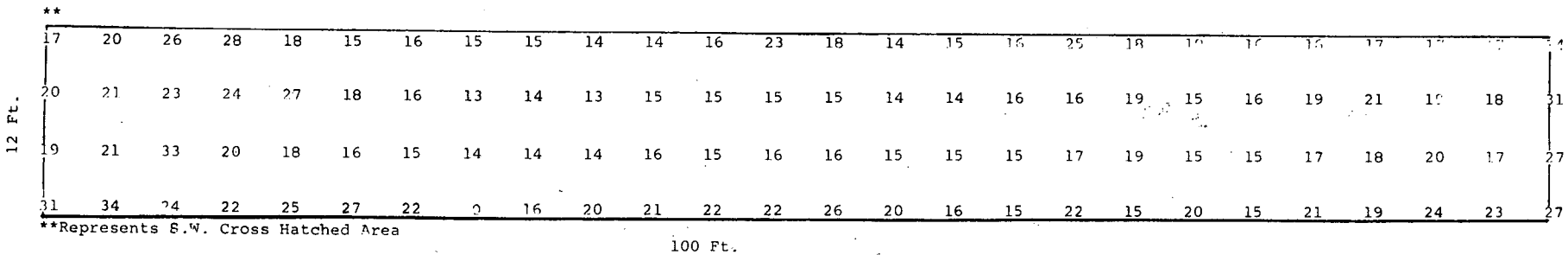
Not to Scale

Polk County
I-35-2(129)69--01-77 Des. No. 273
Location: I-35 Over Raccoon River Southbound
Year Overlaid: 1973

Electrical Potential
Negative Voltage-Copper Sulfate
Half Cell
Detail Sheet

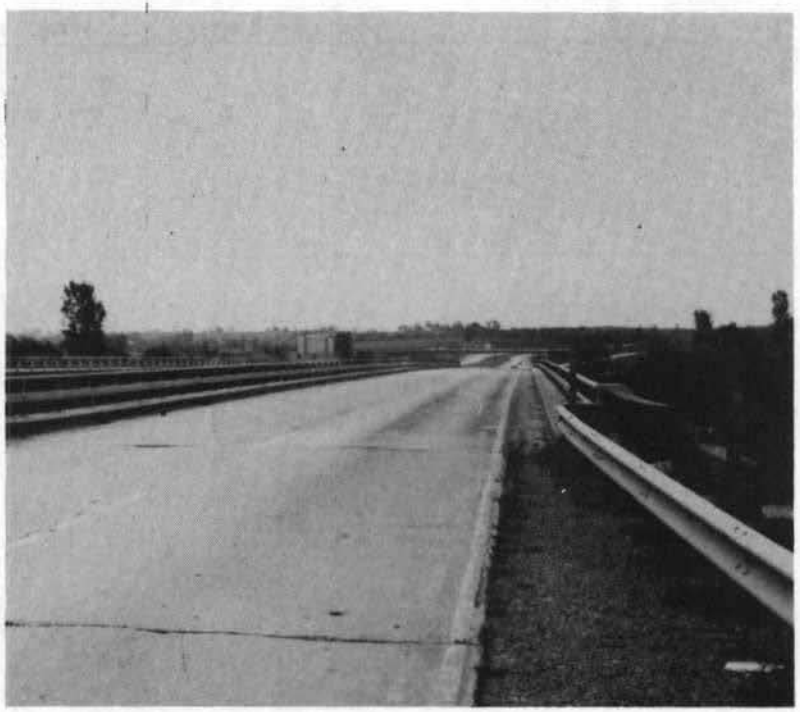


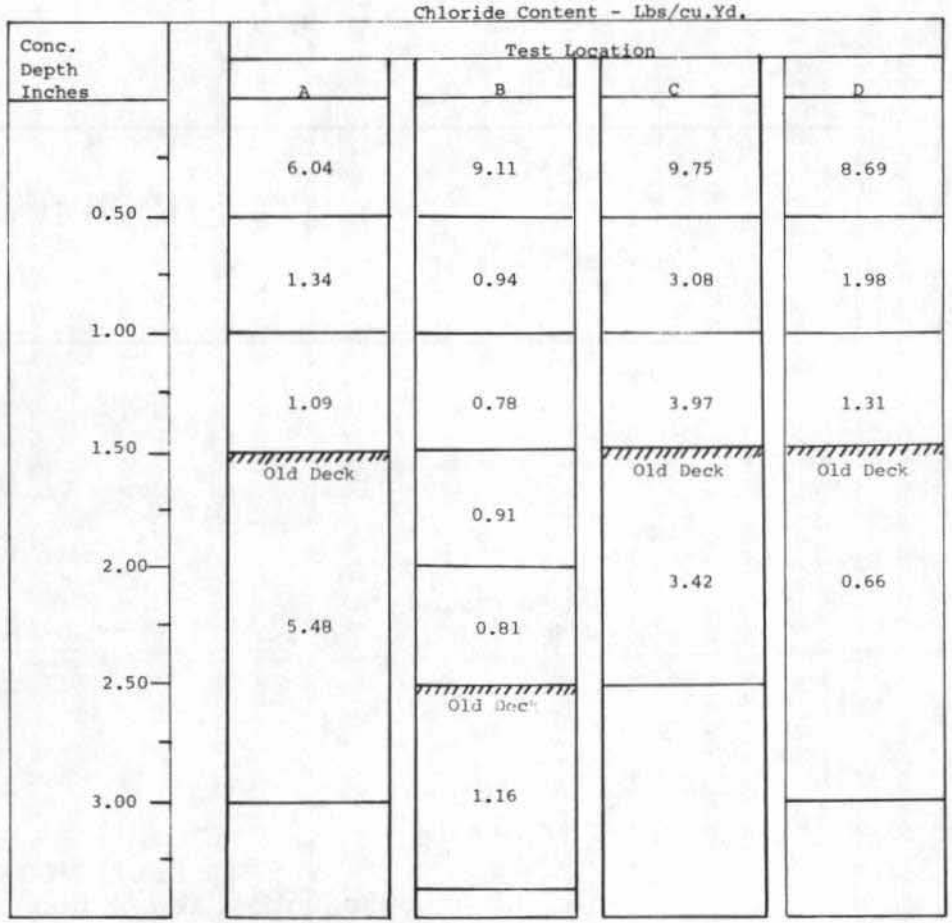
* Represents N.E. Cross Hatched Area



**Represents S.W. Cross Hatched Area

Polk County
I-35-2(129)69--01-77 Des.No. 273
Location: I-35 Over Raccoon River Southbound
Year Overlaid: 1973





Polk County

I-235-2(134)81-01-77 Des No. 573

Location: I-235 Over Des Moines River Westbound Bridge

Year Overlaid: 1973

Bridge Deck Dimensions
Width - 52 ft.
Length - 860 ft.

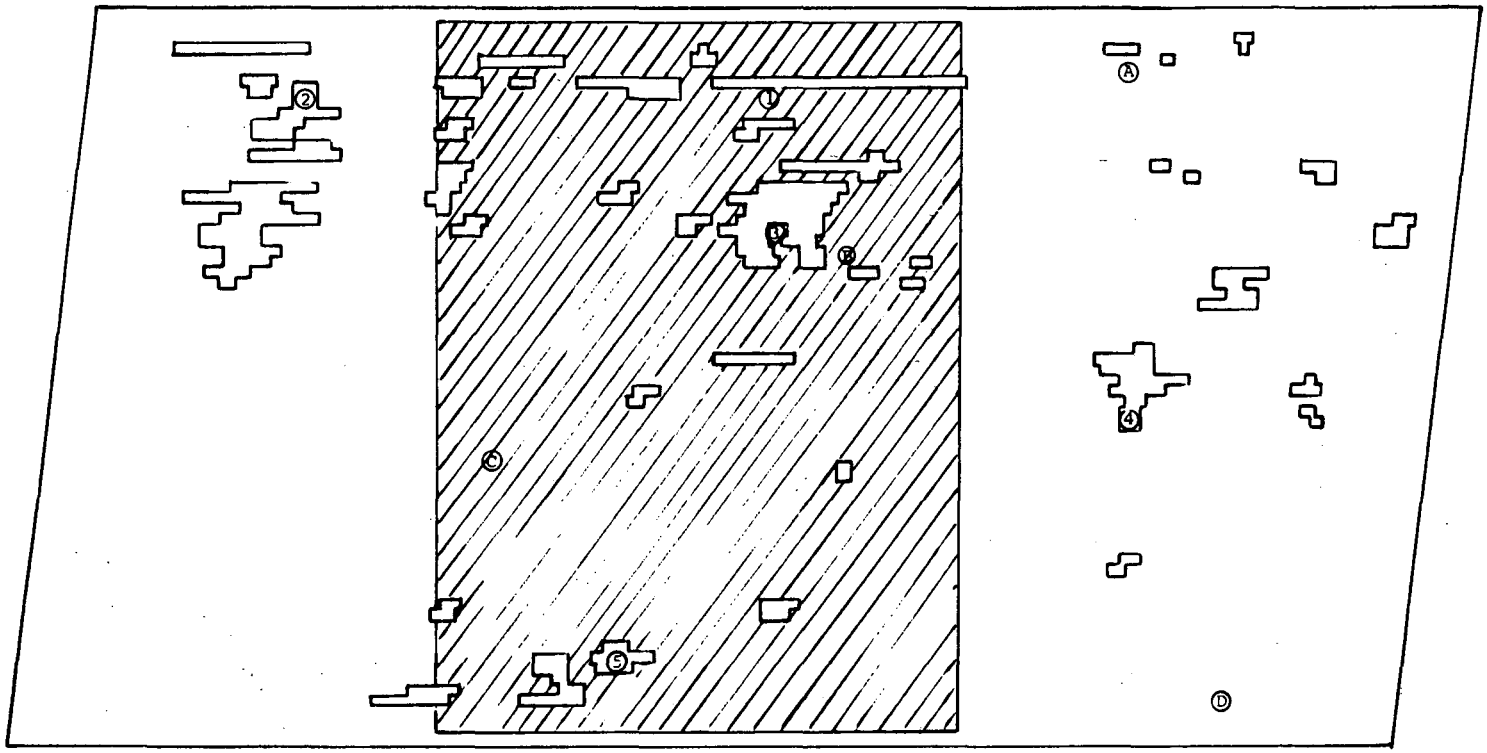
Deck Area - 44,720 ft.^{2}
Delaminated Area - 669.75 ft.^{2}
% Delamination - 4.86% *

* 52' x 265' Test Section in Westbound Lane
From East Abutment to First Expansion Joint

N

Indicates areas where Electrical Potential Readings were taken
Details next page

Letters indicate chloride cores.
Numbers indicate delamination cores.

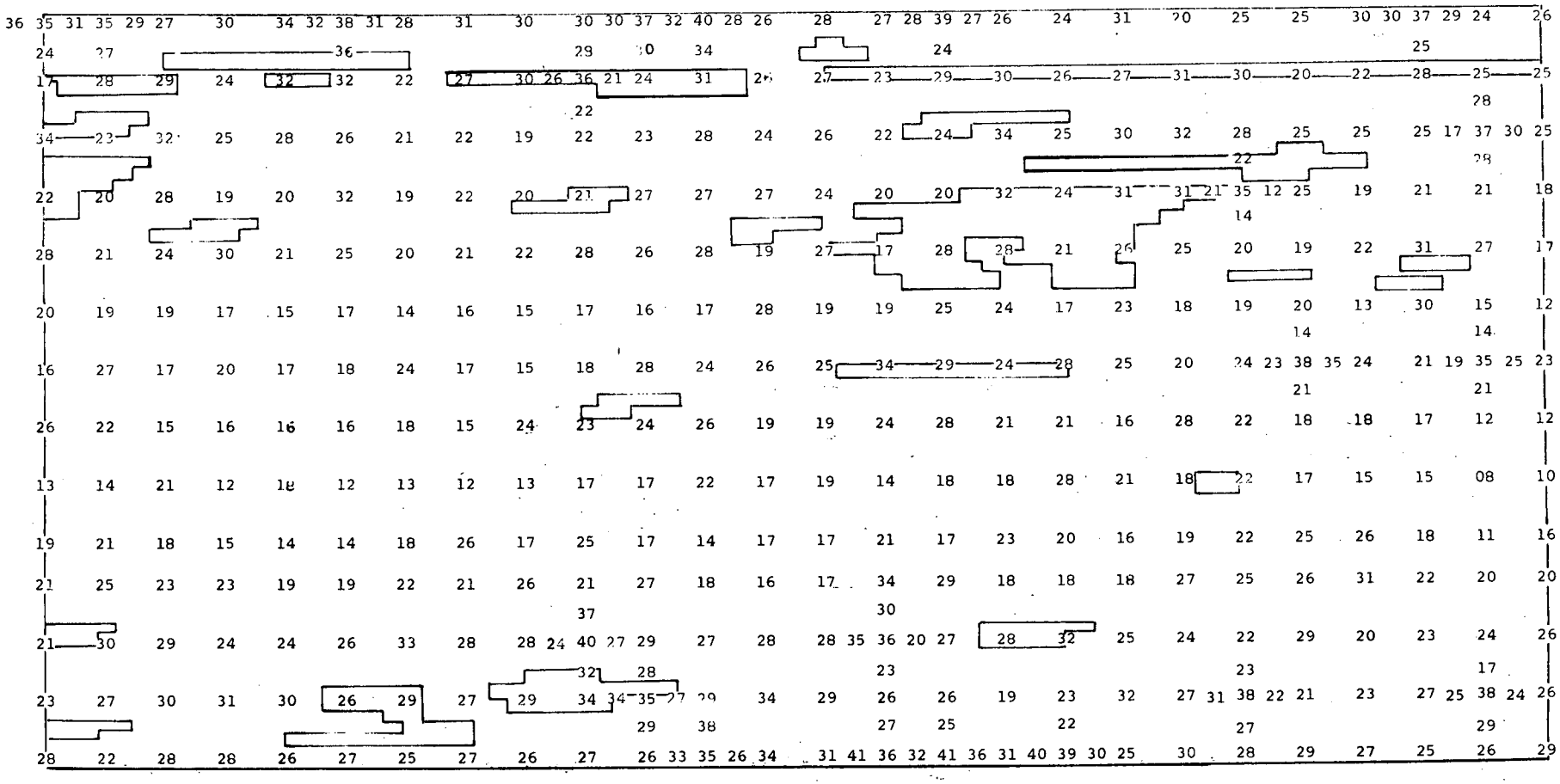


Not To Scale

Blocked out areas indicate delamination

Polk County
I-235-2(134)81-01-77 Des. No. 573
Location: I-235 Over Des Moines River Westbound Bridge
Year Overlaid: 1973

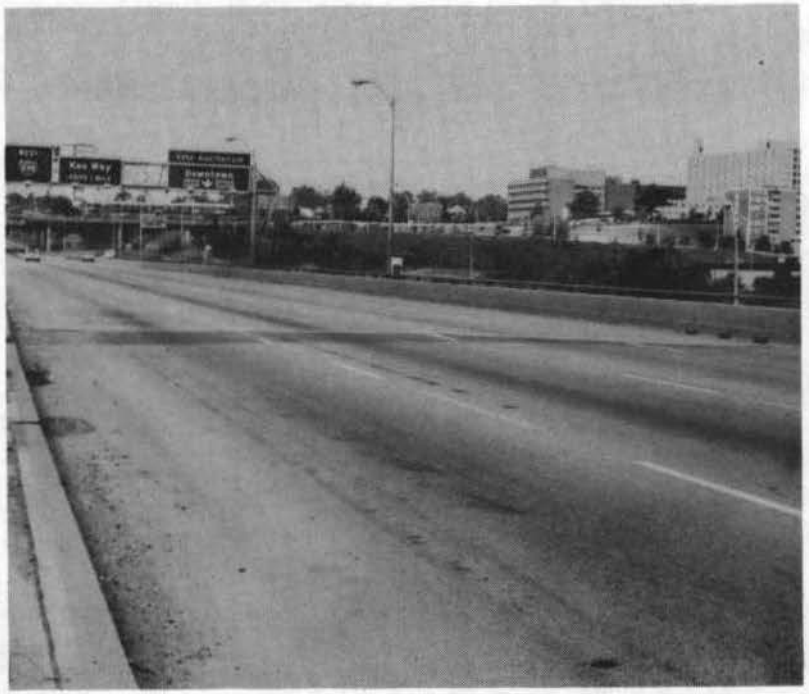
Electrical Potential
Negative Voltage - Copper Sulfate
Half Cell
Detail Sheet

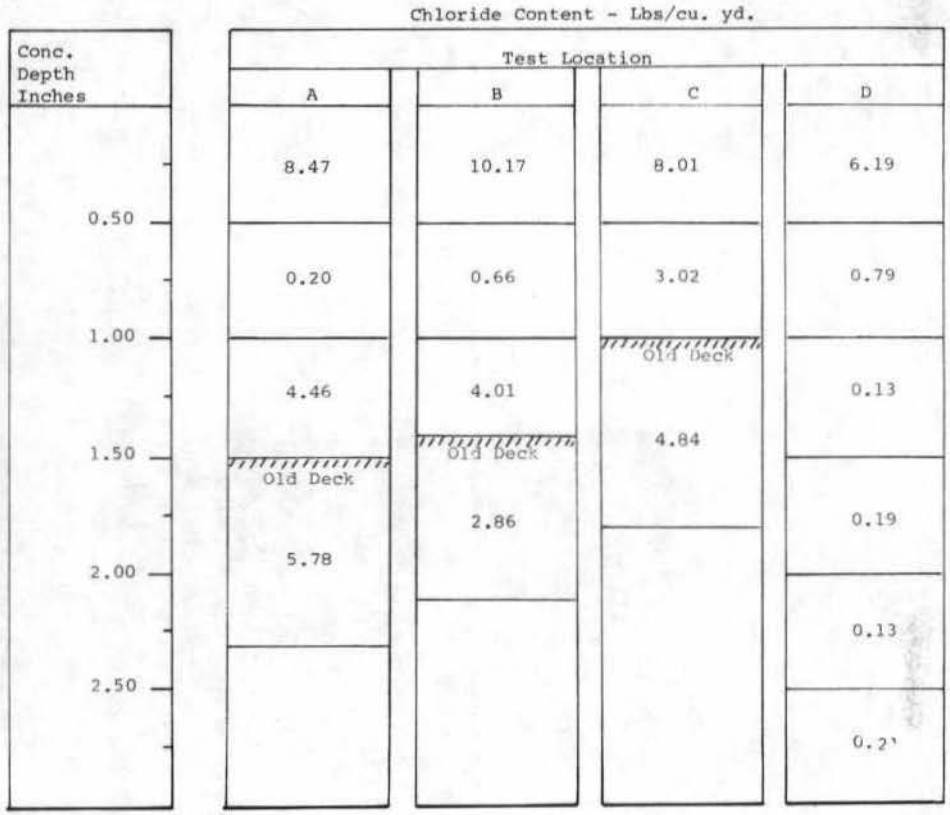


100 Ft.

Blocked out areas indicate delamination

Polk County
I-235-2(134)-81-01-77 Des. No. 573
Location: I-235 Over Des Moines River Westbound Bridge
Year Overlaid: 1973





Polk County
I-235-2(134)81-01-77 Des. No. 573
Location: I-235 Over Des Moines River Westbound Bridge
Year Overlaid: 1973

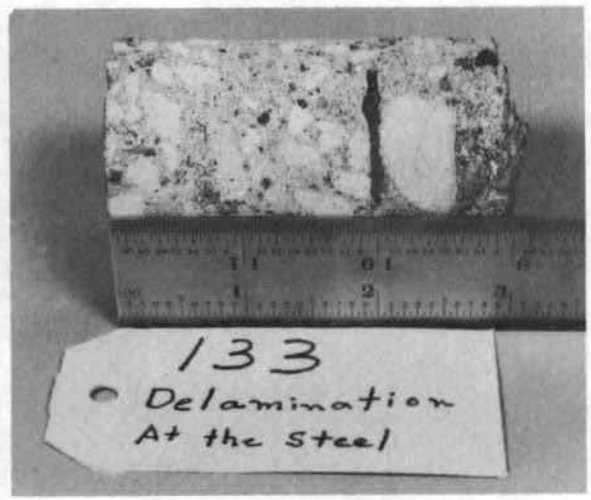
DELAMINATION CORES

Core #1

Core #2

Core #3

Core #4



Core #5