5.4. STATE-DEPENDENT INSPECTION RESULTS

While performing Tasks A through H, inspectors were asked to follow pre-defined guidelines and to record their findings on NDEVC forms. These guidelines were based on the AASHTO definitions of the various inspection types, and the forms were hybrid forms primarily based on the National Bridge Inventory (NBI) items. Several different inspection formats exist, most notably element-level inspections (for example, the commercially available Pontis program) and NBIS inspections. Since both the procedures and the forms used in Tasks A through H may have been different from those that some inspectors normally use, two additional tasks were developed that allowed inspectors to operate under conditions closer to "normal." The objective of Tasks I and J was to provide insight into the inspection procedures and reporting techniques used by the individual States. These two tasks are referred to as the State-dependent tasks.

5.4.1. State-Dependent Task Descriptions

Inspectors were asked to work in teams while performing Tasks I and J. Teams were to inspect according to their normal procedures and to record information on normal State forms for Task I, and on forms provided by the NDEVC for Task J. Recall that Task I was a Routine Inspection of the southern two spans of the Van Buren Road Bridge, and that Task J was an In-Depth Inspection (delamination survey) of the southern two deck spans. The Van Buren Road Bridge is a three-span bridge with a concrete deck on a steel, multi-girder superstructure. Each span is approximately 18 m in length, and is simply supported. The introductory information on this bridge, given in Appendix C in Volume II, was forwarded to the participating DOTs prior to the arrival of the inspectors. Within this information packet were relevant drawings of the structure, information on traffic volume, and equipment to be brought.

The delamination survey of the deck (Task J) had a flexible format, since it was anticipated that some States might perform Task J within the scope of Task I. To prevent knowledge of a delamination survey task from influencing the activities within the Routine Inspection, information regarding Task J was not divulged until after the completion of the Routine Inspection. Once it was clear that the Routine Inspection was not going to include a delamination survey, Task J was administered. If a delamination survey of the deck was performed to a specified extent, Task J was not administered separately. Details regarding the criteria used to judge the performance of a deck inspection are presented in this chapter with the Task J information.

5.4.2. Inspection Process

As with all other tasks, the observers recorded information before, during, and after the actual performance of the task. The following two sections discuss the data recorded from these observations.

5.4.2.1. TASK I INFORMATION RECORDED BY OBSERVERS

Task I is the Routine Inspection of the Van Buren Road Bridge using individual State procedures. Each team of inspectors was given 2 h to complete the task. The average time taken to complete the inspection was 63 min (standard deviation of 25 min), with times ranging from 27 min to 121 min. The distribution of inspection times is shown in figure 151.

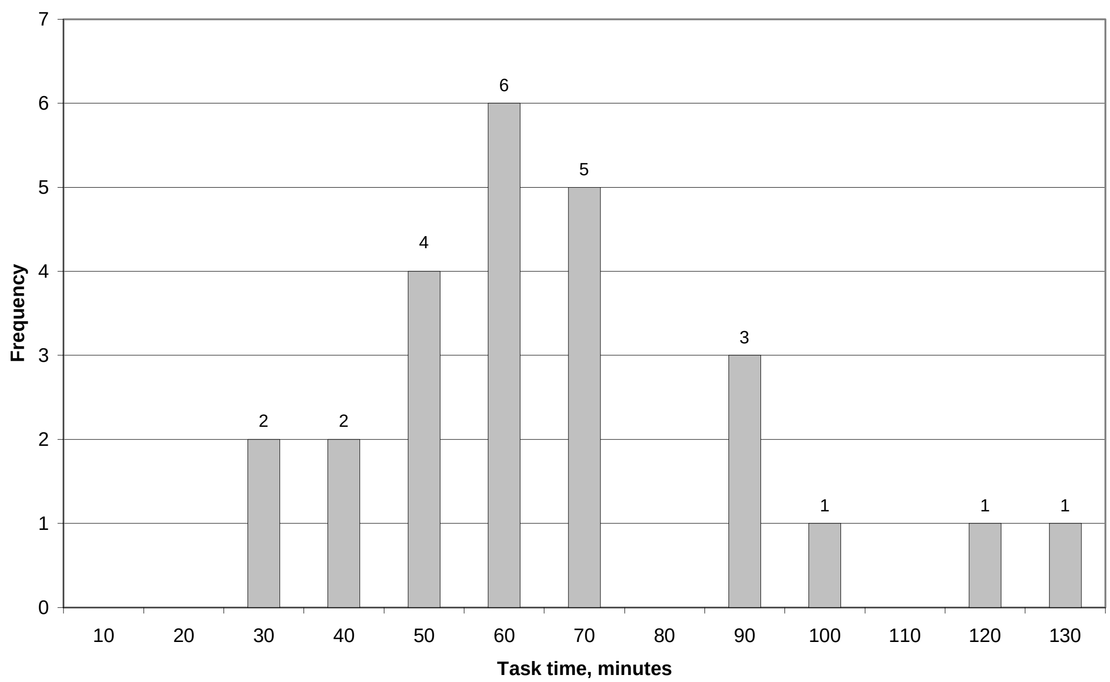


Figure 151. Task I – Actual inspection time.

As in other tasks, pre-task and post-task questionnaires were administered to provide insight into the general condition of the inspectors. Two of the questions asked for information about each inspector, so each individual inspector provided a response. Since the team could prepare for this task in advance, an additional question was asked about the amount of preparation time. Table 209 summarizes all of the responses to the quantitative pre-task questions. The factor Time Since Similar Inspection had a short average period of time of approximately 6 weeks. This is the shortest period of time for any of the tasks. Also, the teams' estimates of the amount of time it would take to inspect this bridge were significantly higher than the actual time spent. As shown in table 209, the estimates ranged from 30 min to 8 h. The average actual inspection time was less than two-thirds of the average estimated time. Of the three teams that had estimates higher than the allotted time, all finished before the expiration of the allotted time. Seven teams took more time than their estimates, but only one team had to be stopped at the end of the allotted time. The distribution of estimated inspection times is shown in figure 152.

Table 209. Task I – Quantitative pre-task questionnaire responses.

	Range of Possible Answers		Inspector Responses			
	Low	High	Average	Standard Deviation	Maximum	Minimum
How long has it been since you completed an inspection of a bridge of this type (in weeks)? (question for individuals)	N/A*	N/A	5.6	8.8	52	1
How long did you spend preparing to complete this inspection prior to arriving at the bridge site (in man-hours)?	N/A	N/A	2.2	3.1	16	0
Given the available equipment and the defined tasks, how long do you think you would normally spend on this inspection (in minutes)?	N/A	N/A	98.4	92.8	480	30
How rested are you? (question for individuals)	1 = very tired	9 = very rested	7.0	1.3	9	4

* N/A = Not applicable.

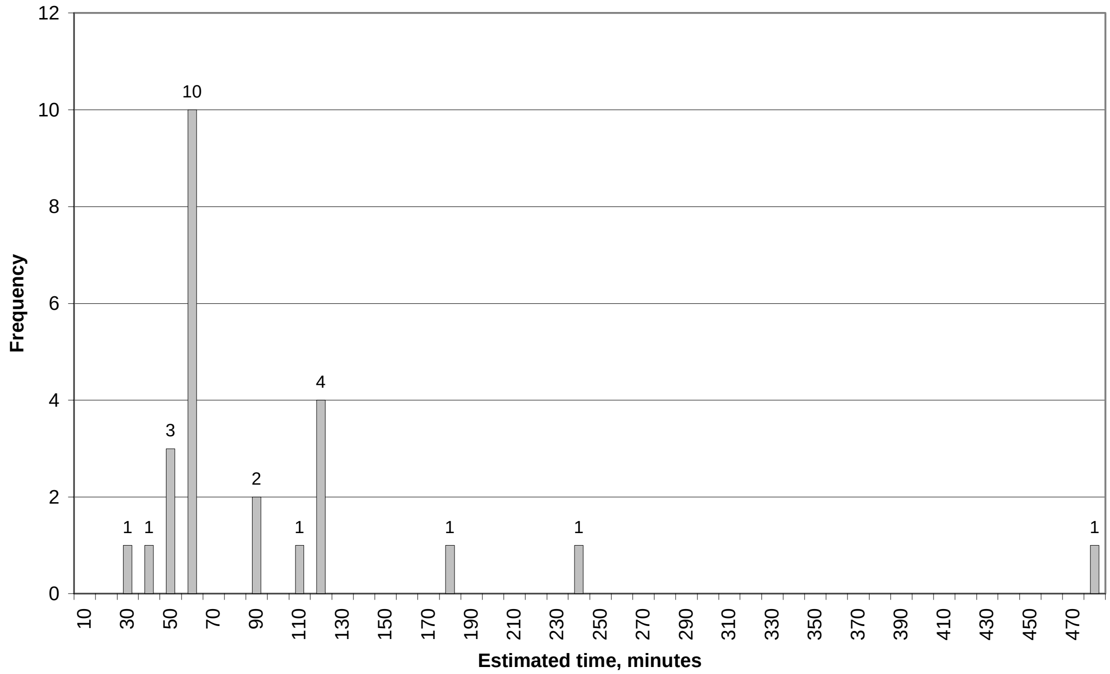


Figure 152. Task I – Predicted inspection time.

Unlike the other tasks, teams only had access to a 6.1-m extension ladder, not the 9.8-m ladders used elsewhere. Since the majority of the superstructure of the Van Buren Road Bridge could be reached from ground level, this ladder was considered adequate for the task. However, to ascertain if any of the participating States would have used different access equipment, one of the questions in the pre-task questionnaire concerned access equipment. Table 210 summarizes the responses to this question. None of the teams indicated that any form of access equipment beyond a ladder would be used to inspect this bridge. Note that 80 percent of the teams indicated that they would use a ladder, even though most of the bridge could be reached from ground level.

Unlike the other tasks, the pre-task question dealing with the description of the structure was not asked, since the plans for the bridge had previously been made available to the teams. However, the pre-task question that focused on what kinds of problems the teams might expect to find during their inspection was asked. The responses are summarized in table 211. Steel corrosion and concrete deterioration were expected by about three-quarters of the teams. All but one of the “Other” responses related to either scour or settlement cracking of the substructure.

As with all of the other tasks, the NDEVC observers recorded the environmental conditions. Tables 212 and 213 summarize the environmental data recorded. Also note the very low measured wind speed. The underside of the Van Buren Road Bridge is sheltered from wind by small trees and brush, creating very still conditions.

Table 210. Task I – Normal access equipment use.

Accessibility Equipment/Vehicle Type	Percentage of Respondents
Snooper	0%
Lift	0%
Ladder	80%
Scaffolding	0%
Climbing Equipment	0%
Permanent Inspection Platform	0%
Movable Platform	0%
None	16%
Other	4%

Table 211. Task I – Problems expected.

Problem Type	Percentage of Respondents
Concrete Deterioration	76%
Steel Corrosion or Section Loss	76%
Fatigue Cracking	40%
Bearing Problems	36%
Deck Delaminations	36%
Joint Deterioration	36%
Underside Deck Cracking	32%
Paint Deterioration	20%
Leakage	12%
Leaching	4%
Impact Damage	4%
Other: Missing/Loose Bolts	4%
Other	16%

Table 212. Task I – Direct environmental measurements.

Environmental Measurement	Average	Standard Deviation	Maximum	Minimum
Temperature (ºC)	26.8	4.7	35.0	13.9
Humidity (%)	53.9	13.3	83	31
Heat Index (ºC)	27.8	5.6	37.8	13.9
Wind Speed (km/h)	0.5	0.9	3.2	0.0
Light Intensity Within Superstructure (lux)	70	39	172	11
Light Intensity on Deck (lux)	63,100	27,500	104,500	8,040

Table 213. Task I – Qualitative weather conditions.

Weather Condition	Percentage of Inspections
0 – 20% Cloudy	44%
20 – 40% Cloudy	12%
40 – 60% Cloudy	0%
60 – 80% Cloudy	4%
80 – 100% Cloudy	24%
Hazy	8%
Fog	0%
Drizzle	4%
Steady Rain	4%
Thunderstorm	0%

A list was developed detailing items on the bridge that could be inspected. This list, along with the percentage of the teams that inspected each item, is summarized in table 214. The usage percentages are best estimates of what the teams examined; however, some percentages are approximate since some of the individual items were difficult to differentiate in the field. An example of this is “Inspect … bearing location” and “Inspect … bearing rotation.” Without the use of a rotation-measuring device, it was difficult to determine if an inspection at a bearing location included a visual assessment of the rotation.   Some of the notable items include the following:

- Approximately 90 percent of the inspection teams inspected the major substructure elements.

Table 214. Task I – Bridge component inspection results.

	Inspection Item	Percentage of Inspectors
General	Check Overall Alignment (West side)	24%
	Check Overall Alignment (East side)	28%
Superstructure	Inspect South Bearing Location	96%
	Inspect South Bearing Rotation	60%
	Inspect Middle Bearing Location	96%
	Inspect Middle Bearing Rotation	64%
	Inspect North Bearing Location	80%
	Inspect North Bearing Rotation	56%
South Span	Inspect Coverplate Terminations	76%
	Inspect for Missing/Loose Bolts	48%
	Inspect Diaphragm Weld Connections	64%
Middle Span	Inspect Coverplate Terminations	76%
	Inspect for Missing/Loose Bolts	52%
	Inspect Diaphragm Weld Connections	60%
Substructure	Inspect South Pier Cap	100%
	Sound South Pier Cap	52%
	Inspect North Pier Cap	96%
	Sound North Pier Cap	28%
	Inspect South Pier Columns	88%
	Sound South Pier Columns	28%
	Inspect North Pier Columns	92%
	Sound North Pier Columns	24%
	Some Substructure Sounding	60%
Deck	Any Deck “Sounding”	80%
	Sound Deck (masonry hammer)	44%
	Chain-Drag Deck (partial)	24%
	Chain-Drag Deck (complete)	36%
	Sound West Parapet	28%
	Sound East Parapet	20%
	Inspect South Expansion Joint	92%
	Inspect Middle Deck Joint	88%
	Inspect North Deck Joint	88%
South Span	Inspect Underside of Deck for Cracking	88%
North Span	Inspect Underside of Deck for Cracking	88%

- About half of the inspection teams did not perform any sounding on the substructure.
- Nearly all of the inspection teams examined the bearing locations.

- About three-quarters of the inspection teams examined the area around the termination of the flange cover plates.
- Almost 90 percent of the inspection teams examined the underside of the deck for cracking.
- Nearly all of the inspection teams examined the deck joints.
- Eighty percent of the inspection teams performed sounding on the top of the deck.

Tool use for Task I was similar to most of the other Routine Inspection tasks. Almost all of the tools used can be placed into four categories: ladder, tape measure, flashlights, and sounding equipment. The two other items used are binoculars (once), and a level used as a straightedge (once). Complete tool use is summarized in table 215.

Table 215. Task I – Use of inspection tools.

Tool	Percentage of Inspectors
Tape Measure	64%
2.4-m Stepladder	0%
6.1-m Extension Ladder	56%
Any Flashlight	44%
Two AA-cell Flashlight	12%
Three D-cell Flashlight	12%
Lantern Flashlight	24%
Any "Sounding" Tool	84%
Masonry Hammer	68%
Chain	48%
Level as a Level	0%
Level as a Straightedge	4%
Binoculars	4%
Magnifying Glass	0%
Engineering Scale	0%
Protractor	0%
Plumb Bob	0%
String	0%
Hand Clamp	0%

A post-task questionnaire was administered following Task I. Responses to these questions are summarized in table 216. Several of the questions solicited individual responses. To present

Table 216. Task I – Quantitative post-task questionnaire responses.

	Range of Possible Answers		Inspector/Team Responses			
	Low	High	Average	Standard Deviation	Maximum	Minimum
Did this task do an accurate job of measuring your inspection skills? (individual question)	1 = not accurate	9 = very accurate	7.9	1.0	9	5
How rested are you? (individual question)	1 = very tired	9 = very rested	6.8	1.3	9	4
How well did you understand the instructions you were given?	1 = very poorly	9 = very well	8.4	0.9	9	5
How accessible do you feel the various bridge components were?	1 = very inaccessible	9 = very accessible	8.2	0.7	9	7
How well do you feel that this bridge has been maintained?	1 = very poorly	9 = very well	6.6	1.3	9	4
How complex was this bridge?	1 = very simple	9 = very complex	3.9	1.2	6	1
Do you think my presence as an observer had any influence on your inspection?	1 = no influence	9 = great influence	1.9	1.3	6	1
Did you feel rushed while completing this task? (individual question)	1 = not rushed	9 = very rushed	2.1	1.8	7	1
What was your effort level on this task in comparison with your normal effort level? (individual question)	1 = much lower	9 = much greater	5.1	0.4	7	4
How thorough were you in completing this task in comparison to your normal inspection?	1 = less thorough	9 = more thorough	5.4	0.8	8	5

these data, answers have been compiled from both inspectors. Since this task asked teams to use their own State procedures, the question about similarity to normal Routine Inspections was not asked. The inspectors indicated that their rested level dropped during the performance of this task, as reflected in the Rested Level Before Task of 7.0 and 6.8 after. The question, "Did this task do an accurate job of measuring your inspection skills?" received a high average response. The average response to this question was 7.9, which, along with Task H, is the highest average response.

5.4.2.2. TASK J INFORMATION RECORDED BY OBSERVERS

Task J was administered in a much more liberal format than any other task. This allowed for observations about the levels of detail of delamination surveys during Routine Inspections. If the delamination survey portion of Task I was deemed thorough enough, Task J was not specifically administered. The two criteria for judging the thoroughness of the Task I inspection were: (1) the use of a systematic approach to cover nearly all of the deck top surface, and (2) the creation of a schematic sketch to indicate the size and extent of the defects discovered. Regardless of the thoroughness of the delamination survey performed as part of Task I, inspectors were allowed the opportunity to perform a further inspection for Task J.

Three inspection teams refused to perform this task. All three refusals came when it was raining at the bridge, with the teams frequently citing that the rain would interfere with the sounding operation.

A total of 2 h were allotted for the completion of this task. The average time spent was 36 min (standard deviation of 27 min), with a range from 8 min to 105 min. Note that the teams that performed Task J within Task I do not have time records; therefore, the average time does not include these teams. Furthermore, three teams performed the delamination survey in less than 20 min.

It was anticipated that some teams might perform Task J within Task I. Therefore, pre- and post-task questionnaires were not uniformly administered, and the results are not presented.

Typical environmental measurements were recorded. A light intensity measurement was always taken on the deck surface, while temperature, humidity, and wind measurement locations varied. When a team completed Task J as part of Task I, these measurements were taken from under the deck, as in Task I. If Task J was administered separately, these measurements were taken above the deck. The under-deck measurements are not included with the Task J environmental measurements summarized in table 217.

Again, a qualitative descriptor was included to further describe the environmental conditions under which each task was performed. As shown in table 218, the task was never performed in the rain.

Observers tracked the methods used to evaluate the condition of the deck. Hammer use and chain-drag use are summarized in table 219. An additional category was tracked for the inspection teams that performed Task J, noting whether they refined the shape of suspect areas once they were discovered. However, since this information was not tracked for those who performed Task J as part of Task I, it is omitted from this presentation.

Table 217. Task J – Direct environmental measurements.

Environmental Measurement	Average	Standard Deviation	Maximum	Minimum
Temperature (ºC)	30.5	3.9	37.2	22.8
Humidity (%)	48.3	10.8	74	33
Wind (km/h)	2.0	2.8	9.7	0.0
Heat Index (ºC)	33.0	6.2	45.9	22.8
Light Intensity on Deck (lux)	67,400	27,500	109,400	17,000

Table 218. Task J – Qualitative weather conditions.

Weather Condition	Percentage of Inspections
0 – 20% Cloudy	62%
20 – 40% Cloudy	10%
40 – 60% Cloudy	10%
60 – 80% Cloudy	5%
80 – 100% Cloudy	5%
Hazy	10%
Fog	0%
Drizzle	0%
Steady Rain	0%
Thunderstorm	0%

Table 219. Task J – Bridge component inspection results.

	Inspection Item	Percentage of Teams
Deck	Some Deck Sounding	100%
	Sound Deck (Chain-drag)	90%
	Sound Deck (Hammer)	33%

No inspection teams used any tools beyond the basic masonry hammer, tape measure, and chain to perform Task J. A usage breakdown of these three items is summarized in table 220.

Table 220. Task J – Use of inspection tools.

Tool	Percentage of Teams
Any "Sounding" Tool	100%
Chain	90%
Masonry Hammer	43%
Tape Measure	71%

Since some teams performed Task J within Task I, the post-task questionnaires were not administered. Therefore, there is no post-task data to report.

5.4.3. Task I

Task I results are summarized in four sections. First, the notable procedural differences observed between the inspection teams are presented. Second, reporting format differences are discussed. Next, a statistical evaluation of the Condition Ratings is discussed. Finally, observations of the element-level inspection results are presented.

5.4.3.1. PROCEDURAL VARIATIONS

One of the goals of the State-dependent tasks was to study procedural similarities and differences in the inspection techniques used by the States. Procedural similarities and differences for the task that have been noted are presented in the following section.

Teamwork between the participating inspectors was an aspect of Task I that varied between the individual teams. Before discussing aspects of how the inspectors worked together, it is first important to establish which teams arrived as working partners and which teams were assembled for this study. A nearly even division was present, with 11 pre-existing teams, and 13 assembled teams out of the 24 total teams. The 25th State only sent one individual, so therefore this inspector is not a member of either of the team groupings.

The inspection styles varied considerably. Some teams had a very experienced inspector primarily taking notes, while the less experienced partner performed most of the observations. The converse was also observed, where the senior inspector performed most of the observations and dictated notes to the partner. Alternately, a number of teams performed the inspection with a relatively equal distribution of note-taking and inspection. Some of these equal partnerships inspected independently, while others inspected jointly. To summarize the different styles, teams were categorized by two sets of descriptors. One descriptor characterized the division of labor between the two inspectors, the other characterized the relationship between the two inspectors. The division of labor was characterized by the following categories: worked together, inspector and note-taker, and independent inspectors (with or without consultation). The relationship category was characterized by the following categories: equals, leader/inspector, and leader/helper. Both descriptors also needed the "Unclassified" category to be able to completely capture all of the teams. A description matrix is presented in figure 153, summarizing the criteria used to categorize the different teams. Figure 154 summarizes the total number of teams in each combination, while figures 155 and 156 present the number of teams in each category for pre-existing teams and assembled teams, respectively. As shown in the figures, 9 of the 11 pre-existing teams performing Task I were judged to have worked with a degree of hierarchy (such as leader/helper or leader/inspector). Along similar lines, 11 of the 13 assembled teams worked as equals.

5.4.3.2. REPORTING VARIATIONS

Significant differences were observed in the reports resulting from this inspection task. While most of these differences are form and format-related, there are other more important differences as well.

		Relationship			
		Equals	Leader/Inspector	Leader/Helper	Unclassified
Division of Labor	Worked Together	Inspectors generally looked at inspection areas together and conferred. No clear leadership role assumed.	Inspectors generally looked at inspection areas together. Clear leadership role assumed by one person. Subordinate knowledgeable inspector with some independence.	Inspectors generally looked at inspection areas together. Clear leadership role assumed by one person. Subordinate working at the direction of the leader.	Inspectors generally worked together. No noted leadership division.
	Inspector and Note-Taker	One inspector and one note-taker. No clear leadership role assumed.	One inspector and one note-taker. Clear leadership role assumed by one person. Subordinate knowledgeable inspector with some independence.	One inspector and one note-taker. Leader either directs helper's inspection or dictates inspection notes.	One inspector and one note-taker. No noted leadership division.
	Independent Inspectors	Inspectors divided the inspection task and inspected separately. Inspectors may or may not have conferred. No clear leadership role assumed.	Inspectors divided the inspection task and inspected separately. Inspectors may or may not have conferred. Clear leadership role assumed by one person. Subordinate knowledgeable inspector with some independence.	Inspectors divided the inspection task and inspected separately. Inspectors may or may not have conferred. Leader makes inspection decisions with little input from helper.	Inspectors divided the inspection task and inspected separately. Inspectors may or may not have conferred. No noted leadership division.
	Unclassified	No noted teamwork aspects. No clear leadership role assumed.	No noted teamwork aspects. Clear leadership role assumed by one person. Subordinate knowledgeable inspector with some independence.	No noted teamwork aspects. Clear leadership role assumed by one person. Subordinate working at the direction of the leader.	No noted teamwork aspects. No noted leadership division.

Figure 153. Inspection team characterization criteria matrix.

	Equals	Leader/ Inspector	Leader/ Helper	Unclassified
Worked Together	5	0	1	1
Inspector and Note-Taker	1	3	0	0
Independent Inspectors	5	2	3	0
Unclassified	1	1	0	1

Figure 154. Overall inspection team characterization matrix of data.

	Equals	Leader/ Inspector	Leader/ Helper	Unclassified
Worked Together	0	0	1	1
Inspector and Note-Taker	0	3	0	0
Independent Inspectors	1	1	3	0
Unclassified	0	1	0	0

Figure 155. Pre-existing team characterization matrix of data.

	Equals	Leader/ Inspector	Leader/ Helper	Unclassified
Worked Together	5	0	0	0
Inspector and Note-Taker	1	0	0	0
Independent Inspectors	4	1	0	0
Unclassified	1	0	0	1

Figure 156. Assembled team characterization matrix of data.

5.4.3.2.1. Form Preparation

Preparation was one area where there were significant differences observed. There are three primary areas in which inspectors spent time preparing for this task: (1) Structure Inventory and Appraisal (SI&A) forms, (2) other forms for the condition report, and (3) physical/mental preparation (non-form related). Of these three areas, any time spent for physical/mental preparation is often personal, and therefore, there will be no tangible evidence of the time spent. No conclusions can be made regarding this component of the preparation time. No specific instructions were given regarding SI&A forms for Task I. Submission of SI&A forms was welcome; but was not expected since the majority of this information is fixed, with very little field data. Only nine States prepared SI&A forms for inclusion in their report.

For the main condition reports, teams have been subdivided into three groups based on the level of preparation that can be observed in their reports. Table 221 summarizes the Reported Preparation Time data for the “No Preparation Observed” group, the “Some Preparation Observed” group, and the “Indeterminate Preparation” group. As shown in table 221, 13 States had no apparent preparation for their forms. These 13 States may have done some other types of preparation or selected appropriate generic forms; however, this is not reflected in the group division. Six States had obviously made some preparations for their forms prior to arrival. The remaining six States had an indeterminate level of preparation. This level is indeterminate because they only submitted a final computer-generated report, with no intermediate notes (i.e., the level of preparation could not be ascertained from the final work product). The average Reported Preparation Time for those with evidence of preparation is 4.4 man-hours, while the average for the indeterminate group is 1.5 man-hours. Of the indeterminate preparation group, two teams indicated that less than 0.5 man-hours had been spent in Reported Preparation Time, which indicates that form preparation was not likely for those two teams. It is not discernable how the other four teams in the indeterminate group spent their time preparing for Task I.

Overall, the inspection teams indicated an average Reported Preparation Time of 2.2 man-hours (standard deviation of 3.1), with responses ranging from 0 to 16 man-hours. Only two teams indicated that no preparation work had been performed prior to arrival at the bridge site. One of these teams departed their home State early and did not receive the Advance Information Packet in time to make any preparations prior to arrival.

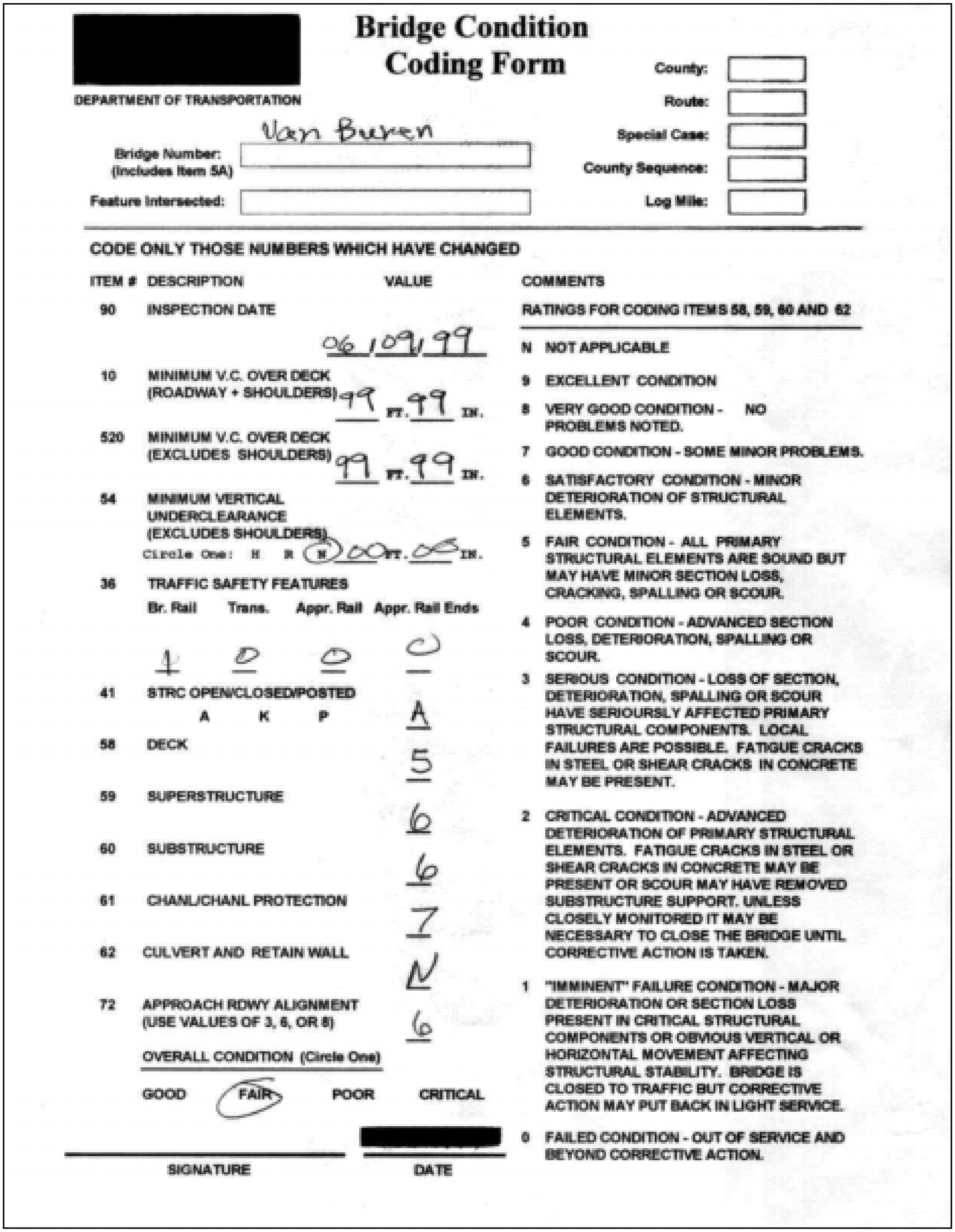
Table 221. Task I – Reported Preparation Time.

Preparation Group	Reported Preparation Time (in man-hours)				
	Number of Teams	Average	Standard Deviation	Minimum	Maximum
No Preparation Observed	13	1.5	1.0	0	3
Some Preparation Observed	6	4.4	5.8	1	16
Indeterminate Preparation	6	1.5	1.4	0.25	4
≤ 0.5 man-hours	2	0.4	0.2	0.25	0.5
> 0.5 man-hours	4	2.1	1.3	1	4
Overall	25	2.2	3.1	0	16

5.4.3.2.2. Inspection Report Presentation

Reports that were submitted generally fell into one of three categories. The first category includes teams that submitted an apparently final report that was filled out by hand in the field. This category includes hand-coded reports ready for data entry by others, but excludes field-generated, computer-processed reports. A second category includes those teams that submitted a complete inspection report; however, from sample reports provided, it is clear that the reports were not yet in their final form. The third category includes teams that submitted a final report similar to their sample reports. These reports were computer-generated, and these teams had either asked to take their data back to their office to generate the final report or had the use of a portable computer to generate the report in the field. These computer reports ranged from line-item data summaries to word-processed inspection reports. Some printouts were mere listings of information without formatting, while others used boxes, color, and other formatting techniques to make the information stand out.

Nine teams submitted field-written final reports; 4 teams submitted field-written intermediate reports; and 11 teams submitted computer-generated final reports. Sample pages of each style are shown in figures 157 through 163. Figures 157 through 159 are from a single field-written final report; figures 160 and 161 are from a single field-written intermediate report; and figures 162 and 163 are from a single computer-generated final report. In these sample report pages, specific information that could identify any individual performing the inspection or their corresponding State has been blacked out. These figures illustrate some of the ranges of information density per page and the readability of the reports. Note that these figures are all



[redacted]

DEPARTMENT OF TRANSPORTATION

Bridge Condition Coding Form

County:

Route:

Special Case:

County Sequence:

Log Mile:

Van Buren

Bridge Number: (Includes Item 5A)

Feature Intersected:

CODE ONLY THOSE NUMBERS WHICH HAVE CHANGED

ITEM #	DESCRIPTION	VALUE
90	INSPECTION DATE	06/09/99
10	MINIMUM V.C. OVER DECK (ROADWAY + SHOULDERS)	99 FT. 99 IN.
520	MINIMUM V.C. OVER DECK (EXCLUDES SHOULDERS)	99 FT. 99 IN.
54	MINIMUM VERTICAL UNDERCLEARANCE (EXCLUDES SHOULDERS) Circle One: H R N	00 FT. 00 IN.
36	TRAFFIC SAFETY FEATURES: Br. Rail / Trans. / Appr. Rail / Appr. Rail Ends	1 / 0 / 0 / 0
41	STRC OPEN/CLOSED/POSTED A K P	A
58	DECK	5
59	SUPERSTRUCTURE	6
60	SUBSTRUCTURE	6
61	CHANL/CHANL PROTECTION	7
62	CULVERT AND RETAIN WALL	N
72	APPROACH RDWY ALIGNMENT (USE VALUES OF 3, 6, OR 8)	6

OVERALL CONDITION (Circle One)

GOOD FAIR POOR CRITICAL

SIGNATURE

[redacted]

DATE

COMMENTS

RATINGS FOR CODING ITEMS 58, 59, 60 AND 62

N NOT APPLICABLE

9 EXCELLENT CONDITION

8 VERY GOOD CONDITION - NO PROBLEMS NOTED.

7 GOOD CONDITION - SOME MINOR PROBLEMS.

6 SATISFACTORY CONDITION - MINOR DETERIORATION OF STRUCTURAL ELEMENTS.

5 FAIR CONDITION - ALL PRIMARY STRUCTURAL ELEMENTS ARE SOUND BUT MAY HAVE MINOR SECTION LOSS, CRACKING, SPALLING OR SCOUR.

4 POOR CONDITION - ADVANCED SECTION LOSS, DETERIORATION, SPALLING OR SCOUR.

3 SERIOUS CONDITION - LOSS OF SECTION, DETERIORATION, SPALLING OR SCOUR HAVE SERIOURSLY AFFECTED PRIMARY STRUCTURAL COMPONENTS. LOCAL FAILURES ARE POSSIBLE. FATIGUE CRACKS IN STEEL OR SHEAR CRACKS IN CONCRETE MAY BE PRESENT.

2 CRITICAL CONDITION - ADVANCED DETERIORATION OF PRIMARY STRUCTURAL ELEMENTS. FATIGUE CRACKS IN STEEL OR SHEAR CRACKS IN CONCRETE MAY BE PRESENT OR SCOUR MAY HAVE REMOVED SUBSTRUCTURE SUPPORT. UNLESS CLOSELY MONITORED IT MAY BE NECESSARY TO CLOSE THE BRIDGE UNTIL CORRECTIVE ACTION IS TAKEN.

1 "IMMINENT" FAILURE CONDITION - MAJOR DETERIORATION OR SECTION LOSS PRESENT IN CRITICAL STRUCTURAL COMPONENTS OR OBVIOUS VERTICAL OR HORIZONTAL MOVEMENT AFFECTING STRUCTURAL STABILITY. BRIDGE IS CLOSED TO TRAFFIC BUT CORRECTIVE ACTION MAY PUT BACK IN LIGHT SERVICE.

0 FAILED CONDITION - OUT OF SERVICE AND BEYOND CORRECTIVE ACTION.

Figure 157. Sample Condition Rating page from a field-written final report.

[redacted]

BRIDGE LOCATION NO. Van Buren - -
CO. ROUTE LOG MILE

Page No.
DATE: [redacted]

SUBSTRUCTURE

ABUTMENTS COMMENTS

CAPS	(G)	F	P	C	Lt debris on bridge seat
BREASTWALL	G	F	P	C	N/A
WINGS	(G)	F	P	C	
BACKWALL	(G)	F	P	C	slight scale, water stains
PLUMB	(G)	F	P	C	
FOOTING	G	F	P	C	Not visible
PILES	G	F	P	C	" "
EMBANKMENT	(G)	F	P	C	
BEARING SURFACE	(G)	F	P	C	
SLOPE PAVING	(G)	F	P	C	
RIP RAP	G	F	P	C	N/A

PIERS N/A

CAPS	G	F	P	C	
COLUMNS	G	F	P	C	
PLUMB	G	F	P	C	
FOOTINGS	G	F	P	C	
PILES	G	F	P	C	
BEARING SURFACE	G	F	P	C	

BENTS

CAPS	(G)	F	P	C	wire popouts, rebar spall
COLUMNS	(G)	F	P	C	"
PLUMB	(G)	F	P	C	
FOOTINGS	G	F	P	C	not visible
PILES	G	F	P	C	" "
BEARING SURFACE	(G)	F	P	C	

PILES NEED REPLACEMENT NO [ ] YES [ ]

PILES TO BE REPLACED: PILE BENT PILE BENT PILE BENT PILE BENT PILE BENT

Figure 158. Sample substructure page from a field-written final report.

Bridge No. VAN BUREN RD BRDGE

Bent No. 2 of 2

Date [redacted]

ELEMENT	RATING	COMMENT
CAP	G-F	LITE SCALE, 2 WIRE POPOUTS ON BOTTOM
COLUMNS	G	
PLUMP	G	
FOOTINGS	NV	
BEARING	F	SLITE CORROSION, PAINT SCALE, LITE RUST

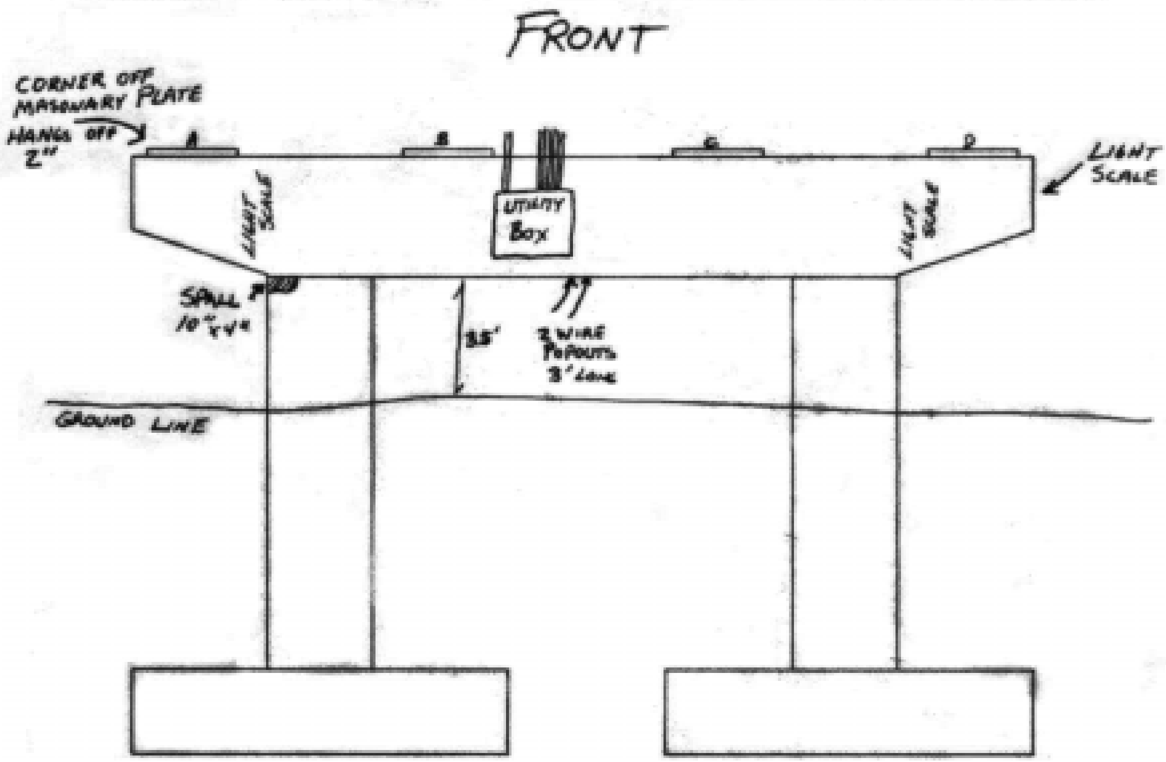
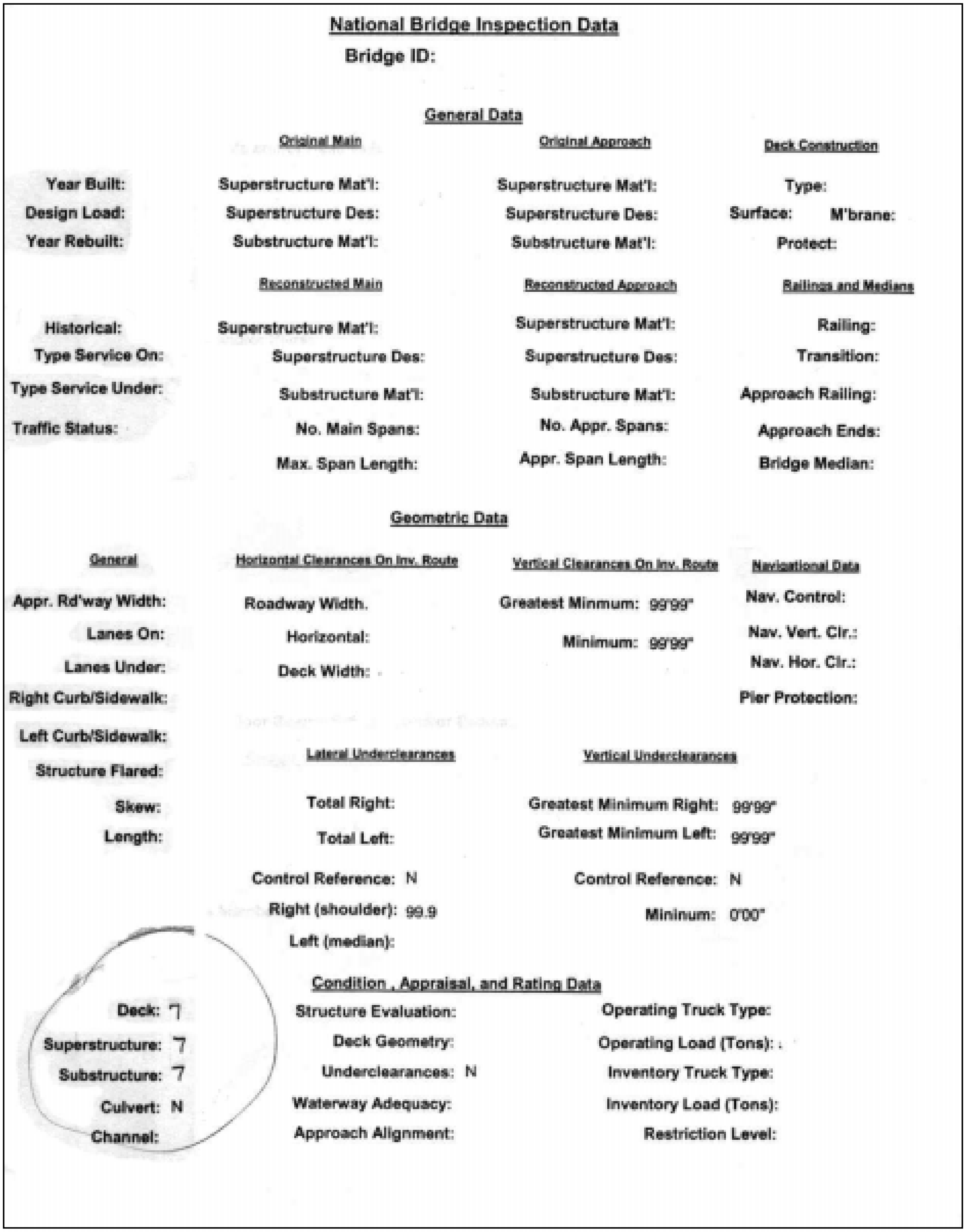


Figure 159. Sample substructure worksheet page from a field-written final report.



National Bridge Inspection Data

Bridge ID:

General Data

	Original Main	Original Approach	Deck Construction
Year Built:	Superstructure Mat'l:	Superstructure Mat'l:	Type:
Design Load:	Superstructure Des:	Superstructure Des:	Surface: M'brane:
Year Rebuilt:	Substructure Mat'l:	Substructure Mat'l:	Protect:
	Reconstructed Main	Reconstructed Approach	Railings and Medians
Historical:	Superstructure Mat'l:	Superstructure Mat'l:	Railing:
Type Service On:	Superstructure Des:	Superstructure Des:	Transition:
Type Service Under:	Substructure Mat'l:	Substructure Mat'l:	Approach Railing:
Traffic Status:	No. Main Spans:	No. Appr. Spans:	Approach Ends:
	Max. Span Length:	Appr. Span Length:	Bridge Median:

Geometric Data

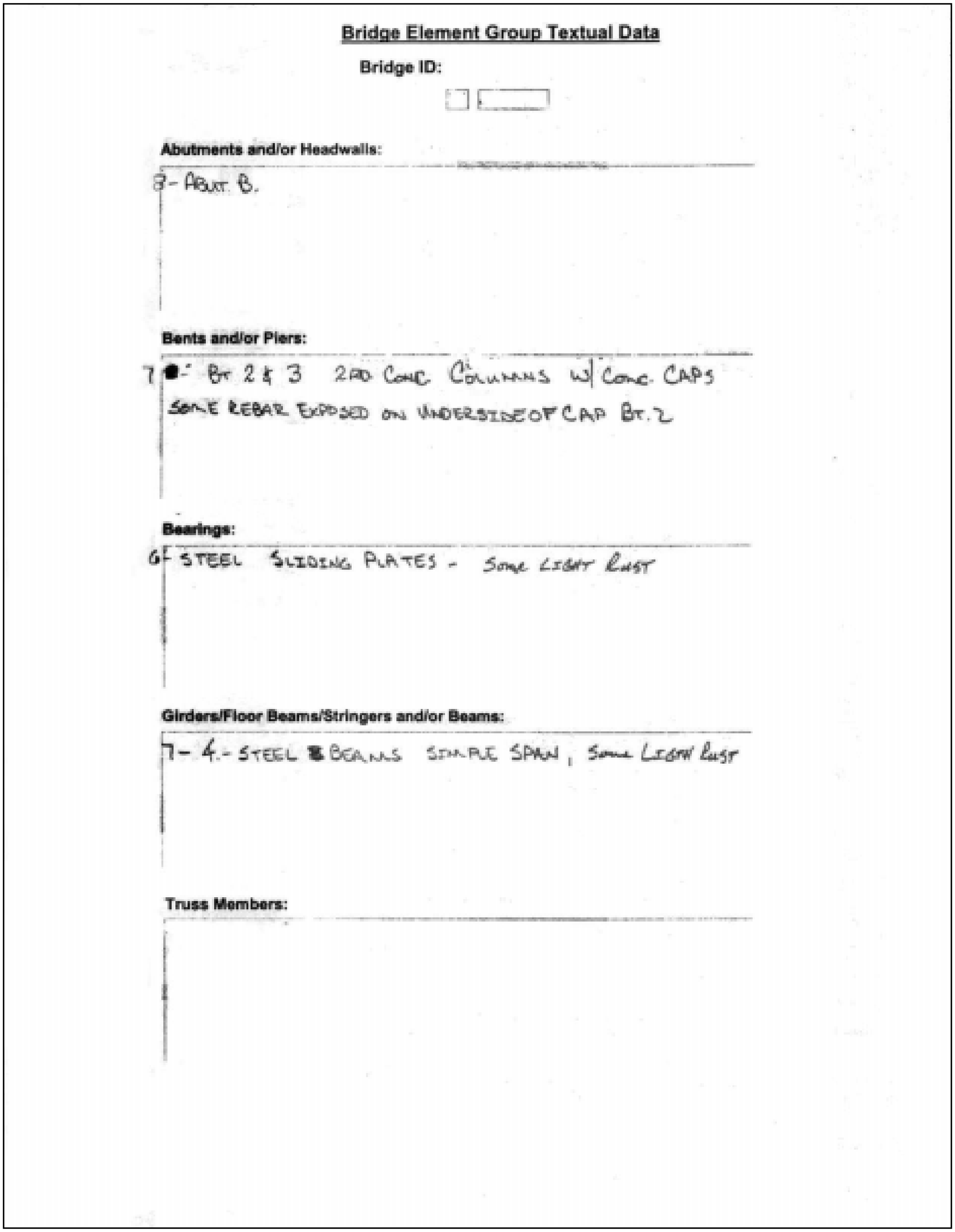
General	Horizontal Clearances On Inv. Route	Vertical Clearances On Inv. Route	Navigational Data
Appr. Rd'way Width:	Roadway Width.	Greatest Minmum: 99'99"	Nav. Control:
Lanes On:	Horizontal:	Minimum: 99'99"	Nav. Vert. Clr.:
Lanes Under:	Deck Width:		Nav. Hor. Clr.:
Right Curb/Sidewalk:			Pier Protection:
Left Curb/Sidewalk:			

	Lateral Underclearances	Vertical Underclearances
Structure Flared:		
Skew:	Total Right:	Greatest Minimum Right: 99'99"
Length:	Total Left:	Greatest Minimum Left: 99'99"
	Control Reference: N	Control Reference: N
	Right (shoulder): 99.9	Mininum: 0'00"
	Left (median):	

Condition , Appraisal, and Rating Data

Deck: 7	Structure Evaluation:	Operating Truck Type:
Superstructure: 7	Deck Geometry:	Operating Load (Tons):
Substructure: 7	Underclearances: N	Inventory Truck Type:
Culvert: N	Waterway Adequacy:	Inventory Load (Tons):
Channel:	Approach Alignment:	Restriction Level:

Figure 160. Sample Condition Rating page from a field-written intermediate report.



Bridge Element Group Textual Data

Bridge ID:

Abutments and/or Headwalls:

3- Abut. B.

Bents and/or Piers:

7 [illegible]- Bt 2 & 3 2 RD Conc. Columns w/ Conc. Caps
Some rebar exposed on underside of cap Bt. 2

Bearings:

6- Steel sliding plates - Some light rust

Girders/Floor Beams/Stringers and/or Beams:

7- 4.- Steel Beams Simple Span, Some light rust

Truss Members:

Figure 161. Sample notes page from a field-written intermediate report.

[redacted]

PAGE 1 OF 3

2-DIST	B.I.N.

STRUCTURES INSPECTION FIELD REPORT

ROUTINE INSPECTION

BR. DEPT. NO.

CITY/TOWN	8-STRUCTURE NO.	11-KILO. POINT	41-STATUS	90-ROUTINE INSP DATE
			OPEN-A	[redacted]

07-FACILITY CARRIED	MEMORIAL NAME/LOCAL NAME	27-YR BUILT	106-YR REBUILT	YR REHAB'D (NON 106)
VAN BUREN RD		1960	0000	

06-FEATURES INTERSECTED	26-FUNCTIONAL CLASS.	DISTRICT BRIDGE INSPECTION ENGINEER
QUANTICO CREEEK		

43-STRUCTURE TYPE	22-OWNER	21-MAINTAINER	TEAM LEADER:
STEEL STRINGER/MULTI-BEAM			[redacted]

107-DECK TYPE	WEATHER	TEMP. (air)	TEAM MEMBERS
CONCRETE CAST-IN-PLACE	SUNNY	24 C	[redacted]

ITEM 58 — DECK: 6

DECK		DEF
1. Wearing surface	N	
2. Deck Condition	6	M/P
3. Stay in place forms	N	
4. Curbs	7	
5. Median	N	
6. Sidewalks	N	
7. Parapets	N	
8. Railing	7	M/P
9. Anti Missile Fence	N	
10. Drainage System	7	
11. Lighting Standards	N	
12. Utilities	N	
13. Deck Joints	6	M/P
14.		
15.		
16.		

CURB REVEAL (in millimeters)	N/E	S/W
	230	230

APPROACHES		DEF
a. Appr. pavement condition	N	
b. Appr. Roadway Settlement	N	
c. Appr. Sidewalk Settlement	N	

OVERHEAD SIGNS (Attached to bridge) (Y/N): N

		DEF
a. Condition of Welds	N	
b. Condition of Bolts	N	
c. Condition of Signs	N	

ITEM 59 — SUPERSTRUCTURE: 7

SUPERSTRUCTURE		DEF
1. Stringers	N	
2. Floorbeams	N	
3. Floor System Bracing	N	
4. Girders or Beams	7	
5. Trusses - General	N	
a. Upper Chords	N	
b. Lower Chords	N	
c. Web Members	N	
d. Lateral Bracings	N	
e. Sway Bracings	N	
f. Portals	N	
g. End Posts	N	
6. Pin & Hangers	N	
7. Conn Pl's, Gussets & Angles	7	
8. Cover Plates	7	
9. Bearing Devices	7	
10. Diaphragms/Cross Frames	7	
11. Rivets & Bolts	7	
12. Welds	7	
13. Member Alignment	8	
14. Paint/ Coating	6	M/P
15.		
Year Painted:	X	

COLLISION DAMAGE: *Please explain*
None (X) Minor ( ) Moderate ( ) Severe ( )

LOAD DEFLECTION: *Please explain*
None ( ) Minor (X) Moderate ( ) Severe ( )

LOAD VIBRATION: *Please explain*
None ( ) Minor (X) Moderate ( ) Severe ( )

Any Fracture Critical Member : (Y/N) N

Any Cracks : (Y/N) N

ITEM 60 — SUBSTRUCTURE: 7

SUBSTRUCTURE	Dive Rpt.	This Rpt.		DEF
1. Abutments			7	
a. Pedestals	N	7		
b. Bridge Seats	N	7		
c. Backwalls	N	7		M/P
d. Breastwalls	N	7		M/P
e. Wingwalls	N	8		
f. Slope Paving/Rip-Rap	N	8		
g. Pointing	N	N		
h. Footings	N	H		
i. Piles	N	N		
j. Scour	N	8		
k. Settlement	N	8		
l.				
m.				
2. Piers or Bents			7	
a. Pedestals	N	7		
b. Caps	N	7		M/P
c. Columns	N	7		M/P
d. Stems/Webs/Pierwalls	N	N		
e. Pointing	N	N		
f. Footing	N	H		
g. Piles	N	N		
h. Scour	N	7		
i. Settlement	N	8		
j.				
k.				
3. Pile Bents			N	
a. Pile Caps	N	N		
b. Piles	N	N		
c. Diagonal Bracing	N	N		
d. Horizontal Bracing	N	N		
e. Fasteners	N	N		

UNDERMINING (Y/N) *If YES please explain* N

COLLISION DAMAGE:
None (X) Minor ( ) Moderate ( ) Severe ( )

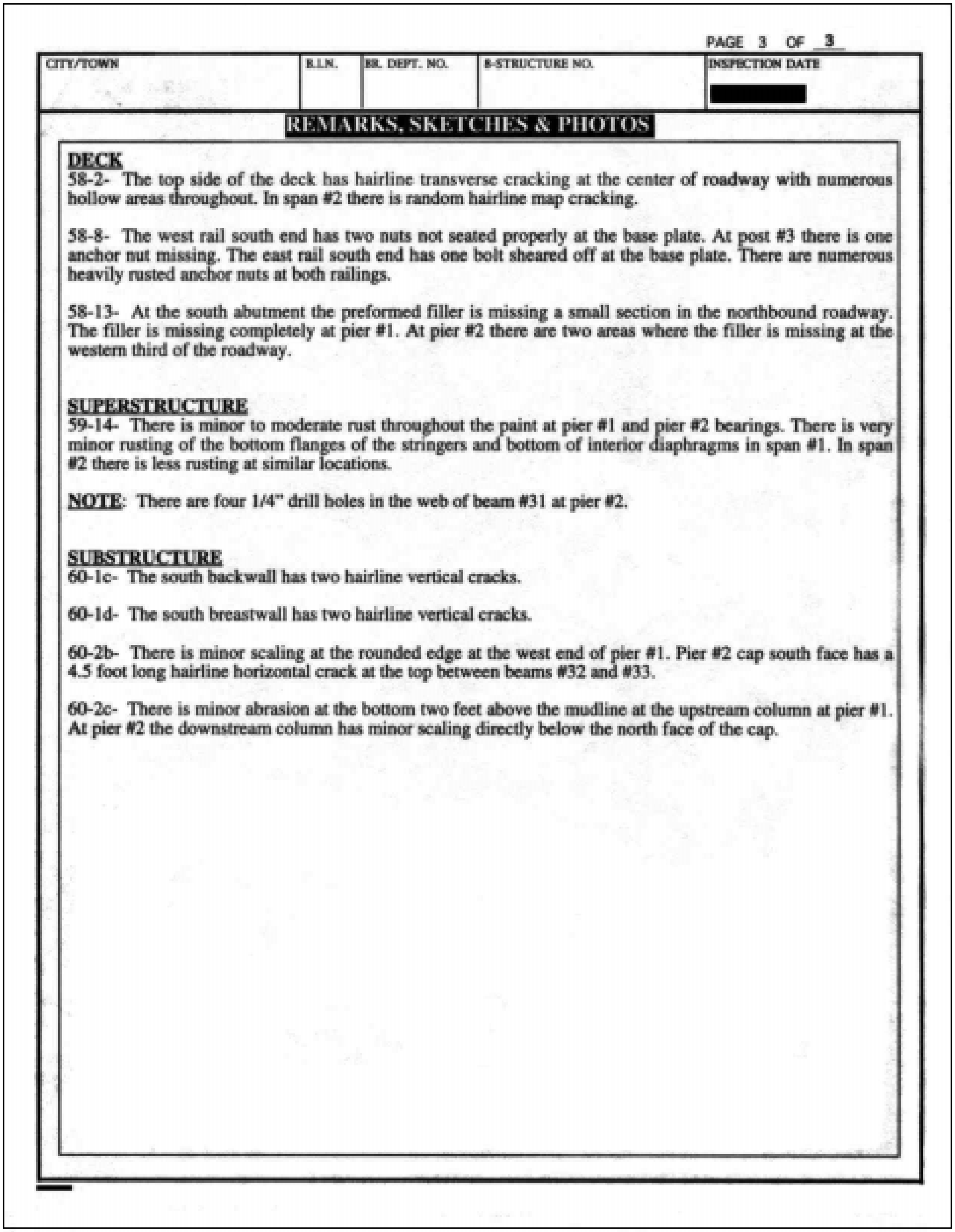
I-60 (Dive Report): N *I-60 (This Report):* 7

93b-U/W (DIVE) INSP DATE: N 00

X=UNKNOWN N=NOT APPLICABLE H=HIDDEN/INACCESSIBLE R=REMOVED

[redacted]

Figure 162. Sample Condition Rating page from a computer-generated final report.



PAGE 3 OF 3

CITY/TOWN	B.I.N.	BR. DEPT. NO.	8-STRUCTURE NO.	INSPECTION DATE
				[redacted]

REMARKS, SKETCHES & PHOTOS

DECK
58-2- The top side of the deck has hairline transverse cracking at the center of roadway with numerous hollow areas throughout. In span #2 there is random hairline map cracking.

58-8- The west rail south end has two nuts not seated properly at the base plate. At post #3 there is one anchor nut missing. The east rail south end has one bolt sheared off at the base plate. There are numerous heavily rusted anchor nuts at both railings.

58-13- At the south abutment the preformed filler is missing a small section in the northbound roadway. The filler is missing completely at pier #1. At pier #2 there are two areas where the filler is missing at the western third of the roadway.

SUPERSTRUCTURE
59-14- There is minor to moderate rust throughout the paint at pier #1 and pier #2 bearings. There is very minor rusting of the bottom flanges of the stringers and bottom of interior diaphragms in span #1. In span #2 there is less rusting at similar locations.

NOTE: There are four 1/4" drill holes in the web of beam #31 at pier #2.

SUBSTRUCTURE
60-1c- The south backwall has two hairline vertical cracks.

60-1d- The south breastwall has two hairline vertical cracks.

60-2b- There is minor scaling at the rounded edge at the west end of pier #1. Pier #2 cap south face has a 4.5 foot long hairline horizontal crack at the top between beams #32 and #33.

60-2c- There is minor abrasion at the bottom two feet above the mudline at the upstream column at pier #1. At pier #2 the downstream column has minor scaling directly below the north face of the cap.

Figure 163. Sample notes page from a computer-generated final report.

excerpts from larger reports, none of which are presented in their entirety. In addition, note that the shortest report fit on 1 page, while the longest was 29 pages. Despite the drastic length differences, the same basic information was contained in most of the reports.

5.4.3.2.3. NBI vs. Element-Level Assessments

There were three different styles used in the reports to describe the condition of the bridge. The first style was an NBI-oriented format. This style presents the Condition Ratings in the NBI line-item style. This style may include element-level assessments, but only as supplementary information. Excerpts from an NBI-oriented format are shown in figures 157 and 163. The second primary style used the Pontis program or another element-level format, as shown in figure 164. This format typically will include the NBIS ratings, but the element-level ratings are incorporated into the report as primary information. The NBIS ratings may, or may not, be calculated from the element-level information. The third inspection style was a pure notation format, where conditions were noted in longhand. An example of the pure notation format is shown in figure 161. Thirteen of the reports have been categorized as NBI-style, nine as element-level style, and three as notation style. Some of the reports share aspects of both categories, especially the computer printouts generated after the inspection. In general, if the element-level assessments were an integral part of the report, it was considered to be element-level style, and if the element-level assessments were included as supplemental worksheets, it was considered to be NBI style. Just over half of the NBI-style reports (7 of the 13 reports) were supplemented with element-level data. Two of the three notation-style formats included other sample information that made it obvious that the notes would normally be entered into bridge inventory software packages.

Nineteen of the reports had a section that dealt with maintenance recommendations, with 18 of these providing some recommendations in that section. None of the remaining five reports contained any comments regarding maintenance recommendations. Figures 165 and 166 illustrate examples of maintenance recommendation sections. Table 222 summarizes the items listed for maintenance actions by the various inspection reports. As shown in table 222, the most common repair recommendation was to clean and seal the joints, followed by cleaning

[redacted] **BRIDGE INSPECTION REPORT** Agency [redacted]

Page 1 of 2
[redacted]

Bridge No.	000/TASK3			Structure Type	SS
Bridge Name	VAN BUREN ROAD	Route		Intersecting	QUANTICO CREEK
Structure ID	000TASK3	MilePost 0		Location	

Inspection Date [redacted]
Inspection Hours 002.0

Inspector's Signature [redacted] Indent# D2000 Co-Inspector's Signature [redacted]

Structural Adqcy (501)	7 Drains (509)	0 Bridge Rails (536)	Y Repair Flag (550)
Deck Geometry (502)	7 Curbs (521)	0 Transition (536)	Card Check Flag (551)
Underclearance (503)	9 Sidewalks (522)	0 Guardrails (536)	Photos Flag (552)
5 Operating Level (504)	7 Paint (524)	0 Terminals (536)	S Seasonal Code (553)
8 Alignment Adqcy (505)	8 Chan/Protection (529)	0 Number Utilities (525)	Y Soundings Flag (554)
8 Waterway Adqcy(506)	1 Pier/Abut/Protect (531)	Revise Rating (540)	Measure Clearance (555)
6 DeckOverall (507)	6 Scour (532)	0 12 Inspection Frequency(539)	Y Monitor Structure (556)
6 Superstructure (513)	6 Aproach/Rdwy (533)		
7 Substructure (526)	9 Retaining Walls (534)		
9 Culvert (530)	9 Pier Protection (535)	L 50 7 8 Deck Scaling(512)	Sufficiency Rating

Elem	Element Description	Total	Units	Env	State1	State2	State3	State4	State5
12	Concrete Deck	3672	SF	3	3672	0	0	0	0
90	Steel Rolled Girder-Painted	724	LF	3	724	0	0	0	0
205	Concrete Col/Pile Extension	4	EA	3	4	0	0	0	0
215	Concrete Abutment	80	LF	3	80	0	0	0	0
220	Conc Submerged Pile Cap/Footing	2	EA	3	2	0	0	0	0
234	Concrete Pier Cap	51	LF	3	51	0	0	0	0
311	Moveable Bearing (Roller,Sliding)	16	EA	3	0	16	0	0	0
313	Fixed Bearing	16	EA	3	0	16	0	0	0
331	Concrete Bridge Railing	368	LF	3	368	0	0	0	0
361	Scour	1	EA	3	1	0	0	0	0
404	Compression Seal / Concrete Header	84	LF	3	37	20	27	0	0

0 Routine Inspection on Test Bridge - Van Buren Road Bridge - Task #3
The orientation is from south to north.

12 CONCRETE DECK:
Worn to aggregate in wheel lines. Scattered transverse cracks. A few pop-outs and mudball voids. Chain dragged the southbound lane - 5%-20% surface delaminated. Light scale throughout. Minor "D" cracks forming at joints.

Longitudinal and transverse hairline cracks in soffit.

90 STEEL PAINTED BEAMS:
There are four lines of steel beams laterally braced at 1/4 points. The intermediate diaphragm supports are welded to the webs of beams, many appear cracked - rusty cracked paint along the vertical welds, could not clean to verify. The beams have bottom cover plates and cracks appear to have started at south ends of beams 1C and 2B and north end of 1D.

205 CONCRETE COLUMNS:
2 concrete columns at each pier. Pier 3 has light water abrasion and numerous popouts at the waterline. Scattered hairline cracks.

215 CONCRETE ABUTMENTS:
No defects observed.

311 MOVABLE BEARINGS:
Movable bearings at the north end of each beam. Some pack rust forming between support plate and bearing, surface rust throughout.

313 FIXED BEARINGS:
Fixed bearings at south end of each beam. Some pack rust forming between support plate and bearing, surface rust throughout.

331 CONCRETE BRIDGE RAILING:
Concrete parapet with type 1R aluminum top. Light scale throughout concrete. Broken anchor bolts and loose nuts in spots on aluminum top.

361 SCOUR:
Soundings taken today. No observed change since as-built.

Figure 164. Sample element-level report format.

ELEMENT	TQ	CS 1	CS 2	CS 3	CS 4	CS 5
001 DISTRICT ACTION REQUESTED	9					

Screamer ○ F.Y.I. ○ District ◉ Inaccessible? ○

1] REMOVE ALL VEGETATION FROM SOUTHERN WINGS & SIDES OF STRUCTURE. 2] CLEAN OUT ALL DRAIN HOLES & INSTALL FIBERGLASS SHIELDS TO DRAIN WATER AWAY FROM STEEL. 3] RESEAL ALL JOINTS A.S.A.P.. PIER 1 OPEN 1 1/4", PIER 2 & S. ABUT. OPEN 3/4". 4] PAINT ID #s ON END BLOCKS, BRIDGE # 6114 IS PAINTED NEAR THE N.E. END. 5] INSTALL GUARDRAILS AT ALL 4 CORNERS & ATTACH THEM TO THE ENDBLOCKS. 6] TIGHTEN OR REPLACE ANY LOOSE & OR MISSING ANCHOR BOLTS FOR HANDRAILS AT THE SOUTH ENDS & GRIND SMOOTH THE 4th VERTICAL POST FROM THE S.E. CORNER WHICH HAS A SMALL CHIP AT THE TOP WITH SHARP EDGES EXPOSED & IS A PEDESTRIAN HAZARD. 7] STRIP THE ROADWAY AS REQUIRED. 8] RESEAL THE TOP OF THE SOUTH SLOPE @ THE BREASTWALL JOINT. 9] REPLACE ALL MISSING REFLECTORS ON PARAPETS.

Figure 165. First example of maintenance recommendation section.

WORK RECOMMENDATIONS

Perfrom an in-depth investigation of the cover plate welds.

Item#	Rec. Date	Work By	Work Id.	Prog. Method	Cost
1	[redacted]	Other	41234X99265X		

Clean joints and replace seals with an approved Type "A" joint seal compound.

Item#	Rec. Date	Work By	Work Id.	Prog. Method	Cost
2	[redacted]	Bridge Crew	41234X99265X	H3013	$3,000

Clean debris from around the bearing area.

Item#	Rec. Date	Work By	Work Id.	Prog. Method	Cost
3	[redacted]	Bridge Crew	41234X99265X	H2152	$1,000

Extract five 4" diameter cores from five random locations on the deck, and send to [redacted] for petrographic analysis. In addition chip back a small portion of unsound concrete and inspect the condition of the reinforcing steel.

Item#	Rec. Date	Work By	Work Id.	Prog. Method	Cost
4	[redacted]	Bridge Crew	41234X99265X	H0122	$4,000

Figure 166. Second example of maintenance recommendation section.

and painting the bearings. Of note from the table, more teams recommended that an overlay program be initiated (three) than indicated that a deck survey be performed (two) or that the delaminations should be repaired (two). Also, note that the third most frequent response (seven teams) was that there were no recommendations at all or that maintenance was not required. In fact, one of these teams indicated that their State does not allow the inspectors to make repair recommendations; those decisions are left to a separate maintenance unit.

Table 222. Task I – Repair recommendations.

Recommendation	Number of Teams
Seal Joints	14
Clean & Paint Bearings	8
Tighten Handrail Connections	6
Cut Vegetation	5
Perform In-Depth Inspection of Welds	5
Clean Drains/Improve Drainage	4
Determine Chloride Content	3
Install Guardrails	3
Install Overlay	3
Repair Delaminations	2
Perform Deck Survey	2
Clean and Paint Beams	2
Miscellaneous Concrete Repair	2
Monitor Welds	2
Install Reflectors/Other Signage	2
Determine Core Strength	1
Clean Debris Off Substructure	1
Monitor Erosion	1
Seal Concrete Cracks	1
No Recommendations or Maintenance Not Required	7

5.4.3.2.4. Photographic Documentation

Twelve teams used pictures to provide photographic documentation of their findings, and of the 12, 8 provided a log of photographs taken. Another two teams provided a log of photographs that they would have taken had they had a camera with them. Therefore, a total of 14 teams provided photographic documentation of their inspection. Twelve basic categories were used to describe the photographs. Credit was only given on a category basis; multiple pictures within a particular category were only counted once (e.g., if there were both east and west elevation photographs, the elevation category was credited once, not twice). Table 223 summarizes the frequency of pictures taken by the various teams. Figures 167 through 178 illustrate examples of these categories. The three "overall" pictures listed in table 223 were taken the most frequently, while close-up photographic documentation of each of the specific elements listed in table 223 was provided by half or fewer of the inspection teams.

Table 223. Task I – Photographic documentation.

Photograph Category	Frequency
Overall Approach	79%
Overall Elevation	64%
Overall Below-Deck Superstructure and Substructure	50%
Girder	50%
Joint	50%
Railing	43%
Bearing	36%
Curb	29%
Pier Cap	21%
Abutment	14%
Deck	14%
Stream Profile	14%

5.4.3.2.5. Equipment Use

Some other important information was also tracked in the various reports. Team usage of access equipment to perform this task has been documented elsewhere. Seven of the reports also included information about the access equipment required to perform this inspection or future inspections.

5.4.3.3. CONDITION RATINGS COMPARISONS

Twenty-four of the 25 teams provided Condition Ratings of the primary elements of this bridge. Table 224 provides a summary of the statistical information associated with these ratings, while figure 179 shows the actual frequency distribution of the Condition Ratings. Table 224 also provides the NDEVC reference rating for each of the primary elements.

As shown in table 224, the average deck rating is 5.8, compared to a reference value of 7. The superstructure average rating is 6.8, compared to a reference of 7; and the substructure average rating is 6.7, compared to a reference of 8. Results of detailed delamination surveys are typically not available when generating deck Condition Ratings, especially when there are no

Figure 167. Overall approach example photograph.

Figure 168. Overall elevation example photograph.

Figure 169. Overall below-deck superstructure and substructure example photograph.

Figure 170. Girder close-up example photograph.

Figure 171. Joint close-up example photograph.

Figure 172. Railing close-up example photograph.

Figure 173. Bearing close-up example photograph.

Figure 174. Curb close-up example photograph.

Figure 175. Pier cap close-up example photograph.

Figure 176. Abutment close-up example photograph.

Figure 177. Deck close-up example photograph.

Figure 178. Stream profile example photograph.

visible indications of delaminations. Therefore, a detailed delamination survey performed by the NDEVC was not considered when assigning the deck reference Condition Rating.

A series of t-tests were performed to determine whether the sample averages were different from the reference values at a 10 percent significance level. Only the average of the superstructure ratings passed this test, being statistically not different from the reference.

Table 224. NBIS Condition Ratings for Task I.

Condition Rating	Primary Element		
	Deck	Superstructure	Substructure
Reference	7	7	8
Average	5.8	6.8	6.7
Standard Deviation	0.92	0.64	0.62
COV	0.16	0.09	0.09
Minimum	4	6	6
Maximum	7	9	8
Mode	5	7	7
N	24	24	24

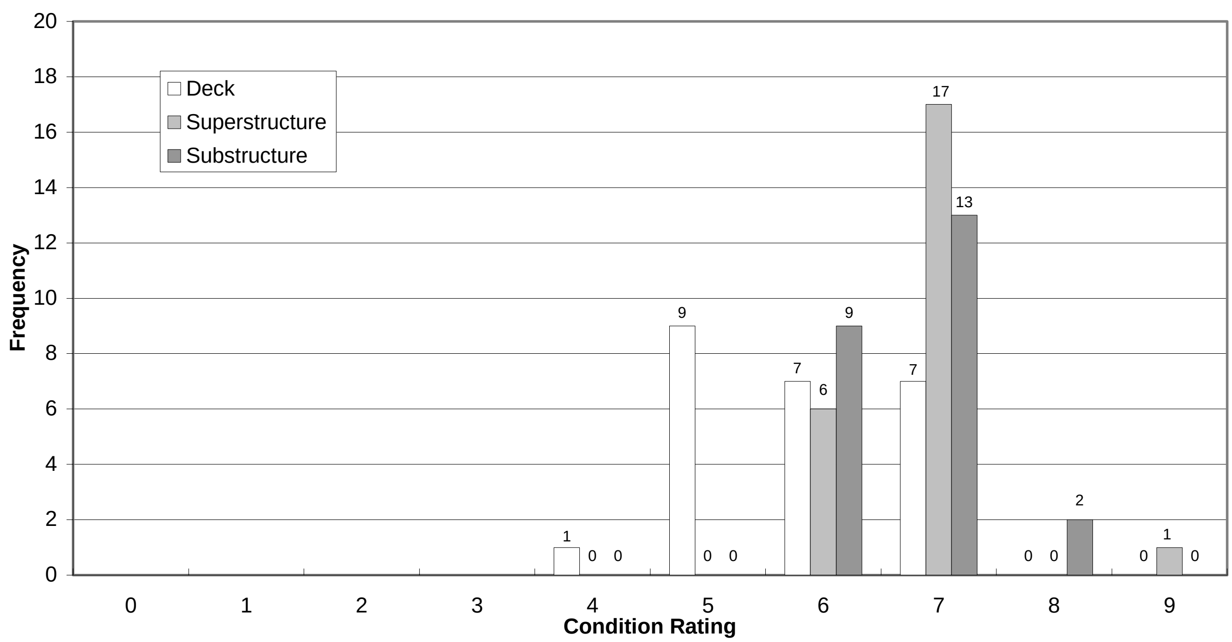


Figure 179. Condition Rating frequency distribution.

5.4.3.3.1. Distribution of Experimental Population

Table 225 summarizes the distribution of the Condition Ratings about the reference, mode, and average values. As shown in table 225, although 96 percent of the inspectors were within one rating point of the reference for the superstructure, fewer than two-thirds of the inspectors were within one rating point of the reference for the deck and substructure. Note that the distribution comparison for the average value only includes two rating values (i.e., with an average of 5.8, the deck average comparisons include ratings between 4.8 and 6.8; therefore, only ratings of 5 and 6 are included). Also shown in the table, 71 of the 72 element ratings fell within two points of the reference value. The one rating outside of this interval was three points from the reference value. Similarly, 71 of the 72 element ratings were within two points of the sample averages; again, the one outlier fell within three points of its sample average. All of the element ratings fell within two points of the sample modes.

Table 225. Distribution of sample Condition Ratings.

Element	Reference	Average	Mode	Percentage of Sample Within					
				± 1	± 2	± 1	± 2	± 1	± 2
				of					
				Reference		Average		Mode	
Deck	7	5.8	5	58	96	67	100	71	100
Superstructure	7	6.8	7	96	100	96	96	96	100
Substructure	8	6.7	7	63	100	92	100	100	100

Since the State-dependent tasks only produced one set of Condition Ratings, reporting DFR by element is irrelevant. However, the deck, superstructure, and substructure ratings can be combined using the DFR concept described in the Routine Inspection section. The overall average DFR is -0.88 (standard deviation of 0.89), with a minimum of -3 and a maximum of 2. When using this concept to describe the data, the distribution is as shown in table 219. Note that the distribution is bimodal. If the mode is considered to be -1, 97 percent of the ratings are within one rating point. If the mode is considered to be 0, 72 percent of the ratings are within one rating point. Seventy of the 72 ratings (97 percent) are within one point of either mode value.

Table 226. Distribution of sample DFRs.

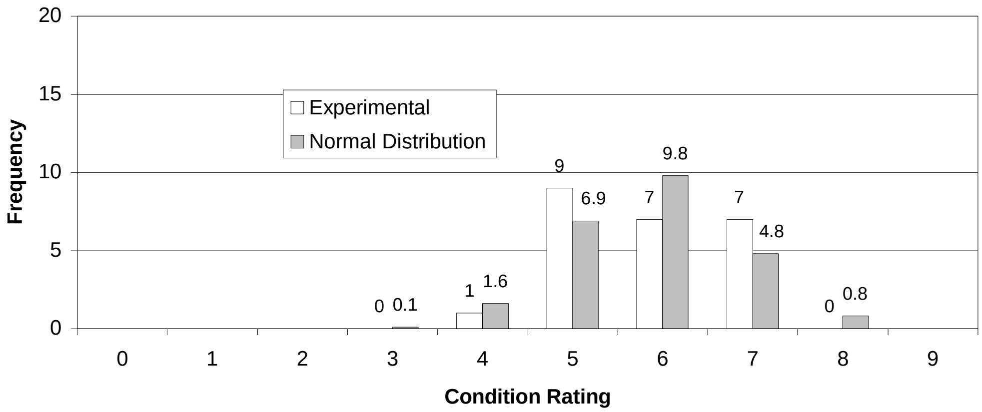
Element	Average DFR	Mode DFR	Percentage of Sample Within ±1 of Zero DFR	±2 of Zero DFR	±1 of Average DFR	±2 of Average DFR	±1 of Mode DFR	±2 of Mode DFR
All Elements	-0.89	-1, 0	72	99	72	97	97, 72*	99

* Distribution is bimodal. If -1 is considered the mode, 97 percent are within one rating point. If 0 is considered the mode, 72 percent is within one rating point.

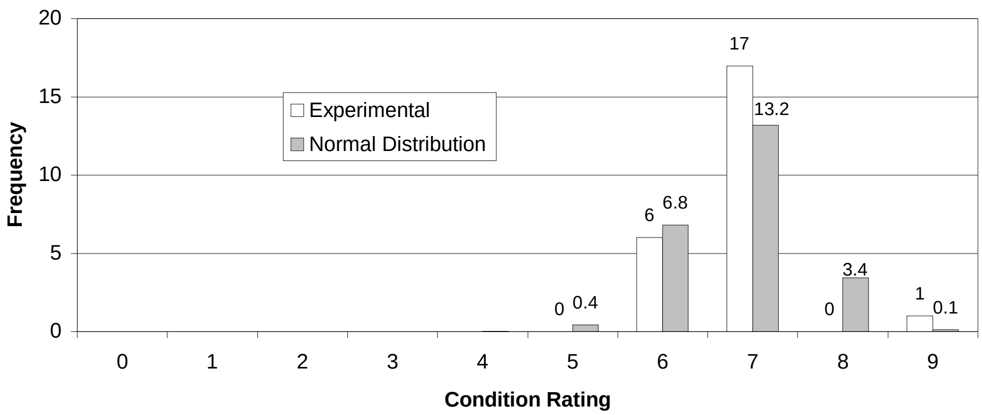
5.4.3.3.2. Analytical Modeling

Comparing the ratings against the normal distribution allows a determination of whether the sample followed a normal distribution. Figure 180 shows the frequency histograms for the deck, superstructure, and substructure for Task I. Also shown in figure 180 is the normal distribution based on the average, size, and standard deviation of the sample. The appropriateness of the distribution was then verified by applying the χ^2 test for goodness-of-fit. At the 5 percent significance level, the goodness-of-fit test was satisfied by the Condition Rating distributions for the deck and the substructure. The test was not satisfied for the superstructure.

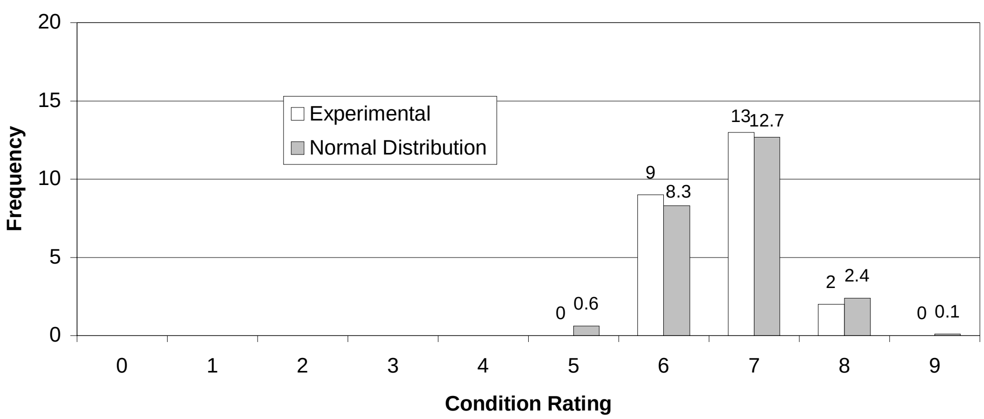
To examine the overall distribution of the State-dependent Condition Ratings, the DFR histogram is presented as figure 181. This figure combines the DFR distributions for the deck, superstructure, and substructure. Again, the expected normal distribution for the overall average DFR is also presented. When the χ^2 test for goodness-of-fit is applied, it passes the test at the 5 percent significance level and can be considered normally distributed. Assuming the normal distribution, it would be predicted for Task I that 68 percent of the population of bridge inspectors would produce Condition Ratings with an overall DFR between -1.8 and 0. Similarly, 95 percent of the population would have an overall DFR between -2.6 and 0.9, and 99 percent of the population would have an overall DFR between -3.2 and 1.4.



a. Deck



b. Superstructure



c. Substructure

Figure 180. Task I experimental and theoretical Condition Rating distribution.

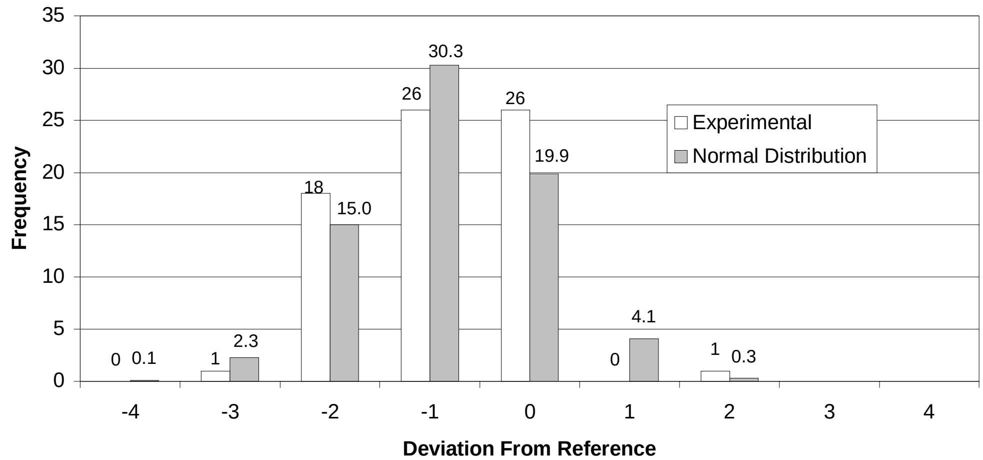


Figure 181. Experimental and theoretical DFR distribution – All element types.

5.4.3.3.3. Variability of Condition Ratings by State and Region

Similar to the comparisons performed in the Routine Inspection section, it was desirable to see whether there were any differences in the way each State rated bridges. A qualitative analysis of the Condition Ratings assigned by the 24 teams that performed Task I indicated that there was no consistent, overall trend. It was found that of the 24 ratings provided, 10 teams were higher than the sample averages for all 3 primary elements. Conversely, only three teams were lower than the sample averages for all three primary elements. The team from State 3, which had a statistical difference between their Routine Inspection ratings (Tasks A, B, C, D, E, and G) and those from the other teams, was found in Task I to have the highest overall ratings. This team was the only team to provide primary element ratings more than two points higher than average, and they also had another primary element rating more than one point higher than average.

Of the 10 teams that provided ratings higher than average for all 3 primary elements, 5 were found to be from northern States. Additional analyses were performed that compared the ratings assigned by teams from a region with teams from other regions. The regional definitions were based on the 10 FHWA regions. It was found that there was a statistical difference in the higher superstructure and substructure ratings assigned from the northern region previously mentioned. In addition, a statistical difference was noticed in the lower deck ratings assigned by an eastern region. None of the other regions had statistical differences between their ratings and those assigned by the other teams. Regional weather conditions may not be the only reason for these differences. Among the many other possible reasons for these differences, some might include the material types frequently used, administrative policies, and interactions between neighboring States.

5.4.3.3.4. Assembled Team vs. Existing Team Condition Ratings

A comparison was made between the Condition Ratings assigned by the assembled teams and those assigned by the existing teams. Table 227 summarizes some of the basic statistical information for these two groups. As shown in table 227, there is very little difference between the average Condition Ratings of the assembled teams and those of the existing teams. At a 5 percent significance level, the t-test indicates that there is no statistical difference between these two groups.

Table 227. Condition Rating comparisons between assembled teams and existing teams.

	Assembled Team			Existing Team		
	Deck	Superstructure	Substructure	Deck	Superstructure	Substructure
Reference	7	7	8	7	7	8
Mean	5.9	6.7	6.8	5.9	7.0	6.7
Mode	6	7	7	5	7	7
Standard	0.79	0.49	0.62	0.94	0.77	0.65
Minimum	5	6	6	5	6	6
Maximum	7	7	8	7	9	8
N	12	12	12	11	11	11

5.4.3.3.5. Division of Labor

The Division of Labor category was examined to see if there was a difference among the Condition Ratings assigned by the groups. Specifically, comparisons were made between each of the groups (Worked Together, Inspector and Note-Taker, Independent Inspectors, and Unclassified) and the combination of the other teams that were not members of that particular group. One team that was classified into a Division of Labor category did not submit ratings, and this team has been omitted from this analysis. Table 228 summarizes the results from the

Table 228. Division of Labor.

Group	Element	Average	Standard Deviation	Pass t-Test at 5% Significance?
Overall	Deck	5.8	0.92	—
	Superstructure	6.8	0.64	—
	Substructure	6.7	0.62	—
Worked Together	Deck	6.1	0.90	No
	Superstructure	6.9	0.38	No
	Substructure	6.9	0.69	No
Inspector and Note-Taker	Deck	5.8	0.96	No
	Superstructure	6.5	0.58	No
	Substructure	6.3	0.50	No
Independent Inspectors	Deck	5.8	0.79	No
	Superstructure	6.9	0.88	No
	Substructure	6.8	0.63	No
Unclassified	Deck	5.3	1.53	No
	Superstructure	7.0	0.00	No
	Substructure	6.7	0.58	No

different groups. None of the groups passed the t-test, indicating that there was no statistical difference among the Condition Ratings assigned by the groups.

5.4.3.3.6. Relationship

Similar to the Division of Labor category, the Relationship category was also used to combine similar teams into groups. This analysis determined whether there was a statistical difference between the ratings assigned by one team and those assigned by the other teams. Results from these analyses are presented in table 229. Only one group had a statistical difference for the ratings assigned to one of the elements. This group was the Leader/Helper group assigning ratings for the superstructure. None of the other groups or elements passed the t-test.

5.4.3.3.7. Level of Preparation

The Level of Preparation category was also used to determine whether the different levels of preparation affected the Condition Ratings assigned. Two different analyses were performed: one based on the preparation apparent from the materials submitted, and a second based on the

Table 229. Relationship.

Group	Element	Average	Standard Deviation	Pass t-Test at 5% Significance?
Overall	Deck	5.8	0.92	—
	Superstructure	6.8	0.64	—
	Substructure	6.7	0.62	—
Equals	Deck	5.8	0.75	No
	Superstructure	6.7	0.47	No
	Substructure	6.7	0.65	No
Leader / Inspector	Deck	5.3	0.95	No
	Superstructure	6.7	0.49	No
	Substructure	6.4	0.53	No
Leader / Helper	Deck	6.3	0.96	No
	Superstructure	7.5	1.00	Yes
	Substructure	7.3	0.50	No
Unclassified	Deck	7.0	0.00	No
	Superstructure	6.5	0.71	No
	Substructure	6.5	0.71	No

reported amount of time spent preparing for this inspection. The classification categories are: Preparation Before Arrival, No Preparation Apparent, Indeterminate Preparation, and Less Than 2 H Preparation. Note that Preparation Before Arrival, No Preparation Apparent, and Indeterminate Preparation are mutually exclusive categories. This analysis determined whether there was a statistical difference between the ratings assigned by one group and the balance of the other groups. The results from the analysis based on the materials submitted are presented in table 230, while results based on the Reported Preparation Time are presented in table 231. Only two groups, Indeterminate Preparation and Less Than 2 H Preparation, had a statistical difference for any of the ratings assigned. Both groups had average Condition Ratings that were lower than the corresponding balance of other groups for deck elements.

5.4.3.3.8. Report Presentation

The Inspection Report Presentation category was also used to determine whether there was a correlation between the different report formats used and the Condition Ratings assigned. The

Table 230. Level of Preparation (based on reports submitted).

Group	Element	Average	Standard Deviation	Pass t-Test at 5% Significance?
Overall	Deck	5.8	0.92	—
	Superstructure	6.8	0.64	—
	Substructure	6.7	0.62	—
Preparation Before Arrival	Deck	5.8	0.75	No
	Superstructure	6.7	0.52	No
	Substructure	6.8	0.41	No
No Preparation Apparent	Deck	6.2	0.94	No
	Superstructure	7.0	0.74	No
	Substructure	6.8	0.72	No
Indeterminate Preparation	Deck	5.2	0.75	Yes
	Superstructure	6.7	0.52	No
	Substructure	6.3	0.52	No

Table 231. Level of Preparation (based on reported preparation time).

Group	Element	Average	Standard Deviation	Pass t-Test at 5% Significance?
Overall	Deck	5.8	0.92	—
	Superstructure	6.8	0.64	—
	Substructure	6.7	0.62	—
Less Than 2 H Preparation	Deck	5.4	1.00	Yes
	Superstructure	7.0	0.74	No
	Substructure	6.6	0.52	No

classification categories were: Final Report (Computer-Generated), Final Report (Field-Written), and Intermediate Report (Field-Written). This analysis determined whether there was a statistical difference between the ratings assigned by one group and the balance of the other groups. Results from these analyses are presented in table 232. None of the groups had a statistical difference for the ratings assigned for any of the elements.

5.4.3.4. ELEMENT-LEVEL COMPARISONS

The element-level inspection is the other primary inspection style. Several teams submitted inspection information in this format. The element-level inspections rely upon specific definitions of elements to classify the bridge structure and describe any deterioration observed.

Table 232. Report Categories.

Group	Element	Average	Standard Deviation	Pass t-Test at 5% Significance?
Overall	Deck	5.8	0.92	—
	Superstructure	6.8	0.64	—
	Substructure	6.7	0.62	—
				—
Final Report (Computer-Generated)	Deck	5.5	0.93	No
	Superstructure	6.7	0.47	No
	Substructure	6.5	0.69	No
Final Report (Field-Written)	Deck	6.0	1.0	No
	Superstructure	7.0	0.87	No
	Substructure	6.9	0.60	No
Intermediate Report (Field-Written)	Deck	6.3	0.50	No
	Superstructure	6.8	0.50	No
	Substructure	6.8	0.50	No

One of the most common element-level inspection systems uses the Pontis bridge management system, but other systems also exist. As indicated above, 16 teams submitted element-level inspection data. Two of those teams used element nomenclature inconsistent with the Commonly Recognized (CoRe) elements, as defined in the *AASHTO Guide for Commonly Recognized (CoRe) Structural Elements*.[5] These CoRe elements are commonly used by the Pontis program and elsewhere. Therefore, only 14 of the element-level inspection data sets contained information that was comparable. A wide variety of observations can be made from the element-level data. Conclusions can be drawn regarding inspector familiarity with the system from the selection of the various element categories used to describe the structure.

Comparisons can also be made regarding the quantities and units used by the various States. Finally, comparisons can be made using the Condition States of the CoRe elements.

5.4.3.4.1. Element Use

The CoRe elements are defined in the CoRe element guide mentioned above. In general, they share three traits: (1) the elements are generally primary structural members of the same material type, (2) the elements represent members that can deteriorate in a similar manner and have specific Condition State descriptions to represent the various deterioration levels, and (3) the elements can be inventoried in a quantifiable manner.[5] CoRe elements are defined for most types of *primary superstructure elements* (girders, trusses, arches, etc.), *primary substructure elements* (abutments, columns, caps, piles, etc.), *primary deck elements* (concrete, timber, open steel, etc.), and *other primary elements* (bearings, joints, and railings).

CoRe elements can be divided into sub-elements to further track cost or performance. Sub-elements should use the same units as the parent element, and parent element data should still be obtainable from sub-element data. Replacing element no. 107, "Open Steel Girder, Painted" with two sub-elements— no. 172, "Open Steel Girder, Painted, Exterior" and no. 173, "Open Steel Girder, Painted, Interior"— is an example of the use of sub-elements. Individual sub-elements are State-defined; they are not defined in reference 5. The sub-elements may not have uniform element number assignments; therefore, a sub-element such as "Open Steel Girder, Painted, Exterior" will probably have two different numbers if used by two different States.

Further flexibility in the system can be added by using Smart Flags. Smart Flags allow the tracking of local deterioration not included within the Condition State language for that element. Examples of Smart Flags include Pack Rust, Fatigue Cracking, and Deck Cracking.

The balance of items tracked are the Non-CoRe elements. These Non-CoRe items track other members that may not be primary members, or may not be easily described in Condition State language. Examples of Non-CoRe elements are wingwalls and slope protection devices. Within this study, use of the CoRe elements on the major elements was fairly consistent, while use on elements such as joints and rails was not. Teams were provided with bridge plans in advance and were asked to prepare for this inspection as they normally would. It was expected that this would include element selection and quantity take-offs for the teams performing element-level inspections (if it would not normally be done in the field). Table 233 summarizes the use of the CoRe elements. Fourteen reports with element data followed this format.

Table 233. Use of CoRe Elements.

Element Number	Description	Usage Frequency
12	Concrete Deck – Bare	13
18	Concrete Deck – Protected w/Thin Overlay	1
107	Open Girder, Steel Painted	11
201	Column or Pile Extension – Steel Unpainted	1
205	Column or Pile Extension – Reinforced Concrete	14
215	Abutment – Reinforced Concrete	14
234	Pier Cap – Reinforced Concrete	14
301	Pourable Joint Seal	5
302	Compression Joint Seal	4
304	Open Expansion Joints	1
311	Moveable Bearing (Roller, Sliding, etc.)	13
313	Fixed Bearing	12
330	Bridge Railing – Metal, Coated	3
331	Bridge Railing – Reinforced Concrete	7
333	Bridge Railing – Other	3
334	Bridge Railing – Metal, Uncoated	3

The major deck, superstructure, and substructure elements were used consistently. As shown in table 233, all but one team used element no. 12 to describe the deck. The one team that did not choose this element inspected in the rain, and apparently thought that there was an overlay on the deck. Three teams did not use element no. 107 for the steel girders, although, in fairness, these three teams used sub-elements to track the girders either as rolled, or as exterior/interior. Major substructure elements were also uniformly recorded. One difference with these major substructure elements is that one team made notes about the steel piles, which are indicated on the plans, but are not visible. The bearings were also uniformly recorded, although one team did not comment on the moveable bearings, and two teams did not comment on the fixed bearings.

The other primary elements were recorded much less consistently. As noted above, there was the most confusion with the use of CoRe elements for the joints. Five teams thought that the joints were pourable seals, four thought that they were compression seals, and another team thought that they were open joints. This confusion is thought to have three primary causes. First, the as-built plans indicate that 25-mm preformed seals were to be installed at the time of construction. Second, significant portions of the joints are currently missing. Third, the portions that remain have significant debris on top of the joint, obscuring the view of the joint material. Since the inspectors were not allowed to disturb the debris above the joint, there was no way to visually determine joint composition. All of these items indicate that the joint confusion is not necessarily a misapplication of the CoRe elements on the part of the inspectors.

Confusion also existed with the use of the bridge railing elements. As shown in table 233, three teams used element no. 330, “Bridge Railing – Metal, Coated”; seven teams used element no. 331, “Bridge Railing, Reinforced Concrete”; three teams used element no. 333, “Bridge Railing – Other”; and three teams used element no. 334, “Bridge Railing – Metal, Uncoated.” Note that the total number of elements used exceeds the number of teams producing element-level inspection results consistent with CoRe element use. Several teams used both the reinforced concrete railing element and the uncoated metal railing element to describe the complete railing. As shown in figure 182, the rail is a combination rail, with a reinforced concrete lower section and a metal handrail above. The CoRe element guide indicates that combination rails should be recorded as no. 333, Bridge Railing – Other; if made of multiple materials, the rail is not to be split between the various types.[5] No procedural requirements with the experiment can be linked to the confusion on the appropriate railing type.

The most variation occurred with the non-CoRe elements. Five teams used five different elements to track wingwall information. Another four teams used five different elements to track slope protection.

5.4.3.4.2. Quantities and Units

The CoRe element guide also defines units of measurement associated with each element, using metric units where possible.[5] In the study, most of the reported units used matched the reference definitions. However, there were a few notable exceptions. Some of these exceptions may be due to changes in element use by the individual States. Three of the

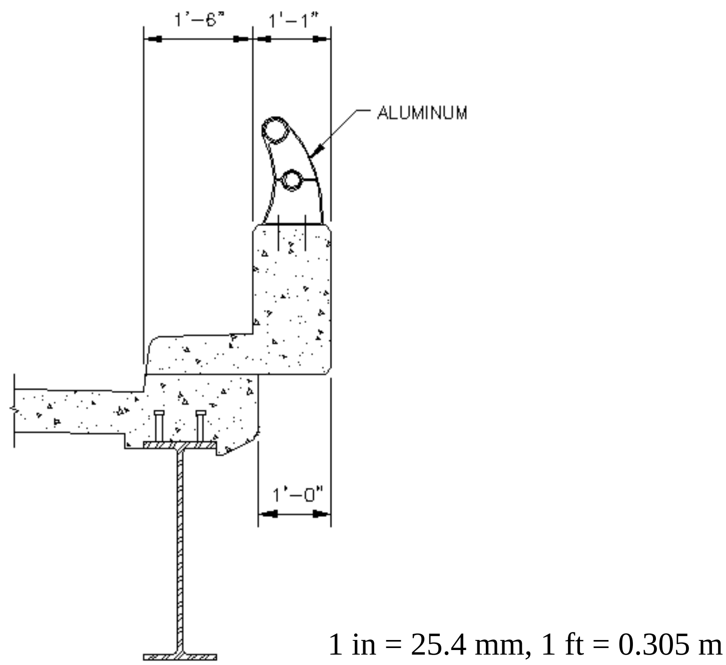


Figure 182. Combination rail section.

teams used metric units; the other 11 used English units. Another unit change occurred with a particular team; this team used area units to describe the girder, column, and abutment elements (instead of the typical linear feet [LF], each [EA], and LF, respectively). Teams also had many inconsistencies in the unit usage of element no. 12, “Concrete Deck – Bare.” Of the 13 teams that used this element, only 4 used the reference unit EA, while the other 9 teams used area units (either square feet [SF] or square meters [SM]). Again, this may be due to changes in the element-level system by the States. Other inconsistencies with the use of the deck element units are presented with Task J. Since non-CoRe elements are State-defined, it was expected that most teams would use different units. This situation was found to be true.

Also observed in the element-level ratings was the improper use of quantities. No restrictions on the scope of the inspection were presented in the Advance Information package sent to the inspection teams. Therefore, the inspection teams that performed a quantity take-off prior to arrival at the test bridge would have prepared quantities based on the complete bridge. However, the inspectors were told upon arrival at the bridge site that the scope of the inspection task would be limited to the southern two spans. Six of the 14 teams submitted reports that used quantities for a three-span bridge. Two possibilities exist to explain this behavior. Either those teams inspected all three spans, and therefore based their quantities on the full bridge (only one team was documented as such), or their quantities were never adjusted to the two-span amounts. An additional three teams submitted inconsistent quantities (for example, a two-span deck quantity with only one span of girder information). Only 5 of the 14 teams (36 percent) submitted quantities consistent with the inspection of the two southern spans.

5.4.3.4.3. Element-Level Ratings Comparisons

It was desirable to compare the ratings assigned by the various teams submitting element-level inspection data. The CoRe elements were selected for these comparisons, since they have common definitions for the different Condition States. Elements that are included in these comparisons are the concrete deck, steel girders, concrete columns, concrete abutments, concrete pier caps, moveable bearings, and fixed bearings. There was significant variability in the use of the joint and railing elements, so comparisons were not made with these elements. To normalize the ratings and allow for comparison, it was necessary to convert each of the quantities in the Condition States to percentages. These percentages were based on each report's stated quantity for that particular element. Table 234 summarizes the distribution of ratings assigned to each Condition State (CS). Note that "N/A" has been used to indicate that a particular element has no defined Condition States at that level. Some slight variability did exist with the CoRe elements considered. However, since these variations are minor, this variability has been overlooked. As an example, 13 of the 14 reports used deck element no. 12, "Concrete Deck – Bare," and the other report used no. 18, "Concrete Deck – Protected With Thin Overlay." In comparing the concrete deck elements, element no. 18 information was combined with element no. 12 information. The distributions reported in table 234 may be slightly misleading because many of the elements do not allow quantities to be split among different Condition States.

Table 234. Distribution of ratings for element-level inspections.

Element	CS1	CS2	CS3	CS4	CS5
Deck	20%	15%	43%	21%	0%
Steel Girders	63%	36%	1%	0%	0%
Concrete Columns	86%	14%	0%	0%	N/A
Concrete Abutments	99%	1%	0%	0%	N/A
Concrete Pier Caps	90%	6%	4%	0%	N/A
Moveable Bearings	48%	52%	0%	N/A	N/A
Fixed Bearings	57%	38%	4%	N/A	N/A

5.4.4. Task J

In Task J, the inspectors were asked to perform a deck survey of the two southernmost deck spans of the Van Buren Road Bridge. Since it was understood that only the tools in their tool bags could be used, a complete deck survey, including chloride analysis, was not possible. A delamination survey was asked of the inspectors, and that is what all inspectors understood that they were to perform. It was desirable to determine how many teams perform a delamination survey as part of their normal Routine Inspections. Other objectives included an investigation of the procedures and reporting variations of a delamination survey, and an assessment of the accuracy of that inspection. This deck shows very few visible signs of deterioration; however, it contains a significant amount of delaminated concrete. A sounding survey may be the primary technique used to detect this type of deterioration. A previous delamination survey performed by the NDEVC on the entire deck indicated that it is approximately 15 to 20 percent delaminated. This first preliminary inspection was performed approximately 1 year prior to the study and primarily concentrated on estimating the quantity of the repair area as if it were to be repaired. A more detailed survey was performed after the field tasks, primarily oriented toward determining detailed outlines of the delaminations. Given that the underside of the deck is in very good condition and that all of the inspection teams performed their sounding surveys from the top of the deck, the NDEVC also chose to perform this sounding survey from the top of the deck. Approximately 2 man-days were spent creating this detailed survey. The two surveys correlated fairly well, considering their different objectives. Both of these inspections included the north span, which has smaller-sized delaminations than the other two spans, and, therefore, lowers the overall delamination percentage. When the north span is excluded (to match the scope of the Task J inspection), the delamination percentage found by the detailed survey is approximately 19 percent. A map of the delaminations identified by the NDEVC in the southern two spans is presented in figure 183.

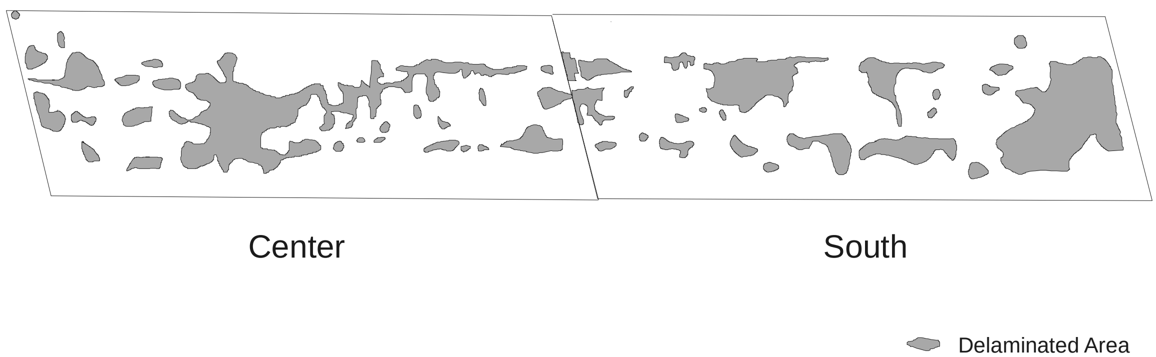


Figure 183. Delaminations detected at the Van Buren Road Bridge by the NDEVC.

A coring program was developed to confirm the delamination calls made in the detailed NDEVC survey. Ten cores were taken from the three spans, eight of which were in the two spans covered within the scope of the Task J inspection. Of the 10 core locations, 5 were located within areas that were indicated by the NDEVC as being delaminated. The results of the coring verified that the delamination calls from the detailed NDEVC survey were correct at all 10 locations.

Two limitations of the task probably had an impact on the results obtained by the inspectors. First, inspectors were not allowed to make any marks on the bridge while performing the task. Several inspectors commented to the observers during this task that they would normally have marked the outlines of the delaminations they had found directly on the concrete. These inspectors were then forced to communicate the shape of the delaminations through other means, and they felt that the limitation of not marking on the deck may have affected their results. A second limitation was discovered during the analysis of the data. The data sheets prepared for this task by the NDEVC were on unlined paper and contained a drawing of the deck to a scale of 10 mm = 0.96 m (converted from the English 1/8 in = 1 ft). During the analysis of the results, three significant variations were found. First, several delamination maps were not drawn to scale. Second, on some teams' delamination maps, some delaminations that were shaped and sized correctly, were not in the correct position. Third, some delaminations calls were positioned in series from one end of the span and contained dimensions to close the string. After the calls were plotted, the corrected closing distances were significantly different than the closing distances indicated on the maps. Attempts to correct these errors failed, due to uncertainty as to which dimension or position was correct.

5.4.4.1. PROCEDURAL VARIATIONS

Twenty-two teams performed a sounding survey to quantify the level of deterioration. The other three teams experienced rainy conditions; therefore, they did not perform the task. Nine teams initiated a sounding survey during Task I that was systematic and detailed enough for the observers to direct the inspectors to the appropriate Task J data sheets in their notebook. As mentioned above, the occasional integration of this task into Task I meant that pre- and post-task data were not collected. Firsthand observations during the task were conducted as expected, and most of these have already been presented.

One piece of observer information not yet presented is a qualitative assessment of the chaining experience of the teams. Sixteen of the teams demonstrated at least marginal experience performing a deck sounding survey. Seven teams indicated that a delamination survey would never be performed by the regular inspectors in the field, and that this task was one of the first times that they had ever performed a deck sounding survey. Five of those teams indicated that other inspection teams or other divisions would normally perform the delamination surveys. Two teams indicated that nearly all of the bridges in their State have an asphalt overlay; therefore, inspectors almost never perform delamination surveys. Finally, two teams showed their sounding inexperience in their selection and use of the available tools.

Two primary procedures were used to perform the sounding. These included using a masonry hammer to tap on the concrete surface or dragging a length of steel chain across the deck surface. Delaminations will produce discernable changes in tone using either method, and the degree of change in tone varies depending on the size and depth of the delaminations. The majority of the teams (20 out of 22) used the chain as their primary sounding technique. Of these, at least half further refined the size and shape of the delaminated areas detected by using the hammer. Only two teams, and one member of a third team, used the hammer as their primary sounding tool.

5.4.4.2. REPORTING VARIATIONS

The reporting techniques varied considerably for the delamination survey. Although some teams brought along worksheets to record delaminations, most teams used the deck plans provided by the NDEVC. Twenty teams submitted delamination maps. An additional two teams provided a delamination percentage without an accompanying map. Sketches ranged from quickly drawn, schematic representations of the deterioration with no dimensions provided, to positioned sketches with dimensions provided. Only a few teams used their resulting delamination map to provide an estimate of the percentage of delaminations. To illustrate the range of sketches submitted, figures 184 through 187 show sample delamination maps. Note that none of these sketches are drawn to scale. An example of a fully-dimensioned sketch recording delamination positions, but without a total delamination quantity, is presented as figure 184. Figure 185 shows a sketch with only partial delamination positioning, which also does not provide a total delamination quantity. Figure 186 illustrates a sketch without dimensions; however, it does include an estimate of the total delamination quantity. Figure 187 shows one of the sketches made by a team on their own notepaper.

5.4.4.2.1. Delamination Percentages

The overall average of delamination percentages found by the 22 teams performing this task is 13 percent. Further investigations into these results can be made by dividing the sample into groups. Delamination maps resulting from this task can be grouped into three different categories: (1) those that quantified the total delamination areas; (2) those that measured individual delamination areas but did not quantify the total delamination areas; and (3) those that indicated only approximate delaminated areas, without any measurements. The team delamination percentages are presented by category in table 235. Eight teams provided

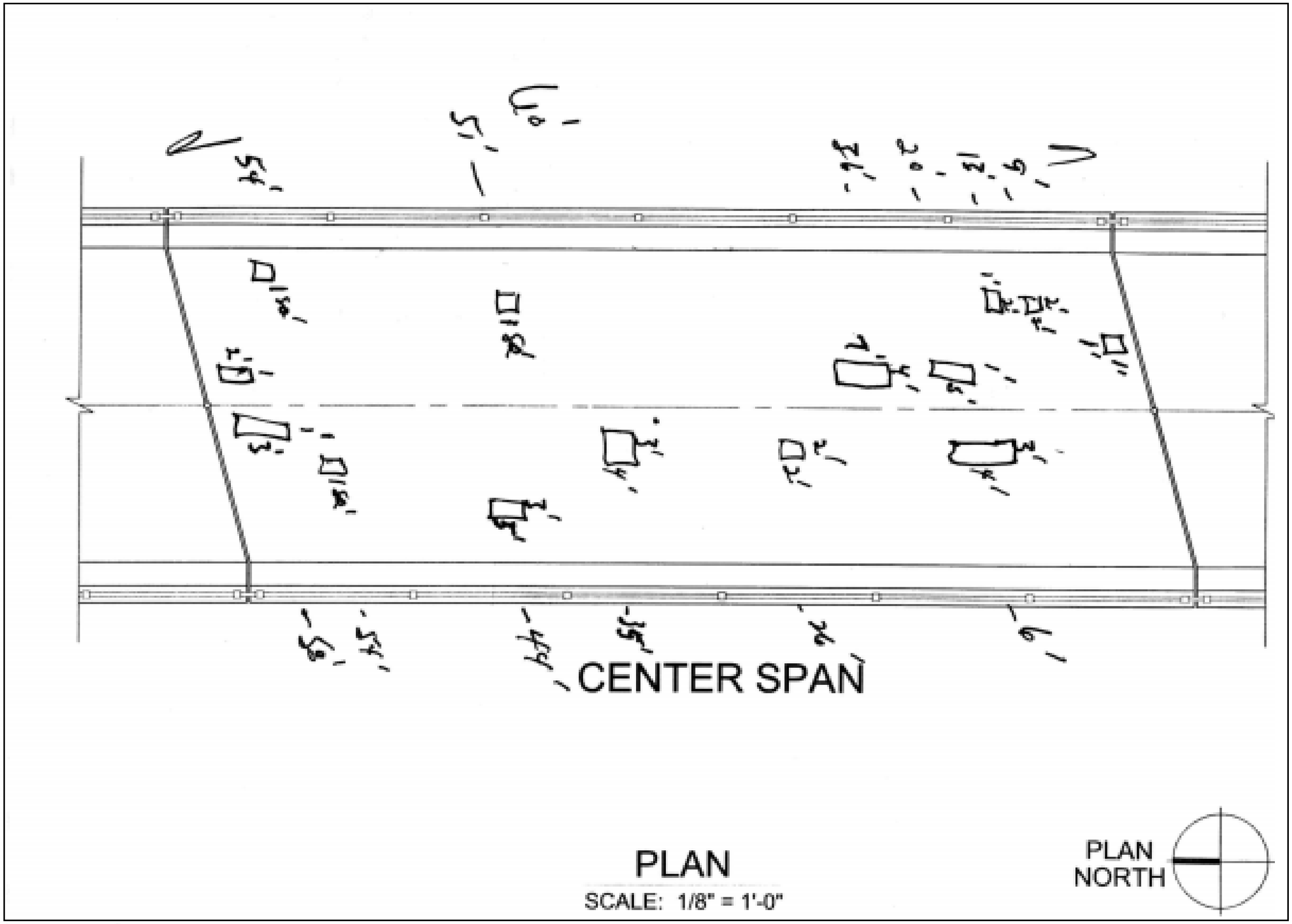


Figure 184. First sample of sketches provided by inspection teams for Task J.

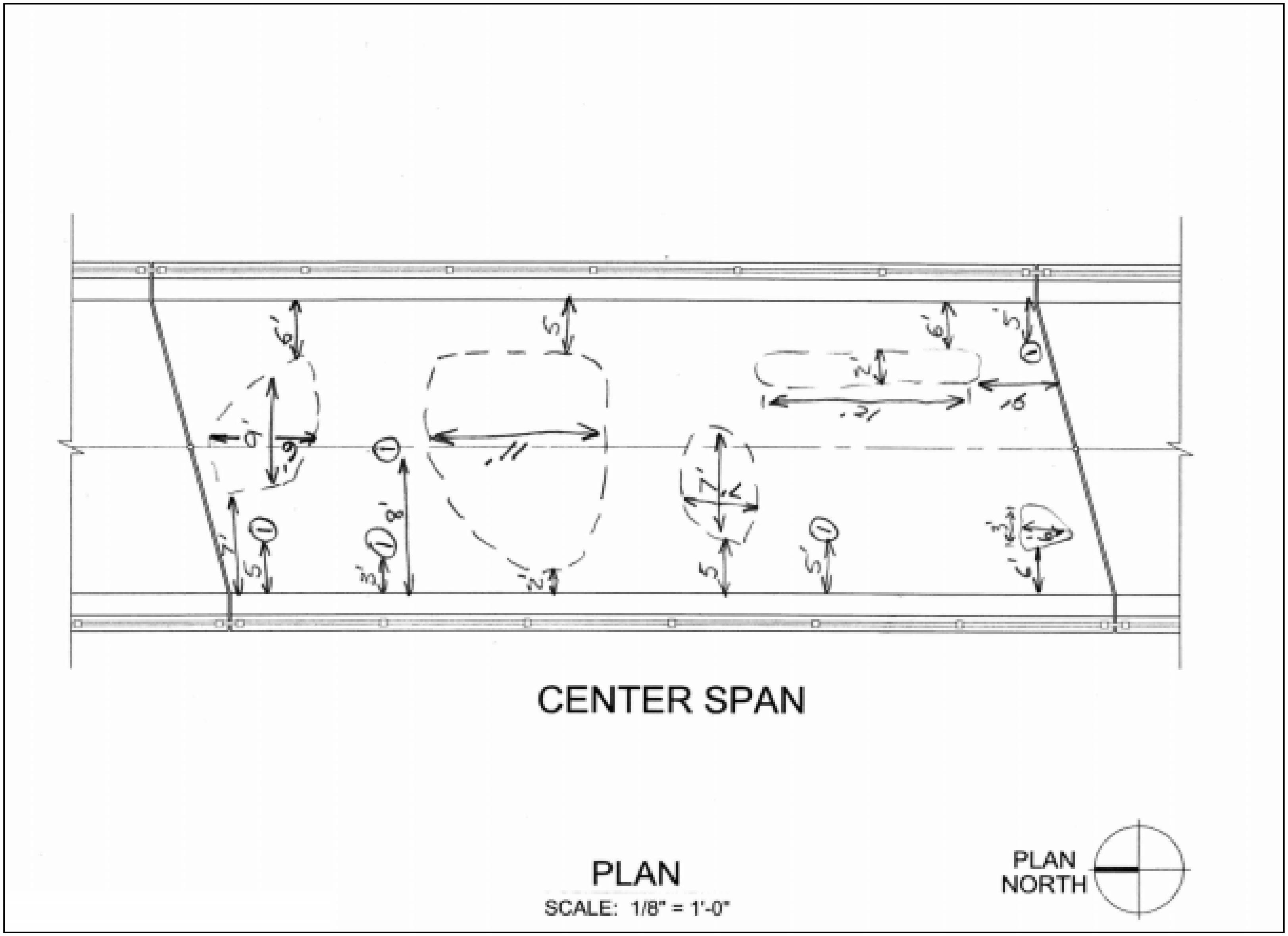


Figure 185. Second sample of sketches provided by inspection teams for Task J.

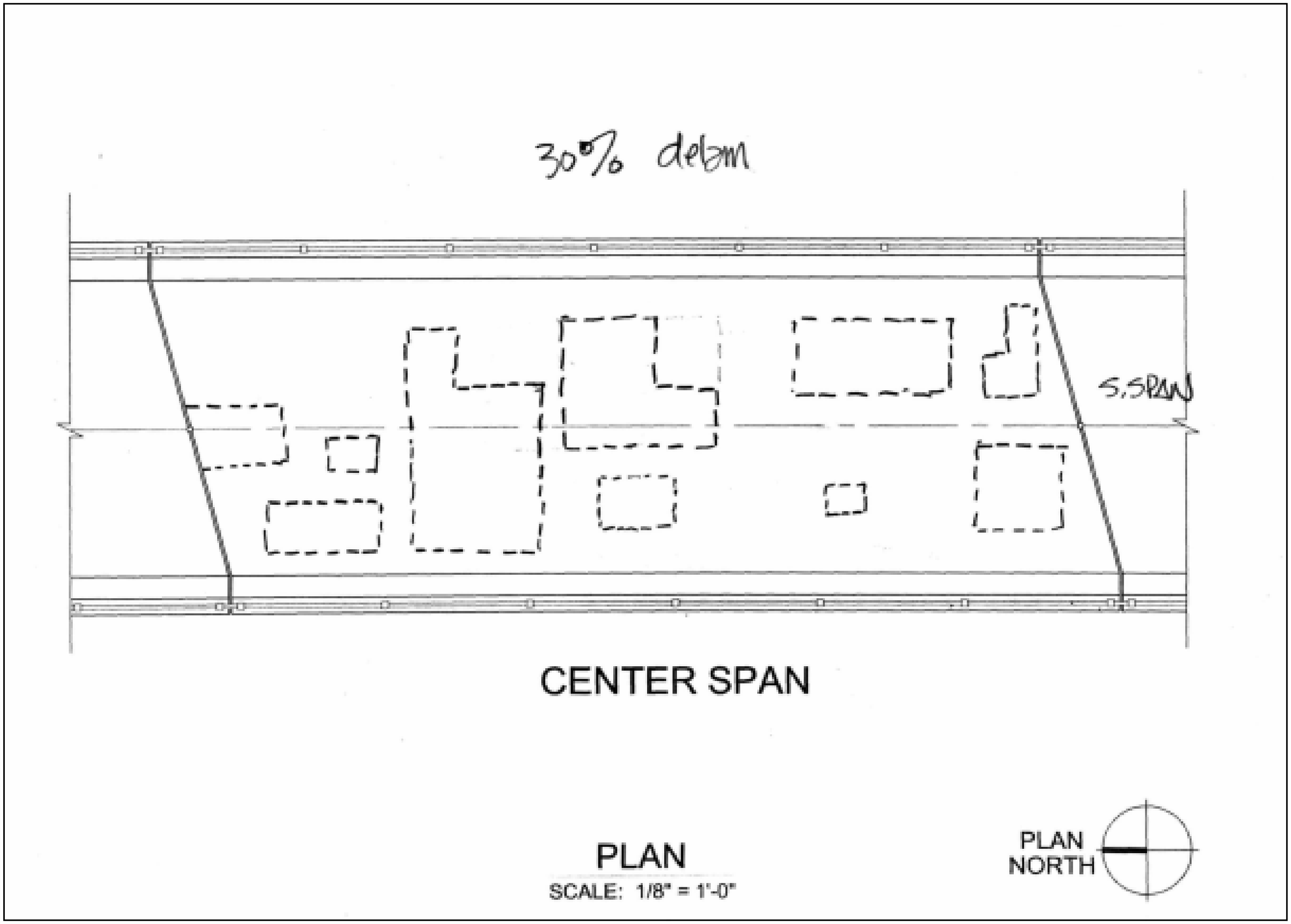


Figure 186. Third sample of sketches provided by inspection teams for Task J.

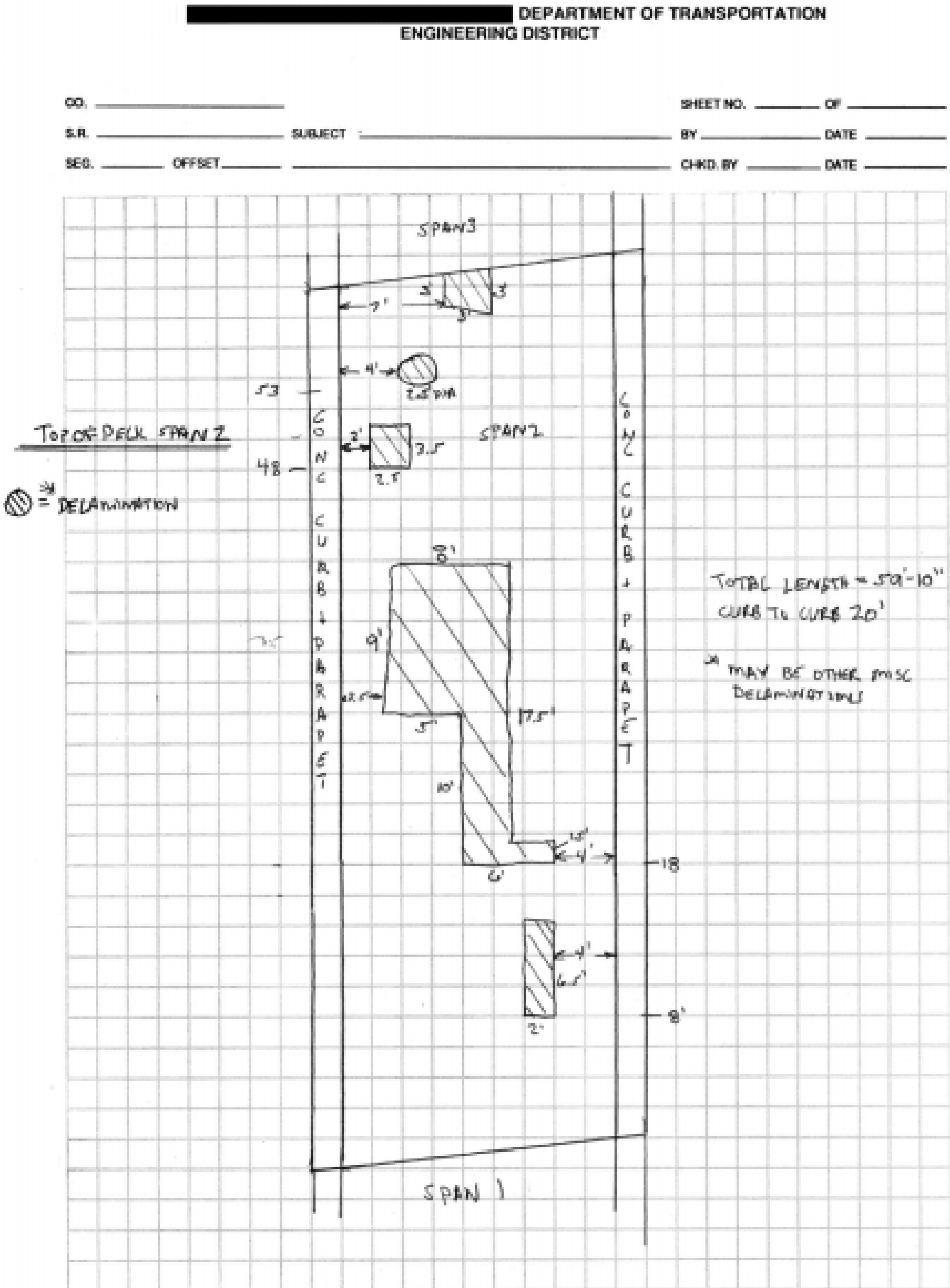


Figure 187. Fourth sample of sketches provided by inspection teams for Task J.

Table 235. Team delamination percentages.

Dimensioned and Totaled Group		Dimensioned, But Not Totaled, Group		No Dimensions Group	
Team Number	Delamination Percentage	Team Number	Delamination Percentage	Team Number	Delamination Percentage
1	2%	9	2%	20	9%
2	4%	10	5%	21	11%
3	5%	11	7%	22	35%
4	10%	12	9%		
5*	10%	13	10%		
6*	15%	14	11%		
7	16%	15	13%		
8	17%	16	17%		
		17	21%		
		18	25%		
		19	30%		
	10% average		14% average		18% average

*No map provided.

quantified delamination areas (either an estimated area of delaminated concrete or an estimated delamination percentage). Two of these eight teams provided only an estimate of the total delamination quantity; no sketches were provided. The average of these eight team estimates is 10 percent delaminated, with estimates ranging from 2 to 17 percent. An additional 11 teams provided delamination maps with dimensions, but without totals. The average delamination percentage according to this group is 14 percent, with estimates ranging from 2 to 30 percent. The remaining three teams who performed this task submitted delamination maps without dimensions. Additional work was needed to calculate delamination percentages for this group. Since no dimensions were given on the sketches of these three teams, it had to be assumed that the sketches were drawn to scale. Their sketches were digitized and the delamination percentages were determined graphically using the digital images. The average delamination percentage for these three teams is 18 percent, with team estimates ranging from 9 to 35 percent.

The results can also be compared for those inspectors displaying some experience at sounding and for those inspectors who appeared to have little or no experience. As mentioned above, 7 of the teams appeared to have little or no experience, while 16 teams appeared to have at least some experience. If the results are divided into an inexperienced group and the experienced group, the averages are 10 percent delaminated for the inexperienced group and 14 percent delaminated for the experienced group.

The NDEVC-estimated delamination percentage can be used to explore the accuracy of the reported delamination percentages. Recall that the NDEVC estimate is 19 percent. As shown in table 235, only 4 of the 22 teams produced delamination percentages for their inspections with a 15 percent error rate (i.e., between 16 percent and 22 percent) as compared to the NDEVC estimate. Furthermore, only five of the teams produced delamination percentages within 5 percentage points of the NDEVC estimate (i.e., between 14 percent and 24 percent). This 5 percentage point standard will be used for subsequent analyses.

5.4.4.3. INSPECTION FACTORS

An analysis was performed to determine whether there was a correlation between some of the inspection factors and the resulting team delamination percentages. Inspection factors that were considered include Heat Index, Light Intensity on Deck, Time of Day, and Day of Week. Initially, a linear, univariate analysis was performed to determine the degree of correlation. Since the largest correlation coefficient for these analyses was 0.19, a second-order, univariate analysis was performed on the same four variables. In the second-order analysis, the degree of correlation between Heat Index and team delamination percentage improved, with a correlation coefficient of 0.47. The maximum correlation coefficient for the other three variables was low, with a maximum of 0.29. A multivariate, second-order analysis was performed using the same four variables. The correlation coefficient for this multivariate analysis is 0.64. In parallel with previous discussions, the resulting equation is given in Equation 11, while the coefficients from this equation are shown in table 236. To ensure uniformity, the value used for the Heat Index was that obtained from Task I below the superstructure.

$$Delamination\ Percentage = y_0 + I_1 + I_2 + I_3 + I_4 \qquad (11)$$

where: $I_1 = a(F_1) + b(F_1)^2$
$I_2 = c(F_2) + d(F_2)^2$

$$I_3 = e(F_3) + f(F_3)^2$$
$$I_4 = g(F_4) + h(F_4)^2$$

with: F_1 = Day of Week

F_2 = Light Intensity on Deck

F_3 = Heat Index

F_4 = Time of Day

Table 236. Equation coefficients for predicting deck delamination percentages.

Coefficient	Value
y_0	326
a	6.14
b	-0.893
c	-3.27e-4
d	2.89e-9
e	-5.52
f	0.0976
g	-38.2
h	1.50

Figures 188 through 191 graphically represent the influence of each of the four factors investigated (Day of Week, Light Intensity, Heat Index, and Time of Day). As can be seen from these graphs, the influence of the Heat Index seems to have the most influence on the resulting delamination percentage.

5.4.4.3.1. Delamination Estimates Compared to Element-Level Data

The results of Task J can be compared with the deck results from Task I. Particularly useful in these comparisons are the Pontis data for element no. 12, Concrete Deck – Bare. A discussion has already been presented regarding the use of units (according to the CoRe element guide, not necessarily according to individual State procedures) in the element-level data. Further inconsistencies in CoRe element use are observed when each team's individual deck delamination percentage is compared with the Condition State assigned by that team to the deck element. The language in the CoRe element guide is very precise in describing the different Condition States. To summarize the Condition State language for deck elements:

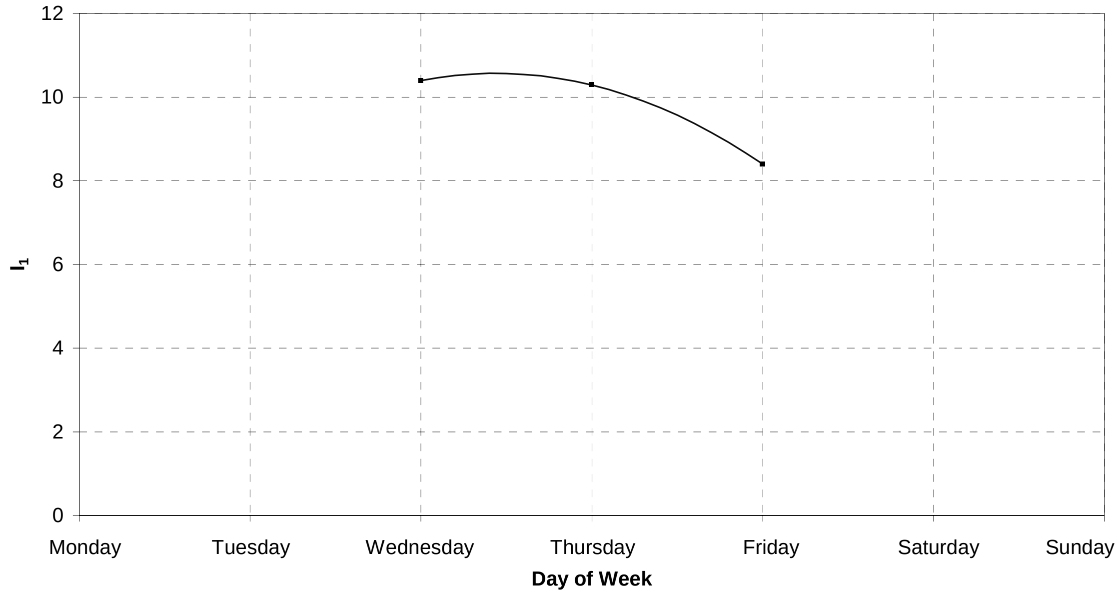


Figure 188. Influence of Day of Week on delamination percentage.

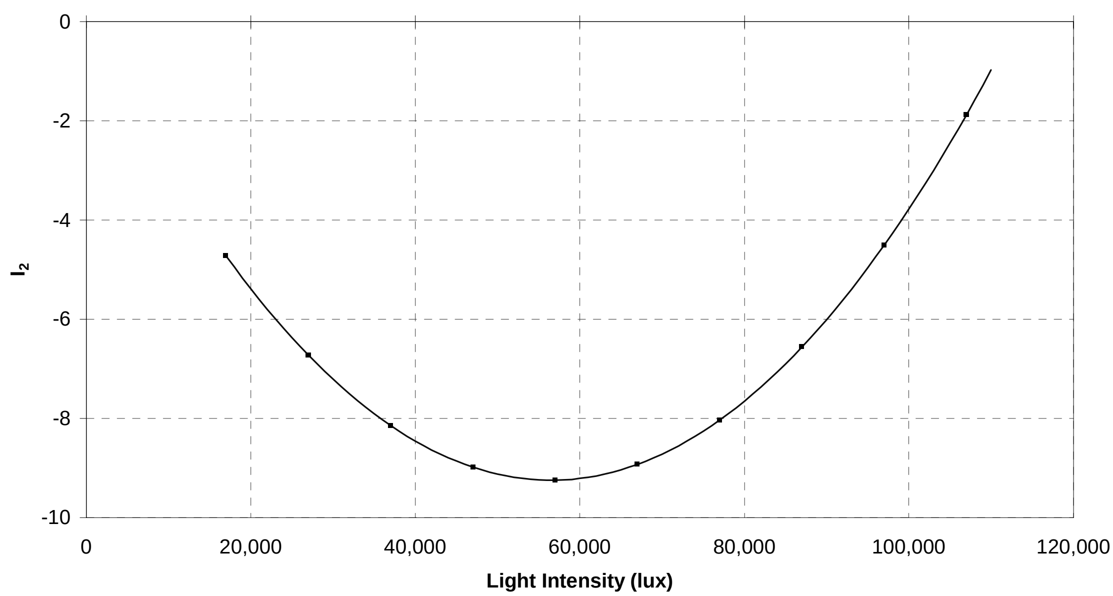


Figure 189. Influence of Light Intensity on delamination percentage.

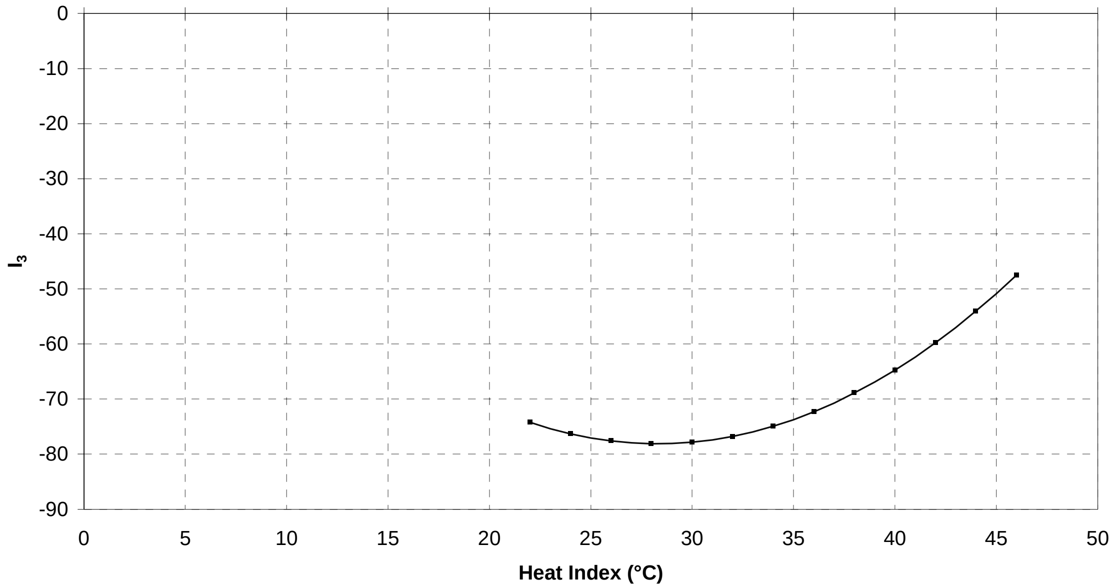


Figure 190. Influence of Heat Index on delamination percentage.

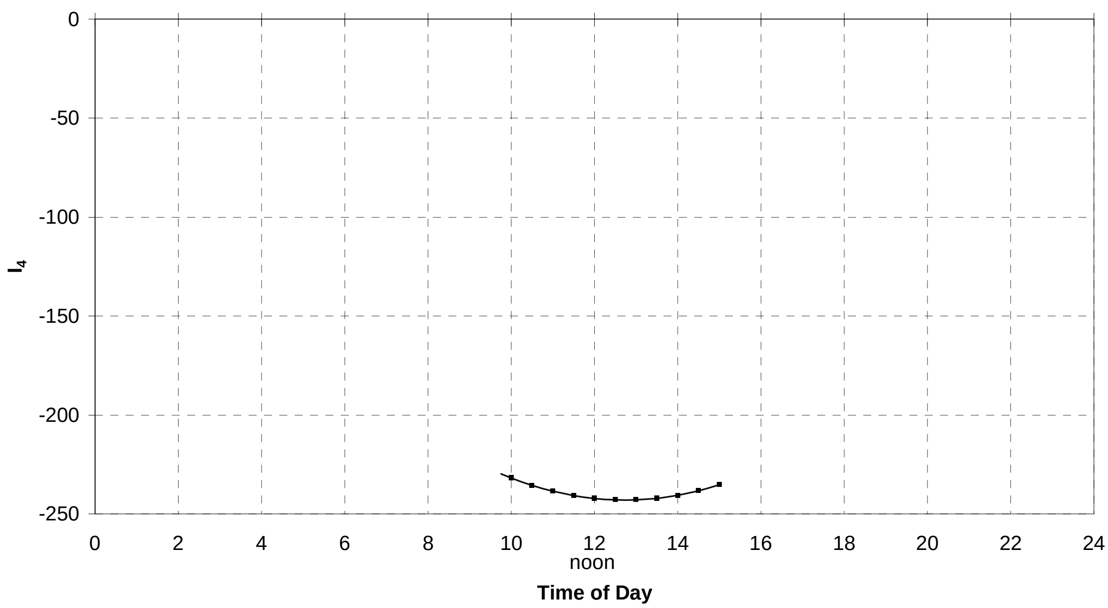


Figure 191. Influence of Time of Day on delamination percentage.

CS1 exhibits no deterioration, CS2 has less than 2 percent deterioration, CS3 has between 2 and 10 percent deterioration, CS4 has between 10 and 25 percent deterioration, and CS5 has more than 25 percent deterioration. All of the deck is to be rated in the single Condition State that is appropriate (i.e., no splitting across multiple Condition States).

Of the 13 teams that both have element-level data and have performed Task J, 3 subdivided the deck into multiple Condition States for their element-level ratings. Of the remaining 10 teams, 5 properly selected the appropriate Condition State for the level of deterioration indicated on their Task J data sheets, while 5 selected Condition States that do not match their estimated delamination percentages. It has been reported that some States may have changed the element-level definitions to allow for their specific uses, possibly changes along these lines have introduced these types of inconsistencies.

5.4.4.3.2.   Comparison of Individual Delaminations

If it is assumed that the actual delamination percentage is approximately 19 percent, and if an allowance of ± 5 percentage points is permitted as reasonable error (between 14 and 24 percent delaminated), table 235 shows that only five of the teams had estimates that fell in this range. This is less than a quarter of the teams that performed the task.

Figures 192 through 211 show overlays of the team sketches superimposed upon the delamination outlines determined by the NDEVC. These figures are identified using the same team identifiers used in table 235. Recall that Teams 5 and 6 did not submit delamination maps; therefore, data from these teams are not included in figures 192 through 211. These overlays were created assuming that the maps submitted by the teams were drawn to scale. For most of the sketches, this assumption is justifiable. However, a few of the maps were drawn to an inconsistent scale, with 0.6-m by 0.6-m dimensioned areas drawn about the same size as 1.8-m by 1.8-m dimensioned areas. Attempts were made to regenerate some of these maps using the position and size information provided, but these "corrected" maps had enough other errors in positioning and sizing that they were not considered to have improved on the original sketch that was submitted. Therefore, all areas are shown without modification. In two cases, automobiles were parked on the deck, preventing complete inspection of the deck. These areas have been noted.

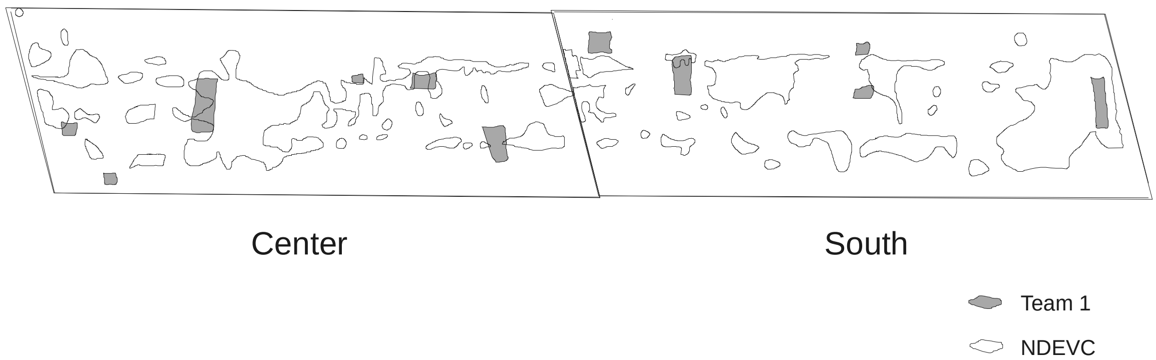


Figure 192. Delamination map from Team 1.

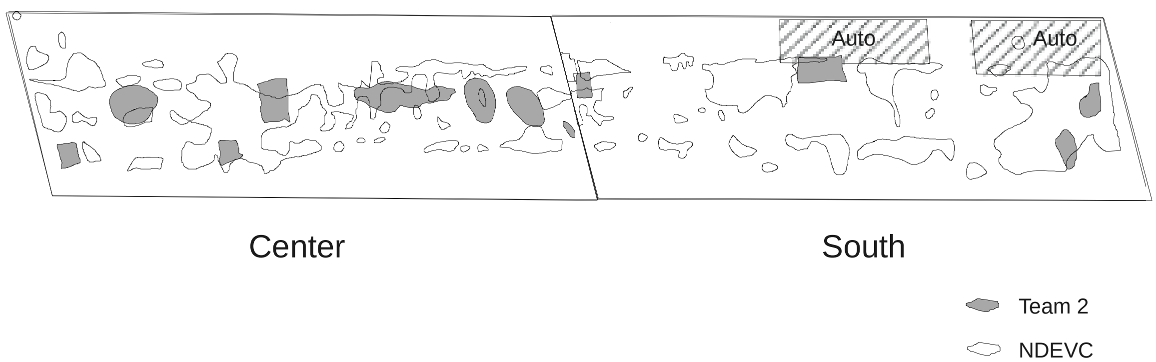


Figure 193. Delamination map from Team 2.

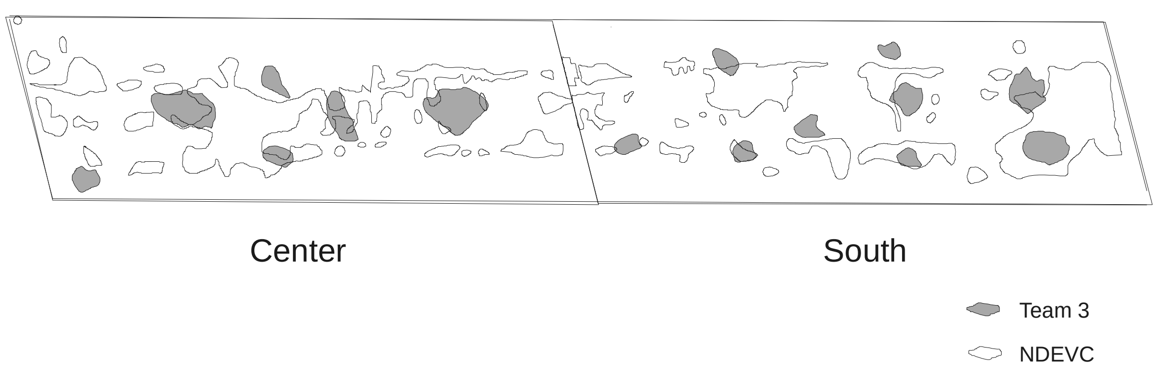


Figure 194. Delamination map from Team 3.

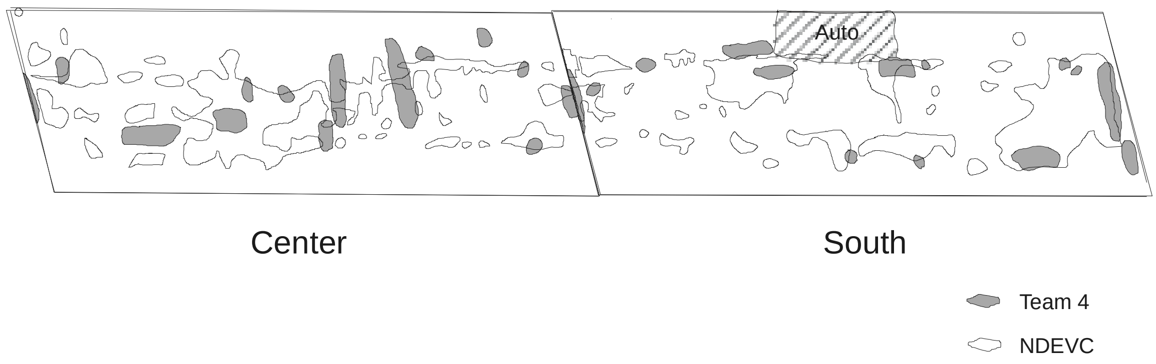


Figure 195. Delamination map from Team 4.

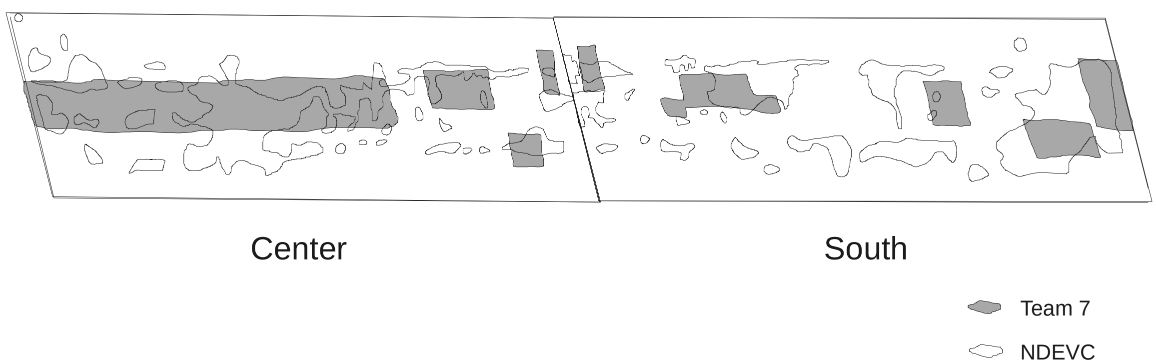


Figure 196. Delamination map from Team 7.

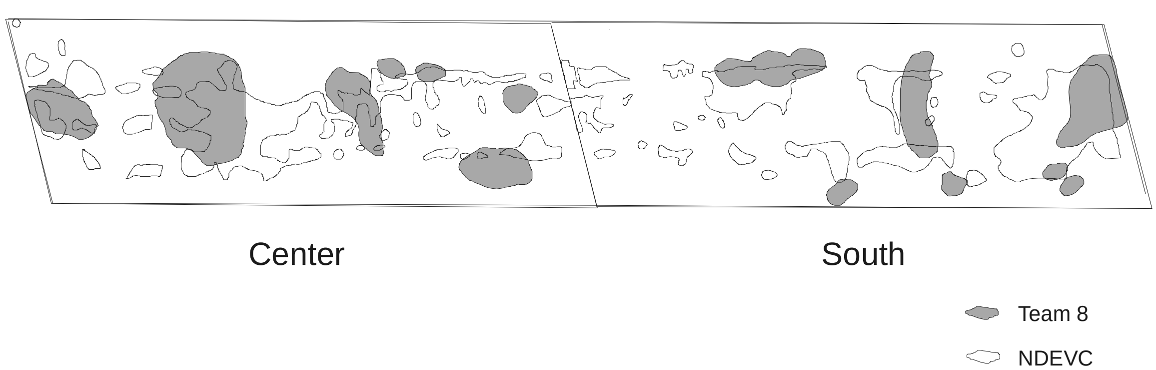


Figure 197. Delamination map from Team 8.

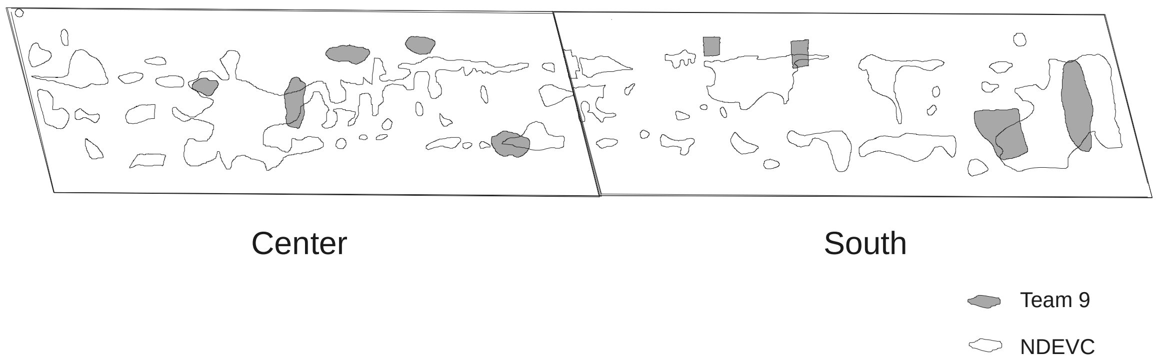


Figure 198. Delamination map from Team 9.

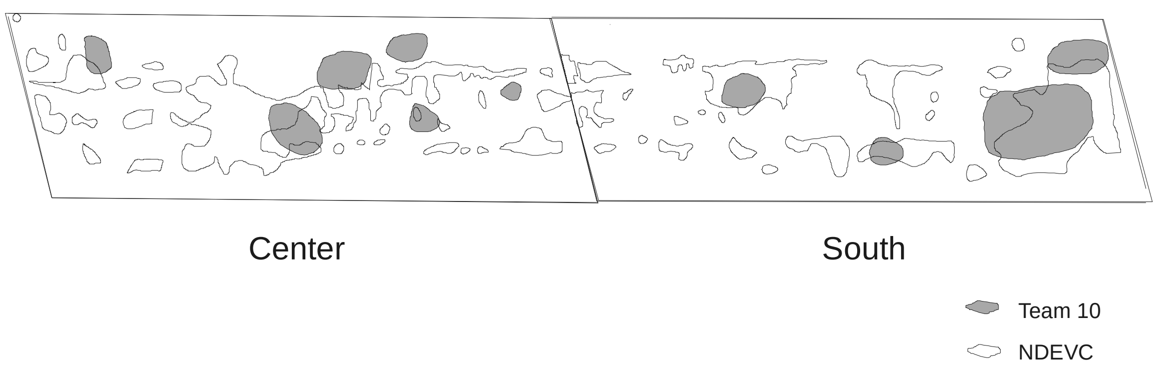


Figure 199. Delamination map from Team 10.

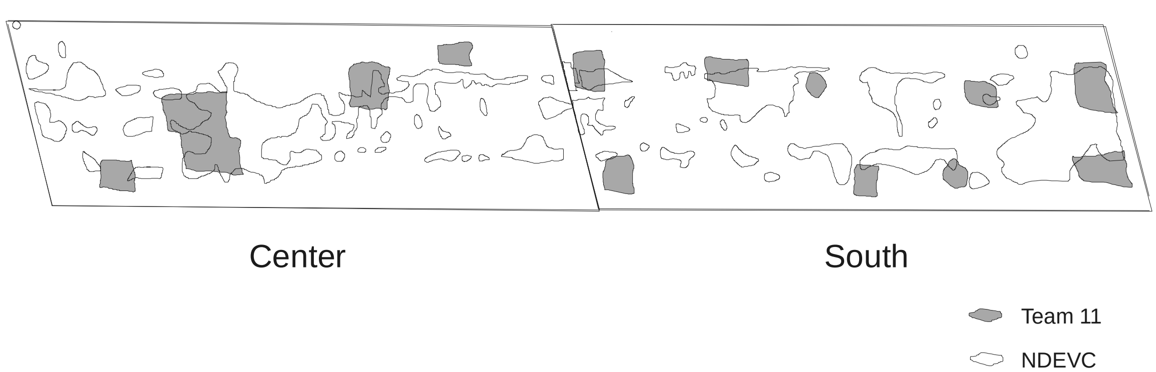


Figure 200. Delamination map from Team 11.

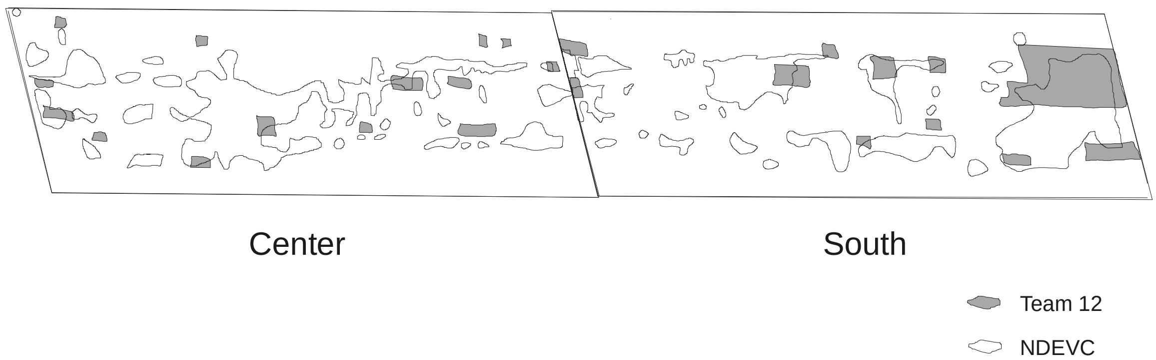


Figure 201. Delamination map from Team 12.

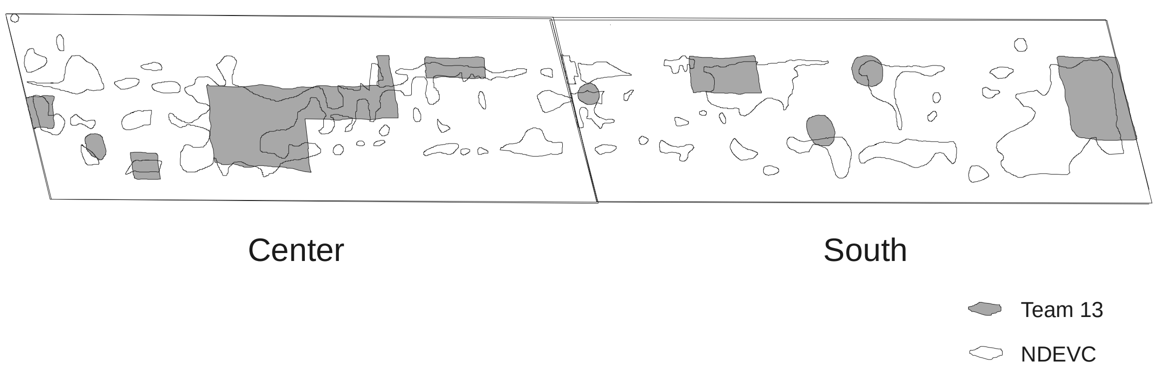


Figure 202. Delamination map from Team 13.

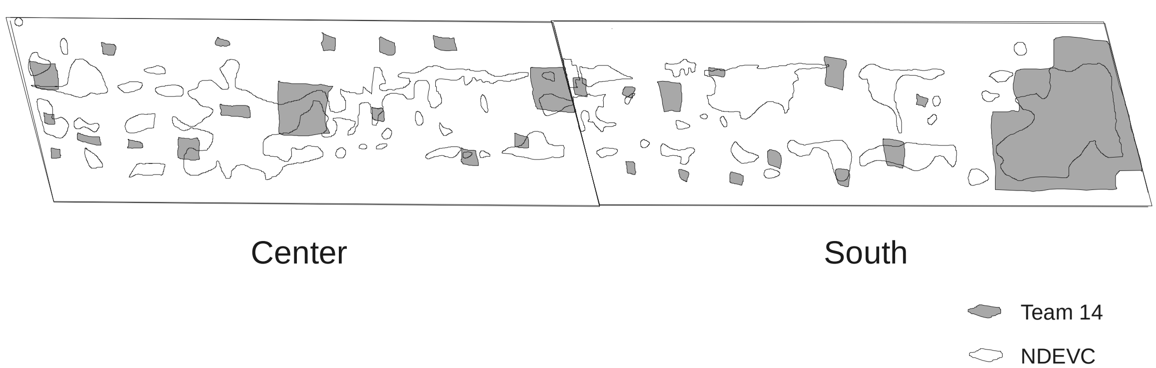


Figure 203. Delamination map from Team 14.

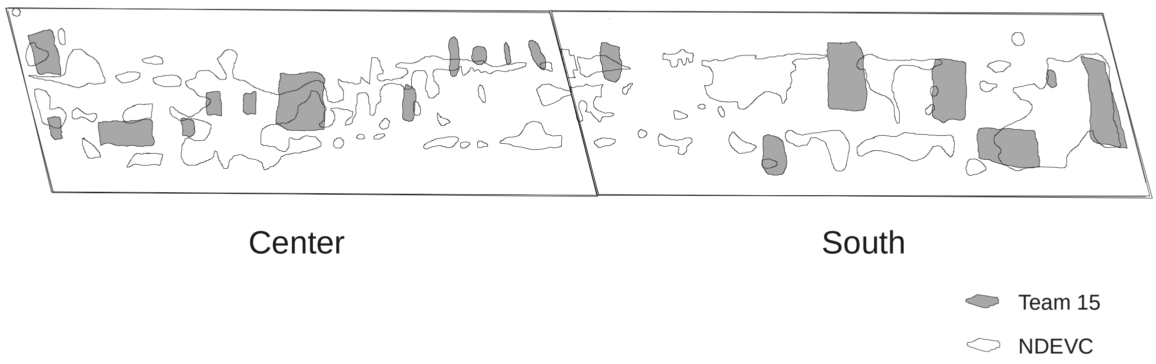


Figure 204. Delamination map from Team 15.

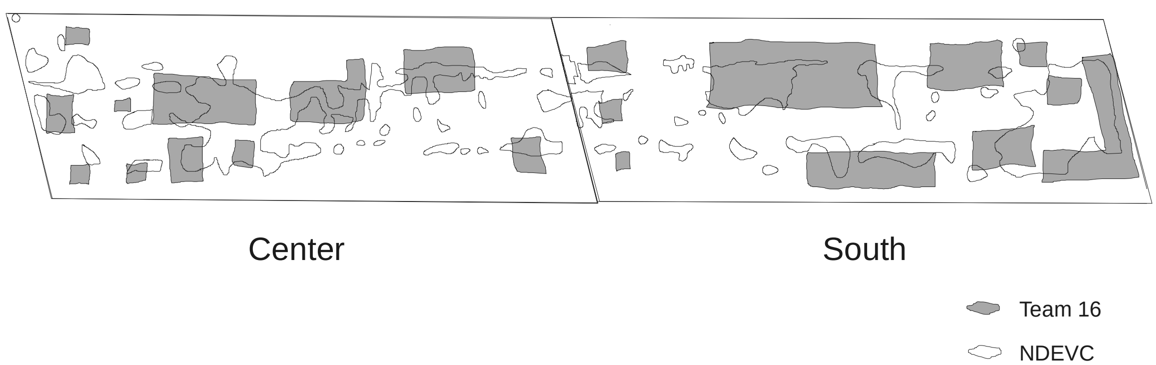


Figure 205. Delamination map from Team 16.

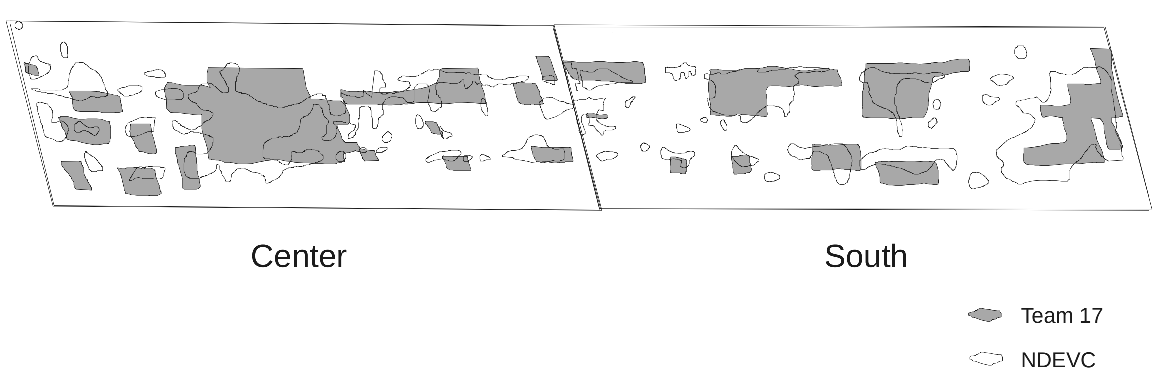


Figure 206. Delamination map from Team 17.

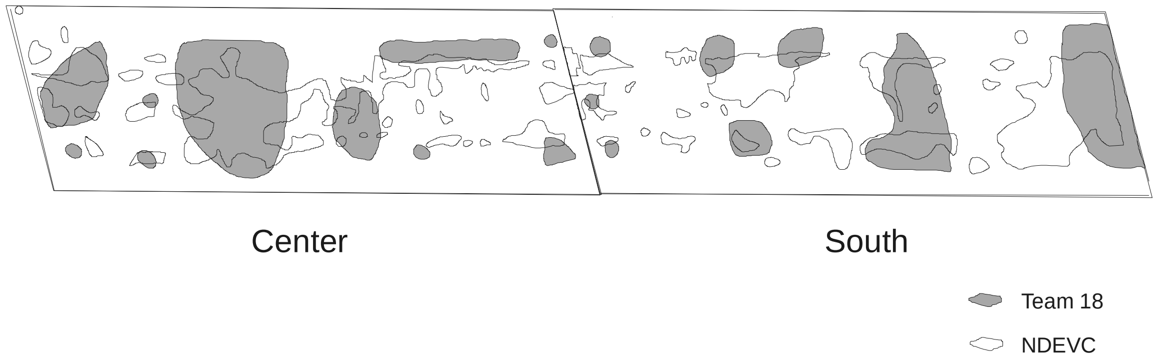


Figure 207. Delamination map from Team 18.

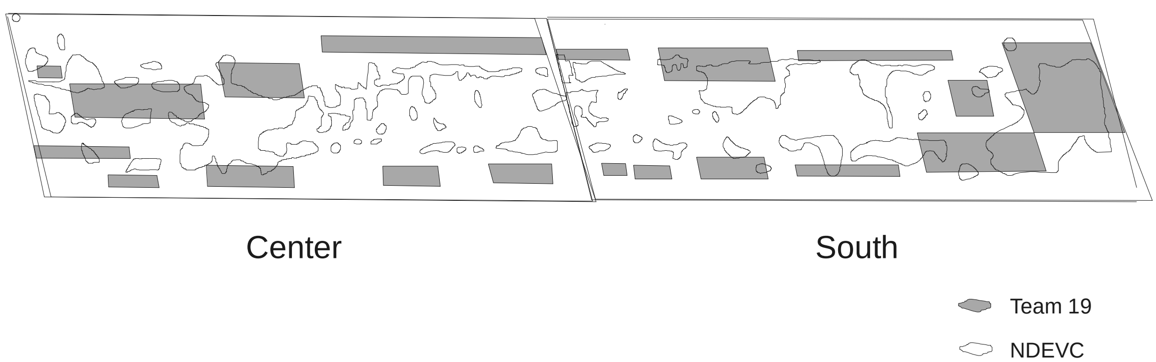


Figure 208. Delamination map from Team 19.

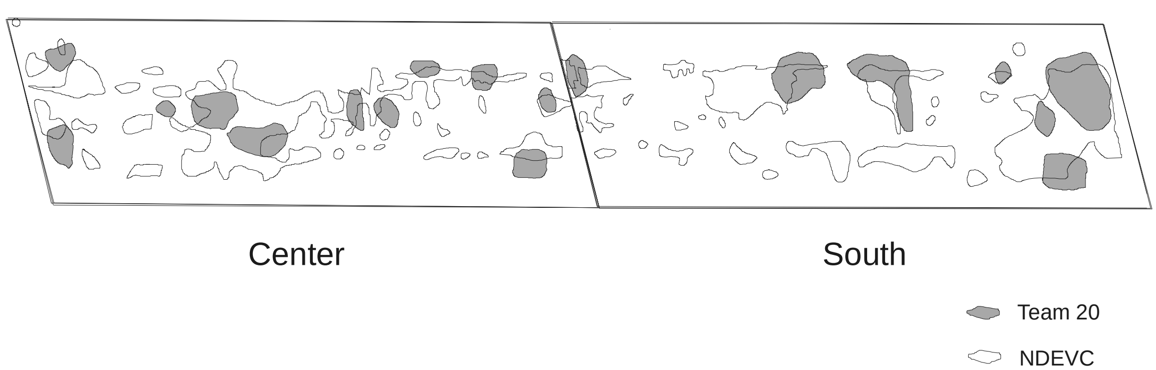


Figure 209. Delamination map from Team 20.

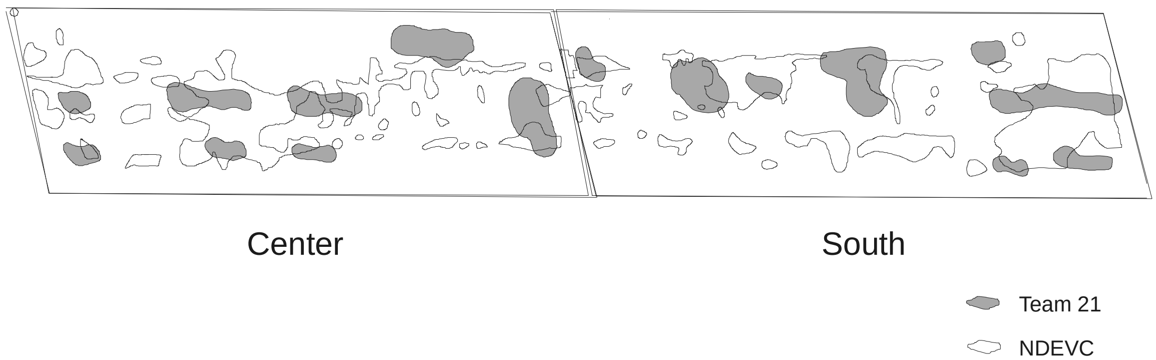


Figure 210. Delamination map from Team 21.

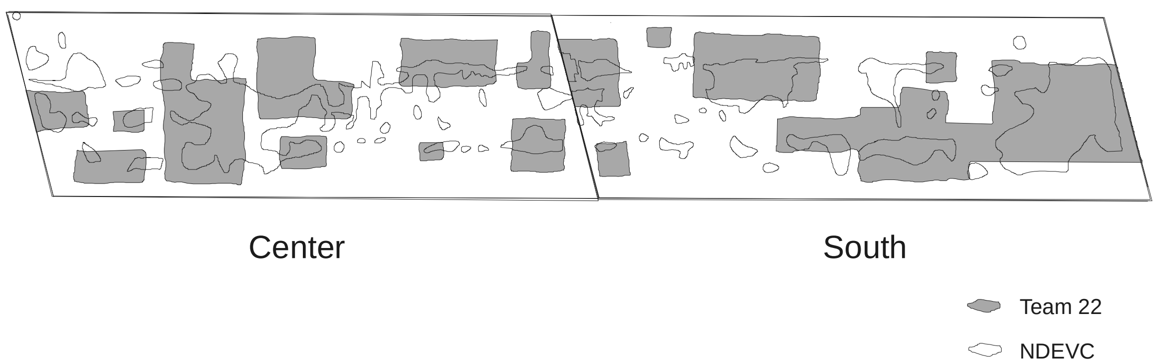


Figure 211. Delamination map from Team 22.

RECTANGULAR OUTLINES VERSUS ACTUAL OUTLINES: Looking at the delamination maps presented in figures 192 through 211, it appears that two different philosophies were used to develop these sketches. One philosophy uses rectangular areas to mark the delaminations. The other philosophy uses areas that are either generally circular or oval to mark the actual outlines of the delaminations. Table 237 summarizes the delamination percentages indicated by each of these two groups. As shown in table 237, the teams that mainly seemed to indicate actual areas had a much smaller average delamination percentage than those who indicated rectangular areas. The indication from this table is that inspector accuracy of delamination percentage estimates may actually be poorer than previously reported. Although the average delamination estimates of the teams that indicated rectangular areas are much closer to the

Table 237. Team delamination percentages – Actual areas versus rectangular areas.

Team Number	Actual Areas	Team Number	Rectangular Areas
1	2%	7	16%
2	4%	11	7%
3	5%	12	9%
4	10%	13	10%
8	17%	14	11%
9	2%	15	13%
10	5%	16	17%
18	25%	17	21%
20	9%	19	30%
21	11%	22	35%
	9% average		17% average

NDEVC average, their estimates have been inflated by adding nearby undelaminated areas to their totals.

COMMON AREAS NOT INDICATED AS DELAMINATED: Superposition of the delamination maps provided by the 20 teams can be used to illustrate areas that none of the teams indicated were delaminated. This superposition is shown in figure 212, where areas indicated to be delaminated are shown in white, and areas not indicated to be delaminated by any team are shown in either light or dark gray. Recall that no adjustments were made to the sketches as drawn, so some errors exist within this superposition, but it remains illustrative of several points. Approximately 31 percent of the deck, largely concentrated along the curbs, did not receive any delamination calls. Conversely, the union of all of the areas indicated as being delaminated is 69 percent. Recall that the average deck delamination was 13 percent, and the highest team total was 35 percent. This indicates a significant divergence of opinion as to where the delaminations are located. Figure 212 also indicates the areas identified as being delaminated by the NDEVC that were not indicated by any of the inspection teams on any of the delamination maps. These areas are shaded more heavily, and comprise about one-half of 1 percent of the deck area. As shown, these areas are typically very small and near the edges of the areas called out as delaminations. It seems reasonable to assume that a large percentage of these areas exist due to errors in recording the delaminations identified.

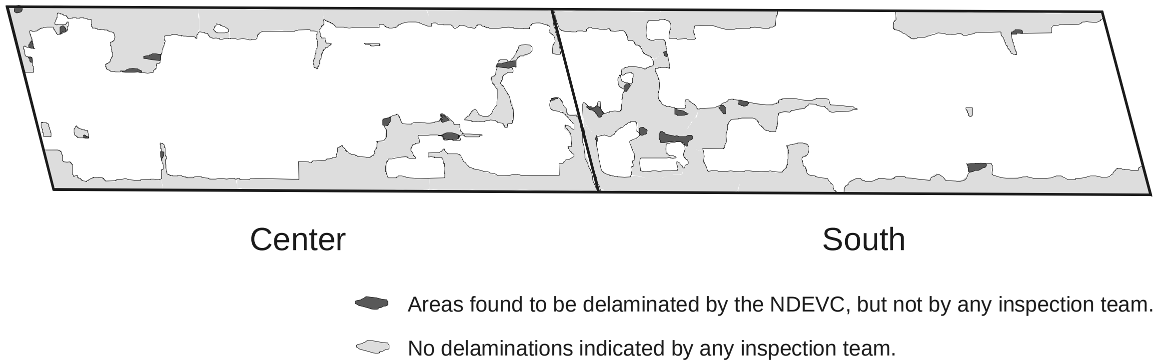


Figure 212. Areas all teams indicated were intact.

COMMON AREAS INDICATED AS DELAMINATED: Given the inspection team delamination reporting method used, it is also possible to determine common deck areas that several teams indicated were delaminated. This could be completed several different ways. First the intersection of all 20 maps was generated. However, it was observed that there were no areas that all teams indicated were delaminated; therefore, this figure is not presented.

An alternative method of presentation to illustrate commonly indicated delaminated areas was developed that uses additive fills for each team's delaminations. As the fills overlap, a darker shading results. The degree of shading indicates the frequency of delamination calls. The complete additive overlay is presented in figure 213. In parallel with figure 213, table 238 quantifies the percentage of deck area at each level of commonality (i.e., the percentage of the deck covered by areas indicated as being delaminated by exactly N teams). This table also shows the maximum amount of deck area to receive at least N delamination calls. In examining this table, it can be seen that the highest degree of commonality for any single, sizable delamination (0.2 percent of the deck area, or 0.4 m^2) was 15 teams. Figure 214 shows the delamination map representing delamination calls by at least 15 teams. This image actually indicates a maximum degree of commonality of 17 teams (this area is actually less than 32 cm^2). This area is small enough that it is probably outside the tolerance of the map and may not actually exist.

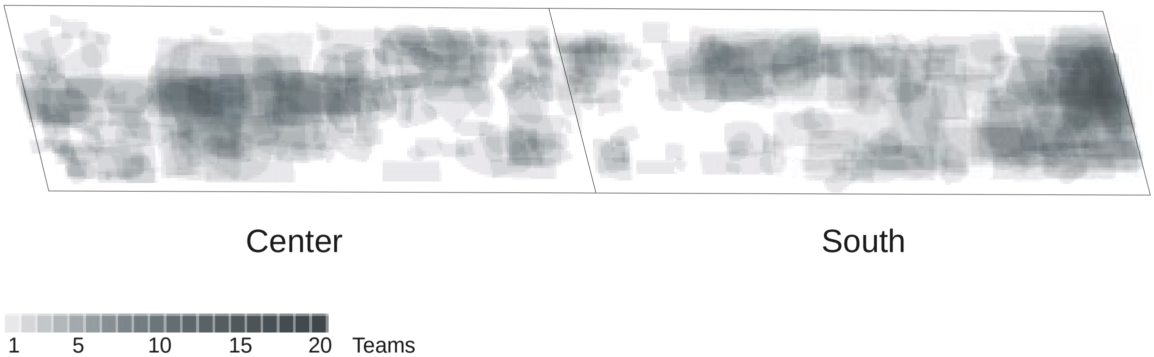


Figure 213. Transparent overlay of all delamination maps.

Table 238. Commonality percentages of deck delamination areas.

Level of Commonality	Percentage of Deck Area	Cumulative Percentage of Deck Area Delaminated
0	31.0	—
1	15.8	69.0
2	13.0	53.2
3	11.0	40.2
4	8.3	29.2
5	6.5	20.9
6	4.8	14.5
7	3.5	9.7
8	2.2	6.2
9	1.3	4.0
10	1.0	2.7
11	0.6	1.7
12	0.5	1.2
13	0.3	0.7
14	0.2	0.4
15	0.1	0.2
16	0.04	0.04
17	0.001	0.001
18	0	0
19	0	0
20	0	0

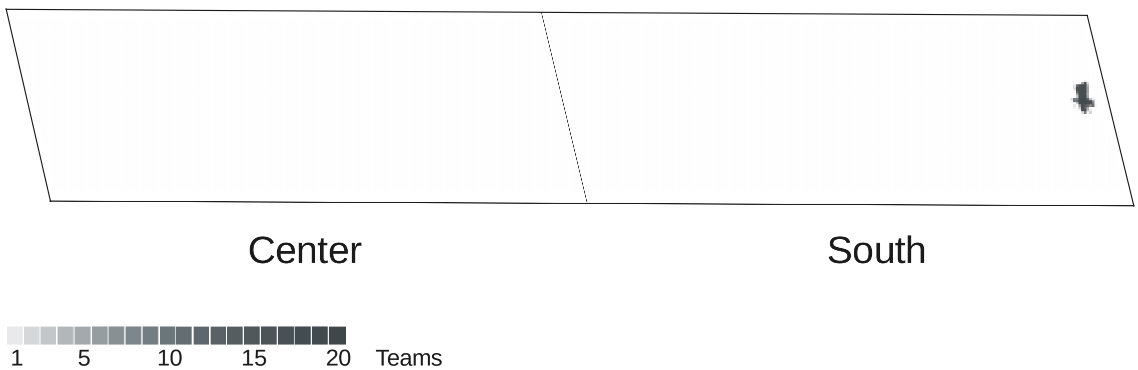


Figure 214. Areas indicated as containing delaminations by 15 or more teams.

Two other commonality levels were studied graphically. First, since the delamination maps submitted by the teams were approximate, the areas indicated as being delaminated by at least three teams were investigated. This investigation may reduce some of the errors within the maps by eliminating unique delamination calls and the first intersection level, both of which may be mislocated due to positioning errors in recording the data. As shown in figure 215, the total area with at least three delamination calls covers 40 percent of the deck area. Second, it was calculated that the amount of the deck area covered by at least five delamination calls was 21 percent. This level is closest to the 19 percent indicated by the NDEVC survey. Figure 216 compares the delamination map showing at least five delamination calls with the survey performed by the NDEVC.

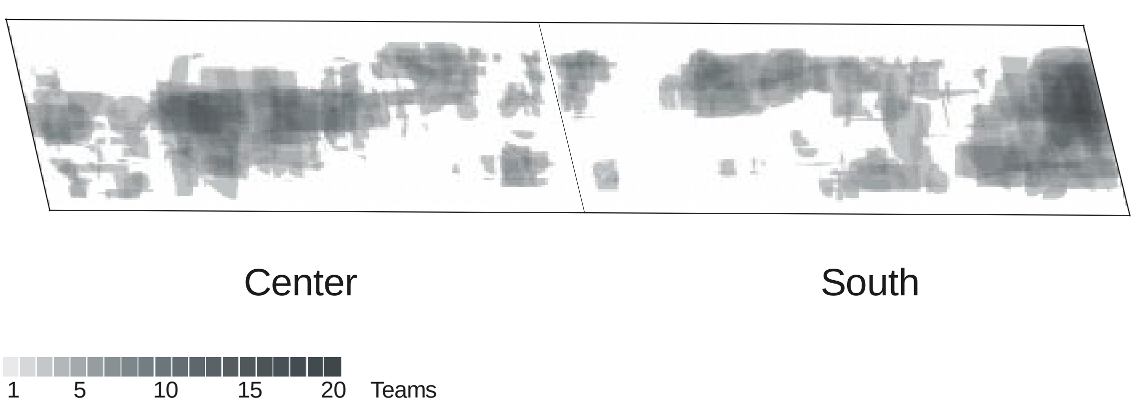


Figure 215. Areas indicated as containing delaminations by three or more teams.

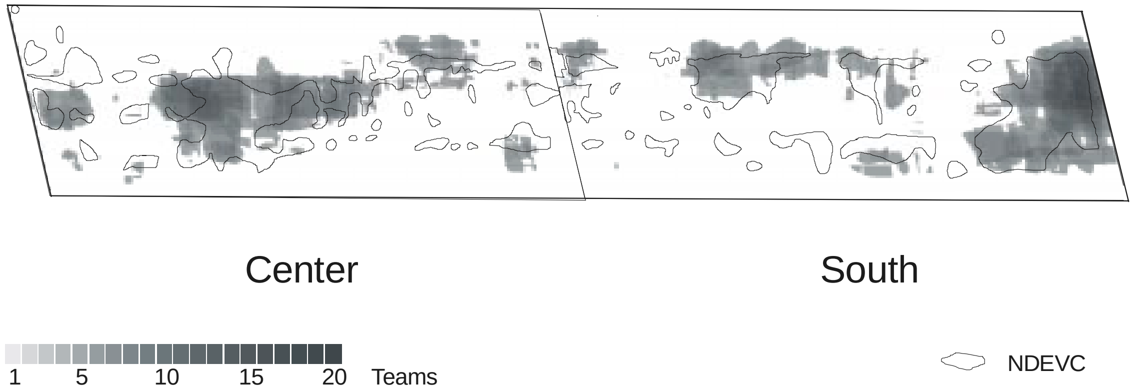


Figure 216. Areas indicated as containing delaminations by five or more teams, together with the results of the NDEVC survey.

The coring program that was mentioned previously also investigated some of the differences between team delamination calls and the NDEVC survey. Specifically, four of these disputed areas were cored; half of which were considered to be delaminated by the NDEVC. In addition, one of the disputed areas had at least five delamination calls by teams, although the NDEVC did not detect any signs of delamination. The results of the coring program determined that all four of the disputed areas were properly called by the NDEVC.

Another analysis was performed that investigated the correlation of the delamination maps between any two teams. There are 190 possible combinations of 2 different delamination maps. Figure 217 shows a histogram of the amount of intersection of the delamination areas for these combinations of two teams. The maximum amount of deck area indicated as being delaminated according to the intersection of two teams is 15.5 percent, while the most frequent amount of delamination intersection is between 1 and 2 percent.

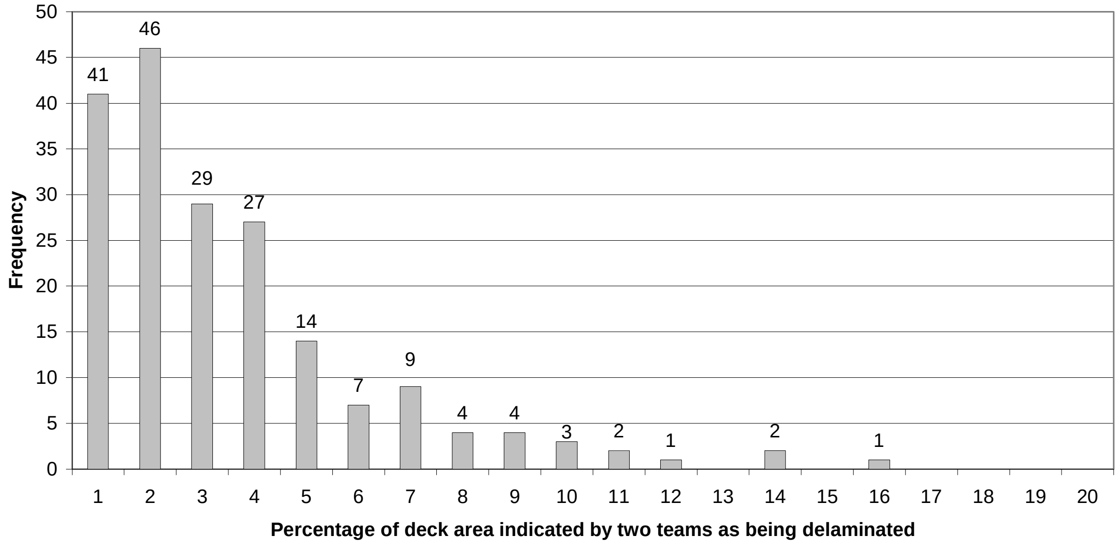


Figure 217. Histogram of amount of deck area indicated by two teams as being delaminated.