Long-Term Pavement Performance Ohio SPS-1 and SPS-2 Dynamic Load Response Data Processing

PUBLICATION NO. FHWA-HRT-14-088 MARCH 2015

U.S. Department of Transportation
Federal Highway Administration

Research, Development, and Technology
Turner-Fairbank Highway Research Center
6300 Georgetown Pike
McLean, VA 22101-2296

FOREWORD

This report documents the reinterpretation of the dynamic load response (DLR) traces for selected Long-Term Pavement Performance (LTPP) test sections in Ohio. The report also describes the work performed to correct data issues such as trace peak time lag shifts, sensor locations, and wheelpath offsets for asphalt concrete and portland cement concrete pavements. The reinterpreted DLR data have been made available in the LTPP program's Standard Data Release 27.0 and later versions.[1] This new LTPP DLR data will serve as a unique resource for researchers in investigating the dynamic interaction between truck axle loads and pavements, validating their pavement dynamic loading models, and developing mechanistic pavement performance prediction models.

Jorge E. Pagán-Ortiz
Director, Office of Infrastructure
Research and Development

TECHNICAL REPORT DOCUMENTATION PAGE

1. Report No. FHWA-HRT-14-088	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle Long-Term Pavement Performance Ohio SPS-1 and SPS-2 Dynamic Load Response Data Processing		5. Report Date March 2015
		6. Performing Organization Code
7. Author(s) Mahesh Agurla and Sean Lin		8. Performing Organization Report No.
9. Performing Organization Name and Address Engineering & Software Consultants, Inc. 14123 Robert Paris Court Chantilly, VA 20151		10. Work Unit No. (TRAIS)
		11. Contract or Grant No. DTFH61-12-C-00002
12. Sponsoring Agency Name and Address Office of Infrastructure Research and Development Federal Highway Administration 6300 Georgetown Pike McLean, VA 22101-2296		13. Type of Report and Period Covered Research Report
		14. Sponsoring Agency Code
15. Supplementary Notes The Contracting Officer's Representative (COR) was Aramis Lopez, and the Task Manager was Larry Wiser, HRDI-30.		

16. Abstract

The dynamic load response (DLR) Study Team reinterpreted 4,290 Ohio Specific Pavement Studies (SPS)-1 (asphalt concrete pavements) raw traces and 9,240 Ohio SPS-2 (portland cement concrete pavements) raw traces, correcting the data issues identified by Long-Term Pavement Performance (LTPP) data analysis/operations feedback reports and the technical memorandum, *Investigation of Ohio DLR data in LTPP Database* for LTPP Standard Data Release (SDR) 22.0, including trace peak time lag shifts, incorrect sensor locations, and wheelpath offsets. (See references 2–6.) The team calibrated and smoothed the SPS-1 and SPS-2 raw traces before categorizing those traces into three categories: good, maybe, and not good. For the SPS-1 data, approximately 24 percent of strain gauge traces, 55 percent of linear variable differential transformer (LVDT) traces, and 99 percent of pressure cell traces were categorized as good. For the SPS-2 data, only smoothed traces were categorized due to significant noise in the raw traces. Approximately 61 percent of strain gauge traces and 15 percent of LVDT traces were categorized as good. Only good traces were used for further extraction of trace peaks and valleys for SDR 27.0.[1] In addition, the sensor locations and the corresponding wheelpath offsets were also corrected.

The reinterpreted DLR data resolved the data issues and have been published in SDR 27.0.[1] To aid future DLR data users in identifying the layout and status of each sensor from one test visit or run to another, appendices A through E show the sensor layouts in the Ohio SPS-1 and SPS-2 DLR test sections as well as the results of the 23 Ohio SPS-1 DLR tests and the 24 Ohio SPS-2 DLR tests.

17. Key Words Dynamic load response, Strain gauge, Linear variable differential transformer, Pressure cell, Pavement deflection peak and valley, Raw trace, Test run, Truck axle load	18. Distribution Statement No restrictions. This document is available to the public through the National Technical Information Service, Springfield, VA 22161. http://www.ntis.gov

19. Security Classification (of this report) Unclassified	20. Security Classification (of this page) Unclassified	21. No. of Pages 169	22. Price

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		AREA		
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yard	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
		NOTE: volumes greater than 1000 L shall be shown in m^3		
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
		TEMPERATURE (exact degrees)		
°F	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	°C
		ILLUMINATION		
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	candela/m^2	cd/m^2
		FORCE and PRESSURE or STRESS		
lbf	poundforce	4.45	newtons	N
lbf/in^2	poundforce per square inch	6.89	kilopascals	kPa

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
		AREA		
mm^2	square millimeters	0.0016	square inches	in^2
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.195	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	square kilometers	0.386	square miles	mi^2
		VOLUME		
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	cubic meters	35.314	cubic feet	ft^3
m^3	cubic meters	1.307	cubic yards	yd^3
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2000 lb)	T
		TEMPERATURE (exact degrees)		
°C	Celsius	1.8C+32	Fahrenheit	°F
		ILLUMINATION		
lx	lux	0.0929	foot-candles	fc
cd/m^2	candela/m^2	0.2919	foot-Lamberts	fl
		FORCE and PRESSURE or STRESS		
N	newtons	0.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inch	lbf/in^2

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ACRONYMS AND ABBREVIATIONS

AC	Asphalt concrete
ASCII	American Standard Code for Information Interchange
CL	Center lane
DAOFR	Data analysis/operations feedback report
DLR	Dynamic load response
LTPP	Long-Term Pavement Performance
LVDT	Linear variable differential transformer
OU	Ohio University
PATB	Permeable asphalt treated base
PC	Pressure cell
PCC	Portland cement concrete
QC	Quality control
SDR	Standard Data Release
SHRP	Strategic Highway Research Program
SPS	Specific Pavement Studies
TCS	Test control software

1. BACKGROUND

The Long-Term Pavement Performance (LTPP) program conducted an internal review of the dynamic load response (DLR) data collected in 1996–1997 from Route US-23 in Delaware County north of Columbus, OH. Figure 1 shows the layout of the Strategic Highway Research Program (SHRP) test pavement for Specific Pavement Studies (SPS).(7) Forty test sections were constructed by the Ohio Department of Transportation on 3.5 mi of US-23. The test sections encompassed the SPS-1, SPS-2, SPS-8, and SPS-9 experiments. This study focused on the DLR data collected on Ohio SPS-1 (asphalt concrete (AC)) and SPS-2 (portland cement concrete (PCC)) test sections.

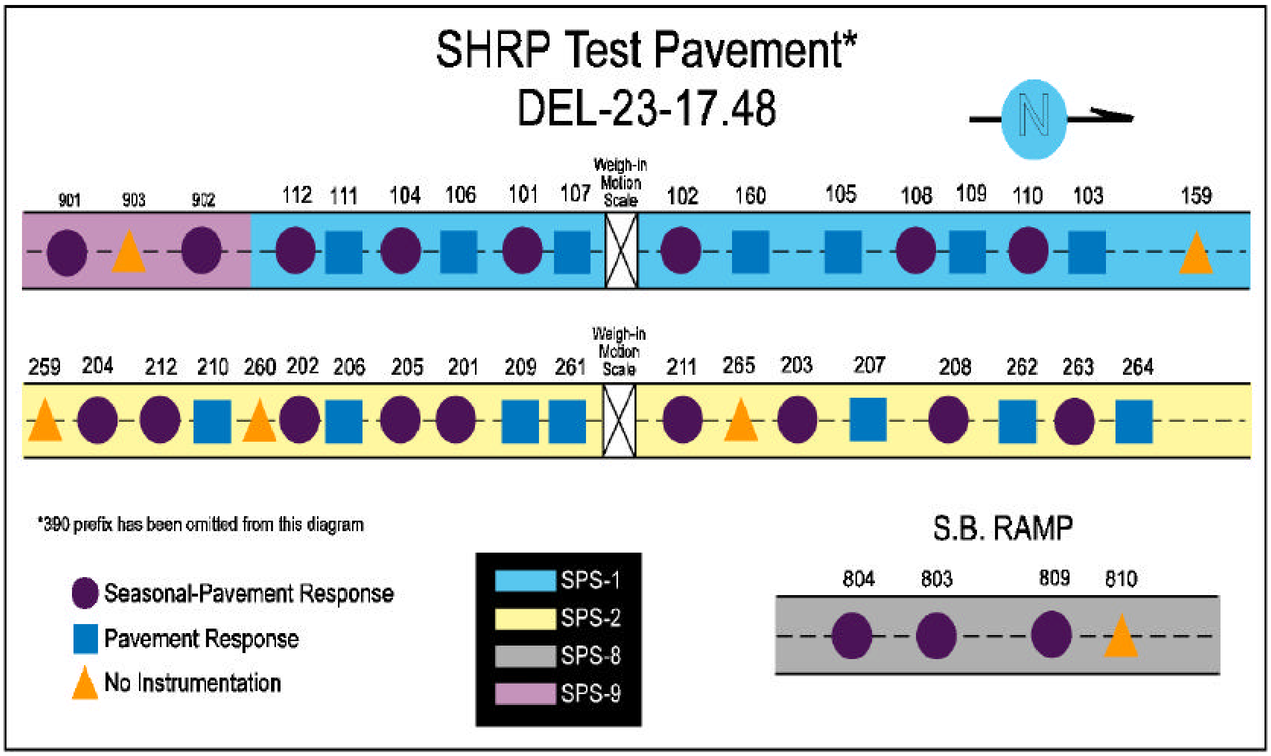


Figure 1. Illustration. SHRP test pavement layout.(7)

Figure 2 shows the instrumentation layout in plan and profile views as well as the pavement layer structure in profile view for Ohio SPS-1 test section 390102. The instrumentation consisted of strain gauges (transverse and longitudinal), linear variable differential transformers (LVDTs), and pressure cell (PC) sensors. In the plan view, the LVDTs are capped with a single-layer deflectometer. The sensors were deployed on the defined right wheelpath, which was 30 inches from the right pavement edge. A total of 12 sensors were deployed on test section 390102: 4 LVDTs (LVDT1 through LVDT4), 2 PCs (PC1 and PC2), and 6 strain gauges (Dyn7 through Dyn12).

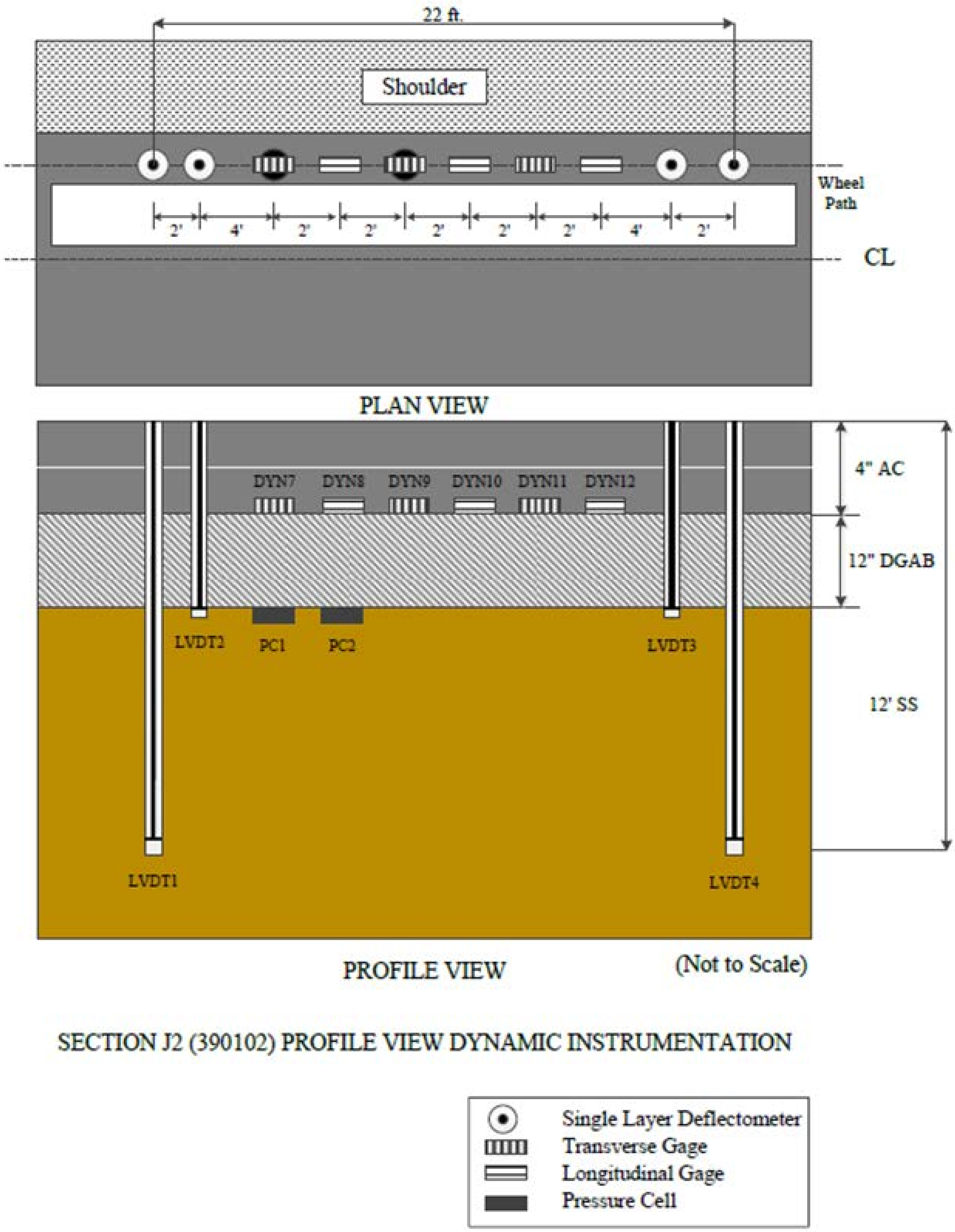


Figure 2. Illustration. Ohio SPS-1 test section 390102 sensor layout.

Each of the other SPS-1 test sections (390104, 390108, and 390110) had a total of nine strain gauge sensors, Dyn10 through Dyn18 (see appendix A). The number of LVDTs and PCs for those sections were the same as for test section 390102.

The profile view in figure 2 shows that Dyn7, Dyn9, and Dyn11 were buried in the transverse direction, whereas Dyn8, Dyn10, and Dyn12 were buried in the longitudinal direction. The trace pattern for a strain gauge sensor is contingent on the direction in which the sensor is laid. If a strain gauge is buried in the transverse direction, then the sensor would only display peaks (compressive strains) but not valleys (tensile strains) in a raw trace. In contrast, if a strain gauge is buried in the longitudinal direction, it would display both peaks and valleys in a raw trace.

In terms of sensor locations, the metrics for the SPS-1 (AC) test sections are as follows: X_AC is the distance along the direction of traffic as referenced from the start of the southernmost first LVDT gauge in the section; Y_AC is the distance from the shoulder joint as referenced from the start of the southernmost first LVDT gauge in the section; and Z is the distance from the pavement surface to the measurement point of the sensor. (Sensor layouts of Ohio SPS-1 test sections 390102, 390104, 390108, and 390110 are shown in figure 2 and figure 25 through figure 27.)

Figure 3 shows the instrumentation layout in plan and profile view as well as the pavement layer structure in profile view for Ohio SPS-2 test section 390212. The instrumentation consisted of strain gauges (Dynatest®), LVDTs, PCs, rossettes PMR-60, KM-100B gauges, Carlson A-8 gauges, and VCE-1200 VW gauges. The raw DLR traces for Ohio SPS-2 test jobs show time history data only for strain gauge and LVDT sensors; recorded time history data do not exist for the other sensors. A total of 16 LVDTs (LVDT1 through LVDT16) and 8 strain gauges (Dyn1 through Dyn8) were deployed on SPS-2 test sections. Test sections 390201, 390205, and 390208 had similar sensor instrumentation to that of test section 390212.

In terms of sensor locations, the metrics for the SPS-2 (PCC) test sections are as follows: X is the distance in millimeters along the direction of traffic as referenced from the entry slab corner; Y is the distance in millimeters from the shoulder joint as referenced from the entry slab corner; and Z is the distance in millimeters from the pavement surface to the measurement point of the sensor. (Sensor layouts of Ohio SPS-2 test sections 390201, 390205, 390208, and 390212 are shown in figure 50, figure 53, figure 60, and figure 67 in appendix C.)

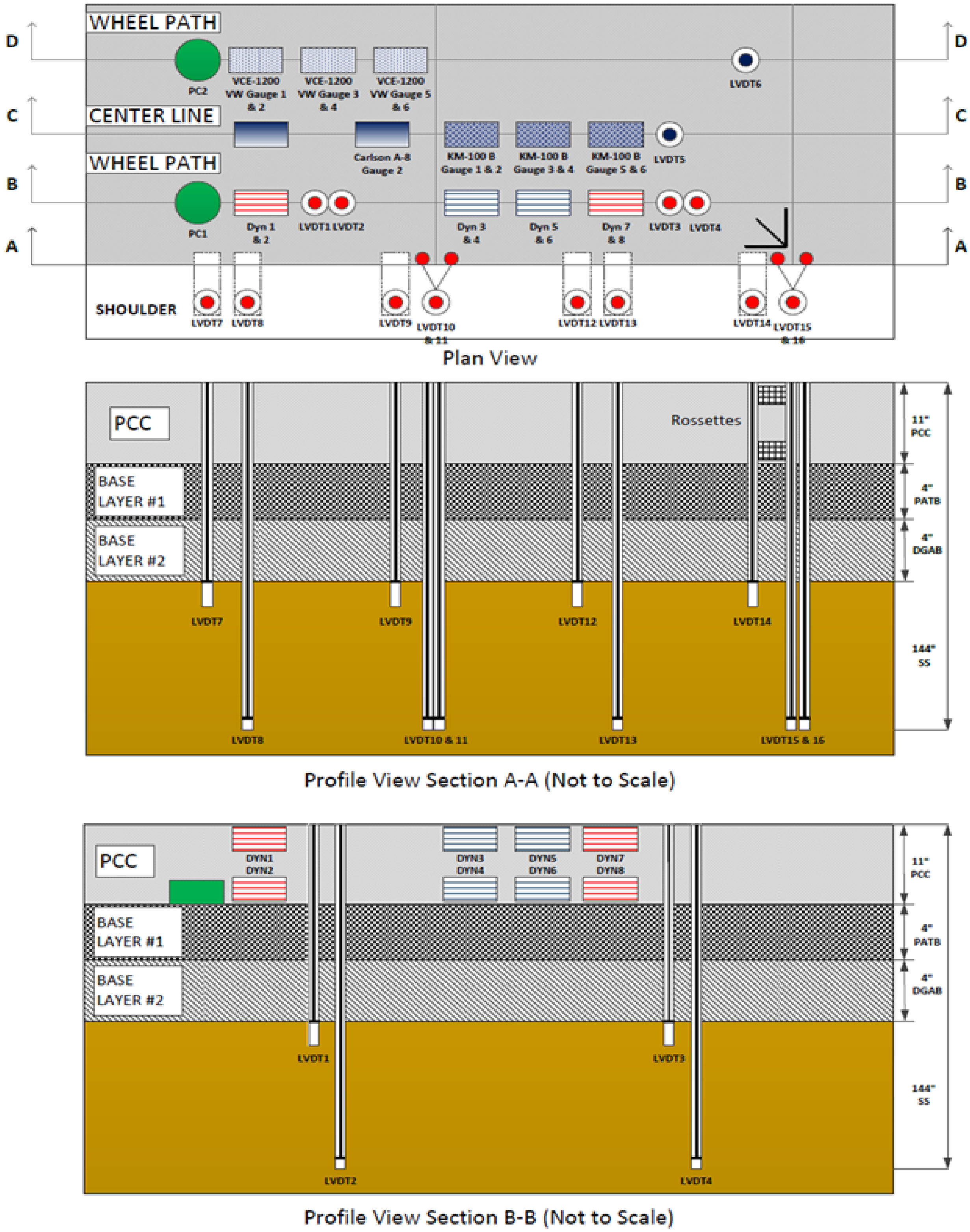


Figure 3. Illustration. Ohio SPS-2 test section 390212 sensor layout.

Since the completion of the Ohio SHRP test site in 1996, nine series of controlled vehicle tests have been conducted to monitor DLR under known vehicle parameters and environmental conditions. For the SPS-1 test sections, a series II test truck with a single or tandem rear axle was used in different tests (i.e., one rear axle configuration with load parameters was used in each test job). For the SPS-2 (PCC) test sections, series II and IV test trucks (each of which had a single or tandem rear axle configuration) were used in different test runs (i.e., within one test job, one test run used a single rear axle test truck, while the other test run used a tandem rear axle test truck).

Appendices A through E in this report show the sensor layouts in the Ohio SPS-1 and SPS-2 DLR test sections as well as the results, both numerically and in color-coded graphic form, of the 23 Ohio SPS-1 DLR test jobs and the 24 Ohio SPS-2 DLR test jobs.

2. PROBLEM STATEMENT

Several DLR data inconsistencies were identified by the data analysis/operations feedback reports (DAOFRs) Ecompex-75–77 and the technical memorandum, *Investigation of Ohio DLR data in LTPP Database*. (See references 2–5.) The inconsistencies were between SPS-1 DLR raw data and SPS-1 DLR data in LTPP Standard Data Release (SDR) 22.0 and concerned differences in strain gauge trace peaks and related time stamps, sensor locations, and wheelpath offsets.[6] Similar inconsistencies were also found between SPS-2 DLR raw data and SPS-2 DLR data in SDR 22.0.

Ecompex-75 and 76 and the technical memorandum indicated that the SPS-1 DLR data in SDR 22.0 had time lag shifts in pavement deflection peak strains when compared to the DLR raw data (i.e., the test control software (TCS) data in American Standard Code for Information Interchange (ASCII) format). (See references 2, 3, 5, and 6.) A *time lag shift* is defined as the difference in time stamps between two peak strains.

For test section 390102, figure 4 and table 1 compare the Dyn12 strain gauge peaks for a tandem-axle truck between SPS-1 DLR data in SDR 22.0 and raw DLR data. The data are from test J2C run 1. In figure 4, the Dyn12 raw data trace has three peaks. The first peak on the left was generated by the front axle, and the next two peaks were generated by the two rear axles. The SDR 22.0 Dyn12 trace has only two rear-axles peaks; the trace does not contain the front-axle peak.

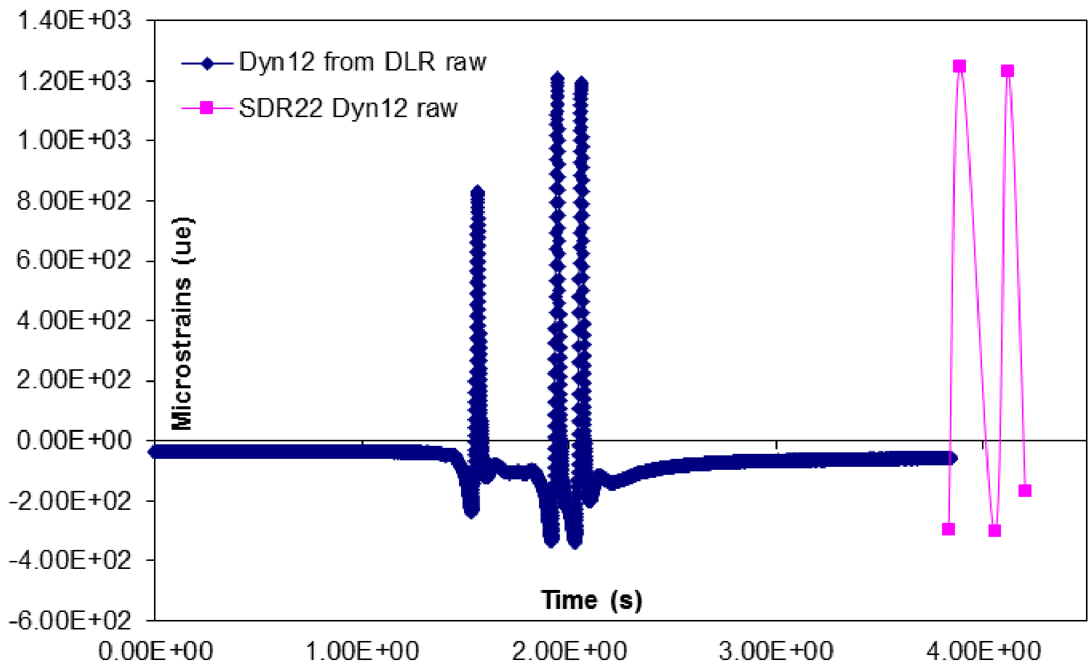


Figure 4. Graph. Dyn12 strain gauge traces for test section 390102 test J2C run 1 with 2,000.579 Hz.

Table 1. Dyn12 strain gauge data for test section 390102.

Test Name	Run	Test Date	Truck ID		Dyn12 Peak No.	TCS Raw		SDR 22.0 Raw		TCS Raw Versus SDR 22.0 Raw Time Lag Shift Factor
			TCS	SDR 22.0		Dyn12 (με)	Time (s)	Dyn12 (με)	Time (s)	
J2C	1	8/5/1996	2B	2	1	1,210.00	1.94	1,245.20	3.89	1.92
J2C	1	8/5/1996	2B	2	2	1,180.00	2.06	1,232.70	4.12	
J2C	2	8/5/1996	2B	2	1	1,180.00	1.83	1,282.70	3.81	N/A
J2C	2	8/5/1996	2B	2	2	1,300.00	1.94	1,315.20	N/A	
J2E	2	8/6/1996	2C	1	1	1,270.00	1.43	1,282.70	2.85	2.01
J2E	2	8/6/1996	2C	1	2	1,540.00	1.70	1,537.70	3.39	
J2E	3	8/6/1996	2C	1	1	999.00	0.87	1,015.20	1.74	1.97
J2E	3	8/6/1996	2C	1	2	1,440.00	1.15	1,455.20	2.29	
J2E	10	8/6/1996	2C	1	1	472.00	1.24	480.10	2.49	2.01
J2E	10	8/6/1996	2C	1	2	1,650.00	1.40	1,650.30	2.81	
J2G	1	8/9/1996	2D	1	1	736.00	1.13	740.10	2.25	2.00
J2G	1	8/9/1996	2D	1	2	1,110.00	1.41	1,117.70	2.81	

N/A = Data not available.
Note: For SDR 22.0 Truck ID, 1 refers to a single rear axle truck, and 2 refers to a tandem rear axle truck.

The time lag shift factor was computed by comparing strain gauge Dyn12 peak value time stamps between the TCS raw data and SDR 22.0 raw data. For example, for test J2C run 1, the time lag shift factor of 1.92 was computed as follows: $(4.12 - 3.89)/(2.06 - 1.95) = 1.92$.

The inconsistencies involving strain gauge locations and wheelpath offset values between the SPS-1 raw DLR data and DLR data in SDR 22.0 were reported in Ecompex-77.[4] Figure 5 shows a sample sketch of Dyn12 strain gauge locations using data from table 2. The strain gauge location of Dyn12 in the raw data was 16 ft from the end station of test section 390102; the Dyn12 strain gauge in SDR 22.0 was 8 ft from the end station of the section.

Inconsistent wheelpath offsets between the raw DLR data and DLR data in SDR 22.0 are shown in figure 5 and listed in table 2. The wheelpath offset data were measured from the defined wheelpath, which was 30 inches from the right pavement edge. The SDR 22.0 wheelpath offset data were measured from the right pavement edge. Figure 5 shows the wheelpath offset data (the raw data) as 23 inches and the SDR 22.0 wheelpath offset data as 21 inches. Thus, the total of the two offsets is 44 inches, which is inconsistent with 30 inches, the width of the defined wheelpath.

In the table, X_AC is the distance along the direction of traffic as referenced from the start of the first LVDT gauge in the section; Y_AC is the distance from the shoulder joint as referenced from the start of the first LVDT gauge in the section; and Z is the distance from the pavement surface to measurement point of sensor. For the Ohio raw data, X is the X-coordinate measured from southernmost joint of first instrumented slab in PCC sections or from southernmost deep LVDT in AC sections and increases to the north; Y is the y-coordinate measured from the right edge of pavement and increases to the left; and Z is the z-coordinate measured from surface of pavement and increases downward, which makes a left-handed coordinate system in the northbound lane.

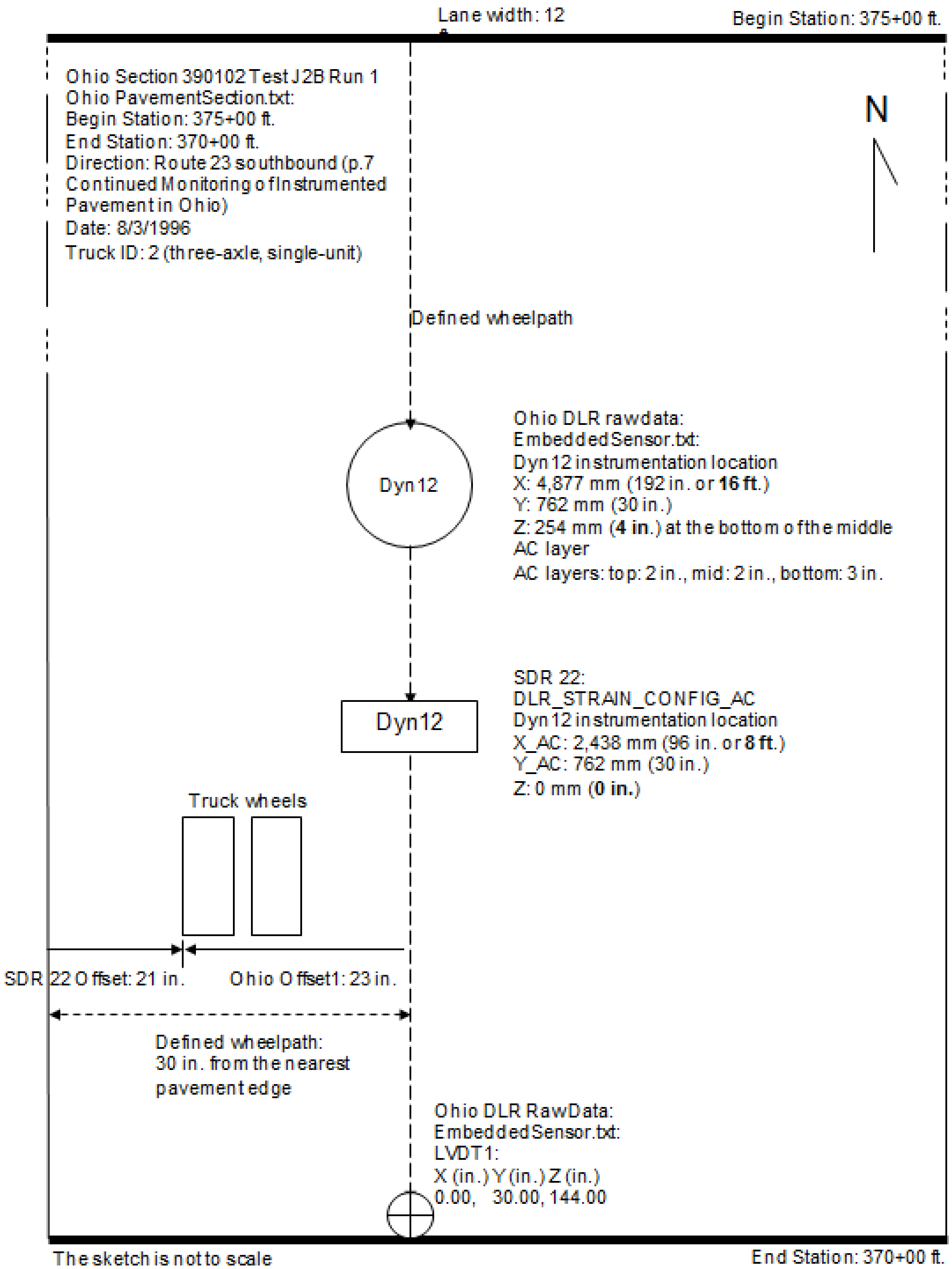


Figure 5. Illustration. Dyn12 strain gauge locations and wheelpath offsets for test section 390102.

Table 2. Strain gauge locations for SDR 22.0 and Ohio raw data.

Test Section ID	Test Name	Tag ID	DLR AC Strain Configuration for SDR 22.0 X_AC (inches)	Y_AC (inches)	Z (inches)	Ohio Raw Data X (inches)	Y (inches)	Z (inches)
390102	J2B	Dyn1	**216**	30	**0**	**72**	30	**2**
390102	J2B	Dyn2	**192**	30	**0**	**96**	30	**2**
390102	J2B	Dyn3	**168**	30	**0**	**120**	30	**2**
390102	J2B	Dyn4	144	30	**0**	144	30	**2**
390102	J2B	Dyn5	**120**	30	**0**	**168**	30	**2**
390102	J2B	Dyn6	**96**	30	**0**	**192**	30	**2**
390102	J2B	Dyn7	**96**	30	**0**	**72**	30	**4**
390102	J2B	Dyn8	96	30	**0**	96	30	**4**
390102	J2B	Dyn9	**96**	30	**0**	**120**	30	**4**
390102	J2B	Dyn10	**96**	30	**0**	**144**	30	**4**
390102	J2B	Dyn11	**96**	30	**0**	**168**	30	**4**
390102*	**J2B**	**Dyn12**	**96**	30	**0**	**192**	30	**4**
390102	J2B	Dyn13	**96**	72	**0**	**72**	72	**4**
390102	J2C	Dyn12	**96**	30	**0**	**192**	30	**4**
390102	J2C	Dyn13	**96**	72	**0**	**72**	72	**4**
390102	J2E	Dyn12	**96**	30	**0**	**192**	30	**4**
390102	J2E	Dyn13	**96**	72	**0**	**72**	72	**4**
390102	J2G	Dyn12	**96**	30	**0**	**192**	30	**4**
390102	J2G	Dyn13	**96**	72	**0**	**72**	72	**4**
390104	J4B	Dyn1	**216**	30	**0**	**72**	30	**2**
390104	J4B	Dyn2	**192**	30	**0**	**96**	30	**2**
390104	J4B	Dyn10	**96**	30	**0**	**72**	30	**7**
390104	J4B	Dyn11	96	30	**0**	96	30	**7**
390104	J4B	Dyn12	**96**	30	**0**	**120**	30	**7**
390104	J4B	Dyn13	**96**	30	**0**	**144**	30	**7**
390104	J4B	Dyn14	**96**	30	**0**	**168**	30	**7**
390104	J4B	Dyn15	**96**	30	**0**	**192**	30	**7**

*Indicates this scenario was plotted in figure 5.
Note: Bold text indicates inconsistent strain gauge locations.

Similar to the data for SPS-1, the SPS-2 (PCC) DLR data in SDR 22.0 had time lag shifts in pavement deflection peak strains when compared to raw DLR data and also had inconsistent sensor locations and wheelpath offset values. Figure 6 compares the Dyn5 strain gauge peaks for a tandem-axle truck between SPS-2 DLR data in SDR 22.0 and SPS-2 raw DLR data for Ohio test section 390201.

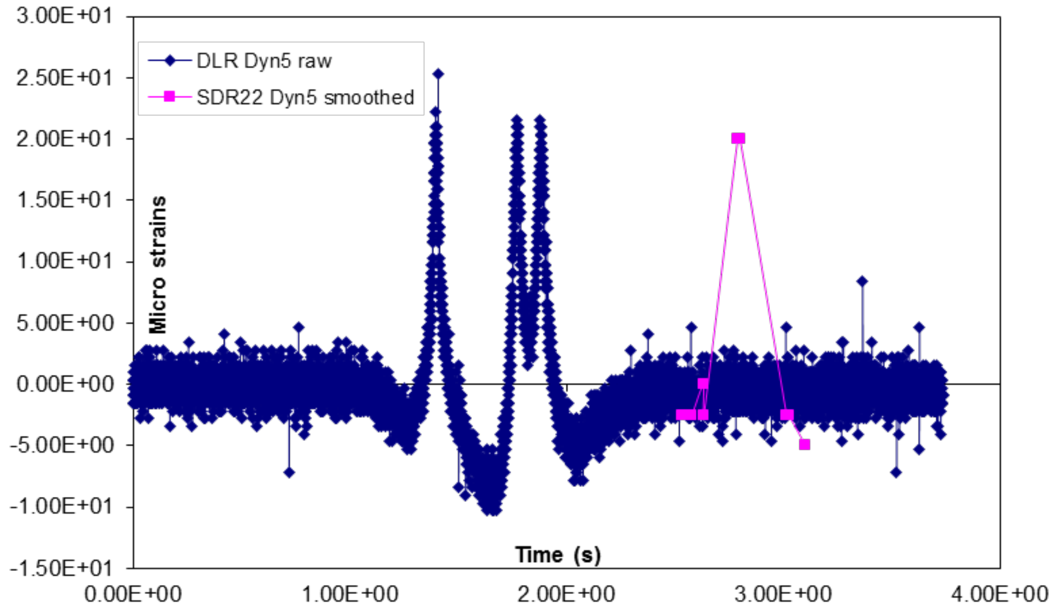


Figure 6. Graph. Dyn5 strain gauge traces for test section 390201 test J1A run 2.

3. OBJECTIVE

The primary objective of this study was to address the SPS-1 (AC) and SPS-2 (PCC) DLR data issues in SDR 22.0, which were identified in Ecompex-75–77 and the technical memorandum, *Investigation of Ohio DLR data in LTPP Database*, by re-interpreting the SPS-1 and SPS-2 DLR raw traces. (See references 2–6.) Processing the DLR raw data involved the following steps:

1. Smoothing the raw traces.

2. Performing quality control (QC) analysis for strain gauge, LVDT, and PC sensors by categorizing them as producing "good," "maybe," and "not good" traces and graphically depicting the results in the profile view of a test section's sensor layout.

3. Extracting trace peaks and valleys.

4. Correcting sensor locations and wheelpath offsets.

5. Populating the DLR tables in the next SDR using this study's processed DLR data.

4. DLR DATA

Ohio University (OU) submitted two datasets: the Ohio raw DLR data and the OU-processed DLR data. The raw DLR data contained the raw traces from each test job collected on SPS-1 and SPS-2 DLR test sections. The OU-processed DLR data had text files (e.g., EmbeddedSensor.txt, TruckPass.txt, TruckPeak.txt, etc.) pertaining to truck pass, truck run, truck peak, axle spacing, embedded senor, truck geometry, surface temperature, etc., for SPS-1, SPS-2, SPS-8, and SPS-9 test sections.

In this study, the DLR raw traces were collected by OPTIM Corporation's MEGADAC SERIES 3100 data acquisition system from the strain gauge, LVDT, and PC sensors for SPS-1 and SPS-2 test sections and were first converted to ASCII data format using TCS. To maintain consistency and clarity throughout this report, the term "DLR data" is used instead of ASCII formatted Ohio raw DLR data, and the term "Ohio data" is used for OU-processed DLR data in text files.

OHIO SPS-1 DATA

In the test summary provided in table 3, the SPS-1 DLR data contain a total of 34 tests, of which tests J2B, J8B, J8C, and J8F were empty, and tests J6J4K, J6J4L, J8J5K, J8J5L, J10BX, J10J9K, and J10J9L did not have information pertaining to sensor locations as was in OU text files EmbeddedSensor.txt, TruckPass.txt, and TruckPeak.txt in the SPS-1 data. Therefore, these 11 tests were excluded from processing due to incomplete information. A total of 23 tests were used for the SPS-1 DLR data processing. Each test had test files or runs in ASCII format. For example, test J2A had a total of 16 test runs named AJ2A.001 to AJ2A.016. Each test run contained raw traces collected by strain gauge, LVDT, and PC sensors.

The naming convention for a test run such as AJ2A.001 is as follows:

- The first letter, A, does not represent anything, as it is the same for all test runs.
- The second letter represents the test.
- The following number refers to the section (e.g., the "2" in J2 refers to test section 390102).
- The third letter represents visits to the site in alphabetical order (e.g., A for the first visit, B for the second visit, C for the third visit, etc.).
- The numeric extension is the test run number for that particular visit to that particular site.

Table 3 shows the test names, test run count, sensors count (number of sensors deployed for a particular sensor type for a particular test section), and sensors trace count.

Table 3. SPS-1 DLR data trace count.

Test Job	Test Section	Test Date	No. of Test Runs	No. of Strain Gauges (Count)	No. of LVDTs (Count)	No. of PCs (Count)	No. of Strain Gauge Traces (Sum)	No. of LVDT Traces (Sum)	No. of PC Traces (Sum)
J2A	390102	8/2/1996	16	6	4	2	96	64	32
J2C	390102	8/5/1996	10	6	4	2	60	40	20
J2D	390102	8/6/1996	16	6	4	2	96	64	32
J2E	390102	8/6/1996	13	6	4	2	78	52	26
J2F	390102	8/7/1996	8	6	4	2	48	32	16
J2G	390102	8/9/1996	12	6	4	2	72	48	24
J4A	390104	8/2/1996	16	9	4	2	144	64	32
J4B	390104	8/3/1996	13	9	4	2	117	52	26
J4C	390104	8/5/1996	10	9	4	2	90	40	20
J4D	390104	8/6/1996	15	9	4	2	135	60	30
J4E	390104	8/6/1996	13	9	4	2	117	52	26
J4F	390104	8/7/1996	12	9	4	2	108	48	24
J4G	390104	8/9/1996	12	9	4	2	108	48	24
J8A	390108	8/2/1996	16	9	4	2	144	64	32
J8D	390108	8/6/1996	15	9	4	2	135	60	30
J8E	390108	8/6/1996	13	9	4	2	117	52	26
J8G	390108	8/9/1996	12	9	4	2	108	48	24
J10A	390110	8/2/1996	16	9	4	2	144	64	32
J10C	390110	8/5/1996	10	9	4	2	90	40	20
J10D	390110	8/6/1996	16	9	4	2	144	64	32
J10E	390110	8/6/1996	12	9	4	2	108	48	24
J10F	390110	8/7/1996	13	9	4	2	117	52	26
J10G	390110	8/9/1996	12	9	4	2	108	48	24
Total							**2,484**	**1,204**	**602**
Grand Total								**4,290**	

OHIO SPS-2 DATA

The SPS-2 DLR data contained a total of 24 tests. All of the tests were used for data processing. Table 4 shows the test names, test run count, sensor count (number of sensors deployed for a particular sensor type for a particular test section), and sensor trace count. The SPS-2 DLR data did not contain any data from PC sensors.

Table 4. SPS-2 DLR data trace count.

Test Job	Test Section	Test Date	No. of Test Runs	No. of Strain Gauges (Count)	No. of LVDTs (Count)	No. of Strain Gauge Traces (Sum)	No. of LVDT Traces (Sum)
J1A	390201	8/12/1996	28	4	16	112	448
J1B	390201	8/13/1996	24	4	16	96	384
J1C	390201	8/14/1996	14	4	16	56	224
J5A	390205	8/12/1996	29	4	16	116	464
J5B	390205	8/13/1996	25	4	16	100	400
J5C	390205	8/14/1996	14	4	16	56	224
J8A	390208	8/12/1996	26	4	16	104	416
J8B	390208	8/13/1996	26	4	16	104	416
J8C	390208	8/14/1996	17	4	16	68	272
J12A	390212	8/12/1996	4	4	16	16	64
J12B	390212	8/13/1996	26	4	16	104	416
J12C	390212	8/14/1996	14	4	16	56	224
J5J1M	390205	7/29/1997	18	4	16	72	288
J5J1N	390205	7/30/1997	18	4	16	72	288
J5J1O	390205	7/30/1997	18	4	16	72	288
J5J1P	390205	8/06/1997	18	4	16	72	288
J8S3M	390208	7/29/1997	18	4	16	72	288
J8S3N	390208	7/30/1997	18	4	16	72	288
J8S3O	390208	7/30/1997	18	4	16	72	288
J8S3P	390208	8/06/1997	18	4	16	72	288
J12J10M	390212	7/29/1997	18	4	16	72	288
J12J10N	390212	7/30/1997	18	4	16	72	288
J12J10O	390212	7/30/1997	18	4	16	72	288
J12J10P	390212	8/06/1997	17	4	16	68	272
Total						**1,848**	**7,392**
Grand Total						**9,240**	

5. METHODOLOGY

This section presents a step-by-step approach of the study methodology used to process the Ohio SPS-1 and SPS-2 DLR data using Matlab®.[8] For the SPS-1 data that had relatively distinct pavement deflection signal peaks and valleys, a peak finding algorithm was developed using the tools available in Matlab® to perform the first five steps of the methodology. For the SPS-2 data that had indistinctive pavement deflection signal peaks and valleys with significant noise, a bandpass filter algorithm was developed using the Matlab® toolbox to perform the methodology. The methodology was as follows:

1. Calibrate the DLR data.
2. Apply gain adjustment factors.
3. Smooth the raw traces.
4. Extract trace peaks and valleys.
5. Perform a QC analysis.
6. Correct sensor locations and wheelpath offsets.

DLR DATA CALIBRATION

Ohio SPS-1 Data Calibration

The Ohio SPS-1 DLR data had two sensor types in need of data calibration: LVDTs and PCs. Calibration factors were obtained from OU, and the LTPP team clarified that all LVDT calibrations (approximately 600 LVDTs) were linear and passed through the origin with slopes ranging from 19.5 to 20.5 V/inch. Therefore, an average value of 20.0 V/inch was used to convert LVDT traces from voltage to pavement deflection in inches. For all the PC sensors, a factor of 10 psi/V was used, which was generally correct to within ±2 percent according to OU.[9] Dynatest® strain gauges were calibrated using the MEGADAC data acquisition system in the one-fourth Wheatstone bridge setup and did not require any calibrations. Units of strain gauge traces were in microstrain (µe). All calibrations for LVDT and PC sensors were computed in Matlab®.[8]

Ohio SPS-2 Data Calibration

For the Ohio SPS-2 data, only the LVDT sensor type was in need of data calibration. As with LVDT calibration in the SPS-1 data, LVDT calibration factors with an average value of 20.0 V/inch were used to convert LVDT traces from voltage to pavement deflection in inches. LVDT data calibrations were also completed using Matlab®.[8]

GAIN ADJUSTMENT FACTOR

Following calibration, the sensor traces were normalized to base zero on the y-axis (pavement deflection) so that the resulting peak values represented the change due to load response. Base zero was under no load conditions. A gain adjustment factor was calculated as the average of the first 500 data points in a calibrated raw trace. The factor was subtracted from each trace data point to normalize the trace to zero on the y-axis. Theoretically, the number of data points needed to determine a gain adjustment factor is about 10 percent of the data collection frequency for each sensor. If data collection frequency is 2,000 Hz, the number of data points needed to determine a gain adjustment factor is 10 percent of 2,000 Hz, or 200 data points per second. If data collection frequency is 500 Hz, the number of data points needed to determine a gain adjustment factor is 10 percent of 500 Hz, or 50 data points per second. In this study, the DLR study team decided to use the first 500 data points to average a gain adjustment because the SPS-1 gain adjustment factors appeared to stabilize when the number of data points was about 500. Similarly, the team used the first 500 data points to determine a gain adjustment factor for the SPS-2 data.

Ohio SPS-1 Gain Adjustment Factor

Each SPS-1 time history dataset in the majority of the DLR raw trace files contained, on average, 5,000 data points. A sample size of 10 percent (500 data points) of the time history measurements was considered reasonable to calculate the gain adjustment factor. The DLR study team also computed the gain adjustment factor considering 200, 300, and 400 data points at the start of the trace, but there was not any significant difference in mean values for these sets of data points. For example, the computed mean values for the AJ2A.007 test run were -1.0470, -1.1168, -1.1345, and -1.1326 for 200, 300, 400, and 500 data points, respectively. The mean value of the first 500 data observations was subtracted from each observation of a sensor raw trace to normalize the trace to zero on the y-axis (pavement deflection). For example, assuming that the Dyn12 strain gauge trace in test J2F had a total of 6,000 observations, the mean value of the first 500 observations was subtracted from each observation of the total 6,000 observations. The algorithm adjusted all sensor traces to base zero on the y-axis for all files in test J2F.

Ohio SPS-2 Gain Adjustment Factor

Each SPS-2 time history dataset in the majority of the DLR raw trace files contained, on average, close to 7,000 data points. Due to stiffer PCC sections compared to the SPS-1 AC sections, the SPS-2 data had significantly more noise and lower pavement deflection magnitudes. Nevertheless, the mean value of the first 500 data observations—the same number used to normalize the SPS-1 datasets—was subtracted from each observation of a sensor raw trace to normalize the trace to zero on the y-axis (pavement deflection). In retrospect, due to significant noise in the SPS-2 data, the first 500 data points may not have been sufficient. In future research, the first 700 data points is recommended for determining a gain adjustment factor for the SPS-2 data. A total of 700 data points amount to approximately 10 percent of each SPS-2 time history dataset. Furthermore, due to significant noise in the SPS-2 data, it is extremely difficult to identify peaks and valleys in raw traces of the data. Thus, smoothing the SPS-2 raw traces become necessary; only from a smoothed trace can peaks and valleys be extracted.

SMOOTHING RAW TRACES

Smoothing SPS-1 DLR Data Traces

Smoothing of raw sensor traces was necessary to eliminate redundant local minima, local maxima, and noise. The DLR tables in SDR 22.0 have time stamp columns and location (pavement deflection value) stamp columns for both raw and smoothed traces for all strain gauge, LVDT, and PC sensors. In this study, the mslowess function available in the Matlab® bioinformatics toolbox was explored to smooth sensor traces, where "ms" stands for mass spectrometry and "lowess" stands for locally weighted scatterplot smoothing method and assumes a default span of 10 data samples.(10) For the SPS-1 raw traces collected by strain gauge, LVDT, or PC, the mslowess function was used for smoothing.

Smoothing SPS-2 DLR Data Traces

The SPS-2 strain gauge raw traces were significantly noisier and of lower deflection magnitude due to stiffer PCC sections. Thus, it was extremely difficult to extract pavement deflection peaks and valleys. Figure 7 shows a comparison plot of a normalized raw trace in red versus a moving median-smoothed trace in blue versus a bandpass filter-smoothed trace in green as sampled from Dyn8 strain gauge in SPS-2 test section 390201 test J1A run 27. The figure demonstrates the level of noise and magnitude of the signal associated with a typical SPS-2 raw trace collected from a strain gauge compared to the signals associated with smoothed traces. The SPS-2 LVDT raw traces did not appear to be as noisy as did the strain gauge traces; therefore, the moving median function was used to smooth SPS-2 LVDT raw traces.

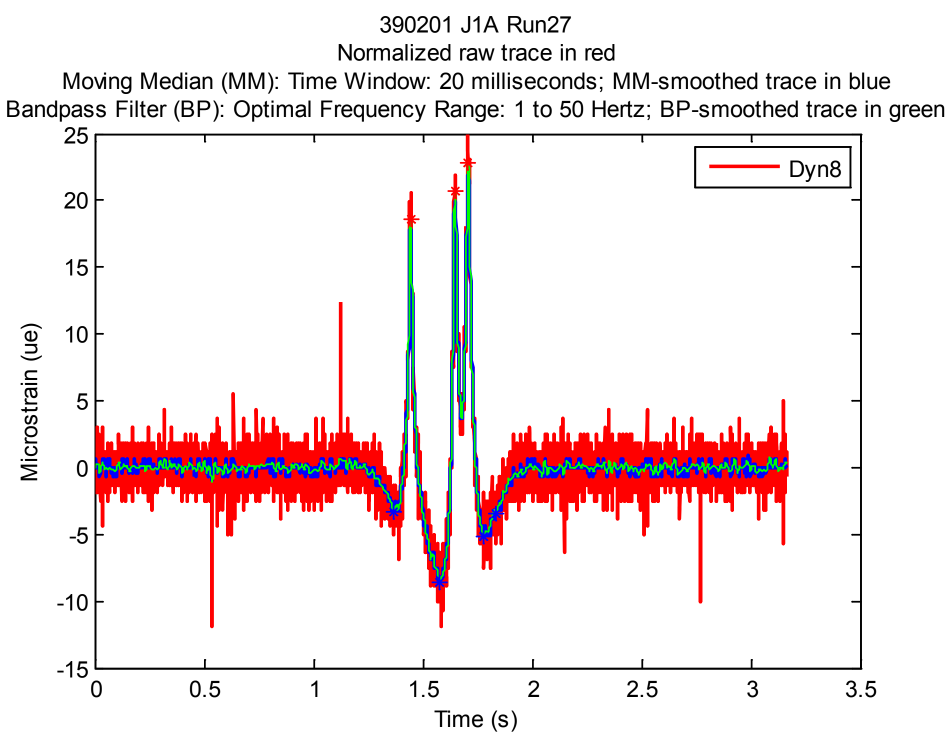


Figure 7. Graph. Normalized Dyn8 strain gauge raw traces for Ohio SPS-2 test section 390201 test J1A run 27.

The bandpass filter function in Matlab® appears to be a feasible solution for filtering out the significant noise in SPS-2 strain gauge raw traces, as shown in figure 8. Before the noise is filtered, the power density function in Matlab® can be used to identify an optimal bandpass filtering frequency range by plotting the power density of a raw trace. The optimal range can be further tightened by comparing bandpass filter-smoothed trace plots created within various narrower frequency ranges. In general for the SPS-2 strain gauge raw traces, 1 to 50 Hz appeared to be the optimal filtering frequency range for the bandpass filter. Thus, it was the filtering frequency range chosen for the bandpass filter to smooth the SPS-2 strain gauge raw traces. Figure 8 shows a magnified view of the three trace peaks in figure 7: a normalized raw trace (red), a moving median-smoothed (with a moving average window of 20 ms) trace (blue), and a bandpass filter-smoothed trace (green). The bandpass filter-smoothed trace in green appears to approximate the raw trace peaks in red better than the moving median-smoothed trace in blue. Also, the bandpass filter-smoothed trace in green appears to demonstrate the least noise.

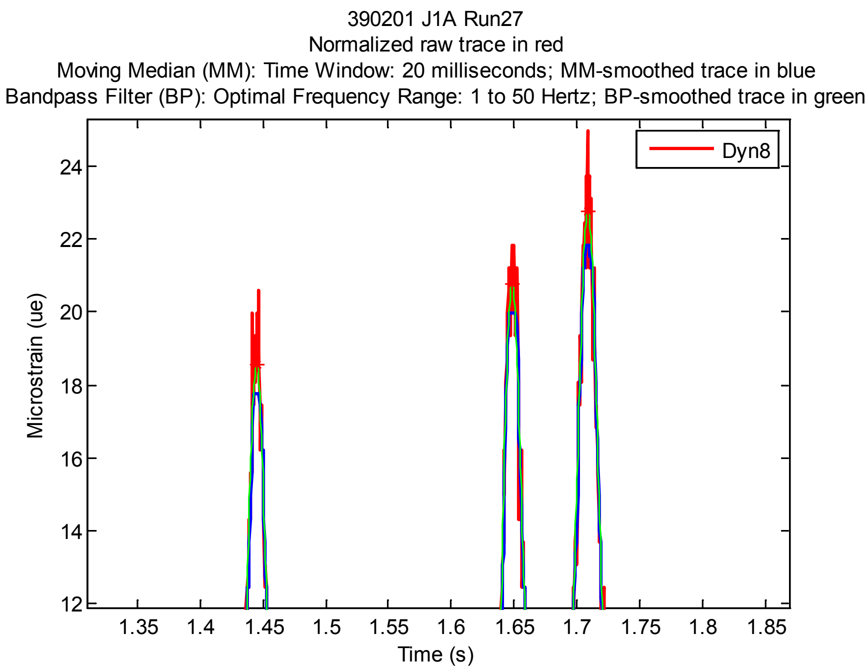


Figure 8. Graph. Magnified view of the three trace peaks in figure 7.

EXTRACTING TRACE PEAKS AND VALLEYS

Extraction of Ohio SPS-1 Trace Peaks and Valleys

The mspeaks function of Matlab® was used to extract the trace peaks and valleys from both the raw and smoothed traces from strain gauges, LVDTs, and PCs for the SPS-1 data.[11] The function finds the relevant peaks in raw noisy peak trace data and creates a peak list, which is a two-column matrix containing the time stamp value and magnitude (location stamp) value for each peak. The mspeaks function has input arguments such as height filter value and over-segmentation filter value to locate peaks. The height filter value is a positive real value that specifies the minimum height for reported peaks, and the over-segmentation filter value is a positive real value that specifies the minimum distance in time stamp units between neighboring peaks. When a trace is not smoothed appropriately, multiple maxima can appear to represent the same peak. Increasing the filter value helps to join over-segmented peaks into a single peak. The default value for both arguments is zero. The extracted trace peaks and valleys identified from the mspeaks function are used in QC analysis to categorize the sensor traces. Figure 9 shows the extracted peaks (red stars), valleys (green stars) and identifying information for a smoothed longitudinal trace from a Dyn11strain gauge sensor.

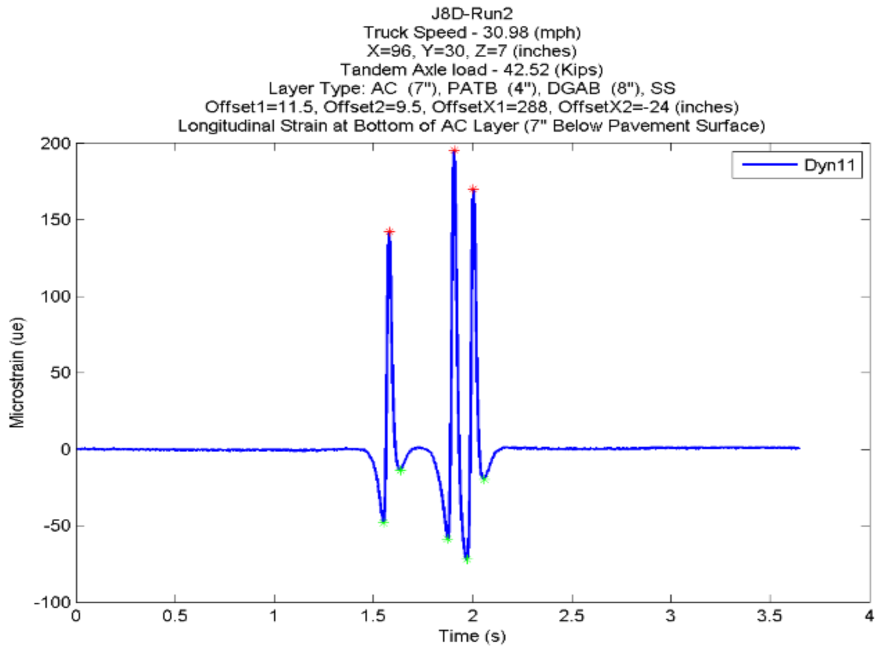


Figure 9. Graph. Extracted trace peaks and valleys from an Ohio SPS-1 test run.

Extraction of Ohio SPS-2 Trace Peaks and Valleys

The mspeaks function of Matlab® was used to extract the trace peaks and valleys from only the smoothed traces for the SPS-2 data because the raw traces were too noisy for extraction.(11) Figure 10 shows the bandpass filter-smoothed trace from test J1A run 27 for Dyn8. The red stars in the figure indicate the pavement deflection signal peaks, and the blue stars indicate the signal valleys. The local valley (blue star) near 2 s was manually removed before incorporating the extracted peaks and valleys and their time stamps into the DLR_STRAIN_TRACE_SUM_PCC table in SDR 27.0 database.(1)

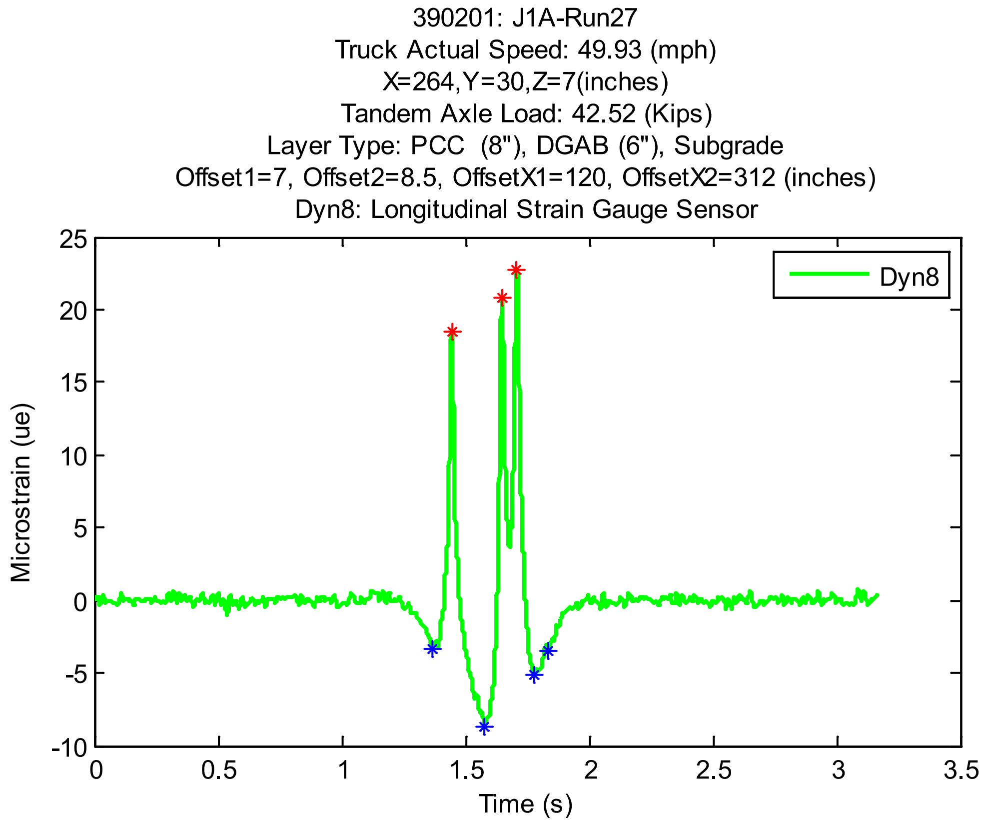


Figure 10. Graph. Extracted trace peaks and valleys from an Ohio SPS-2 test run.

QC ANALYSIS

QC analysis is a process used to assess data quality. It provides insight into data quality issues and helps in decisionmaking. In this study, a QC analysis was performed to categorize the sensor raw and smoothed traces into three quality categories: good, maybe, and not good. The QC analysis was based on the number of peaks and the difference between the beginning and the ending offset of a trace. A peak occurs with the passage of an axle. Thus, the passage of a single-axle dump truck ideally produces two peaks (the single front axle and the single rear axle), and the passage of a tandem-axle dump truck ideally produces three peaks (the single front axle and the two rear axles). An offset is a reference point of value averaging two hundred data points in a trace.

The three criteria used to categorize DLR raw and smoothed traces include the following:

- **Good**: Number of peaks is equal to the number of test truck axles, and the difference between the beginning and the ending offset is less than 10 percent of the first peak.
- **Maybe**: Number of peaks is equal to the number of test truck axles, and the difference between the beginning and the ending offset is more than 10 percent of the first peak.
- **Not good**: Number of peaks is less than or greater than the number of test truck axles.

Ohio SPS-1 QC Analysis

Figure 11 has three transverse strain gauge trace charts for good, maybe, and not good traces. The graph on the left satisfied the good trace criterion: the number of peaks (two) was equal to the number of test truck axles (a single-axle truck (two axles) made the test run), and the difference in the beginning and ending offset was less than 10 percent of the first peak. The middle graph satisfied the number of peaks (three; a tandem-axle truck with a total of three axles made the test run) but failed to satisfy the difference in the beginning and ending offset of less than 10 percent of the first peak. The difference in the beginning and ending offset was more than 10 percent, satisfying the maybe trace criterion. The graph on the right did not satisfy the number of peaks (three) for a tandem-axle truck; it had multiple peaks. Thus, it was categorized as a not good trace.

Figure 12 shows SPS-1 LVDT trace categorization. There is no figure for SPS-1 PC traces; almost all (99 percent) of the raw and smoothed traces from SPS-1 PCs were categorized as good traces.

Ohio SPS-2 QC Analysis

Due to significant noise in SPS-2 strain gauge and LVDT raw traces, only smoothed SPS-2 strain gauge and LVDT traces were categorized using the trace categorization approach. Figure 13 and figure 14 show sample categorization results for longitudinal strain gauge and LVDT traces, respectively.

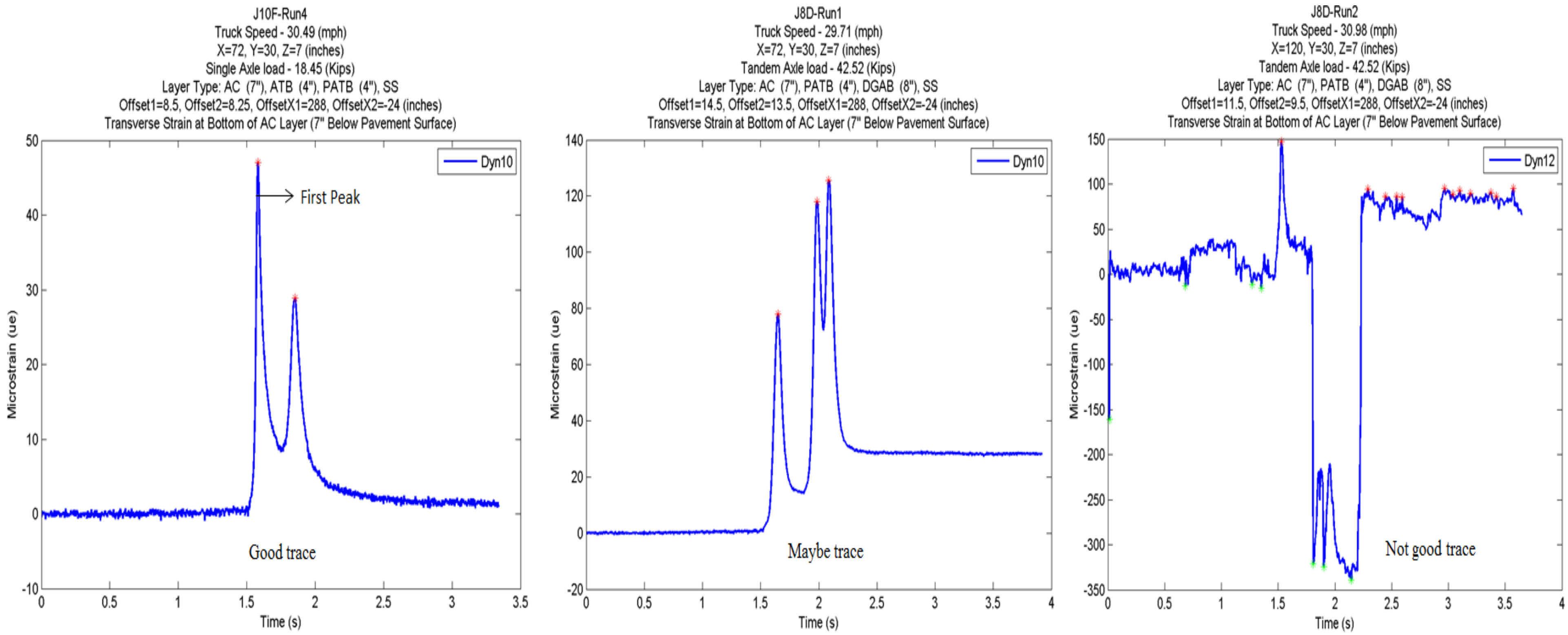


Figure 11. Graph. Ohio SPS-1 transverse strain gauge trace categorization.

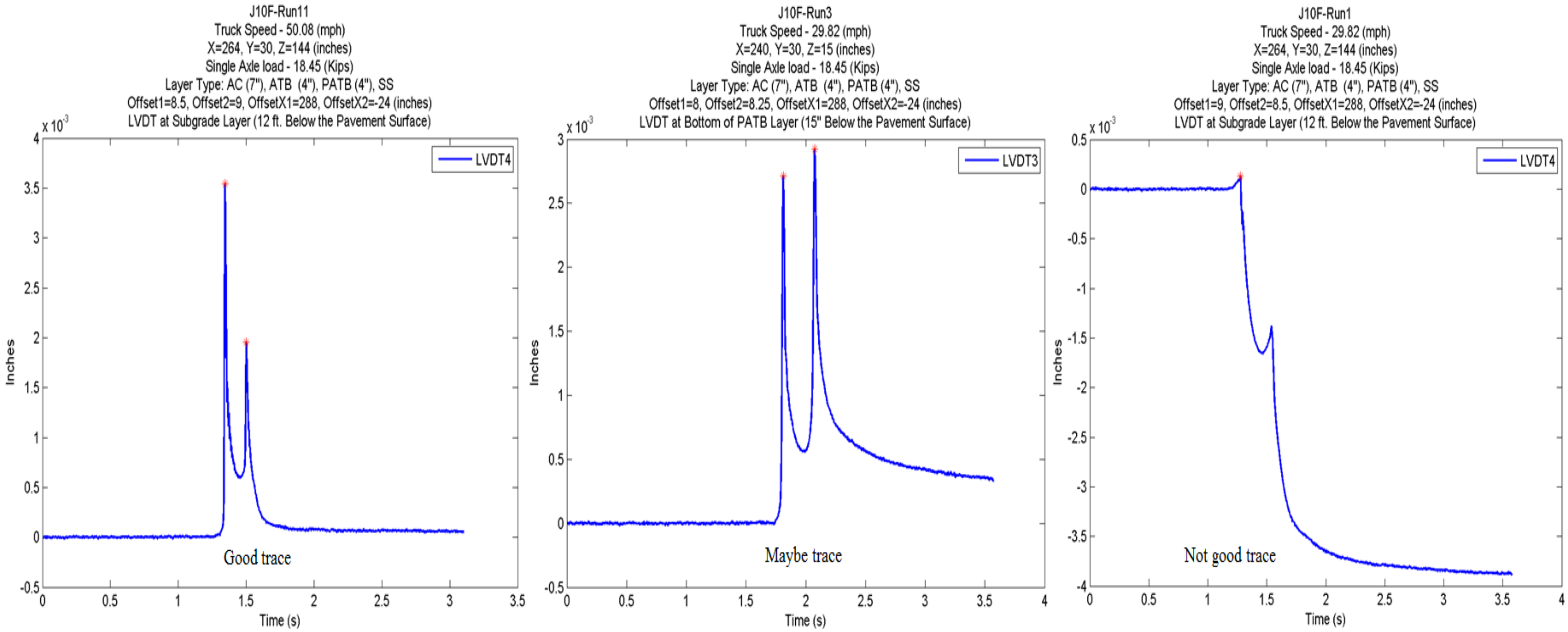


Figure 12. Graph. Ohio SPS-1 LVDT trace categorization.

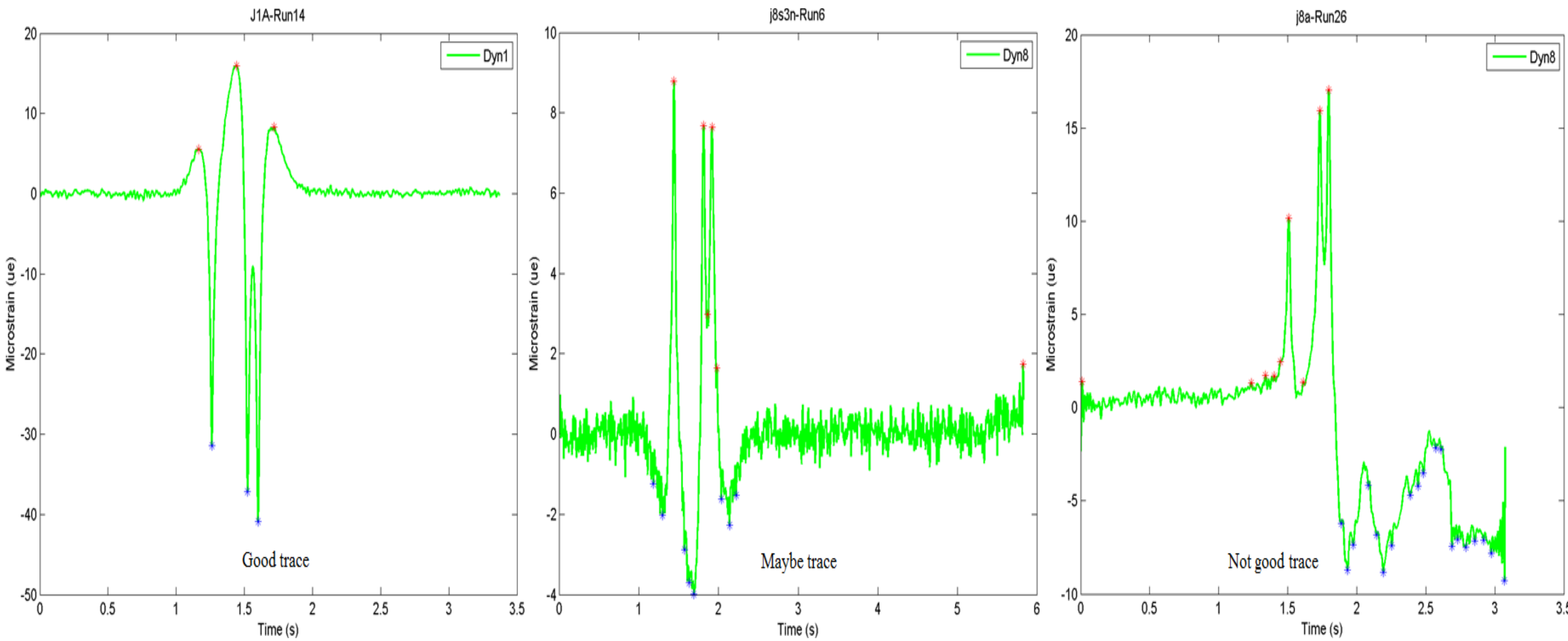


Figure 13. Graph. Ohio SPS-2 longitudinal strain gauge trace categorization.

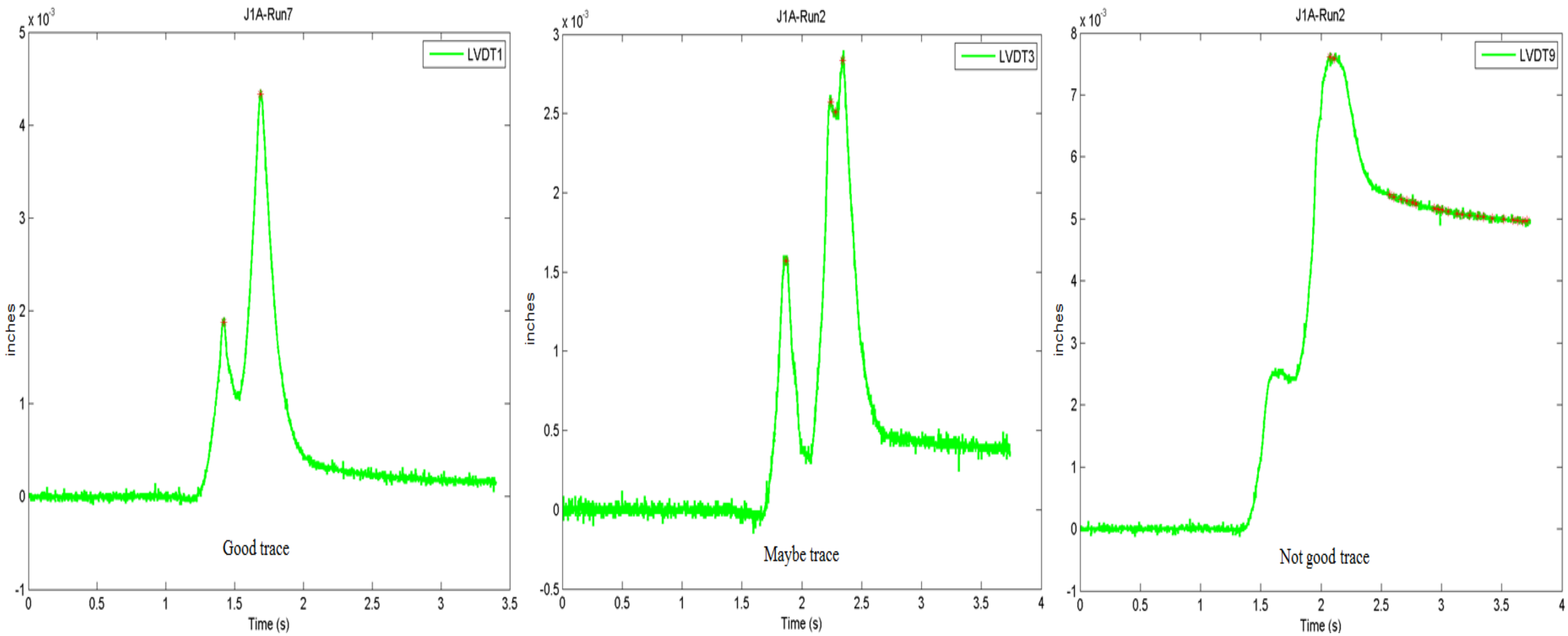


Figure 14. Graph. Ohio SPS-2 LVDT trace categorization.

CORRECTING SENSOR LOCATIONS AND WHEELPATH OFFSETS

Inconsistent sensor locations between SPS-1 and SPS-2 data and SDR 22.0 were corrected using the embedded sensor data in the OU dataset (EmbeddedSensor.txt). An inner join procedure, based SDR 22.0 tables on STATE_CODE, SHRP_ID, and TAG_ID as matching columns, was used that joined all the columns in the DLR_STRAIN_CONFIG_AC table with the strain gauge sensor location (columns X, Y, and Z) in the embedded sensor data. LVDT and PC sensor locations in the DLR_LVDT_CONFIG_AC and DLR_PC_CONFIG_AC tables were also corrected using the same embedded sensor data.(6)

Similarly, the inconsistent wheelpath offset data in DLR_TEST_MATRIX table were updated using the OU truck pass (TruckPass.txt) data, OU truck run (TruckRun.txt) data, and raw DLR ASCII data.(6) However, the DLR_TEST_MATRIX table in SDR 22.0 has wheelpath offset records for both Ohio and North Carolina test sections. Only Ohio wheelpath offset records were inner joined with STATE_CODE, SHRP_ID, SUBSERIES, and RUN_NUMBER as matching columns in the Ohio TruckPass.txt data. Since the wheelpath offset data for North Carolina test sections were not available, the North Carolina wheelpath offset records were not updated.

6. QC RESULTS

OHIO SPS-1 DATA QC RESULTS

This section presents the results from the application of the methodology described in chapter 5 to process DLR raw data. The results were useful in making decisions as to which quality DLR data (good and maybe traces by test job and by sensor type) should be included into SDR 27.0.(1) Also, the QC-processed DLR data can be used to determine the approaches and methodologies most appropriate for applications in pavement analysis and design processes.

Smoothed Trace Processing

Each of the 23 tests in the SPS-1 DLR data was separately processed using Matlab®.(8) Test J2F, which had eight test runs (AJ2F.001 through AJ2F.008) is used to illustrate the working of the methodology described in chapter 5 in Matlab®. The peak finding algorithm developed was test specific; that is, the algorithm ran through all the test runs (files) in a particular test. It imported all the runs in test J2F into the Matlab® environment. Calibration factors discussed in the first step of the methodology were applied to LVDT and PC sensors to convert them into pavement deflection in inches and test vehicle loading in pounds per square inch. As discussed in the third step of the methodology, sensor traces for three sensor types—strain gauge, LVDT, and PC—for all runs in test J2F were smoothed using the mslowess function available in the Matlab® bioinformatics tool box.(10)

The QC part of the methodology checked trace quality categorization for all smoothed sensor traces in test J2F based on three criteria: good, maybe, and not good. The QC results were saved separately into a Microsoft Excel® file using sensor type and test name as the file name (e.g., LVDT_J2F_QC for an LVDT sensor in test J2F). QC results in the Microsoft Excel® file were checked manually for each smoothed trace to correct any improperly categorized traces.

Table 5 shows the summarized QC results for each run number and sensor type for test J2F. Numbers 1 through 3 for strain gauge (Dyn7 to Dyn12), LVDT (LVDT1 to LVDT2), and PC (PC1 and PC2) sensors in table 6 represent the trace quality in good, maybe, and not food trace categories respectively. In test J2F, there were 48 strain gauge traces of which 16 traces were good (the eight “1s” or good traces in the Dyn9 column plus the eight “1s” in the Dyn12 column).

Table 5. Summarized QC results for smoothed traces in Ohio SPS-1 test J2F.

Run No.	Dyn						LVDT				PC	
	7	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**	**4**	**1**	**2**
1	3	3	1	3	3	1	1	2	1	1	1	1
2	3	3	1	3	3	1	1	1	1	1	1	1
3	3	3	1	3	3	1	1	2	1	1	1	1
4	3	3	1	3	3	1	1	1	1	1	1	1
5	3	3	1	3	3	1	1	2	1	1	1	1
6	3	3	1	3	3	1	1	1	1	1	1	1
7	3	3	1	3	3	1	1	1	1	1	1	1
8	3	3	1	3	3	1	1	1	1	1	1	1
Total												
Good	0	0	8	0	0	8	8	5	8	8	8	8
Maybe	0	0	0	0	0	0	0	3	0	0	0	0
Not good	8	8	0	8	8	0	0	0	0	0	0	0

Table 6. Peaks and valleys extracted for smoothed traces in test J2F (µe).

Tag ID	Test Name	Run	Time Smooth 1	Strain Value Smooth 1	Time Smooth 2	Strain Value Smooth 2	Time Smooth 3	Strain Value Smooth 3	Time Smooth 4	Strain Value Smooth 4	Time Smooth 5	Strain Value Smooth 5	Time Smooth 6	Strain Value Smooth 6
Dyn9	J2F	1	1.58	228.28	1.85	333.01								
Dyn9	J2F	2	1.59	759.57	1.84	296.37								
Dyn9	J2F	3	1.52	709.65	1.76	301.81								
Dyn9	J2F	4	1.50	718.30	1.74	276.85								
Dyn9	J2F	5	1.60	1067.32	1.83	341.22								
Dyn9	J2F	6	1.52	822.41	1.71	281.21								
Dyn9	J2F	7	1.53	293.97	1.72	245.72								
Dyn9	J2F	8	1.43	481.43	1.62	228.29								
Dyn12	J2F	1	1.43	433.04	1.70	796.86	1.40	-110.72	1.47	-58.19	1.67	-196.59	1.75	-119.02
Dyn12	J2F	2	1.44	677.99	1.72	893.38	1.41	-173.41	1.49	-60.70	1.69	-214.46	1.77	-123.61
Dyn12	J2F	3	1.38	636.70	1.65	872.43	1.36	-167.57	1.43	-70.65	1.62	-229.22	1.70	-122.18
Dyn12	J2F	4	1.35	641.91	1.62	937.55	1.33	-179.50	1.40	-75.22	1.59	-225.53	1.67	-129.91
Dyn12	J2F	5	1.47	766.11	1.72	967.68	1.45	-217.15	1.51	-83.93	1.69	-242.25	1.77	-118.40
Dyn12	J2F	6	1.41	627.06	1.62	1086.41	1.39	-225.64	1.45	-86.46	1.60	-277.34	1.66	-117.95
Dyn12	J2F	7	1.42	441.83	1.62	1089.63	1.40	-185.48	1.46	-77.49	1.60	-280.45	1.66	-108.65
Dyn12	J2F	8	1.32	547.97	1.52	1141.55	1.30	-212.76	1.36	-79.22	1.50	-284.95	1.56	-119.13

Note: Dyn 9 sensor which is laid in transverse direction for test section J2 has two trace peaks. Time stamp and strain value information for those two peaks is presented and remaining cells are shown as blank cells. Whereas, Dyn 12 sensor which is laid in longitudinal direction for the same test section has two peaks and four valleys. A total of six time stamps and strain values are shown.

The QC results obtained for test J2F are shown in figure 15. The trace quality obtained from the two sensor types (strain gauge and LVDT) are graphically presented either in combination or separately in green, orange, and red colors to represent good, maybe and not good sensors. For example, strain gauge sensors Dyn7, Dyn8, Dyn10, and Dyn11 are in red, indicating data in the not good category, whereas Dyn9, Dyn12, LVDT1, LVDT3, and LVDT4 are in green indicating data in the good category. The LVDT2 sensor is in a combination of orange and green, meaning that the data obtained from this sensor was of good quality for some runs and of maybe quality for the remaining runs. Except for three traces, the QC results obtained for PC sensors were in the good category for all of the traces; they are not represented in colors in the drawings. Graphical representation of QC results for all 23 tests are in appendix B.

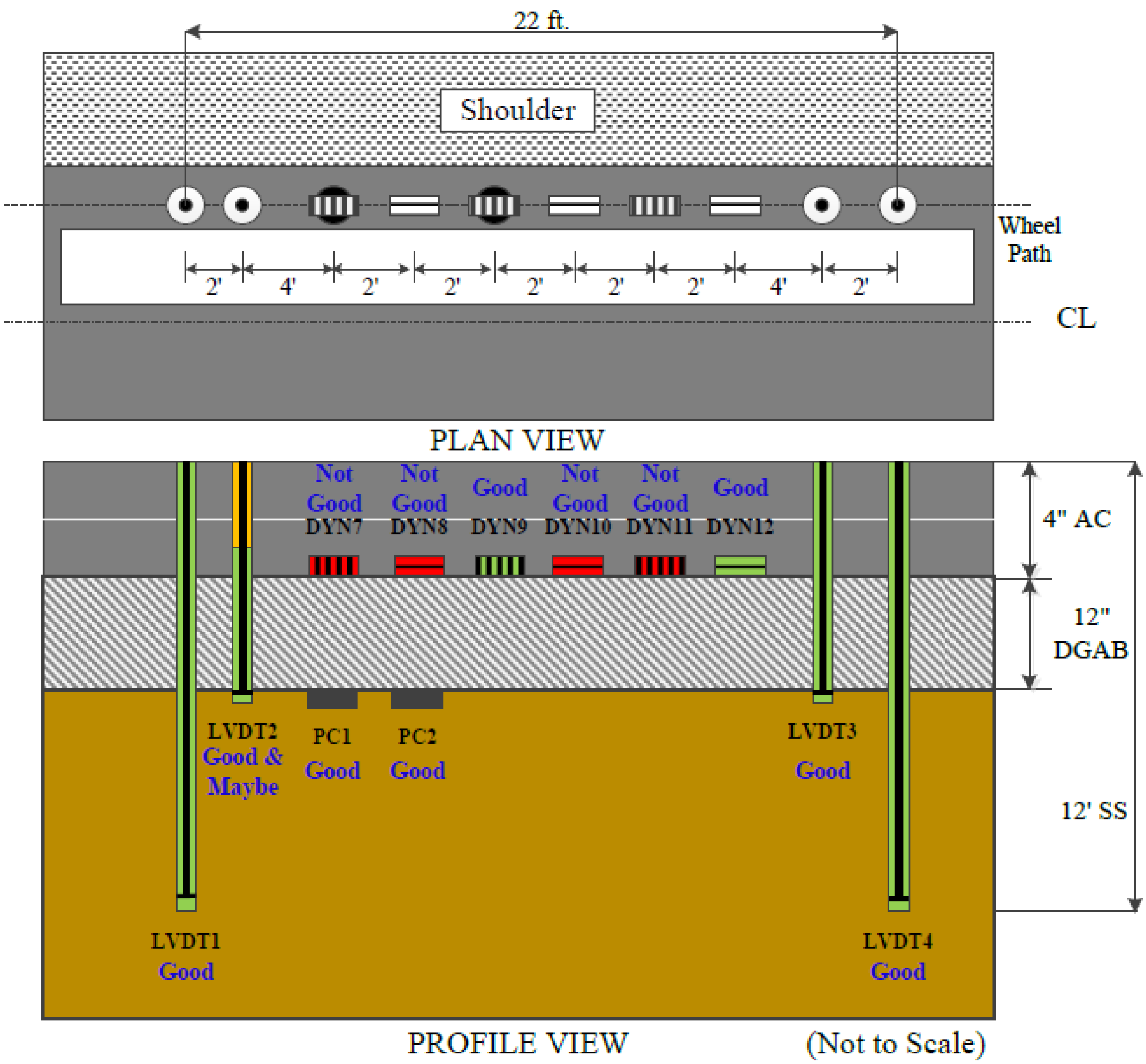


Figure 15. Illustration. QC results by sensor type for test section 390102 test J2F.

The peaks and valleys for the smoothed traces in test J2F were extracted using the mspeaks function discussed in the fourth step listed in the methodology in chapter 5.(11) These extracted peaks and valleys for each trace were directly saved into a separate Microsoft Excel® file using a file name of sensor type, sensor number, test name, and run number (e.g., Dyn12_J2F1 is Dyn12 sensor in test J2F for run 1). Based on the QC results, the peaks and valleys extracted for good traces for test J2F are summarized in table 6. For test J2F, a two-axle test truck was used. Because sensor Dyn9 was laid in a transverse direction, it had only two peaks, whereas sensor Dyn12 was laid in a longitudinal direction and therefore had two peaks and four valley points.

Raw (Unsmoothed) Trace Processing

The same processing steps were applied to raw (unsmoothed) traces for test J2F. The results are shown in table 7 and table 8. Table 7 has the summarized QC results for raw traces. Similar to table 5, numbers 1 through 3 for strain gauge, LVDT, and PC sensors represent good, maybe, and not good trace categories respectively. There were no differences between the QC results for raw traces and the QC results for smoothed traces. Table 8 shows the summarized peaks and valleys extracted for good raw traces.

Table 7. Summarized QC results for raw traces in test J2F.

	Dyn						LVDT				PC	
Run No.	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**	**4**	**1**	**2**
1	3	3	1	3	3	1	1	2	1	1	1	1
2	3	3	1	3	3	1	1	1	1	1	1	1
3	3	3	1	3	3	1	1	2	1	1	1	1
4	3	3	1	3	3	1	1	1	1	1	1	1
5	3	3	1	3	3	1	1	2	1	1	1	1
6	3	3	1	3	3	1	1	1	1	1	1	1
7	3	3	1	3	3	1	1	1	1	1	1	1
8	3	3	1	3	3	1	1	1	1	1	1	1
Total												
Good	0	0	8	0	0	8	8	5	8	8	8	8
Maybe	0	0	0	0	0	0	0	3	0	0	0	0
Not good	8	8	0	8	8	0	0	0	0	0	0	0

Table 8. Peaks and valleys extracted for raw traces in test J2F.

Tag ID	Test Name	Run	Time Raw 1 (s)	Strain Value Raw 1 (µe)	Time Raw 2 (s)	Strain Value Raw 2 (µe)	Time Raw 3 (s)	Strain Value Raw 3 (µe)	Time Raw 4 (s)	Strain Value Raw 4 (µe)	Time Raw 5 (s)	Strain Value Raw 5 (µe)	Time Raw 6 (s)	Strain Value Raw 6 (µe)
Dyn9	J2F	1	1.58	229.81	1.85	333.57								
Dyn9	J2F	2	1.59	761.85	1.84	297.43								
Dyn9	J2F	3	1.52	712.71	1.76	302.67								
Dyn9	J2F	4	1.50	719.66	1.74	278.99								
Dyn9	J2F	5	1.60	1070.29	1.83	343.34								
Dyn9	J2F	6	1.52	825.52	1.71	282.34								
Dyn9	J2F	7	1.53	295.44	1.72	247.31								
Dyn9	J2F	8	1.43	483.47	1.62	229.69								
Dyn12	J2F	1	1.43	435.75	1.70	801.42	1.40	-111.18	1.47	-59.30	1.67	-196.81	1.75	-119.30
Dyn12	J2F	2	1.44	682.82	1.72	898.46	1.41	-174.14	1.49	-61.63	1.69	-214.77	1.77	-124.14
Dyn12	J2F	3	1.38	641.79	1.65	878.06	1.36	-168.92	1.43	-71.41	1.62	-230.17	1.70	-122.66
Dyn12	J2F	4	1.35	647.40	1.62	942.43	1.33	-180.81	1.40	-75.80	1.59	-226.44	1.67	-130.18
Dyn12	J2F	5	1.47	773.32	1.72	973.96	1.45	-218.65	1.51	-84.27	1.69	-243.03	1.77	-118.64
Dyn12	J2F	6	1.41	635.66	1.62	1095.08	1.39	-226.93	1.45	-86.91	1.60	-278.18	1.66	-118.17
Dyn12	J2F	7	1.42	446.82	1.62	1100.64	1.40	-186.37	1.46	-78.23	1.60	-282.00	1.66	-109.48
Dyn12	J2F	8	1.32	556.01	1.52	1152.32	1.30	-214.07	1.36	-79.68	1.50	-285.95	1.56	-119.68

Note: Dyn 9 sensor, which is laid in the transverse direction for test section J2, has two trace peaks. Time stamp and strain value information for those two peaks is presented, and the remaining cells are left blank. Whereas the Dyn 12 sensor, which is laid in the longitudinal direction for the same test section, has two peaks and four valleys. A total of six time stamps and strain values are shown.

The first peaks extracted for good sensor traces in test J2F in table 6 and table 8 were used to check how close the processed J2F data were to the data in the Ohio data peak file (TruckPeak.txt). Table 9 shows the comparison of data peak values with first peak values of smoothed and raw traces for strain gauges Dyn9 and Dyn12 in test J2F. The column labeled "X" is the estimated x-coordinate position of the front-axle at the time the peak occurred. The X-coordinate was measured from the southernmost deep LVDT in the AC sections. For Dyn9 strain gauge, the smoothed and raw peak values were close to the Ohio data peak values. For Dyn12 strain gauge, however, there was more divergence between the smoothed and raw peak values and the data peak values.

Table 9. Comparison of first peak smooth and raw peak values with Ohio peak values.

Test Job	Run	Test Section	Sensor Name	X (inches)	Ohio Peak Value (µe)	Smooth Peak Value (µe)	Raw Peak Value (µe)
J2F	1	390102	Dyn9	118.3	224.30	228.28	229.81
J2F	2	390102	Dyn9	121.8	751.90	759.57	761.85
J2F	3	390102	Dyn9	121.5	702.10	709.65	712.71
J2F	4	390102	Dyn9	121.0	709.90	718.30	719.66
J2F	5	390102	Dyn9	121.8	1,048.00	1,067.32	1,070.29
J2F	6	390102	Dyn9	121.5	814.60	822.41	825.52
J2F	7	390102	Dyn9	118.5	289.50	293.97	295.44
J2F	8	390102	Dyn9	120.5	475.60	481.43	483.47
J2F	1	390102	Dyn12	194.7	411.40	433.04	435.75
J2F	2	390102	Dyn12	195.4	629.80	677.99	682.82
J2F	3	390102	Dyn12	195.5	585.00	636.70	641.79
J2F	4	390102	Dyn12	194.5	591.60	641.91	647.40
J2F	5	390102	Dyn12	194.8	683.80	766.11	773.32
J2F	6	390102	Dyn12	195.2	581.80	627.06	635.66
J2F	7	390102	Dyn12	194.8	418.80	441.83	446.82
J2F	8	390102	Dyn12	195.2	509.90	547.97	556.01

Dyn9's actual location was X = 120 inches, and Dyn12's actual location was X = 192 inches. The Ohio peak data, however, showed multiple locations for sensors, the locations being 2 to 3 inches off the actual sensor location (see table 18 in chapter 7). It was observed that the smoothed and raw peak values are close to the Ohio data peak values such that X values are closer and below the actual sensor location. For example, the Dyn9 sensor for run 1 had a peak value of 224.30 µe at X = 118.3 inches. The X value was close to and below the actual sensor location of X = 120 inches, and the smoothed and raw peak values of 228.23 and 229.81 µe, respectively, were very close to the data peak value of 224.30 µe. Conversely, the Dyn12 sensor for run 1 had a location at X = 194.7 inches and a peak value of 411.40 µe. The location of X = 194.7 inches was above the actual location of X = 192 inches. The first peak values of the smoothed and raw traces, 433.04 and 435.75 µe, respectively, were considerably removed from the peak value of 411.40 µe.

Beginning offset, ending offset, and range values were computed for all sensor traces in test J2F. Table 10 shows beginning and ending offset and range values for a PC sensor in test J2F.

Table 10. PC sensor begin offset, end offset, and range values.

Test File	PC1			PC2		
	Beginning Offset	**Ending Offset**	**Range**	**Beginning Offset**	**Ending Offset**	**Range**
AJ2F001	0.0000206	0.0172634	1.227	0.0000000	0.0223676	1.215
AJ2F002	0.0000675	0.0140629	1.300	-0.0000228	0.0189775	1.387
AJ2F003	-0.0000184	0.0141437	1.330	0.0000303	0.0200913	1.490
AJ2F004	0.0000341	0.0096094	1.329	0.0000631	0.0128362	1.495
AJ2F005	0.0000228	0.0115536	1.344	0.0000078	0.0179510	1.576
AJ2F006	-0.0000250	0.0099899	1.082	-0.0000269	0.0131659	1.336
AJ2F007	0.0000203	0.0076421	1.035	0.0000162	0.0112694	1.328
AJ2F008	0.0000191	0.0092828	1.126	-0.0000325	0.0102851	1.392

The preceding data processing steps for smoothed and raw traces in test J2F were repeated one by one for the remaining 22 tests. The QC results summarized for all 23 tests for both smoothed and raw traces are shown in table 11 and table 12. Similar to table 6 and table 8 for test J2F, DLR data tables were created separately for good traces of each sensor type for the 23 tests and will be included in future SDRs.

Table 11. Summarized QC results for SPS-1 smoothed traces.

Test Job Name	No. of Test Runs	Strain Gauge			Total	LVDT			Total	PC			Total
		Good	Maybe	Not Good		Good	Maybe	Not Good		Good	Maybe	Not Good	
J2A	16	32	13	51	96	39	7	18	64	32	0	0	32
J2C	10	12	0	48	60	26	4	10	40	20	0	0	20
J2D	16	17	8	71	96	45	11	8	64	32	0	0	32
J2E	13	15	0	57	72	41	7	0	48	24	0	0	24
J2F	8	16	0	32	48	29	3	0	32	16	0	0	16
J2G	12	16	8	48	72	38	10	0	48	24	0	0	24
J4A	16	46	5	93	144	32	32	0	64	32	0	0	32
J4B	13	30	5	82	117	24	24	4	52	26	0	0	26
J4C	10	15	9	48	72	16	12	4	32	14	0	2	16
J4D	15	30	15	90	135	32	27	1	60	30	0	0	30
J4E	13	26	15	76	117	40	12	0	52	26	0	0	26
J4F	12	24	33	51	108	24	24	0	48	24	0	0	24
J4G	12	24	7	77	108	24	24	0	48	24	0	0	24
J8A	16	48	48	48	144	21	43	0	64	31	1	0	32
J8D	15	45	45	45	135	22	38	0	60	30	0	0	30
J8E	13	39	44	34	117	23	29	0	52	26	0	0	26
J8G	12	36	37	35	108	36	12	0	48	24	0	0	24
J10A	16	15	5	115	135	26	15	19	60	30	0	0	30
J10C	10	10	0	80	90	6	19	15	40	20	0	0	20
J10D	16	19	21	104	144	13	43	8	64	32	0	0	32
J10E	12	12	17	79	108	27	15	6	48	24	0	0	24
J10F	13	61	12	44	117	31	16	5	52	26	0	0	26
J10G	12	12	34	62	108	36	12	0	48	24	0	0	24
Total	**301**	**600**	**381**	**1,470**	**2,451**	**651**	**439**	**98**	**1,188**	**591**	**1**	**2**	**594**

Table 12. Summarized QC results for SPS-1 raw traces.

Test Job Name	No. of Test Runs	Strain Gauge			Total	LVDT			Total	PC			Total
		Good	Maybe	Not Good		Good	Maybe	Not Good		Good	Maybe	Not Good	
J2A	16	32	13	51	96	39	7	18	64	32	0	0	32
J2C	10	12	0	48	60	26	4	10	40	20	0	0	20
J2D	16	17	8	71	96	45	11	8	64	32	0	0	32
J2E	13	14	0	58	72	39	9	0	48	24	0	0	24
J2F	8	16	0	32	48	29	3	0	32	16	0	0	16
J2G	12	16	8	48	72	38	7	3	48	24	0	0	24
J4A	16	46	2	96	144	32	32	0	64	32	0	0	32
J4B	13	30	2	85	117	24	24	4	52	26	0	0	26
J4C	10	15	2	55	72	14	14	4	32	14	0	2	16
J4D	15	30	15	90	135	32	27	1	60	30	0	0	30
J4E	13	26	15	76	117	39	13	0	52	26	0	0	26
J4F	12	24	1	83	108	24	24	0	48	24	0	0	24
J4G	12	24	7	77	108	24	24	0	48	24	0	0	24
J8A	16	48	48	48	144	21	43	0	64	31	1	0	32
J8D	15	45	45	45	135	22	38	0	60	30	0	0	30
J8E	13	39	44	34	117	23	29	0	52	26	0	0	26
J8G	12	36	37	35	108	36	12	0	48	24	0	0	24
J10A	16	15	5	115	135	24	18	18	60	30	0	0	30
J10C	10	10	0	80	90	6	19	15	40	20	0	0	20
J10D	16	19	21	104	144	13	43	8	64	32	0	0	32
J10E	12	12	17	79	108	27	15	6	48	24	0	0	24
J10F	13	61	12	44	117	30	17	5	52	26	0	0	26
J10G	12	12	34	62	108	36	12	0	48	24	0	0	24
Total	**542**	**599**	**336**	**1,516**	**2,451**	**643**	**445**	**100**	**1,188**	**591**	**1**	**2**	**594**

Table 13 shows the summarized QC results for smoothed traces for strain gauge, LVDT, and PC sensors with percentages in parentheses. Of the three sensor types, PCs had the highest percentage of good traces with 99 percent, followed by LVDTs with 55 percent, and strain gauges with 24 percent.

Table 13. Summarized QC results for Ohio SPS-1 smoothed traces.

Sensor Type	Good	Maybe	Not Good	Total Traces Completed
Strain gauge	600 (24.48%)	381 (15.54%)	1,470 (59.98%)	2,451 (100%)
LVDT	651 (54.80%)	439 (36.95%)	98 (8.25%)	1,188 (100%)
PC	591 (94.49%)	1 (0.17%)	2 (0.34%)	594 (100%)
Total				**4,233**

Similarly, table 14 shows the summarized QC results for raw traces for strain gauge, LVDT, and PC sensors with percentages in parentheses. No significant difference in percentage was observed when compared to the QC results of smoothed traces. Similar to table 13, of the three sensor types, PCs had the highest percentage of good traces with 99 percent, followed by LVDTs with 54 percent, and strain gauges with 24 percent.

Table 14. Summarized QC results for Ohio SPS-1 raw (unsmoothed) traces.

Sensor Type	Good	Maybe	Not Good	Total Traces Completed
Strain gauge	599 (24.44%)	336 (13.71%)	1,516 (61.85%)	2,451 (100%)
LVDT	643 (54.12%)	445 (37.46%)	100 (8.42%)	1,188 (100%)
PC	591 (99.49%)	1 (0.17%)	2 (0.34%)	594 (100%)
Total				**4,233**

OHIO SPS-2 DATA QC RESULTS

Table 15 shows the comparison of SPS-2 first peak smooth values of test J1A and the Dyn1 sensor with Ohio data peak values. The extracted smooth values of test J1A and the Dyn1 sensor closely match the Ohio peak values.

Table 15. Comparison of first peak smooth values with Ohio peak values.

Test Job	Run	Test Section	Sensor Name	X (inches)	Ohio Peak Value (µe)	Smooth Peak Value (µe)
J1A	1	390201	Dyn1	82.3	-22.07	-22.53
J1A	2	390201	Dyn1	85.2	-38.20	-38.68
J1A	3	390201	Dyn1	82.6	-20.62	-20.22
J1A	4	390201	Dyn1	85.0	-36.42	-36.75
J1A	5	390201	Dyn1	82.5	-20.48	-20.07
J1A	6	390201	Dyn1	85.7	-34.08	-34.64
J1A	7	390201	Dyn1	82.4	-20.74	-20.73
J1A	8	390201	Dyn1	85.0	-34.25	-34.15
J1A	9	390201	Dyn1	82.4	-21.29	-21.28
J1A	10	390201	Dyn1	84.4	-35.69	-35.75
J1A	11	390201	Dyn1	81.8	-18.50	-18.05
J1A	12	390201	Dyn1	85.3	-36.14	-35.73
J1A	13	390201	Dyn1	82.8	-21.16	-20.77
J1A	14	390201	Dyn1	85.0	-32.30	-31.41
J1A	15	390201	Dyn1	82.1	-20.61	-20.16
J1A	16	390201	Dyn1	85.0	-34.77	-34.12
J1A	17	390201	Dyn1	82.1	-20.10	-19.69
J1A	18	390201	Dyn1	85.1	-32.73	-32.08
J1A	19	390201	Dyn1	82.2	-20.49	-19.45
J1A	20	390201	Dyn1	84.3	-30.04	-29.23
J1A	21	390201	Dyn1	82.7	-22.58	-21.49
J1A	22	390201	Dyn1	84.3	-33.11	-31.97
J1A	23	390201	Dyn1	82.1	-22.10	-20.99
J1A	24	390201	Dyn1	84.8	-28.67	-27.59
J1A	25	390201	Dyn1	82.2	-21.36	-19.78
J1A	26	390201	Dyn1	83.9	-30.20	-29.13
J1A	27	390201	Dyn1	84.3	-35.76	-34.43
J1A	28	390201	Dyn1	85.1	-33.05	-32.11

Table 16 shows summarized QC results for smoothed traces for all 24 Ohio SPS-2 tests.

Table 16. Summarized QC results for Ohio SPS-2 smoothed traces.

Test Job	No. of Test Runs	Strain Gauge				LVDT			
		Good	Maybe	Not Good	Total	Good	Maybe	Not Good	Total
J1A	28	112	0	0	112	103	7	282	392
J1B	24	96	0	0	96	30	28	278	336
J1C	14	56	0	0	56	55	34	107	196
J5A	29	9	0	107	116	45	4	357	406
J5B	25	75	0	25	100	46	18	286	350
J5C	14	42	0	14	56	23	12	161	196
J8A	26	78	0	26	104	68	13	283	364
J8B	26	87	0	17	104	70	6	288	364
J8C	17	52	0	16	68	55	12	171	238
J12A	4	16	0	0	16	9	5	42	56
J12B	26	102	2	0	104	75	10	279	364
J12C	14	51	3	2	56	68	3	125	196
J5J1M	18	72	0	0	72	67	8	177	252
J5J1N	18	72	0	0	72	52	8	92	152
J5J1O	18	49	3	20	72	58	5	189	252
J5J1P	18	64	0	8	72	53	5	194	252
J8S3M	18	16	0	56	72	10	7	235	252
J8S3N	18	20	9	43	72	3	9	240	252
J8S3O	18	17	1	54	72	12	2	238	252
J8S3P	18	15	2	55	72	0	2	250	252
J12J10M	18	0	11	61	72	24	20	208	252
J12J10N	18	11	7	54	72	15	9	228	252
J12J10O	18	9	15	48	72	21	2	229	252
J12J10P	17	0	0	68	68	25	50	163	238
Total	**462**	**1,121**	**53**	**674**	**1,848**	**987**	**279**	**5,102**	**6,368**

Table 17 shows summarized QC results for smoothed traces for all 24 SPS-2 tests with percentages in parentheses. A total of 61 percent of strain gauges had good traces, whereas only 15 percent of LVDTs had good traces.

Table 17. Summarized QC results for Ohio SPS-2 smoothed traces.

Sensor Type	Good	Maybe	Not Good	Total
Strain gauge	1,121 (60.66%)	53 (2.87%)	674 (36.47%)	1,848 (100%)
LVDT	987 (15.50%)	279 (4.38%)	5,102 (80.12%)	6,368 (100%)
Total				**8,216**

7. DLR TRACE ISSUES

Some dubious sensor trace patterns were encountered in the processing of the Ohio SPS-1 and SPS-2 DLR data. For example, some sensor traces exhibited a flat unresponsive pattern. Other sensor traces indicated the mislabeling of a transverse strain gauge as a longitudinal strain gauge.

OHIO SPS-1 TRACE ISSUES

LVDT Trace Pattern Issue

All of the LVDTs were buried deep in the subgrade or close to the interface between the subgrade and the base layer in the Ohio test sections. Thus, LVDT traces should not contain any trace valleys (no tensile strains) but only peaks (compressive strains). However, the LVDT3 sensor for tests J2A, J2C, J2D, J2E, J2F, and J2G (test section 390102) showed a trace pattern similar to a longitudinal strain gauge trace that assumes valleys. Figure 16 shows LVDT3 trace in test J2A with a trace pattern similar to a longitudinal strain gauge trace.

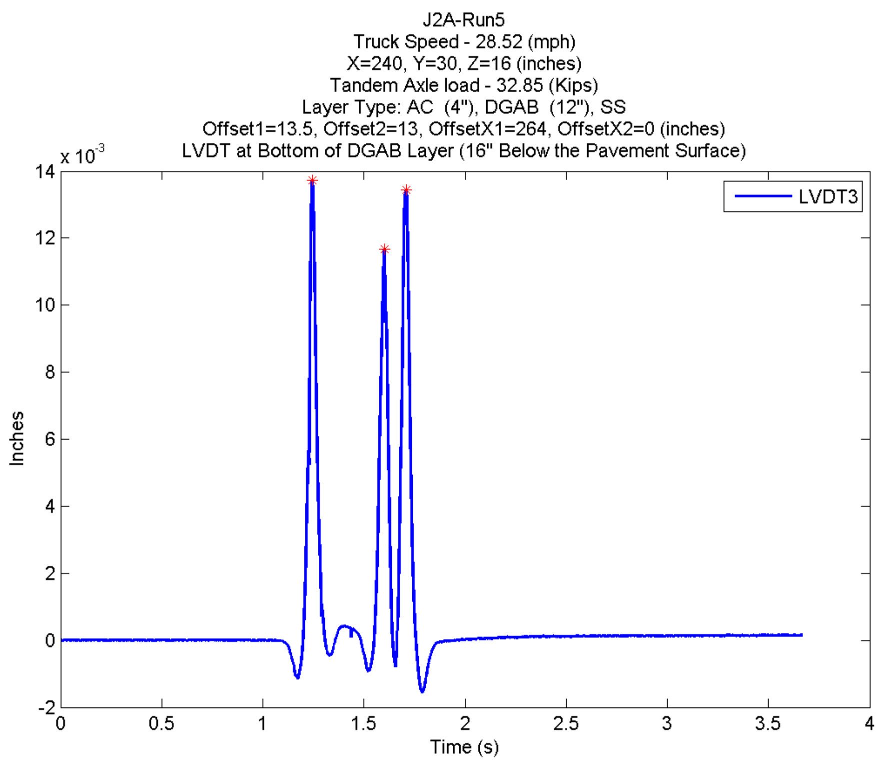


Figure 16. Graph. Transverse LVDT3 longitudinal strain gauge trace that assumes valleys.

Strain Gauge Trace Pattern Issue

Strain gauge sensors Dyn10 and Dyn11 for tests J2A, J2C, J2D, J2E, J2F, and J2G in test section 390102 showed a flat unresponsive trace pattern. The assumption was that the sensors were not connected properly. Figure 17 shows flat strain gauge sensor Dyn10 trace in test J2A.

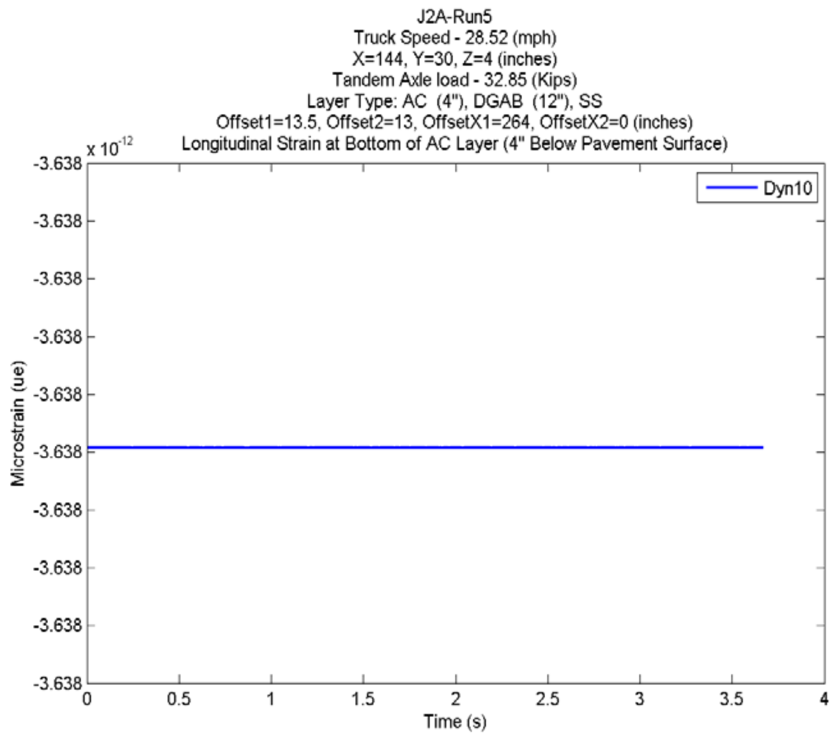


Figure 17. Graph. Unresponsive strain gauge trace.

Longitudinal strain gauges are expected to assume trace valleys, whereas transverse strain gauges are not. However, longitudinal strain gauge sensor Dyn17 for tests J8A, J8D, J8E, and J8G (test section 390108) showed a trace pattern that, if flipped, is similar to a transverse strain gauge trace that assumed no valleys. Figure 18 shows the longitudinal Dyn17 strain gauge trace in test J8A exhibiting an upside down transverse strain gauge trace pattern.

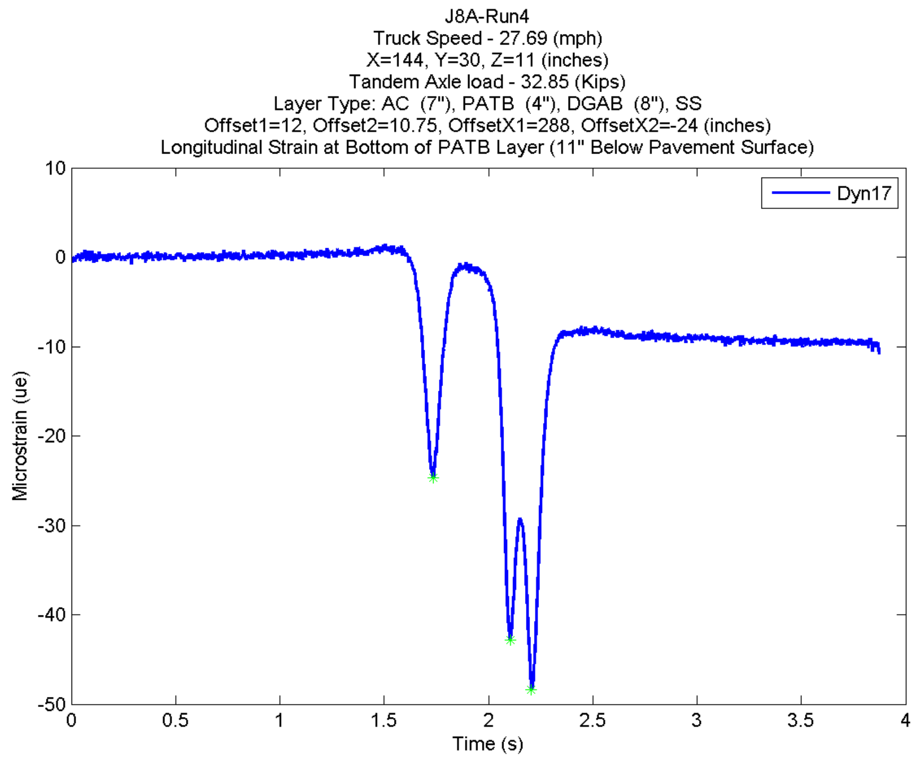


Figure 18. Graph. Longitudinal Dyn17 strain gauge trace exhibiting an upside down transverse pattern.

The LVDT3 and Dyn17 strain gauge sensors for test sections 390102 and 390108 may have been mislabeled inadvertently. The data collection dates match for tests in both test sections. For example, the data collection date for tests J2A (LVDT3) and J8A (Dyn17) were the same. Similarly, data collection dates for tests J2D, J2E, and J2G (LVDT3) were the same as for tests J8D, J8E, and J8G (Dyn17), respectively.

The peak data information contained in Ohio truck peak (TruckPeak.txt) file was unclear. The data have peak values recorded for the same sensor number and run number but at different sensor locations. Table 18 shows sample truck peak data for test section 390102 strain gauge sensor Dyn12 run 1. The column labeled "X" represents the estimated position of the front-axle at the time when the peak occurred. Specifically, it is the X-coordinate measured from the southernmost deep LVDT in the AC sections. The column labeled "Peak Value" shows the recorded front-axle peak values. The actual location of strain gauge sensor Dyn12 from the measured southernmost deep LVDT in the AC sections was 192 inches (X = 192 inches), but the truck peak data showed multiple sensor locations (X values). Also, the peak value of 411.40 με at X = 194.7 inches closely matched the first peak value extracted from the DLR data process, which was 433.04 με at X = 192 inches.

Table 18. Sample Ohio SPS-1 truck peak data for test J2F.

Series	Subseries	Run	Section	Sensor Name	Sensor Number	X (inches)	Peak Value (µe)
2	F	1	390102	Dyn	12	30.0	-118.60
2	F	1	390102	Dyn	12	55.8	758.00
2	F	1	390102	Dyn	12	71.0	-203.30
2	F	1	390102	Dyn	12	120.1	5.03
2	F	1	390102	Dyn	12	171.5	-57.61
2	F	1	390102	Dyn	12	194.7	411.40
2	F	1	390102	Dyn	12	209.9	-114.10

The beginning offset, ending offset, and range values for strain gauges, LVDTs, and PCs obtained from the DLR raw traces did not match the beginning and ending offset and range values in SDR 22.0.(6) Per the technical support service contractor's recommendations, the beginning offset, ending offset, and range columns were removed and do not show up in SDR 27.0.(1)

OHIO SPS-2 TRACE ISSUES

The DLR SPS-2 data information was reviewed for data discrepancies before processing. Data information included the SPS-2 TCS raw data, the OU data, SDR 22.0 DLR data, and information from *Evaluation of Pavement Performance on DEL 23*.(12) Site visits A, B, and C of SPS-2 tests J1, J5, J8, and J12 (test sections 390201, 390205, 390208, and 390212, respectively) were inconsistent with SPS-2 subseries H, I, and J of the OU file. In contrast, site visits A through G of SPS-1 tests J2, J4, J8, and J10 (test sections 390102, 390104, 390108, and 390110, respectively), had matching subseries in the OU data file. The data collection dates of the SPS-2 test section visits A, B, and C, however, matched subseries H, I, and J, respectively, of the OU data file. Since subseries A through G had already been used for SPS-1, the assumption is that OU assigned H, I, and J in place of A, B, and C for SPS-2. Also, the wheelpath offset values in SDR 22.0 for SPS-2 were populated from subseries H, I, and J of the data file for test sections A, B, and C, respectively. Table 19 shows the inconsistencies between the SPS-2 test section visits and the OU subseries.

Table 19. Ohio SPS-2 inconsistencies between test section visits and subseries.

Raw Ohio-TCS Data			Test Truck Series from Sargand et al. [12]	OU Data	
Test Job	No. of Files/Runs	Test Date		Subseries	Start Time for Run 1*
J1A	28	8/12/1996	2	H	15:15:00
J1B	26	8/13/1996	2	I	11:00:00
J1C	14	8/14/1996	2	J	10:11:00
J5A	29	8/12/1996	2	H	15:15:00
J5B	26	8/13/1996	2	I	11:00:00
J5C	14	8/14/1996	2	J	10:11:00
J5J1M	18	7/29/1997	4	M	13:10:00
J5J1N	18	7/30/1997	4	N	10:20:00
J5J1O	18	7/30/1997	4	O	13:32:00
J5J1P	18	8/06/1997	4	P	07:18:00
J8A	26	8/12/1996	2	H	15:15:00
J8B	27	8/13/1996	2	I	11:00:00
J8C	17	8/14/1996	2	J	10:11:00
J8S3M	18	7/29/1997	4	M	13:10:00
J8S3N	18	7/30/1997	4	N	10:20:00
J8S3O	18	7/30/1997	4	O	13:32:00
J8S3P	18	8/06/1997	4	P	07:18:00
J12A	4	8/12/1996	2	H	15:15:00
J12B	27	8/13/1996	2	I	11:00:00
J12C	14	8/14/1996	2	J	10:11:00
J12J10M	18	7/29/1997	4	M	13:10:00
J12J10N	18	7/30/1997	4	N	10:20:00
J12J10O	18	7/30/1997	4	O	13:32:00
J12J10P	17	8/06/1997	4	P	07:18:00

*The dates of the runs in this column are the same as the test dates listed in column 3.
Note: Test truck series 2 and 4 were used for Ohio SPS-2.

SPS-2 DLR sensors LVDT5 and LVDT6 were unresponsive for all tests; LVDT5 and LVDT6 records all had zero values.

The ASCII files for SPS-2 tests J5J1M, J5J1N, J5J1O, J5J1P, J8S3M, J8S3N, J8S3O, J8S3P, J12J10M, J12J10N, J12J10O, and J12J10P had 32 LVDT sensors (LVDT1 through LVDT32). The other tests (J1A, J1B, J1C, J5A, J5B, J5C, J8A, J8B, J8C, J12A, J12B, and J12C) had only 16 LVDT sensors (LVDT1 through LVDT16). The DLR study team processed only the first 16 LVDTs (LVDT1 through LVDT16) based on information present in the OU EmbeddedSensor.txt file, which showed only the first 16 LVDTs.

Table 20 shows strain gauge sensors for each SPS-2 test that had time history data. For example, test J1A had eight strain gauge sensors of which only four sensors (Dyn1, Dyn4, Dyn5, and Dyn8) had time history data. The other strain gauge sensors (Dyn2, Dyn3, Dyn6, and Dyn7) did not have time history data.

Table 20. Strain gauge sensors with time history data for each test.

Test Job	Test Section	Strain Gauge Sensors that have Time History Data
J1A	390201	Dyn1, Dyn4, Dyn5, and Dyn8
J1B	390201	Dyn1, Dyn4, Dyn5, and Dyn8
J1C	390201	Dyn1, Dyn2, Dyn7, and Dyn8
J5A	390205	Dyn1, Dyn4, Dyn5, and Dyn8
J5B	390205	Dyn1, Dyn2, Dyn7, and Dyn8
J5C	390205	Dyn1, Dyn2, Dyn7, and Dyn8
J8A	390208	Dyn1, Dyn4, Dyn5, and Dyn8
J8B	390208	Dyn1, Dyn2, Dyn7, and Dyn8
J8C	390208	Dyn1, Dyn2, Dyn7, and Dyn8
J12A	390212	Dyn1, Dyn4, Dyn5, and Dyn8
J12B	390212	Dyn1, Dyn2, Dyn7, and Dyn8
J12C	390212	Dyn1, Dyn2, Dyn7, and Dyn8
J5J1M	390205	Dyn1, Dyn2, Dyn7, and Dyn8
J5J1N	390205	Dyn1, Dyn2, Dyn7, and Dyn8
J5J1O	390205	Dyn1, Dyn2, Dyn7, and Dyn8
J5J1P	390205	Dyn1, Dyn2, Dyn7, and Dyn8
J8S3M	390208	Dyn1, Dyn2, Dyn7, and Dyn8
J8S3N	390208	Dyn1, Dyn2, Dyn7, and Dyn8
J8S3O	390208	Dyn1, Dyn2, Dyn7, and Dyn8
J8S3P	390208	Dyn1, Dyn2, Dyn7, and Dyn8
J12J10M	390212	Dyn1, Dyn2, Dyn7, and Dyn8
J12J10N	390212	Dyn1, Dyn2, Dyn7, and Dyn8
J12J10O	390212	Dyn1, Dyn2, Dyn7, and Dyn8
J12J10P	390212	Dyn1, Dyn2, Dyn7, and Dyn8

Note: All Ohio SPS-2 test sections had eight strain gauge sensors deployed.

Table 21 shows multiple peak values for Dyn1 run 1. Based on the Embeddedsensor.txt file, the location of the Dyn1 sensor was 84 inches from the southernmost first LVDT (the coordinate reference point), so the first peak value of -22.07 was compared to the smooth first peak values extracted from SPS-2.

Table 21. Sample Ohio SPS-2 truck peak data for test J1A.

Series	Subseries	Run	Section	Sensor Name	Senor Number	X (inches)	Peak Value (µe)
2	H	1	390201	Dyn	1	18.6	3.00
2	H	1	390201	Dyn	1	82.3	-22.07
2	H	1	390201	Dyn	1	153.9	11.14
2	H	1	390201	Dyn	1	222.0	-44.72
2	H	1	390201	Dyn	1	311.9	4.95

Note: Subseries “H” infers “A.” Please see the second bullet under Ohio SPS-2 data issues in chapter 10.

In table 22, Dyn8 strain gauge from test J5J1P runs 1–10 collected at 499.964 Hz on August 6, 1997, had significantly larger raw strain values compared to other SPS-2 strain gauge values, which were mostly less than 100 µe. Thus, further investigation is needed for this strain gauge.

Table 22. Raw Dyn8 strain gauge values of test J5J1P.

State Code	SHRP ID	Run Number	Minimum Strain Raw Value (µe)	Maximum Strain Raw Value (µe)
39	0205	1	19,939.61	19,974.62
39	0205	2	20,024.00	20,058.39
39	0205	3	19,990.25	20,027.13
39	0205	4	20,066.51	20,097.77
39	0205	5	20,164.66	20,200.29
39	0205	6	20,224.04	20,257.80
39	0205	7	20,269.05	20,307.19
39	0205	8	20,340.94	20,372.82
39	0205	9	20,386.58	20,422.21
39	0205	10	20,458.47	20,483.47

The first 500 trace data points were used to average a gain adjustment factor for SPS-2 data. On average, each SPS-2 time history dataset contains close to 7,000 data points, whereas each SPS-1 time history dataset contains about 5,000 data points. Due to significant noise in the SPS-2 data, the first 500 data points may not be enough. For future research, the first 700 data points should be used to determine a gain adjustment factor for SPS-2 data, where 700 is approximately 10 percent of each SPS-2 time history dataset.

As with the SPS-1 data, the SPS-2 beginning offset, ending offset, and range values for strain gauges and LVDTs obtained from the DLR raw traces did not match the beginning and ending offset and range values in SDR 22.0. Per the technical support service contractor's recommendations, the beginning offset, ending offset, and range columns were removed and did not show up in SDR 27.0.

8. UPDATES TO THE OHIO SPS-1 AND SPS-2 DLR TABLES

This chapter summarizes the key updates made to the Ohio SPS-1 and SPS-2 DLR tables in SDR 27.0.[1] The following updates were made to the five trace tables:

- A new gain adjust factor (average of the first 500 trace data points) column was added. A gain adjustment factor was subtracted from each raw trace data point to generate a normalized trace base zero on the y-axis—that is, under no load conditions—so that the resulting peak values represented the change due to load response. For the SPS-1 data, normalized raw or smoothed traces were used to extract the trace peaks and valleys. For the SPS-2 data that had significant noise in the raw traces, only normalized smoothed traces were used to extract the trace peaks and valleys even though the gain adjustment factor was determined using the raw trace data.

- A new data collection frequency column was added for the frequency at which the trace data point was collected by the corresponding sensor identified by the tag ID (sensor ID) field.

- For the SPS-1 data, TIME_RAW_* (timestamps) and STRAIN/LVDT/PRESSURE_VALUE_RAW_* (trace peak and valley location values) were updated using the data extracted from SPS-1 normalized raw traces.

- Also for the SPS-1 data, TIME_SMOOTH_* (timestamps) and STRAIN/LVDT/PRESSURE _VALUE_SMOOTH_* (trace peak and valley location values) were updated using the data extracted from SPS-1 smoothed traces.

- For the SPS-2 data, TIME_RAW_* and STRAIN/LVDT_VALUE_RAW_* columns were removed from the DLR database because the SPS-2 raw traces were too noisy to extract any meaningful peaks and valleys.

- Also for the SPS-2 data, TIME_SMOOTH_* (timestamps) and STRAIN/LVDT _VALUE_SMOOTH_* (trace peak and valley location values) were updated using the data extracted from SPS-2 smoothed traces.

In the five configuration tables, the following updates were made:

- Initially, some newly added SPS-1 and SPS-2 tests had missing sensor calibration information such as channel number, record status, input card, card gain, post gain, and gauge resolution. By matching State code, SHRP ID, and Tag ID (sensor ID) of existing tests that had sensor calibration information, those tests that had missing information could be populated regardless of test names.

- The sensor locations in terms of X, Y, and Z coordinates were updated using the X, Y, and Z data by matching section ID and sensor ID.

- The sensor layer number column was updated using the Z (sensor depth in inches) data and the layer column.

- The strain gauge orientation column in the DLR_STRAIN_CONFIG_AC/PCC tables was updated using the DirCosX (1 for longitudinal) and DirCosY (1 for transverse) data.

In the DLR_TEST_MATRIX table, the following updates were made:

- Run time (the time of the test as determined by the data acquisition computer's internal clock) was updated using the timestamp in cell A3 of each AJ*.* raw trace file by matching STATE_CODE, SHRP_ID, TEST_NAME, and RUN_NUMBER.

- Revision date (Date of latest revision to the information stored in the DLR_TEST_MATRIX table) was set to August 24, 2012, the date when the DLR study team submitted the newly created SPS-1 and SPS-2 DLR database.

- Actual speed (actual speed of the test truck) was newly added and populated using the Speed data in TruckPass.txt. The DLR study team believed that this column, in addition to the desired speed column, will provide valuable information for data users when interpreting DLR traces.

- WHEEL_PATH_OFFSET1_M (distance from the edge of pavement to the outside of the front tire track for OH data) was updated using the OFFSET1 data in TruckPass.txt.

- WHEEL_PATH_OFFSET2_M (distance from the edge of pavement to the outside of the rear tire track for OH data) was updated using the OFFSET2 data in TruckPass.txt.

- WHEEL_PATH_OFFSETX1_M (distance along the direction of traffic as referenced from the start of the southernmost first LVDT in the section to the location where the front axle wheelpath offset was measured) was newly added using the OFFSETX1 data inTruckPass.txt.

- WHEEL_PATH_OFFSETX2_M (distance along the direction of traffic as referenced from the start of the southernmost 1st LVDT in the section to the location where the rear axle wheelpath offset was measured) was newly added using the OFFSETX2 data in TruckPass.txt.

- When comparing the DLR_TEST_MATRIX table in SDR 22.0 to the five trace tables, the DLR study team found that 9 of the 724 records in DLR_TEST_MATRIX did not have any source data to populate the following columns: ACTUAL_SPEED, WHEEL_PATH_OFFSET1_M, WHEEL_PATH_OFFSET2_M, WHEEL_PATH_OFFSETX1_M, WHEEL_PATH_OFFSETX2_M, and MATRIX_INDEX. Consequently, the nine records, which are listed in table 23, were removed and are not in the final DLR_TEST_MATRIX table in SDR 27.0.

Table 23. Records in the DLR_TEST_MATRIX table in SDR 22.0 with no source data.

State Code	SHRP ID	Test Name	Run Number
39	104	J4A	7
39	104	J4D	12
39	104	J4F	9
39	108	J8D	3
39	110	J10E	1
39	201	J1B	6
39	205	J5A	29
39	205	J5B	5
39	212	J12J10P	2

Run 1 of test J10E in table 23 is an example of a missing record. The available records in TruckPass.txt for run 1 are listed in table 24. Test section 390110 (test J10E run 1) is not on the list. Because the nine records in table 23 were removed from the DLR_TEST_MATRIX table, 54 traces that did not have a matching record in the DLR_TEST_MATRIX were removed from the 5 trace tables in SDR 27.0.(1)

Table 24. TruckPass.txt records for run 1.

Series	Subseries	Section	Actual Speed (mi/h)	Offset1	Offset2	OffsetX1	OffsetX2
2	E	390102	28.77	10.000	10.000	264.00	0.00
2	E	390104	29.63	9.000	8.500	264.00	0.00
2	E	390105	28.31	9.500	9.500	264.00	0.00
2	E	390108	28.31	8.000	8.000	288.00	-24.00

9. SAMPLE RESULTS

This chapter compares the DLR trace plots created using the Ohio SPS-1 DLR raw data, SDR 22.0 data, and the new Ohio SPS-1 and SPS-2 DLR database (temporarily designated as SDR 27.0) that was created using the methodology described in this report.

OHIO SPS-1 DATA SAMPLE PLOTS

Figure 19 to figure 21 show the sample plots for test section 390102 test J2C run 1 using the newly created SPS-1 and SPS-2 DLR database (temporarily designated as SDR 27.0) for Dyn12, LVDT1, and PC1 sensors, respectively. The newly created data appear to match the DLR raw traces.

For the strain gauges, the front axle pavement deflection peaks and valleys as well as their corresponding time stamps were included in the newly created SPS-1 and SPS-2 DLR database.[9] The front axle deflections were missing in SDR 22.0. It was suggested that the onset of a third valley near time point 1.8 s was not required to be included in the database because researchers will focus on the peaks and valleys in a trace. As a result, the SDR.0 27 Dyn12 raw trace in figure 19 goes directly from the second valley to the third valley without matching the DLR raw Dyn12 trace between the two valleys.

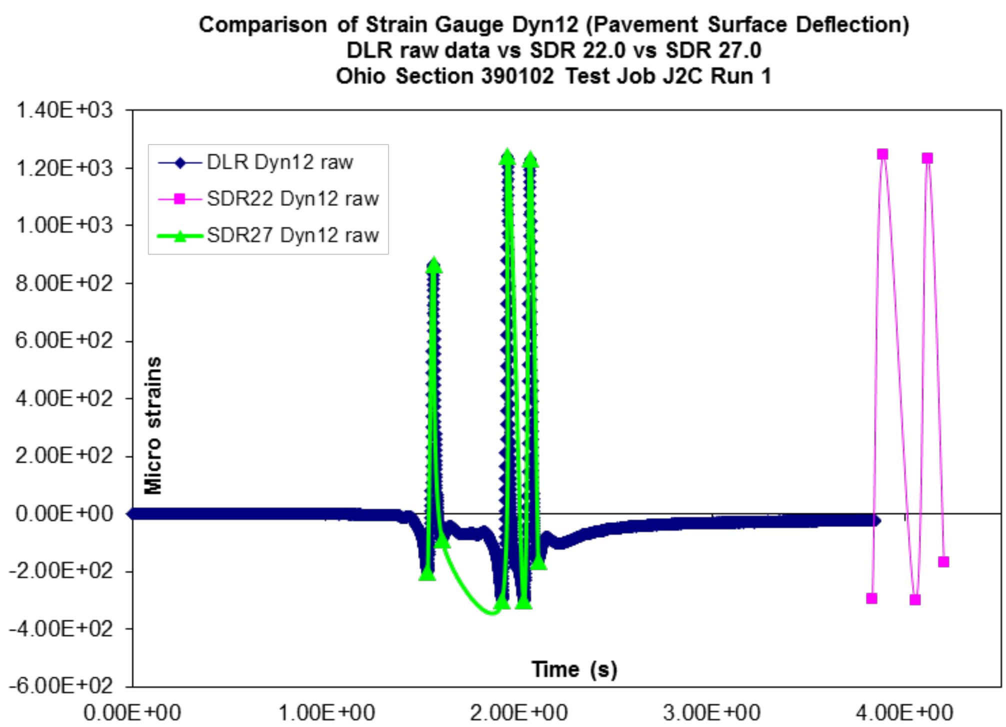
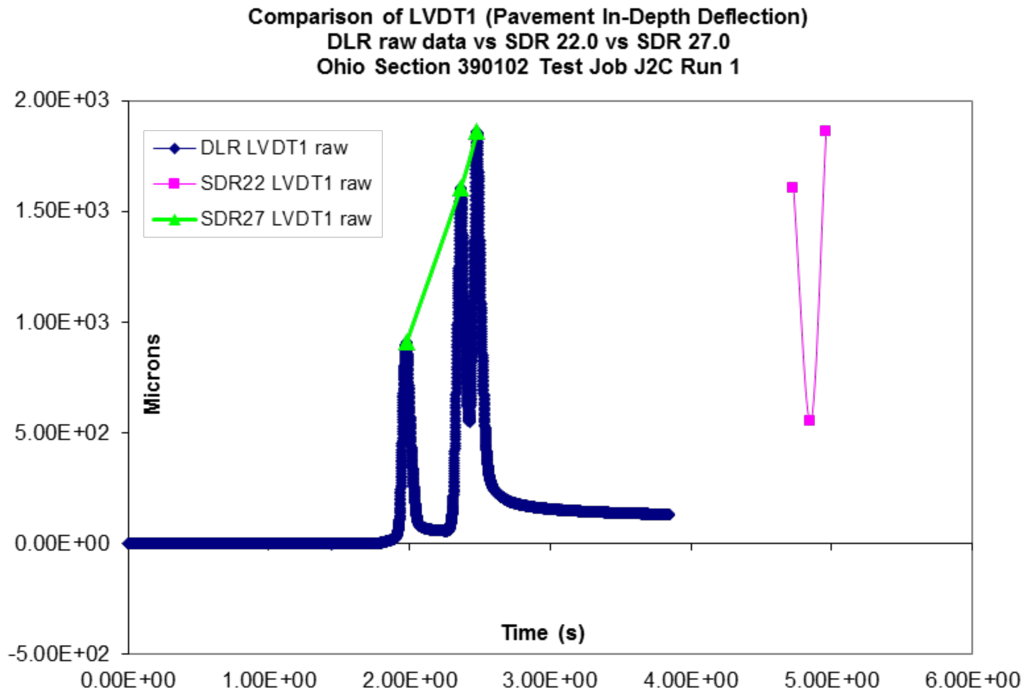


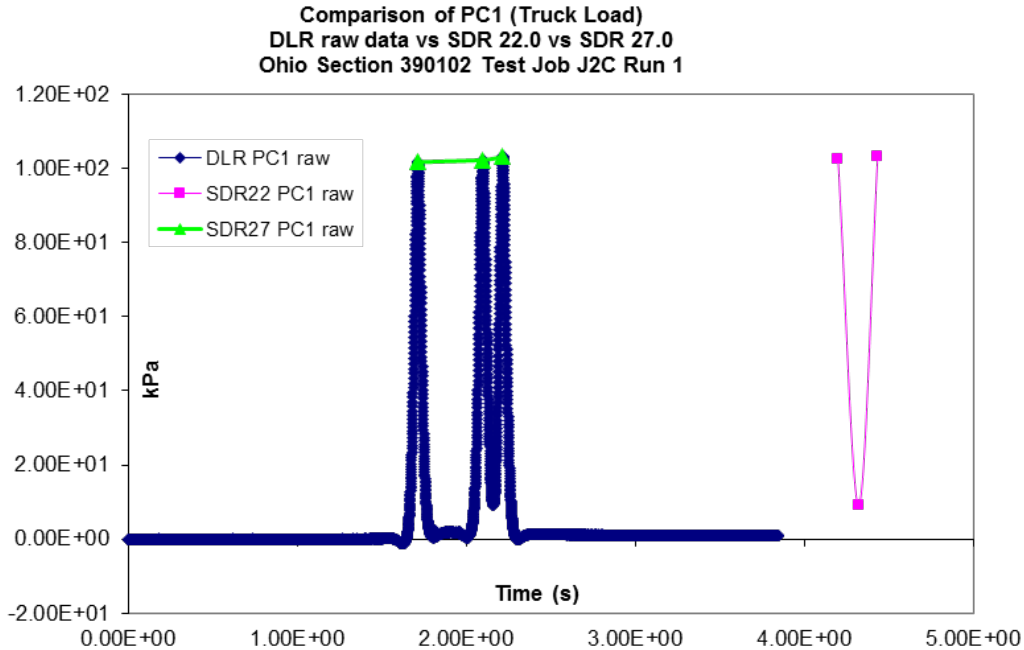
Figure 19. Graph. Dyn12 strain gauge traces for Ohio test section 390102 test J2C run 1 on August 5, 1996.



1 micron = 3.93×10^{-5} inches

Figure 20. Graph. LVDT1 traces for Ohio test section 390102 test J2C run 1 on August 5, 1996.

As shown in figure 20, only the peaks (but no valleys) and their corresponding time stamps were included in the SPS-1 and SPS-2 DLR database.[9]



1 kPa = 0.145 lbf/inch^2

Figure 21. Graph. PC1 traces for Ohio test section 390102 test J2C run 1 on August 5, 1996.

As shown in figure 21, only the peaks (but no valleys) and their corresponding time stamps were included in the SPS-1 and SPS-2 DLR database.(9)

OHIO SPS-2 DATA SAMPLE PLOTS

Figure 22 and figure 23 show the sample plots of test section 390201 test J1A run 2 using the newly created SPS-1 and SPS-2 DLR database (temporarily designated as SDR 27.0) for Dyn5 and LVDT1 sensors, respectively. The newly created data appear to match the DLR raw traces.

For the strain gauges, the front axle pavement deflection peaks and valleys as well as their corresponding time stamps were included in the newly created SPS-1 and SPS-2 DLR database.(9) The front axle deflections were missing in SDR 22.0.(6) It was suggested that the third valley near time point 2.0 s was not required to be included in the database. As a result, the SDR 27.0 Dyn5 smoothed trace in figure 22 goes directly from the second peak to the third peak without matching the third valley of the DLR Dyn5 raw trace between the two tandem axle peaks.

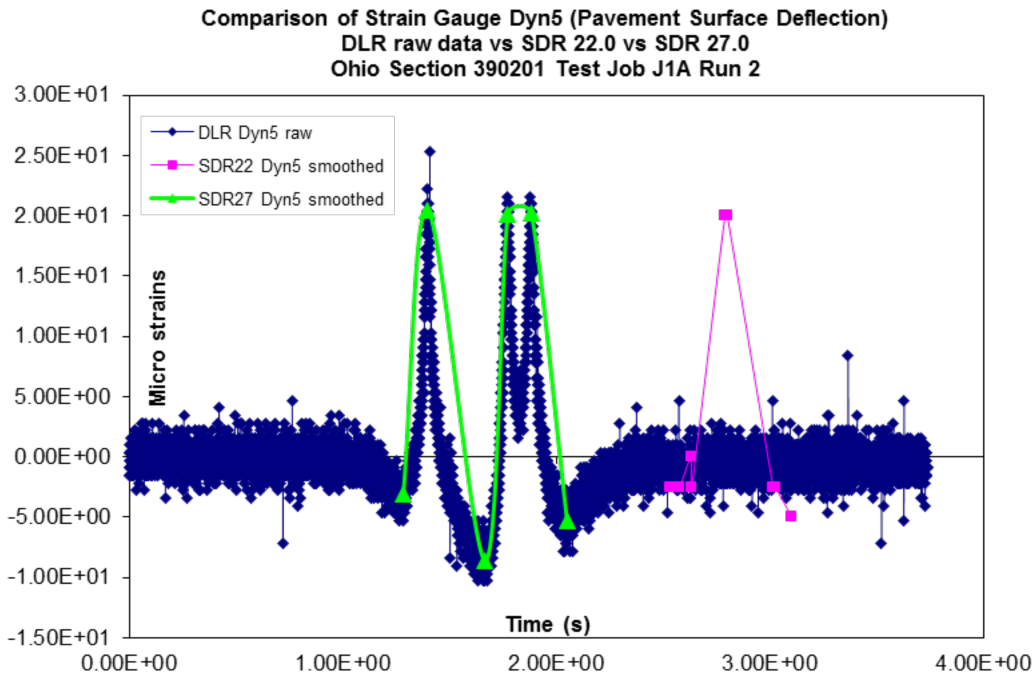
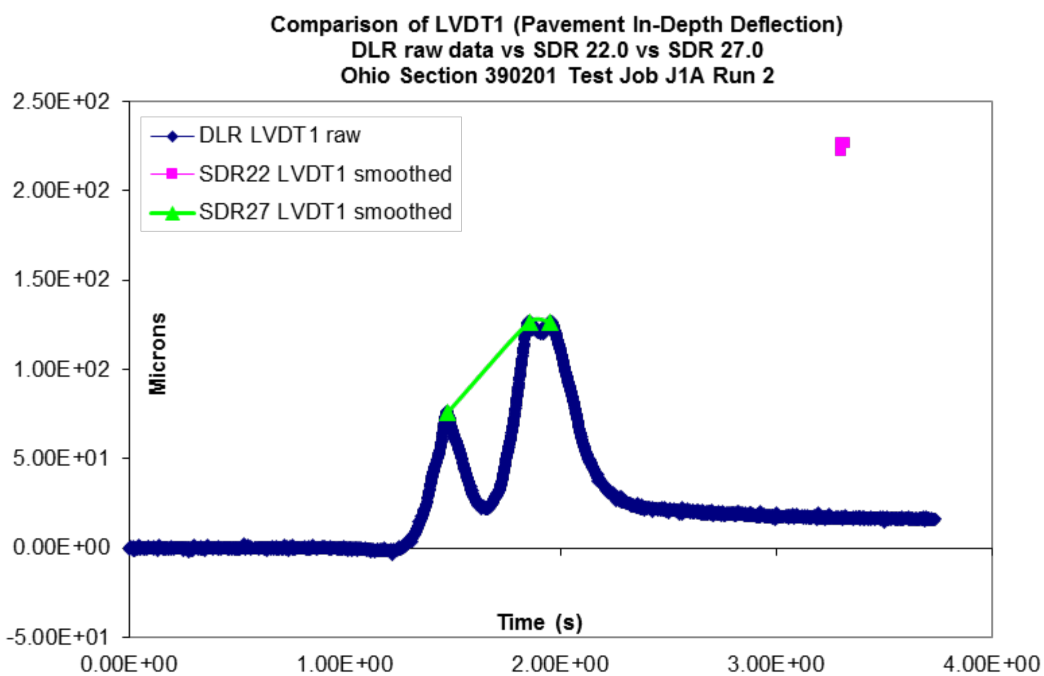


Figure 22. Graph. Dyn5 strain gauge traces for Ohio test section 390201 test J1A run 2 on August 12, 1996.



1 micron = 3.93×10^{-5} inches

Figure 23. Graph. LVDT1 traces for Ohio test section 390201 test J1A run 2 on August 12, 1996.

As shown in figure 23, only the peaks (but no valleys) and their corresponding time stamps were included in the SPS-1 and SPS-2 DLR database.(9)

10. CONCLUSIONS

The DLR study team reinterpreted 4,290 Ohio SPS-1 DLR raw traces (table 3) and 9,240 Ohio SPS-2 DLR raw traces (table 4), correcting the data issues identified by DAOFRs Ecomplex-75–77 and the technical memorandum, *Investigation of Ohio DLR data in LTPP Database*, for SDR 22.0, including trace peak time lag shift, incorrect sensor locations, and wheelpath offsets. (See references 2–5.) Using the methodology in chapter 5 of this report, the DLR study team calibrated and smoothed the SPS-1 and SPS-2 raw traces before categorizing those traces into three categories: good, maybe, and not good. For the SPS-1 data, the trace categorization QC results for smoothed and raw traces are listed in table 13 and table 14, respectively. Approximately 24 percent of strain gauge traces, 55 percent of LVDT traces, and 99 percent of PC traces were concluded to be good. For the SPS-2 data, due to significant noise in the raw traces, only smoothed traces were categorized, and the QC results are listed in table 17. Approximately 61 percent of strain gauge traces and 15 percent of LVDT traces were concluded to be good. Only good traces were used for further extraction of trace peaks and valleys for the upcoming SDR 27.0. In addition, the sensor locations and the corresponding wheelpath offsets were corrected using the approach in chapter 5. Overall, the newly created DLR data in SDR 27.0 appear to match the DLR raw traces, as demonstrated by the plots in chapter 9.

Moreover, the QC results from the categorization were manually checked, and the sensor status from visit to visit and run to run for all SPS-1 and SPS-2 tests for smoothed and raw traces were verified. In addition, the first peak value extracted for good traces was compared with the data from OU, which indicated that the values were very close for most of the sensors for all test sections (see table 18 and table 21).

Appendices A–E show the sensor layouts in the Ohio SPS-1 and SPS-2 DLR test sections as well as of the 23 Ohio SPS-1 DLR tests and the 24 Ohio SPS-2 DLR tests to aid future DLR data users in identifying the layout and status of each sensor from one test visit or run to another.

In the remainder of this chapter, the data issues identified in the DLR raw traces are enumerated.

OHIO SPS-1 DATA ISSUES

Ohio SPS-1 data issues are as follows:

- Some tests in the DLR data did not have any test files, and some files did not have information pertaining to sensor location, truck pass, and truck peak in Ohio data. These test were not considered for processing. As a result, only 23 out of 34 tests were considered for DLR data processing.
- Strain gauge sensors Dyn10 and Dyn11 for tests J2A, J2C, J2D, J2E, J2F, and J2G in test section 390102 showed a flat trace pattern.
- All of the LVDTs were buried deep into the subgrade or close to the interface between the subgrade and the base layer in the test sections. Thus, the LVDT traces should not contain any trace valleys (no tensile strains) but only peaks (compressive strains). The

LVDT3 sensor for tests J2A, J2C, J2D, J2E, J2F, and J2G (test section 390102), however, showed a trace pattern similar to a longitudinal strain gauge trace that contains trace valleys.

- Longitudinal strain gauges are expected to assume trace valleys, whereas transverse strain gauges are not. The longitudinal strain gauge sensor Dyn17 for tests J8A, J8D, J8E, and J8G (test section 390108), however, showed a trace pattern similar to a transverse strain gauge trace that assumed no valleys.

- As indicated by table 9, a significant difference between the extracted peaks and the Ohio data peak for some sensors was observed. This could be due to the sensor locations reported in the OU data (Truckpeak.txt) being approximately two to three inches off the actual sensor locations as measured from the southernmost deep LVDT.

- In table 25, inconsistent Z-coordinates (depth of the sensor from the pavement surface) for strain gauges Dyn16 to Dyn18 were found between test section390108 profile view and EmbeddedSensor.txt. Tests J8A, J8D, J8E, and J8G were conducted in test section 390108. The tests consisted of three AC layers (2, 2, and 3 inches), one permeable asphalt treated base (PATB) (4 inches), one dense graded aggregate base (8 inches), and subgrade. The test section 390108 profile view showed that Dyn16 to Dyn18 were buried at the bottom (Z = 11 inches from the pavement surface) of the top PATB base layer (4 inches), which is below the three AC layers. In contrast, EmbeddedSensor.txt showed that Dyn16 to Dyn18 were buried at Z = 7 inches from the pavement surface and the Layer was "bottom," referring to the bottom of the lowest of the three AC layers. Thus, the DLR study team recommends changing the Z-coordinate of test section 390108 Dyn16 to Dyn18 from 7 inches to 11 inches and changing the layer to "base PATB" or "base" from "bottom" for this case.

- The construction plan from one of the original DLR documents showed that two AC layers were planned for test sections 390102, 390104, 390108, and 390110. The section profile views of these sections, however, showed three AC layers. Based on the construction plan, the SECTION_LAYER_STRUCTURE table in SDR 26.0 had two AC layers, with the bottom AC layer combining the two bottom AC layers (2 and 3 inches) shown in the profile views into a 5-inch AC layer while keeping the top 2-inch AC layer as the top AC layer. The DLR study team recommends revising the SECTION_LAYER_STRUCTURE table in order to show the three (instead of two) AC layers.

Table 25. Sample data from Ohio data for test section 390108.

Name	Sensor Number	Model	X	Y	Z	Path	Layer	DirCosX	DirCosY	DirCosZ
Dyn	16	PAST -II AC	72	72	7*	CL	Bottom*	0	1	0
Dyn	17	PAST -II AC	96	72	7*	CL	Bottom*	1	0	0
Dyn	18	PAST -II AC	120	72	7*	CL	Bottom*	0	1	0

CL = Center lane.
*Indicates suspect data.

OHIO SPS-2 DATA ISSUES

Ohio SPS-2 data issues are as follows:

- Due the fact that test J12A1 was empty and test J12J10M1 was a partial repeat of J12J10M, the two test were not processed. As a result, only 24 out of 26 tests were considered for DLR data processing.
- Site visits (A, B, and C) of SPS-2 test sections 0201, 0205, 0208, and 0212 were inconsistent with the SPS-2 subseries (H, I, and J) of OU data. Since subseries A–G were already used for SPS-1 in the OU data, it was assumed that OU assigned H, I, and J instead of A, B, and C for SPS-2.
- In the DLR_STRAIN_TRACE_SUM_PCC table, Dyn8 strain gauge from test J5J1P runs 1–10 had significantly larger raw strain values compared to other SPS-2 strain gauge values, which were mostly less than 100 με (see table 22). Thus, further investigation is needed for this strain gauge.
- SPS-2 DLR sensors LVDT5 and LVDT6 were unresponsive for all tests (the values were all zero).
- The ASCII files for SPS-2 tests J5J1M, J5J1N, J5J1O, J5J1P, J8S3M, J8S3N, J8S3O, J8S3P, J12J10M, J12J10N, J12J10O, and J12J10P had 32 LVDT sensors (LVDT1 through LVDT32). The other tests (J1A, J1B, J1C, J5A, J5B, J5C, J8A, J8B, J8C, J12A, J12B, and J12C) had only 16 LVDT sensors (LVDT1 through LVDT16). The DLR study team processed only the first 16 LVDTs (LVDT1 through LVDT16) based on information present in the EmbeddedSensor.txt file, which showed only the first 16 LVDTs.
- The first 500 trace data points were used to determine the gain adjustment factor for SPS-2 data. On average, each SPS-2 time history dataset contains close to 7,000 data points, whereas each SPS-1 time history dataset contains approximately 5,000 data points. Due to significant noise in the SPS-2 data, the first 500 data points may not be enough. For future research, the first 700 data points should be used to determine the gain

adjustment factor for SPS-2 data; 700 is approximately 10 percent of each SPS-2 time history dataset.

OHIO SPS-1 AND 2 COMMON DATA ISSUES

Common data issues for Ohio SPS-1 and SPS-2 are as follows:

- The proposed REF_LOC_NO, the distance between the beginning of a test section and the southernmost first LVDT that serves as the origin of the sensor coordinate system, is not possible to determine. The section beginning was not used as a reference for sensor location, and sections have since been overlaid, making this measurement unattainable.
- As listed in table 18 (SPS-1) and table 21 (SPS-2), the peak data information contained in the Ohio data file was unclear. The data had multiple sensor location values for the same sensor and run.
- The beginning offset, ending offset, and range values for strain gauges, LVDTs, and PCs (the latter for SPS-1 only) obtained from the DLR raw traces did not match the beginning and ending offset and range values in SDR 22.0. Per the technical support service contractor's recommendations, the beginning offset, ending offset, and range columns were removed and will not be in the upcoming SDR 27.0.
- The information on channel number, record status, input card, card gain, post gain, gauge resolution, etc. in DLR_STRAIN_CONFIG_AC/PCC, DLR_LVDT_CONFIG_AC/PCC, and DLR_PRESSURE_CONFIG_AC, and run time in DLR_TEST_MATRIX presented in DLR tables in SDR was not found.
- The inconsistent wheelpath offset field in DLR_TEST_MATRIX was updated only for test sections using the truck pass data in the Ohio dataset (TruckPass.txt). The DLR_TEST_MATRIX table in SDR, however, had wheelpath offset records for both Ohio and North Carolina test sections. Since the wheelpath offset data for the North Carolina test sections was not available, the wheelpath offset records for the North Carolina test sections were not updated.
- The nine records in the DLR_TEST_MATRIX table in SDR 22.0 that did not have any source data to update were removed (see table 23). As a result, 54 traces that did not have a matching record in the DLR_TEST_MATRIX were removed from the 5 trace tables in the upcoming SDR 27.0.
- No information could be found in the DLR_TEST_MATRIX to interpret data in the MATRIX_INDEX column (distinct coded reference number for controlled truck testing used to aggregate the tests according to the type of truck, vehicle speed, and general time of testing). Thus, the DLR study team recommends removing the column.

APPENDIX A. SENSOR LAYOUT IN THE OHIO SPS-1 DLR SECTIONS

Figure 24 through figure 26 show the instrumentation layout in plan and profile view as well as the pavement layer structure in profile view for Ohio SPS-1 test sections.

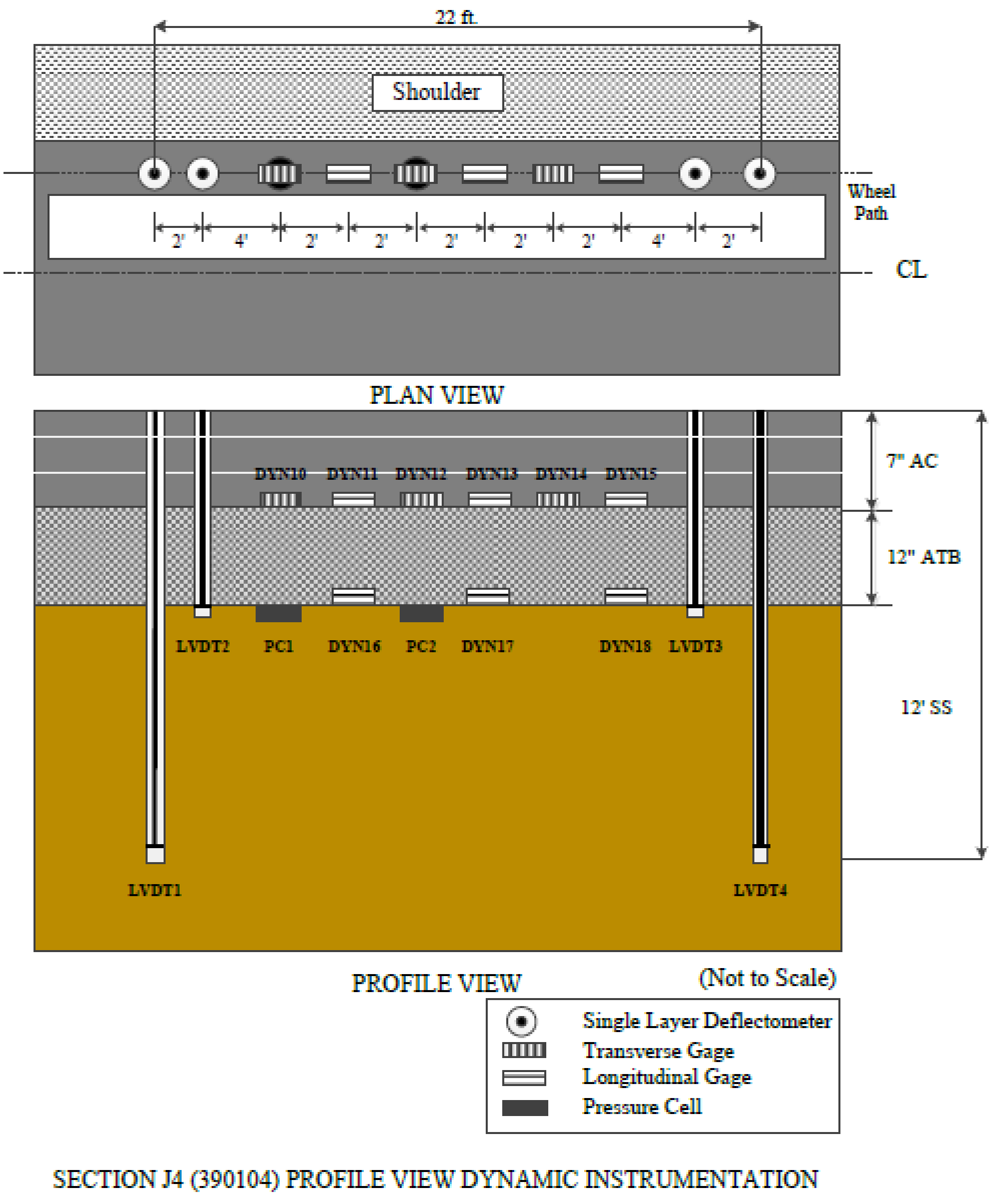


Figure 24. Illustration. Ohio SPS-1 test section 390104 sensor layout.

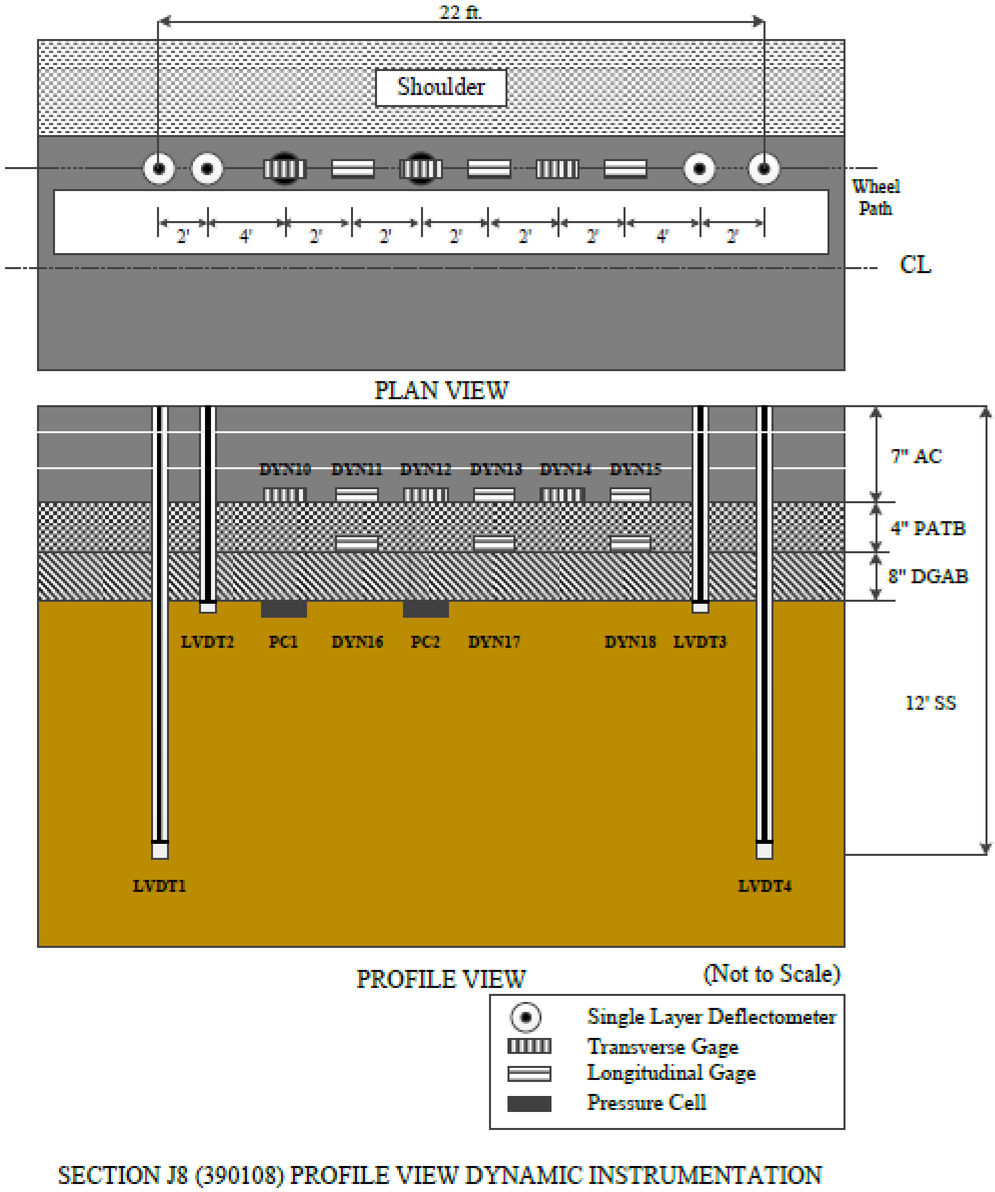


Figure 25. Illustration. Ohio SPS-1 test section 390108 sensor layout.

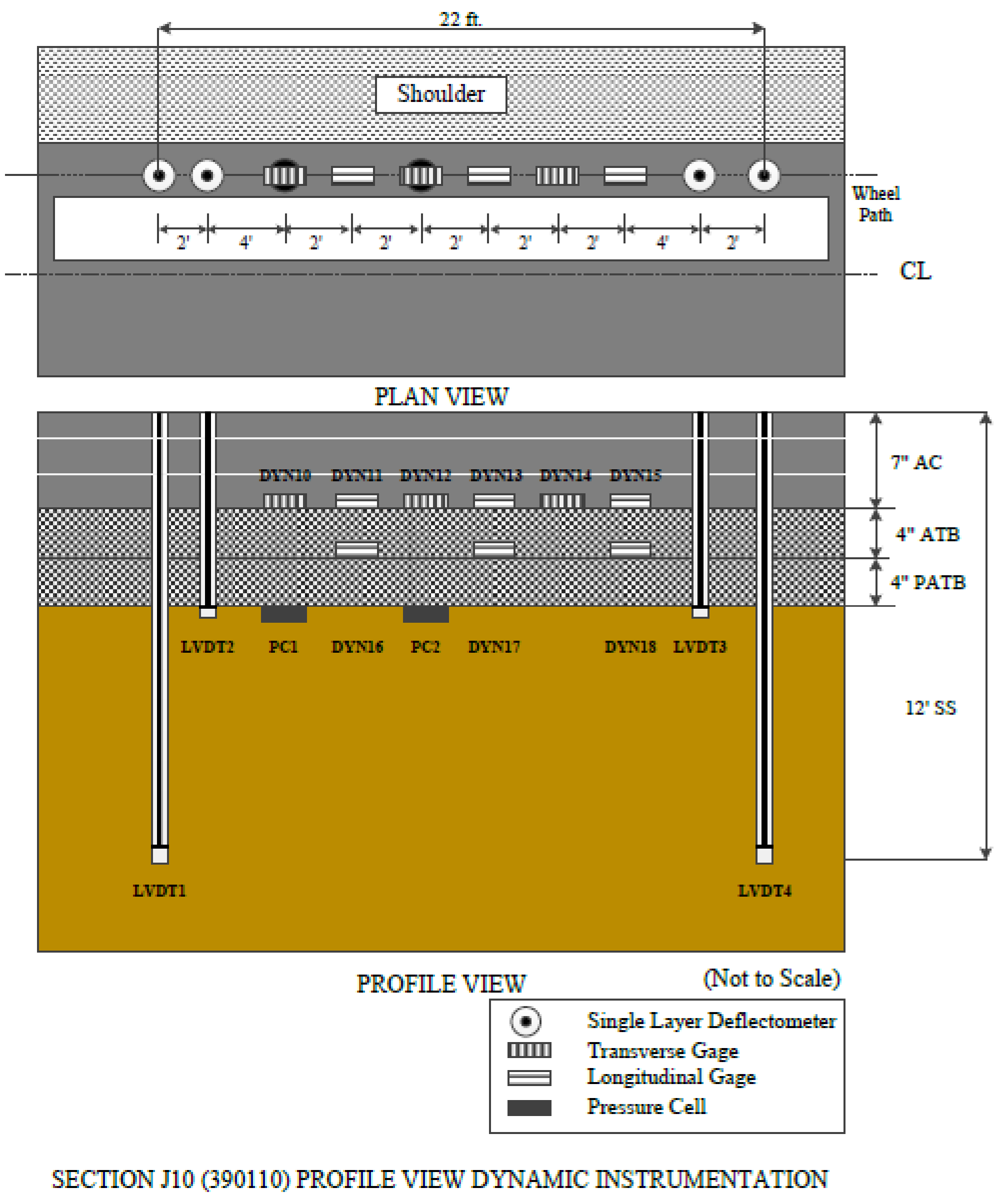


Figure 26. Illustration. Ohio SPS-1 test section 390110 sensor layout.

APPENDIX B. SENSOR STATUS OF THE 23 OHIO SPS-1 DLR TESTS

Appendix B shows the instrumentation layout in plan and profile view as well as the pavement layer structure in profile view with sensor status (good, maybe, and not good) for the 23 Ohio SPS-1 DLR test sections.

For figure 27 through 49, sensor colors represent the status of a sensor based on QC results, where green represents good, orange represents maybe, and red represents not good. The sensors with color combinations of more than one color represent status in combination. For example, if a sensor color is in a combination of green and orange, the status of the sensor is a combination of good and maybe.

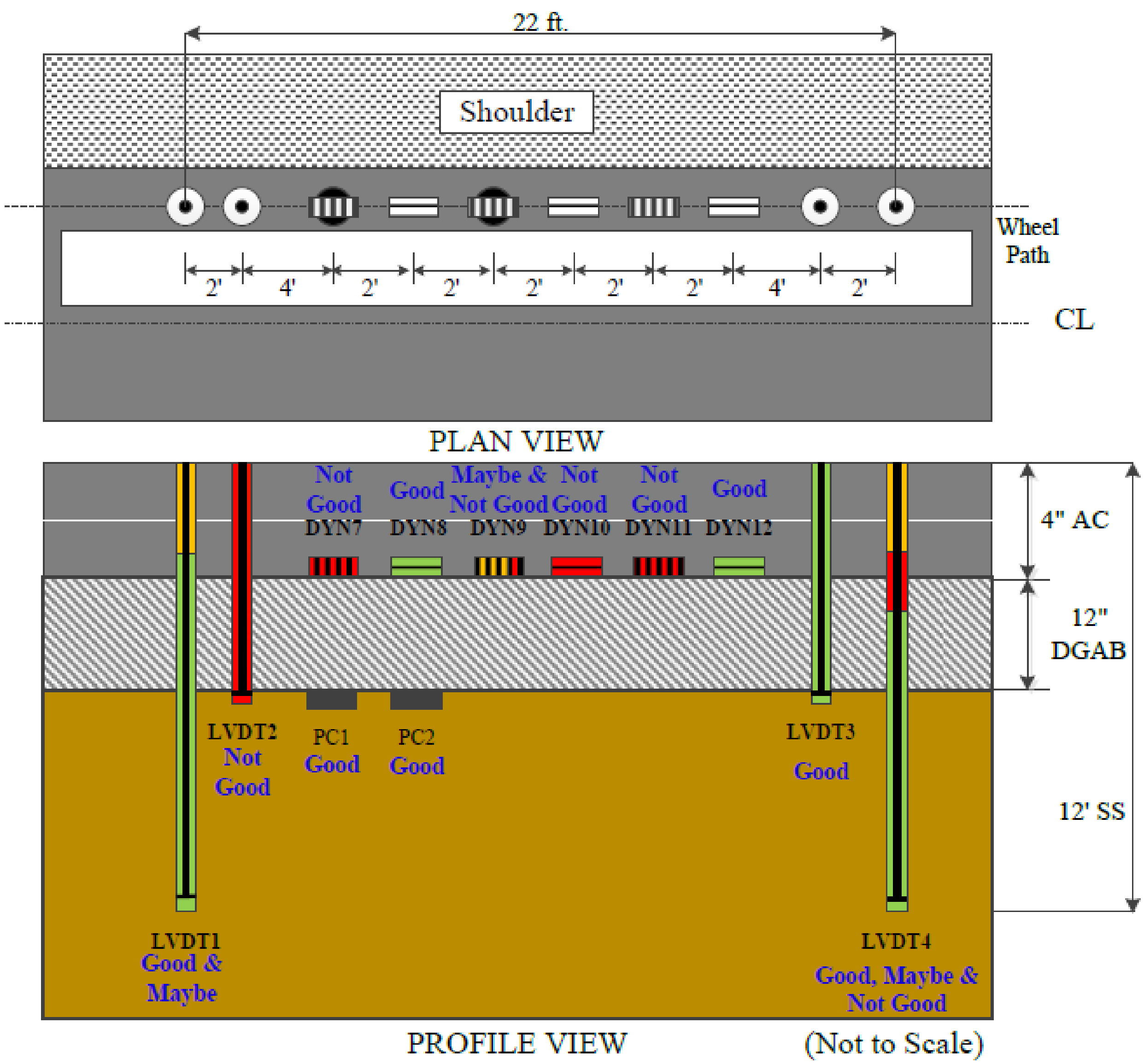


Figure 27. Illustration. QC results by sensor type for test section 390102 test J2A.

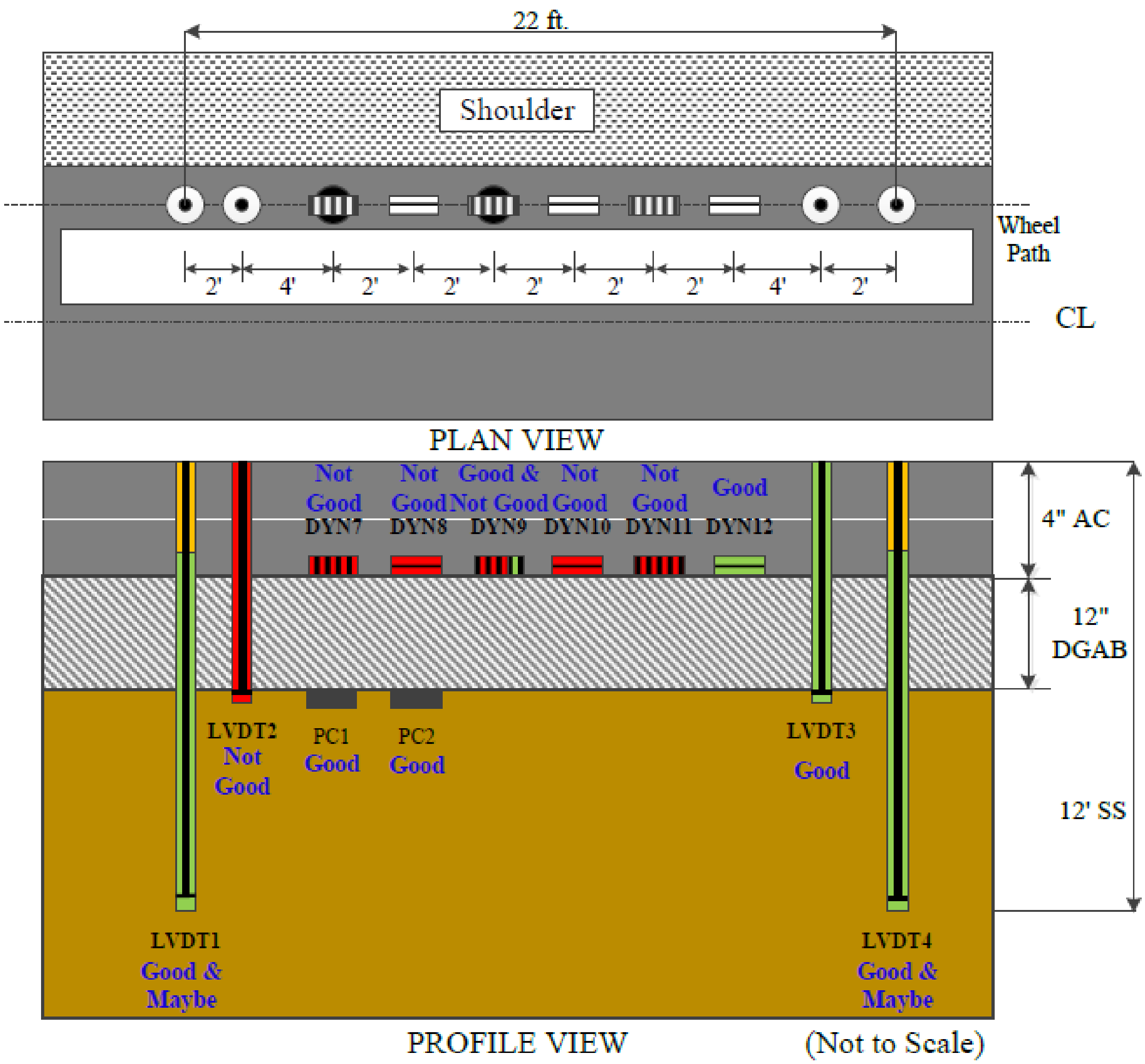


Figure 28. Illustration. QC results by sensor type for test section 390102 test J2C.

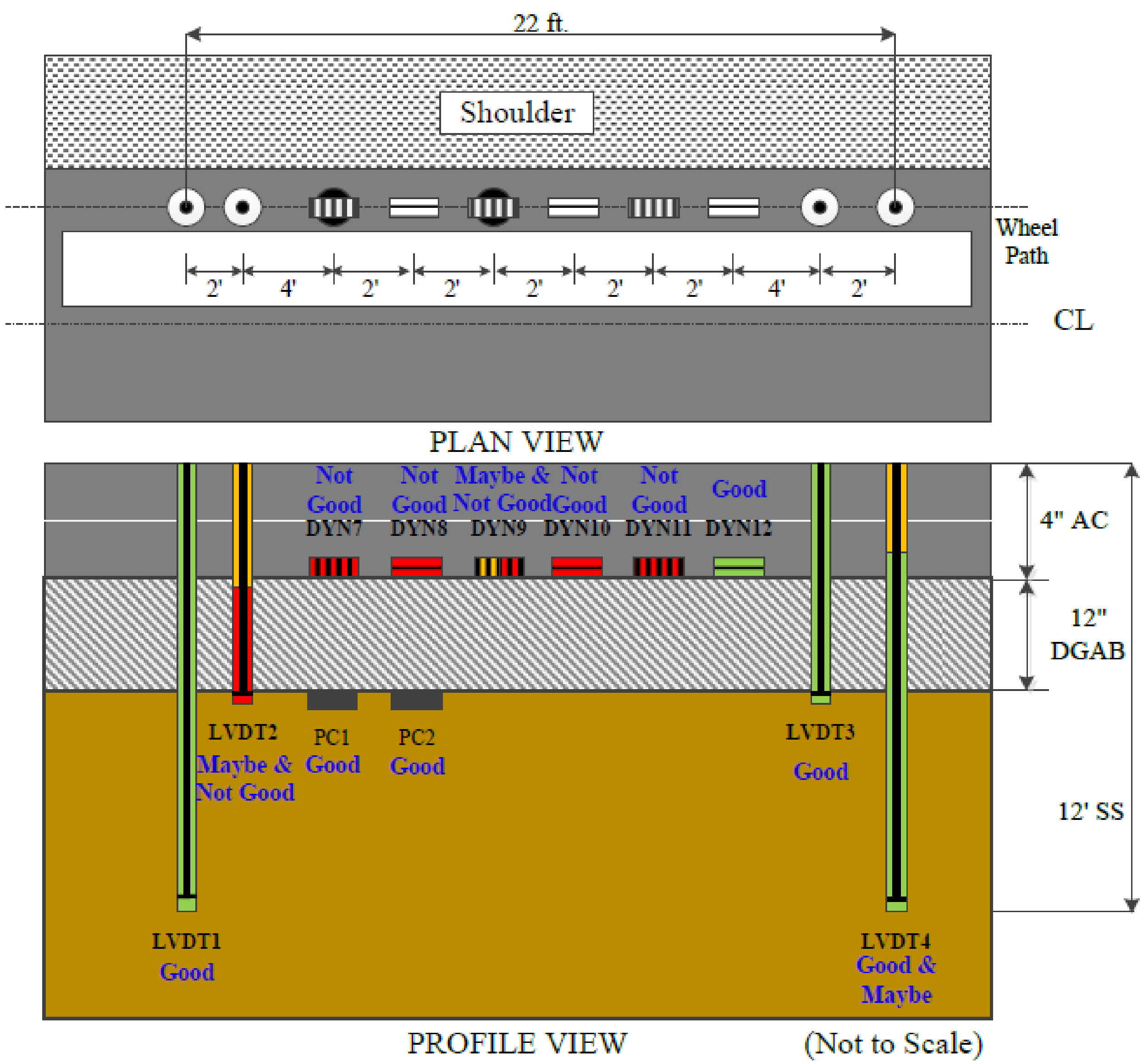


Figure 29. Illustration. QC results by sensor type for test section 390102 test J2D.

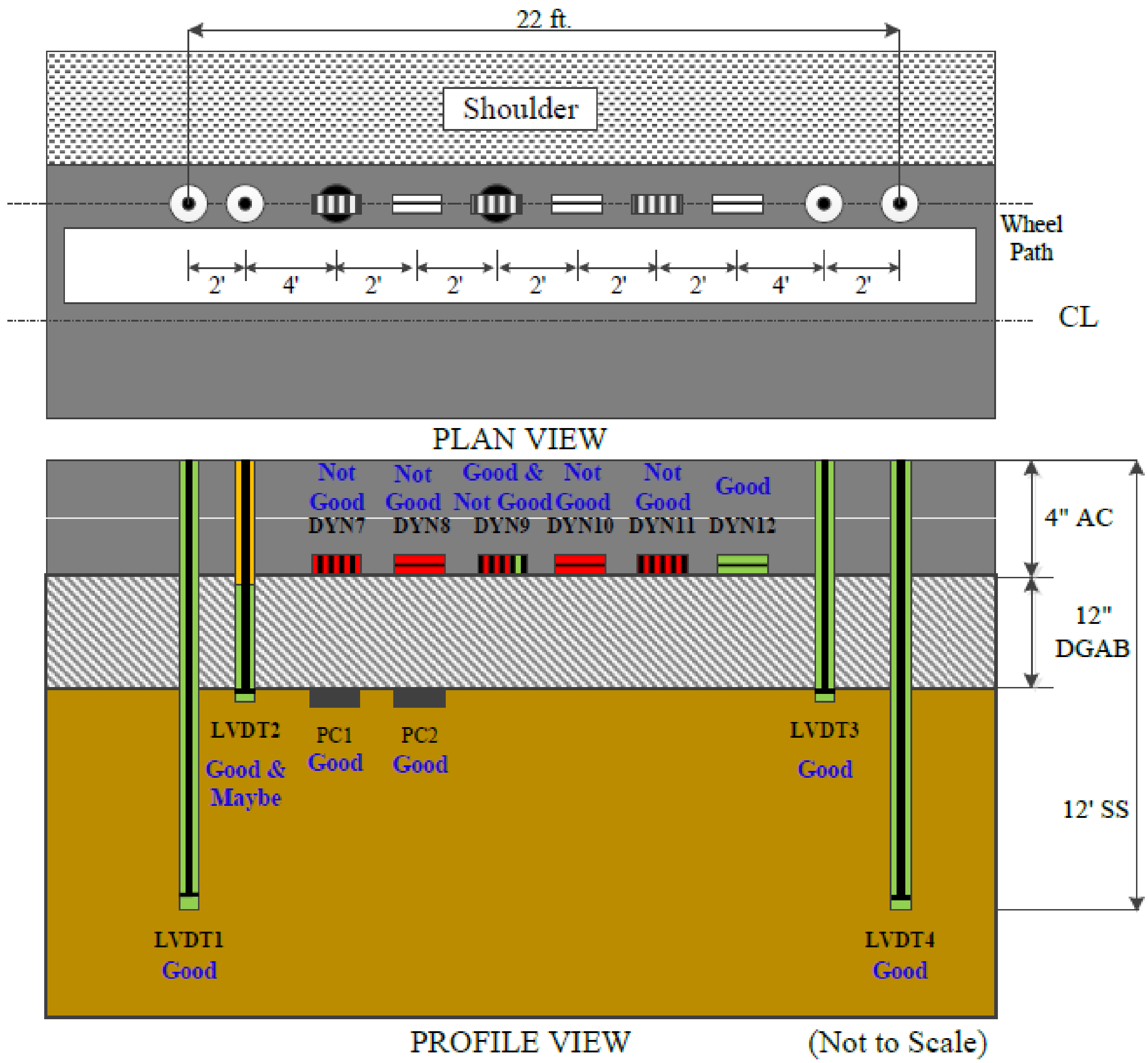


Figure 30. Illustration. QC results by sensor type for test section 390102 test J2E.

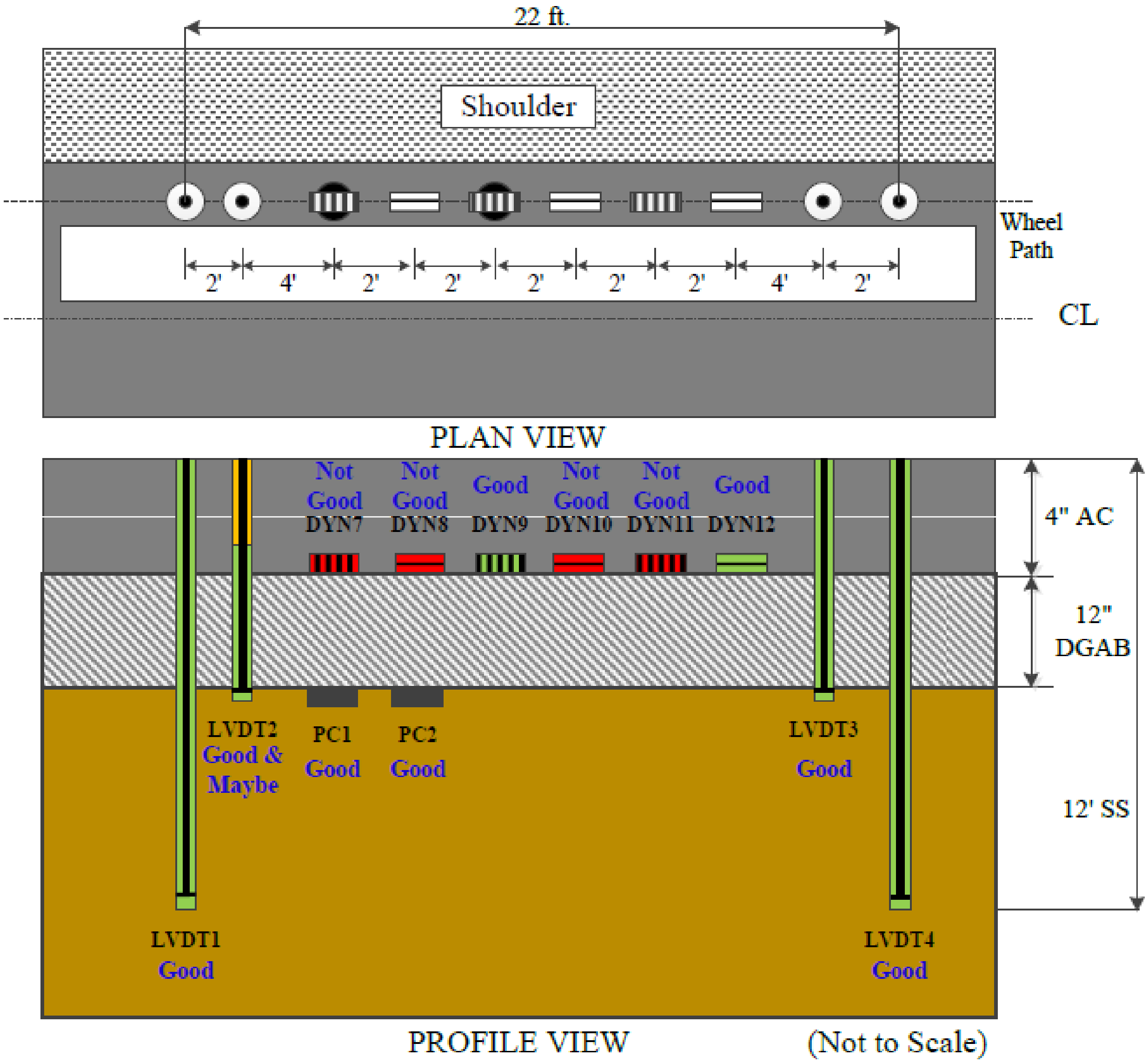


Figure 31. Illustration. QC results by sensor type for test section 390102 test J2F.

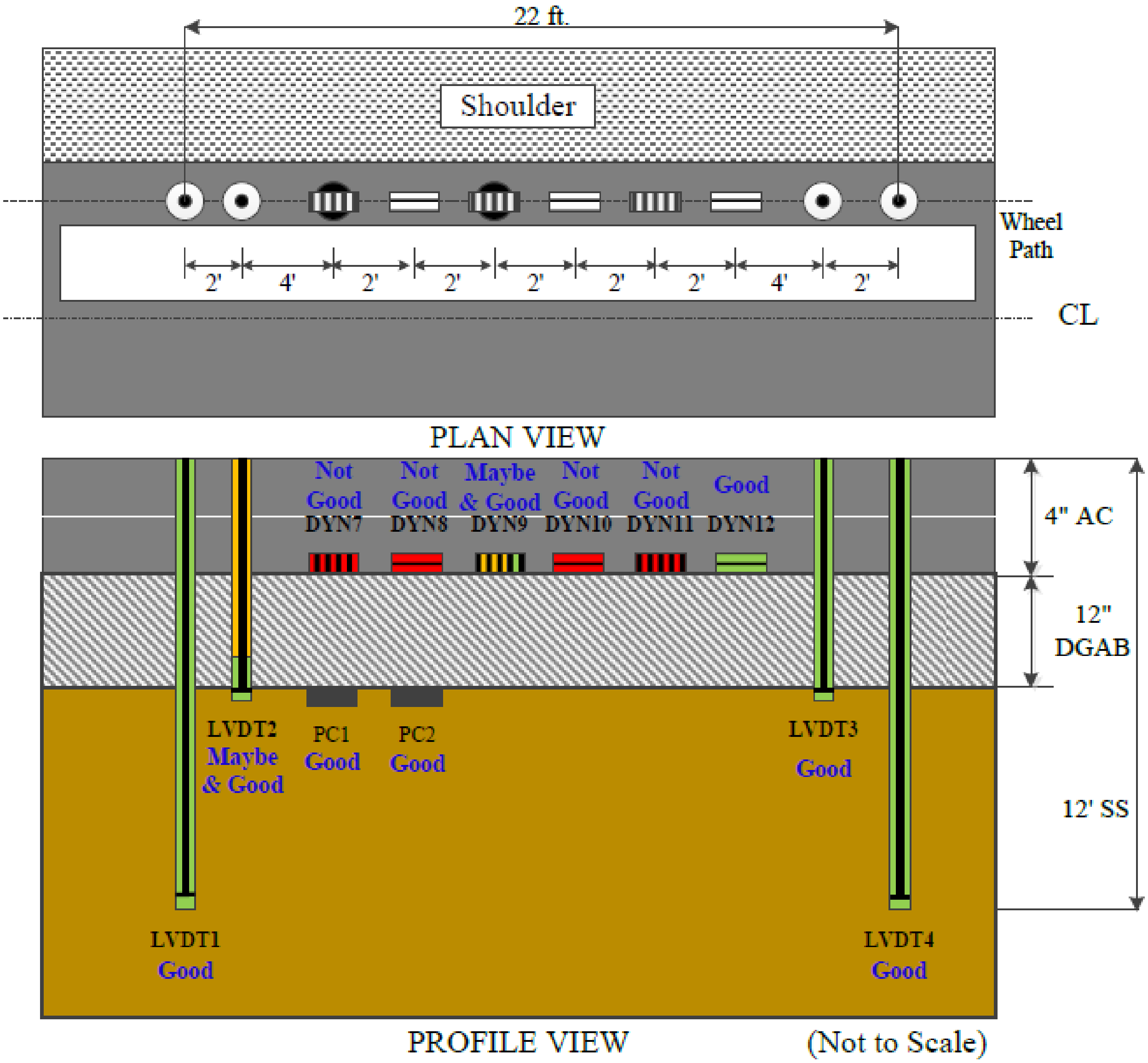


Figure 32. Illustration. QC results by sensor type for test section 390102 test J2G.

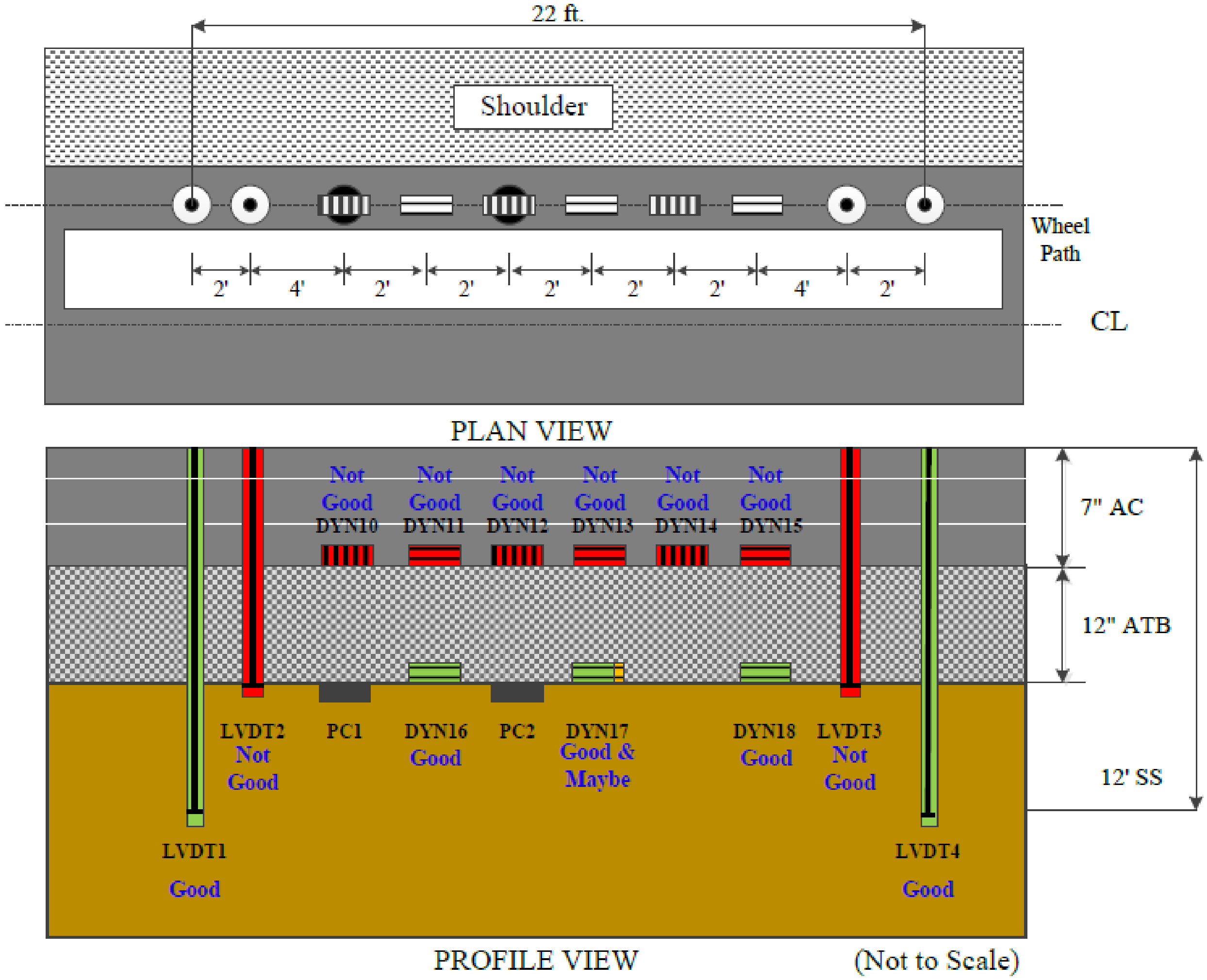


Figure 33. Illustration. QC results by sensor type for test section 390104 test J4A.

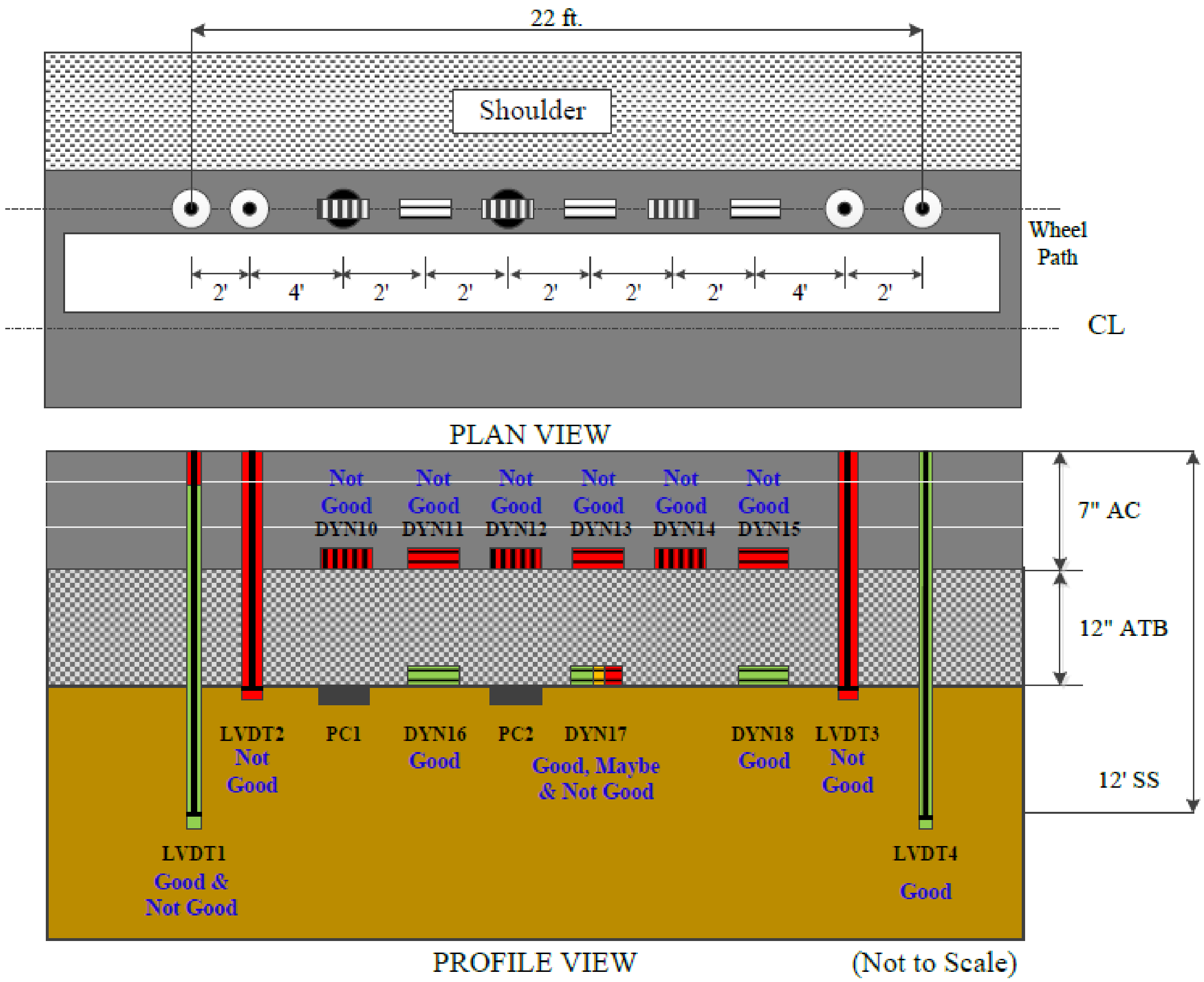


Figure 34. Illustration. QC results by sensor type for test section 390104 test J4B.

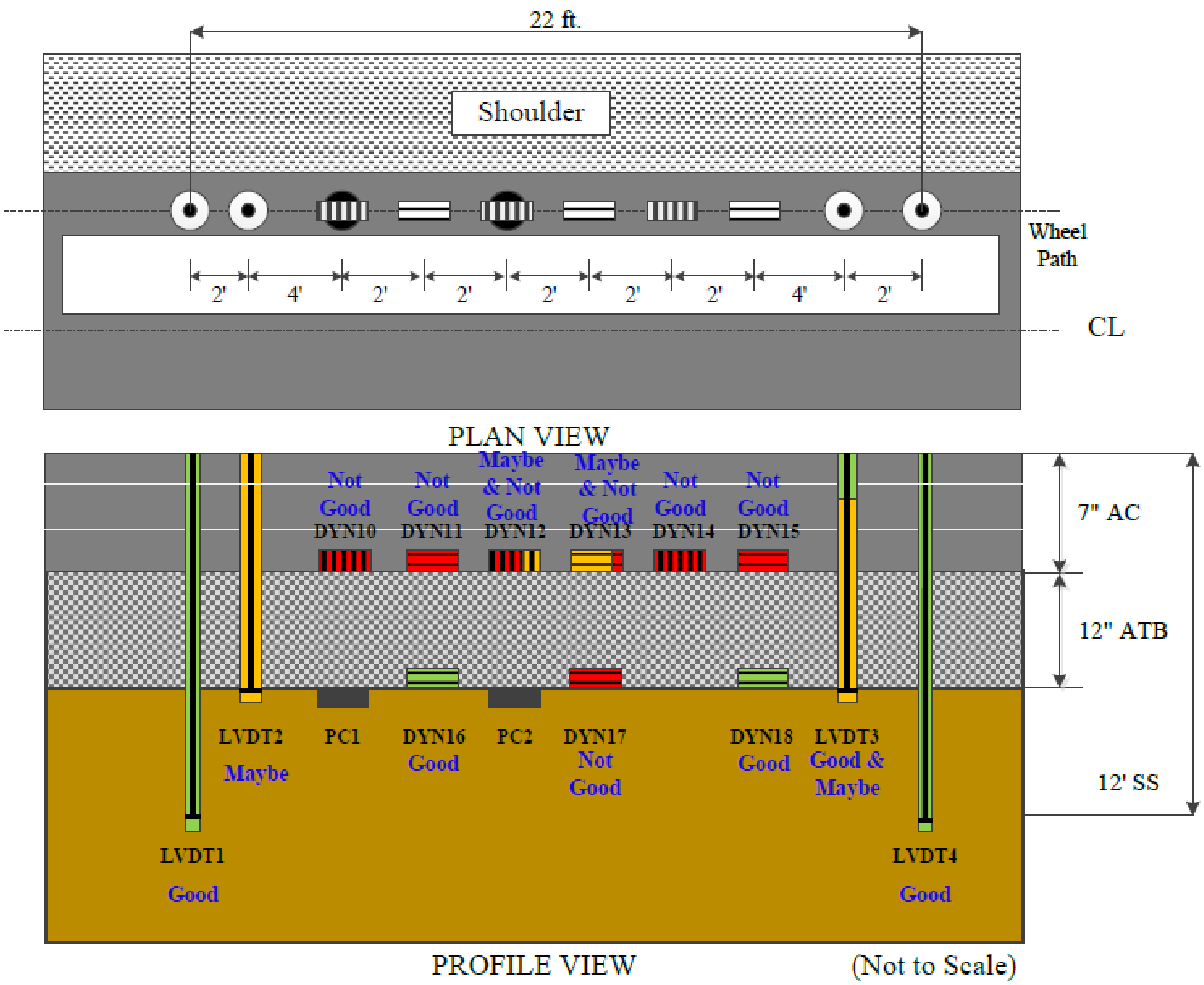


Figure 35. Illustration. QC results by sensor type for test section 390104 test J4C.

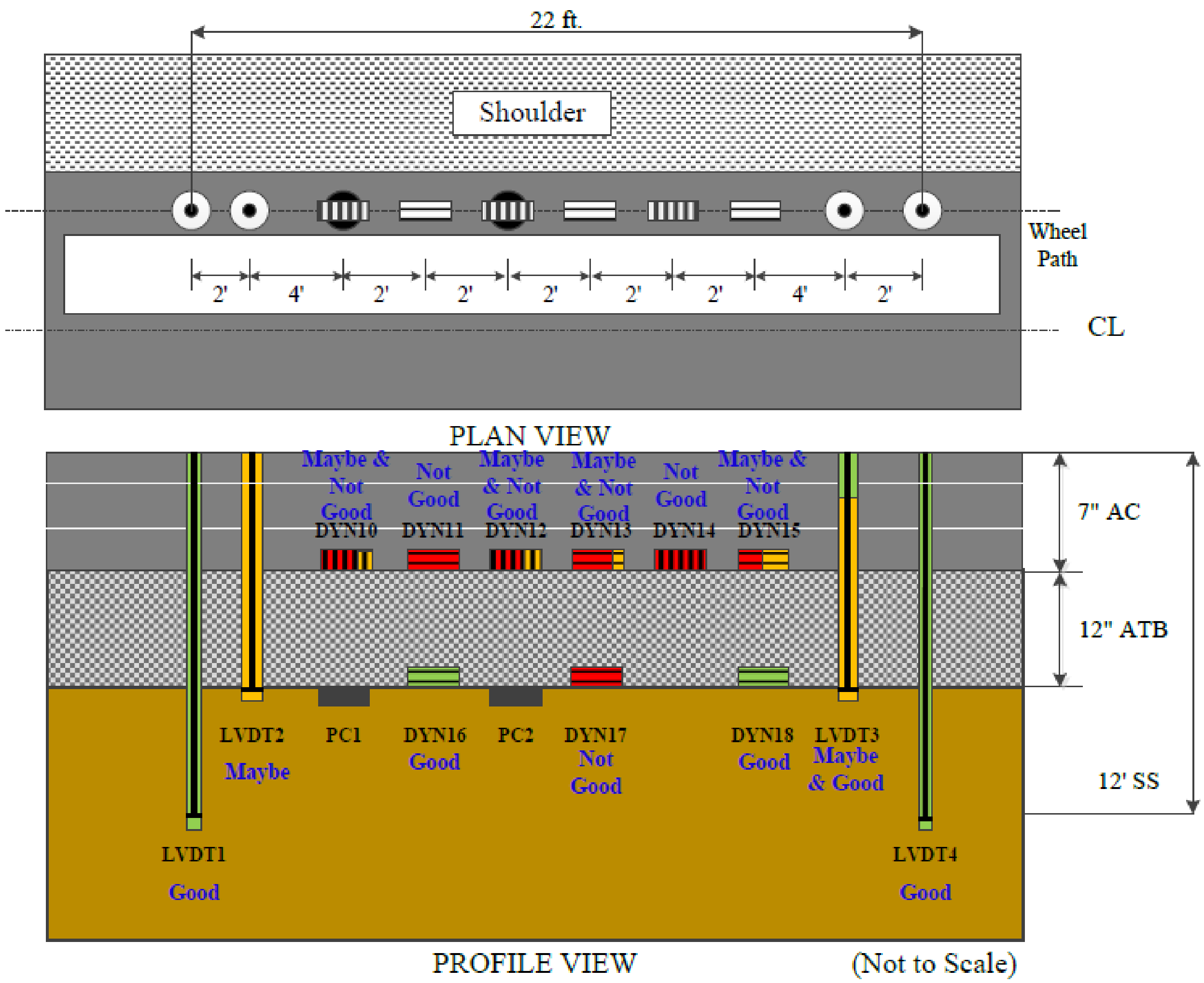


Figure 36. Illustration. QC results by sensor type for test section 390104 test J4D.

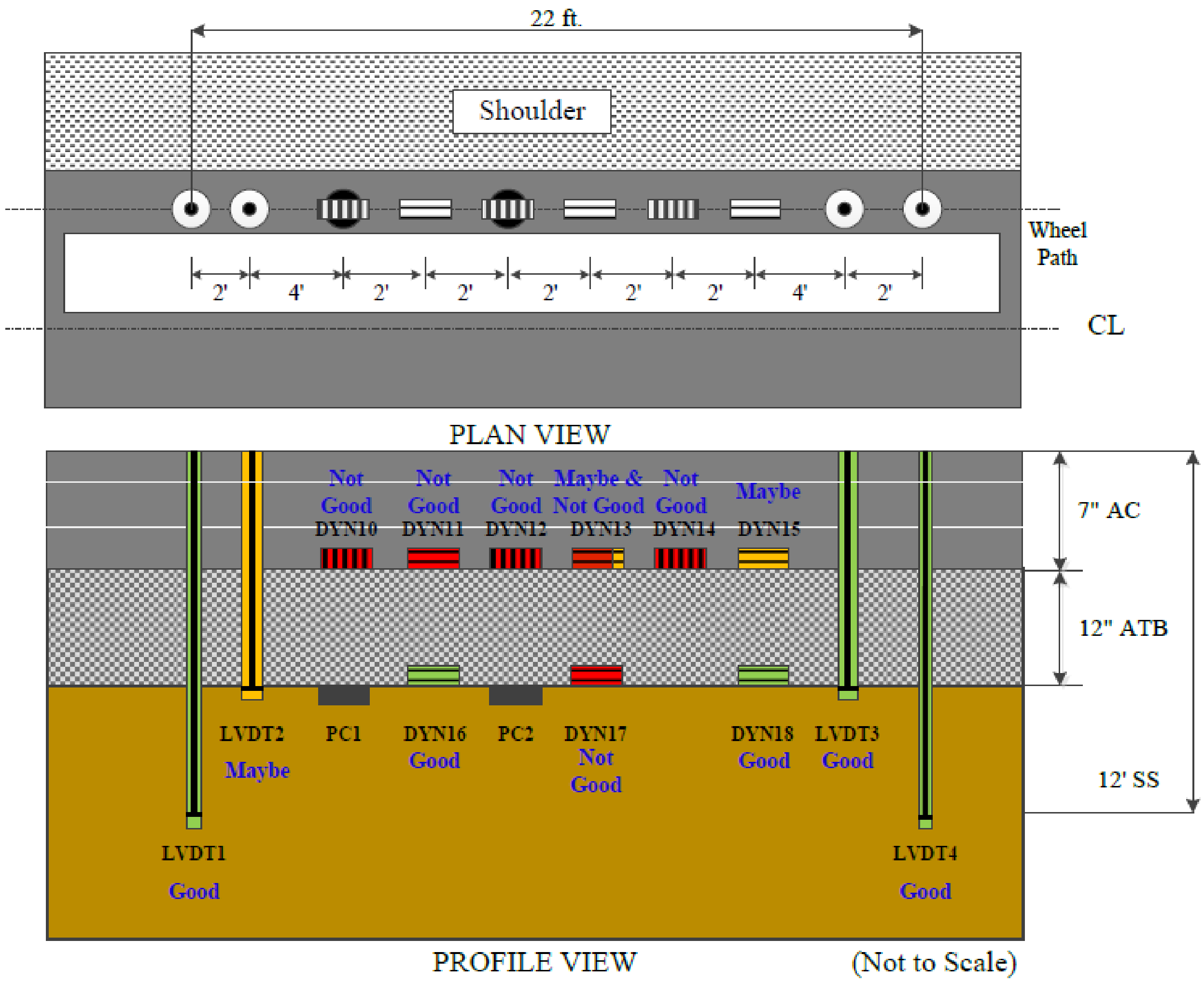


Figure 37. Illustration. QC results by sensor type for test section 390104 test J4E.

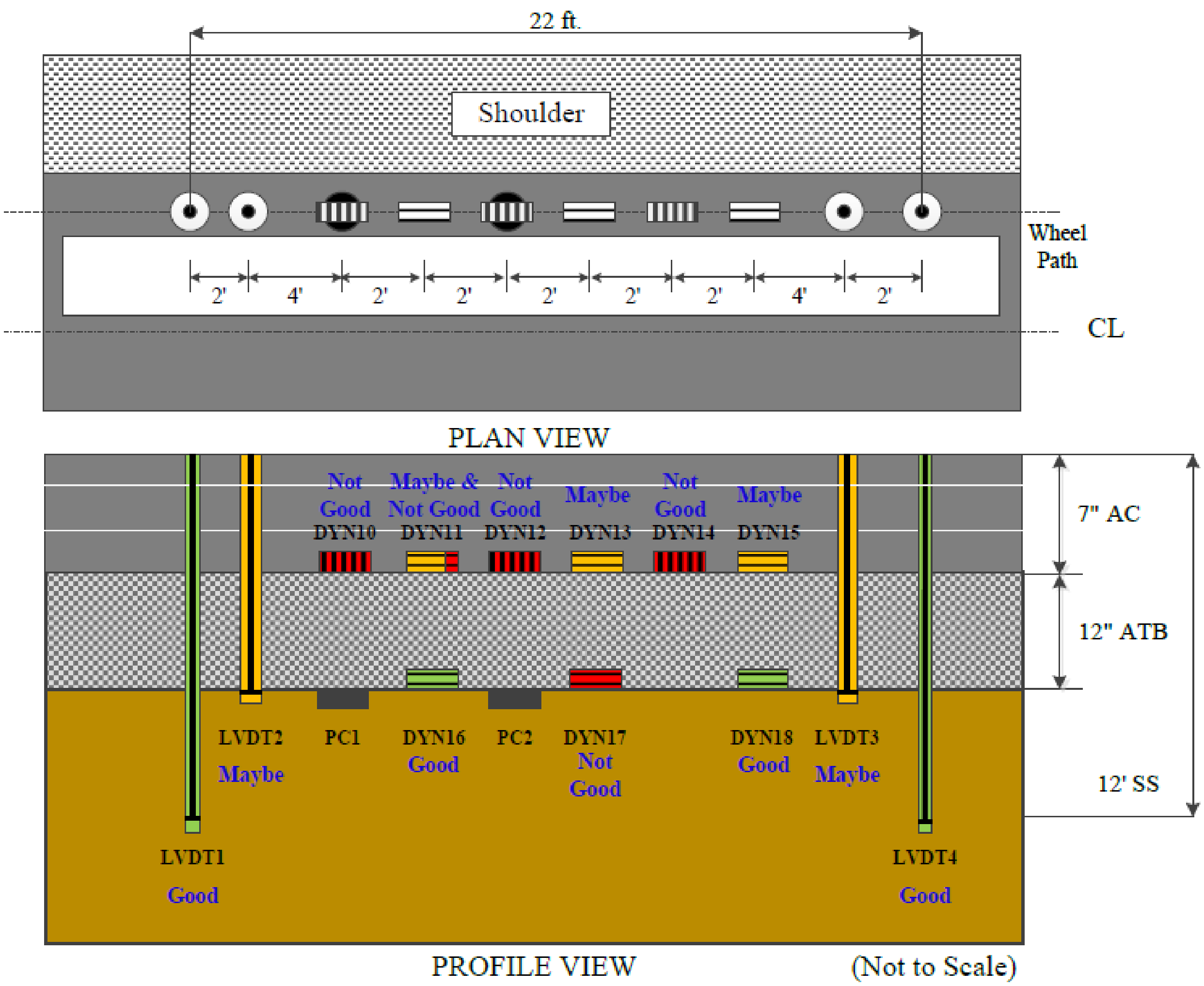


Figure 38. Illustration. QC results by sensor type for test section 390104 test J4F.

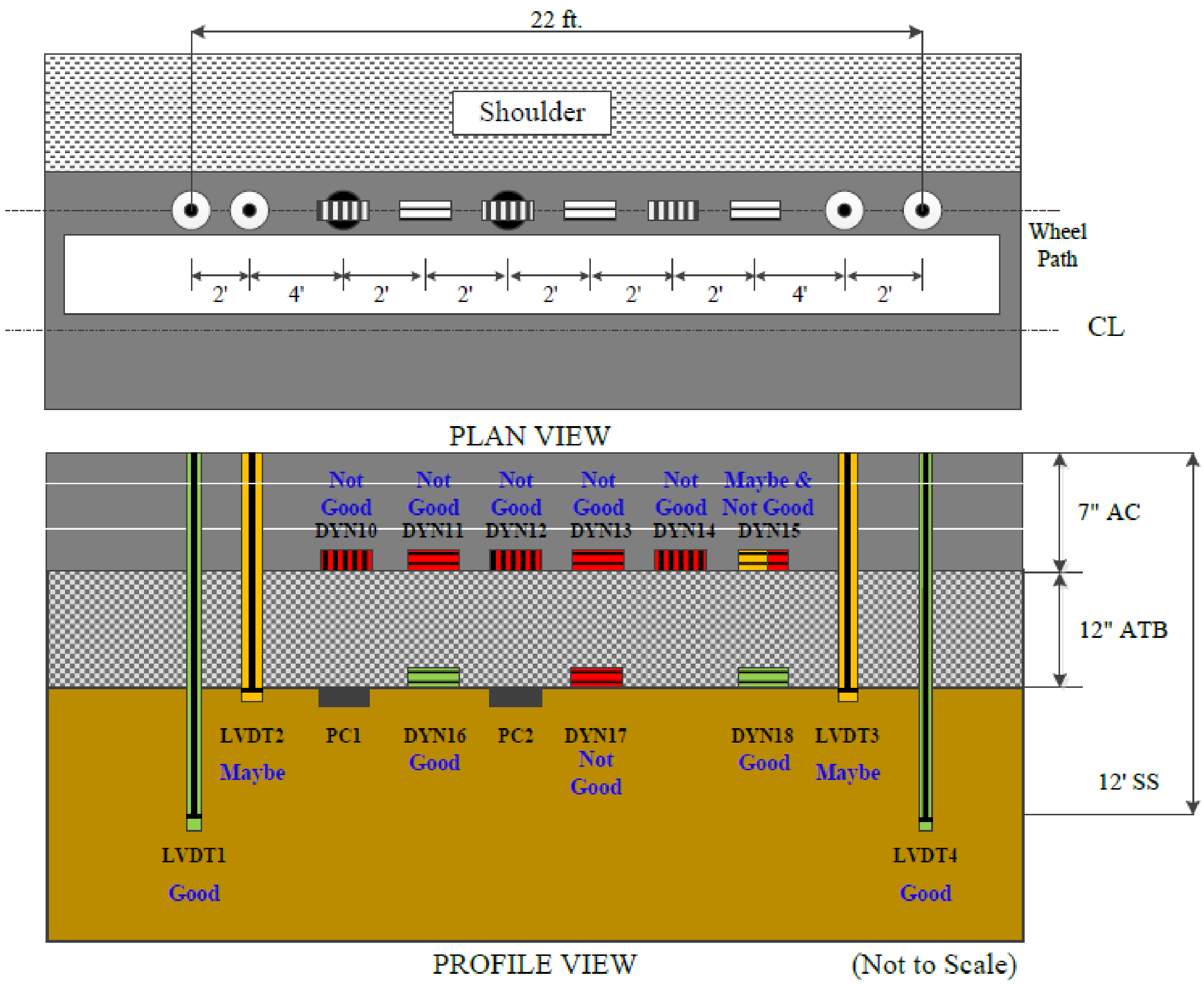


Figure 39. Illustration. QC results by sensor type for test section 390104 test J4G.

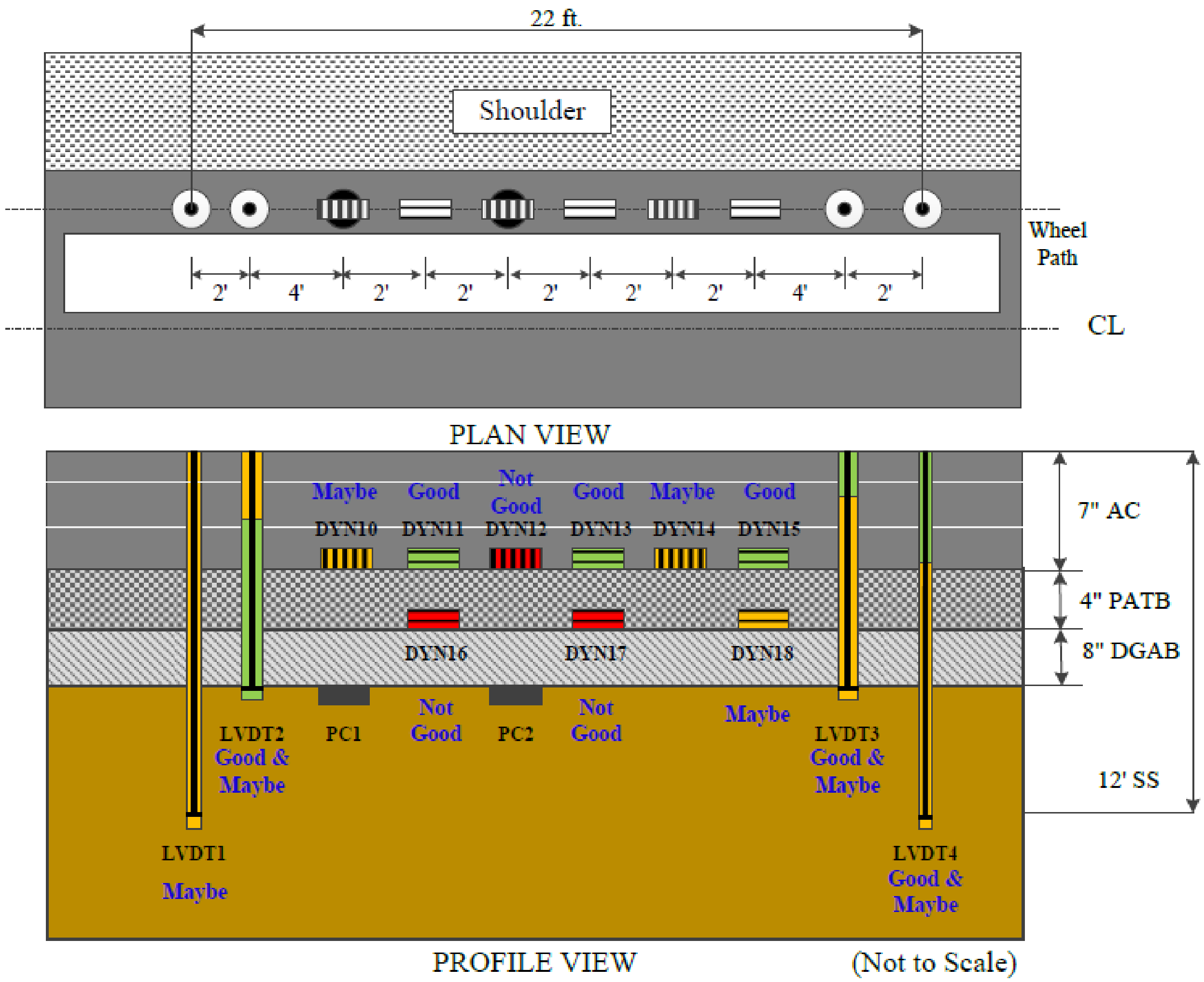


Figure 40. Illustration. QC results by sensor type for test section 390108 test J8A.

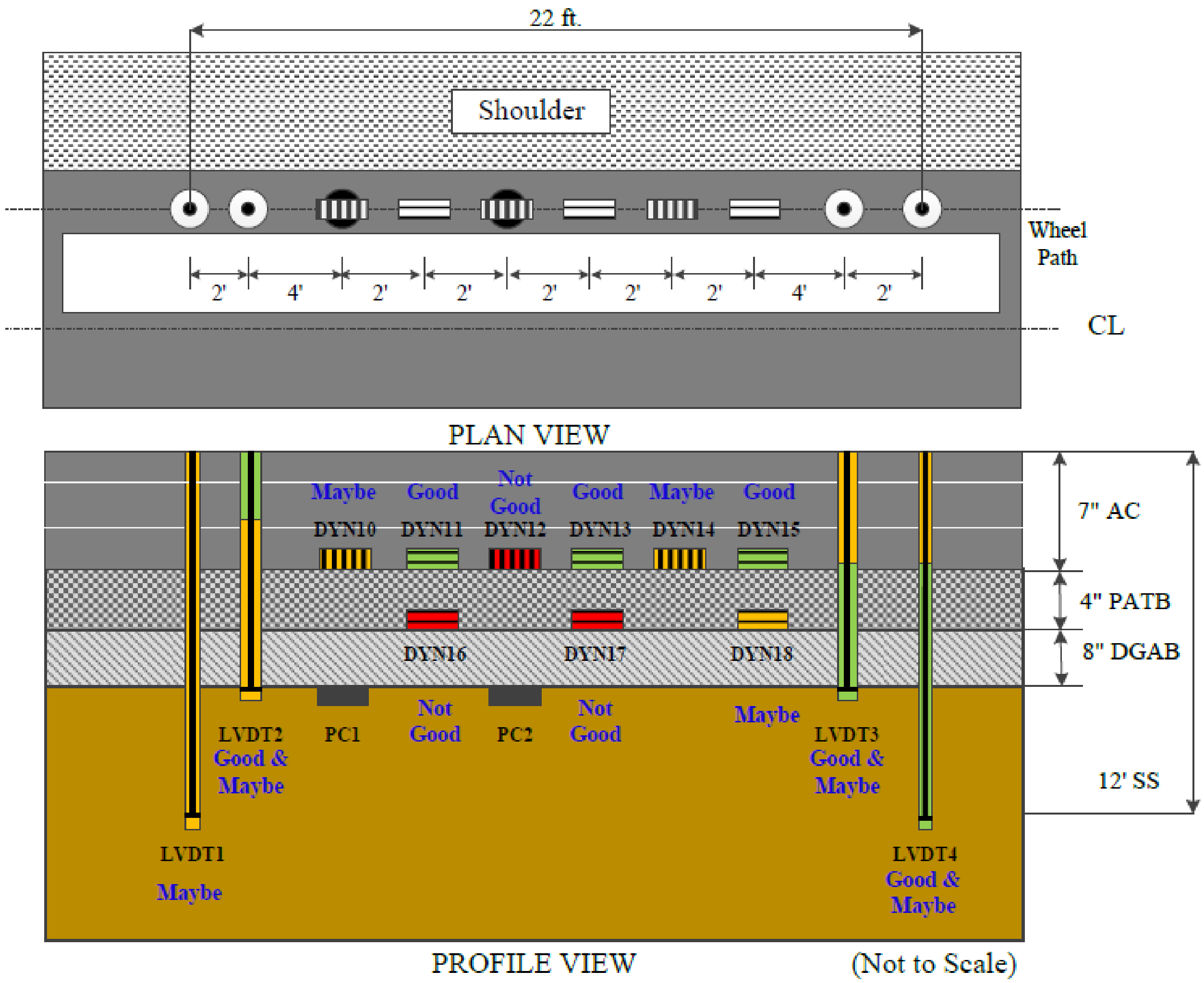


Figure 41. Illustration. QC results by sensor type for test section 390108 test J8D.

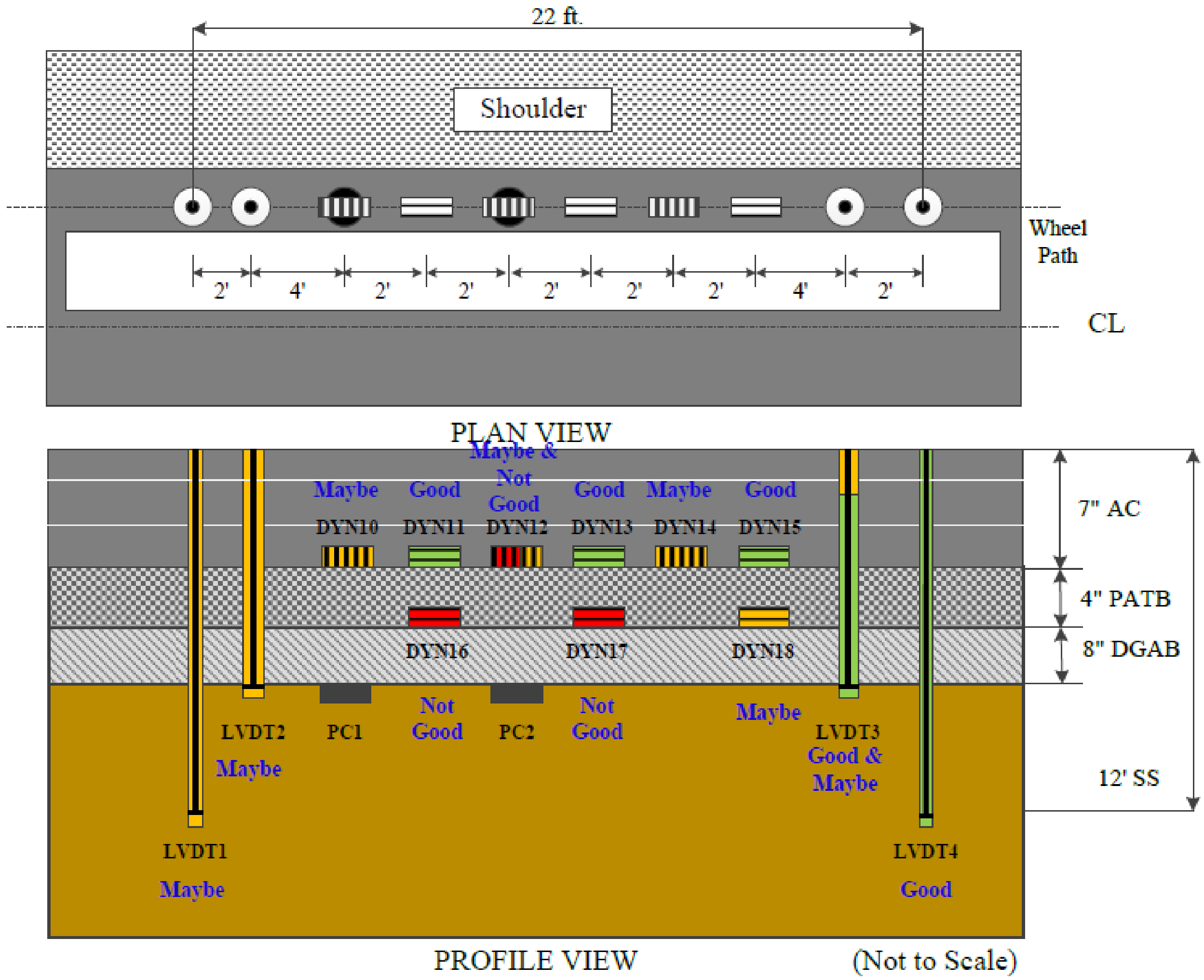


Figure 42. Illustration. QC results by sensor type for test section 390108 test J8E.

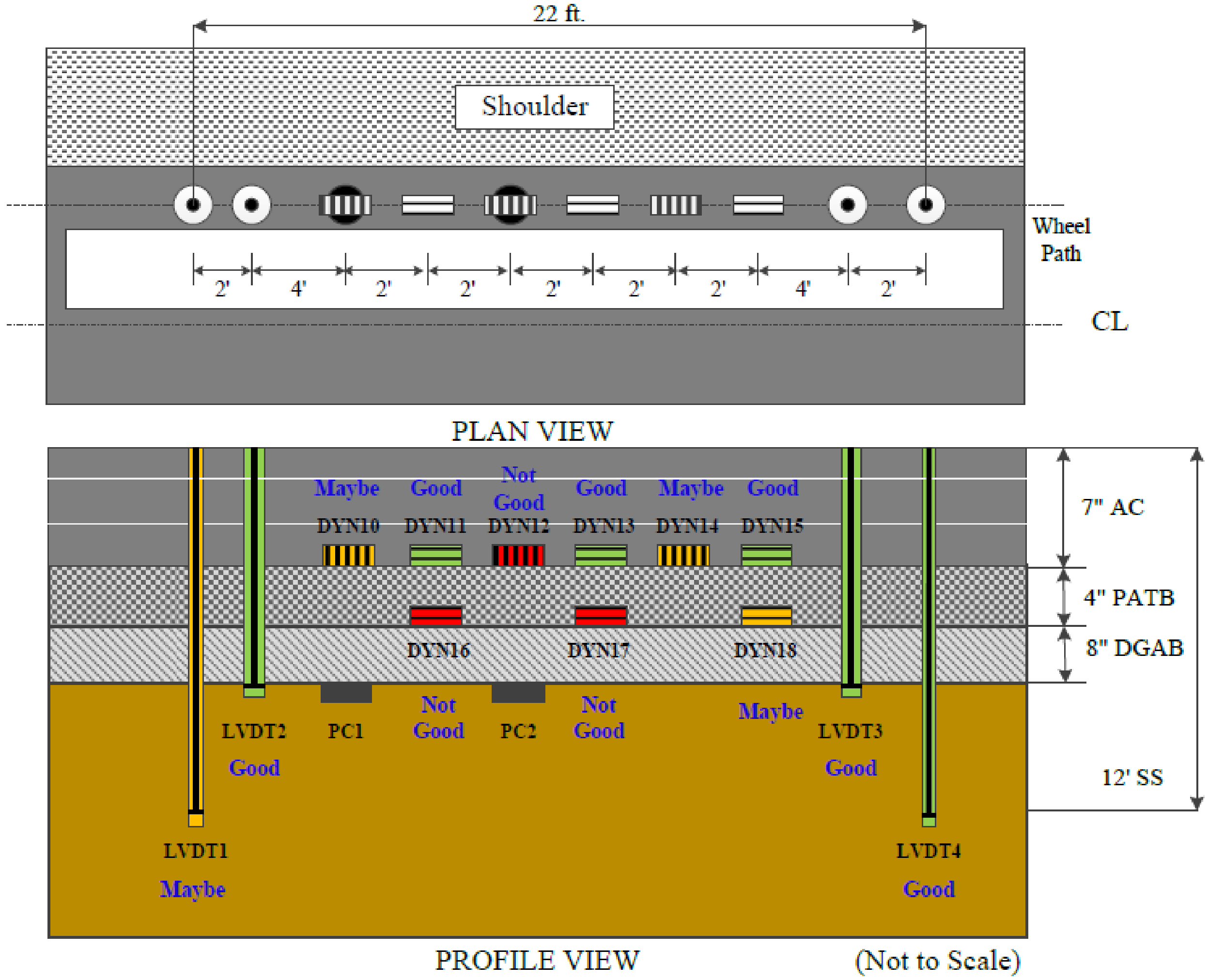


Figure 43. Illustration. QC results by sensor type for test section 390108 test J8G.

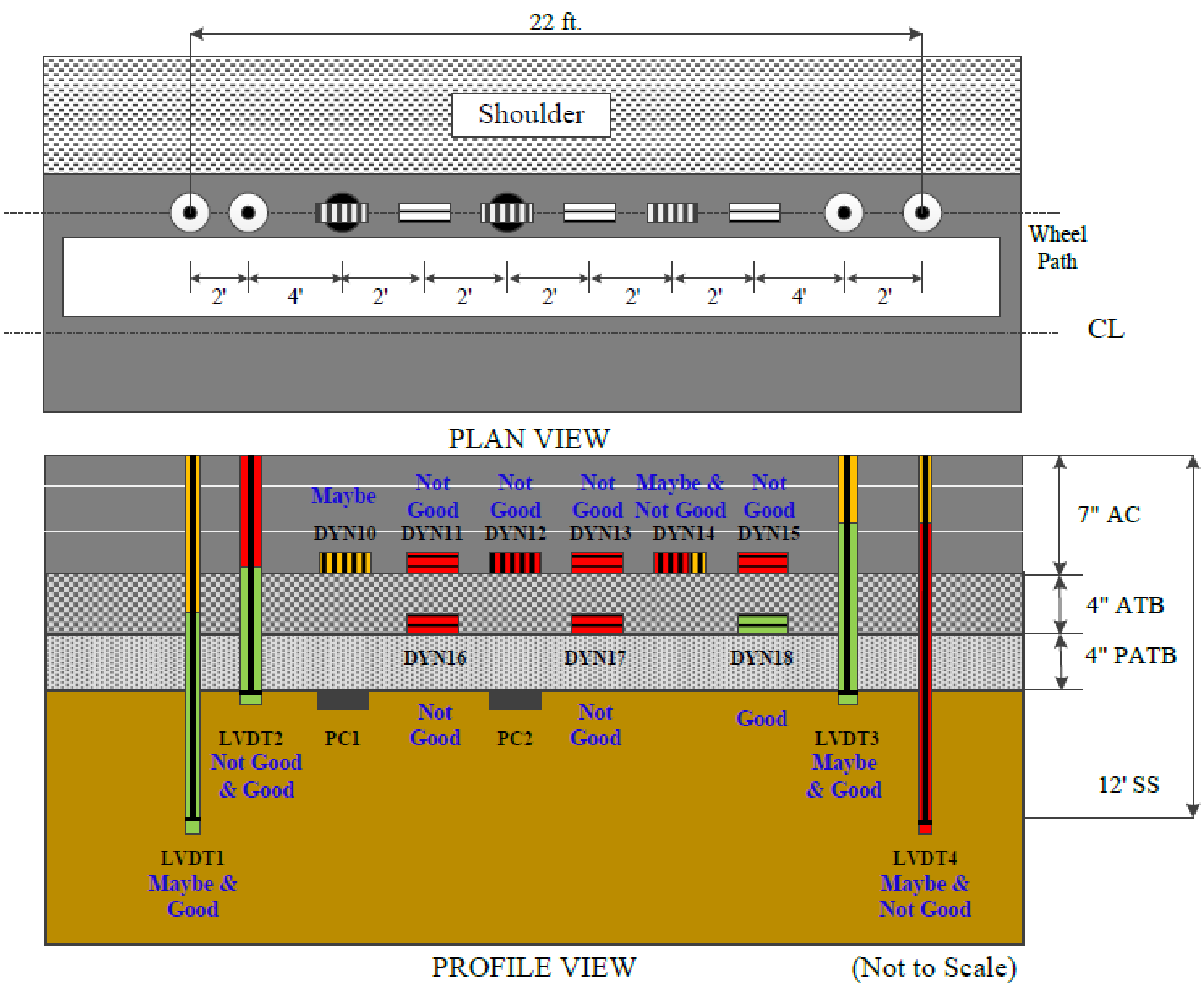


Figure 44. Illustration. QC results by sensor type for test section 390110 test J10A.

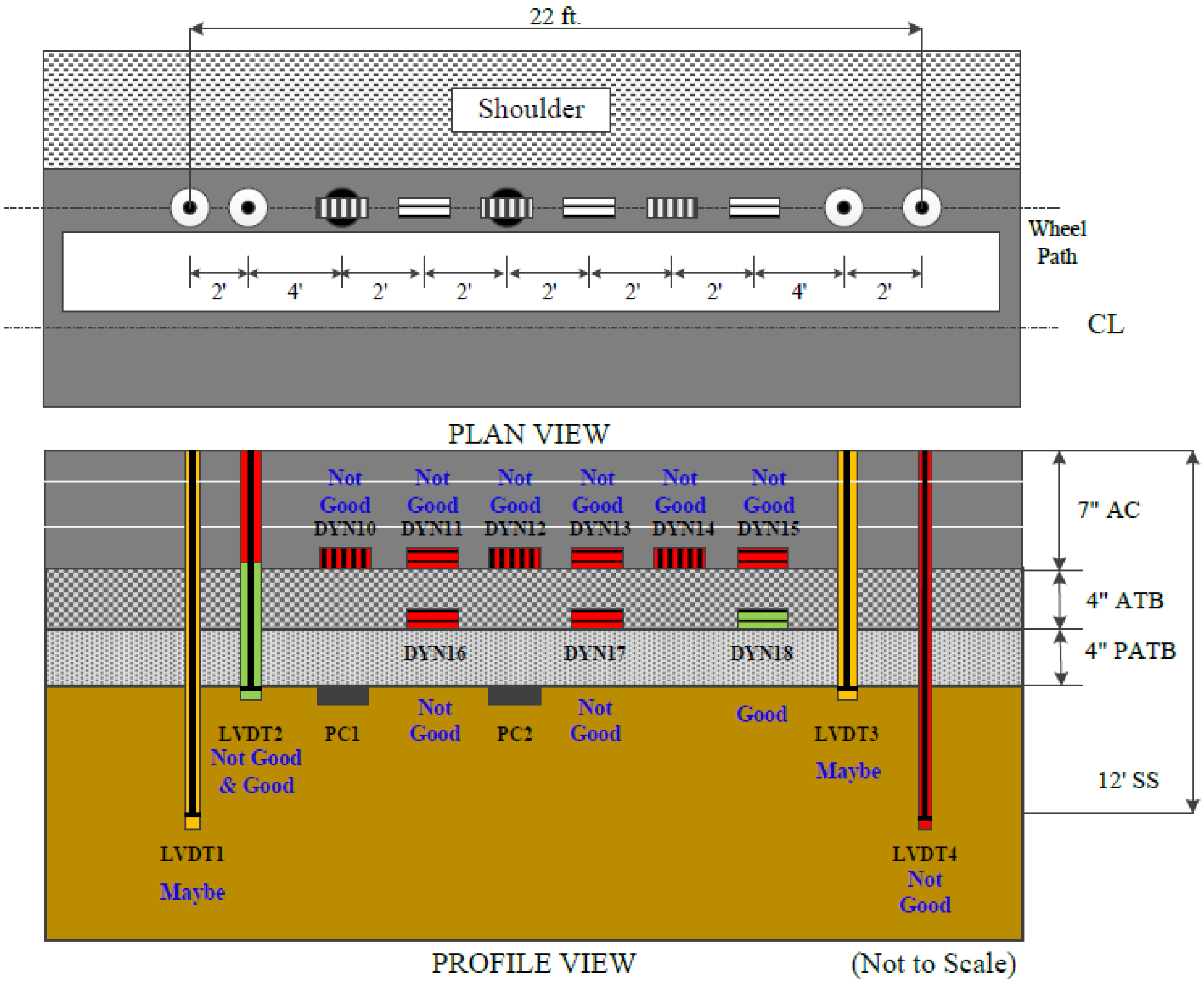


Figure 45. Illustration. QC results by sensor type for test section 390110 test J10C.

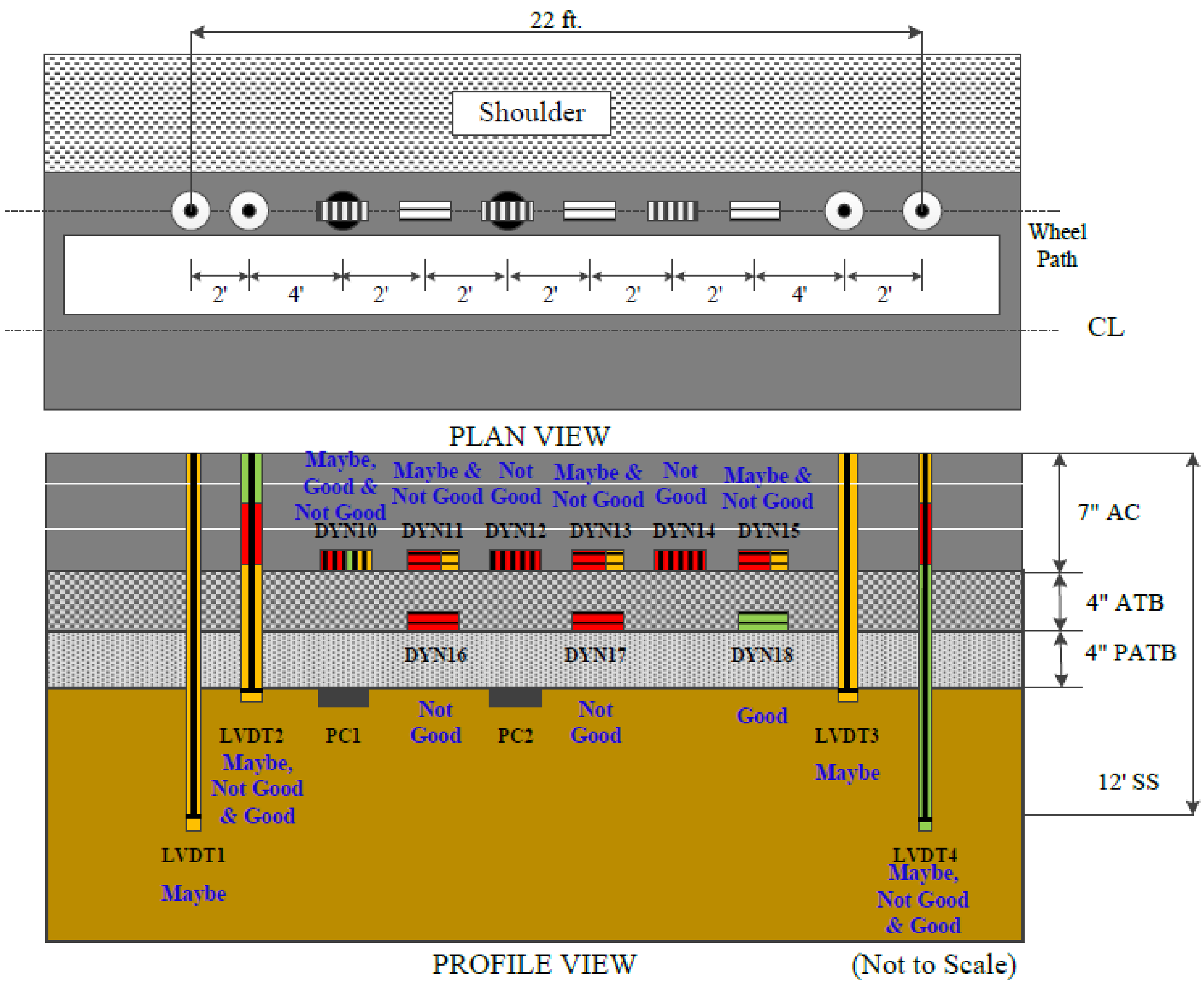


Figure 46. Illustration. QC results by sensor type for test section 390110 test J10D.

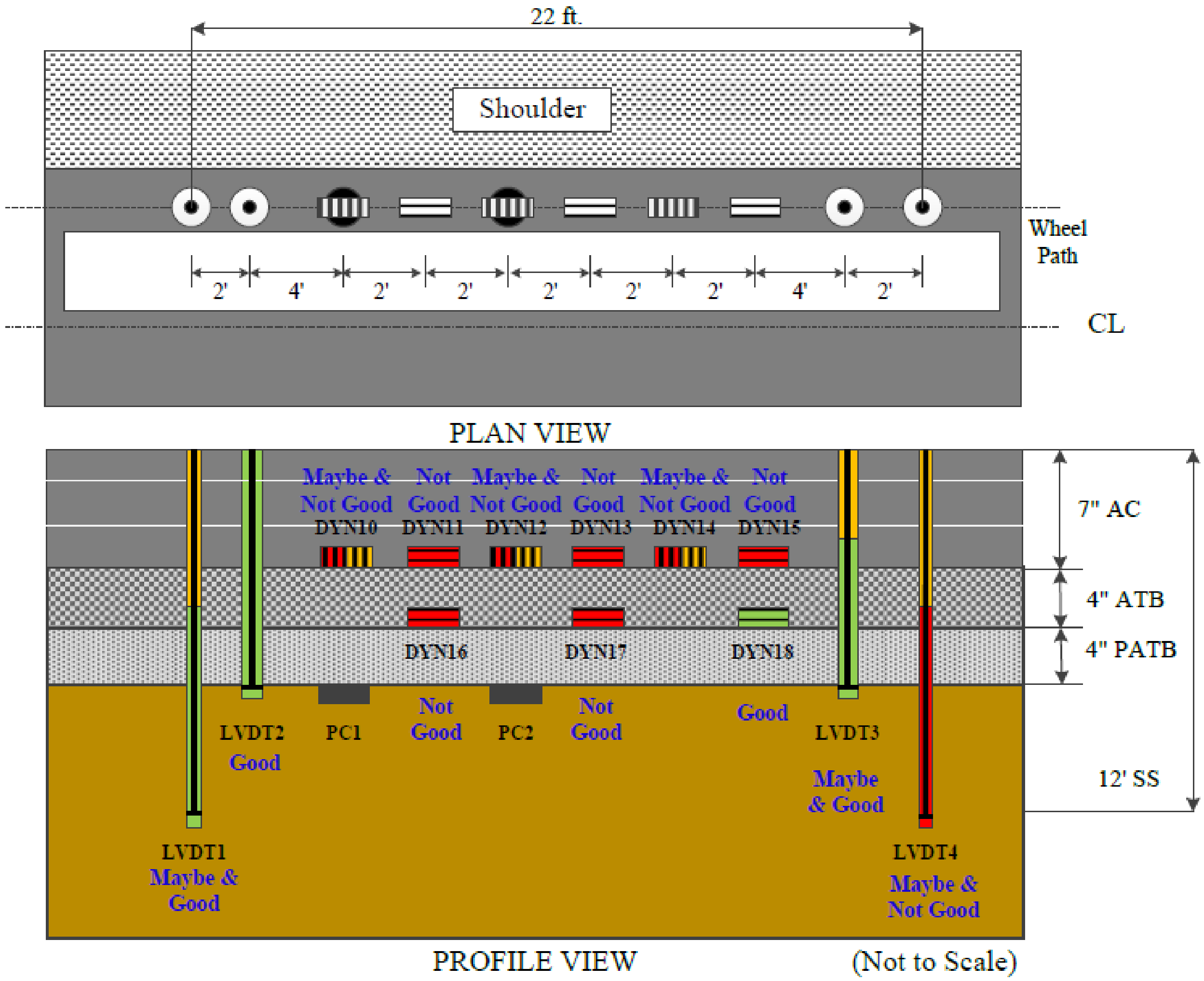


Figure 47. Illustration. QC results by sensor type for test section 390110 test J10E.

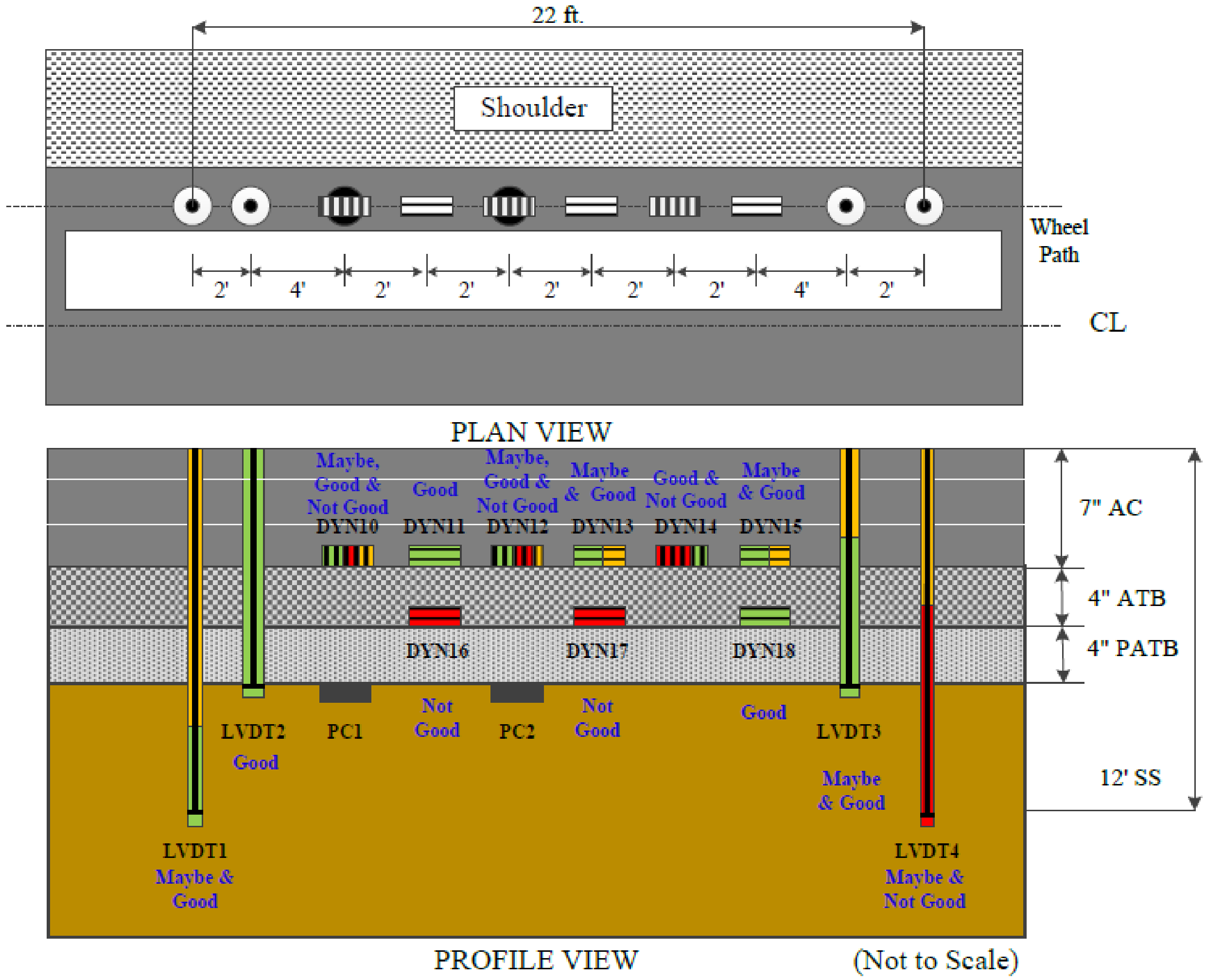


Figure 48. Illustration. QC results by sensor type for test section 390110 test J10F.

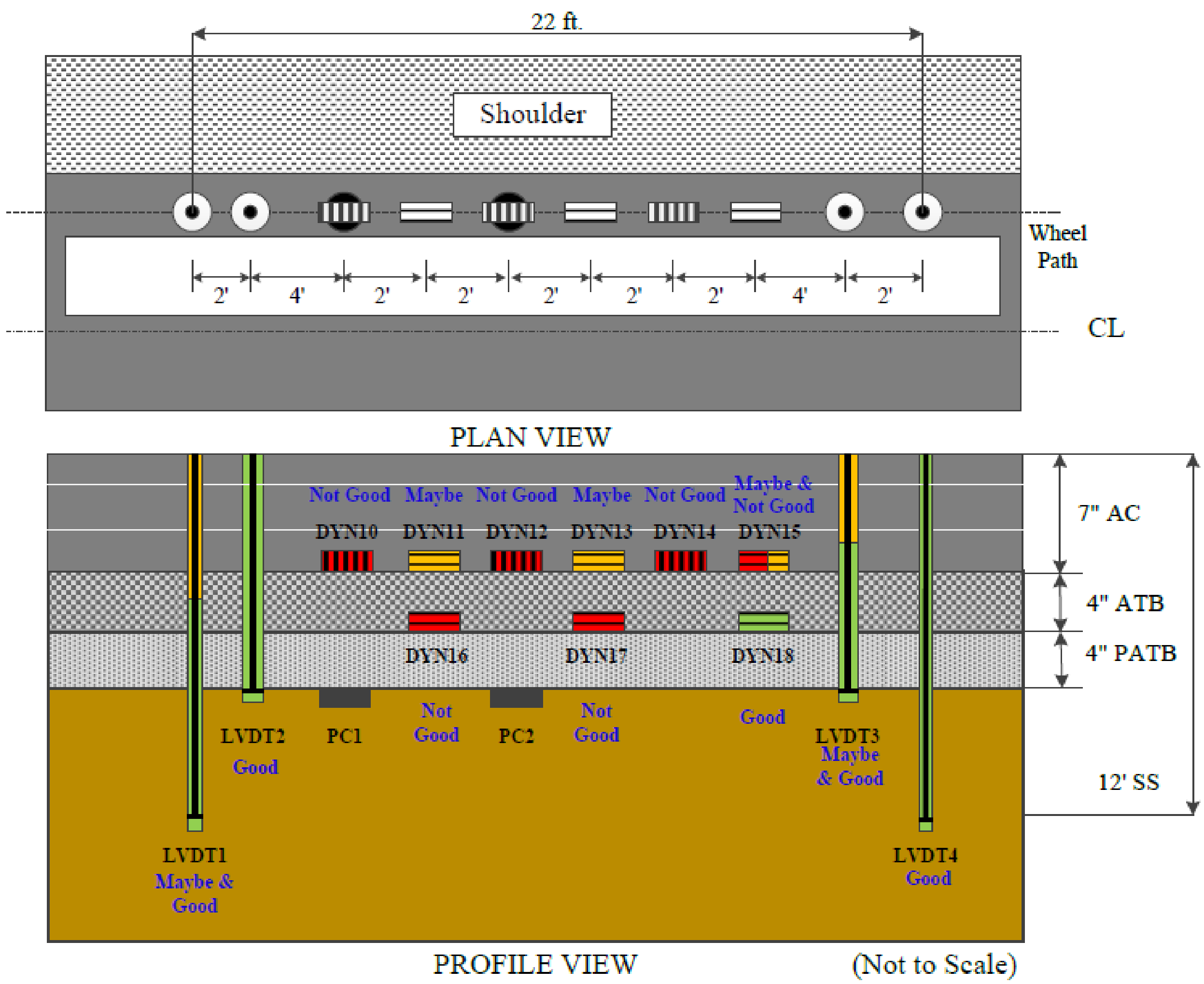


Figure 49. Illustration. QC results by sensor type for test section 390110 test J10G.

APPENDIX C. SENSOR LAYOUT AND QC STATUS FOR OHIO SPS-2 DLR SECTIONS

Appendix C shows the instrumentation layout in plan and profile views as well as the pavement layer structure in profile view with sensor status (good, maybe, and not good) for the 24 Ohio SPS-2 DLR test sections. For figure 50 through figure 73, sensor colors represent the status of a sensor based on QC results, where green represents good, orange represents maybe, and red represents not good. The sensors with color combinations of more than one color represent status in combination. For example, if a sensor color is in a combination of green and orange, the status of the sensor is a combination of good and maybe.

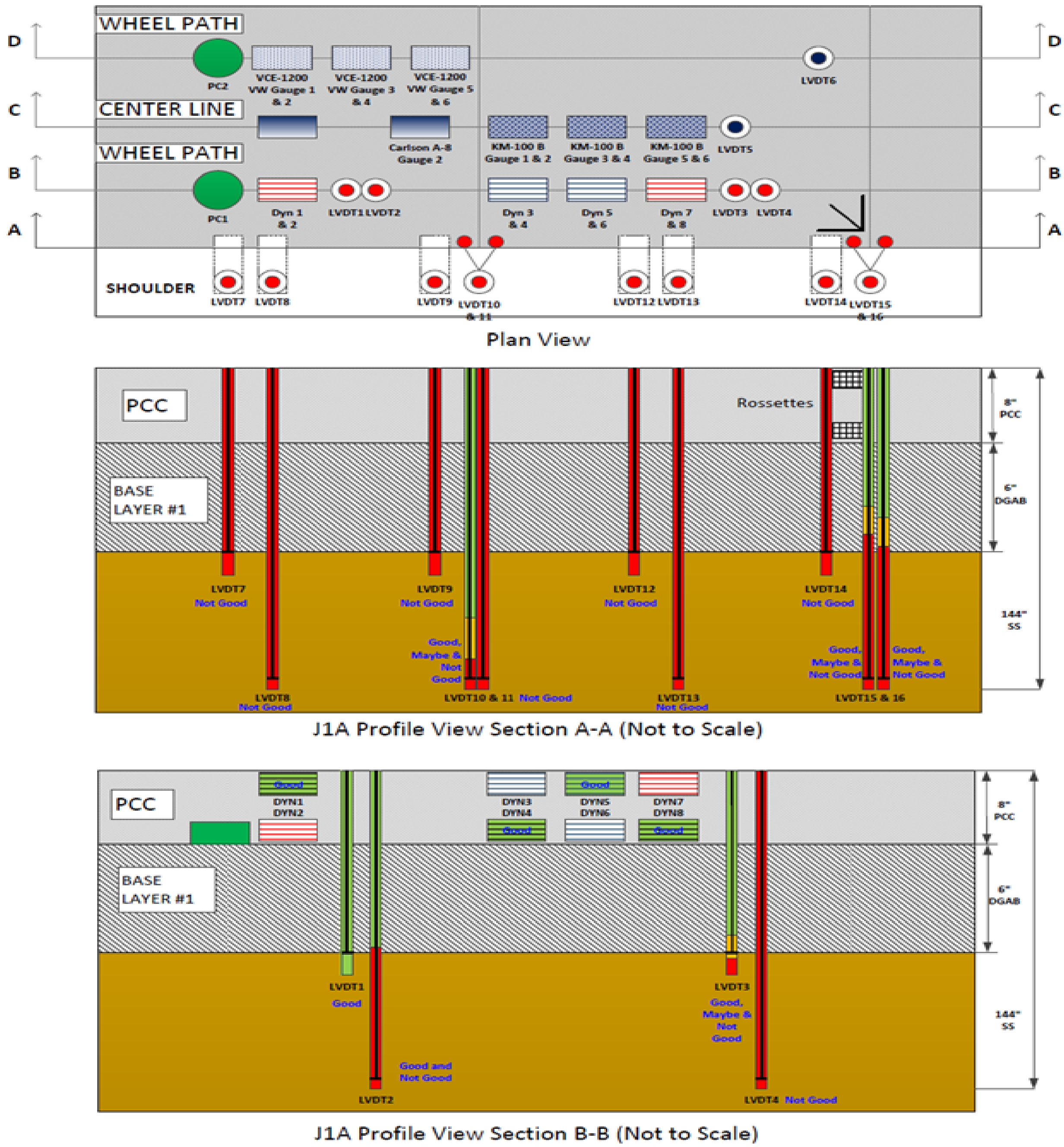


Figure 50. Illustration. QC results by sensor type for test section 390201 test J1A.

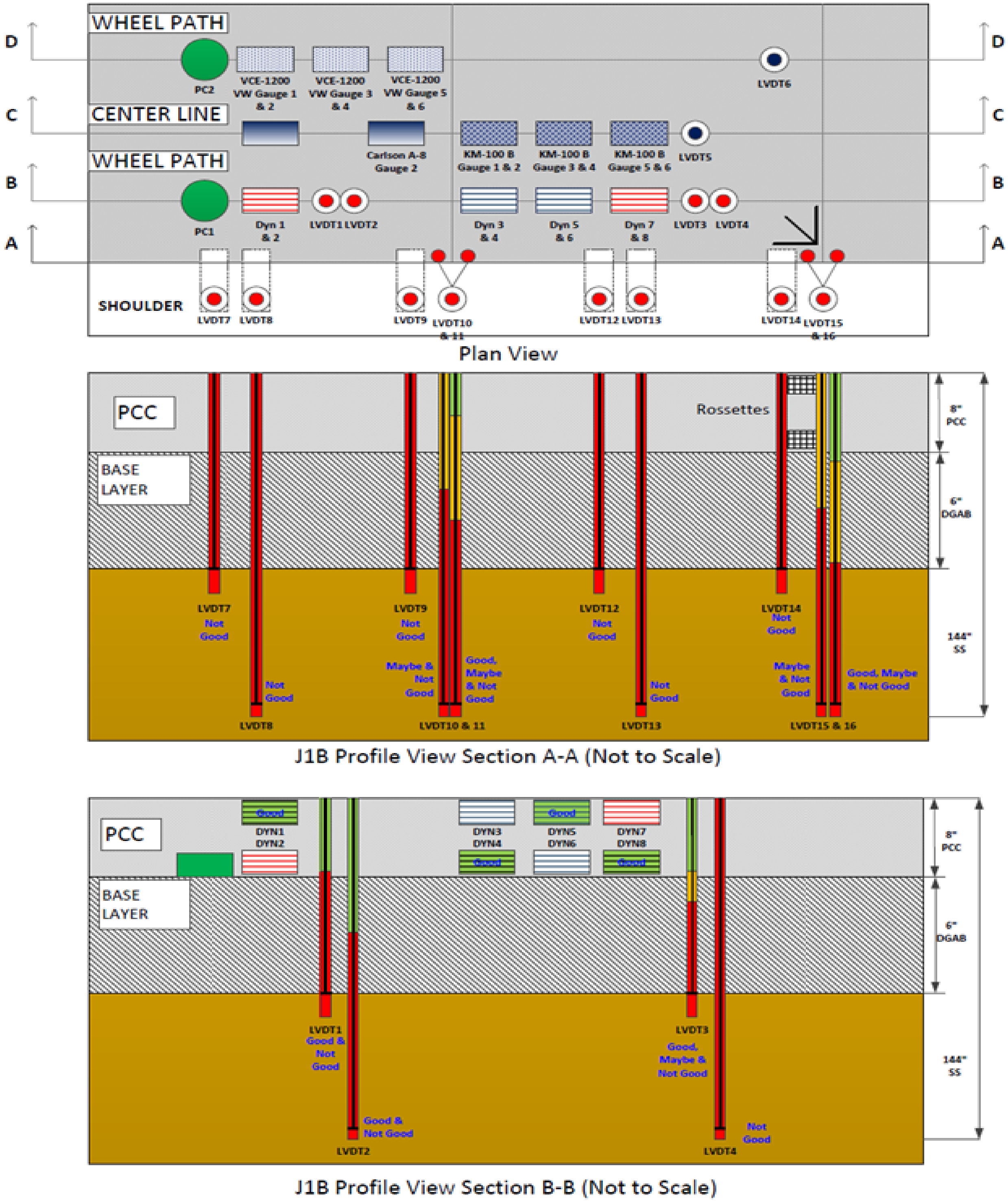


Figure 51. Illustration. QC results by sensor type for test section 390201 test J1B.

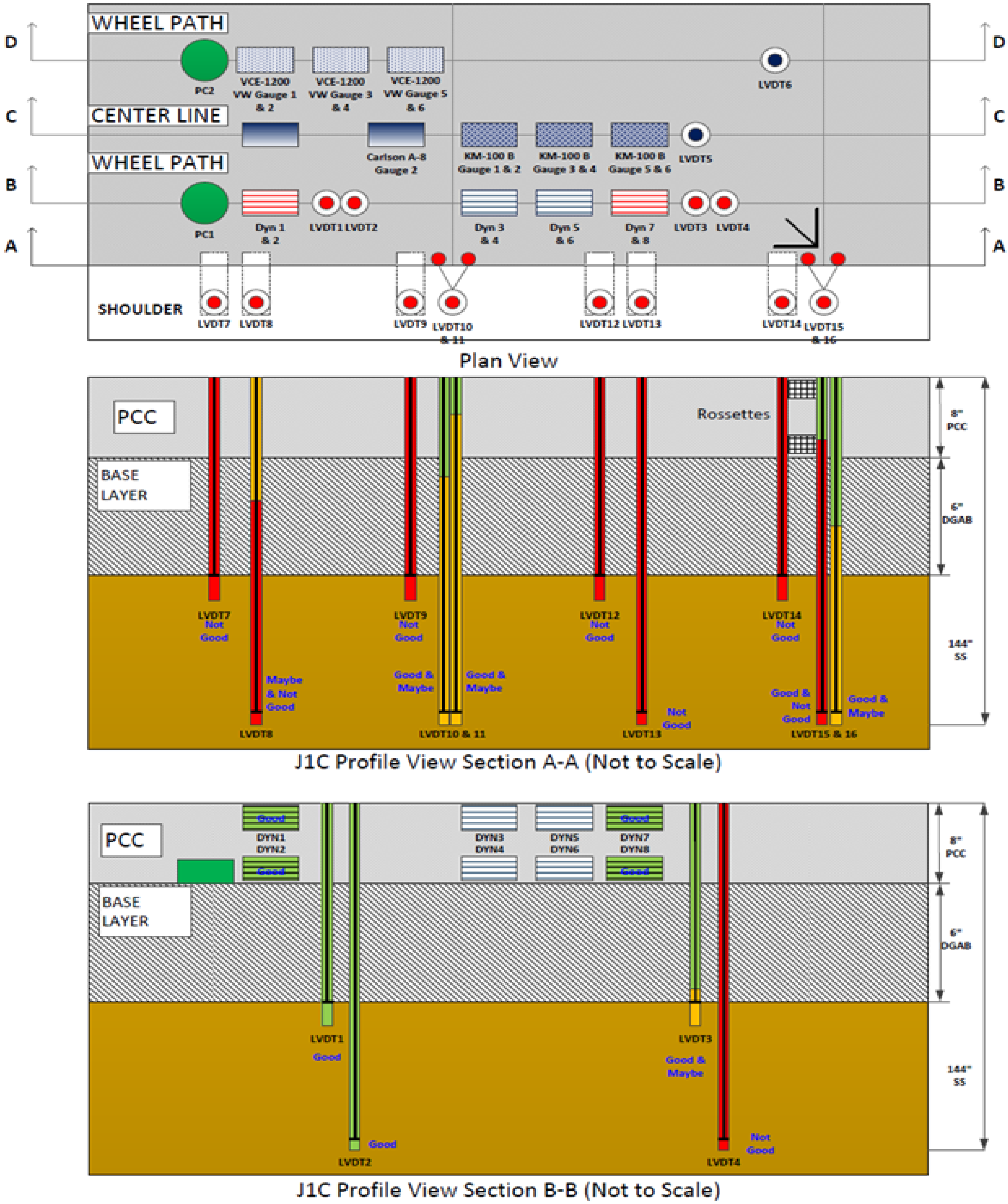


Figure 52. Illustration. QC results by sensor type for test section 390201 test J1C.

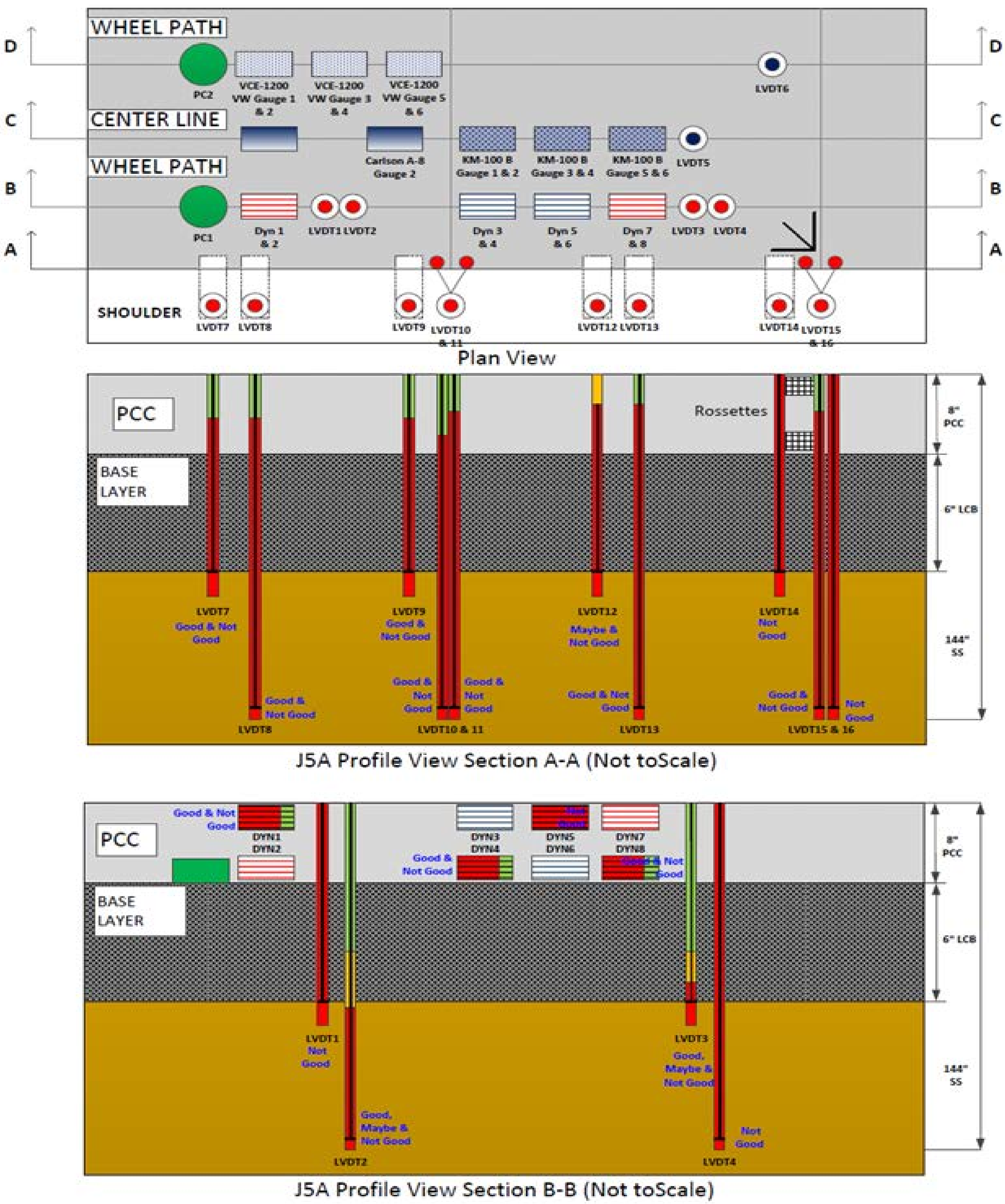


Figure 53. Illustration. QC results by sensor type for test section 390205 test J5A.

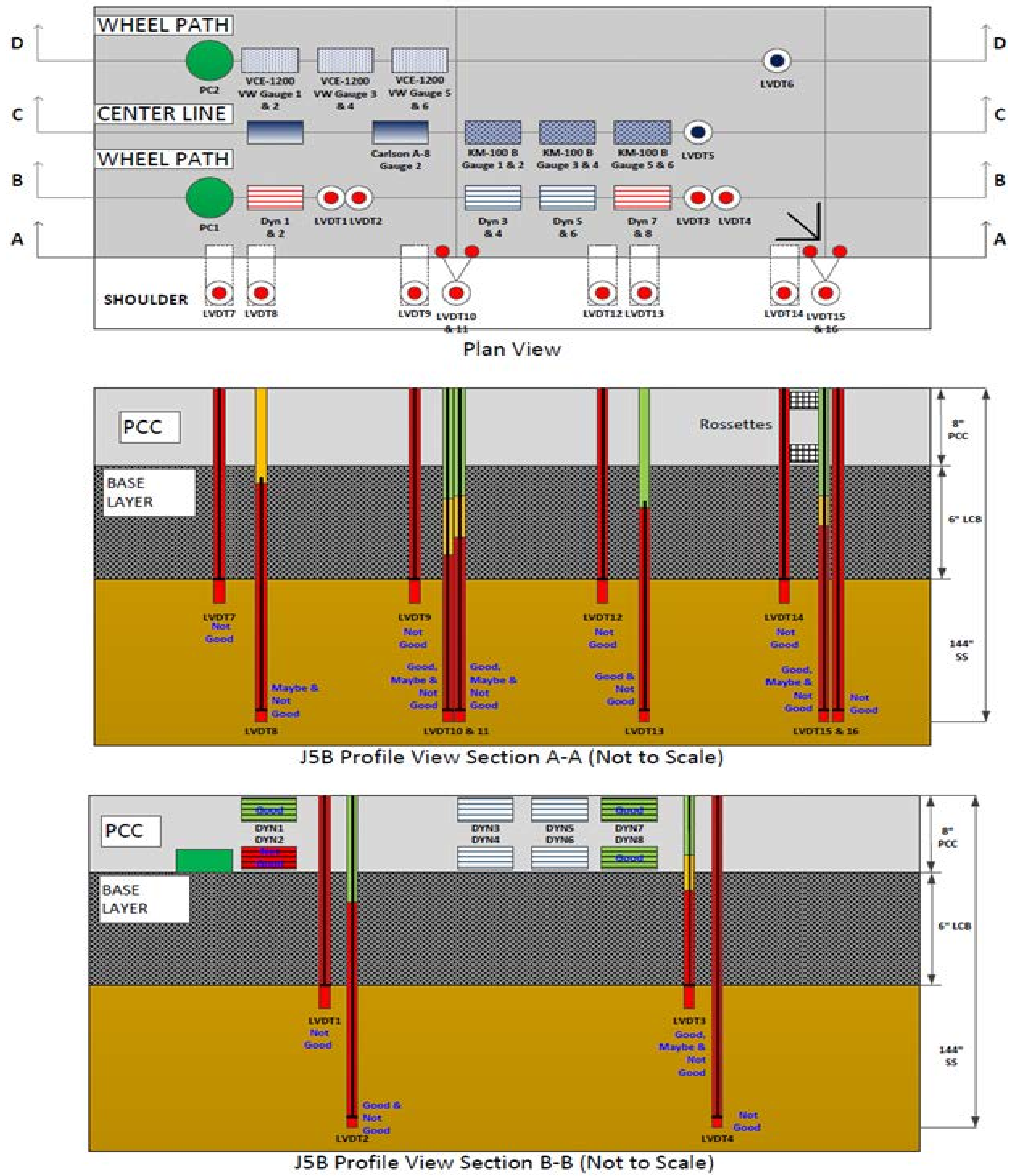


Figure 54. Illustration. QC results by sensor type for test section 390205 test J5B.

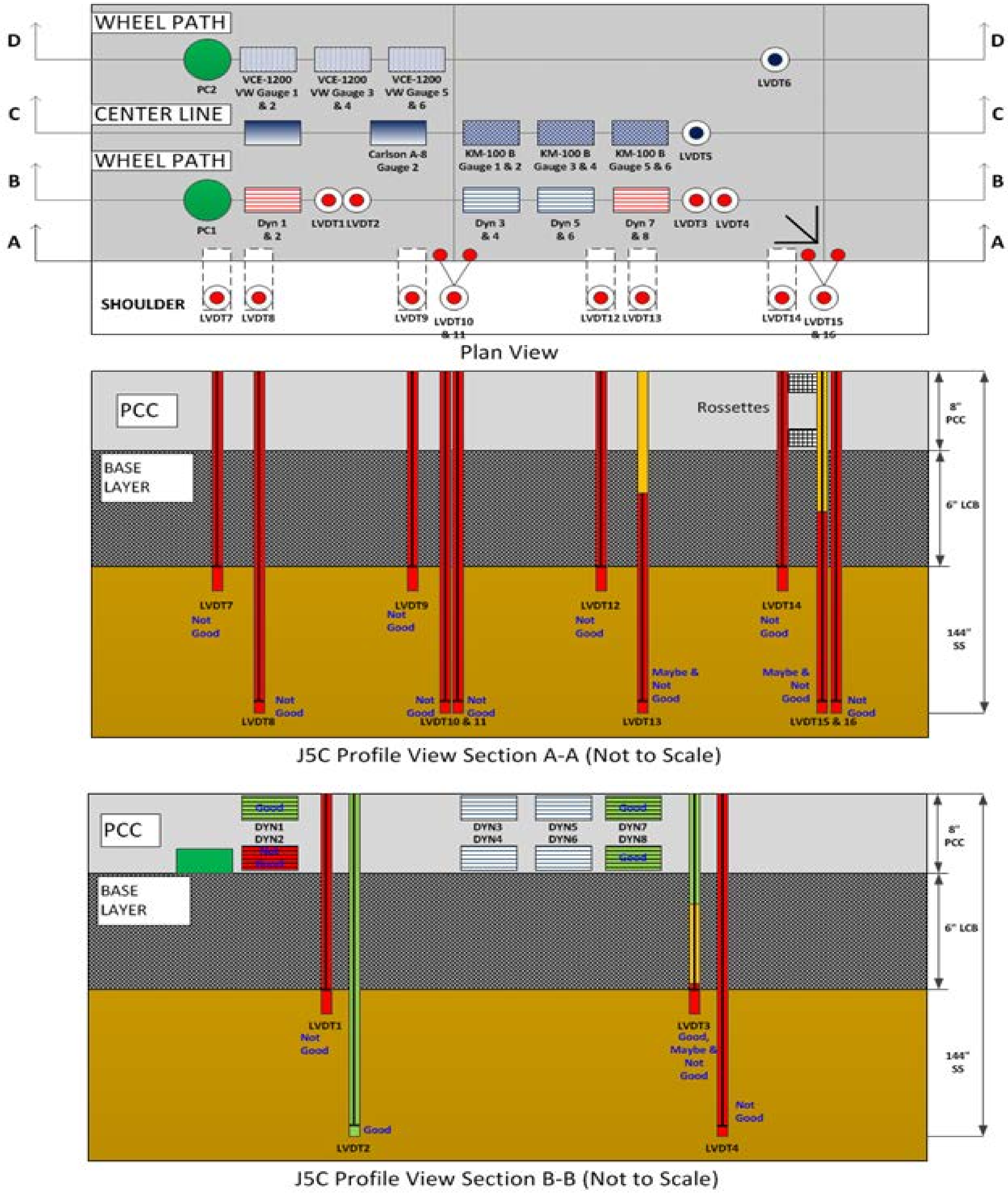


Figure 55. Illustration. QC results by sensor type for test section 390205 test J5C.

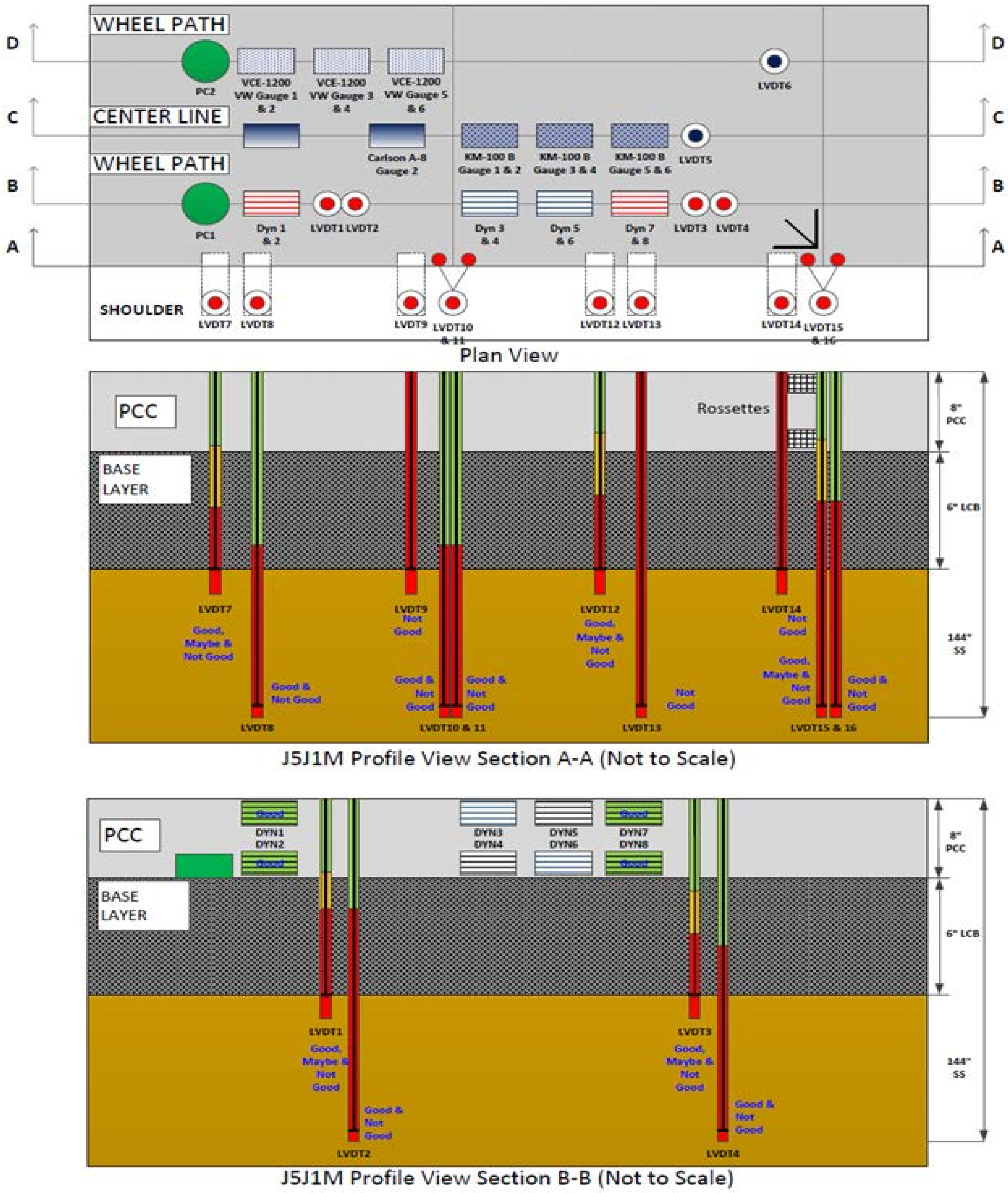


Figure 56. Illustration. QC results by sensor type for test section 390205 test J5J1M.

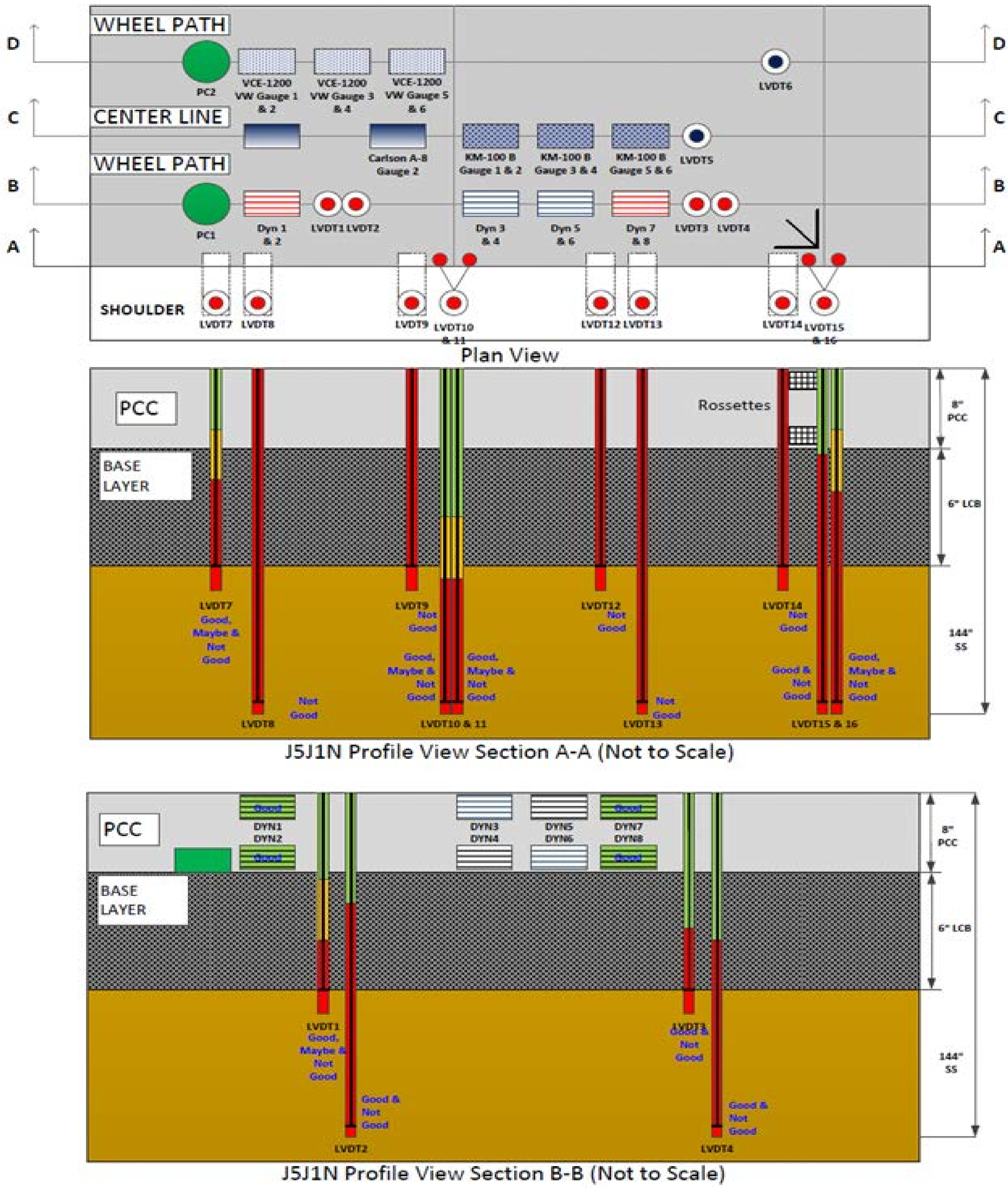


Figure 57. Illustration. QC results by sensor type for test section 390205 test J5J1N.

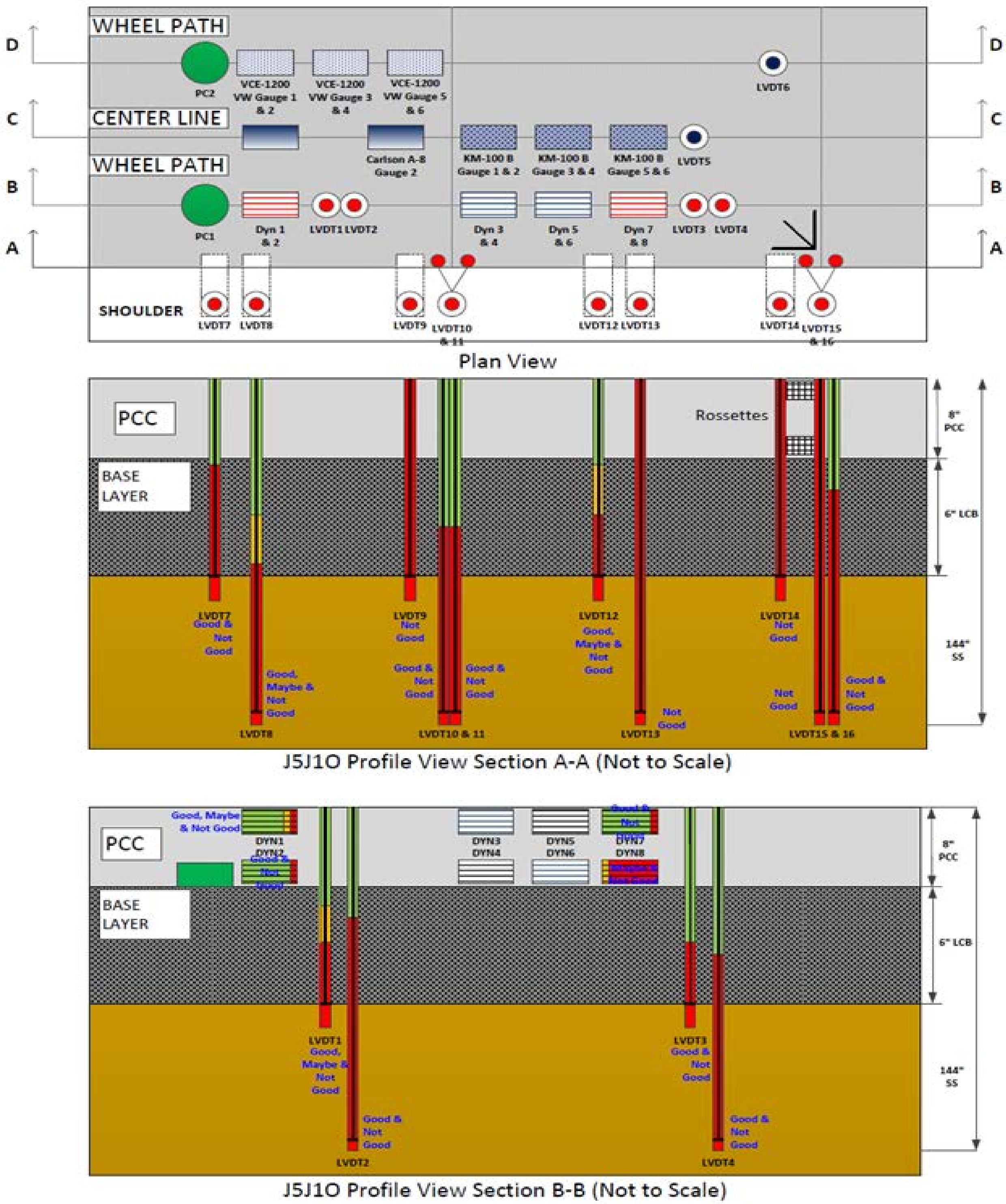


Figure 58. Illustration. QC results by sensor type for test section 390205 test J5J1O.

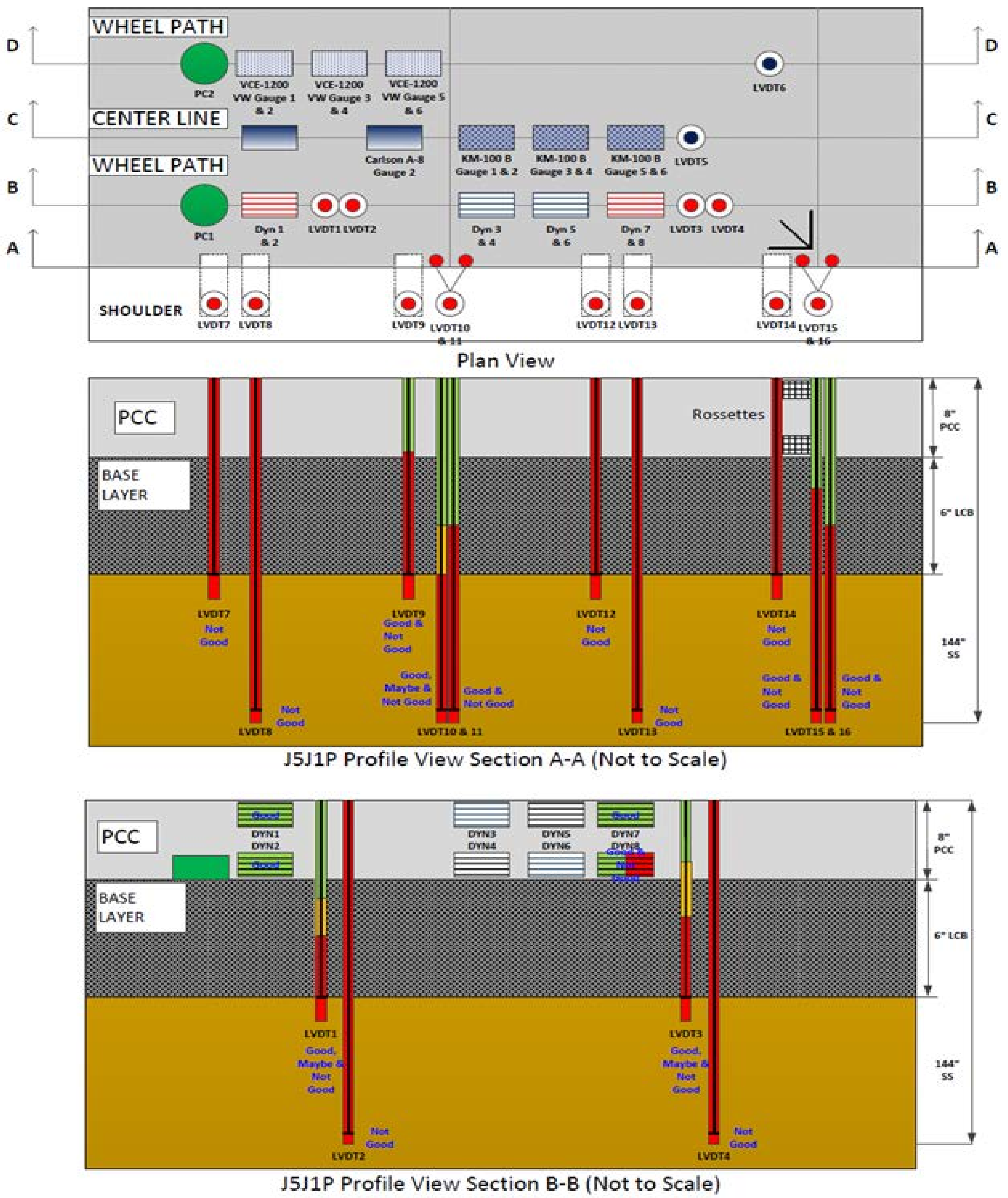


Figure 59. Illustration. QC results by sensor type for test section 390205 test J5J1P.

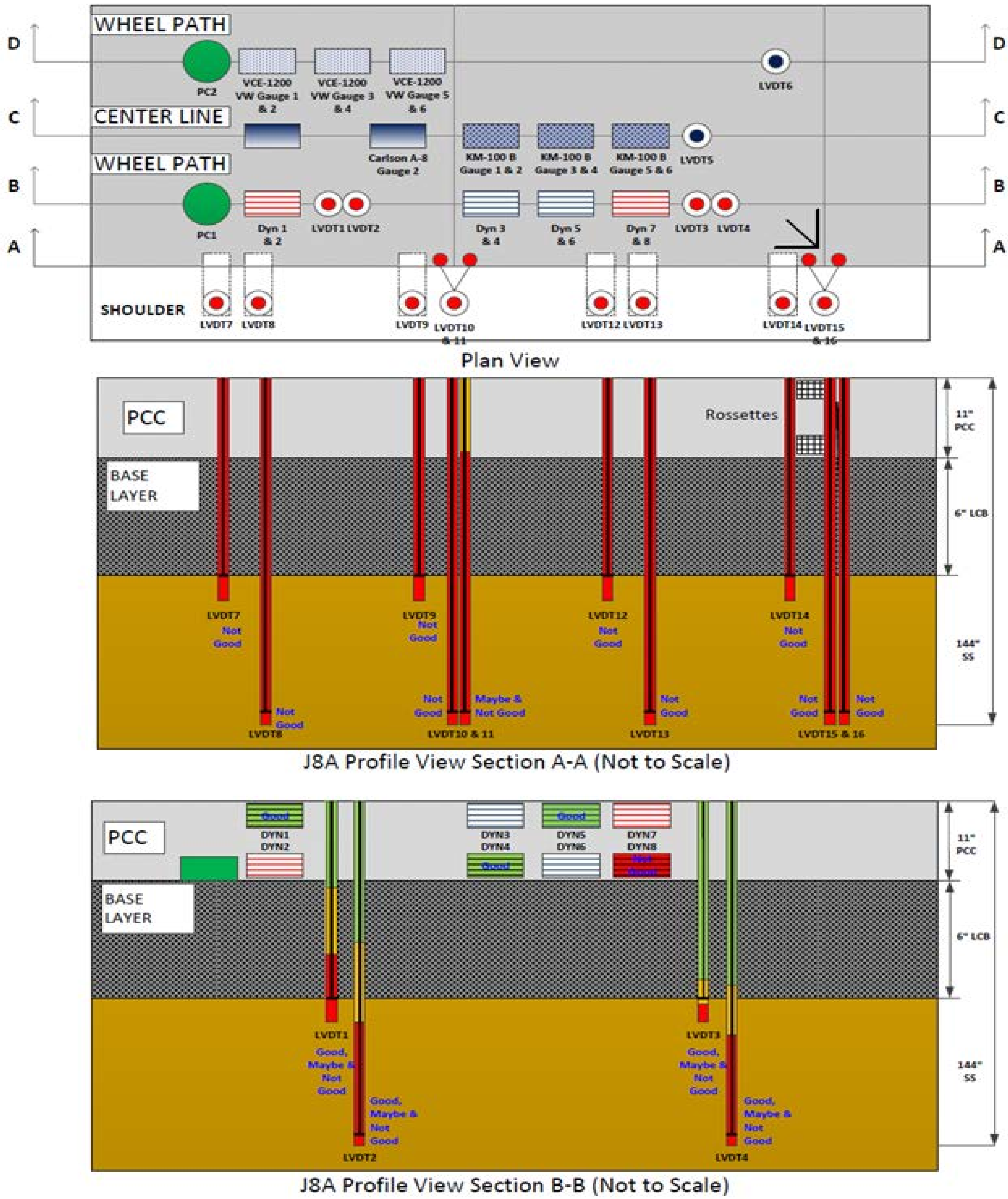


Figure 60. Illustration. QC results by sensor type for test section 390208 test J8A.

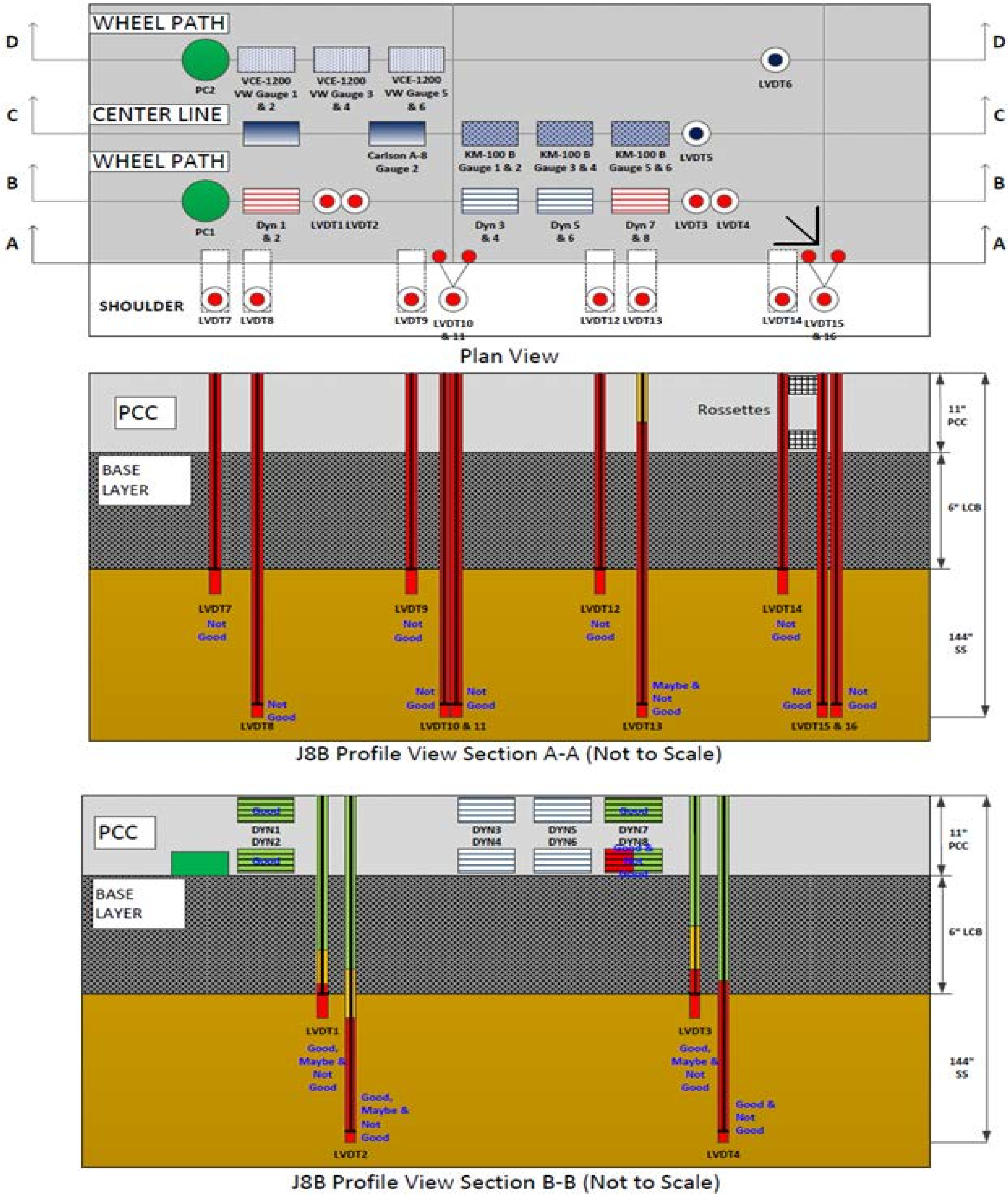


Figure 61. Illustration. QC results by sensor type for test section 390208 test J8B.

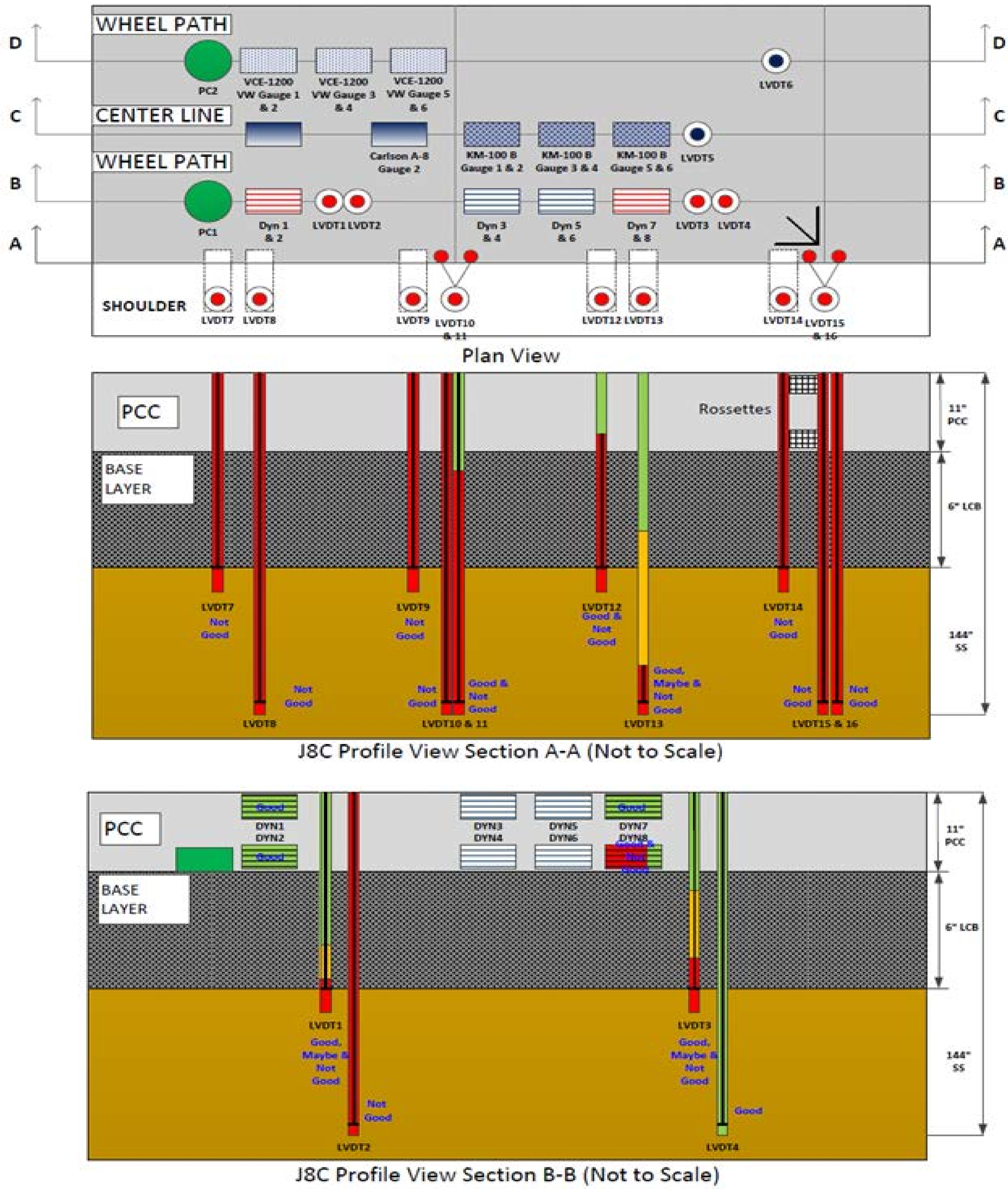


Figure 62. Illustration. QC results by sensor type for test section 390208 test J8C.

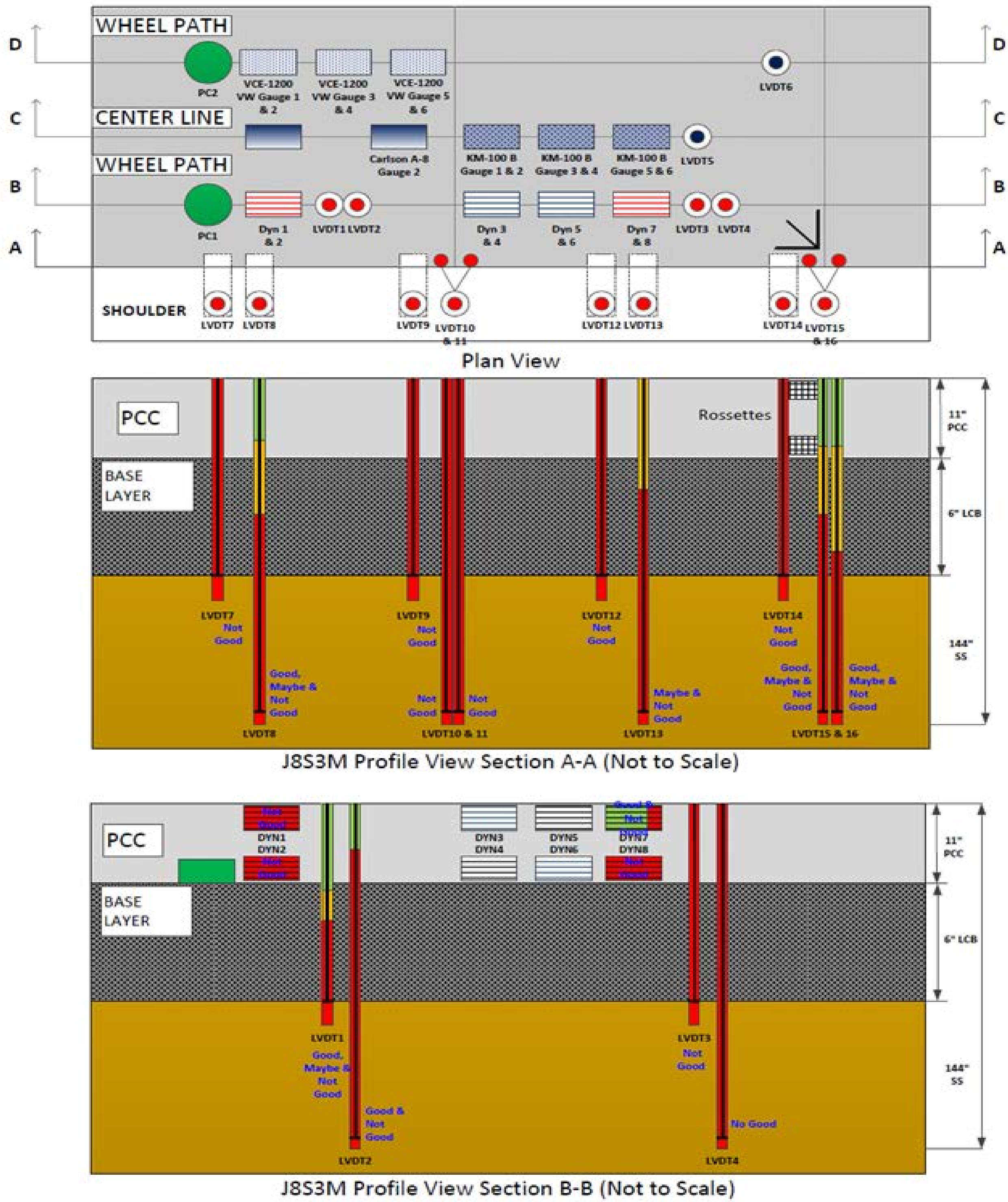


Figure 63. Illustration. QC results by sensor type for test section 390208 test J8S3M.

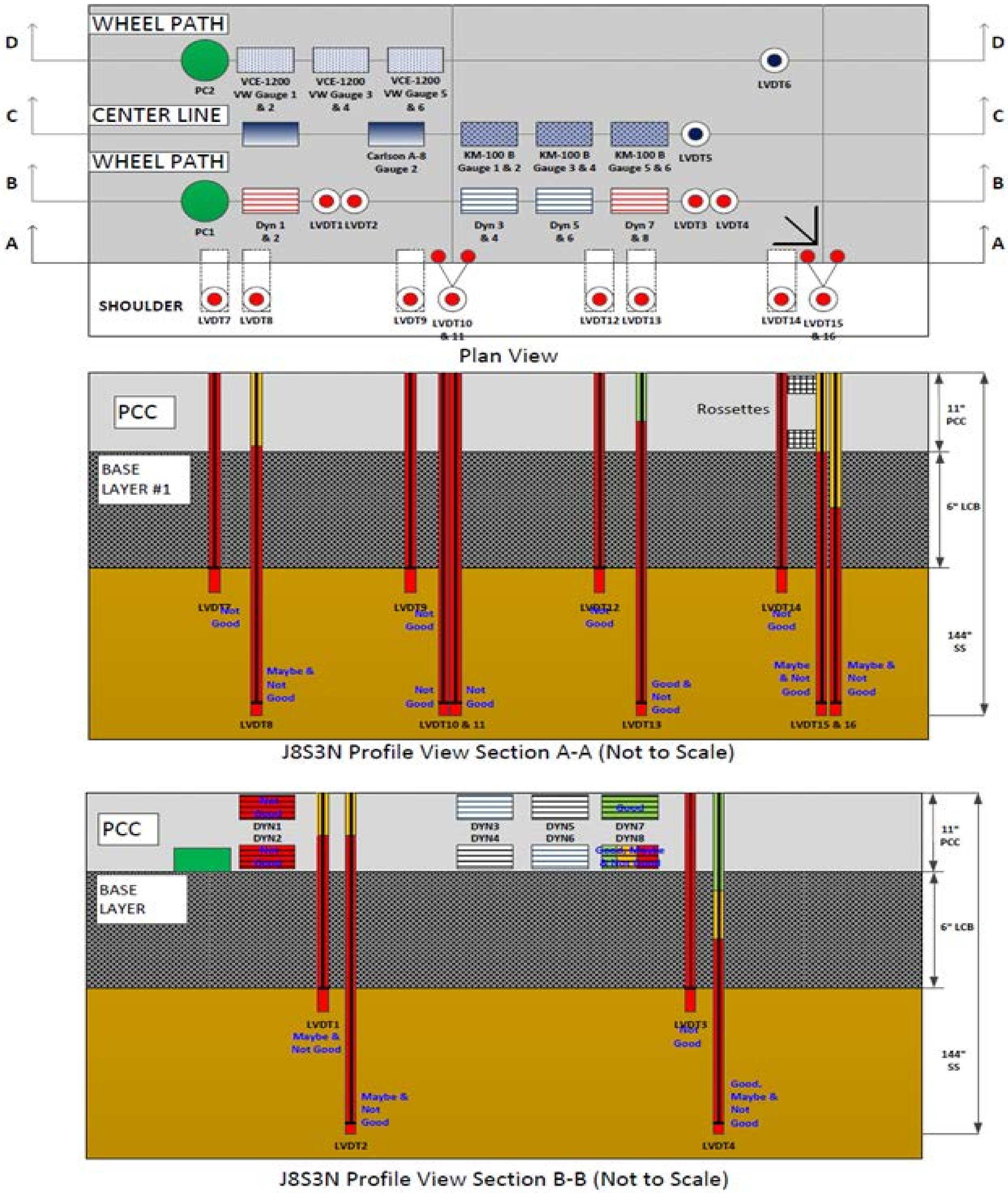


Figure 64. Illustration. QC results by sensor type for test section 390208 test J8S3N.

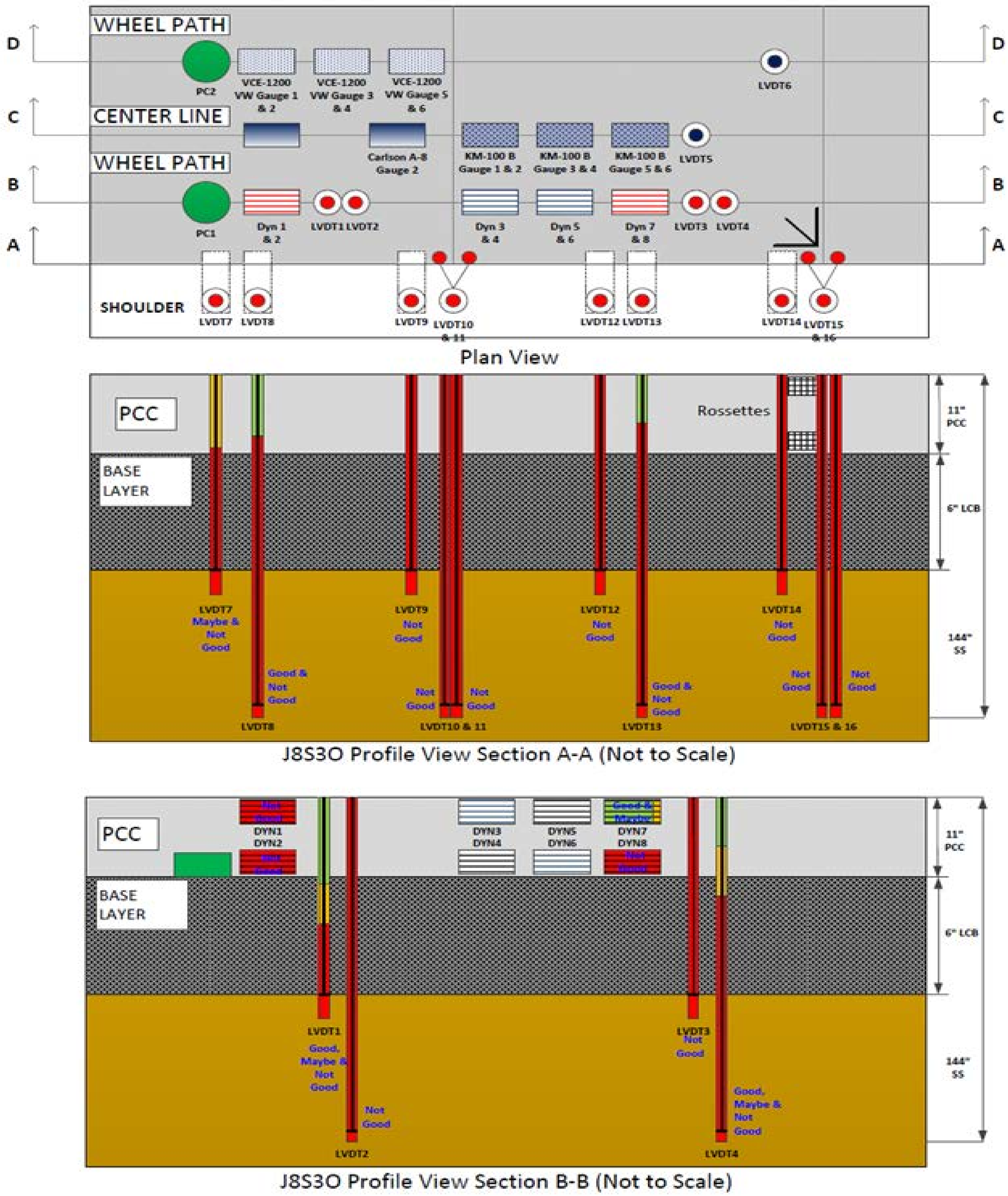


Figure 65. Illustration. QC results by sensor type for test section 390208 test J8S3O.

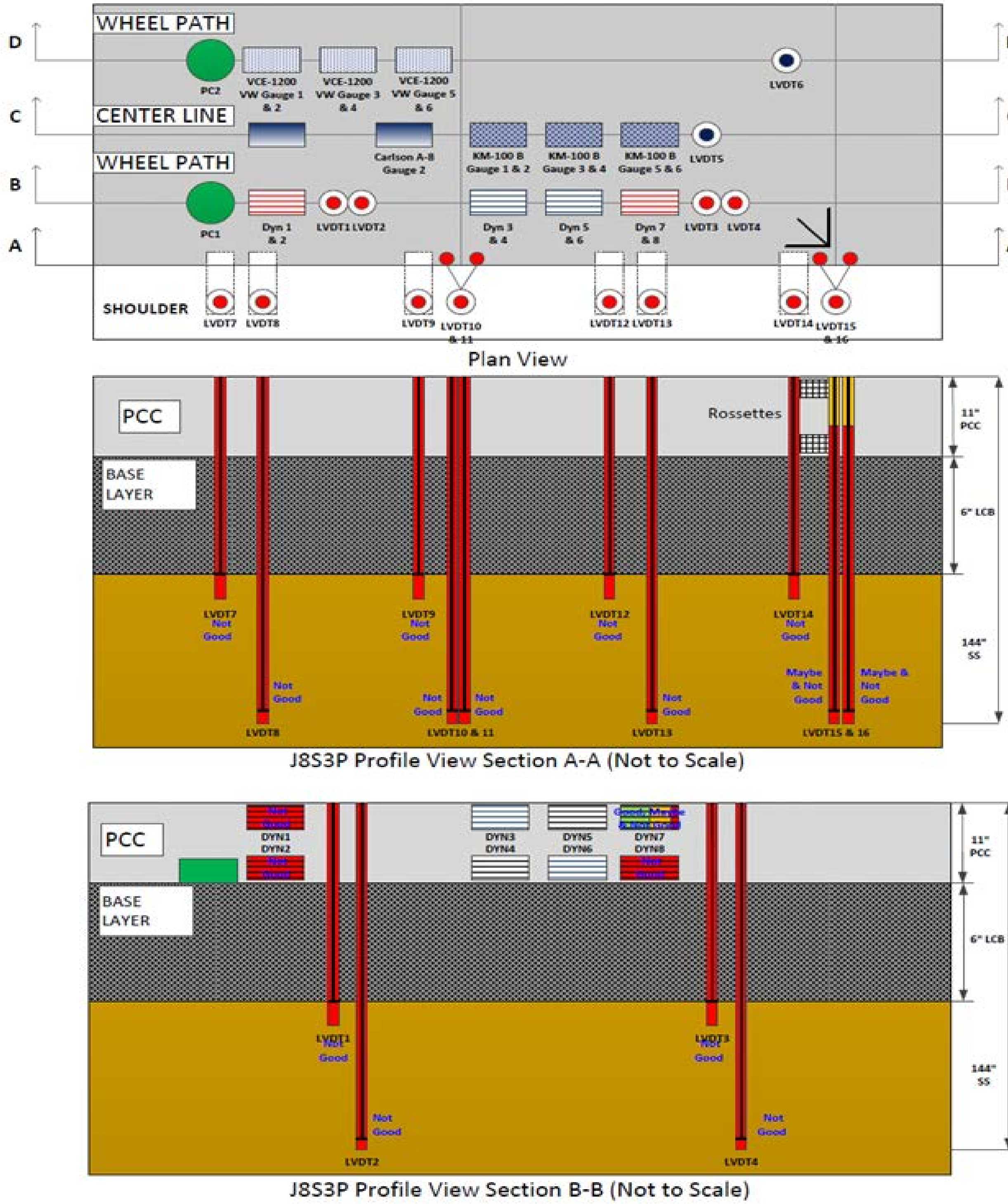


Figure 66. Illustration. QC results by sensor type for test section 390208 test J8S3P.

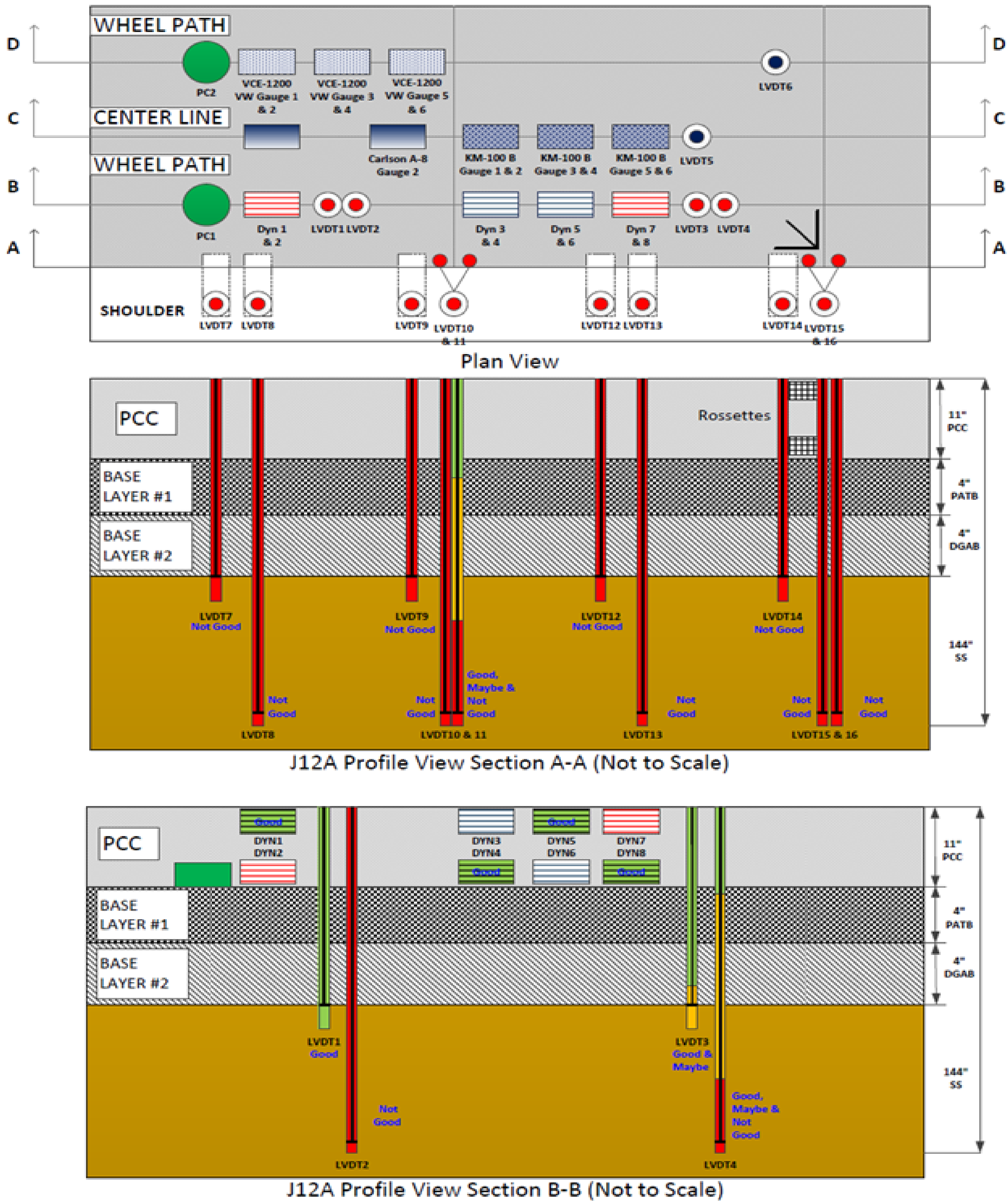


Figure 67. Illustration. QC results by sensor type for test section 390212 test J12A.

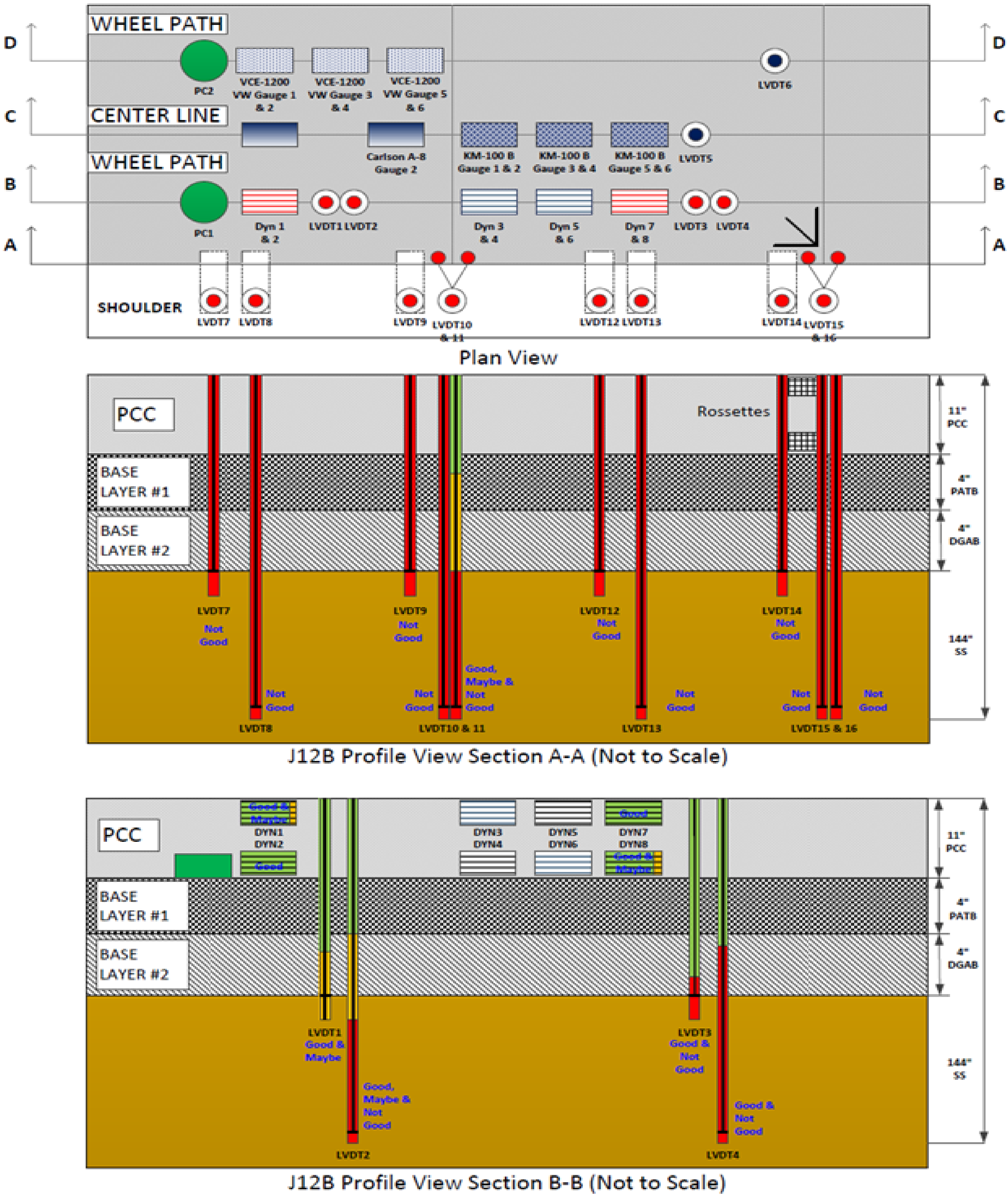


Figure 68. Illustration. QC results by sensor type for test section 390212 test J12B.

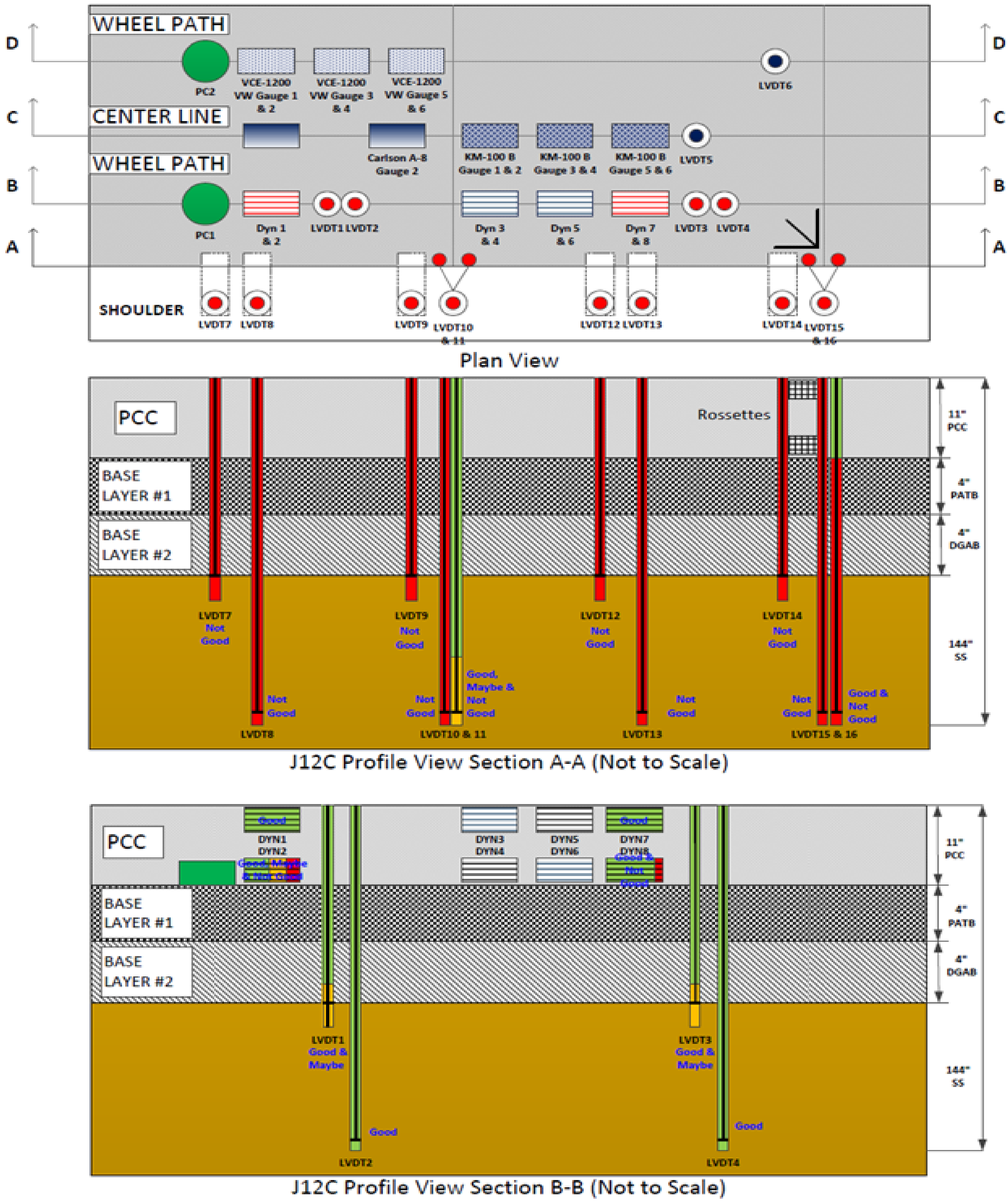


Figure 69. Illustration. QC results by sensor type for test section 390212 test J12C.

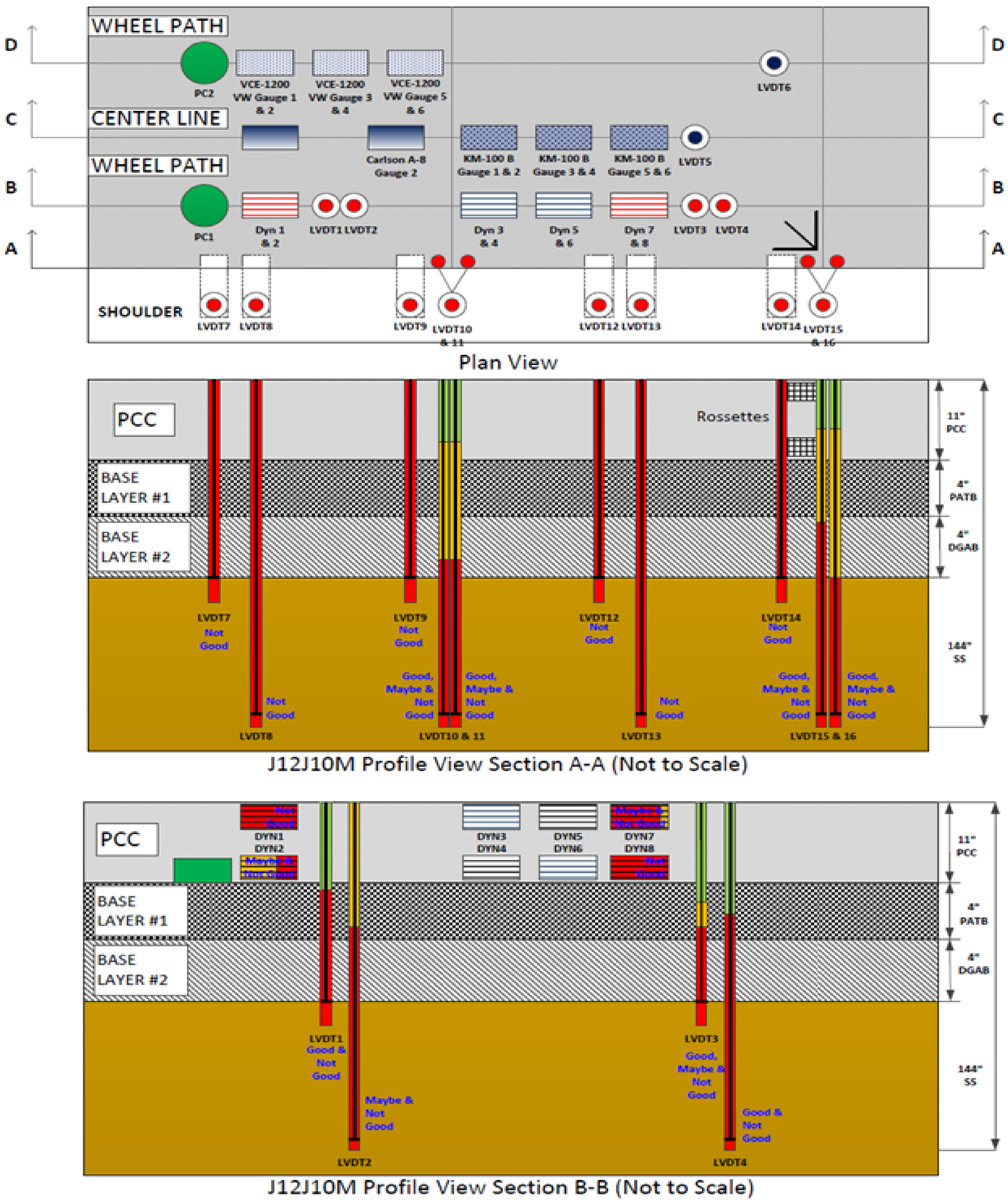


Figure 70. Illustration. QC results by sensor type for test section 390212 test J12J10M.

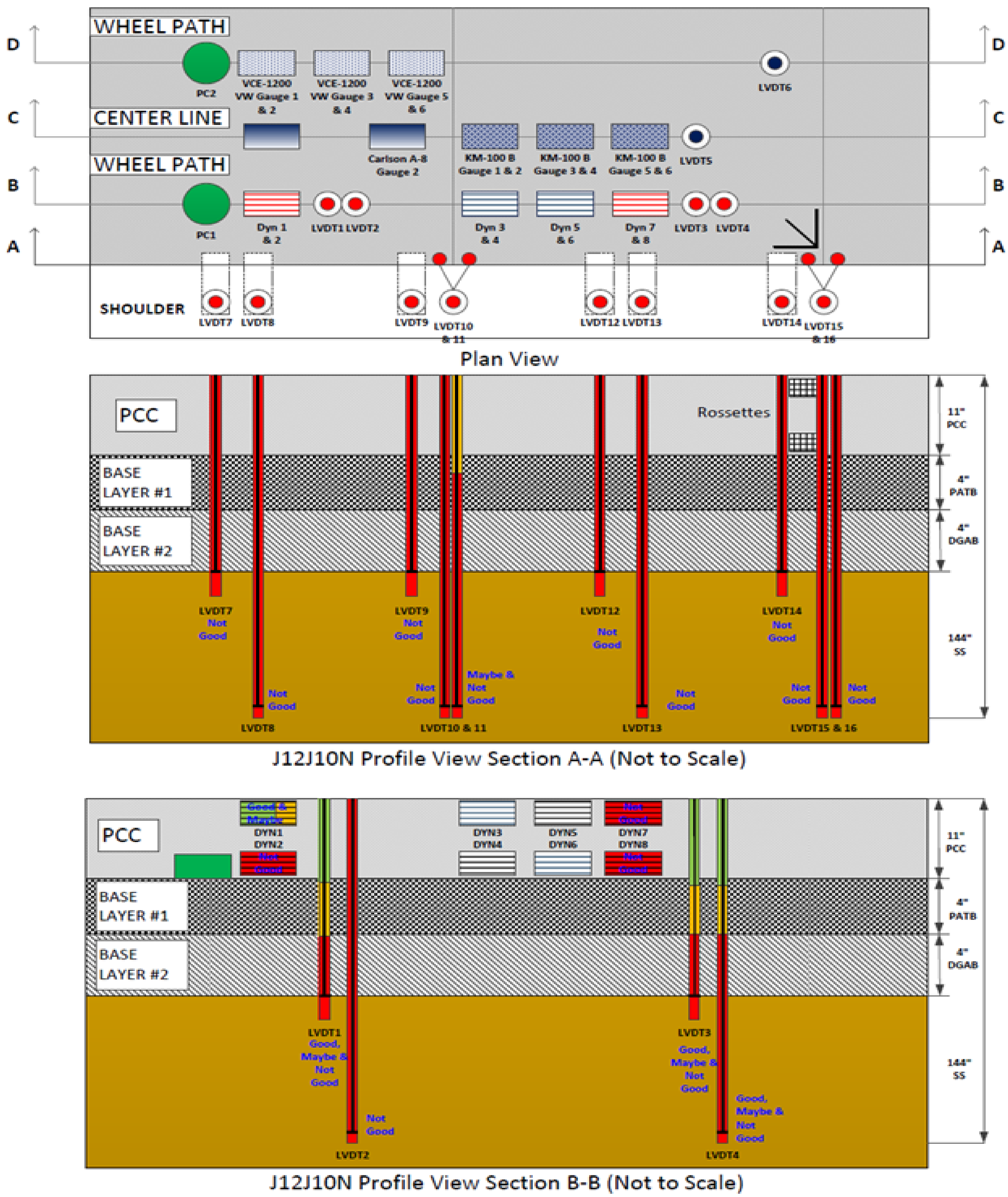


Figure 71. Illustration. QC results by sensor type for test section 390212 test J12J10N.

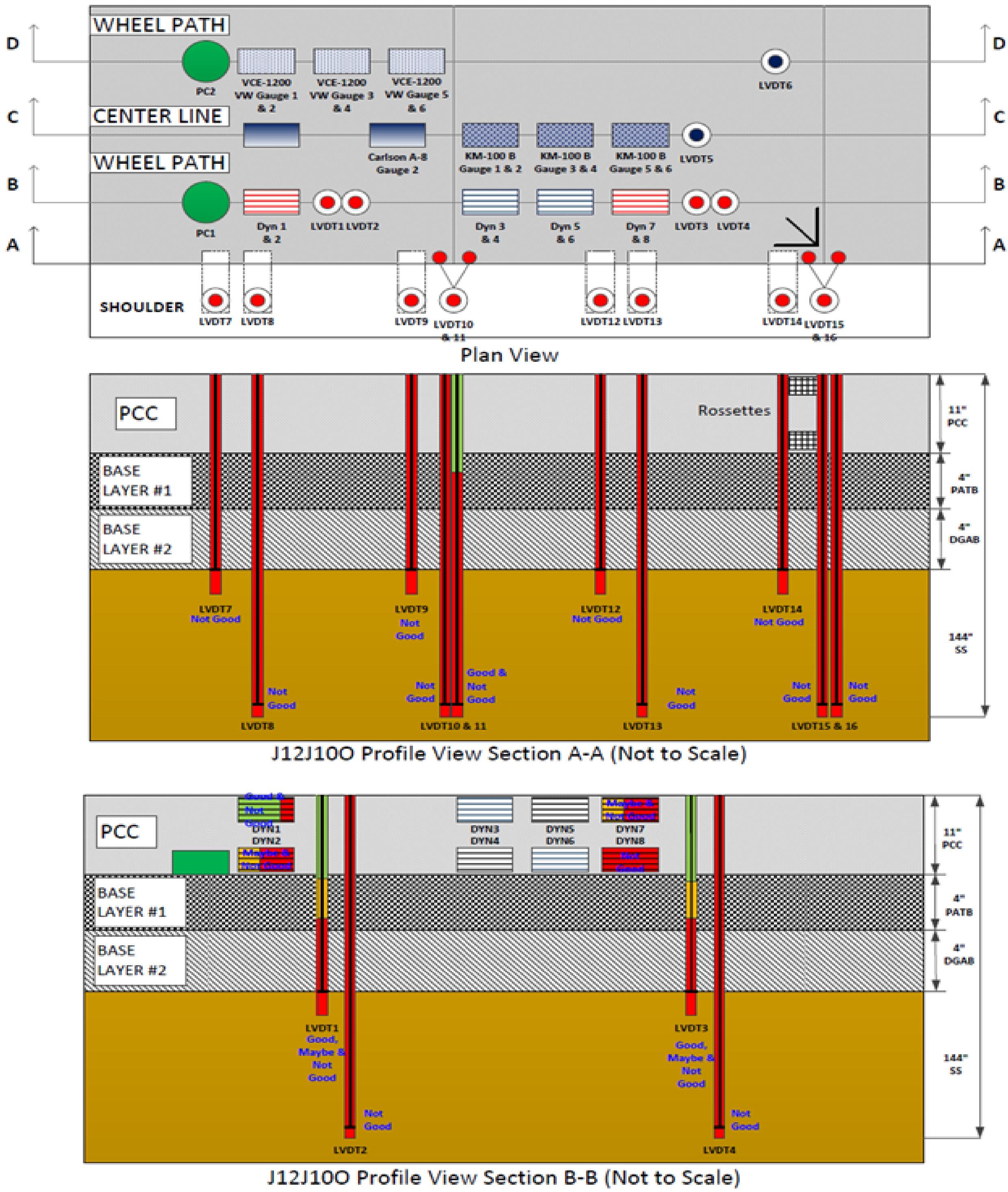


Figure 72. Illustration. QC results by sensor type for test section 390212 test J12J10O.

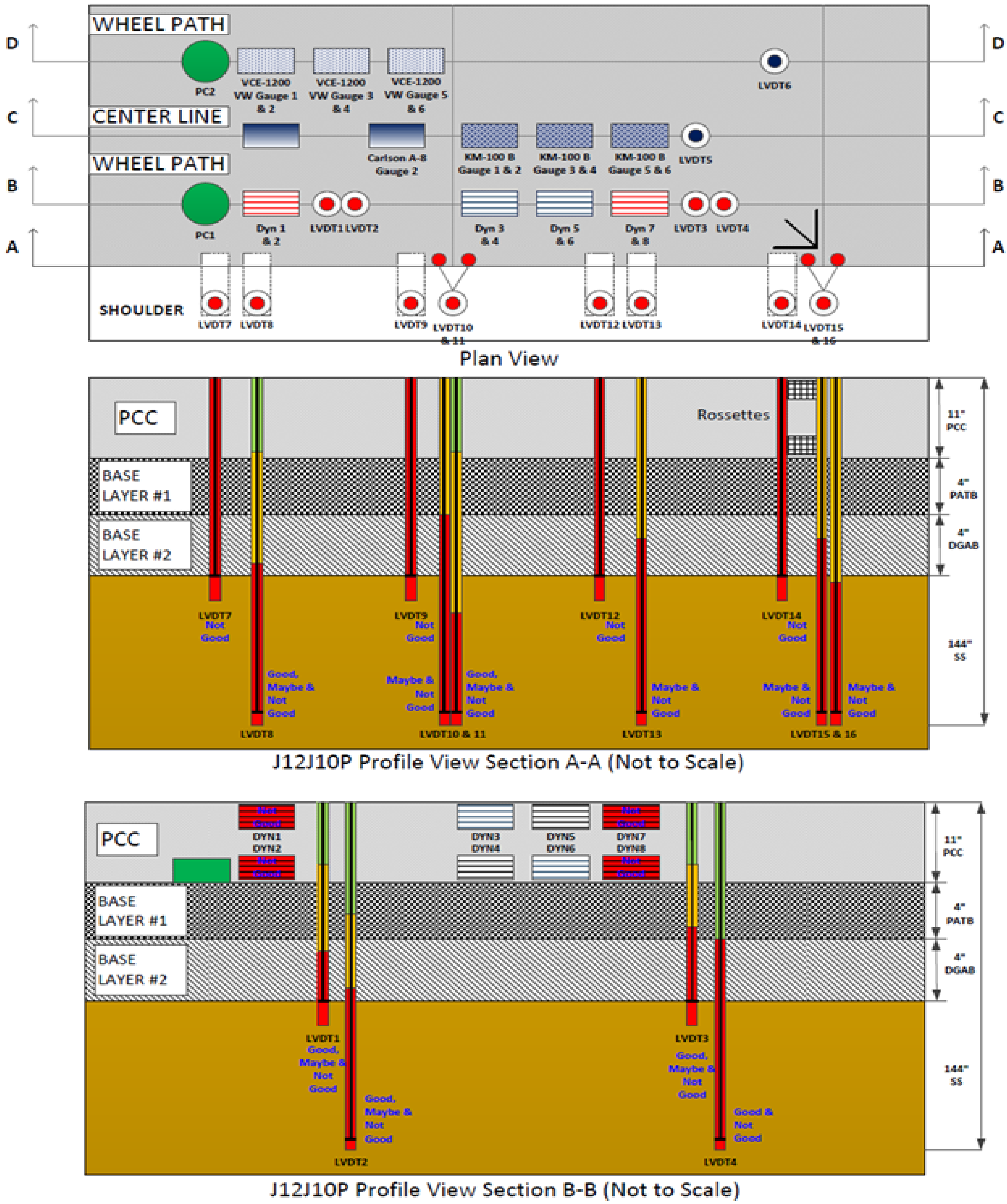


Figure 73. Illustration. QC results by sensor type for test section 390212 test J12J10P.

APPENDIX D. SENSOR NUMERICAL STATUS FOR 23 OHIO SPS-1 DLR TESTS

Appendix D shows the sensor numerical statuses for the 23 Ohio SPS-1 DLR tests. For Table 26 through table 48, numbers 1, 2, and 3 under each sensor column (excluding the run number column) represent good, maybe, and not good, respectively.

Table 26. Summarized QC results for smoothed traces in test section 390102 test J2A.

	Dyn						LVDT				PC	
Run No.	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**	**4**	**1**	**2**
1	3	1	3	3	3	1	1	3	1	1	1	1
2	3	1	3	3	3	1	1	3	1	1	1	1
3	3	1	2	3	3	1	1	3	1	1	1	1
4	3	1	2	3	3	1	1	3	1	1	1	1
5	3	1	3	3	3	1	1	3	1	1	1	1
6	3	1	2	3	3	1	1	3	1	1	1	1
7	3	1	2	3	3	1	1	3	1	1	1	1
8	3	1	2	3	3	1	1	3	1	3	1	1
9	3	1	2	3	3	1	1	3	1	3	1	1
10	3	1	2	3	3	1	1	3	1	1	1	1
11	3	1	2	3	3	1	1	3	1	1	1	1
12	3	1	2	3	3	1	1	3	1	1	1	1
13	3	1	2	3	3	1	1	3	1	1	1	1
14	3	1	2	3	3	1	2	3	1	2	1	1
15	3	1	2	3	3	1	2	3	1	2	1	1
16	3	1	2	3	3	1	2	3	2	2	1	1
Total												
Good	0	16	0	0	0	16	13	0	15	11	16	16
Maybe	0	0	13	0	0	0	3	0	1	3	0	0
Not good	16	0	3	16	16	0	0	16	0	2	0	0

Table 27. Summarized QC results for smoothed traces in test section 390102 test J2C.

	Dyn						LVDT				PC	
Run No.	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**	**4**	**1**	**2**
1	3	3	3	3	3	1	1	3	1	1	1	1
2	3	3	3	3	3	1	1	3	1	1	1	1
3	3	3	3	3	3	1	1	3	1	1	1	1
4	3	3	3	3	3	1	1	3	1	1	1	1
5	3	3	1	3	3	1	2	3	1	1	1	1
6	3	3	1	3	3	1	2	3	1	2	1	1
7	3	3	3	3	3	1	1	3	1	1	1	1
8	3	3	3	3	3	1	1	3	1	2	1	1
9	3	3	3	3	3	1	1	3	1	1	1	1
10	3	3	3	3	3	1	1	3	1	1	1	1
Total												
Good	0	0	2	0	0	10	8	0	10	8	10	10
Maybe	0	0	0	0	0	0	2	0	0	2	0	0
Not good	10	10	8	10	10	0	0	10	0	0	0	0

Table 28. Summarized QC results for smoothed traces in test section 390102 test J2D.

	Dyn						LVDT				PC	
Run No.	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**	**4**	**1**	**2**
1	3	3	2	3	3	1	1	3	1	2	1	1
2	3	3	1	3	3	1	1	3	1	1	1	1
3	3	3	2	3	3	1	1	3	1	1	1	1
4	3	3	2	3	3	1	1	3	1	1	1	1
5	3	3	2	3	3	1	1	3	1	1	1	1
6	3	3	2	3	3	1	1	3	1	1	1	1
7	3	3	2	3	3	1	1	3	1	1	1	1
8	3	3	2	3	3	1	1	3	1	1	1	1
9	3	3	3	3	3	1	1	2	1	1	1	1
10	3	3	3	3	3	1	1	2	1	1	1	1
11	3	3	3	3	3	1	1	2	1	1	1	1
12	3	3	3	3	3	1	1	2	1	1	1	1
13	3	3	3	3	3	1	1	2	1	1	1	1
14	3	3	2	3	3	1	1	2	1	1	1	1
15	3	3	3	3	3	1	1	2	2	1	1	1
16	3	3	3	3	3	1	1	2	1	2	1	1
Total												
Good	0	0	1	0	0	16	16	0	15	14	16	16
Maybe	0	0	8	0	0	0	0	8	1	2	0	0
Not good	16	16	7	16	16	0	0	8	0	0	0	0

Table 29. Summarized QC results for smoothed traces in test section 390102 test J2E.

	Dyn						LDVT				PC	
Run No.	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**	**4**	**1**	**2**
1	3	3	3	3	3	1	1	1	1	1	1	1
2	3	3	1	3	3	1	1	2	1	1	1	1
4	3	3	3	3	3	1	1	1	1	1	1	1
5	3	3	3	3	3	1	1	2	1	1	1	1
6	3	3	3	3	3	1	1	1	1	1	1	1
7	3	3	1	3	3	1	1	1	1	1	1	1
8	3	3	1	3	3	1	1	1	1	1	1	1
9	3	3	3	3	3	1	1	2	1	1	1	1
10	3	3	3	3	3	1	1	2	1	1	1	1
11	3	3	3	3	3	1	1	2	1	1	1	1
12	3	3	3	3	3	1	1	2	1	1	1	1
13	3	3	3	3	3	1	1	2	1	1	1	1
Total												
Good	0	0	3	0	0	12	12	5	12	12	12	12
Maybe	0	0	0	0	0	0	0	7	0	0	0	0
Not good	12	12	9	12	12	0	0	0	0	0	0	0

Table 30. Summarized QC results for smoothed traces in test section 390102 test J2F.

	Dyn						LVDT				PC	
Run No.	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**	**4**	**1**	**2**
1	3	3	1	3	3	1	1	2	1	1	1	1
2	3	3	1	3	3	1	1	1	1	1	1	1
3	3	3	1	3	3	1	1	2	1	1	1	1
4	3	3	1	3	3	1	1	1	1	1	1	1
5	3	3	1	3	3	1	1	2	1	1	1	1
6	3	3	1	3	3	1	1	1	1	1	1	1
7	3	3	1	3	3	1	1	1	1	1	1	1
8	3	3	1	3	3	1	1	1	1	1	1	1
Total												
Good	0	0	8	0	0	8	8	5	8	8	8	8
Maybe	0	0	0	0	0	0	0	3	0	0	0	0
Not good	8	8	0	8	8	0	0	0	0	0	0	0

Table 31. Summarized QC results for smoothed traces in test section 390102 test J2G.

Run No.	Dyn						LVDT				PC	
	7	8	9	10	11	12	1	2	3	4	1	2
1	3	3	2	3	3	1	1	2	1	1	1	1
2	3	3	2	3	3	1	1	2	1	1	1	1
3	3	3	2	3	3	1	1	2	1	1	1	1
4	3	3	2	3	3	1	1	2	1	1	1	1
5	3	3	2	3	3	1	1	2	1	1	1	1
6	3	3	2	3	3	1	1	1	1	1	1	1
7	3	3	2	3	3	1	1	2	1	1	1	1
8	3	3	1	3	3	1	1	2	1	1	1	1
9	3	3	1	3	3	1	1	2	1	1	1	1
10	3	3	1	3	3	1	1	2	1	1	1	1
11	3	3	1	3	3	1	1	2	1	1	1	1
12	3	3	2	3	3	1	1	1	1	1	1	1
Total												
Good	0	0	4	0	0	12	12	2	12	12	12	12
Maybe	0	0	8	0	0	0	0	10	0	0	0	0
Not good	12	12	0	12	12	0	0	0	0	0	0	0

Table 32. Summarized QC results for smoothed traces in test section 390102 test J4A.

Run No.	Dyn									LVDT				PC	
	10	11	12	13	14	15	16	17	18	1	2	3	4	1	2
1	2	3	2	3	2	3	1	1	1	1	2	2	1	1	1
2	3	3	3	3	3	3	1	1	1	1	2	2	1	1	1
3	3	3	3	3	3	3	1	1	1	1	2	2	1	1	1
4	3	3	3	3	3	3	1	1	1	1	2	2	1	1	1
5	3	3	3	3	3	3	1	1	1	1	2	2	1	1	1
6	3	3	3	3	3	3	1	1	1	1	2	2	1	1	1
7	3	3	3	3	3	3	1	1	1	1	2	2	1	1	1
8	3	3	3	3	3	3	1	1	1	1	2	2	1	1	1
9	3	3	3	3	3	3	1	1	1	1	2	2	1	1	1
10	3	3	3	3	3	3	1	1	1	1	2	2	1	1	1
11	3	3	3	3	3	3	1	1	1	1	2	2	1	1	1
12	3	3	3	3	3	3	1	1	1	1	2	2	1	1	1
13	3	3	3	3	3	3	1	1	1	1	2	2	1	1	1
14	3	3	3	3	3	3	1	1	1	1	2	2	1	1	1
15	3	3	3	3	3	3	1	2	1	1	2	2	1	1	1
16	3	3	3	3	3	3	1	2	1	1	2	2	1	1	1
Total															
Good	0	0	0	0	0	0	16	14	16	16	0	0	16	16	16
Maybe	1	0	1	0	1	0	0	2	0	0	16	16	0	0	0
Not good	15	16	15	16	15	16	0	0	0	0	0	0	0	0	0

Table 33. Summarized QC results for smoothed traces in test section 390102 test J4B.

	Dyn									LVDT				PC	
Run No.	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**1**	**2**	**3**	**4**	**1**	**2**
1	2	3	3	3	2	3	1	1	1	1	2	2	1	1	1
2	3	3	3	3	3	3	1	1	1	1	2	2	1	1	1
3	3	3	3	3	3	3	1	2	1	1	2	2	1	1	1
4	3	3	3	3	3	3	1	2	1	1	2	2	1	1	1
5	3	3	3	3	3	3	1	1	1	1	2	2	1	1	1
6	3	3	3	3	3	3	1	3	1	1	2	2	1	1	1
7	3	3	3	3	3	3	1	3	1	1	2	2	1	1	1
8	3	3	3	3	3	3	1	3	2	1	2	2	1	1	1
9	3	3	3	3	3	3	1	1	1	1	2	2	1	1	1
10	3	3	3	3	3	3	1	1	1	3	2	2	1	1	1
11	3	3	3	3	3	3	1	3	1	1	2	2	1	1	1
12	3	3	3	3	3	3	1	3	1	1	3	3	1	1	1
13	3	3	3	3	3	3	1	3	1	3	2	2	1	1	1
Total															
Good	0	0	0	0	0	0	13	5	12	11	0	0	13	13	13
Maybe	1	0	0	0	1	0	0	2	1	0	12	12	0	0	0
Not good	12	13	13	13	12	13	0	6	0	2	1	1	0	0	0

Table 34. Summarized QC results for smoothed traces in test section 390102 test J4C.

	Dyn									LVDT				PC	
Run No.	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**1**	**2**	**3**	**4**	**1**	**2**
1	1	3	2	3	2	3	1	3	1	1	2	2	1	1	1
2	3	3	3	2	3	3	1	3	1	1	2	2	1	1	1
3	3	3	3	2	3	3	1	3	1	1	2	2	1	1	1
4	3	3	2	2	3	3	1	3	1	1	2	1	1	1	1
5	3	3	3	2	3	3	1	3	1	1	2	1	1	1	1
6	3	3	3	2	3	3	1	3	1	1	2	2	1	1	1
7	3	3	3	2	3	3	1	3	1	1	2	2	1	1	1
8	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Total															
Good	1	0	0	0	0	0	7	0	7	7	0	2	7	7	7
Maybe	0	0	2	6	1	0	0	0	0	0	7	5	0	0	0
Not good	7	8	6	2	7	8	1	8	1	1	1	1	1	1	1

Table 35. Summarized QC results for smoothed traces in test section 390102 test J4D.

	Dyn									LVDT				PC	
Run No.	10	11	12	13	14	15	16	17	18	1	2	3	4	1	2
1	3	3	3	2	3	2	1	3	1	1	2	2	1	1	1
2	3	3	3	2	3	2	1	3	1	1	2	2	1	1	1
3	2	3	2	3	2	2	1	3	1	1	2	2	2	1	1
4	3	3	3	3	3	2	1	3	1	1	2	2	1	1	1
5	3	3	3	3	3	2	1	3	1	1	2	2	1	1	1
6	3	3	3	3	3	2	1	3	1	1	2	2	1	1	1
7	3	3	3	3	3	2	1	3	1	1	2	2	1	1	1
8	3	3	3	3	3	2	1	3	1	1	2	2	1	1	1
9	3	3	3	3	3	3	1	3	1	1	2	2	1	1	1
10	2	3	2	3	3	3	1	3	1	1	2	1	1	1	1
11	3	3	3	3	3	3	1	3	1	1	2	2	1	1	1
12	3	3	3	3	3	3	1	3	1	3	2	2	1	1	1
13	3	3	3	3	3	3	1	3	1	1	2	1	1	1	1
14	3	3	3	3	3	3	1	3	1	1	2	1	1	1	1
15	3	3	3	3	3	3	1	3	1	1	2	1	1	1	1
Total															
Good	0	0	0	0	0	0	15	0	15	14	0	4	14	15	15
Maybe	2	0	2	2	1	8	0	0	0	0	15	11	1	0	0
Not good	13	15	13	13	14	7	0	15	0	1	0	0	0	0	0

Table 36. Summarized QC results for smoothed traces in test section 390102 test J4E.

	Dyn									LVDT				PC	
Run No.	10	11	12	13	14	15	16	17	18	1	2	3	4	1	2
1	3	3	3	3	3	2	1	3	1	1	2	1	1	1	1
2	3	3	3	2	3	2	1	3	1	1	2	1	1	1	1
3	3	3	3	3	3	2	1	3	1	1	2	1	1	1	1
4	3	3	3	3	3	2	1	3	1	1	2	1	1	1	1
5	3	3	3	3	3	2	1	3	1	1	2	1	1	1	1
6	3	3	3	3	3	2	1	3	1	1	2	1	1	1	1
7	3	3	3	3	3	2	1	3	1	1	2	1	1	1	1
8	3	3	3	2	3	2	1	3	1	1	2	1	1	1	1
9	3	3	3	3	3	2	1	3	1	1	1	1	1	1	1
10	3	3	3	3	3	2	1	3	1	1	2	1	1	1	1
11	3	3	3	3	3	2	1	3	1	1	2	1	1	1	1
12	3	3	3	3	3	2	1	3	1	1	2	1	1	1	1
13	3	3	3	3	3	2	1	3	1	1	2	1	1	1	1
Total															
Good	0	0	0	0	0	0	13	0	13	13	1	13	13	13	13
Maybe	0	0	0	2	0	13	0	0	0	0	12	0	0	0	0
Not good	13	13	13	11	13	0	0	13	0	0	0	0	0	0	0

Table 37. Summarized QC results for smoothed traces in test section 390102 test J4F.

Run No.	Dyn									LVDT				PC	
	10	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**1**	**2**	**3**	**4**	**1**	**2**
1	3	2	3	2	3	2	1	3	1	1	2	2	1	1	1
2	3	2	3	2	3	2	1	3	1	1	2	2	1	1	1
3	3	2	3	2	3	2	1	3	1	1	2	2	1	1	1
4	3	2	3	2	3	2	1	3	1	1	2	2	1	1	1
5	3	2	3	2	3	2	1	3	1	1	2	2	1	1	1
6	3	2	3	2	3	2	1	3	1	1	2	2	1	1	1
7	3	2	3	2	3	2	1	3	1	1	2	2	1	1	1
8	3	2	3	2	3	2	1	3	1	1	2	2	1	1	1
9	3	3	3	2	3	2	1	2	1	1	2	2	1	1	1
10	3	3	3	2	3	2	1	3	1	1	2	2	1	1	1
11	3	3	3	2	3	2	1	3	1	1	2	2	1	1	1
12	3	3	3	2	3	2	1	3	1	1	2	2	1	1	1
Total															
Good	0	0	0	0	0	0	12	0	12	12	0	0	12	12	12
Maybe	0	8	0	12	0	12	0	1	0	0	12	12	0	0	0
Not good	12	4	12	0	12	0	0	11	0	0	0	0	0	0	0

Table 38. Summarized QC results for smoothed traces in test section 390102 test J4G.

Run No.	Dyn									LVDT				PC	
	10	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**1**	**2**	**3**	**4**	**1**	**2**
1	3	3	3	3	3	2	1	3	1	1	2	2	1	1	1
2	3	3	3	3	3	2	1	3	1	1	2	2	1	1	1
3	3	3	3	3	3	2	1	3	1	1	2	2	1	1	1
4	3	3	3	3	3	2	1	3	1	1	2	2	1	1	1
5	3	3	3	3	3	2	1	3	1	1	2	2	1	1	1
6	3	3	3	3	3	2	1	3	1	1	2	2	1	1	1
7	3	3	3	3	3	2	1	3	1	1	2	2	1	1	1
8	3	3	3	3	3	3	1	3	1	1	2	2	1	1	1
9	3	3	3	3	3	3	1	3	1	1	2	2	1	1	1
10	3	3	3	3	3	3	1	3	1	1	2	2	1	1	1
11	3	3	3	3	3	3	1	3	1	1	2	2	1	1	1
12	3	3	3	3	3	3	1	3	1	1	2	2	1	1	1
Total															
Good	0	0	0	0	0	0	12	0	12	12	0	0	12	12	12
Maybe	0	0	0	0	0	7	0	0	0	0	12	12	0	0	0
Not good	12	12	12	12	12	5	0	12	0	0	0	0	0	0	0

Table 39. Summarized QC results for smoothed traces in test section 390102 test J8A.

Run No.	Dyn									LVDT				PC	
	10	11	12	13	14	15	16	17	18	1	2	3	4	1	2
1	2	1	3	1	2	1	3	3	2	2	1	2	1	1	1
2	2	1	3	1	2	1	3	3	2	2	1	2	2	1	1
3	2	1	3	1	2	1	3	3	2	2	1	2	2	1	1
4	2	1	3	1	2	1	3	3	2	2	1	2	1	1	1
5	2	1	3	1	2	1	3	3	2	2	1	2	2	2	1
6	2	1	3	1	2	1	3	3	2	2	1	1	1	1	1
7	2	1	3	1	2	1	3	3	2	2	1	2	1	1	1
8	2	1	3	1	2	1	3	3	2	2	2	2	1	1	1
9	2	1	3	1	2	1	3	3	2	2	2	2	2	1	1
10	2	1	3	1	2	1	3	3	2	2	1	2	1	1	1
11	2	1	3	1	2	1	3	3	2	2	2	2	2	1	1
12	2	1	3	1	2	1	3	3	2	2	2	2	2	1	1
13	2	1	3	1	2	1	3	3	2	1	1	1	1	1	1
14	2	1	3	1	2	1	3	3	2	2	2	2	2	1	1
15	2	1	3	1	2	1	3	3	2	2	1	2	2	1	1
16	2	1	3	1	2	1	3	3	2	2	1	2	2	1	1
Total															
Good	0	16	0	16	0	16	0	0	0	1	11	2	7	15	16
Maybe	16	0	0	0	16	0	0	0	16	15	5	14	9	1	0
Not good	0	0	16	0	0	0	16	16	0	0	0	0	0	0	0

Table 40. Summarized QC results for smoothed traces in test section 390102 test J8D.

Run No.	Dyn									LVDT				PC	
	10	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**1**	**2**	**3**	**4**	**1**	**2**
1	2	1	3	1	2	1	3	3	2	2	1	2	2	1	1
2	2	1	3	1	2	1	3	3	2	2	1	2	1	1	1
3	2	1	3	1	2	1	3	3	2	2	1	1	1	1	1
4	2	1	3	1	2	1	3	3	2	2	2	2	2	1	1
5	2	1	3	1	2	1	3	3	2	2	2	2	1	1	1
6	2	1	3	1	2	1	3	3	2	2	2	1	1	1	1
7	2	1	3	1	2	1	3	3	2	2	2	1	1	1	1
8	2	1	3	1	2	1	3	3	2	2	2	1	1	1	1
9	2	1	3	1	2	1	3	3	2	2	2	2	2	1	1
10	2	1	3	1	2	1	3	3	2	2	2	1	1	1	1
11	2	1	3	1	2	1	3	3	2	2	2	1	1	1	1
12	2	1	3	1	2	1	3	3	2	2	2	1	1	1	1
13	2	1	3	1	2	1	3	3	2	2	2	1	1	1	1
14	2	1	3	1	2	1	3	3	2	2	2	2	2	1	1
15	2	1	3	1	2	1	3	3	2	2	2	2	1	1	1
Total															
Good	0	15	0	15	0	15	0	0	0	0	3	8	11	15	15
Maybe	15	0	0	0	15	0	0	0	15	15	12	7	4	0	0
Not good	0	0	15	0	0	0	15	15	0	0	0	0	0	0	0

Table 41. Summarized QC results for smoothed traces in test section 390102 test J8E.

Run No.	Dyn									LVDT				PC	
	10	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**1**	**2**	**3**	**4**	**1**	**2**
1	2	1	2	1	2	1	3	3	2	2	2	2	1	1	1
2	2	1	2	1	2	1	3	3	2	2	2	2	1	1	1
3	2	1	2	1	2	1	3	3	2	2	2	1	1	1	1
4	2	1	2	1	2	1	3	3	2	2	2	1	1	1	1
5	2	1	2	1	2	1	3	3	2	2	2	1	1	1	1
6	2	1	3	1	2	1	3	3	2	2	2	1	1	1	1
7	2	1	3	1	2	1	3	3	2	2	2	1	1	1	1
8	2	1	3	1	2	1	3	3	2	2	2	1	1	1	1
9	2	1	3	1	2	1	3	3	2	2	2	1	1	1	1
10	2	1	3	1	2	1	3	3	2	2	2	2	1	1	1
11	2	1	3	1	2	1	3	3	2	2	2	1	1	1	1
12	2	1	3	1	2	1	3	3	2	2	2	2	1	1	1
13	2	1	3	1	2	1	3	3	2	2	1	1	1	1	1
Total															
Good	0	13	0	13	0	13	0	0	0	0	1	9	13	13	13
Maybe	13	0	5	0	13	0	0	0	13	13	12	4	0	0	0
Not good	0	0	8	0	0	0	13	13	0	0	0	0	0	0	0

Table 42. Summarized QC results for smoothed traces in test section 390102 test J8G.

Run No.	Dyn									LVDT				PC	
	10	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**1**	**2**	**3**	**4**	**1**	**2**
1	2	1	2	1	2	1	3	3	2	2	1	1	1	1	1
2	2	1	3	1	2	1	3	3	2	2	1	1	1	1	1
3	2	1	3	1	2	1	3	3	2	2	1	1	1	1	1
4	2	1	3	1	2	1	3	3	2	2	1	1	1	1	1
5	2	1	3	1	2	1	3	3	2	2	1	1	1	1	1
6	2	1	3	1	2	1	3	3	2	2	1	1	1	1	1
7	2	1	3	1	2	1	3	3	2	2	1	1	1	1	1
8	2	1	3	1	2	1	3	3	2	2	1	1	1	1	1
9	2	1	3	1	2	1	3	3	2	2	1	1	1	1	1
10	2	1	3	1	2	1	3	3	2	2	1	1	1	1	1
11	2	1	3	1	2	1	3	3	2	2	1	1	1	1	1
12	2	1	3	1	2	1	3	3	2	2	1	1	1	1	1
Total															
Good	0	12	0	12	0	12	0	0	0	0	12	12	12	12	12
Maybe	12	0	1	0	12	0	0	0	12	12	0	0	0	0	0
Not good	0	0	11	0	0	0	12	12	0	0	0	0	0	0	0

Table 43. Summarized QC results for smoothed traces in test section 390102 test J10A.

Run No.	Dyn									LVDT				PC	
	10	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**1**	**2**	**3**	**4**	**1**	**2**
2	2	3	3	3	3	3	3	3	1	2	3	1	3	1	1
3	2	3	3	3	2	3	3	3	1	2	3	2	3	1	1
4	3	3	3	3	3	3	3	3	1	2	3	1	3	1	1
5	3	3	3	3	3	3	3	3	1	1	3	1	3	1	1
6	2	3	3	3	3	3	3	3	1	1	1	1	3	1	1
7	3	3	3	3	3	3	3	3	1	1	1	1	3	1	1
8	3	3	3	3	2	3	3	3	1	2	1	1	3	1	1
9	3	3	3	3	3	3	3	3	1	2	1	2	3	1	1
10	3	3	3	3	3	3	3	3	1	2	1	2	3	1	1
11	3	3	3	3	3	3	3	3	1	2	1	1	3	1	1
12	3	3	3	3	3	3	3	3	1	1	3	1	2	1	1
13	3	3	3	3	3	3	3	3	1	1	3	1	2	1	1
14	3	3	3	3	3	3	3	3	1	1	3	1	2	1	1
15	3	3	3	3	3	3	3	3	1	1	3	1	2	1	1
16	3	3	3	3	3	3	3	3	1	1	3	1	2	1	1
Total															
Good	0	0	0	0	0	0	0	0	15	8	6	12	0	15	15
Maybe	3	0	0	0	2	0	0	0	0	7	0	3	5	0	0
Not good	12	15	15	15	13	15	15	15	0	0	9	0	10	0	0

Table 44. Summarized QC results for smoothed traces in test section 390102 test J10C.

	Dyn									LVDT				PC	
Run No.	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**1**	**2**	**3**	**4**	**1**	**2**
1	3	3	3	3	3	3	3	3	1	3	3	3	3	1	1
2	3	3	3	3	3	3	3	3	1	2	1	2	3	1	1
3	3	3	3	3	3	3	3	3	1	2	1	2	3	1	1
4	3	3	3	3	3	3	3	3	1	2	3	2	3	1	1
5	3	3	3	3	3	3	3	3	1	2	1	2	3	1	1
6	3	3	3	3	3	3	3	3	1	2	3	2	3	1	1
7	3	3	3	3	3	3	3	3	1	2	2	2	3	1	1
8	3	3	3	3	3	3	3	3	1	2	1	2	3	1	1
9	3	3	3	3	3	3	3	3	1	2	1	2	3	1	1
10	3	3	3	3	3	3	3	3	1	2	1	2	3	1	1
Total															
Good	0	0	0	0	0	0	0	0	10	0	6	0	0	10	10
Maybe	0	0	0	0	0	0	0	0	0	9	1	9	0	0	0
Not good	10	10	10	10	10	10	10	10	0	1	3	1	10	0	0

Table 45. Summarized QC results for smoothed traces in test section 390102 test J10D.

	Dyn									LVDT				PC	
Run No.	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**1**	**2**	**3**	**4**	**1**	**2**
1	1	2	2	2	3	2	3	3	1	2	2	2	1	1	1
2	1	2	2	2	3	2	3	3	1	2	2	2	2	1	1
3	3	2	3	2	3	2	3	3	1	2	3	2	1	1	1
4	1	2	3	2	3	2	3	3	1	2	3	2	1	1	1
5	2	2	3	2	3	2	3	3	1	2	3	2	3	1	1
6	2	3	3	2	3	2	3	3	1	2	3	2	2	1	1
7	3	3	3	3	3	3	3	3	1	2	2	1	1	1	1
8	3	3	3	3	3	3	3	3	1	2	1	2	1	1	1
9	3	3	3	3	3	3	3	3	1	2	1	2	1	1	1
10	3	3	3	3	3	3	3	3	1	2	2	2	1	1	1
11	3	3	3	3	3	3	3	3	1	2	1	2	1	1	1
12	3	3	3	3	3	3	3	3	1	2	2	2	1	1	1
13	3	3	3	3	3	3	3	3	1	2	2	2	3	1	1
14	3	3	3	3	3	3	3	3	1	2	2	2	3	1	1
15	3	3	3	3	3	3	3	3	1	2	2	2	2	1	1
16	3	3	3	3	3	3	3	3	1	2	2	2	3	1	1
Total															
Good	3	0	0	0	0	0	0	0	16	0	3	1	9	16	16
Maybe	2	5	2	6	0	6	0	0	0	16	9	15	3	0	0
Not good	11	11	14	10	16	10	16	16	0	0	4	0	4	0	0

Table 46. Summarized QC results for smoothed traces in test section 390102 test J10E.

Run No.	Dyn									LVDT				PC	
	10	11	12	13	14	15	16	17	18	1	2	3	4	1	2
1	3	3	3	3	3	3	3	3	1	2	1	2	2	1	1
2	2	3	2	3	2	3	3	3	1	2	1	1	3	1	1
3	2	3	2	3	2	3	3	3	1	1	1	1	3	1	1
4	2	3	2	3	2	3	3	3	1	1	1	1	3	1	1
5	3	3	3	3	3	3	3	3	1	2	1	2	2	1	1
6	3	3	3	3	3	3	3	3	1	2	1	1	2	1	1
7	2	3	2	3	2	3	3	3	1	1	1	1	3	1	1
8	3	3	3	3	3	3	3	3	1	2	1	1	2	1	1
9	3	3	3	3	3	3	3	3	1	2	1	2	2	1	1
10	2	3	3	3	2	3	3	3	1	1	1	1	3	1	1
11	3	3	3	3	3	3	3	3	1	1	1	1	2	1	1
12	2	3	2	3	2	3	3	3	1	1	1	1	3	1	1
Total															
Good	0	0	0	0	0	0	0	0	12	6	12	9	0	12	12
Maybe	6	0	5	0	6	0	0	0	0	6	0	3	6	0	0
Not good	6	12	7	12	6	12	12	12	0	0	0	0	6	0	0

Table 47. Summarized QC results for smoothed traces in test section 390102 test J10F.

Run No.	Dyn									LVDT				PC	
	10	11	12	13	14	15	16	17	18	1	2	3	4	1	2
1	2	1	2	1	2	1	3	3	1	2	1	2	3	1	1
2	1	1	1	1	1	1	3	3	1	2	1	2	3	1	1
3	1	1	1	1	1	1	3	3	1	2	1	2	3	1	1
4	1	1	1	1	1	1	3	3	1	2	1	1	3	1	1
5	1	1	1	1	3	1	3	3	1	2	1	1	2	1	1
6	1	1	1	1	3	1	3	3	1	2	1	2	2	1	1
7	3	1	3	1	3	1	3	3	1	1	1	2	3	1	1
8	1	1	1	1	3	1	3	3	1	2	1	1	1	1	1
9	2	1	3	1	3	1	3	3	1	2	1	1	1	1	1
10	3	1	3	2	3	1	3	3	1	1	1	1	1	1	1
11	1	1	2	2	3	2	3	3	1	2	1	1	1	1	1
12	3	1	3	2	3	2	3	3	1	1	1	1	1	1	1
13	3	1	3	2	3	2	3	3	1	1	1	1	1	1	1
Total															
Good	7	13	6	9	3	10	0	0	13	4	13	8	6	13	13
Maybe	2	0	2	4	1	3	0	0	0	9	0	5	2	0	0
Not good	4	0	5	0	9	0	13	13	0	0	0	0	5	0	0

Table 48. Summarized QC results for smoothed traces in test section 390102 test J10G.

	Dyn									LVDT				PC	
Run No.	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**1**	**2**	**3**	**4**	**1**	**2**
1	2	2	3	2	3	2	3	3	1	2	1	2	1	1	1
2	3	2	3	2	3	2	3	3	1	2	1	2	2	1	1
3	3	2	3	2	3	2	3	3	1	2	1	1	1	1	1
4	3	2	3	2	3	2	3	3	1	2	1	2	1	1	1
5	3	2	3	2	3	2	3	3	1	2	1	2	1	1	1
6	3	2	3	2	3	2	3	3	1	2	1	1	1	1	1
7	3	2	3	2	3	2	3	3	1	1	1	2	1	1	1
8	3	2	3	2	3	2	3	3	1	1	1	1	1	1	1
9	3	2	3	2	3	2	3	3	1	1	1	1	1	1	1
10	3	2	3	2	3	3	3	3	1	1	1	1	1	1	1
11	3	2	3	2	3	3	3	3	1	1	1	1	1	1	1
12	3	2	3	2	3	3	3	3	1	1	1	1	1	1	1
Total															
Good	0	0	0	0	0	0	0	0	12	6	12	7	11	12	12
Maybe	1	12	0	12	0	9	0	0	0	6	0	5	1	0	0
Not good	11	0	12	0	12	3	12	12	0	0	0	0	0	0	0

APPENDIX E. SENSOR NUMERICAL STATUS FOR 24 OHIO SPS-2 DLR TESTS

Appendix E shows the sensor numerical statuses for the 24 Ohio SPS-2 DLR tests. For table 49 through table 72, numbers 1, 2, and 3 under each sensor column (excluding the run number column) represent the following: 1 = good, 2 = maybe, and 3 = not good, respectively. Numbers 2 and 3 under the column labeled “Truck- Axle” represent the following: 2 = two-axle truck and 3 = three-axle truck.

Table 49. Summarized QC results for smoothed traces in test section 390201 Test J1A.

Truck-Axle	Run No.	LVDT														Dyn			
		1	2	3	4	7	8	9	10	11	12	13	14	15	16	1	4	5	8
2	1	1	1	3	3	3	3	3	2	3	3	3	3	3	2	1	1	1	1
3	2	1	1	2	3	3	3	3	3	3	3	3	3	3	2	1	1	1	1
2	3	1	1	1	3	3	3	3	1	3	3	3	3	2	1	1	1	1	1
3	4	1	3	2	3	3	3	3	3	3	3	3	3	3	3	1	1	1	1
2	5	1	1	1	3	3	3	3	1	3	3	3	3	2	1	1	1	1	1
3	6	1	1	1	3	3	3	3	3	3	3	3	3	3	3	1	1	1	1
2	7	1	1	1	3	3	3	3	1	3	3	3	3	1	1	1	1	1	1
3	8	1	3	1	3	3	3	3	3	3	3	3	3	3	3	1	1	1	1
2	9	1	1	1	3	3	3	3	1	3	3	3	3	1	1	1	1	1	1
3	10	1	3	1	3	3	3	3	3	3	3	3	3	3	3	1	1	1	1
2	11	1	1	1	3	3	3	3	1	3	3	3	3	1	1	1	1	1	1
3	12	1	3	1	3	3	3	3	3	3	3	3	3	3	3	1	1	1	1
2	13	1	1	1	3	3	3	3	1	3	3	3	3	1	1	1	1	1	1
3	14	1	3	1	3	3	3	3	3	3	3	3	3	3	1	1	1	1	1
2	15	1	1	1	3	3	3	3	1	3	3	3	3	1	1	1	1	1	1
3	16	1	3	1	3	3	3	3	3	3	3	3	3	3	3	1	1	1	1
2	17	1	1	1	3	3	3	3	1	3	3	3	3	1	1	1	1	1	1
3	18	1	3	1	3	3	3	3	3	3	3	3	3	3	3	1	1	1	1
2	19	1	1	1	3	3	3	3	1	3	3	3	3	1	1	1	1	1	1
3	20	1	3	1	3	3	3	3	3	3	3	3	3	3	3	1	1	1	1
2	21	1	1	1	3	3	3	3	1	3	3	3	3	1	1	1	1	1	1
3	22	1	3	1	3	3	3	3	3	3	3	3	3	3	3	1	1	1	1
2	23	1	1	1	3	3	3	3	1	3	3	3	3	1	1	1	1	1	1

3	24	1	3	1	3	3	3	3	3	3	3	3	3	3	3	1	1	1	1
2	25	1	1	1	3	3	3	3	1	3	3	3	3	1	1	1	1	1	1
3	26	1	3	1	3	3	3	3	3	3	3	3	3	3	3	1	1	1	1
3	27	1	3	1	3	3	3	3	3	3	3	3	3	3	3	1	1	1	1
3	28	1	3	1	3	3	3	3	3	3	3	3	3	3	3	1	1	1	1
Total																			
Good		28	15	25	0	0	0	0	12	0	0	0	0	10	13	28	28	28	28
Maybe		0	0	2	0	0	0	0	1	0	0	0	0	2	2	0	0	0	0
Not good		0	13	1	28	28	28	28	15	28	28	28	28	16	13	0	0	0	0

Table 50. Summarized QC results for smoothed traces in test section 390201 test J1B.

Truck-Axle	Run No.	LVDT														Dyn			
		1	**2**	**3**	**4**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**1**	**4**	**5**	**8**
2	1	1	1	2	3	3	3	3	3	3	3	3	3	3	3	1	1	1	1
3	2	1	3	1	3	3	3	3	3	3	3	3	3	3	3	1	1	1	1
2	3	1	1	1	3	3	3	3	2	3	3	3	3	3	1	1	1	1	1
3	4	1	3	1	3	3	3	3	3	3	3	3	3	3	3	1	1	1	1
2	5	1	1	1	3	3	3	3	2	2	3	3	3	2	1	1	1	1	1
3	6	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	1	1	1
2	7	3	3	3	3	3	3	3	2	3	3	3	3	2	2	1	1	1	1
3	8	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	1	1	1
2	9	3	3	3	3	3	3	3	3	2	3	3	3	2	2	1	1	1	1
3	10	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	1	1	1
2	11	3	3	3	3	3	3	3	2	2	3	3	3	2	3	1	1	1	1
3	12	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	1	1	1
2	13	3	3	3	3	3	3	3	3	2	3	3	3	2	2	1	1	1	1
3	14	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	1	1	1
2	15	3	3	3	3	3	3	3	2	2	3	3	3	2	2	1	1	1	1
3	16	3	3	3	3	3	3	3	2	3	3	3	3	3	3	1	1	1	1
2	17	3	3	3	3	3	3	3	2	2	3	3	3	3	3	1	1	1	1
3	18	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	1	1	1
2	19	1	1	1	3	3	3	3	3	1	3	3	3	3	1	1	1	1	1
2	20	1	1	1	3	3	3	3	3	1	3	3	3	2	1	1	1	1	1
2	23	3	3	3	3	3	3	3	3	2	3	3	3	2	3	1	1	1	1
3	24	1	3	1	3	3	3	3	3	3	3	3	3	3	3	1	1	1	1
3	25	1	3	1	3	3	3	3	3	3	3	3	3	3	2	1	1	1	1
3	26	1	3	1	3	3	3	3	3	3	3	3	3	3	3	1	1	1	1
Total																			
Good		10	5	9	0	0	0	0	0	2	0	0	0	0	4	24	24	24	24
Maybe		0	0	1	0	0	0	0	7	7	0	0	0	8	5	0	0	0	0
Not good		14	19	14	24	24	24	24	17	15	24	24	24	16	15	0	0	0	0

Table 51. Summarized QC results for smoothed traces in test section 390201 test J1C.

Truck-Axle	Run No.	LVDT														Dyn			
		1	2	3	4	7	8	9	10	11	12	13	14	15	16	1	2	7	8
2	1	1	1	2	3	3	3	3	2	2	3	3	3	3	2	1	1	1	1
2	2	1	1	1	3	3	3	3	1	2	3	3	3	3	1	1	1	1	1
2	3	1	1	1	3	3	3	3	1	2	3	3	3	3	1	1	1	1	1
2	4	1	1	1	3	3	3	3	1	2	3	3	3	3	2	1	1	1	1
2	5	1	1	1	3	3	3	3	2	2	3	3	3	3	2	1	1	1	1
2	6	1	1	1	3	3	3	3	2	2	3	3	3	3	2	1	1	1	1
2	7	1	1	1	3	3	2	3	2	2	3	3	3	3	2	1	1	1	1
2	8	1	1	1	3	3	2	3	2	2	3	3	3	3	1	1	1	1	1
2	9	1	1	1	3	3	3	3	2	2	3	3	3	3	1	1	1	1	1
2	10	1	1	1	3	3	3	3	2	2	3	3	3	3	2	1	1	1	1
2	11	1	1	1	3	3	2	3	2	2	3	3	3	3	1	1	1	1	1
2	12	1	1	1	3	3	3	3	2	2	3	3	3	3	1	1	1	1	1
2	13	1	1	1	3	3	3	3	2	2	3	3	3	3	1	1	1	1	1
2	14	1	1	1	3	3	2	3	1	1	3	3	3	1	1	1	1	1	1
Total																			
Good		14	14	13	0	0	0	0	4	1	0	0	0	1	8	14	14	14	14
Maybe		0	0	1	0	0	4	0	10	13	0	0	0	0	6	0	0	0	0
Not good		0	0	0	14	14	10	14	0	0	14	14	14	13	0	0	0	0	0

Table 52. Summarized QC results for smoothed traces in test section 390205 test J5A.

Truck-Axle	Run No.	LVDT														Dyn			
		1	2	3	4	7	8	9	10	11	12	13	14	15	16	1	4	5	8
2	1	3	1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
3	2	3	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
2	3	3	1	1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
3	4	3	3	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
2	5	3	1	1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
3	6	3	3	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
2	7	3	1	1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
3	8	3	3	1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
2	9	3	1	1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
3	10	3	1	1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
2	11	3	1	1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
3	12	3	3	1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
2	13	3	1	1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
3	14	3	3	1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
2	15	3	3	1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
3	16	3	3	1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
2	17	3	1	1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
3	18	3	3	1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
2	19	3	1	1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
3	20	3	3	1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
2	21	3	3	1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
3	22	3	3	1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
2	23	3	1	1	3	3	3	3	1	3	3	3	3	3	3	3	3	3	3
3	24	3	3	1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
2	25	3	1	1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
3	26	3	3	1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
3	27	3	3	1	3	3	3	3	3	3	3	3	3	3	3	1	1	3	1
3	28	3	3	1	3	3	3	3	3	3	3	3	3	3	3	1	1	3	1
2	29	3	1	3	3	1	1	1	1	1	2	1	3	1	3	1	1	3	1

Total																		
Good	0	13	24	0	1	1	1	2	1	0	1	0	1	0	3	3	0	3
Maybe	0	1	2	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Not good	29	15	3	29	28	28	28	27	28	28	28	29	28	29	26	26	29	26

Table 53. Summarized QC results for smoothed traces in test section 390205 test J5B.

Truck-Axle	Run No.	LVDT														Dyn			
		1	2	3	4	7	8	9	10	11	12	13	14	15	16	1	2	7	8
2	1	3	1	3	3	3	3	3	3	3	3	3	3	3	3	1	3	1	1
3	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	3	1	1
2	3	3	3	1	3	3	3	3	2	3	3	3	3	2	3	1	3	1	1
3	4	3	3	2	3	3	3	3	2	3	3	3	3	3	3	1	3	1	1
2	5	3	3	3	3	3	2	3	2	2	3	1	3	1	3	1	3	1	1
3	6	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	3	1	1
2	7	3	1	3	3	3	2	3	1	1	3	1	3	1	3	1	3	1	1
3	8	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	3	1	1
2	9	3	1	3	3	3	2	3	2	2	3	1	3	1	3	1	3	1	1
3	10	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	3	1	1
2	11	3	1	3	3	3	2	3	1	1	3	1	3	1	3	1	3	1	1
3	12	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	3	1	1
2	13	3	1	3	3	3	2	3	1	1	3	1	3	1	3	1	3	1	1
3	14	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	3	1	1
2	15	3	1	3	3	3	2	3	1	1	3	1	3	1	3	1	3	1	1
3	16	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	3	1	1
2	17	3	3	3	3	3	2	3	1	1	3	1	3	1	3	1	3	1	1
3	18	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	3	1	1
2	19	3	3	1	3	3	3	3	3	3	3	3	3	3	3	1	3	1	1
2	20	3	1	1	3	3	3	3	3	3	3	1	3	1	3	1	3	1	1
2	21	3	3	3	3	3	2	3	1	2	3	1	3	1	3	1	3	1	1
2	23	3	3	3	3	3	2	3	1	1	3	1	3	1	3	1	3	1	1
3	24	3	3	1	3	3	3	3	3	3	3	3	3	3	3	1	3	1	1
3	25	3	3	1	3	3	3	3	3	3	3	3	3	3	3	1	3	1	1
3	26	3	3	1	3	3	3	3	3	3	3	3	3	3	3	1	3	1	1
Total																			
Good		0	7	6	0	0	0	0	7	6	0	10	0	10	0	25	0	25	25
Maybe		0	0	1	0	0	9	0	4	3	0	0	0	1	0	0	0	0	0
Not good		25	18	18	25	25	16	25	14	16	25	15	25	14	25	0	25	0	0

Table 54. Summarized QC results for smoothed traces in test section 390205 test J5C.

Truck-Axle	Run No.	LVDT														Dyn			
		1	**2**	**3**	**4**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**1**	**2**	**7**	**8**
2	1	3	1	3	3	3	3	3	3	3	3	3	3	3	3	1	3	1	1
2	2	3	1	2	3	3	3	3	3	3	3	3	3	3	3	1	3	1	1
2	3	3	1	1	3	3	3	3	3	3	3	3	3	3	3	1	3	1	1
2	4	3	1	1	3	3	3	3	3	3	3	3	3	3	3	1	3	1	1
2	5	3	1	2	3	3	3	3	3	3	3	3	3	3	3	1	3	1	1
2	6	3	1	2	3	3	3	3	3	3	3	3	3	3	3	1	3	1	1
2	7	3	1	2	3	3	3	3	3	3	3	3	3	3	3	1	3	1	1
2	8	3	1	1	3	3	3	3	3	3	3	3	3	2	3	1	3	1	1
2	9	3	1	1	3	3	3	3	3	3	3	3	3	3	3	1	3	1	1
2	10	3	1	1	3	3	3	3	3	3	3	3	3	3	3	1	3	1	1
2	11	3	1	1	3	3	3	3	3	3	3	2	3	2	3	1	3	1	1
2	12	3	1	1	3	3	3	3	3	3	3	2	3	2	3	1	3	1	1
2	13	3	1	1	3	3	3	3	3	3	3	2	3	2	3	1	3	1	1
2	14	3	1	1	3	3	3	3	3	3	3	2	3	3	3	1	3	1	1
Total																			
Good		0	14	9	0	0	0	0	0	0	0	0	0	0	0	14	0	14	14
Maybe		0	0	4	0	0	0	0	0	0	0	4	0	4	0	0	0	0	0
Not good		14	0	1	14	14	14	14	14	14	14	10	14	10	14	0	14	0	0

Table 55. Summarized QC results for smoothed traces in test section 390205 test J5J1M.

Truck-Axle	Run No.	LVDT														Dyn			
		1	**2**	**3**	**4**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**1**	**2**	**7**	**8**
2	1	3	3	2	3	3	1	3	3	3	3	3	3	3	3	1	1	1	1
3	2	3	3	1	3	3	3	3	3	3	3	3	3	3	3	1	1	1	1
2	3	1	1	1	1	2	1	3	1	1	3	3	3	2	1	1	1	1	1
3	4	3	3	1	3	3	3	3	3	3	3	3	3	3	3	1	1	1	1
2	5	1	1	1	1	1	1	3	1	1	1	3	3	3	1	1	1	1	1
3	6	2	3	1	3	3	3	3	3	3	3	3	3	3	3	1	1	1	1
2	7	1	3	1	1	3	1	3	1	1	3	3	3	3	3	1	1	1	1
3	8	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	1	1	1
2	9	1	1	1	1	1	1	3	1	1	2	3	3	1	1	1	1	1	1
3	10	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	1	1	1
2	11	1	1	1	1	2	1	3	1	1	2	3	3	3	3	1	1	1	1
3	12	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	1	1	1
2	13	1	1	1	1	2	1	3	1	1	3	3	3	3	3	1	1	1	1
3	14	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	1	1	1
2	15	1	3	1	1	1	1	3	1	1	1	3	3	3	3	1	1	1	1
3	16	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	1	1	1
2	17	1	3	1	1	1	1	3	1	1	3	3	3	3	3	1	1	1	1
3	18	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	1	1	1
Total																			
Good		8	5	11	8	4	9	0	8	8	2	0	0	1	3	18	18	18	18
Maybe		1	0	1	0	3	0	0	0	0	2	0	0	1	0	0	0	0	0
Not good		9	13	6	10	11	9	18	10	10	14	18	18	16	15	0	0	0	0

Table 56. Summarized QC results for smoothed traces in test section 390205 test J5J1N.

Truck-Axle	Run No.	LVDT 1	LVDT 2	LVDT 3	LVDT 4	LVDT 7	LVDT 8	LVDT 9	LVDT 10	LVDT 11	LVDT 12	LVDT 13	LVDT 14	LVDT 15	LVDT 16	Dyn 1	Dyn 2	Dyn 7	Dyn 8
2	1	3	1	1	1	3	3	3	2	2	3	3	3	3	3	1	1	1	1
3	2	2	3	1	3	3	3	3	3	3	3	3	3	3	3	1	1	1	1
2	3	1	3	1	1	3	3	3	1	1	3	3	3	1	3	1	1	1	1
3	4	2	3	1	3	3	3	3	3	3	3	3	3	3	3	1	1	1	1
2	5	1	1	1	1	3	3	3	1	1	3	3	3	1	1	1	1	1	1
3	6	2	3	1	3	3	3	3	3	3	3	3	3	3	3	1	1	1	1
2	7	1	3	1	1	2	3	3	1	1	3	3	3	3	3	1	1	1	1
3	8	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	1	1	1
2	9	1	3	1	1	3	3	3	1	1	3	3	3	3	2	1	1	1	1
3	10	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	1	1	1
2	11	1	3	1	1	1	3	3	1	1	3	3	3	3	3	1	1	1	1
3	12	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	1	1	1
2	13	1	3	1	3	2	3	3	1	1	3	3	3	3	3	1	1	1	1
3	14	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	1	1	1
2	15	1	3	1	1	1	3	3	1	1	3	3	3	3	3	1	1	1	1
3	16	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	1	1	1
2	17	1	3	1	1	1	3	3	1	1	3	3	3	3	3	1	1	1	1
3	18	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	1	1	1
Total																			
Good		8	2	12	8	3	0	0	8	8	0	0	0	2	1	18	18	18	18
Maybe		3	0	0	0	2	0	0	1	1	0	0	0	0	1	0	0	0	0
Not good		7	16	6	10	13	18	18	9	9	18	18	18	16	16	0	0	0	0

Table 57. Summarized QC results for smoothed traces in test section 390205 test J5J1O.

Truck-Axle	Run No.	LVDT														Dyn			
		1	**2**	**3**	**4**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**1**	**2**	**7**	**8**
2	1	2	1	1	1	3	1	3	1	1	3	3	3	3	3	2	1	3	3
3	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	1	1	3
2	3	1	1	1	1	1	1	3	1	1	2	3	3	3	1	1	1	1	3
3	4	1	3	1	3	3	3	3	3	3	3	3	3	3	3	1	1	1	3
2	5	1	1	1	1	1	1	3	1	1	2	3	3	3	3	1	1	1	3
3	6	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	1	1	3
2	7	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
3	8	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	1	1	3
2	9	1	3	1	3	1	1	3	1	1	1	3	3	3	3	1	1	1	3
3	10	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	1	1	3
2	11	1	3	1	3	1	1	3	1	1	2	3	3	3	3	1	1	1	3
3	12	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	1	1	3
2	13	1	3	1	3	1	3	3	1	1	1	3	3	3	3	1	1	1	2
3	14	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	1	1	3
2	15	1	3	1	3	1	3	3	1	1	1	3	3	3	3	1	1	1	2
3	16	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	1	1	3
2	17	1	3	1	3	1	2	3	1	1	1	3	3	3	3	1	1	1	3
3	18	1	3	1	3	3	3	3	3	3	3	3	3	3	3	1	1	1	3
Total																			
Good		9	3	10	3	7	5	0	8	8	4	0	0	0	1	16	17	16	0
Maybe		1	0	0	0	0	1	0	0	0	3	0	0	0	0	1	0	0	2
Not good		8	15	8	15	11	12	18	10	10	11	18	18	18	17	1	1	2	16

Table 58. Summarized QC results for smoothed traces in test section 390205 test J5J1P.

Truck-Axle	Run No.	LVDT														Dyn			
		1	**2**	**3**	**4**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**1**	**2**	**7**	**8**
3	1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	1	1	1
2	2	2	3	3	3	3	3	1	1	1	3	3	3	1	1	1	1	1	1
3	3	3	3	3	3	3	3	3	2	3	3	3	3	3	3	1	1	1	1
2	4	1	3	3	3	3	3	1	1	1	3	3	3	1	1	1	1	1	1
3	5	3	3	3	3	3	3	3	2	3	3	3	3	3	3	1	1	1	1
2	6	1	3	3	3	3	3	1	1	1	3	3	3	1	1	1	1	1	1
3	7	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	1	1	1
2	8	1	3	3	3	3	3	1	1	1	3	3	3	3	1	1	1	1	1
3	9	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	1	1	1
2	10	1	3	3	3	3	3	1	1	1	3	3	3	1	1	1	1	1	1
3	11	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	1	1	3
2	12	1	3	2	3	3	3	1	1	1	3	3	3	1	1	1	1	1	3
3	13	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	1	1	3
2	14	1	3	2	3	3	3	1	1	1	3	3	3	1	1	1	1	1	3
3	15	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	1	1	3
2	16	1	3	1	3	3	3	1	1	1	3	3	3	1	1	1	1	1	3
3	17	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	1	1	3
2	18	3	3	1	3	3	3	1	1	1	3	3	3	1	1	1	1	1	3
Total																			
Good		7	0	2	0	0	0	9	9	9	0	0	0	8	9	18	18	18	10
Maybe		1	0	2	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0
Not good		10	18	14	18	18	18	9	7	9	18	18	18	10	9	0	0	0	8

Table 59. Summarized QC results for smoothed traces in test section 390208 test J8A.

Truck-Axle	Run No.	LVDT														Dyn			
		1	2	3	4	7	8	9	10	11	12	13	14	15	16	1	4	5	8
2	1	3	2	3	1	3	3	3	3	3	3	3	3	3	3	1	1	1	3
3	2	3	2	3	2	3	3	3	3	3	3	3	3	3	3	1	1	1	3
2	3	2	1	2	1	3	3	3	3	3	3	3	3	3	3	1	1	1	3
3	4	2	3	2	2	3	3	3	3	3	3	3	3	3	3	1	1	1	3
2	5	1	1	1	1	3	3	3	3	2	3	3	3	3	3	1	1	1	3
3	6	2	2	1	1	3	3	3	3	3	3	3	3	3	3	1	1	1	3
2	7	1	1	1	1	3	3	3	3	3	3	3	3	3	3	1	1	1	3
3	8	2	3	1	1	3	3	3	3	3	3	3	3	3	3	1	1	1	3
2	9	1	1	1	1	3	3	3	3	2	3	3	3	3	3	1	1	1	3
3	10	1	3	1	1	3	3	3	3	3	3	3	3	3	3	1	1	1	3
2	11	1	1	1	1	3	3	3	3	3	3	3	3	3	3	1	1	1	3
3	12	3	3	1	3	3	3	3	3	3	3	3	3	3	3	1	1	1	3
2	13	1	1	1	1	3	3	3	3	3	3	3	3	3	3	1	1	1	3
3	14	1	3	1	3	3	3	3	3	3	3	3	3	3	3	1	1	1	3
2	15	1	1	1	1	3	3	3	3	3	3	3	3	3	3	1	1	1	3
3	16	3	3	1	3	3	3	3	3	3	3	3	3	3	3	1	1	1	3
2	17	1	1	1	1	3	3	3	3	3	3	3	3	3	3	1	1	1	3
3	18	1	3	1	3	3	3	3	3	3	3	3	3	3	3	1	1	1	3
2	19	1	1	1	1	3	3	3	3	3	3	3	3	3	3	1	1	1	3
3	20	1	3	1	3	3	3	3	3	3	3	3	3	3	3	1	1	1	3
2	21	1	1	1	1	3	3	3	3	3	3	3	3	3	3	1	1	1	3
3	22	1	3	1	3	3	3	3	3	3	3	3	3	3	3	1	1	1	3
2	23	1	1	1	1	3	3	3	3	3	3	3	3	3	3	1	1	1	3
3	24	1	3	1	3	3	3	3	3	3	3	3	3	3	3	1	1	1	3
2	25	1	1	1	1	3	3	3	3	3	3	3	3	3	3	1	1	1	3
3	26	1	3	1	3	3	3	3	3	3	3	3	3	3	3	1	1	1	3
Total																			
Good		18	12	22	16	0	0	0	0	0	0	0	0	0	0	26	26	26	0
Maybe		4	3	2	2	0	0	0	0	2	0	0	0	0	0	0	0	0	0
Not good		4	11	2	8	26	26	26	26	24	26	26	26	26	26	0	0	0	26

Table 60. Summarized QC results for smoothed traces in test section 390208 test J8B.

Truck-Axle	Run No.	LVDT														Dyn			
		1	2	3	4	7	8	9	10	11	12	13	14	15	16	1	2	7	8
2	1	3	2	3	1	3	3	3	3	3	3	3	3	3	3	1	1	1	3
3	2	3	1	3	1	3	3	3	3	3	3	3	3	3	3	1	1	1	3
2	3	1	1	1	1	3	3	3	3	3	3	2	3	3	3	1	1	1	1
3	4	1	1	1	1	3	3	3	3	3	3	3	3	3	3	1	1	1	3
2	5	1	1	1	1	3	3	3	3	3	3	3	3	3	3	1	1	1	3
3	6	1	3	1	3	3	3	3	3	3	3	3	3	3	3	1	1	1	1
2	7	1	1	1	1	3	3	3	3	3	3	3	3	3	3	1	1	1	3
3	8	1	3	1	3	3	3	3	3	3	3	3	3	3	3	1	1	1	3
2	9	1	1	1	1	3	3	3	3	3	3	3	3	3	3	1	1	1	3
3	10	1	3	1	3	3	3	3	3	3	3	3	3	3	3	1	1	1	3
2	11	1	1	1	1	3	3	3	3	3	3	3	3	3	3	1	1	1	3
3	12	1	3	1	3	3	3	3	3	3	3	3	3	3	3	1	1	1	1
2	13	1	1	1	1	3	3	3	3	3	3	3	3	3	3	1	1	1	3
3	14	1	3	1	3	3	3	3	3	3	3	3	3	3	3	1	1	1	3
2	15	1	1	1	1	3	3	3	3	3	3	3	3	3	3	1	1	1	3
3	16	1	3	1	3	3	3	3	3	3	3	3	3	3	3	1	1	1	1
2	17	1	1	1	1	3	3	3	3	3	3	3	3	3	3	1	1	1	1
3	18	1	1	2	1	3	3	3	3	3	3	3	3	3	3	1	1	1	3
2	19	1	1	1	1	3	3	3	3	3	3	3	3	3	3	1	1	1	1
2	20	1	1	1	1	3	3	3	3	3	3	3	3	3	3	1	1	1	1
2	21	1	1	1	1	3	3	3	3	3	3	3	3	3	3	1	1	1	1
3	22	1	2	3	1	3	3	3	3	3	3	3	3	3	3	1	1	1	3
3	24	1	3	3	3	3	3	3	3	3	3	3	3	3	3	1	1	1	3
3	25	1	3	3	3	3	3	3	3	3	3	3	3	3	3	1	1	1	1
3	26	2	3	3	3	3	3	3	3	3	3	3	3	3	3	1	1	1	3
3	27	2	3	3	3	3	3	3	3	3	3	3	3	3	3	1	1	1	3
Total																			
Good		22	14	18	16	0	0	0	0	0	0	0	0	0	0	26	26	26	9
Maybe		2	2	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Not good		2	10	7	10	26	26	26	26	26	26	25	26	26	26	0	0	0	17

Table 61. Summarized QC results for smoothed traces in test section 390208 test J8C.

Truck-Axle	Run No.	LVDT														Dyn			
		1	2	3	4	7	8	9	10	11	12	13	14	15	16	1	2	7	8
2	1	3	3	3	1	3	3	3	3	3	3	2	3	3	3	1	1	1	3
2	2	3	3	3	1	3	3	3	3	3	3	2	3	3	3	1	1	1	3
2	3	2	3	3	1	3	3	3	3	3	3	1	3	3	3	1	1	1	3
2	4	1	3	2	1	3	3	3	3	3	3	2	3	3	3	1	1	1	3
2	5	1	3	1	1	3	3	3	3	3	3	2	3	3	3	1	1	1	3
2	6	1	3	2	1	3	3	3	3	3	3	2	3	3	3	1	1	1	3
2	7	1	3	2	1	3	3	3	3	3	3	1	3	3	3	1	1	1	3
2	8	1	3	1	1	3	3	3	3	3	3	1	3	3	3	1	1	1	3
2	9	1	3	1	1	3	3	3	3	3	3	1	3	3	3	1	1	1	3
2	10	1	3	1	1	3	3	3	3	1	3	1	3	3	3	1	1	1	3
2	11	1	3	2	1	3	3	3	3	1	1	1	3	3	3	1	1	1	3
2	12	1	3	1	1	3	3	3	3	3	1	1	3	3	3	1	1	1	3
2	13	1	3	1	1	3	3	3	3	3	3	1	3	3	3	1	1	1	3
2	14	1	3	1	1	3	3	3	3	3	3	1	3	3	3	1	1	1	3
2	15	1	3	1	1	3	3	3	3	3	3	2	3	3	3	1	1	1	1
2	16	1	3	1	1	3	3	3	3	3	1	2	3	3	3	1	1	1	3
2	17	1	3	1	1	3	3	3	3	3	3	3	3	3	3	1	1	1	3
Total																			
Good		14	0	10	17	0	0	0	0	2	3	9	0	0	0	17	17	17	1
Maybe		1	0	4	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0
Not good		2	17	3	0	17	17	17	17	15	14	1	17	17	17	0	0	0	16

Table 62. Summarized QC results for smoothed traces in test section 390208 test J8S3M.

Truck-Axle	Run No.	LVDT														Dyn			
		1	2	3	4	7	8	9	10	11	12	13	14	15	16	1	2	7	8
2	1	3	3	3	3	3	3	3	3	3	3	3	3	2	2	3	3	1	3
3	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	3
2	3	2	3	3	3	3	2	3	3	3	3	2	3	3	3	3	3	1	3
3	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	3
2	5	1	1	3	3	3	1	3	3	3	3	2	3	1	2	3	3	1	3
3	6	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	3
2	7	1	3	3	3	3	3	3	3	3	3	3	3	3	1	3	3	1	3
3	8	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	3
2	9	1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	3
3	10	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	3
2	11	1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	3
3	12	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	3
2	13	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
3	14	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	3
2	15	1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
3	16	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	3
2	17	1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	3
3	18	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	3
Total																			
Good		6	1	0	0	0	1	0	0	0	0	0	0	1	1	0	0	16	0
Maybe		1	0	0	0	0	1	0	0	0	0	2	0	1	2	0	0	0	0
Not good		11	17	18	18	18	16	18	18	18	18	16	18	16	15	18	18	2	18

Table 63. Summarized QC results for smoothed traces in test section 390208 test J8S3N.

Truck-Axle	Run No.	LVDT														Dyn			
		1	2	3	4	7	8	9	10	11	12	13	14	15	16	1	2	7	8
2	1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	2
3	2	3	3	3	1	3	3	3	3	3	3	3	3	3	3	3	3	1	2
2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	2
3	4	3	3	3	3	3	3	3	3	3	3	1	3	3	3	3	3	1	2
2	5	3	2	3	2	3	2	3	3	3	3	3	3	2	2	3	3	1	1
3	6	3	3	3	1	3	3	3	3	3	3	3	3	3	3	3	3	1	2
2	7	3	3	3	3	3	3	3	3	3	3	3	3	2	2	3	3	1	1
3	8	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	2
2	9	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	2
3	10	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	2
2	11	3	3	3	3	3	3	3	3	3	3	3	3	3	2	3	3	1	2
3	12	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	3
2	13	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	3
3	14	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	3
2	15	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	3
3	16	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	3
2	17	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	3
3	18	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	3
Total																			
Good		0	0	0	2	0	0	0	0	0	0	1	0	0	0	0	0	18	2
Maybe		1	1	0	1	0	1	0	0	0	0	0	0	2	3	0	0	0	9
Not good		17	17	18	15	18	17	18	18	18	18	17	18	16	15	18	18	0	7

Table 64. Summarized QC results for smoothed traces in test section 390208 test J8S3O.

Truck-Axle	Run No.	LVDT														Dyn			
		1	2	3	4	7	8	9	10	11	12	13	14	15	16	1	2	7	8
2	1	3	3	3	2	3	3	3	3	3	3	3	3	3	3	3	3	1	3
3	2	3	3	3	1	3	3	3	3	3	3	3	3	3	3	3	3	1	3
2	3	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	3
3	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	3
2	5	1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	3
3	6	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	3
2	7	1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	3
3	8	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	3
2	9	1	3	3	3	1	1	3	3	3	3	3	3	3	3	3	3	1	3
3	10	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	3
2	11	1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	3
3	12	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	3
2	13	1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	3
3	14	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	3
2	15	1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	3
3	16	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	3
2	17	1	3	3	3	1	3	3	3	3	3	1	3	3	3	3	3	1	3
3	18	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	3
Total																			
Good		7	0	0	1	2	1	0	0	0	0	1	0	0	0	0	0	17	0
Maybe		1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Not good		10	18	18	16	16	17	18	18	18	18	17	18	18	18	18	18	0	18

Table 65. Summarized QC results for smoothed traces in test section 390208 test J8S3P.

Truck-Axle	Run No.	LVDT														Dyn			
		1	**2**	**3**	**4**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**1**	**2**	**7**	**8**
3	1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	3
3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	3
2	4	3	3	3	3	3	3	3	3	3	3	3	3	2	2	3	3	1	3
3	5	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	3
2	6	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	3
3	7	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	3
2	8	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	3
3	9	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	3
2	10	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	3
3	11	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	3
2	12	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	3
3	13	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	3
2	14	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	3
3	15	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	3
2	16	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	3
3	17	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	3
2	18	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	3
Total																			
Good		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	0
Maybe		0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	2	0
Not good		18	18	18	18	18	18	18	18	18	18	18	18	17	17	18	18	1	18

Table 66. Summarized QC results for smoothed traces in test section 390212 test J12A.

Truck-Axle	Run No.	LVDT														Dyn			
		1	**2**	**3**	**4**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**1**	**4**	**5**	**8**
2	1	1	3	1	1	3	3	3	3	2	3	3	3	3	3	1	1	1	1
3	2	1	3	1	2	3	3	3	3	2	3	3	3	3	3	1	1	1	1
2	3	1	3	1	2	3	3	3	3	1	3	3	3	3	3	1	1	1	1
3	4	1	3	2	3	3	3	3	3	3	3	3	3	3	3	1	1	1	1
Total																			
Good		4	0	3	1	0	0	0	0	1	0	0	0	0	0	4	4	4	4
Maybe		0	0	1	2	0	0	0	0	2	0	0	0	0	0	0	0	0	0
Not good		0	4	0	1	4	4	4	4	1	4	4	4	4	4	0	0	0	0

Table 67. Summarized QC results for smoothed traces in test section 390212 test J12B.

Truck-Axle	Run No.	LVDT														Dyn			
		1	2	3	4	7	8	9	10	11	12	13	14	15	16	1	2	7	8
2	1	1	3	1	1	3	3	3	3	3	3	3	3	3	3	1	1	1	1
3	2	1	1	1	3	3	3	3	3	3	3	3	3	3	3	1	1	1	1
2	3	1	1	1	1	3	3	3	3	3	3	3	3	3	3	1	1	1	1
3	4	1	3	1	3	3	3	3	3	3	3	3	3	3	3	1	1	1	1
2	5	1	2	1	1	3	3	3	3	3	3	3	3	3	3	1	1	1	1
3	6	2	3	1	3	3	3	3	3	3	3	3	3	3	3	2	1	1	2
2	7	1	1	1	1	3	3	3	3	3	3	3	3	3	3	1	1	1	1
3	8	1	3	1	3	3	3	3	3	3	3	3	3	3	3	1	1	1	1
2	9	1	3	1	1	3	3	3	3	3	3	3	3	3	3	1	1	1	1
3	10	1	3	1	3	3	3	3	3	3	3	3	3	3	3	1	1	1	1
2	11	1	2	1	1	3	3	3	3	2	3	3	3	3	3	1	1	1	1
3	12	2	3	1	3	3	3	3	3	3	3	3	3	3	3	1	1	1	1
2	13	1	1	1	1	3	3	3	3	2	3	3	3	3	3	1	1	1	1
3	14	1	3	1	3	3	3	3	3	3	3	3	3	3	3	1	1	1	1
2	15	1	2	1	1	3	3	3	3	2	3	3	3	3	3	1	1	1	1
3	16	1	3	1	3	3	3	3	3	3	3	3	3	3	3	1	1	1	1
2	17	1	1	1	1	3	3	3	3	1	3	3	3	3	3	1	1	1	1
3	18	1	3	1	3	3	3	3	3	2	3	3	3	3	3	1	1	1	1
2	19	1	1	1	1	3	3	3	3	1	3	3	3	3	3	1	1	1	1
2	20	1	1	1	1	3	3	3	3	1	3	3	3	3	3	1	1	1	1
2	21	1	1	1	1	3	3	3	3	1	3	3	3	3	3	1	1	1	1
3	22	1	3	1	3	3	3	3	3	2	3	3	3	3	3	1	1	1	1
3	24	1	3	1	3	3	3	3	3	3	3	3	3	3	3	1	1	1	1
3	25	1	1	3	3	3	3	3	3	3	3	3	3	3	3	1	1	1	1
3	26	1	1	1	3	3	3	3	3	3	3	3	3	3	3	1	1	1	1
3	27	1	3	1	3	3	3	3	3	3	3	3	3	3	3	1	1	1	1
Total																			
Good		24	10	25	12	0	0	0	0	4	0	0	0	0	0	25	26	26	25
Maybe		2	3	0	0	0	0	0	0	5	0	0	0	0	0	1	0	0	1
Not good		0	13	1	14	26	26	26	26	17	26	26	26	26	26	0	0	0	0

Table 68. Summarized QC results for smoothed traces in test section 390212 test J12C.

Truck-Axle	**Run No.**	**LVDT**														**Dyn**			
		1	**2**	**3**	**4**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**1**	**2**	**7**	**8**
2	1	2	1	2	1	3	3	3	3	2	3	3	3	3	3	1	1	1	1
2	2	1	1	1	1	3	3	3	3	1	3	3	3	3	3	1	1	1	1
2	3	1	1	1	1	3	3	3	3	1	3	3	3	3	3	1	2	1	1
2	4	1	1	1	1	3	3	3	3	1	3	3	3	3	3	1	3	1	1
2	5	1	1	1	1	3	3	3	3	1	3	3	3	3	3	1	1	1	1
2	6	1	1	1	1	3	3	3	3	1	3	3	3	3	3	1	1	1	1
2	7	1	1	1	1	3	3	3	3	1	3	3	3	3	3	1	2	1	1
2	8	1	1	1	1	3	3	3	3	1	3	3	3	3	3	1	1	1	1
2	9	1	1	1	1	3	3	3	3	1	3	3	3	3	3	1	1	1	1
2	10	1	1	1	1	3	3	3	3	1	3	3	3	3	3	1	1	1	3
2	11	1	1	1	1	3	3	3	3	1	3	3	3	3	3	1	1	1	1
2	12	1	1	1	1	3	3	3	3	1	3	3	3	3	3	1	2	1	1
2	13	1	1	1	1	3	3	3	3	1	3	3	3	3	3	1	1	1	1
2	14	1	1	1	1	3	3	3	3	1	3	3	3	3	1	1	1	1	1
Total																			
Good		13	14	13	14	0	0	0	0	13	0	0	0	0	1	14	10	14	13
Maybe		1	0	1	0	0	0	0	0	1	0	0	0	0	0	0	3	0	0
Not good		0	0	0	0	14	14	14	14	0	14	14	14	14	13	0	1	0	1

Table 69. Summarized QC results for smoothed traces in test section 390212 test J12J10M.

Truck-Axle	Run No.	LVDT														Dyn			
		1	**2**	**3**	**4**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**1**	**2**	**7**	**8**
2	1	3	2	2	1	3	3	3	2	2	3	3	3	2	2	3	3	3	3
3	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	3
2	3	1	2	1	1	3	3	3	2	2	3	3	3	2	2	3	3	3	3
3	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
2	5	1	3	1	1	3	3	3	1	1	3	3	3	1	1	3	3	3	3
3	6	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
2	7	1	3	1	3	3	3	3	3	3	3	3	3	3	2	3	2	3	3
3	8	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	3	3
2	9	1	3	1	3	3	3	3	3	3	3	3	3	3	3	3	2	3	3
3	10	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	3	3
2	11	1	3	1	1	3	3	3	2	2	3	3	3	2	2	3	2	3	3
3	12	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	3	3
2	13	1	3	1	3	3	3	3	2	2	3	3	3	3	2	3	2	3	3
3	14	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	3	3
2	15	1	3	1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
3	16	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	3	3
2	17	1	3	1	3	3	3	3	3	3	3	3	3	3	2	3	3	3	3
3	18	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	3	3
Total																			
Good		8	0	8	4	0	0	0	1	1	0	0	0	1	1	0	0	0	0
Maybe		0	2	1	0	0	0	0	4	4	0	0	0	3	6	0	10	1	0
Not good		10	16	9	14	18	18	18	13	13	18	18	18	14	11	18	8	17	18

Table 70. Summarized QC results for smoothed traces in test section 390212 test J12J10N.

Truck-Axle	Run No.	LVDT														Dyn			
		1	**2**	**3**	**4**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**1**	**2**	**7**	**8**
2	1	2	3	2	3	3	3	3	3	3	3	3	3	3	3	1	3	3	3
3	2	3	3	3	1	3	3	3	3	3	3	3	3	3	3	1	3	3	3
2	3	1	3	1	3	3	3	3	3	3	3	3	3	3	3	1	3	3	3
3	4	3	3	3	2	3	3	3	3	3	3	3	3	3	3	1	3	3	3
2	5	1	3	1	3	3	3	3	3	3	3	3	3	3	3	1	3	3	3
3	6	3	3	1	1	3	3	3	3	3	3	3	3	3	3	1	3	3	3
2	7	1	3	1	3	3	3	3	3	3	3	3	3	3	3	1	3	3	3
3	8	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	3	3	3
2	9	1	3	1	3	3	3	3	3	3	3	3	3	3	3	1	3	3	3
3	10	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	3	3	3
2	11	2	3	1	3	3	3	3	3	2	3	3	3	3	3	1	3	3	3
3	12	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	3	3	3
2	13	1	3	2	3	3	3	3	3	3	3	3	3	3	3	2	3	3	3
3	14	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	3	3	3
2	15	1	3	2	3	3	3	3	3	2	3	3	3	3	3	2	3	3	3
3	16	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	3	3	3
2	17	1	3	2	3	3	3	3	3	3	3	3	3	3	3	2	3	3	3
3	18	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	3	3	3
Total																			
Good		7	0	6	2	0	0	0	0	0	0	0	0	0	0	11	0	0	0
Maybe		2	0	4	1	0	0	0	0	2	0	0	0	0	0	7	0	0	0
Not good		9	18	8	15	18	18	18	18	16	18	18	18	18	18	0	18	18	18

Table 71. Summarized QC results for smoothed traces in test section 390212 test J12J10O.

Truck-Axle	Run No.	LVDT														Dyn			
		1	2	3	4	7	8	9	10	11	12	13	14	15	16	1	2	7	8
2	1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
3	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	3	3	3
2	3	1	3	1	3	3	3	3	3	3	3	3	3	3	3	1	3	3	3
3	4	2	3	3	3	3	3	3	3	3	3	3	3	3	3	1	3	3	3
2	5	1	3	1	3	3	3	3	3	1	3	3	3	3	3	1	3	3	3
3	6	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	3	3	3
2	7	1	3	1	3	3	3	3	3	1	3	3	3	3	3	1	2	3	3
3	8	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	2	2	3
2	9	1	3	1	3	3	3	3	3	3	3	3	3	3	3	2	3	2	3
3	10	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	3	2	3
2	11	1	3	1	3	3	3	3	3	1	3	3	3	3	3	2	3	2	3
3	12	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	3	2	3
2	13	1	3	1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
3	14	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1	3	2	3
2	15	1	3	1	3	3	3	3	3	1	3	3	3	3	3	2	3	3	3
3	16	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	3	3	3
2	17	1	3	1	3	3	3	3	3	1	3	3	3	3	3	2	3	3	3
3	18	3	3	2	3	3	3	3	3	3	3	3	3	3	3	2	3	3	3
Total																			
Good		8	0	8	0	0	0	0	0	5	0	0	0	0	0	9	0	0	0
Maybe		1	0	1	0	0	0	0	0	0	0	0	0	0	0	7	2	6	0
Not good		9	18	9	18	18	18	18	18	13	18	18	18	18	18	2	16	12	18

Table 72. Summarized QC results for smoothed traces in test section 390212 test J12J10P.

Truck-Axle	Run No.	LVDT														Dyn			
		1	**2**	**3**	**4**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**1**	**2**	**7**	**8**
3	1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
2	2	2	1	2	1	3	1	3	2	1	3	2	3	3	2	3	3	3	3
3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
2	4	2	1	2	1	3	1	3	2	1	3	2	3	2	2	3	3	3	3
3	5	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
2	6	2	1	1	1	3	2	3	2	2	3	2	3	2	2	3	3	3	3
3	7	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
2	8	2	2	2	1	3	2	3	2	2	3	2	3	2	2	3	3	3	3
3	9	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
2	10	2	1	2	1	3	2	3	2	2	3	2	3	2	2	3	3	3	3
3	11	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
2	12	2	1	1	1	3	2	3	2	2	3	2	3	2	2	3	3	3	3
3	13	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
2	14	1	1	1	1	3	3	3	2	2	3	2	3	2	2	3	3	3	3
3	15	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
2	16	1	1	1	1	3	3	3	3	2	3	3	3	2	2	3	3	3	3
3	17	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Total																			
Good		2	7	4	8	0	2	0	0	2	0	0	0	0	0	0	0	0	0
Maybe		6	1	4	0	0	4	0	7	6	0	7	0	7	8	0	0	0	0
Not good		9	9	9	9	17	11	17	10	9	17	10	17	10	9	17	17	17	17

REFERENCES

1. Federal Highway Administration. (2012). *LTPP Pavement Performance Database Release Notes: Standard Data Release 27.0 January 2013*, U.S. Department of Transportation, Washington, DC. Obtained from: http://www.infopave.com/InfoPave_Repository/files/SDR27_LTPP_Data_Release_Notes_27.pdf. Site last accessed February 5, 2015.

2. Lin, S. (2009). *LTPP Data Analysis/Operations Feedback Report*, Report No. Ecompex-75_Rev_1. Ecompex, Inc., McLean, VA.

3. Lin, S. (2009). *LTPP Data Analysis/Operations Feedback Report*, Report No. Ecompex-76_Rev_1. Ecompex, Inc., McLean, VA.

4. Lin, S. (2009). *LTPP Data Analysis/Operations Feedback Report*, Report No. Ecompex-77_Rev_1. Ecompex, Inc., McLean, VA.

5. Elkins, G. (2009). *Investigation of Ohio DLR data in LTPP Database*, Technical Memorandum, AMEC, Reno, NV.

6. Federal Highway Administration. (2007). *LTPP Pavement Performance Data Release Notes: Standard Data Release 22.0 January 2008*, U.S. Department of Transportation, Washington, DC. Obtained from: http://www.infopave.com/InfoPave_Repository/files/LTPP%20Release%2022%20Release%20Notes.PDF. Site last accessed February 5, 2015.

7. Sargand, S. et al. (1999). *Coordination of Load Response Instrumentation of SHRP Pavements—Ohio University*, Report No. FHWA/OH-99/009, Ohio University, Athens, OH.

8. MATLAB Version 7.11. (2010). The MathWorks Inc., Natick, MA.

9. Weaver, E. (2000). *Comparison and Quality Evaluation of LTPP DLR Data from Ohio and North Carolina*. Federal Highway Administration, McLean, VA.

10. Mslowess. MathWorks, Inc., Natick, MA. Obtained from: http://www.mathworks.com/help/toolbox/bioinfo/ref/mslowess.html. Site last accessed December 29, 2011.

11. Mspeaks. MathWorks, Inc., Natick, MA. Obtained from: http://www.mathworks.com/help/toolbox/bioinfo/ref/mspeaks.html?nocookie=true. Site last accessed December 29, 2011.

12. Sargand, S. et al. (2007). *Evaluation of Pavement Performance on DEL 23*, Report No. FHWA/OH-2007/05, Ohio University, Athens, OH.

HRDI-30/03-15(300)E