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Successful Practices in Weigh-in-Motion Data Quality with WIM Guidebook

Volume 2

Arizona Department of Transportation Research Center

Successful Practices in Weigh-in-Motion Data Quality with WIM Guidebook

SPR-731

Volume 2: Appendices

July 2017

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16. Abstract

The Arizona Department of Transportation (ADOT) plans to install new weigh-in-motion (WIM) stations with either piezo-polymer or piezo-quartz sensors. Recognizing some limitations of WIM sensor technologies, ADOT sponsored this study to ensure the accuracy of the future WIM data collection. The project tasks included (1) reviewing other highway agencies' practices related to WIM data quality assurance through literature review and a survey; (2) developing a guidebook of clear recommendations for managing WIM installation, calibration, maintenance, and data quality assurance; and (3) developing a research report with recommendations on how to achieve successful implementation of a WIM program.

Through reviewing available literature and surveying selected highway agencies, the project team determined that the piezo-quartz sensors perform much better than the piezo-polymer sensors due to their consistent reliability, reduced calibration requirements, and relative temperature insensitivity. With proper installation, piezo-quartz WIM sensors should provide accurate axle and truck weight measurements in Arizona.

Findings also indicated that piezo-polymer sensors should perform well in Arizona for vehicle classification, traffic volume, and speed studies, but not for weight data collection. This is due to the temperature sensitivity of piezo-polymer sensors and to the limitations of auto-calibration and temperature compensation technologies in environments where pavements undergo rapid day-to-night temperature changes and are subjected to high seasonal temperatures. Piezo-polymer sensor use with an auto-calibration feature for weight measurements should be evaluated on a case-by-case basis.

Using findings from the literature review and the successful WIM practices survey, the research team developed a guidebook with recommendations and procedures for WIM site selection and qualification, installation, calibration, maintenance, data quality assurance, and personnel needed to support ADOT's WIM program. These recommendations are specific to WIM systems that use piezo-quartz sensors and piezo-polymer sensors. The guidebook is included as Chapter 4 of this final report.

17. Key Words
Weigh in motion, Weigh in motion scales, Piezoelectricity, Piezoelectric Materials, Sensors, Calibration

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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

*SI is the symbol for the International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380.
(Revised March 2003)

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LIST OF ABBREVIATIONS AND ACRONYMS

AASHTO	American Association of State Highway and Transportation Officials
AC	asphalt concrete
AC	alternating current
ADOT	Arizona Department of Transportation
ARA	Applied Research Associates
ASTM	American Society for Testing and Materials
BL	Brass Linguini®
BP	bending-plate
CDS	comparison data set
ConnDOT	Connecticut DOT
CPATT	Centre for Pavement and Transportation Technology
DOT	Department of Transportation
DMV	Department of Motor Vehicles
F	Fahrenheit
FDOT	Florida Department of Transportation
FHWA	Federal Highway Administration
ft	feet
GDOT	Georgia Department of Transportation
GFCI	ground fault circuit interrupter
GRS	galvanized rigid steel
GUI	graphical user interface
GVW	gross vehicle weight
ISWIM	International Society for Weigh-In-Motion
IRD	International Road Dynamics, Inc.
IRI	International Roughness Index
kips	kilopounds
lb	pounds
LDOTD	Louisiana Department of Transportation and Development
LRI	long-range index
LTAS	LTPP traffic analysis software
LTPP	Long-Term Pavement Performance (program name)
MEPDG	*Mechanistic Empirical Pavement Design Guide*
MnDOT	Minnesota DOT
MPD	Multimodal Planning Division
NATMEC	North American Travel Monitoring Exhibition and Conference
NCDOT	North Carolina Department of Transportation
NCHRP	National Cooperative Highway Research Program
NCR	Non-compliance report

OHPI	Office of Highway Policy Information
OWL	Optimal WIM Locator
PCC	portland cement concrete
PVC	polyvinyl chloride
PVDF	piezoelectric polyvinylidene fluoride
QA	quality assurance
QC	quality control
RMC	rigid metal conduit
SPS	Specific Pavement Studies
SRI	Short-Range Index
TMAS	Travel Monitoring Analysis System
TPAS	Traffic Polling and Analysis System
TRB	Transportation Research Board
TTI	Texas Transportation Institute
VTRIS	Vehicle Travel Information System
WIM	weigh-in-motion

APPENDIX A – COMPLETED SURVEY FORMS

APPENDIX A – TABLE OF CONTENTS

1. Connecticut Department of Transportation (Donna Weaver)
2. Florida Department of Transportation (Steven Bentz
3. Georgia Department of Transportation (Jane Smith)
4. Federal Highway Administration (Steven Jessberger)
5. Federal Highway Administration (Deborah Walker)
6. International Road Dynamics (Roy Czinku)
7. Louisiana Department of Transportation (Harold R. Paul)
8. Marshall University (Dr. Andrew Nichols)
9. New Mexico Department of Transportation (Yolanda Duran)
10. Pennsylvania Department of Transportation (Andrea Bahoric)
11. Texas Department of Transportation (Catherine Woolf)
12. Virginia Department of Transportation (Tom Shinkel)

Connecticut Department of Transportation (Donna Weaver)
Transportation Planner

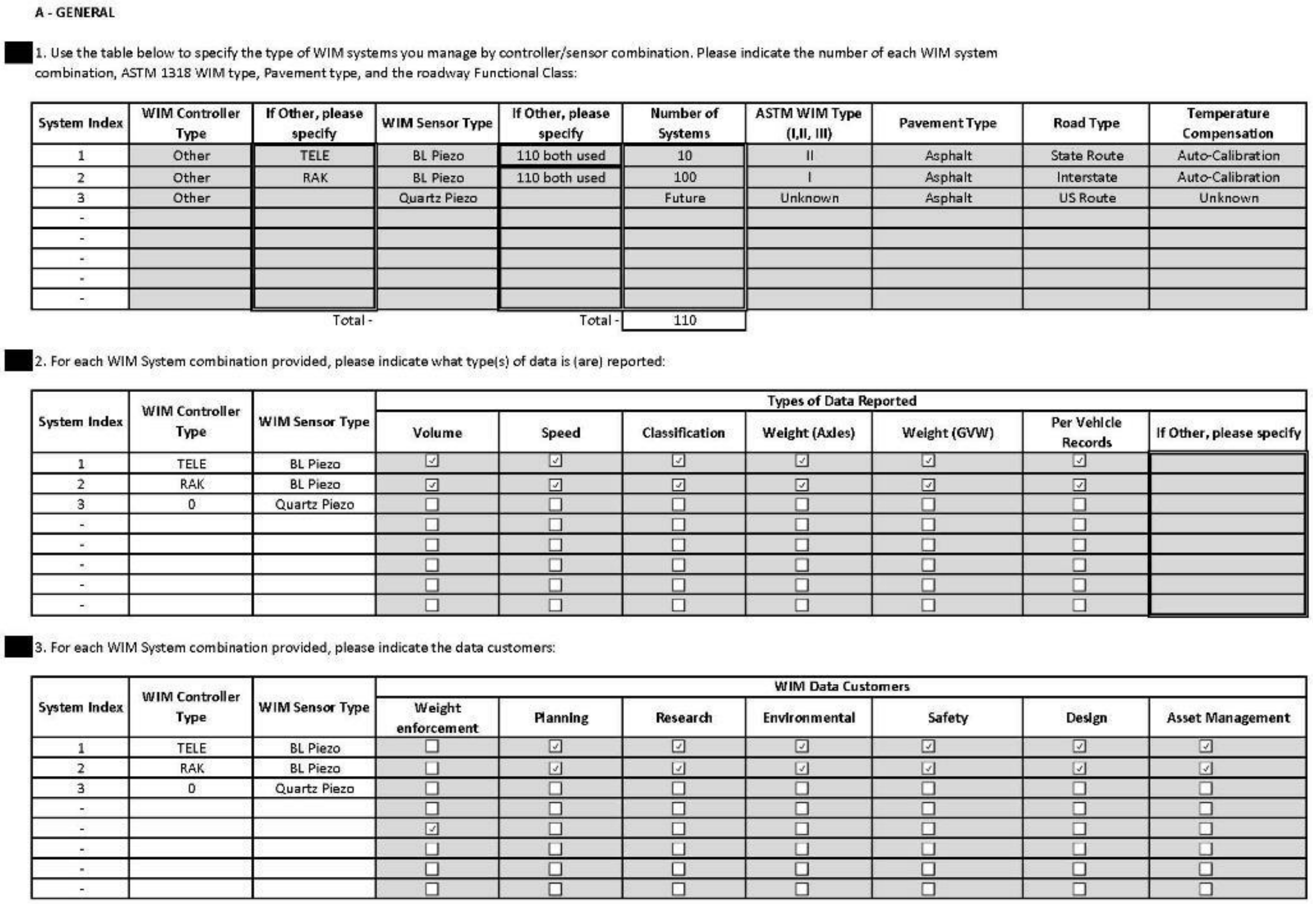
With inputs from

Anne-Marie McDonnell, Transportation Engineer

Vice-President – International society for Weigh-in-Motion

Chair – TRB WIM Subcommittee on Weigh-in-Motion

Member – TRB Highway Traffic Monitoring Committee



A - GENERAL

[redacted] 1. Use the table below to specify the type of WIM systems you manage by controller/sensor combination. Please indicate the number of each WIM system combination, ASTM 1318 WIM type, Pavement type, and the roadway Functional Class:

System Index	WIM Controller Type	If Other, please specify	WIM Sensor Type	If Other, please specify	Number of Systems	ASTM WIM Type (I,II, III)	Pavement Type	Road Type	Temperature Compensation
1	Other	TELE	BL Piezo	110 both used	10	II	Asphalt	State Route	Auto-Calibration
2	Other	RAK	BL Piezo	110 both used	100	I	Asphalt	Interstate	Auto-Calibration
3	Other		Quartz Piezo		Future	Unknown	Asphalt	US Route	Unknown
-									
-									
-									
-									
-									
		Total -		Total -	110				

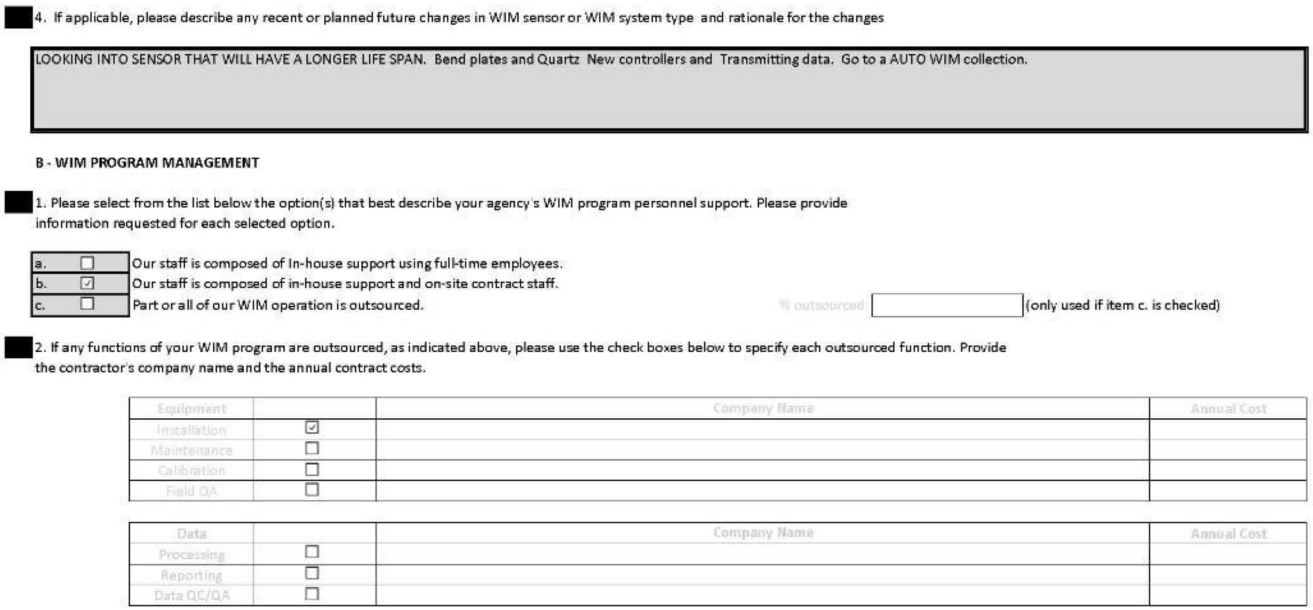
[redacted] 2. For each WIM System combination provided, please indicate what type(s) of data is (are) reported:

System Index	WIM Controller Type	WIM Sensor Type	Types of Data Reported						
			Volume	Speed	Classification	Weight (Axles)	Weight (GVW)	Per Vehicle Records	If Other, please specify
1	TELE	BL Piezo	☑	☑	☑	☑	☑	☑	
2	RAK	BL Piezo	☑	☑	☑	☑	☑	☑	
3	0	Quartz Piezo	☐	☐	☐	☐	☐	☐	
-			☐	☐	☐	☐	☐	☐	
-			☐	☐	☐	☐	☐	☐	
-			☐	☐	☐	☐	☐	☐	
-			☐	☐	☐	☐	☐	☐	
-			☐	☐	☐	☐	☐	☐	

[redacted] 3. For each WIM System combination provided, please indicate the data customers:

System Index	WIM Controller Type	WIM Sensor Type	WIM Data Customers						
			Weight enforcement	Planning	Research	Environmental	Safety	Design	Asset Management
1	TELE	BL Piezo	☐	☑	☑	☑	☑	☑	☑
2	RAK	BL Piezo	☐	☑	☑	☑	☑	☑	☑
3	0	Quartz Piezo	☐	☐	☐	☐	☐	☐	☐
-			☐	☐	☐	☐	☐	☐	☐
-			☑	☐	☐	☐	☐	☐	☐
-			☐	☐	☐	☐	☐	☐	☐
-			☐	☐	☐	☐	☐	☐	☐
-			☐	☐	☐	☐	☐	☐	☐

Figure 1. Connecticut DOT Survey Response



4. If applicable, please describe any recent or planned future changes in WIM sensor or WIM system type and rationale for the changes

LOOKING INTO SENSOR THAT WILL HAVE A LONGER LIFE SPAN. Bend plates and Quartz New controllers and Transmitting data. Go to a AUTO WIM collection.

B - WIM PROGRAM MANAGEMENT

1. Please select from the list below the option(s) that best describe your agency's WIM program personnel support. Please provide information requested for each selected option.

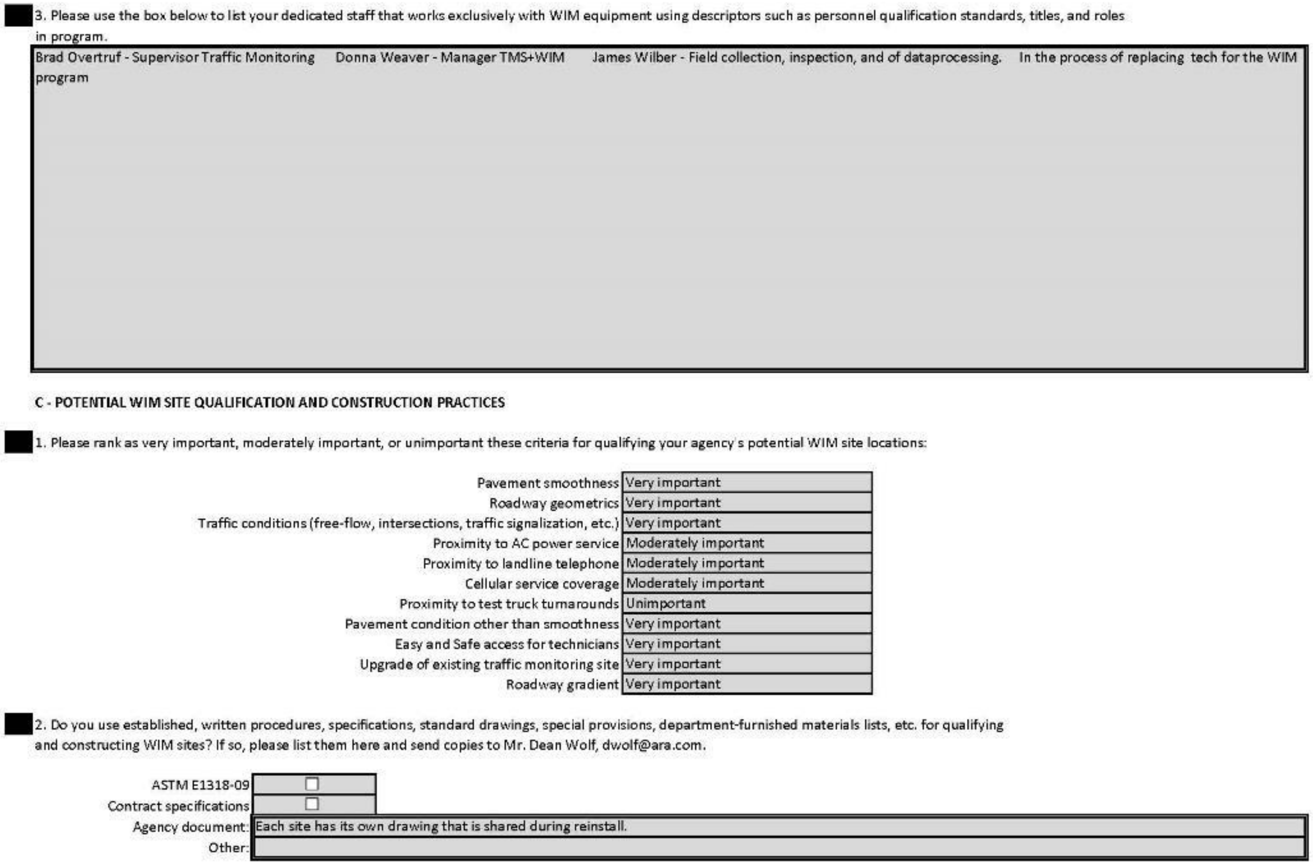
a. ☐ Our staff is composed of In-house support using full-time employees.
b. ☑ Our staff is composed of in-house support and on-site contract staff.
c. ☐ Part or all of our WIM operation is outsourced. % outsourced ______ (only used if item c. is checked)

2. If any functions of your WIM program are outsourced, as indicated above, please use the check boxes below to specify each outsourced function. Provide the contractor's company name and the annual contract costs.

Equipment		Company Name	Annual Cost
Installation	☑		
Maintenance	☐		
Calibration	☐		
Field QA	☐		

Data		Company Name	Annual Cost
Processing	☐		
Reporting	☐		
Data QC/QA	☐		

Figure 2. Connecticut DOT Survey Response



3. Please use the box below to list your dedicated staff that works exclusively with WIM equipment using descriptors such as personnel qualification standards, titles, and roles in program.

Brad Overtruf - Supervisor Traffic Monitoring   Donna Weaver - Manager TMS+WIM   James Wilber - Field collection, inspection, and of dataprocessing.   In the process of replacing tech for the WIM program

C - POTENTIAL WIM SITE QUALIFICATION AND CONSTRUCTION PRACTICES

1. Please rank as very important, moderately important, or unimportant these criteria for qualifying your agency's potential WIM site locations:

Pavement smoothness	Very important
Roadway geometrics	Very important
Traffic conditions (free-flow, intersections, traffic signalization, etc.)	Very important
Proximity to AC power service	Moderately important
Proximity to landline telephone	Moderately important
Cellular service coverage	Moderately important
Proximity to test truck turnarounds	Unimportant
Pavement condition other than smoothness	Very important
Easy and Safe access for technicians	Very important
Upgrade of existing traffic monitoring site	Very important
Roadway gradient	Very important

2. Do you use established, written procedures, specifications, standard drawings, special provisions, department-furnished materials lists, etc. for qualifying and constructing WIM sites? If so, please list them here and send copies to Mr. Dean Wolf, dwolf@ara.com.

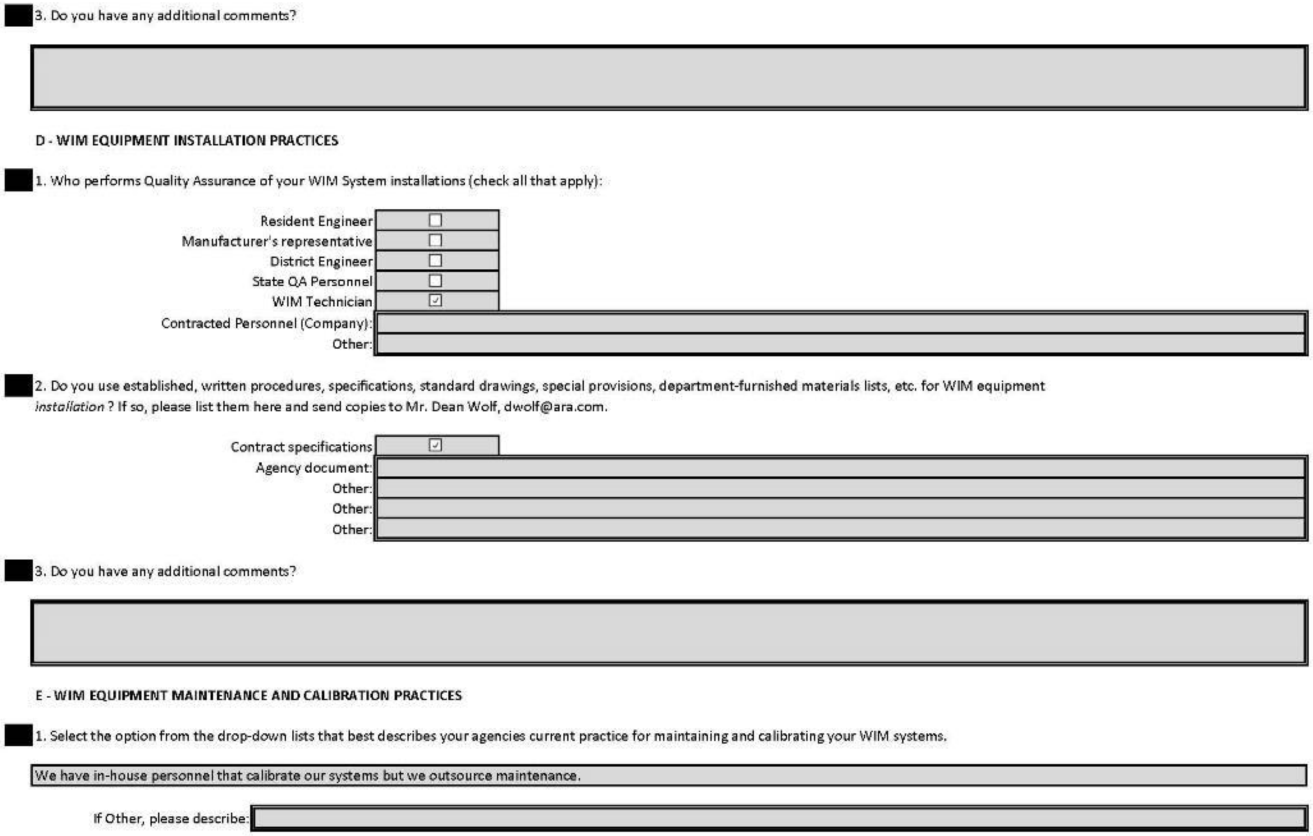
ASTM E1318-09 ☐

Contract specifications ☐

Agency document: Each site has its own drawing that is shared during reinstall.

Other:

Figure 3. Connecticut DOT Survey Response



[redacted] 3. Do you have any additional comments?

D - WIM EQUIPMENT INSTALLATION PRACTICES

[redacted] 1. Who performs Quality Assurance of your WIM System installations (check all that apply):

Resident Engineer ☐
Manufacturer's representative ☐
District Engineer ☐
State QA Personnel ☐
WIM Technician ☑
Contracted Personnel (Company):
Other:

[redacted] 2. Do you use established, written procedures, specifications, standard drawings, special provisions, department-furnished materials lists, etc. for WIM equipment *installation* ? If so, please list them here and send copies to Mr. Dean Wolf, dwolf@ara.com.

Contract specifications ☑
Agency document:
Other:
Other:
Other:

[redacted] 3. Do you have any additional comments?

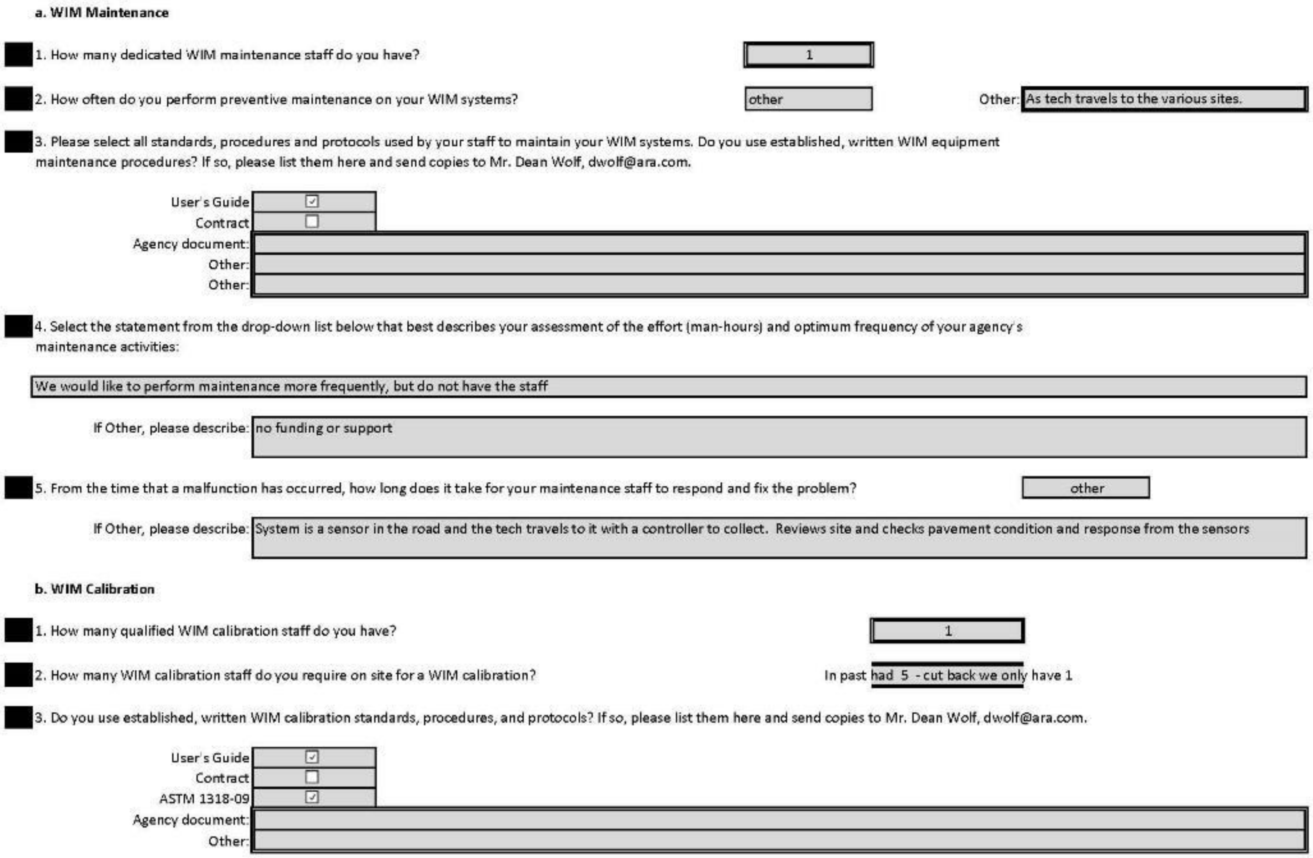
E - WIM EQUIPMENT MAINTENANCE AND CALIBRATION PRACTICES

[redacted] 1. Select the option from the drop-down lists that best describes your agencies current practice for maintaining and calibrating your WIM systems.

We have in-house personnel that calibrate our systems but we outsource maintenance.

If Other, please describe:

Figure 4. Connecticut DOT Survey Response



a. WIM Maintenance

1. How many dedicated WIM maintenance staff do you have? 1

2. How often do you perform preventive maintenance on your WIM systems? other Other: As tech travels to the various sites.

3. Please select all standards, procedures and protocols used by your staff to maintain your WIM systems. Do you use established, written WIM equipment maintenance procedures? If so, please list them here and send copies to Mr. Dean Wolf, dwolf@ara.com.

User's Guide ☑
Contract ☐
Agency document:
Other:
Other:

4. Select the statement from the drop-down list below that best describes your assessment of the effort (man-hours) and optimum frequency of your agency's maintenance activities:

We would like to perform maintenance more frequently, but do not have the staff

If Other, please describe: no funding or support

5. From the time that a malfunction has occurred, how long does it take for your maintenance staff to respond and fix the problem? other

If Other, please describe: System is a sensor in the road and the tech travels to it with a controller to collect. Reviews site and checks pavement condition and response from the sensors

b. WIM Calibration

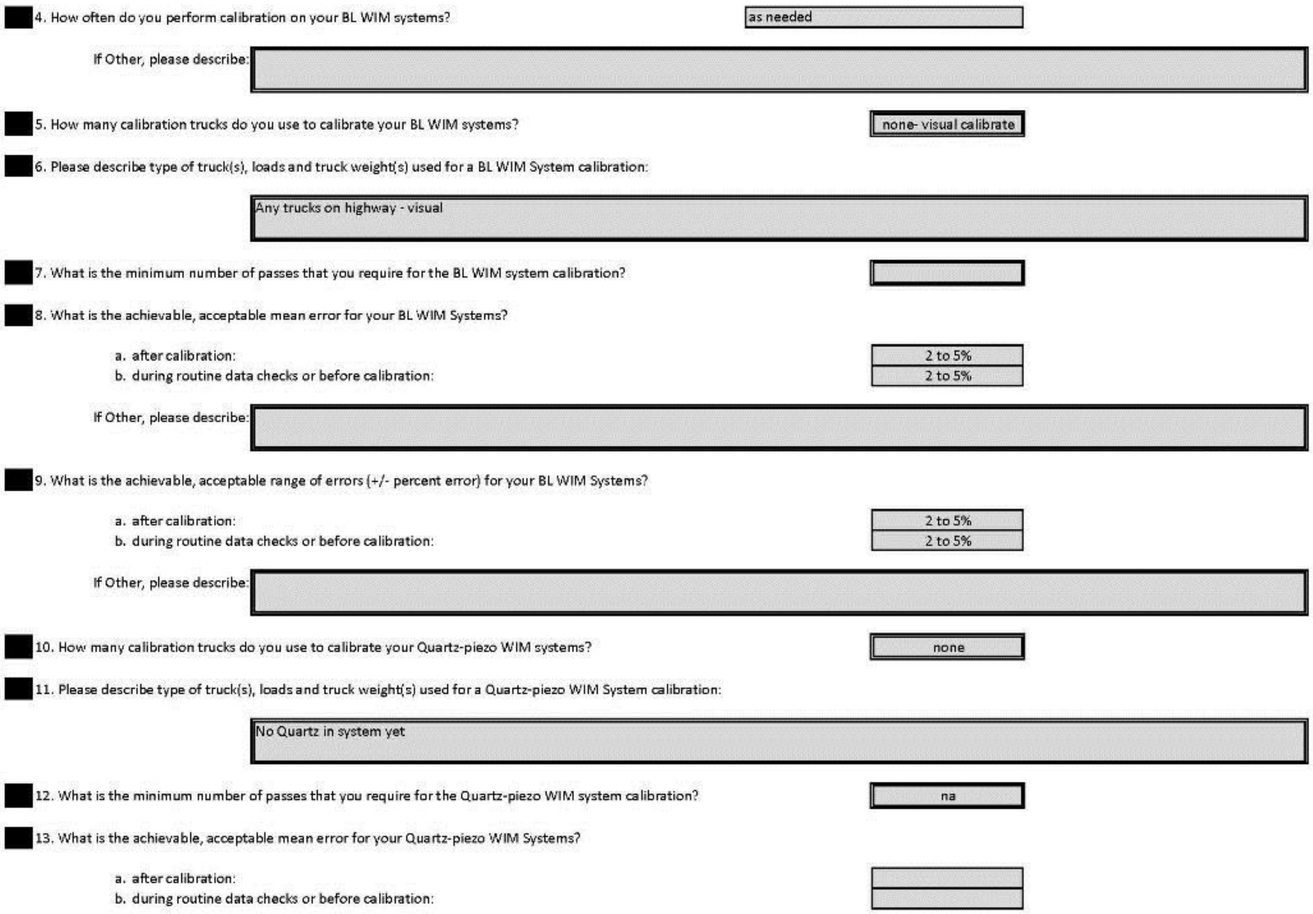
1. How many qualified WIM calibration staff do you have? 1

2. How many WIM calibration staff do you require on site for a WIM calibration? In past had 5 - cut back we only have 1

3. Do you use established, written WIM calibration standards, procedures, and protocols? If so, please list them here and send copies to Mr. Dean Wolf, dwolf@ara.com.

User's Guide ☑
Contract ☐
ASTM 1318-09 ☑
Agency document:
Other:

Figure 5. Connecticut DOT Survey Response



4. How often do you perform calibration on your BL WIM systems? as needed

If Other, please describe:

5. How many calibration trucks do you use to calibrate your BL WIM systems? none- visual calibrate

6. Please describe type of truck(s), loads and truck weight(s) used for a BL WIM System calibration:

Any trucks on highway - visual

7. What is the minimum number of passes that you require for the BL WIM system calibration?

8. What is the achievable, acceptable mean error for your BL WIM Systems?

a. after calibration: 2 to 5%
b. during routine data checks or before calibration: 2 to 5%

If Other, please describe:

9. What is the achievable, acceptable range of errors (+/- percent error) for your BL WIM Systems?

a. after calibration: 2 to 5%
b. during routine data checks or before calibration: 2 to 5%

If Other, please describe:

10. How many calibration trucks do you use to calibrate your Quartz-piezo WIM systems? none

11. Please describe type of truck(s), loads and truck weight(s) used for a Quartz-piezo WIM System calibration:

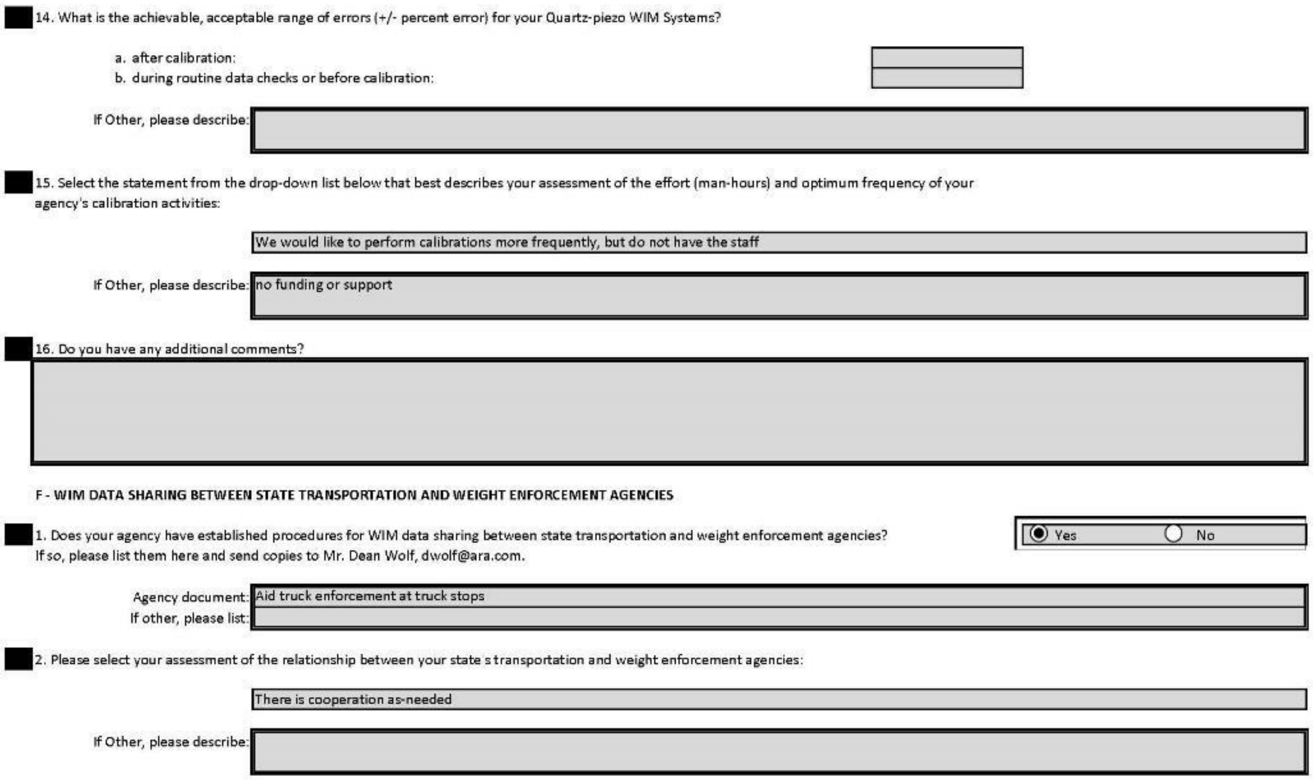
No Quartz in system yet

12. What is the minimum number of passes that you require for the Quartz-piezo WIM system calibration? na

13. What is the achievable, acceptable mean error for your Quartz-piezo WIM Systems?

a. after calibration:
b. during routine data checks or before calibration:

Figure 6. Connecticut DOT Survey Response



14. What is the achievable, acceptable range of errors (+/- percent error) for your Quartz-piezo WIM Systems?

a. after calibration:

b. during routine data checks or before calibration:

If Other, please describe:

15. Select the statement from the drop-down list below that best describes your assessment of the effort (man-hours) and optimum frequency of your agency's calibration activities:

We would like to perform calibrations more frequently, but do not have the staff

If Other, please describe: no funding or support

16. Do you have any additional comments?

F - WIM DATA SHARING BETWEEN STATE TRANSPORTATION AND WEIGHT ENFORCEMENT AGENCIES

1. Does your agency have established procedures for WIM data sharing between state transportation and weight enforcement agencies? If so, please list them here and send copies to Mr. Dean Wolf, dwolf@ara.com.

● Yes ○ No

Agency document: Aid truck enforcement at truck stops

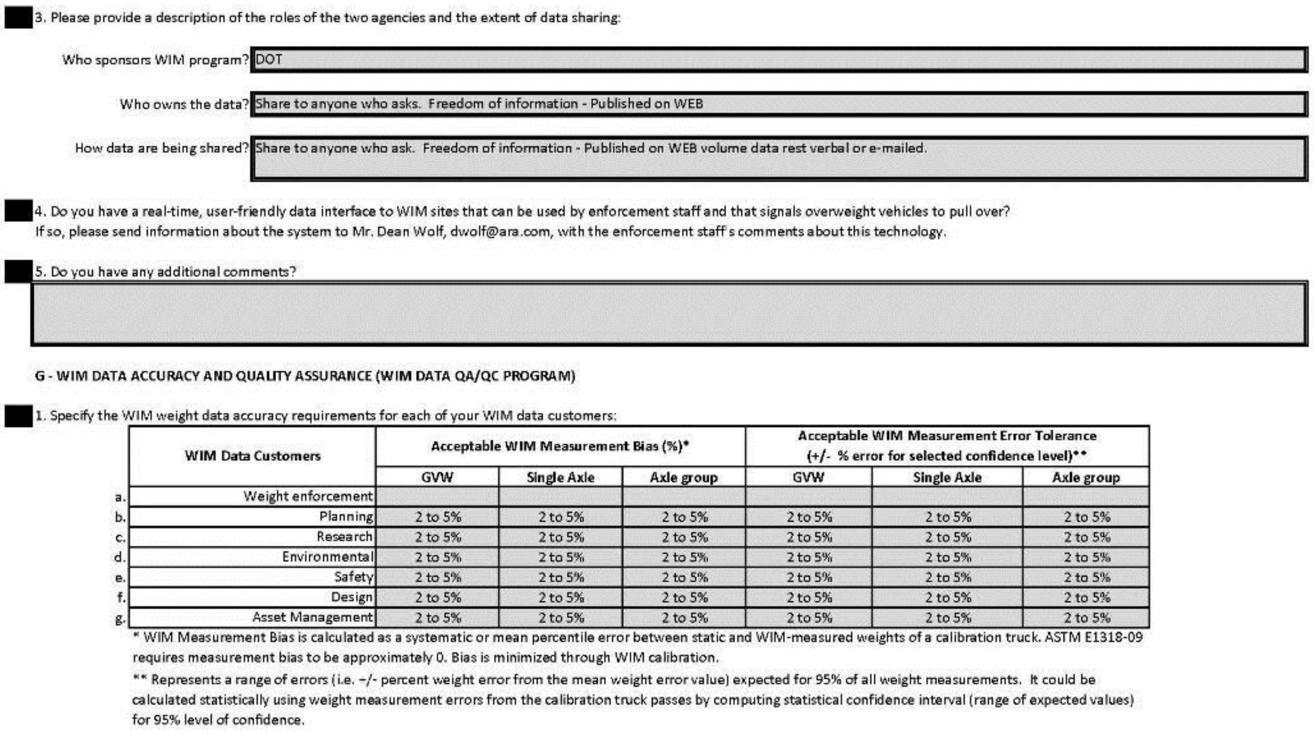
If other, please list:

2. Please select your assessment of the relationship between your state's transportation and weight enforcement agencies:

There is cooperation as-needed

If Other, please describe:

Figure 7. Connecticut DOT Survey Response



3. Please provide a description of the roles of the two agencies and the extent of data sharing:

Who sponsors WIM program? DOT

Who owns the data? Share to anyone who asks. Freedom of information - Published on WEB

How data are being shared? Share to anyone who ask. Freedom of information - Published on WEB volume data rest verbal or e-mailed.

4. Do you have a real-time, user-friendly data interface to WIM sites that can be used by enforcement staff and that signals overweight vehicles to pull over?
If so, please send information about the system to Mr. Dean Wolf, dwolf@ara.com, with the enforcement staff's comments about this technology.

5. Do you have any additional comments?

G - WIM DATA ACCURACY AND QUALITY ASSURANCE (WIM DATA QA/QC PROGRAM)

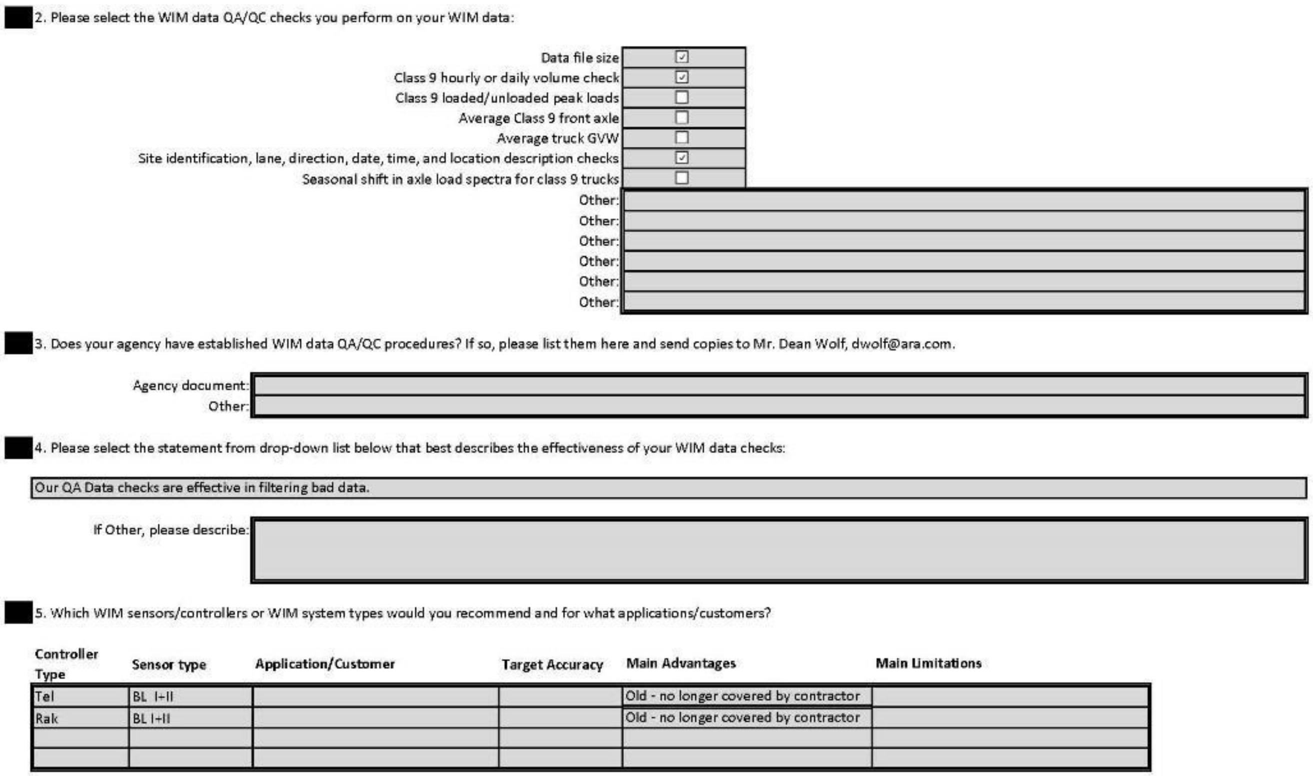
1. Specify the WIM weight data accuracy requirements for each of your WIM data customers:

	WIM Data Customers	Acceptable WIM Measurement Bias (%)*			Acceptable WIM Measurement Error Tolerance (+/- % error for selected confidence level)**		
		GVW	Single Axle	Axle group	GVW	Single Axle	Axle group
a.	Weight enforcement						
b.	Planning	2 to 5%	2 to 5%	2 to 5%	2 to 5%	2 to 5%	2 to 5%
c.	Research	2 to 5%	2 to 5%	2 to 5%	2 to 5%	2 to 5%	2 to 5%
d.	Environmental	2 to 5%	2 to 5%	2 to 5%	2 to 5%	2 to 5%	2 to 5%
e.	Safety	2 to 5%	2 to 5%	2 to 5%	2 to 5%	2 to 5%	2 to 5%
f.	Design	2 to 5%	2 to 5%	2 to 5%	2 to 5%	2 to 5%	2 to 5%
g.	Asset Management	2 to 5%	2 to 5%	2 to 5%	2 to 5%	2 to 5%	2 to 5%

* WIM Measurement Bias is calculated as a systematic or mean percentile error between static and WIM-measured weights of a calibration truck. ASTM E1318-09 requires measurement bias to be approximately 0. Bias is minimized through WIM calibration.

** Represents a range of errors (i.e. -/- percent weight error from the mean weight error value) expected for 95% of all weight measurements. It could be calculated statistically using weight measurement errors from the calibration truck passes by computing statistical confidence interval (range of expected values) for 95% level of confidence.

Figure 8. Connecticut DOT Survey Response



[redacted] 2. Please select the WIM data QA/QC checks you perform on your WIM data:

Data file size	☑
Class 9 hourly or daily volume check	☑
Class 9 loaded/unloaded peak loads	☐
Average Class 9 front axle	☐
Average truck GVW	☐
Site identification, lane, direction, date, time, and location description checks	☑
Seasonal shift in axle load spectra for class 9 trucks	☐
Other:	
Other:	
Other:	
Other:	
Other:	
Other:	

[redacted] 3. Does your agency have established WIM data QA/QC procedures? If so, please list them here and send copies to Mr. Dean Wolf, dwolf@ara.com.

Agency document:

Other:

[redacted] 4. Please select the statement from drop-down list below that best describes the effectiveness of your WIM data checks:

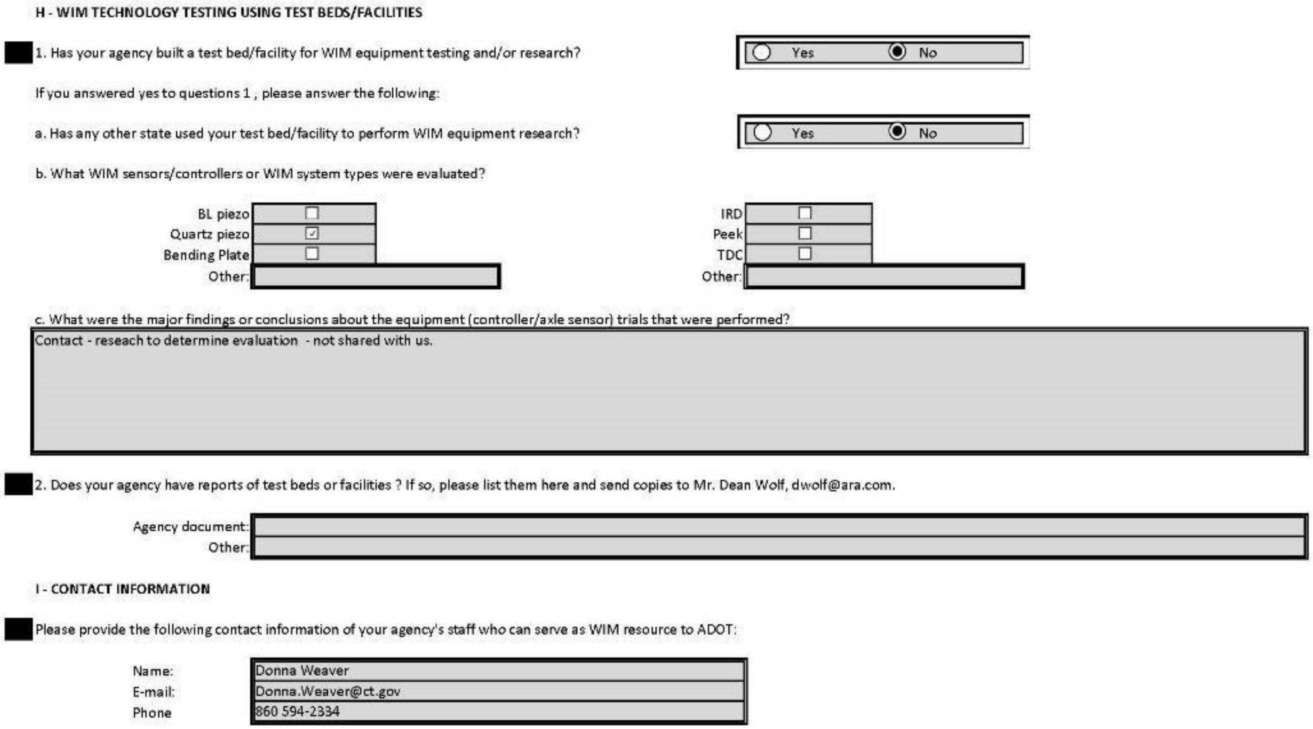
Our QA Data checks are effective in filtering bad data.

If Other, please describe:

[redacted] 5. Which WIM sensors/controllers or WIM system types would you recommend and for what applications/customers?

Controller Type	Sensor type	Application/Customer	Target Accuracy	Main Advantages	Main Limitations
Tel	BL I+II			Old - no longer covered by contractor	
Rak	BL I+II			Old - no longer covered by contractor	

Figure 9. Connecticut DOT Survey Response



H - WIM TECHNOLOGY TESTING USING TEST BEDS/FACILITIES

1. Has your agency built a test bed/facility for WIM equipment testing and/or research? ○ Yes ● No

If you answered yes to questions 1 , please answer the following:

a. Has any other state used your test bed/facility to perform WIM equipment research? ○ Yes ● No

b. What WIM sensors/controllers or WIM system types were evaluated?

BL piezo	☐	IRD	☐
Quartz piezo	☑	Peek	☐
Bending Plate	☐	TDC	☐
Other:		Other:	

c. What were the major findings or conclusions about the equipment (controller/axle sensor) trials that were performed?

Contact - reseach to determine evaluation - not shared with us.

2. Does your agency have reports of test beds or facilities ? If so, please list them here and send copies to Mr. Dean Wolf, dwolf@ara.com.

Agency document:

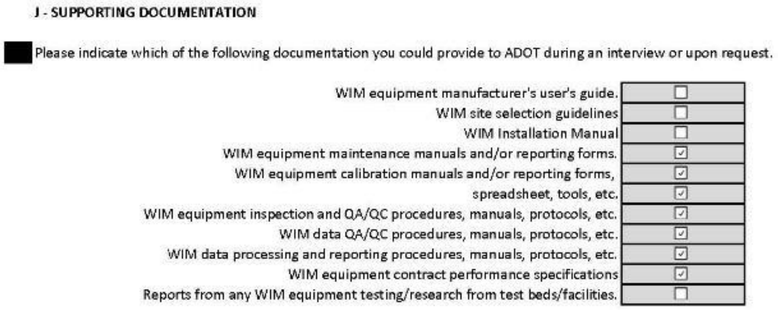
Other:

I - CONTACT INFORMATION

Please provide the following contact information of your agency's staff who can serve as WIM resource to ADOT:

Name: Donna Weaver
E-mail: Donna.Weaver@ct.gov
Phone 860 594-2334

Figure 10. Connecticut DOT Survey Response



J - SUPPORTING DOCUMENTATION

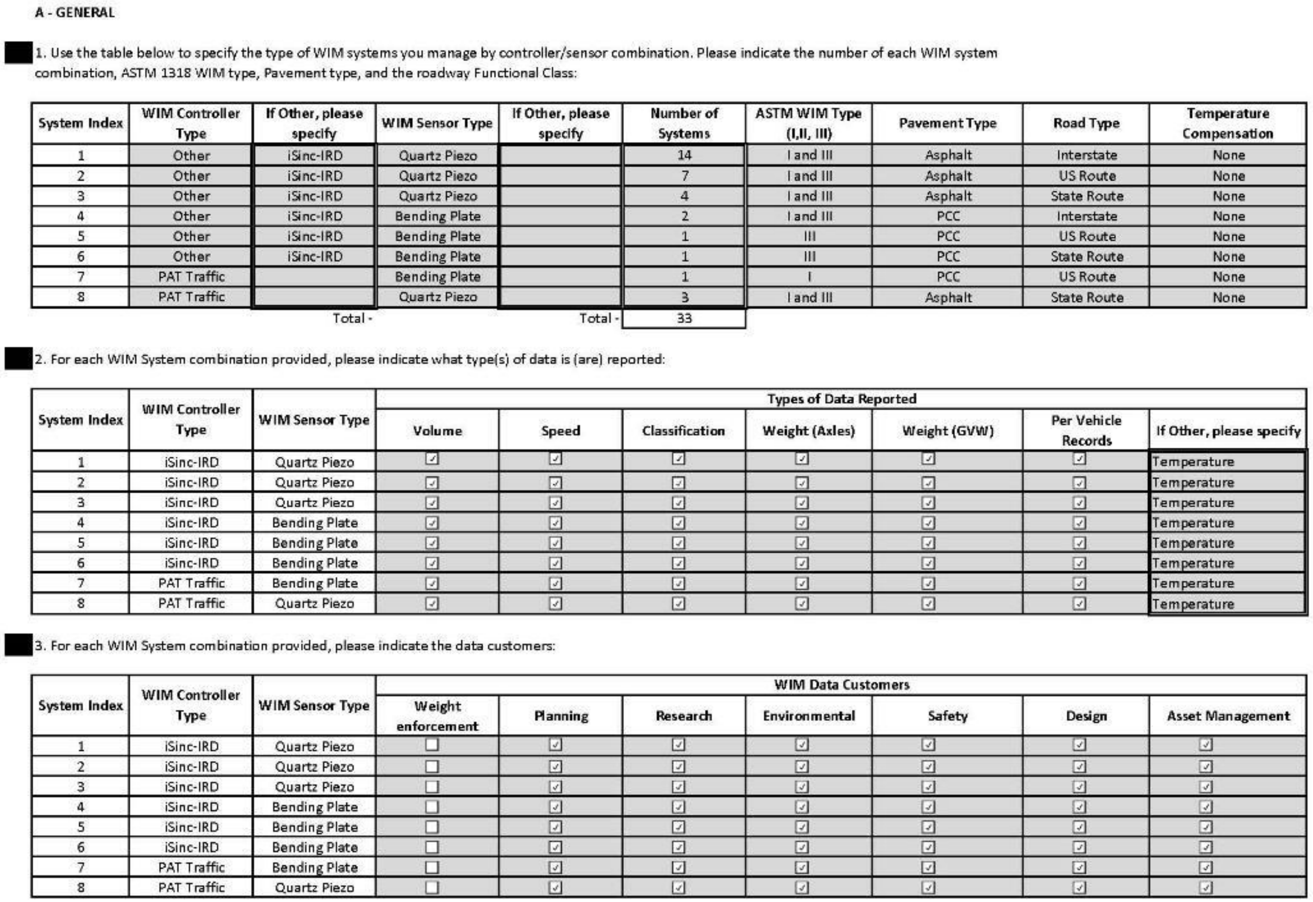
[redacted] Please indicate which of the following documentation you could provide to ADOT during an interview or upon request.

WIM equipment manufacturer's user's guide.	☐
WIM site selection guidelines	☐
WIM Installation Manual	☐
WIM equipment maintenance manuals and/or reporting forms.	☑
WIM equipment calibration manuals and/or reporting forms,	☑
spreadsheet, tools, etc.	☑
WIM equipment inspection and QA/QC procedures, manuals, protocols, etc.	☑
WIM data QA/QC procedures, manuals, protocols, etc.	☑
WIM data processing and reporting procedures, manuals, protocols, etc.	☑
WIM equipment contract performance specifications	☑
Reports from any WIM equipment testing/research from test beds/facilities.	☐

Figure 11. Connecticut DOT Survey Response

Florida Department of Transportation (Steven Bentz)
Administrator, Transportation Data

With Inputs from
Michael Leggett – Red Hill Engineering
Senior Engineer – WIM Specialist



A - GENERAL

[redacted] 1. Use the table below to specify the type of WIM systems you manage by controller/sensor combination. Please indicate the number of each WIM system combination, ASTM 1318 WIM type, Pavement type, and the roadway Functional Class:

System Index	WIM Controller Type	If Other, please specify	WIM Sensor Type	If Other, please specify	Number of Systems	ASTM WIM Type (I,II, III)	Pavement Type	Road Type	Temperature Compensation
1	Other	iSinc-IRD	Quartz Piezo		14	I and III	Asphalt	Interstate	None
2	Other	iSinc-IRD	Quartz Piezo		7	I and III	Asphalt	US Route	None
3	Other	iSinc-IRD	Quartz Piezo		4	I and III	Asphalt	State Route	None
4	Other	iSinc-IRD	Bending Plate		2	I and III	PCC	Interstate	None
5	Other	iSinc-IRD	Bending Plate		1	III	PCC	US Route	None
6	Other	iSinc-IRD	Bending Plate		1	III	PCC	State Route	None
7	PAT Traffic		Bending Plate		1	I	PCC	US Route	None
8	PAT Traffic		Quartz Piezo		3	I and III	Asphalt	State Route	None
		Total -		Total -	33				

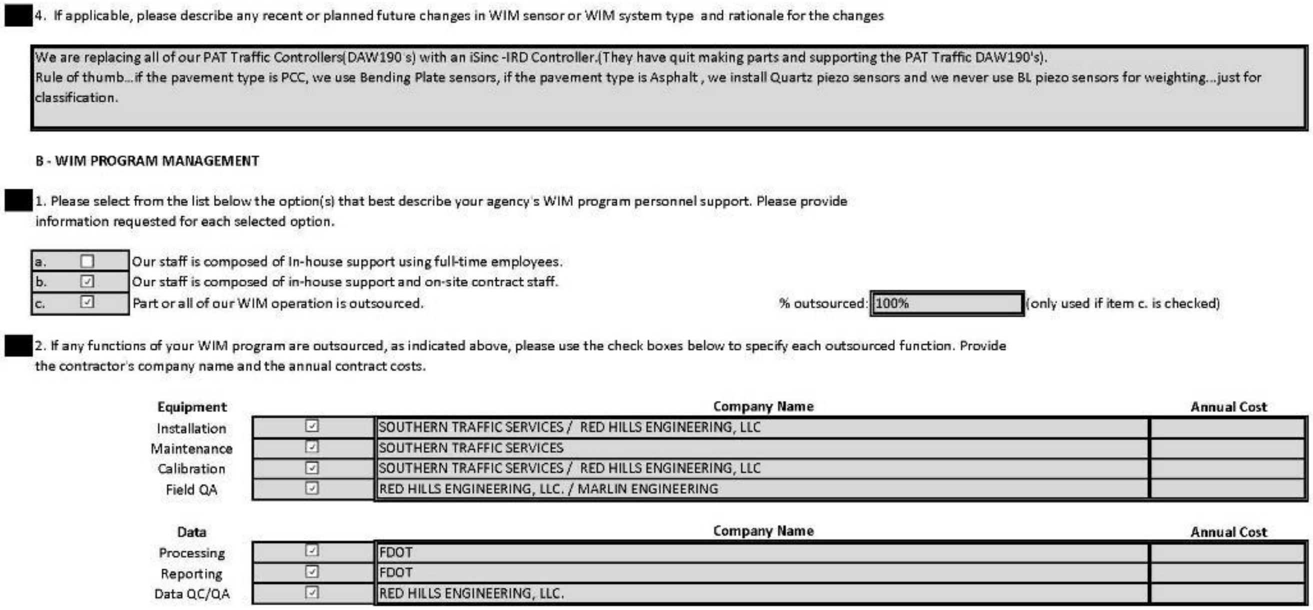
[redacted] 2. For each WIM System combination provided, please indicate what type(s) of data is (are) reported:

System Index	WIM Controller Type	WIM Sensor Type	Types of Data Reported						
			Volume	Speed	Classification	Weight (Axles)	Weight (GVW)	Per Vehicle Records	If Other, please specify
1	iSinc-IRD	Quartz Piezo	☑	☑	☑	☑	☑	☑	Temperature
2	iSinc-IRD	Quartz Piezo	☑	☑	☑	☑	☑	☑	Temperature
3	iSinc-IRD	Quartz Piezo	☑	☑	☑	☑	☑	☑	Temperature
4	iSinc-IRD	Bending Plate	☑	☑	☑	☑	☑	☑	Temperature
5	iSinc-IRD	Bending Plate	☑	☑	☑	☑	☑	☑	Temperature
6	iSinc-IRD	Bending Plate	☑	☑	☑	☑	☑	☑	Temperature
7	PAT Traffic	Bending Plate	☑	☑	☑	☑	☑	☑	Temperature
8	PAT Traffic	Quartz Piezo	☑	☑	☑	☑	☑	☑	Temperature

[redacted] 3. For each WIM System combination provided, please indicate the data customers:

System Index	WIM Controller Type	WIM Sensor Type	WIM Data Customers						
			Weight enforcement	Planning	Research	Environmental	Safety	Design	Asset Management
1	iSinc-IRD	Quartz Piezo	☐	☑	☑	☑	☑	☑	☑
2	iSinc-IRD	Quartz Piezo	☐	☑	☑	☑	☑	☑	☑
3	iSinc-IRD	Quartz Piezo	☐	☑	☑	☑	☑	☑	☑
4	iSinc-IRD	Bending Plate	☐	☑	☑	☑	☑	☑	☑
5	iSinc-IRD	Bending Plate	☐	☑	☑	☑	☑	☑	☑
6	iSinc-IRD	Bending Plate	☐	☑	☑	☑	☑	☑	☑
7	PAT Traffic	Bending Plate	☐	☑	☑	☑	☑	☑	☑
8	PAT Traffic	Quartz Piezo	☐	☑	☑	☑	☑	☑	☑

Figure 12. Florida DOT Survey Response



4. If applicable, please describe any recent or planned future changes in WIM sensor or WIM system type and rationale for the changes

We are replacing all of our PAT Traffic Controllers(DAW190's) with an iSinc -IRD Controller.(They have quit making parts and supporting the PAT Traffic DAW190's).
Rule of thumb...if the pavement type is PCC, we use Bending Plate sensors, if the pavement type is Asphalt, we install Quartz piezo sensors and we never use BL piezo sensors for weighting...just for classification.

B - WIM PROGRAM MANAGEMENT

1. Please select from the list below the option(s) that best describe your agency's WIM program personnel support. Please provide information requested for each selected option.

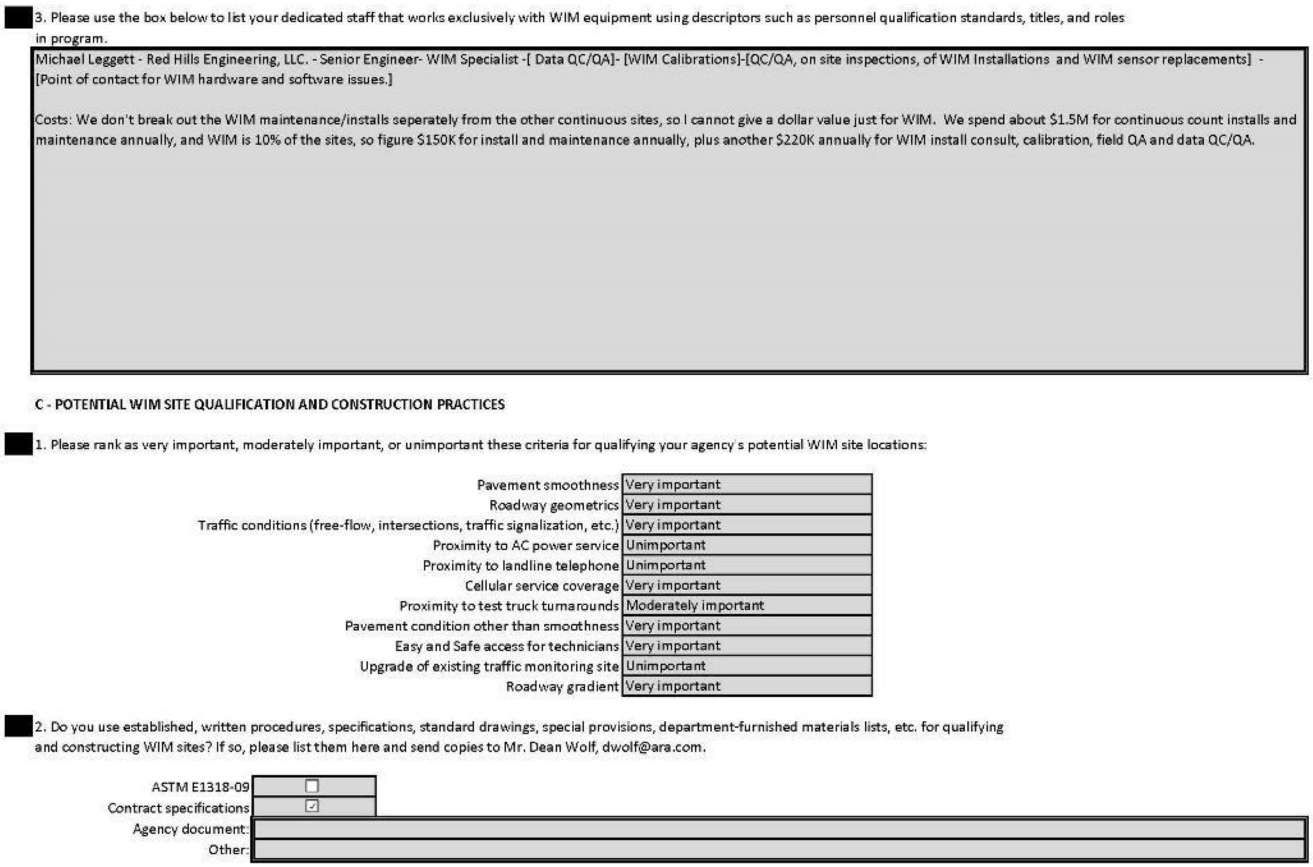
a.	☐	Our staff is composed of In-house support using full-time employees.	
b.	☑	Our staff is composed of in-house support and on-site contract staff.	
c.	☑	Part or all of our WIM operation is outsourced.	% outsourced: 100% (only used if item c. is checked)

2. If any functions of your WIM program are outsourced, as indicated above, please use the check boxes below to specify each outsourced function. Provide the contractor's company name and the annual contract costs.

Equipment		Company Name	Annual Cost
Installation	☑	SOUTHERN TRAFFIC SERVICES / RED HILLS ENGINEERING, LLC	
Maintenance	☑	SOUTHERN TRAFFIC SERVICES	
Calibration	☑	SOUTHERN TRAFFIC SERVICES / RED HILLS ENGINEERING, LLC	
Field QA	☑	RED HILLS ENGINEERING, LLC. / MARLIN ENGINEERING	

Data		Company Name	Annual Cost
Processing	☑	FDOT	
Reporting	☑	FDOT	
Data QC/QA	☑	RED HILLS ENGINEERING, LLC.	

Figure 13. Florida DOT Survey Response



[redacted] 3. Please use the box below to list your dedicated staff that works exclusively with WIM equipment using descriptors such as personnel qualification standards, titles, and roles in program.

Michael Leggett - Red Hills Engineering, LLC. - Senior Engineer- WIM Specialist -[Data QC/QA]- [WIM Calibrations]-[QC/QA, on site inspections, of WIM Installations and WIM sensor replacements] - [Point of contact for WIM hardware and software issues.]

Costs: We don't break out the WIM maintenance/installs seperately from the other continuous sites, so I cannot give a dollar value just for WIM. We spend about $1.5M for continuous count installs and maintenance annually, and WIM is 10% of the sites, so figure $150K for install and maintenance annually, plus another $220K annually for WIM install consult, calibration, field QA and data QC/QA.

C - POTENTIAL WIM SITE QUALIFICATION AND CONSTRUCTION PRACTICES

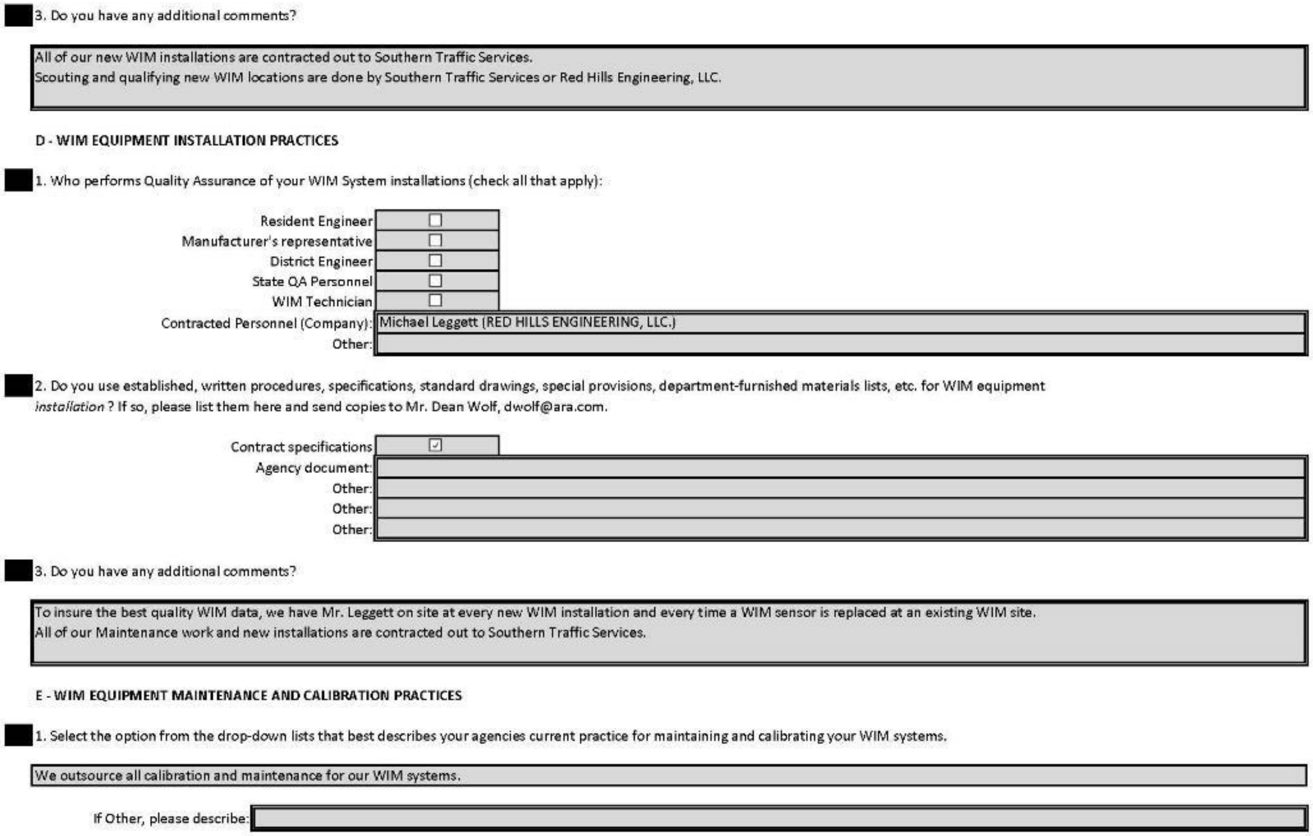
[redacted] 1. Please rank as very important, moderately important, or unimportant these criteria for qualifying your agency's potential WIM site locations:

Pavement smoothness	Very important
Roadway geometrics	Very important
Traffic conditions (free-flow, intersections, traffic signalization, etc.)	Very important
Proximity to AC power service	Unimportant
Proximity to landline telephone	Unimportant
Cellular service coverage	Very important
Proximity to test truck turnarounds	Moderately important
Pavement condition other than smoothness	Very important
Easy and Safe access for technicians	Very important
Upgrade of existing traffic monitoring site	Unimportant
Roadway gradient	Very important

[redacted] 2. Do you use established, written procedures, specifications, standard drawings, special provisions, department-furnished materials lists, etc. for qualifying and constructing WIM sites? If so, please list them here and send copies to Mr. Dean Wolf, dwolf@ara.com.

ASTM E1318-09	☐
Contract specifications	☑
Agency document:	
Other:	

Figure 14. Florida DOT Survey Response



3. Do you have any additional comments?

All of our new WIM installations are contracted out to Southern Traffic Services.
Scouting and qualifying new WIM locations are done by Southern Traffic Services or Red Hills Engineering, LLC.

D - WIM EQUIPMENT INSTALLATION PRACTICES

1. Who performs Quality Assurance of your WIM System installations (check all that apply):

Resident Engineer ☐
Manufacturer's representative ☐
District Engineer ☐
State QA Personnel ☐
WIM Technician ☐
Contracted Personnel (Company): Michael Leggett (RED HILLS ENGINEERING, LLC.)
Other:

2. Do you use established, written procedures, specifications, standard drawings, special provisions, department-furnished materials lists, etc. for WIM equipment *installation* ? If so, please list them here and send copies to Mr. Dean Wolf, dwolf@ara.com.

Contract specifications ☑
Agency document:
Other:
Other:
Other:

3. Do you have any additional comments?

To insure the best quality WIM data, we have Mr. Leggett on site at every new WIM installation and every time a WIM sensor is replaced at an existing WIM site.
All of our Maintenance work and new installations are contracted out to Southern Traffic Services.

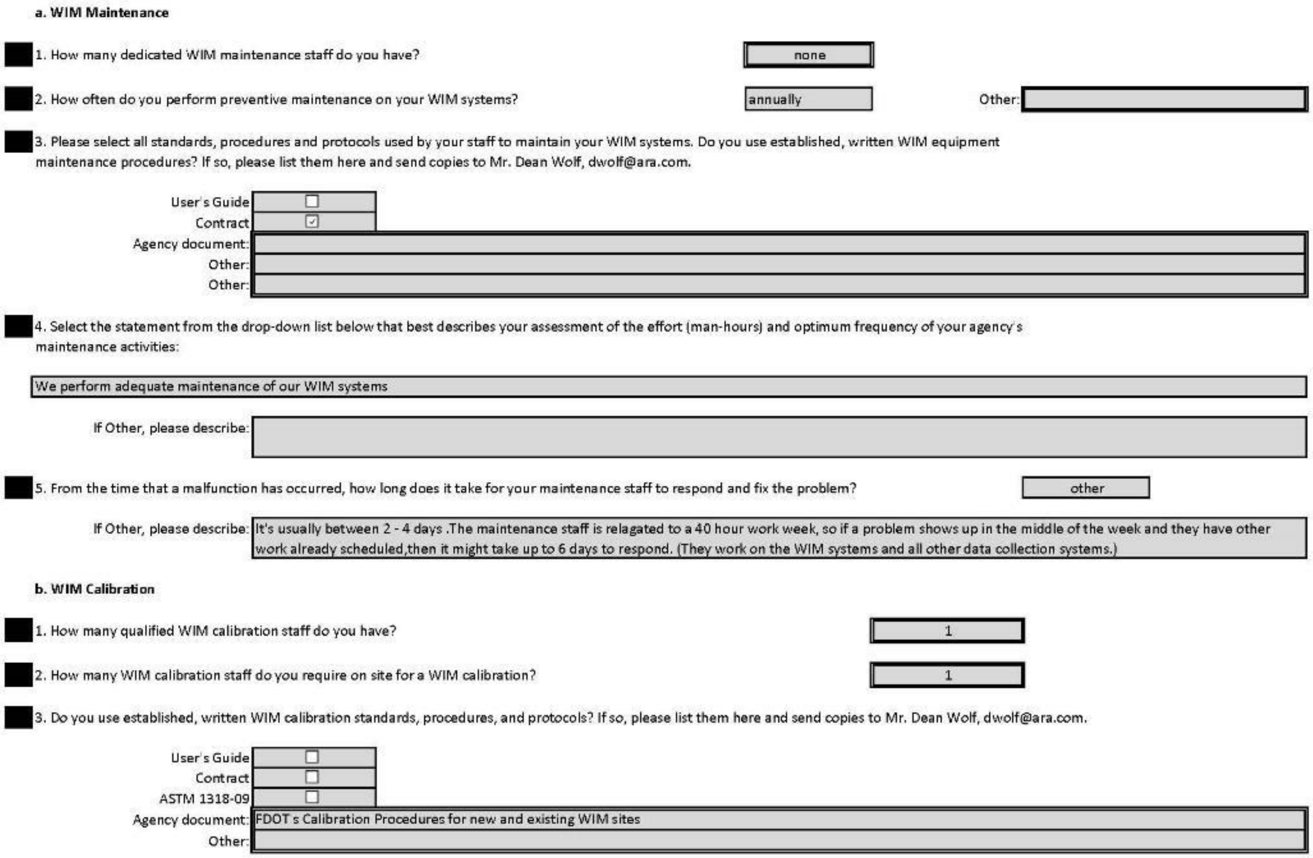
E - WIM EQUIPMENT MAINTENANCE AND CALIBRATION PRACTICES

1. Select the option from the drop-down lists that best describes your agencies current practice for maintaining and calibrating your WIM systems.

We outsource all calibration and maintenance for our WIM systems.

If Other, please describe:

Figure 15. Florida DOT Survey Response



a. WIM Maintenance

1. How many dedicated WIM maintenance staff do you have? none

2. How often do you perform preventive maintenance on your WIM systems? annually Other:

3. Please select all standards, procedures and protocols used by your staff to maintain your WIM systems. Do you use established, written WIM equipment maintenance procedures? If so, please list them here and send copies to Mr. Dean Wolf, dwolf@ara.com.

User's Guide ☐
Contract ☑
Agency document:
Other:
Other:

4. Select the statement from the drop-down list below that best describes your assessment of the effort (man-hours) and optimum frequency of your agency's maintenance activities:

We perform adequate maintenance of our WIM systems

If Other, please describe:

5. From the time that a malfunction has occurred, how long does it take for your maintenance staff to respond and fix the problem? other

If Other, please describe: It's usually between 2 - 4 days .The maintenance staff is relagated to a 40 hour work week, so if a problem shows up in the middle of the week and they have other work already scheduled,then it might take up to 6 days to respond. (They work on the WIM systems and all other data collection systems.)

b. WIM Calibration

1. How many qualified WIM calibration staff do you have? 1

2. How many WIM calibration staff do you require on site for a WIM calibration? 1

3. Do you use established, written WIM calibration standards, procedures, and protocols? If so, please list them here and send copies to Mr. Dean Wolf, dwolf@ara.com.

User's Guide ☐
Contract ☐
ASTM 1318-09 ☐
Agency document: FDOT s Calibration Procedures for new and existing WIM sites
Other:

Figure 16. Florida DOT Survey Response

4. How often do you perform calibration on your BL WIM systems? never

If Other, please describe: We don't use BL piezo sensors for WIM.

5. How many calibration trucks do you use to calibrate your BL WIM systems? N/A

6. Please describe type of truck(s), loads and truck weight(s) used for a BL WIM System calibration:

N/A

7. What is the minimum number of passes that you require for the BL WIM system calibration? N/A

8. What is the achievable, acceptable mean error for your BL WIM Systems?

a. after calibration:
b. during routine data checks or before calibration:

If Other, please describe:

9. What is the achievable, acceptable range of errors (+/- percent error) for your BL WIM Systems?

a. after calibration:
b. during routine data checks or before calibration:

If Other, please describe:

10. How many calibration trucks do you use to calibrate your Quartz-piezo WIM systems? 1

11. Please describe type of truck(s), loads and truck weight(s) used for a Quartz-piezo WIM System calibration:

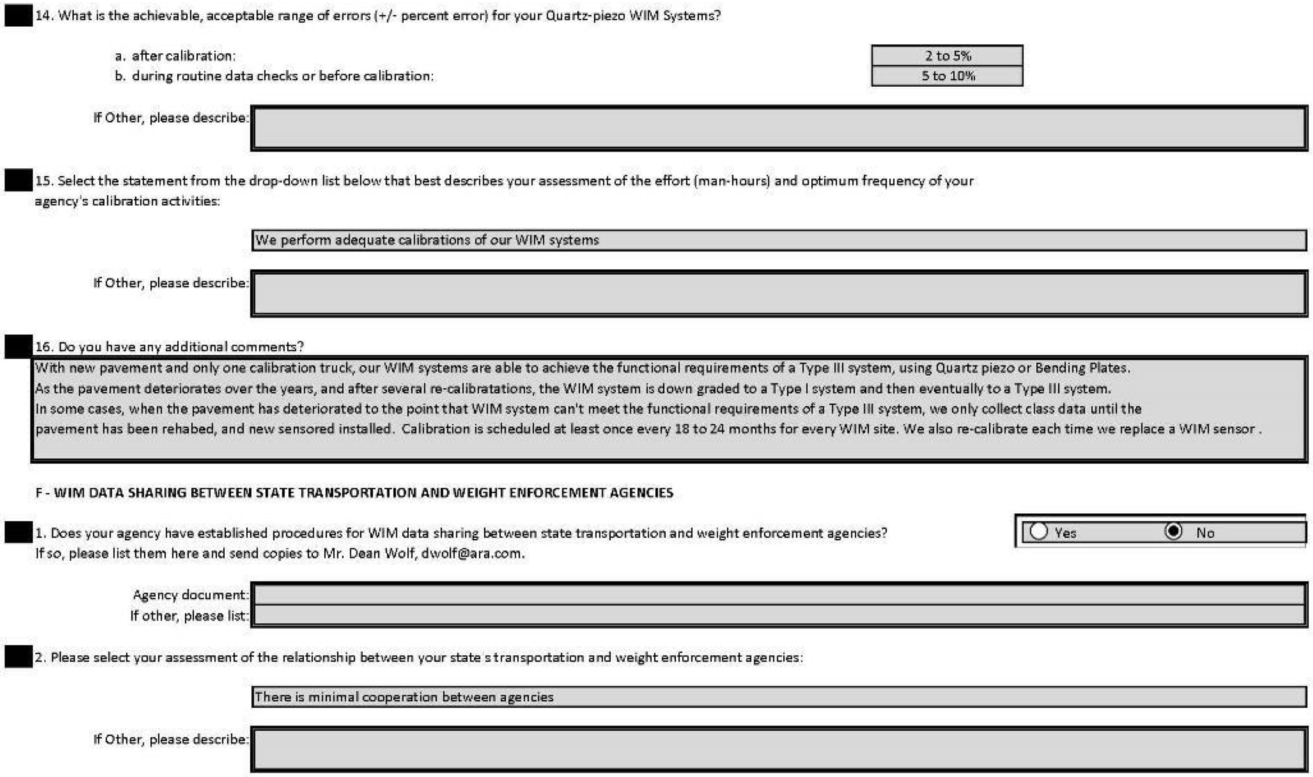
At least one Class 9 truck with air ride supension on the tracker and trailer with a non-liquid load .
It's loaded at a minimum of 90 percent the truck's legal operating weight. (Usually we have a truck with a load between 74 and 78 KIPS)

12. What is the minimum number of passes that you require for the Quartz-piezo WIM system calibration? 10

13. What is the achievable, acceptable mean error for your Quartz-piezo WIM Systems?

a. after calibration: <2%
b. during routine data checks or before calibration: 2 to 5%

Figure 17. Florida DOT Survey Response



14. What is the achievable, acceptable range of errors (+/- percent error) for your Quartz-piezo WIM Systems?

a. after calibration:	2 to 5%
b. during routine data checks or before calibration:	5 to 10%

If Other, please describe:

15. Select the statement from the drop-down list below that best describes your assessment of the effort (man-hours) and optimum frequency of your agency's calibration activities:

We perform adequate calibrations of our WIM systems

If Other, please describe:

16. Do you have any additional comments?

With new pavement and only one calibration truck, our WIM systems are able to achieve the functional requirements of a Type III system, using Quartz piezo or Bending Plates.
As the pavement deteriorates over the years, and after several re-calibratations, the WIM system is down graded to a Type I system and then eventually to a Type III system.
In some cases, when the pavement has deteriorated to the point that WIM system can't meet the functional requirements of a Type III system, we only collect class data until the
pavement has been rehabed, and new sensored installed. Calibration is scheduled at least once every 18 to 24 months for every WIM site. We also re-calibrate each time we replace a WIM sensor .

F - WIM DATA SHARING BETWEEN STATE TRANSPORTATION AND WEIGHT ENFORCEMENT AGENCIES

1. Does your agency have established procedures for WIM data sharing between state transportation and weight enforcement agencies?
If so, please list them here and send copies to Mr. Dean Wolf, dwolf@ara.com.

○ Yes ● No

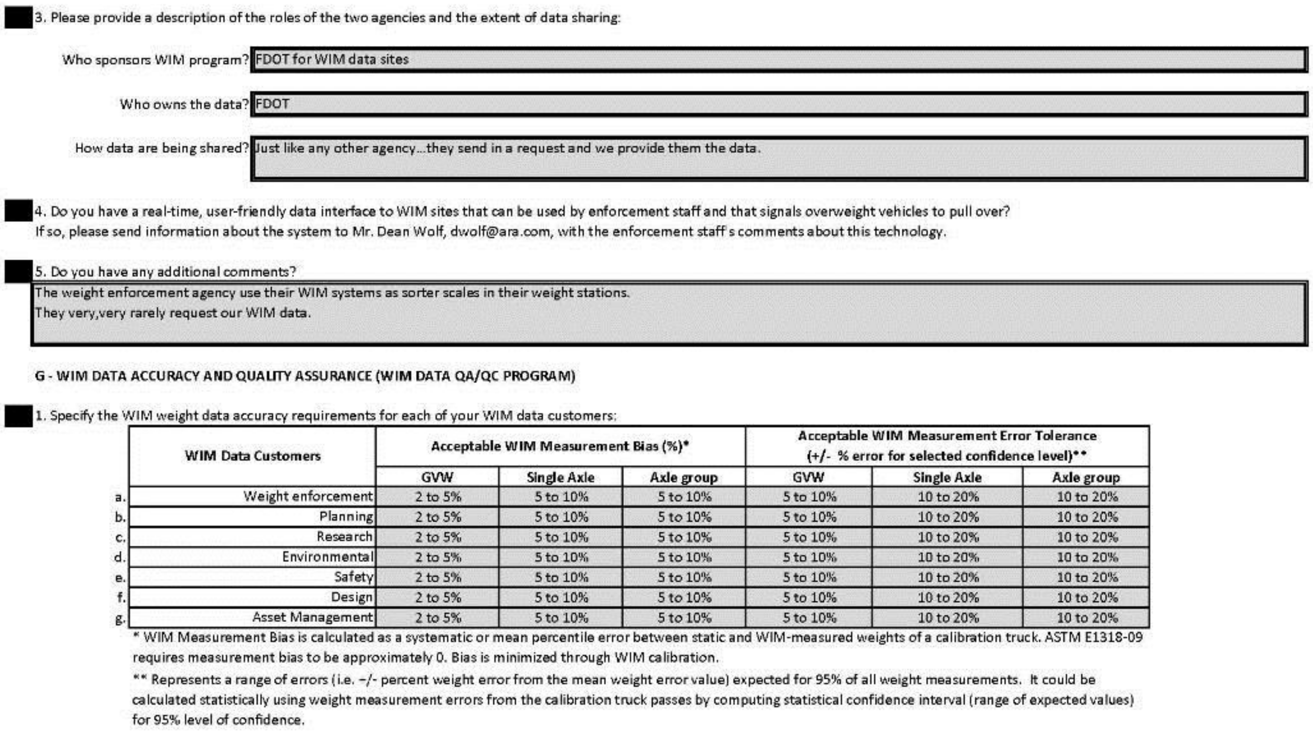
Agency document:
If other, please list:

2. Please select your assessment of the relationship between your state's transportation and weight enforcement agencies:

There is minimal cooperation between agencies

If Other, please describe:

Figure 18. Florida DOT Survey Response



[redacted] 3. Please provide a description of the roles of the two agencies and the extent of data sharing:

Who sponsors WIM program? FDOT for WIM data sites

Who owns the data? FDOT

How data are being shared? Just like any other agency...they send in a request and we provide them the data.

[redacted] 4. Do you have a real-time, user-friendly data interface to WIM sites that can be used by enforcement staff and that signals overweight vehicles to pull over?
If so, please send information about the system to Mr. Dean Wolf, dwolf@ara.com, with the enforcement staff's comments about this technology.

[redacted] 5. Do you have any additional comments?

The weight enforcement agency use their WIM systems as sorter scales in their weight stations.
They very,very rarely request our WIM data.

G - WIM DATA ACCURACY AND QUALITY ASSURANCE (WIM DATA QA/QC PROGRAM)

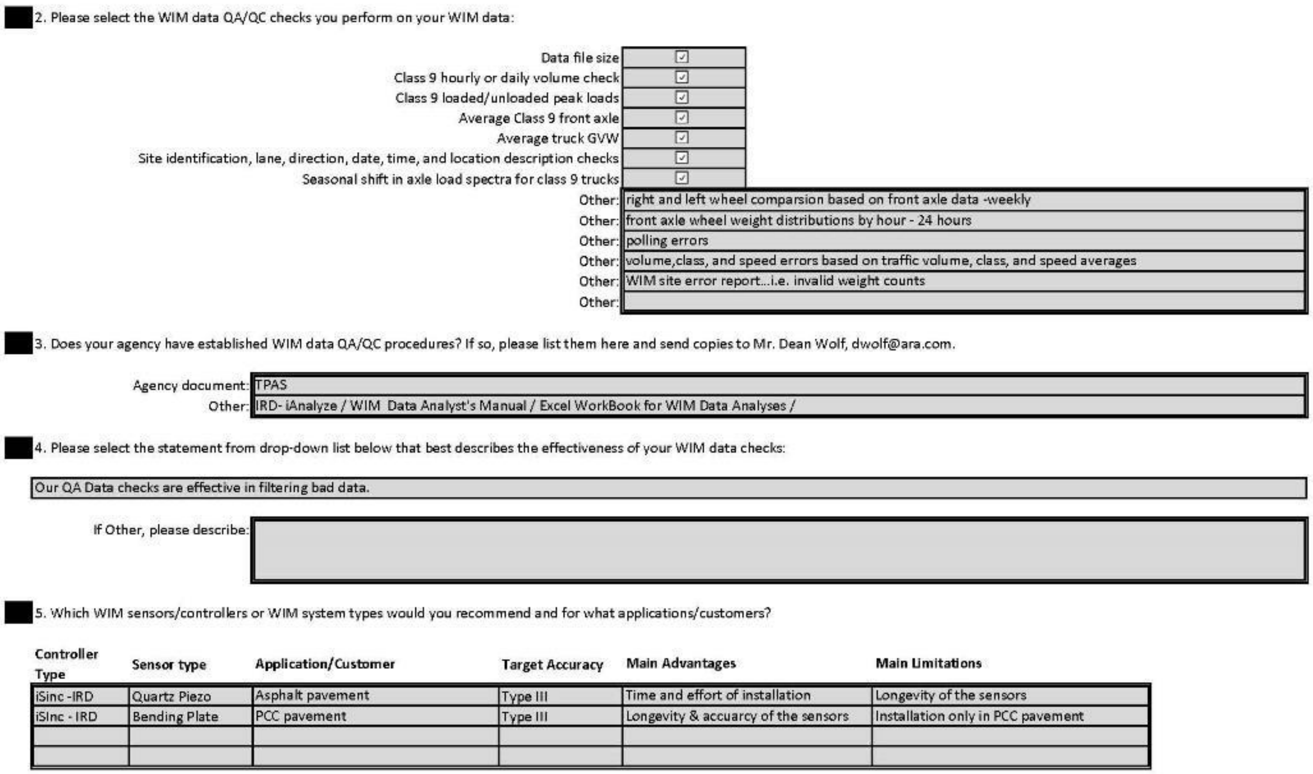
[redacted] 1. Specify the WIM weight data accuracy requirements for each of your WIM data customers:

	WIM Data Customers	Acceptable WIM Measurement Bias (%)*			Acceptable WIM Measurement Error Tolerance (+/- % error for selected confidence level)**		
		GVW	Single Axle	Axle group	GVW	Single Axle	Axle group
a.	Weight enforcement	2 to 5%	5 to 10%	5 to 10%	5 to 10%	10 to 20%	10 to 20%
b.	Planning	2 to 5%	5 to 10%	5 to 10%	5 to 10%	10 to 20%	10 to 20%
c.	Research	2 to 5%	5 to 10%	5 to 10%	5 to 10%	10 to 20%	10 to 20%
d.	Environmental	2 to 5%	5 to 10%	5 to 10%	5 to 10%	10 to 20%	10 to 20%
e.	Safety	2 to 5%	5 to 10%	5 to 10%	5 to 10%	10 to 20%	10 to 20%
f.	Design	2 to 5%	5 to 10%	5 to 10%	5 to 10%	10 to 20%	10 to 20%
g.	Asset Management	2 to 5%	5 to 10%	5 to 10%	5 to 10%	10 to 20%	10 to 20%

* WIM Measurement Bias is calculated as a systematic or mean percentile error between static and WIM-measured weights of a calibration truck. ASTM E1318-09 requires measurement bias to be approximately 0. Bias is minimized through WIM calibration.

** Represents a range of errors (i.e. -/- percent weight error from the mean weight error value) expected for 95% of all weight measurements. It could be calculated statistically using weight measurement errors from the calibration truck passes by computing statistical confidence interval (range of expected values) for 95% level of confidence.

Figure 19. Florida DOT Survey Response



[redacted] 2. Please select the WIM data QA/QC checks you perform on your WIM data:

Data file size	☑
Class 9 hourly or daily volume check	☑
Class 9 loaded/unloaded peak loads	☑
Average Class 9 front axle	☑
Average truck GVW	☑
Site identification, lane, direction, date, time, and location description checks	☑
Seasonal shift in axle load spectra for class 9 trucks	☑
Other:	right and left wheel comparsion based on front axle data -weekly
Other:	front axle wheel weight distributions by hour - 24 hours
Other:	polling errors
Other:	volume,class, and speed errors based on traffic volume, class, and speed averages
Other:	WIM site error report...i.e. invalid weight counts
Other:	

[redacted] 3. Does your agency have established WIM data QA/QC procedures? If so, please list them here and send copies to Mr. Dean Wolf, dwolf@ara.com.

Agency document: TPAS

Other: IRD- iAnalyze / WIM Data Analyst's Manual / Excel WorkBook for WIM Data Analyses /

[redacted] 4. Please select the statement from drop-down list below that best describes the effectiveness of your WIM data checks:

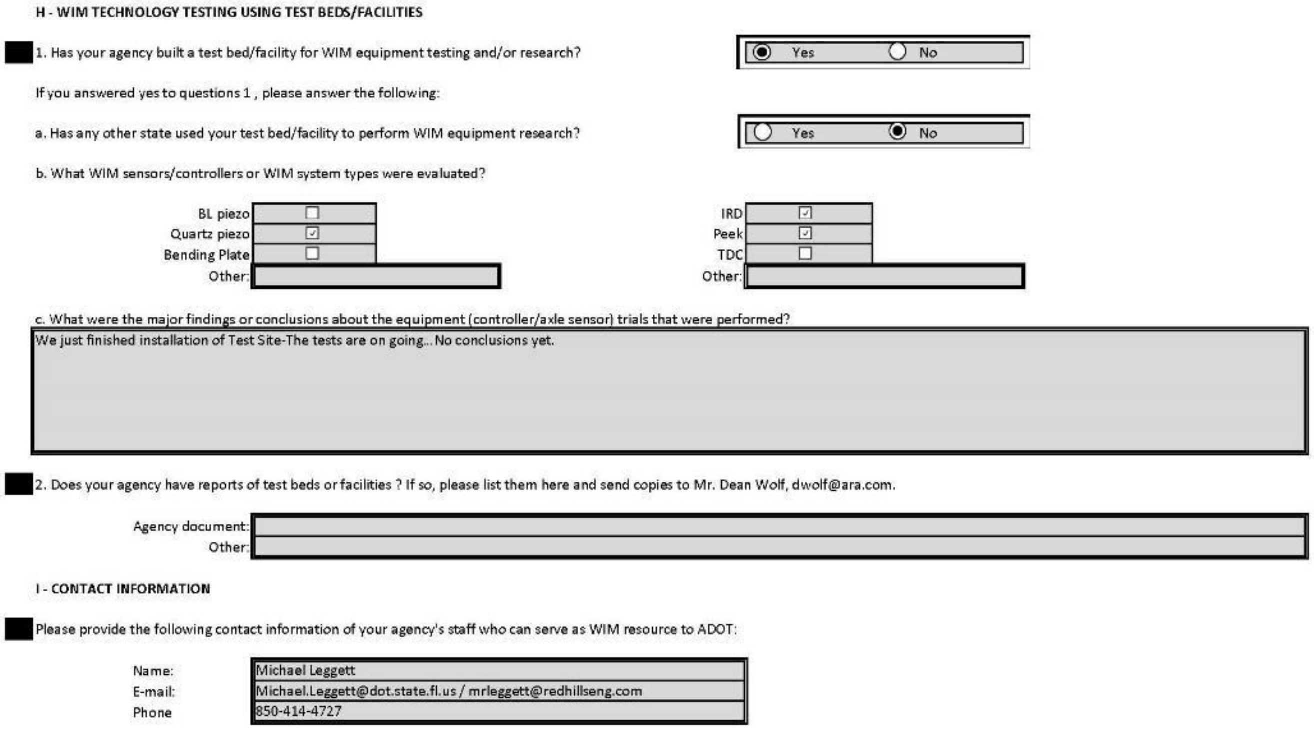
Our QA Data checks are effective in filtering bad data.

If Other, please describe:

[redacted] 5. Which WIM sensors/controllers or WIM system types would you recommend and for what applications/customers?

Controller Type	Sensor type	Application/Customer	Target Accuracy	Main Advantages	Main Limitations
iSinc -IRD	Quartz Piezo	Asphalt pavement	Type III	Time and effort of installation	Longevity of the sensors
iSInc - IRD	Bending Plate	PCC pavement	Type III	Longevity & accuarcy of the sensors	Installation only in PCC pavement

Figure 20. Florida DOT Survey Response



H - WIM TECHNOLOGY TESTING USING TEST BEDS/FACILITIES

1. Has your agency built a test bed/facility for WIM equipment testing and/or research? ● Yes ○ No

If you answered yes to questions 1 , please answer the following:

a. Has any other state used your test bed/facility to perform WIM equipment research? ○ Yes ● No

b. What WIM sensors/controllers or WIM system types were evaluated?

BL piezo ☐
Quartz piezo ☑
Bending Plate ☐
Other:

IRD ☑
Peek ☑
TDC ☐
Other:

c. What were the major findings or conclusions about the equipment (controller/axle sensor) trials that were performed?

We just finished installation of Test Site-The tests are on going...No conclusions yet.

2. Does your agency have reports of test beds or facilities ? If so, please list them here and send copies to Mr. Dean Wolf, dwolf@ara.com.

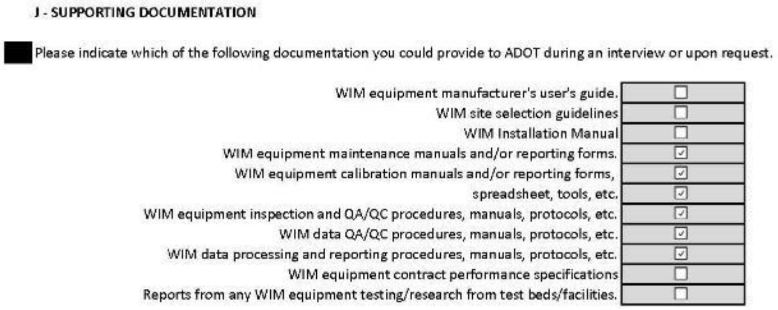
Agency document:
Other:

I - CONTACT INFORMATION

Please provide the following contact information of your agency's staff who can serve as WIM resource to ADOT:

Name: Michael Leggett
E-mail: Michael.Leggett@dot.state.fl.us / mrleggett@redhillseng.com
Phone 850-414-4727

Figure 21. Florida DOT Survey Response



J - SUPPORTING DOCUMENTATION

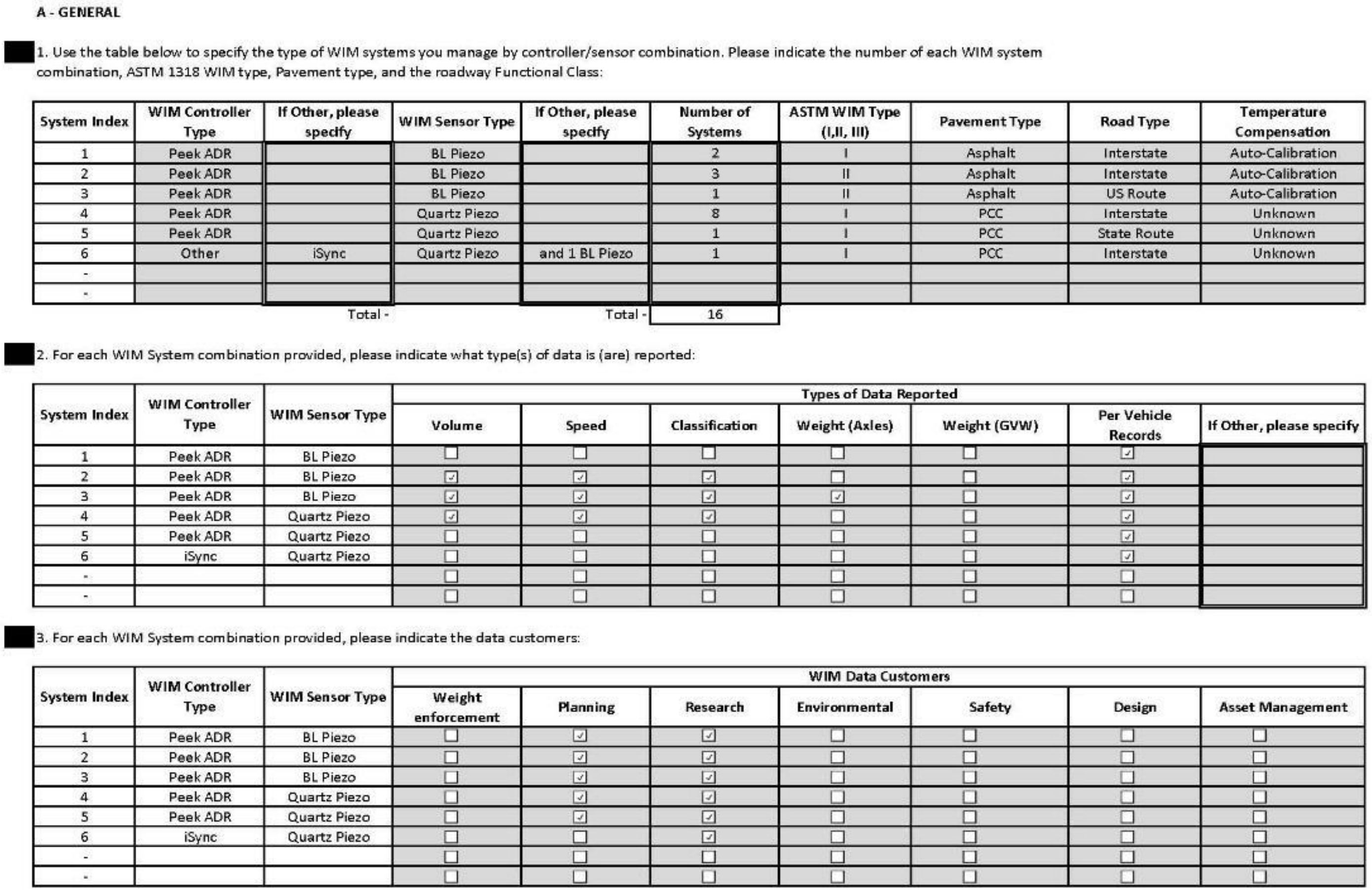
[redacted] Please indicate which of the following documentation you could provide to ADOT during an interview or upon request.

WIM equipment manufacturer's user's guide.	☐
WIM site selection guidelines	☐
WIM Installation Manual	☐
WIM equipment maintenance manuals and/or reporting forms.	☑
WIM equipment calibration manuals and/or reporting forms,	☑
spreadsheet, tools, etc.	☑
WIM equipment inspection and QA/QC procedures, manuals, protocols, etc.	☑
WIM data QA/QC procedures, manuals, protocols, etc.	☑
WIM data processing and reporting procedures, manuals, protocols, etc.	☑
WIM equipment contract performance specifications	☐
Reports from any WIM equipment testing/research from test beds/facilities.	☐

Figure 22. Florida DOT Survey Response

Georgia Department of Transportation (Jane Smith)
State Transportation Data Administrator

With Inputs from
Michael Hester
Transportation Data Program Manager



A - GENERAL

[redacted] 1. Use the table below to specify the type of WIM systems you manage by controller/sensor combination. Please indicate the number of each WIM system combination, ASTM 1318 WIM type, Pavement type, and the roadway Functional Class:

System Index	WIM Controller Type	If Other, please specify	WIM Sensor Type	If Other, please specify	Number of Systems	ASTM WIM Type (I,II, III)	Pavement Type	Road Type	Temperature Compensation
1	Peek ADR		BL Piezo		2	I	Asphalt	Interstate	Auto-Calibration
2	Peek ADR		BL Piezo		3	II	Asphalt	Interstate	Auto-Calibration
3	Peek ADR		BL Piezo		1	II	Asphalt	US Route	Auto-Calibration
4	Peek ADR		Quartz Piezo		8	I	PCC	Interstate	Unknown
5	Peek ADR		Quartz Piezo		1	I	PCC	State Route	Unknown
6	Other	iSync	Quartz Piezo	and 1 BL Piezo	1	I	PCC	Interstate	Unknown
-									
-									
		Total -		Total -	16				

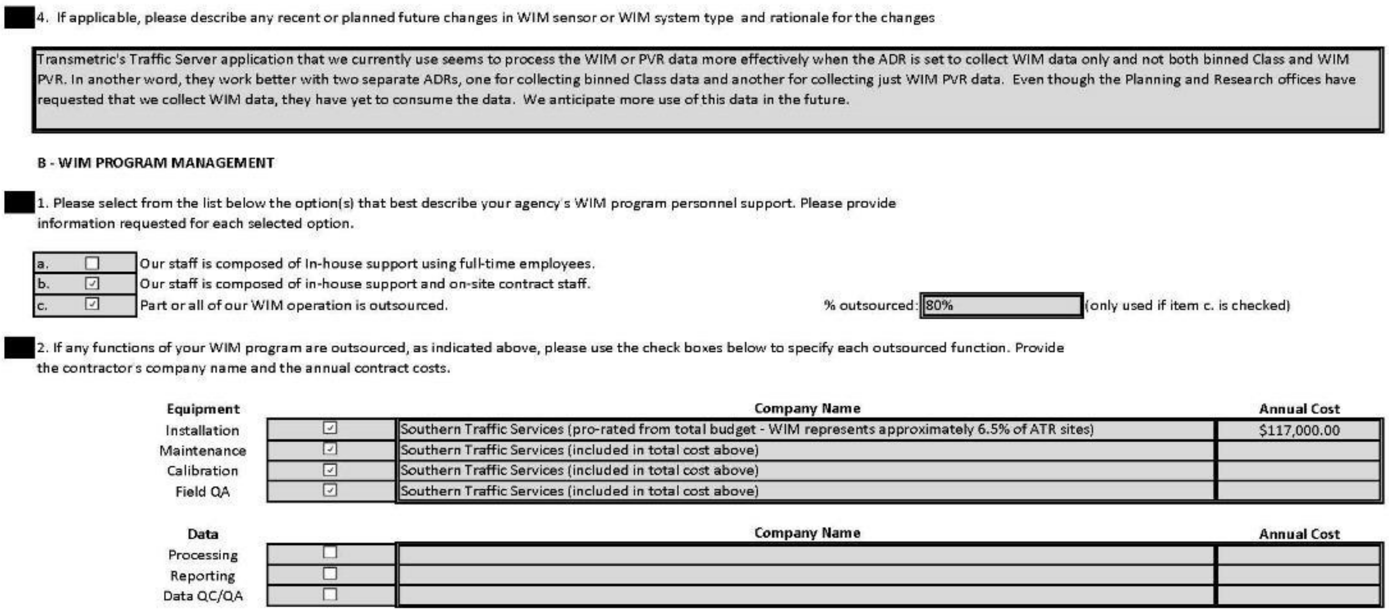
[redacted] 2. For each WIM System combination provided, please indicate what type(s) of data is (are) reported:

System Index	WIM Controller Type	WIM Sensor Type	Types of Data Reported						
			Volume	Speed	Classification	Weight (Axles)	Weight (GVW)	Per Vehicle Records	If Other, please specify
1	Peek ADR	BL Piezo	☐	☐	☐	☐	☐	☑	
2	Peek ADR	BL Piezo	☑	☑	☑	☐	☐	☑	
3	Peek ADR	BL Piezo	☑	☑	☑	☑	☐	☑	
4	Peek ADR	Quartz Piezo	☑	☑	☑	☐	☐	☑	
5	Peek ADR	Quartz Piezo	☐	☐	☐	☐	☐	☑	
6	iSync	Quartz Piezo	☐	☐	☐	☐	☐	☑	
-			☐	☐	☐	☐	☐	☐	
-			☐	☐	☐	☐	☐	☐	

[redacted] 3. For each WIM System combination provided, please indicate the data customers:

System Index	WIM Controller Type	WIM Sensor Type	WIM Data Customers						
			Weight enforcement	Planning	Research	Environmental	Safety	Design	Asset Management
1	Peek ADR	BL Piezo	☐	☑	☑	☐	☐	☐	☐
2	Peek ADR	BL Piezo	☐	☑	☑	☐	☐	☐	☐
3	Peek ADR	BL Piezo	☐	☑	☑	☐	☐	☐	☐
4	Peek ADR	Quartz Piezo	☐	☑	☑	☐	☐	☐	☐
5	Peek ADR	Quartz Piezo	☐	☑	☑	☐	☐	☐	☐
6	iSync	Quartz Piezo	☐	☐	☑	☐	☐	☐	☐
-			☐	☐	☐	☐	☐	☐	☐
-			☐	☐	☐	☐	☐	☐	☐

Figure 23. Georgia DOT Survey Response



[redacted] 4. If applicable, please describe any recent or planned future changes in WIM sensor or WIM system type and rationale for the changes

Transmetric's Traffic Server application that we currently use seems to process the WIM or PVR data more effectively when the ADR is set to collect WIM data only and not both binned Class and WIM PVR. In another word, they work better with two separate ADRs, one for collecting binned Class data and another for collecting just WIM PVR data. Even though the Planning and Research offices have requested that we collect WIM data, they have yet to consume the data. We anticipate more use of this data in the future.

B - WIM PROGRAM MANAGEMENT

[redacted] 1. Please select from the list below the option(s) that best describe your agency's WIM program personnel support. Please provide information requested for each selected option.

a.	☐	Our staff is composed of In-house support using full-time employees.
b.	☑	Our staff is composed of in-house support and on-site contract staff.
c.	☑	Part or all of our WIM operation is outsourced.

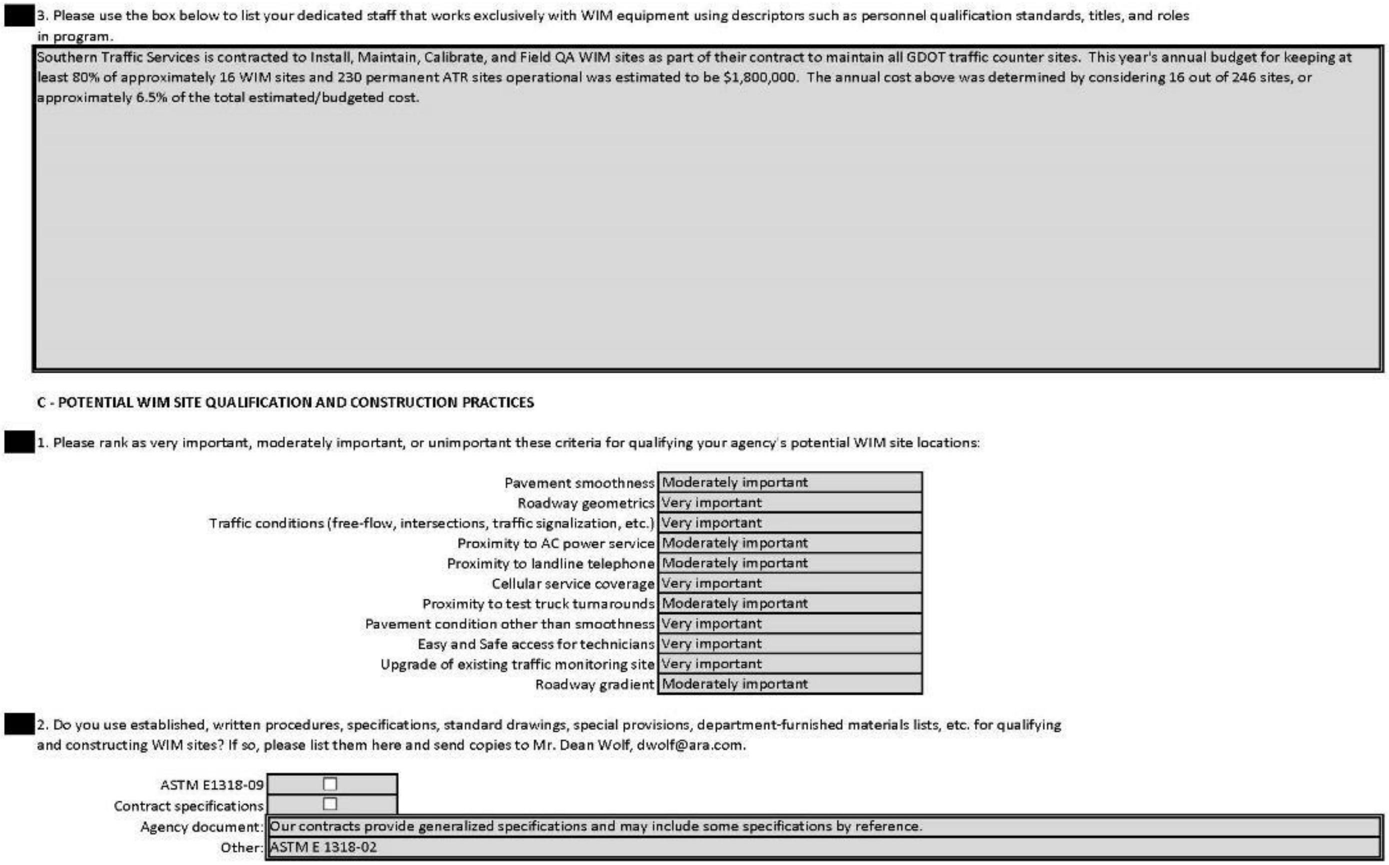
% outsourced: 80% (only used if item c. is checked)

[redacted] 2. If any functions of your WIM program are outsourced, as indicated above, please use the check boxes below to specify each outsourced function. Provide the contractor's company name and the annual contract costs.

Equipment		Company Name	Annual Cost
Installation	☑	Southern Traffic Services (pro-rated from total budget - WIM represents approximately 6.5% of ATR sites)	$117,000.00
Maintenance	☑	Southern Traffic Services (included in total cost above)	
Calibration	☑	Southern Traffic Services (included in total cost above)	
Field QA	☑	Southern Traffic Services (included in total cost above)	

Data		Company Name	Annual Cost
Processing	☐		
Reporting	☐		
Data QC/QA	☐		

Figure 24. Georgia DOT Survey Response



3. Please use the box below to list your dedicated staff that works exclusively with WIM equipment using descriptors such as personnel qualification standards, titles, and roles in program.

Southern Traffic Services is contracted to Install, Maintain, Calibrate, and Field QA WIM sites as part of their contract to maintain all GDOT traffic counter sites. This year's annual budget for keeping at least 80% of approximately 16 WIM sites and 230 permanent ATR sites operational was estimated to be $1,800,000. The annual cost above was determined by considering 16 out of 246 sites, or approximately 6.5% of the total estimated/budgeted cost.

C - POTENTIAL WIM SITE QUALIFICATION AND CONSTRUCTION PRACTICES

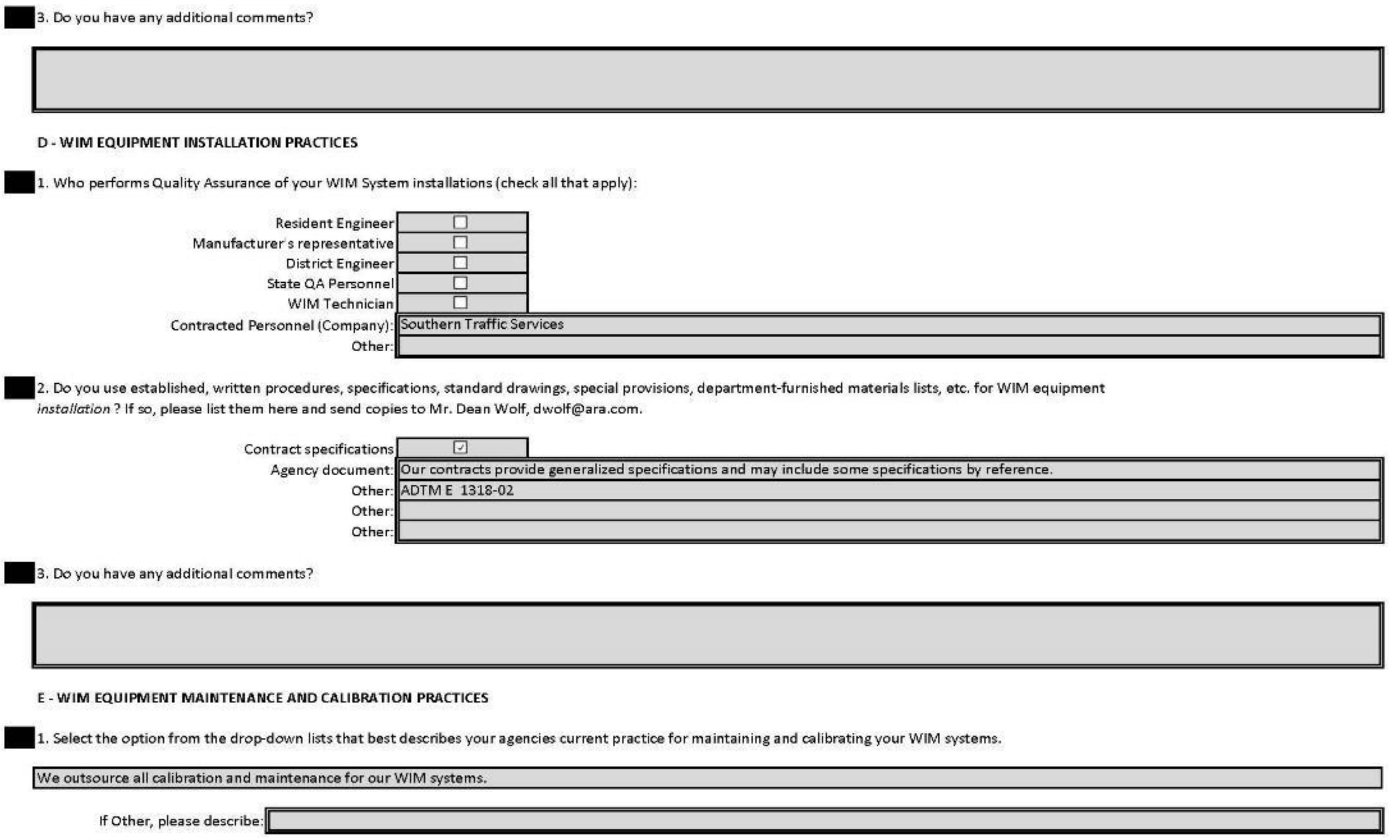
1. Please rank as very important, moderately important, or unimportant these criteria for qualifying your agency's potential WIM site locations:

Pavement smoothness	Moderately important
Roadway geometrics	Very important
Traffic conditions (free-flow, intersections, traffic signalization, etc.)	Very important
Proximity to AC power service	Moderately important
Proximity to landline telephone	Moderately important
Cellular service coverage	Very important
Proximity to test truck turnarounds	Moderately important
Pavement condition other than smoothness	Very important
Easy and Safe access for technicians	Very important
Upgrade of existing traffic monitoring site	Very important
Roadway gradient	Moderately important

2. Do you use established, written procedures, specifications, standard drawings, special provisions, department-furnished materials lists, etc. for qualifying and constructing WIM sites? If so, please list them here and send copies to Mr. Dean Wolf, dwolf@ara.com.

ASTM E1318-09 ☐
Contract specifications ☐
Agency document: Our contracts provide generalized specifications and may include some specifications by reference.
Other: ASTM E 1318-02

Figure 25. Georgia DOT Survey Response



3. Do you have any additional comments?

D - WIM EQUIPMENT INSTALLATION PRACTICES

1. Who performs Quality Assurance of your WIM System installations (check all that apply):

Resident Engineer ☐
Manufacturer's representative ☐
District Engineer ☐
State QA Personnel ☐
WIM Technician ☐
Contracted Personnel (Company): Southern Traffic Services
Other:

2. Do you use established, written procedures, specifications, standard drawings, special provisions, department-furnished materials lists, etc. for WIM equipment *installation* ? If so, please list them here and send copies to Mr. Dean Wolf, dwolf@ara.com.

Contract specifications ☑
Agency document: Our contracts provide generalized specifications and may include some specifications by reference.
Other: ADTM E 1318-02
Other:
Other:

3. Do you have any additional comments?

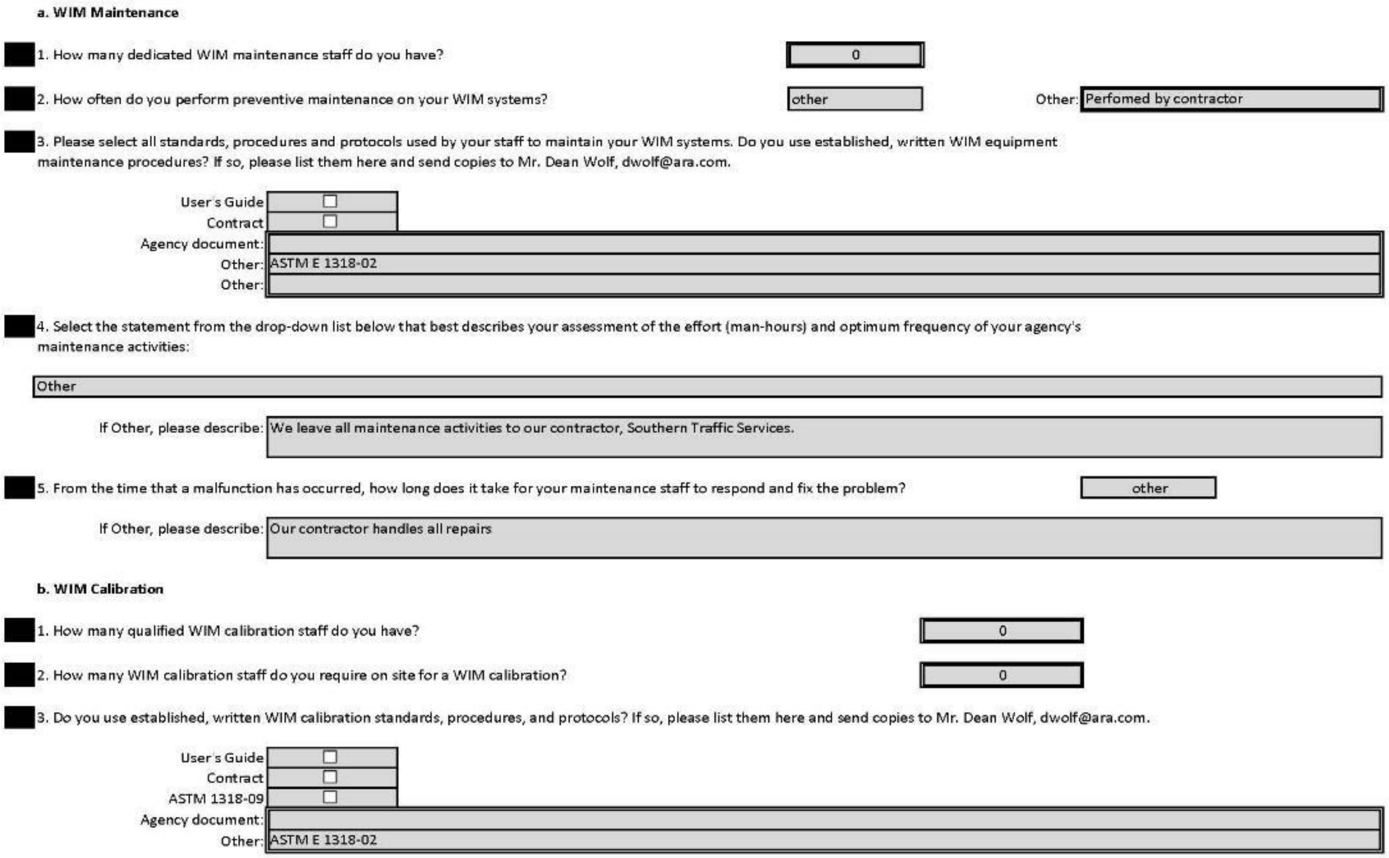
E - WIM EQUIPMENT MAINTENANCE AND CALIBRATION PRACTICES

1. Select the option from the drop-down lists that best describes your agencies current practice for maintaining and calibrating your WIM systems.

We outsource all calibration and maintenance for our WIM systems.

If Other, please describe:

Figure 26. Georgia DOT Survey Response



a. WIM Maintenance

1. How many dedicated WIM maintenance staff do you have? 0

2. How often do you perform preventive maintenance on your WIM systems? other Other: Perfomed by contractor

3. Please select all standards, procedures and protocols used by your staff to maintain your WIM systems. Do you use established, written WIM equipment maintenance procedures? If so, please list them here and send copies to Mr. Dean Wolf, dwolf@ara.com.

User's Guide ☐
Contract ☐
Agency document:
Other: ASTM E 1318-02
Other:

4. Select the statement from the drop-down list below that best describes your assessment of the effort (man-hours) and optimum frequency of your agency's maintenance activities:

Other

If Other, please describe: We leave all maintenance activities to our contractor, Southern Traffic Services.

5. From the time that a malfunction has occurred, how long does it take for your maintenance staff to respond and fix the problem? other

If Other, please describe: Our contractor handles all repairs

b. WIM Calibration

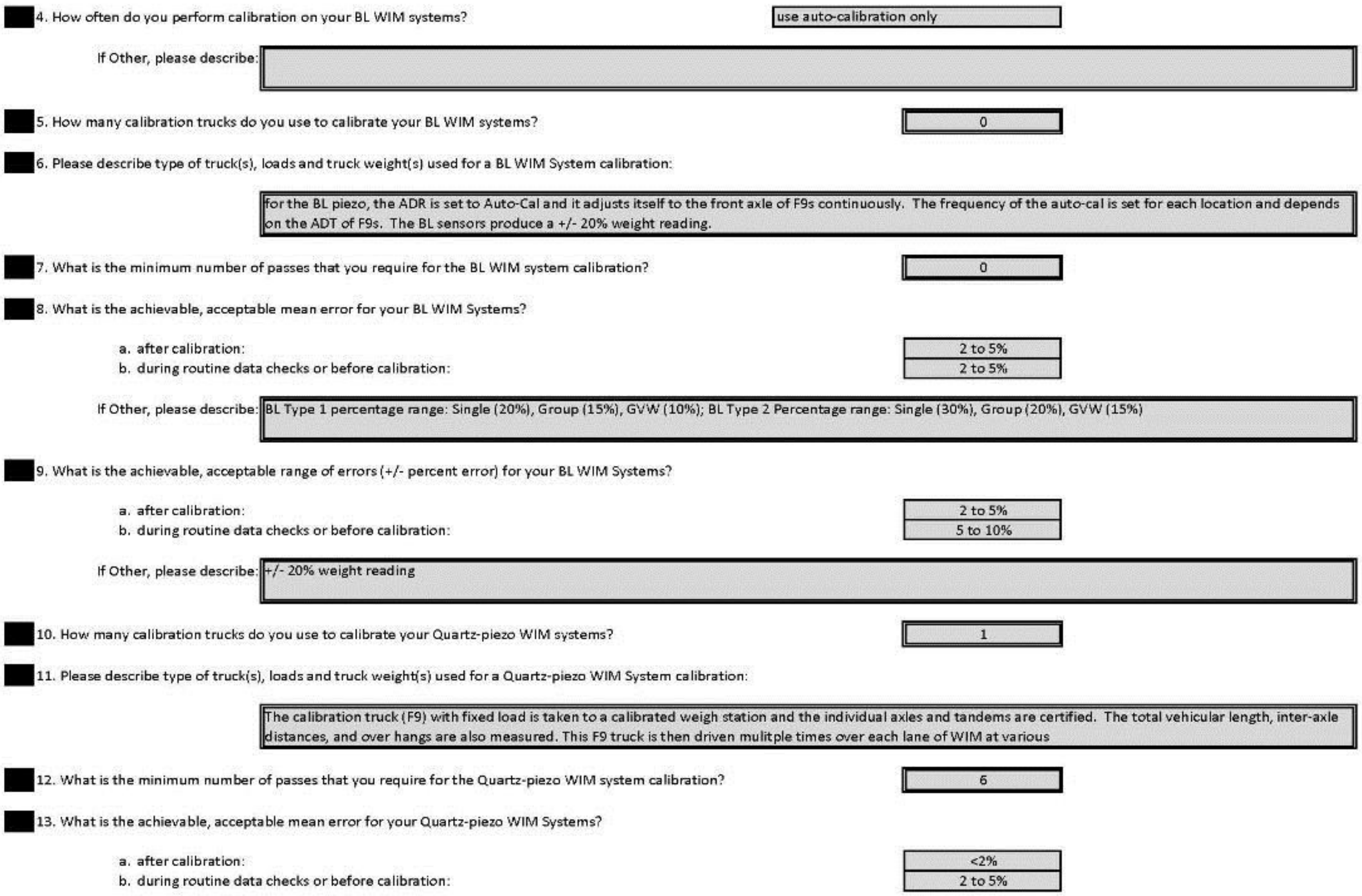
1. How many qualified WIM calibration staff do you have? 0

2. How many WIM calibration staff do you require on site for a WIM calibration? 0

3. Do you use established, written WIM calibration standards, procedures, and protocols? If so, please list them here and send copies to Mr. Dean Wolf, dwolf@ara.com.

User's Guide ☐
Contract ☐
ASTM 1318-09 ☐
Agency document:
Other: ASTM E 1318-02

Figure 27. Georgia DOT Survey Response



[redacted] 4. How often do you perform calibration on your BL WIM systems? use auto-calibration only

If Other, please describe:

[redacted] 5. How many calibration trucks do you use to calibrate your BL WIM systems? 0

[redacted] 6. Please describe type of truck(s), loads and truck weight(s) used for a BL WIM System calibration:

for the BL piezo, the ADR is set to Auto-Cal and it adjusts itself to the front axle of F9s continuously. The frequency of the auto-cal is set for each location and depends on the ADT of F9s. The BL sensors produce a +/- 20% weight reading.

[redacted] 7. What is the minimum number of passes that you require for the BL WIM system calibration? 0

[redacted] 8. What is the achievable, acceptable mean error for your BL WIM Systems?

a. after calibration: 2 to 5%
b. during routine data checks or before calibration: 2 to 5%

If Other, please describe: BL Type 1 percentage range: Single (20%), Group (15%), GVW (10%); BL Type 2 Percentage range: Single (30%), Group (20%), GVW (15%)

[redacted] 9. What is the achievable, acceptable range of errors (+/- percent error) for your BL WIM Systems?

a. after calibration: 2 to 5%
b. during routine data checks or before calibration: 5 to 10%

If Other, please describe: +/- 20% weight reading

[redacted] 10. How many calibration trucks do you use to calibrate your Quartz-piezo WIM systems? 1

[redacted] 11. Please describe type of truck(s), loads and truck weight(s) used for a Quartz-piezo WIM System calibration:

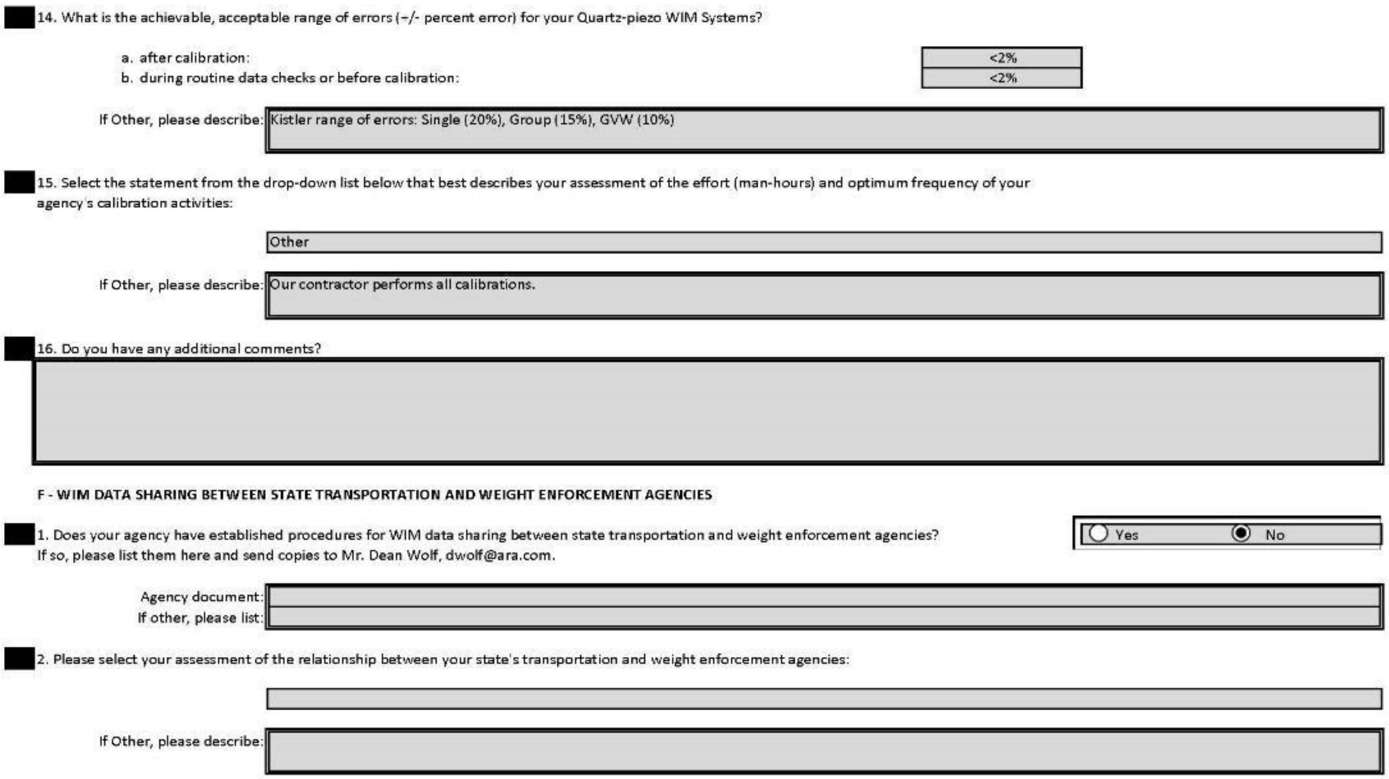
The calibration truck (F9) with fixed load is taken to a calibrated weigh station and the individual axles and tandems are certified. The total vehicular length, inter-axle distances, and over hangs are also measured. This F9 truck is then driven mulitple times over each lane of WIM at various

[redacted] 12. What is the minimum number of passes that you require for the Quartz-piezo WIM system calibration? 6

[redacted] 13. What is the achievable, acceptable mean error for your Quartz-piezo WIM Systems?

a. after calibration: <2%
b. during routine data checks or before calibration: 2 to 5%

Figure 28. Georgia DOT Survey Response



14. What is the achievable, acceptable range of errors (-/- percent error) for your Quartz-piezo WIM Systems?

a. after calibration:	<2%
b. during routine data checks or before calibration:	<2%

If Other, please describe: Kistler range of errors: Single (20%), Group (15%), GVW (10%)

15. Select the statement from the drop-down list below that best describes your assessment of the effort (man-hours) and optimum frequency of your agency's calibration activities:

Other

If Other, please describe: Our contractor performs all calibrations.

16. Do you have any additional comments?

F - WIM DATA SHARING BETWEEN STATE TRANSPORTATION AND WEIGHT ENFORCEMENT AGENCIES

1. Does your agency have established procedures for WIM data sharing between state transportation and weight enforcement agencies? If so, please list them here and send copies to Mr. Dean Wolf, dwolf@ara.com.

○ Yes ● No

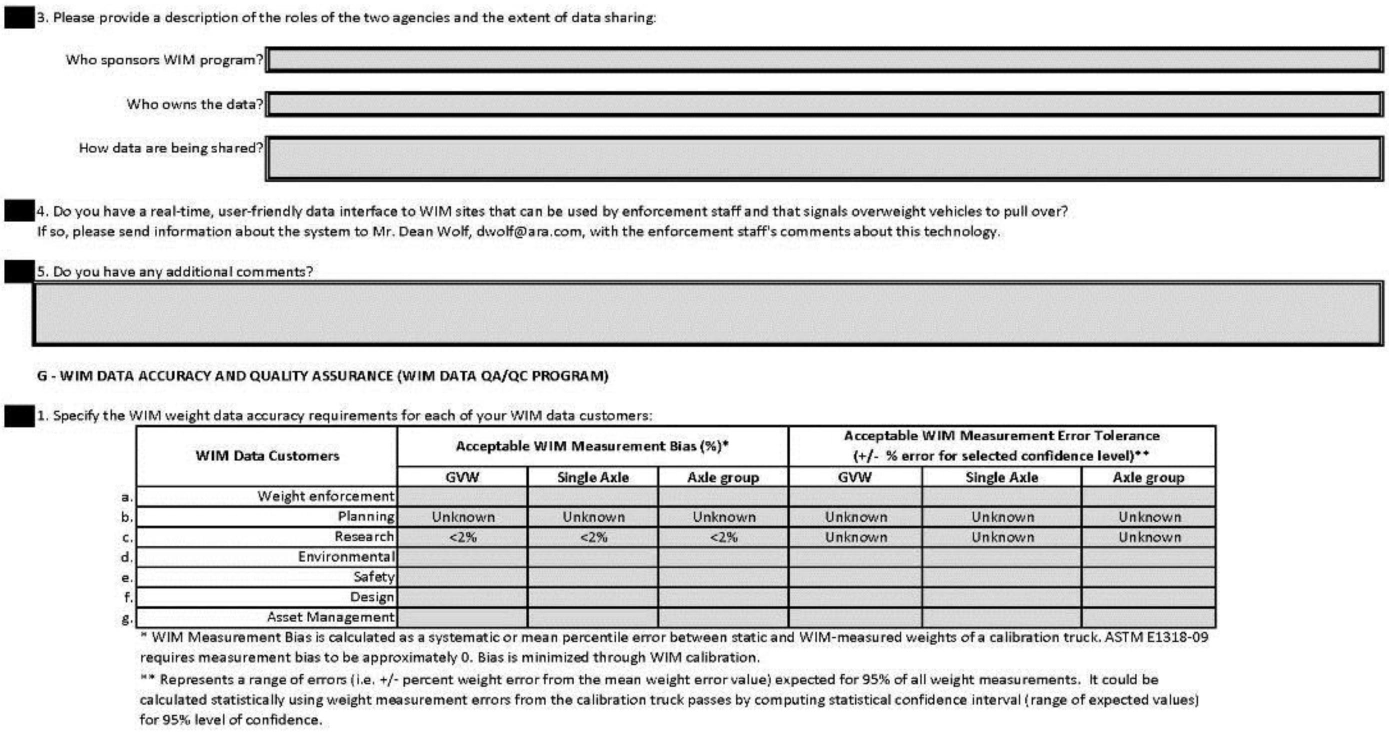
Agency document:

If other, please list:

2. Please select your assessment of the relationship between your state's transportation and weight enforcement agencies:

If Other, please describe:

Figure 29. Georgia DOT Survey Response



[redacted] 3. Please provide a description of the roles of the two agencies and the extent of data sharing:

Who sponsors WIM program?

Who owns the data?

How data are being shared?

[redacted] 4. Do you have a real-time, user-friendly data interface to WIM sites that can be used by enforcement staff and that signals overweight vehicles to pull over?
If so, please send information about the system to Mr. Dean Wolf, dwolf@ara.com, with the enforcement staff's comments about this technology.

[redacted] 5. Do you have any additional comments?

G - WIM DATA ACCURACY AND QUALITY ASSURANCE (WIM DATA QA/QC PROGRAM)

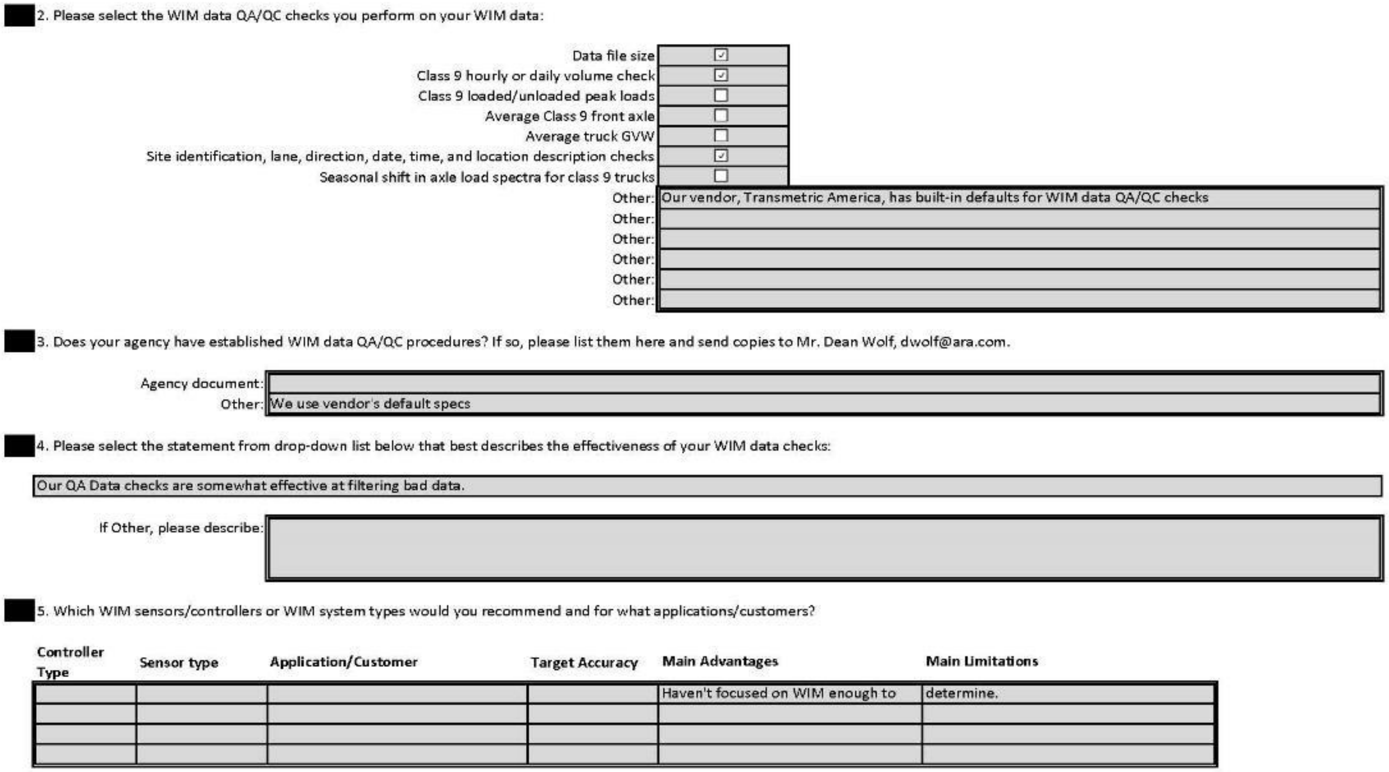
[redacted] 1. Specify the WIM weight data accuracy requirements for each of your WIM data customers:

	WIM Data Customers	Acceptable WIM Measurement Bias (%)*			Acceptable WIM Measurement Error Tolerance (+/- % error for selected confidence level)**		
		GVW	Single Axle	Axle group	GVW	Single Axle	Axle group
a.	Weight enforcement						
b.	Planning	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
c.	Research	<2%	<2%	<2%	Unknown	Unknown	Unknown
d.	Environmental						
e.	Safety						
f.	Design						
g.	Asset Management						

* WIM Measurement Bias is calculated as a systematic or mean percentile error between static and WIM-measured weights of a calibration truck. ASTM E1318-09 requires measurement bias to be approximately 0. Bias is minimized through WIM calibration.

** Represents a range of errors (i.e. +/- percent weight error from the mean weight error value) expected for 95% of all weight measurements. It could be calculated statistically using weight measurement errors from the calibration truck passes by computing statistical confidence interval (range of expected values) for 95% level of confidence.

Figure 30. Georgia DOT Survey Response



[redacted] 2. Please select the WIM data QA/QC checks you perform on your WIM data:

Data file size	☑
Class 9 hourly or daily volume check	☑
Class 9 loaded/unloaded peak loads	☐
Average Class 9 front axle	☐
Average truck GVW	☐
Site identification, lane, direction, date, time, and location description checks	☑
Seasonal shift in axle load spectra for class 9 trucks	☐
Other:	Our vendor, Transmetric America, has built-in defaults for WIM data QA/QC checks
Other:	
Other:	
Other:	
Other:	
Other:	

[redacted] 3. Does your agency have established WIM data QA/QC procedures? If so, please list them here and send copies to Mr. Dean Wolf, dwolf@ara.com.

Agency document:
Other: We use vendor's default specs

[redacted] 4. Please select the statement from drop-down list below that best describes the effectiveness of your WIM data checks:

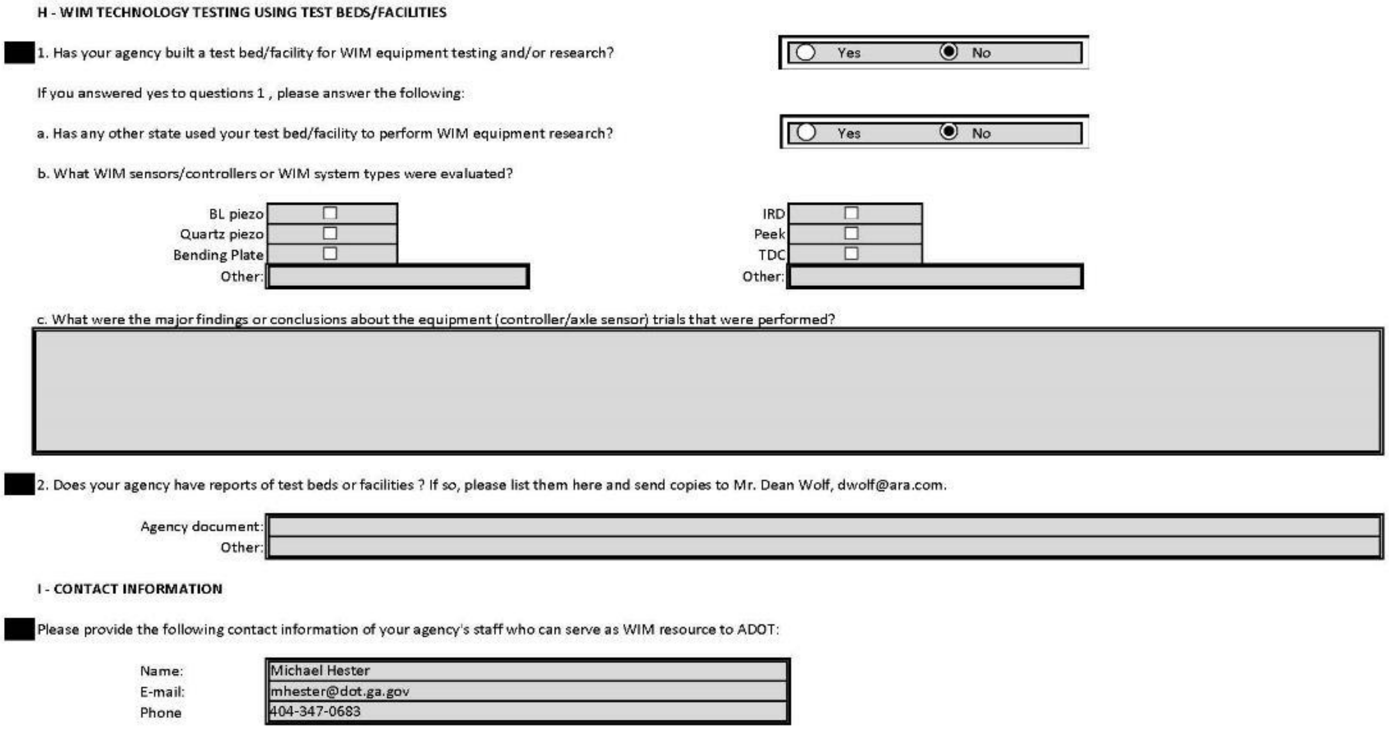
Our QA Data checks are somewhat effective at filtering bad data.

If Other, please describe:

[redacted] 5. Which WIM sensors/controllers or WIM system types would you recommend and for what applications/customers?

Controller Type	Sensor type	Application/Customer	Target Accuracy	Main Advantages	Main Limitations
				Haven't focused on WIM enough to	determine.

Figure 31. Georgia DOT Survey Response



H - WIM TECHNOLOGY TESTING USING TEST BEDS/FACILITIES

1. Has your agency built a test bed/facility for WIM equipment testing and/or research? ○ Yes ● No

If you answered yes to questions 1 , please answer the following:

a. Has any other state used your test bed/facility to perform WIM equipment research? ○ Yes ● No

b. What WIM sensors/controllers or WIM system types were evaluated?

BL piezo ☐
Quartz piezo ☐
Bending Plate ☐
Other:

IRD ☐
Peek ☐
TDC ☐
Other:

c. What were the major findings or conclusions about the equipment (controller/axle sensor) trials that were performed?

2. Does your agency have reports of test beds or facilities ? If so, please list them here and send copies to Mr. Dean Wolf, dwolf@ara.com.

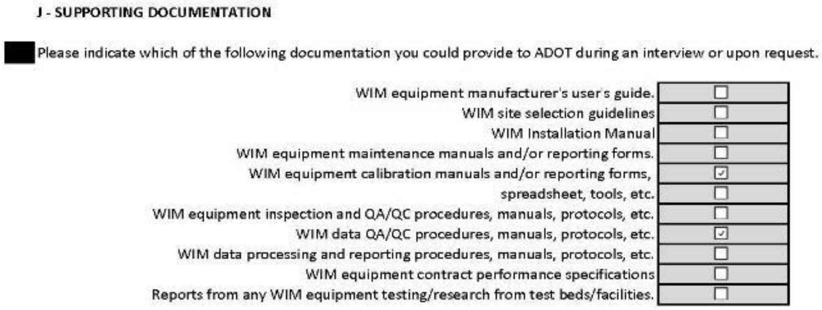
Agency document:
Other:

I - CONTACT INFORMATION

Please provide the following contact information of your agency's staff who can serve as WIM resource to ADOT:

Name: Michael Hester
E-mail: mhester@dot.ga.gov
Phone 404-347-0683

Figure 32. Georgia DOT Survey Response



J - SUPPORTING DOCUMENTATION

[redacted] Please indicate which of the following documentation you could provide to ADOT during an interview or upon request.

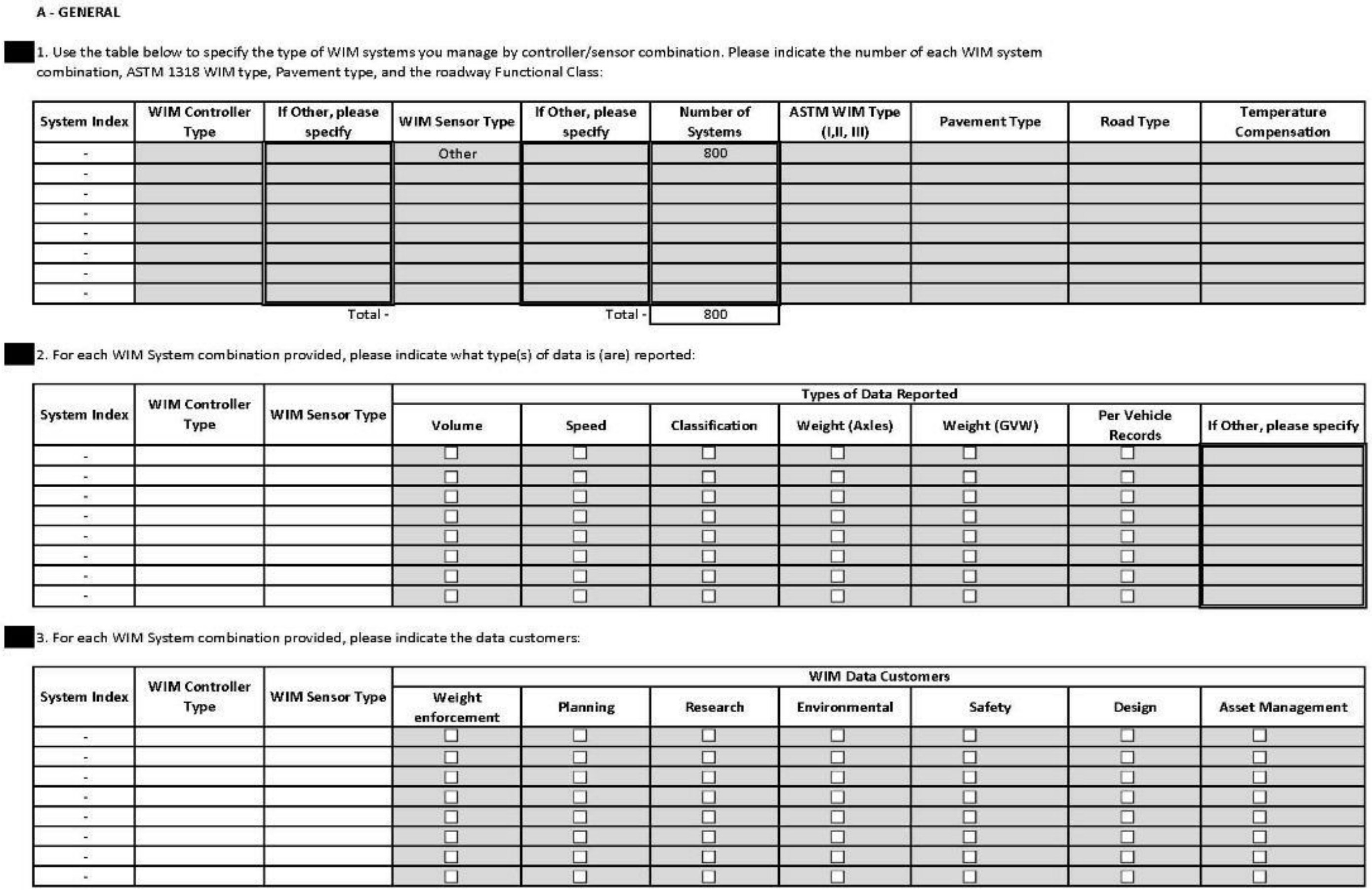
WIM equipment manufacturer's user's guide. ☐
WIM site selection guidelines ☐
WIM Installation Manual ☐
WIM equipment maintenance manuals and/or reporting forms. ☐
WIM equipment calibration manuals and/or reporting forms, ☑
spreadsheet, tools, etc. ☐
WIM equipment inspection and QA/QC procedures, manuals, protocols, etc. ☐
WIM data QA/QC procedures, manuals, protocols, etc. ☑
WIM data processing and reporting procedures, manuals, protocols, etc. ☐
WIM equipment contract performance specifications ☐
Reports from any WIM equipment testing/research from test beds/facilities. ☐

Figure 33. Georgia DOT Survey Response

Federal Highway Administration (Steven Jessberger)

Senior Transportation Specialist - Office of Highway Policy Information

Member – TRB Traffic Expert Task Group
Member – TRB Highway Traffic Monitoring Committee (ABJ-35)



A - GENERAL

[redacted] 1. Use the table below to specify the type of WIM systems you manage by controller/sensor combination. Please indicate the number of each WIM system combination, ASTM 1318 WIM type, Pavement type, and the roadway Functional Class:

System Index	WIM Controller Type	If Other, please specify	WIM Sensor Type	If Other, please specify	Number of Systems	ASTM WIM Type (I,II, III)	Pavement Type	Road Type	Temperature Compensation
-			Other		800				
-									
-									
-									
-									
-									
-									
-									
		Total -		Total -	800				

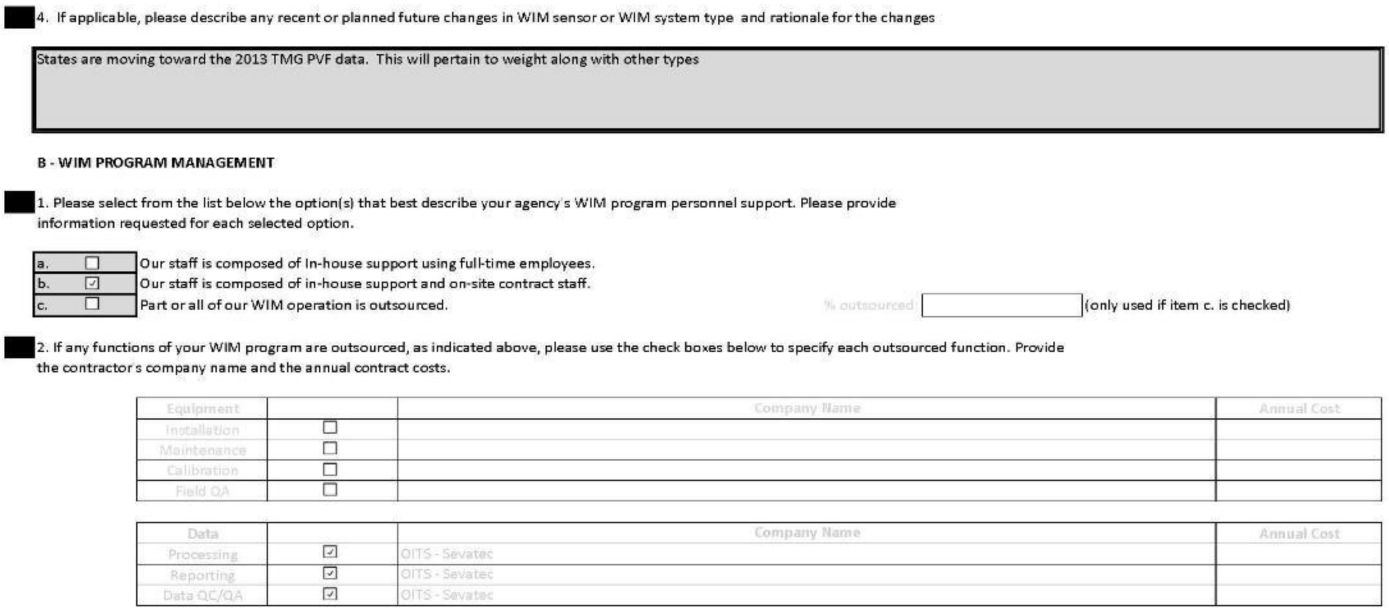
[redacted] 2. For each WIM System combination provided, please indicate what type(s) of data is (are) reported:

System Index	WIM Controller Type	WIM Sensor Type	Types of Data Reported						
			Volume	Speed	Classification	Weight (Axles)	Weight (GVW)	Per Vehicle Records	If Other, please specify
-			☐	☐	☐	☐	☐	☐	
-			☐	☐	☐	☐	☐	☐	
-			☐	☐	☐	☐	☐	☐	
-			☐	☐	☐	☐	☐	☐	
-			☐	☐	☐	☐	☐	☐	
-			☐	☐	☐	☐	☐	☐	
-			☐	☐	☐	☐	☐	☐	
-			☐	☐	☐	☐	☐	☐	

[redacted] 3. For each WIM System combination provided, please indicate the data customers:

System Index	WIM Controller Type	WIM Sensor Type	WIM Data Customers						
			Weight enforcement	Planning	Research	Environmental	Safety	Design	Asset Management
-			☐	☐	☐	☐	☐	☐	☐
-			☐	☐	☐	☐	☐	☐	☐
-			☐	☐	☐	☐	☐	☐	☐
-			☐	☐	☐	☐	☐	☐	☐
-			☐	☐	☐	☐	☐	☐	☐
-			☐	☐	☐	☐	☐	☐	☐
-			☐	☐	☐	☐	☐	☐	☐
-			☐	☐	☐	☐	☐	☐	☐

Figure 34. FHWA – Jessberger – Responses to Survey



[redacted] 4. If applicable, please describe any recent or planned future changes in WIM sensor or WIM system type and rationale for the changes

States are moving toward the 2013 TMG PVF data. This will pertain to weight along with other types

B - WIM PROGRAM MANAGEMENT

[redacted] 1. Please select from the list below the option(s) that best describe your agency's WIM program personnel support. Please provide information requested for each selected option.

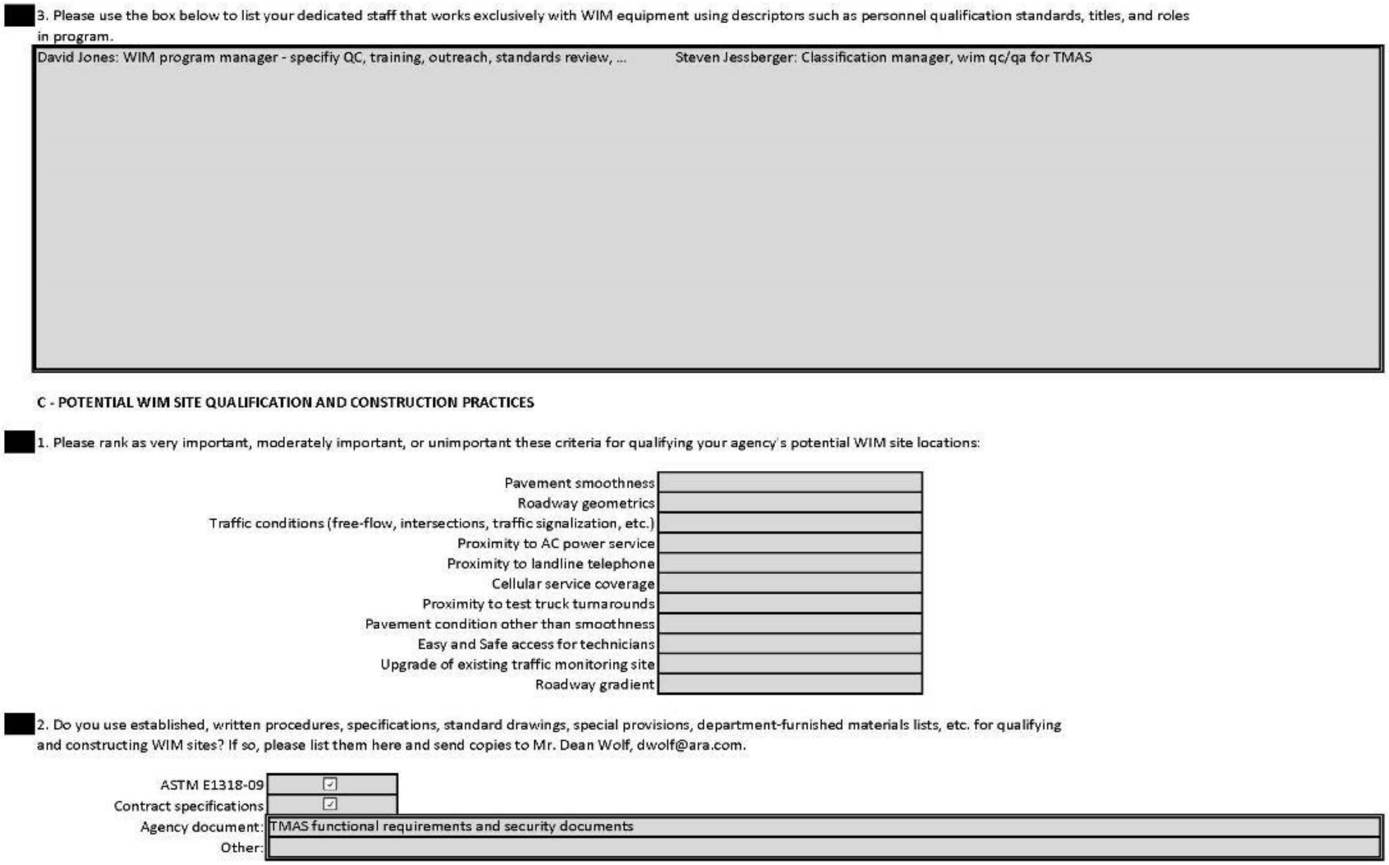
a. ☐ Our staff is composed of In-house support using full-time employees.
b. ☑ Our staff is composed of in-house support and on-site contract staff.
c. ☐ Part or all of our WIM operation is outsourced. % outsourced (only used if item c. is checked)

[redacted] 2. If any functions of your WIM program are outsourced, as indicated above, please use the check boxes below to specify each outsourced function. Provide the contractor's company name and the annual contract costs.

Equipment		Company Name	Annual Cost
Installation	☐		
Maintenance	☐		
Calibration	☐		
Field QA	☐		

Data		Company Name	Annual Cost
Processing	☑	OITS - Sevatec	
Reporting	☑	OITS - Sevatec	
Data QC/QA	☑	OITS - Sevatec	

Figure 35. FHWA – Jessberger – Responses to Survey



[redacted] 3. Please use the box below to list your dedicated staff that works exclusively with WIM equipment using descriptors such as personnel qualification standards, titles, and roles in program.

David Jones: WIM program manager - specifiy QC, training, outreach, standards review, ...   Steven Jessberger: Classification manager, wim qc/qa for TMAS

C - POTENTIAL WIM SITE QUALIFICATION AND CONSTRUCTION PRACTICES

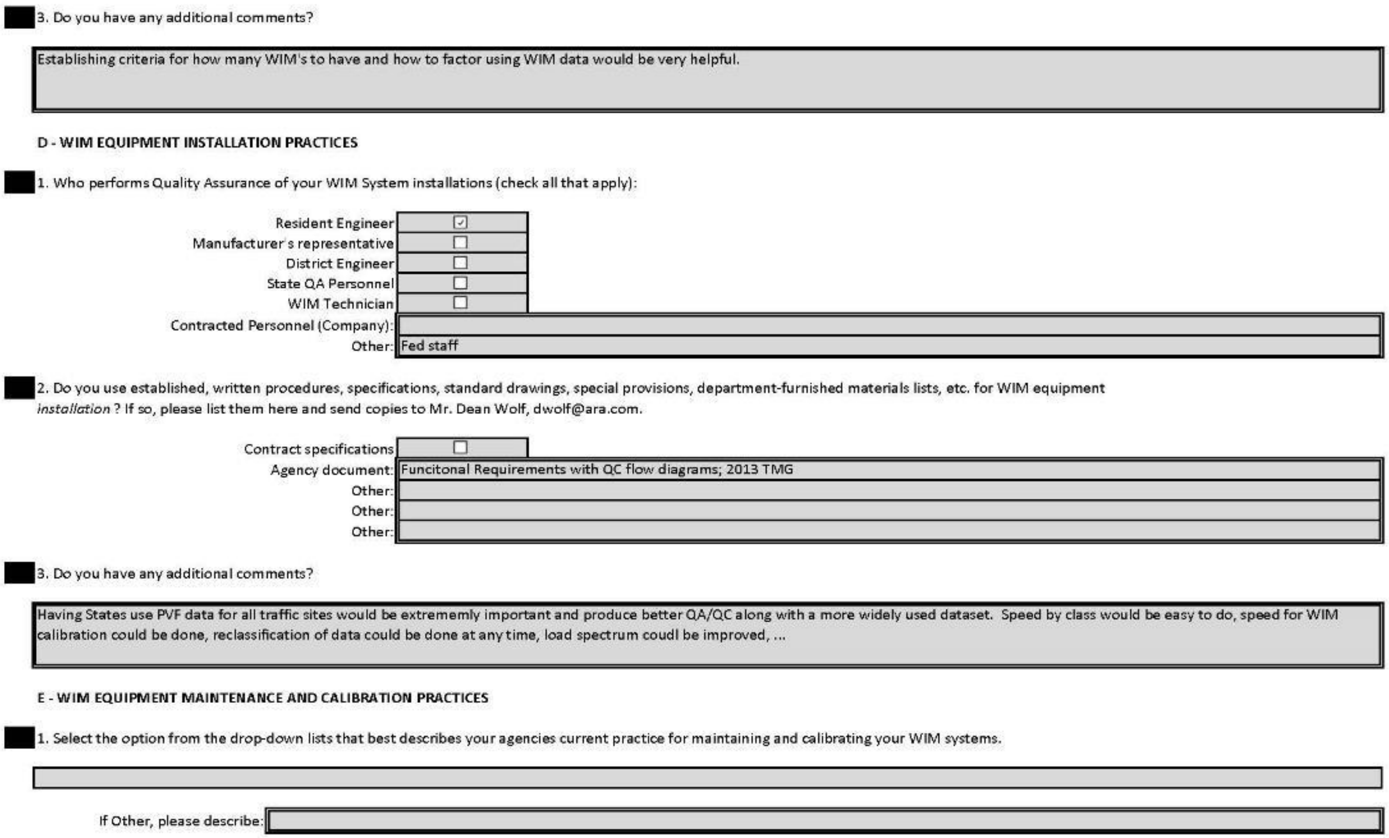
[redacted] 1. Please rank as very important, moderately important, or unimportant these criteria for qualifying your agency's potential WIM site locations:

Pavement smoothness	
Roadway geometrics	
Traffic conditions (free-flow, intersections, traffic signalization, etc.)	
Proximity to AC power service	
Proximity to landline telephone	
Cellular service coverage	
Proximity to test truck turnarounds	
Pavement condition other than smoothness	
Easy and Safe access for technicians	
Upgrade of existing traffic monitoring site	
Roadway gradient	

[redacted] 2. Do you use established, written procedures, specifications, standard drawings, special provisions, department-furnished materials lists, etc. for qualifying and constructing WIM sites? If so, please list them here and send copies to Mr. Dean Wolf, dwolf@ara.com.

ASTM E1318-09	☑
Contract specifications	☑
Agency document:	TMAS functional requirements and security documents
Other:	

Figure 36. FHWA – Jessberger – Responses to Survey



[redacted] 3. Do you have any additional comments?

Establishing criteria for how many WIM's to have and how to factor using WIM data would be very helpful.

D - WIM EQUIPMENT INSTALLATION PRACTICES

[redacted] 1. Who performs Quality Assurance of your WIM System installations (check all that apply):

Resident Engineer ☑
Manufacturer's representative ☐
District Engineer ☐
State QA Personnel ☐
WIM Technician ☐
Contracted Personnel (Company):
Other: Fed staff

[redacted] 2. Do you use established, written procedures, specifications, standard drawings, special provisions, department-furnished materials lists, etc. for WIM equipment *installation* ? If so, please list them here and send copies to Mr. Dean Wolf, dwolf@ara.com.

Contract specifications ☐
Agency document: Funcitonal Requirements with QC flow diagrams; 2013 TMG
Other:
Other:
Other:

[redacted] 3. Do you have any additional comments?

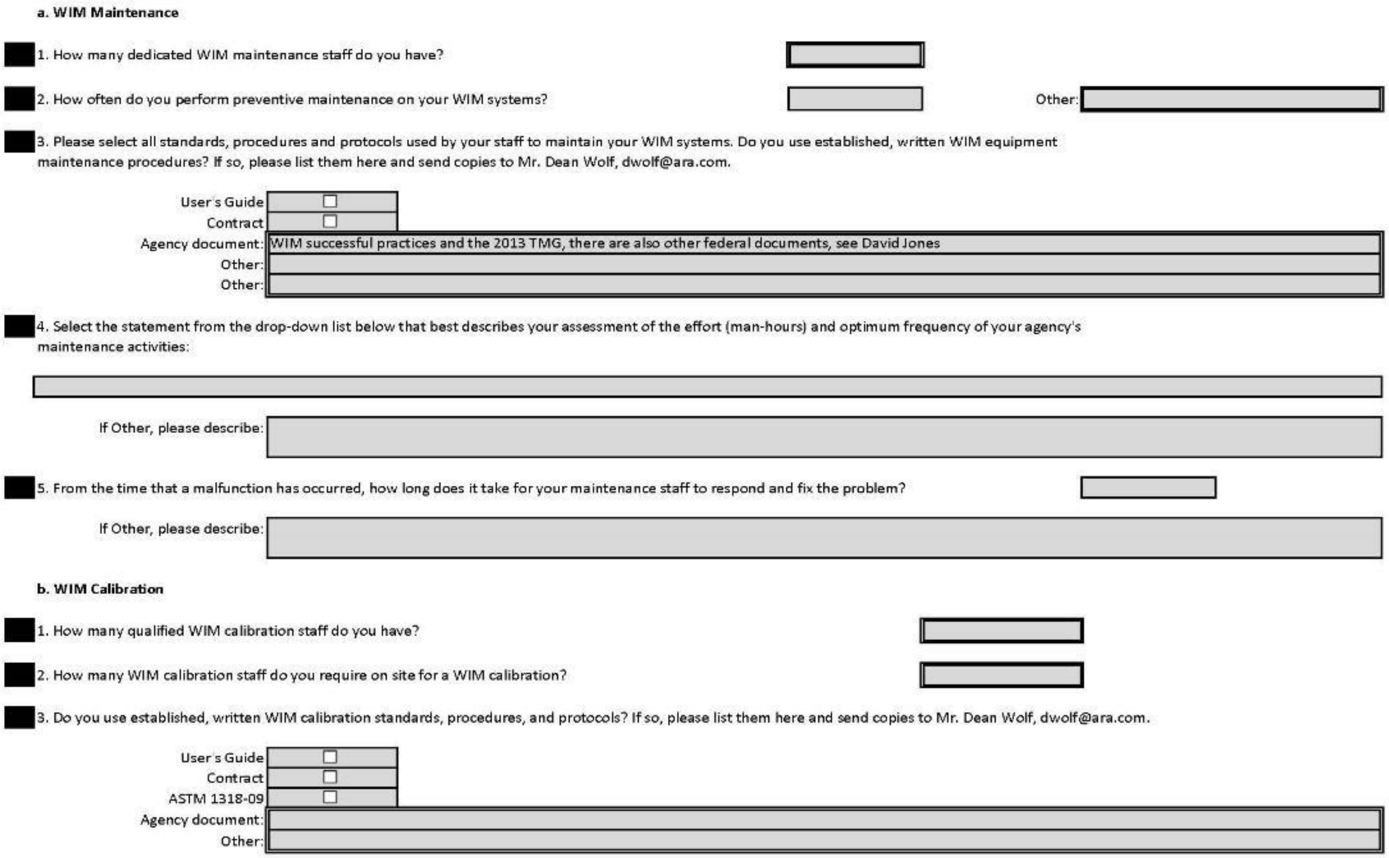
Having States use PVF data for all traffic sites would be extrememly important and produce better QA/QC along with a more widely used dataset. Speed by class would be easy to do, speed for WIM calibration could be done, reclassification of data could be done at any time, load spectrum coudl be improved, ...

E - WIM EQUIPMENT MAINTENANCE AND CALIBRATION PRACTICES

[redacted] 1. Select the option from the drop-down lists that best describes your agencies current practice for maintaining and calibrating your WIM systems.

If Other, please describe:

Figure 37. FHWA – Jessberger – Responses to Survey



a. WIM Maintenance

1. How many dedicated WIM maintenance staff do you have?

2. How often do you perform preventive maintenance on your WIM systems? Other:

3. Please select all standards, procedures and protocols used by your staff to maintain your WIM systems. Do you use established, written WIM equipment maintenance procedures? If so, please list them here and send copies to Mr. Dean Wolf, dwolf@ara.com.

User's Guide ☐
Contract ☐
Agency document: WIM successful practices and the 2013 TMG, there are also other federal documents, see David Jones
Other:
Other:

4. Select the statement from the drop-down list below that best describes your assessment of the effort (man-hours) and optimum frequency of your agency's maintenance activities:

If Other, please describe:

5. From the time that a malfunction has occurred, how long does it take for your maintenance staff to respond and fix the problem?

If Other, please describe:

b. WIM Calibration

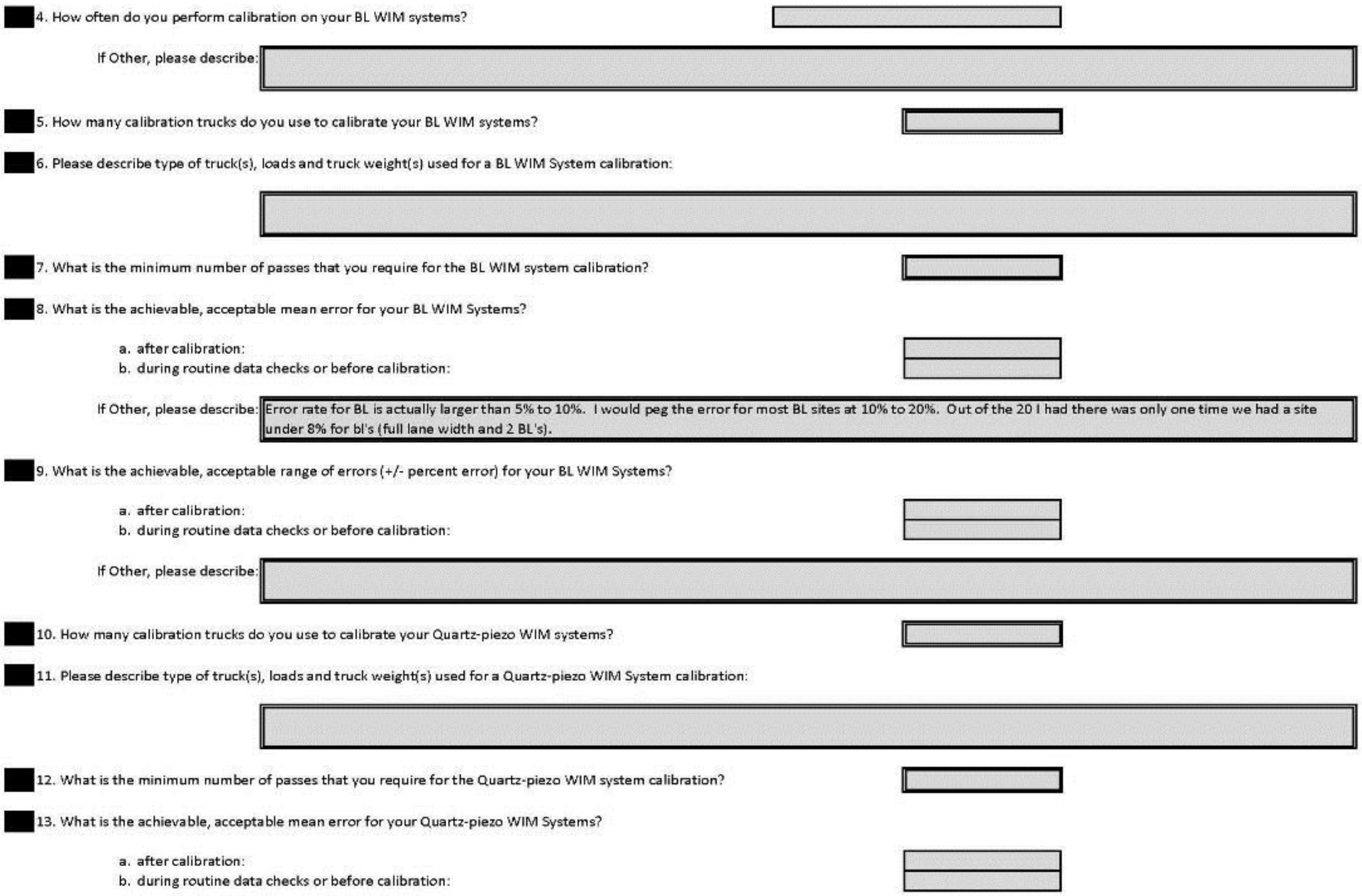
1. How many qualified WIM calibration staff do you have?

2. How many WIM calibration staff do you require on site for a WIM calibration?

3. Do you use established, written WIM calibration standards, procedures, and protocols? If so, please list them here and send copies to Mr. Dean Wolf, dwolf@ara.com.

User's Guide ☐
Contract ☐
ASTM 1318-09 ☐
Agency document:
Other:

Figure 38. FHWA – Jessberger – Responses to Survey



4. How often do you perform calibration on your BL WIM systems?

If Other, please describe:

5. How many calibration trucks do you use to calibrate your BL WIM systems?

6. Please describe type of truck(s), loads and truck weight(s) used for a BL WIM System calibration:

7. What is the minimum number of passes that you require for the BL WIM system calibration?

8. What is the achievable, acceptable mean error for your BL WIM Systems?

a. after calibration:
b. during routine data checks or before calibration:

If Other, please describe: Error rate for BL is actually larger than 5% to 10%. I would peg the error for most BL sites at 10% to 20%. Out of the 20 I had there was only one time we had a site under 8% for bl's (full lane width and 2 BL's).

9. What is the achievable, acceptable range of errors (+/- percent error) for your BL WIM Systems?

a. after calibration:
b. during routine data checks or before calibration:

If Other, please describe:

10. How many calibration trucks do you use to calibrate your Quartz-piezo WIM systems?

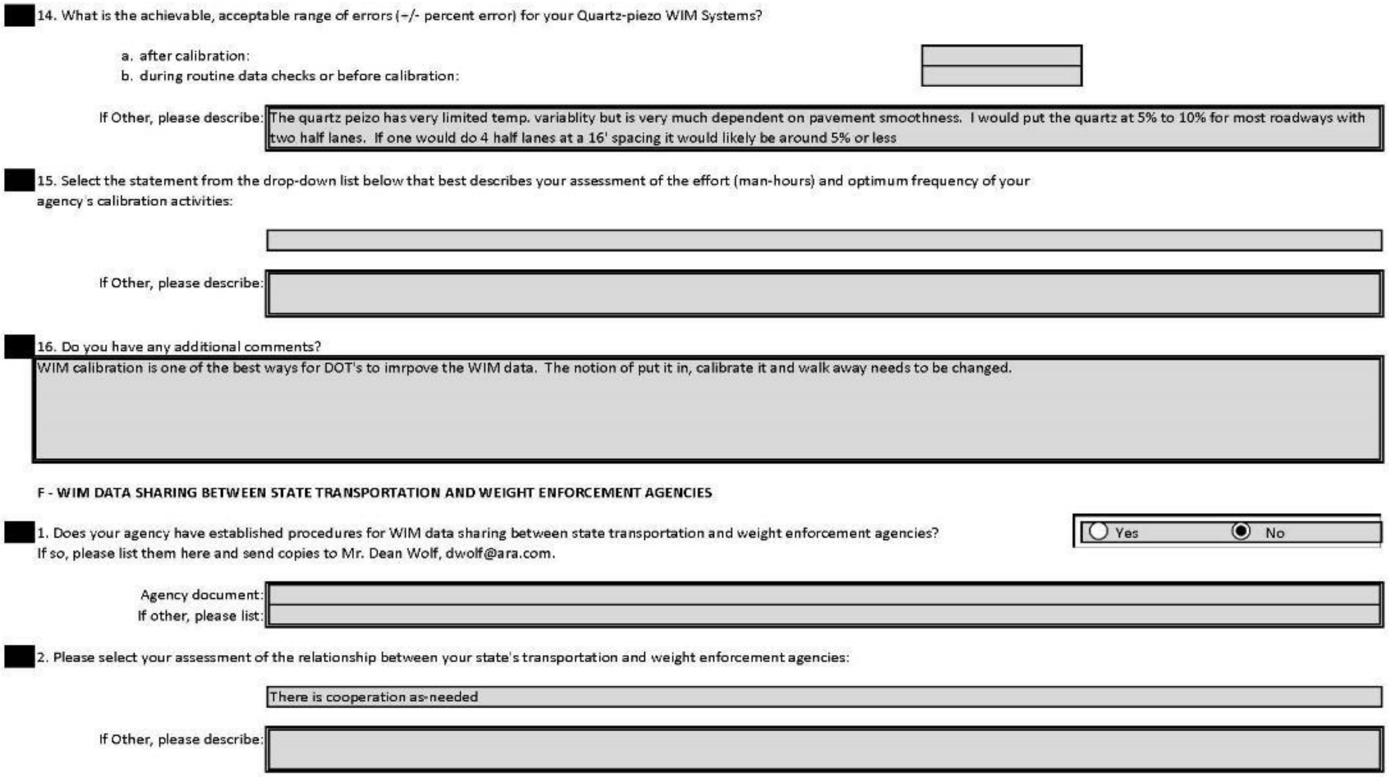
11. Please describe type of truck(s), loads and truck weight(s) used for a Quartz-piezo WIM System calibration:

12. What is the minimum number of passes that you require for the Quartz-piezo WIM system calibration?

13. What is the achievable, acceptable mean error for your Quartz-piezo WIM Systems?

a. after calibration:
b. during routine data checks or before calibration:

Figure 39. FHWA – Jessberger – Responses to Survey



[redacted] 14. What is the achievable, acceptable range of errors (-/- percent error) for your Quartz-piezo WIM Systems?

a. after calibration:
b. during routine data checks or before calibration:

If Other, please describe: The quartz peizo has very limited temp. variablity but is very much dependent on pavement smoothness. I would put the quartz at 5% to 10% for most roadways with two half lanes. If one would do 4 half lanes at a 16' spacing it would likely be around 5% or less

[redacted] 15. Select the statement from the drop-down list below that best describes your assessment of the effort (man-hours) and optimum frequency of your agency's calibration activities:

If Other, please describe:

[redacted] 16. Do you have any additional comments?

WIM calibration is one of the best ways for DOT's to imrpove the WIM data. The notion of put it in, calibrate it and walk away needs to be changed.

F - WIM DATA SHARING BETWEEN STATE TRANSPORTATION AND WEIGHT ENFORCEMENT AGENCIES

[redacted] 1. Does your agency have established procedures for WIM data sharing between state transportation and weight enforcement agencies? If so, please list them here and send copies to Mr. Dean Wolf, dwolf@ara.com.

○ Yes ● No

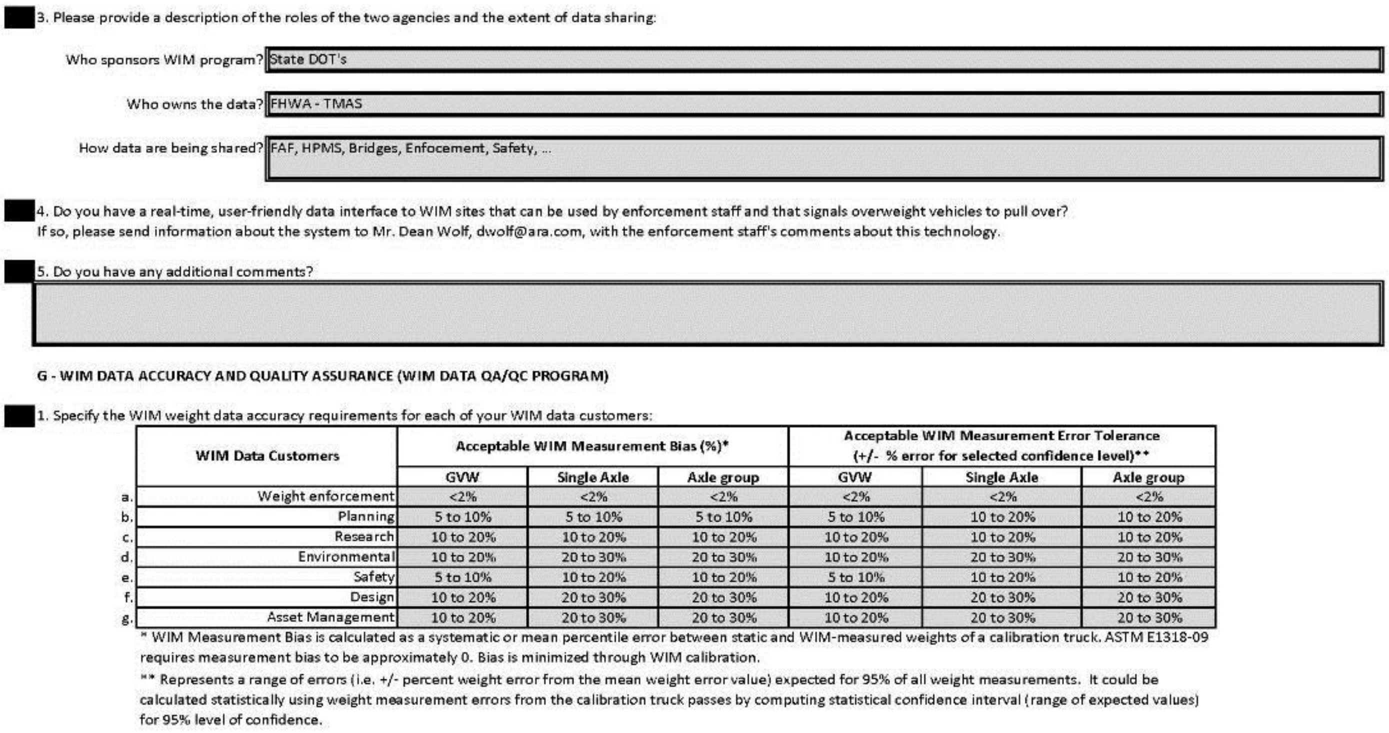
Agency document:
If other, please list:

[redacted] 2. Please select your assessment of the relationship between your state's transportation and weight enforcement agencies:

There is cooperation as-needed

If Other, please describe:

Figure 40. FHWA – Jessberger – Responses to Survey



[redacted] 3. Please provide a description of the roles of the two agencies and the extent of data sharing:

Who sponsors WIM program? State DOT's

Who owns the data? FHWA - TMAS

How data are being shared? FAF, HPMS, Bridges, Enfocement, Safety, ...

[redacted] 4. Do you have a real-time, user-friendly data interface to WIM sites that can be used by enforcement staff and that signals overweight vehicles to pull over?
If so, please send information about the system to Mr. Dean Wolf, dwolf@ara.com, with the enforcement staff's comments about this technology.

[redacted] 5. Do you have any additional comments?

G - WIM DATA ACCURACY AND QUALITY ASSURANCE (WIM DATA QA/QC PROGRAM)

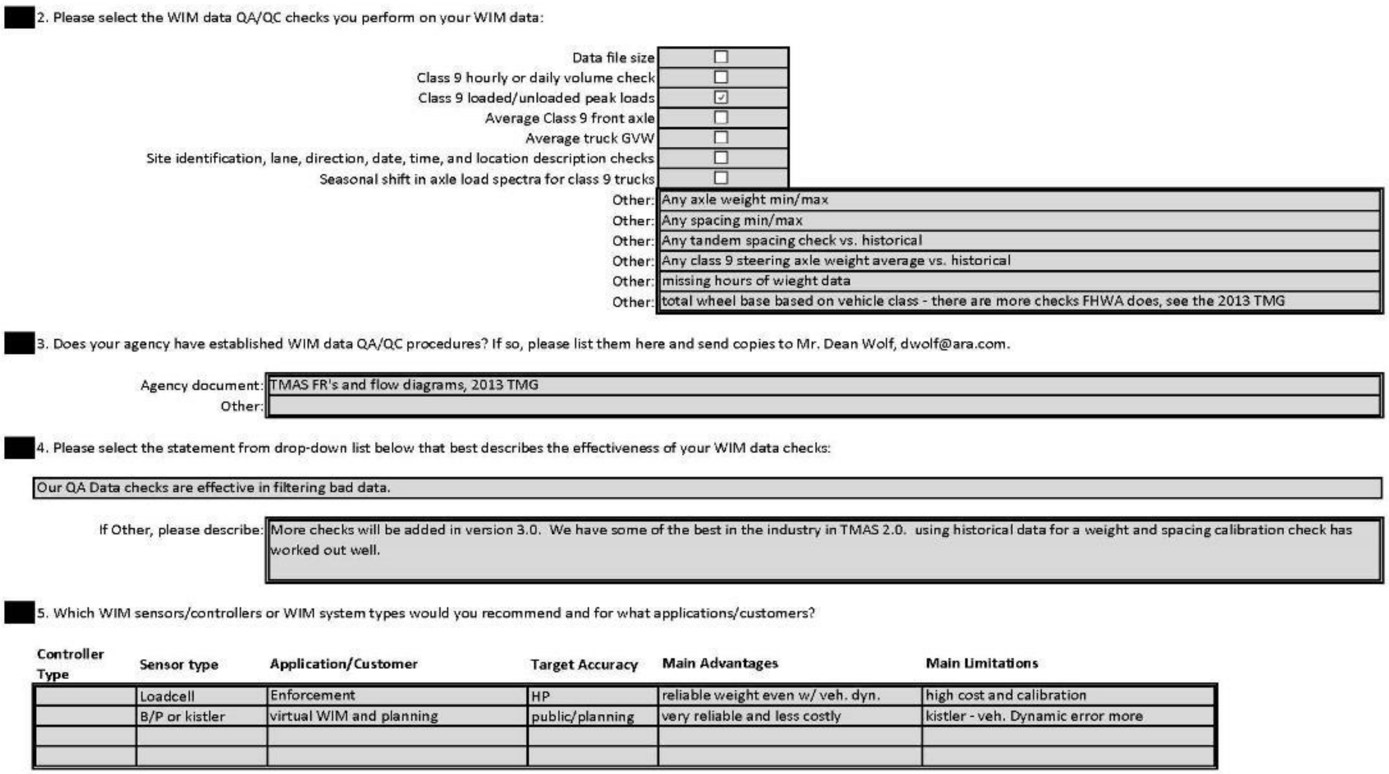
[redacted] 1. Specify the WIM weight data accuracy requirements for each of your WIM data customers:

	WIM Data Customers	Acceptable WIM Measurement Bias (%)*			Acceptable WIM Measurement Error Tolerance (+/- % error for selected confidence level)**		
		GVW	Single Axle	Axle group	GVW	Single Axle	Axle group
a.	Weight enforcement	<2%	<2%	<2%	<2%	<2%	<2%
b.	Planning	5 to 10%	5 to 10%	5 to 10%	5 to 10%	10 to 20%	10 to 20%
c.	Research	10 to 20%	10 to 20%	10 to 20%	10 to 20%	10 to 20%	10 to 20%
d.	Environmental	10 to 20%	20 to 30%	20 to 30%	10 to 20%	20 to 30%	20 to 30%
e.	Safety	5 to 10%	10 to 20%	10 to 20%	5 to 10%	10 to 20%	10 to 20%
f.	Design	10 to 20%	20 to 30%	20 to 30%	10 to 20%	20 to 30%	20 to 30%
g.	Asset Management	10 to 20%	20 to 30%	20 to 30%	10 to 20%	20 to 30%	20 to 30%

* WIM Measurement Bias is calculated as a systematic or mean percentile error between static and WIM-measured weights of a calibration truck. ASTM E1318-09 requires measurement bias to be approximately 0. Bias is minimized through WIM calibration.

** Represents a range of errors (i.e. +/- percent weight error from the mean weight error value) expected for 95% of all weight measurements. It could be calculated statistically using weight measurement errors from the calibration truck passes by computing statistical confidence interval (range of expected values) for 95% level of confidence.

Figure 41. FHWA – Jessberger – Responses to Survey



[redacted] 2. Please select the WIM data QA/QC checks you perform on your WIM data:

Data file size	☐
Class 9 hourly or daily volume check	☐
Class 9 loaded/unloaded peak loads	☑
Average Class 9 front axle	☐
Average truck GVW	☐
Site identification, lane, direction, date, time, and location description checks	☐
Seasonal shift in axle load spectra for class 9 trucks	☐
Other:	Any axle weight min/max
Other:	Any spacing min/max
Other:	Any tandem spacing check vs. historical
Other:	Any class 9 steering axle weight average vs. historical
Other:	missing hours of wieght data
Other:	total wheel base based on vehicle class - there are more checks FHWA does, see the 2013 TMG

[redacted] 3. Does your agency have established WIM data QA/QC procedures? If so, please list them here and send copies to Mr. Dean Wolf, dwolf@ara.com.

Agency document: TMAS FR's and flow diagrams, 2013 TMG

Other:

[redacted] 4. Please select the statement from drop-down list below that best describes the effectiveness of your WIM data checks:

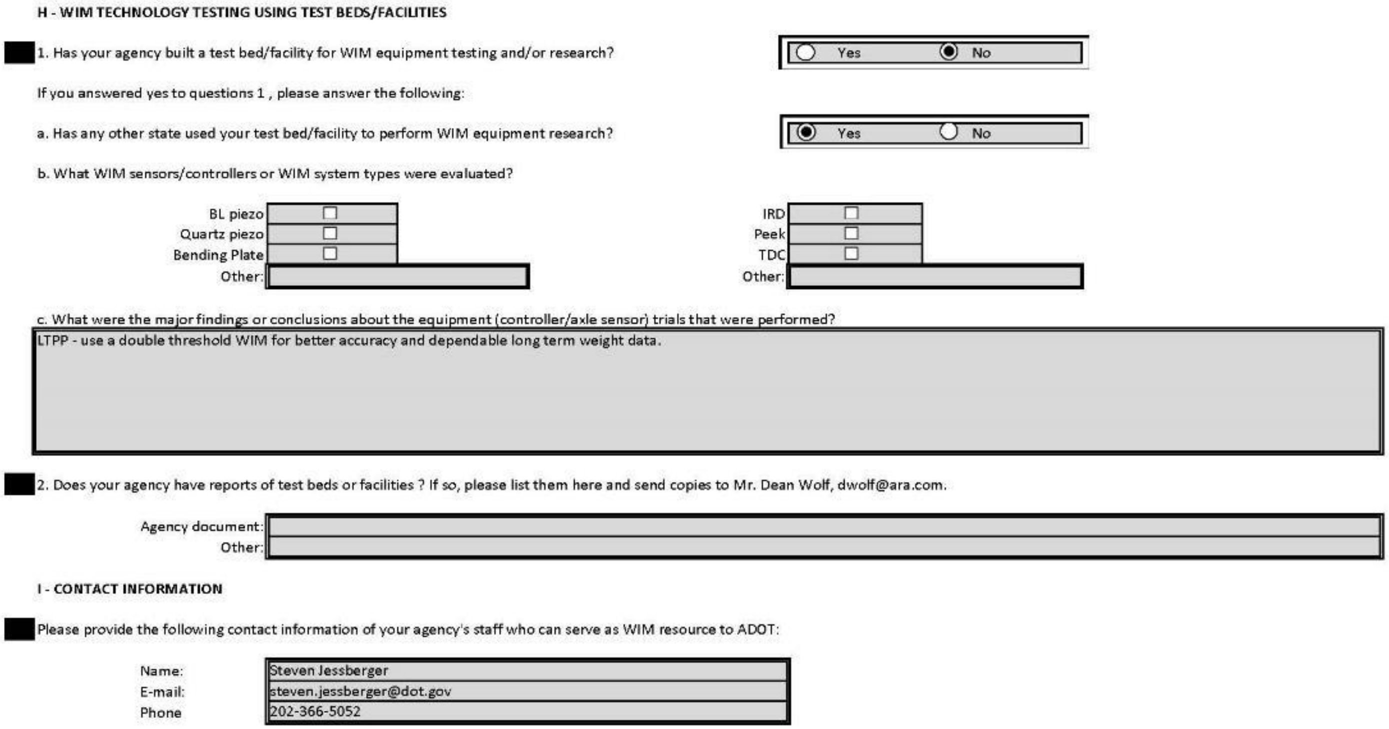
Our QA Data checks are effective in filtering bad data.

If Other, please describe: More checks will be added in version 3.0. We have some of the best in the industry in TMAS 2.0. using historical data for a weight and spacing calibration check has worked out well.

[redacted] 5. Which WIM sensors/controllers or WIM system types would you recommend and for what applications/customers?

Controller Type	Sensor type	Application/Customer	Target Accuracy	Main Advantages	Main Limitations
	Loadcell	Enforcement	HP	reliable weight even w/ veh. dyn.	high cost and calibration
	B/P or kistler	virtual WIM and planning	public/planning	very reliable and less costly	kistler - veh. Dynamic error more

Figure 42. FHWA – Jessberger – Responses to Survey



H - WIM TECHNOLOGY TESTING USING TEST BEDS/FACILITIES

1. Has your agency built a test bed/facility for WIM equipment testing and/or research? ○ Yes ● No

If you answered yes to questions 1 , please answer the following:

a. Has any other state used your test bed/facility to perform WIM equipment research? ● Yes ○ No

b. What WIM sensors/controllers or WIM system types were evaluated?

BL piezo	☐	IRD	☐
Quartz piezo	☐	Peek	☐
Bending Plate	☐	TDC	☐
Other:		Other:	

c. What were the major findings or conclusions about the equipment (controller/axle sensor) trials that were performed?

LTPP - use a double threshold WIM for better accuracy and dependable long term weight data.

2. Does your agency have reports of test beds or facilities ? If so, please list them here and send copies to Mr. Dean Wolf, dwolf@ara.com.

Agency document:

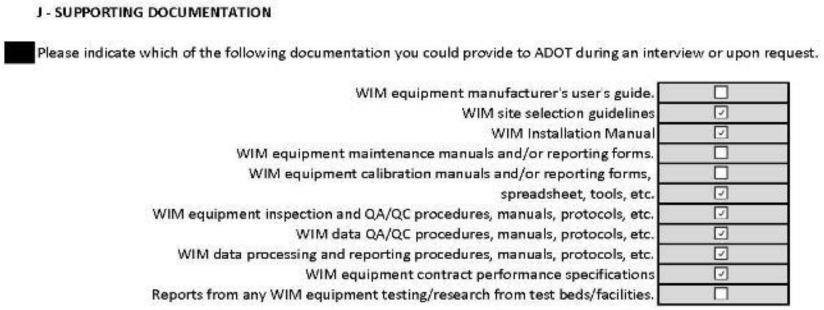
Other:

I - CONTACT INFORMATION

Please provide the following contact information of your agency's staff who can serve as WIM resource to ADOT:

Name:	Steven Jessberger
E-mail:	steven.jessberger@dot.gov
Phone	202-366-5052

Figure 43. FHWA – Jessberger – Responses to Survey



J - SUPPORTING DOCUMENTATION

[redacted] Please indicate which of the following documentation you could provide to ADOT during an interview or upon request.

WIM equipment manufacturer's user's guide.	☐
WIM site selection guidelines	☑
WIM Installation Manual	☑
WIM equipment maintenance manuals and/or reporting forms.	☐
WIM equipment calibration manuals and/or reporting forms,	☐
spreadsheet, tools, etc.	☑
WIM equipment inspection and QA/QC procedures, manuals, protocols, etc.	☑
WIM data QA/QC procedures, manuals, protocols, etc.	☑
WIM data processing and reporting procedures, manuals, protocols, etc.	☑
WIM equipment contract performance specifications	☑
Reports from any WIM equipment testing/research from test beds/facilities.	☐

Figure 44. FHWA – Jessberger – Responses to Survey

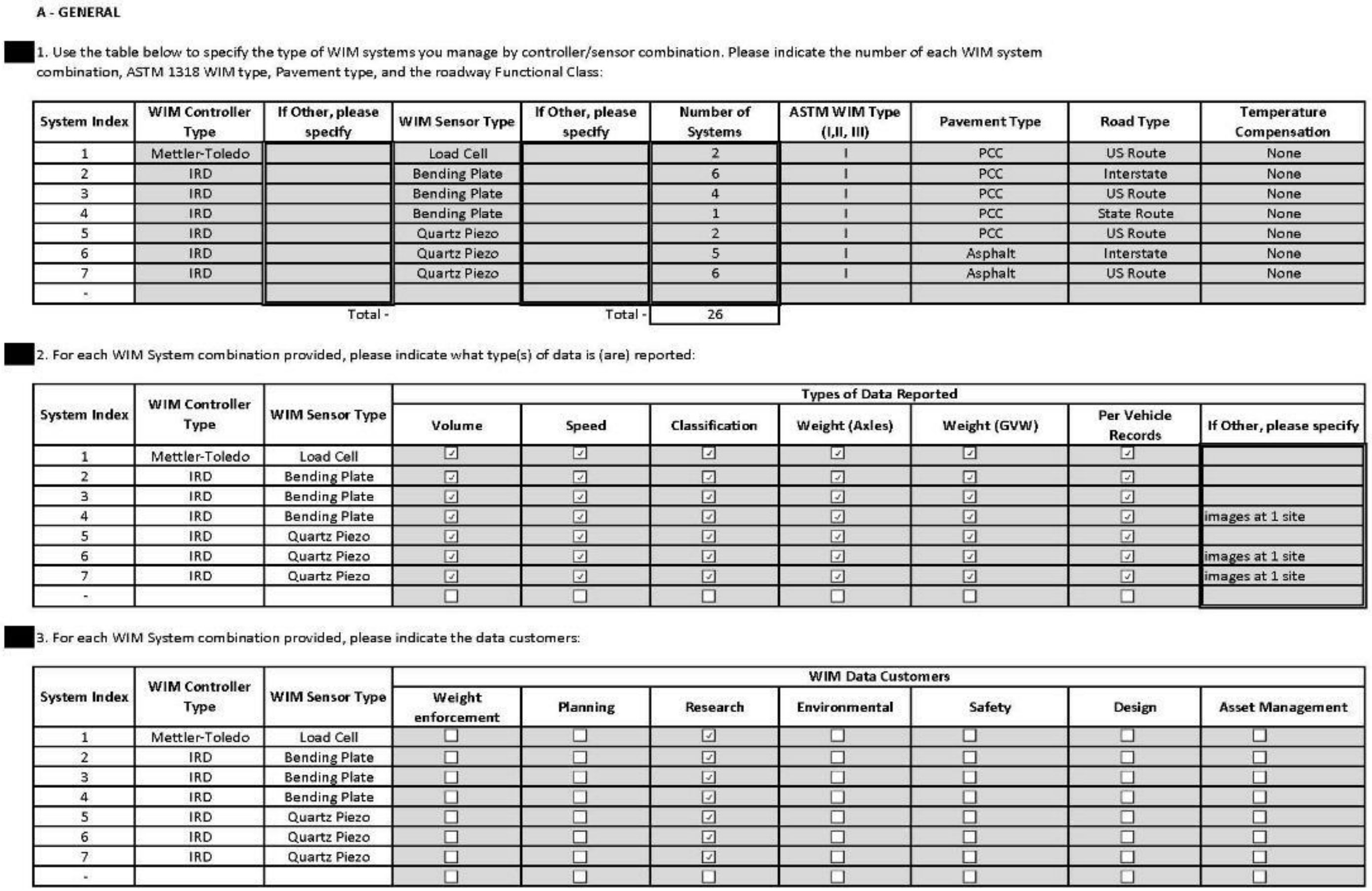
Federal Highway Administration (Deborah Walker)

Highway Research Engineer - Turner-Fairbank Highway Research Center

Office of Infrastructure Research and Development – Long Term Pavement Performance (LTPP) Team

Manager – LTPP SPS WIM TPF 5(004)

Executive Secretary – International Society for Weigh-in-Motion



A - GENERAL

[redacted] 1. Use the table below to specify the type of WIM systems you manage by controller/sensor combination. Please indicate the number of each WIM system combination, ASTM 1318 WIM type, Pavement type, and the roadway Functional Class:

System Index	WIM Controller Type	If Other, please specify	WIM Sensor Type	If Other, please specify	Number of Systems	ASTM WIM Type (I,II, III)	Pavement Type	Road Type	Temperature Compensation
1	Mettler-Toledo		Load Cell		2	I	PCC	US Route	None
2	IRD		Bending Plate		6	I	PCC	Interstate	None
3	IRD		Bending Plate		4	I	PCC	US Route	None
4	IRD		Bending Plate		1	I	PCC	State Route	None
5	IRD		Quartz Piezo		2	I	PCC	US Route	None
6	IRD		Quartz Piezo		5	I	Asphalt	Interstate	None
7	IRD		Quartz Piezo		6	I	Asphalt	US Route	None
-									
		Total -		Total -	26				

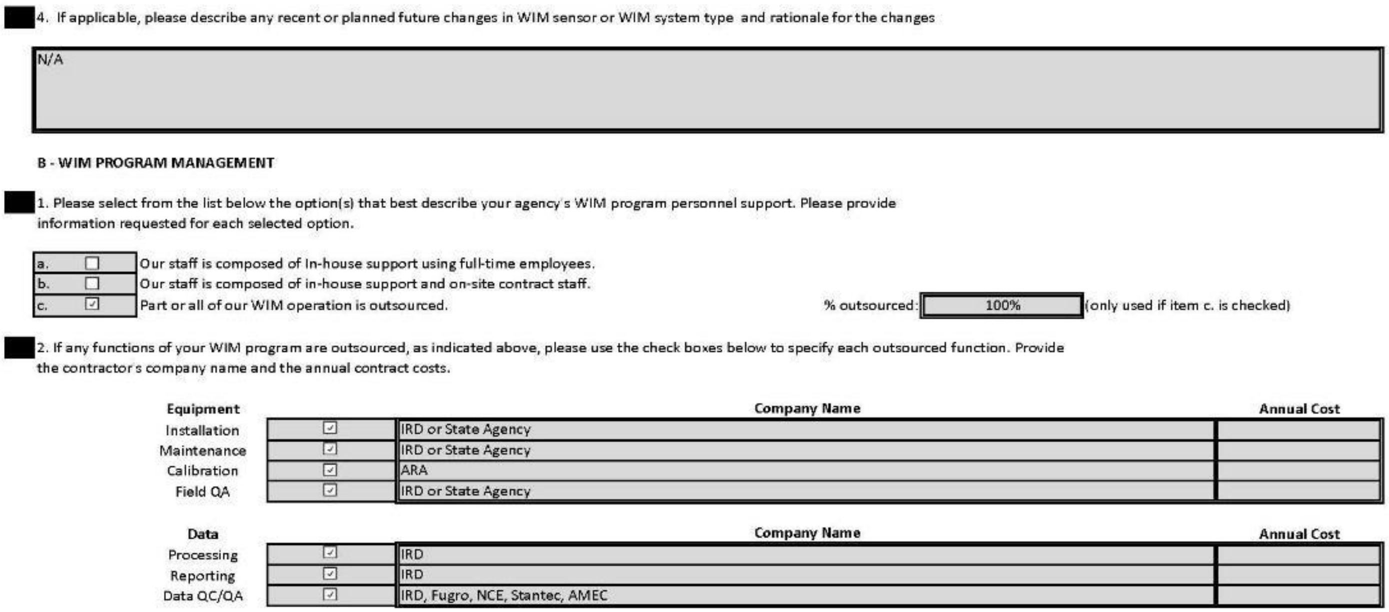
[redacted] 2. For each WIM System combination provided, please indicate what type(s) of data is (are) reported:

System Index	WIM Controller Type	WIM Sensor Type	Types of Data Reported						
			Volume	Speed	Classification	Weight (Axles)	Weight (GVW)	Per Vehicle Records	If Other, please specify
1	Mettler-Toledo	Load Cell	☑	☑	☑	☑	☑	☑	
2	IRD	Bending Plate	☑	☑	☑	☑	☑	☑	
3	IRD	Bending Plate	☑	☑	☑	☑	☑	☑	
4	IRD	Bending Plate	☑	☑	☑	☑	☑	☑	images at 1 site
5	IRD	Quartz Piezo	☑	☑	☑	☑	☑	☑	
6	IRD	Quartz Piezo	☑	☑	☑	☑	☑	☑	images at 1 site
7	IRD	Quartz Piezo	☑	☑	☑	☑	☑	☑	images at 1 site
-			☐	☐	☐	☐	☐	☐	

[redacted] 3. For each WIM System combination provided, please indicate the data customers:

System Index	WIM Controller Type	WIM Sensor Type	WIM Data Customers						
			Weight enforcement	Planning	Research	Environmental	Safety	Design	Asset Management
1	Mettler-Toledo	Load Cell	☐	☐	☑	☐	☐	☐	☐
2	IRD	Bending Plate	☐	☐	☑	☐	☐	☐	☐
3	IRD	Bending Plate	☐	☐	☑	☐	☐	☐	☐
4	IRD	Bending Plate	☐	☐	☑	☐	☐	☐	☐
5	IRD	Quartz Piezo	☐	☐	☑	☐	☐	☐	☐
6	IRD	Quartz Piezo	☐	☐	☑	☐	☐	☐	☐
7	IRD	Quartz Piezo	☐	☐	☑	☐	☐	☐	☐
-			☐	☐	☐	☐	☐	☐	☐

Figure 45. FHWA – Walker – Responses to Survey



[redacted] 4. If applicable, please describe any recent or planned future changes in WIM sensor or WIM system type and rationale for the changes

N/A

B - WIM PROGRAM MANAGEMENT

[redacted] 1. Please select from the list below the option(s) that best describe your agency s WIM program personnel support. Please provide information requested for each selected option.

a. ☐ Our staff is composed of In-house support using full-time employees.
b. ☐ Our staff is composed of in-house support and on-site contract staff.
c. ☑ Part or all of our WIM operation is outsourced.

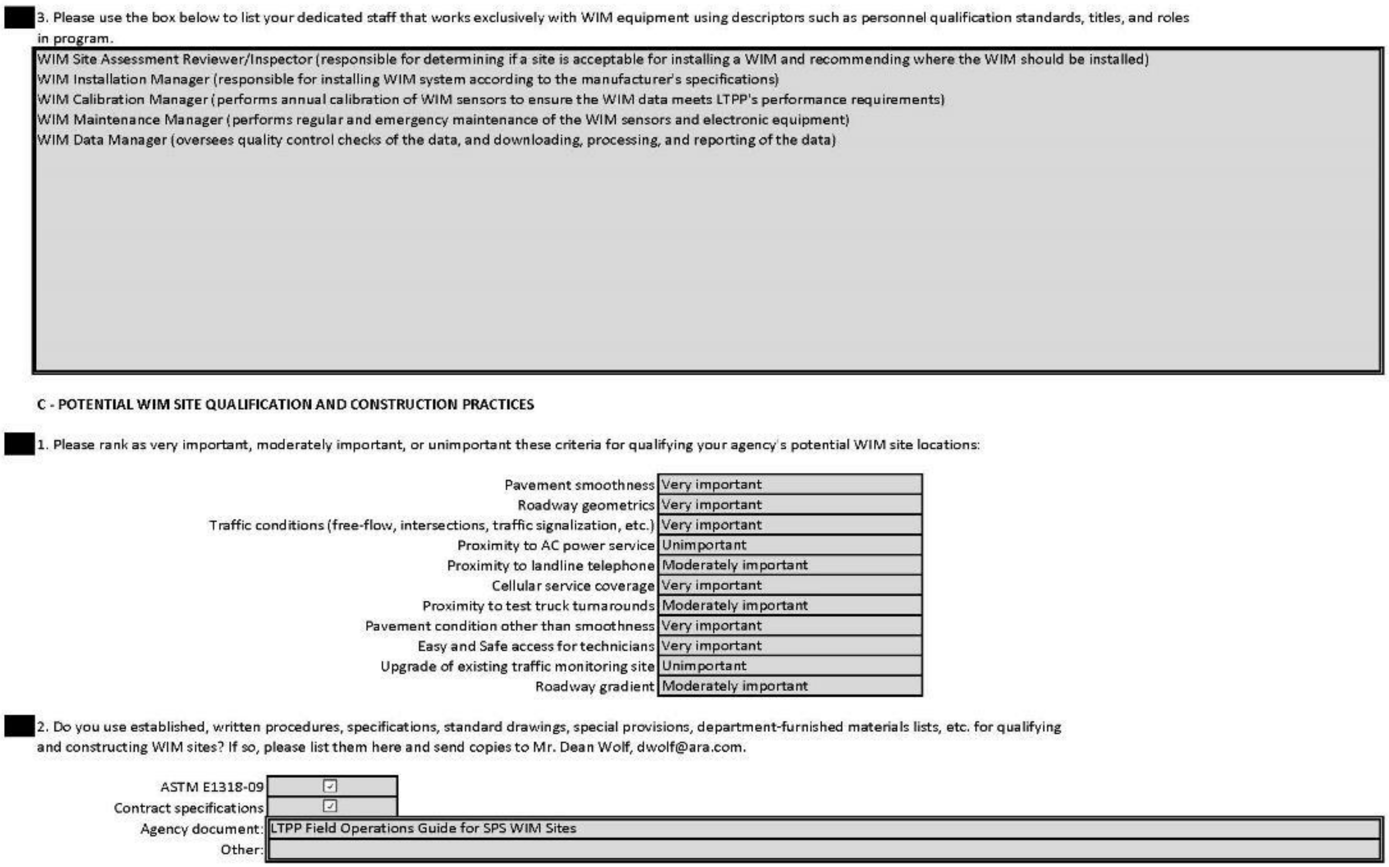
% outsourced: 100% (only used if item c. is checked)

[redacted] 2. If any functions of your WIM program are outsourced, as indicated above, please use the check boxes below to specify each outsourced function. Provide the contractor s company name and the annual contract costs.

Equipment		Company Name	Annual Cost
Installation	☑	IRD or State Agency	
Maintenance	☑	IRD or State Agency	
Calibration	☑	ARA	
Field QA	☑	IRD or State Agency	

Data		Company Name	Annual Cost
Processing	☑	IRD	
Reporting	☑	IRD	
Data QC/QA	☑	IRD, Fugro, NCE, Stantec, AMEC	

Figure 46. FHWA – Walker – Responses to Survey



[redacted] 3. Please use the box below to list your dedicated staff that works exclusively with WIM equipment using descriptors such as personnel qualification standards, titles, and roles in program.

WIM Site Assessment Reviewer/Inspector (responsible for determining if a site is acceptable for installing a WIM and recommending where the WIM should be installed)
WIM Installation Manager (responsible for installing WIM system according to the manufacturer's specifications)
WIM Calibration Manager (performs annual calibration of WIM sensors to ensure the WIM data meets LTPP's performance requirements)
WIM Maintenance Manager (performs regular and emergency maintenance of the WIM sensors and electronic equipment)
WIM Data Manager (oversees quality control checks of the data, and downloading, processing, and reporting of the data)

C - POTENTIAL WIM SITE QUALIFICATION AND CONSTRUCTION PRACTICES

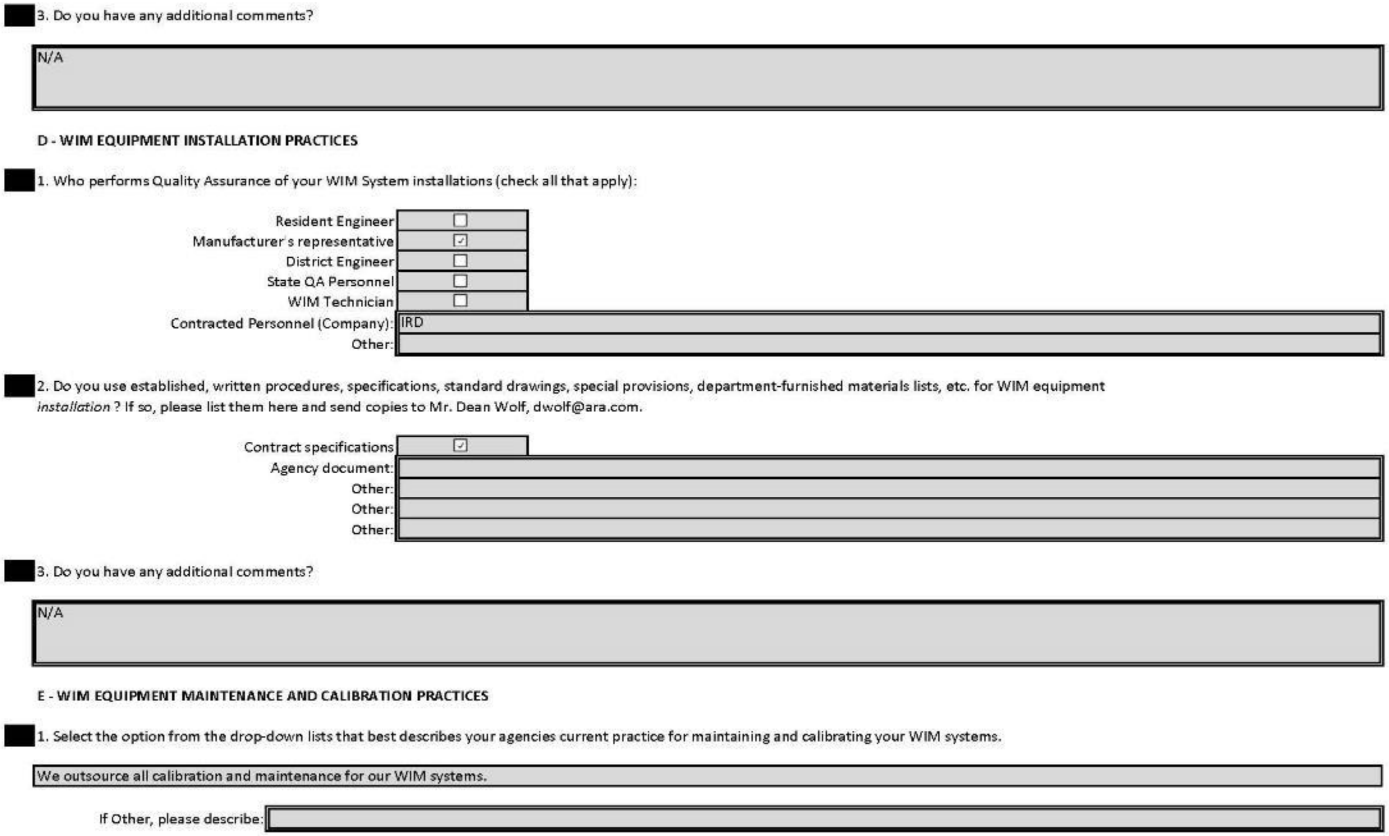
[redacted] 1. Please rank as very important, moderately important, or unimportant these criteria for qualifying your agency's potential WIM site locations:

Pavement smoothness	Very important
Roadway geometrics	Very important
Traffic conditions (free-flow, intersections, traffic signalization, etc.)	Very important
Proximity to AC power service	Unimportant
Proximity to landline telephone	Moderately important
Cellular service coverage	Very important
Proximity to test truck turnarounds	Moderately important
Pavement condition other than smoothness	Very important
Easy and Safe access for technicians	Very important
Upgrade of existing traffic monitoring site	Unimportant
Roadway gradient	Moderately important

[redacted] 2. Do you use established, written procedures, specifications, standard drawings, special provisions, department-furnished materials lists, etc. for qualifying and constructing WIM sites? If so, please list them here and send copies to Mr. Dean Wolf, dwolf@ara.com.

ASTM E1318-09	☑
Contract specifications	☑
Agency document:	LTPP Field Operations Guide for SPS WIM Sites
Other:	

Figure 47. FHWA – Walker – Responses to Survey



3. Do you have any additional comments?

N/A

D - WIM EQUIPMENT INSTALLATION PRACTICES

1. Who performs Quality Assurance of your WIM System installations (check all that apply):

Resident Engineer ☐
Manufacturer's representative ☑
District Engineer ☐
State QA Personnel ☐
WIM Technician ☐
Contracted Personnel (Company): IRD
Other:

2. Do you use established, written procedures, specifications, standard drawings, special provisions, department-furnished materials lists, etc. for WIM equipment *installation* ? If so, please list them here and send copies to Mr. Dean Wolf, dwolf@ara.com.

Contract specifications ☑
Agency document:
Other:
Other:
Other:

3. Do you have any additional comments?

N/A

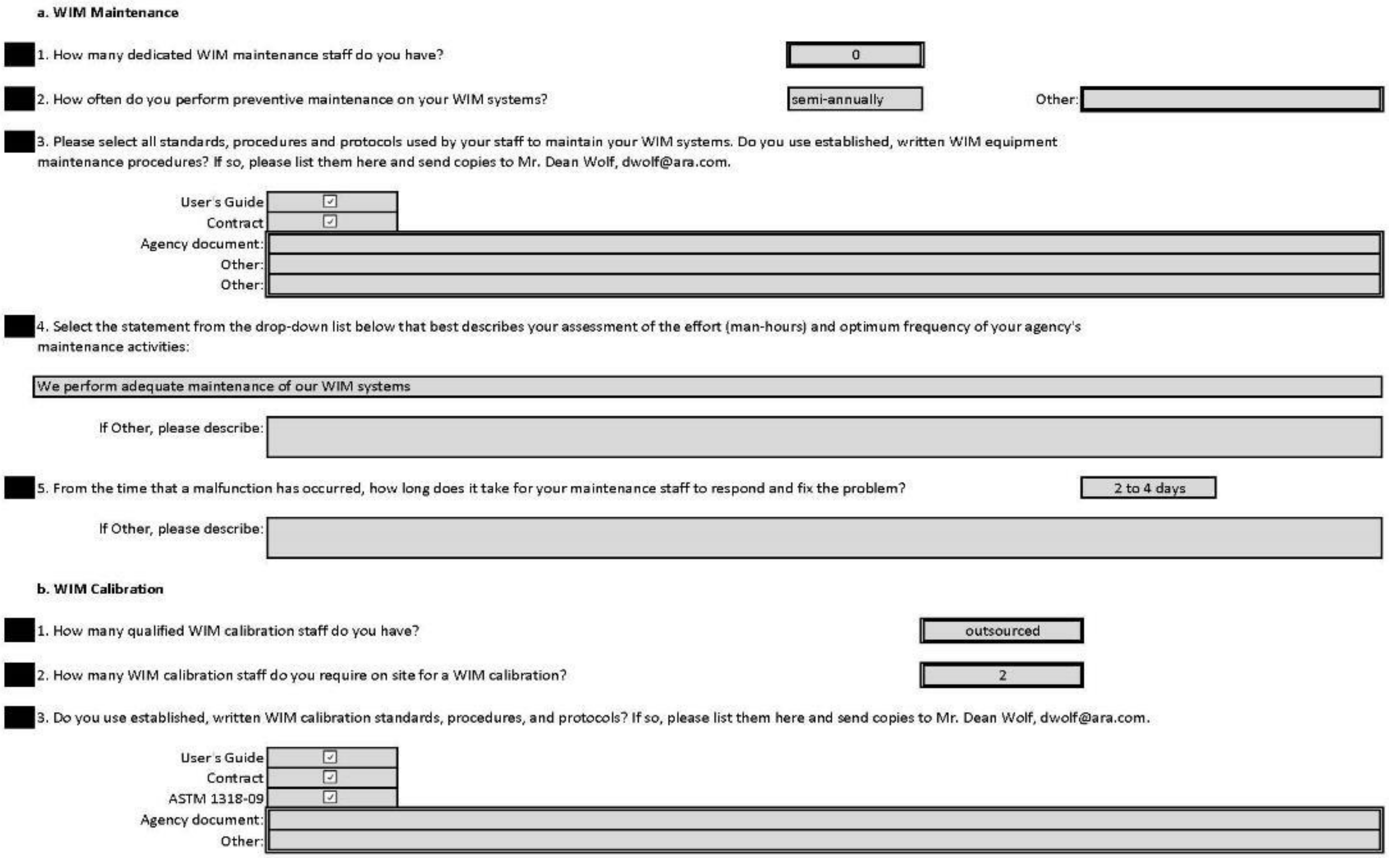
E - WIM EQUIPMENT MAINTENANCE AND CALIBRATION PRACTICES

1. Select the option from the drop-down lists that best describes your agencies current practice for maintaining and calibrating your WIM systems.

We outsource all calibration and maintenance for our WIM systems.

If Other, please describe:

Figure 48. FHWA – Walker – Responses to Survey



a. WIM Maintenance

1. How many dedicated WIM maintenance staff do you have? 0

2. How often do you perform preventive maintenance on your WIM systems? semi-annually Other:

3. Please select all standards, procedures and protocols used by your staff to maintain your WIM systems. Do you use established, written WIM equipment maintenance procedures? If so, please list them here and send copies to Mr. Dean Wolf, dwolf@ara.com.

User's Guide ☑
Contract ☑
Agency document:
Other:
Other:

4. Select the statement from the drop-down list below that best describes your assessment of the effort (man-hours) and optimum frequency of your agency's maintenance activities:

We perform adequate maintenance of our WIM systems

If Other, please describe:

5. From the time that a malfunction has occurred, how long does it take for your maintenance staff to respond and fix the problem? 2 to 4 days

If Other, please describe:

b. WIM Calibration

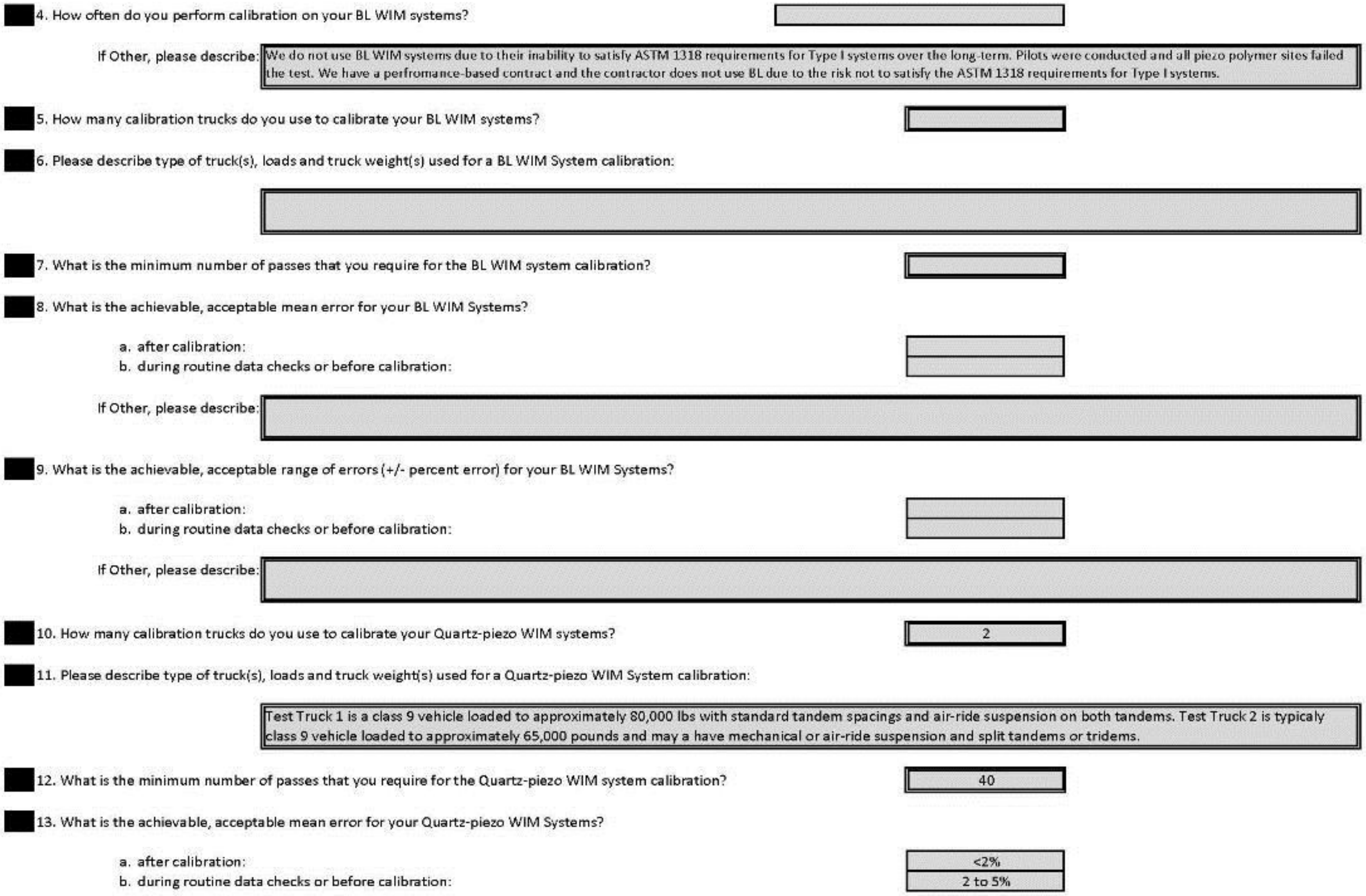
1. How many qualified WIM calibration staff do you have? outsourced

2. How many WIM calibration staff do you require on site for a WIM calibration? 2

3. Do you use established, written WIM calibration standards, procedures, and protocols? If so, please list them here and send copies to Mr. Dean Wolf, dwolf@ara.com.

User's Guide ☑
Contract ☑
ASTM 1318-09 ☑
Agency document:
Other:

Figure 49. FHWA – Walker – Responses to Survey



[redacted] 4. How often do you perform calibration on your BL WIM systems?

If Other, please describe: We do not use BL WIM systems due to their inability to satisfy ASTM 1318 requirements for Type I systems over the long-term. Pilots were conducted and all piezo polymer sites failed the test. We have a perfromance-based contract and the contractor does not use BL due to the risk not to satisfy the ASTM 1318 requirements for Type I systems.

[redacted] 5. How many calibration trucks do you use to calibrate your BL WIM systems?

[redacted] 6. Please describe type of truck(s), loads and truck weight(s) used for a BL WIM System calibration:

[redacted] 7. What is the minimum number of passes that you require for the BL WIM system calibration?

[redacted] 8. What is the achievable, acceptable mean error for your BL WIM Systems?

a. after calibration:
b. during routine data checks or before calibration:

If Other, please describe:

[redacted] 9. What is the achievable, acceptable range of errors (+/- percent error) for your BL WIM Systems?

a. after calibration:
b. during routine data checks or before calibration:

If Other, please describe:

[redacted] 10. How many calibration trucks do you use to calibrate your Quartz-piezo WIM systems? 2

[redacted] 11. Please describe type of truck(s), loads and truck weight(s) used for a Quartz-piezo WIM System calibration:

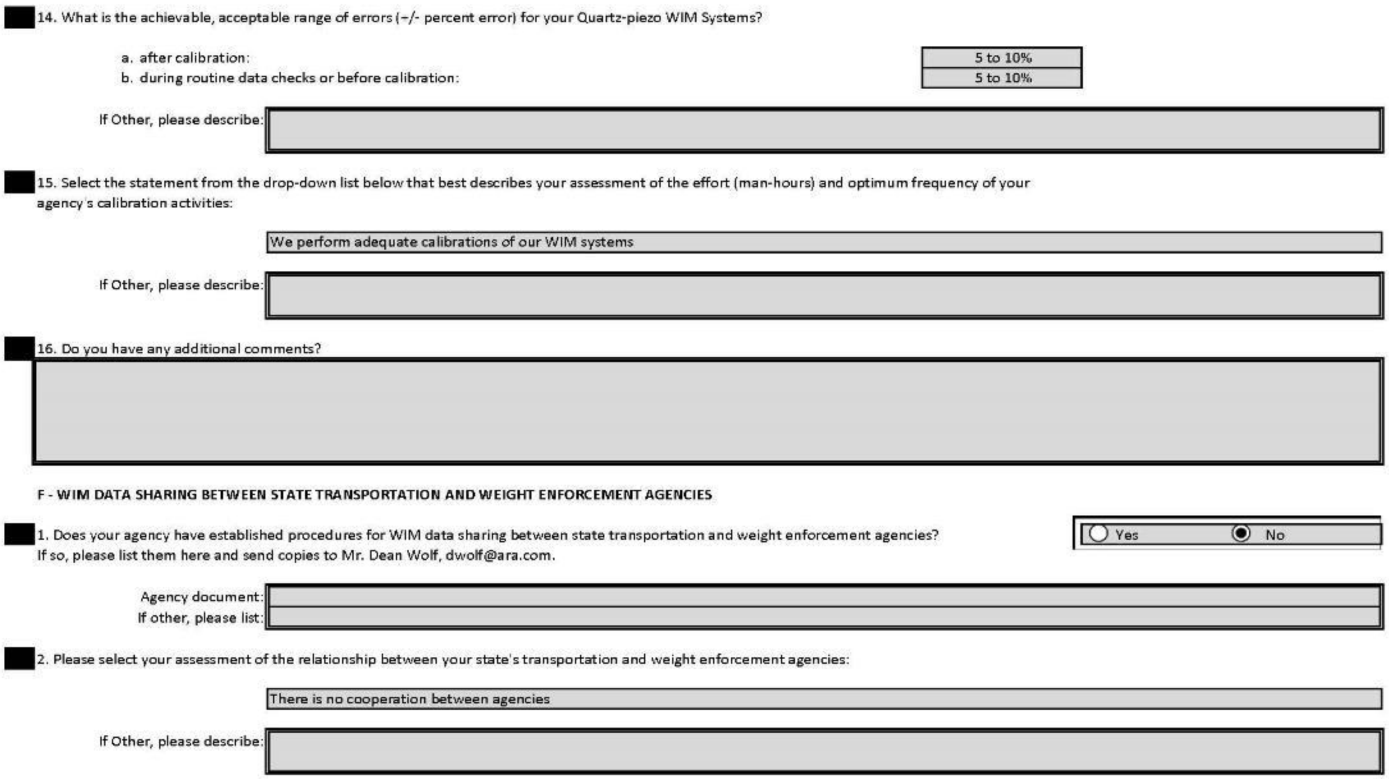
Test Truck 1 is a class 9 vehicle loaded to approximately 80,000 lbs with standard tandem spacings and air-ride suspension on both tandems. Test Truck 2 is typicaly class 9 vehicle loaded to approximately 65,000 pounds and may a have mechanical or air-ride suspension and split tandems or tridems.

[redacted] 12. What is the minimum number of passes that you require for the Quartz-piezo WIM system calibration? 40

[redacted] 13. What is the achievable, acceptable mean error for your Quartz-piezo WIM Systems?

a. after calibration: <2%
b. during routine data checks or before calibration: 2 to 5%

Figure 50. FHWA – Walker – Responses to Survey



[redacted] 14. What is the achievable, acceptable range of errors (-/- percent error) for your Quartz-piezo WIM Systems?

a. after calibration: 5 to 10%
b. during routine data checks or before calibration: 5 to 10%

If Other, please describe:

[redacted] 15. Select the statement from the drop-down list below that best describes your assessment of the effort (man-hours) and optimum frequency of your agency's calibration activities:

We perform adequate calibrations of our WIM systems

If Other, please describe:

[redacted] 16. Do you have any additional comments?

F - WIM DATA SHARING BETWEEN STATE TRANSPORTATION AND WEIGHT ENFORCEMENT AGENCIES

[redacted] 1. Does your agency have established procedures for WIM data sharing between state transportation and weight enforcement agencies? ○ Yes ● No
If so, please list them here and send copies to Mr. Dean Wolf, dwolf@ara.com.

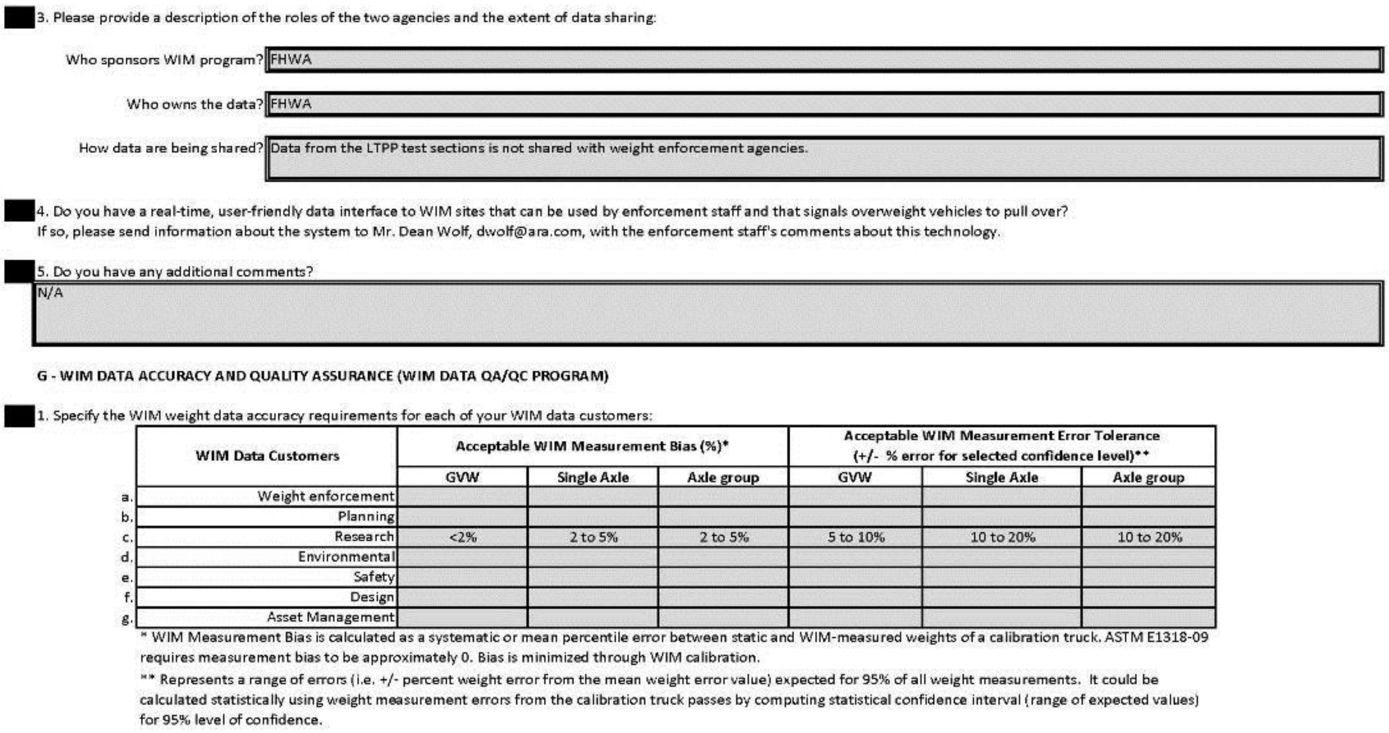
Agency document:
If other, please list:

[redacted] 2. Please select your assessment of the relationship between your state's transportation and weight enforcement agencies:

There is no cooperation between agencies

If Other, please describe:

Figure 51. FHWA – Walker – Responses to Survey



[redacted] 3. Please provide a description of the roles of the two agencies and the extent of data sharing:

Who sponsors WIM program?	FHWA
Who owns the data?	FHWA
How data are being shared?	Data from the LTPP test sections is not shared with weight enforcement agencies.

[redacted] 4. Do you have a real-time, user-friendly data interface to WIM sites that can be used by enforcement staff and that signals overweight vehicles to pull over?
If so, please send information about the system to Mr. Dean Wolf, dwolf@ara.com, with the enforcement staff's comments about this technology.

[redacted] 5. Do you have any additional comments?
N/A

G - WIM DATA ACCURACY AND QUALITY ASSURANCE (WIM DATA QA/QC PROGRAM)

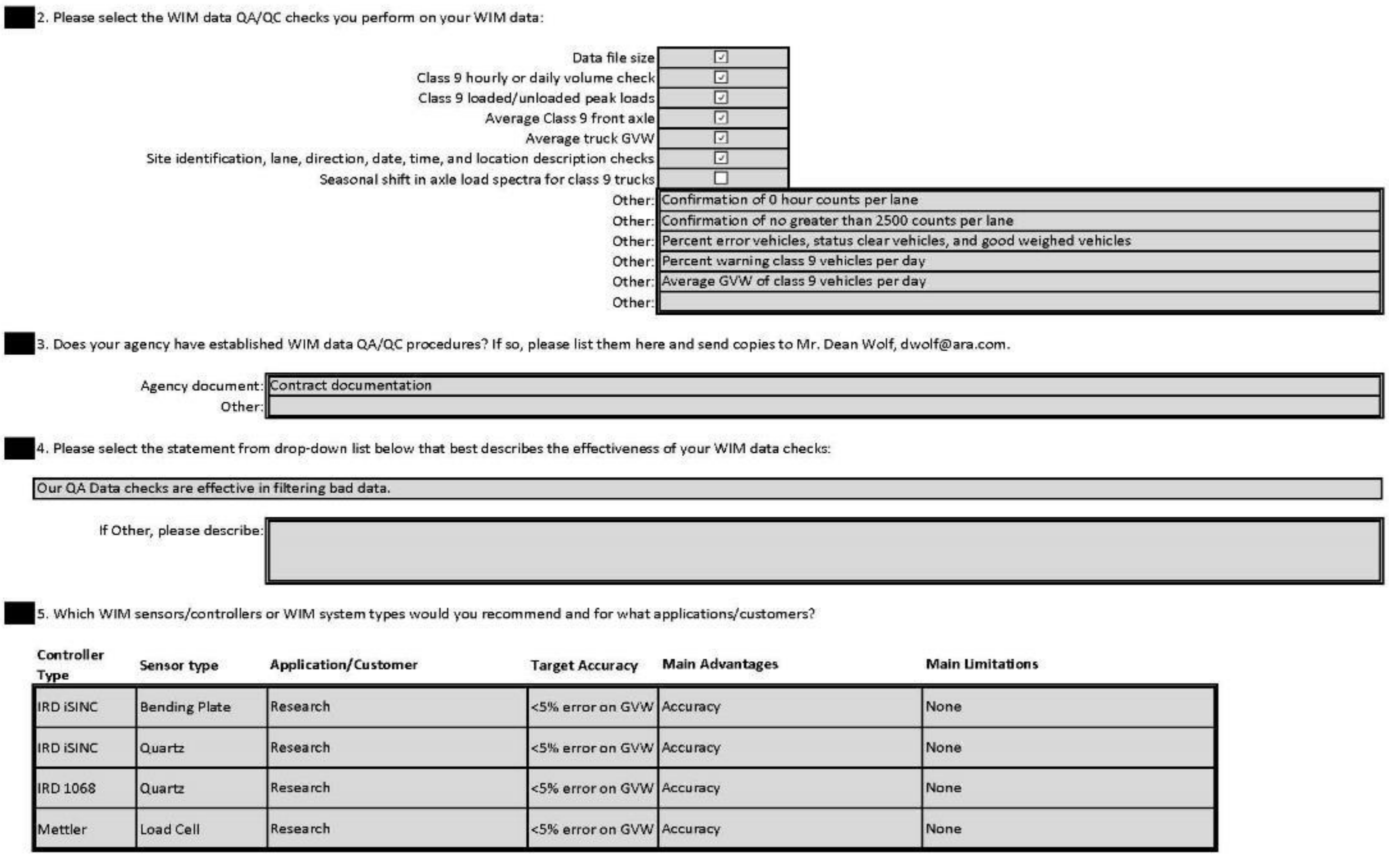
[redacted] 1. Specify the WIM weight data accuracy requirements for each of your WIM data customers:

	WIM Data Customers	Acceptable WIM Measurement Bias (%)*			Acceptable WIM Measurement Error Tolerance (+/- % error for selected confidence level)**		
		GVW	Single Axle	Axle group	GVW	Single Axle	Axle group
a.	Weight enforcement						
b.	Planning						
c.	Research	<2%	2 to 5%	2 to 5%	5 to 10%	10 to 20%	10 to 20%
d.	Environmental						
e.	Safety						
f.	Design						
g.	Asset Management						

* WIM Measurement Bias is calculated as a systematic or mean percentile error between static and WIM-measured weights of a calibration truck. ASTM E1318-09 requires measurement bias to be approximately 0. Bias is minimized through WIM calibration.

** Represents a range of errors (i.e. +/- percent weight error from the mean weight error value) expected for 95% of all weight measurements. It could be calculated statistically using weight measurement errors from the calibration truck passes by computing statistical confidence interval (range of expected values) for 95% level of confidence.

Figure 52. FHWA – Walker – Responses to Survey



[redacted] 2. Please select the WIM data QA/QC checks you perform on your WIM data:

Data file size ☑
Class 9 hourly or daily volume check ☑
Class 9 loaded/unloaded peak loads ☑
Average Class 9 front axle ☑
Average truck GVW ☑
Site identification, lane, direction, date, time, and location description checks ☑
Seasonal shift in axle load spectra for class 9 trucks ☐
Other: Confirmation of 0 hour counts per lane
Other: Confirmation of no greater than 2500 counts per lane
Other: Percent error vehicles, status clear vehicles, and good weighed vehicles
Other: Percent warning class 9 vehicles per day
Other: Average GVW of class 9 vehicles per day
Other:

[redacted] 3. Does your agency have established WIM data QA/QC procedures? If so, please list them here and send copies to Mr. Dean Wolf, dwolf@ara.com.

Agency document: Contract documentation
Other:

[redacted] 4. Please select the statement from drop-down list below that best describes the effectiveness of your WIM data checks:

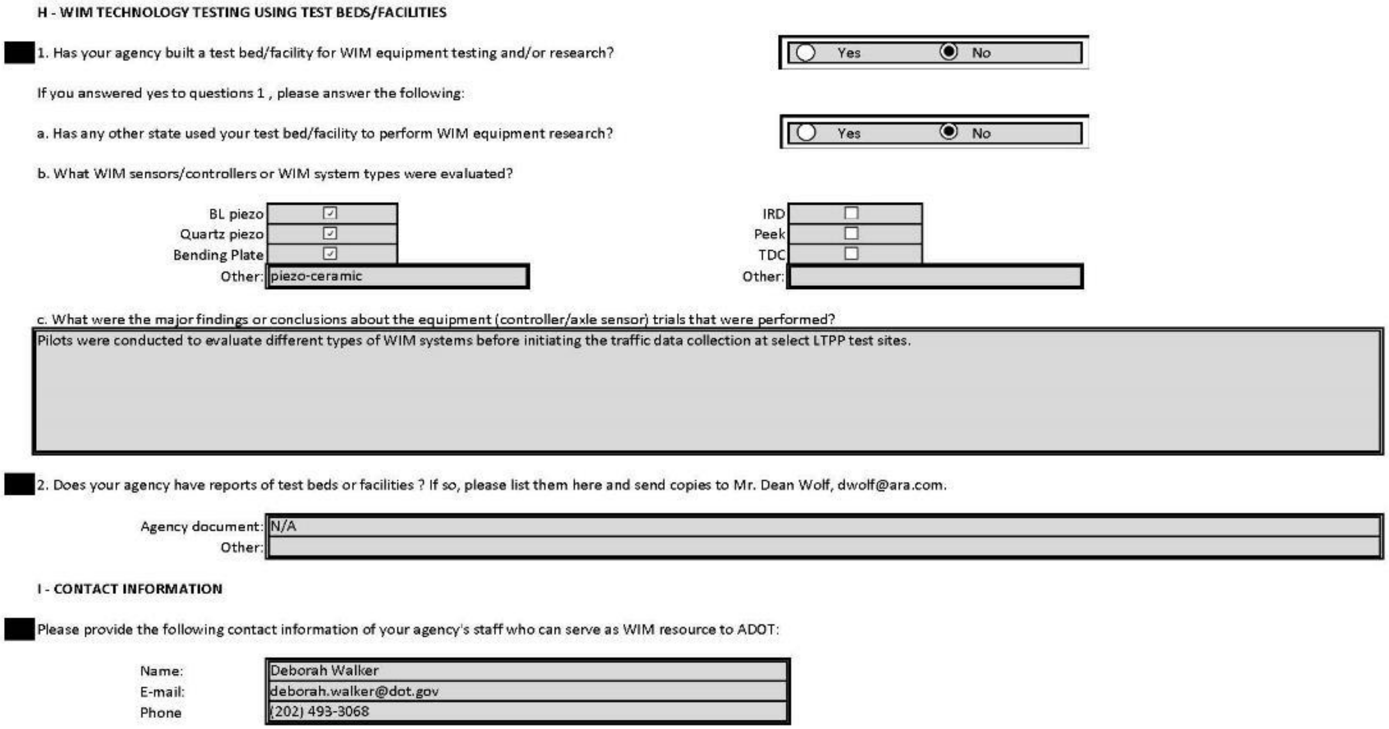
Our QA Data checks are effective in filtering bad data.

If Other, please describe:

[redacted] 5. Which WIM sensors/controllers or WIM system types would you recommend and for what applications/customers?

Controller Type	Sensor type	Application/Customer	Target Accuracy	Main Advantages	Main Limitations
IRD iSINC	Bending Plate	Research	<5% error on GVW	Accuracy	None
IRD iSINC	Quartz	Research	<5% error on GVW	Accuracy	None
IRD 1068	Quartz	Research	<5% error on GVW	Accuracy	None
Mettler	Load Cell	Research	<5% error on GVW	Accuracy	None

Figure 53. FHWA – Walker – Responses to Survey



H - WIM TECHNOLOGY TESTING USING TEST BEDS/FACILITIES

1. Has your agency built a test bed/facility for WIM equipment testing and/or research? ○ Yes ● No

If you answered yes to questions 1 , please answer the following:

a. Has any other state used your test bed/facility to perform WIM equipment research? ○ Yes ● No

b. What WIM sensors/controllers or WIM system types were evaluated?

BL piezo	☑	IRD	☐
Quartz piezo	☑	Peek	☐
Bending Plate	☑	TDC	☐
Other:	piezo-ceramic	Other:	

c. What were the major findings or conclusions about the equipment (controller/axle sensor) trials that were performed?

Pilots were conducted to evaluate different types of WIM systems before initiating the traffic data collection at select LTPP test sites.

2. Does your agency have reports of test beds or facilities ? If so, please list them here and send copies to Mr. Dean Wolf, dwolf@ara.com.

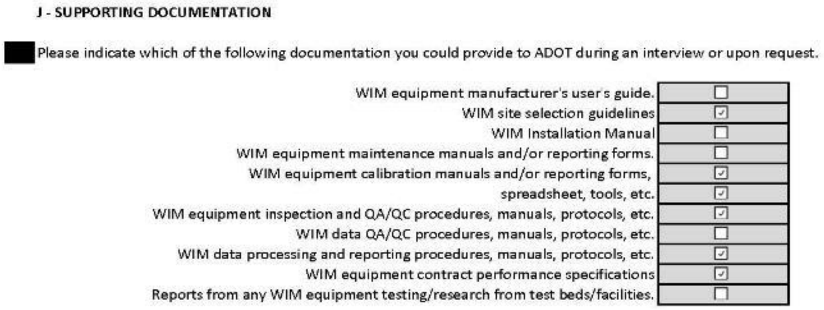
Agency document: N/A
Other:

I - CONTACT INFORMATION

Please provide the following contact information of your agency's staff who can serve as WIM resource to ADOT:

Name: Deborah Walker
E-mail: deborah.walker@dot.gov
Phone (202) 493-3068

Figure 54. FHWA – Walker – Responses to Survey



J - SUPPORTING DOCUMENTATION

[redacted] Please indicate which of the following documentation you could provide to ADOT during an interview or upon request.

WIM equipment manufacturer's user s guide.	☐
WIM site selection guidelines	☑
WIM Installation Manual	☐
WIM equipment maintenance manuals and/or reporting forms.	☐
WIM equipment calibration manuals and/or reporting forms,	☑
spreadsheet, tools, etc.	☑
WIM equipment inspection and QA/QC procedures, manuals, protocols, etc.	☑
WIM data QA/QC procedures, manuals, protocols, etc.	☐
WIM data processing and reporting procedures, manuals, protocols, etc.	☑
WIM equipment contract performance specifications	☑
Reports from any WIM equipment testing/research from test beds/facilities.	☐

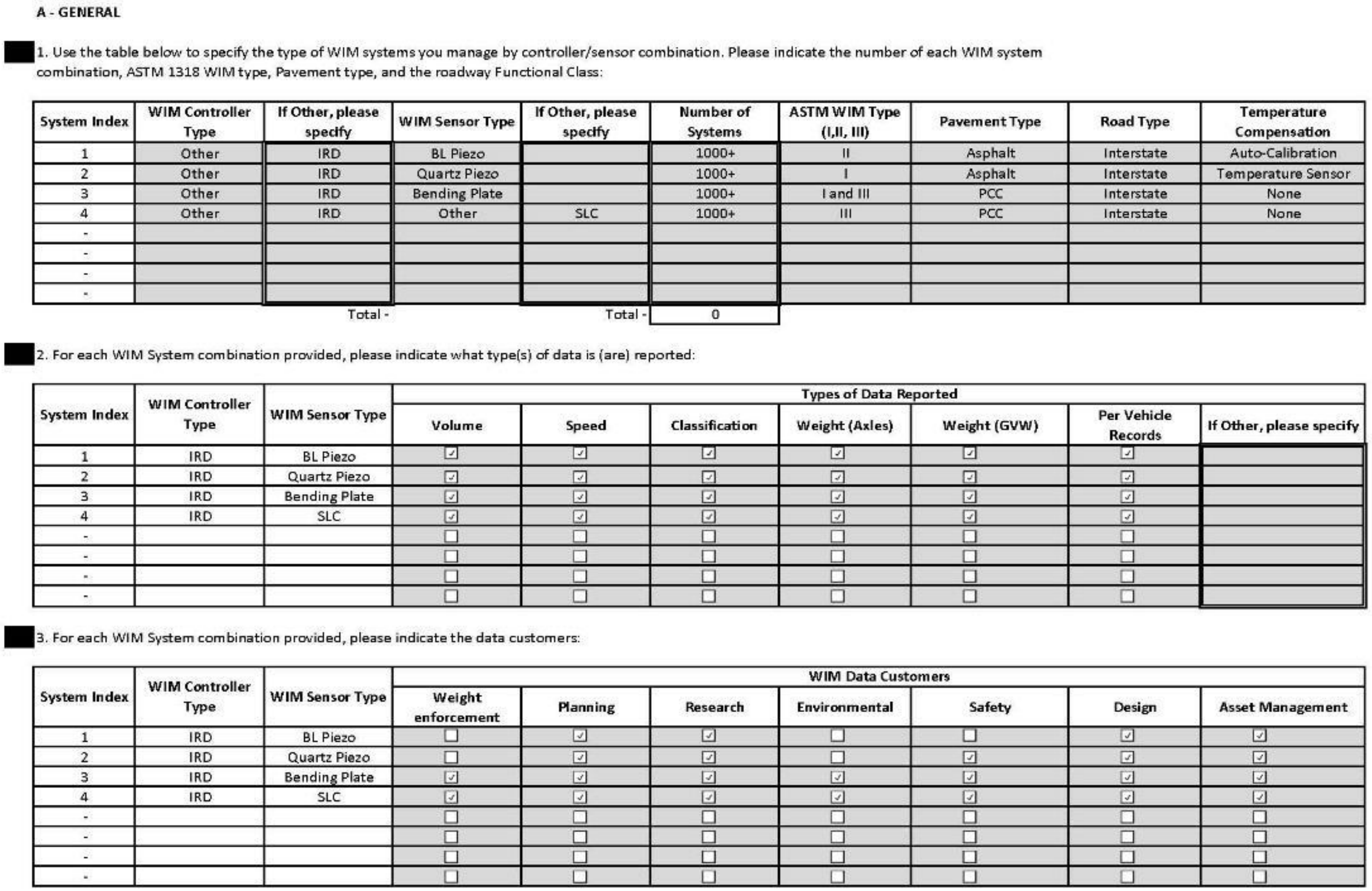
Figure 55. FHWA – Walker – Responses to Survey

International Road Dynamics (Roy Czinku)

Customer Service/Sales Manager

Member – TRB Weigh-in-Motion Subcommittee

Member – International society for Weigh-in-Motion



A - GENERAL

[redacted] 1. Use the table below to specify the type of WIM systems you manage by controller/sensor combination. Please indicate the number of each WIM system combination, ASTM 1318 WIM type, Pavement type, and the roadway Functional Class:

System Index	WIM Controller Type	If Other, please specify	WIM Sensor Type	If Other, please specify	Number of Systems	ASTM WIM Type (I,II, III)	Pavement Type	Road Type	Temperature Compensation
1	Other	IRD	BL Piezo		1000+	II	Asphalt	Interstate	Auto-Calibration
2	Other	IRD	Quartz Piezo		1000+	I	Asphalt	Interstate	Temperature Sensor
3	Other	IRD	Bending Plate		1000+	I and III	PCC	Interstate	None
4	Other	IRD	Other	SLC	1000+	III	PCC	Interstate	None
-									
-									
-									
-									
		Total -		Total -	0				

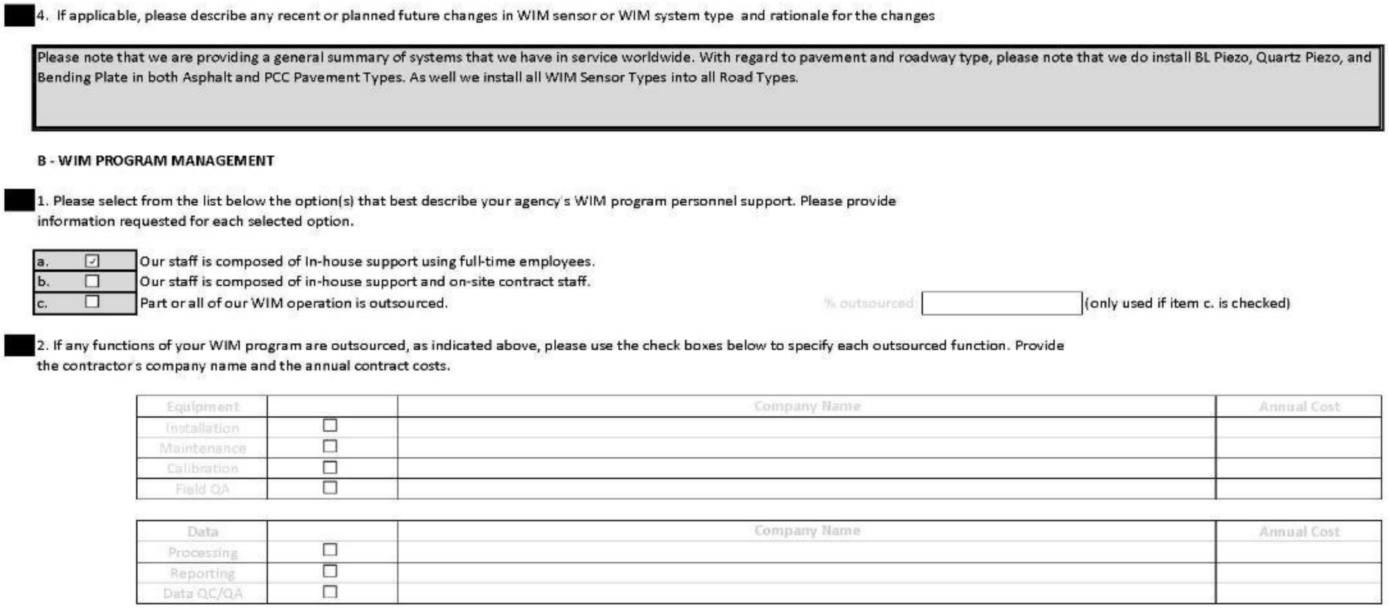
[redacted] 2. For each WIM System combination provided, please indicate what type(s) of data is (are) reported:

System Index	WIM Controller Type	WIM Sensor Type	Types of Data Reported						
			Volume	Speed	Classification	Weight (Axles)	Weight (GVW)	Per Vehicle Records	If Other, please specify
1	IRD	BL Piezo	☑	☑	☑	☑	☑	☑	
2	IRD	Quartz Piezo	☑	☑	☑	☑	☑	☑	
3	IRD	Bending Plate	☑	☑	☑	☑	☑	☑	
4	IRD	SLC	☑	☑	☑	☑	☑	☑	
-			☐	☐	☐	☐	☐	☐	
-			☐	☐	☐	☐	☐	☐	
-			☐	☐	☐	☐	☐	☐	
-			☐	☐	☐	☐	☐	☐	

[redacted] 3. For each WIM System combination provided, please indicate the data customers:

System Index	WIM Controller Type	WIM Sensor Type	WIM Data Customers						
			Weight enforcement	Planning	Research	Environmental	Safety	Design	Asset Management
1	IRD	BL Piezo	☐	☑	☑	☐	☐	☑	☑
2	IRD	Quartz Piezo	☐	☑	☑	☐	☑	☑	☑
3	IRD	Bending Plate	☑	☑	☑	☑	☑	☑	☑
4	IRD	SLC	☑	☑	☑	☑	☑	☑	☑
-			☐	☐	☐	☐	☐	☐	☐
-			☐	☐	☐	☐	☐	☐	☐
-			☐	☐	☐	☐	☐	☐	☐
-			☐	☐	☐	☐	☐	☐	☐

Figure 56. IRD – Responses to Survey



[redacted] 4. If applicable, please describe any recent or planned future changes in WIM sensor or WIM system type and rationale for the changes

Please note that we are providing a general summary of systems that we have in service worldwide. With regard to pavement and roadway type, please note that we do install BL Piezo, Quartz Piezo, and Bending Plate in both Asphalt and PCC Pavement Types. As well we install all WIM Sensor Types into all Road Types.

B - WIM PROGRAM MANAGEMENT

[redacted] 1. Please select from the list below the option(s) that best describe your agency's WIM program personnel support. Please provide information requested for each selected option.

a.	☑	Our staff is composed of In-house support using full-time employees.
b.	☐	Our staff is composed of in-house support and on-site contract staff.
c.	☐	Part or all of our WIM operation is outsourced.

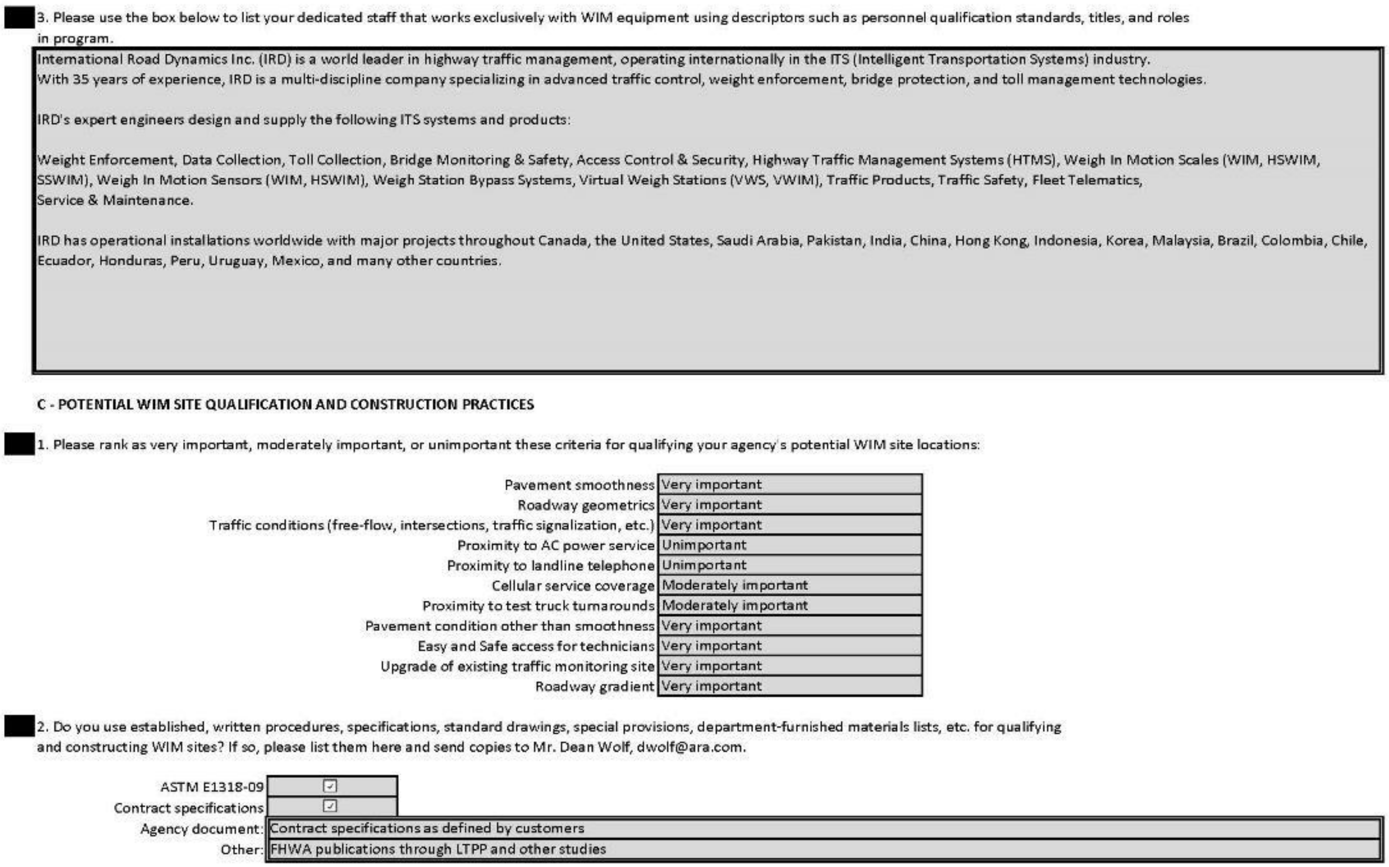
% outsourced ______ (only used if item c. is checked)

[redacted] 2. If any functions of your WIM program are outsourced, as indicated above, please use the check boxes below to specify each outsourced function. Provide the contractor's company name and the annual contract costs.

Equipment		Company Name	Annual Cost
Installation	☐		
Maintenance	☐		
Calibration	☐		
Field QA	☐		

Data		Company Name	Annual Cost
Processing	☐		
Reporting	☐		
Data QC/QA	☐		

Figure 57. IRD – Responses to Survey



[redacted] 3. Please use the box below to list your dedicated staff that works exclusively with WIM equipment using descriptors such as personnel qualification standards, titles, and roles in program.

International Road Dynamics Inc. (IRD) is a world leader in highway traffic management, operating internationally in the ITS (Intelligent Transportation Systems) industry.
With 35 years of experience, IRD is a multi-discipline company specializing in advanced traffic control, weight enforcement, bridge protection, and toll management technologies.

IRD's expert engineers design and supply the following ITS systems and products:

Weight Enforcement, Data Collection, Toll Collection, Bridge Monitoring & Safety, Access Control & Security, Highway Traffic Management Systems (HTMS), Weigh In Motion Scales (WIM, HSWIM, SSWIM), Weigh In Motion Sensors (WIM, HSWIM), Weigh Station Bypass Systems, Virtual Weigh Stations (VWS, VWIM), Traffic Products, Traffic Safety, Fleet Telematics, Service & Maintenance.

IRD has operational installations worldwide with major projects throughout Canada, the United States, Saudi Arabia, Pakistan, India, China, Hong Kong, Indonesia, Korea, Malaysia, Brazil, Colombia, Chile, Ecuador, Honduras, Peru, Uruguay, Mexico, and many other countries.

C - POTENTIAL WIM SITE QUALIFICATION AND CONSTRUCTION PRACTICES

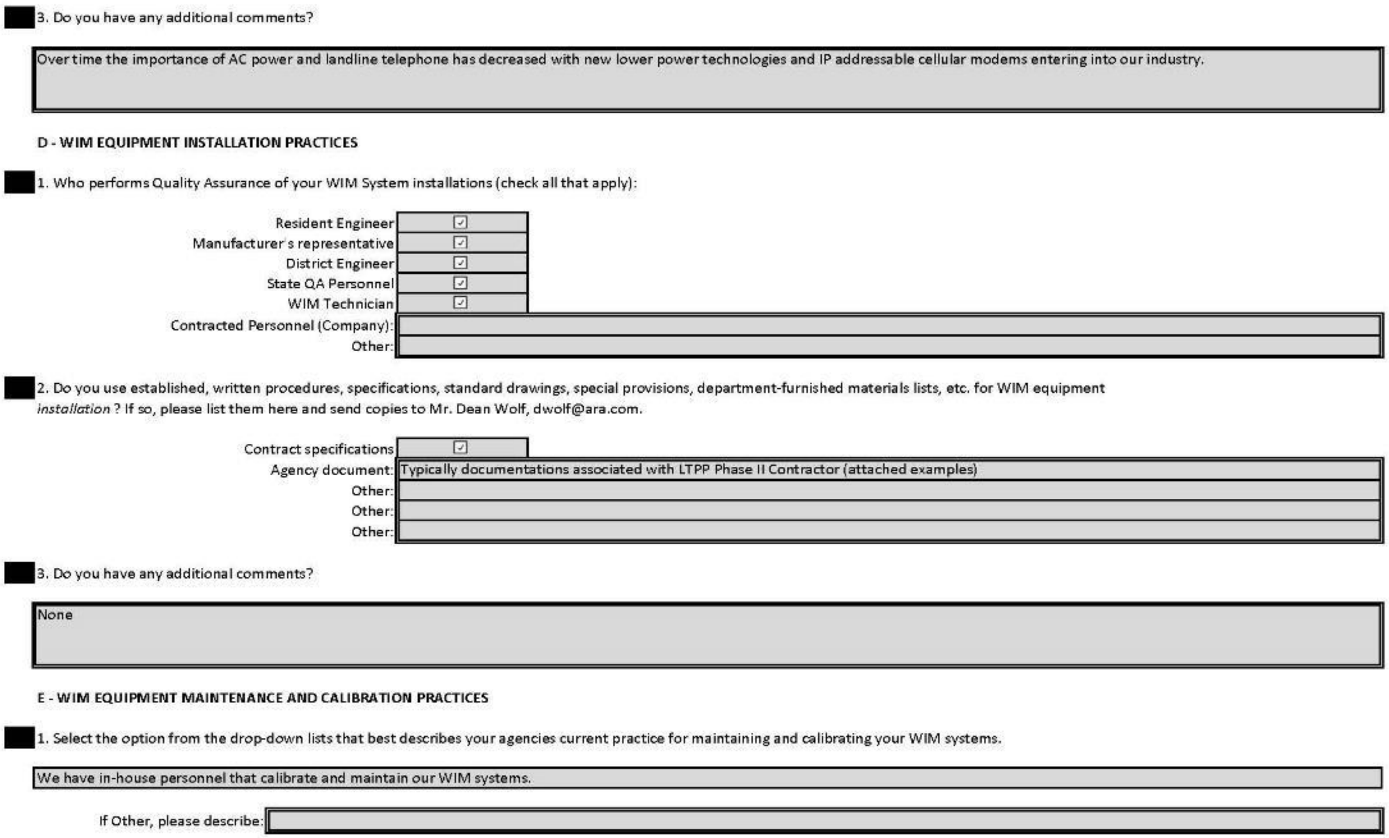
[redacted] 1. Please rank as very important, moderately important, or unimportant these criteria for qualifying your agency's potential WIM site locations:

Pavement smoothness	Very important
Roadway geometrics	Very important
Traffic conditions (free-flow, intersections, traffic signalization, etc.)	Very important
Proximity to AC power service	Unimportant
Proximity to landline telephone	Unimportant
Cellular service coverage	Moderately important
Proximity to test truck turnarounds	Moderately important
Pavement condition other than smoothness	Very important
Easy and Safe access for technicians	Very important
Upgrade of existing traffic monitoring site	Very important
Roadway gradient	Very important

[redacted] 2. Do you use established, written procedures, specifications, standard drawings, special provisions, department-furnished materials lists, etc. for qualifying and constructing WIM sites? If so, please list them here and send copies to Mr. Dean Wolf, dwolf@ara.com.

ASTM E1318-09	☑
Contract specifications	☑
Agency document:	Contract specifications as defined by customers
Other:	FHWA publications through LTPP and other studies

Figure 58. IRD – Responses to Survey



[redacted] 3. Do you have any additional comments?

Over time the importance of AC power and landline telephone has decreased with new lower power technologies and IP addressable cellular modems entering into our industry.

D - WIM EQUIPMENT INSTALLATION PRACTICES

[redacted] 1. Who performs Quality Assurance of your WIM System installations (check all that apply):

Resident Engineer ☑
Manufacturer's representative ☑
District Engineer ☑
State QA Personnel ☑
WIM Technician ☑
Contracted Personnel (Company):
Other:

[redacted] 2. Do you use established, written procedures, specifications, standard drawings, special provisions, department-furnished materials lists, etc. for WIM equipment *installation* ? If so, please list them here and send copies to Mr. Dean Wolf, dwolf@ara.com.

Contract specifications ☑
Agency document: Typically documentations associated with LTPP Phase II Contractor (attached examples)
Other:
Other:
Other:

[redacted] 3. Do you have any additional comments?

None

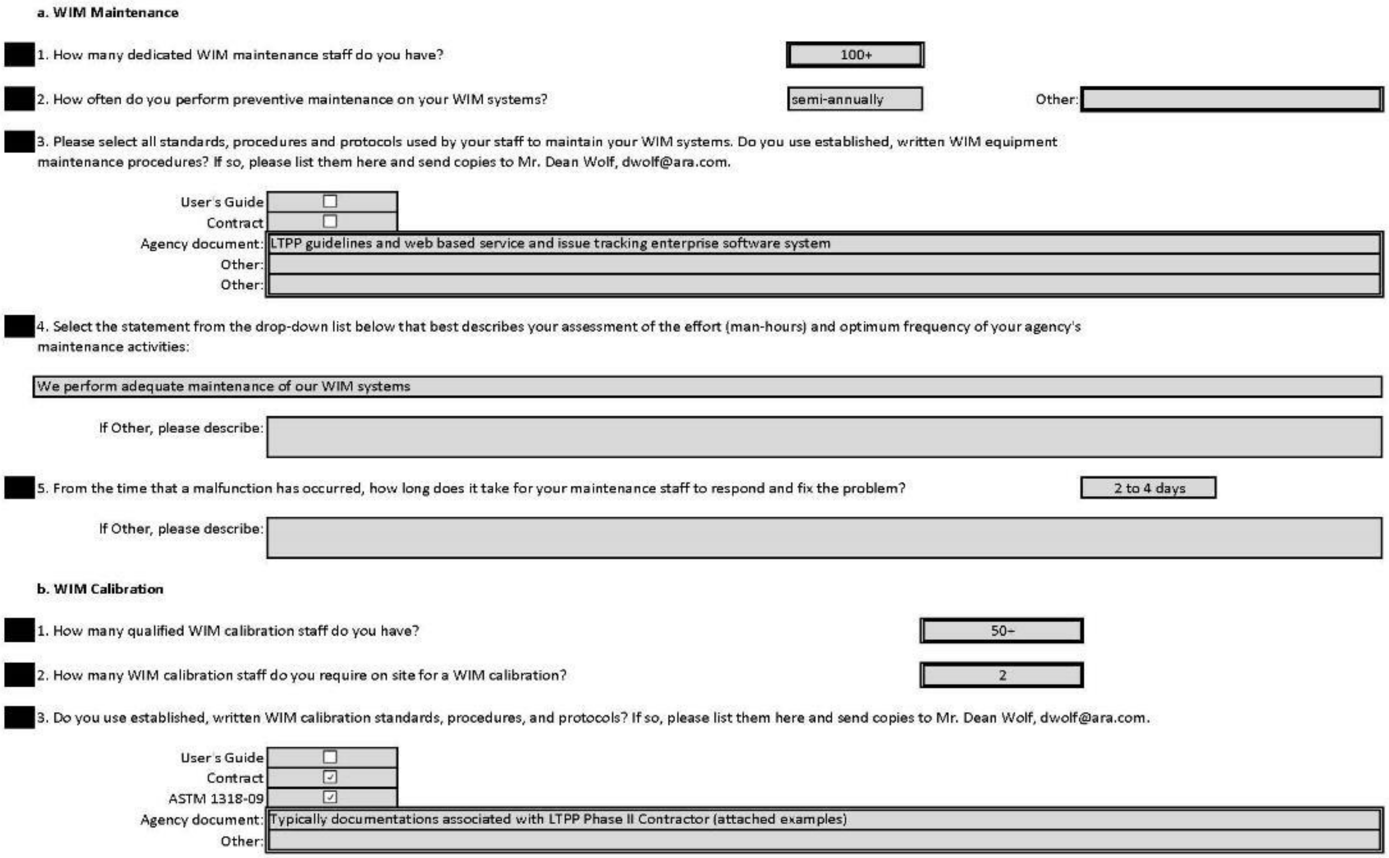
E - WIM EQUIPMENT MAINTENANCE AND CALIBRATION PRACTICES

[redacted] 1. Select the option from the drop-down lists that best describes your agencies current practice for maintaining and calibrating your WIM systems.

We have in-house personnel that calibrate and maintain our WIM systems.

If Other, please describe:

Figure 59. IRD – Responses to Survey



a. WIM Maintenance

[redacted] 1. How many dedicated WIM maintenance staff do you have? 100+

[redacted] 2. How often do you perform preventive maintenance on your WIM systems? semi-annually Other:

[redacted] 3. Please select all standards, procedures and protocols used by your staff to maintain your WIM systems. Do you use established, written WIM equipment maintenance procedures? If so, please list them here and send copies to Mr. Dean Wolf, dwolf@ara.com.

User's Guide ☐
Contract ☐
Agency document: LTPP guidelines and web based service and issue tracking enterprise software system
Other:
Other:

[redacted] 4. Select the statement from the drop-down list below that best describes your assessment of the effort (man-hours) and optimum frequency of your agency's maintenance activities:

We perform adequate maintenance of our WIM systems

If Other, please describe:

[redacted] 5. From the time that a malfunction has occurred, how long does it take for your maintenance staff to respond and fix the problem? 2 to 4 days

If Other, please describe:

b. WIM Calibration

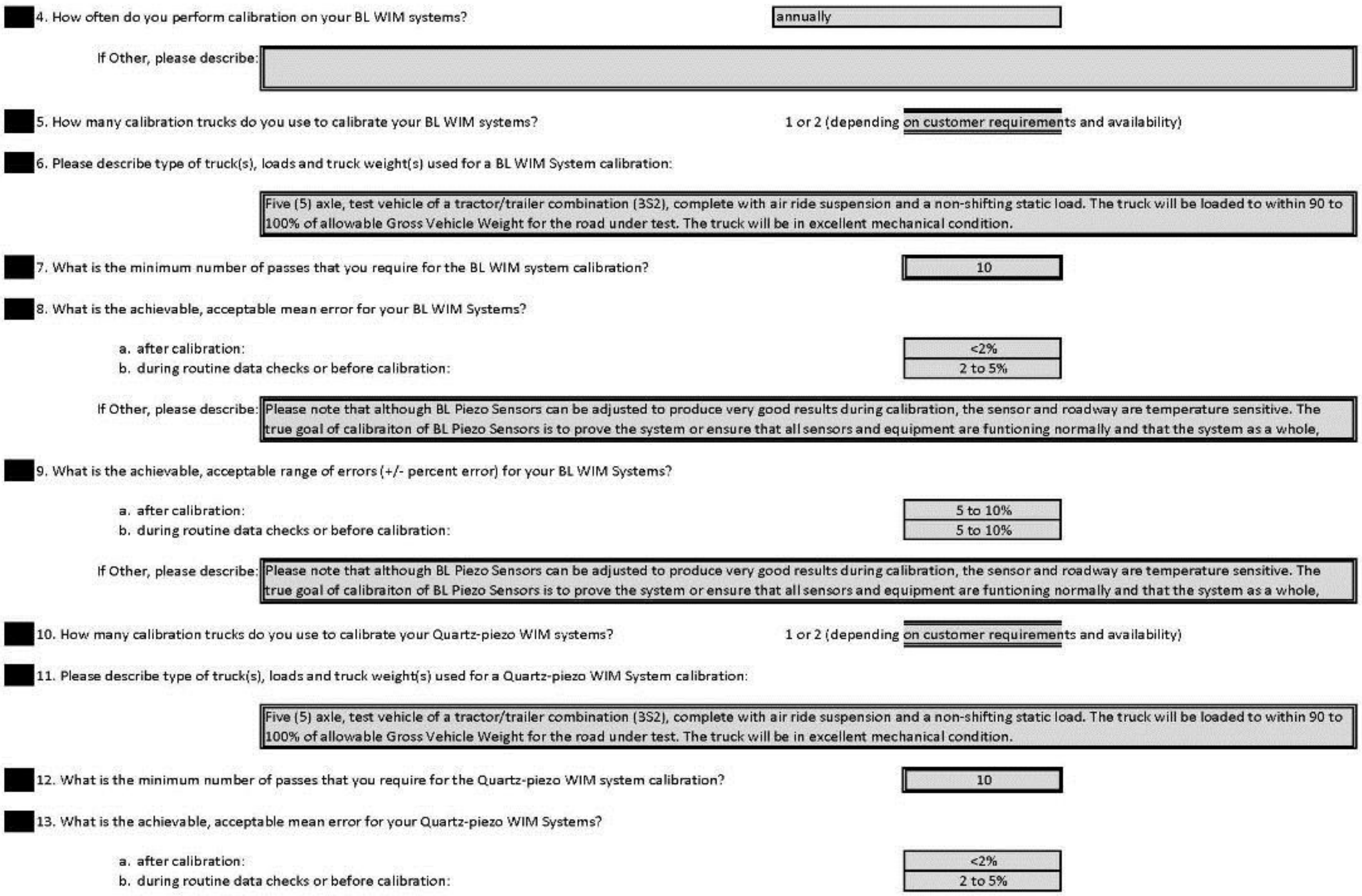
[redacted] 1. How many qualified WIM calibration staff do you have? 50–

[redacted] 2. How many WIM calibration staff do you require on site for a WIM calibration? 2

[redacted] 3. Do you use established, written WIM calibration standards, procedures, and protocols? If so, please list them here and send copies to Mr. Dean Wolf, dwolf@ara.com.

User's Guide ☐
Contract ☑
ASTM 1318-09 ☑
Agency document: Typically documentations associated with LTPP Phase II Contractor (attached examples)
Other:

Figure 60. IRD – Responses to Survey



[redacted] 4. How often do you perform calibration on your BL WIM systems? annually

If Other, please describe:

[redacted] 5. How many calibration trucks do you use to calibrate your BL WIM systems? 1 or 2 (depending on customer requirements and availability)

[redacted] 6. Please describe type of truck(s), loads and truck weight(s) used for a BL WIM System calibration:

Five (5) axle, test vehicle of a tractor/trailer combination (3S2), complete with air ride suspension and a non-shifting static load. The truck will be loaded to within 90 to 100% of allowable Gross Vehicle Weight for the road under test. The truck will be in excellent mechanical condition.

[redacted] 7. What is the minimum number of passes that you require for the BL WIM system calibration? 10

[redacted] 8. What is the achievable, acceptable mean error for your BL WIM Systems?

a. after calibration: <2%
b. during routine data checks or before calibration: 2 to 5%

If Other, please describe: Please note that although BL Piezo Sensors can be adjusted to produce very good results during calibration, the sensor and roadway are temperature sensitive. The true goal of calibraiton of BL Piezo Sensors is to prove the system or ensure that all sensors and equipment are funtioning normally and that the system as a whole,

[redacted] 9. What is the achievable, acceptable range of errors (+/- percent error) for your BL WIM Systems?

a. after calibration: 5 to 10%
b. during routine data checks or before calibration: 5 to 10%

If Other, please describe: Please note that although BL Piezo Sensors can be adjusted to produce very good results during calibration, the sensor and roadway are temperature sensitive. The true goal of calibraiton of BL Piezo Sensors is to prove the system or ensure that all sensors and equipment are funtioning normally and that the system as a whole,

[redacted] 10. How many calibration trucks do you use to calibrate your Quartz-piezo WIM systems? 1 or 2 (depending on customer requirements and availability)

[redacted] 11. Please describe type of truck(s), loads and truck weight(s) used for a Quartz-piezo WIM System calibration:

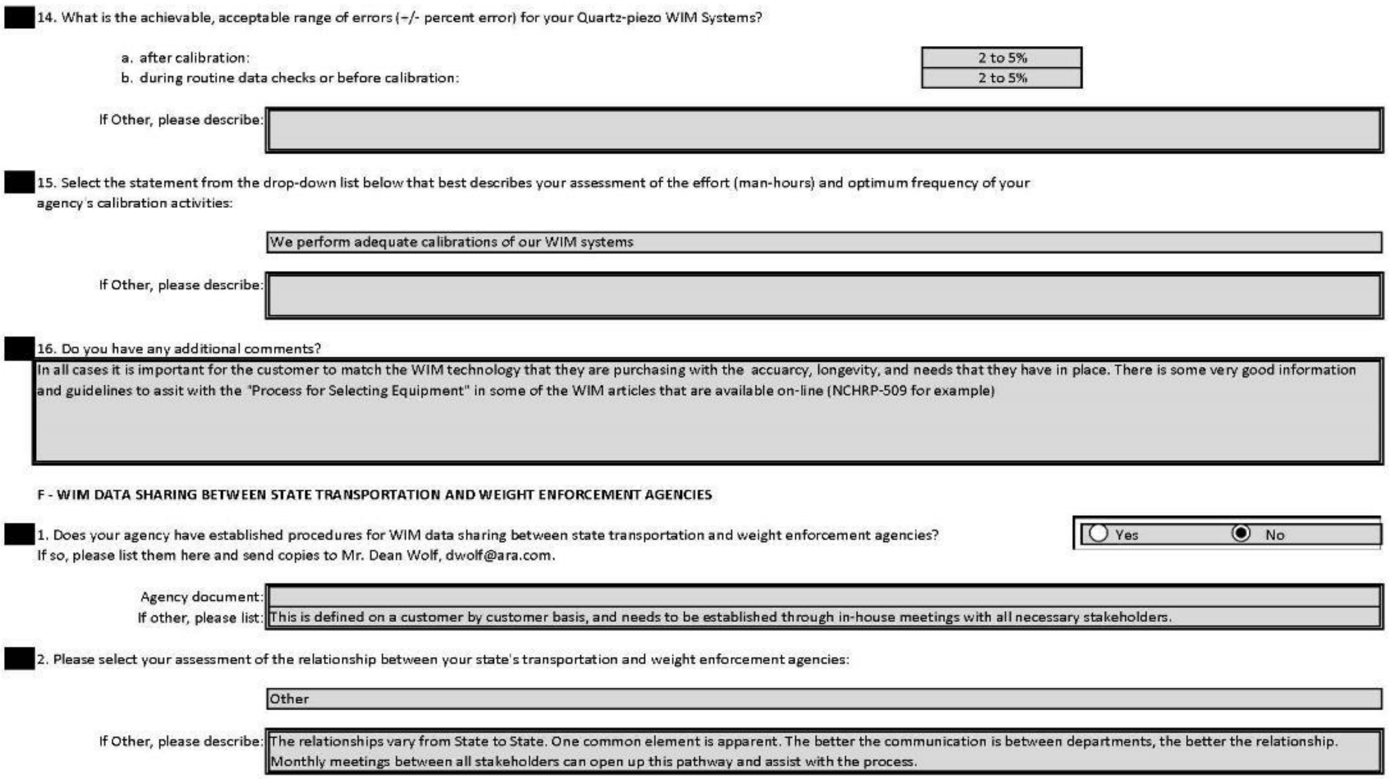
Five (5) axle, test vehicle of a tractor/trailer combination (3S2), complete with air ride suspension and a non-shifting static load. The truck will be loaded to within 90 to 100% of allowable Gross Vehicle Weight for the road under test. The truck will be in excellent mechanical condition.

[redacted] 12. What is the minimum number of passes that you require for the Quartz-piezo WIM system calibration? 10

[redacted] 13. What is the achievable, acceptable mean error for your Quartz-piezo WIM Systems?

a. after calibration: <2%
b. during routine data checks or before calibration: 2 to 5%

Figure 61. IRD – Responses to Survey



14. What is the achievable, acceptable range of errors (–/- percent error) for your Quartz-piezo WIM Systems?

a. after calibration:	2 to 5%
b. during routine data checks or before calibration:	2 to 5%

If Other, please describe:

15. Select the statement from the drop-down list below that best describes your assessment of the effort (man-hours) and optimum frequency of your agency's calibration activities:

We perform adequate calibrations of our WIM systems

If Other, please describe:

16. Do you have any additional comments?

In all cases it is important for the customer to match the WIM technology that they are purchasing with the accuarcy, longevity, and needs that they have in place. There is some very good information and guidelines to assit with the "Process for Selecting Equipment" in some of the WIM articles that are available on-line (NCHRP-509 for example)

F - WIM DATA SHARING BETWEEN STATE TRANSPORTATION AND WEIGHT ENFORCEMENT AGENCIES

1. Does your agency have established procedures for WIM data sharing between state transportation and weight enforcement agencies?
If so, please list them here and send copies to Mr. Dean Wolf, dwolf@ara.com.

○ Yes ● No

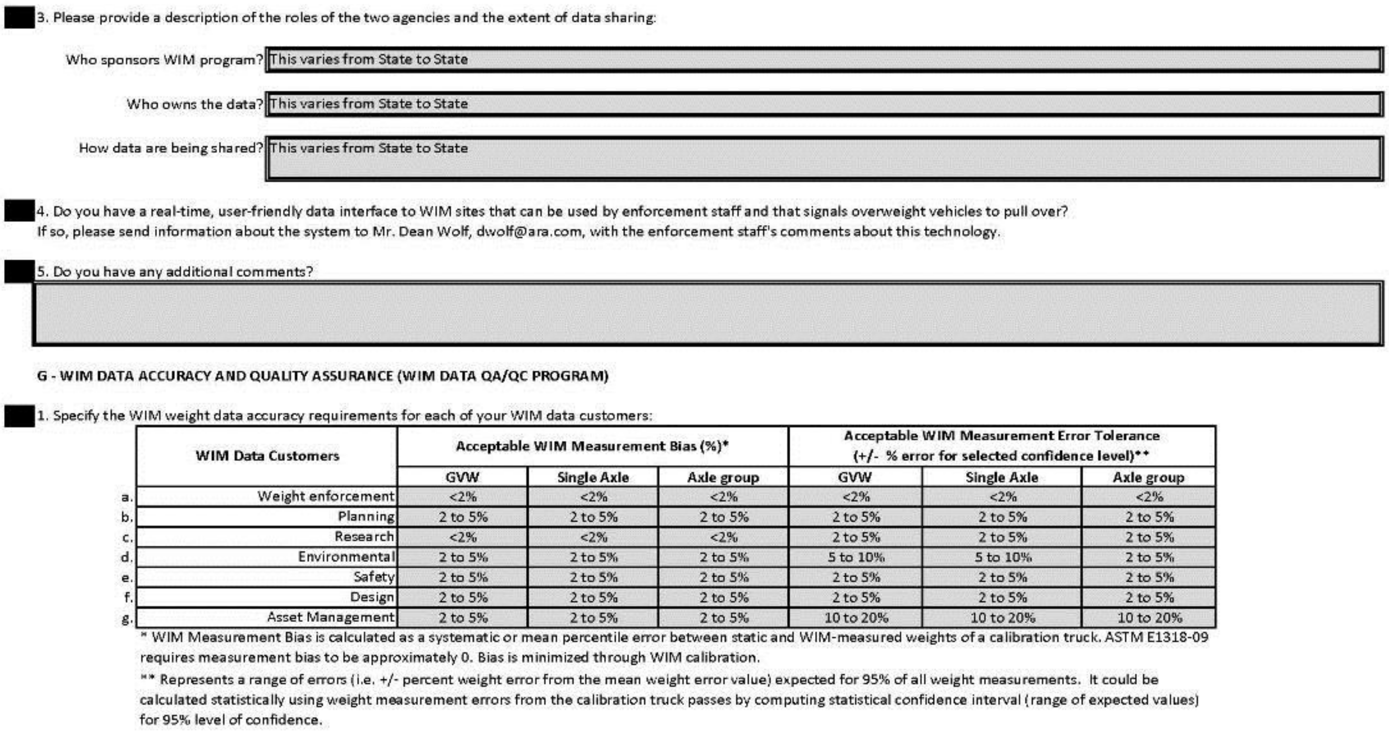
Agency document:
If other, please list: This is defined on a customer by customer basis, and needs to be established through in-house meetings with all necessary stakeholders.

2. Please select your assessment of the relationship between your state's transportation and weight enforcement agencies:

Other

If Other, please describe: The relationships vary from State to State. One common element is apparent. The better the communication is between departments, the better the relationship. Monthly meetings between all stakeholders can open up this pathway and assist with the process.

Figure 62. IRD – Responses to Survey



[redacted] 3. Please provide a description of the roles of the two agencies and the extent of data sharing:

Who sponsors WIM program? This varies from State to State

Who owns the data? This varies from State to State

How data are being shared? This varies from State to State

[redacted] 4. Do you have a real-time, user-friendly data interface to WIM sites that can be used by enforcement staff and that signals overweight vehicles to pull over?
If so, please send information about the system to Mr. Dean Wolf, dwolf@ara.com, with the enforcement staff's comments about this technology.

[redacted] 5. Do you have any additional comments?

G - WIM DATA ACCURACY AND QUALITY ASSURANCE (WIM DATA QA/QC PROGRAM)

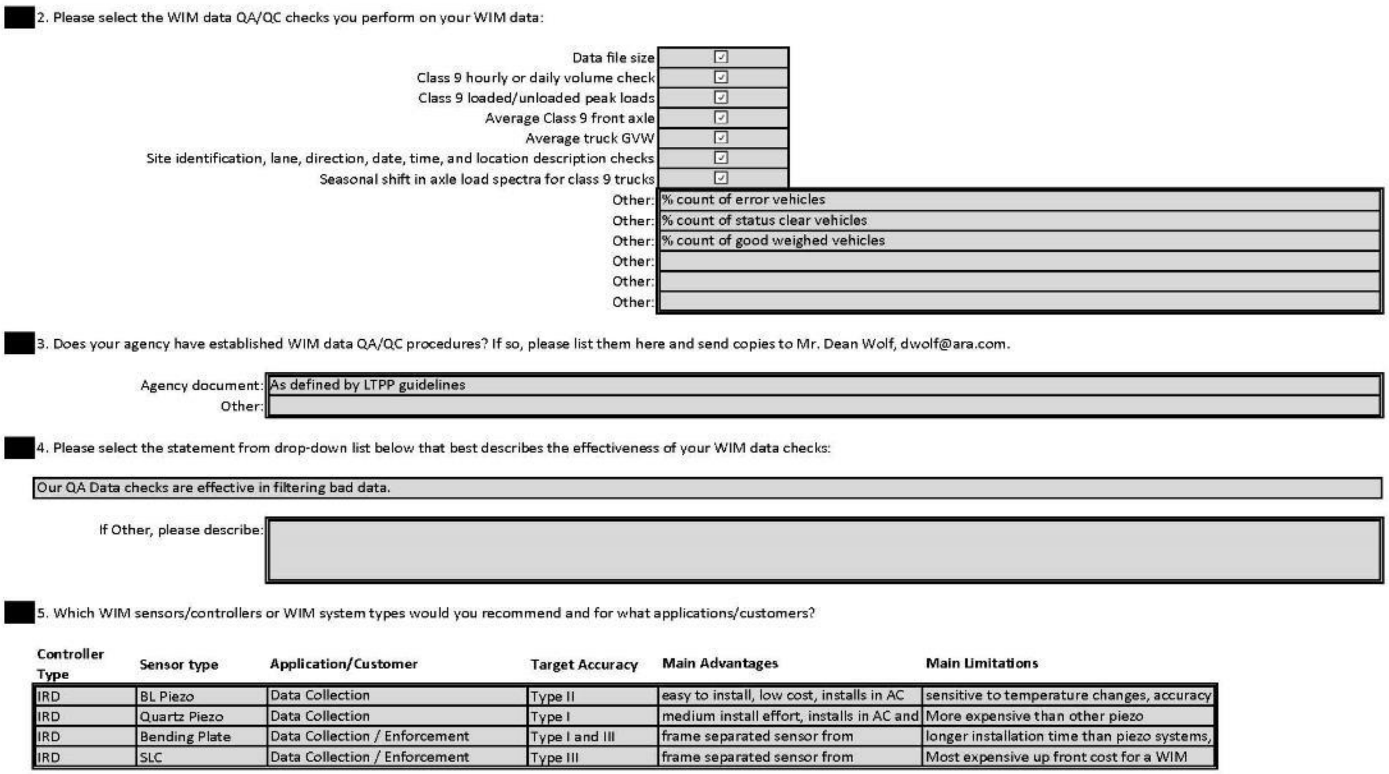
[redacted] 1. Specify the WIM weight data accuracy requirements for each of your WIM data customers:

	WIM Data Customers	Acceptable WIM Measurement Bias (%)*			Acceptable WIM Measurement Error Tolerance (+/- % error for selected confidence level)**		
		GVW	Single Axle	Axle group	GVW	Single Axle	Axle group
a.	Weight enforcement	<2%	<2%	<2%	<2%	<2%	<2%
b.	Planning	2 to 5%	2 to 5%	2 to 5%	2 to 5%	2 to 5%	2 to 5%
c.	Research	<2%	<2%	<2%	2 to 5%	2 to 5%	2 to 5%
d.	Environmental	2 to 5%	2 to 5%	2 to 5%	5 to 10%	5 to 10%	2 to 5%
e.	Safety	2 to 5%	2 to 5%	2 to 5%	2 to 5%	2 to 5%	2 to 5%
f.	Design	2 to 5%	2 to 5%	2 to 5%	2 to 5%	2 to 5%	2 to 5%
g.	Asset Management	2 to 5%	2 to 5%	2 to 5%	10 to 20%	10 to 20%	10 to 20%

* WIM Measurement Bias is calculated as a systematic or mean percentile error between static and WIM-measured weights of a calibration truck. ASTM E1318-09 requires measurement bias to be approximately 0. Bias is minimized through WIM calibration.

** Represents a range of errors (i.e. +/- percent weight error from the mean weight error value) expected for 95% of all weight measurements. It could be calculated statistically using weight measurement errors from the calibration truck passes by computing statistical confidence interval (range of expected values) for 95% level of confidence.

Figure 63. IRD – Responses to Survey



[redacted] 2. Please select the WIM data QA/QC checks you perform on your WIM data:

Data file size	☑
Class 9 hourly or daily volume check	☑
Class 9 loaded/unloaded peak loads	☑
Average Class 9 front axle	☑
Average truck GVW	☑
Site identification, lane, direction, date, time, and location description checks	☑
Seasonal shift in axle load spectra for class 9 trucks	☑
Other:	% count of error vehicles
Other:	% count of status clear vehicles
Other:	% count of good weighed vehicles
Other:	
Other:	
Other:	

[redacted] 3. Does your agency have established WIM data QA/QC procedures? If so, please list them here and send copies to Mr. Dean Wolf, dwolf@ara.com.

Agency document: As defined by LTPP guidelines
Other:

[redacted] 4. Please select the statement from drop-down list below that best describes the effectiveness of your WIM data checks:

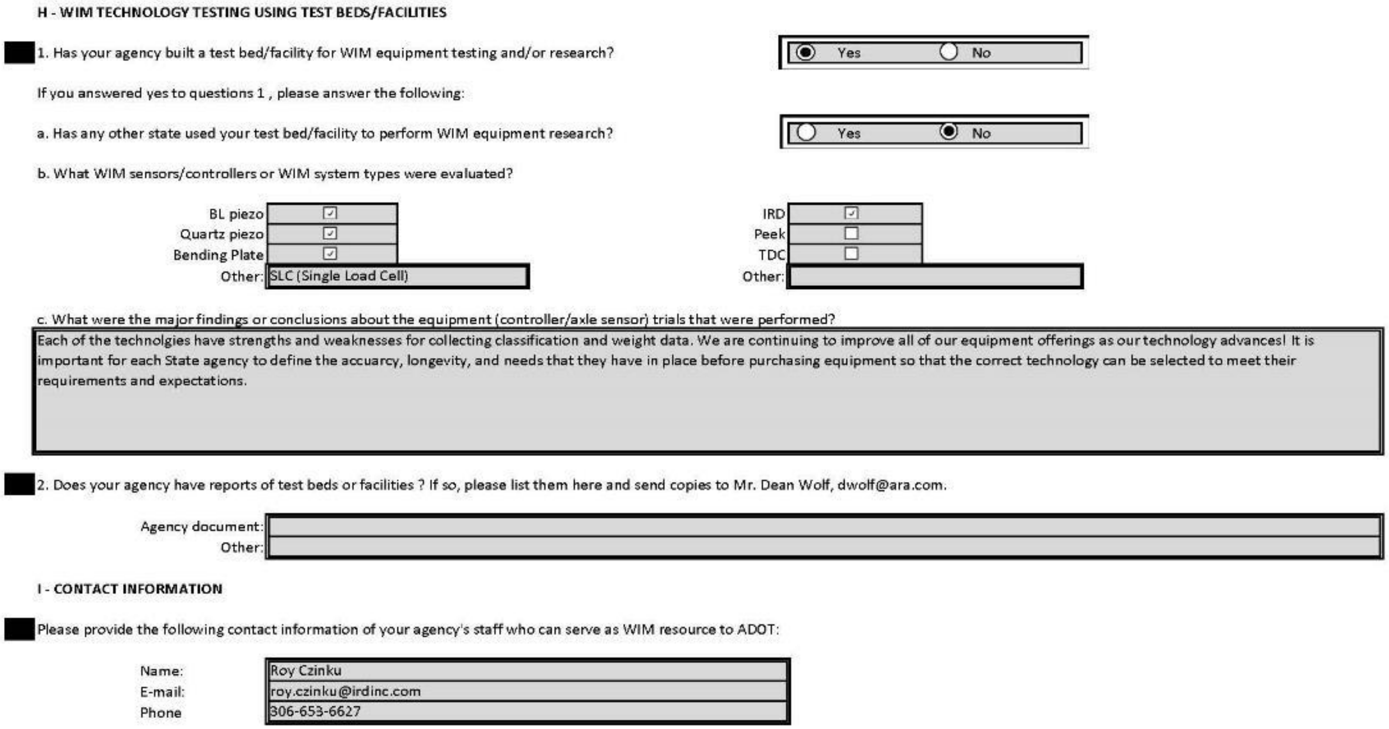
Our QA Data checks are effective in filtering bad data.

If Other, please describe:

[redacted] 5. Which WIM sensors/controllers or WIM system types would you recommend and for what applications/customers?

Controller Type	Sensor type	Application/Customer	Target Accuracy	Main Advantages	Main Limitations
IRD	BL Piezo	Data Collection	Type II	easy to install, low cost, installs in AC	sensitive to temperature changes, accuracy
IRD	Quartz Piezo	Data Collection	Type I	medium install effort, installs in AC and	More expensive than other piezo
IRD	Bending Plate	Data Collection / Enforcement	Type I and III	frame separated sensor from	longer installation time than piezo systems,
IRD	SLC	Data Collection / Enforcement	Type III	frame separated sensor from	Most expensive up front cost for a WIM

Figure 64. IRD – Responses to Survey



H - WIM TECHNOLOGY TESTING USING TEST BEDS/FACILITIES

[redacted] 1. Has your agency built a test bed/facility for WIM equipment testing and/or research? ● Yes ○ No

If you answered yes to questions 1 , please answer the following:

a. Has any other state used your test bed/facility to perform WIM equipment research? ○ Yes ● No

b. What WIM sensors/controllers or WIM system types were evaluated?

BL piezo	☑	IRD	☑
Quartz piezo	☑	Peek	☐
Bending Plate	☑	TDC	☐
Other:	SLC (Single Load Cell)	Other:	

c. What were the major findings or conclusions about the equipment (controller/axle sensor) trials that were performed?

Each of the technolgies have strengths and weaknesses for collecting classification and weight data. We are continuing to improve all of our equipment offerings as our technology advances! It is important for each State agency to define the accuarcy, longevity, and needs that they have in place before purchasing equipment so that the correct technology can be selected to meet their requirements and expectations.

[redacted] 2. Does your agency have reports of test beds or facilities ? If so, please list them here and send copies to Mr. Dean Wolf, dwolf@ara.com.

Agency document:

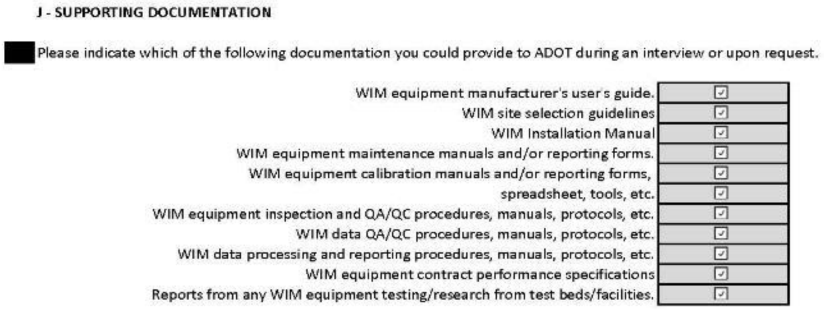
Other:

I - CONTACT INFORMATION

[redacted] Please provide the following contact information of your agency's staff who can serve as WIM resource to ADOT:

Name: Roy Czinku
E-mail: roy.czinku@irdinc.com
Phone 306-653-6627

Figure 65. IRD – Responses to Survey



J - SUPPORTING DOCUMENTATION

[redacted] Please indicate which of the following documentation you could provide to ADOT during an interview or upon request.

WIM equipment manufacturer's user's guide.	☑
WIM site selection guidelines	☑
WIM Installation Manual	☑
WIM equipment maintenance manuals and/or reporting forms.	☑
WIM equipment calibration manuals and/or reporting forms,	☑
spreadsheet, tools, etc.	☑
WIM equipment inspection and QA/QC procedures, manuals, protocols, etc.	☑
WIM data QA/QC procedures, manuals, protocols, etc.	☑
WIM data processing and reporting procedures, manuals, protocols, etc.	☑
WIM equipment contract performance specifications	☑
Reports from any WIM equipment testing/research from test beds/facilities.	☑

Figure 66. IRD – Responses to Survey

Louisiana Department of Transportation (Harold R. Paul)
Director, Louisiana Transportation Research Center

With Inputs from
George Chike

A - GENERAL

[redacted] 1. Use the table below to specify the type of WIM systems you manage by controller/sensor combination. Please indicate the number of each WIM system combination, ASTM 1318 WIM type, Pavement type, and the roadway Functional Class:

System Index	WIM Controller Type	If Other, please specify	WIM Sensor Type	If Other, please specify	Number of Systems	ASTM WIM Type (I,II, III)	Pavement Type	Road Type	Temperature Compensation
1	Other	IRD - TC 540	Bending Plate		1	Unknown	PCC	Interstate	Unknown
2	Other	IRD - TC 540	Bending Plate		1	Unknown	PCC	US Route	Unknown
3	Other	IRD - TC 540	Bending Plate		1	Unknown	PCC	Local Road	Unknown
4	Other	IRD - TC 540	Bending Plate		2	Unknown	PCC	State Route	Unknown
-									
-									
-									
-									
		Total -		Total -	5				

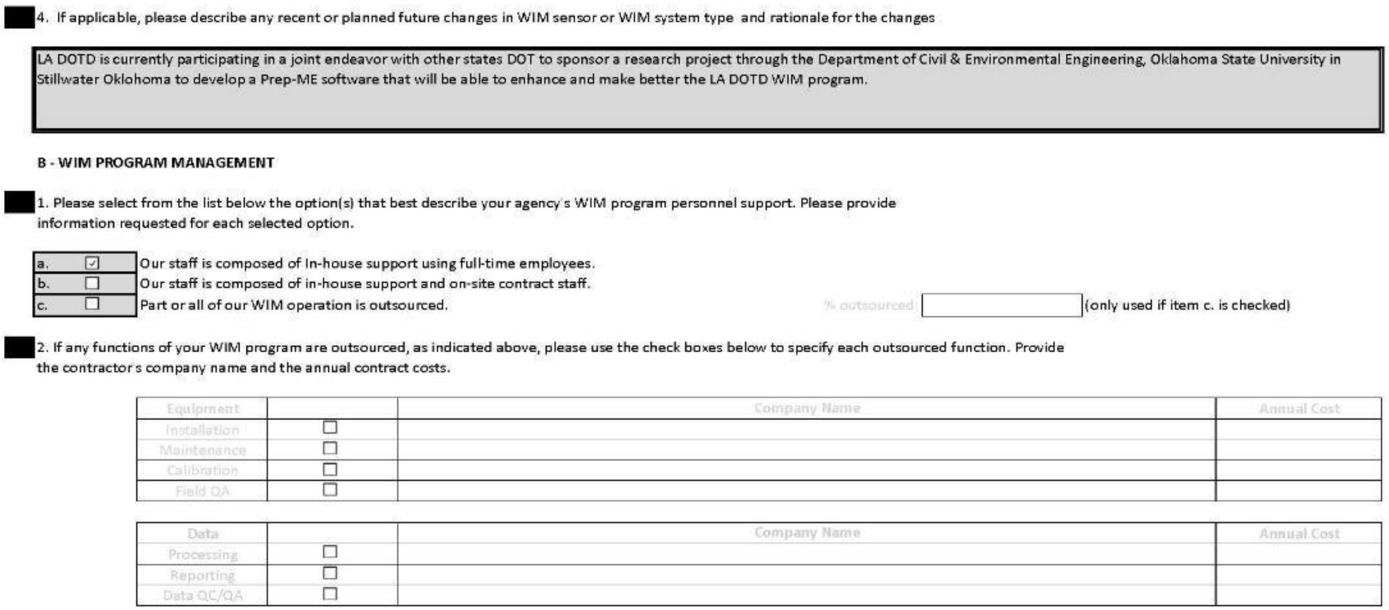
[redacted] 2. For each WIM System combination provided, please indicate what type(s) of data is (are) reported:

System Index	WIM Controller Type	WIM Sensor Type	Types of Data Reported						
			Volume	Speed	Classification	Weight (Axles)	Weight (GVW)	Per Vehicle Records	If Other, please specify
1	IRD - TC 540	Bending Plate	☑	☑	☑	☑	☐	☑	
2	IRD - TC 540	Bending Plate	☑	☑	☑	☑	☐	☑	
3	IRD - TC 540	Bending Plate	☑	☑	☑	☑	☐	☑	
4	IRD - TC 540	Bending Plate	☑	☑	☑	☑	☐	☑	
-			☐	☐	☐	☐	☐	☐	
-			☐	☐	☐	☐	☐	☐	
-			☐	☐	☐	☐	☐	☐	
-			☐	☐	☐	☐	☐	☐	

[redacted] 3. For each WIM System combination provided, please indicate the data customers:

System Index	WIM Controller Type	WIM Sensor Type	WIM Data Customers						
			Weight enforcement	Planning	Research	Environmental	Safety	Design	Asset Management
1	IRD - TC 540	Bending Plate	☐	☑	☑	☐	☑	☑	☑
2	IRD - TC 540	Bending Plate	☐	☑	☑	☐	☑	☑	☑
3	IRD - TC 540	Bending Plate	☐	☑	☑	☐	☑	☑	☑
4	IRD - TC 540	Bending Plate	☐	☑	☑	☐	☑	☑	☑
-			☐	☐	☐	☐	☐	☐	☐
-			☐	☐	☐	☐	☐	☐	☐
-			☐	☐	☐	☐	☐	☐	☐
-			☐	☐	☐	☐	☐	☐	☐

Figure 67. Louisiana DOT – Responses to Survey



[redacted] 4. If applicable, please describe any recent or planned future changes in WIM sensor or WIM system type and rationale for the changes

LA DOTD is currently participating in a joint endeavor with other states DOT to sponsor a research project through the Department of Civil & Environmental Engineering, Oklahoma State University in Stillwater Oklohoma to develop a Prep-ME software that will be able to enhance and make better the LA DOTD WIM program.

B - WIM PROGRAM MANAGEMENT

[redacted] 1. Please select from the list below the option(s) that best describe your agency's WIM program personnel support. Please provide information requested for each selected option.

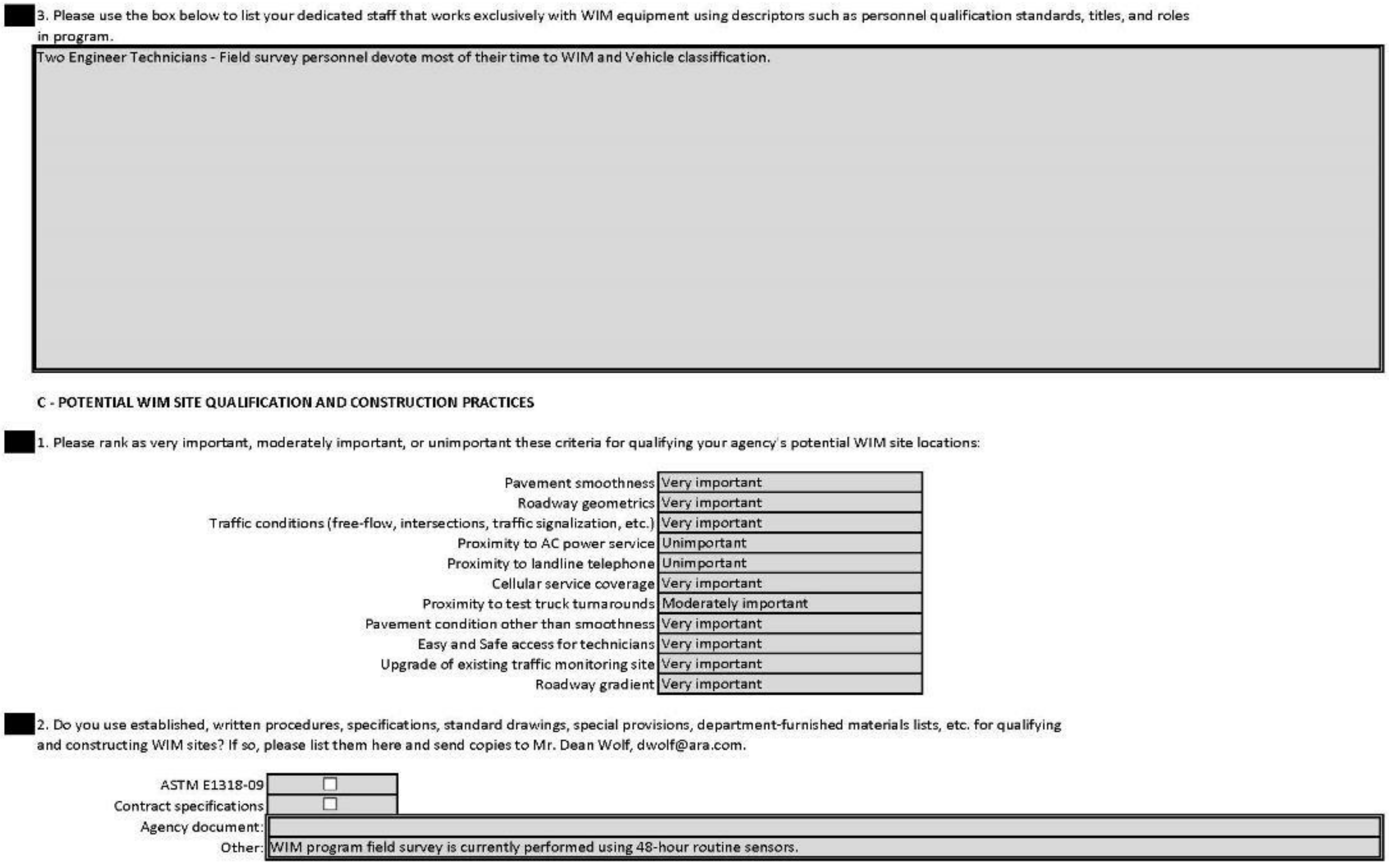
a. ☑ Our staff is composed of In-house support using full-time employees.
b. ☐ Our staff is composed of in-house support and on-site contract staff.
c. ☐ Part or all of our WIM operation is outsourced. % outsourced ☐ (only used if item c. is checked)

[redacted] 2. If any functions of your WIM program are outsourced, as indicated above, please use the check boxes below to specify each outsourced function. Provide the contractor's company name and the annual contract costs.

Equipment		Company Name	Annual Cost
Installation	☐		
Maintenance	☐		
Calibration	☐		
Field QA	☐		

Data		Company Name	Annual Cost
Processing	☐		
Reporting	☐		
Data QC/QA	☐		

Figure 68. Louisiana DOT – Responses to Survey



[redacted] 3. Please use the box below to list your dedicated staff that works exclusively with WIM equipment using descriptors such as personnel qualification standards, titles, and roles in program.

Two Engineer Technicians - Field survey personnel devote most of their time to WIM and Vehicle classiffication.

C - POTENTIAL WIM SITE QUALIFICATION AND CONSTRUCTION PRACTICES

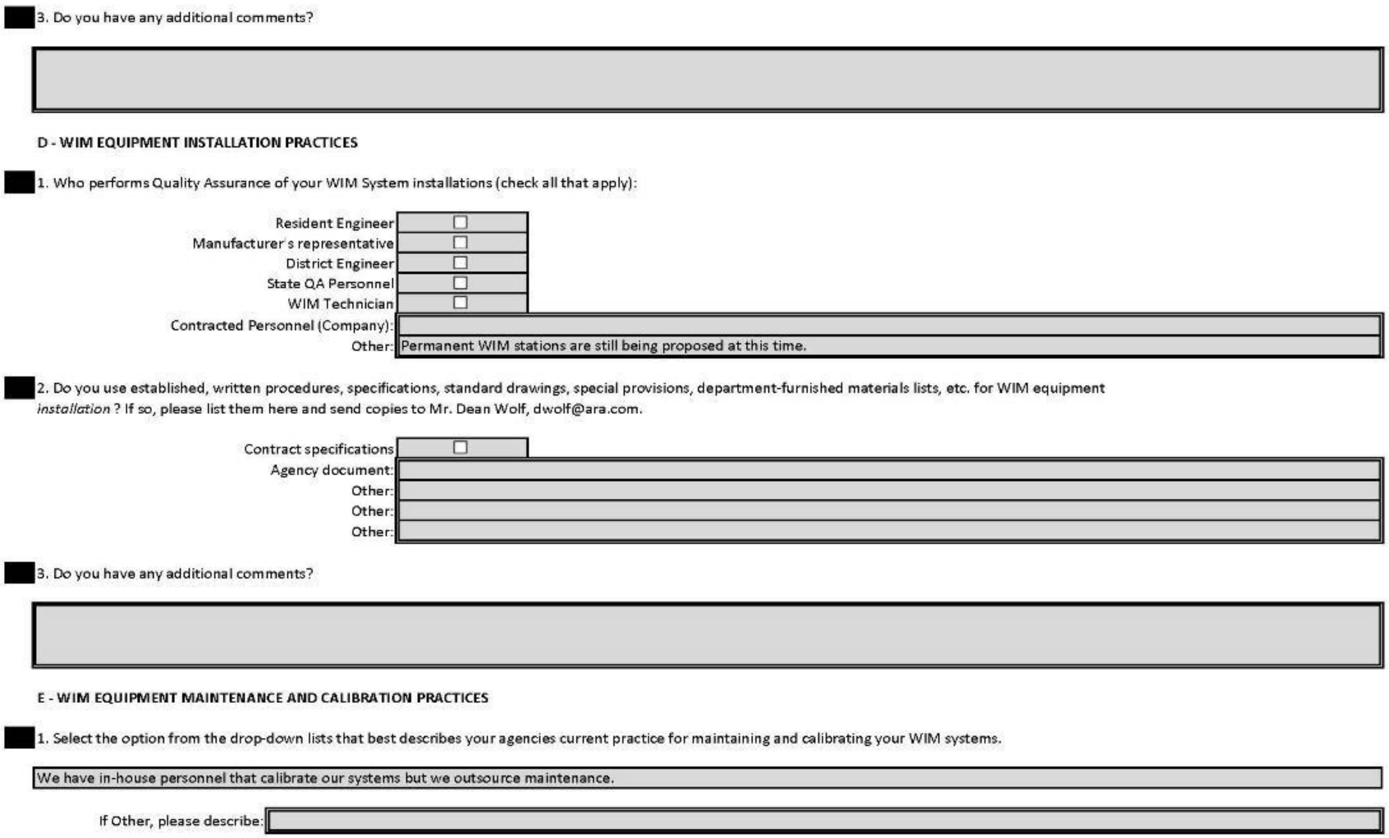
[redacted] 1. Please rank as very important, moderately important, or unimportant these criteria for qualifying your agency's potential WIM site locations:

Pavement smoothness	Very important
Roadway geometrics	Very important
Traffic conditions (free-flow, intersections, traffic signalization, etc.)	Very important
Proximity to AC power service	Unimportant
Proximity to landline telephone	Unimportant
Cellular service coverage	Very important
Proximity to test truck turnarounds	Moderately important
Pavement condition other than smoothness	Very important
Easy and Safe access for technicians	Very important
Upgrade of existing traffic monitoring site	Very important
Roadway gradient	Very important

[redacted] 2. Do you use established, written procedures, specifications, standard drawings, special provisions, department-furnished materials lists, etc. for qualifying and constructing WIM sites? If so, please list them here and send copies to Mr. Dean Wolf, dwolf@ara.com.

ASTM E1318-09	☐
Contract specifications	☐
Agency document:	
Other:	WIM program field survey is currently performed using 48-hour routine sensors.

Figure 69. Louisiana DOT – Responses to Survey



3. Do you have any additional comments?

D - WIM EQUIPMENT INSTALLATION PRACTICES

1. Who performs Quality Assurance of your WIM System installations (check all that apply):

Resident Engineer ☐
Manufacturer's representative ☐
District Engineer ☐
State QA Personnel ☐
WIM Technician ☐
Contracted Personnel (Company):
Other: Permanent WIM stations are still being proposed at this time.

2. Do you use established, written procedures, specifications, standard drawings, special provisions, department-furnished materials lists, etc. for WIM equipment *installation* ? If so, please list them here and send copies to Mr. Dean Wolf, dwolf@ara.com.

Contract specifications ☐
Agency document:
Other:
Other:
Other:

3. Do you have any additional comments?

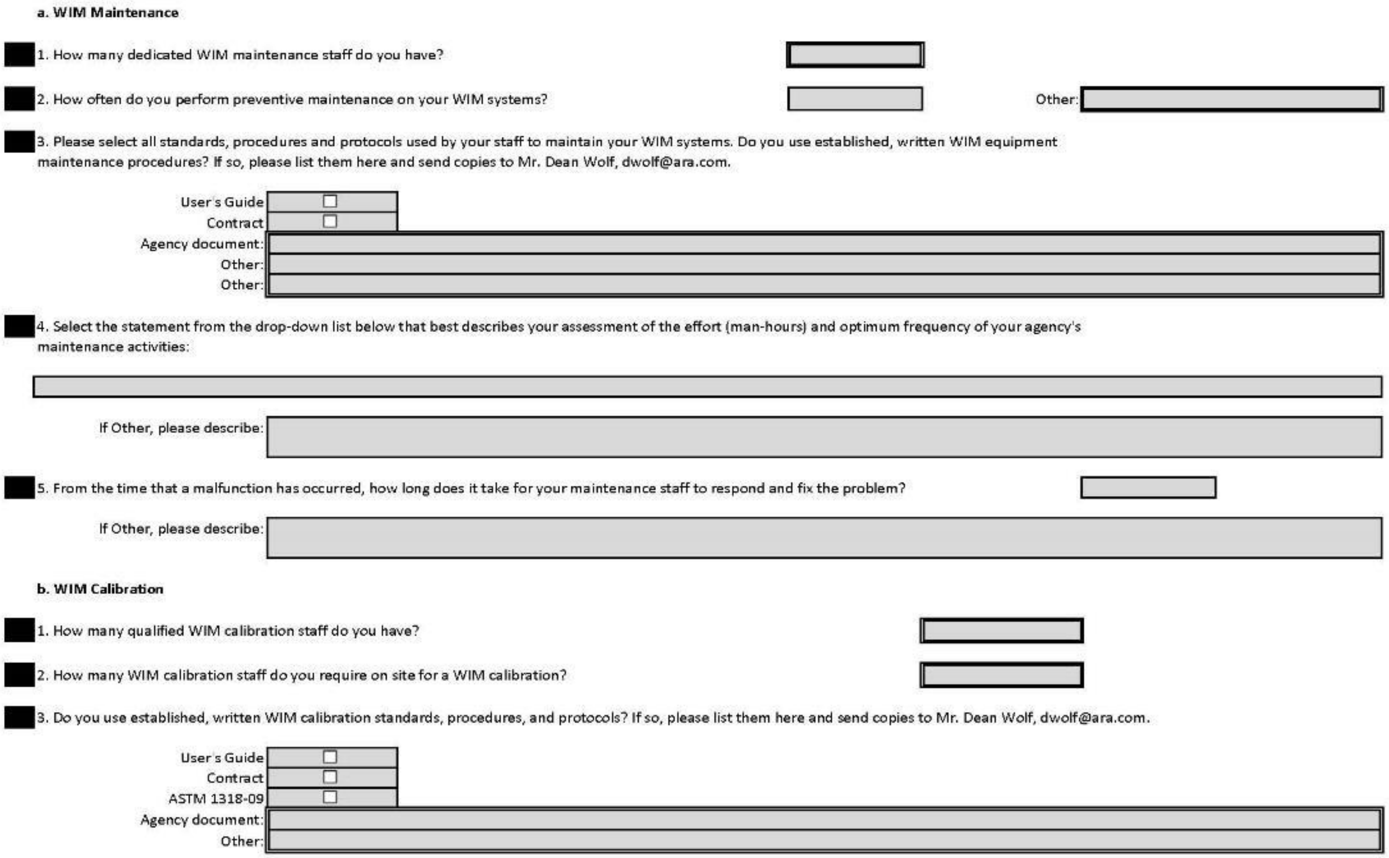
E - WIM EQUIPMENT MAINTENANCE AND CALIBRATION PRACTICES

1. Select the option from the drop-down lists that best describes your agencies current practice for maintaining and calibrating your WIM systems.

We have in-house personnel that calibrate our systems but we outsource maintenance.

If Other, please describe:

Figure 70. Louisiana DOT – Responses to Survey



a. WIM Maintenance

[redacted] 1. How many dedicated WIM maintenance staff do you have?

[redacted] 2. How often do you perform preventive maintenance on your WIM systems? Other:

[redacted] 3. Please select all standards, procedures and protocols used by your staff to maintain your WIM systems. Do you use established, written WIM equipment maintenance procedures? If so, please list them here and send copies to Mr. Dean Wolf, dwolf@ara.com.

User's Guide ☐
Contract ☐
Agency document:
Other:
Other:

[redacted] 4. Select the statement from the drop-down list below that best describes your assessment of the effort (man-hours) and optimum frequency of your agency's maintenance activities:

If Other, please describe:

[redacted] 5. From the time that a malfunction has occurred, how long does it take for your maintenance staff to respond and fix the problem?

If Other, please describe:

b. WIM Calibration

[redacted] 1. How many qualified WIM calibration staff do you have?

[redacted] 2. How many WIM calibration staff do you require on site for a WIM calibration?

[redacted] 3. Do you use established, written WIM calibration standards, procedures, and protocols? If so, please list them here and send copies to Mr. Dean Wolf, dwolf@ara.com.

User's Guide ☐
Contract ☐
ASTM 1318-09 ☐
Agency document:
Other:

Figure 71. Louisiana DOT – Responses to Survey

4. How often do you perform calibration on your BL WIM systems?

If Other, please describe:

5. How many calibration trucks do you use to calibrate your BL WIM systems?

6. Please describe type of truck(s), loads and truck weight(s) used for a BL WIM System calibration:

7. What is the minimum number of passes that you require for the BL WIM system calibration?

8. What is the achievable, acceptable mean error for your BL WIM Systems?

a. after calibration:
b. during routine data checks or before calibration:

If Other, please describe:

9. What is the achievable, acceptable range of errors (+/- percent error) for your BL WIM Systems?

a. after calibration:
b. during routine data checks or before calibration:

If Other, please describe:

10. How many calibration trucks do you use to calibrate your Quartz-piezo WIM systems?

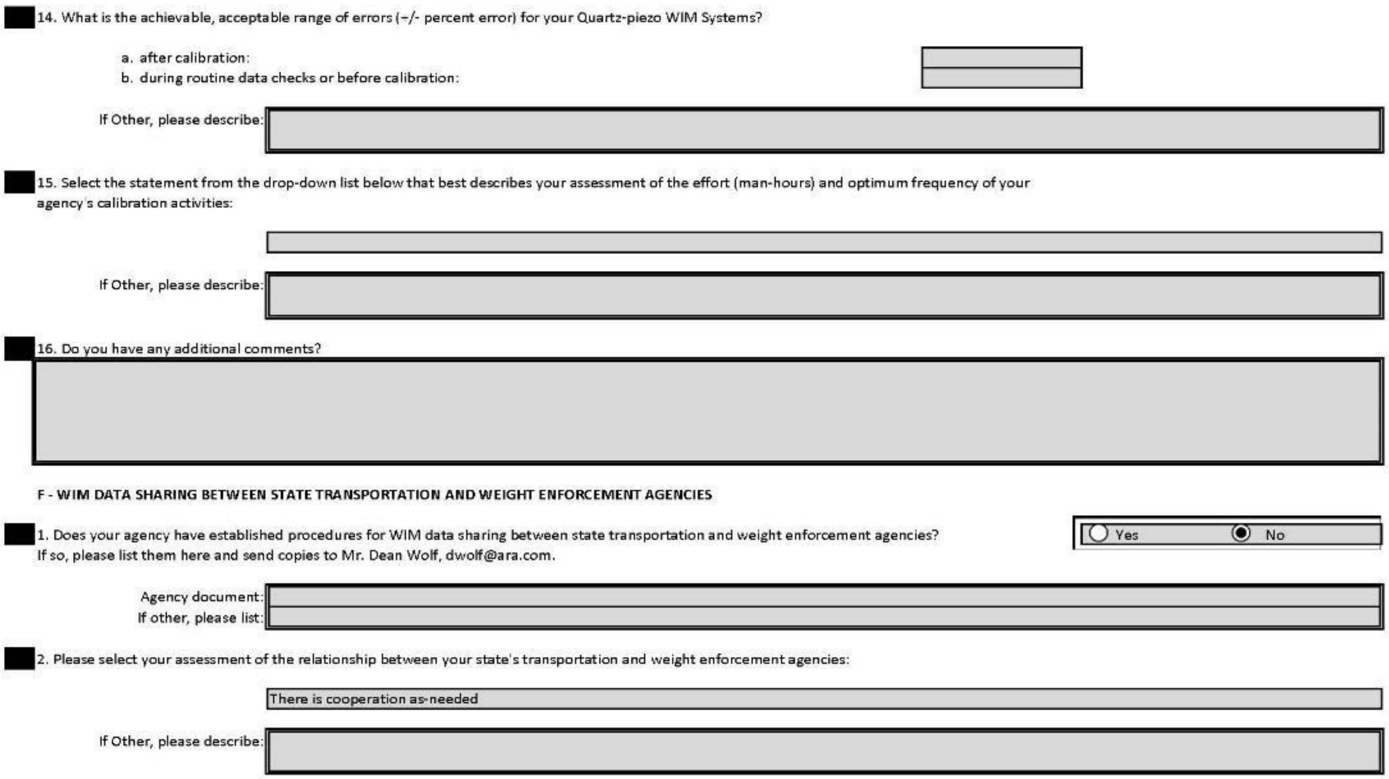
11. Please describe type of truck(s), loads and truck weight(s) used for a Quartz-piezo WIM System calibration:

12. What is the minimum number of passes that you require for the Quartz-piezo WIM system calibration?

13. What is the achievable, acceptable mean error for your Quartz-piezo WIM Systems?

a. after calibration:
b. during routine data checks or before calibration:

Figure 72. Louisiana DOT – Responses to Survey



14. What is the achievable, acceptable range of errors (-/- percent error) for your Quartz-piezo WIM Systems?

a. after calibration:

b. during routine data checks or before calibration:

If Other, please describe:

15. Select the statement from the drop-down list below that best describes your assessment of the effort (man-hours) and optimum frequency of your agency's calibration activities:

If Other, please describe:

16. Do you have any additional comments?

F - WIM DATA SHARING BETWEEN STATE TRANSPORTATION AND WEIGHT ENFORCEMENT AGENCIES

1. Does your agency have established procedures for WIM data sharing between state transportation and weight enforcement agencies? If so, please list them here and send copies to Mr. Dean Wolf, dwolf@ara.com.

○ Yes ● No

Agency document:

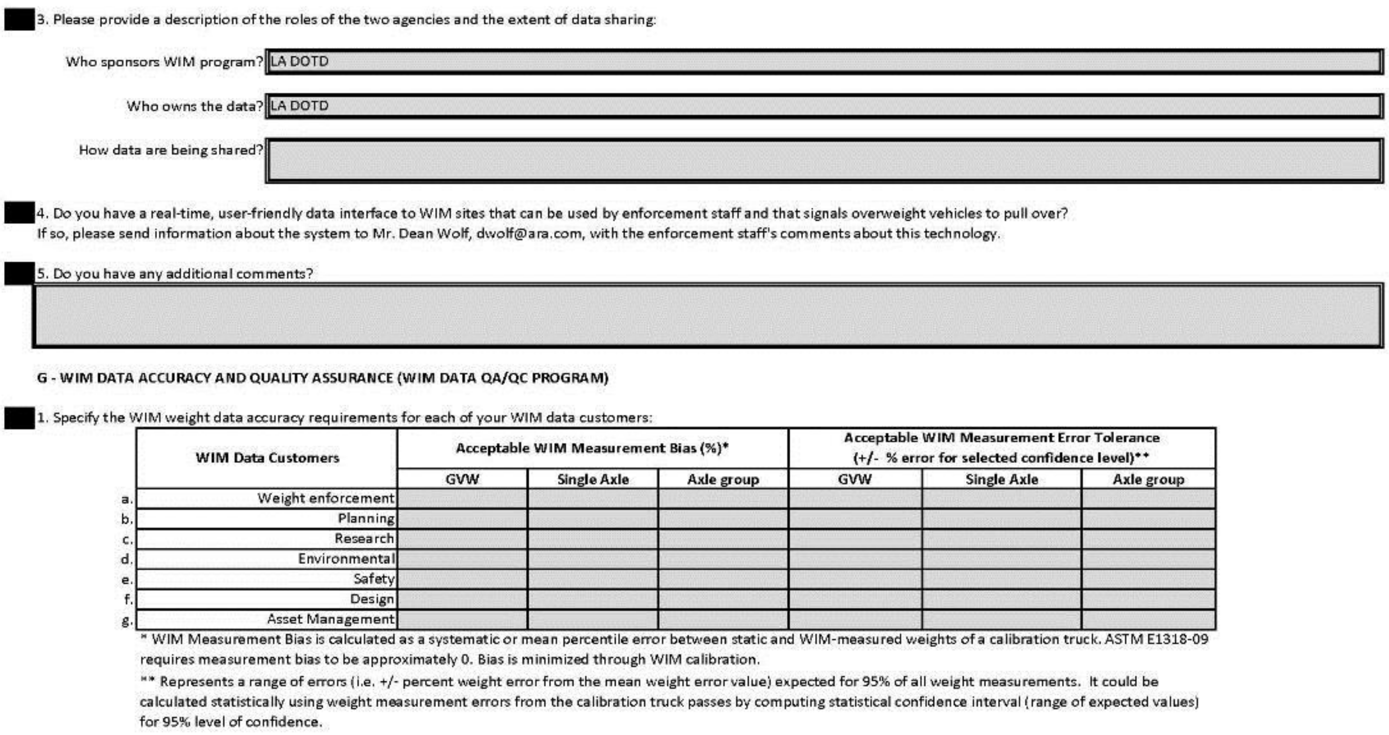
If other, please list:

2. Please select your assessment of the relationship between your state's transportation and weight enforcement agencies:

There is cooperation as-needed

If Other, please describe:

Figure 73. Louisiana DOT – Responses to Survey



[redacted] 3. Please provide a description of the roles of the two agencies and the extent of data sharing:

Who sponsors WIM program? LA DOTD

Who owns the data? LA DOTD

How data are being shared?

[redacted] 4. Do you have a real-time, user-friendly data interface to WIM sites that can be used by enforcement staff and that signals overweight vehicles to pull over?
If so, please send information about the system to Mr. Dean Wolf, dwolf@ara.com, with the enforcement staff's comments about this technology.

[redacted] 5. Do you have any additional comments?

G - WIM DATA ACCURACY AND QUALITY ASSURANCE (WIM DATA QA/QC PROGRAM)

[redacted] 1. Specify the WIM weight data accuracy requirements for each of your WIM data customers:

	WIM Data Customers	Acceptable WIM Measurement Bias (%)*			Acceptable WIM Measurement Error Tolerance (+/- % error for selected confidence level)**		
		GVW	Single Axle	Axle group	GVW	Single Axle	Axle group
a.	Weight enforcement						
b.	Planning						
c.	Research						
d.	Environmental						
e.	Safety						
f.	Design						
g.	Asset Management						

* WIM Measurement Bias is calculated as a systematic or mean percentile error between static and WIM-measured weights of a calibration truck. ASTM E1318-09 requires measurement bias to be approximately 0. Bias is minimized through WIM calibration.

** Represents a range of errors (i.e. +/- percent weight error from the mean weight error value) expected for 95% of all weight measurements. It could be calculated statistically using weight measurement errors from the calibration truck passes by computing statistical confidence interval (range of expected values) for 95% level of confidence.

Figure 74. Louisiana DOT – Responses to Survey

[redacted]2. Please select the WIM data QA/QC checks you perform on your WIM data:

Data file size ☐
Class 9 hourly or daily volume check ☐
Class 9 loaded/unloaded peak loads ☐
Average Class 9 front axle ☐
Average truck GVW ☐
Site identification, lane, direction, date, time, and location description checks ☐
Seasonal shift in axle load spectra for class 9 trucks ☐
Other:
Other:
Other:
Other:
Other:
Other:

[redacted]3. Does your agency have established WIM data QA/QC procedures? If so, please list them here and send copies to Mr. Dean Wolf, dwolf@ara.com.

Agency document:
Other:

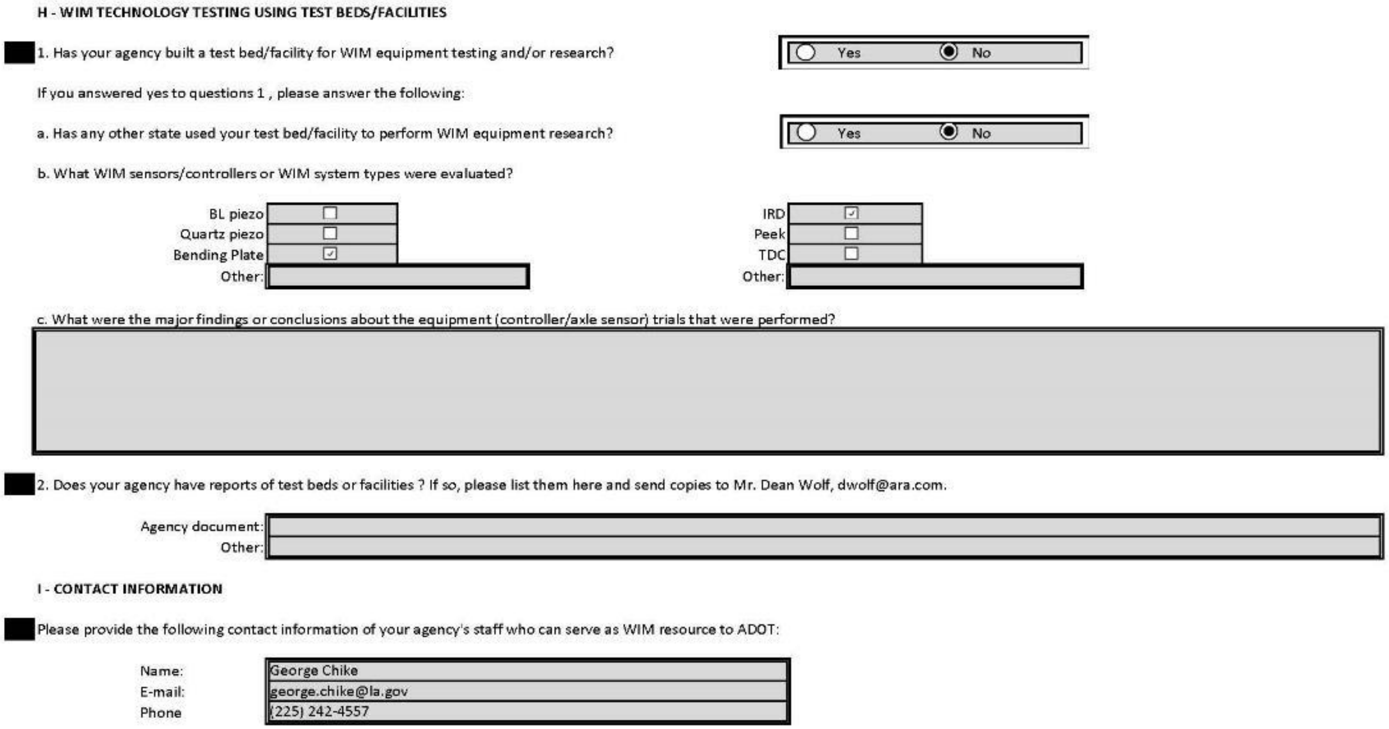
[redacted]4. Please select the statement from drop-down list below that best describes the effectiveness of your WIM data checks:

If Other, please describe:

[redacted]5. Which WIM sensors/controllers or WIM system types would you recommend and for what applications/customers?

Controller Type	Sensor type	Application/Customer	Target Accuracy	Main Advantages	Main Limitations

Figure 75. Louisiana DOT – Responses to Survey



H - WIM TECHNOLOGY TESTING USING TEST BEDS/FACILITIES

1. Has your agency built a test bed/facility for WIM equipment testing and/or research? ○ Yes ● No

If you answered yes to questions 1 , please answer the following:

a. Has any other state used your test bed/facility to perform WIM equipment research? ○ Yes ● No

b. What WIM sensors/controllers or WIM system types were evaluated?

BL piezo	☐	IRD	☑
Quartz piezo	☐	Peek	☐
Bending Plate	☑	TDC	☐
Other:		Other:	

c. What were the major findings or conclusions about the equipment (controller/axle sensor) trials that were performed?

2. Does your agency have reports of test beds or facilities ? If so, please list them here and send copies to Mr. Dean Wolf, dwolf@ara.com.

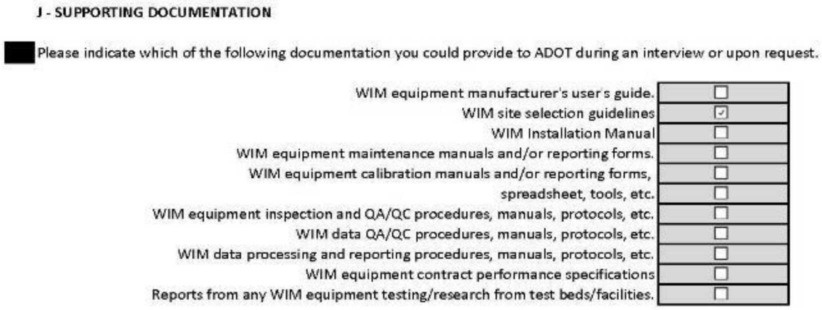
Agency document:
Other:

I - CONTACT INFORMATION

Please provide the following contact information of your agency's staff who can serve as WIM resource to ADOT:

Name:	George Chike
E-mail:	george.chike@la.gov
Phone	(225) 242-4557

Figure 76. Louisiana DOT – Responses to Survey



J - SUPPORTING DOCUMENTATION

[redacted] Please indicate which of the following documentation you could provide to ADOT during an interview or upon request.

WIM equipment manufacturer's user's guide. ☐
WIM site selection guidelines ☑
WIM Installation Manual ☐
WIM equipment maintenance manuals and/or reporting forms. ☐
WIM equipment calibration manuals and/or reporting forms, ☐
spreadsheet, tools, etc. ☐
WIM equipment inspection and QA/QC procedures, manuals, protocols, etc. ☐
WIM data QA/QC procedures, manuals, protocols, etc. ☐
WIM data processing and reporting procedures, manuals, protocols, etc. ☐
WIM equipment contract performance specifications ☐
Reports from any WIM equipment testing/research from test beds/facilities. ☐

Figure 77. Louisiana DOT – Responses to Survey

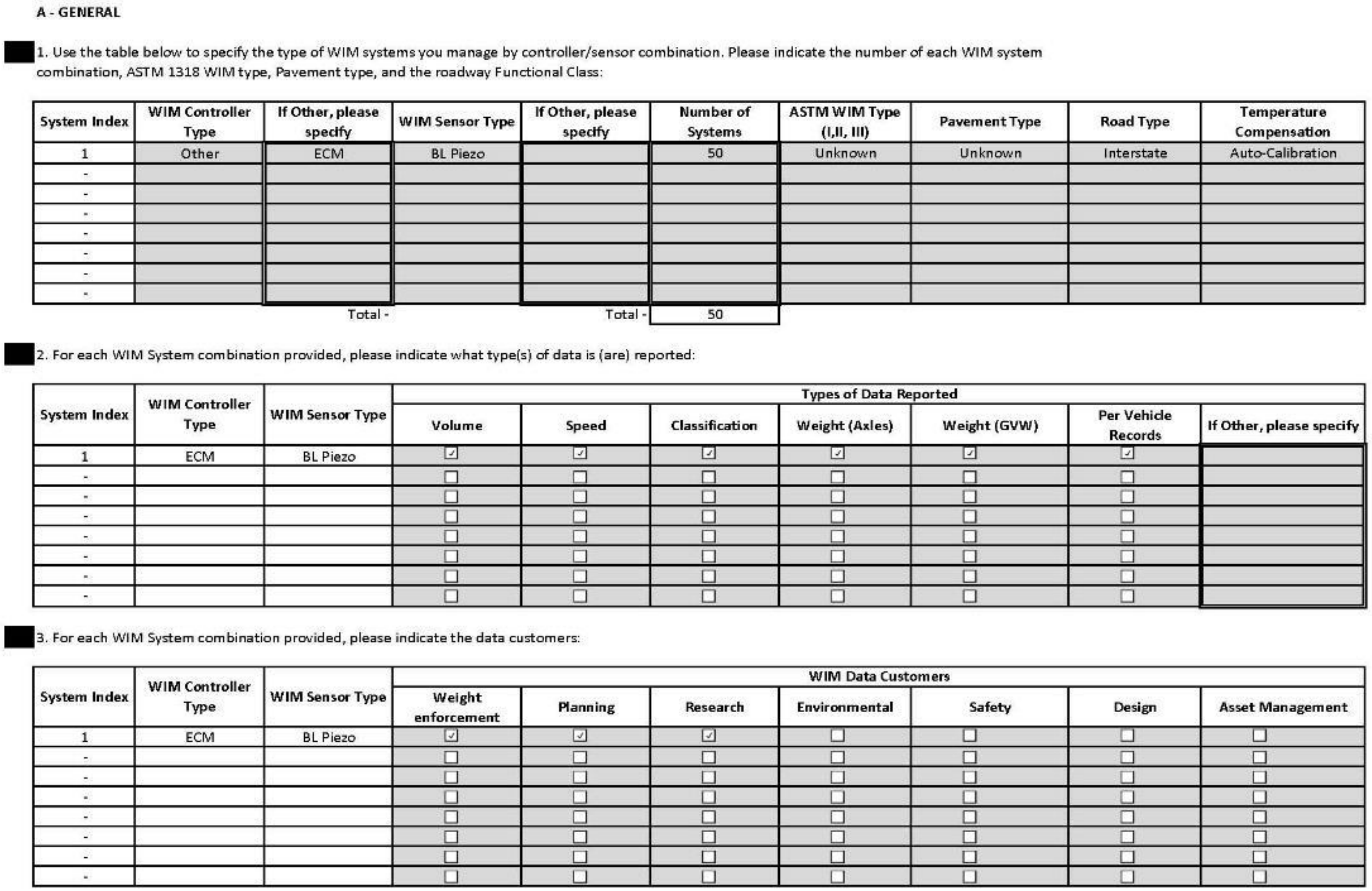
Marshall University (Dr. Andrew Nichols)

Associate Professor of Engineering

Program Director – Intelligent Transportation System, Rahall Appalachian Transportation Institute

Secretary – TRB Highway Traffic Monitoring Committee (ABJ-35)

Member – TRB Traffic Expert Task Group



A - GENERAL

[redacted] 1. Use the table below to specify the type of WIM systems you manage by controller/sensor combination. Please indicate the number of each WIM system combination, ASTM 1318 WIM type, Pavement type, and the roadway Functional Class:

System Index	WIM Controller Type	If Other, please specify	WIM Sensor Type	If Other, please specify	Number of Systems	ASTM WIM Type (I,II, III)	Pavement Type	Road Type	Temperature Compensation
1	Other	ECM	BL Piezo		50	Unknown	Unknown	Interstate	Auto-Calibration
-									
-									
-									
-									
-									
-									
-									
		Total -		Total -	50				

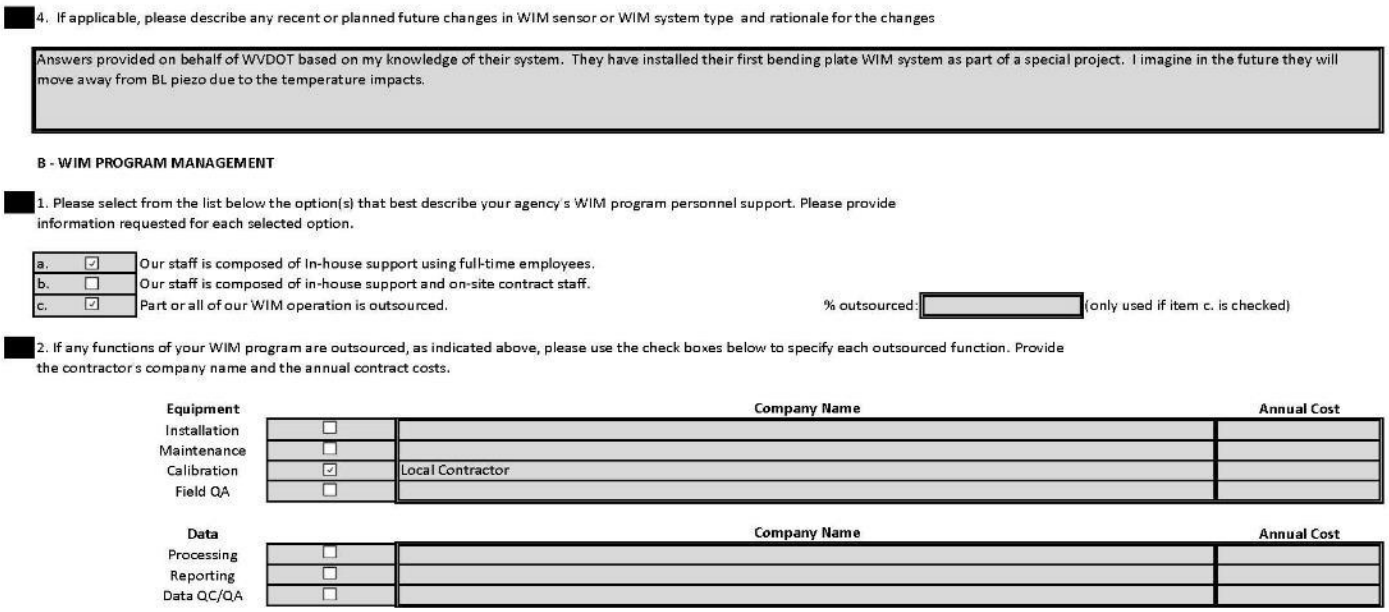
[redacted] 2. For each WIM System combination provided, please indicate what type(s) of data is (are) reported:

System Index	WIM Controller Type	WIM Sensor Type	Types of Data Reported						
			Volume	Speed	Classification	Weight (Axles)	Weight (GVW)	Per Vehicle Records	If Other, please specify
1	ECM	BL Piezo	☑	☑	☑	☑	☑	☑	
-			☐	☐	☐	☐	☐	☐	
-			☐	☐	☐	☐	☐	☐	
-			☐	☐	☐	☐	☐	☐	
-			☐	☐	☐	☐	☐	☐	
-			☐	☐	☐	☐	☐	☐	
-			☐	☐	☐	☐	☐	☐	
-			☐	☐	☐	☐	☐	☐	

[redacted] 3. For each WIM System combination provided, please indicate the data customers:

System Index	WIM Controller Type	WIM Sensor Type	WIM Data Customers						
			Weight enforcement	Planning	Research	Environmental	Safety	Design	Asset Management
1	ECM	BL Piezo	☑	☑	☑	☐	☐	☐	☐
-			☐	☐	☐	☐	☐	☐	☐
-			☐	☐	☐	☐	☐	☐	☐
-			☐	☐	☐	☐	☐	☐	☐
-			☐	☐	☐	☐	☐	☐	☐
-			☐	☐	☐	☐	☐	☐	☐
-			☐	☐	☐	☐	☐	☐	☐
-			☐	☐	☐	☐	☐	☐	☐

Figure 78. Nichols – Responses to Survey



[redacted] 4. If applicable, please describe any recent or planned future changes in WIM sensor or WIM system type and rationale for the changes

Answers provided on behalf of WVDOT based on my knowledge of their system. They have installed their first bending plate WIM system as part of a special project. I imagine in the future they will move away from BL piezo due to the temperature impacts.

B - WIM PROGRAM MANAGEMENT

[redacted] 1. Please select from the list below the option(s) that best describe your agency's WIM program personnel support. Please provide information requested for each selected option.

a.	☑	Our staff is composed of In-house support using full-time employees.
b.	☐	Our staff is composed of in-house support and on-site contract staff.
c.	☑	Part or all of our WIM operation is outsourced.

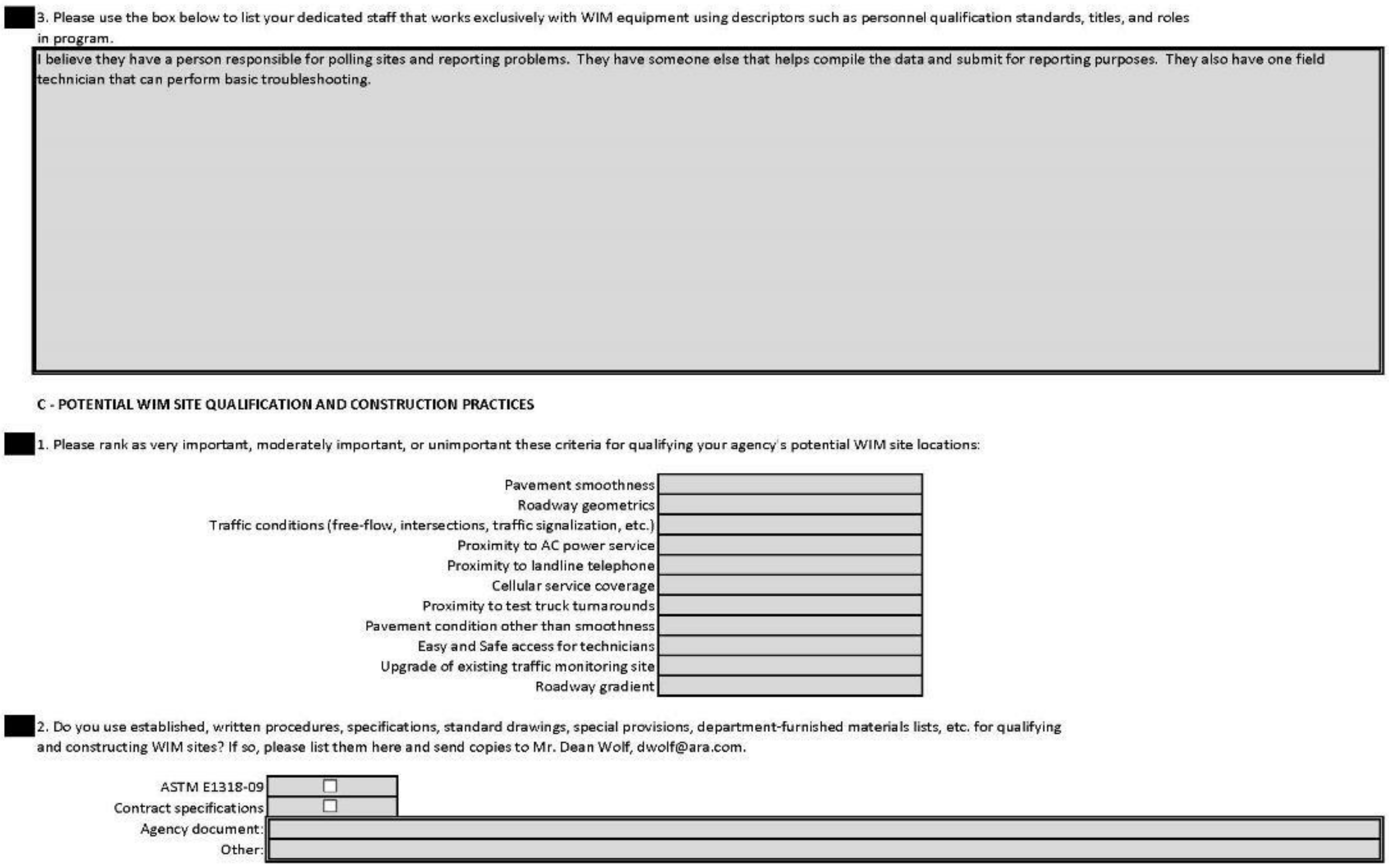
% outsourced: (only used if item c. is checked)

[redacted] 2. If any functions of your WIM program are outsourced, as indicated above, please use the check boxes below to specify each outsourced function. Provide the contractor's company name and the annual contract costs.

Equipment		Company Name	Annual Cost
Installation	☐		
Maintenance	☐		
Calibration	☑	Local Contractor	
Field QA	☐		

Data		Company Name	Annual Cost
Processing	☐		
Reporting	☐		
Data QC/QA	☐		

Figure 79. Nichols – Responses to Survey



[redacted] 3. Please use the box below to list your dedicated staff that works exclusively with WIM equipment using descriptors such as personnel qualification standards, titles, and roles in program.

I believe they have a person responsible for polling sites and reporting problems. They have someone else that helps compile the data and submit for reporting purposes. They also have one field technician that can perform basic troubleshooting.

C - POTENTIAL WIM SITE QUALIFICATION AND CONSTRUCTION PRACTICES

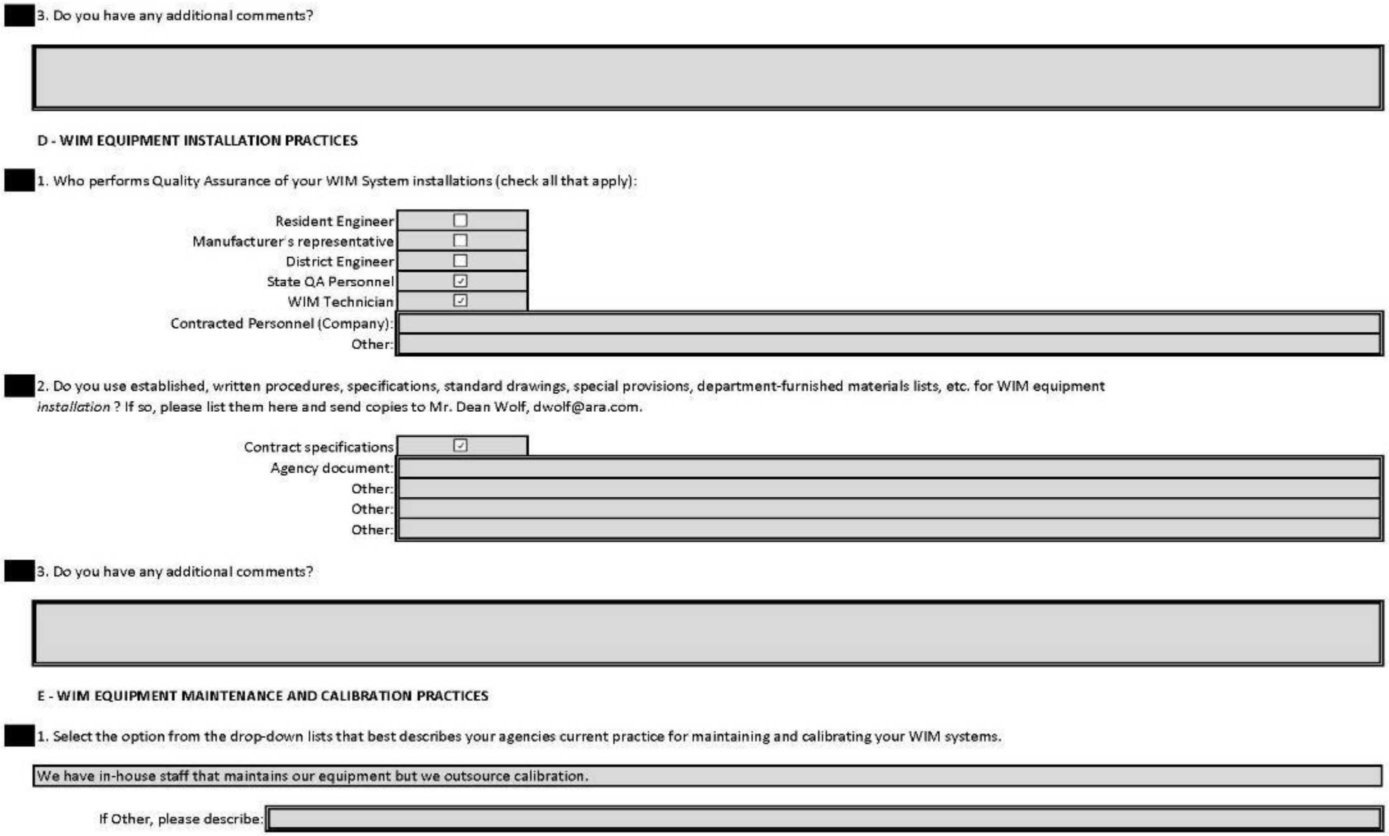
[redacted] 1. Please rank as very important, moderately important, or unimportant these criteria for qualifying your agency's potential WIM site locations:

Pavement smoothness	
Roadway geometrics	
Traffic conditions (free-flow, intersections, traffic signalization, etc.)	
Proximity to AC power service	
Proximity to landline telephone	
Cellular service coverage	
Proximity to test truck turnarounds	
Pavement condition other than smoothness	
Easy and Safe access for technicians	
Upgrade of existing traffic monitoring site	
Roadway gradient	

[redacted] 2. Do you use established, written procedures, specifications, standard drawings, special provisions, department-furnished materials lists, etc. for qualifying and constructing WIM sites? If so, please list them here and send copies to Mr. Dean Wolf, dwolf@ara.com.

ASTM E1318-09	☐
Contract specifications	☐
Agency document:	
Other:	

Figure 80. Nichols – Responses to Survey



3. Do you have any additional comments?

D - WIM EQUIPMENT INSTALLATION PRACTICES

1. Who performs Quality Assurance of your WIM System installations (check all that apply):

Resident Engineer	☐
Manufacturer's representative	☐
District Engineer	☐
State QA Personnel	☑
WIM Technician	☑
Contracted Personnel (Company):	
Other:	

2. Do you use established, written procedures, specifications, standard drawings, special provisions, department-furnished materials lists, etc. for WIM equipment *installation* ? If so, please list them here and send copies to Mr. Dean Wolf, dwolf@ara.com.

Contract specifications	☑
Agency document:	
Other:	
Other:	
Other:	

3. Do you have any additional comments?

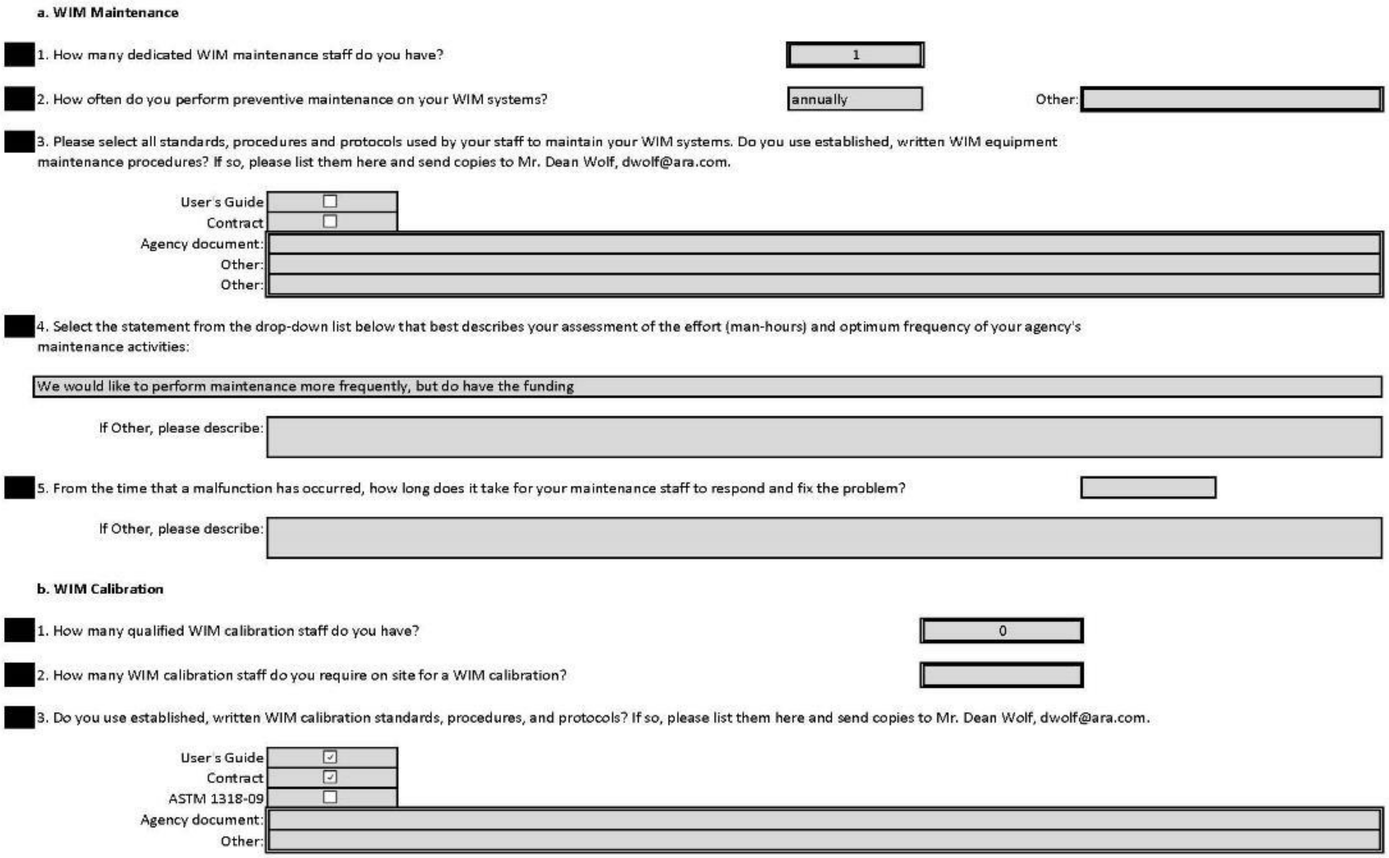
E - WIM EQUIPMENT MAINTENANCE AND CALIBRATION PRACTICES

1. Select the option from the drop-down lists that best describes your agencies current practice for maintaining and calibrating your WIM systems.

We have in-house staff that maintains our equipment but we outsource calibration.

If Other, please describe:

Figure 81. Nichols – Responses to Survey



a. WIM Maintenance

1. How many dedicated WIM maintenance staff do you have? 1

2. How often do you perform preventive maintenance on your WIM systems? annually Other:

3. Please select all standards, procedures and protocols used by your staff to maintain your WIM systems. Do you use established, written WIM equipment maintenance procedures? If so, please list them here and send copies to Mr. Dean Wolf, dwolf@ara.com.

User's Guide ☐
Contract ☐
Agency document:
Other:
Other:

4. Select the statement from the drop-down list below that best describes your assessment of the effort (man-hours) and optimum frequency of your agency's maintenance activities:

We would like to perform maintenance more frequently, but do have the funding

If Other, please describe:

5. From the time that a malfunction has occurred, how long does it take for your maintenance staff to respond and fix the problem?

If Other, please describe:

b. WIM Calibration

1. How many qualified WIM calibration staff do you have? 0

2. How many WIM calibration staff do you require on site for a WIM calibration?

3. Do you use established, written WIM calibration standards, procedures, and protocols? If so, please list them here and send copies to Mr. Dean Wolf, dwolf@ara.com.

User's Guide ☑
Contract ☑
ASTM 1318-09 ☐
Agency document:
Other:

Figure 82. Nichols – Responses to Survey

4. How often do you perform calibration on your BL WIM systems? after installation only

If Other, please describe:

5. How many calibration trucks do you use to calibrate your BL WIM systems?

6. Please describe type of truck(s), loads and truck weight(s) used for a BL WIM System calibration:

7. What is the minimum number of passes that you require for the BL WIM system calibration?

8. What is the achievable, acceptable mean error for your BL WIM Systems?

a. after calibration:
b. during routine data checks or before calibration:

If Other, please describe:

9. What is the achievable, acceptable range of errors (+/- percent error) for your BL WIM Systems?

a. after calibration:
b. during routine data checks or before calibration:

If Other, please describe:

10. How many calibration trucks do you use to calibrate your Quartz-piezo WIM systems?

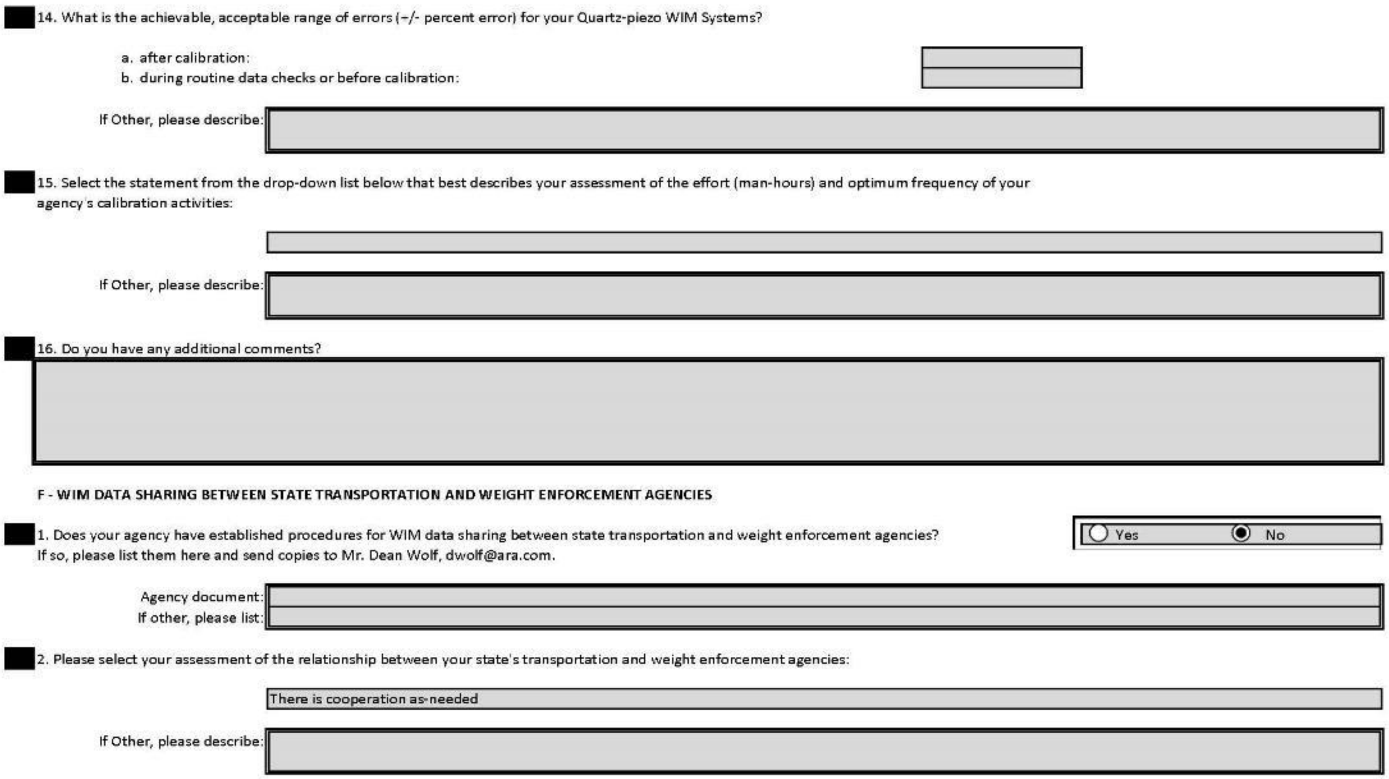
11. Please describe type of truck(s), loads and truck weight(s) used for a Quartz-piezo WIM System calibration:

12. What is the minimum number of passes that you require for the Quartz-piezo WIM system calibration?

13. What is the achievable, acceptable mean error for your Quartz-piezo WIM Systems?

a. after calibration:
b. during routine data checks or before calibration:

Figure 83. Nichols – Responses to Survey



[redacted] 14. What is the achievable, acceptable range of errors (-/- percent error) for your Quartz-piezo WIM Systems?

a. after calibration:
b. during routine data checks or before calibration:

If Other, please describe:

[redacted] 15. Select the statement from the drop-down list below that best describes your assessment of the effort (man-hours) and optimum frequency of your agency's calibration activities:

If Other, please describe:

[redacted] 16. Do you have any additional comments?

F - WIM DATA SHARING BETWEEN STATE TRANSPORTATION AND WEIGHT ENFORCEMENT AGENCIES

[redacted] 1. Does your agency have established procedures for WIM data sharing between state transportation and weight enforcement agencies?
If so, please list them here and send copies to Mr. Dean Wolf, dwolf@ara.com.

○ Yes ● No

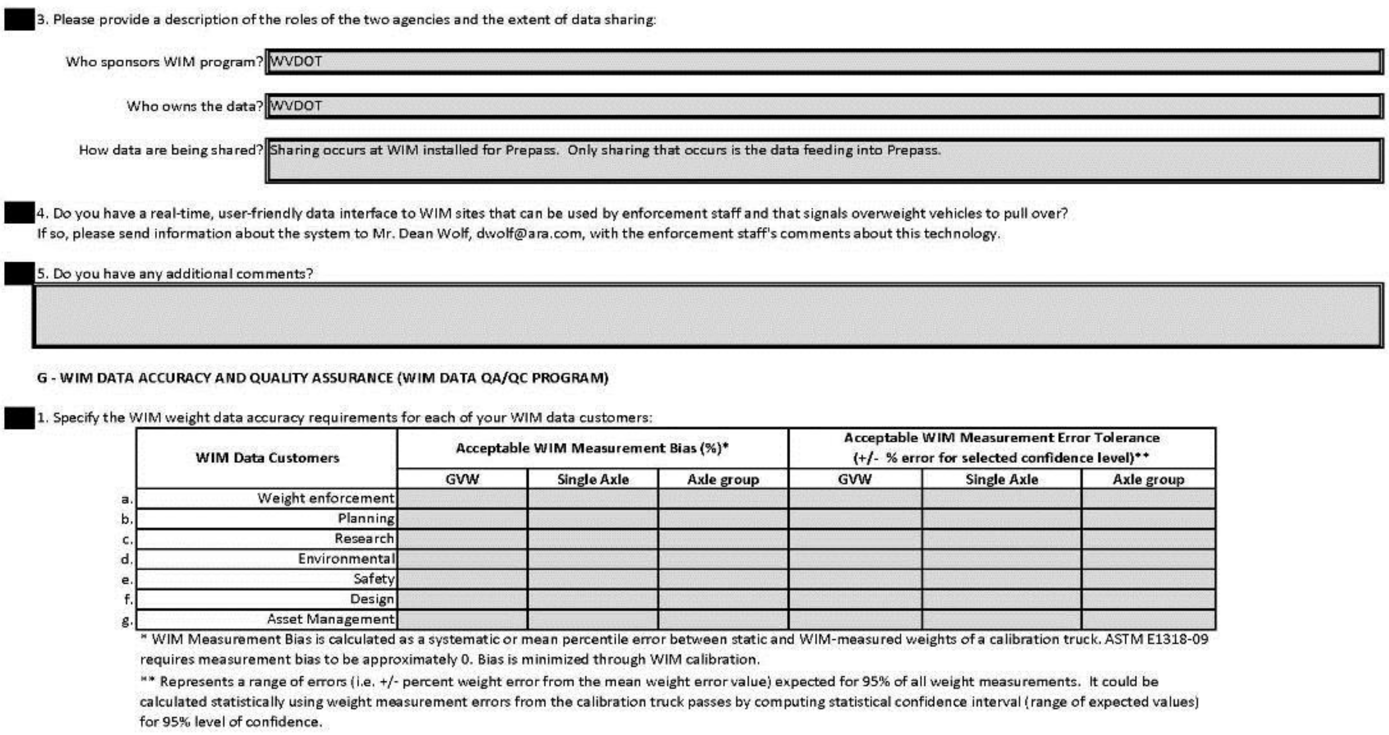
Agency document:
If other, please list:

[redacted] 2. Please select your assessment of the relationship between your state's transportation and weight enforcement agencies:

There is cooperation as-needed

If Other, please describe:

Figure 84. Nichols – Responses to Survey



3. Please provide a description of the roles of the two agencies and the extent of data sharing:

Who sponsors WIM program? WVDOT

Who owns the data? WVDOT

How data are being shared? Sharing occurs at WIM installed for Prepass. Only sharing that occurs is the data feeding into Prepass.

4. Do you have a real-time, user-friendly data interface to WIM sites that can be used by enforcement staff and that signals overweight vehicles to pull over?
If so, please send information about the system to Mr. Dean Wolf, dwolf@ara.com, with the enforcement staff's comments about this technology.

5. Do you have any additional comments?

G - WIM DATA ACCURACY AND QUALITY ASSURANCE (WIM DATA QA/QC PROGRAM)

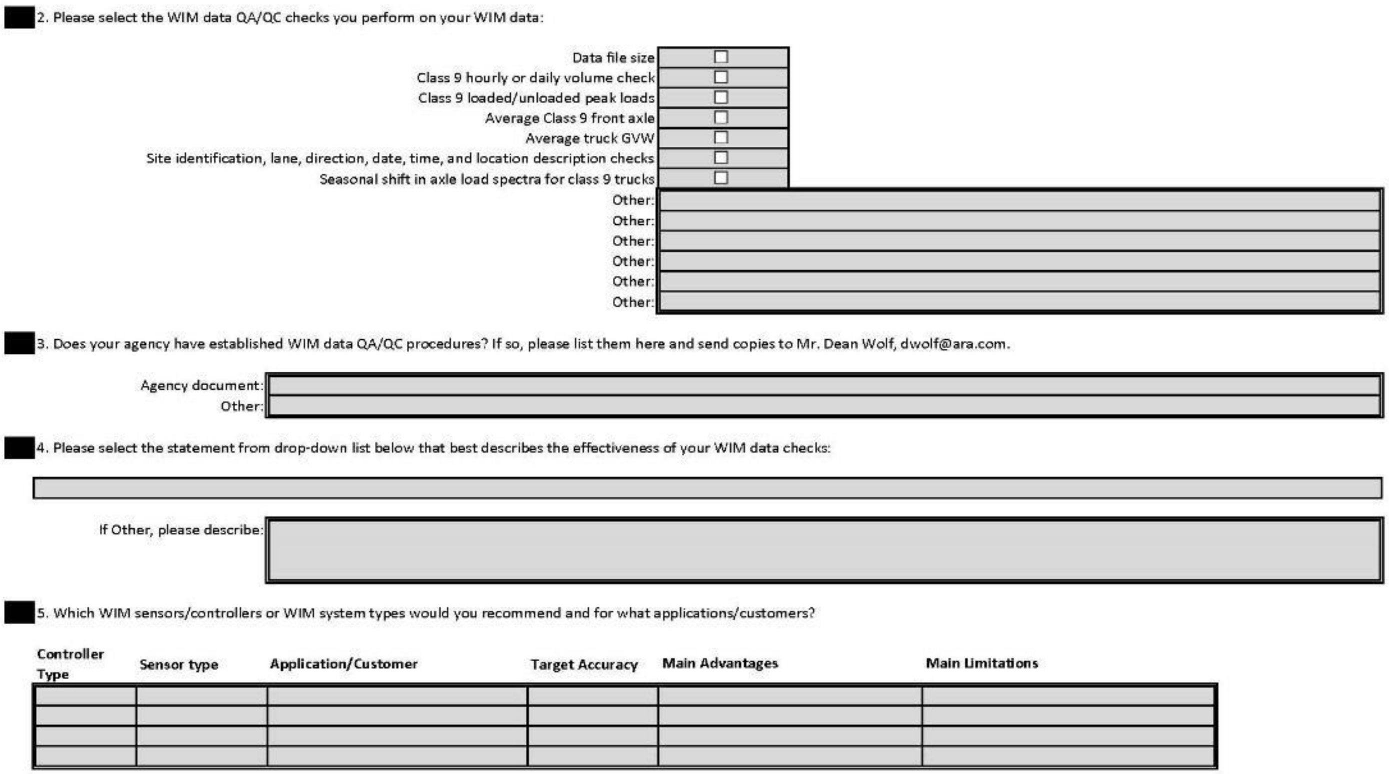
1. Specify the WIM weight data accuracy requirements for each of your WIM data customers:

	WIM Data Customers	Acceptable WIM Measurement Bias (%)*			Acceptable WIM Measurement Error Tolerance (+/- % error for selected confidence level)**		
		GVW	Single Axle	Axle group	GVW	Single Axle	Axle group
a.	Weight enforcement						
b.	Planning						
c.	Research						
d.	Environmental						
e.	Safety						
f.	Design						
g.	Asset Management						

* WIM Measurement Bias is calculated as a systematic or mean percentile error between static and WIM-measured weights of a calibration truck. ASTM E1318-09 requires measurement bias to be approximately 0. Bias is minimized through WIM calibration.

** Represents a range of errors (i.e. +/- percent weight error from the mean weight error value) expected for 95% of all weight measurements. It could be calculated statistically using weight measurement errors from the calibration truck passes by computing statistical confidence interval (range of expected values) for 95% level of confidence.

Figure 85. Nichols – Responses to Survey



[redacted] 2. Please select the WIM data QA/QC checks you perform on your WIM data:

Data file size ☐
Class 9 hourly or daily volume check ☐
Class 9 loaded/unloaded peak loads ☐
Average Class 9 front axle ☐
Average truck GVW ☐
Site identification, lane, direction, date, time, and location description checks ☐
Seasonal shift in axle load spectra for class 9 trucks ☐
Other:
Other:
Other:
Other:
Other:
Other:

[redacted] 3. Does your agency have established WIM data QA/QC procedures? If so, please list them here and send copies to Mr. Dean Wolf, dwolf@ara.com.

Agency document:
Other:

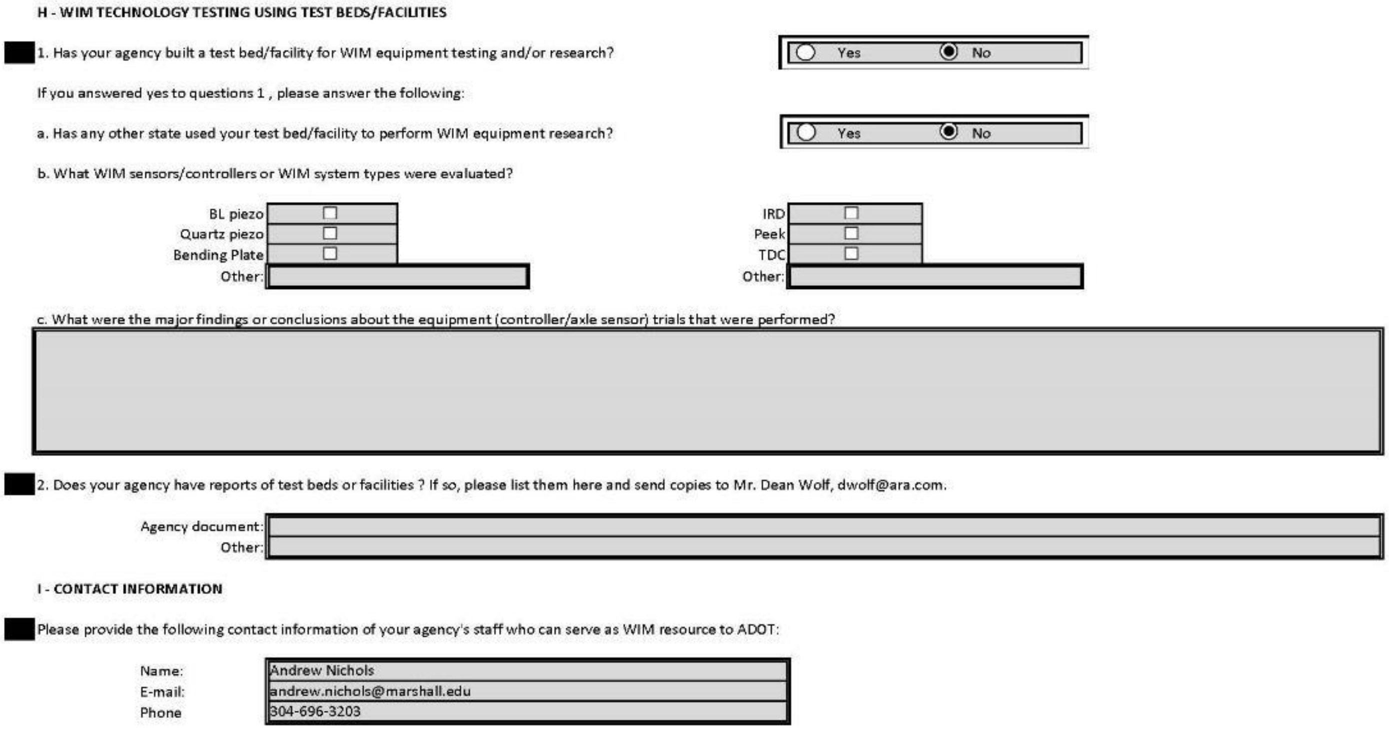
[redacted] 4. Please select the statement from drop-down list below that best describes the effectiveness of your WIM data checks:

If Other, please describe:

[redacted] 5. Which WIM sensors/controllers or WIM system types would you recommend and for what applications/customers?

Controller Type	Sensor type	Application/Customer	Target Accuracy	Main Advantages	Main Limitations

Figure 86. Nichols – Responses to Survey



H - WIM TECHNOLOGY TESTING USING TEST BEDS/FACILITIES

[redacted] 1. Has your agency built a test bed/facility for WIM equipment testing and/or research? ○ Yes ● No

If you answered yes to questions 1 , please answer the following:

a. Has any other state used your test bed/facility to perform WIM equipment research? ○ Yes ● No

b. What WIM sensors/controllers or WIM system types were evaluated?

BL piezo	☐	IRD	☐
Quartz piezo	☐	Peek	☐
Bending Plate	☐	TDC	☐
Other:		Other:	

c. What were the major findings or conclusions about the equipment (controller/axle sensor) trials that were performed?

[redacted] 2. Does your agency have reports of test beds or facilities ? If so, please list them here and send copies to Mr. Dean Wolf, dwolf@ara.com.

Agency document:

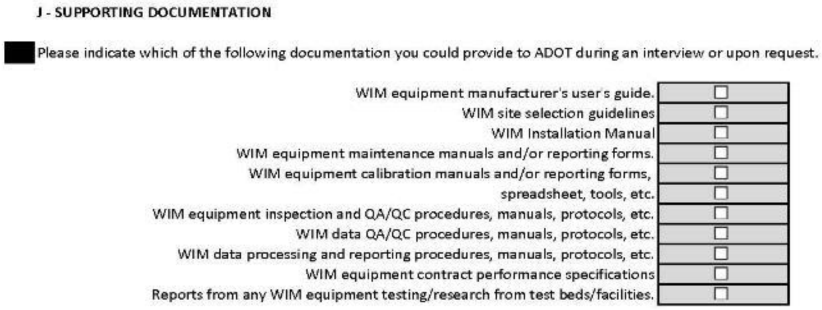
Other:

I - CONTACT INFORMATION

[redacted] Please provide the following contact information of your agency's staff who can serve as WIM resource to ADOT:

Name: Andrew Nichols
E-mail: andrew.nichols@marshall.edu
Phone 304-696-3203

Figure 87. Nichols – Responses to Survey



J - SUPPORTING DOCUMENTATION

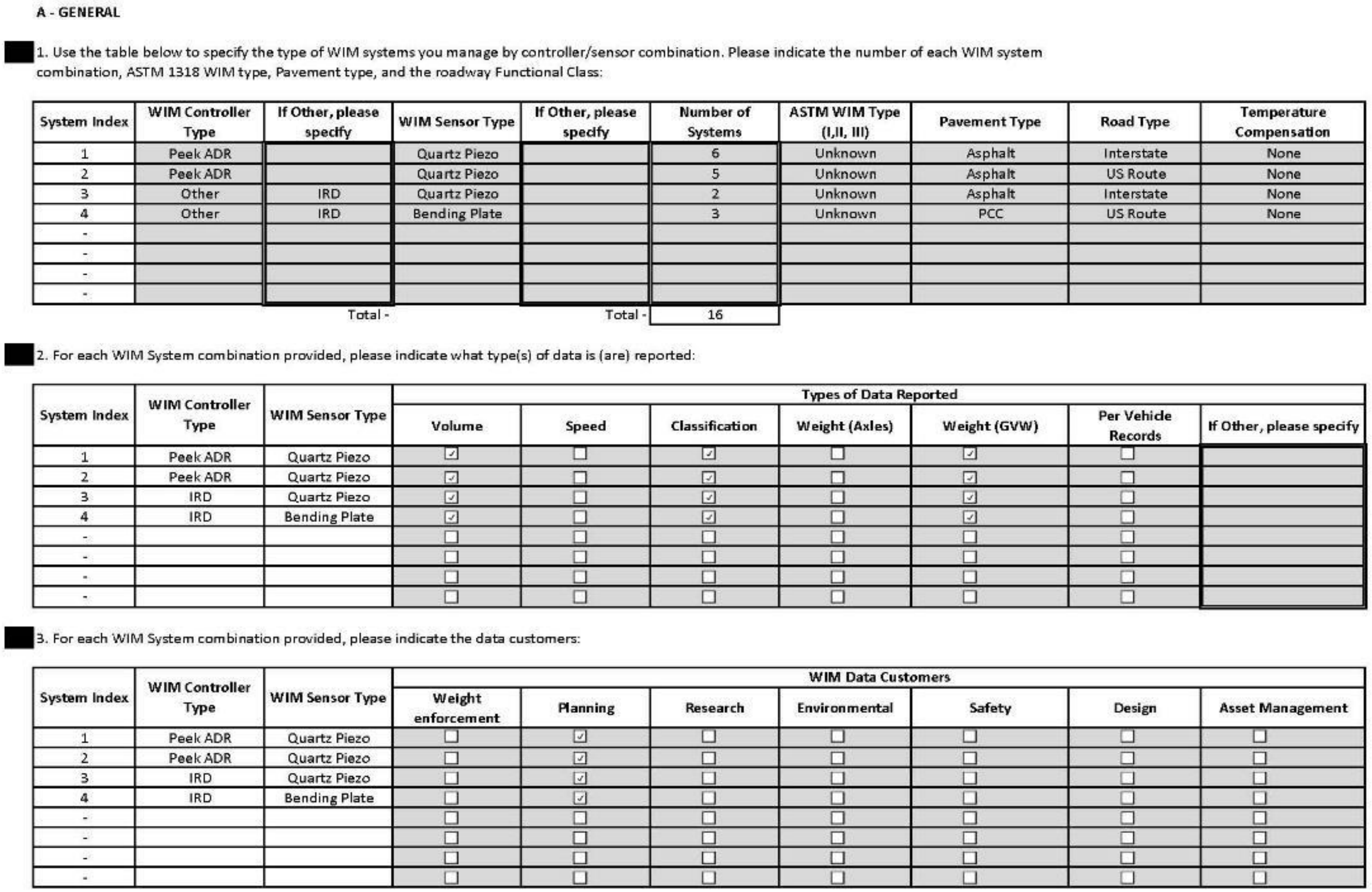
[redacted] Please indicate which of the following documentation you could provide to ADOT during an interview or upon request.

WIM equipment manufacturer's user's guide.	☐
WIM site selection guidelines	☐
WIM Installation Manual	☐
WIM equipment maintenance manuals and/or reporting forms.	☐
WIM equipment calibration manuals and/or reporting forms,	☐
spreadsheet, tools, etc.	☐
WIM equipment inspection and QA/QC procedures, manuals, protocols, etc.	☐
WIM data QA/QC procedures, manuals, protocols, etc.	☐
WIM data processing and reporting procedures, manuals, protocols, etc.	☐
WIM equipment contract performance specifications	☐
Reports from any WIM equipment testing/research from test beds/facilities.	☐

Figure 88. Nichols – Responses to Survey

New Mexico Department of Transportation (Yolanda Duran)

Chief, Data Management Bureau



A - GENERAL

[redacted] 1. Use the table below to specify the type of WIM systems you manage by controller/sensor combination. Please indicate the number of each WIM system combination, ASTM 1318 WIM type, Pavement type, and the roadway Functional Class:

System Index	WIM Controller Type	If Other, please specify	WIM Sensor Type	If Other, please specify	Number of Systems	ASTM WIM Type (I,II, III)	Pavement Type	Road Type	Temperature Compensation
1	Peek ADR		Quartz Piezo		6	Unknown	Asphalt	Interstate	None
2	Peek ADR		Quartz Piezo		5	Unknown	Asphalt	US Route	None
3	Other	IRD	Quartz Piezo		2	Unknown	Asphalt	Interstate	None
4	Other	IRD	Bending Plate		3	Unknown	PCC	US Route	None
-									
-									
-									
-									
		Total -		Total -	16				

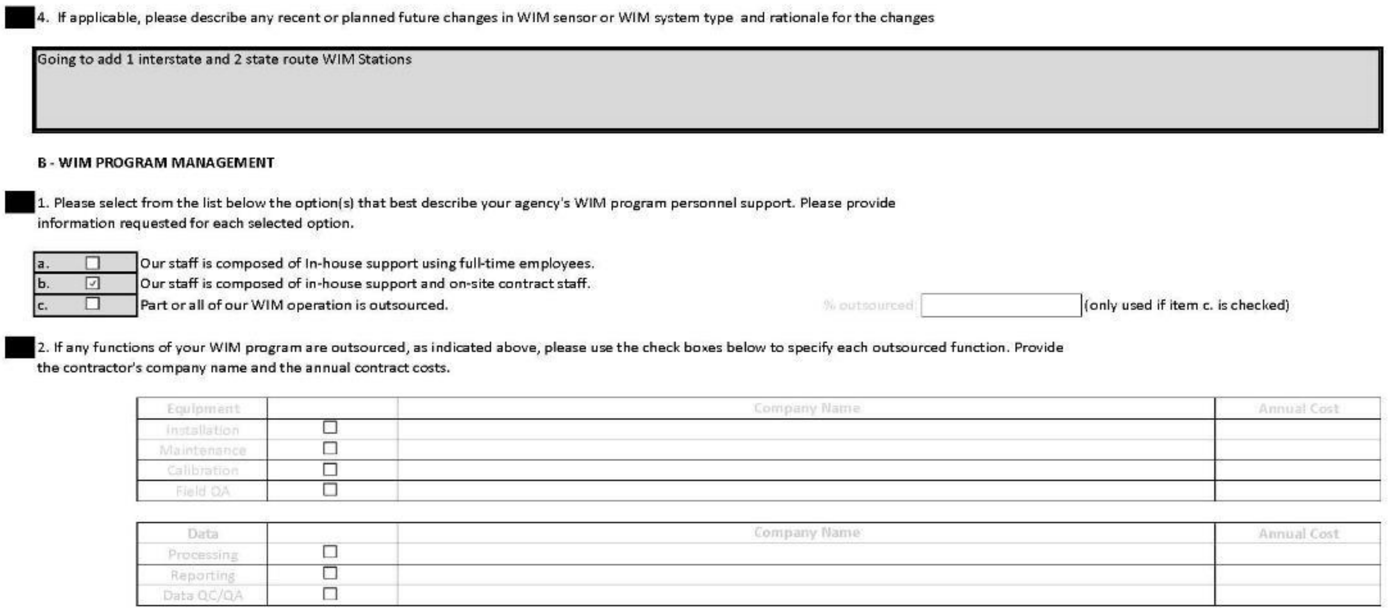
[redacted] 2. For each WIM System combination provided, please indicate what type(s) of data is (are) reported:

System Index	WIM Controller Type	WIM Sensor Type	Types of Data Reported						
			Volume	Speed	Classification	Weight (Axles)	Weight (GVW)	Per Vehicle Records	If Other, please specify
1	Peek ADR	Quartz Piezo	☑	☐	☑	☐	☑	☐	
2	Peek ADR	Quartz Piezo	☑	☐	☑	☐	☑	☐	
3	IRD	Quartz Piezo	☑	☐	☑	☐	☑	☐	
4	IRD	Bending Plate	☑	☐	☑	☐	☑	☐	
-			☐	☐	☐	☐	☐	☐	
-			☐	☐	☐	☐	☐	☐	
-			☐	☐	☐	☐	☐	☐	
-			☐	☐	☐	☐	☐	☐	

[redacted] 3. For each WIM System combination provided, please indicate the data customers:

System Index	WIM Controller Type	WIM Sensor Type	WIM Data Customers						
			Weight enforcement	Planning	Research	Environmental	Safety	Design	Asset Management
1	Peek ADR	Quartz Piezo	☐	☑	☐	☐	☐	☐	☐
2	Peek ADR	Quartz Piezo	☐	☑	☐	☐	☐	☐	☐
3	IRD	Quartz Piezo	☐	☑	☐	☐	☐	☐	☐
4	IRD	Bending Plate	☐	☑	☐	☐	☐	☐	☐
-			☐	☐	☐	☐	☐	☐	☐
-			☐	☐	☐	☐	☐	☐	☐
-			☐	☐	☐	☐	☐	☐	☐
-			☐	☐	☐	☐	☐	☐	☐

Figure 89. New Mexico DOT – Responses to Survey



4. If applicable, please describe any recent or planned future changes in WIM sensor or WIM system type and rationale for the changes

Going to add 1 interstate and 2 state route WIM Stations

B - WIM PROGRAM MANAGEMENT

1. Please select from the list below the option(s) that best describe your agency's WIM program personnel support. Please provide information requested for each selected option.

a.	☐	Our staff is composed of In-house support using full-time employees.
b.	☑	Our staff is composed of in-house support and on-site contract staff.
c.	☐	Part or all of our WIM operation is outsourced.

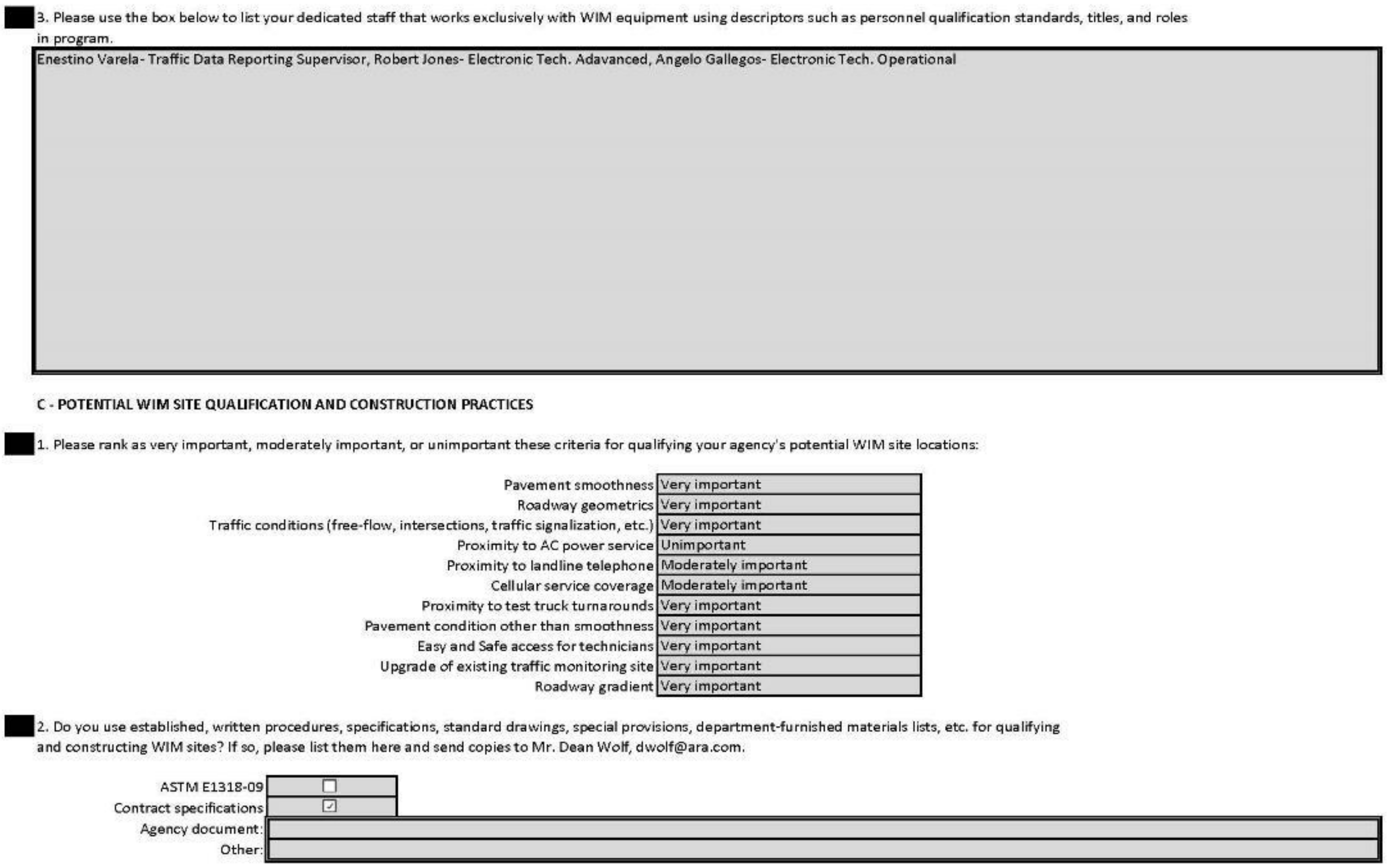
% outsourced: ____ (only used if item c. is checked)

2. If any functions of your WIM program are outsourced, as indicated above, please use the check boxes below to specify each outsourced function. Provide the contractor's company name and the annual contract costs.

Equipment		Company Name	Annual Cost
Installation	☐		
Maintenance	☐		
Calibration	☐		
Field QA	☐		

Data		Company Name	Annual Cost
Processing	☐		
Reporting	☐		
Data QC/QA	☐		

Figure 90. New Mexico DOT – Responses to Survey



[redacted] 3. Please use the box below to list your dedicated staff that works exclusively with WIM equipment using descriptors such as personnel qualification standards, titles, and roles in program.

Enestino Varela- Traffic Data Reporting Supervisor, Robert Jones- Electronic Tech. Adavanced, Angelo Gallegos- Electronic Tech. Operational

C - POTENTIAL WIM SITE QUALIFICATION AND CONSTRUCTION PRACTICES

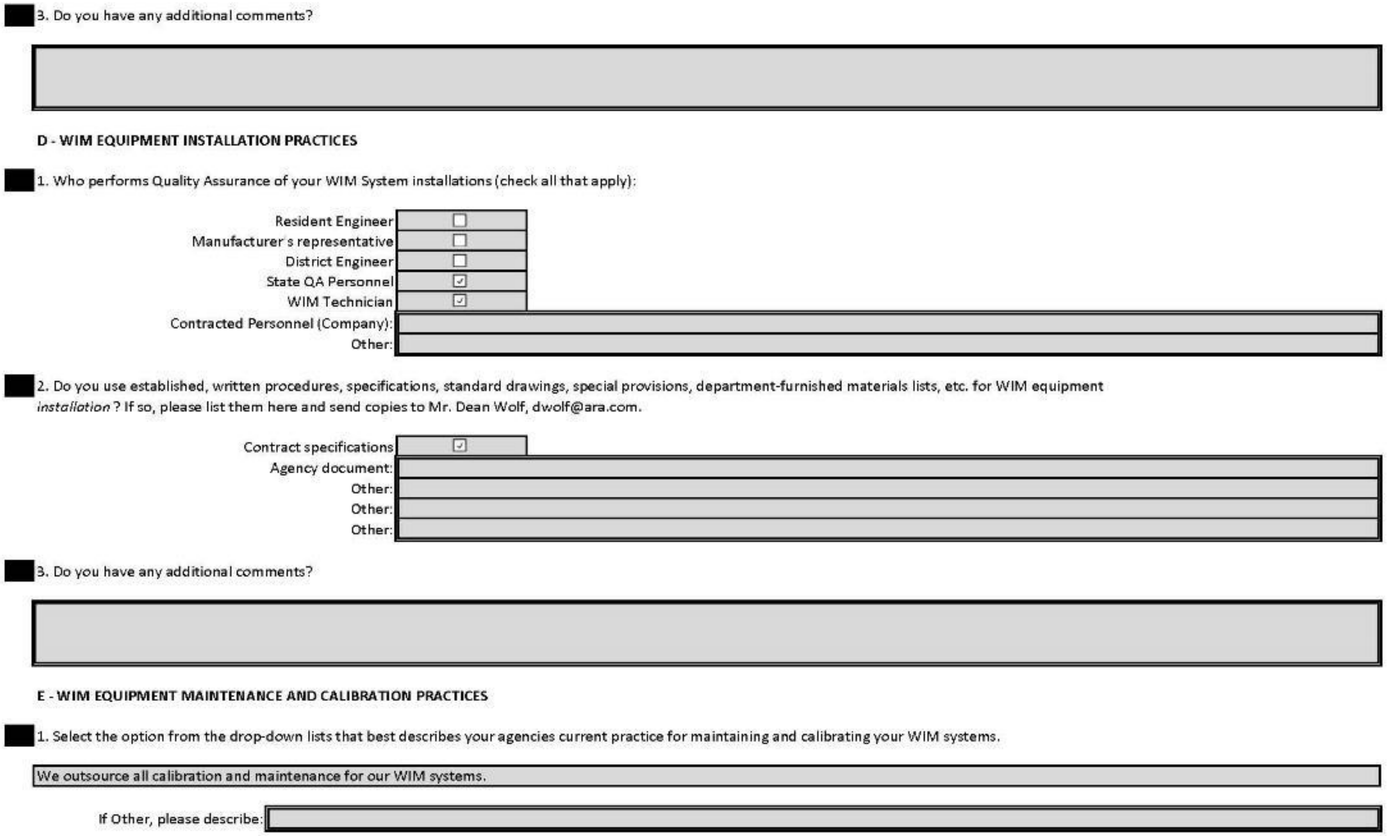
[redacted] 1. Please rank as very important, moderately important, or unimportant these criteria for qualifying your agency's potential WIM site locations:

Pavement smoothness	Very important
Roadway geometrics	Very important
Traffic conditions (free-flow, intersections, traffic signalization, etc.)	Very important
Proximity to AC power service	Unimportant
Proximity to landline telephone	Moderately important
Cellular service coverage	Moderately important
Proximity to test truck turnarounds	Very important
Pavement condition other than smoothness	Very important
Easy and Safe access for technicians	Very important
Upgrade of existing traffic monitoring site	Very important
Roadway gradient	Very important

[redacted] 2. Do you use established, written procedures, specifications, standard drawings, special provisions, department-furnished materials lists, etc. for qualifying and constructing WIM sites? If so, please list them here and send copies to Mr. Dean Wolf, dwolf@ara.com.

ASTM E1318-09 ☐
Contract specifications ☑
Agency document:
Other:

Figure 91. New Mexico DOT – Responses to Survey



3. Do you have any additional comments?

D - WIM EQUIPMENT INSTALLATION PRACTICES

1. Who performs Quality Assurance of your WIM System installations (check all that apply):

Resident Engineer ☐
Manufacturer's representative ☐
District Engineer ☐
State QA Personnel ☑
WIM Technician ☑
Contracted Personnel (Company):
Other:

2. Do you use established, written procedures, specifications, standard drawings, special provisions, department-furnished materials lists, etc. for WIM equipment *installation*? If so, please list them here and send copies to Mr. Dean Wolf, dwolf@ara.com.

Contract specifications ☑
Agency document:
Other:
Other:
Other:

3. Do you have any additional comments?

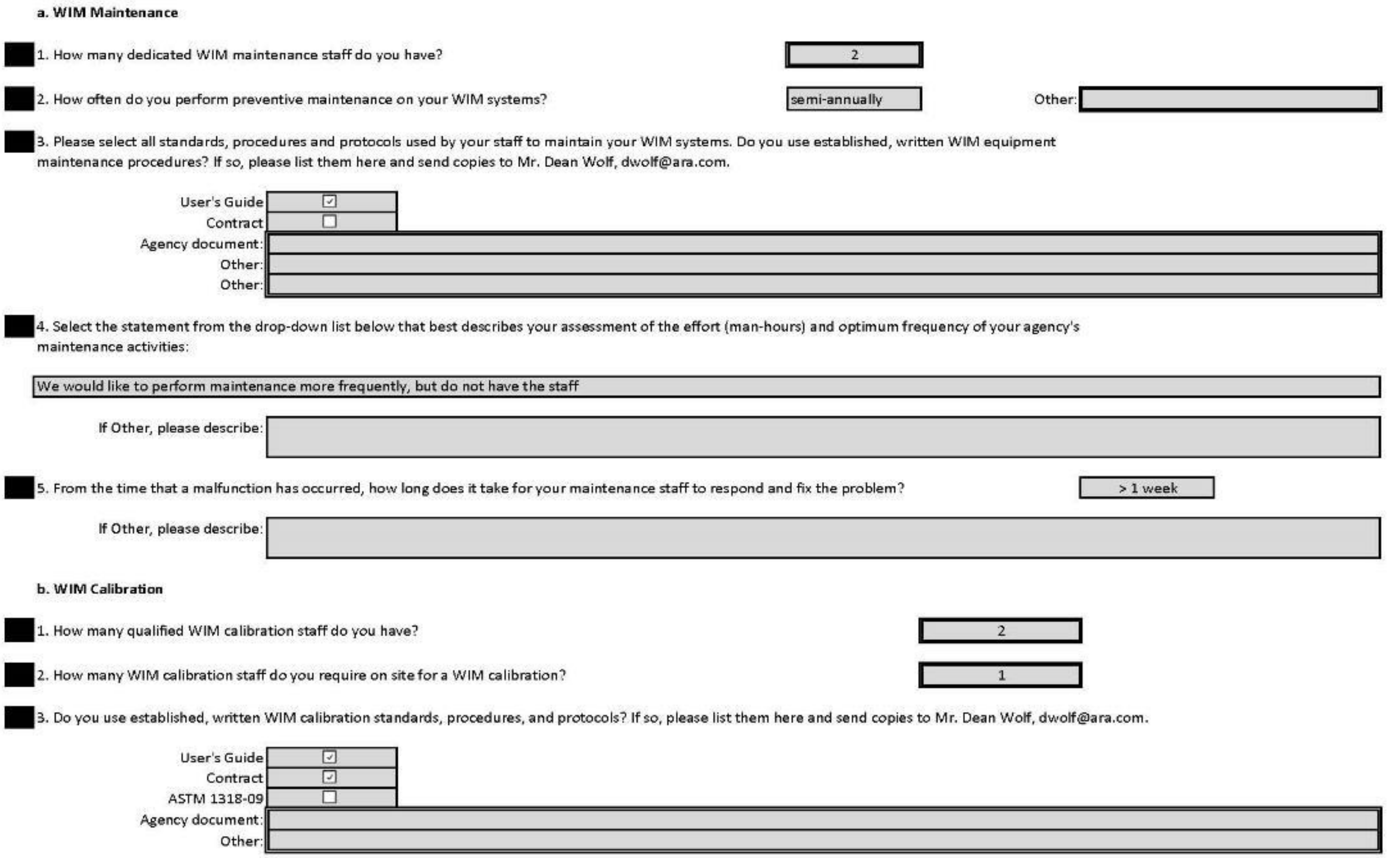
E - WIM EQUIPMENT MAINTENANCE AND CALIBRATION PRACTICES

1. Select the option from the drop-down lists that best describes your agencies current practice for maintaining and calibrating your WIM systems.

We outsource all calibration and maintenance for our WIM systems.

If Other, please describe:

Figure 92. New Mexico DOT – Responses to Survey



a. WIM Maintenance

[redacted] 1. How many dedicated WIM maintenance staff do you have? 2

[redacted] 2. How often do you perform preventive maintenance on your WIM systems? semi-annually Other:

[redacted] 3. Please select all standards, procedures and protocols used by your staff to maintain your WIM systems. Do you use established, written WIM equipment maintenance procedures? If so, please list them here and send copies to Mr. Dean Wolf, dwolf@ara.com.

User's Guide ☑
Contract ☐
Agency document:
Other:
Other:

[redacted] 4. Select the statement from the drop-down list below that best describes your assessment of the effort (man-hours) and optimum frequency of your agency's maintenance activities:

We would like to perform maintenance more frequently, but do not have the staff

If Other, please describe:

[redacted] 5. From the time that a malfunction has occurred, how long does it take for your maintenance staff to respond and fix the problem? > 1 week

If Other, please describe:

b. WIM Calibration

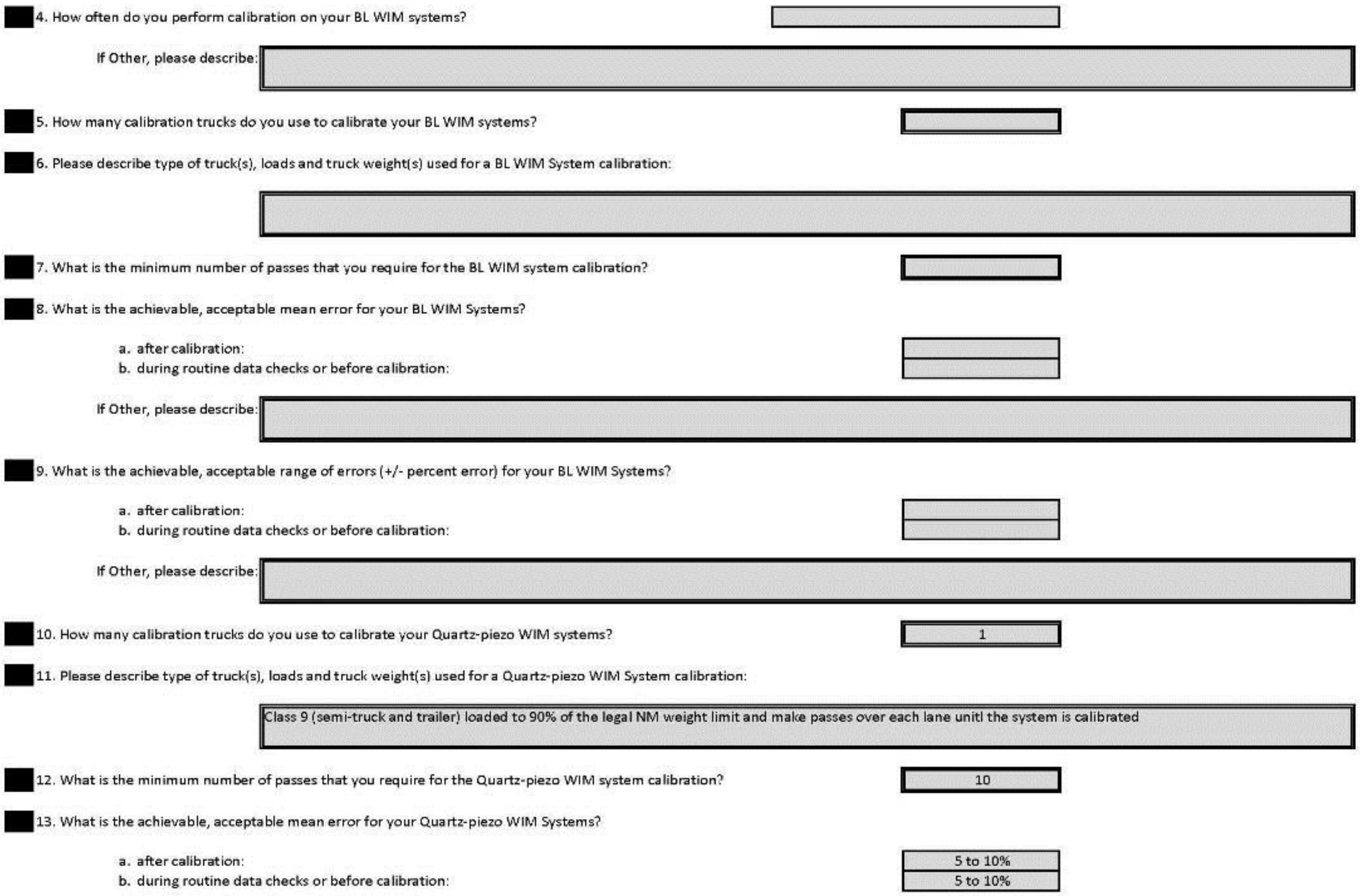
[redacted] 1. How many qualified WIM calibration staff do you have? 2

[redacted] 2. How many WIM calibration staff do you require on site for a WIM calibration? 1

[redacted] 3. Do you use established, written WIM calibration standards, procedures, and protocols? If so, please list them here and send copies to Mr. Dean Wolf, dwolf@ara.com.

User's Guide ☑
Contract ☑
ASTM 1318-09 ☐
Agency document:
Other:

Figure 93. New Mexico DOT – Responses to Survey



4. How often do you perform calibration on your BL WIM systems?

If Other, please describe:

5. How many calibration trucks do you use to calibrate your BL WIM systems?

6. Please describe type of truck(s), loads and truck weight(s) used for a BL WIM System calibration:

7. What is the minimum number of passes that you require for the BL WIM system calibration?

8. What is the achievable, acceptable mean error for your BL WIM Systems?

a. after calibration:

b. during routine data checks or before calibration:

If Other, please describe:

9. What is the achievable, acceptable range of errors (+/- percent error) for your BL WIM Systems?

a. after calibration:

b. during routine data checks or before calibration:

If Other, please describe:

10. How many calibration trucks do you use to calibrate your Quartz-piezo WIM systems? 1

11. Please describe type of truck(s), loads and truck weight(s) used for a Quartz-piezo WIM System calibration:

Class 9 (semi-truck and trailer) loaded to 90% of the legal NM weight limit and make passes over each lane unitl the system is calibrated

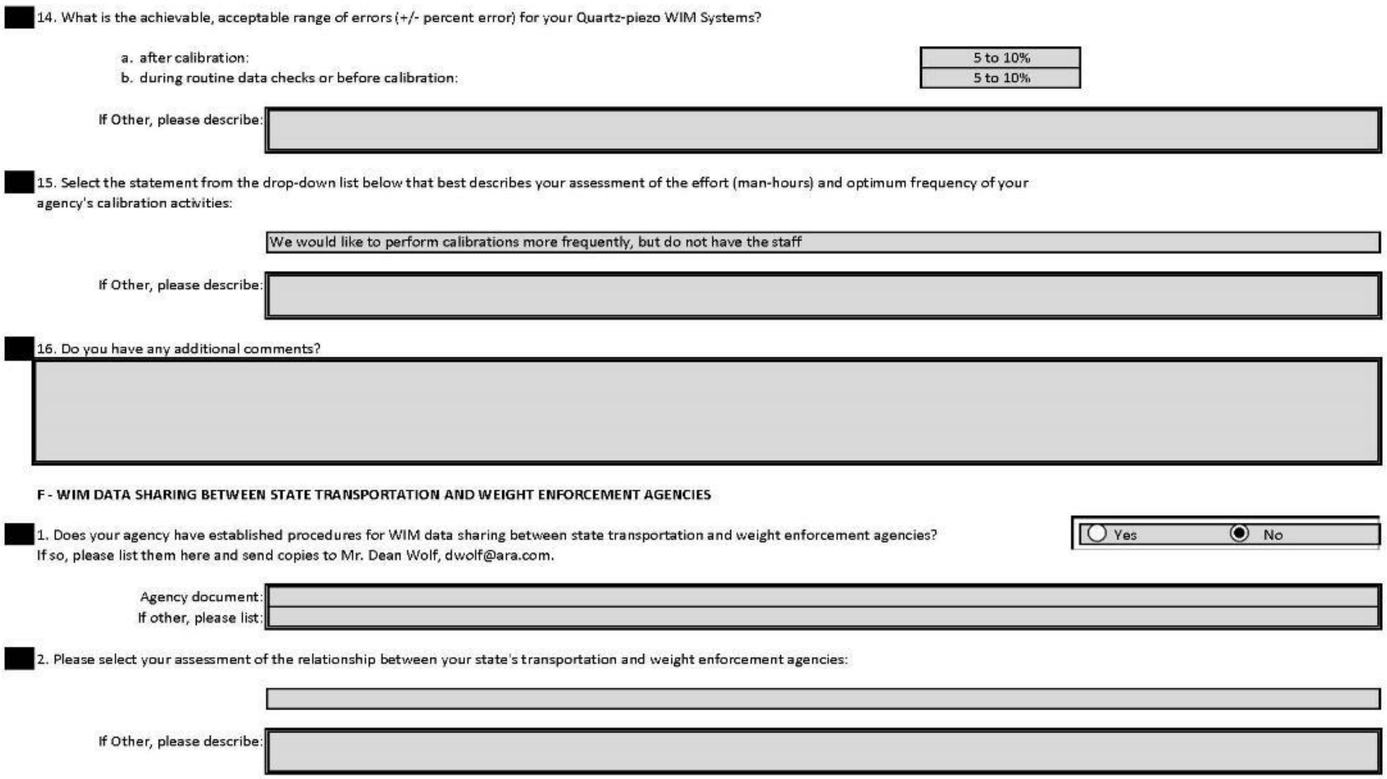
12. What is the minimum number of passes that you require for the Quartz-piezo WIM system calibration? 10

13. What is the achievable, acceptable mean error for your Quartz-piezo WIM Systems?

a. after calibration: 5 to 10%

b. during routine data checks or before calibration: 5 to 10%

Figure 94. New Mexico DOT – Responses to Survey



14. What is the achievable, acceptable range of errors (+/- percent error) for your Quartz-piezo WIM Systems?

a. after calibration: 5 to 10%
b. during routine data checks or before calibration: 5 to 10%

If Other, please describe:

15. Select the statement from the drop-down list below that best describes your assessment of the effort (man-hours) and optimum frequency of your agency's calibration activities:

We would like to perform calibrations more frequently, but do not have the staff

If Other, please describe:

16. Do you have any additional comments?

F - WIM DATA SHARING BETWEEN STATE TRANSPORTATION AND WEIGHT ENFORCEMENT AGENCIES

1. Does your agency have established procedures for WIM data sharing between state transportation and weight enforcement agencies? If so, please list them here and send copies to Mr. Dean Wolf, dwolf@ara.com.

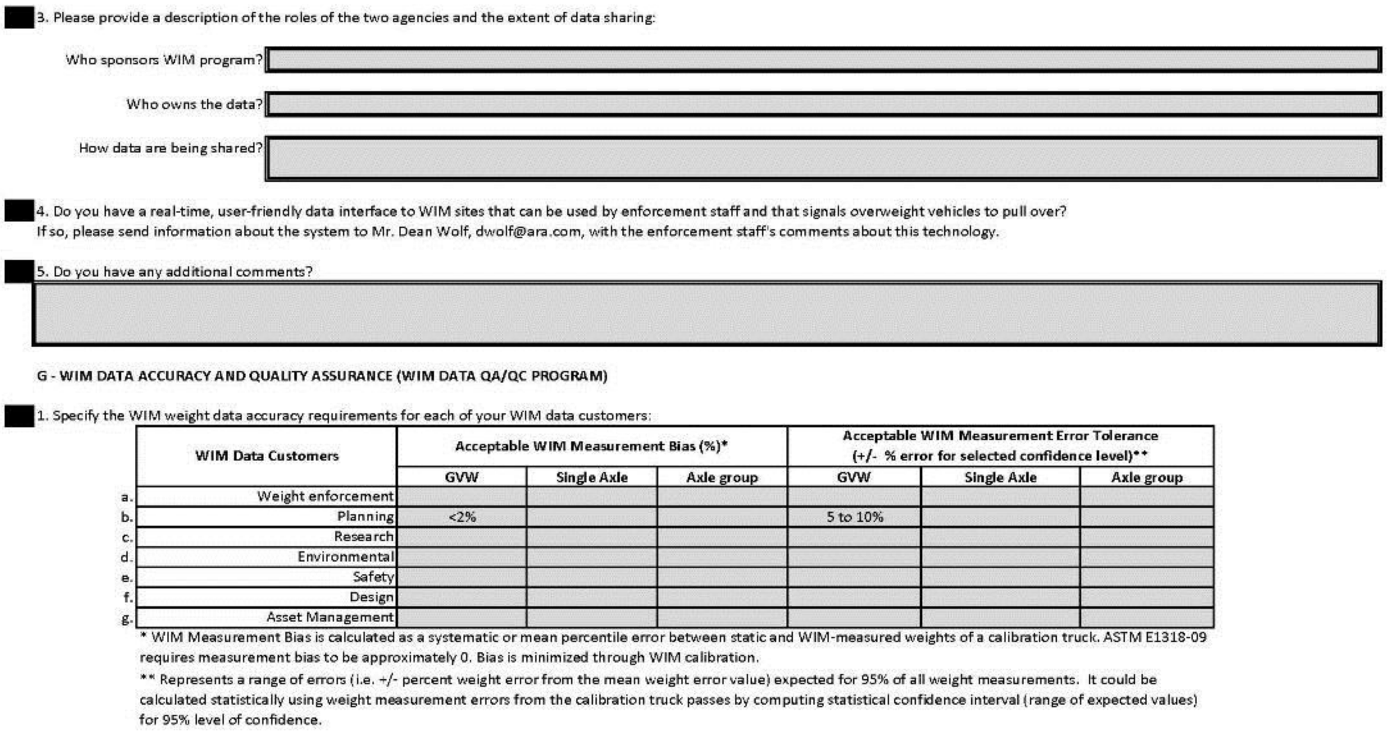
○ Yes ● No

Agency document:
If other, please list:

2. Please select your assessment of the relationship between your state's transportation and weight enforcement agencies:

If Other, please describe:

Figure 95. New Mexico DOT – Responses to Survey



[redacted] 3. Please provide a description of the roles of the two agencies and the extent of data sharing:

Who sponsors WIM program?

Who owns the data?

How data are being shared?

[redacted] 4. Do you have a real-time, user-friendly data interface to WIM sites that can be used by enforcement staff and that signals overweight vehicles to pull over?
If so, please send information about the system to Mr. Dean Wolf, dwolf@ara.com, with the enforcement staff's comments about this technology.

[redacted] 5. Do you have any additional comments?

G - WIM DATA ACCURACY AND QUALITY ASSURANCE (WIM DATA QA/QC PROGRAM)

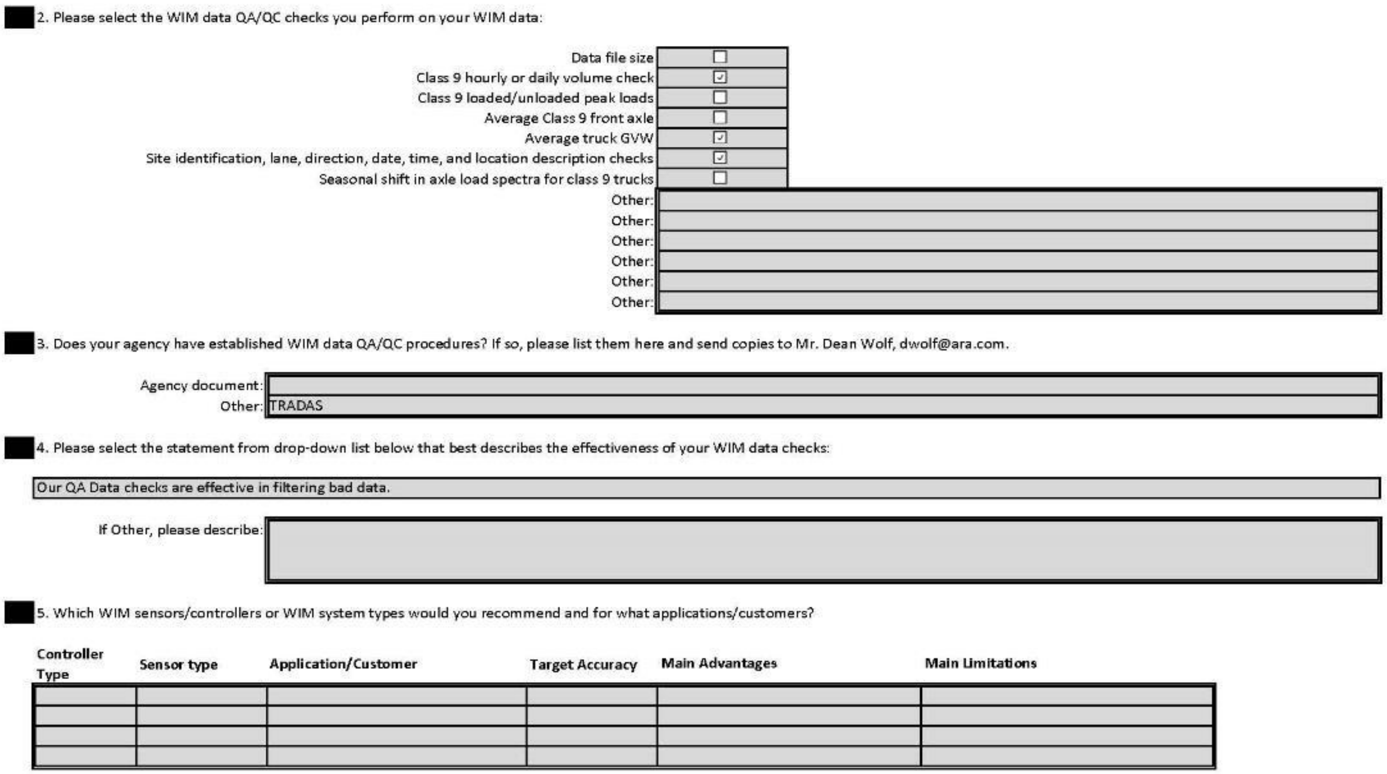
[redacted] 1. Specify the WIM weight data accuracy requirements for each of your WIM data customers:

	WIM Data Customers	Acceptable WIM Measurement Bias (%)*			Acceptable WIM Measurement Error Tolerance (+/- % error for selected confidence level)**		
		GVW	Single Axle	Axle group	GVW	Single Axle	Axle group
a.	Weight enforcement						
b.	Planning	<2%			5 to 10%		
c.	Research						
d.	Environmental						
e.	Safety						
f.	Design						
g.	Asset Management						

* WIM Measurement Bias is calculated as a systematic or mean percentile error between static and WIM-measured weights of a calibration truck. ASTM E1318-09 requires measurement bias to be approximately 0. Bias is minimized through WIM calibration.

** Represents a range of errors (i.e. +/- percent weight error from the mean weight error value) expected for 95% of all weight measurements. It could be calculated statistically using weight measurement errors from the calibration truck passes by computing statistical confidence interval (range of expected values) for 95% level of confidence.

Figure 96. New Mexico DOT – Responses to Survey



[redacted] 2. Please select the WIM data QA/QC checks you perform on your WIM data:

Data file size ☐
Class 9 hourly or daily volume check ☑
Class 9 loaded/unloaded peak loads ☐
Average Class 9 front axle ☐
Average truck GVW ☑
Site identification, lane, direction, date, time, and location description checks ☑
Seasonal shift in axle load spectra for class 9 trucks ☐
Other:
Other:
Other:
Other:
Other:
Other:

[redacted] 3. Does your agency have established WIM data QA/QC procedures? If so, please list them here and send copies to Mr. Dean Wolf, dwolf@ara.com.

Agency document:
Other: TRADAS

[redacted] 4. Please select the statement from drop-down list below that best describes the effectiveness of your WIM data checks:

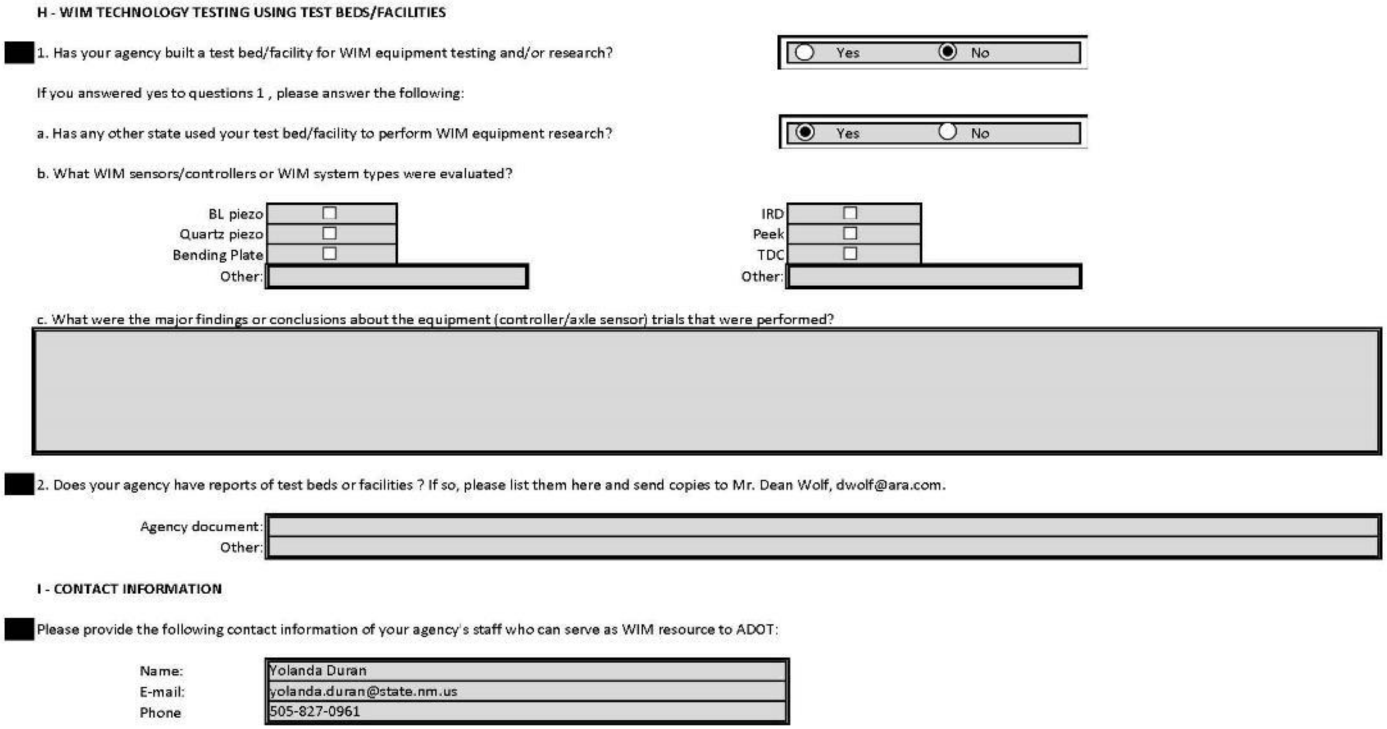
Our QA Data checks are effective in filtering bad data.

If Other, please describe:

[redacted] 5. Which WIM sensors/controllers or WIM system types would you recommend and for what applications/customers?

Controller Type	Sensor type	Application/Customer	Target Accuracy	Main Advantages	Main Limitations

Figure 97. New Mexico DOT – Responses to Survey



H - WIM TECHNOLOGY TESTING USING TEST BEDS/FACILITIES

1. Has your agency built a test bed/facility for WIM equipment testing and/or research? ○ Yes ● No

If you answered yes to questions 1 , please answer the following:

a. Has any other state used your test bed/facility to perform WIM equipment research? ● Yes ○ No

b. What WIM sensors/controllers or WIM system types were evaluated?

BL piezo	☐	IRD	☐
Quartz piezo	☐	Peek	☐
Bending Plate	☐	TDC	☐
Other:		Other:	

c. What were the major findings or conclusions about the equipment (controller/axle sensor) trials that were performed?

2. Does your agency have reports of test beds or facilities ? If so, please list them here and send copies to Mr. Dean Wolf, dwolf@ara.com.

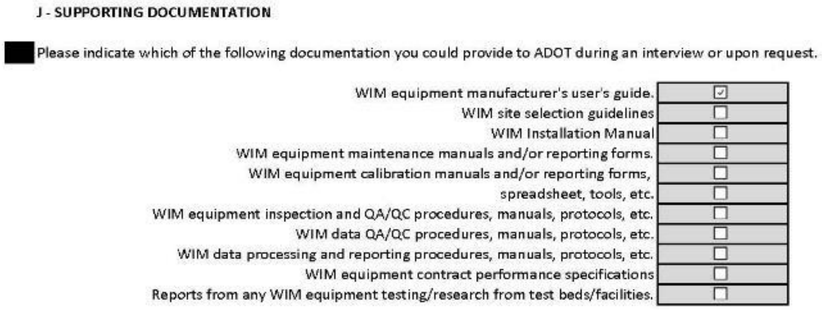
Agency document:
Other:

I - CONTACT INFORMATION

Please provide the following contact information of your agency's staff who can serve as WIM resource to ADOT:

Name: Yolanda Duran
E-mail: yolanda.duran@state.nm.us
Phone 505-827-0961

Figure 98. New Mexico DOT – Responses to Survey



J - SUPPORTING DOCUMENTATION

[redacted] Please indicate which of the following documentation you could provide to ADOT during an interview or upon request.

WIM equipment manufacturer's user's guide.	☑
WIM site selection guidelines	☐
WIM Installation Manual	☐
WIM equipment maintenance manuals and/or reporting forms.	☐
WIM equipment calibration manuals and/or reporting forms,	☐
spreadsheet, tools, etc.	☐
WIM equipment inspection and QA/QC procedures, manuals, protocols, etc.	☐
WIM data QA/QC procedures, manuals, protocols, etc.	☐
WIM data processing and reporting procedures, manuals, protocols, etc.	☐
WIM equipment contract performance specifications	☐
Reports from any WIM equipment testing/research from test beds/facilities.	☐

Figure 99. New Mexico DOT – Responses to Survey

Pennsylvania Department of Transportation (Andrea Bahoric)

Manager, Transportation Planning Division

Member – TRB Highway Traffic Monitoring Committee (ABJ-35)

A - GENERAL

[redacted] 1. Use the table below to specify the type of WIM systems you manage by controller/sensor combination. Please indicate the number of each WIM system combination, ASTM 1318 WIM type, Pavement type, and the roadway Functional Class:

System Index	WIM Controller Type	If Other, please specify	WIM Sensor Type	If Other, please specify	Number of Systems	ASTM WIM Type (I,II, III)	Pavement Type	Road Type	Temperature Compensation
1	Other	IRD - iSINC	Quartz Piezo		5	I	Asphalt	Interstate	Temperature Sensor
2	Other	IRD - iSINC	Quartz Piezo		4	I	Asphalt	US Route	Temperature Sensor
3	Other	IRD - iSINC	Quartz Piezo		2	I	Asphalt	State Route	Temperature Sensor
4	Other	IRD - DAW190	BL Piezo		1	I	Asphalt	State Route	Temperature Sensor
5	Other	IRD - DAW190	Quartz Piezo		1	I	Asphalt	US Route	Temperature Sensor
-									
-									
-									
		Total -		Total -	13				

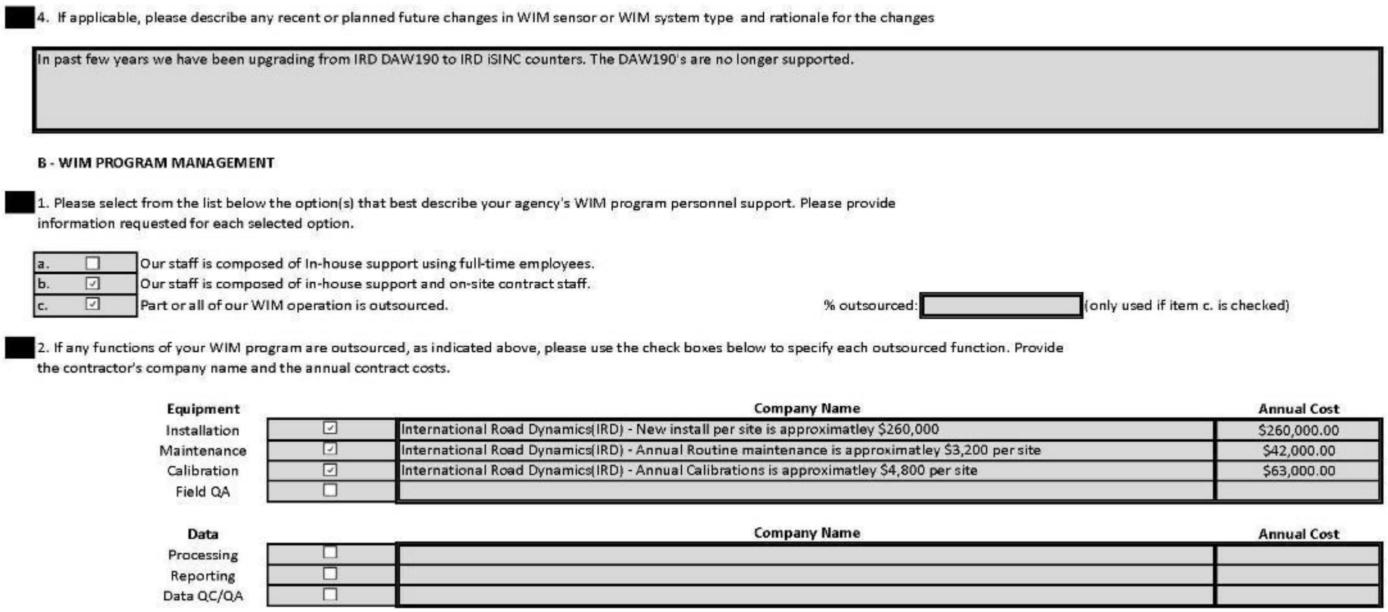
[redacted] 2. For each WIM System combination provided, please indicate what type(s) of data is (are) reported:

System Index	WIM Controller Type	WIM Sensor Type	Types of Data Reported						
			Volume	Speed	Classification	Weight (Axles)	Weight (GVW)	Per Vehicle Records	If Other, please specify
1	IRD - iSINC	Quartz Piezo	☑	☑	☑	☑	☑	☑	
2	IRD - iSINC	Quartz Piezo	☑	☑	☑	☑	☑	☑	
3	IRD - iSINC	Quartz Piezo	☑	☑	☑	☑	☑	☑	
4	IRD - DAW190	BL Piezo	☑	☑	☑	☑	☑	☑	
5	IRD - DAW190	Quartz Piezo	☑	☑	☑	☑	☑	☑	
-			☐	☐	☐	☐	☐	☐	
-			☐	☐	☐	☐	☐	☐	
-			☐	☐	☐	☐	☐	☐	

[redacted] 3. For each WIM System combination provided, please indicate the data customers:

System Index	WIM Controller Type	WIM Sensor Type	WIM Data Customers						
			Weight enforcement	Planning	Research	Environmental	Safety	Design	Asset Management
1	IRD - iSINC	Quartz Piezo	☑	☑	☐	☐	☐	☑	☐
2	IRD - iSINC	Quartz Piezo	☐	☑	☐	☐	☐	☑	☐
3	IRD - iSINC	Quartz Piezo	☐	☑	☐	☐	☐	☑	☐
4	IRD - DAW190	BL Piezo	☐	☑	☐	☐	☐	☑	☐
5	IRD - DAW190	Quartz Piezo	☐	☑	☐	☐	☐	☑	☐
-			☐	☐	☐	☐	☐	☐	☐
-			☐	☐	☐	☐	☐	☐	☐
-			☐	☐	☐	☐	☐	☐	☐

Figure 100. Pennsylvania DOT – Responses to Survey



[redacted] 4. If applicable, please describe any recent or planned future changes in WIM sensor or WIM system type and rationale for the changes

In past few years we have been upgrading from IRD DAW190 to IRD iSINC counters. The DAW190's are no longer supported.

B - WIM PROGRAM MANAGEMENT

[redacted] 1. Please select from the list below the option(s) that best describe your agency's WIM program personnel support. Please provide information requested for each selected option.

a.	☐	Our staff is composed of In-house support using full-time employees.
b.	☑	Our staff is composed of in-house support and on-site contract staff.
c.	☑	Part or all of our WIM operation is outsourced.

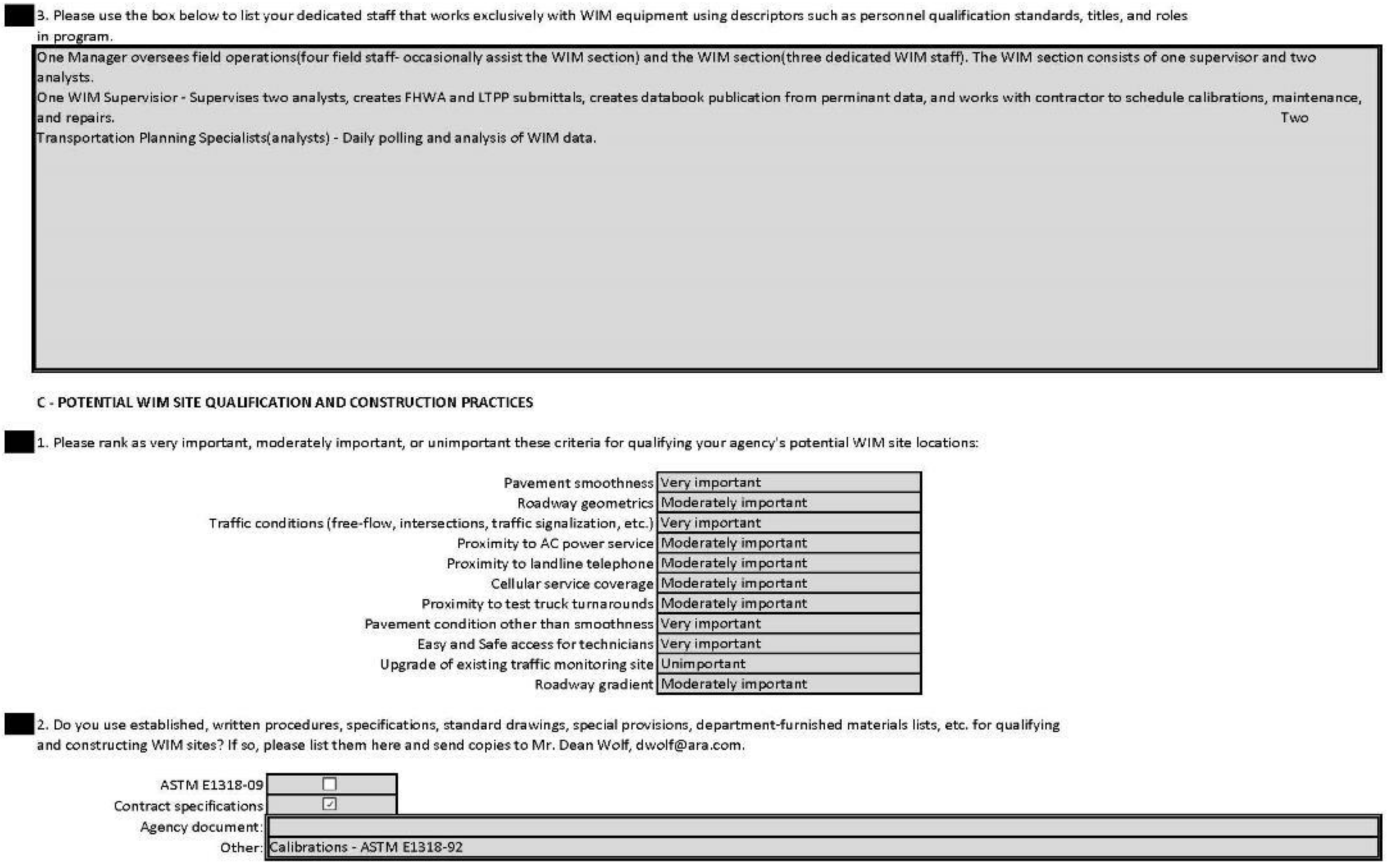
% outsourced: (only used if item c. is checked)

[redacted] 2. If any functions of your WIM program are outsourced, as indicated above, please use the check boxes below to specify each outsourced function. Provide the contractor's company name and the annual contract costs.

Equipment		**Company Name**	**Annual Cost**
Installation	☑	International Road Dynamics(IRD) - New install per site is approximatley $260,000	$260,000.00
Maintenance	☑	International Road Dynamics(IRD) - Annual Routine maintenance is approximatley $3,200 per site	$42,000.00
Calibration	☑	International Road Dynamics(IRD) - Annual Calibrations is approximatley $4,800 per site	$63,000.00
Field QA	☐		

Data		**Company Name**	**Annual Cost**
Processing	☐		
Reporting	☐		
Data QC/QA	☐		

Figure 101. Pennsylvania DOT – Responses to Survey



3. Please use the box below to list your dedicated staff that works exclusively with WIM equipment using descriptors such as personnel qualification standards, titles, and roles in program.

One Manager oversees field operations(four field staff- occasionally assist the WIM section) and the WIM section(three dedicated WIM staff). The WIM section consists of one supervisor and two analysts.
One WIM Supervisior - Supervises two analysts, creates FHWA and LTPP submittals, creates databook publication from perminant data, and works with contractor to schedule calibrations, maintenance, and repairs. Two
Transportation Planning Specialists(analysts) - Daily polling and analysis of WIM data.

C - POTENTIAL WIM SITE QUALIFICATION AND CONSTRUCTION PRACTICES

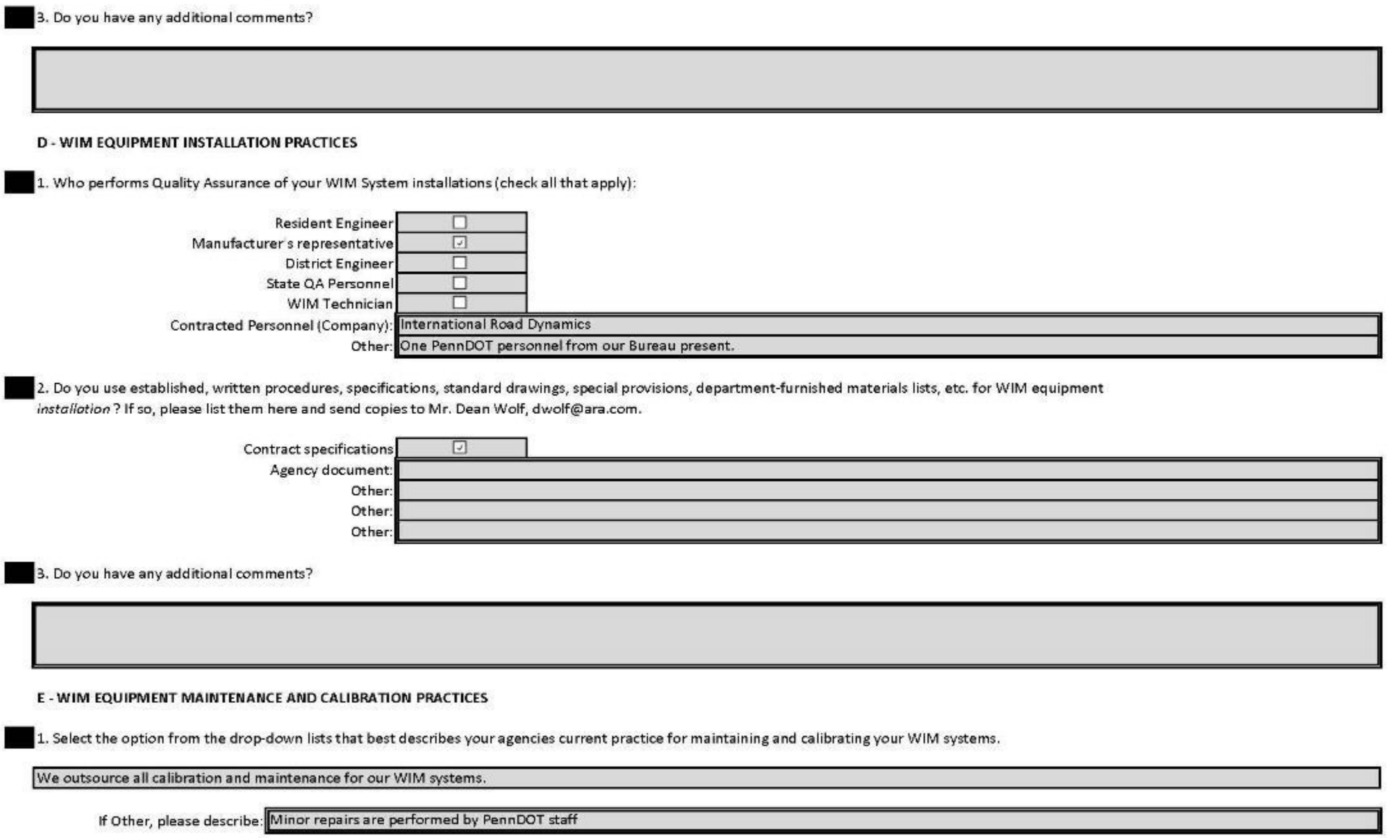
1. Please rank as very important, moderately important, or unimportant these criteria for qualifying your agency's potential WIM site locations:

Pavement smoothness	Very important
Roadway geometrics	Moderately important
Traffic conditions (free-flow, intersections, traffic signalization, etc.)	Very important
Proximity to AC power service	Moderately important
Proximity to landline telephone	Moderately important
Cellular service coverage	Moderately important
Proximity to test truck turnarounds	Moderately important
Pavement condition other than smoothness	Very important
Easy and Safe access for technicians	Very important
Upgrade of existing traffic monitoring site	Unimportant
Roadway gradient	Moderately important

2. Do you use established, written procedures, specifications, standard drawings, special provisions, department-furnished materials lists, etc. for qualifying and constructing WIM sites? If so, please list them here and send copies to Mr. Dean Wolf, dwolf@ara.com.

ASTM E1318-09	☐
Contract specifications	☑
Agency document:	
Other:	Calibrations - ASTM E1318-92

Figure 102. Pennsylvania DOT – Responses to Survey



3. Do you have any additional comments?

D - WIM EQUIPMENT INSTALLATION PRACTICES

1. Who performs Quality Assurance of your WIM System installations (check all that apply):

Resident Engineer ☐
Manufacturer's representative ☑
District Engineer ☐
State QA Personnel ☐
WIM Technician ☐
Contracted Personnel (Company): International Road Dynamics
Other: One PennDOT personnel from our Bureau present.

2. Do you use established, written procedures, specifications, standard drawings, special provisions, department-furnished materials lists, etc. for WIM equipment *installation*? If so, please list them here and send copies to Mr. Dean Wolf, dwolf@ara.com.

Contract specifications ☑
Agency document:
Other:
Other:
Other:

3. Do you have any additional comments?

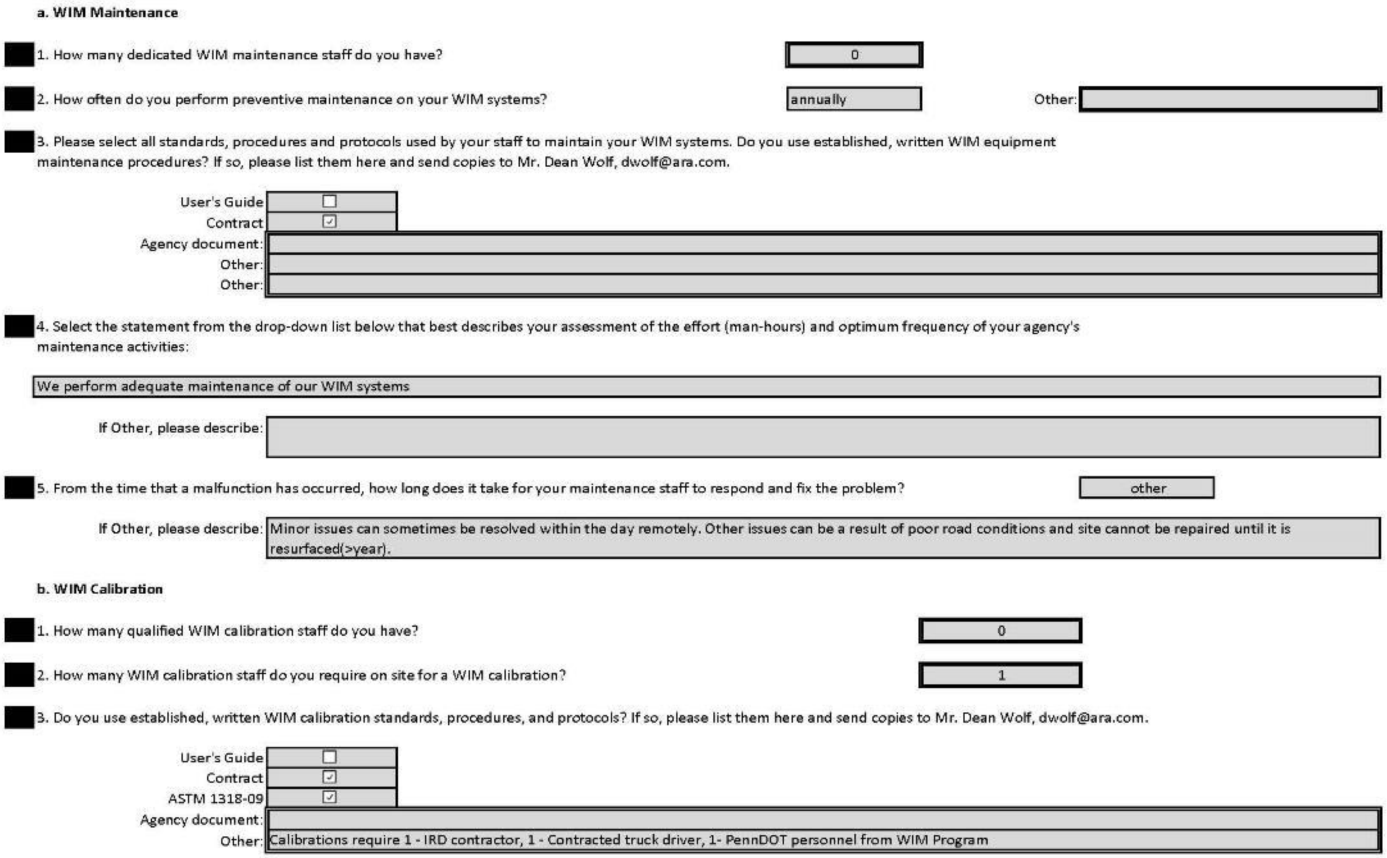
E - WIM EQUIPMENT MAINTENANCE AND CALIBRATION PRACTICES

1. Select the option from the drop-down lists that best describes your agencies current practice for maintaining and calibrating your WIM systems.

We outsource all calibration and maintenance for our WIM systems.

If Other, please describe: Minor repairs are performed by PennDOT staff

Figure 103. Pennsylvania DOT – Responses to Survey



a. WIM Maintenance

1. How many dedicated WIM maintenance staff do you have? 0

2. How often do you perform preventive maintenance on your WIM systems? annually Other:

3. Please select all standards, procedures and protocols used by your staff to maintain your WIM systems. Do you use established, written WIM equipment maintenance procedures? If so, please list them here and send copies to Mr. Dean Wolf, dwolf@ara.com.

User's Guide ☐
Contract ☑
Agency document:
Other:
Other:

4. Select the statement from the drop-down list below that best describes your assessment of the effort (man-hours) and optimum frequency of your agency's maintenance activities:

We perform adequate maintenance of our WIM systems

If Other, please describe:

5. From the time that a malfunction has occurred, how long does it take for your maintenance staff to respond and fix the problem? other

If Other, please describe: Minor issues can sometimes be resolved within the day remotely. Other issues can be a result of poor road conditions and site cannot be repaired until it is resurfaced(>year).

b. WIM Calibration

1. How many qualified WIM calibration staff do you have? 0

2. How many WIM calibration staff do you require on site for a WIM calibration? 1

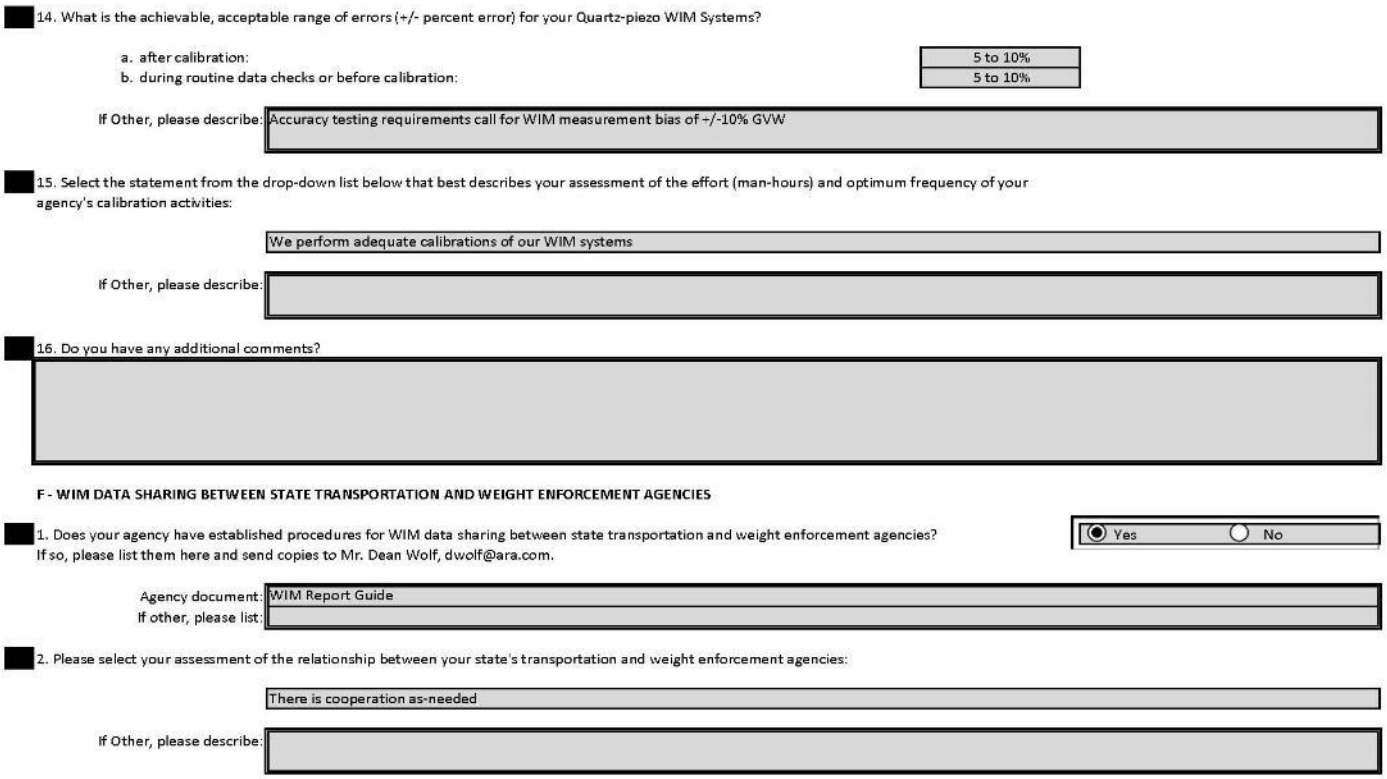
3. Do you use established, written WIM calibration standards, procedures, and protocols? If so, please list them here and send copies to Mr. Dean Wolf, dwolf@ara.com.

User's Guide ☐
Contract ☑
ASTM 1318-09 ☑
Agency document:
Other: Calibrations require 1 - IRD contractor, 1 - Contracted truck driver, 1- PennDOT personnel from WIM Program

Figure 104. Pennsylvania DOT – Responses to Survey

4. How often do you perform calibration on your BL WIM systems?	annually
If Other, please describe:	
5. How many calibration trucks do you use to calibrate your BL WIM systems?	1
6. Please describe type of truck(s), loads and truck weight(s) used for a BL WIM System calibration:	
	Class 9 (5 axle), loaded to approximatley 75,000lbs
7. What is the minimum number of passes that you require for the BL WIM system calibration?	10
8. What is the achievable, acceptable mean error for your BL WIM Systems?	
a. after calibration:	5 to 10%
b. during routine data checks or before calibration:	5 to 10%
If Other, please describe:	Accuracy testing requirements call for WIM measurement bias of +/-10% GVW
9. What is the achievable, acceptable range of errors (+/- percent error) for your BL WIM Systems?	
a. after calibration:	5 to 10%
b. during routine data checks or before calibration:	5 to 10%
If Other, please describe:	Accuracy testing requirements call for WIM measurement bias of +/-10% GVW
10. How many calibration trucks do you use to calibrate your Quartz-piezo WIM systems?	1
11. Please describe type of truck(s), loads and truck weight(s) used for a Quartz-piezo WIM System calibration:	
	Class 9 (5 axle), loaded to approximatley 75,000lbs
12. What is the minimum number of passes that you require for the Quartz-piezo WIM system calibration?	10
13. What is the achievable, acceptable mean error for your Quartz-piezo WIM Systems?	
a. after calibration:	5 to 10%
b. during routine data checks or before calibration:	5 to 10%

Figure 105. Pennsylvania DOT – Responses to Survey



14. What is the achievable, acceptable range of errors (+/- percent error) for your Quartz-piezo WIM Systems?

a. after calibration:	5 to 10%
b. during routine data checks or before calibration:	5 to 10%

If Other, please describe: Accuracy testing requirements call for WIM measurement bias of +/-10% GVW

15. Select the statement from the drop-down list below that best describes your assessment of the effort (man-hours) and optimum frequency of your agency's calibration activities:

We perform adequate calibrations of our WIM systems

If Other, please describe:

16. Do you have any additional comments?

F - WIM DATA SHARING BETWEEN STATE TRANSPORTATION AND WEIGHT ENFORCEMENT AGENCIES

1. Does your agency have established procedures for WIM data sharing between state transportation and weight enforcement agencies? If so, please list them here and send copies to Mr. Dean Wolf, dwolf@ara.com.

● Yes ○ No

Agency document: WIM Report Guide

If other, please list:

2. Please select your assessment of the relationship between your state's transportation and weight enforcement agencies:

There is cooperation as-needed

If Other, please describe:

Figure 106. Pennsylvania DOT – Responses to Survey

[redacted] 3. Please provide a description of the roles of the two agencies and the extent of data sharing:

Who sponsors WIM program?	PennDOT owns WIM equipment
Who owns the data?	PennDOT owns data associated with the 13 planning mainline WIMs
How data are being shared?	Reports are available to State Police through PennDOT.

[redacted] 4. Do you have a real-time, user-friendly data interface to WIM sites that can be used by enforcement staff and that signals overweight vehicles to pull over?
If so, please send information about the system to Mr. Dean Wolf, dwolf@ara.com, with the enforcement staff's comments about this technology.

[redacted] 5. Do you have any additional comments?

G - WIM DATA ACCURACY AND QUALITY ASSURANCE (WIM DATA QA/QC PROGRAM)

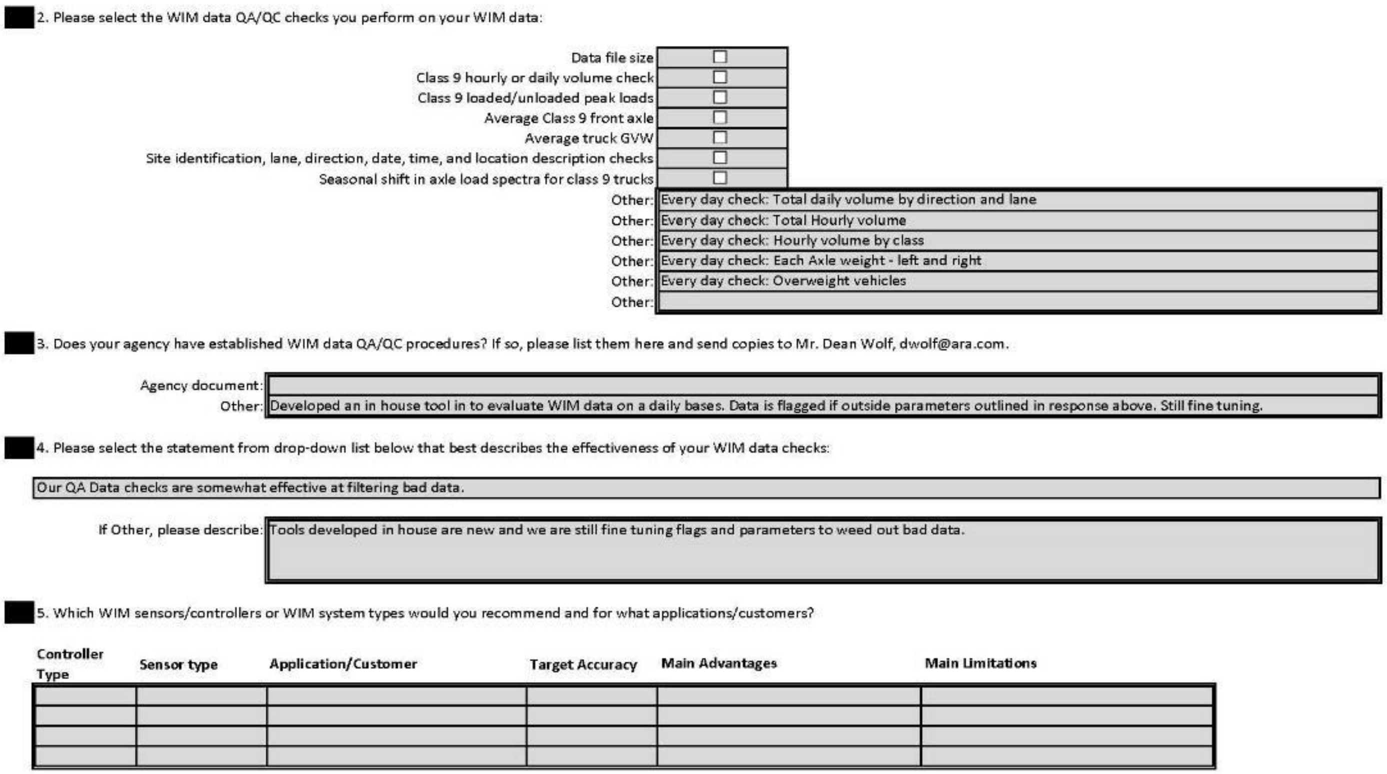
[redacted] 1. Specify the WIM weight data accuracy requirements for each of your WIM data customers:

	WIM Data Customers	**Acceptable WIM Measurement Bias (%)***			**Acceptable WIM Measurement Error Tolerance (+/- % error for selected confidence level)****		
		GVW	**Single Axle**	**Axle group**	**GVW**	**Single Axle**	**Axle group**
a.	Weight enforcement						
b.	Planning	5 to 10%	Unknown	Unknown	Unknown	Unknown	Unknown
c.	Research						
d.	Environmental						
e.	Safety						
f.	Design						
g.	Asset Management						

* WIM Measurement Bias is calculated as a systematic or mean percentile error between static and WIM-measured weights of a calibration truck. ASTM E1318-09 requires measurement bias to be approximately 0. Bias is minimized through WIM calibration.

** Represents a range of errors (i.e. +/- percent weight error from the mean weight error value) expected for 95% of all weight measurements. It could be calculated statistically using weight measurement errors from the calibration truck passes by computing statistical confidence interval (range of expected values) for 95% level of confidence.

Figure 107. Pennsylvania DOT – Responses to Survey



[redacted] 2. Please select the WIM data QA/QC checks you perform on your WIM data:

Data file size	☐
Class 9 hourly or daily volume check	☐
Class 9 loaded/unloaded peak loads	☐
Average Class 9 front axle	☐
Average truck GVW	☐
Site identification, lane, direction, date, time, and location description checks	☐
Seasonal shift in axle load spectra for class 9 trucks	☐
Other:	Every day check: Total daily volume by direction and lane
Other:	Every day check: Total Hourly volume
Other:	Every day check: Hourly volume by class
Other:	Every day check: Each Axle weight - left and right
Other:	Every day check: Overweight vehicles
Other:	

[redacted] 3. Does your agency have established WIM data QA/QC procedures? If so, please list them here and send copies to Mr. Dean Wolf, dwolf@ara.com.

Agency document:

Other: Developed an in house tool in to evaluate WIM data on a daily bases. Data is flagged if outside parameters outlined in response above. Still fine tuning.

[redacted] 4. Please select the statement from drop-down list below that best describes the effectiveness of your WIM data checks:

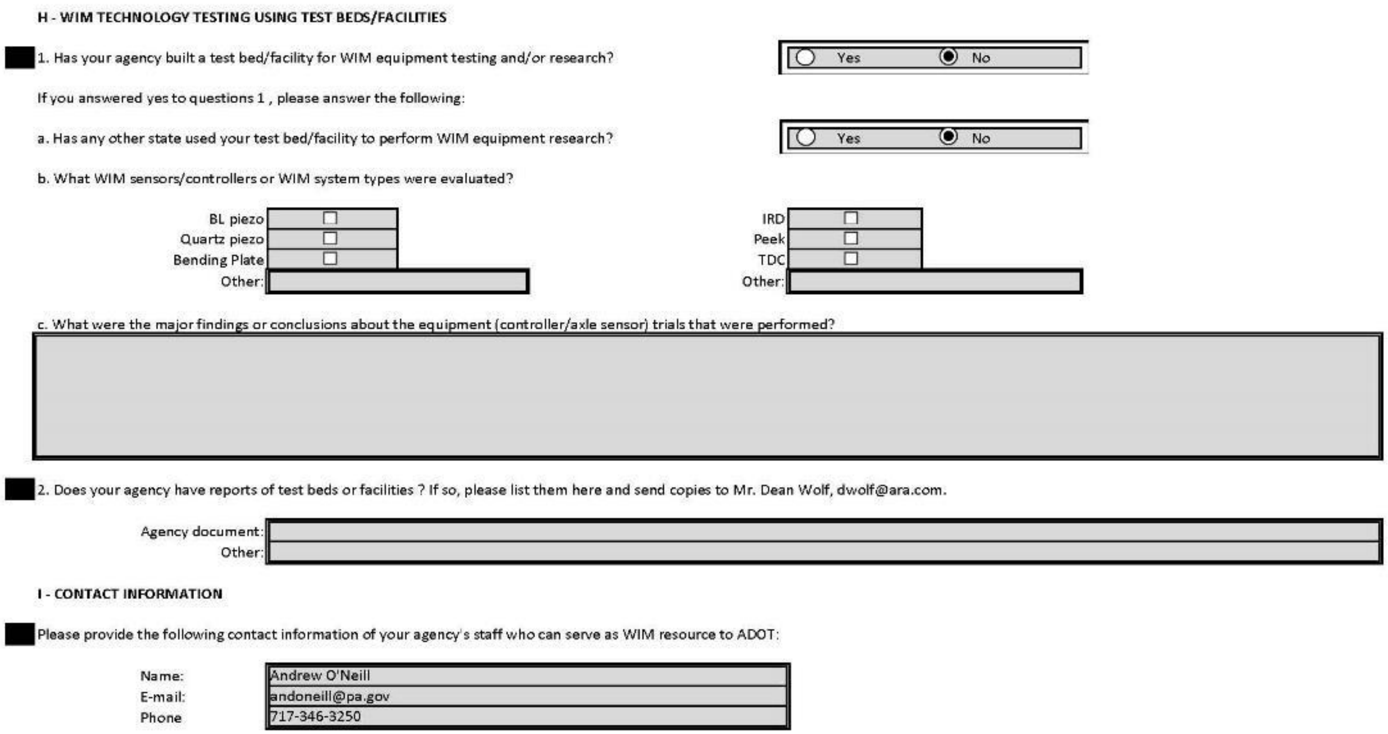
Our QA Data checks are somewhat effective at filtering bad data.

If Other, please describe: Tools developed in house are new and we are still fine tuning flags and parameters to weed out bad data.

[redacted] 5. Which WIM sensors/controllers or WIM system types would you recommend and for what applications/customers?

Controller Type	Sensor type	Application/Customer	Target Accuracy	Main Advantages	Main Limitations

Figure 108. Pennsylvania DOT – Responses to Survey



H - WIM TECHNOLOGY TESTING USING TEST BEDS/FACILITIES

1. Has your agency built a test bed/facility for WIM equipment testing and/or research? ○ Yes ● No

If you answered yes to questions 1 , please answer the following:

a. Has any other state used your test bed/facility to perform WIM equipment research? ○ Yes ● No

b. What WIM sensors/controllers or WIM system types were evaluated?

BL piezo	☐	IRD	☐
Quartz piezo	☐	Peek	☐
Bending Plate	☐	TDC	☐
Other:		Other:	

c. What were the major findings or conclusions about the equipment (controller/axle sensor) trials that were performed?

2. Does your agency have reports of test beds or facilities ? If so, please list them here and send copies to Mr. Dean Wolf, dwolf@ara.com.

Agency document:

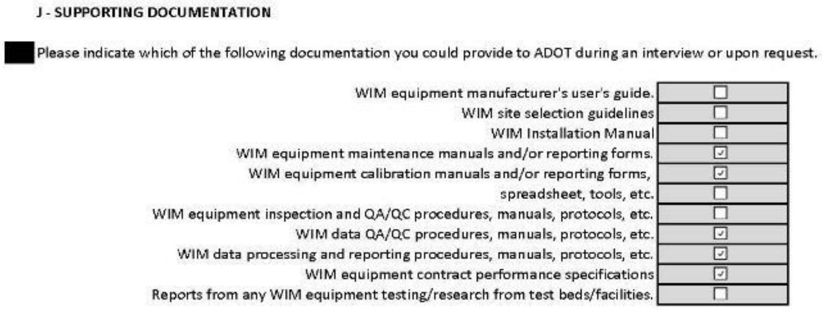
Other:

I - CONTACT INFORMATION

Please provide the following contact information of your agency's staff who can serve as WIM resource to ADOT:

Name:	Andrew O'Neill
E-mail:	andoneill@pa.gov
Phone	717-346-3250

Figure 109. Pennsylvania DOT – Responses to Survey



J - SUPPORTING DOCUMENTATION

[redacted] Please indicate which of the following documentation you could provide to ADOT during an interview or upon request.

WIM equipment manufacturer's user's guide.	☐
WIM site selection guidelines	☐
WIM Installation Manual	☐
WIM equipment maintenance manuals and/or reporting forms.	☑
WIM equipment calibration manuals and/or reporting forms,	☑
spreadsheet, tools, etc.	☐
WIM equipment inspection and QA/QC procedures, manuals, protocols, etc.	☐
WIM data QA/QC procedures, manuals, protocols, etc.	☑
WIM data processing and reporting procedures, manuals, protocols, etc.	☑
WIM equipment contract performance specifications	☑
Reports from any WIM equipment testing/research from test beds/facilities.	☐

Figure 110. Pennsylvania DOT – Responses to Survey

Texas Department of Transportation (Catherine Woolf)

Traffic Data Systems Engineer

A - GENERAL

[redacted] 1. Use the table below to specify the type of WIM systems you manage by controller/sensor combination. Please indicate the number of each WIM system combination, ASTM 1318 WIM type, Pavement type, and the roadway Functional Class:

System Index	WIM Controller Type	If Other, please specify	WIM Sensor Type	If Other, please specify	Number of Systems	ASTM WIM Type (I,II, III)	Pavement Type	Road Type	Temperature Compensation
1	PAT Traffic		Quartz Piezo		17	II	Asphalt	State Route	Temperature Sensor
2	PAT Traffic		Bending Plate		15	II	PCC	Interstate	Temperature Sensor
-									
-									
-									
-									
-									
-									
		Total -		Total -	32				

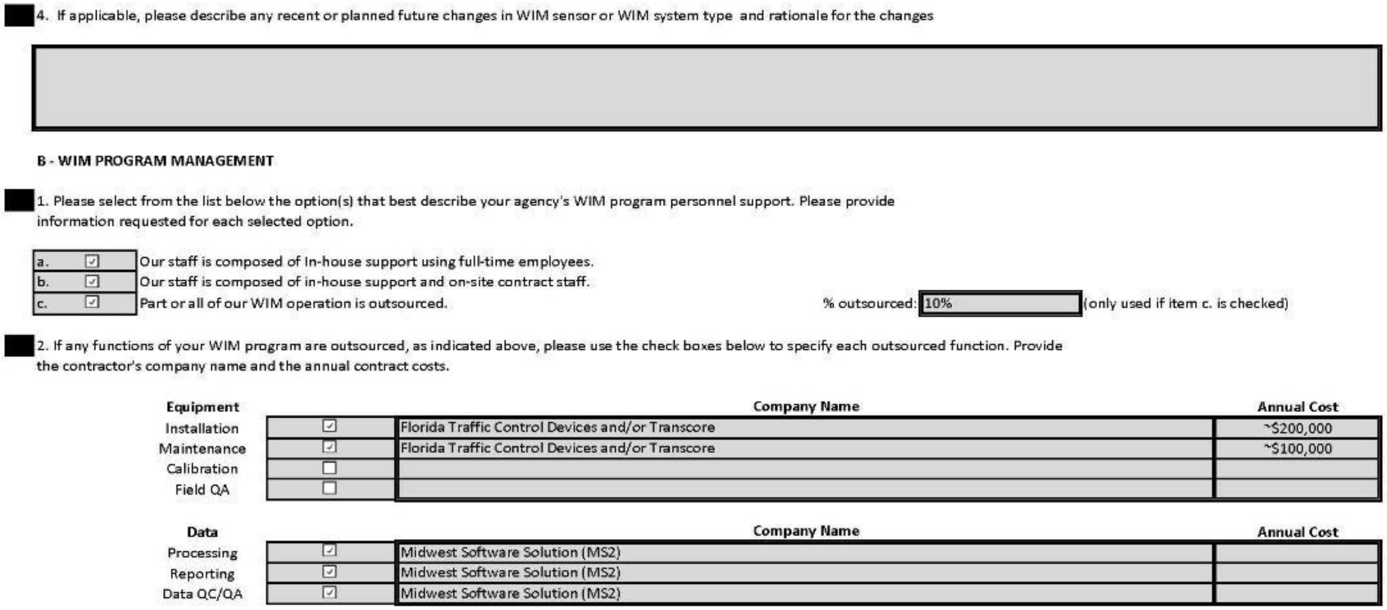
[redacted] 2. For each WIM System combination provided, please indicate what type(s) of data is (are) reported:

System Index	WIM Controller Type	WIM Sensor Type	Types of Data Reported						
			Volume	Speed	Classification	Weight (Axles)	Weight (GVW)	Per Vehicle Records	If Other, please specify
1	PAT Traffic	Quartz Piezo	☑	☑	☑	☑	☑	☑	
2	PAT Traffic	Bending Plate	☑	☑	☑	☑	☑	☑	
-			☐	☐	☐	☐	☐	☐	
-			☐	☐	☐	☐	☐	☐	
-			☐	☐	☐	☐	☐	☐	
-			☐	☐	☐	☐	☐	☐	
-			☐	☐	☐	☐	☐	☐	
-			☐	☐	☐	☐	☐	☐	

[redacted] 3. For each WIM System combination provided, please indicate the data customers:

System Index	WIM Controller Type	WIM Sensor Type	WIM Data Customers						
			Weight enforcement	Planning	Research	Environmental	Safety	Design	Asset Management
1	PAT Traffic	Quartz Piezo	☑	☑	☑	☑	☑	☑	☑
2	PAT Traffic	Bending Plate	☑	☑	☑	☑	☑	☑	☑
-			☐	☐	☐	☐	☐	☐	☐
-			☐	☐	☐	☐	☐	☐	☐
-			☐	☐	☐	☐	☐	☐	☐
-			☐	☐	☐	☐	☐	☐	☐
-			☐	☐	☐	☐	☐	☐	☐
-			☐	☐	☐	☐	☐	☐	☐

Figure 111. Texas DOT – Responses to Survey



[redacted] 4. If applicable, please describe any recent or planned future changes in WIM sensor or WIM system type and rationale for the changes

B - WIM PROGRAM MANAGEMENT

[redacted] 1. Please select from the list below the option(s) that best describe your agency's WIM program personnel support. Please provide information requested for each selected option.

a.	☑	Our staff is composed of In-house support using full-time employees.
b.	☑	Our staff is composed of in-house support and on-site contract staff.
c.	☑	Part or all of our WIM operation is outsourced.

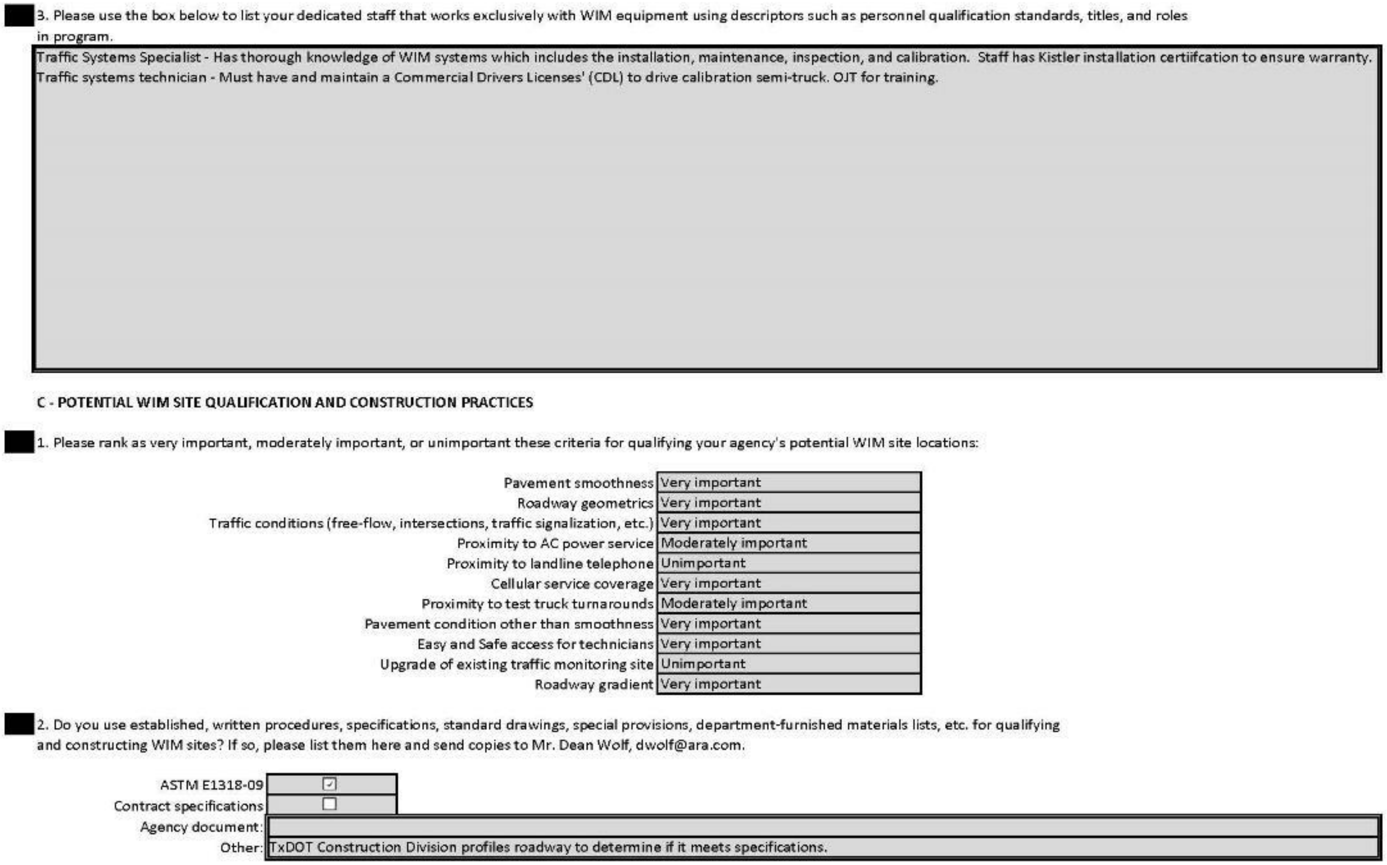
% outsourced: 10% (only used if item c. is checked)

[redacted] 2. If any functions of your WIM program are outsourced, as indicated above, please use the check boxes below to specify each outsourced function. Provide the contractor's company name and the annual contract costs.

Equipment		Company Name	Annual Cost
Installation	☑	Florida Traffic Control Devices and/or Transcore	~$200,000
Maintenance	☑	Florida Traffic Control Devices and/or Transcore	~$100,000
Calibration	☐		
Field QA	☐		

Data		Company Name	Annual Cost
Processing	☑	Midwest Software Solution (MS2)	
Reporting	☑	Midwest Software Solution (MS2)	
Data QC/QA	☑	Midwest Software Solution (MS2)	

Figure 112. Texas DOT – Responses to Survey



[redacted] 3. Please use the box below to list your dedicated staff that works exclusively with WIM equipment using descriptors such as personnel qualification standards, titles, and roles in program.

Traffic Systems Specialist - Has thorough knowledge of WIM systems which includes the installation, maintenance, inspection, and calibration. Staff has Kistler installation certiifcation to ensure warranty.
Traffic systems technician - Must have and maintain a Commercial Drivers Licenses' (CDL) to drive calibration semi-truck. OJT for training.

C - POTENTIAL WIM SITE QUALIFICATION AND CONSTRUCTION PRACTICES

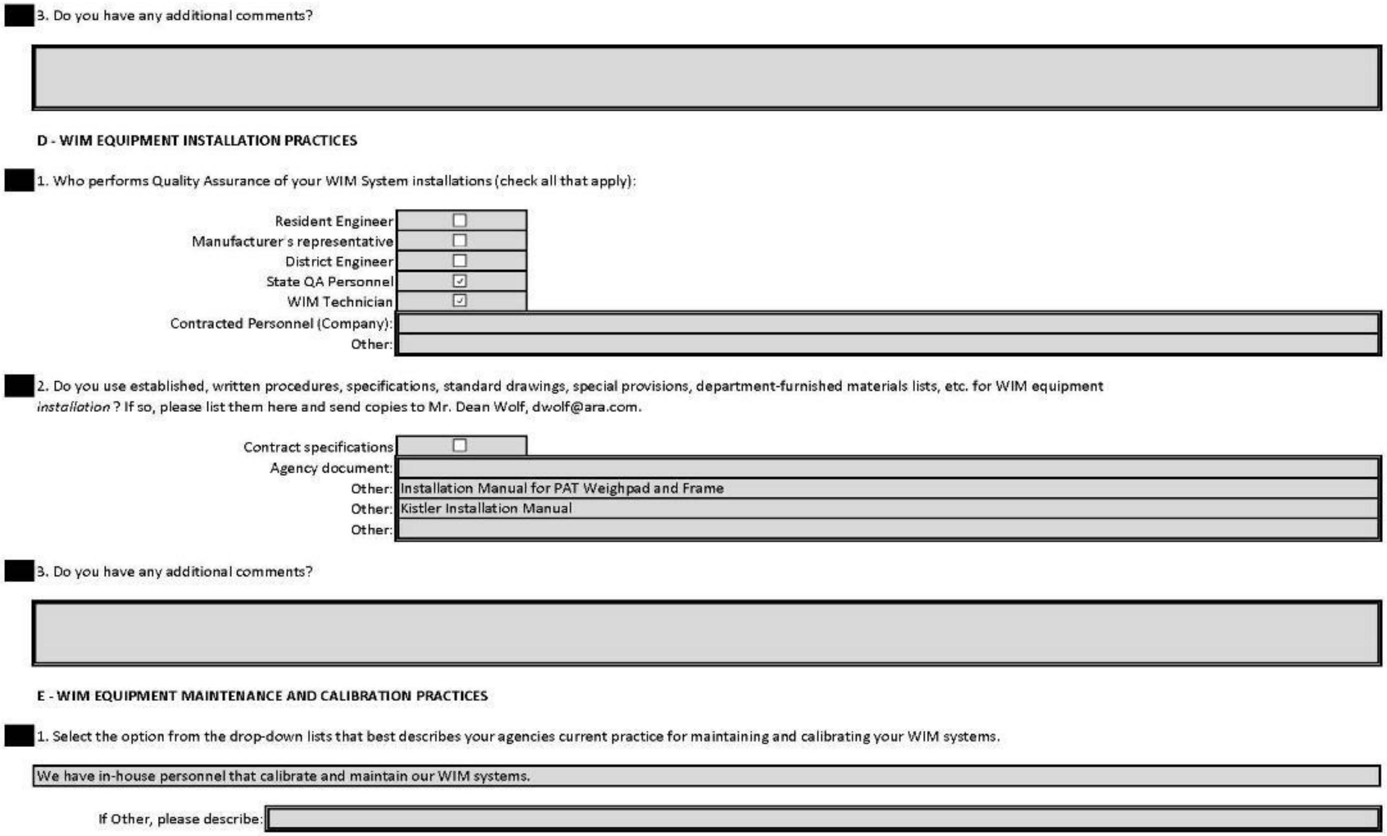
[redacted] 1. Please rank as very important, moderately important, or unimportant these criteria for qualifying your agency's potential WIM site locations:

Pavement smoothness	Very important
Roadway geometrics	Very important
Traffic conditions (free-flow, intersections, traffic signalization, etc.)	Very important
Proximity to AC power service	Moderately important
Proximity to landline telephone	Unimportant
Cellular service coverage	Very important
Proximity to test truck turnarounds	Moderately important
Pavement condition other than smoothness	Very important
Easy and Safe access for technicians	Very important
Upgrade of existing traffic monitoring site	Unimportant
Roadway gradient	Very important

[redacted] 2. Do you use established, written procedures, specifications, standard drawings, special provisions, department-furnished materials lists, etc. for qualifying and constructing WIM sites? If so, please list them here and send copies to Mr. Dean Wolf, dwolf@ara.com.

ASTM E1318-09	☑
Contract specifications	☐
Agency document:	
Other:	TxDOT Construction Division profiles roadway to determine if it meets specifications.

Figure 113. Texas DOT – Responses to Survey



[redacted] 3. Do you have any additional comments?

D - WIM EQUIPMENT INSTALLATION PRACTICES

[redacted] 1. Who performs Quality Assurance of your WIM System installations (check all that apply):

Resident Engineer	☐
Manufacturer's representative	☐
District Engineer	☐
State QA Personnel	☑
WIM Technician	☑
Contracted Personnel (Company):	
Other:	

[redacted] 2. Do you use established, written procedures, specifications, standard drawings, special provisions, department-furnished materials lists, etc. for WIM equipment *installation*? If so, please list them here and send copies to Mr. Dean Wolf, dwolf@ara.com.

Contract specifications	☐
Agency document:	
Other:	Installation Manual for PAT Weighpad and Frame
Other:	Kistler Installation Manual
Other:	

[redacted] 3. Do you have any additional comments?

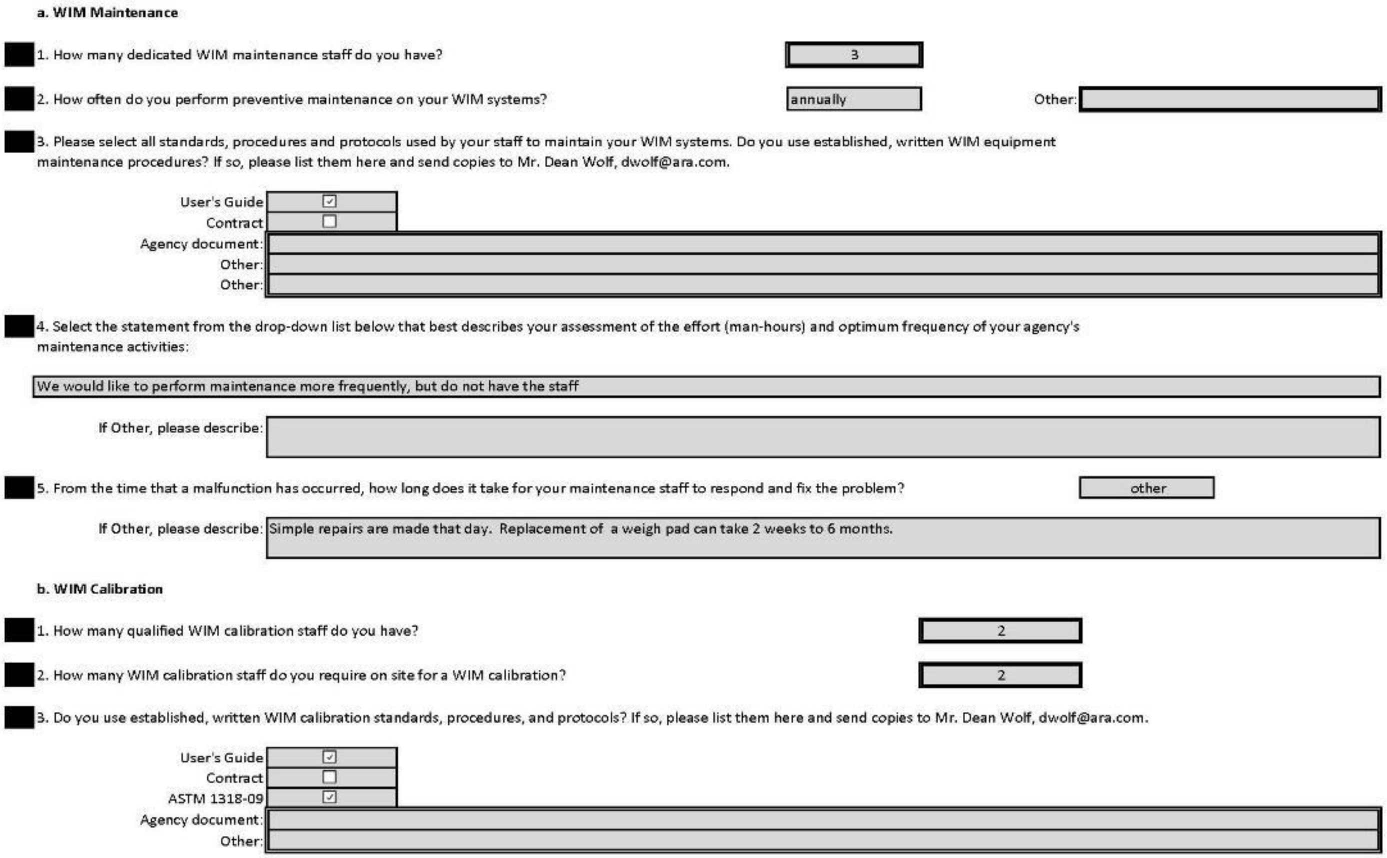
E - WIM EQUIPMENT MAINTENANCE AND CALIBRATION PRACTICES

[redacted] 1. Select the option from the drop-down lists that best describes your agencies current practice for maintaining and calibrating your WIM systems.

We have in-house personnel that calibrate and maintain our WIM systems.

If Other, please describe:

Figure 114. Texas DOT – Responses to Survey



a. WIM Maintenance

1. How many dedicated WIM maintenance staff do you have? 3

2. How often do you perform preventive maintenance on your WIM systems? annually Other:

3. Please select all standards, procedures and protocols used by your staff to maintain your WIM systems. Do you use established, written WIM equipment maintenance procedures? If so, please list them here and send copies to Mr. Dean Wolf, dwolf@ara.com.

User's Guide ☑
Contract ☐
Agency document:
Other:
Other:

4. Select the statement from the drop-down list below that best describes your assessment of the effort (man-hours) and optimum frequency of your agency's maintenance activities:

We would like to perform maintenance more frequently, but do not have the staff

If Other, please describe:

5. From the time that a malfunction has occurred, how long does it take for your maintenance staff to respond and fix the problem? other

If Other, please describe: Simple repairs are made that day. Replacement of a weigh pad can take 2 weeks to 6 months.

b. WIM Calibration

1. How many qualified WIM calibration staff do you have? 2

2. How many WIM calibration staff do you require on site for a WIM calibration? 2

3. Do you use established, written WIM calibration standards, procedures, and protocols? If so, please list them here and send copies to Mr. Dean Wolf, dwolf@ara.com.

User's Guide ☑
Contract ☐
ASTM 1318-09 ☑
Agency document:
Other:

Figure 115. Texas DOT – Responses to Survey

4. How often do you perform calibration on your BL WIM systems? never

If Other, please describe: Do not us BL WIM

5. How many calibration trucks do you use to calibrate your BL WIM systems?

6. Please describe type of truck(s), loads and truck weight(s) used for a BL WIM System calibration:

7. What is the minimum number of passes that you require for the BL WIM system calibration?

8. What is the achievable, acceptable mean error for your BL WIM Systems?

a. after calibration:
b. during routine data checks or before calibration:

If Other, please describe:

9. What is the achievable, acceptable range of errors (+/- percent error) for your BL WIM Systems?

a. after calibration:
b. during routine data checks or before calibration:

If Other, please describe:

10. How many calibration trucks do you use to calibrate your Quartz-piezo WIM systems? 1

11. Please describe type of truck(s), loads and truck weight(s) used for a Quartz-piezo WIM System calibration:

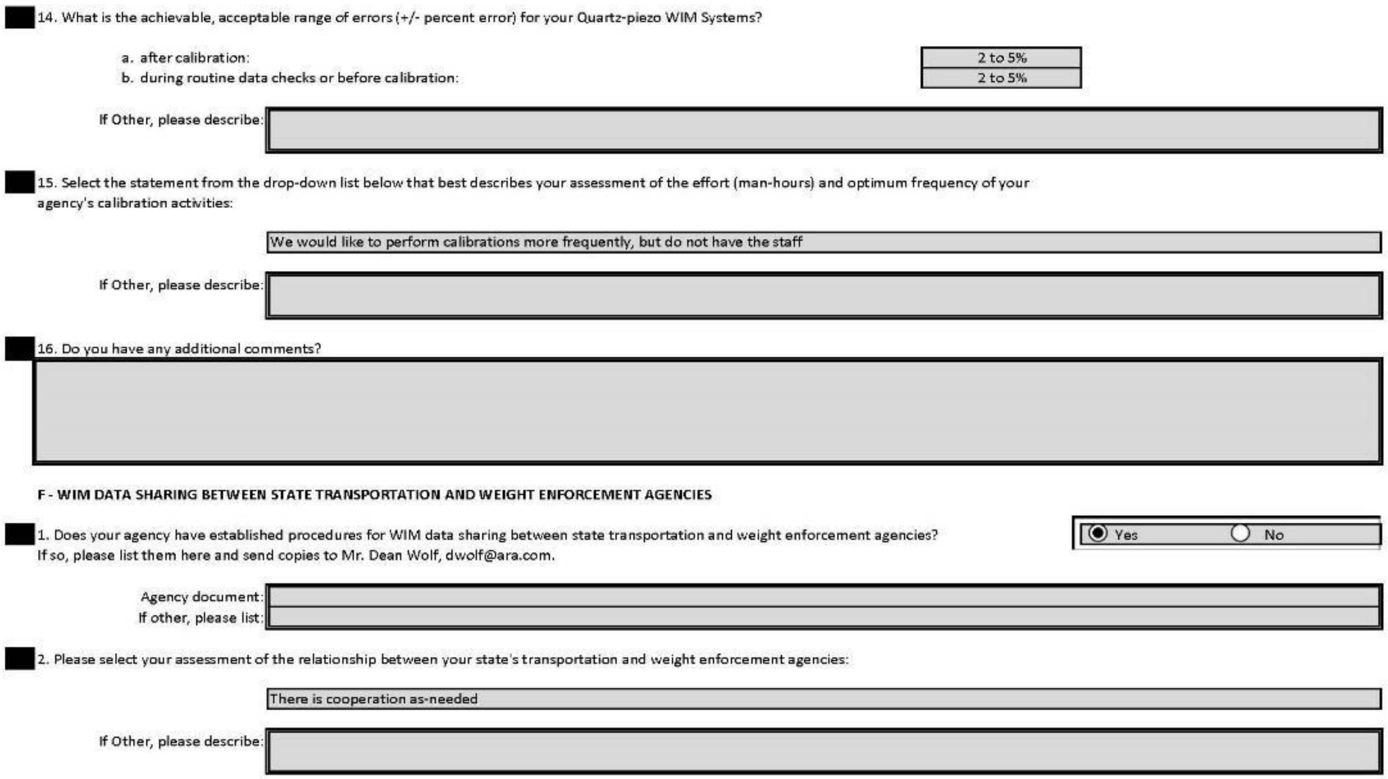
18 wheeler - loaded with concrete blocks - GVW -78K

12. What is the minimum number of passes that you require for the Quartz-piezo WIM system calibration? 4

13. What is the achievable, acceptable mean error for your Quartz-piezo WIM Systems?

a. after calibration: 2 to 5%
b. during routine data checks or before calibration: 2 to 5%

Figure 116. Texas DOT – Responses to Survey



[redacted] 14. What is the achievable, acceptable range of errors (+/- percent error) for your Quartz-piezo WIM Systems?

a. after calibration: 2 to 5%
b. during routine data checks or before calibration: 2 to 5%

If Other, please describe:

[redacted] 15. Select the statement from the drop-down list below that best describes your assessment of the effort (man-hours) and optimum frequency of your agency's calibration activities:

We would like to perform calibrations more frequently, but do not have the staff

If Other, please describe:

[redacted] 16. Do you have any additional comments?

F - WIM DATA SHARING BETWEEN STATE TRANSPORTATION AND WEIGHT ENFORCEMENT AGENCIES

[redacted] 1. Does your agency have established procedures for WIM data sharing between state transportation and weight enforcement agencies?
If so, please list them here and send copies to Mr. Dean Wolf, dwolf@ara.com.

● Yes ○ No

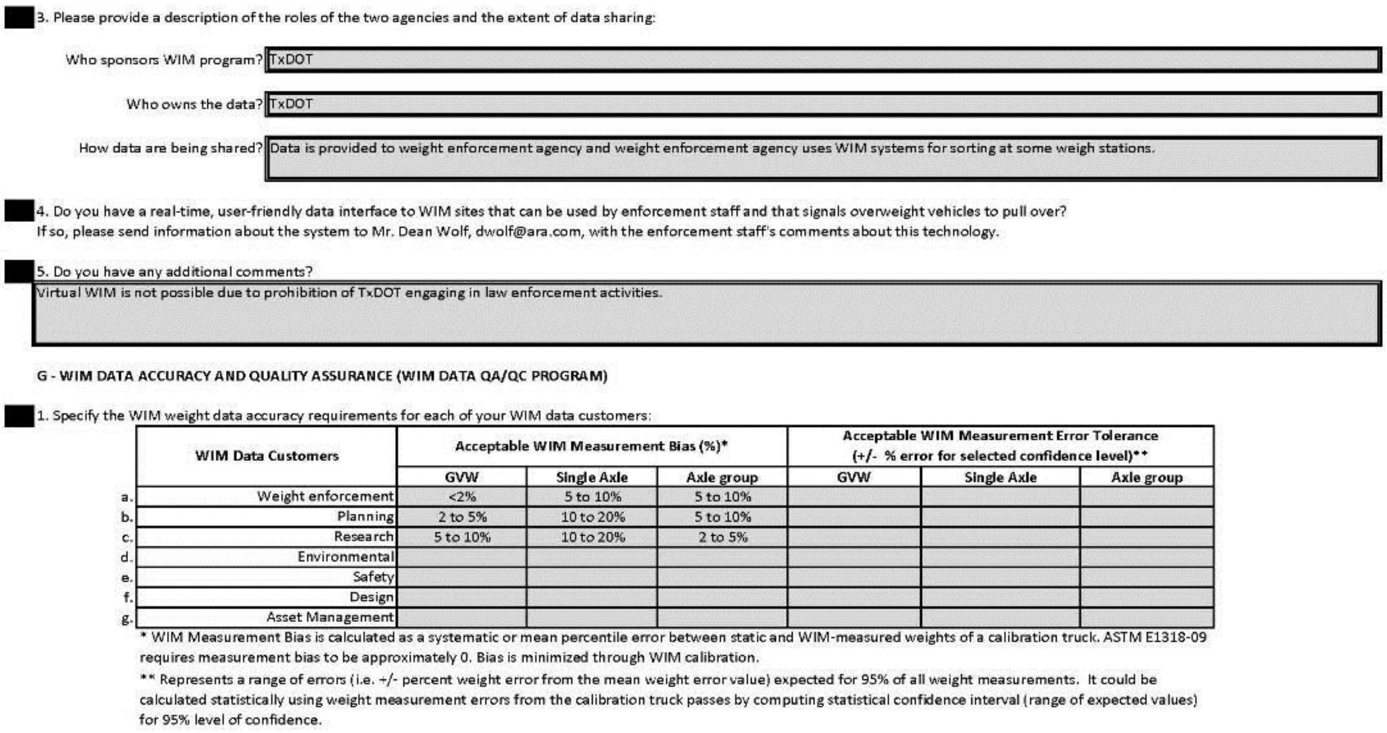
Agency document:
If other, please list:

[redacted] 2. Please select your assessment of the relationship between your state's transportation and weight enforcement agencies:

There is cooperation as-needed

If Other, please describe:

Figure 117. Texas DOT – Responses to Survey



[redacted] 3. Please provide a description of the roles of the two agencies and the extent of data sharing:

Who sponsors WIM program?	TxDOT
Who owns the data?	TxDOT
How data are being shared?	Data is provided to weight enforcement agency and weight enforcement agency uses WIM systems for sorting at some weigh stations.

[redacted] 4. Do you have a real-time, user-friendly data interface to WIM sites that can be used by enforcement staff and that signals overweight vehicles to pull over?
If so, please send information about the system to Mr. Dean Wolf, dwolf@ara.com, with the enforcement staff's comments about this technology.

[redacted] 5. Do you have any additional comments?

Virtual WIM is not possible due to prohibition of TxDOT engaging in law enforcement activities.

G - WIM DATA ACCURACY AND QUALITY ASSURANCE (WIM DATA QA/QC PROGRAM)

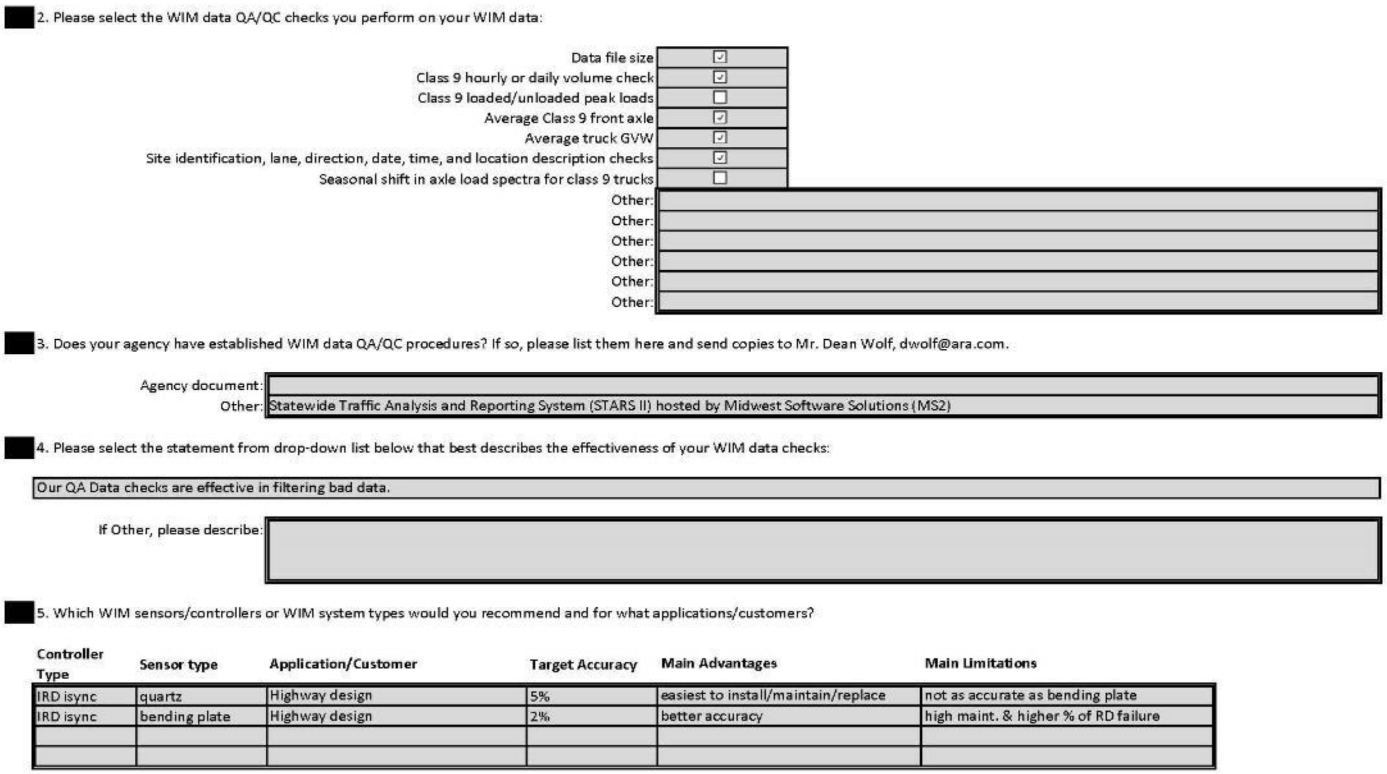
[redacted] 1. Specify the WIM weight data accuracy requirements for each of your WIM data customers:

	WIM Data Customers	Acceptable WIM Measurement Bias (%)*			Acceptable WIM Measurement Error Tolerance (+/- % error for selected confidence level)**		
		GVW	Single Axle	Axle group	GVW	Single Axle	Axle group
a.	Weight enforcement	<2%	5 to 10%	5 to 10%			
b.	Planning	2 to 5%	10 to 20%	5 to 10%			
c.	Research	5 to 10%	10 to 20%	2 to 5%			
d.	Environmental						
e.	Safety						
f.	Design						
g.	Asset Management						

* WIM Measurement Bias is calculated as a systematic or mean percentile error between static and WIM-measured weights of a calibration truck. ASTM E1318-09 requires measurement bias to be approximately 0. Bias is minimized through WIM calibration.

** Represents a range of errors (i.e. +/- percent weight error from the mean weight error value) expected for 95% of all weight measurements. It could be calculated statistically using weight measurement errors from the calibration truck passes by computing statistical confidence interval (range of expected values) for 95% level of confidence.

Figure 118. Texas DOT – Responses to Survey



[redacted] 2. Please select the WIM data QA/QC checks you perform on your WIM data:

Data file size	☑
Class 9 hourly or daily volume check	☑
Class 9 loaded/unloaded peak loads	☐
Average Class 9 front axle	☑
Average truck GVW	☑
Site identification, lane, direction, date, time, and location description checks	☑
Seasonal shift in axle load spectra for class 9 trucks	☐
Other:	
Other:	
Other:	
Other:	
Other:	
Other:	

[redacted] 3. Does your agency have established WIM data QA/QC procedures? If so, please list them here and send copies to Mr. Dean Wolf, dwolf@ara.com.

Agency document:
Other: Statewide Traffic Analysis and Reporting System (STARS II) hosted by Midwest Software Solutions (MS2)

[redacted] 4. Please select the statement from drop-down list below that best describes the effectiveness of your WIM data checks:

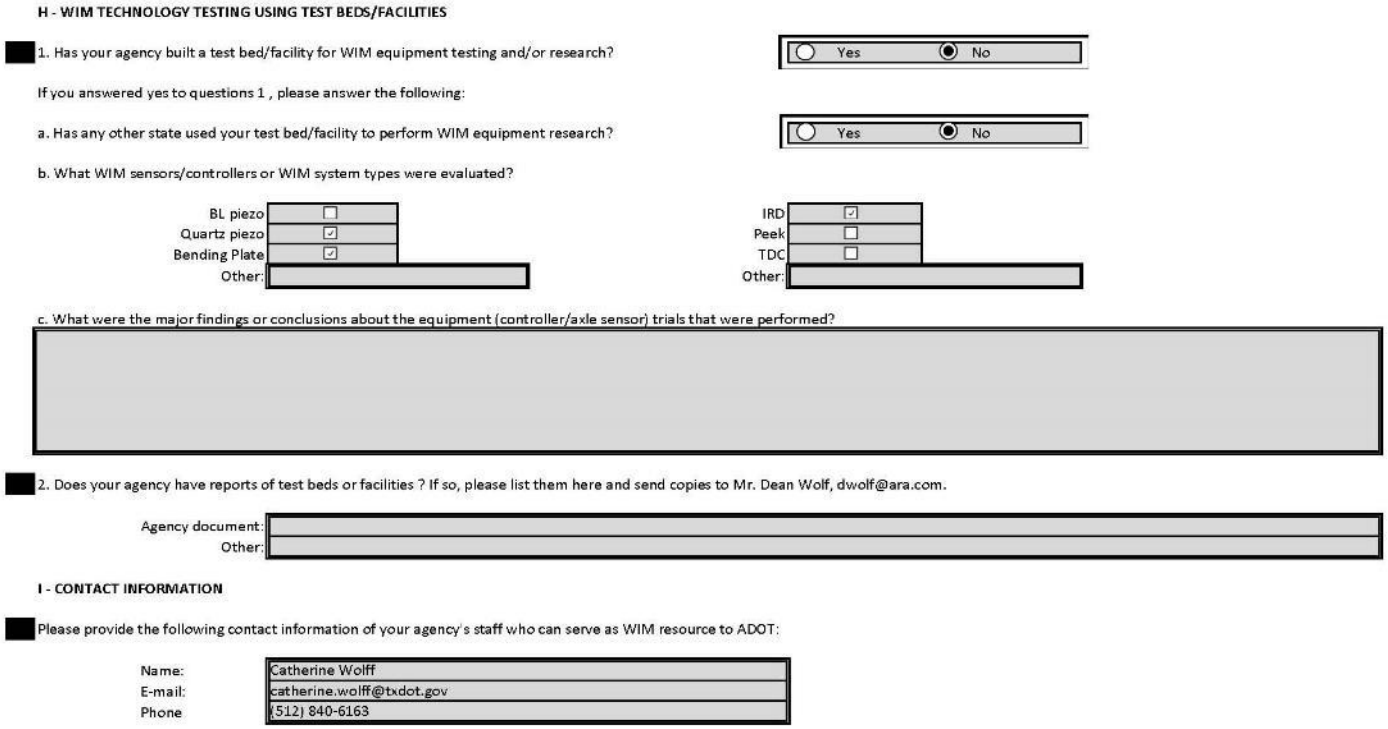
Our QA Data checks are effective in filtering bad data.

If Other, please describe:

[redacted] 5. Which WIM sensors/controllers or WIM system types would you recommend and for what applications/customers?

Controller Type	Sensor type	Application/Customer	Target Accuracy	Main Advantages	Main Limitations
IRD isync	quartz	Highway design	5%	easiest to install/maintain/replace	not as accurate as bending plate
IRD isync	bending plate	Highway design	2%	better accuracy	high maint. & higher % of RD failure

Figure 119. Texas DOT – Responses to Survey



H - WIM TECHNOLOGY TESTING USING TEST BEDS/FACILITIES

[redacted] 1. Has your agency built a test bed/facility for WIM equipment testing and/or research? ○ Yes ● No

If you answered yes to questions 1 , please answer the following:

a. Has any other state used your test bed/facility to perform WIM equipment research? ○ Yes ● No

b. What WIM sensors/controllers or WIM system types were evaluated?

BL piezo ☐
Quartz piezo ☑
Bending Plate ☑
Other:

IRD ☑
Peek ☐
TDC ☐
Other:

c. What were the major findings or conclusions about the equipment (controller/axle sensor) trials that were performed?

[redacted] 2. Does your agency have reports of test beds or facilities ? If so, please list them here and send copies to Mr. Dean Wolf, dwolf@ara.com.

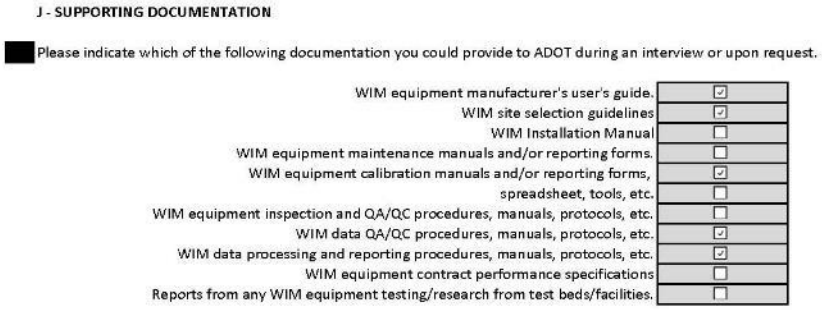
Agency document:
Other:

I - CONTACT INFORMATION

[redacted] Please provide the following contact information of your agency's staff who can serve as WIM resource to ADOT:

Name: Catherine Wolff
E-mail: catherine.wolff@txdot.gov
Phone (512) 840-6163

Figure 120. Texas DOT – Responses to Survey



J - SUPPORTING DOCUMENTATION

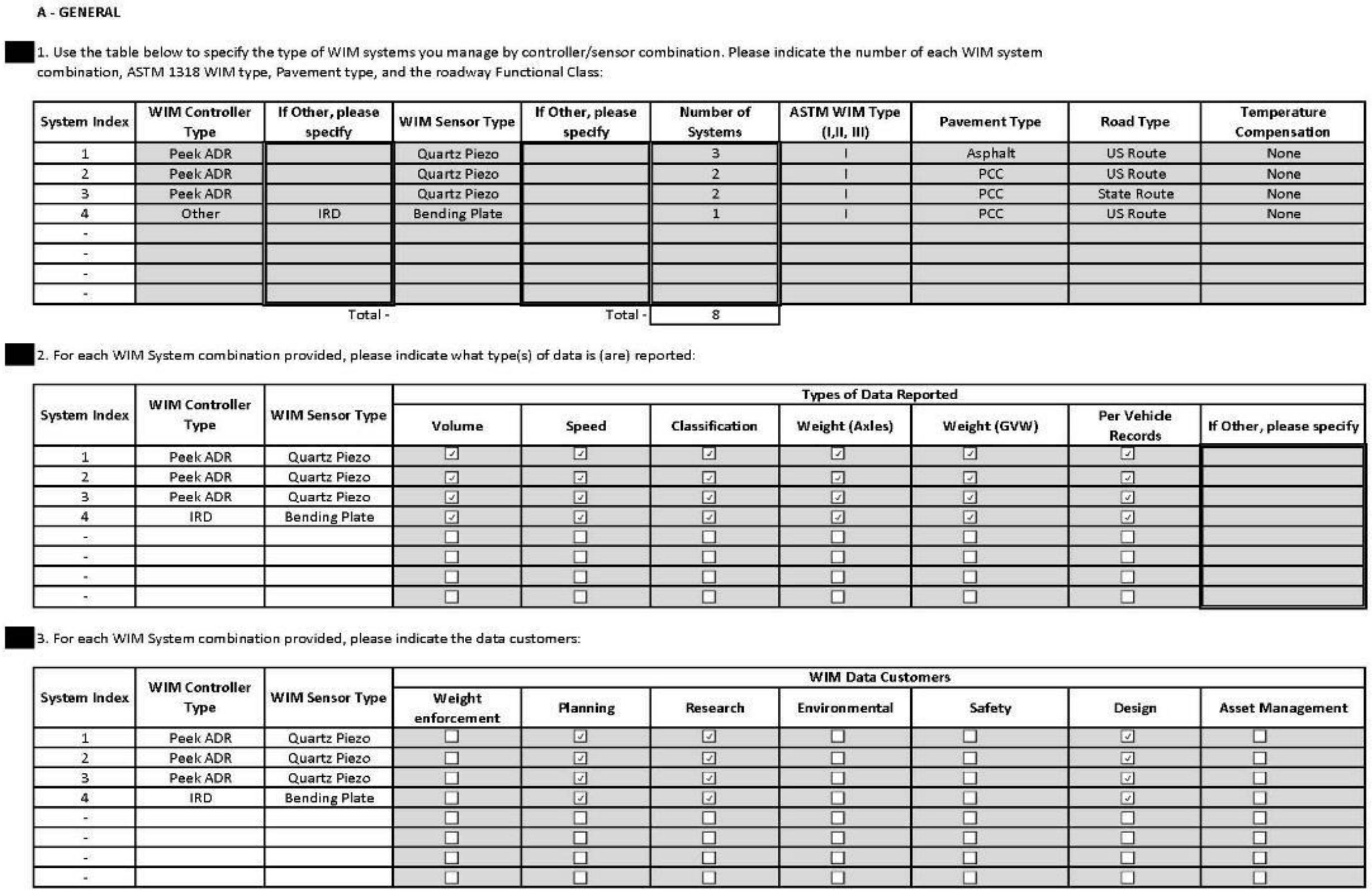
[redacted] Please indicate which of the following documentation you could provide to ADOT during an interview or upon request.

WIM equipment manufacturer's user's guide.	☑
WIM site selection guidelines	☑
WIM Installation Manual	☐
WIM equipment maintenance manuals and/or reporting forms.	☐
WIM equipment calibration manuals and/or reporting forms,	☑
spreadsheet, tools, etc.	☐
WIM equipment inspection and QA/QC procedures, manuals, protocols, etc.	☐
WIM data QA/QC procedures, manuals, protocols, etc.	☑
WIM data processing and reporting procedures, manuals, protocols, etc.	☑
WIM equipment contract performance specifications	☐
Reports from any WIM equipment testing/research from test beds/facilities.	☐

Figure 121. Texas DOT – Responses to Survey

Virginia Department of Transportation (Tom Shinkel)
Program Manager, Traffic Engineering Division

With Inputs from
Hamlin Williams
WIM Program Manager, Traffic Engineering Division



A - GENERAL

[redacted] 1. Use the table below to specify the type of WIM systems you manage by controller/sensor combination. Please indicate the number of each WIM system combination, ASTM 1318 WIM type, Pavement type, and the roadway Functional Class:

System Index	WIM Controller Type	If Other, please specify	WIM Sensor Type	If Other, please specify	Number of Systems	ASTM WIM Type (I,II, III)	Pavement Type	Road Type	Temperature Compensation
1	Peek ADR		Quartz Piezo		3	I	Asphalt	US Route	None
2	Peek ADR		Quartz Piezo		2	I	PCC	US Route	None
3	Peek ADR		Quartz Piezo		2	I	PCC	State Route	None
4	Other	IRD	Bending Plate		1	I	PCC	US Route	None
-									
-									
-									
-									
		Total -		Total -	8				

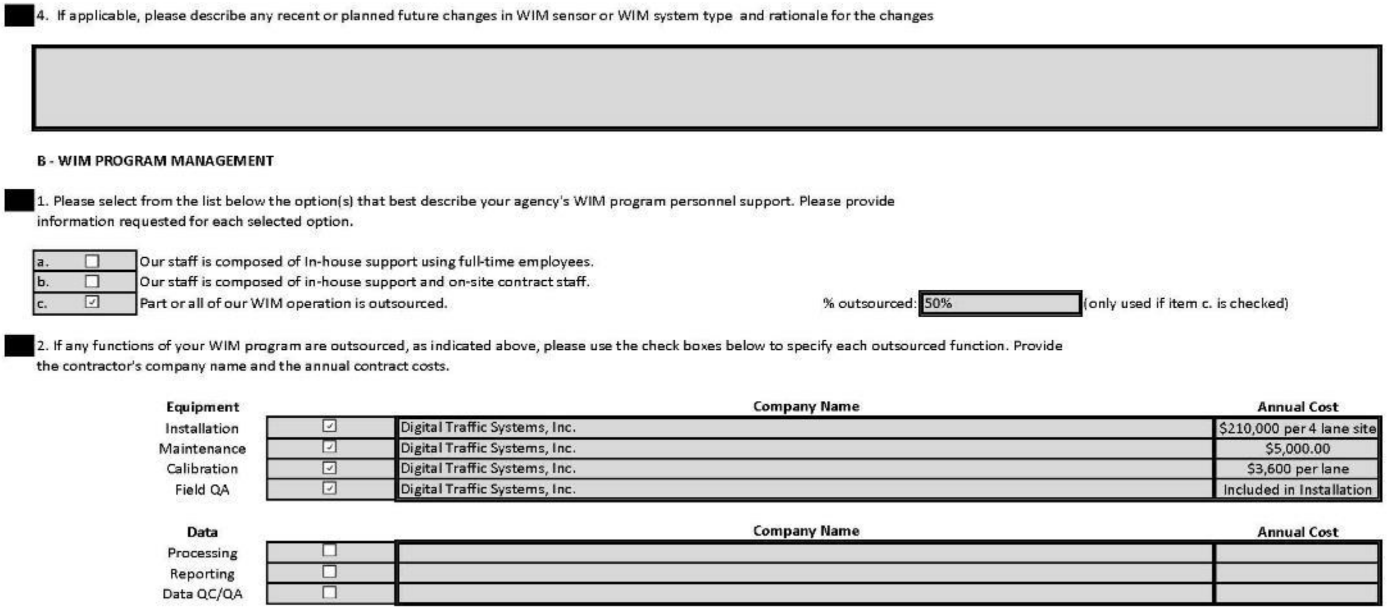
[redacted] 2. For each WIM System combination provided, please indicate what type(s) of data is (are) reported:

System Index	WIM Controller Type	WIM Sensor Type	Types of Data Reported						
			Volume	Speed	Classification	Weight (Axles)	Weight (GVW)	Per Vehicle Records	If Other, please specify
1	Peek ADR	Quartz Piezo	☑	☑	☑	☑	☑	☑	
2	Peek ADR	Quartz Piezo	☑	☑	☑	☑	☑	☑	
3	Peek ADR	Quartz Piezo	☑	☑	☑	☑	☑	☑	
4	IRD	Bending Plate	☑	☑	☑	☑	☑	☑	
-			☐	☐	☐	☐	☐	☐	
-			☐	☐	☐	☐	☐	☐	
-			☐	☐	☐	☐	☐	☐	
-			☐	☐	☐	☐	☐	☐	

[redacted] 3. For each WIM System combination provided, please indicate the data customers:

System Index	WIM Controller Type	WIM Sensor Type	WIM Data Customers						
			Weight enforcement	Planning	Research	Environmental	Safety	Design	Asset Management
1	Peek ADR	Quartz Piezo	☐	☑	☑	☐	☐	☑	☐
2	Peek ADR	Quartz Piezo	☐	☑	☑	☐	☐	☑	☐
3	Peek ADR	Quartz Piezo	☐	☑	☑	☐	☐	☑	☐
4	IRD	Bending Plate	☐	☑	☑	☐	☐	☑	☐
-			☐	☐	☐	☐	☐	☐	☐
-			☐	☐	☐	☐	☐	☐	☐
-			☐	☐	☐	☐	☐	☐	☐
-			☐	☐	☐	☐	☐	☐	☐

Figure 122. Virginia DOT – Responses to Survey



[redacted] 4. If applicable, please describe any recent or planned future changes in WIM sensor or WIM system type and rationale for the changes

B - WIM PROGRAM MANAGEMENT

[redacted] 1. Please select from the list below the option(s) that best describe your agency's WIM program personnel support. Please provide information requested for each selected option.

a. ☐ Our staff is composed of In-house support using full-time employees.
b. ☐ Our staff is composed of in-house support and on-site contract staff.
c. ☑ Part or all of our WIM operation is outsourced.

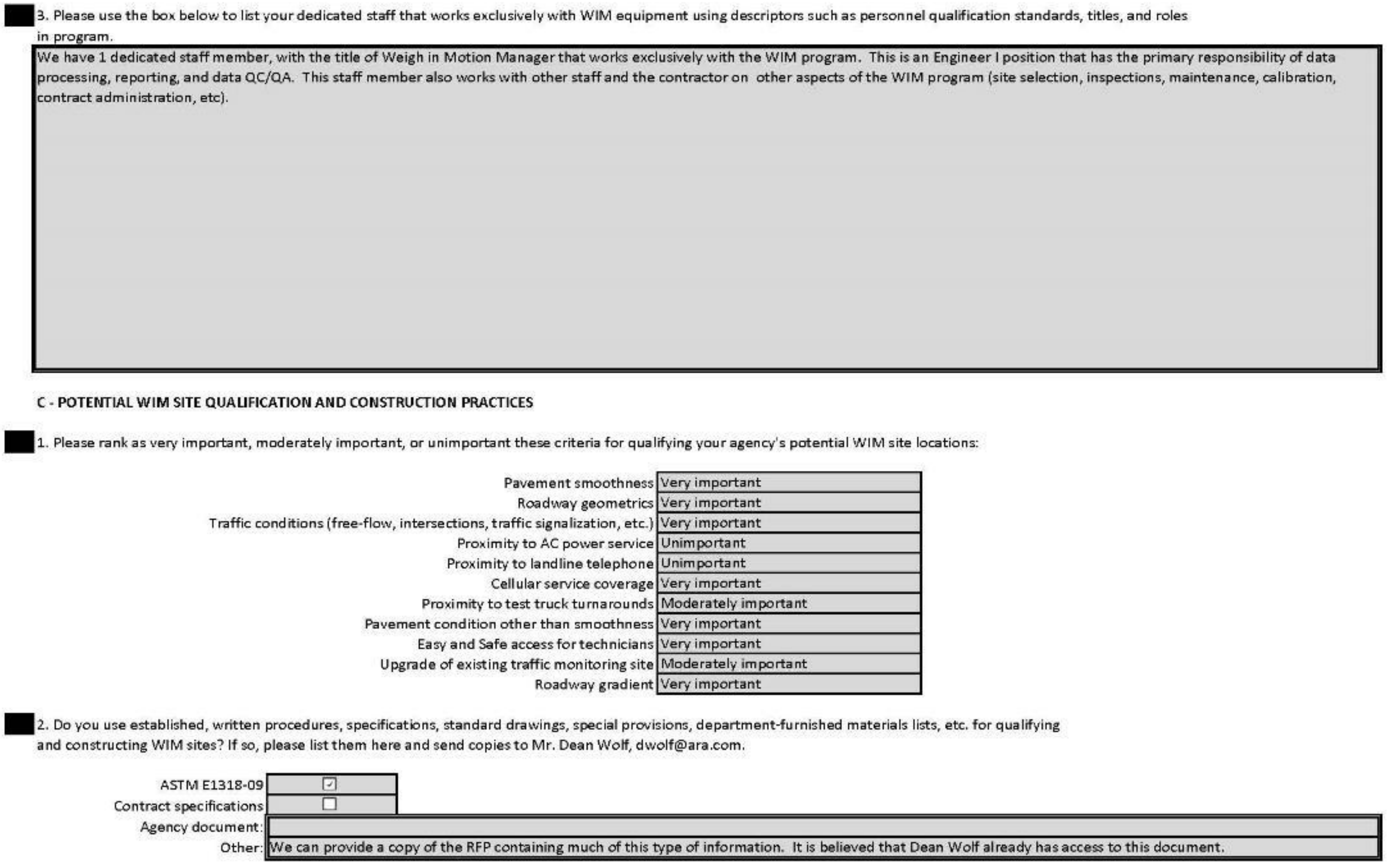
% outsourced: 50% (only used if item c. is checked)

[redacted] 2. If any functions of your WIM program are outsourced, as indicated above, please use the check boxes below to specify each outsourced function. Provide the contractor's company name and the annual contract costs.

Equipment		Company Name	Annual Cost
Installation	☑	Digital Traffic Systems, Inc.	$210,000 per 4 lane site
Maintenance	☑	Digital Traffic Systems, Inc.	$5,000.00
Calibration	☑	Digital Traffic Systems, Inc.	$3,600 per lane
Field QA	☑	Digital Traffic Systems, Inc.	Included in Installation

Data		Company Name	Annual Cost
Processing	☐		
Reporting	☐		
Data QC/QA	☐		

Figure 123. Virginia DOT – Responses to Survey



[redacted] 3. Please use the box below to list your dedicated staff that works exclusively with WIM equipment using descriptors such as personnel qualification standards, titles, and roles in program.

We have 1 dedicated staff member, with the title of Weigh in Motion Manager that works exclusively with the WIM program. This is an Engineer I position that has the primary responsibility of data processing, reporting, and data QC/QA. This staff member also works with other staff and the contractor on other aspects of the WIM program (site selection, inspections, maintenance, calibration, contract administration, etc).

C - POTENTIAL WIM SITE QUALIFICATION AND CONSTRUCTION PRACTICES

[redacted] 1. Please rank as very important, moderately important, or unimportant these criteria for qualifying your agency's potential WIM site locations:

Pavement smoothness	Very important
Roadway geometrics	Very important
Traffic conditions (free-flow, intersections, traffic signalization, etc.)	Very important
Proximity to AC power service	Unimportant
Proximity to landline telephone	Unimportant
Cellular service coverage	Very important
Proximity to test truck turnarounds	Moderately important
Pavement condition other than smoothness	Very important
Easy and Safe access for technicians	Very important
Upgrade of existing traffic monitoring site	Moderately important
Roadway gradient	Very important

[redacted] 2. Do you use established, written procedures, specifications, standard drawings, special provisions, department-furnished materials lists, etc. for qualifying and constructing WIM sites? If so, please list them here and send copies to Mr. Dean Wolf, dwolf@ara.com.

ASTM E1318-09	☑
Contract specifications	☐
Agency document:	
Other:	We can provide a copy of the RFP containing much of this type of information. It is believed that Dean Wolf already has access to this document.

Figure 124. Virginia DOT – Responses to Survey

3. Do you have any additional comments?

D - WIM EQUIPMENT INSTALLATION PRACTICES

1. Who performs Quality Assurance of your WIM System installations (check all that apply):

Resident Engineer ☐
Manufacturer's representative ☐
District Engineer ☐
State QA Personnel ☐
WIM Technician ☐
Contracted Personnel (Company): Digital Traffic Systems, Inc.
Other:

2. Do you use established, written procedures, specifications, standard drawings, special provisions, department-furnished materials lists, etc. for WIM equipment *installation*? If so, please list them here and send copies to Mr. Dean Wolf, dwolf@ara.com.

Contract specifications ☑
Agency document:
Other: We can provide a copy of the RFP containing much of this type of information. It is believed that Dean Wolf already has access to this document.
Other: Our contractor, DTS, maintains a proprietary procedures manual.
Other:

3. Do you have any additional comments?

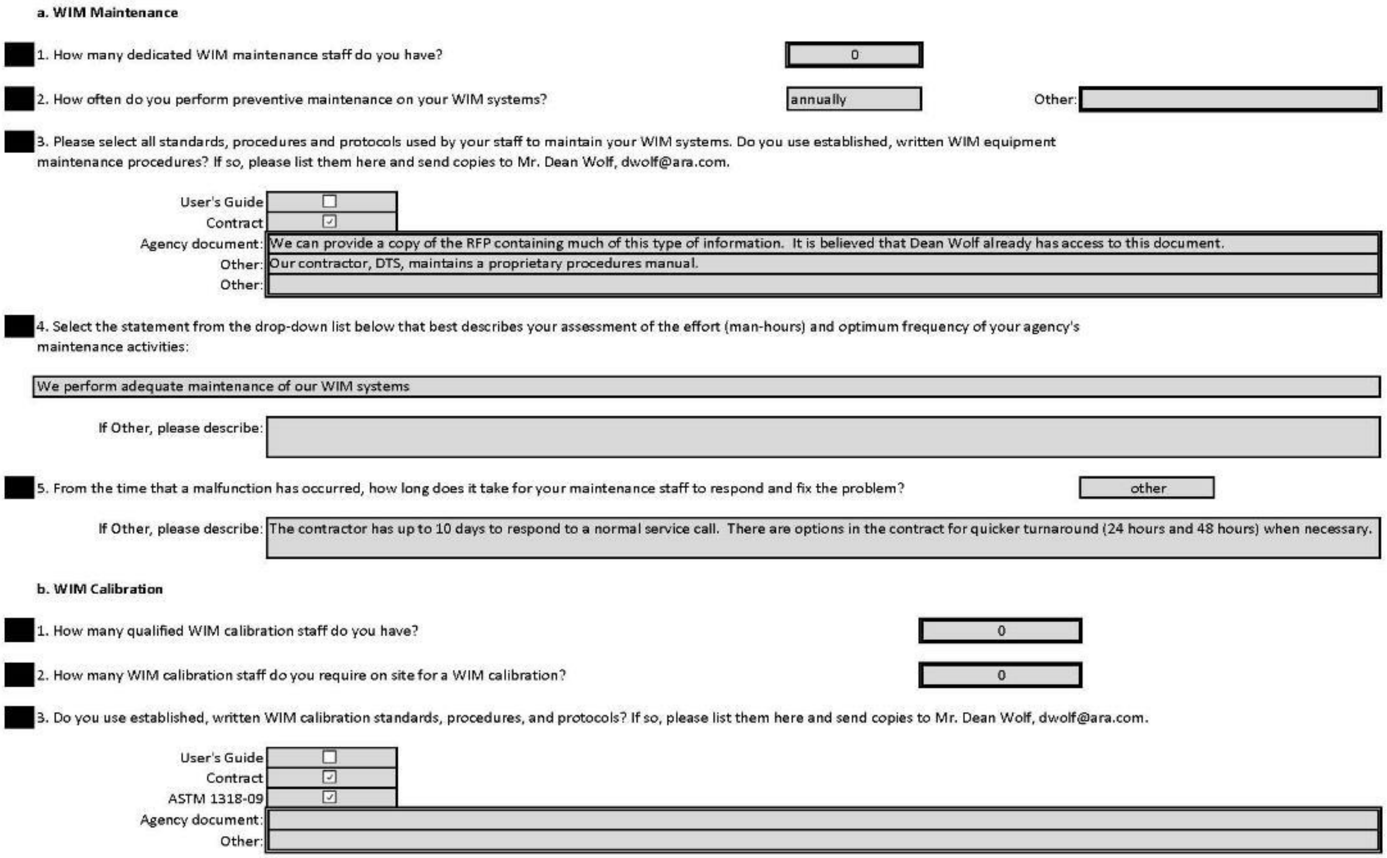
E - WIM EQUIPMENT MAINTENANCE AND CALIBRATION PRACTICES

1. Select the option from the drop-down lists that best describes your agencies current practice for maintaining and calibrating your WIM systems.

We outsource all calibration and maintenance for our WIM systems.

If Other, please describe:

Figure 125. Virginia DOT – Responses to Survey



a. WIM Maintenance

1. How many dedicated WIM maintenance staff do you have? 0

2. How often do you perform preventive maintenance on your WIM systems? annually Other:

3. Please select all standards, procedures and protocols used by your staff to maintain your WIM systems. Do you use established, written WIM equipment maintenance procedures? If so, please list them here and send copies to Mr. Dean Wolf, dwolf@ara.com.

User's Guide ☐
Contract ☑
Agency document: We can provide a copy of the RFP containing much of this type of information. It is believed that Dean Wolf already has access to this document.
Other: Our contractor, DTS, maintains a proprietary procedures manual.
Other:

4. Select the statement from the drop-down list below that best describes your assessment of the effort (man-hours) and optimum frequency of your agency's maintenance activities:

We perform adequate maintenance of our WIM systems

If Other, please describe:

5. From the time that a malfunction has occurred, how long does it take for your maintenance staff to respond and fix the problem? other

If Other, please describe: The contractor has up to 10 days to respond to a normal service call. There are options in the contract for quicker turnaround (24 hours and 48 hours) when necessary.

b. WIM Calibration

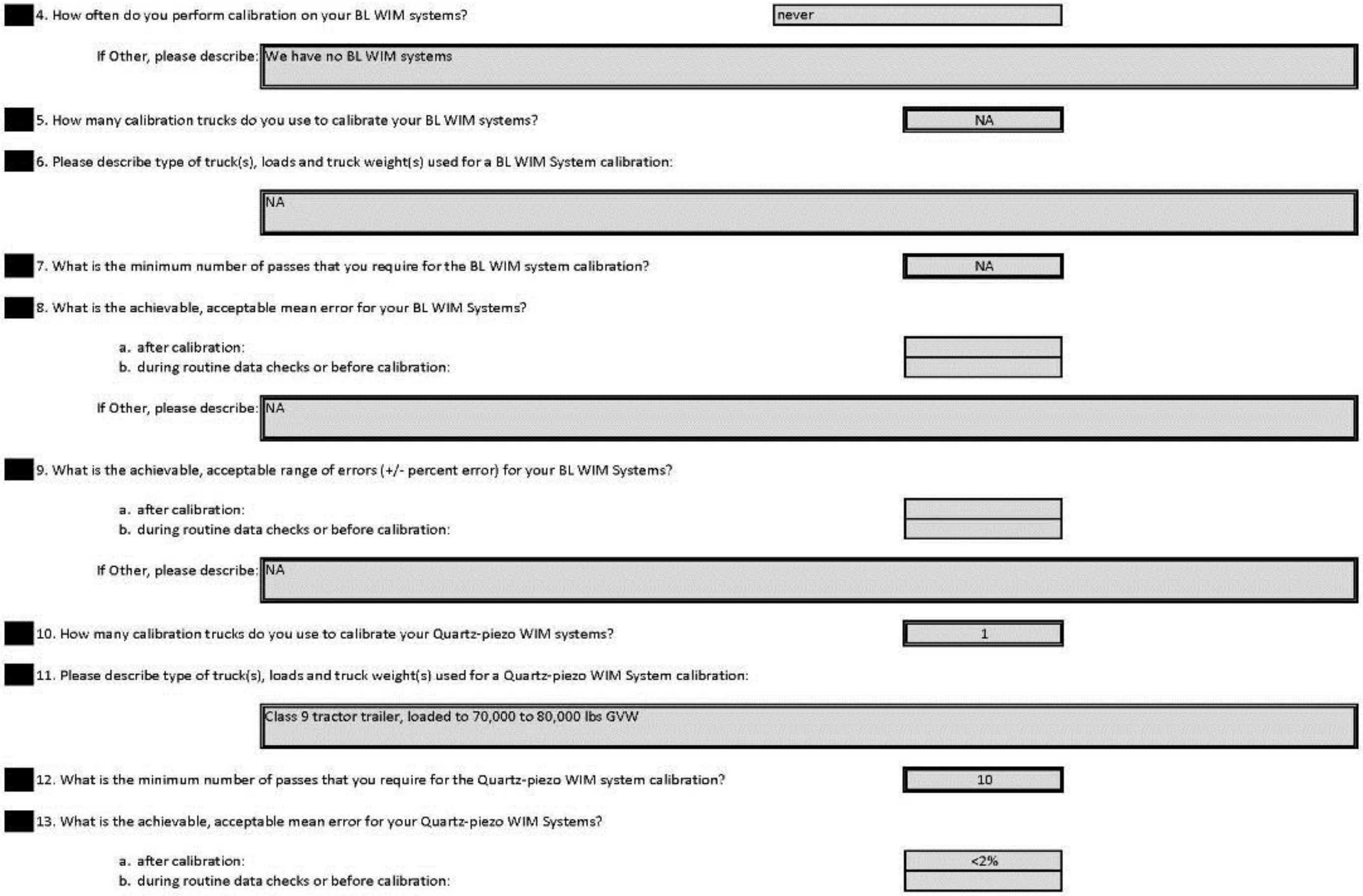
1. How many qualified WIM calibration staff do you have? 0

2. How many WIM calibration staff do you require on site for a WIM calibration? 0

3. Do you use established, written WIM calibration standards, procedures, and protocols? If so, please list them here and send copies to Mr. Dean Wolf, dwolf@ara.com.

User's Guide ☐
Contract ☑
ASTM 1318-09 ☑
Agency document:
Other:

Figure 126. Virginia DOT – Responses to Survey



[redacted] 4. How often do you perform calibration on your BL WIM systems?	never
If Other, please describe:	We have no BL WIM systems
[redacted] 5. How many calibration trucks do you use to calibrate your BL WIM systems?	NA
[redacted] 6. Please describe type of truck(s), loads and truck weight(s) used for a BL WIM System calibration:	NA
[redacted] 7. What is the minimum number of passes that you require for the BL WIM system calibration?	NA
[redacted] 8. What is the achievable, acceptable mean error for your BL WIM Systems?	
a. after calibration:	
b. during routine data checks or before calibration:	
If Other, please describe:	NA
[redacted] 9. What is the achievable, acceptable range of errors (+/- percent error) for your BL WIM Systems?	
a. after calibration:	
b. during routine data checks or before calibration:	
If Other, please describe:	NA
[redacted] 10. How many calibration trucks do you use to calibrate your Quartz-piezo WIM systems?	1
[redacted] 11. Please describe type of truck(s), loads and truck weight(s) used for a Quartz-piezo WIM System calibration:	Class 9 tractor trailer, loaded to 70,000 to 80,000 lbs GVW
[redacted] 12. What is the minimum number of passes that you require for the Quartz-piezo WIM system calibration?	10
[redacted] 13. What is the achievable, acceptable mean error for your Quartz-piezo WIM Systems?	
a. after calibration:	<2%
b. during routine data checks or before calibration:	

Figure 127. Virginia DOT – Responses to Survey

14. What is the achievable, acceptable range of errors (+/- percent error) for your Quartz-piezo WIM Systems?

a. after calibration: 5 to 10%
b. during routine data checks or before calibration:

If Other, please describe: We try to achieve ASTM Type I accuracy

15. Select the statement from the drop-down list below that best describes your assessment of the effort (man-hours) and optimum frequency of your agency's calibration activities:

We perform adequate calibrations of our WIM systems

If Other, please describe:

16. Do you have any additional comments?

F - WIM DATA SHARING BETWEEN STATE TRANSPORTATION AND WEIGHT ENFORCEMENT AGENCIES

1. Does your agency have established procedures for WIM data sharing between state transportation and weight enforcement agencies? ● Yes ○ No
If so, please list them here and send copies to Mr. Dean Wolf, dwolf@ara.com.

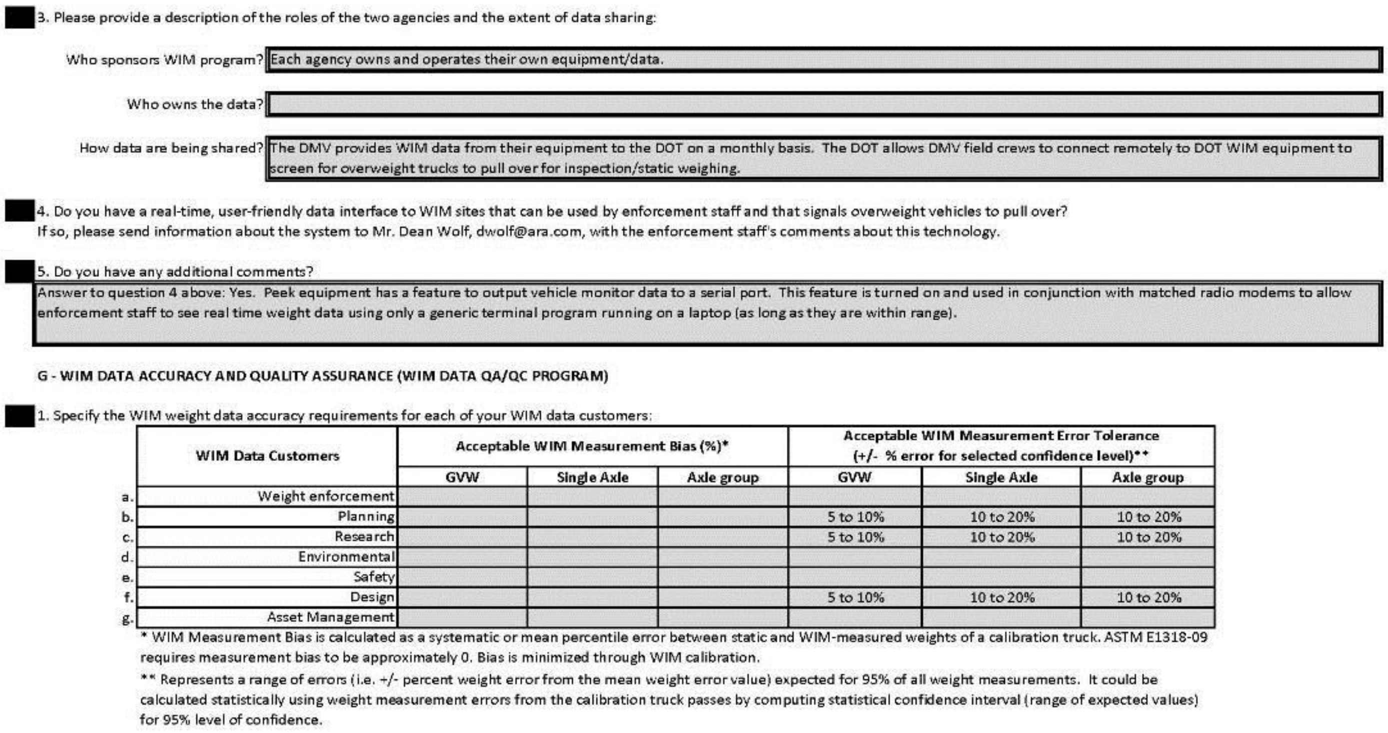
Agency document:
If other, please list: There is an informal agreement between the Department of Motor Vehicles (enforcement agency) and the Department of Transportation (data collection agency).

2. Please select your assessment of the relationship between your state's transportation and weight enforcement agencies:

There is full cooperation

If Other, please describe:

Figure 128. Virginia DOT – Responses to Survey



[redacted] 3. Please provide a description of the roles of the two agencies and the extent of data sharing:

Who sponsors WIM program?	Each agency owns and operates their own equipment/data.
Who owns the data?	
How data are being shared?	The DMV provides WIM data from their equipment to the DOT on a monthly basis. The DOT allows DMV field crews to connect remotely to DOT WIM equipment to screen for overweight trucks to pull over for inspection/static weighing.

[redacted] 4. Do you have a real-time, user-friendly data interface to WIM sites that can be used by enforcement staff and that signals overweight vehicles to pull over?
If so, please send information about the system to Mr. Dean Wolf, dwolf@ara.com, with the enforcement staff's comments about this technology.

[redacted] 5. Do you have any additional comments?

Answer to question 4 above: Yes. Peek equipment has a feature to output vehicle monitor data to a serial port. This feature is turned on and used in conjunction with matched radio modems to allow enforcement staff to see real time weight data using only a generic terminal program running on a laptop (as long as they are within range).

G - WIM DATA ACCURACY AND QUALITY ASSURANCE (WIM DATA QA/QC PROGRAM)

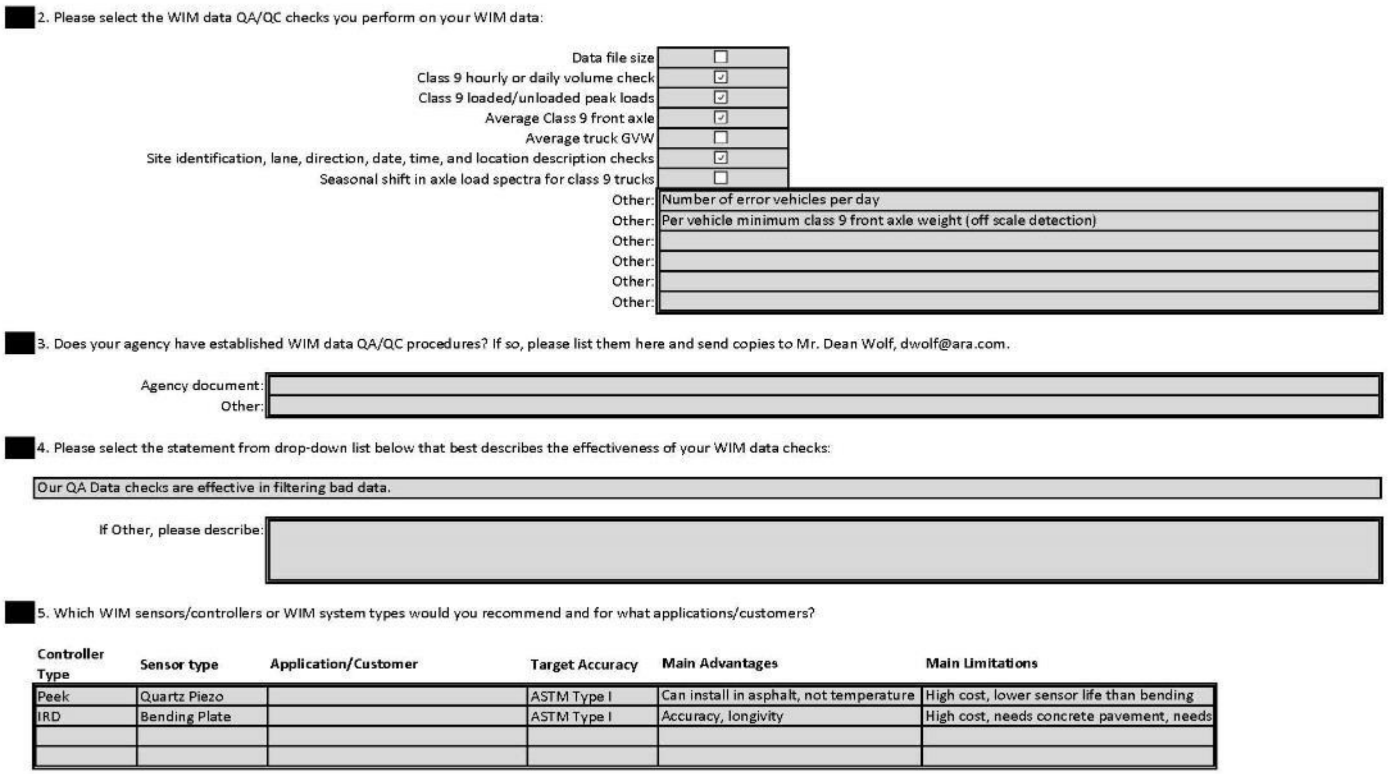
[redacted] 1. Specify the WIM weight data accuracy requirements for each of your WIM data customers:

	WIM Data Customers	Acceptable WIM Measurement Bias (%)*			Acceptable WIM Measurement Error Tolerance (+/- % error for selected confidence level)**		
		GVW	Single Axle	Axle group	GVW	Single Axle	Axle group
a.	Weight enforcement						
b.	Planning				5 to 10%	10 to 20%	10 to 20%
c.	Research				5 to 10%	10 to 20%	10 to 20%
d.	Environmental						
e.	Safety						
f.	Design				5 to 10%	10 to 20%	10 to 20%
g.	Asset Management						

* WIM Measurement Bias is calculated as a systematic or mean percentile error between static and WIM-measured weights of a calibration truck. ASTM E1318-09 requires measurement bias to be approximately 0. Bias is minimized through WIM calibration.

** Represents a range of errors (i.e. +/- percent weight error from the mean weight error value) expected for 95% of all weight measurements. It could be calculated statistically using weight measurement errors from the calibration truck passes by computing statistical confidence interval (range of expected values) for 95% level of confidence.

Figure 129. Virginia DOT – Responses to Survey



[redacted] 2. Please select the WIM data QA/QC checks you perform on your WIM data:

Data file size	☐
Class 9 hourly or daily volume check	☑
Class 9 loaded/unloaded peak loads	☑
Average Class 9 front axle	☑
Average truck GVW	☐
Site identification, lane, direction, date, time, and location description checks	☑
Seasonal shift in axle load spectra for class 9 trucks	☐
Other:	Number of error vehicles per day
Other:	Per vehicle minimum class 9 front axle weight (off scale detection)
Other:	
Other:	
Other:	
Other:	

[redacted] 3. Does your agency have established WIM data QA/QC procedures? If so, please list them here and send copies to Mr. Dean Wolf, dwolf@ara.com.

Agency document:
Other:

[redacted] 4. Please select the statement from drop-down list below that best describes the effectiveness of your WIM data checks:

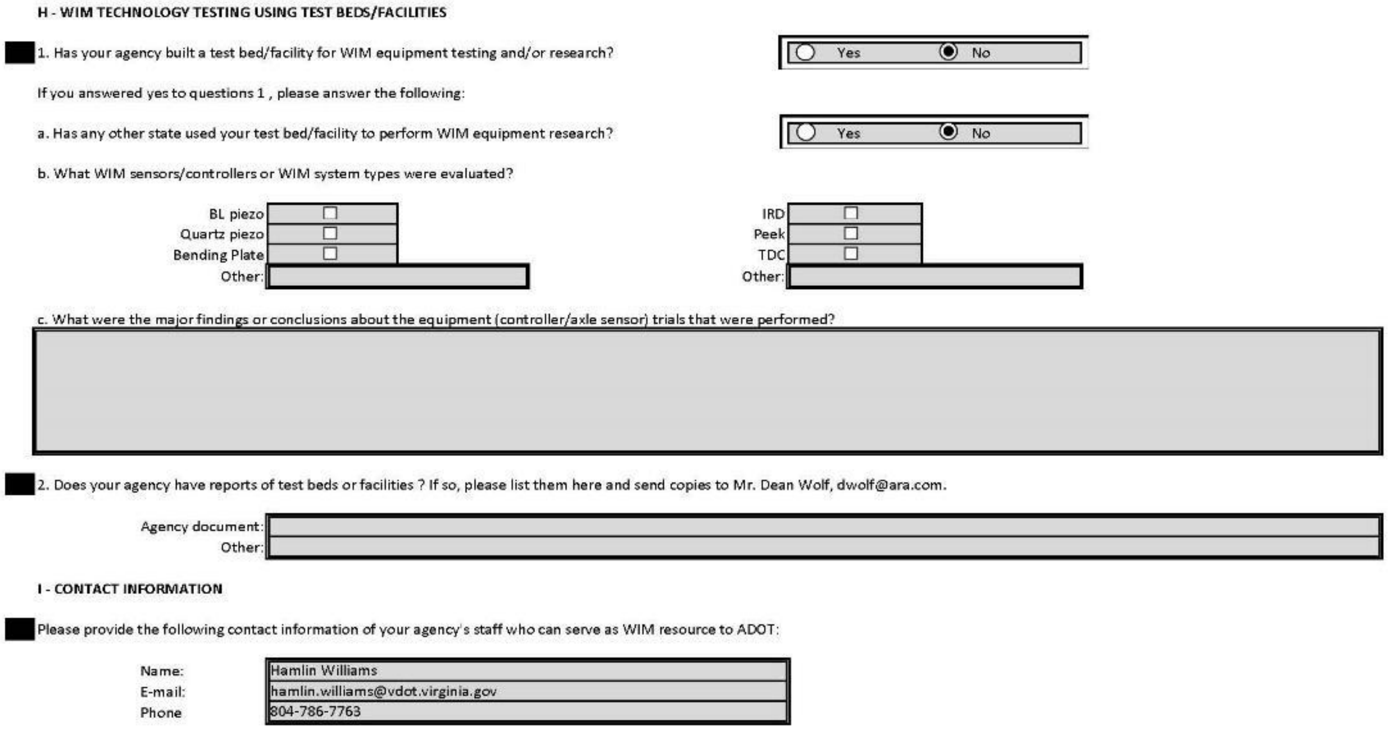
Our QA Data checks are effective in filtering bad data.

If Other, please describe:

[redacted] 5. Which WIM sensors/controllers or WIM system types would you recommend and for what applications/customers?

Controller Type	Sensor type	Application/Customer	Target Accuracy	Main Advantages	Main Limitations
Peek	Quartz Piezo		ASTM Type I	Can install in asphalt, not temperature	High cost, lower sensor life than bending
IRD	Bending Plate		ASTM Type I	Accuracy, longivity	High cost, needs concrete pavement, needs

Figure 130. Virginia DOT – Responses to Survey



H - WIM TECHNOLOGY TESTING USING TEST BEDS/FACILITIES

1. Has your agency built a test bed/facility for WIM equipment testing and/or research? ○ Yes ● No

If you answered yes to questions 1 , please answer the following:

a. Has any other state used your test bed/facility to perform WIM equipment research? ○ Yes ● No

b. What WIM sensors/controllers or WIM system types were evaluated?

BL piezo	☐	IRD	☐
Quartz piezo	☐	Peek	☐
Bending Plate	☐	TDC	☐
Other:		Other:	

c. What were the major findings or conclusions about the equipment (controller/axle sensor) trials that were performed?

2. Does your agency have reports of test beds or facilities ? If so, please list them here and send copies to Mr. Dean Wolf, dwolf@ara.com.

Agency document:

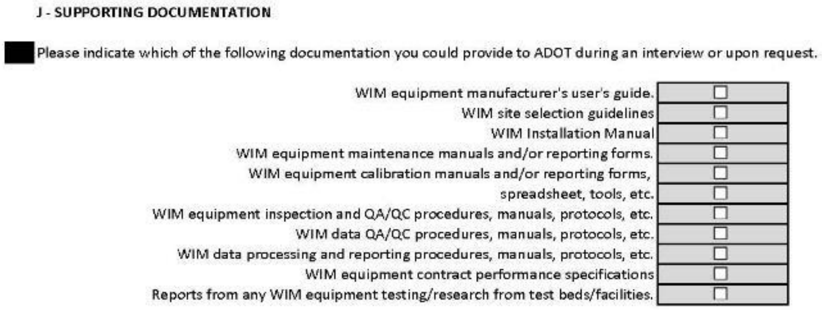
Other:

I - CONTACT INFORMATION

Please provide the following contact information of your agency's staff who can serve as WIM resource to ADOT:

Name:	Hamlin Williams
E-mail:	hamlin.williams@vdot.virginia.gov
Phone	804-786-7763

Figure 131. Virginia DOT – Responses to Survey



J - SUPPORTING DOCUMENTATION

[redacted] Please indicate which of the following documentation you could provide to ADOT during an interview or upon request.

WIM equipment manufacturer's user's guide.	☐
WIM site selection guidelines	☐
WIM Installation Manual	☐
WIM equipment maintenance manuals and/or reporting forms.	☐
WIM equipment calibration manuals and/or reporting forms,	☐
spreadsheet, tools, etc.	☐
WIM equipment inspection and QA/QC procedures, manuals, protocols, etc.	☐
WIM data QA/QC procedures, manuals, protocols, etc.	☐
WIM data processing and reporting procedures, manuals, protocols, etc.	☐
WIM equipment contract performance specifications	☐
Reports from any WIM equipment testing/research from test beds/facilities.	☐

Figure 132. Virginia DOT – Responses to Survey

APPENDIX B – FHWA LTPP SITE EVALUATION FORM (CA SPS-2)

C.0 SITE EVALUATION FORM

C.1 PROPOSED WIM LOCATION

Proposed WIM Site Location – 4 Lane Roadway (2 Lanes each Direction)

Cnty: Merced Rte: SR-99 Direction: NB MP: R32.5 Ln: Outside

Proposed WIM Scale location is 20' downstream from end of test section 060203 and 75' upstream from start of section 060211.

C.1.1 EXISTING ROADWAY SURROUNDING THE PROPOSED WIM SITE

Type Pvmnt: PCC Yr Const: 2000 Ln Width: Striped 12' Thick: 11"
Jointed plain, joints perpendicular 15' oc, dowelled, sealed, minor spalling, good cond.

Observed Structural Soundness: Good

Observed Smoothness: Minor long wavelength, considerable short wavelength

Outside Shldr Type: PCC Width: Striped 10 ' Cond: Good

Inside Shldr Type: AC Width: 8' Cond: Good

C.1.2 PAVEMENT 325' PRIOR AND 75' FOLLOWING WIM SCALES

Type Pvmnt: PCC Yr Const: 2000 Ln Width: Striped 12' Thick: 11"
Jointed plain, joints perpendicular 15' oc, dowelled, sealed, minor spalling, good cond.

Observed Structural Soundness: Good

Observed Smoothness: Minor long wavelength, considerable short wavelength

Outside Shldr Type: PCC Width: Striped 10 ' Cond: Good

Inside Shldr Type: AC Width: 8 ' Cond: Good

Notes/Comments on Pavement:
A blanket grind of the PCC pavement 325' in advance and 75' trailing the proposed WIM scales location will be required to eliminate short wavelength profile problems. First 285' of the 1000' evaluation section is older PCCP at 12' wide with skewed joints, 10' wide outside AC shoulder, and 8' wide inside AC shoulder. There is a significant "dip" in the roadway at the cold joint of these two pavements and there is a random transverse crack in the first PCC panel following this cold joint. This joint is +/- 615' in advance of the proposed WIM scale location and the vehicle body motion effected by its dip dampens out well before the vehicle reaches the scale location.

C.1.3 OTHER ROADWAY GEOMETRICS

Horizontal Align: Tangent Grade: Minimal, <0.5% Cross-slope: est. +/- 1.5% to outside shldr

Striping: NB outside lane long. joints at 14' wide and shldr at 8' wide; 4" solid shldr stripe delineates as 12' lane and 10' shldr.

C.1.4 OBSERVED TRAFFIC OPERATING CHARACTERISTICS

Posted Speed Limit, MPH: Autos 65 Trucks 55

Observed Speed Range, MPH: Autos 60 – 75 Trucks 60 - 65

Passing, merging, not following lane lines? Good Lane Discipline - occasional passing

Stop and go traffic, congestion periods? Free flowing at all times during assessment

Traffic signals or interchanges affecting traffic flow? The traffic entering NB SR-99 from the Collier Rd. on ramp enters the roadway approximately 900' in advance of the proposed scale location. However, this on ramp traffic is light and no adverse affect on traffic flow through the WIM site was observed during the assessment.

Other adverse traffic flow conditions? None, but traffic flow is heavy. Most trucks traveling in outside lane.

Truck traffic at "cruising" speed and no lugging? Yes, as observed.

Truck traffic staying within lane lines? Yes, but occasional truck hugging shoulder stripe

Observed truck suspension or body motion dynamics? Minor body motion observed; wheels of empty trucks could be heard crossing transverse joints.

Drive-thru noted suspension or body motion dynamics? Some suspension chatter noted-need blanket grind WIM Pavement. Only minor body motion detected.

Truck traffic composition same at WIM site and SPS site? Yes

Truck traffic on/off locations between WIM site and SPS site? No; proposed WIM site within limits of test sections.

Notes/Comments on Geometrics and/or Traffic Operating Characteristics:

C.1.5 ACCESS TO UTILITY SERVICES

Potential source(s) for power and phone: Overhead power lines paralleling Sycamore St. cross the roadway at +/-300' downstream with a pole immediately adjacent to the R/W fence. A telephone service point exists +/-1100' north of this point near the power line run and it may be feasible to use the power poles to extend the phone service to the roadway. Another option would be to extend existing power and phone conduits and conductors via trenching from the foundations of the abandoned WIM and service cabinets +/-3200' back to the proposed new WIM cabinet location.

C.1.6 EQUIPMENT INSTALLATION CAPABILITY

Adequate location for controller cabinet? Yes, opposite WIM scales on roadway's embankment slope at 30' from edge of traveled way. This location would be high enough above the toe of slope such that ponding water from heavy rains should not enter the cabinet.

Distance from edge of traveled way to R/W? 52'

Distance from edge of traveled way to cabinet? +/-30'

Visibility from cabinet of sensors and approaching vehicles? Good

Adequate location for service facilities? Yes, adjacent planned cabinet location or adjacent R/W fence.

Adequate drainage for scale pits? Yes

Adequate roadway and overall site drainage? Yes, but appears that water will pond in or move thru low area between roadway embankment and R/W fence.

Potential for ponding or flooding at cabinet or pullboxes? Minimal if not installed in low area at toe of embankment.

Potential for traffic control problems during installation? Minimal; fair sight distance and can use inside lane's 8' wide shoulder to accommodate traffic shift for outside lane's closure for wide work area. High traffic volumes will certainly require all work in roadway be performed at night. Will probably be necessary to require reduced speed limits during lane closures with enforcement presence.

Ability to provide safe clearance in work zone from live traffic via:

- ☑ OK from State Agency to use opposite shoulder for traffic shift
- ☐ Multiple Adjacent Lanes

Notes/Comments on Equipment Installation Capability:
Lane closures will have to be well coordinated with the State. Edge drain laterals observed in vicinity- need to check with State as to exact location and depth of edge drains to accommodate construction of scale pit and its conduit and drain.

C.1.7 POTENTIAL WIM SENSOR/EQUIPMENT INTERFERENCE SOURCES

Overhead power lines? Service type lines cross over roadway +/-300’ downstream from cabinet location- not a problem.

Adjacent railroad? Railroad parallels NB R/W at +/- 120 from proposed cabinet location- not a problem.

C.1.8 CONDITIONS FOR USE OF TEST TRUCKS FOR CALIBRATION AND EVALUATIONS

Direction NB - Nearest usable truck turnaround location: South Ave (Exit 206)
Distance from WIM Site: 0.7 Mi

Direction SB - Nearest usable truck turnaround location: Winton Pkwy (Exit 203)
Distance from WIM Site: 1.9 Mi

Circuit travel distance: +/-6 Miles Estimated lap time: <10 Minutes

Potential circuit route restrictions? None foreseen- these are well signed full interchanges which should be easily maneuvered. For the low speed runs, it may be feasible to use the SB Collier Rd off ramp. However, the return NB on ramp enters the main line only +/-900’ in advance of the scales and heavy mainline traffic would restrict ability of truck driver to maintain proper speed during merging.

C.1.9 LOCATION OF TRUCKING FIRM AND CERTIFIED STATIC SCALES:

Trucks: Contact Richard Reynolds Phone 209-321-1685

Reynolds advises he can provide two trucks with all air tandems and load at +/-80k and +/-60k with almond hulls, feed, or similar bulk loads (trailer tarped on top).


10/03/2006


10/03/2006


10/03/2006


10/03/2006

Certified Scales:

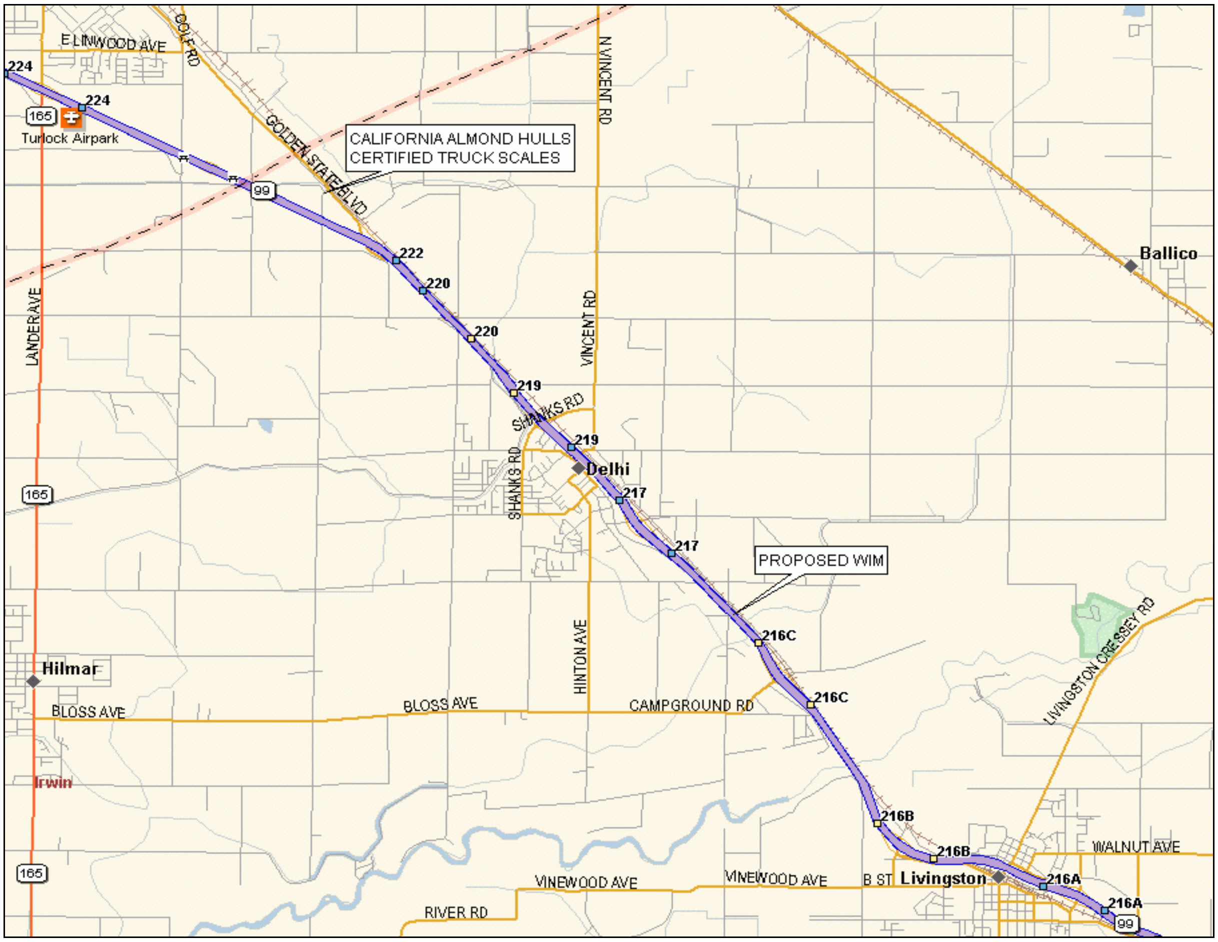
California
Almond
Hulls
A Marketing Co-op

Bertha Areias
Operations Manager

Office (209) 667-1440
Fax (209) 667-1472
Cell (209) 988-2020
Email cahbertha@aol.com

11860 Griffith Avenue, Turlock, CA 95380-9624

10/03/2006



These scales are very convenient to the WIM site (4.5 miles)

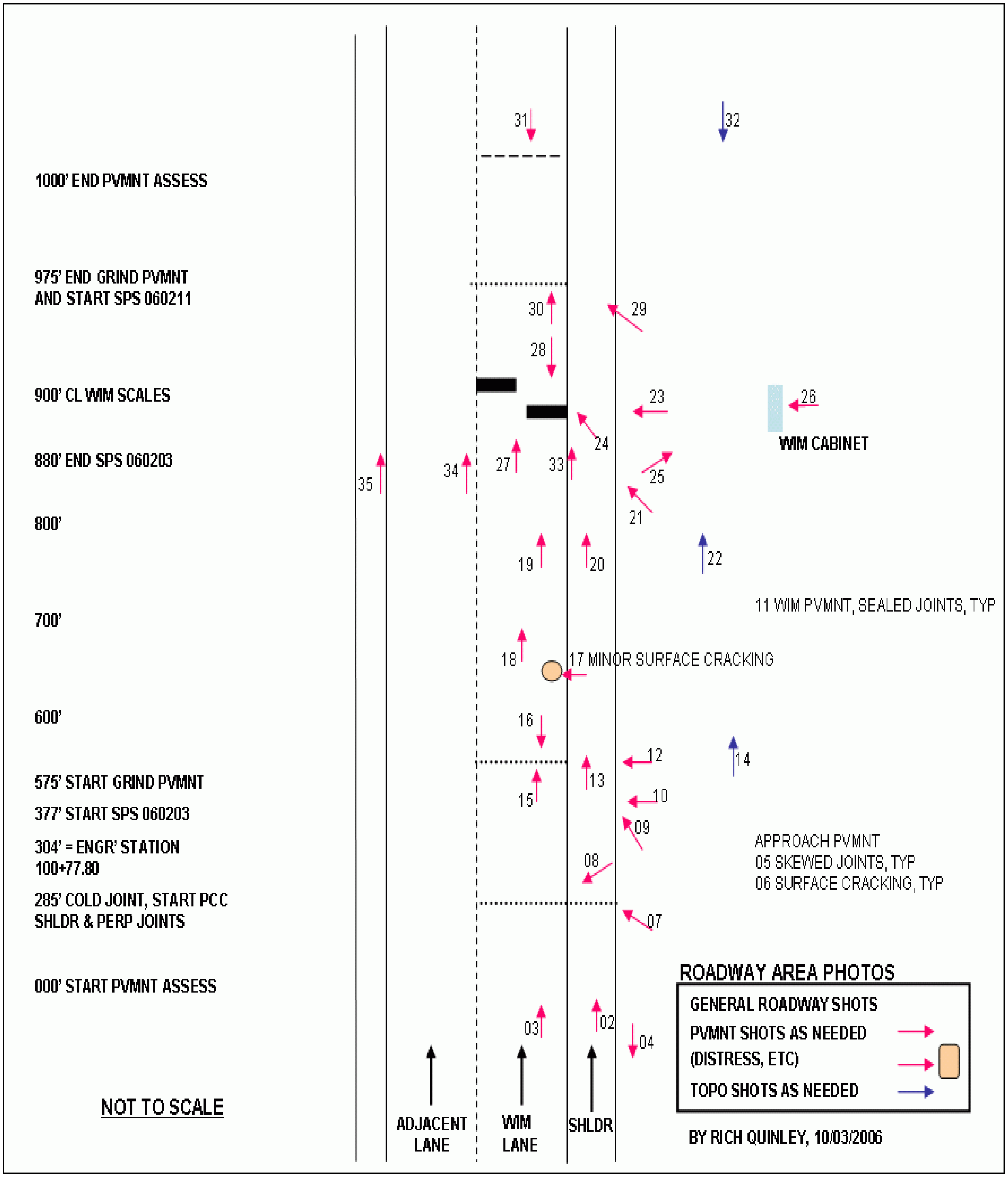
Cost quoted at $5 per load ticket, but costs for multiple weighings probably negotiable.

C.1.10 GPS RECORDINGS

ROADWAY LOCATION (WB)		GPS RECORDINGS	
WIM Scales			
New scale location		N37° 24.956’	W120° 45.496’
Abandoned WIM location		N37° 25.334’	W120° 45.940’
Roadway Mile Posts			
PM MER R32.00 NB		N37° 24.589’	W120° 45.159’
PM MER R33.00 NB		N37° 25.264’	W120° 45.845’
SPS Pavement Test Sections *			
SPS-2 060203	Start	N37° 24.890’	W120° 45.426’
SPS-2 060204	End	N37° 25.399’	W120° 46.038’
Test Truck Turnaround Locations			
NB, South Ave		N37° 25.373’	W120° 45.993’
SB, Collier Rd		N37° 24.747’	W120° 45.325’
SB, Winton Pkwy		N37° 23.566’	W120° 44.368’
Other Locations			
Exist tel service pt (Sycamore St & 2nd Ave. S)		N37° 25.181’	W120° 45.548’

BY Rich Quinley 10/03/2006

C.2 Location Log of Photos



C.3 EQUIPMENT AND MATERIALS

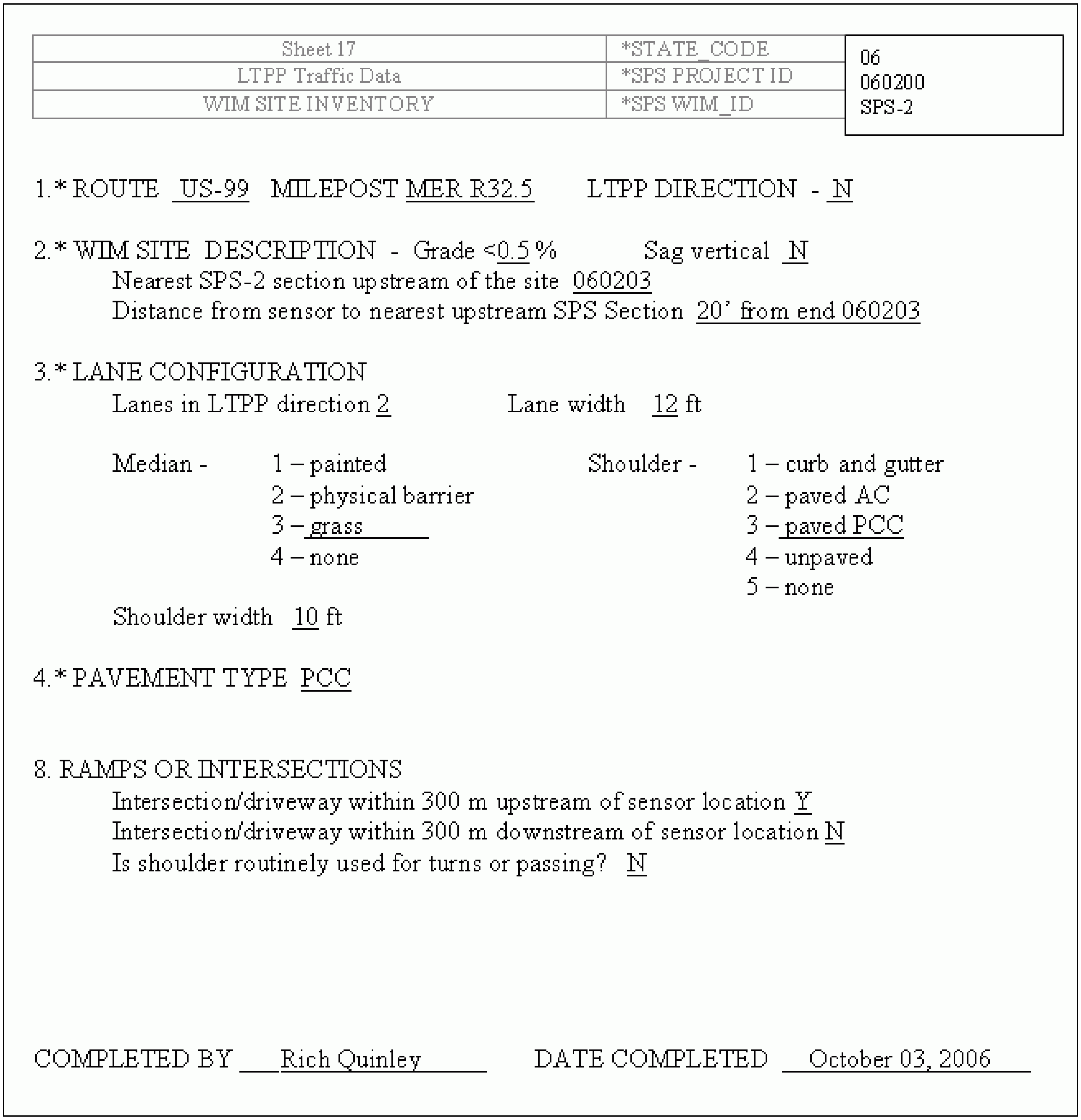
☑ Site Evaluation Forms
☑ Graph paper and note paper
☑ Clipboard
☑ Pens & pencils
☑ Small stapler
☑ Digital camera, with PC cable
☑ GPS receiver
☑ Notebook PC
☑ Calculator
☑ Cell phone
☑ Site Pre-visit Handout Guide
☑ Metal tape measure (25 ft.)
☑ Measuring wheel (ft.) and/or 100 ft. rag tape
☑ Folding rule (6 foot)
☑ Hand level
☑ Small torpedo level
☑ Keel markers
☑ Spray can white paint
☑ String Line ____________________________
☑ Line Level ________________________
☑ Hammer and Concrete Nails ______________
☐ ____

Request furnish on-site by Highway Agency:
☐ Spray can white paint
☐ Lath, 4 ft.
☐ Hammer
☐ Misc. small tools
☐ Keys for known Agency service cabinets
Note: Key for existing cabinet is a standard Type II

Proper attire for field work and expected weather:
☑ Durable shoes
☐ Cold weather layering
☑ Rain gear
☐ ____

Safety equipment per State Highway Agency requirements:
☑ Hard hat
☑ Safety vest – type Hi-Vis Safety Yellow
☑ Steel toe shoes
☐ Other required equipment _____________________

D.0 SHEET 17



Sheet 17	*STATE_CODE	06
LTPP Traffic Data	*SPS PROJECT ID	060200
WIM SITE INVENTORY	*SPS WIM_ID	SPS-2

1.* ROUTE US-99 MILEPOST MER R32.5 LTPP DIRECTION - N

2.* WIM SITE DESCRIPTION - Grade <0.5 % Sag vertical N
Nearest SPS-2 section upstream of the site 060203
Distance from sensor to nearest upstream SPS Section 20' from end 060203

3.* LANE CONFIGURATION
Lanes in LTPP direction 2 Lane width 12 ft

Median -
1 – painted
2 – physical barrier
[✓ 3 – grass]
4 – none

Shoulder -
1 – curb and gutter
2 – paved AC
[✓ 3 – paved PCC]
4 – unpaved
5 – none

Shoulder width 10 ft

4.* PAVEMENT TYPE PCC

8. RAMPS OR INTERSECTIONS
Intersection/driveway within 300 m upstream of sensor location Y
Intersection/driveway within 300 m downstream of sensor location N
Is shoulder routinely used for turns or passing? N

COMPLETED BY Rich Quinley DATE COMPLETED October 03, 2006

E.0 PHOTOGRAPHS

E.1.1 SPS-2 TEST SECTION MARKERS

E.1.2 FACING DOWNSTREAM 900 FEET IN ADVANCE OF WIM SCALE LOCATION

E.1.3 COLD JOINT AT 615 FEET IN ADVANCE OF WIM SCALE LOCATION

E.1.4 START SPS 060203 AT 523 FEET IN ADVANCE WIM SCALE LOCATION

E.1.5 FACING DOWNSTREAM AT START OF 400 FOOT WIM PAVEMENT SECTION

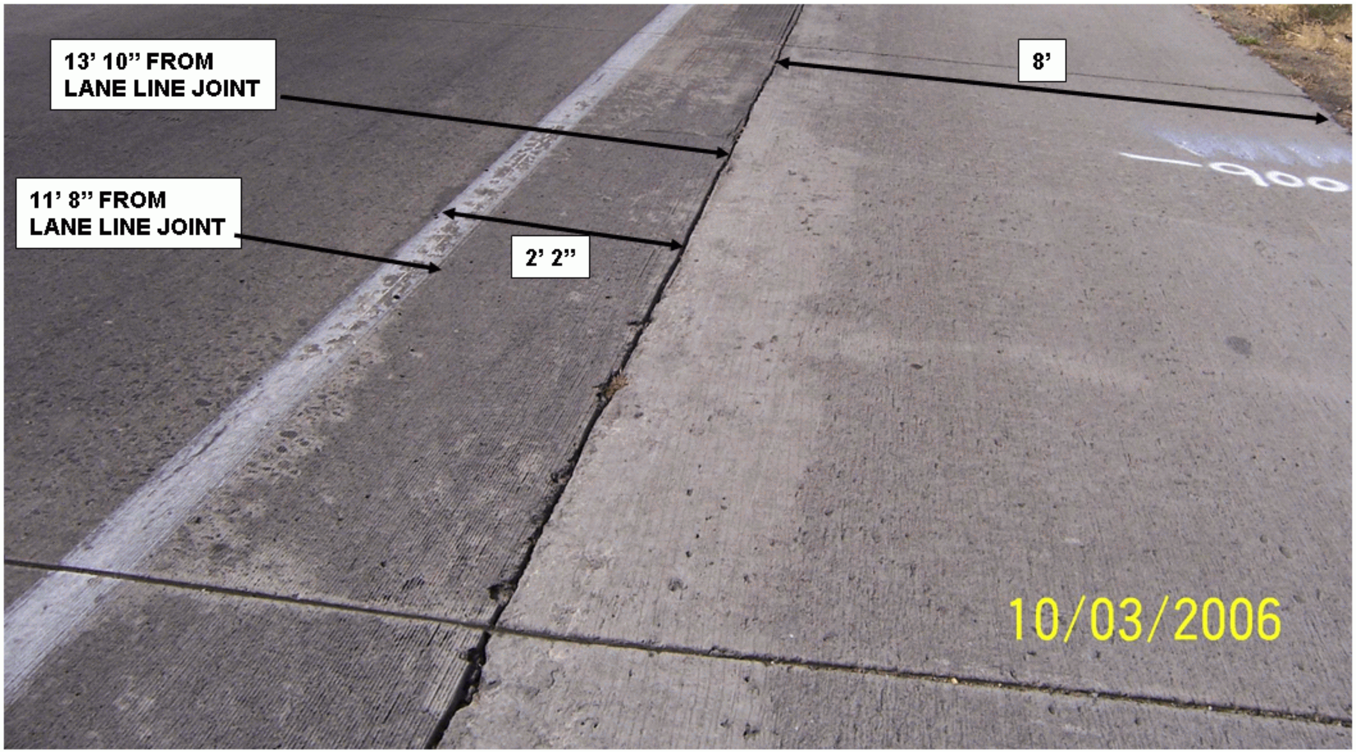
E.1.6 FACING UPSTREAM AT START OF 400 FOOT WIM PAVEMENT SECTION

E.1.7 WIM PAVEMENT, SEALED JOINTS (TYPICAL)

E.1.8 WIM PAVEMENT, FACING DOWNSTREAM 100 FEET IN ADVANCE OF SCALES

E.1.9 RECOMMENDED SCALES LOCATION

E.1.10 SHOULDER STRIPING DETAIL AT WIM SCALE LOCATION



E.1.11 FACING DOWNSTREAM FROM RECOMMENDED SCALES LOCATION

E.1.12 FACING UPSTREAM FROM RECOMMENDED SCALES LOCATION

E.1.13 END WIM PAVEMENT SECTION, FACING DOWNSTREAM


10/03/2006

E.1.14 END 1000 FOOT EVALUATION SECTION FACING UPSTREAM


10/03/2006

E.1.15 Existing WIM system

APPENDIX C – WIM SYSTEM INSTALLATION SAMPLE DOCUMENTS AND FORMS

APPENDIX C – TABLE OF CONTENTS

1. FHWA LTPP Sample Installation and Calibration Report for California SPS-2
2. LTPP Weigh-in-Motion (WIM) System: Model Performance Specifications and Application Requirements for Equipment
3. LTPP WIM System Installation and Calibration Audit forms
4. VDOT Continuous Count Station Installation QA Checklist
5. VDOT Continuous Count Station Installation Non-Compliance Report (NCR)

INTERNATIONAL ROAD DYNAMICS INC.

LTPP WIM DATA COLLECTION SYSTEMS

INSTALLATION AND CALIBRATION FOR CALIFORNIA SPS-2 LTPP ID 060200

FEBRUARY 4, 2008
CLIN 2004A TASK ORDER # 15

CONTRACT NO. DTFH61-05-D-00001

U.S. Department of Transportation
Federal Highway Administration

LONG TERM Pavement PERFORMANCE

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- 6.1.4 Weight Graphs
- 6.1.5 Temperature Influence Graphs

1.0 EXECUTIVE SUMMARY

This report details the installation and calibration of the California LTPP SPS-2 Weigh-in-Motion (WIM) site located on SR-99 at mile post 32.5. The WIM site is instrumented with IRD's Intelligent Sensor Interface Network Controller (iSINC) WIM Electronics and the IRD/PAT 1.75 Meter Bending Plate sensor.

The LTPP lane is in the north bound driving lane and is equipped with two inductive loops and two bending plates. The sensor configuration is loop - bending plate - bending plate -loop. The bending plates are spaced 10 feet apart and are placed in the left and right wheel path. The inductive loops are placed before and after the leading and trailing bending plates. The WIM Controller cabinet is located on the shoulder of the north bound drive lane.

For remote communication the WIM system uses a Raven CDMA modem manufactured by Sierra Wireless. The modem was provided by CALTRANS. Initially CALTRANS provided a CDMA modem manufactured by Data Remote Inc. Attempts to configure this modem to operate with IRD's WIM electronics were unsuccessful.

Power is provided by two 80 watt Solar Panels charging one 12 volt 100amp hour battery. The Solar Power System was furnished and installed by CALTRANS.

The WIM equipment installation began on November 27, 2007 and was completed on November 30, 2007. Power and phone service was established at the WIM site in mid January. The site was calibrated on January 30, 2008 using two loaded 5 axle semis.

The calibration results demonstrate the WIM system meets the LTPP performance requirements for weight and axle spacing as detailed in the *Data Collection Guide for SPS WIM Sites*.

2.0 POINT OF CONTACTS

Debbie Walker (COTR)
FHWA LTPP
ph: (202) 493-3068
email: deborah.walker@fhwa.dot.gov

Kevin Senn (RSC)
Nichols Consulting Engineers
ph: (775) 827-4400

Jason Dietz (Division Representative)
FHWA
ph: (916) 498-5886

State of California (CALTRANS)
Linda Savinelli (916) 761-4335
Stan Norikane (916) 761-5651
Joe Avis Ph: (916) 654-5975

Bruce Myers
International Road Dynamics (Phase 2 Contractor)
ph: (717) 264-2077
email: bruce.myers@irdinc.com

3.0 SHEET 16 – SITE CALIBRATION SUMMARY

SITE CALIBRATION INFORMATION

1. DATE OF CALIBRATION (MONTH/DAY/YEAR): **January 30, 2008**

2. TYPE OF EQUIPMENT CALIBRATED:
   - ☒ WIM
   - ☐ CLASSIFIER
   - ☐ BOTH

3. REASON FOR CALIBRATION
   - ☐ REGULARLY SCHEDULED SITE VISIT
   - ☐ RESEARCH
   - ☐ EQUIPMENT REPLACEMENT
   - ☐ TRAINING
   - ☐ DATA TRIGGERED SYSTEM REVISION
   - ☒ NEW EQUIPMENT INSTALLATION
   - ☐ OTHER (SPECIFY) ____________________

4. SENSORS INSTALLED IN LTPP LANE AT THIS SITE (CHECK ALL THAT APPLY):
   - ☐ BARE ROUND PIEZO CERAMIC
   - ☐ BARE FLAT PIEZO
   - ☒ BENDING PLATES
   - ☐ CHANNELIZED ROUND PIEZO
   - ☐ LOAD CELLS
   - ☐ QUARTZ PIEZO
   - ☐ CHANNELIZED FLAT PIEZO
   - ☒ INDUCTANCE LOOPS
   - ☐ CAPACITANCE PADS
   - ☐ OTHER (SPECIFY) ____________________

5. EQUIPMENT MANUFACTURER: **International Road Dynamics Inc.**

WIM SYSTEM CALIBRATION SPECIFICS

6. CALIBRATION TECHNIQUE USED:
   - ☐ TRAFFIC STREAM:
     - NUMBER OF TRUCKS ____________
     - ☐ STATIC SCALE
   - ☒ TEST TRUCKS:
     - NUMBER OF TEST TRUCKS **2**
     - PASSES PER TRUCK **30**

TRUCK#	TYPE	SUSPENSION
1	**9**	**1 & 2**
2	**9**	**1 & 2**
3	**X**	**X**
4	**X**	**X**
5	**X**	**X**

TYPE PER FHWA 13 BIN SYSTEM

SUSPENSION TYPES:
1 – AIR
2 – LEAF SPRING
3 – OTHER

7. SUMMARY CALIBRATION RESULTS (EXPRESSED AS A PERCENT)

GVW MEAN DIFFERENCE	**.2 %**	STANDARD DEVIATION **.9%**
SINGLE AXLE MEAN DIFFERENCE	**- .6%**	STANDARD DEVIATION **1.7%**
DOUBLE AXLES MEAN DIFFERENCE	**.3%**	STANDARD DEVIATION **1.6%**

8. NUMBER OF SPEEDS AT WHICH CALIBRATION WAS PERFORMED: **3**

9. DEFINE THE SPEED RANGES USED (MPH): **45 - 53, 54 – 58, 59 – 62, 63 - 66**

10. CALIBRATION FACTOR (AT EXPECTED FREE FLOW SPEED) **See following sheets**

11. IS AUTO-CALIBRATION USED AT THIS SITE? ☐
    IF USED, LIST AND DEFINE AUTO-CALIBRATION VALUE ______________________________

CLASSIFIER TEST SPECIFICS

12. METHOD FOR COLLECTING INDEPENDENT VOLUME MEASUREMENT BY VEHICLE CLASS:
    ☐ VIDEO
    ☒ MANUAL
    ☐ PARALLEL CLASSIFIERS

13. METHOD TO DETERMINE LENGTH OF COUNT:
    TIME
    NUMBER OF VEHICLES
    NUMBER OF TRUCKS

14. MEAN DIFFERENCE IN VOLUMES BY VEHICLES CLASSIFICATION:

FHWA CLASS 2	100**%**
FHWA CLASS 3	100**%**
FHWA CLASS 4&5	100**%**
FHWA CLASS 8	100**%**
FHWA CLASS 9	100**%**
FHWA CLASS 12	**%**
“UNCLASSIFIED” VEHICLES:	**%**

15. PICTURES: ______________________________

16. NOTES:
    ____

PERSON LEADING CALIBRATION EFFORT: **Richard Maynard**
CONTACT INFORMATION: **(916) 712-6444**

3.1.1 iSINC Site Calibration Factors & Site Parameters as of 01-30-2008

Calibration Parameters

Select Lane		**1**					
Select Axle Sensor		**1**					
Threshold		**40**					
WIM Calib Factors >		Select Speed Bin	**1**	**2**	**3**	4	5
		Max Speed (kph)	**80**	**88**	**96**	**105**	**112**
		Calib Factor	**3395**	**3395**	**3420**	**3360**	**3360**
Select Lane		**1**					
Select Axle Sensor		**2**					
Threshold		**40**					
WIM Calib Factors >		Select Speed Bin	**1**	**2**	**3**	4	5
		Max Speed (kph)	**80**	**88**	**96**	**105**	**112**
		Calib Factor	**3395**	**3395**	**3420**	**3360**	**3360**

Site Parameters

Lane Name			1
Lane State			ENABLED
Upstream Loop >		Loop State	ENABLED
		Module UID	9
		Channel Num	0
		Polarity Active	LOW
		Width (cm)	300
Downstream Loop >		Loop State	ENABLED
		Module UID	9
		Channel Num	1
		Polarity Active	LOW
		Width (cm)	300
		Distance(cm)	667
Axle Sensors >		Select Axle	1
		Axle State	ENABLED
		Module UID	5
		Channel Num	0
		Polarity Active	HIGH
		Type	PAT BP
		Distance(cm)	270
		Temp State	ENABLED
		Temp Module UID	5
		Temp Channel Num	0
Axle Sensors >		Select Axle	2
		Axle State	ENABLED
		Module UID	5
		Channel Num	1
		Polarity Active	HIGH
		Type	PAT BP
		Distance(cm)	570
		Temp State	ENABLED
		Temp Module UID	5
		Temp Channel Num	0
Processing >	MaxTimeout(ms)		3000
	Dynamic Comp(%)		100
	Sig Wt Diff(%)		40
	Min Axle Wt(kg)		1360
	Veh Rec Mode		Split
	Axle Sensor Width(cm)		50
	Axl Sep(cm)		272
Axle Snsor Debounce >	Type	PAT BP	
	On (ticks)	25	
	Off (ticks)	10	
DIOM Debounce	Loop On (ticks)	40	
	Loop Off (ticks)	40	
	Ovrhgt on (ticks)	40	
	Ovrhgt off (ticks)	0	
	Axle On (ticks)	40	
	Axle Off (ticks)	40	

4.0 WIM SITE INVENTORY

1. ROUTE SR-99 MILEPOST:32.5 LTPP DIRECTION: **N** S E W

2. SITE DESCRIPTION
   GRADE: <1%
   ☐ Sag vertical
   Nearest SPS section upstream of the site: 060203
   Distance from sensor to nearest upstream SPS Section:

3. LANE CONFIGURATION
   Number of lanes in LTPP direction: 2 lanes
   Lane width: 12 ft.
   ☐ Median painted
   ☐ Median physical barrier
   ☒ Median grass
   ☐ Median none
   ☐ Shoulder curb and gutter
   ☒ Shoulder paved AC
   ☐ Shoulder paved PCC
   ☐ Shoulder unpaved
   Shoulder width: 10 ft.

4. PAVEMENT TYPE: PCC

5. CONDITION: (Surface distresses by type / severity within WIM section)
   Good

6. SENSOR SEQUENCE: Loop – Bending Plate – Bending Plate - Loop

7. PAVEMENT REPLACEMENT AND/OR GRINDING:
   Straightedge check: Performed ___________Result: ☒ Pass / ☐ Marginal / ☐ Unsatisfactory
   Short wave check: Performed ____________Result: ☒ Pass / ☐ Marginal / ☐ Unsatisfactory
   Long wave check: Performed ____________Result: ☒ Pass / ☐ Marginal / ☐ Unsatisfactory

8. ANY EFFECTS FROM RAMPS OR LANE TRANSITIONS:
   ☐ Intersection/driveway within 300m upstream, distance: ________________________________
   ☐ Intersection/driveway within 300m downstream, distance: ______________________________
   ☐ LTPP lane used for passing by vehicles traveling in south bound lane

9. DRAINAGE:
   ☐ Open to ground
   ☒ Pipe to culvert or ditch
   ☐ None
   ☐ French drain

10. CABINET LOCATION:
    ☒ Same side of road as LTPP lane
    ☐ Median
    ☒ Behind guard rail
    Distance from edge of travel lane to cabinet: 25 ft
    Distance from sensors: 35 ft
    Type: 336
    Access controlled by: ☐ LTPP / ☒ State / ☐ Joint
    Primary contact: Stan Norikane (916) 654-5651
    Alternate contact: Linda Savinelli

11. POWER:
    Power type: ☐ Overhead / ☐ Underground / ☒ Solar
    Distance from cabinet to drop: 10 ft
    Service provider: N/A.

12. TELEPHONE:
    Telephone type: ☐ Overhead / ☐ Underground / ☒ Cell (CDMA)
    Distance from cabinet to drop: N/A
    Phone # : californiasps2wim.earlink.com

13. SYSTEM:
    Software: iSINC
    Version:
    Connection: ☒ RS232 / ☐ Parallel port / ☐ USB / ☐ Other

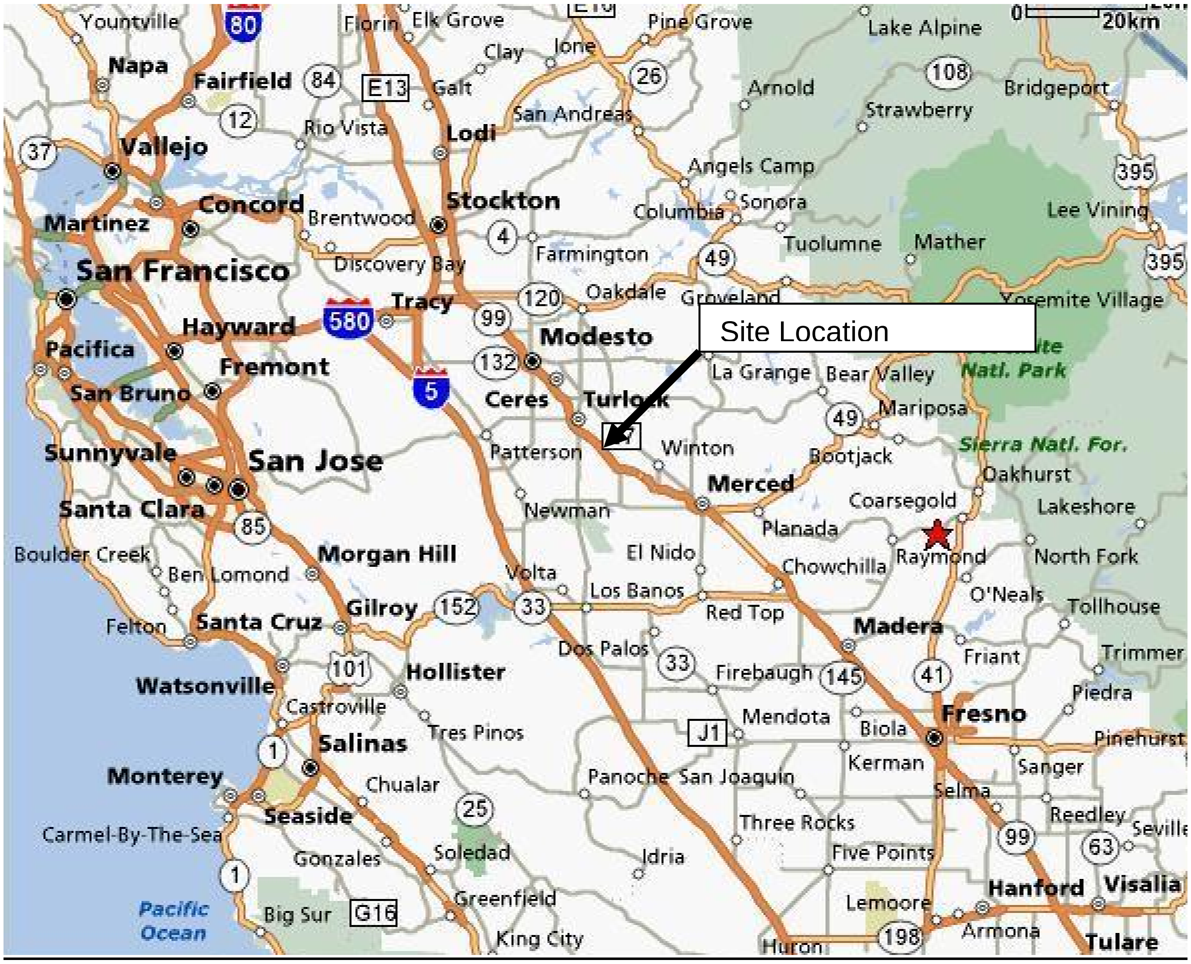
14. TEST TRUCK CYCLE:
    Turnaround time: 8 minutes
    Turnaround distance: 5 miles

15. PICTURES: See following pages, Site Map, WIM Site, Site layout drawings

16. NOTES:

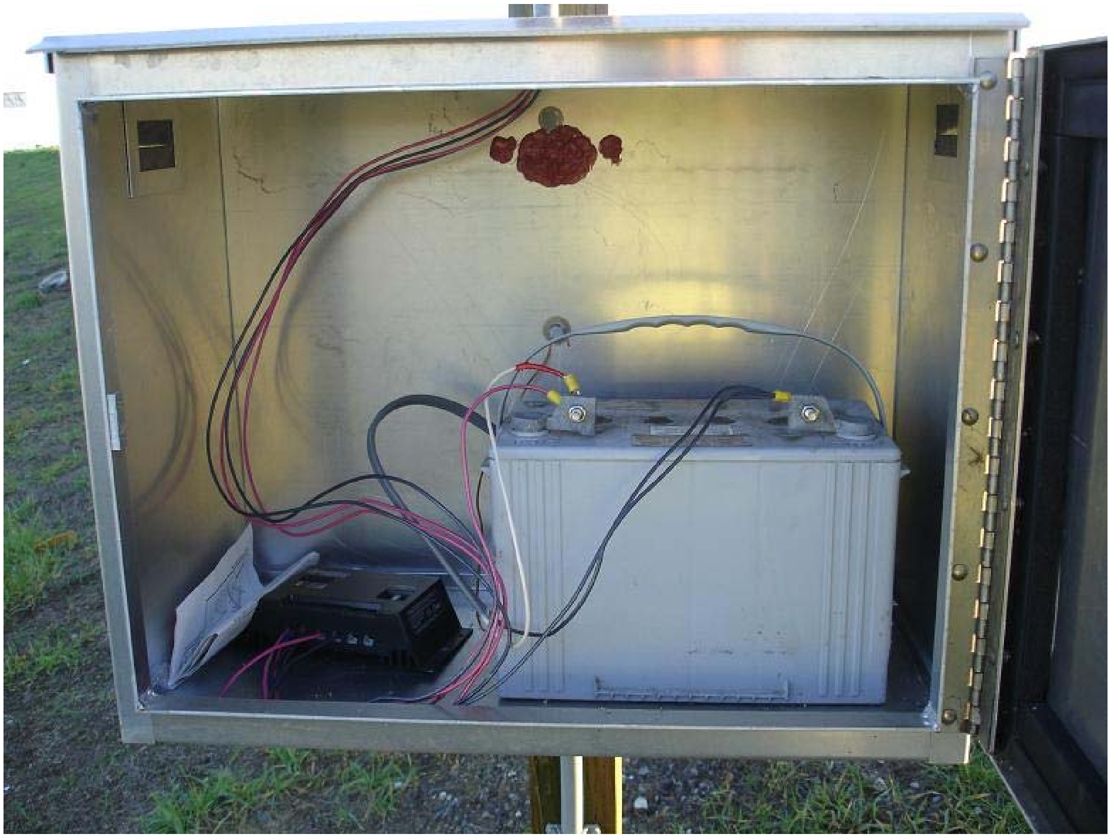
COMPLETED BY: **Bruce Myers**
CONTACT INFORMATION: (**717) 264-2077**

4.1.1 SITE MAP

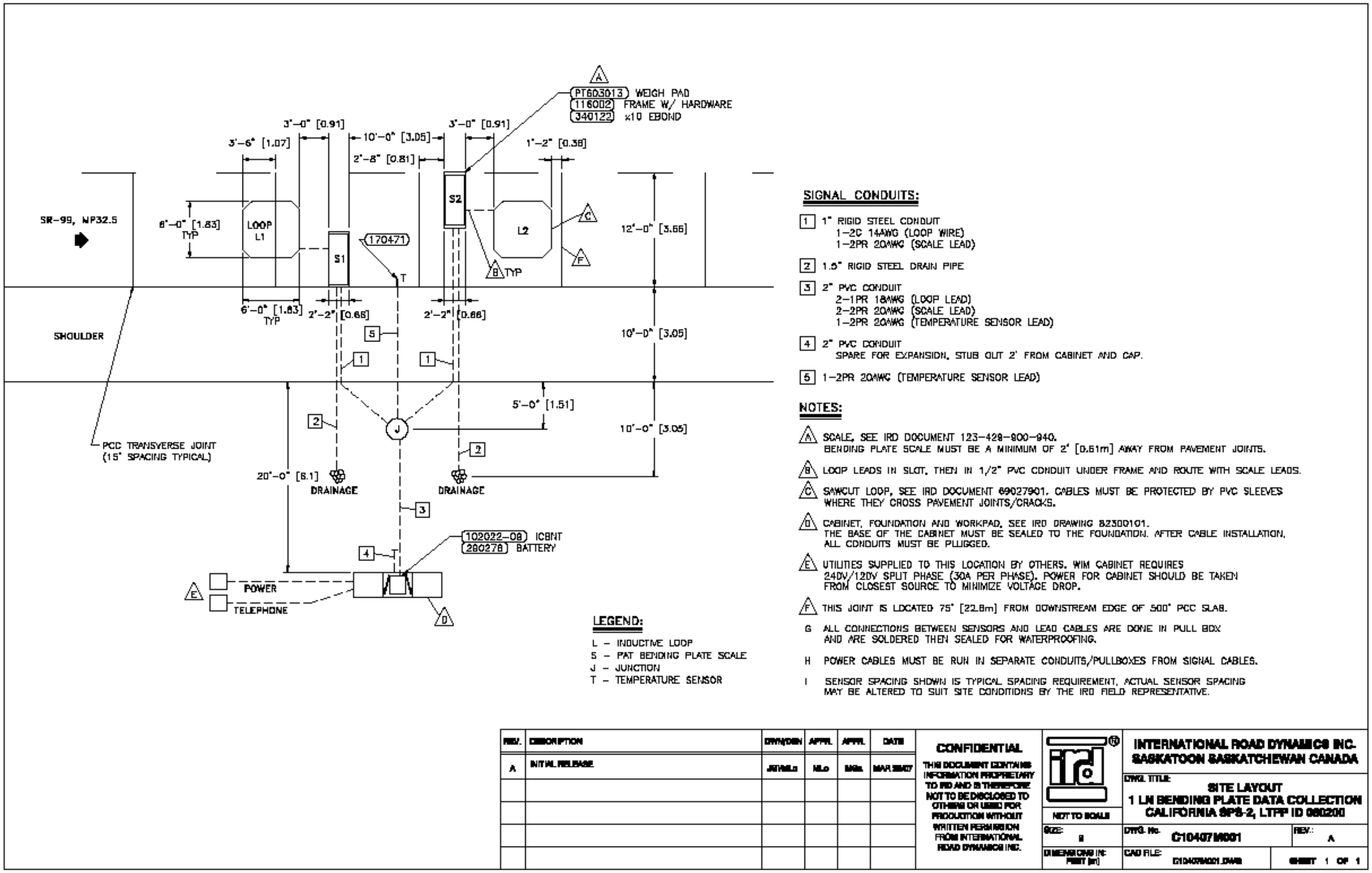


SR-99 Mile Post 32.5

4.1.2 PICTURES, WIM SITE



4.1.3 SITE DRAWING & LAYOUT



SIGNAL CONDUITS:

1 1" RIGID STEEL CONDUIT
1-2C 14AWG (LOOP WIRE)
1-2PR 20AWG (SCALE LEAD)

2 1.5" RIGID STEEL DRAIN PIPE

3 2" PVC CONDUIT
2-1PR 18AWG (LOOP LEAD)
2-2PR 20AWG (SCALE LEAD)
1-2PR 20AWG (TEMPERATURE SENSOR LEAD)

4 2" PVC CONDUIT
SPARE FOR EXPANSION, STUB OUT 2' FROM CABINET AND CAP.

5 1-2PR 20AWG (TEMPERATURE SENSOR LEAD)

NOTES:

A SCALE, SEE IRD DOCUMENT 123-429-900-940.
BENDING PLATE SCALE MUST BE A MINIMUM OF 2' [0.61m] AWAY FROM PAVEMENT JOINTS.

B LOOP LEADS IN SLOT, THEN IN 1/2" PVC CONDUIT UNDER FRAME AND ROUTE WITH SCALE LEADS.

C SAWCUT LOOP, SEE IRD DOCUMENT 69027901. CABLES MUST BE PROTECTED BY PVC SLEEVES WHERE THEY CROSS PAVEMENT JOINTS/CRACKS.

D CABINET, FOUNDATION AND WORKPAD, SEE IRD DRAWING 82300101.
THE BASE OF THE CABINET MUST BE SEALED TO THE FOUNDATION. AFTER CABLE INSTALLATION, ALL CONDUITS MUST BE PLUGGED.

E UTILITIES SUPPLIED TO THIS LOCATION BY OTHERS. WIM CABINET REQUIRES 240V/120V SPLIT PHASE (30A PER PHASE). POWER FOR CABINET SHOULD BE TAKEN FROM CLOSEST SOURCE TO MINIMIZE VOLTAGE DROP.

F THIS JOINT IS LOCATED 75' [22.8m] FROM DOWNSTREAM EDGE OF 500' PCC SLAB.

G ALL CONNECTIONS BETWEEN SENSORS AND LEAD CABLES ARE DONE IN PULL BOX AND ARE SOLDERED THEN SEALED FOR WATERPROOFING.

H POWER CABLES MUST BE RUN IN SEPARATE CONDUITS/PULLBOXES FROM SIGNAL CABLES.

I SENSOR SPACING SHOWN IS TYPICAL SPACING REQUIREMENT, ACTUAL SENSOR SPACING MAY BE ALTERED TO SUIT SITE CONDITIONS BY THE IRD FIELD REPRESENTATIVE.

LEGEND:

L – INDUCTIVE LOOP
S – PAT BENDING PLATE SCALE
J – JUNCTION
T – TEMPERATURE SENSOR

REV.	DESCRIPTION	DWN/DSN	APPR.	APPR.	DATE
A	INITIAL RELEASE	JRVNLo	NLo	MGa	MAR 2007

CONFIDENTIAL

THIS DOCUMENT CONTAINS INFORMATION PROPRIETARY TO IRD AND IS THEREFORE NOT TO BE DISCLOSED TO OTHERS OR USED FOR PRODUCTION WITHOUT WRITTEN PERMISSION FROM INTERNATIONAL ROAD DYNAMICS INC.

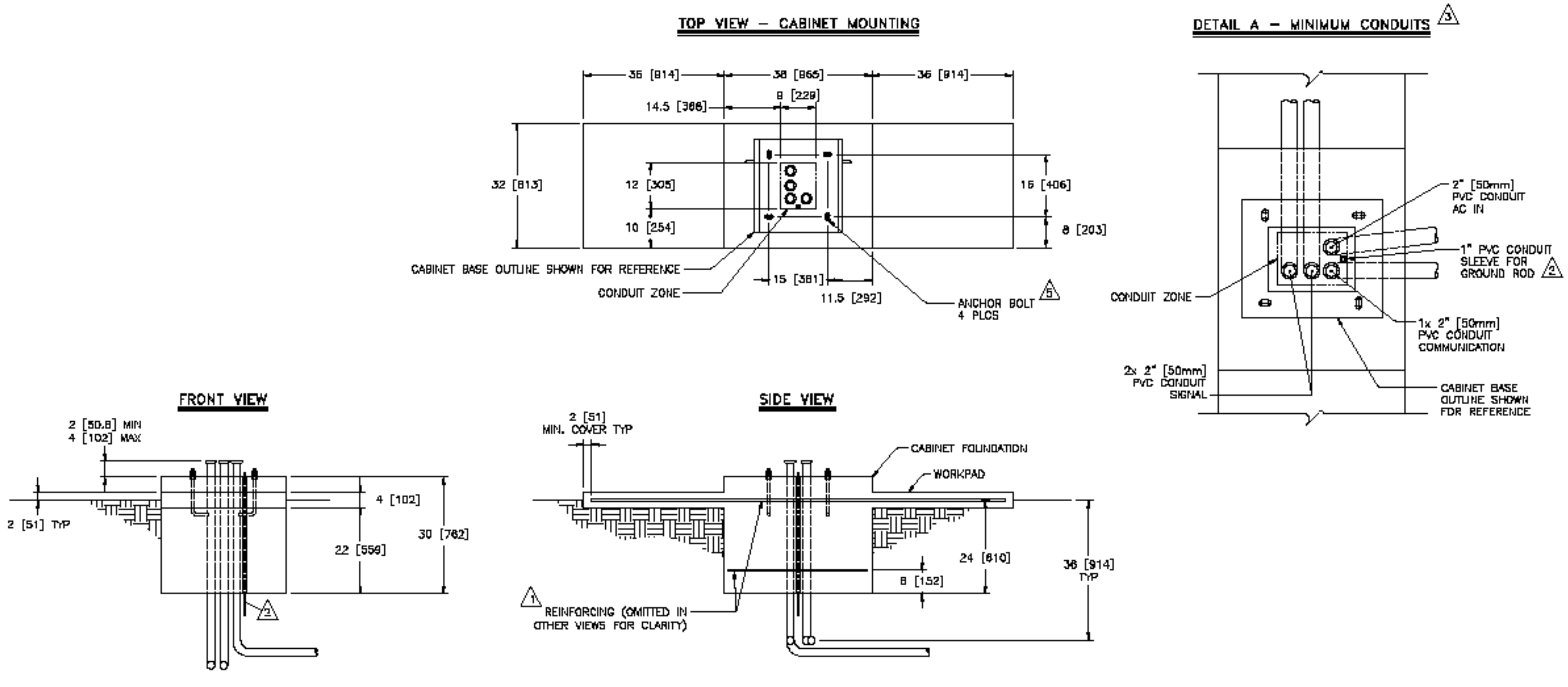
NOT TO SCALE
SIZE: B
DIMENSIONS IN: FEET [m]

INTERNATIONAL ROAD DYNAMICS INC.
SASKATOON SASKATCHEWAN CANADA

DWG. TITLE:
SITE LAYOUT
1 LN BENDING PLATE DATA COLLECTION
CALIFORNIA SPS-2, LTPP ID 060200

DWG. No. C10407M001
REV.: A
CAD FILE: C10407M001.DWG
SHEET 1 OF 1

4.1.4 WIM CABINET CONCRETE PEDESTAL



NOTES:

1. INSTALL REINFORCING MATS. #4 [12M] BAR 12" [300mm] ON CENTER EACH WAY. EPOXY COAT OR GALVANIZE. REINFORCEMENTS ARE MINIMUM REQUIREMENTS AND MAY BE SUPERSEDED BY LOCAL CONSTRUCTION CODES.
2. GROUND ROD MUST BE PROVIDED TO MEET LOCAL ELECTRICAL CODE.
3. ALL CONDUITS SHOWN SHALL BE FURNISHED AND INSTALLED IN FOUNDATION IN ACCORDANCE WITH LOCAL CODES. CAP IF NOT USED. ADDITIONAL CONDUITS MAY BE REQUIRED.
4. CONCRETE SHALL HAVE MINIMUM COMPRESSIVE STRENGTH OF 3000 PSI [20.7 MPa].
5. CABINET ANCHORS MUST BE GALVANIZED OR STAINLESS STEEL AND MAY BE CAST IN PLACE, CHEMICAL OR EXPANSION TYPE DRILLED INTO BASE. TYPICAL SIZE IS 3/4" NC x 12" x 4". ANCHORS SHALL PROJECT A MINIMUM OF 2" [50mm] AND A MAXIMUM OF 2-1/2" [63mm] ABOVE FOUNDATION.

REV.	DESCRIPTION	DWN/CHK	APPR.	APPR.	DATE
A	INITIAL RELEASE	JB/DR			

CONFIDENTIAL

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NOT TO SCALE
SIZE: B
DIMENSIONS IN: INCHES [mm]

INTERNATIONAL ROAD DYNAMICS INC.
SASKATOON SASKATCHEWAN CANADA

DWG. TITLE: STANDARD DRAWING
CABINET BASE
iSINC 3365 ELECTRONICS

DWG. No. 62300101
REV.: A
CAD FILE: 62300101.DWG
SHEET 1 OF 1

4.1.5 ELECTRICAL READINGS

International Road Dynamics Inc.

Site Service Sheet

Clear

System Type: iSINC/PAT BP

Date: 1/30/2008 **State:** California **Location:** SR-99 NB MP 32.5
Job #: SO#10407M **Site #:** **LTPP ID:** 60200

	Lane - 1		Lane -		Lane -		Lane -	
Loops	**Lead**	**Trail**						
Resistance	1.0	1.0						
Leakage	inf.	inf.						
Inductance	155mH	150mH						
Frequency	N/A	N/A						

	Lane - 1		Lane -		Lane -		Lane -	
Weighpads	**Lead**	**Trail**						
Supply	971	972						
Signal	844	845						
Shield	inf.	inf.						
Zero Pt	0.0mV	0.1mV						
Serial #								

Piezos								
Amplitude								
Capacitance								
Resistance								

System	
A/C Service	N/A
Power Supply	N/A
Solar Panel	14.0vdc
Back-Up	14.0vdc
System Input	11.33vdc
Modem Power	13.87vdc
Phone off hook	N/A
Phone on hook	N/A

Technician: **Richard Maynard** **Date:** **1/30/2008**

5.0 WIM CALIBRATION

5.1.1 TEST TRUCK #1 INFORMATION

DATE OF CALIBRATION: **January 30, 2008**

1. TEST TRUCK NUMBER: 1   2. FHWA CLASS: 9   3. Number of axles: 5

Axle	Empty Truck Axle Weights (lb)	4. Pre-Test Loaded Axle Weights (lb)	5. Post-Test Loaded Axle Weights (lb)	6. Measured Directly or Calculated
A		11740		D
B		27080		D (B&C combined)
C				
D		23980		D (D&E combined)
E				

7. CALCULATIONS:

Empty Truck Gross Weight (lb)	Pre-Test Loaded Gross Weight (lb)	Post-Test Loaded Gross Weight (lb)	Pre to Post Difference (lb)
	62800		62800

8. TRACTOR CAB STYLE: ☐ Cab over engine / ☒ Conventional ☒ With sleeper

9. TRACTOR MANUFACTURER:
   Make: Kenworth
   Model:

10. TRAILER LOAD DESCRIPTION: Lumber

11. TRAILER TARE WEIGHT (lb): ____________________

12. AXLE SPACINGS

Axle	Spacing (feet & inches)
A-B	18.4'
B-C	4.3'
C-D	32’
D-E	4.3’

KINGPIN OFFSET FROM AXLE B (ft, + towards rear): +1.5 ft

SUSPENSSION:

Axle	17. Tire Size	18. Suspension description (leaf, air, # of leaves, taper or flat leaf, etc.)
A	11R24.5	Leaf spring – two leaves
B	11R24.5	air
C	11R24.5	air
D	11R24.5	air
E	11R24.5	air

5.1.2 PICTURES, TEST TRUCK 1

California
Cascade
Industries
33
US DOT 399789

5.1.3 TEST TRUCK #2 INFORMATION

DATE OF CALIBRATION: **January 30, 2008**

1. TEST TRUCK NUMBER: 2 2. FHWA CLASS: 9 3. Number of axles: 5

Axle	Empty Truck Axle Weights (lb)	4. Pre-Test Loaded Axle Weights (lb)	5. Post-Test Loaded Axle Weights (lb)	6. Measured Directly or Calculated
A		11980		D
B		30580		D (B&C combined)
C				
D		36020		D (D&E combined)
E				

7. CALCULATIONS:

Empty Truck Gross Weight (lb)	Pre-Test Loaded Gross Weight (lb)	Post-Test Loaded Gross Weight (lb)	Pre to Post Difference (lb)
	78580		78580

8. TRACTOR CAB STYLE: ☐ Cab over engine / ☒ Conventional ☒ With sleeper

9. TRACTOR MANUFACTURER:
Make: Kenworth
Model:

10. TRAILER LOAD DESCRIPTION: Lumber

11. TRAILER TARE WEIGHT (lb): ______

12. AXLE SPACINGS

Axle	Spacing (feet & inches)
A-B	18.4’
B-C	4.3’
C-D	26.8’
D-E	10.1’

KINGPIN OFFSET FROM AXLE B (ft, + towards rear): +1.5 ft

SUSPENSSION:

Axle	17. Tire Size	18. Suspension description (leaf, air, # of leaves, taper or flat leaf, etc.)
A	11R24.5	Leaf spring – two leaves
B	11R24.5	air
C	11R24.5	air
D	11R24.5	air
E	11R24.5	air

5.1.4 PICTURES, TEST TRUCK 2


7
California Cascade Industries
SACTO, CA
ICC MC-295462
US DOT 399789

6.0 TEST TRUCK CALIBRATION RECORDS

6.1.1 VALIDATION RUNS

International Road Dynamics Inc.

FHWA VERIFICATION

Static Test Vehicle Measurements

ID				GVW	F/A	T1	T2	1>2	2>3	3>4	4>5
1				62.8	11.7	27.1	24.0	18.4	4.3	32.0	4.3
2				78.6	12.0	30.6	36.0	18.4	4.3	26.8	10.1

b

Dynamic Test Vehicle Measurements

ID	V#	Speed	Temp	GVW	F/A	T1	T2	1>2	2>3	3>4	4>5
1	61938	65	52	63.5	11.6	27.4	24.5	18.4	4.2	32.1	4.3
2	62029	64	52	77.9	11.9	29.8	36.0	18.4	4.3	26.8	10.1
2	62113	64	52	79.3	12.0	30.6	36.6	18.4	4.3	26.8	10.1
1	62141	63	52	62.6	11.7	26.9	24.0	18.4	4.2	32.0	4.3
2	62234	64	52	78.7	12.2	29.9	36.6	18.4	4.3	26.9	10.0
1	62256	65	52	63.2	11.8	27.3	24.1	18.4	4.2	32.1	4.3
2	62345	64	52	78.9	11.9	31.1	35.8	18.4	4.3	26.8	10.1
1	62383	59	52	63.2	11.7	27.1	24.4	18.4	4.2	31.8	4.2
1	62488	59	54	62.8	12.0	26.9	23.9	18.3	4.2	31.9	4.2
2	62547	59	54	78.1	11.8	30.6	35.6	18.4	4.3	26.8	10.0
1	62596	59	54	63.3	11.9	26.9	24.6	18.4	4.2	32.0	4.3
2	62654	60	54	78.1	11.9	30.3	35.9	18.4	4.3	26.8	10.1
1	62700	54	54	63.4	11.6	27.1	24.7	18.4	4.2	32.0	4.3
2	62761	55	54	78.4	11.7	31.2	35.2	18.4	4.3	26.8	10.0
1	62824	55	54	62.9	11.6	27.2	24.2	18.4	4.2	32.1	4.3
2	62883	55	54	78.0	11.9	30.4	35.6	18.3	4.3	26.8	10.0
1	62937	50	54	63.0	11.5	27.6	23.9	18.5	4.2	32.2	4.3
2	62988	54	54	77.9	11.9	30.0	35.9	18.4	4.3	26.7	10.0
1	63070	54	55	63.0	11.5	27.0	24.5	18.4	4.2	32.0	4.3
2	63104	49	55	79.8	12.1	31.0	36.6	18.3	4.3	26.7	10.0
1	63185	50	55	62.5	11.6	26.9	24.1	18.4	4.2	32.0	4.3
2	63217	50	55	79.5	11.7	30.1	37.7	18.3	4.3	26.9	10.0
1	63290	50	55	63.0	12.0	27.2	23.8	18.4	4.2	32.0	4.3
2	63323	50	55	79.9	11.6	30.5	37.6	18.3	4.3	26.7	10.0
1	63392	62	55	63.4	11.9	27.1	24.5	18.4	4.2	32.1	4.3
2	63437	64	55	78.1	11.9	30.5	35.6	18.3	4.3	26.7	10.0
1	63490	65	55	63.3	11.7	27.2	24.5	18.5	4.2	32.2	4.3
2	63549	64	55	78.5	11.9	30.9	35.6	18.3	4.3	26.7	10.0
1	63600	64	55	63.3	11.6	26.9	24.8	18.4	4.2	32.1	4.3
2	63654	59	55	77.2	11.5	30.2	35.6	18.3	4.3	26.8	10.0
1	63685	59	55	64.0	12.0	27.2	24.9	18.4	4.2	32.0	4.3
2	63751	59	55	79.0	11.9	30.7	36.5	18.3	4.3	26.7	10.0
1	63796	54	55	64.2	11.8	27.7	24.7	18.4	4.2	32.0	4.3
2	63893	55	55	78.2	11.7	30.5	36.1	18.4	4.3	26.9	10.0
1	63915	54	55	61.8	11.2	26.5	24.1	18.4	4.2	32.1	4.3
2	64010	55	55	77.9	12.1	30.7	35.1	18.3	4.2	26.7	10.0
1	64024	50	55	62.9	11.6	27.2	24.1	18.4	4.2	32.1	4.3
2	64122	50	55	78.6	11.6	31.3	35.7	18.3	4.2	26.8	10.0
1	64140	49	55	62.9	11.8	26.7	24.4	18.4	4.2	32.0	4.3
2	64234	50	55	77.9	11.7	30.0	36.2	18.3	4.3	26.6	10.0

Date: 2008/01/30
Technician: Richard Maynard - IRD
Location: Delhi LTPP - Hwy 99 NB

6.1.2 TEST TRUCKS ERROR CALCULATIONS

Truck	V#	Speed	Temp	GVW	F/A	T1	T2	1>2	2>3	3>4	4>5
1	61938	65	52	1.1%	-0.9%	1.1%	2.1%	0.0	-0.1	0.1	0.0
2	62029	64	52	-0.9%	-0.8%	-2.6%	0.0%	0.0	0.0	0.0	0.0
2	62113	64	52	0.9%	0.0%	0.0%	1.7%	0.0	0.0	0.0	0.0
1	62141	63	52	-0.3%	0.0%	-0.7%	0.0%	0.0	-0.1	0.0	0.0
2	62234	64	52	0.1%	1.7%	-2.3%	1.7%	0.0	0.0	0.1	-0.1
1	62256	65	52	0.6%	0.9%	0.7%	0.4%	0.0	-0.1	0.1	0.0
2	62345	64	52	0.4%	-0.8%	1.6%	-0.6%	0.0	0.0	0.0	0.0
1	62383	59	52	0.6%	0.0%	0.0%	1.7%	0.0	-0.1	-0.2	-0.1
1	62488	59	54	0.0%	2.6%	-0.7%	-0.4%	-0.1	-0.1	-0.1	-0.1
2	62547	59	54	-0.6%	-1.7%	0.0%	-1.1%	0.0	0.0	0.0	-0.1
1	62596	59	54	0.8%	1.7%	-0.7%	2.5%	0.0	-0.1	0.0	0.0
2	62654	60	54	-0.6%	-0.8%	-1.0%	-0.3%	0.0	0.0	0.0	0.0
1	62700	54	54	1.0%	-0.9%	0.0%	2.9%	0.0	-0.1	0.0	0.0
2	62761	55	54	-0.3%	-2.5%	2.0%	-2.2%	0.0	0.0	0.0	-0.1
1	62824	55	54	0.2%	-0.9%	0.4%	0.8%	0.0	-0.1	0.1	0.0
2	62883	55	54	-0.8%	-0.8%	-0.7%	-1.1%	-0.1	0.0	0.0	-0.1
1	62937	50	54	0.3%	-1.7%	1.8%	-0.4%	0.1	-0.1	0.2	0.0
2	62988	54	54	-0.9%	-0.8%	-2.0%	-0.3%	0.0	0.0	-0.1	-0.1
1	63070	54	55	0.3%	-1.7%	-0.4%	2.1%	0.0	-0.1	0.0	0.0
2	63104	49	55	1.5%	0.8%	1.3%	1.7%	-0.1	0.0	-0.1	-0.1
1	63185	50	55	-0.5%	-0.9%	-0.7%	0.4%	0.0	-0.1	0.0	0.0
2	63217	50	55	1.1%	-2.5%	-1.6%	4.7%	-0.1	0.0	0.1	-0.1
1	63290	50	55	0.3%	2.6%	0.4%	-0.8%	0.0	-0.1	0.0	0.0
2	63323	50	55	1.7%	-3.3%	-0.3%	4.4%	-0.1	0.0	-0.1	-0.1
1	63392	62	55	1.0%	1.7%	0.0%	2.1%	0.0	-0.1	0.1	0.0
2	63437	64	55	-0.6%	-0.8%	-0.3%	-1.1%	-0.1	0.0	-0.1	-0.1
1	63490	65	55	0.8%	0.0%	0.4%	2.1%	0.1	-0.1	0.2	0.0
2	63549	64	55	-0.1%	-0.8%	1.0%	-1.1%	-0.1	0.0	-0.1	-0.1
1	63600	64	55	0.8%	-0.9%	-0.7%	3.3%	0.0	-0.1	0.1	0.0
2	63654	59	55	-1.8%	-4.2%	-1.3%	-1.1%	-0.1	0.0	0.0	-0.1
1	63685	59	55	1.9%	2.6%	0.4%	3.7%	0.0	-0.1	0.0	0.0
2	63751	59	55	0.5%	-0.8%	0.3%	1.4%	-0.1	0.0	-0.1	-0.1
1	63796	54	55	2.2%	0.9%	2.2%	2.9%	0.0	-0.1	0.0	0.0
2	63893	55	55	-0.5%	-2.5%	-0.3%	0.3%	0.0	0.0	0.1	-0.1
1	63915	54	55	-1.6%	-4.3%	-2.2%	0.4%	0.0	-0.1	0.1	0.0
2	64010	55	55	-0.9%	0.8%	0.3%	-2.5%	-0.1	-0.1	-0.1	-0.1
1	64024	50	55	0.2%	-0.9%	0.4%	0.4%	0.0	-0.1	0.1	0.0
2	64122	50	55	0.0%	-3.3%	2.3%	-0.8%	-0.1	-0.1	0.0	-0.1
1	64140	49	55	0.2%	0.9%	-1.5%	1.7%	0.0	-0.1	0.0	0.0
2	64234	50	55	-0.9%	-2.5%	-2.0%	0.6%	-0.1	0.0	-0.2	-0.1

6.1.3 OVERALL PERFORMANCE

International Road Dynamics Inc.

FHWA VERIFICATION

Specifications

Confidence	95%	Speed range low	45	to	53
	(1.96)	Speed range medium	53	to	59
Gross vehicle weight	10%	Speed range high	59	to	70
Tandem group weight	15%	Temperature range low	50	to	52
Single axle weight	20%	Temperature range medium	52	to	54
Axle spacings	0.5	Temperature range high	54	to	56

Overall

Characteristic	Error	StdDev	Specification	Calculated	Pass/Fail
Gross vehicle weight	0.2%	0.9%	10%	2.0%	pass
Tandem group weight	0.3%	1.6%	15%	3.4%	pass
Single axle weight	-0.6%	1.7%	20%	4.0%	pass
Axle spacings	0.0	0.1	0.5	0.2	pass

Speed range 45 to 53 (10 runs)

Characteristic	Error	StdDev	Specification	Calculated
Gross vehicle weight	0.4%	0.8%	10%	2.1%
Tandem group weight	0.6%	1.8%	15%	4.2%
Single axle weight	-1.1%	2.0%	20%	4.3%
Axle spacings	0.0	0.1	0.5	0.2

Speed range 53 to 59 (17 runs)

Characteristic	Error	StdDev	Specification	Calculated
Gross vehicle weight	0.0%	1.1%	10%	2.2%
Tandem group weight	0.2%	1.6%	15%	3.4%
Single axle weight	-0.7%	2.0%	20%	4.8%
Axle spacings	0.0	0.1	0.5	0.2

Speed range 59 to 70 (12 runs)

Characteristic	Error	StdDev	Specification	Calculated
Gross vehicle weight	0.3%	0.7%	10%	1.7%
Tandem group weight	0.3%	1.5%	15%	3.2%
Single axle weight	-0.1%	1.0%	20%	2.2%
Axle spacings	0.0	0.1	0.5	0.1

Temperature range 50 to 52 (8 runs)

Characteristic	Error	StdDev	Specification	Calculated
Gross vehicle weight	0.3%	0.7%	10%	1.7%
Tandem group weight	0.3%	1.4%	15%	3.1%
Single axle weight	0.0%	0.9%	20%	1.8%

Temperature range 52 to 54 (10 runs)

Characteristic	Error	StdDev	Specification	Calculated
Gross vehicle weight	-0.1%	0.7%	10%	1.4%
Tandem group weight	0.0%	1.4%	15%	2.8%
Single axle weight	-0.6%	1.5%	20%	3.7%

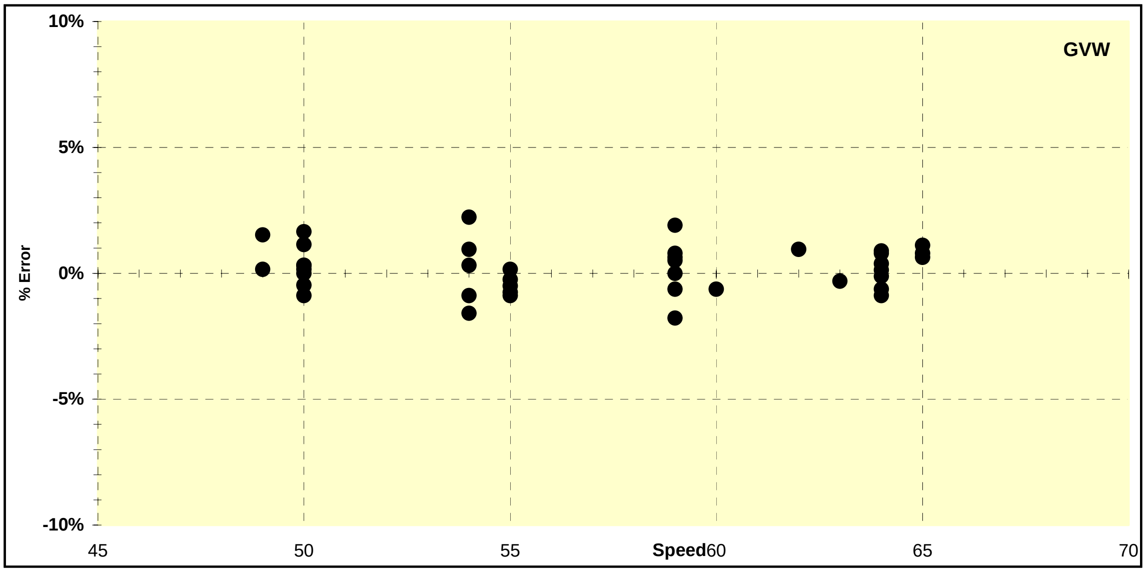
Temperature range 54 to 56 (22 runs)

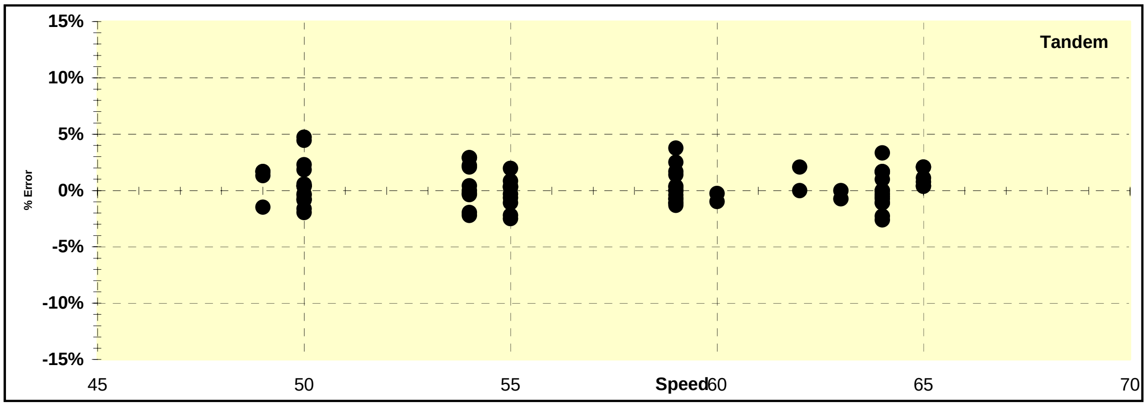
Characteristic	Error	StdDev	Specification	Calculated
Gross vehicle weight	0.3%	1.1%	10%	2.4%
Tandem group weight	0.5%	1.7%	15%	4.0%
Single axle weight	-0.9%	2.0%	20%	5.0%

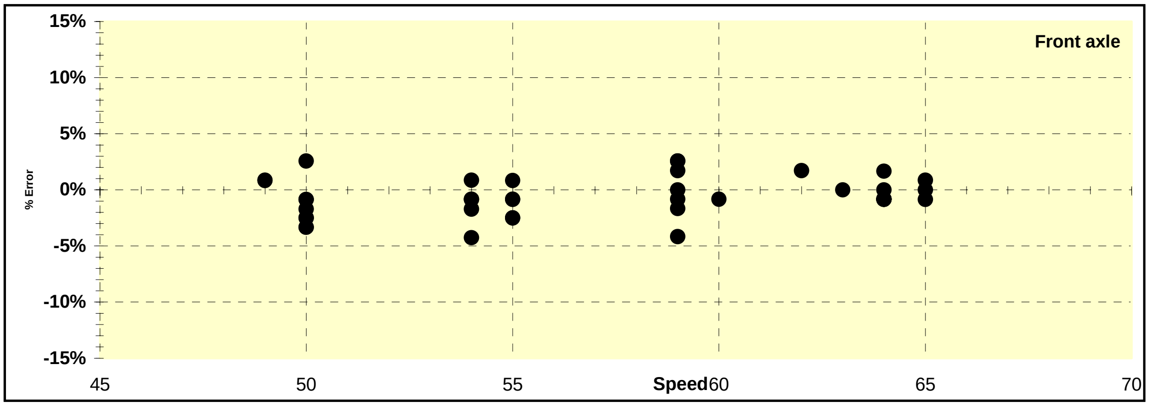
6.1.4 WEIGHT GRAPHS

International Road Dynamics Inc.

FHWA VERIFICATION



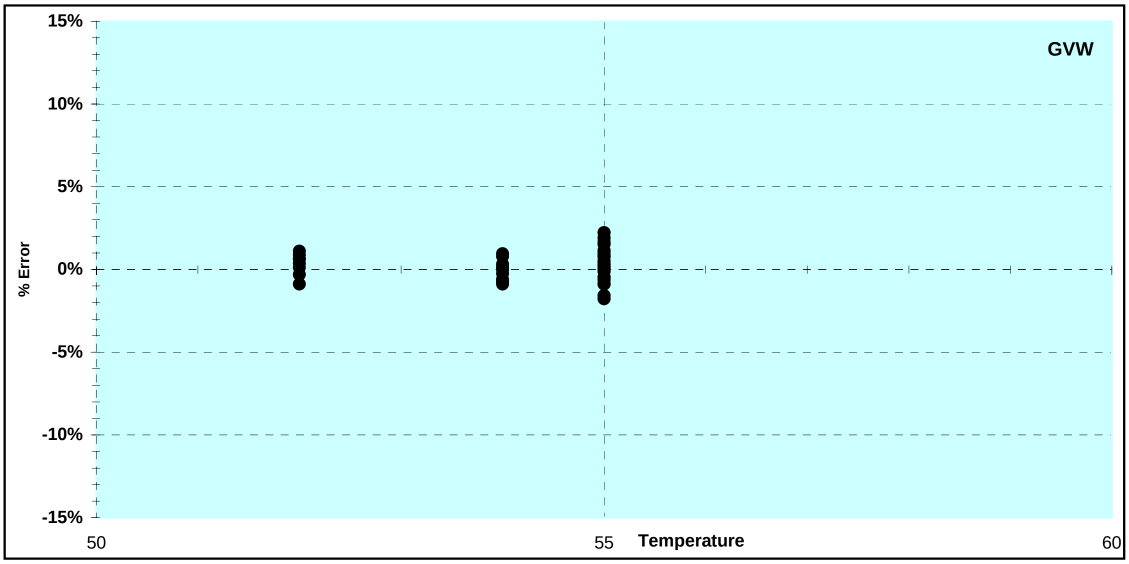


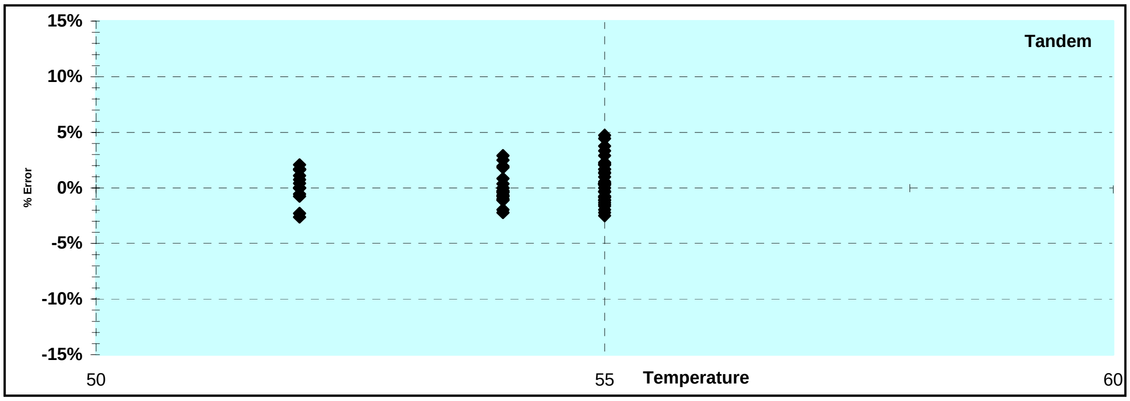


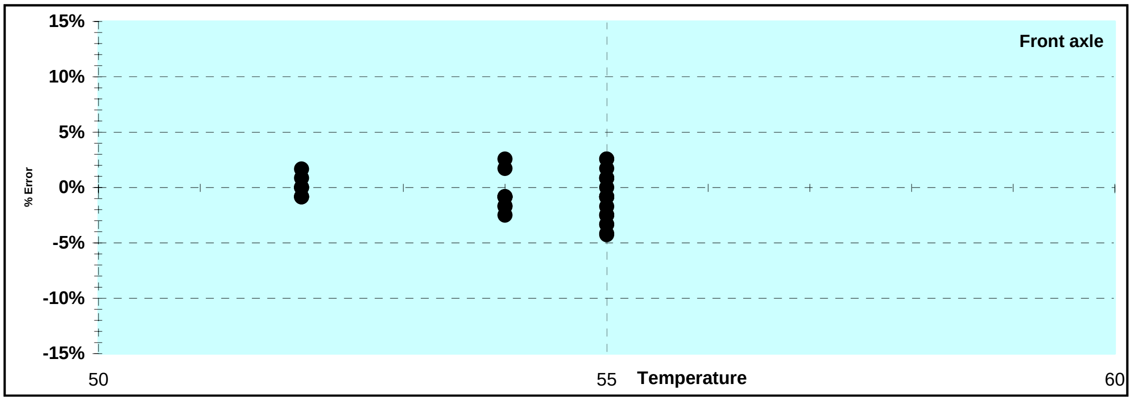
6.1.5 TEMPERATURE INFLUENCE GRAPHS

International Road Dynamics Inc.

FHWA VERIFICATION







LTPP Weigh-in-Motion (WIM) System: Model Performance Specifications and Application Requirements for Equipment – Hardware and Software

Version 2.0

Federal Highway Administration
Office of Infrastructure Research, Development and Technology
Turner-Fairbank Highway Research Center
6300 Georgetown Pike, HRDI-13
McLean, Virginia 22101-2296

ETG MODS

U.S. Department of Transportation
Federal Highway Administration

Long-Term Pavement Performance
Serving your need for durable pavements

Introduction

It is the intent of these specifications to establish the minimum requirements for high speed weigh-in-motion equipment utilized the purpose of collecting traffic data at Long-Term Pavement Performance (LTPP) Specific Pavement Studies (SPS) sites.

High Speed Weigh-in-Motion System

The Weigh-in-Motion System (hereafter WIM system) shall include equipment and software for collecting, processing, storing, transmitting and manipulating information related to the counting, classifying and speed monitoring of all vehicles and the weighing of trucks and buses at highway speeds.

The WIM system shall provide for single threshold weighing, and operate over a speed range of 5 mph to 100 mph. Single threshold weighing shall consist of scales in each lane of measurement. The weigh sensors shall cover the entire lane width. The WIM system shall consist of the following components:

1. Wheel scales shall report weight data for each wheel track (right axle weight and left axle weight). Such wheel weight data shall be uniform across the total width of the scale.

2. A WIM controller shall be installed in the controller cabinet. The WIM controller shall include all of the equipment and software to calculate, store and transmit to a host computer all data specified in these specifications. Either a keyboard and monitor or a portable personal computer (including protective case) for the purpose of accessing the WIM controller shall be furnished as part of the WIM controller. The WIM controller shall operate on AC power with a DC battery backup system to provide uninterrupted power to the WIM controller during AC power outages for a minimum of one hour. The system shall be able to operate on solar power if AC power is unavailable. The modem to be installed in the controller cabinet shall be compatible with the host computer modems described elsewhere in these specifications. The user shall have the capability of entering a site designation code up to three characters.

3. Surge protection devices against lightning and other transient high voltage consisting of:
   - Power Source Protection
   - Phone Line Protection
   - Loop Input Protection
   - WIM Sensor Protection
   - Grounding
     - All conduit shall be metal and bonded with #8 bare copper wire.
     - A ground rod with an impedance of 10 ohms or less shall be placed at the cabinet foundation.
     - The ground rod shall be connected to the electronics backplane with #6 bare wire.
     - If solar powered, a lightning rod shall be placed on top of the solar panel pole, and shall be independently grounded.

4. All necessary interconnecting cables and miscellaneous materials to make an operational system.

Functional Requirements

1. The WIM system shall be able to accommodate vehicles and vehicle combinations with up to eleven axles and shall automatically determine the following for each vehicle, by lane of travel:
   - Weight of each axle by left and right wheel weights, speed, axle spacing, and vehicle length. The WIM system shall provide for calibration features such that the accuracy required under LTPP standards for equipment performance verification can be met
   - Vehicle Classification. The WIM system shall provide for a minimum of 15 vehicle classifications. Class 1 through Class 13 shall be used according to the classification scheme shown in Section 4, Appendix A, of the Federal Highway Administration 3d edition of the Traffic Monitoring Guide, February 1995. Class 14 will identify special vehicles as determined by the user. Class 15 will identify any vehicle not conforming to the classification criteria for Classes 1 through 14. Classification criteria for Classes 1 through 14 shall be programmable by the user. The WIM system shall provide sufficient flexibility in spacings and weights (axle and/or gross) for each of these classes so that accurate classifying is achievable.

- Invalid Measurements. An "invalid measurement" code shall be assigned to any vehicle meeting the front axle weight threshold (discussed below) when (1) the left and right wheel weights of any axle have a difference of 40 percent or more; and (2) either of the wheel weights of such axle exceeds 2.0 kip. Both the 40 percent and 2.0 kip values shall be programmable by the operator. Any vehicle assigned an "invalid measurement" code shall not be considered a "Weighed Vehicle" but shall be classified and counted and all vehicle data shall be stored in the vehicle record.
- Determination of Weight Violations. For any vehicle meeting the front axle weight threshold (discussed below), the WIM system shall determine which, if any, axle(s) or axle grouping(s) exceed the weight limits set forth in the "Weight Violation Table" contained in these specifications. Any vehicle with one or more weight violations will be coded as to such a violation or combination of violations. The weight limitations set forth in the "Weight Violation Table" shall be the default settings. Such weights shall be programmable by the user.

2. The WIM controller shall calculate and store all specified data on a storage medium. The on-site data storage device shall have the capacity to store a minimum of fourteen days of vehicle count data and individual vehicle records. The storage device shall be completely solid state with no mechanical components and shall be a type not susceptible to loss of accumulated data should electrical power be interrupted. The WIM controller shall continue to calculate and store data for all vehicles passing through the system during periods of access, both on-site by portable PC and by the host computer for purposes of programming, real-time view and downloading of data.

   The WIM controller shall store the following data:
   - Hourly vehicle counts by lane, by class and by speed range for each 24-hour period (Class/Count Summary).
   - Individual vehicle records for all vehicles with a front axle weight greater than 3.5 kip (hereafter referred to as "truck records"). The front axle weight threshold for truck records shall be programmable by the operator with 3.5 kip as default setting. Each truck record shall include, as a minimum, the following data:
     - Time and Date
     - Lane Number
     - Vehicle Number
     - Speed
     - Vehicle Classification
     - Weight in kips of each wheel or dual set of wheels by left and right side and by axle number
     - Spacing in feet between each sequentially numbered axle
     - Overall length of each vehicle or combination of vehicles in feet
     - Code for weight violation(s)
     - Code for invalid measurement(s)

3. Data shall be calculated and formatted such that all data can be accessed and all required reports can be generated by use of the WIM system application software.

4. All equipment with exception of the WIM controller's modem shall operate properly within an atmospheric temperature range of -40°C to +70°C or –40°F to 158°F without the need of an added heating or cooling device.

5. The WIM controller shall have the communication capabilities to allow off-site personnel to view the operation of the WIM site and to allow for data transfer through telemetry over a dial-up, voice-grade telephone line. The WIM controller's modem shall be fully compatible with the host computer modem. The modem shall be specified by the WIM vendor. The WIM controller shall also allow on-site personnel to connect a computer to the WIM system for on-site observation and for the transfer of data.

High Speed WIM System Application Software

An application program, hereafter referred to as the "system program," which can be run on the host computer shall be furnished as part of the high speed WIM system. The host computer will be furnished by others and will consist of:

- Personal computer using the current version of the Windows Operating System.
- Printer
- A 56,600 Baud modem.

The system program shall provide communications between the host computer and the on-site WIM controller and shall process downloaded data to generate the specified ASCII files. Although referred to herein as a single software program, communications functions and data processing functions may be provided as two separate programs as long as all functional requirements are met. The system program shall be "user friendly", hierarchical menu driven and shall perform the following applications:

Communications

1. The communications portion of the system program shall include the following applications:
    - Real Time View. The real time view application shall provide for the on-line monitoring of traffic. The display on the host computer shall depict the axle configuration of each vehicle passing through the site. The contents and format for the real time display shall be similar to the sample display contained in these specifications. The user shall have the options of displaying either all traffic or only vehicle classifications 4 through 15 as well as the option of displaying a selected individual lane or all lanes. Printing of the real time data on the host computer printer shall be facilitated by means of an on/off toggle key from the keyboard.
    - System Data Programming. The system data programming application shall provide for on-line modification to the WIM controller's software parameters, such as speed and weight calibration factors, vehicle classification parameters, weight violation table parameters, and front axle weight threshold.
    - Manual Downloading. The manual downloading application shall provide for the downloading of selected daily data files from the storage medium of the WIM controller to the storage medium of the host computer. The program shall provide for a listing of the daily data files stored in the WIM controller and shall provide for user selection of the file or files to be downloaded from such a listing. The program shall provide for the downloading of the current day's data stored as of the time of downloading.
    - Automatic Downloading. The automatic downloading applications shall provide for unattended downloading of daily data files stored in the WIM controller's storage medium to the storage medium of the host computer. The program shall provide the following:
        - User's input for the date and time that unattended downloading is to begin.
        - Downloading of all daily files not previously downloaded by the automatic downloading application.
        - At least three attempts to make telephone connection with the WIM controller.
        - At least three attempts to download files from the WIM controller before aborting download.
        - Discontinuation of telephone connection after downloading of files from the WIM controller (or after an abort)) and returning the host computer to a standby mode.
    - History File. The history file application shall create a daily file, which chronologically records events occurring during manual and automatic downloading sessions. Such events shall include, but not be limited to, modem result messages, start and end time of each file download and any pertinent messages generated by the program. The program shall provide for either:
        - The history file shall be in the form of an ASCII text file which can be viewed or sent to the printer or,
        - A menu selection which shall provide for a listing of available history files and user selection of a file to be sent to the printer in the form of a report.

2. The communications portion of the system program shall meet the following functional requirements:
   - Host computer’s modem configuration. The program shall initialize the host computer’s modem so that all necessary operating characteristics are set.
   - Baud Rate. The program will provide for operation at a minimum rate of 19200 baud.
   - Error Control. The program shall not in any way disable the modems’ error-checking features, which prevent phone-line noise from corrupting data during file downloading.
   - File Downloading Monitoring. The program shall display a window that allows the user to monitor the progress of file downloading. The program shall also provide for the abort of a file download.

Report Preparation

The report preparation application shall generate specified reports using the downloaded data. Such reports shall be sent to the host computer printer or to file. The program shall prepare the following reports:

- From vehicle class/count summary file:
  - Distribution of class and speed counts by lane.
  - Distribution of vehicle counts by hour of day by lane.
  - Distribution of vehicle classifications by hour of day.
  - Distribution of vehicle classifications by day of month.
  - Distribution of vehicles by speed by hour of day.
- From individual truck records file:
  - Distribution of truck record data by lane.
  - Distribution of weight violations and invalid measurements of vehicle classifications 4 through 15.
  - Distribution of weight violations by hour of day for vehicle classifications 4 through 14.
  - Distribution of overweight vehicles by hour of day for vehicle classifications 4 through 14.
  - Distribution of gross weights for vehicle classifications 4 through 14.
  - Distribution of 18 kip equivalent single axle loadings (ESALs) by hour of day for vehicle classifications 4 through 14. Program provides for user input of:
    - Pavement type:
      - (1) flexible pavement and structural number; or,
      - (2) rigid pavement and slab thickness.
    - Vehicle status:
      - (1) “all “weighed vehicles (default); or,
      - (2) “legal only” weighed vehicles; or,
      - (3) “overweight only” weighed vehicles.
  - Distribution of axles by groups (single, tandem, tridem) by hour of day for vehicle classifications 4 through 14.
  - Distribution of trucks by day of month for classifications 4 through 15.

Determination of 18 kip equivalent single axle loads shall be in accordance with the methodology of the 1993 AASHTO Pavement Design Guide.

The reports shall include all information contained in and formatted similarly to the sample reports contained in these specifications (See Appendix A). The reports shall be printed in condensed print when necessary to fit on 8-½ inch x 11-inch sheets. The program shall provide for the generation of reports in the following two modes:

- Manual Mode. For daily reports the program shall provide for user selection of the date and the specific report. For monthly reports, the program shall provide for user selection of the month/year and the specific report. The selected month report shall include the data from all downloaded daily data files resident with the system program on a directory or subdirectory of the host computer’s storage medium. The program shall also provide for user selection of the lane or lanes to be covered by the specific report (not applicable to the “Distribution of Class and Speed Counts by Lane,” “the Distribution of Vehicle Counts by Hour of Day by Lane,” and the “Distribution of Truck Record Data by Lane” reports). The default shall be “all lanes.” The printed report shall note which lanes are represented.

- Automatic Mode. The program shall provide for user designation of one or a combination of the specific daily reports for automatic processing. User selection of lane or lanes is not required (the "all lanes" default may be used). User selection of vehicle status for the 18 kip ESAL report is not required (the "all" weighed vehicles default may be used). Such designations shall be effected by means of either:
  - An ASCII text file, which can be revised with text editor or word processor, supplied with a "Sample" designation; or,
  - A menu selection, which shall provide for user input designation.

  Upon selection of automatic mode of report preparation by the user, the program shall send to the printer all pre-designated reports for all downloaded daily data files resident with the system program on a directory or subdirectory of the host computer's storage medium. The designated reports shall remain in effect for subsequent automatic mode sessions unless report designation, is revised by the user.

Truck Record Batch Print

The truck record batch print application shall provide for the display of, all on/off printer-toggle of individual truck records. The program shall provide for a listing of the daily truck records files available on the storage medium of the host computer and the user's selection of one of those files. The program shall also provide for the user's selection of the vehicle class or classes for which individual truck records will be displayed or printed as well as the starting hour of day.

The user shall have the following options in viewing and printing the individual truck records.

- Scroll and print continuously all records for the selection of class(es); user has capability to stop/resume scrolling or terminates program.
- Scroll each record one at a time; user has capability to:
  - Print displayed record and display next record.
  - Display next record.
  - Terminate program.

An example of the truck record batch print is included in Appendix A.

ASCII Export Utility

The ASCII export utility application shall allow the user to generate specified ASCII files using downloaded files. The user will have the choice of:

- Vehicle Class/Count Summary file:
  - ASCII classification file
  - ASCII speed file
- Individual Truck Record file:
  - ASCII truck record file

The file formats for these files are contained in Appendix A.

Traffic Monitoring Guide Files Utility

The TMG files utility shall allow the user to generate ASCII files conforming to the instructions contained in Section 6 of the FHWA Traffic Monitoring Guide 3rd edition using downloaded files.

Data Files

Notwithstanding the method of data manipulation and formatting used by the WIM controller, data files shall conform to the following:

- Individual daily data files shall be created and stored in the storage medium of the WIM controller. Each daily data file shall include data for each 00:00 hour through a 23:59 hour period and shall have a file name which uniquely identifies the file as to site designation, date, and file contents (i.e., class/count summary data, individual truck record data, or both).
- The daily data files shall be created at the start of each day. Data for each vehicle shall be filed within one hour of the vehicle's passing through the site, and the current day's files shall be accommodative to efficient use of storage medium space and rapid downloading via modem to the host computers.
- Daily files containing class/count summary data and individual truck records data may be created in the storage medium of the WIM controller as two separate daily files or as one daily file. However, if one daily file is created and downloaded as such, the system program shall create two separate daily files, each with a file name which uniquely identifies it as to site, date and whether it is a vehicle class/count summary file or an individual truck records file.

Acceptance Test

The WIM Vendor shall demonstrate that the WIM system is available for use by the owner by successfully completing the acceptance test for each lane of data collection. The acceptance test shall consist of the following:

- Verification of WIM System Accuracy
    - Step One. Obtain at least 2 trucks to use for testing the WIM system accuracy. Select truck types that are most representative of the trucks that frequent the WIM location. One of the test trucks shall be a class 9 truck that has air ride suspension for both tractor and trailer, a non-liquid load, and loaded to a minimum of 90 percent of the truck's legal operating weight. The other truck will be of the 2nd most commonly occurring type of truck, and loaded to 80 – 90% of the truck's legal operating weight. If the class 9 truck is the most common type of truck at the WIM location, it is OK to use two class 9 trucks for testing the WIM system's accuracy. No unloaded trucks will be used for testing the WIM system's accuracy. The procedure for weighing and measuring the test vehicle(s) to obtain reference values is found in sections 7.1.3 to 7.1.3.7 of ASTM E 1318-02:

      7.1.3.1 "Measure the center-to-center spacing between successive axles on each test vehicle and record this data to the nearest 0.1 ft (0.03m) as axle-spacing reference values."

      7.1.3.2 " Weigh each test vehicle a minimum of three times, with brakes released, as described in 7.1.1 and 7.1.2 to measure tire loads for the wheel(s) on each end of every axle on the static vehicle. Move the vehicle completely away from the scale or weigher before beginning a new set of tire-load measurements, and always approach the weighing devices from the same direction for weighing. Sum the applicable tire loads to determine wheel, axle, and tandem-axle loads as well as gross-vehicle weight each time the vehicle is weighed." (A scale which weighs individual axle and tandem loads is acceptable).

      7.1.3.3 " Calculate the arithmetic mean for all wheel load, axle-load, tandem-axle-load, and gross-vehicle-weight values that result from weighing each test vehicle three or more times; …"

      Average the three "static weight values" of the test vehicle(s) for the drive axle-load(s), 1st tandem-axle load(s), 2nd tandem-axle load(s), and gross-vehicle weight(s) to derive the static weights used in the accuracy verification.

      Some type of communication, (cellular phone, CB radio, etc.), with the driver(s) of the test vehicle(s) will need to be established before the initial calibration begins.

    - Step Two. The communications software shall have a history file, (log file), applications which will create a daily file, in an ASCII type format, which chronologically records events occurring during initial calibration runs (and the final verification runs). Such events shall include, but not be limited to, recording the initial calibration factors of the WIM system, the calibration runs, final calibration factors, and any changes made to the calibration factors during the initial calibration runs (and the final verification runs).

- Step Three. The test truck(s) is driven over the WIM sensors in each lane a minimum of three times at each set speed point, and three times at each 8kph (5mph) increment between the first and third speed points.

  Due to the temperature variations usually occurring during the course of the day, the truck will start at the lowest speed point and continue in sequence to the highest speed point. If the three speed points are set at 40 mph, 55 mph, and 70 mph, then the test truck(s) will start at 40mph and then go in sequence to 45 mph, then to 50 mph, etc., until the 70 mph point is reached. The truck(s) will then start all over again and repeat the same sequence two more times until there are a total of 21 runs for each test truck used in the validation.

  The gross weight percent error is calculated for each run and plotted on a "Gross Weight Percent Error by Vehicle Speed" graph for each WIM lane. These graphs are analyzed to make the final adjustments to the WIM weight factors if necessary. They are also used to record pavement effects on vehicle dynamics for the site history.

  If for any reason an adjustment needs to be made to the WIM Weight or Spacing factors, before all runs are completed, the validation runs will have to start all over again.

- Step Four. Download the data file and close and save the history (log) file. For the site calibration to be accepted, the gross weight percent error of the validation data will have to be evenly distributed around the zero axis of the "Gross Weight Percent Error by Vehicle Speed" graph for each speed point in each WIM lane.

  For a Type I WIM System the validation data will meet (or exceed) the functional performance requirements as found in table 2 under Section 5 of the ASTM E 1318-02 of the Standard Specifications for Highway WIM with a 95% Confidence Limit:
  - Gross-Vehicle Weight: +/- 10%
  - Axle-Group Load: +/- 15%
  - Axle Load: +/- 20%

- Continuous operation of WIM system on-site equipment for 15 consecutive days following completion of the WIM system accuracy validation testing. Failure of the system to record and store data meeting the requirements set forth in these specifications for an accumulated time exceeding 3 hours during the 15 day-period shall be cause for the acceptance test to be repeated.
- Testing of the WIM system application software during the above noted 15 day-period and the full working day following the 15 day-period. Failure of the software to perform any application meeting the requirements set forth in these specifications shall be cause for the acceptance test to be repeated.

Failure of the host computer or its peripheral equipment or of a communication line not furnished by the WIM vendor to transmit data may not be considered unacceptable performance, provided the WIM vendor demonstrates to the satisfaction of the owner that the failure is not caused by any of the WIM vendor furnished equipment.

Maintenance and Operations Manuals

The WIM vendor shall furnish a maintenance manual for the WIM controller, including vehicle detector sensor units and an operation manual for the system. The maintenance manual and operation manual may be combined into one manual. The manual(s) shall include, but need not be limited to, the following items:

- Specifications
- Design characteristics
- General operation theory
- Function of all controls
- Trouble shooting procedure (diagnostic routine)
- Block circuit diagram
- Geographical layout of components
- Schematic diagrams, signal responses and acceptable thresholds
- List of component parts with stock numbers
- Documentation for application software

Traffic Sheet 27A	* STATE ASSIGNED ID __ __ __ __
LTPP MONITORED TRAFFIC DATA	* STATE CODE __ __
SITE AUDIT MEASUREMENTS	* SECTION ID __ __ __ __
WIM SENSORS AND LAYOUT	

Rev. 7/21/2005

1. Contractor: 2. Audit No.:

3. Contract No.: 4. Audit Date:

5. Location: 6. Audit Type:

7. Installation Sub-Contractor:

8. Auditor/ Organization:

9. Measurements: Label Sensors and Loops on Traffic Sheet 26A. Add any additional measurements.

See Figure 10-1 for the locations of the measurements in table below.

Measurement	**Sensor 1**	**Sensor 2**	**Sensor 3**	**Check**
L1				
W1				Difference between any two W is <= 0.25 inch
W2				
W3				
Y/N				
DS1				
DS2				
Y/N				-0.25” <=DS1-DS2 <= 0.25”

See Figure 10-2 for the locations of measurements in table below.

Measurement	**Loop 1**	**Loop 2**	**Loop 3**	**Check**
S1				
S2				
Y/N				S1=S2

See Figure 10-3 and Figure 10-4 for the locations of measurements in table below.

Measurement	**Sensor 1**	**Sensor 2**	**Sensor3**	**Check**
S3				
S4				
S5				
Y/N				S3=S4=S5
Y/N				S1=S5

10. Auditor’s Signature.. Date........................

Traffic Sheet 27B	* STATE ASSIGNED ID __ __ __ __
LTPP MONITORED TRAFFIC DATA	* STATE CODE __ __
SITE AUDIT MEASUREMENTS	* SECTION ID __ __ __ __
LOOPS	

Rev. 7/21/2005

1. Contractor: 2. Audit No.:

3. Contract No.: 4. Audit Date:

5. Location: 6. Audit Type:

7. Installation Sub-Contractor:

8. Auditor/ Organization:

9. Measurements:

See Figure 10-5 for the locations of measurements.

Measurement	**Loop 1**	**Loop 2**	**Loop 3**	**Check**
L				
W				
D1				
D2				
Y/N				-1.0 " <=D1-D2 <= 1.0"
C1				
C2				
Y/N				-1.0 " <=C1-C2 <= 1.0"
E11				
E12				
Y/N				E11=E12 & 6"<= E11 <= 12"
E21				
E22				
Y/N				E21=E22 & 6"<= E21 <= 12"
E31				
E32				
Y/N				E31=E32 & 6"<= E31 <= 12"
E41				
E42				
Y/N				E41=E42 & 6"<= E41 <= 12"

10. Auditor's Signature.. Date.........................

Traffic Sheet 27C	* STATE ASSIGNED ID __ __ __ __
LTPP MONITORED TRAFFIC DATA	* STATE CODE __ __
SITE AUDIT MEASUREMENTS	* SECTION ID __ __ __ __
DEPTH CHECKS	

Rev. 7/21/2005

1. Contractor: 2. Audit No.:

3. Contract No.: 4. Audit Date:

5. Location: 6. Audit Type:

7. Installation Sub-Contractor:

8. Auditor/ Organization:

9. Measurements:

See Figure 10-6 the locations of measurements.

Measurement	**Loop 1**	**Loop 2**	**Loop 3**	**Sensor 1**	**Sensor 2**	**Sensor 3**
d1						
d2						
d3						
d4						
d5						
d6						
d7						
d8						
d9						
d10						
d11						
d12						

10. Auditor’s Signature... Date.........................

QA INSPECTOR CHECKLIST

Task Work Order: 576-D2-02023401-6 Route: I-81 Direction: NB
Latitude: 37.52030 Longitude: -79.71758
Start Date: 4/19/2016 End Date: 5/16/2016
QA Inspector: Corey Lowe Crew Leader: Dan Hagerman
Crew: Robert Greene, Ramon Greene, Lenny Walls, Calvin Howell, Gustavo Flores

Site packet with the following items: Approved and correct dates

Y N N/A
- ☑ ☐ ☐ TWO - work to be performed
- ☑ ☐ ☐ Warranty cards, material usage sheets
- ☑ ☐ ☐ Approved site sketch
- ☑ ☐ ☐ Lane/shoulder closure request form
- ☑ ☐ ☐ Cleared Miss Utility and VDOT locates
- ☑ ☐ ☐ Approved TCP

Y N N/A
- ☐ ☐ ☑ Approved deviations
- ☑ ☐ ☐ Site log and telephone sign w/Zip-Lock bag
- ☐ ☐ ☑ Permits
- ☑ ☐ ☐ New site- cabinet sticker/ground array sticker
- ☑ ☐ ☐ Virginia State Police log
- ☑ ☐ ☐ District contact info (STC)

Before leaving office: Crew leader or QA has the following items:

Y N N/A
- ☑ ☐ ☐ DTS install manual (check for addendums)
- ☑ ☐ ☐ VDOT Road and Bridge Standards
- ☑ ☐ ☐ MSDS book
- ☑ ☐ ☐ VDOT Road and Bridge Specs
- ☑ ☐ ☐ VDOT Work Area Protection Manual
- ☑ ☐ ☐ Contract
- ☑ ☐ ☐ Sufficient/appropriate truck inventory

Y N N/A
- ☑ ☐ ☐ DTS Safety Manual
- ☑ ☐ ☐ DTS Policy Manual
- ☑ ☐ ☐ Approved traffic control devices for job: signs, cones, stands, barrels (if interstate night work), arrow board(s), TMA
- ☑ ☐ ☐ ARA QA Manual
- ☑ ☐ ☐ Current QA forms (QA Checklist, Non-Conformance Report, Drive-thru Log, Daily Report, etc.

Completing work:

Y N N/A
- ☑ ☐ ☐ Site returned to pre-construction condition: cleaned, seeded, straw, etc.
- ☑ ☐ ☐ Post construction sensor check- existing and new sensors in working order
- ☑ ☐ ☐ Site log filled out (if new site- new log left in cabinet)
  - ☑ ☐ ☐ o Loop spacing documented
  - ☑ ☐ ☐ o Type of piezo installed
  - ☑ ☐ ☐ o Depth of piezo installation
  - ☑ ☐ ☐ o Grounding sketch left in cabinet
- ☑ ☐ ☐ STC/DTS informed of work completed
- ☑ ☐ ☐ All applicable pictures and/or video is captured
- ☑ ☐ ☐ Verified communications
- ☑ ☐ ☐ Site packet completed correctly
  - ☑ ☐ ☐ o VSP logs
  - ☑ ☐ ☐ o Warranty cards
  - ☑ ☐ ☐ o Material usage
  - ☑ ☐ ☐ o Site sketch
- ☑ ☐ ☐ All TWO items completed and approved by QA
- ☑ ☐ ☐ All paperwork submitted to DTS office
- ☑ ☐ ☐ Site sketch provided to Technical Services Manager

Notes:

1. JB1 form needs removed and bolts installed in lid.
2. Photo resolutions on dates 4-20, 4-21, 5-3, and 5-10 are 640x480.
3. Year stamp on photos from 5-16-15 and 5-17-15 is wrong, should read 16 (2016).
4. Slope test was performed without a 4' straight edge.

QA Signature:		**CL Signature:**	

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DAILY LOG

Day #	1	**Day:**	Tuesday	**Date:**	4/19/2016	**NCRs -**	0

9:00 PM - 2:00 AM DTS set up MOT, closed lane 1 shoulder on I-81 NB. Performed slope test and DCP test. Installed helical pier (6' pier).

Contacted TOC:	Yes	
Camera recording:	N/A	
	Low	High
Air temp:	n/a	n/a
Pavement temp:	n/a	n/a
Start time:	9:00 PM	
End time:	2:00 AM	
MOT set up correctly:	Yes	

VSP onsite: Yes Qty: 1

VSP cancellation time:

MOT drive-thru: (who/when) - C. Lowe@ 10:22 PM, 12:29 AM

Reason:

Type of MOT: Shoulder

Check the following (Check all that apply):

- ☑ Signs
- 📷 ☐ Arrow Panel
- ☑ Cones
- ☑ TMA
- 📷 ☐ PCMS
- ☐ Drums
- ☐ Accidents

Credentials:

- ☐ Flagger cards
- ☑ CL VDOT Badge

Days since last day on site: 0

(if greater than 30 days, conduct inspection)

N/A	**√**	**Daily checks before arriving on site**:
☐	☑	Safety meeting held
☐	☑	Vehicle inspection (lights, fuel, operation, etc.)
☐	☑	Inspect and start all equipment for proper operation
☐	☑	Equipment in working condition
☑	☐	Grout and sealant inspected
☐	☑	Proper tools in working condition
☐	☑	All crew members have proper personal protective equipment (PPE)

☐ Sensors Installed (select from dropdowns):

Loops				**Piezos**		**Kistler**	

Day #	2	**Day:**	Wednesday	**Date:**	4/20/2016	**NCRs -**	0

9:00 PM - 4:30 AM DTS set up MOT, closed lane 1 shoulder on I-81 NB. Crew laid out lane 1 and 2 HR's and exit holes in lane 1 shoulder. Crew assembled solar panel and pole and pedestal while waiting for Miss Utility. Crew trenched 15' from pole and cabinet and installed 1" and 2" conduit, backfilled trench in 3 lifts and placed red marker tape. Installed pole and cabinet and LB.

Contacted TOC:	Yes	
Camera recording:	N/A	
	Low	High
Air temp:	n/a	n/a
Pavement temp:	n/a	n/a
Start time:	9:00 PM	
End time:	4:30 AM	
MOT set up correctly:	Yes	

VSP onsite: Yes Qty: 1

VSP cancellation time:

MOT drive-thru: (who/when) - C. Lowe@ 10:28 PM, 12:08 AM, 2:44 AM

Reason:

Type of MOT: Shoulder

Check the following (Check all that apply):

- ☑ Signs
- 📷 ☐ Arrow Panel
- ☑ Cones
- ☑ TMA
- 📷 ☐ PCMS
- ☐ Drums
- ☐ Accidents

Credentials:

- ☐ Flagger cards
- ☑ CL VDOT Badge

Days since last day on site: 1

(if greater than 30 days, conduct inspection)

N/A	**√**	**Daily checks before arriving on site**:
☐	☑	Safety meeting held
☐	☑	Vehicle inspection (lights, fuel, operation, etc.)
☐	☑	Inspect and start all equipment for proper operation
☐	☑	Equipment in working condition
☑	☐	Grout and sealant inspected
☐	☑	Proper tools in working condition
☐	☑	All crew members have proper personal protective equipment (PPE)

☐ Sensors Installed (select from dropdowns):

Loops				**Piezos**		**Kistler**	

ALL MOT DRIVE-THRU TIMES AND DISCREPANCIES TO BE ANNOTATED ON WORK ZONE SAFETY CHECKLIST FORM

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DAILY LOG

Day #	3	**Day:**	Thursday	**Date:**	4/21/2016	**NCRs -**	0

Contacted TOC: Yes
Camera recording: N/A

	Low	High
Air temp:	n/a	n/a
Pavement temp:	n/a	n/a

Start time: 9:00 PM
End time: 5:00 AM
MOT set up correctly: Yes
VSP onsite: Yes Qty: 1
VSP cancellation time:
Reason:
Type of MOT: Shoulder

9:00 PM - 5:00 AM - DTS set up MOT, closed lane 1 shoulder on I-81 NB. Crew continued with lane 1 shoulder trenching and conduit installation, drilled exit holes and installed JB1. Backfilled trench in 3 lifts and placed red marker tape.

MOT drive-thru: (who/when) - C. Lowe@ 10:14 PM, 12:09 AM, 2:31 AM

Check the following (Check all that apply):

- ☑ Signs
- 📷 ☐ Arrow Panel
- ☑ Cones
- ☑ TMA
- 📷 ☐ PCMS
- ☐ Drums
- ☐ Accidents

Credentials:

- ☐ Flagger cards
- ☑ CL VDOT Badge

Days since last day on site: 1
(if greater than 30 days, conduct inspection)

N/A	**√**	**Daily checks before arriving on site**:
☐	☑	Safety meeting held
☐	☑	Vehicle inspection (lights, fuel, operation, etc.)
☐	☑	Inspect and start all equipment for proper operation
☐	☑	Equipment in working condition
☑	☐	Grout and sealant inspected
☐	☑	Proper tools in working condition
☐	☑	All crew members have proper personal protective equipment (PPE)

☐ Sensors Installed (select from dropdowns):

Loops				**Piezos**		**Kistler**	

Day #	4	**Day:**	Monday	**Date:**	4/25/2016	**NCRs -**	0

Contacted TOC: Yes
Camera recording: Yes

	Low	High
Air temp:	63	77
Pavement temp:	63	79

Start time: 9:00 PM
End time: 6:00 AM
MOT set up correctly: Yes
VSP onsite: Yes Qty: 1
VSP cancellation time:
Reason:
Type of MOT: Lane

9:00 PM - 6:00 AM DTS set up MOT, closed lane 1 on I-81 NB. Laid out lane 1 sensors and homeruns. Saw cut, cleaned, and dried L1, L2, L3 HR, L4 HR, P1, and P2. Installed and half-sealed L1, L2, and P2 HR (polytube method), will require final sealing. Installed 3 ground rods in JB1 and pulled ground wire to cabinet.

MOT drive-thru: (who/when) - A. Lewis @ 10:19 PM, 12:14 AM, 2:19 AM, 4:06 AM

Check the following (Check all that apply):

- ☑ Signs
- 📷 ☑ Arrow Panel
- ☑ Cones
- ☑ TMA
- 📷 ☑ PCMS
- ☑ Drums
- ☐ Accidents

Credentials:

- ☐ Flagger cards
- ☑ CL VDOT Badge

Days since last day on site: 4
(if greater than 30 days, conduct inspection)

N/A	**√**	**Daily checks before arriving on site**:
☐	☑	Safety meeting held
☐	☑	Vehicle inspection (lights, fuel, operation, etc.)
☐	☑	Inspect and start all equipment for proper operation
☐	☑	Equipment in working condition
☐	☑	Grout and sealant inspected
☐	☑	Proper tools in working condition
☐	☑	All crew members have proper personal protective equipment (PPE)

☑ Sensors Installed (select from dropdowns):

Loops				**Piezos**		**Kistler**	
L1	L2						

ALL MOT DRIVE-THRU TIMES AND DISCREPANCIES TO BE ANNOTATED ON WORK ZONE SAFETY CHECKLIST FORM

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DAILY LOG

Day #	5	**Day:**	Tuesday	**Date:**	5/3/2016	**NCRs -**	0

Contacted TOC: Yes
Camera recording: Yes

	Low	High
Air temp:	56	65
Pavement temp:	62	71

Start time: 9:00 PM
End time: 6:00 AM
MOT set up correctly: Yes
VSP onsite: Yes Qty: 1
VSP cancellation time:
Reason:
Type of MOT: Lane

9:00 PM - 6:00 AM DTS set up MOT, closed lane 2 on I-81 NB. Laid out lane 2 arrays, saw cut and dried slots. Installed L3, L4, and P2 (stacked). Sealed loops and home runs with 6006EX.

MOT drive-thru: (who/when) - C. Lowe @ 10:52 PM, 12:50 AM, 3:24 AM

Check the following (Check all that apply):
☑ Signs
📷 ☑ Arrow Panel
☑ Cones
☑ TMA
📷 ☑ PCMS
☑ Drums
☐ Accidents

Credentials:
☐ Flagger cards
☑ CL VDOT Badge

Days since last day on site: 8
(if greater than 30 days, conduct inspection)

N/A	√	**Daily checks before arriving on site**:
☐	☑	Safety meeting held
☐	☑	Vehicle inspection (lights, fuel, operation, etc.)
☐	☑	Inspect and start all equipment for proper operation
☐	☑	Equipment in working condition
☐	☑	Grout and sealant inspected
☐	☑	Proper tools in working condition
☐	☑	All crew members have proper personal protective equipment (PPE)

☑ Sensors Installed (select from dropdowns):

Loops				**Piezos**		**Kistler**	
L3				P2			
L4							

Day #	6	**Day:**	Tuesday	**Date:**	5/10/2016	**NCRs -**	0

Contacted TOC: Yes
Camera recording: Yes

	Low	High
Air temp:	61	62
Pavement temp:	70	71

Start time: 9:00 PM
End time: 4:00 AM
MOT set up correctly: Yes
VSP onsite: Yes Qty: 1
VSP cancellation time:
Reason:
Type of MOT: Lane

9:00 PM - 4:00 AM DTS set up MOT and closed lane 1 on I-81 NB. Cleaned and dried slots. Installed P1 and continued sealing lane 1 loops and home runs. Installed tech pad, pulled wires to cabinet. Installed solar panel and checked pole and cabinet level. Set solar panel angle and sealed exterior chase nipples and LB. Seeded and matted trench area. Work stopped at 2:30 AM due to rain.

Note - VSP backed into TMA truck while DTS was picking up lane closure.

MOT drive-thru: (who/when) - C. Lowe @ 10:23 PM, 12:47 AM

Check the following (Check all that apply):
☑ Signs
📷 ☑ Arrow Panel
☑ Cones
☑ TMA
📷 ☑ PCMS
☑ Drums
☑ Accidents

Credentials:
☐ Flagger cards
☑ CL VDOT Badge

Days since last day on site: 7
(if greater than 30 days, conduct inspection)

N/A	√	**Daily checks before arriving on site**:
☐	☑	Safety meeting held
☐	☑	Vehicle inspection (lights, fuel, operation, etc.)
☐	☑	Inspect and start all equipment for proper operation
☐	☑	Equipment in working condition
☐	☑	Grout and sealant inspected
☐	☑	Proper tools in working condition
☐	☑	All crew members have proper personal protective equipment (PPE)

☑ Sensors Installed (select from dropdowns):

Loops				**Piezos**		**Kistler**	
				P1			

ALL MOT DRIVE-THRU TIMES AND DISCREPANCIES TO BE ANNOTATED ON WORK ZONE SAFETY CHECKLIST FORM

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DAILY LOG

Day #	7	**Day:**	Monday	**Date:**	5/16/2016	**NCRs -**	0

Contacted TOC: Yes
Camera recording: Yes

	Low	High
Air temp:	53	55
Pavement temp:	60	62

Start time: 9:00 PM
End time: 3:00 AM
MOT set up correctly: Yes
VSP onsite: Yes Qty: 1
VSP cancellation time:
Reason:
Type of MOT: Lane

9:00 PM - 3:00 AM DTS set up MOT and closed lane 1 on I-81 NB. Cleaned and dried slots and ground P1 down to a dime height. Continued to seal lane 1 loops and home runs. Installed JB1 collar. Performed post-construction sensor readings and final ground reading (5.2). Removed wooden pole, cabinet, and JB at 37.5195, -79.72054. All TWO work complete.

MOT drive-thru: (who/when) - C. Lowe@ 10:22 PM, 12:10 AM

Check the following (Check all that apply):
☑ Signs
📷 ☑ Arrow Panel
☑ Cones
☑ TMA
📷 ☑ PCMS
☑ Drums
☐ Accidents

Credentials:
☐ Flagger cards
☑ CL VDOT Badge

Days since last day on site: 6
(if greater than 30 days, conduct inspection)

N/A	√	**Daily checks before arriving on site**:
☐	☑	Safety meeting held
☐	☑	Vehicle inspection (lights, fuel, operation, etc.)
☐	☑	Inspect and start all equipment for proper operation
☐	☑	Equipment in working condition
☐	☑	Grout and sealant inspected
☐	☑	Proper tools in working condition
☐	☑	All crew members have proper personal protective equipment (PPE)

☐ Sensors Installed (select from dropdowns):

Loops				**Piezos**		**Kistler**	

Day #		**Day:**		**Date:**		**NCRs -**	

Contacted TOC:
Camera recording:

	Low	High
Air temp:		
Pavement temp:		

Start time:
End time:
MOT set up correctly:
VSP onsite: Qty:
VSP cancellation time:
Reason:
Type of MOT:

MOT drive-thru: (who/when) -

Check the following (Check all that apply):
☐ Signs
📷 ☐ Arrow Panel
☐ Cones
☐ TMA
📷 ☐ PCMS
☐ Drums
☐ Accidents

Credentials:
☐ Flagger cards
☐ CL VDOT Badge

Days since last day on site:
(if greater than 30 days, conduct inspection)

N/A	√	**Daily checks before arriving on site**:
☐	☐	Safety meeting held
☐	☐	Vehicle inspection (lights, fuel, operation, etc.)
☐	☐	Inspect and start all equipment for proper operation
☐	☐	Equipment in working condition
☐	☐	Grout and sealant inspected
☐	☐	Proper tools in working condition
☐	☐	All crew members have proper personal protective equipment (PPE)

☐ Sensors Installed (select from dropdowns):

Loops				**Piezos**		**Kistler**	

ALL MOT DRIVE-THRU TIMES AND DISCREPANCIES TO BE ANNOTATED ON WORK ZONE SAFETY CHECKLIST FORM

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MAJOR ITEM INSTALLATION CHECK SHEET

ITEM	COMMENTS							
Description of work:	New Install		Other:					
Pavement type:	Asphalt	Pavement condition:	Good		# Lanes -	4		
Other/comments:								

ITEM	QTY	UNIT		ITEM	QTY	UNIT				
Directional Bore	0	Feet								
Trenching	87	Feet								
1" PVC Conduit	22	10' Sticks		2" PVC Conduit	14	10' Sticks		3" PVC Conduit		10' Sticks
Rock Excavation	0	cu. Yd								
Cabinets	1	Type:	pedestal		Poles	1	Type:	aluminum		
Ground Rod	24	Feet		📷 Ground Wells	0	Each				
Ground Wire	60	Feet		📷 Cadwelds	1	Each				
Helical Pier	1	Each		Pier Size -	6	Feet				
📷 Retaining wall:	0	Feet								
📷 Junction Boxes	1	Each								
📷 Delineator Stakes	0	Each	JB1	0	JB2	0	JB3	0	JB4	0
			JB5	0	JB6	0				
Loops	4	Each	☑ L1	☑ L2	☑ L3	☑ L4	☐ L5	☐ L6	☐ L7	☐ L8
			☐ L9	☐ L10	☐ L11	☐ L12	☐ L13	☐ L14	☐ L15	☐ L16
Loop Wire	1324	Feet								
Loop Feeder Cable	0	Feet								
6' Piezo	0	Each								
8' Piezo	0	Each	P1	10	P2	10	P3		P4	
9' Piezo	0	Each	P5		P6		P7		P8	
10' Piezo	4	Each	P9		P10		P11		P12	
11' Piezo	0	Each	P13		P14		P15		P16	
12' Piezo	0	Each								
Piezo Feeder Cable	0	Feet								
Gravel	10	cu. Ft	JB1	10	JB2	0	JB3	0	JB4	0
			JB5	0	JB6	0				
Driveway Gravel	0	tons								
Concrete	12	Bag	JB1	12	JB2	0	JB3	0	JB4	0
			JB5	0	JB6	0	Tech Pad	0	Found.	0
Sidewalk concrete	0	sq. Yd								
Fill-in concrete:	0	cu. Ft	(non-structural)							
📷 Solar Panel	2	Each	☐ 20	☐ 30	☐ 40	☐ 50	☑ 65	☐ 80		
			Manufacturer:	Ameresco						

Special Materials Used:

8 cu. ft. of gravel used for abandoned site
1 Pre-fabricated tech. pad.

Additional Notes (Describe installation variances, work yet to be completed):

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CHEMICAL USAGE

Date	Air Temp		Road Temp		Lane(s)	Purpose	Chemical 📷 Used	Amount	📷 Batch		Premix Temp	Max Cure Temp	BPO/Hard. Used	Install Temp	
	Low	High	Low	High					Code	Date				Air	Road
4/25/2016	63	77	63	79	1	L1, L2, P2 HR's	6006EX	3	5080402	8/4/2015	66.2	97.2	2	63	63
4/25/2016	63	77	63	79	1	L1, L2, P2 HR's	6006EX	4	5052601	5/26/2015	66.2	97.2	2	63	63
5/3/2016	56	65	62	71	2	L3, L4, HR's	6006EX	9	5052601	5/26/2015	67.3	98.4	2	56	62
5/3/2016	56	65	62	71	2	P2	AS-475	1	G15-0676	9/14/2015	70.6	109.3	2.5	56	62
5/10/2016	61	62	70	71	1	L1, L2, P2 HR's	6006EX	8	5052601	5/26/2015	72.3	99.1	2	61	70
5/10/2016	61	62	70	71	1	P1	AS-475	1	G15-0677	9/14/2015	73.9	110.2	2.5	61	70
5/10/2016	61	62	70	71	1	L1, L2, P2 HR	6006EX	4	5080402	8/4/2015	72.3	99.1	2	61	70
5/16/2016	53	55	60	62	1	L1, L2, HR's	6006EX	6	5080402	8/4/2015	73.1	98.8	2	53	60

Totals -	**AS-475**	2	buckets	**F40**	0	buckets	**E-bond A**	0	cans
	6006EX	34	cans	**Aquaphalt**	0	bags	**E-bond B**	0	cans
	6006	0	cans	**1000A1**	0	cans	**Sand**	0	bags
	PU-200	0	cans						

Notes:

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SHOULDER WORK

TRENCHING / BORING / EXCAVATION WORK:

Depth of conduit:	📷 24	Inches		Pre-bore pavement check:	📷 N/A
Conduit cut and glued properly?		📷 YES		Depth of bore (attempt 1):	N/A
Bell ends properly placed on conduit?		📷 YES		Depth of bore (attempt 2):	N/A
Trenched area tamped in layers?		📷 YES		Depth of bore (attempt 3):	N/A
Seeded? YES	Raked? YES			Post-bore pavement check:	📷 N/A
	Matted? 📷 YES			Any sign of roadway damage?	📷 N/A
Red plastic locator tape used?		📷 YES			
Exit conduits 5” from surface?	📷 YES	Duct sealed?	📷 YES		
Exit holes precut?		YES			
Conduits blown out?		YES			
Pull-string installed through conduit?	YES	Duct sealed?	📷 YES		

CABINET/POST/PIER:

Pole outside of deflection zone?	N/A	Type:	N/A		
Cabinet chase nipple sealed?	📷 YES				
Cabinet facing correct direction?	📷 YES	As per:	TWO		
Anti-sieze used on fasteners/hardware?	YES	Breakaway holes drilled:	N/A		
Solar panel at proper angle/direction?	📷 YES	*(Direction: 188° South, Angle: Latitude +15°)*			
Solar panel output: Full sun?	NO	Output (VDC) - 1 -	2.3	2 -	3.9
		3 -		4 -	
Solar panel brackets installed correctly?	📷 YES	Solar panel connections soldered?	NO		
Conduits installed properly?	YES	All solar panel bracket screws, washers and bolts installed and tightened?	YES		
VDOT warning sticker on cabinet?	📷 YES				
Correct VDOT number?	YES	Base plate not greater than 2” above lowest grade, level with highest grade?	YES		
A/C Sticker present?	N/A				
Helical pier plumb during every foot?	📷 YES	Delineator stakes level?	N/A		
Rodent guard properly installed?	📷 YES	Delineator stake stickers present?	📷 N/A		
Concrete mixed per manufacturer’s instructions?	N/A	Sono-Tube removed (above ground)?	N/A		
		Reinforcement cage installed?	N/A		
Depth of foundation:	N/A in.	Length & diameter of cage installed:		Length:	N/A
3” min. coverage around cage?	N/A			Depth:	N/A
Foundation installed properly?	N/A	J-bolts installed correctly?	N/A		

JUNCTION BOX / SERVICE PAD:

Concrete mixed per manufacturer’s instructions?	YES	Junction box installed level with grade?	📷 YES	Tamped?	YES
		Concrete collar 12” wide x 8” deep?	📷 YES		
Gravel installed properly?	YES	Service pad installed?	YES		
Conduit installed properly?	YES	Forms removed?	NO		

GROUNDING:

Installation method:	Primary	📷 Ground Rod Readings:					
Ground reading before Cadweld:	📷 6.2	1st rod:	10.4	2nd rod:	6.6	3rd rod:	6.2
Ground reading after Cadweld:	📷 5.2	4th rod:		5th rod:			
Ground wire routed through separate 1” conduit?	YES	Approval after 5th rod per:					
		6th rod:		7th rod:		8th rod:	
Is there a ground well installed?	📷 N/A	9th rod:		10th rod:		11th rod:	
Is a ground array sticker installed?	📷 N/A	Ground sketch completed?					YES
Soil conditions:	some moisture	Ground sketch left in cabinet?					📷 YES

NOTES:

Pier ground reading of 20.9 Ohms.
JB1 form needs to be removed.

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LOOP REPLACEMENT AND INSTALLATION INFORMATION SHEET

MEASURED LOOP SPACING (Measured leading edge to leading edge in 10^{ths} of a foot. Collect during lane closures only.)

Lane 1	Lane 2	Lane 3	Lane 4	Lane 5	Lane 6	Lane 7	Lane 8
📷 16.0	📷 16.0	📷	📷	📷	📷	📷	📷
	Comments:						

CABLE LOCATOR:

When repairing paved over sensors, was an electronic cable locator used? If no, explain:	N/A	Explanation:	

Insulation leak before encapsulation: (MΩ)

L1	L2	L3	L4	L5	L6	L7	L8	L9	L10	L11	L12
OL	OL	OL	OL								

Resistance before encapsulation: (Ω)

L1	L2	L3	L4	L5	L6	L7	L8	L9	L10	L11	L12
0.94	0.92	1.07	1.01								

Inductance before encapsulation: (μH)

L1	L2	L3	L4	L5	L6	L7	L8	L9	L10	L11	L12
157.5	154.9	166.7	161.5								

Loop Length (feet):

L1	L2	L3	L4	L5	L6	L7	L8	L9	L10	L11	L12
316	316	346	346								

Loops 6' x 6'?	Yes	Cracks sealed within sensor array?	📷 N/A
Wrapped 4-times counter-clockwise?	📷 Yes	Loops and homeruns clean and dry?	Yes
Sealant within 1/16" from road surface?	📷 Yes	Lead-ins twisted/taped properly?	📷 Yes
Loops rinsed/dried a minimum of 2-times?	Yes	Saw cuts extend 8" beyond the corner?	📷 Yes
Cable at bottom of slot?	Yes	Polytube installed correctly?	📷 Yes

☐ **Deviations -**

Curing Time Matrix							
N/R = Not recommended			**Ambient Temperature in °Fahrenheit**				
Tube(s)	**30°- 45°**	**46°- 55°**	**56°- 65°**	**66°- 75°**	**76°- 80°**	**81°- 90°**	**+90°**
Per Gal	**Time in Minutes**						
1	N/R	N/R	N/R	N/R	N/R	N/R	12-18
2	N/R	30-35	25-30	20-25	15-20	10-15	Under 10
3	20-25	15-20	10-15	7-10	N/R	N/R	N/R

****Note: Loop sealant should not be over 1-year old. ****

NOTES:

Polytube was utilized in lane 1 for lane 2 sensors.

PIEZO REPLACEMENT AND INSTALLATION INFORMATION SHEET

PIEZO ELECTRONIC STATIC READINGS:

PIEZO	FROM FACTORY WARRANTY SHEET						PREP / BEFORE INSTALL		FINAL AT CABINET	
	Serial #	Sensor length	Cable length	Factory Capacitance	Dissipation	Sensor type	Cap. before grinding	Resistance	Cap. after grinding	Resistance
P1T	JBL214072	10'	300'	14.55	0.0096	BL	14.29	OL	8.69	OL
P1B	JBL214221	10'	300'	14.26	0.0403	BL	14.22	OL	8.73	OL
P2T	JBL208009	10'	300'	13.72	0.0194	BL	14.29	OL	8.99	OL
P2B	JBL214100	10'	300'	14.73	0.0082	BL	14.37	OL	9.12	OL

PIEZO INSTALLATION DETAILS:

PIEZO	Piezo installation method:	PIEZO SAW CUT		PIEZO ELEMENT(S)		Heater used:	Proper mix times (3/2 min):	Backer rod removed:	Sensor depth	Grout height
		Rinsed twice:	Clean and dry:	Tested:	Clean and dry:					
P1	stacker	Yes	Yes	Yes	Yes	No	Yes	Yes	2.5" / 1.5"	1/16"
P2	stacker	Yes	Yes	Yes	Yes	No	Yes	Yes	2.5" / 1.5"	1/16"

☐ **Deviations -**

If Road temperature is: <55 degrees, use 3 vials of the BPO / 55-75 degrees F, use 2-1/2 vials of the BPO / > 75 degrees, use 2 vials of the BPO

DO NOT use grout if over 12 months old.

NOTES:

576-D2-02023401-6

SENSOR TEST RESULTS

PRE-CONSTRUCTION:

Dir	Lane	Loop	Insulation Leak (MegaOhms)	Loop Resistance	Loop Inductance	Piezo	Piezo Capacitance / Resistance	
	1	1	Ω	Ω	µH		nF	Ω
		2	Ω	Ω	µH		nF	Ω
	2	3	Ω	Ω	µH		nF	Ω
		4	Ω	Ω	µH		nF	Ω
	3	5	Ω	Ω	µH		nF	Ω
		6	Ω	Ω	µH		nF	Ω
	4	7	Ω	Ω	µH		nF	Ω
		8	Ω	Ω	µH		nF	Ω
	5	9	Ω	Ω	µH		nF	Ω
		10	Ω	Ω	µH		nF	Ω
	6	11	Ω	Ω	µH		nF	Ω
		12	Ω	Ω	µH		nF	Ω
	7	13	Ω	Ω	µH		nF	Ω
		14	Ω	Ω	µH		nF	Ω
	8	15	Ω	Ω	µH		nF	Ω
		16	Ω	Ω	µH		nF	Ω

📷 Earth ground: 5,2 Ω

POST CONSTRUCTION:

Dir	Lane	Loop	Insulation Leak (MegaOhms)	Loop Resistance	Loop Inductance	Piezo	Piezo Capacitance / Resistance	
	1	1	OL Ω	0.83 Ω	153.2 µH	P1T	8.69 nF	OL Ω
		2	OL Ω	0.83 Ω	153.0 µH	P1B	8.73 nF	OL Ω
	2	3	OL Ω	0.89 Ω	161.3 µH	P2T	8.99 nF	OL Ω
		4	OL Ω	0.89 Ω	156.1 µH	P2B	9.12 nF	OL Ω
	3	5	Ω	Ω	µH		nF	Ω
		6	Ω	Ω	µH		nF	Ω
	4	7	Ω	Ω	µH		nF	Ω
		8	Ω	Ω	µH		nF	Ω
	5	9	Ω	Ω	µH		nF	Ω
		10	Ω	Ω	µH		nF	Ω
	6	11	Ω	Ω	µH		nF	Ω
		12	Ω	Ω	µH		nF	Ω
	7	13	Ω	Ω	µH		nF	Ω
		14	Ω	Ω	µH		nF	Ω
	8	15	Ω	Ω	µH		nF	Ω
		16	Ω	Ω	µH		nF	Ω

📷 Earth ground: 5.2 Ω

NOTES:

APPLIED RESEARCH ASSOCIATES, INC.

NON-CONFORMANCE REPORT

NCR Number:

TWO Number:

QA Inspector:

Crew Leader:

NCR Category: **Date:**

IDENTIFICATION	
Non-conformance was discovered during what activity:	
Preparation	Site pack review; vehicle, tool, materials inspection.
MOT setup	Equipment inspection, drive-thru
Site layout	Sensor layout, measurement
Shoulder work	Trenching, conduit install, junction box install, backfill, landscaping
Sensor installation	Piezo, loop installation, grout mixing, cleaning, loop sealant
Junction boxes	Collar, grade, service loops, bell ends, duct seal, marking, delineator
Cabinet work	Stickers, sensor testing, wiring, site log, ground sketch, duct seal
Solar panel	Angle, direction, hardware, wiring
Grounding	Ground wire, ground rod, ground well, cadweld
Clean up	Seed/straw, debris
DESCRIPTION (provide photographs)	
Description of non-conformance (use continuation page if necessary)	

Non-critical NCR – future disposition **Critical NCR** – immediate disposition

ACTION TAKEN ON SITE				
Action taken to prevent misuse (use continuation page if necessary)				
DISPOSITION				
Use-as-is	Rework	Repair	Replace	Reject
Approval of disposition	Assistant Program Manager Name:		Date:	
CORRECTIVE/PREVENTIVE ACTION				
Description of proposed action (use continuation page if necessary)				
APPROVAL OF CORRECTIVE/PREVENTIVE ACTION				
Program Manager			Date:	
CLOSING THE NON-CONFORMANCE				
Planned disposition has been completed and corrective/preventive action has been implemented				
Asst. Program Manager			Date:	
QA Manager			Date:	
Program Manager			Date:	

APPENDIX D – WIM SYSTEM CALIBRATION DOCUMENTS AND SAMPLE FORMS AND TOOLS

APPENDIX D – TABLE OF CONTENTS

1. FDOT Instructions for Calibrating New WIM Sites
2. FDOT Instructions for Calibrating Existing WIM Sites
3. IRD FHWA Verification 2008B WIM Calibration Tool Snapshot
4. TXDOT Standard WIM Calibration Log
5. ARA WIM Calibration Tool Snapshot
6. VDOT WIM Calibration Procedures
7. VDOT Continuous Count Station Installation WIM Calibration Report

FDOT WEIGH-IN-MOTION CALIBRATION AND ACCEPTANCE PROCEDURES

I. Precalibration Preparation for “New” WIM Sites

New WIM sites constructed either through the BC570 Telemetry System Repair contract or by roadway construction contract will not be accepted unless they are in good working order and therefore would not require issuance of task work order(TWO) for a “preventive maintenance” (PM) inspection.

The weigh-in-motion Data Quality Engineer (WIM DQE) will monitor and analyze the data from all new WIM sites to determine, to the extent practical, the operating condition and data quality of each site. These observations will be used in determining the speed points used in calibrating a WIM site. Only sites that are perceived to be in good working order will be considered as candidates for calibration and acceptance testing.
“ Before initial calibration begins, the existing site conditions shall be described quantitatively and made matter of permanent record for future reference.”

This shall include an inspection of the physical aspects of the sensors in the road, the road surface conditions, an inspection of the electrical characteristics of the WIM system electronic hardware, of the various sensors that are being used, and the utilities at the site. When logging into the WIM equipment, the communications software shall have a history or log file applications, which will create a daily file, in an ASCII type format, which chronologically records events occurring during the set up/maintenance of the WIM system. Such events shall include, but not be limited to, recording the initial calibration factors of the WIM system, the classification table, and the different sensor set up configurations.

(In other words, the WIM site has to be in good working before beginning with the initial calibration.) A report to this effect will be provided to the Transportation Statistics Office along with the history or log file from the site.

The WIM DQE will analyze this report and make a decision on whether or not to proceed with the initial calibration. Should the decision be to proceed, i.e., the site is considered to be in acceptable condition and in good working order, a written memo will be issued for calibrating the site.

Upon receipt of this memo, the contractor will notify the Department of the intended schedule. For calibration efforts to be effective, the time between precalibration preparation and the performance of the calibration must be minimized. This time period should not exceed two to three weeks. During this “lag” time, the WIM DQE will continue to remotely monitor the operation of the site. The contractor will notify the Department a minimum of one workweek prior to performing the calibration.

The WIM DQE will download at least three days, (Tuesday –Thursday), of data before the beginning of the initial calibration. (This data will give us a before “ snap-shot” of the traffic at this site, an idea of what to set the speed points at, and it will also help establish initial calibration factors.)

Once the data is analyzed, the WIM DQE will determine the three speed points the system will be calibrated at and will then notify the contractor.

II. Initial Calibration Procedures

Step One

At least one vehicle class 9-test truck shall be found that has air ride suspension in the tractor and trailer.

The test truck shall have a non-liquid load and shall be loaded at a minimum of 90 percent of the truck's legal operating weight. (Between 72 and 80 KIPS)

The procedure for weighting and measuring the test vehicle(s) to obtain reference values is found in sections 7.1.3 to 7.1.3.7 of ASTM E 1318-02.

7.1.3.1 "Measure the center-to-center spacing between successive axles on each test vehicle and record this data to the nearest 0.1 ft (0.03m) as axle-spacing reference values."

7.1.3.2 " Weigh each test vehicle a minimum of three times, with brakes released, as described in 7.1.1 and 7.1.2 to measure tire loads for the wheel(s) on each end of every axle on the static vehicle. Move the vehicle completely away from the scale or weigher before beginning a new set of tire-load measurements, and always approach the weighing devices from the same direction for weighing. Sum the applicable tire loads to determine wheel ,axle, and tandem-axle loads as well as gross-vehicle weight each time the vehicle is weighed." (A scale which weighs individual axle and tandem loads is acceptable)

7.1.3.3 " Calculate the arithmetic mean for all wheel load, axle-load, tandem-axle-load, and gross-vehicle-weight values that result from weighing each test vehicle three or more times; …"

Use the arithmetic mean of all three weighings for your "static weight values" of the test vehicle(s) for the drive axle-load(s), 1st tandem-axle-load(s), 2nd tandem-axle-load(s), and gross-vehicle- weight(s) used in the calibration/validation procedures.

Some type of communication, (cellular phone, CB radio, etc.), with the driver(s) of the test vehicle(s) will need to be established before the initial calibration begins.

Step Two

The communications software shall have a history file, (log file), applications which will create a daily file, in an ASCII type format, which chronologically records events occurring during initial calibration runs (and the final verification runs). Such events shall include, but not be limited to, recording the initial calibration factors of the WIM system, the calibration runs, final calibration factors, and any changes made to the calibration factors during the initial calibration runs, (and the final verification runs).

Step Three

The test vehicle(s) makes several runs in each lane equipped with WIM sensors to check the weight and axle spacing factors. (One run at each speed point is recommended.)

The axle spacing factor should be corrected at this time since the axle spacing is used to validate the speed-readings. Because WIM estimates are most likely speed dependent, speed accuracy is an important part of the calibration.

Each initial run will also let you know whether your weight factors are within the "ball park." Make any changes in the weight correction factors, if necessary, at this point. (Don't make any changes to any of the calibration factors until all three runs are completed.)

Step Four

The test truck(s) is driven over the WIM sensors in each lane a **minimum** of two times at each set speed point.

Due to the temperature variations you usually find during the course of the day, it's recommended that the truck starts at the lowest speed point and continues in sequence to the highest speed point.

(If the first speed point is set at 40 mph and the fifth speed point at 60 mph, then the test truck(s) will run once at 40 mph, 45 mph, 50mph, 55 mph, and 60 mph in that sequence, and then run once more at the same sequence; for a total of 10 runs.) (The gross weight percent error is calculated for each run and then this information is plotted on a " Gross Weight Percent Error By Vehicle Speed" graph for each WIM lane.

These graphs are analyzed to adjust the WIM weight factors. If more runs are needed to make the final adjustments, they will also be done in sequence, starting at the first speed point and continuing to the highest speed point.

(The vendor needs to prove that the system is linearly calibratable and meet the accuracy requirements set forth in the table 2 under Section 5 of the ASTM E 1318-02 of the Standard Specification for Highway WIM .)

Make final adjustments to weight and axle spacing factors before accuracy requirement testing begins.

If initial calibration is done on a different day from the accuracy requirement testing, download that days' data file.

III. Accuracy Requirement Testing Procedures

The Accuracy Requirement Testing has to take place within thirty days of the initial calibration. The WIM DQE will be on site to monitor the Accuracy Requirement Testing.

Step One

Repeat Step One of the initial calibration procedures.

Step Two

Start your history (log) file; (see Step Two of the initial calibration procedures).

Step Three

The test truck(s) is driven over the WIM sensors in each lane a minimum of four times at each set speed point, (these speed points will be determined by the WIM QDE before the initial Calibration even begins).

Due to the temperature variations you usually find during the course of the day, the truck will start at the lowest speed point and continue in sequence to the highest speed point.

(If the 1st speed point is set at 40 mph and the fifth speed point is set at 60 mph, then the test truck(s) will start at 40mph and then go in sequence to 45 mph, then to 50 mph, etc., until you have reached 60 mph. The truck(s) will then start all over again and repeat the same sequence three more times until there are a total of 20 runs for each test truck used in the validation.). The gross weight percent error is calculated for each run and then this information is plotted on a " Gross Weight Percent Error By Vehicle Speed" graph for each WIM lane.

These graphs are analyzed to make the final adjustments to the WIM weight factors if necessary. (They are also used to record pavement effects on vehicle dynamics for the site history.)

If for any reason an adjustment needs to be made to the WIM Weight or Spacing factors, before all runs are completed, the validation runs will have to start all over again.

Step Four

Down load your data file and close and save your history (log) file.

A copy of all data files, history (log) files, and graphs will be provided to the Transportation Statistics Office.

For the site calibration to be accepted, the gross weight percent error of the validation data will have to be evenly distributed around the zero axis of the " Gross Weight Percent Error By Vehicle Speed" graph for each speed point in each WIM lane. For a Type II WIM System the validation data will meet (or exceed) the functional performance requirements as found in table 2 under Section 5 of the ASTM E 1318-02 of the Standard Specifications for Highway WIM.

1. Gross-Vehicle Weight : +/- 15%
2. Axle-Group Load: +/- 20 %
3. Axle Load: +/- 30 %

For a Type I WIM System the validation data will meet (or exceed) the functional performance requirements as found in table 2 under Section 5 of the ASTM E 1318-02 of the Standard Specifications for Highway WIM.

1. Gross-Vehicle Weight: +/- 10%
2. Axle-Group Load: +/- 15%
3. Axle Load: +/- 25%

FDOT WEIGH- IN- MOTION CALIBRATION AND VALIDATION PROCEDURES

I. Precalibration Preparation for Existing WIM Sites

The weigh-in-motion Data Quality Engineer (WIM DQE) will monitor and analyze the data from all WIM sites to determine, to the extent practical, the operating condition and data quality of each site. These observations will be used in determining the need for calibrating a WIM site. Only sites that are perceived to be in good working order will be considered as candidates for calibration.

Once a site has been determined to be a candidate for calibration, a task work order (TWO) will be issued to the contractor for a “preventive maintenance” (PM) inspection.
Note: A WIM site that is being repaired through the BC570 Telemetry System Repair Contract will be considered a candidate for calibration when the repairs warrant the need for calibration. As part of the repair TWO, any necessary PM inspections should be conducted and a separate PM TWO will not be issued
Before initial calibration begins, the existing site conditions shall be described quantitatively and made matter of permanent record for future reference.
This shall include an inspection of the physical aspects of the sensors in the road, the road surface conditions, an inspection of the electrical characteristics of the WIM system electronic hardware, of the various sensors that are being used, and the utilities at the site.
When logging into the WIM equipment, the communications software shall have a history or log file applications, which will create a daily file, in an ASCII type format, which chronologically records events occurring during the set up/maintenance of the WIM system. Such events shall include, but not be limited to, recording the initial calibration factors of the WIM system, (Modes 0, 1,and 2 of the PAT Systems) the classification table, (Mode 3 of the PAT Systems) and the different sensor set up configurations, (Mode 5,6 and where applicable Mode J , L and P).

(In other words, the WIM site has to be in good working before beginning with the initial calibration.) A report to this effect will be provided to the Transportation Statistics Office along with the history or log file from the site.

The WIM DQE will analyze this report and make a decision on whether or not to proceed with the initial calibration. Should the decision be to proceed, i.e., the site is considered to be in acceptable condition and in good working order, a TWO will be issued for calibrating the site.

Upon receipt of a TWO for calibrating a WIM site, the contractor will notify the Department of the intended schedule. For calibration efforts to be effective, the time between precalibration preparation and the performance of the calibration must be minimized. This time period should not exceed two to three weeks. During this “lag” time, the WIM DQE will continue to remotely monitor the operation of the site. The contractor will notify the Department a minimum of one workweek prior to performing the calibration.

The WIM DQE will download at least three days, (Tuesday –Thursday), of data before the beginning of the initial calibration. (This data will give us a before “ snap-shot” of the traffic at this site, an idea of what to set the speed points at, and it will also help establish initial calibration factors.)

Once the data is analyzed, the WIM DQE will determine the three speed points the system will be calibrated at and will then notify the contractor.

II. Initial Calibration Procedures

Step One

At least one vehicle class 9-test truck shall be found that has air ride suspension in the tractor and trailer.

The test truck shall have a non-liquid load and shall be loaded at a minimum of 90 percent of the truck's legal operating weight. (Between 72 and 80 KIPS)

This procedure for weighting and measuring the test vehicle(s)in order to obtain reference values is found in sections 7.1.3 to 7.1.3.7 of ASTM E 1318-02.

7.1.3.1 "Measure the center-to-center spacing between successive axles on each test vehicle and record this data to the nearest 0.1 ft (0.03m) as axle-spacing reference values."

7.1.3.2 " Weigh each test vehicle a minimum of three times, with brakes released, as described in 7.1.1 and 7.1.2 to measure tire loads for the wheel(s) on each end of every axle on the static vehicle. Move the vehicle completely away from the scale or weigher before beginning a new set of tire-load measurements, and always approach the weighing devices from the same direction for weighing. Sum the applicable tire loads to determine wheel ,axle, and tandem-axle loads as well as gross-vehicle weight each time the vehicle is weighed." (A scale which weighs individual axle and tandem loads is acceptable)

7.1.3.3 " Calculate the arithmetic mean for all wheel load, axle-load, tandem-axle-load, and gross-vehicle-weight values that result from weighing each test vehicle three or more times; …"

Use the arithmetic mean of all three weighings for your "static weight values" of the test vehicle(s) for the drive axle-load(s), 1st tandem-axle-load(s), 2nd tandem-axle-load(s), and gross-vehicle- weight(s) used in the calibration/validation procedures.

Some type of communication, (cellular phone, CB radio, etc.), with the driver(s) of the test vehicle(s) will need to be established before the initial calibration begins.

Step Two

The communications software shall have a history file, (log file), applications which will create a daily file, in an ASCII type format, which chronologically records events occurring during initial calibration runs (and the final verification runs). Such events shall include, but not be limited to, recording the initial calibration factors of the WIM system, the calibration runs, final calibration factors, and any changes made to the calibration factors during the initial calibration runs, (and the final verification runs).

Step Three

The test vehicle(s)will make several runs in each lane equipped with WIM sensors to check the weight and axle spacing factors. (At least one run at each speed point.) The axle spacing factors would be corrected at this time since the axle spacing is used to validate the speed-readings. Because WIM estimates are most likely speed dependent, speed accuracy is an important part of the calibration.

Each initial run will also let you know whether your weight factors are within the "ball park." Make any changes in the weight correction factors, if necessary, at this point. (Don't make any changes to any of the calibration factors until all three runs are completed.)

Step Four

The test truck(s) is driven over the WIM sensors in each lane a **minimum** of two times at each set speed point.
Due to the temperature variations you usually find during the course of the day, it's recommended that the truck starts at the lowest speed point and continues in sequence to the highest speed point.
(If the first speed point is set at 40 mph and the fifth speed point at 60 mph, then the test truck(s) will run once at 40 mph, 45 mph, 50mph, 55 mph, and 60 mph in that sequence, and then run once more at the same sequence; for a total of 10 runs.) (The gross weight percent error is calculated for each run and then this information is plotted on a " Gross Weight Percent Error By Vehicle Speed" graph for each WIM lane.
These graphs are analyzed to adjust the WIM weight factors. If more runs are needed to make the final adjustments, they will also be done in sequence, starting at the first speed point and continuing to the highest speed point.
(The vendor needs to prove that the system is linearly calibratable and meet the accuracy requirements set forth in the table 2 under Section 5 of the ASTM E 1318-02 of the Standard Specification for Highway WIM .)
Make final adjustments to weight and axle spacing factors before accuracy requirement testing begins.
If initial calibration is done on a different day from the accuracy requirement testing, download that days' data file.

III. Validation Testing Procedures

The Validation Testing has to take place within thirty days of the initial calibration.
The WIM DQE will be on site to monitor the Validation Testing.

Step One

Repeat Step One of the initial calibration procedures.

Step Two

Start your history (log) file; (see Step Two of the initial calibration procedures).

Step Three

The test truck(s) is driven over the WIM sensors in each lane a minimum of four times at each set speed point, (these speed points will be determined by the WIM QDE before the initial Calibration even begins).
Due to the temperature variations you usually find during the course of the day, the truck will start at the lowest speed point and continue in sequence to the highest speed point.
(If the 1st speed point is set at 40 mph and the fifth speed point is set at 60 mph, then the test truck(s) will start at 40mph and then go in sequence to 45 mph, then to 50 mph, etc., until you have reached 60 mph. The truck(s) will then start all over again and repeat the same sequence three more times until there are a total of 20 runs for each test truck used in the validation.). The

gross weight percent error is calculated for each run and then this information is plotted on a " Gross Weight Percent Error By Vehicle Speed" graph for each WIM lane.
These graphs are analyzed to make the final adjustments to the WIM weight factors if necessary. (They are also used to record pavement effects on vehicle dynamics for the site history.)
If for any reason an adjustment needs to be made to the WIM Weight or Spacing factors, before all runs are completed, the validation runs will have to start all over again.

Step Four

Down load your data file and close and save your history (log) file.

A copy of all data files, history (log) files, and graphs will be provided to the Transportation Statistics Office.

For the site calibration to be accepted, the gross weight percent error of the validation data will have to be evenly distributed around the zero axis of the " Gross Weight Percent Error By Vehicle Speed" graph for each speed point in each WIM lane. For a Type II WIM System the validation data will meet (or exceed) the functional performance requirements as found in table 2 under Section 5 of the ASTM E 1318-02 of the Standard Specifications for Highway WIM.
1. Gross-Vehicle Weight : +/- 15%
2. Axle-Group Load: +/- 20 %
3. Axle Load: +/- 30 %

For a Type I WIM System the validation data will meet (or exceed) the functional performance requirements as found in table 2 under Section 5 of the ASTM E 1318-02 of the Standard Specifications for Highway WIM.

1. Gross-Vehicle Weight: +/- 10%
2. Axle-Group Load: +/- 15%
3. Axle Load: +/- 25%

International Road Dynamics Inc.

FHWA VERIFICATION 2008b

Static Test Vehicle Measurements

ID				GVW	F/A	T1	T2	1>2	2>3	3>4	4>5
1				78.2	11.5	33.0	34.0				

Dynamic Test Vehicle Measurements

ID	V#	Speed	Temp	GVW	F/A	T1	T2	1>2	2>3	3>4	4>5
1	31648	64		78.2	10.7	33.6	33.9				
1	32537	63		79.8	11.6	33.6	34.6				
1	33290	64		77.0	10.2	34.1	32.8				
1	27181	64		79.1	10.6	33.1	35.4				
1	28658	64		78.3	11.0	32.9	34.4				
1	29411	64		78.7	9.7	33.8	35.1				
1	30492	61		79.0	10.5	33.9	34.6				
1	31237	61		78.1	10.5	34.2	33.3				
1	32108	63		79.6	10.1	34.9	34.5				
1	32869	62		75.6	9.5	32.8	33.3				
1	13315	73		73.8	9.7	32.2	31.9				
1	14452	73		81.4	10.7	34.0	36.8				
1	15163	73		80.9	11.4	34.6	34.8				
1	20333	73		77.3	10.4	32.2	29.2				
1	21249	70		81.9	10.8	37.9	33.1				
1	14122	72		78.8	9.6	35.0	33.9				
1	15449	70		79.1	9.9	35.8	33.5				
1	16663	70		77.4	10.7	32.7	33.1				
1											

Date:

Technician:

Location:

International Road Dynamics Inc.

FHWA VERIFICATION 2008b

Specifications

Confidence	95%	Speed range low	45	to	55
	(1.96)	Speed range medium	55	to	65
Gross vehicle weight	10%	Speed range high	65	to	76
Tandem group weight	15%	Temperature range low	60	to	80
Single axle weight	20%	Temperature range medium	80	to	100
Axle spacings	0.5	Temperature range high	100	to	120

Overall

Characteristic	Error	StdDev	Specification	Calculated	Pass/Fail
Gross vehicle weight	0.5%	2.5%	10%	5.4%	pass
Tandem group weight	1.1%	4.8%	15%	10.5%	pass
Single axle weight	-9.4%	5.2%	20%	19.6%	pass
Axle spacings	#DIV/0!	#DIV/0!	0.5	#NUM!	#NUM!

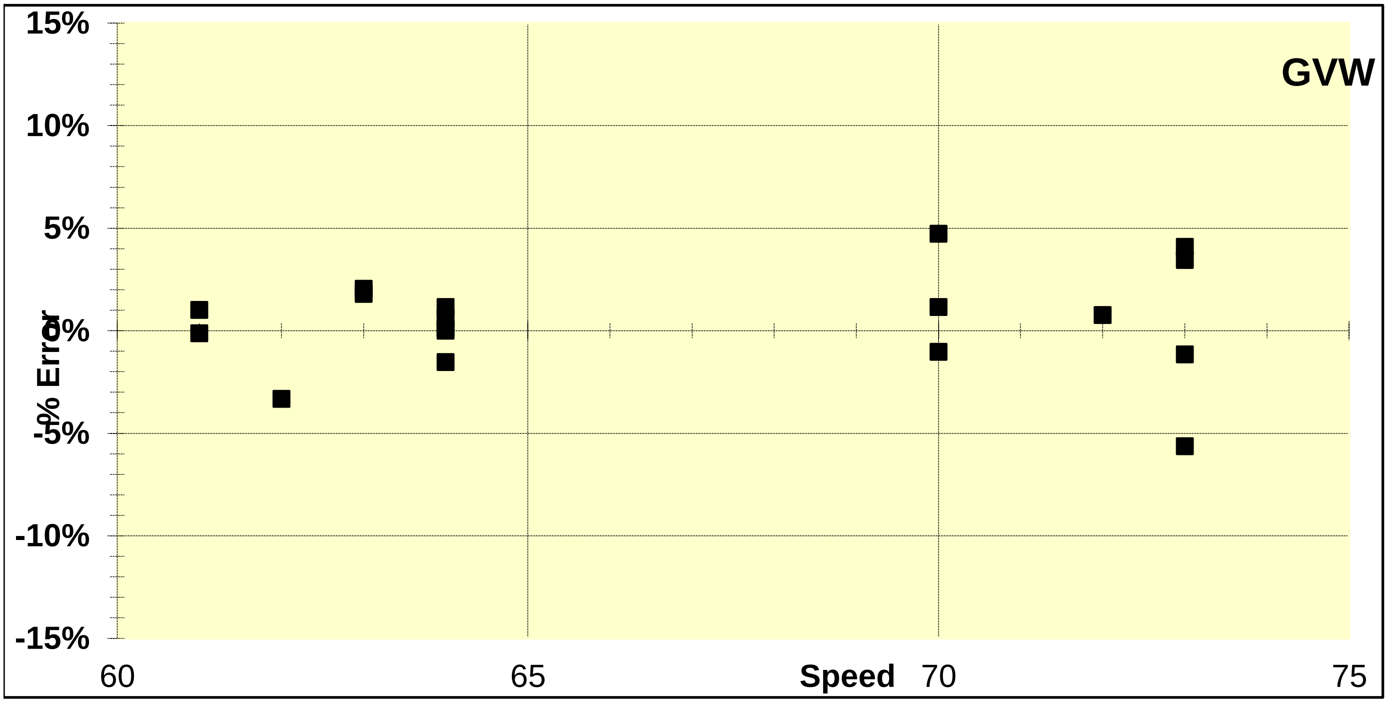
Speed range 55 to 65 (10 runs)

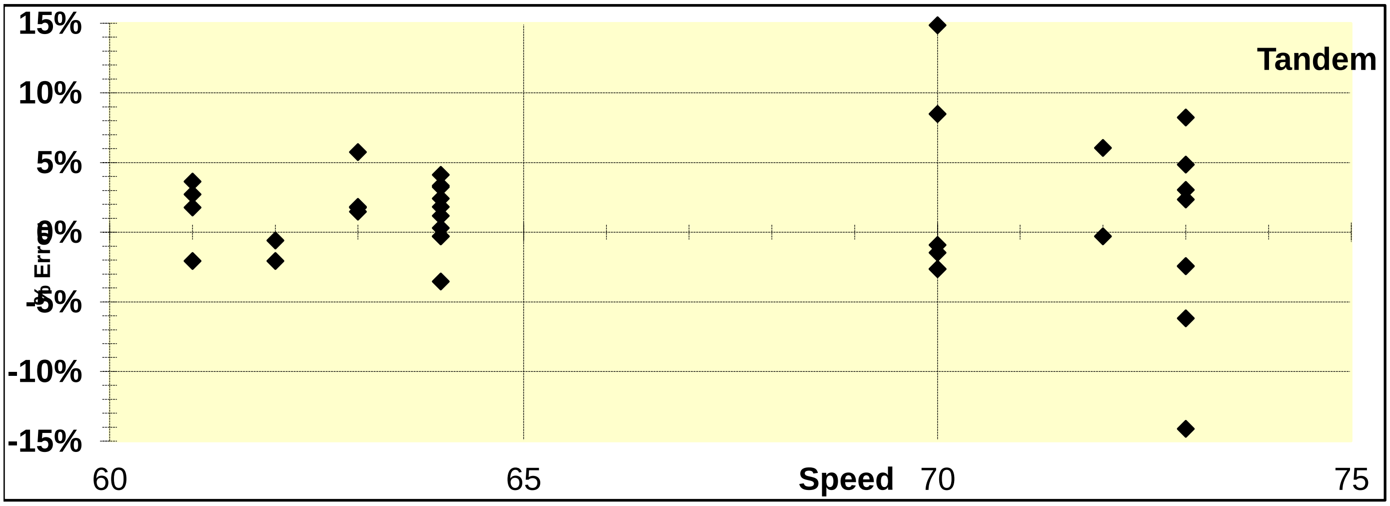
Characteristic	Error	StdDev	Specification	Calculated
Gross vehicle weight	0.2%	1.6%	10%	3.6%
Tandem group weight	1.3%	2.3%	15%	6.0%
Single axle weight	-9.2%	5.3%	20%	20.4%
Axle spacings	#DIV/0!	#DIV/0!	0.5	#NUM!

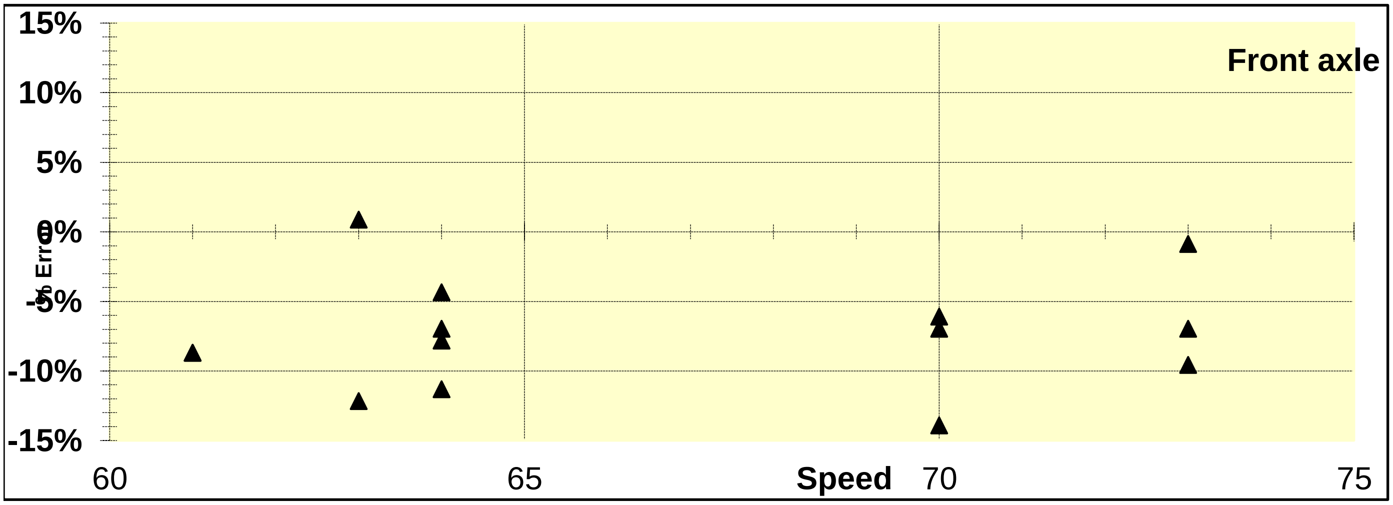
Speed range 65 to 76 (8 runs)

Characteristic	Error	StdDev	Specification	Calculated
Gross vehicle weight	0.8%	3.4%	10%	8.0%
Tandem group weight	0.9%	6.8%	15%	14.7%
Single axle weight	-9.6%	5.4%	20%	21.0%
Axle spacings	#DIV/0!	#DIV/0!	0.5	#NUM!

Location ?　　Technician ?　　Date ?





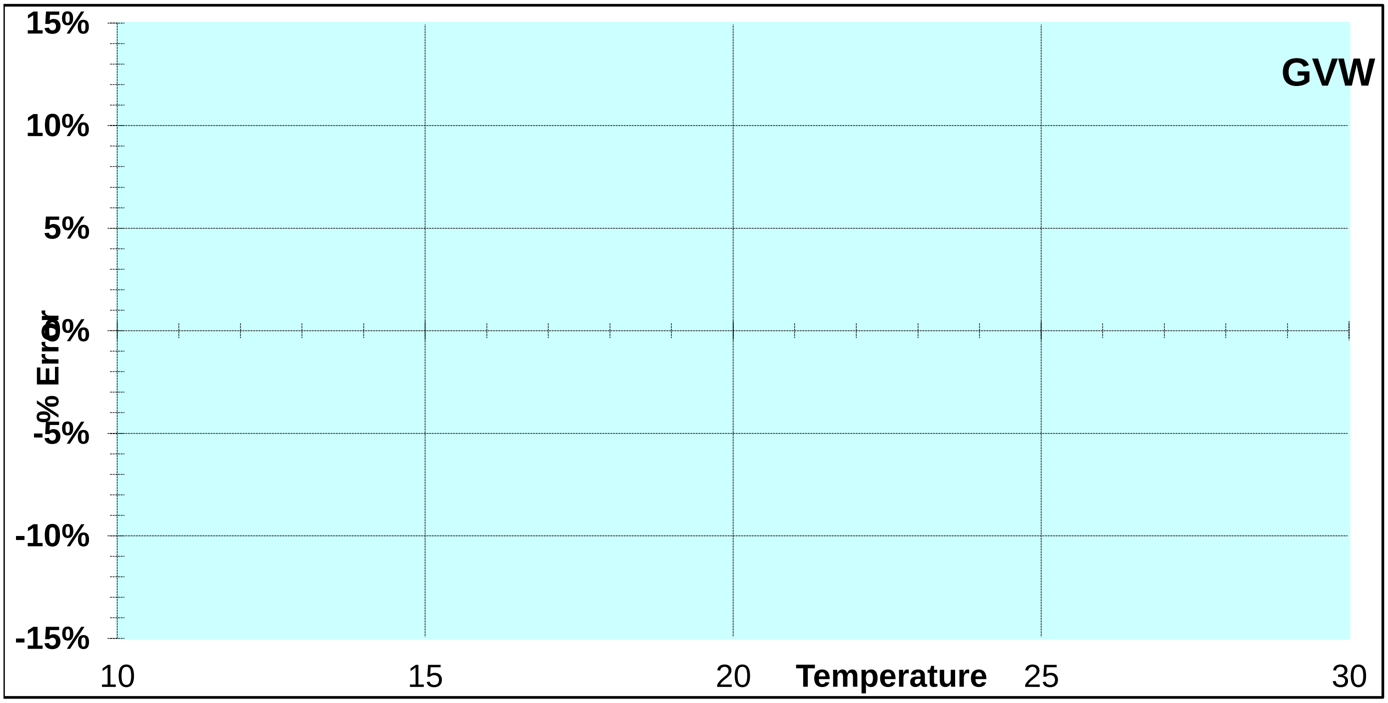


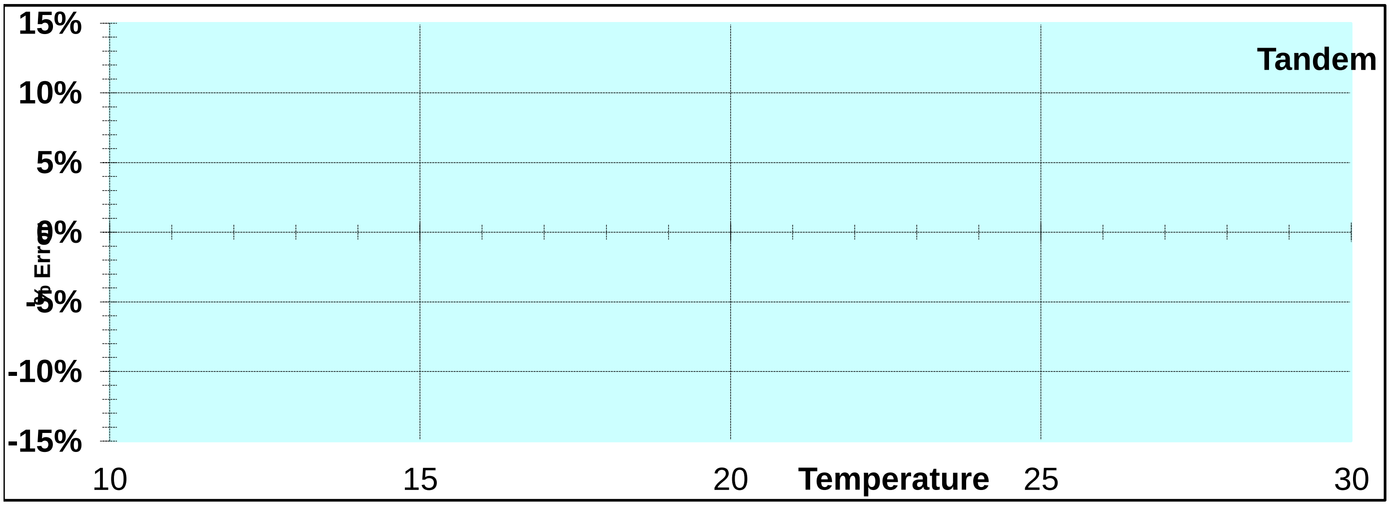
Location ?

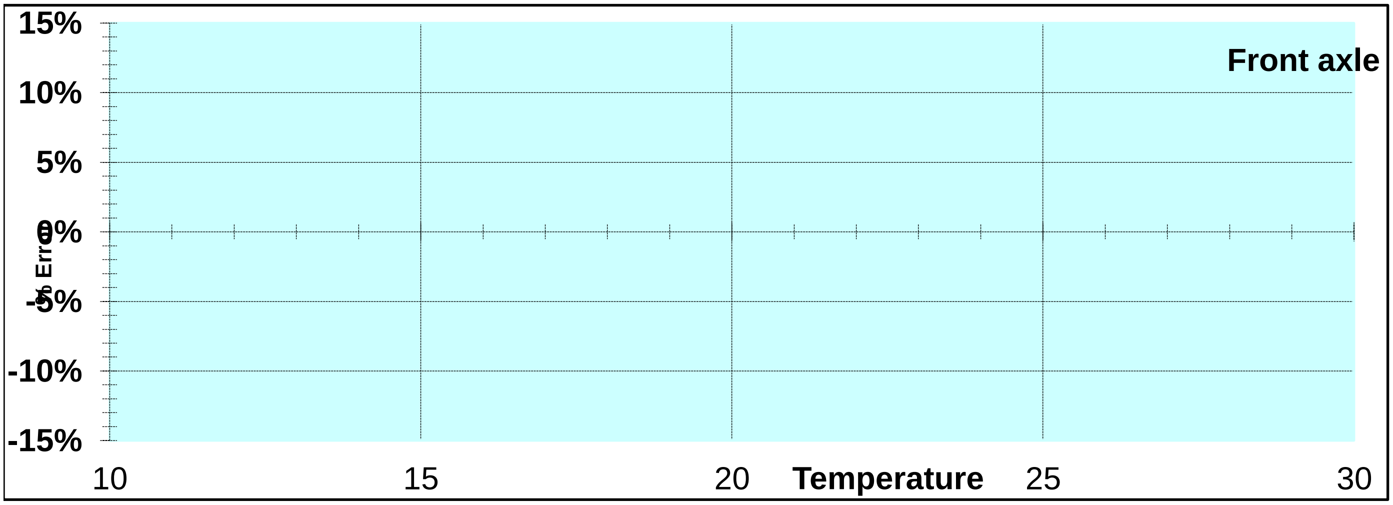
Technician ?

Date ?

FHWA VERIFICATION 2008b







Location ?

Technician ?

Date ?

CALIBRATION LOG FOR WEIGH-IN-MOTION

Site # LW-513 **in** Bell **County**

Date 8-12-15 **Cal Truck Type** 5 axle

Gross Wt. 78.2 **St Ax** 11.5 **Dr Ax** 33.0 **TrAx/s** 34.0

Technician Cloyd, Alencio **Posted Highway Speed** 75

LANE (1) **Correction Factor** 975

	Gross (WIM)	St Ax	Dr Ax/Axs	Tr Ax/Axs	Speed	Truck	
30147	(1) 84.5	11.6	34.4	38.6	65	65	
30930	(2) 74.4	10.6	31.8	32.0		64	925
31648	(3) 78.2 78.3	10.7	33.6	33.9		64	935
32537	(4) 79.8 78'	11.6 10.8	33.6	34.6		63	
	Avg 77.0	10.2	34.1	32.8		64	
33290	GVW	Av	= M Factor	x Correciton Factor = (NCF)			
	Check Run			New Calibration Factor	935		

LANE (2) **Correction Factor** 1000

	Gross (WIM)	St Ax	Dr Ax/Axs	Tr Ax/ Axs	Speed	Truck	
26454	(1) 81.9	11.0	35.1	35.8	65	65	
27181	(2) 79.1	10.6	33.1	35.4		64	970
28658	(3) 78.3 78.7	11.0 10.4	32.9	34.4		64	
29411	(4) 78.6	9.7	33.8	35.1		64	
.6%	Avg						
	GVW	Av	= M Factor	x Correction Factor = (NCF)			
	Check Run			New Correction Factor	970		

LANE (~~2~~) 5 **Correction Factor** 925 No Change

	Gross (WIM)	St Ax	Dr Ax/Axs	Tr Ax/ Axs	Speed	Truck
26768	(1) 75.8	9.4	33.2	33.1	65	63
27521	(2) 77.4 77.2	9.6 9.7	33.9	33.9		62
29021	(3) 78.4	10.1	33.4	34.9		62
	(4)					
-1.3%	Avg					
	GVW	Av	= M Factor	x Correction Factor = (NCF)		
	Check Run			New Correction Factor	925	

LANE (~~4~~) 6 **Correction Factor** 1005

	Gross (WIM)	St Ax	Dr Ax/Axs	Tr Ax/ Axs	Speed	Truck	
29753	(1) 84.0	9.9	36.3	36.8	65		
30492	(2) 79.0	10.5	33.9	34.6	61		950
31237	(3) 78.1	10.5 2	34.2	33.3	61		
32108	(4) 79.6 78.1	10.1 10'	34.9	34.5	63		
	Avy 75.6	9.5	32.8	33.3	62		
32869	GVW	Av	= M Factor	x Correction Factor = (NCF)			
	Check Run			New Correction Factor	950		

CALIBRATION LOG FOR WEIGH-IN-MOTION

Site # LW-513 **in** Bell **County**

Date 8-12-15 **Cal Truck Type** 5 Axle

Gross Wt. 78.2 **St Ax** 11.2 **Dr Ax** 33. **TrAx/s** 34.0

Technician Lloyd, Atenzio **Posted Highway Speed** 75

LANE (1) **Correction Factor** 970

	Gross (WIM)	St Ax	Dr Ax/Axs	Tr Ax/Axs	Speed	Truck	
11674	(1) 82.3	11.6	35.2	35.4	75	73	
12801	(2) 71.7	10.9	29.5	30.8		-75	945
13315	(3) 73.8 *	9.7	32.2	31.9		73	955
13964	(4) ~~55.7~~ 78 ~~14.9~~						~~970~~
14452	Avg 81.4 *	10.7	34.0	36.8 34.8		73	955
15163	GVW 80.9 * Av 11.4	= M Factor 34.6	x Correciton Factor = (NCF)			73	"
6.7%	Check Run		New Calibration Factor			955	

LANE (2) **Correction Factor** 1060

	Gross (WIM)	St Ax	Dr Ax/Axs	Tr Ax/ Axs	Speed	Truck	
12249	(1) 85.2	11.6	37.2	36.3	75	74	
15502	(2) 81.5	11.6	35.0	34.9		77	1020
16390	(3) 78.5 79.0	10.5	33.6	34.4		73	1000
17036	(4) 80.2	10.0	35.1	34.3		72	
17753	Avg 78.4	10.5	34.8	33.2		74	
	GVW Av	= M Factor	x Correction Factor = (NCF)				
1%	Check Run		New Correction Factor			1000	

LANE (3) **Correction Factor** 1035

	Gross (WIM)	St Ax	Dr Ax/Axs	Tr Ax/ Axs	Speed	Truck	
18405	(1) 81.1	11.6	32.7	36.8	75	73	
19066	(2) 80.2	9.4	34.3	36.5		74	1015
19682	(3) 82.2	10.7	34.4	37.1		75	1000
20333	(4) 77.3 74.5	9.0	33.2	35.1		74	975
20962	Avg 71.8	10.4	32.2	29.2 32.0		73	
21656	GVW 74.5 Av 9.4	= M Factor 33.2	x Correction Factor = (NCF)			74	
4.7%	Check Run		New Correction Factor			975	

LANE (4) **Correction Factor** 965

	Gross (WIM)	St Ax	Dr Ax/Axs	Tr Ax/ Axs	Speed	Truck	
18686	(1) 80.2	10.5	35.6	34.2	75	73	
20609	(2) 82.2	11.0	35.2	36.1		70	950
21249	(3) 71.4	8.7	30.9	33.0		72	920
21927	(4) 81.9	10.8	37.9	33.1		70	930
22591	Avy 79.7 80.0	9.4	34.4	36.0		68	
	GVW Av	= M Factor	x Correction Factor = (NCF)				
3.3%	Check Run		New Correction Factor			930	

CALIBRATION LOG FOR WEIGH-IN-MOTION

Site # LW-513 **in** Bell **County**

Date 8-12-15 **Cal Truck Type** 5 Axle

Gross Wt. 78.2 **St Ax** 11.5 **Dr Ax** 33. **TrAx/s** 34.0

Technician Lloyd Atencio **Posted Highway Speed** 75

LANE ~~(1)~~ 5 **Correction Factor** 920

	Gross (WIM)	St Ax	Dr Ax/Axs	Tr Ax/Axs	Speed	Truck	
13022	(1) 79.4	9.8	35.6	34.0	75	72	
16663	(2) 77.4	10.7	35.1	31.6		70	910
17398	(3) 75.0 76.4	9.2	32.7	33.1		72	
18071	(4) 76.7	9.0	34.3	33.3		71	
2.3%	Avg						

GVW ____ **Av** ____ **= M Factor** ____ **x Correciton Factor = (NCF)** ____

Check Run ____ **New Calibration Factor** 910

LANE ~~(2)~~ 6 **Correction Factor** 1000

	Gross (WIM)	St Ax	Dr Ax/Axs	Tr Ax/ Axs	Speed	Truck	
11952	(1) 80.0	9.9	37.5	32.7	75	69	
12478	(2) 82.3	10.2	37.1	35.0		71	980
13544	(3) 74.2	9.8	33.0	31.3		70	950
14122	(4) 78.8	9.6	35.	33.9		72	965
15449	Avg 79.1 SMP	9.9	35.8	33.5		70	
1%							

GVW ____ **Av** ____ **= M Factor** ____ **x Correction Factor = (NCF)** ____

Check Run ____ **New Correction Factor** 965

LANE (3) **Correction Factor** ____

Gross (WIM)	St Ax	Dr Ax/Axs	Tr Ax/ Axs	Speed	Truck
(1)					
(2)					
(3)					
(4)					
Avg					

GVW ____ **Av** ____ **= M Factor** ____ **x Correction Factor = (NCF)** ____

Check Run ____ **New Correction Factor** ____

LANE (4) **Correction Factor** ____

Gross (WIM)	St Ax	Dr Ax/Axs	Tr Ax/ Axs	Speed	Truck
(1)					
(2)					
(3)					
(4)					
Avy					

GVW ____ **Av** ____ **= M Factor** ____ **x Correction Factor = (NCF)** ____

Check Run ____ **New Correction Factor** ____

WIMSUITE

MAIN MENU

APPLIED RESEARCH ASSOCIATES, INC.

Forms and Tables

View	Description	Shortcut
Site Setup	Site Information	Ctrl-e
Cal Setup	Calibration Information and Setup	
Cal_Truck_Data	Composite Test Truck Weight and Spacing Data	Ctrl-t
Truck_Runs_Checks	Test Truck Run Data and Verification	Ctrl-i
Sheet_20_Results	Classification and Speed Study Results	
Results_by_Truck	Tabular Results by Truck	
Results_by_Speed	Tabular Results by Speed	
Results_by_Temp	Tabular Results by Temperature	
Cal_Factors	Starting and Recommended Calibration Factors	Ctrl-j
Statistical_Results	Statistical Results in Tabular Form	Ctrl-r
Report_Tables	Formatted Report Tables	

Forms

View	Description	.pdf
Class	Speed and Classification Studies	
Run Data	WIM Site Truck Records	
Equipment	Site Photo Log - Equipment	
Trucks	Site Photo Log - Trucks	
Pavement	Site Photo Log - Blank	

Graphs

View	Description	Shortcut
Speed_Temp	Speed v Temperature Combinations	Ctrl-g
Speed_GVW	GVW Error by Speed	
Speed_Steer	Steering Axle Error by Speed	
Speed_Single	Single Axle Error by Speed	
Speed_Tandem	Tandem Axle Error by Speed	
Speed_Tridem	Tridem Axle Error by Speed	
Speed_AL	Axle Length Error by Speed	
Speed_OL	Overall Length by Speed	
Speed_Truck_GVW	GVW Error by Truck by Speed	
Speed_Truck_Steer	Steer Error by Truck by Speed	
Temp_GVW	GVW Error by Temperature	Ctrl-w
Temp_Steer	Steering Axle Error by Temperature	
Temp_Single	Single Axle Error by Temperature	
Temp_Tandem	Tandem Axle Error by Temperature	
Temp_Tridem	Tridem Axle Error by Temperature	
Temp_AL	Axle Length Error by Temperature	
Temp_OL	Overall Length by Temperature	
Temp_Truck_GVW	GVW Error by Truck by Temperature	
Temp_Truck_Steer	Steer Error by Truck by Temperature	

SITE SETUP PAGE

Clear

Site Info

State -
State Abbreviation - #N/A
Location -

State Site#
Lane #

Route -
Milepost -

Speed Limit -
Pavement type -

Equipment

WIM Equipment Type -
Sensor Type -
Classification Scheme -
Unclassified Vehicle -
Auto-Calibration -

CALIBRATION SETUP PAGE

Clear

System Parameters

Weather -			Date -	

# of Calibration Factors -	1
WIM Equipment Type -	0

Speed Points		
bin #	mph	kph
1 -		
2 -		
3 -		
4 -		
5 -		

Sensor Distance Factor -	
Loop Width Factor -	

Truck Test Speeds		
1 -		
2 -		
3 -		

Weight Multiplier -	

IRD iSINC or 1060 Series				
Dynamic Compensation -				
Side -	Left		Right	
Sensor -				
1 -				
2 -				
3 -				
4 -				
5 -				

IRD DAW	
Overall -	
F/A -	
Left -	
Right -	
SP1 -	
SP2 -	
SP3 -	

Peek ADR	
Left -	
Right -	

Mettler	
Heavy -	
Medium -	
Light -	

TEST TRUCK INFORMATION

☐ Clear

# of Test Trucks -	

	Class	Suspension			Axle Spacings		
		Steer	Drive	Trailer	Drive	Trailer	Tridem
Test Truck 1 -							
Test Truck 2 -							
Test Truck 3 -							

Truck Names	
Truck 1 -	Primary
Truck 2 -	
Truck 3 -	

Odometer Readings			MPG
Truck	Before	After	
1			
2			
3			

Pre-Test

Truck	Weigh	Axle A weight	Axle B weight	Axle C weight	Axle D weight	Axle E weight	Axle F weight	GVW	A-B space	B-C space	C-D space	D-E space	E-F space	OL	AL

Instance #1

Truck	Weigh	Axle A weight	Axle B weight	Axle C weight	Axle D weight	Axle E weight	Axle F weight	GVW

Instance #2

Truck	Weigh	Axle A weight	Axle B weight	Axle C weight	Axle D weight	Axle E weight	Axle F weight	GVW

Post-Test

Truck	Weigh	Axle A weight	Axle B weight	Axle C weight	Axle D weight	Axle E weight	Axle F weight	GVW

Averages

trucks -			
weights			
Axle 1			
Axle 2			
Axle 3			
Tandem 1			
Axle 4			
Axle 5			
Tandem 2			
Axle 6			
Tridem			
GVW			
axle spacings			
A-B			
B-C			
C-D			
D-E			
E-F			
OL			
AL			

TEST TRUCK RUN DATA

Calibration Round -

Start Time - 0:00

Stop Time - 0:00

Total Passes	Truck Pass	Truck #	Time	Vehicle #	Class	Temp	WIM Speed	Radar Speed	Axle A weight (Left/Right)		Axle B weight (Left/Right)	

CALIBRATION FACTOR ADJUSTMENTS

# of Test Trucks -	0
# of Speed Bins -	3

Equipment -	0
Weight Multiple -	0

Calibration -	Auto

Reset

Setup

Equipment Type -		0	
test speeds		Speed	Mean GVW
1 -	Low		
2 -	Medium		
3 -	High		

Front Axle Calibration

Old Front Axle Factor -	
Static Front Axle -	
Static GVW -	
WIM Front Axle weight -	
WIM GVW Average weight -	
Front Axle measurement error -	
GVW measurement error -	
Difference (pct) -	
Adjustment factor -	1.00
Adjusted error (pct) -	
Zero -	
New Front Axle factor -	
Expected Front Axle WIM measurement -	
Expected WIM GVW measurement -	
Expected Front Axle measurement error -	
Expected GVW measurement error -	

Distance Measurement Calibration

Static			
Truck	# of runs	AL	OL
Primary -	0		
Secondary -	0		
Third -			

WIM

Overall Length Calculation				
0	%	OL error	% error	weighted
	#DIV/0!		#VALUE!	
wgtd. err	%	old factor	change	new factor

Axle Length Calculation				
0	%	AL error	% error	wgtd err
	#DIV/0!		#VALUE!	#VALUE!
wgtd. err	%	old factor	change	new factor

Weight Compensation Factor Calibration

IRD iSINC/1060 Series

IRD DAW-190

PEEK

Mettler

ECM

STATISTICAL RESULTS

Overall Results

All Test Runs

	mean	2SD	P/F	low limit	high limit	1SD
steering axle						
tandem axles						
GVW						
single axles						
axle groups						
tridem axles						
vehicle length (ft)						
vehicle speed (mph)						
axle spacing (ft)						

Data Entry and Review

data entry -	
review -	

Clear

Results by Truck

All Trucks

	mean	2SD	P/F	low limit	high limit	1SD
steering axle						
tandem axles						
GVW						
single axles						
axle groups						
tridem axles						
vehicle length (ft)						
vehicle speed (mph)						
axle spacing (ft)						

	mean	2SD	P/F	low limit	high limit	1SD
steering axle						
tandem axles						
GVW						
single axles						
axle groups						
tridem axles						
vehicle length (ft)						
vehicle speed (mph)						
axle spacing (ft)						

	mean	2SD	P/F	low limit	high limit	1SD
steering axle						
tandem axles						
GVW						
single axles						
axle groups						
tridem axles						
vehicle length (ft)						
vehicle speed (mph)						
axle spacing (ft)						

	mean	2SD	P/F	low limit	high limit	1SD
steering axle						
tandem axles						
GVW						
single axles						
axle groups						
tridem axles						
vehicle length (ft)						
vehicle speed (mph)						
axle spacing (ft)						

1. The Contractor shall not charge VDOT for a TMA when site conditions make it possible to park all service vehicles beyond the clear zone and work being performed is beyond the clear zone.

(h) The Contractor will implement the policy of avoidance of re-using old piezo saw slots for new installations.

(i) The Contractor shall incorporate the proposed "WIM Calibration Activity Plan" as detailed below Into the contract:
"The WIM calibration performance evaluation activities will be in accordance with the <u>LTPP Field Operations Guide for SPS WIM Sites</u> (WIM Guide), Sections 3 and 4, and directed by the On-Site Task Leader. The activities described in this section will be carried out without closing any travel lanes lane to traffic. The main performance evaluation activities will include:

☐ Pre-Validation Briefing

☐ Site Inventory

☐ Pre-Evaluation Site Assessment

☐ WIM System Troubleshooting (if required)

☐ Static weighing and measuring of test trucks

☐ Equipment Setup

☐ Initial Performance Evaluation – initial set of test truck runs

☐ Calibration

☐ Validation – final test truck runs

☐ Statistical Data Analysis

☐ Data Download

☐ Secure Site and Validation Equipment

Pre-Validation Briefing

A Pre-Validation Briefing will be conducted by the On-Site Task Leader before any on-site activities are performed. Attendees will consist of the Validation Team, the Agency representative, and the Test Truck Drivers. Topics discussed will be Roadside Safety, Traffic Safety, Validation Procedures, and Objectives of the Validation. Test Truck turnarounds, test speeds and test truck movement requirements will be explained and stressed to the test truck drivers. Field personnel will be refreshed on the proper operation instructed on the proper use of the temperature and speed collection devices and the Task Leader will ensure that all participants are wearing appropriate personal protection equipment.

Site Inventory

The Project Field Binder will contain the latest site inventory, acquired from the Agency during the Pre-Visit Coordination and Preparation activities, if available. All information contained on the Inventory will be verified and updated as required.

As part of the update, digital photographs will be collected of all WIM equipment, pavement condition in the WIM scale area and downstream and upstream of the WIM scale area.

Upon completion of the on-site activities, a new Inventory Form will be generated with updated data and provided as an Appendix to the Summary Report.

Pre-Evaluation Site Assessment

The Project Field Binder will contain the latest Assessment and associated addenda, acquired from the Agency during the Pre-Visit Coordination and Preparation activities, if available. All information contained on the Assessment Form will be verified and updated as required. Several activities associated with the Assessment will be repeated with each subsequent visit to the site. This is to ensure that site conditions and WIM equipment operating values are kept up to date. These include:

Assessment of Pavement and Vehicle Interaction

The objective of the visual assessment of the pavement and vehicle-pavement interaction in the vicinity of the WIM scale is to estimate the potential influence of pavement profile on the dynamic wheel loads recorded by the WIM sensors.

The measured pavement profiles, the visual observation of the profile on the site, and the audio and visual observation of trucks passing over the scale will be carried out to evaluate dynamic movements of trucks in the vicinity of the scale. Particular attention will be paid to trucks with low vehicle mass damping such as empty dump trucks. Separate observations will be made regarding suspended vehicle mass (heaving and vibration of truck body above the suspension system) and unsuspended vehicle mass (shaking and vibration of wheels).

Any distresses that are believed to be detrimental to the proper operation will be plotted on the distress evaluation map, and detailed in the Summary Report. Digital photographs will be taken and will be provided as an Appendix to the report.

Physical Inspection of the WIM System Components

Ideally, this activity will be carried out in cooperation with a highway agency representative. A highway agency representative may provide additional information about the past performance of system components and their maintenance history. However, if need be, we will perform this activity independently. A universal key can typically open cabinets housing traffic data collection equipment in North America. Access to the cabinets will be addressed as part of the Pre-Visit Coordination and Preparation activities.

The physical inspection and assessment of the WIM equipment will encompass the following components:

☐ Cabinet and foundation
☐ Pull-boxes
☐ Service Mast
☐ Power service equipment
☐ Telephone service equipment
☐ Equipment grounds

☐ Conduit

Performance of Equipment Diagnostics

The main objective of performing equipment diagnostics will be to assess the operating condition of the WIM equipment. The performance of the equipment diagnostics will include, as a minimum, the obtaining of test readings from:

☐ Power service equipment
☐ Telephone service equipment
☐ In-road sensors

WIM System Troubleshooting (if required)

The *Field Troubleshooting Guide for Weigh in Motion Systems* will be included in the Project Field Binder. This document provides step-by-step procedures, including a troubleshooting outline, for performing a systematic approach to ensure the quality of the troubleshooting process. Generally speaking, a maintenance technician's approach to a service call will be as follows:

☐ Perform an exterior safety check around the work area and cabinet; including locating possible hazards (e.g. vandalism, holes, broken glass, wildlife, etc.)
☐ Perform all visual inspections (equipment, sensor array, off-road items)
☐ Use Field Guide for Troubleshooting Weigh in Motion Systems to localize faulty component(s).
☐ Performing necessary adjustments or repairs in consult with the manufacturer.
☐ Verify system operation (may require Data Manager to communicate with site)
☐ Document the actions taken in detail on the WIM Troubleshooting Form.

Static Weighing and Measuring of Test Trucks

The LTTP Guide for WIM Sites provides detailed recommendations on how to select and perform static weighing of test trucks. In principle, we will follow the Guide recommendations. Other conditions for establishing static weights of the test trucks, described in the WIM Guide, will apply, namely:
☐ Test trucks will be weighed at certified static scales that meet Handbook 44 specifications.
☐ Each individual axle, axle group, and the GVW will be measured at least two times.
☐ Characteristics of test trucks will be obtained and recorded in the WIMCal calibration spreadsheet.
☐ Average weights will be calculated and used as the reference weights for the WIM performance evaluation. These reference weights will be entered in the WIMCal calibration Spreadsheet.

Equipment Setup

Once it has been established that the WIM Equipment is in working order, and a determination has been made that the test trucks are in compliance with the Test Truck Quality Plan, the Task Leader will direct the setup of all required video data collection and WIM equipment communication equipment. The laptop computer that contains the communication software will be set up in the ARA's lead vehicle, with an interconnecting cable of sufficient length to bridge the distance between the WIM controller and the laptop computer.

Once communications have been established, a log file will be opened in order to save all test truck run records, providing a means for permanent storage, Quality Assurance comparisons, and for the WIMCal program to populate the test truck run spreadsheet. Starting calibration factors will be drawn from the WIM Controller and entered into the WIMCal setup spreadsheet.

Performance of an Initial Performance Evaluation

An initial WIM performance evaluation will be done for each lane for which a Task Order has been received. No adjustment to the system calibration or operating values will be made before or during the initial WIM performance evaluation.

The objective of the initial performance evaluation is to determine whether or not the equipment meets the performance requirements for WIM sites, and what type of calibration, if any, is required.
The initial WIM performance evaluation will be carried out by driving the test truck(s) over the WIM scale a minimum of ten times and then evaluating the reliability of the WIM loading estimations by comparing the average static truck weights with the dynamic test truck weights reported by the WIM system. The WIMCal spreadsheet macros automatically calculate the error and standard deviations for single axles, axle groups, GVW, spacing and overall length of the WIM equipment. Based on these errors, WIMCal will provide new calibration factors to be installed in the WIM equipment firmware by the Task Leader.

Assessment of the VC System and Vehicle Classification Algorithm

The vehicle classification algorithm is a computerized decision tree used to classify vehicles into vehicle categories. For WIM systems, the decision tree may utilize the number of axles, axle spacings, and axle weights. The vehicle classification algorithm at each WIM site will be requested during Pre-Visit Coordination and Preparation activities. The main objective of the assessment of the WIM system vehicle classification is to ensure that an appropriate vehicle classification algorithm is included in the system software. The assessment of the WIM system and vehicle classification algorithm will consist of the following two activities:

☐ Field evaluation.
☐ Examination of the vehicle classification algorithm.

Test Trucks and Drivers

Typically, one test truck will be used. A secondary truck type may also be used. Prior to beginning any test runs, the test truck drivers will be briefed on the proper truck operating guidelines as set forth in the Test Truck Quality Plan of the dynamic guidelines set forth during the pre-validation briefing

Test Truck Operation

The test trucks will move at a constant predetermined speed as they cross the WIM scale. The position of the trucks across the traffic lane will correspond to the typical position of trucks within the traffic lane. For 12-feet wide traffic lanes, the position of the truck will be in the middle of the lane. When the driver of the truck is about one minute from crossing the WIM site location he or she will announce the upcoming arrival of the truck to the data collection crew. After crossing the WIM scale, the driver will contact the data collection crew again and report the speed at which he or she crossed the WIM scale.

Number of Runs

The minimum number of runs is ten (10) per test truck.

Test Truck Speed

The speed of test trucks when crossing the WIM scale will be determined using the methodology presented in the WIM Guide. Test runs will start at the slowest speed selected for each test vehicle. The second run for each vehicle will be at the medium test speed, followed by a run at the highest test speed. This pattern will continue until each truck has made at least twenty runs over the WIM scale. If congestion or other factors would limit the ability of a driver to make a specific test run at a given speed, the driver will attempt to make that run at the next slower speed, while keeping a constant speed as the test truck passes over the scale. When the intended speed cannot be maintained, the driver will attempt to make the next test run at the originally intended speed.

Pavement Temperature

The WIM calibration will be carried out over the greatest range of temperatures possible in order to determine the possible effect of pavement temperature on the loading estimations made by the WIM equipment. To accomplish this, test truck runs will begin as close to 7:00 AM as possible, when pavement temperatures are expected to be at their lowest, and finish as close to 4:00 PM, when pavement temperatures are typically highest. Pavement temperature measurements will be carried out on the pavement surface, near the WIM sensor but not on the sensor, using an infrared device. The pavement temperature will be recorded for each test truck run in the WIMCal spreadsheet.

Speed Measurements

The accuracy of truck speed measurements obtained by the WIM system will be determined by comparing the speed of selected trucks reported by the WIM system with the speed measured by a laser speed gun. The data collection crews will use the speed gun to determine whether the WIM system is correctly measuring traffic speeds. Once the crew has established that the scale system is correctly measuring vehicle speed, additional speed data may not be collected other than for the test trucks. The test truck speeds that will be used to analyze WIM performance will be typically obtained from WIM system reports. The speeds reported by the WIM system will be verified by comparing the truck speeds reported by the WIM system with the truck speeds obtained by measurements using a speed gun.

Data Collection Procedure

The on-site WIM computer will be connected to an on-site display device such as a computer screen of a portable computer. For each vehicle pass, the field data collection staff will record the WIM system output as it appears on the laptop display. The WIMCal macro, upon being prompted by the operator, will automatically populate the spreadsheet with the vehicle record from the log file. The truck data record page. As a back-up, the key data will be recorded on a paper form of the spreadsheet, including vehicle speed, axle weights, GVW, and axle spacing. In addition, the entire record of the test trucks produced by the WIM system will be electronically stored. This will typically result in the storage of the following information for each test truck run: Axle weights, axle spacing, truck speed, sequential record number, and a time stamp. If provided by the WIM system, pavement temperature (reported by the WIM system) and a calibration factor will be also stored.

Data Analysis

After completing the initial data collection, the data will be statistically evaluated in the field and the results will be compared with the functional performance requirements for the WIM systems on SPS sites. These functional requirements are listed in Table 7 and correspond to the functional requirements for Type I WIM systems specified in ASTM standard E1318-00 [7].

Table 3 - Functional performance requirements for WIM systems on SPS sites.

Variable	**Tolerance for 95% Probability of**
Single axles	± 20 percent
Tandem axles and other axle groups	± 15 percent
Gross vehicle weight	± 10 percent
Vehicle speed	± 1 mph (2 km/h)
Axle spacing length	± 0.5 ft (150 mm)

To obtain the 95% tolerance, the standard deviation will be multiplied by the Student's t statistics for **a**=0.0025 (two-sided test) and for n-1 degrees of freedom (n = number of measurements). Data analysis will utilize the WIMCal spreadsheet and graphs generated from the collected data. Additional details of the calculation procedure are provided in the *Data Collection Guide for SPS WIM Sites*. The tolerances calculated for the test runs will be compared with the tolerances given in table 7. If a calculated value exceeds the value in table 7, the WIM system has failed to meet the specified performance requirement. However, regardless of the outcome of the comparison with the specified tolerances, the evaluation will proceed to the Calibration activities.

Digital Traffic Systems and ARA will arrange for the test (calibration) vehicles. The typical lead time for a WIM calibration is two (2) to three (3) weeks. Since the lead time is primarily a function of the availability of the test trucks, the calibrations can be performed with as little as one weeks' notice.

(j) The Contractor shall install finished Kistler sensors flush with the surrounding pavement.

(k) Upon the request of the VDOT CA, the Contractor shall enable IP address filtering and change the default password for CDMA modems as added security features and minimize the possibility of unauthorized access.

DTS will implement the following plan upon VDOT's specific request/direction, wherein DTS will enable IP address filtering and change the default password for the CDMA modems as added security features.

WIM System Field Calibration Summary Report

Virginia WIM Site # 09002101
US 15

Calibration Date: February 13, 2016
Submitted: March 3, 2016

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1 Executive Summary

A WIM calibration was performed on February 13, 2016 at Virginia DOT WIM Site 09002101 located on US Route 15.

This is a two-lane site. The northbound lane is designated as Lane 1 and the southbound lane is designated as Lane 2 by the WIM Controller. Both lanes are equipped with quartz WIM sensors. The system was installed on August 18, 2015 by Digital Traffic Systems, Inc. The site utilizes a TDC WIM controller.

The equipment is in working order. The most recent electronic and electrical checks of the WIM components conducted on August 21, 2014 determined that all equipment is operating within the manufacturer's tolerances. None of the in-road sensors show signs of damage or excessive wear and appear to be fully secured in the pavement.

During the on-site pavement evaluation, there were no distresses noted that may affect the measurement accuracies of the WIM system. A visual observation of the trucks as they approach, traverse, and leave the sensor area did not indicate any adverse dynamics that would affect the accuracy of the WIM system. The trucks appeared to track down the center of the lane.

There were two test trucks used for the calibration. One of the test trucks was a Class 9 vehicle with air suspension on the tractor and trailer tandems, and standard tandem spacings. It was loaded with concrete blocks. The secondary test truck was a Class 5 box truck, with mechanical suspension of both axles.

Based on the criteria contained in the LTPP Field Operations Guide for SPS WIM Sites, Version 1.0 (05/09), this site is providing research quality loading data. All parameters met the specified criteria for mean error and the 95% performance criteria. Detailed results of the calibration activities are provided in Section 6.

Based on the vehicles observed during the classification study, the misclassification percentage is 0.0% for heavy trucks (vehicle classes 6 – 13), is within the 2.0% acceptability criteria for LTPP SPS WIM sites. The overall misclassification rate for all trucks (4 – 15) is 1.6 percent, although there was a very limited number of heavy vehicles using the roadway during the study.

2 Pre-Visit Data Analysis

A pre-visit dataset for the two weeks immediately preceding the calibration visit was developed. The pre-visit data analysis provides a reasonable expectation of the measurement accuracies of the system prior to the on-site calibration visit. It also provides information for establishing the type, weight, configuration and operating speeds of the test trucks that will be used for the calibration.

For the pre-visit dataset analysis, the truck classifications and speed, the GVW and steering axle weights for Class 9 trucks, and the GVW for Class 5 trucks from the pre-visit dataset were analyzed for each lane. For the Class 9 GVW distribution, the unloaded peak is expected to be at approximately 36 kips and the loaded peak is expected to be at approximately 80 kips. The average steering axle weight for Class 9 trucks is expected to be between 10.0 and 12.0 kips. The average weight for Class 5 trucks is expected to be approximately 20 kips.

2.1 Lane 1

2.1.1 Truck Classification Distribution

Figure 2-1 provides the Classification Distribution for trucks (4 – 13) in lane 1. As shown in the graph, the most prevalent truck types in this lane are Class 9 (44.5%) and Class 5 (32.5%). 3.4% of the vehicles traveling over the WIM scales in this lane are trucks (4-13). Based on this information, one Class 9 truck and one Class 5 truck will be used for calibration.

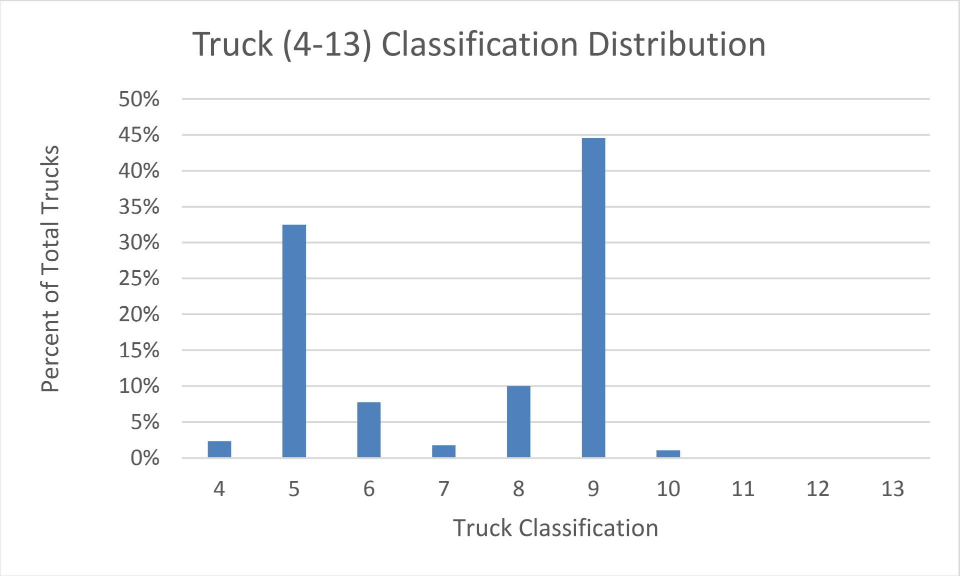

Figure 2-1 – Truck Classification Distribution – Lane 1

2.1.2 Truck Speed Distribution

Figure 2-2 provides the Speed Distribution for trucks (Class 4 through 13). As shown in the graph, the majority of the trucks are traveling between 50 and 60 mph. The average truck speed for this lane is 51 mph. The 15th percentile speed for trucks is 47 mph and the 85th percentile speed is 55 mph. Based on this information, the test trucks speed for the calibration is expected to be 50 mph.

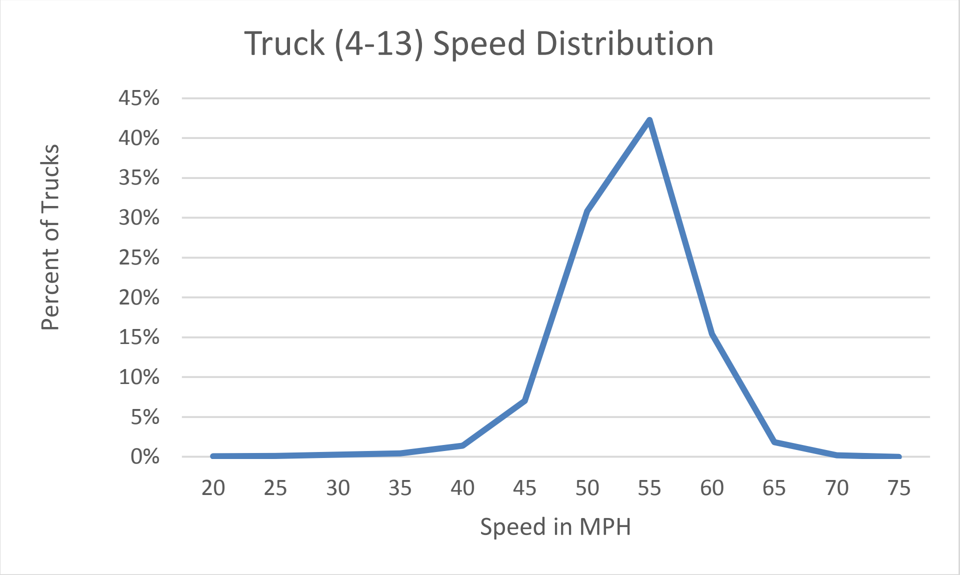

Figure 2-2 – Truck Speed Distribution - Lane 1

2.1.3 Class 9 GVW Distribution

Figure 2-3 provides the Class 9 GVW distribution for lane 1. The unloaded peak at 36 kips and the loaded peak at 80 kips indicate that the WIM system is estimating Class 9 GVW with reasonable accuracy in this lane. The average overall length for Class 9 trucks is 66.1 feet. The average tractor tandem spacing is 4.3 feet.

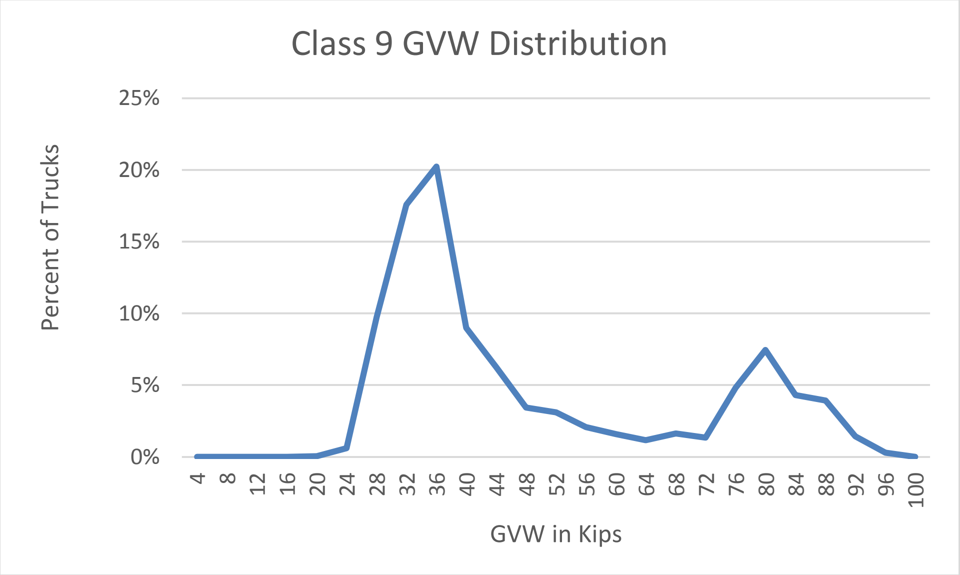

Figure 2-3 – Class 9 GVW Distribution - Lane 1

2.1.4 Class 9 Steering Axle Weight Distribution

Figure 2-4 provides the steering axle weight distribution for Class 9 trucks in lane 1. The average front axle weight for Class 9 trucks is 10.4 kips, indicating that the WIM system is estimating steering axle weights with reasonable accuracy in this lane.

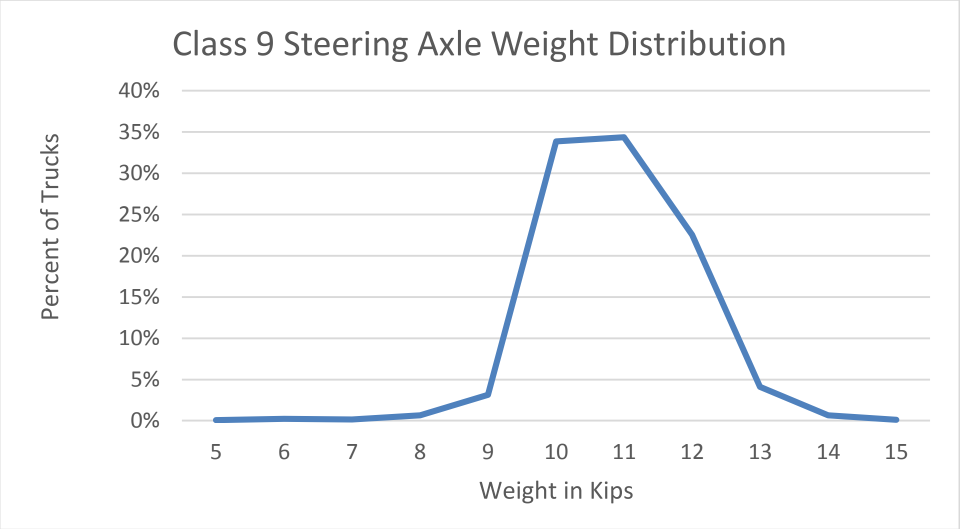

Figure 2-4 - Class 9 Steering Axle Weight Distribution - Lane 1

2.1.5 Class 5 GVW Distribution

Figure 2-5 provides the Class 5 GVW distribution for lane 1. The peak at 20 kips indicates that the WIM system is estimating Class 5 GVW with reasonable accuracy in this lane. The average GVW for Class 5 trucks is 18.3 kips. The average overall length is 33.9 feet and the average axle spacing is 19.4 feet.

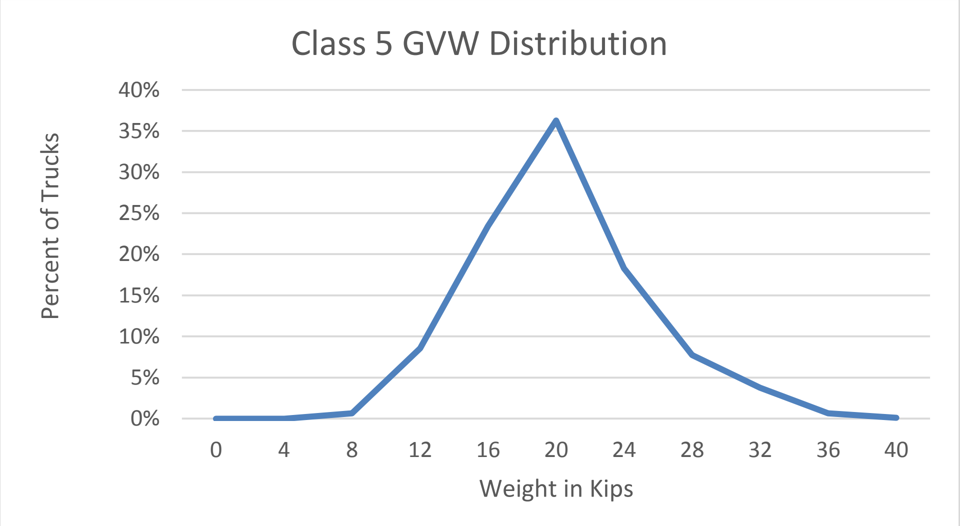

Figure 2-5 – Class 5 GVW Distribution - Lane 1

2.2 Lane 2

2.2.1 Truck Classification Distribution

Figure 2-6 provides the Classification Distribution for trucks (4 – 13) in Lane 2. As shown in the graph, the most prevalent truck types in this lane are Class 9 trucks (47.3%) and Class 5 (32.5%). 3.5% of the vehicles traveling over the WIM scales in this lane are trucks (4-13). Based on this information, one Class 9 truck and one Class 5 truck will be used for calibration.

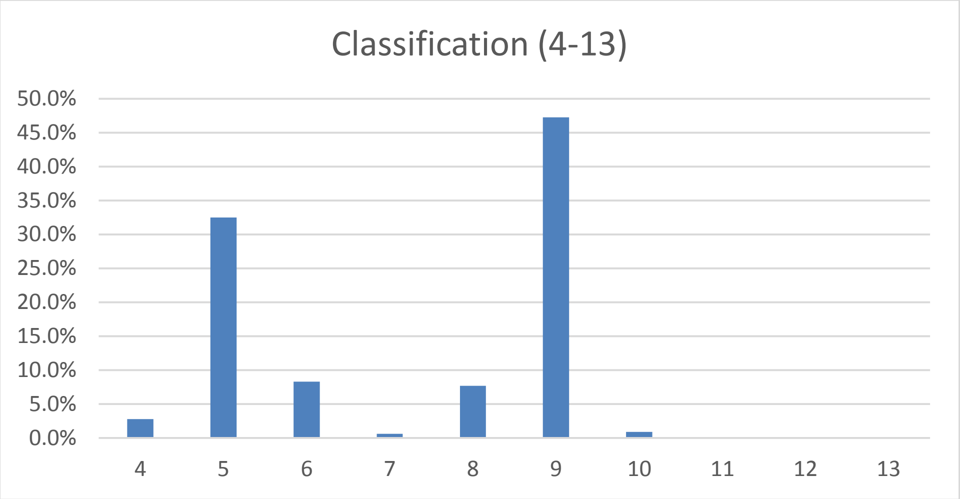

Figure 2-6 – Truck Classification Distribution – Lane 2

2.2.2 Truck Speed Distribution

Figure 2-7 provides the Speed Distribution for trucks in Classes 4 through 13. As shown in the graph, the majority of the trucks are traveling between 45 and 60 mph. The average truck speed for this lane is 48 mph. The 15th percentile speed for trucks is 44 mph and the 85th percentile speed is 53 mph. Based on this information, the test trucks speed for the calibration is expected to be 50 mph.

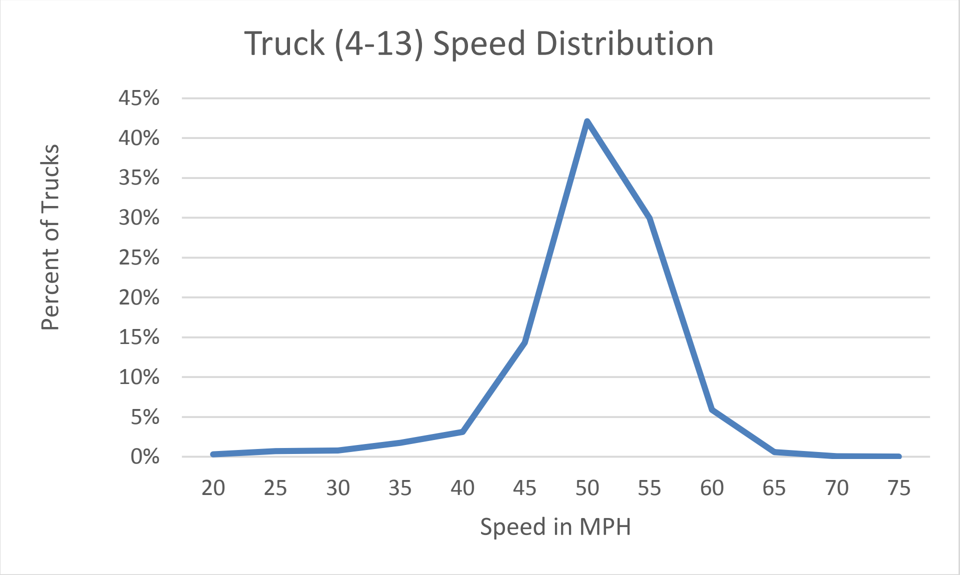

Figure 2-7 – Truck Speed Distribution - Lane 2

2.2.3 Class 9 GVW Distribution

Figure 2-8 provides the Class 9 GVW distribution for Lane 2. The unloaded peak at 36 kips and the loaded peak at 80 kips indicate that the WIM system is estimating Class 9 GVW with reasonable accuracy in this lane. The average GVW for Class 9 trucks is 58.1 kips. The average overall length is 67.3 feet. The average tractor tandem spacing for Class 9 trucks is 4.3 feet.

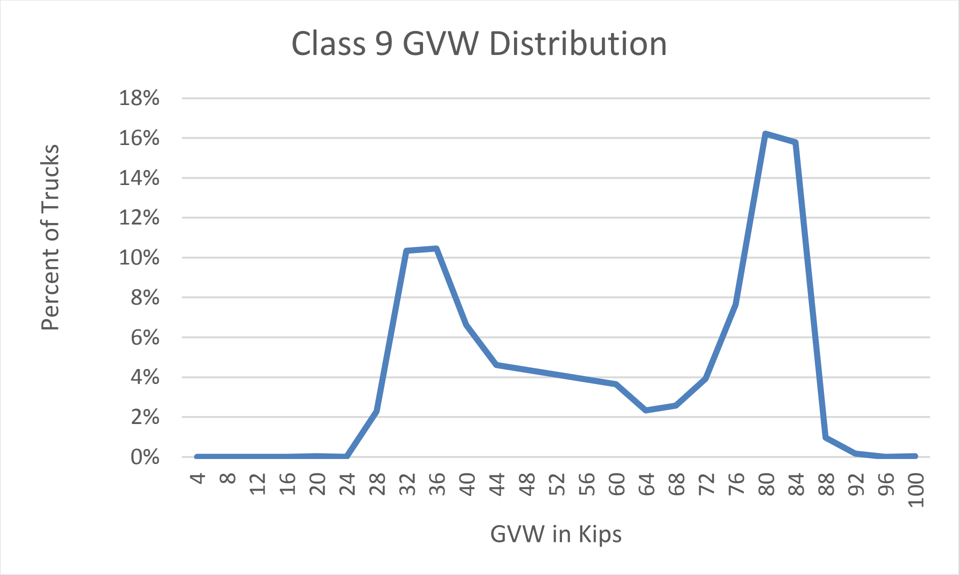

Figure 2-8 – Class 9 GVW Distribution - Lane 2

2.2.4 Class 9 Steering Axle Weight Distribution

Figure 2-9 provides the steering axle weight distribution for Class 9 trucks in Lane 2. The average front axle weight for Class 9 trucks in Lane 2 is 11.2 kips, indicating that the WIM system may be estimating steering axle weights with reasonable accuracy in this lane.

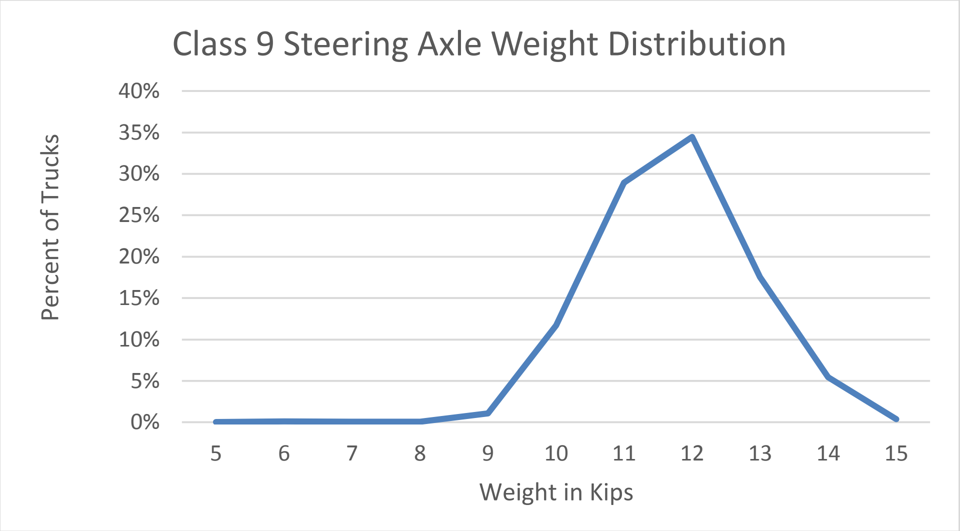

Figure 2-9 - Class 9 Steering Axle Weight Distribution - Lane 2

2.2.5 Class 5 GVW Distribution

Figure 2-10 provides the Class 5 GVW distribution for Lane 2. The peak at 20 kips indicates that the WIM system may be properly estimating Class 5 GVW in this lane. The average Class 5 GVW is 19.8 kips. The average overall length is 33.8 feet and the average axle spacing for Class 5 trucks is 19.4 feet.

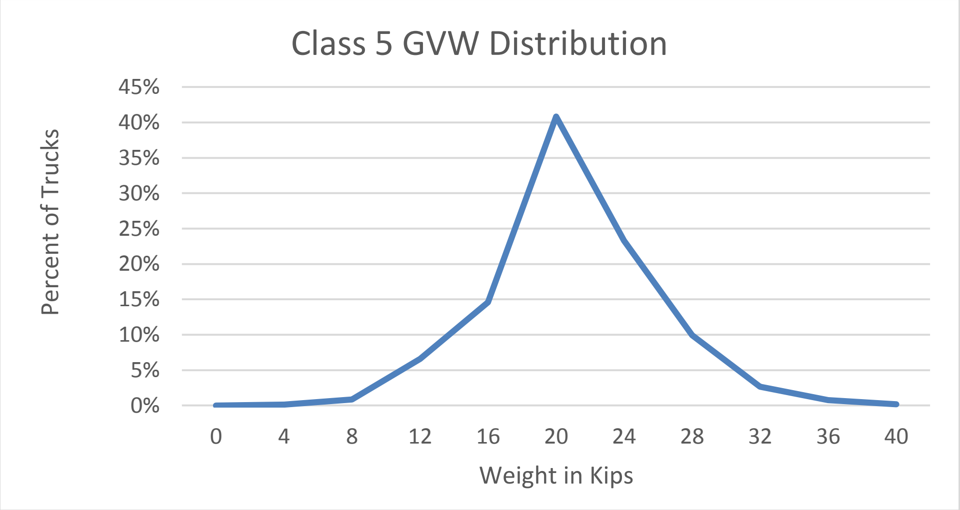

Figure 2-10 – Class 5 GVW Distribution - Lane 2

3 WIM Equipment Discussion

3.1 Description

Each lane at this site is instrumented with Kistler quartz weighing sensors. The WIM system utilizes a TDC WIM Controller. The site was installed on August 18, 2015 by Digital Traffic Systems (DTS). As the installation contractor, Digital Traffic Systems also performs routine and corrective equipment maintenance.

3.2 Physical Inspection

Prior to the pre-calibration test truck runs, a physical inspection of all WIM equipment and support services equipment was conducted. No deficiencies were noted.

3.3 Electronic and Electrical Testing

Electronic and electrical checks of all system components were conducted during an installation post-inspection conducted by DTS on August 21, 2014. Dynamic and static electronic checks of the in-road sensors were performed. All values for the WIM sensors and inductive loops were within tolerances. Electronic tests of the power and communication devices indicated that they were operating normally.

3.4 Equipment Troubleshooting and Diagnostics

The WIM system appeared to collect, analyze and report vehicle measurements normally. No troubleshooting actions were taken.

3.5 Recommended Equipment Maintenance

No unscheduled equipment maintenance actions are recommended.

4 Pavement Discussion

Both lanes at this WIM site location are instrumented with WIM sensor arrays. The sensors are installed in asphalt pavement.

4.1 Pavement Condition Survey

During a visual distress survey of the pavement conducted from the shoulder, no distresses were noted that may affect the accuracy of the WIM system.

4.2 Pavement Vehicle Interaction

The WIM approach area of the pavement was inspected during the calibration visit, and truck dynamics in this area were closely observed. There were no distresses observed at these locations that would influence truck dynamics in the WIM scale area. The visual observation of the trucks as they approach, traverse and leave the sensor area did not indicate any visible motion of the trucks that would affect the performance of the WIM scales. Trucks appear to track down the center of the lane.

4.3 Recommended Pavement Remediation

No pavement remediation is recommended.

5 Test Trucks

There were two test trucks used for the calibration. The primary test truck was a Class 9 vehicle with air suspension on the tractor and trailer tandems, and standard (4 feet) tandem spacings. It was loaded with concrete blocks.

Photo 5-1 – Class 9 WIM Calibration Test Truck

The secondary truck was a Class 5 box truck with mechanical suspension on both axles. It was loaded with various equipment and tools.

Photo 5-2 – Class 5 WIM Calibration Test Truck

Prior to the pre-calibration test truck runs, the test trucks were weighed and measured and photographs of the truck, tractor and suspension were obtained. Axle length (AL) was measured from the center hub of the first axle to the center hub of the last axle. Axle spacings were measured from the center hub of the each axle to the center hub of the subsequent axle. Overall length (OL) was measured from the edge of the front bumper to the edge of the rear bumper. The test trucks were re-weighed at the conclusion of the post-calibration. The beginning calibration test truck weights and measurements are provided in Table 5-1.

Table 5-1 – Pre-Calibration Test Truck Measurements

Truck	Class	Weights (kips)						Spacings (feet)					
		GVW	Ax1	Ax2	Ax3	Ax4	Ax5	1-2	2-3	3-4	4-5	AL	OL
1	9	75.8	9.9	16.7	16.7	16.2	16.2	12.5	4.8	35.3	4.1	56.7	64.0
2	5	19.9	8.0	11.9				21.8				21.8	34.0

Since the number of pre- and post-calibration test truck runs were similar, and to establish more precise results from the test truck run sets, the pre- and post-calibration test truck weights were averaged to create pre-calibration post-test truck weights. These weights were also used for the post-calibration pre-test truck runs weights. The “midpoint” weights are provided in Table 5-2.

Table 5-2 – Midpoint Test Truck Measurements

Truck	Class	Weights (kips)						Spacings (feet)					
		GVW	Ax1	Ax2	Ax3	Ax4	Ax5	1-2	2-3	3-4	4-5	AL	OL
1	9	75.8	9.9	16.7	16.7	16.2	16.2	12.5	4.8	35.3	4.1	56.7	64.0
2	5	19.9	8.0	11.9				21.8				21.8	34.0

The final calibration test truck weights and measurements are provided in Table 5-3.

Table 5-3 – Post-Calibration Test Truck Measurements

Truck	Class	Weights (kips)						Spacings (feet)					
		GVW	Ax1	Ax2	Ax3	Ax4	Ax5	1-2	2-3	3-4	4-5	AL	OL
1	9	75.4	9.7	16.7	16.7	16.1	16.1	12.5	4.8	35.3	4.1	56.7	64.0
2	5	19.8	8.0	11.8				21.8				21.8	34.0

6 Statistical Reliability of the WIM Equipment

The following section provides summaries of data collected during the pre- and post-calibration test truck runs, as well as information resulting from the classification study. All analyses of test truck data and information on necessary equipment adjustments are provided.

The pre- and post-calibration runs were conducted on February 13, 2016. The pre- and post-calibration test truck run times are provided in Table 6-1.

Table 6-1 – Test Truck Run Times

Test Truck Run Set		Lane 1	Lane 2
Pre	**Start**	8:56 AM	8:44 AM
	Stop	12:11 AM	12:00 PM
Post	**Start**	2:12 PM	2:21 PM
	Stop	4:17 PM	4:27 PM

For the pre- and post-calibrations, the test truck was run at the speed of free-flow truck traffic – 50 mph. Due to the cold and cloudy weather conditions, the measured pre-calibration pavement temperatures varied by only 2.1 degrees Fahrenheit, from 8.0 to 10.1 and the measured post-calibration pavement temperatures varied by only 10.6 degrees Fahrenheit, from 7.0 to 17.6.

The temperature range observed during the pre- and post-calibration test truck runs did not meet the preferred 30 degree spread, however, the WIM system did not appear to demonstrate a significant relationship between any of the measured parameters and temperature for the temperatures that were observed in the field during the calibration.

6.1 Lane 1 Calibration

6.1.1 Pre-Calibration

Table 6-2 provides a summary of the pre-calibration results. As shown in the table, the site did not meet the LTPP 95% confidence requirements for vehicle length due to the overall length measurement error for the Class 9 truck, but the site did meet the measurement requirements for all weight parameters and for axle length as a result of the pre-calibration test truck runs.

Table 6-2 – Lane 1 Pre-Calibration Overall Results

Parameter	**95% Confidence Limit of Error**	**Site Values**	**Class 9 Truck**	**Class 5 Truck**
Steering Axles	+20 percent	3.7 ± 9.2	7.0%	0.4%
Tandem Axles	+15 percent	-4.9 ± 3.6	-4.9%	N/A
GVW	+10 percent	-1.7 ± 4.6	-3.1%	-0.2%
Vehicle Length	±3.0 percent (1.7 ft)	1.8 ± 2.5	2.8 ft	0.7 ft
Axle Length	+ 0.5 ft [150mm]	0.0 ± 0.2	-0.1 ft	0.0 ft

Truck speed was manually collected for each test run using a LIDAR gun and compared with the speed reported by the WIM equipment. For this site, the WIM equipment did not demonstrate a significant bias in speed measurement.

6.1.2 Calibration

A calibration was performed between the pre- and post-calibrations to improve the overall accuracies of the WIM system. A weighted formula was used to determine the calibration adjustments based on a comparison between the class 9 (60%) and class 5 (40%) truck population. Information regarding the basis for changing equipment compensation factors, supporting data for the changes, and the resulting WIM accuracies from the calibrations are provided in this section.

The operating system weight compensation parameters that were in place prior to the pre-calibration are shown in Table 6-3.

Table 6-3 – Lane 1 Initial System Parameters

Starting Factors	
Mean Impact Factor -	1034
Steer Axle Factor -	1000
Loop Compensation Factor-	100
Axle Sensor Separation -	12.0

6.1.2.1 Equipment Adjustments

For GVW, the pre-calibration test truck runs produced an overall GVW error of -1.7 percent and a steering axle error of 3.7 percent. To compensate for this error, the changes in Table 6-4 were made to the compensation factors based on the weighted formula. The front axle weight estimations were 5.4 percent greater than the GVW estimations in this lane.

Table 6-4 – Lane 1 Calibration Equipment Factor Changes

Factor	Old	Error	New
Mean Impact Factor -	1034	-1.7%	1013
Steer Axle Factor -	1000	3.7%	940
Loop Compensation Factor-	100	3.6%	97
Axle Sensor Separation -	12.0	-0.1%	12.0

The Steer Axle Factor was adjusted so that the measurement estimations would be in line with the GVW estimation. In this case, since the GVW measurement error was -1.7 percent and the steering axle bias was 3.7 percent, the Steer Axle Factor was adjusted so that the steering axle estimation would decrease by approximately 6.0 percent (3.7 - (-1.7)). The Axle Length of the test trucks were underestimated by only 0.1 percent, on average. Consequently, the Axle Separation Factor was not adjusted to compensate for this error.

6.1.3 Post-Calibration

Due to inconsistencies with the results of the Steer Axle Factor calibration, the factor was reset to 1000 for both lanes after three post-calibration test truck runs were performed. The post-calibration results represent the final seven runs that were completed in each lane. Additionally, the Loop Compensation Factor was changed to 97, based on combined results of the first three runs.

Table 6-5 provides a summary of the post-calibration results. As shown in the table, the site did not meet the LTPP 95% confidence requirement for overall length, however the mean error was very close to zero. All other parameters met the requirements for loading and distance measurement as a result of the calibration test truck runs. All parameters for both trucks met the requirements for mean error.

Table 6-5 – Lane 1 Post-Calibration Overall Results

Parameter	95% Confidence Limit of Error	Site Values	Class 9 Truck	Class 5 Truck
Steering Axles	±20 percent	6.0 ± 6.5	7.4%	4.5%
Tandem Axles	±15 percent	-2.6 ± 4.3	-2.6%	N/A
GVW	±10 percent	1.1 ± 6.3	-1.3%	3.4%
Vehicle Length	±3.0 percent (1.7 ft)	0.1 ± 2.5	0.8 ft	-0.6 ft
Axle Length	± 0.5 ft [150mm]	0.0 ± 0.1	-0.1 ft	0.0 ft

As shown in the table, the mean error for each WIM measurement parameter is well within the ASTM 1318 requirements. It appears that the inability for the vehicle length measurements to meet the ASTM requirements for 95% confidence may be attributed to the use of two test trucks with dissimilar lengths.

The effect of the calibration adjustments on the WIM system weight measurements accuracy is shown in Table 6-6. The 2.0% steering axle calibration reflects the change made to the Mean Impact Factor based on the GVW error.

Table 6-6 – Pre/Post Weight Measurement Error Comparison – Lane 1

Parameter	Pre-Calibration Error			Calib-ration	Post-Calibration Error			Percent Difference		
	Class 5	Class 9	Total		Class 5	Class 9	Total	Class 5	Class 9	Total
Steering	0.4%	7.0%	3.7%	2.0%	4.5%	7.4%	6.0%	+4.1%	+0.4%	+2.3%
Tandem	N/A	-4.9%	-4.9%	2.0%	N/A	-2.6%	-2.6%	N/A	+2.3%	+2.3%
GVW	-0.2%	-3.1%	-1.7%	2.0%	3.4%	-1.3%	1.1%	+3.6%	+1.8%	+2.8%

As shown in the table, the following conclusions can be made as a result of the post-calibration runs:

- All changes to the average weight measurements reflect the calibration adjustment that was made to the Mean Impact Factor (MIF). The changes appear to have had a greater effect on the Class 5 truck.

- The overall GVW estimation error decreased from -1.7 to 1.1, which reflects the 2 percent adjustment to the MIF.

- The underestimation of tandem axle weights increased 2.3 percent, from -4.9 to -2.6. The change can be attributed to the 2 percent adjustment that was made to the Mean Impact Factor.

- The overestimation of steering axles increased by 2.3 percent, from 3.7 to 6.0. This can be attributed to the 2 percent adjustment that was made to the Mean Impact Factor.

- The difference between the front axle error and the GVW measurement error increased from +5.4% to 5.9%.

Additionally, the Overall Length measurement mean error decreased from 1.8 feet to 0.5 feet, which reflects the adjustment that was made to the Loop Compensation Factor.

6.1.4 Final WIM System Compensation Factors

The final factors for Lane 1 that were left in place at the conclusion of the calibration are provided in Table 6-7.

Table 6-7 – Lane 1 Final Factors

Factor	New
Mean Impact Factor -	1013
Steer Axle Factor -	1000
Loop Compensation Factor-	97
Axle Sensor Separation -	12.0

6.2 Lane 2 Calibration

6.2.1 Pre-Calibration

Table 6-8 provides a summary of the pre-calibration results. As shown in the table, the site did not meet the LTPP 95% confidence requirements for vehicle length, but did meet the measurement requirements for all weight parameters and for axle length as a result of the pre-calibration test truck runs.

Table 6-8 – Lane 2 Pre-Calibration Overall Results

Parameter	95% Confidence Limit of Error	Site Values	Class 9 Truck	Class 5 Truck
Steering Axles	+20 percent	8.3% ± 6.7%	9.1%	7.5%
Tandem Axles	+15 percent	1.4% ± 4.0%	1.4%	N/A
GVW	+10 percent	4.1% ± 3.2%	3.3%	4.9%
Vehicle Length	±3.0 percent (1.7 ft)	2.3 ft ± 2.1 ft	3.2 ft	1.5 ft
Axle Length	+ 0.5 ft [150mm]	0.0 ft ± 0.1 ft	0.0 ft	0.0 ft

Truck speed was manually collected for each test run using a LIDAR gun and compared with the speed reported by the WIM equipment. For this site, the WIM equipment did not demonstrate a significant bias in speed measurement.

6.2.2 Calibration

A calibration was performed between the pre- and post-calibrations to improve the overall accuracies of the WIM system. A weighted formula was used to determine the calibration adjustments based on a comparison between the class 9 (60%) and class 5 (40%) truck population. Information regarding the basis for changing equipment compensation factors, supporting data for the changes, and the resulting WIM accuracies from the calibrations are provided in this section.

The operating system weight compensation parameters that were in place prior to the pre-calibration are shown in Table 6-9.

Table 6-9 – Lane 2 Initial System Parameters

Starting Factors	
Mean Impact Factor -	1012
Steer Axle Factor -	958
Loop Compensation Factor-	100
Axle Sensor Separation -	12.0

6.2.2.1 Equipment Adjustments

For GVW, the pre-calibration test truck runs produced an overall GVW error of 4.1 percent and a steering axle error of 8.3 percent. To compensate for this error, the changes in Table 6-10 were made to the compensation factors.

Table 6-10 – Lane 2 Calibration Equipment Factor Changes

Factor	Old	Error	New
Mean Impact Factor -	1012	4.1%	1050
Steer Axle Factor -	1000	8.3%	958
Loop Compensation Factor-	100	4.8%	95
Axle Sensor Separation -	12.0	-0.3%	12.0

The Steer Axle Factor was adjusted so that the measurement estimation error would be in line with the GVW estimation error. In this case, since the GVW measurement error was 4.1 percent and the steering axle bias was 8.3 percent, the Steer Axle Factor was adjusted so that the steering axle estimation would decrease by approximately 4.2 percent (8.3 – 4.1). The Axle Length of the test trucks were underestimated by only 0.3 percent, on average. Consequently, the Axle Separation Factor was not adjusted to compensate for this error.

6.2.3 Post-Calibration

Due to inconsistencies with the results of the Steer Axle Factor calibration, the factor was reset to 1000 for both lanes after three test truck runs were performed. The post-calibration results represent the final seven runs that were completed in each lane. Additionally, the Loop Compensation Factor was changed to 97, based on combined results of the first three runs.

Table 6-11 provides a summary of the post-calibration results. As shown in the table, the site did not meet the LTPP 95% confidence requirement for overall length. All other parameters met the requirements for loading and distance measurement as a result of the calibration test truck runs. All parameters met the requirements for mean error.

Table 6-11 – Lane 2 Post-Calibration Overall Results

Parameter	**95% Confidence Limit of Error**	**Site Values**	**Class 9 Truck**	**Class 5 Truck**
Steering Axles	±20 percent	0.9% ± 7.1%	0.3%	1.4%
Tandem Axles	±15 percent	-2.0% ± 3.3%	-2.0%	N/A
GVW	±10 percent	-0.5% ± 3.5%	-1.8%	0.9%
Vehicle Length	±3.0 percent (1.7 ft)	0.5 ft ± 2.5 ft	1.2 ft	-0.3 ft
Axle Length	± 0.5 ft [150mm]	0.0 ft ± 0.1 ft	-0.1 ft	0.0 ft

As shown in the table, the mean error for each WIM measurement parameter is well within the ASTM 1318 requirements. It appears that the inability for the vehicle length measurements to meet the ASTM requirements for 95% confidence may be attributed the use of two test trucks with dissimilar overall lengths.

The effect of the calibration adjustments on the WIM system weight measurements accuracy is shown in Table 6-6. The -3.8% steering axle calibration reflects the change made to the Mean Impact Factor based on the GVW error.

Table 6-12 – Pre/Post Weight Measurement Error Comparison – Lane 2

Parameter	**Pre-Calibration Error**			**Calib-ration**	**Post-Calibration Error**			**Percent Difference**		
	Class 5	**Class 9**	**Total**		**Class 5**	**Class 9**	**Total**	**Class 5**	**Class 9**	**Total**
Steering	7.5%	9.1%	8.3%	-3.8%	1.4%	0.3%	0.9%	-6.1%	-8.8%	-7.5%
Tandem	N/A	1.4%	1.4%	-3.8%	N/A	-2.0%	-2.0%	N/A	-3.4%	-3.4%
GVW	4.9%	3.3%	4.1%	-3.8%	0.9%	-1.8%	-0.5%	-4.0%	-5.1%	-4.6%

As shown in the table, the following conclusions can be made as a result of the post-calibration runs:

- The changes to the average tandem weights and GVW measurements reflect the calibration adjustment that was made to the Mean Impact Factor (MIF). The steering axle weight estimation decreased nearly twice as much as expected. The changes appear to have had a greater effect on the Class 5 truck.

- The overall GVW estimation error decreased from 4.1 to -0.5, which reflects the 3.8 percent adjustment to the MIF.

- The 1.4 percent overestimation for tandem axle weights became a 2.0 percent underestimation as a result of the calibration. However, the change can be attributed to the 3.8 percent adjustment that was made to the Mean Impact Factor.

- The overestimation of steering axles decreased by 7.5 percent, from 8.3 to 0.9 percent. This can be partially attributed to the 3.8 percent adjustment that was made to the Mean Impact Factor, but is twice as much change than what was expected.

- The difference between the front axle error and the GVW measurement error decreased from +4.2% to +1.4% even though the Steer Axle Factor was not changed.

Additionally, the Overall Length measurement mean error decreased from 2.3 feet to 0.5 feet, which reflects the adjustment that was made to Loop Compensation Factor.

6.2.4 Final WIM System Compensation Factors

The final factors for Lane 2 that were left in place at the conclusion of the calibration are provided in Table 6-13.

Table 6-13 – Lane 2 Final Factors

Factor	New
Mean Impact Factor -	1050
Steer Axle Factor -	1000
Loop Compensation Factor-	97
Axle Sensor Separation -	12.0

7 Classification Algorithm Evaluation

A limited classification algorithm study was conducted during the post-calibration test truck runs. Due to the limited number of heavy trucks in classes 4 through 13 that passed over the WIM scales during this time, a fully representative study could not be performed.

Misclassified vehicles are defined as those vehicles that are manually classified by observation as one type of vehicle but identified by the WIM equipment as another type of vehicle. Based on the 257 vehicles observed during the calibration study, the misclassification percentage is 0.0% for heavy trucks (vehicle classes 6 – 13), which is within the 2.0% acceptability criteria for LTPP SPS WIM sites. The overall misclassification rate for all vehicles (2 – 15) is 1.6 percent.

The results of the classification study are shown in Table 7-1. As shown in the table, there were very few heavy vehicles that traveled over the WIM scale during the classification study. The misclassified percentage shown in the table represents the percentage of the misclassified vehicles in the manual sample. Each of the misclassifications involved Class 5 pick-ups that were misidentified as Class 3 by the WIM System, most likely due to shorter axle spacings.

Table 7-1 – Classification Study Results

Class	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
Observed Count	200	35	0	17	0	0	0	5	0	0	0	0
WIM Count	200	39	0	13	0	0	0	5	0	0	0	0
Observed Percent	78%	14%	0%	7%	0%	0%	0%	2%	0%	0%	0%	0%
WIM Percent	79%	15%	0%	5%	0%	0%	0%	2%	0%	0%	0%	0%
Misclassified Count	0	-4	0	4	0	0	0	0	0	0	0	0
Misclassified Percent	0%	11%	0%	24%	0%	0%	0%	0%	0%	0%	0%	0%
Unclassified Count	0	0	0	0	0	0	0	0	0	0	0	0
Unclassified Percent	0	0	0	0	0	0	0	0	0	0	0	0

Unclassified vehicles are defined as those vehicles that cannot be identified by the WIM equipment algorithm. These are typically trucks with unusual trailer tandem configurations and are identified as Class 15 by the WIM equipment. Based on the manually collected sample of the 257 vehicles, 0.0 percent of the vehicles at this site were reported as unclassified during the study. This is within the established criteria of 2.0% for LTTP SPS WIM sites.

8 Post-Visit Data Analysis

A post-visit dataset for the two weeks immediately following the on-site calibration was developed and compared with the pre-visit dataset to evaluate of the effectiveness of the calibration.

For the post-visit dataset analysis, the truck classifications and speed, the GVW and steering axle weights for Class 9 trucks, and the GVW for Class 5 trucks from the post-visit dataset were analyzed for each lane. For the Class 9 GVW distribution, the unloaded peak is expected to be at approximately 36 kips and the loaded peak is expected to be at approximately 80 kips. The average steering axle weight for Class 9 trucks is expected to be between 10.0 and 12.0 kips. The average weight for Class 5 trucks is expected to be approximately 20 kips.

8.1 Lane 1

8.1.1 Truck Classification Distribution

Figure 8-1 provides the Classification Distribution for trucks (4 – 13) in lane 1. As shown in the graph, the most prevalent truck types in this lane are Class 9 (44.3%) and Class 5 (33.5%). 3.5 percent of the vehicles that travel over the WIM scales in this lane are trucks (4 – 13).

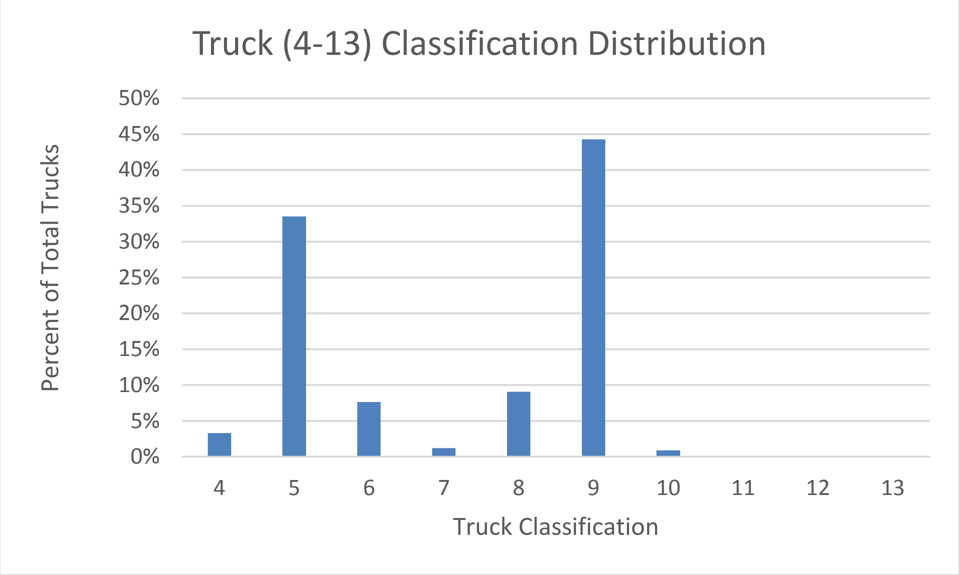

Figure 8-1 – Truck Classification Distribution – Lane 1

8.1.2 Truck Speed Distribution

Figure 8-2 provides the Speed Distribution for trucks for vehicle Classes 4 through 13. As shown in the graph, the majority of the trucks are traveling between 45 and 60 mph. The average truck speed for this lane is 50 mph. The 15th percentile speed is 46 mph and the 85th percentile speed is 55 mph.

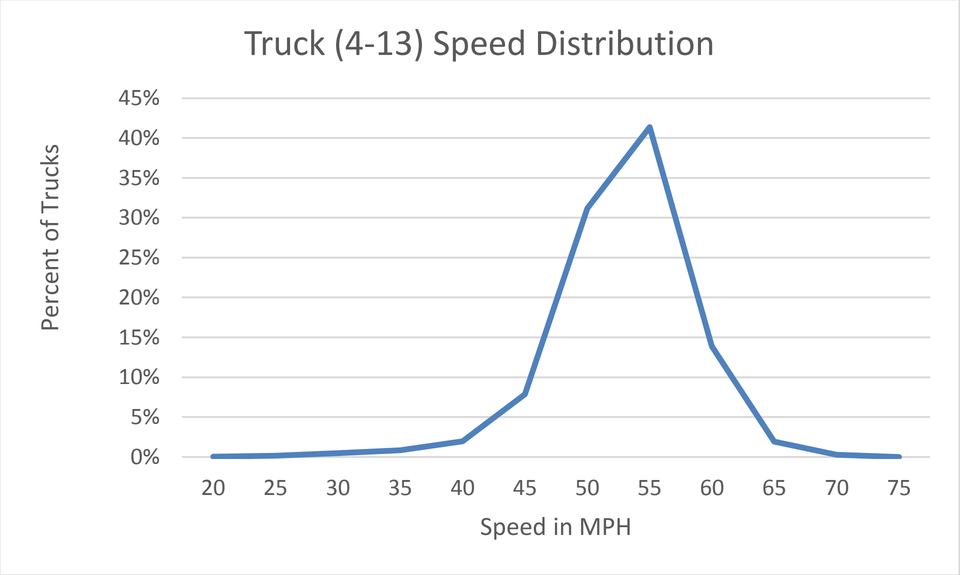

Figure 8-2 – Truck Speed Distribution - Lane 1

8.1.3 Class 9 GVW Distribution

Figure 8-3 provides the Class 9 GVW distribution for lane 1. The unloaded peak at 36 kips and the loaded peak at 80 kips indicate that the WIM system is estimating Class 9 GVW with reasonable accuracy in this lane. The average GVW for Class 9 trucks is 46.1 kips. The average overall length is 64.1 feet, and the average tractor tandem spacing is 4.3 feet.

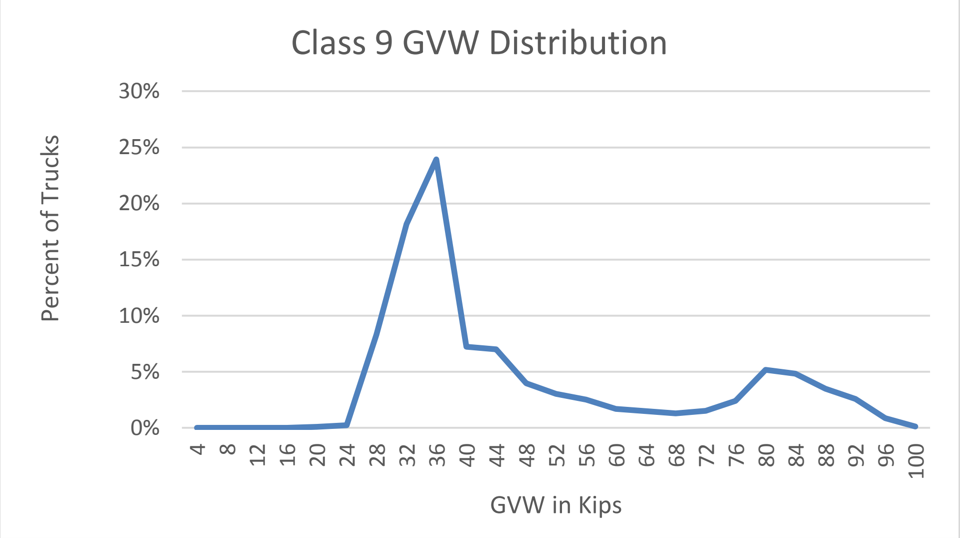

Figure 8-3 – Class 9 GVW Distribution - Lane 1

8.1.4 Class 9 Steering Axle Weight Distribution

Figure 8-4 provides the steering axle weight distribution for Class 9 trucks in lane 1. The average front axle weight for Class 9 trucks is 10.7 kips, indicating that the WIM system is estimating steering axle weights with reasonable accuracy in this lane.

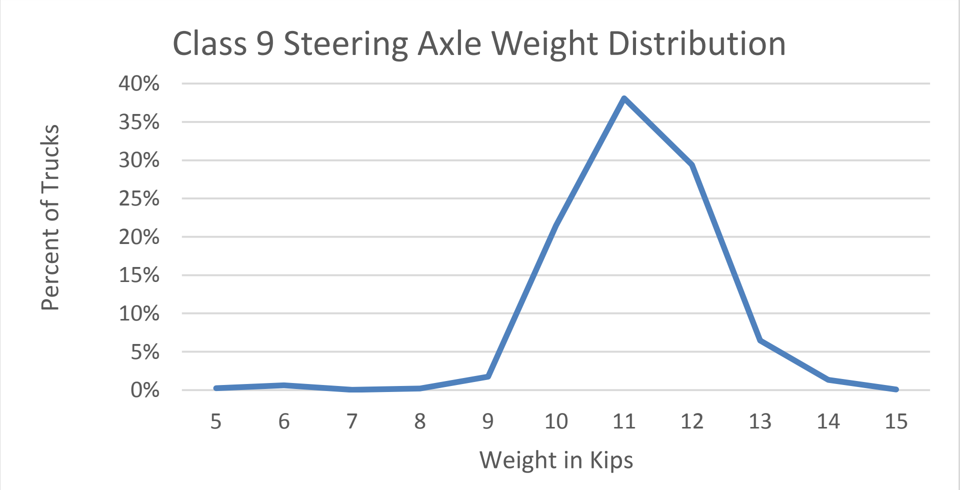

Figure 8-4 - Class 9 Steering Axle Weight Distribution - Lane 1

8.1.5 Class 5 GVW Distribution

Figure 8-5 provides the Class 5 GVW distribution for lane 1. The peak at 20 kips indicates that the WIM system is estimating Class 5 GVW with reasonable accuracy in this lane. The average GVW for Class 5 trucks is 18.8 kips. The average overall length is 32.9 feet and the average axle spacing is 19.5 feet.

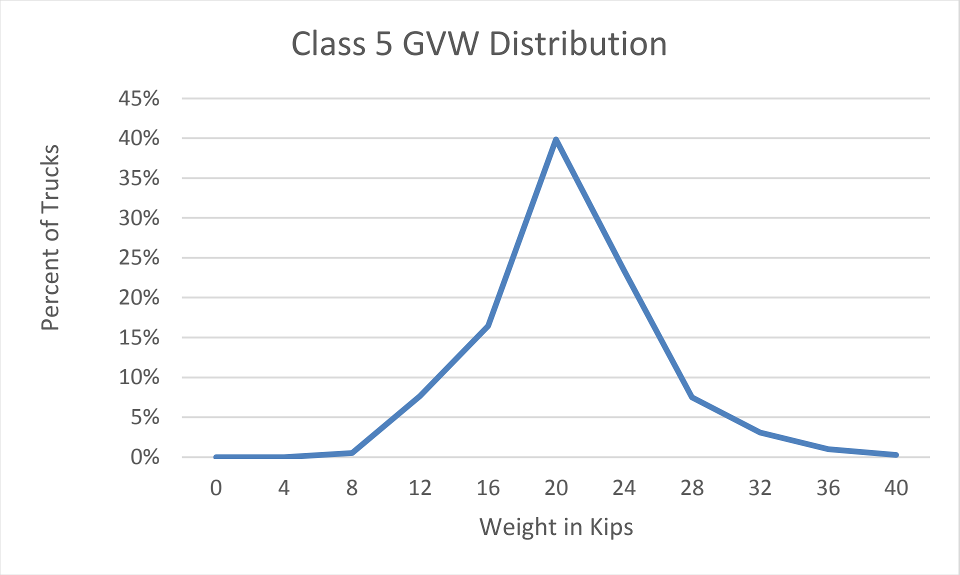

Figure 8-5 – Class 5 GVW Distribution - Lane 1

8.2 Lane 2

8.2.1 Truck Classification Distribution

Figure 8-6 provides the Classification Distribution for trucks (4 – 13) in Lane 2. As shown in the graph, the most prevalent truck types in this lane are Class 9 trucks (46.4%) and Class 5 (32.7%). 3.6 percent of the vehicles that travel over the WIM scales in this lane are trucks (4 – 13).

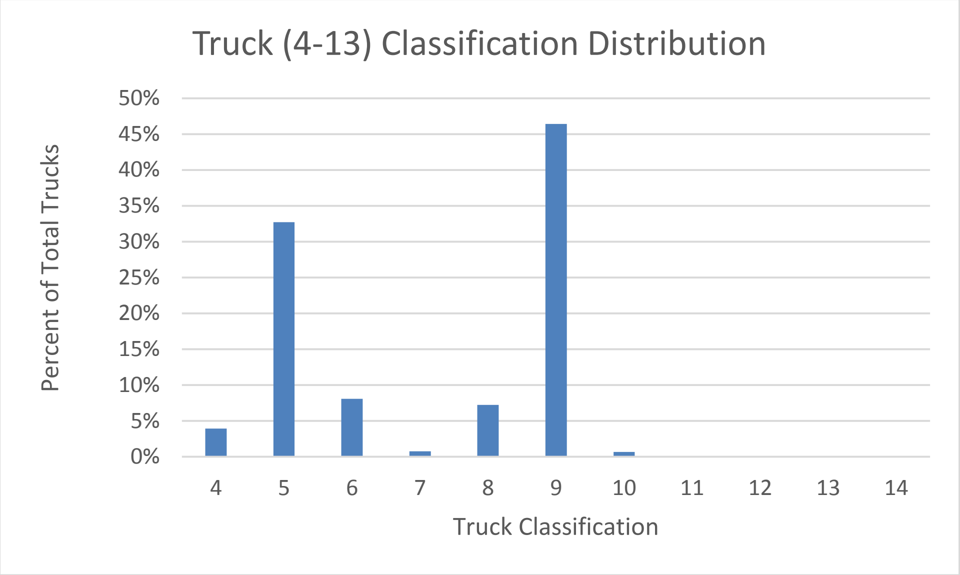

Figure 8-6 – Truck Classification Distribution – Lane 2

8.2.2 Truck Speed Distribution

Figure 8-7 provides the Speed Distribution for trucks in Classes 4 through 13. As shown in the graph, the majority of the trucks are traveling between 45 and 60 mph. The average truck speed for this lane is 47 mph. The 15th percentile speed is 42 mph and the 85th percentile speed is 53 mph.

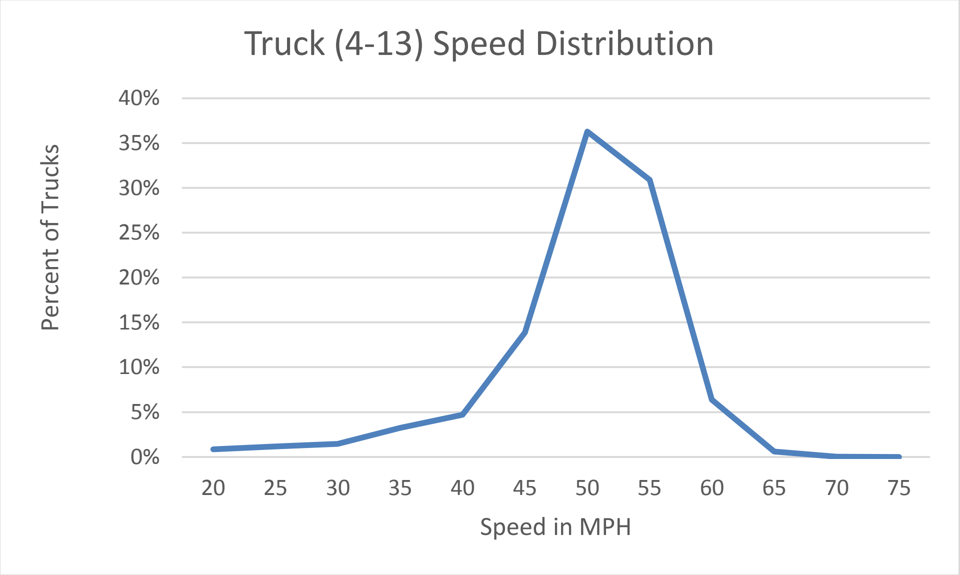

Figure 8-7 – Truck Speed Distribution - Lane 2

8.2.3 Class 9 GVW Distribution

Figure 8-8 provides the Class 9 GVW distribution for Lane 2. The unloaded peak at 36 kips and the loaded peak at 80 kips indicate that the WIM system is estimating Class 9 GVW with reasonable accuracy in this lane. The average GVW for Class 9 trucks is 58.5 kips. The average overall length for Class 9 trucks is 64.9 feet and the average tractor tandem spacing is 4.3 feet.

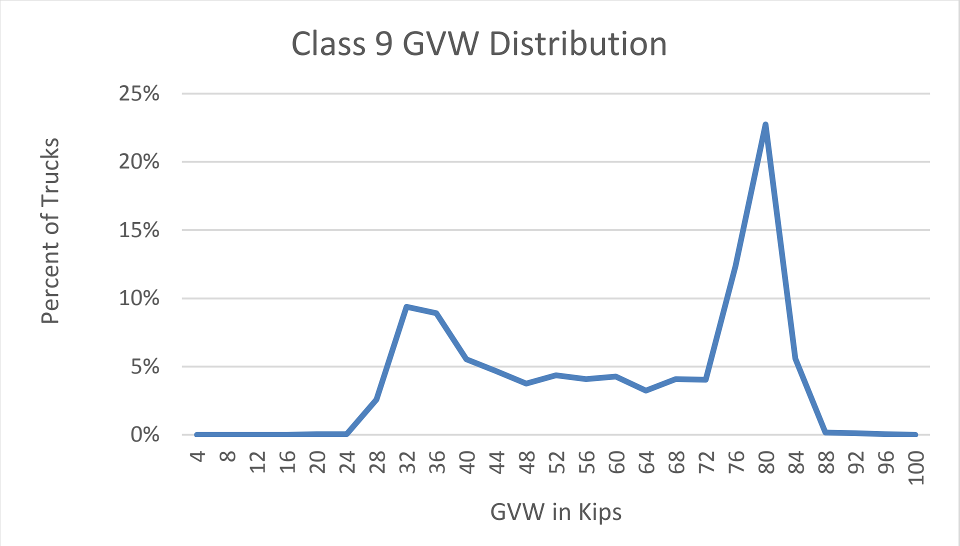

Figure 8-8 – Class 9 GVW Distribution - Lane 2

8.2.4 Class 9 Steering Axle Weight Distribution

Figure 8-9 provides the steering axle weight distribution for Class 9 trucks in Lane 2. The average front axle weight for Class 9 trucks in Lane 2 is 10.9 kips, indicating that the WIM system is estimating steering axle weights with reasonable accuracy in this lane.

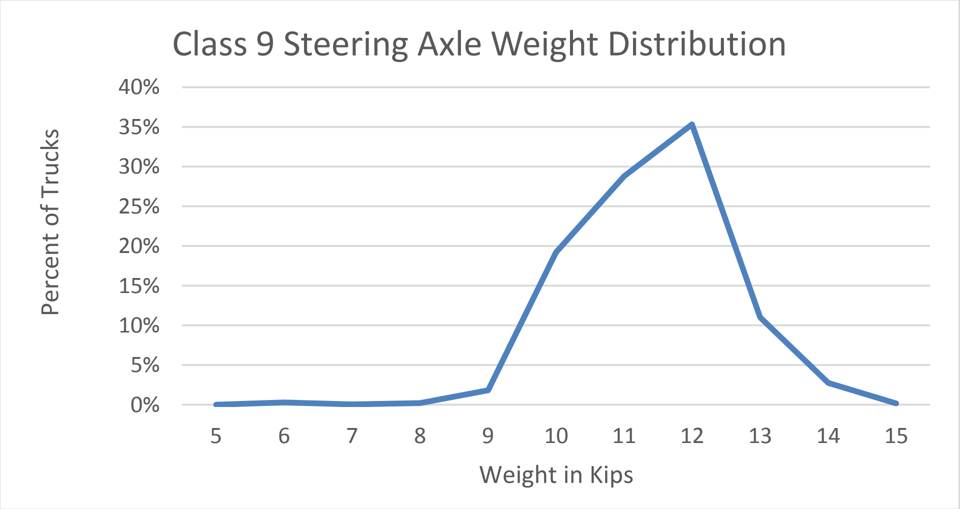

Figure 8-9 - Class 9 Steering Axle Weight Distribution - Lane 2

8.2.5 Class 5 GVW Distribution

Figure 8-10 provides the Class 5 GVW distribution for Lane 2. The peak at 20 kips indicates that the WIM system is estimating Class 5 GVW with reasonable accuracy in this lane. The average Class 5 GVW is 19.0 kips. The average overall length is 32.8 feet and the average axle spacing is 19.4 feet.

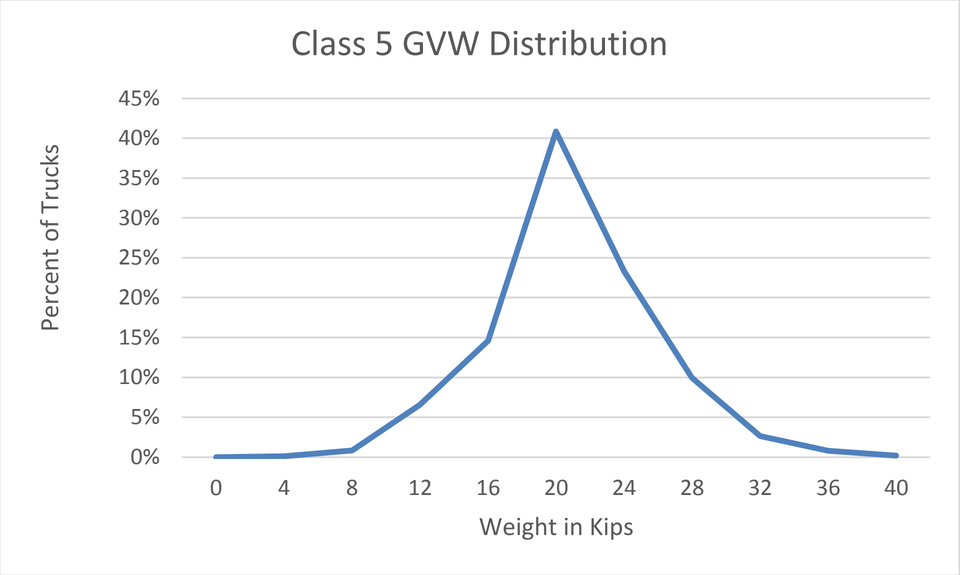

Figure 8-10 – Class 5 GVW Distribution - Lane 2

8.3 Comparative Analysis

To evaluate the effectiveness of the calibration, a comparison was made between the pre- and post-calibration datasets for each lane.

8.3.1 Lane 1

Table 8-1 provides the average Class 9 and Class 5 average weight and distance measurements for the two datasets for lane 1.

Table 8-1 – Data Comparison – Lane 1

	Class 9				Class 5		
	Avg GVW	**Avg F/A**	**Avg Length**	**Avg 2-3**	**Avg GVW**	**Avg Length**	**Avg spacing**
pre-visit -	46.6	10.4	66.1	4.3	18.3	33.9	19.4
calibration -	-2.0%	-2.0%	-3.0%	0.0%	-2.0%	-3.0%	0.0%
post-visit -	46.1	10.7	64.1	4.3	18.8	32.9	19.5
difference -	-0.5	0.3	-2.0	0.0	0.5	-1.0	0.1
percent change -	-1.1%	2.9%	-3.0%	0.0%	2.7%	-2.9%	0.5%

As shown in the table, the changes made to the WIM system weight and distance compensation factors are reflected in the values provided by the post-visit dataset for average Class 9 GVW and for overall length for Class 9 and Class 5 trucks. Although the Mean Impact Factor for lane 1 was adjusted to reduce weights by 2.0 percent, and the Loop Compensation Factor was not changed, the average front axle weight for Class 9 trucks increased by 2.9 percent, and the average GVW for Class 5 trucks increased 2.7 percent between the pre-visit to the post-visit datasets.

8.3.2 Lane 2

Table 8-2 provides the average Class 9 and Class 5 average weight and distance measurements for the two datasets for lane 2.

Table 8-2 – Data Comparison – Lane 2

	Class 9				Class 5		
	Avg GVW	**Avg F/A**	**Avg Length**	**Avg 2-3**	**Avg GVW**	**Avg Length**	**Avg spacing**
pre-visit -	58.1	11.2	67.3	4.3	19.8	33.8	19.4
calibration -	3.8%	3.8%	-3.0%	0.0%	3.8%	-3.0%	0.0%
post-visit -	58.5	10.9	64.9	4.3	19.0	32.8	19.4
difference -	0.4	-0.3	-2.4	0.0	-0.8	-1.0	0.0
percent change -	0.7%	-2.7%	-3.6%	0.0%	-4.0%	-3.0%	0.0%

As shown in the table, the changes made to the WIM system weight and distance compensation factors are reflected in the values provided by the post-visit dataset for average Class 9 GVW and for overall length for Class 9 and Class 5 trucks. Although the Mean Impact Factor for lane 2 was adjusted to increase weights by 3.6 percent, and the Loop Compensation Factor was not changed, the average front axle weight for Class 9 trucks decreased by 2.7 percent, and the average GVW for Class 5 trucks decreased 4.0 percent between the pre-visit to the post-visit datasets.

8.3.3 Steer Axle Factor Recommendations

According to the manufacturer, the Steer Axle Factor is a "direct multiplying factor to the front axle. Whatever weight is taken off or added on is then distributed to the next axle group so the gross weight remains the same". During the calibration, the front axle weights for the test trucks did not appear to respond to the adjustments as expected. Since reason for the inconsistency could not be determined on site, the factor for both lanes was returned to the original setting of 1000 for both lanes.

Based on the post-visit data analysis and a review of the results of the calibration, the following recommendations are made:

- Since the pre- and post-calibration results demonstrated a consistent difference between the front axle error and the GVW measurement error of approximately 5 percent, it is recommended that the Steer Axle Factor for lane 1 be reduced from 1000 to 950.

- Since the pre- and post-calibration results demonstrated a difference between the front axle error and the GVW measurement error of approximately +4.2% and +1.4%, respectively, it is recommended that the Steer Axle Factor for lane 2 be reduced from 1000 to 970.

A post-visit analysis of the Steer Axle Function demonstrated that the weight that is removed from the front axle based on the Steer Axle Factor is redistributed to the next axle, and not the next axle group, as stated. Conversely, weight that is taken to increase the weight of the front axle is only taken from the next axle, and not the next axle group, which may dramatically reduce the weight of the next axle.

It is recommended that the manufacturer revise the function of the Steer Axle Factor so that the over- or under-estimation of steering axle errors not be redistributed. The Steer Axle Factor should be a direct multiplier of the reported front axle weight and should be independent of any other axle weight measurement.

9 Additional Information

The following information is provided in the attached appendix:

- WIM Site Inspection, Parts A through G
- Test Truck Photos
- Test Truck Run Records
    - Lane 1 Pre
    - Lane 1 Post
    - Lane 2 Pre
    - Lane 2 Post

APPENDIX E – WIM EQUIPMENT MAINTENANCE DOCUMENTS AND SAMPLE FORMS

APPENDIX E – TABLE OF CONTENTS

1. PennDOT WIM Maintenance Contract Statement of Work
2. LTPP Traffic Sheet 17 – WIM Inventory Form
3. FDOT Traffic Monitoring Inspection Sheet
4. FHWA LTPP Traffic Sheet 22 – WIM Site Equipment Assessment Form
5. FHWA LTPP Traffic Sheet 23 – WIM Troubleshooting Outline Form
6. New Jersey DOT WIM Site Maintenance Log

WORK STATEMENT

ITEM 1: ANNUAL ROUTINE MAINTENANCE SERVICE (Planning WIM Sites Only).

The Department shall pay the Contractor a fixed fee per site as broken out below on the number of annual routine maintenance services at WIM sites identified by the Department. This payment shall cover all costs (including but not limited to wages, travel expenses, etc.) incurred by the Contractor.

Planning WIM Sites		
1-4 Sites	$3,610	per site
5-9 Sites	$3,411	per site
10 or more sites	$3,213	per site

By **March 1**, the Department will submit to the Contractor a list of WIM sites for annual routine maintenance service.

Annual Routine Maintenance Service shall be completed between March 15 and April 30.

Annual Routine Maintenance Service shall include:

1.1 Inductive Loops

1.1.1 Conduct Visual Inspection:
  1.1.1.1 Check sealant condition (i.e. missing, exposed wires).
  1.1.1.2 Check roadway condition (i.e. cracks, potholes).
  1.1.1.3 Check splice(s) if present.
  1.1.1.4 All conditions must be noted on Site Condition Report (**Form 8**) and sketched and photographed showing location of problems.

1.1.2 Perform Tests:
  1.1.2.1 Measure the resistance of continuous loops.
  1.1.2.2 Measure the resistance of loops relative to shield.
  1.1.2.3 Measure the inductance of loops.
  1.1.2.4 All measurements must be noted on Site Service Sheet (**Form 4**) and Site Condition Report (**Form 8**) using the following identification:

(East – E or North – N)(West – W or South – S)

6 Lane Roads:	4 Lane Roads:	2 Lane Roads:
EBD Lead	EBD Lead	EBD Lead
EBD Trail	EBD Trail	EBD Trail
EBM Lead	EBP Lead	WBD Lead
EBM Trail	EBP Trail	WBD Trail
EBP Lead	WBP Lead	
EBP Trail	WBP Trail	
WBP Lead	WBD Lead	

WBP Trail	WBD Trail	
WBM Lead		
WBM Trail		
WBD Lead		
WBD Trail		

1.2 **Piezoelectric, Quartz Sensors, and Weigh Pads**

1.2.1 Conduct Visual Inspection:

1.2.1.1 Check installation of grout and sealant.

1.2.1.2 Check roadway condition (i.e. cracks, potholes).

1.2.1.3 Check splice(s) if present.

1.2.1.4 All conditions must be noted on Site Condition Report (**Form 8**) and sketched and photographed showing location of problems.

1.2.2 Perform Tests:

1.2.2.1 Measure capacitance (nF) and resistance - record on Site Service Sheet (**Form 4**).

1.2.2.2 All measurements/documentation must be noted on Site Service Sheet (**Form 4**) and Site Condition Report (**Form 8**) using the following identification:

(East – E or North – N)(West – W or South – S)

6 Lane Roads:	4 Lane Roads:	2 Lane Roads:
EBD Lead	EBD Lead	EBD Lead
EBD Trail	EBD Trail	EBD Trail
or EBD (Piezo)	or EBD (Piezo)	or EBD (Piezo)
EBM Lead	EBP Lead	WBD Lead
EBM Trail	EBP Trail	WBD Trail
or EBM (Piezo)	or EBP (Piezo)	or WBD (Piezo)
EBP Lead	WBP Lead	
EBP Trail	WBP Trail	
or EBP (Piezo)	or WBP (Piezo)	
WBP Lead	WBD Lead	
WBP Trail	WBD Trail	
or WBP (Piezo)	or WBD (Piezo)	
WBM Lead		
WBM Trail		
or WBM (Piezo)		
WBD Lead		
WBD Trail		
or WBD (Piezo)		

1.2.2.3 Complete Vehicle Classification Accuracy Test.

1.2.2.3.1 A manual vehicle classification will be performed on each lane of the site for a minimum period of 15 minutes and should include a minimum of three (3) vehicle classes (Class 2, Class 3, and one other class based on vehicles available at site. Class 8 or higher preferred). Record the information on Vehicle Classification Accuracy Test Form (**Form 3**).

1.2.2.3.2 The observer will make an entry for each observed vehicle and the corresponding vehicle recorded on the classifier.

1.2.2.3.3 Upon the completion of the manual classification period of 15 minutes, a separate analysis will be completed by performing the steps necessary to determine the percent of error for each lane at the site.

1.2.2.3.4 The indicated *% Error of Machine* must be within +-5%. If the values fall outside of this range, the contractor must effect adjustments according to the machine's manufacturer and repeat 1.2.2.3.1. If second test fails, include necessary repairs in itemized repair cost quote (1.11).

1.3 Control Cabinet

1.3.1 Conduct Visual Inspection of equipment:

1.3.1.1 Check antenna mast.

1.3.1.2 Check cleanliness – remove any debris.

1.3.1.3 Ensure fasteners, hinges, locking mechanism are tight/lubricated/operating properly

1.3.1.4 Ensure connector screws of terminal strips, cables, batteries and accessory components are tight.

1.3.1.5 Ensure conduits are sealed.

1.3.1.6 Replace cabinet filter.

1.3.1.7 Label loop and sensor leads (as needed).

1.3.1.8 Install rodent controls as needed (ex. d-CON).

1.3.1.9 Note all conditions/corrections of problems on Site Condition Report (**Form 8**).

1.4 Electrical/Solar/Service Utilities

1.4.1 Conduct Visual Inspection of electrical equipment and structures, service pole, solar panels:

1.4.1.1 Look for safety hazards.

1.4.1.2 Look for evidence of tampering.

1.4.2 Perform Tests:

1.4.2.1 Measure output of voltage regulator and battery (at solar facilities) or electrical outlet (at AC sites) and record on Site Service Sheet (**Form 4**).

1.4.2.2 Inspect (POTS) telephone connection at interface box and record voltage readings on Site Service Sheet (**Form 4**).

1.4.2.3 Perform modem check. Verify site communication with Central Office.

1.4.2.4 Note all conditions/corrections of problems on Site Condition Report (**Form 8**).

1.5 Pull Boxes

1.5.1 Conduct Visual Inspection of pull box(es):

1.5.1.1 Look for cracks/serviceability/safety hazards.

1.5.1.2 Look at interior for excessive soil collected/ water retention (flooding).

1.5.1.3 Ensure cables are intact and connections, splices are sealed.

1.5.1.4 Check conduits.

1.5.1.5 Note all conditions/corrections of problems on Site Condition Report (**Form 8**).

1.6 Pavement

1.6.1 Conduct Inspection of pavement:

1.6.1.1 Look for cracks/ruts/eroded surfacing.

1.6.1.2 Note any significant impact on loop/sensor installation on Site Condition Report (**Form 8**).

1.7 **Site Plans/Drawings**

1.7.1 Note any changes or modifications to site configuration plans.

1.7.2 If no plan exists, create a set of plans for site; include measurements necessary to document site changes/modifications.

1.7.3 Site plans will include Single Line Drawings.

1.8 **Site Photos**

1.8.1 Take date/time-stamped digital photos of site facilities, particularly the condition of the payment surface around each loop and sensor.

1.8.2 Photograph any site components (include but not limited to cabinet, service pole, pull boxes, etc.) displaying any adverse or unusual change since previous service visit.

1.9 **Site/Equipment Inventory**

1.9.1 Identify and record model and serial numbers on equipment installed at traffic monitoring station (cabinet, counter, modem, solar panel, etc.).

1.9.2 Record information on Site Inventory Report (**Form 7**).

1.10 **Ground Maintenance**

1.10.1 Ensure that grass and weeds are cut and foliage is cleared within 10 foot radius within the right of way around the control cabinet and service pole and path from shoulder.

1.10.2 If trees are located at the site and are a problem notify project supervisor and project manager who will coordinate tree trimming/removal with PennDOT County Maintenance.

1.11 **On Site Repairs**

1.11.1 If the contractor finds defective components or miscellaneous parts listed in IRD/PAT Spare Parts Price List (**Schedule 3**) which they have on hand and are able to repair the site problem, the project supervisor and project manager must be notified by telephone for approval prior to completing the work.

1.11.2 The project supervisor and/or manager will send an e-mail to the Contractor verifying approval provided through the telephone call.

1.11.3 The Contractor shall follow up with itemized cost list for parts used in repair within 7 days following the repair.

1.12 **Itemized Cost quote for Task Order Service**

1.12.1 The Contractor shall submit an itemized cost quote for defective components, miscellaneous parts, and other cost to the Department identified on Site Condition Report (**Form 8**) within 14 days of the Routine Service for each site. The Department will compensate the Contractor for all authorized repairs that are not covered above as follows:

1.12.1.1 Response Times and compensation for repairs shall be as follows:

1.12.1.1.1 Contractor personnel costs per Service Rate Schedule (**Schedule 2**)

1.12.1.1.1.1 Service Vehicle Mileage shall be charged from Technician's home location to the first site visited, between consecutive site visits and back to Technician's home location after the last site visited in accordance with mileages listed on Site Mileage Chart (**Schedule 5 B**). Service Vehicle mileage shall not be charged when the service technician leaves a site to perform service that is not part of this agreement.

1.12.1.1.1.2 Travel time shall be charged from Technician's home location to the first site visited, between consecutive site visits and back to Technician's home location after the last site visited in accordance with travel times listed on Site Travel Time Chart (**Schedule 5 A**). Travel Time shall not be charged when the service technician leaves a site to perform service that is not part of this agreement.

1.12.1.1.2 The Department is not responsible for contractor costs incurred if work must stop for weather conditions, improper scheduling, or equipment failure. It is the contractor's responsibility to coordinate schedule to avoid repeated costs.

1.12.1.1.3 Replacement parts and components per IRD Spare Parts List (**Schedule 3**)

1.12.1.1.4 Cost plus 10% for service equipment rental and miscellaneous parts not listed in **Schedule 3** but approved by the Department.

1.12.1.1.5 Cost plus 10% for subcontractor costs. The Department is not responsible for subcontractor costs incurred if work must stop for weather conditions, improper scheduling, or equipment failure. It is the contractor's responsibility to coordinate subcontractor schedule to avoid repeated costs.

1.12.1.1.6 The Department shall provide the Contractor with notification of acceptance, modification, or rejection of the cost quote within 7 days of its receipt. Once accepted the Department shall issue a Task Order to the Contractor.

1.13 Routine Service Deliverables

Deliverables shall be submitted for each site to the Department within 14 days of each Routine Site Service.

1.13.1 **Form 3** – Vehicle Classification Accuracy Test Form
1.13.2 **Form 4** –Site Service Sheet
1.13.3 **Form 5** – Site Service Report
1.13.4 **Form 7** – Site Inventory Report
1.13.5 **Form 8** – Site Condition Report
1.13.6 Updates to FOM (PennDOT's future internet based Field Operations Manager)
1.13.7 Single Line Drawing
1.13.8 Site Specific Digital Photos
1.13.9 Itemized Repair Cost Quote (if needed)
1.13.10 **OS-501** Confirmation of Service
1.13.11 Copy of all Subcontractor Invoices
1.13.12 Invoicing: IRD cannot submit an invoice to the PO Box until a signed **OS-501** is received back from BPR PennDOT. The invoice and back up documentation including **Form 5** and Subcontractor Invoices must be emailed to the Project Manager for review and if necessary corrected and resubmitted before the **OS-501** Confirmation of Service will be signed by BPR PennDOT approving payment to be made.

ITEM 2: ANNUAL ROUTINE MAINTENANCE SERVICE
(Enforcement WIM Sites Only)

The Department shall pay the Contractor a fixed fee per site as broken out below on the number of annual routine maintenance services at WIM sites identified by the Department. This payment shall covers all costs (including but not limited to wages, travel expenses, etc.) incurred by the Contractor.

PennDOT shall provide lane closure for all Routine Maintenance Service at sites without controlled access, when in-road work is required. The contractor will be responsible for notifying PennDOT's Project manager at least 14 days prior to the start of any work.

Enforcement WIM Sites (25 total sites)		
1-9 Sites	$ 4,884.00	per site
10-19 Sites	$ 4,558.00	per site
20 or more sites	$4,488.00	per site

By **April 15**, the Department will submit to the Contractor a list of WIM sites for annual routine maintenance service.

Annual Routine Maintenance Service shall be completed between May 1 and August 31.

Annual Routine Maintenance Service shall include:

2.1 **Inductive Loops**

- 2.1.1 Conduct Visual Inspection:
  - 2.1.1.1 Check sealant condition (i.e. missing, exposed wires).
  - 2.1.1.2 Check roadway condition (i.e. cracks, potholes).
  - 2.1.1.3 Check splice(s) if present.
  - 2.1.1.4 All conditions must be noted on Site Condition Report (**Form 8**) and sketched and photographed showing location of problems.
- 2.1.2 Perform Tests:
  - 2.1.2.1 Measure the resistance of continuous loops.
  - 2.1.2.2 Measure the resistance of loop relative to shield.
  - 2.1.2.3 Measure the inductance of loops.
  - 2.1.2.4 All measurements must be noted on Site Service Sheet (**Form 4**) and Site Condition Report (**Form 8**) using the following identification:

Ramp
Lead Loop
Trail Loop

2.2 **Piezoelectric, Quartz Sensors, and Weigh Pads**

- 2.2.1 Conduct Visual Inspection:
  - 2.2.1.1 Check installation of grout and sealant.
  - 2.2.1.2 Check roadway condition (i.e. cracks, potholes).

2.2.1.3 Check splice(s) if present.

2.2.1.4 All conditions must be noted on Site Condition Report (**Form 8**) and sketched and photographed showing location of problems.

2.2.2 Weigh Pad Maintenance:

2.2.2.1 Remove nuts and washers on 1.75 Meter Bending Plate Frames.

2.2.2.2 Lift bending plates to one side.

2.2.2.3 Clean drain area under 1.75 Meter Frames.

2.2.2.4 Reset bending plate.

2.2.2.5 Clean side channels and remove debris.

2.2.2.6 Reconnect rubber gaskets to 1.75 Meter Frames.

2.2.2.7 Use anti-seize on bolts before replacing washers and nuts.

2.2.2.8 Install new nuts and washers on 1.75 Meter Bending Plate Frame.

2.2.2.9 Torque all nuts.

2.2.2.10 Cut off any excess rubber gasket material.

2.2.3 Perform Tests:

2.2.3.1 Perform electrical reading checks for 1.75 Meter Bending Plates (resistance, zero point, signal output and leakage) and record on Site Service Sheet (**Form 4**).

2.2.3.2 All measurements/documentation must be noted on Site Service Sheet (**Form 4**) and Site Condition Report (**Form 8**) using the following identification:

Ramp
Lead Left
Lead Right
Trail Left
Trail Right

2.3 Control Cabinet

2.3.1 Conduct Visual Inspection of equipment:

2.3.1.1 Check antenna mast.

2.3.1.2 Check cleanliness – remove any debris.

2.3.1.3 Ensure fasteners, hinges, locking mechanism are tight/lubricated/operating properly.

2.3.1.4 Ensure connector screws of terminal strips, cables, batteries and accessory components are tight.

2.3.1.5 Ensure conduits are sealed.

2.3.1.6 Replace cabinet filter.

2.3.1.7 Label loop and sensor leads (as needed).

2.3.1.8 Install rodent controls as needed (ex. d-CON).

2.3.1.9 Note all conditions/corrections of problems on Site Condition Report (**Form 8**).

2.4 Electrical/Solar/Service Utilities

2.4.1 Conduct Visual Inspection of electrical equipment and structures, service pole, solar panels:

2.4.1.1 Look for safety hazards.

2.4.1.2 Look for evidence of tampering.

2.4.2 Perform Tests:

2.4.2.1 Measure output of voltage regulator and battery (at solar facilities) or electrical outlet (at AC sites) and record on Site Service Sheet (**Form 4**).

2.4.2.2 Perform Communication check for WiFi connection.

2.4.2.3 Note all conditions/corrections of problems on Site Condition Report (**Form 8**)

2.5 **Pull Boxes**

2.5.1 Conduct Visual Inspection of pull box(es):

2.5.1.1 Look for cracks/serviceability/safety hazards.

2.5.1.2 Note all conditions/corrections of problems on Site Condition Report (**Form 8**).

2.6 **Pavement**

2.6.1 Conduct Inspection of pavement:

2.6.1.1 Look for cracks/ruts/eroded surfacing.

2.6.1.2 Note any significant impact on loop/sensor installation on Site Condition Report (**Form 8**).

2.7 **Site Plans/Drawings**

2.7.1 Note any changes or modifications to site configuration plans.

2.7.2 If no plan exists, create a set of plans for site; include measurements necessary to document site changes/modifications.

2.7.3 Site plans will include Single Line Drawings.

2.8 **Site Photos**

2.8.1 Take date/time-stamped digital photos of site facilities, particularly the condition of the payment surface around each loop and sensor.

2.8.2 Photograph any site components (include but not limited to cabinet, service pole, pull boxes, etc.) displaying any adverse or unusual change since previous service visit.

2.9 **Site/Equipment Inventory**

2.9.1 Identify and record model and serial numbers on equipment installed at traffic monitoring station (cabinet, counter, modem, solar panel, etc.).

2.9.2 Record information on Site Inventory Report (**Form 7**).

2.10 **On Site Repairs**

2.10.1 If the contractor finds defective components or miscellaneous parts listed in IRD/PAT Spare Parts Price List (**Schedule 3**) which they have on hand and are able to repair the site problem, the project supervisor and project manager must be notified by telephone for approval prior to completing the work.

2.10.2 The project supervisor and/or manager will send an e-mail to the Contractor verifying approval provided through the telephone call.

2.10.3 The Contractor shall follow up with itemized cost list for parts used in repair within 7 days following the repair.

2.11 **Itemized Cost quote for Task Order Service**

2.11.1 The Contractor shall submit an itemized cost quote for defective components, miscellaneous parts, and other cost to the Department identified on Site Condition Report (**Form 8**) within 14 days of the Routine Service for each site. The Department will compensate the Contractor for all authorized repairs that are not covered above as follows:

2.11.1.1 Response Times and compensation for repairs shall be as follows:

2.11.1.1.1 Contractor personnel costs per Service Rate Schedule (**Schedule 2**).

2.11.1.1.1.1 Service Vehicle Mileage shall be charged from Technician's home location to the first site visited, between consecutive site visits and back to Technician's home location after the last site visited in accordance with mileages listed on Site Mileage Chart (**Schedule 5 B**). Service Vehicle mileage shall not be charged when the service technician leaves a site to perform service that is not part of this agreement.

2.11.1.1.1.2 Travel time shall be charged from Technician's home location to the first site visited, between consecutive site visits and back to Technician's home location after the last site visited in accordance with travel times listed on Site Travel Time Chart (**Schedule 5 A**). Travel Time shall not be charged when the service technician leaves a site to perform service that is not part of this agreement.

2.11.1.1.2 The Department is not responsible for contractor costs incurred if work must stop for weather conditions, improper scheduling, or equipment failure. It is the contractor's responsibility to coordinate schedule to avoid repeated costs.

2.11.1.1.3 Replacement parts and components per IRD Spare Parts List (**Schedule 3**).

2.11.1.1.4 Cost plus 10% for service equipment rental and miscellaneous parts not listed in **Schedule 3** but approved by the Department.

2.11.1.1.5 Cost plus 10% for subcontractor costs. The Department is not responsible for subcontractor costs incurred if work must stop for weather conditions, improper scheduling, or equipment failure. It is the contractor's responsibility to coordinate subcontractor schedule to avoid repeated costs.

2.11.1.1.6 The Department shall provide the Contractor with notification of acceptance, modification, or rejection of the cost quote within 7 days of its receipt. Once accepted the Department shall issue a Task Order to the Contractor.

2.12 Routine Service Deliverables

Deliverables shall be submitted for each site to the Department within 14 days of each Routine Site Service.

2.12.1 **Form 4** –Site Service Sheet
2.12.2 **Form 5** – Site Service Report
2.12.3 **Form 7** – Site Inventory Report
2.12.4 **Form 8** – Site Condition Report
2.12.5 Updates to FOM (PennDOT's future internet based Field Operations Manager)
2.12.6 Single Line Drawing
2.12.7 Site Specific Digital Photos
2.12.8 Itemized Repair Cost Quote (if needed)
2.12.9 **OS-501** Confirmation of Service
2.12.10 Copy of all Subcontractor Invoices
2.12.11 Invoicing: IRD cannot submit an invoice to the PO Box until a signed **OS-501** is received back from BPR PennDOT. The invoice and back up documentation including **Form 5** and Subcontractor Invoices must be emailed to the Project Manager for review and if necessary corrected and resubmitted before the **OS-501** Confirmation of Service will be signed by BPR PennDOT approving payment to be made.

ITEM 3: TASK ORDER SERVICE:

Any work issued for Task Order service calls shall be completed within 3 months of the acceptance of the cost quote by the Department and prior to scheduled calibration of Planning WIM Sites**.**

PennDOT shall provide lane closure for all Routine Maintenance Service at sites without controlled access, when in-road work is required. The contractor will be responsible for notifying PennDOT's Project manager at least 14 days prior to the start of any work.

Task Order Service shall include:

3.1 **Completion of all work identified on the accepted repair cost quote**.

3.2 **Perform Test on Lanes Repaired Only**.

3.2.1 Perform Inductive Loop Tests:
- 3.2.1.1 Measure resistance of continuous loops.
- 3.2.1.2 Measure resistance of loop relative to shield.
- 3.2.1.3 Measure inductance of loops.

3.2.2 Perform Piezo Electric , Quartz Sensor Tests and Weigh Pads Tests:
- 3.2.2.1 Measure capacitance (nF) and resistance (Planning WIM Sites Only).
- 3.2.2.2 Measure resistance, zero point, signal output and leakage on 1.75 Meter Bending Plates (Enforcement WIM Sites Only).
- 3.2.2.3 All measurements must be noted on Site Service Sheet (**Form 4**) using the identification noted in ITEM 1 or ITEM 2.

3.2.3 Complete Vehicle Classification Accuracy Test (Planning WIM Sites Only)
- 3.2.3.1 A manual vehicle classification will be performed on each lane of the site for a minimum period of 15 minutes and should include a minimum of three (3) vehicle classes (Class 2, Class 3, and one other class based on vehicles available at site. Class 8 or higher preferred). Record information on Vehicle Classification Accuracy Test Form (**Form 3**).
- 3.2.3.2 The observer will make an entry for each observed vehicle and the corresponding vehicle recorded on the classifier.
- 3.2.3.3 Upon the completion of the manual classification period, a separate analysis will be completed for each lane at the site.

3.2.4 The indicated *% Error of Machine* should be within +-5%. If the values fall outside of this range, the contractor must effect adjustments according to the machine's manufacturer and repeat as necessary.

3.3 **Site Plans/Drawings Updated**

3.3.1 Note any changes or modifications to site plans. Site plans will include Single Line Drawings.

3.4 **Site Photos**

3.4.1 Take date/time-stamped digital photos of site facilities that were repaired during Task Order Service. Photograph any site components (include but not limited to cabinet, service pole, pull boxes, etc.) displaying an adverse or unusual change since previous service visit.

3.5 **Site/Equipment Inventory**

3.5.1 Identify and record model and serial numbers on equipment installed at traffic monitoring station (cabinet, counter, modem, solar panel, etc.). Record information on Site Inventory Report (**Form 7**).

3.6 Complete and Submit Site Service Report (**Form 5**) including subcontractor costs, service equipment rentals, and all associated copies of receipts to the Department within 30 days of site repair completion. The Department shall have 14 days to accept site repairs and documentation before the Contractor can invoice. Warranty period shall begin upon acceptance of site repairs and documentation by the Department. Warranty Statement (**Form 1**) shall be sent to the Department upon the Department's acceptance.

3.7 **TASK ORDER SERVICE DELIVERABLES**

Deliverables shall be submitted for each site to the Department within 14 days of each Routine Site Service.

3.7.1 **Form 1** – Warranty Form
3.7.2 **Form 3** – Vehicle Classification Accuracy Test Form (Planning WIM Sites Only)
3.7.3 **Form 4** – Site Service Sheet
3.7.4 **Form 5** – Site Service Report
3.7.5 **Form 7** – Site Inventory Report
3.7.6 Updates to FOM (PennDOT's future internet based Field Operations Manager)
3.7.7 Single Line Drawings
3.7.8 Site Specific Digital Photos
3.7.9 **OS-501** Confirmation of Service
3.7.10 Copy of all Subcontractor Invoices
3.7.11 Invoicing: IRD cannot submit an invoice to the PO Box until a signed **OS-501** is received back from BPR PennDOT. The invoice and back up documentation including **Form 5** and Subcontractor Invoices must be emailed to the Project Manager for review and if necessary corrected and resubmitted before the **OS-501** Confirmation of Service will be signed by BPR PennDOT approving payment to be made.

ITEM 4: ANNUAL SITE CALIBRATION (Planning WIM Sites Only)

The Department shall pay the Contractor a fixed fee per site as broken out below on the number of calibrations at WIM sites identified by the Department. This payment shall cover all costs (including but not limited to wages, travel expenses, equipment rental, calibration truck and driver, etc.) incurred by the Contractor.

Planning WIM Sites (13 total sites)		
1-4 Sites	$5,626.00	per site
5-9 Sites	$5,230.00	per site
10 or more sites	$4,834.00	per site

If work is not completed for Task Order Service Call prior to scheduled calibration date, the Department will not be responsible for payment of sites not calibrated. The cost per site is calculated based on the site list provided by the Department on or before September 1.

By **September 1**, the Department will submit to the Contractor a list of WIM sites for annual site calibration service.

Annual Site Calibration shall include:

4.1 **Calibration/accuracy testing of the Department's Weigh-In-Motion Systems sites will be conducted each year, between September 15 and October 31**.

4.2 Calibration will be accomplished by utilizing a modified version of the ASTM Standard E1318-92: Standard Specification for Highway Weigh-In-Motion (WIM) Systems - Type II WIM Systems. The modifications dictate that as a minimum, one 5-Axle single trailer truck of known static weight and axle spacing will be utilized as the reference value for testing. The vendor will provide the truck for calibration.

4.3 The contractor will make all necessary arrangements for conducting a complete WIM calibration at each of the sites. The contractor will then notify the Department of the calibration dates, 7 days prior to the first scheduled calibration. The contractor will calibrate the WIM system utilizing the referenced vehicle and the modified ASTM E 1318-92.

4.4 **Accuracy Testing Requirements**:
To successfully accomplish the accuracy test, the WIM site must be calibrated.
The test for accuracy follows:

- 4.4.1 For all sites the reference vehicle will make a maximum of ten (10) passes over the WIM system at the posted speed. A record will be made of the GVW, axle spacing, axle weight and speed for each pass.
- 4.4.2 Utilizing the recorded GVWs, calculate the percent difference between actual and measured weights of each pass.
- 4.4.3 If after the completion of seven (7) consecutive passes with no adjustment to sensor parameters and each pass is within +/- 5% of GVW, declare the WIM system accurate.

4.4.4 Upon the completion of all passes calculate the percent of the total number of observed values exceeding the known vehicle weight. This will show the percent of calculated differences that exceeded the specified tolerance value (+/-10% of GVW). If the percent of calculated difference is greater than 10%, declare the WIM system inaccurate.

4.5 **Calibration Deliverables**:

Deliverables shall be submitted to the Department within 14 days of each Annual Site Calibration.

4.5.1 **Form 2 -** Calibration Form
4.5.2 **Form 5 -** Site Service Report
4.5.3 **OS-501** Confirmation of Service
4.5.4 Updates to FOM (PennDOT's future internet based Field Operations Manager)
4.5.6 Copy of all Subcontractor Invoices
4.5.7 **Invoicing:** IRD cannot submit an invoice to the PO Box until a signed **OS-501** is received back from BPR PennDOT. The invoice and back up documentation including **Form 5** and Subcontractor Invoices must be emailed to the Project Manager for review and if necessary corrected and resubmitted before the **OS-501** Confirmation of Service will be signed by BPR PennDOT approving payment to be made.

ITEM 5: SITE CALIBRATION (Enforcement WIM Sites Only)

The Department shall pay the Contractor a fixed fee per site to calibrate the Enforcement WIM sites identified by the Department. This payment shall cover all costs (including but not limited to wages, travel expenses, and equipment rental, etc.) incurred by the Contractor. Site calibration shall be scheduled and preformed the day after the performance of the routine maintenance service of the enforcement WIM site.

If the PSP Trooper and Weigh Team do not appear for the scheduled calibration, Schedule 2 service rates will be charged for a return trip by the contractor to calibrate the site in addition to the fixed fee per site.

Enforcement WIM Sites (25 total sites)		
Per Site	$1,388.00	per site

If work is not completed for any Task Order Service Call prior to scheduled calibration date, the Department will not be responsible for payment of sites not calibrated.

By **April 15**, the Department will submit to the Contractor a list of Enforcement WIM sites for site calibration service.

Annual Site Calibration shall include:

5.1 **Calibration/accuracy testing of the Department's Enforcement Weigh-In-Motion Systems sites will be conducted between May 1 and August 31.**

5.1.1 The contractor will make all necessary arrangements for conducting a complete Enforcement WIM calibration at each of the sites. The contractor will then notify the Department of the calibration dates, 7 days prior to the first scheduled calibration.

5.2 Calibration will be accomplished by utilizing random truck traffic and comparing weight to certified portable scale weights as described below:

5.2.1 Using random truck traffic from the traffic stream, use loaded trucks with non-shifting loads (70,000 lb. – 80,000 lb.).
5.2.2 State Police flag targeted truck.
5.2.3 Weight team weighs targeted truck on portable "Certified" scale
5.2.4 Utilizing the recorded GVWs, calculate the percent difference between bending plate and portable scale weights of the truck
5.2.5 Make adjustments to IRD Counter.
5.2.6 Repeat process with another random truck
5.2.7 Goal is to get to less than 5 % difference between two scales

5.3 Accuracy Testing Requirements:
To successfully accomplish the accuracy test, the WIM site must be calibrated.
<u>The test for accuracy follows</u>:

5.3.1 If after the completion of four (4) consecutive scale comparisons with no adjustment to the counter and each pass is within +/- 5% of GVW, declare the WIM system accurate.

5.3.2 If after the completion of six (6) consecutive scale comparisons and each pass is outside of the +/- 5% of GVW, declare the WIM system inaccurate.

5.4 Calibration Deliverables:

Deliverables shall be submitted to the Department within 14 days of each Annual Site Calibration.

5.4.1 **Form 2** - Calibration Form

5.4.2 **Form 5** - Site Service Report

5.4.3 **OS-501** Confirmation of Service

5.4.4 Updates to FOM (PennDOT's future internet based Field Operations Manager)

5.4.5 Copy of all Subcontractor Invoices

5.4.6 **Invoicing**: IRD cannot submit an invoice to the PO Box until a signed **OS-501** is received back from BPR PennDOT. The invoice and back up documentation including **Form 5** and Subcontractor Invoices must be emailed to the Project Manager for review and if necessary corrected and resubmitted before the **OS-501** Confirmation of Service will be signed by BPR PennDOT approving payment to be made.

ITEM 6: NON ROUTINE SITE DIAGNOSIS

6.1 NON ROUTINE SITE DIAGNOSIS:

Upon request of the Department, the Contractor shall be compensated based on Service Rates **(Schedule 2)** for diagnosis of site issues.

6.1.1 The Contractor shall provide the Department with a cost quote to diagnose the site issues within 7 days of the Department's request. The Department shall provide the Contractor with notification of acceptance, modification, or rejection of cost quote within 7 days of its receipt. Once accepted the Department shall issue a Task Order to the Contractor to visit site to diagnose issues.

6.1.2 The Contractor shall have 14 days to perform site diagnosis after the Task Order is issued by the Department to the Contractor. Items found shall be reported on Site Condition Report **(Form 8)**.

6.2 Itemized Cost Quote for Task Order Service

6.2.1 The Contractor shall submit an itemized cost quote for defective components, miscellaneous parts, and other cost to the Department identified on Site Condition Report **(Form 8)** within 7 days.

The Department will compensate the Contractor for all authorized repairs that are not covered above as follows:

6.2.1.1 Response Times and compensation for repairs shall be as follows:

6.2.1.1.1 Contractor personnel costs per Service Rate Schedule (**Schedule 2)**.

6.2.1.1.1.1 Service Vehicle Mileage shall be charged from Technician's home location to the first site visited, between consecutive site visits and back to Technician's home location after the last site visited in accordance with mileages listed on Site Mileage Chart **(Schedule 5 B)**. Service Vehicle mileage shall not be charged when the service technician leaves a site to perform service that is not part of this agreement.

6.2.1.1.1.2 Travel time shall be charged from Technician's home location to the first site visited, between consecutive site visits and back to Technician's home location after the last site visited in accordance with travel times listed on Site Travel Time Chart **(Schedule 5 A)**. Travel Time shall not be charged when the service technician leaves a site to perform service that is not part of this agreement.

6.2.1.1.2 The Department is not responsible for contractor costs incurred if work must stop for weather conditions, improper scheduling, or equipment failure. It is the contractor's responsibility to coordinate schedule to avoid repeated costs.

6.2.1.1.3 Replacement parts and components per IRD Spare Parts List (**Schedule 3).**

6.2.1.1.4 Cost plus 10% for service equipment rental and miscellaneous parts not listed in **Schedule 3** but approved by the Department.

6.2.1.1.5 Cost plus 10% for subcontractor costs. The Department is not responsible for subcontractor costs incurred if work must stop for weather conditions, improper scheduling, or equipment failure. It is the contractor's responsibility to coordinate subcontractor schedule to avoid repeated costs.

6.2.1.1.6 The Department shall provide the Contractor with notification of acceptance, modification, or rejection of the cost quote within 7 days of its receipt. Once accepted the Department shall issue a Task Order to the Contractor.

6.2.2 Refer to ITEM 2: TASK ORDER SERVICE

6.3 Deliverables:

6.3.1 Diagnosis Cost Quote
6.3.2 Itemized Repair Cost Quote
6.3.3 **Form 8** – Site Condition Report
6.3.4 **Form 5** – Site Service Report
6.3.5 **OS-501** Confirmation of Service
6.3.6 Updates to FOM (PennDOT's future internet based Field Operations Manager)
6.3.7 Copy of all Subcontractor Invoices

6.3.8 **Invoicing:** IRD cannot submit an invoice to the PO Box until a signed **OS-501** is received back from BPR PennDOT. The invoice and back up documentation including **Form 5** and Subcontractor Invoices must be emailed to the Project Manager for review and if necessary corrected and resubmitted before the **OS-501** Confirmation of Service will be signed by BPR PennDOT approving payment to be made.

ITEM 7: NEW INSTALLATION OF WIM SITE

7.1 New Site Installation Scope and Review to Develop Installation Cost Quote:

The Contractor shall provide the Department with a cost quote based on Service Rates **(Schedule 2)** for the scope and review a new site installation location as specified by the Department within 7 days of the Department's request. The scope and review of the new site location is for the purpose of developing an itemized cost quote to install the new site. The Department shall provide the Contractor with notification of acceptance, modification, or rejection of cost quote within 7 days of its receipt. Once accepted, the Department shall issue a Task Order to the Contractor to visit the proposed new site location.

7.2 Itemized Cost Quote for New Site Installation:

The Contractor shall submit to the Department an itemized cost quote for all components, miscellaneous parts, and other costs to install a new WIM site within 14 days of receiving a Task Order to scope and review a new site location. The Department shall provide the Contractor with notification of acceptance, modification, or rejection of new site installation cost quote within 7 days of its receipt. Once accepted, the Department shall issue a Task Order to the Contractor to install the site.

The Department will compensate the Contractor for all authorized work as follows:

- 7.2.1 A single line drawing is to be included as part of the cost quote of a new WIM site installation.
- 7.2.2 Contractor personnel costs per Service Rate Schedule (**Schedule 2)**.
  - 7.2.2.1 Service Vehicle Mileage shall be charged from PennDOT Central Office to the site location and back. Service Vehicle mileage shall not be charged when the service technician leaves a site to perform service that is not part of this agreement.
  - 7.2.2.2 The Department is not responsible for contractor costs incurred if work must stop for weather conditions, improper scheduling, or equipment failure. It is the contractor's responsibility to coordinate schedule to avoid repeated costs.
- 7.2.3 Parts and components per IRD Spare Parts List (**Schedule 3).**
- 7.2.4 Cost plus 10% for service equipment rental and miscellaneous parts not listed in **Schedule 3** but approved by the Department.
- 7.2.5 Cost plus 10% for subcontractor costs. The Department is not responsible for subcontractor costs incurred if work must stop for weather conditions, improper scheduling, or equipment failure. It is the contractor's responsibility to coordinate subcontractor schedule to avoid repeated costs.

7.3 The Contractor shall have the site installed and fully functional within 3 months of the acceptance of the cost quote by the Department.

7.3.1 As part of the new site installation, the contractor shall also complete as follows:

7.3.1.1 **Inductive Loops:**

- 7.3.1.1.1 <u>Conduct Visual Inspection</u>:
  - 7.3.1.1.1.1 Note sealant condition.
  - 7.3.1.1.1.2 Note roadway condition (i.e. cracks, potholes).
  - 7.3.1.1.1.3 Note splice (s) if present.
  - 7.3.1.1.1.4 All must be noted on Site Condition Report **(Form 8)** and sketched and photographed showing location of problems.

7.3.1.1.2 Perform Tests:

7.3.1.1.2.1 Measure resistance of continuous loops.

7.3.1.1.2.2 Measure resistance of loops relative to shield.

7.3.1.1.2.3 Measure inductance of loops. All measurements must be noted on Site Service Sheet **(Form 4)** and Site Condition Report **(Form 8)** using the following identification:

(East – E or North – N)(West – W or South – S)

6 Lane Roads:	**4 Lane Roads:**	**2 Lane Roads**:	**Bending Plate**
EBD Lead	EBD Lead	EBD Lead	Lead Loop
EBD Trail	EBD Trail	EBD Trail	Trail Loop
EBM Lead	EBP Lead	WBD Lead	
EBM Trail	EBP Trail	WBD Trail	
EBP Lead	WBP Lead		
EBP Trail	WBP Trail		
WBP Lead	WBD Lead		
WBP Trail	WBD Trail		
WBM Lead			
WBM Trail			
WBD Lead			
WBD Trail			

7.3.1.2 Piezoelectric, Quartz Sensors, and Weigh Pad

7.3.1.2.1 Conduct Visual Inspection:

7.3.1.2.1.1 Note installation of grout and sealant condition.

7.3.1.2.1.2 Note roadway condition (i.e. cracks, potholes).

7.3.1.2.1.3 Note splice(s) if present.

7.3.1.2.1.4 All must be noted on Site Condition Report **(Form 8)** and sketched and photographed showing location of problems.

7.3.1.2.2 Perform Tests:

7.3.1.2.2.1 Measure capacitances (nF) and resistance - record on Site Service Sheet **(Form 4) (Planning WIM Sites Only).**

7.3.1.2.2.2 Preform electrical reading checks for 1.75 Meter Bending Plates (resistance, zero point, signal output and leakage) and record on Site Service Sheet **(Form 4) (Enforcement WIM Sites only).**

7.3.1.2.2.3 All measurements/documentation must be noted on Site Service Sheet **(Form 4)** and Site Condition Report **(Form 8)** using the following identification:

(East – E or North – N)(West – W or South – S)

6 Lane Roads:	**4 Lane Roads:**	**2 Lane Roads:**	**Bending Plate**
EBD Lead	EBD Lead	EBD Lead	Lead Left
EBD Trail	EBD Trail	EBD Trail	Lead Right
or EBD (Piezo)	or EBD (Piezo)	or EBD (Piezo)	Trail Left
EBM Lead	EBP Lead	WBD Lead	Trail Right
EBM Trail	EBP Trail	WBD Trail	
or EBM (Piezo)	or EBP (Piezo)	or WBD (Piezo)	
EBP Lead	WBP Lead		
EBP Trail	WBP Trail		

or EBP (Piezo)	or WBP (Piezo)		
WBP Lead	WBD Lead		
WBP Trail	WBD Trail		
or WBP (Piezo)	or WBD (Piezo)		
WBM Lead			
WBM Trail			
or WBM (Piezo)			
WBD Lead			
WBD Trail			
or WBD (Piezo)			

7.3.1.3 Complete Vehicle Classification Accuracy Test (Planning WIM Sites Only).

7.3.1.3.1 A manual vehicle classification will be performed on each lane of the site for a minimum period of 15 minutes and should include a minimum of three (3) vehicle classes (Class 2, Class 3, and one other class based on vehicles available at site. Class 8 or higher preferred). Record information on Vehicle Classification Accuracy Test Form **(Form 3)**.

7.3.1.3.2 The observer will make an entry for each observed vehicle and the corresponding vehicle recorded on the classifier.

7.3.1.3.3 Upon completion of the manual classification period of 15 minutes. A separate analysis will be completed by performing the steps necessary to determine the percent of error for each lane at the site.

7.3.1.3.4 The indicated *% Error of Machine* must be within +-5%. If the values fall outside of this range, the contractor must effect adjustments according to the machine's manufacturer and repeat 7.3.1.3.1. If second test fails, perform necessary repairs.

7.3.1.4 **Control Cabinet**

7.3.1.4.1 Ensure fasteners, hinges, locking mechanism are tight/lubricated/ operating properly

7.3.1.4.2 Ensure connector screws of terminal strips, cables, batteries and accessory components are tight.

7.3.1.4.3 Ensure conduits are sealed.

7.3.1.4.4 Install cabinet filter.

7.3.1.4.5 Label loop and sensor leads (as needed).

7.3.1.4.6 Install rodent controls as needed (ex. d-CON).

7.3.1.4.7 Note all conditions on Site Condition Report **(Form 8).**

7.3.1.5 **Electrical/Solar/Service Utilities**

7.3.1.5.1 Conduct Visual Inspection of electrical equipment and structures, service pole, solar panels for safety hazards.

7.3.1.5.2 Conduct Visual Inspection of electrical equipment and structures, service pole, solar panels for evidence of tampering.

7.3.1.5.3 Measure output of voltage regulator and battery (at solar facilities) or electrical outlet (at AC sites) and record on Site Service Sheet **(Form 4).**

7.3.1.5.4 If telephone connection available, inspect (POTS) telephone connection at interface box and record voltage readings on Site Service Sheet **(Form 4).**

7.3.1.5.5 Perform modem check. Verify site communication with Central Office (Planning WIM Sites Only).

7.3.1.5.6 Perform communication check for WiFi connection (Enforcement WIM Sites Only).

7.3.1.5.7 Note all conditions of problems on Site Condition Report **(Form 8).**

7.3.1.6 **Pull Boxes**

7.3.1.6.1 Note location of pull box.

7.3.1.6.2 Ensure cables are intact and connections, splices are sealed.

7.3.1.6.3 Check conduits.

7.3.1.6.4 Note all conditions on Site Condition Report **(Form 8).**

7.3.1.7 **Pavement**

7.3.1.7.1 Conduct Inspection of pavement for cracks/ruts/eroded surfacing and note any significant impact on loop/sensor installation on Site Condition Report **(Form 8).**

7.3.1.8 **Site Plans/Drawings**

7.3.1.8.1 Note any changes or modifications to original design plans. If no plan exists, create a set of plans for site; include measurements necessary to document site changes/modifications. Site plans will include Single Line Drawings.

7.3.1.9 **Site Photos**

7.3.1.9.1 Take date/time-stamped digital photos of site facilities, particularly the condition of the payment surface around each loop and sensor. Photograph any site components (include but not limited to cabinet, service pole, pull boxes, etc.

7.3.1.10 **Site/Equipment Inventory**

7.3.1.10.1 Identify and record model and serial numbers on state owned equipment installed at traffic monitoring station (cabinet, counter, modem, solar panel, etc.). Record information on Site Inventory Report **(Form 7).**

7.3.1.11 **Ground Maintenance**

7.3.1.11.1 Ensure that grass and weeds are cut and foliage is cleared within 10 foot radius within the right of way around the control cabinet and service pole and path from shoulder. If trees are located at the site and are a problem notify project supervisor and project manager who will coordinate tree trimming/removal with PennDOT County Maintenance.

7.3.1.12 Complete and Submit Site Service Report **(Form 5)** including subcontractor costs, service equipment rentals, and all associated copies of receipts to the Department within 30 days of site repair completion. The Department shall have 14 days to accept site repairs and documentation before the Contractor can invoice. Warranty period shall begin upon acceptance of site repairs and documentation by the Department. Warranty Statement **(Form 1)** shall be sent to the Department upon the Department's acceptance.

7.4 DELIVERABLES

Deliverables shall be submitted for each site to the Department within 14 days of each Routine Site Service.

7.4.1 **Form 1** – Warranty Form
7.4.2 **Form 3** – Vehicle Classification Accuracy Test Form (Planning WIM Sites Only)
7.4.3 **Form 4** – Site Service Sheet
7.4.4 **Form 5** – Site Service Report
7.4.5 **Form 7** – Site Inventory Report
7.4.6 **Form 8** – Site Condition Report
7.4.7 Updates to FOM (PennDOT's future internet based Field Operations Manager)
7.4.8 Single Line Drawings
7.4.9 Site Specific Digital Photos
7.4.10 **OS-501** Confirmation of Service
7.4.11 Copy of all Subcontractor Invoices
7.4.12 **Invoicing:** IRD cannot submit an invoice to the PO Box until a signed **OS-501** is received back from BPR PennDOT. The invoice and back up documentation including **Form 5** and Subcontractor Invoices must be emailed to the Project Manager for review and if necessary corrected and resubmitted before the **OS-501** Confirmation of Service will be signed by BPR PennDOT approving payment to be made.

DEFINITIONS:

For all items in this Work Statement (only), the following definitions apply:

1. **TASK ORDER SERVICE:** means service performed at the request of the Department.
2. **SITE:** means a traffic monitoring site collecting vehicle Weigh-in-Motion data.
3. **CALIBRATE:** means the process of assuring the site collects vehicle data within the tolerances set by the Department.
4. **REPAIR:** means the corrective action necessary to make a Site and/or the Site components operational.
5. **NOTIFICATION:** means written correspondence, including e-mail to the Project Supervisor and Project Manager.
6. **DAY(S):** means calendar day(s).
7. **YEAR:** means purchase order year.
8. **QUOTE:** Fixed price to repair identified items.

OTHER FUNDAMENTAL ISSUES:

1. **MAINTENANCE AND PROTECTION OF TRAFFIC (**Planning WIM Sites Only): The Contractor shall abide by all Department safety requirements and recommendations as contained in Publication 213. The Contractor will be responsible for notifying the District Traffic Engineer **(Schedule 4)** and the Department Project Supervisor and Project Manager at least 14 days prior to the start of construction and comply with all District policies in effect. Publication 213 may be obtained from the PA Department of Transportation, Distribution Unit, PO Box 2028, Harrisburg, PA 17105.
2. **MAINTENANCE AND PROTECTION OF TRAFFIC (**Enforcement WIM Sites Only): PennDOT shall provide lane closure for all Routine Maintenance and Task Order Service at sites without controlled access, when in-road work is required. The Contractor will be responsible for notifying PennDOT's Project Manager at least 14 days prior to the start of any work.
3. **LIQUIDATED DAMAGES:** The Contractor will be assessed liquidated damages of $100 per day or partial day beyond any time limit contained herein for which the Contractor is responsible.
4. **SCHEDULING:** The Contractor will notify the Project Supervisor and Project Manager by phone with a follow up e-mail 7 days in advance of any on-site activities planned by the Contractor or subcontractors. The Project Supervisor and Project Manager shall be notified by phone (with a follow up e-mail) as soon as possible of any work cancellations.
5. **CERTIFICATION:** Persons certified by the Original Equipment Manufacturers (OEM), if the OEM provides such certification, shall perform all work.
6. **WARRANTIES:** All work performed, materials supplied, and site components repaired or replaced shall be warranted for a period of 1 year or the OEM warranty period, whichever is greater. The warranty period shall begin upon acceptance by the Department of the maintenance done. Warranty period shall begin upon acceptance of site repairs and

documentation by the Department. Warranty Statement **(Form 1)** shall be sent to the Department upon the Department's acceptance.

7. **SOFTWARE & FIRMWARE:** The Contractor will provide any applicable standard software and firmware upgrades to the Department. Data formats need to be compatible with the Department's systems.
8. **OWNERSHIP**: The Department has sole ownership of all components installed under this agreement.
9. **EXCUSABLE DELAY**: The Contractor shall not be liable for any delay in the accomplishment of any services to be rendered hereunder beyond the control of the Contractor, including but not limited to, delays resulting from but not restricted to fires, strikes, labor disputes, way, civil commotion, acts or restrictions of any government, or other similar or dissimilar cause; and the existence of such cause of delay shall justify the suspension of delivery and/or the rendering of services, and shall extend the time of performance on the part of the Contractor to such extent as may be necessary to enable it to make delivery, or to render such services, in the exercise of reasonable diligence after the cause of delay has been removed. Contractor shall give written notice to the Department of the full particulars of the cause of delay as soon as is practical after the occurrence thereof.
10. **AS TO CONTRACTOR**:

International Road Dynamics Inc. (IRD)
2402 Spring Ridge Drive Suite E
Spring Grove, IL 60081-8693

Contract Manager: Jeff McClenaghan
Phone: 306.653.9716 **Fax:** 306.242.5599
E-Mail: Jeff.Mcclenaghan@irdinc.com

Field Representative: Steve Schroeder
Phone: 724.822.7826
E-Mail: steven.schroeder@irdinc.com

Telephone Technical Support: Bruce Myers or Ed Duffy
Phone: 717-264-2077 **Fax:** 717-264-4941

11. **AS TO THE DEPARTMENT**:

Pennsylvania Department of Transportation
Bureau of Planning and Research
6th Floor Keystone Building M-East
400 North Street
Harrisburg, PA 17120

Project Manager: Andrew O'Neill
Phone: 717-346-3250
E-Mail: andoneill@pa.gov

Project Supervisor: Joseph Keller
Phone: 717-787-5983
E-Mail: joskeller@pa.gov

12. **CONTRACT MANAGEMENT INTERACTION**:
    a. **Meetings:** There will be monthly meetings held at the Department's Traffic Equipment and Repair Shop. If agreed to by both parties, the frequency of meetings can be modified.
13. **CONTRACT SCHEDULE:**
    a. **Schedule 1** – WIM Site Locations
    b. **Schedule 2** – IRD-PAT Traffic Service Rate Schedule
    c. **Schedule 3** – IRD-PAT Parts Price List
    d. **Schedule 4** – PennDOT District Traffic Engineers List
    e. **Schedule 5 A** – Site Travel Time Chart
    f. **Schedule 5 B** – Site Mileage Chart

All work performed as part of this contract will be performed between March 1 and October 31 (unless the change date is agreed upon by both parties)

Traffic Sheet 17	STATE CODE: 08
LTPP MONITORED TRAFFIC DATA	SPS WIM ID: 080200
WIM SITE INVENTORY	DATE (mm/dd/yyyy) 6/7/2016

1. ROUTE: I-76 **MILEPOST:** 39.7 **LTPP DIRECTION:** east

2. WIM SITE DESCRIPTION

Grade: <1%

Sag Vertical: N

Nearest Upstream SPS Section: 080223

Distance from sensors to SPS Section: 19.2 feet

3. LANE CONFIGURATION

Lanes in LTPP direction: 2

Median: 3 - grass

Lane width: 12'

Shoulder: 3 - paved PCC

Shoulder width: 10'

4. PAVEMENT TYPE ________

5. PAVEMENT SURFACE CONDITION - Distress Survey

Date: 6/7/16 Photo Filename: 080200_downstream_6_7_16.jpg

Date: 6/7/16 Photo Filename: 080200_trailing_loop_6_7_16.jpg

Date: ________ Photo Filename: ________

6. SENSOR SEQUENCE

Loop - 2 Bending Plate - Loop

7. REPLACEMENT AND/OR GRINDING

Date: ________

Date: ________

Date: ________

8. RAMPS OR INTERSECTIONS

Intersection within 300' upstream of site: N

Intersection within 300' downstream of site: N

Is shoulder routinely used for turning? N

9. DRAINAGE

Drainage *(bending plate and load cell)* : 1 - Open to Ground

Clearance under plate (in.): 4"

Clearance /access to flush fines from under system: N

Traffic Sheet 17 **LTPP MONITORED TRAFFIC DATA** **WIM SITE INVENTORY**	STATE CODE: 08 SPS WIM ID: 080200 DATE (mm/dd/yyyy) 6/7/2016

10. CABINET LOCATION

Same side of road as LTPP lane: Y
Distance from edge of traveled lane: 45 ft
distance from system: 55 ft
type: M

Cabinet access controlled by: Agency and LTPP
Contact name: Roberto E. de Dios Phone # 303-757-9975
Alternate name: Roy Czinku Phone # 306-653-6627

11. POWER

Distance to cabinet from drop: 287 ft
Type: AC
AC in cabinet? Y
Service provider: Phone #

12. TELEPHONE

Distance to cabinet from drop: 288 ft
Type: landline
Service provider: Phone #

13. SYSTEM

Software and version no. MBUS v5.0
Computer connection: RS-232

14. TEST TRUCK TURNAROUND TIME

Duration: 25 minutes Distance: 28 miles

15. PHOTOS

	Filename
Power source:	080200_power_box_6_7_16.jpg
Phone source:	080200_telephone_service_6_7_16.jpg
Cabinet exterior:	080200_cabinet_exterior_6_7_16.jpg
Cabinet interior:	080200_cabinet_interior_front_6_7_16.jpg
Weight sensors:	080200_leading_WIM_sensor_6_7_16.jpg
	080200_trailing_WIM_sensor_6_7_16.jpg
Other sensors:	080200_leading_loop_6_7_16.jpg
	080200_trailing_loop_6_7_16.jpg
Downstream from sensors on LTPP lane:	080200_downstream_6_7_16.jpg
Upstream from sensors on LTPP lane:	080200_upstream_6_7_16.jpg

TRAFFIC MONITORING INSPECTION SHEET (FDOT)

Date: **Technician:** **Certified**:
Site: **Unit:** **NH Number:**
Equip Type: **GPS:** Lat. Long. **SN:**
Modem Operational:

Speed Limit: N /E S / W **Warning Sign Installed:**
Number of Lanes:
Sensor Configuration: **Loop Length**
Sensor Mount: **Piezo Type:** **Sensor Spacing**

Modem Type: **Modem IP** - **ESN (dec)**
Baud Rate:

Power: **No. Solar panels**: **Total Wattage**:
Sun Cond: **Solar Output Voltage:** **Solar Regulator Output Voltage**:

Mast Type:
Cabinet Type: **Loop Sealant:**
Cabinet Mount: **Piezo Sealant:**
Universal Harness:
Backplane:
Total # of Batteries **Battery Voltage (under load)**:
Temp Sensor Reading **Ground Rod Resistance** **ohms**

Surge Suppression:
Power:
Loop Sensor:
Piezo Sensor:
Weigh Pad:

Lane Designation:
Lane 1:
Lane 2:
Lane 3:
Lane 4:
Lane 5:
Lane 6:
Lane 7:
Lane 8:

Operational Check:
Speed ☐ Counts ☐ Classification ☐ Weight ☐

Comments:

Revision:
7/16/2014

TRAFFIC MONITORING INSPECTION SHEET (FDOT)

Loops

		Inductance	Insulation	Resistance	Spliced
Lane 1	Loop 1				
	Loop 2				
Lane 2	Loop 3				
	Loop 4				
Lane 3	Loop 5				
	Loop 6				
Lane 4	Loop 7				
	Loop 8				
Lane 5	Loop 9				
	Loop 10				
Lane 6	Loop 11				
	Loop 12				
Lane 7	Loop 13				
	Loop 14				
Lane 8	Loop 15				
	Loop 16				

Key

Loops

1. **Inductance** (LCR Meter) when checking on a 4 turn loop we need to see at least 100uH. (New or existing)
2. **Insulation** (Megger) when checking you should see a reading of 200 MΩ or higher.(existing 20 MΩ or higher)
3. **Resistance** (Multi-Meter) when checking a reading above 3.0Ω it is considered bad.

TRAFFIC MONITORING INSPECTION SHEET (FDOT)

Piezos

		Voltage	Dissipation	Resistance	Capacitance	Spliced
Lane 1	Piezo 1					
	Piezo 2					
	Piezo 3					
	Piezo 4					
Lane 2	Piezo 1					
	Piezo 2					
	Piezo 3					
	Piezo 4					
Lane 3	Piezo 1					
	Piezo 2					
	Piezo 3					
	Piezo 4					
Lane 4	Piezo 1					
	Piezo 2					
	Piezo 3					
	Piezo 4					
Lane 5	Piezo 1					
	Piezo 2					
	Piezo 3					
	Piezo 4					
Lane 6	Piezo 1					
	Piezo 2					
	Piezo 3					
	Piezo 4					
Lane 7	Piezo 1					
	Piezo 2					
	Piezo 3					
	Piezo 4					
Lane 8	Piezo 1					
	Piezo 2					
	Piezo 3					
	Piezo 4					

Key

Piezos

1. **Voltage:** (o-scope) when checking the minimum peak reading on the o-scope it should be greater than 200mV for a class two vehicle.
2. **Dissipation:** (LCR Meter) when testing the reading shouldn’t be more than 0.04 on new installs. Existing piezos readings can vary.
3. **Resistance:** (Multi-Meter) Measure the resistance across the piezo leads. The meter should be set on the 20MΩ setting. The meter should read in excess of 20MΩ
4. **Capacitance**: (LCR Meter) Measure the capacitance of the sensor with the attached lead in cable. The meter should typically be set on a 20nF range. The red probe should be connected to the center electrode of the cable and the Black probe to the outer braid. A reading between 4nF and 15nF is acceptable.

TRAFFIC MONITORING INSPECTION SHEET (FDOT)

Kistlers

SITE					CPU EPROM:	
KISTLER SENSORS					MEG OHMS	DATE INSTALLED
LANE	CHANNEL	SENSOR	CAP	D		

DIP EPROM:						
LOOPS						
LANE	CHANNEL	FREQ.	THRESHOLD	MEG OHM	RESIST.	INDUCT.
1	2					
2	3					
3	4					
4	6					
5	7					
6	8					

Comments:	WIM SENSOR CONFIGURATION :	CLASS SENSOR CONFIGURATION:

Traffic Sheet 22	STATE CODE:	
LTPP MONITORED TRAFFIC DATA	SPS WIM ID:	0
SITE EQUIPMENT ASSESSSMENT	STATE ASSIGNED ID	0
LTPP LANE ONLY	DATE (mm/dd/yyy)	1/0/1900

SITE EQUIPMENT INFORMATION

1. TYPE OF EQUIPMENT BOTH

2. LANE NUMBER ON SITE ________ **3. DIRECTION ON SITE** ________

4. VENDOR ________ **MODEL** ________ **SERIAL#** ________

5. WEIGHING SENSOR TYPE 0

6. SYSTEM SOFTWARE VERSIONS:

CPU ________

LOOP ________

PIEZO ________

WEIGHPAD/ LOADCELL ________

COMMUNICATIONS ________

7. CLASSIFICATION VIDEO:

TIME FROM: ________ TO: ________
TIME FROM: ________ TO: ________

SITE CONDITIONS

8. PAVEMENT:

Indicate any deficiencies that may affect the performance of the WIM sytem. List all photos on Sheet 24 that support the evaluation.

there were minor transverse cracks within the pavement at 191', 254', and 468' upstream, that appeared to have no effect on the accuracies of the WIM system.

Traffic Sheet 22	STATE CODE:	
LTPP MONITORED TRAFFIC DATA	SPS WIM ID:	0
SITE EQUIPMENT ASSESSSMENT	STATE ASSIGNED ID	0
LTPP LANE ONLY	DATE (mm/dd/yyy)	1/0/1900

9. IN ROAD SENSORS:

Describe any deficiencies regarding the sensor installation. Indicate sensors that show any signs of being broken, severely worn, missing, removed, or loose. List photos on Sheet 24 for

the equipment is operating within the manufacturer's tolerances. Downstream Kistler sensor appears to have a crack in the grout, however the in-road sensors do not show additional signs of damage or excessive wear and appear to be fully secured in the pavement.

TRUCK OBSERVATIONS

10. Indicate any irregular truck behaviors such as bouncing, swerving, or braking near the weighing area (within 40 meters). Note the distance from the weighing sensors.

A visual observation of the trucks as they approach, traverse, and leave the sensor area did not indicate any adverse dynamics that would affect the accuracy of the WIM system. The trucks appear to track down the center of the lane.

Minimum 15 minute or 35 truck sample video sample for pavement interaction deficiencies:

Tape Filename: ______________________________

Time: From: ____________ To: ____________

Traffic Sheet 22
LTPP MONITORED TRAFFIC DATA
SITE EQUIPMENT ASSESSSMENT
LTPP LANE ONLY

STATE CODE:
SPS WIM ID: 0
STATE ASSIGNED ID 0
DATE (mm/dd/yyy) 1/0/1900

11. CLASSIFICATION VERIFICATION VIDEO:

TAPE 1- NAME: ______________________

Interval	Filename	From	To
1			
2			
3			
4			
5			
6			
7			
8			

TAPE 2- NAME: ______________________

Interval	Filename	From	To
1			
2			
3			
4			
5			
6			
7			
8			

TAPE 3- NAME: ______________________

Interval	Filename	From	To
1			
2			
3			
4			
5			
6			
7			
8			

Traffic Sheet 22 **LTPP MONITORED TRAFFIC DATA** **SITE EQUIPMENT ASSESSSMENT** **LTPP LANE ONLY**	STATE CODE: SPS WIM ID: 0 STATE ASSIGNED ID 0 DATE (mm/dd/yyy) 1/0/1900

SYSTEM ACCURACY TESTS

12. CONDUCT THE FOLLOWING SYSTEM ACCURACY TESTS EITHER ON- SITE OR IN OFFICE

Speed Accuracy - Complete Sheet 20 and attach.

Average radar speed #DIV/0! mph   Average WIM Speed #DIV/0! mph
Mean Difference #DIV/0! mph   SD of mean #DIV/0!

Posted Speed Limit 0 mph
Speed Range 15th percentile - #NUM! mph   85th percentile- ________ mph

Spacing and Weight - Complete Sheet 21 and attach.
Average distance between axles of drive tandem ________ feet
% error from 4.25 ft (industry average) OR 15.00 ft (WIM system average)
= 252.9 %

Average front axle weight for Class 9 vehicles ________ lbs
% error from 10.3 kips (industry average) OR 13.9 lbs (known site value)
= 35.0 %

SUPPORT EQUIPMENT STRUCTURES

17. Indicate any deficiencies with any site equipment other than the in-road sensors. List all photos on the Sheet 24 for each occurance.

Cabinet/Foundation None ☑
no cabinet or foundation deficiencies

Pull Boxes None ☑
no pull box deficiencies

Mast None ☑
no service mast deficiencies

Solar Panels None ☑
no solar panel deficiencies

Traffic Sheet 22 **LTPP MONITORED TRAFFIC DATA** **SITE EQUIPMENT ASSESSSMENT** **LTPP LANE ONLY**	STATE CODE: SPS WIM ID: 0 STATE ASSIGNED ID 0 DATE (mm/dd/yyy) 1/0/1900

Telephone D-Mark Box None ☑

no telephone d-mark box deficiencies

Power Service Box None ☑

no power service box deficiencies

Grounding None ☑

no grounding deficiencies

Conduit None ☑

no conduit deficiencies

STATIC AND DYNAMIC ELECTRONIC EQUIPMENT TESTS

18. Complete and attach a Sheet 22 addendum applicable to the installed road equipment.

ADDITIONAL COMMENTS

All values for the WIM sensors and inductive loops were within tolerances. Electronic tests of the power and communication devices indicated that they were operating normally.

Assessor ______________________

Traffic Sheet 22 Addendum - Kistler Quartz	STATE CODE:
LTPP MONITORED TRAFFIC DATA	SPS WIM ID: 0
SITE EQUIPMENT ASSESSSMENT	STATE ASSIGNED ID 0
LTPP LANE ONLY	DATE (mm/dd/yyy) 1/0/1900

STATIC EQUIPMENT VALUES (SYSTEM OFF)

1. POWER

a. Solar Panel	________	WATTS	________	VDC
b. Equipment Power	________	VAC	________	VDC
c. Battery 1	________	VDC		
d. Battery 2	________	VDC		
e. Regulated	________	VDC		
f. Power Supply	________	VAC	________	VDC
g. System Input	________	VAC	________	VDC
h. Modem Power	________	VAC	________	VDC
i. Telephone	________	VDC		

2. LOOP SENSORS

	Resistance	Inductance	Shield
a. Leading	________ Ω	________ µh	________ MΩ
b. Trailing	________ Ω	________ µh	________ MΩ

3. KISTLER SENSORS

	Resistance	Capacitance
a. K1 (lead/left)	________ Ω	________ ηf
b. K2 (lead/middle)	________ Ω	________ ηf
c. K3 (lead mid/right)	________ Ω	________ ηf
d. K4 (lead/right)	________ Ω	________ ηf
e. K5 (trail/left)	________ Ω	________ ηf
f. K6 (trail/mid left)	________ Ω	________ ηf
g. K7 (trail/mid right)	________ Ω	________ ηf
h. K8 (trail/right)	________ Ω	________ ηf

DYNAMIC EQUIPMENT VALUES (SYSTEM ON)

4. LOOP SENSORS

	Frequency
a. Leading	________ KHz
b. Trailing	________ KHz

5. KISTLER SENSORS

Dynamic testing for the Kistler Quartz sensor is not recommended.

Assessor 0

Traffic Sheet 22 Addendum - Load Cell	STATE CODE:
LTPP MONITORED TRAFFIC DATA	SPS WIM ID: 0
SITE EQUIPMENT ASSESSSMENT	STATE ASSIGNED ID 0
LTPP LANE ONLY	DATE (mm/dd/yyy) 1/0/1900

STATIC EQUIPMENT VALUES (SYSTEM OFF)

1. POWER

a. Solar Panel ________ WATTS ________ VDC
b. Equipment Power ________ VAC ________ VDC
c. Battery 1 ________ VDC
d. Battery 2 ________ VDC
e. Regulated ________ VDC
f. Power Supply ________ VDC ________ VDC
g. System Input ________ VAC ________ VDC
h. Modem Power ________ VAC ________ VDC
i. Telephone ________ VDC

2. LOOP SENSORS

	Resistance	Inductance	Shield
a. Leading	________ Ω	________ µh	________ MΩ
b. Trailing	________ Ω	________ µh	________ MΩ

2. LOOP CELL SENSORS

a. Leading Platform

Sensor	Input	Output	Shield
1	________ Ω	________ Ω	________ Ω
2	________ Ω	________ Ω	________ Ω
3	________ Ω	________ Ω	________ Ω

b. Trailing Platform

Sensor	Input	Output	Shield
1	________ Ω	________ Ω	________ Ω
2	________ Ω	________ Ω	________ Ω
3	________ Ω	________ Ω	________ Ω

DYNAMIC EQUIPMENT VALUES (SYSTEM ON)

4. LOOP SENSORS

	Frequency
a. Leading	________ KHz
b. Trailing	________ KHz

Traffic Sheet 22 Addendum - Load Cell	STATE CODE:	
LTPP MONITORED TRAFFIC DATA	SPS WIM ID:	0
SITE EQUIPMENT ASSESSSMENT	STATE ASSIGNED ID	0
LTPP LANE ONLY	DATE (mm/dd/yyy)	1/0/1900

5. LOAD CELL SENSORS

a. Leading Platform

Sensor	Output
1	________ mV
2	________ mV
3	________ mV

b. Trailing Platform

Sensor	Output
1	________ mV
2	________ mV
3	________ mV

Assessor 0

Traffic Sheet 22 Addendum - Piezo	STATE CODE:	
LTPP MONITORED TRAFFIC DATA	SPS WIM ID:	0
SITE EQUIPMENT ASSESSSMENT	STATE ASSIGNED ID	0
LTPP LANE ONLY	DATE (mm/dd/yyy)	1/0/1900

STATIC EQUIPMENT VALUES (SYSTEM OFF)

1. POWER

a. Solar Panel ________ WATTS ________ VDC
b. Equipment Power ________ VAC ________ VDC
c. Battery 1 ________ VDC
d. Battery 2 ________ VDC
e. Regulated ________ VDC
f. Power Supply ________ VDC ________ VDC
g. System Input ________ VAC ________ VDC
h. Modem Power ________ VAC ________ VDC
i. Telephone ________ VDC

2. LOOP SENSORS

	Resistance	Inductance	Shield
a. Leading	________ Ω	________ µh	________ MΩ
b. Trailing	________ Ω	________ µh	________ MΩ

3. PIEZO SENSORS

	Resistance	Capacitance
a. Piezo 1 (lead)	________ Ω	________ ηf
b. Piezo 2	________ Ω	________ ηf
c. Piezo 3	________ Ω	________ ηf
d. Piezo 4 (trail)	________ Ω	________ ηf

DYNAMIC EQUIPMENT VALUES (SYSTEM ON)

4. LOOP SENSORS

	Frequency
a. Leading	________ KHz
b. Trailing	________ KHz

5. PIEZO SENSORS

	Amplitude (Class 9)
Piezo 1 (lead)	________ mV
Piezo 2	________ mV
Piezo 3	________ mV
Piezo 4 (trail)	________ mV

Assessor 0

Traffic Sheet 22 Addendum - Weighpad
LTPP MONITORED TRAFFIC DATA
SITE EQUIPMENT ASSESSSMENT
LTPP LANE ONLY

STATE CODE:
SPS WIM ID: 0
STATE ASSIGNED ID 0
DATE (mm/dd/yyy) 1/0/1900

STATIC EQUIPMENT VALUES (SYSTEM OFF)

1. POWER

a. Solar Panel ________ WATTS ________ VDC
b. Equipment Power ________ VAC ________ VDC
c. Battery 1 ________ VDC
d. Battery 2 ________ VDC
e. Regulated ________ VDC
f. Power Supply ________ VDC ________ VDC
g. System Input ________ VAC ________ VDC
h. Modem Power ________ VAC ________ VDC
i. Telephone ________ VDC

2. LOOP SENSORS

	Resistance	Inductance	Shield
a. Leading	________ Ω	________ µh	________ MΩ
b. Trailing	________ Ω	________ µh	________ MΩ

3. WEIGHPAD SENSORS

	Input	Output	Shield
a. Leading	________ Ω	________ Ω	________ Ω
b. Trailing	________ Ω	________ Ω	________ Ω

DYNAMIC EQUIPMENT VALUES (SYSTEM ON)

4. LOOP SENSORS

	Frequency
a. Leading	________ KHz
b. Trailing	________ KHz

5. WEIGHPAD SENSORS

	Zero Point
a. Leading	________ mV
b. Trailing	________ mV

Assessor 0

Traffic Sheet 23	STATE CODE:	08
LTPP MONITORED TRAFFIC DATA	SPS WIM ID:	080200
WIM Troubleshooting Outline	DATE (mm/dd/yyyy)	6/7/2016

STEP 1 - PROBLEM DESCRIPTION

PROVIDE A DETAILED DESCRIPTION OF THE PROBLEM.

The WIM system appeared to collect, analyze and report vehicle measurements normally. No troubleshooting actions were taken.

STEP 2 - COLLECT SYSTEM DATA

2A SYSTEM PARAMETERS

REVIEW ALL EQUIPMENT OPERATIONAL PARAMETERS SUCH AS CLASSIFICATION ALGORITHMS, DATE/TIME, WEIGHT AND SPEED/SPACING ERROR COMPENSATION FACTORS, AS WELL AS SENSOR LANE ASSIGNMENTS AND THRESHOLD SETTINGS

MAKE NOTE OF ANY SUSPECT VALUES. DO NOT CHANGE VALUES AT THIS TIME.

2B DOWNLOAD SYSTEM DATA

DOWNLOAD SYSTEM TRAFFIC DATA FOR THE DAY OR TIME PERIOD IN QUESTION. SITE PROBLEMS THAT CAN ONLY BE DETERMINED BY REVIEWING DATA FILES WILL MOST LIKELY REQUIRE A SECOND SITE VISIT UNLESS THE FILES CAN BE PROCESSED ONSITE

2C RECORD SYSTEM DIAGNOSTIC MODE VALUES

RECORD ALL SENSOR VALUES GIVEN IN THE SYSTEMS' DIAGNOSTIC MODE FOR THE LANE BEING INVESTIGATED, IF AVAILABLE. MAKE NOTE OF ANY DEFICIENCIES, AND SUSPECT OR INCONSISTANT VALUES.

Traffic Sheet 23 **LTPP MONITORED TRAFFIC DATA** **WIM Troubleshooting Outline**	STATE CODE: 08 SPS WIM ID: 080200 DATE (mm/dd/yyyy) 6/7/2016

LOOP SENSORS:

LOOP	VALUE
LEAD	
TRAIL	

WEIGHPAD / LOAD CELL SENSORS:

SENSOR	VALUE
LEAD/ SENSOR 1	
LEAD/ SENSOR 2	
LEAD/ SENSOR 3	
TRAIL/ SENSOR 1	
TRAIL/ SENSOR 2	
TRAIL/ SENSOR 3	

PIEZO SENSORS:

PIEZO	VALUE
LEADING	
2nd	
3rd	
TRAILING	

KISTLER QUARTZ SENSORS:

SENSOR	VALUE
LEADING	
TRAILING	

TEMPERATURE SENSOR: ________

2D ANALYZE THE INFORMATION COLLECTED

Traffic Sheet 23	STATE CODE: 08
LTPP MONITORED TRAFFIC DATA	SPS WIM ID: 080200
WIM Troubleshooting Outline	DATE (mm/dd/yyyy) 6/7/2016

STEP 3 FINDING THE SCOURCE OF THE PROBLEM

3A- PROBABLE FAULTY FUNCTION

LIST THE DEFICIENCIES DISCOVERED IN STEPS 1 & 2 BELOW. INDICATE THEIR ASSOCIATED WIM SYSTEM PRIMARY FUNCTIONS (POWER, COMMUNICATIONS, WEIGHT & CLASSIFICATION, ETC.).

SYMPTOM	FUNCTION

BASED ON THE SYMPTOMS LISTED ABOVE, MAKE A CONCLUSION AS TO THE MOST PROBABLE FAULTY SYSTEM FUNCTION. ADD ANY CLARIFYING NOTES.

MOST PROBABLE FAULTY FUNCTION: ______________________

3B- FAULTY COMPONENT

USE THE STANDARD EQUIPMENT MAINTENACE FORM (SHEET 22 TO RECORD ALL SYSTEM COMPONENT STATIC AND DYNAMIC VALUES USING THE TEST POINTS INDICATED BELOW FOR THE THE SYSTEM FUNCTION IN QUESTION.

TP#	**TEST POINT DESCRIPTION**	**SYSTEM FUNCTION**	**DESCREPANCY Y/N**
1	WIM SYSTEM POWER INPUT	POWER	
2	DC MODEM INPUT	POWER/ COMMUNICATION	
3	TELCO SURGE SUPPRESSOR OUTPUT	COMMUNICATION	
4	TELCO TERMINAL STRIP OUTPUT	COMMUNICATION	
5	TELCO D-MARK BOX OUTPUT	COMMUNICATION	
6	SENSOR TERMINAL STRIP INPUTS	WEIGHT/CLASSIFICATION	
7	PULL BOX INPUTS	WEIGHT/CLASSIFICATION	
8	DC POWER TERMINAL STRIP OUTPUTS	POWER	
9	DC REGULATOR OUTPUT	POWER	
10	BATTERY OUTPUT	POWER	
11	SOLAR SURGE SUPPRESSOR OUTPUT	POWER	
12	SOLAR PANEL OUTPUT	POWER	
13	AC POWER TERMINAL STRIP	POWER	
14	AC SERVICE DROP OUTPUT	POWER	
15	AC CIRCUIT BREAKER OUTPUT	POWER	
16	AC OUTLET OUTPUT	POWER	
17	EXTERNAL POWER SUPPLY OUTPUT	POWER	

Traffic Sheet 23
LTPP MONITORED TRAFFIC DATA
WIM Troubleshooting Outline

STATE CODE: 08
SPS WIM ID: 080200
DATE (mm/dd/yyyy) 6/7/2016

DESCRIBE ANY SUSPECT TEST RESULTS.

BASED ON THE TEST READINGS MADE, DRAW A CONCLUSION AS TO THE MOST PROBABLE FAULTY COMPONENT AND INDICATE BELOW.

SUSPECTED FAULTY COMPONENT:

STEP- 4 DETERMINE THE CORRECTIVE ACTION

CONSIDERING ALL FACTORS ASSOCIATED WITH THE REPAIR OF THE FAULTY COMPONENT, DETERMINE THE CORRECTIVE ACTION.

DESCRIBE CORRECTIVE ACTION TAKEN.

STEP 5- REPAIRING THE SYSTEM

DESCRIBE THE ACTIONS TAKEN TO REPAIR THE SYSTEM, OR MAKE RECOMMENDATIONS ON THE REPAIRS THAT NEED TO BE TAKEN TO CORRECT THE SYSTEM DEFICIANCY.

ASSESSED BY:

New Jersey DOT Work Log

Date	Site ID	TWO	PO#	Time			Description of work	Charge		
				Start	Stop	Total		Tech	Cal	UNB
								☐	☐	☐
								☐	☐	☐
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								☐	☐	☐

APPENDIX F – WIM DATA QUALITY ASSURANCE AND ANALYSIS SAMPLES

APPENDIX F – TABLE OF CONTENTS

1. FDOT Telemetry Site Quality Control Comments
2. FHWA TMAS 2.0 Quality Control Checks

Telemetry Site Quality Control Comments

93-0099-1	04-27-2015	ATRLANE: 2 HAS 4 ZERO HOURLY COUNTS HR15: 0 HR16: 0 HR17: 0 HR18: 0 DIR: N
72-0172-1	04-27-2015	ATRLANE: 1 HAS 2 ZERO HOURLY COUNTS HR23: 0 HR24: 0 DIR: N
72-0172-1	04-27-2015	ATRLANE: 2 HAS 2 ZERO HOURLY COUNTS HR23: 0 HR24: 0 DIR: N
75-0175-1	04-27-2015	ATRLANE: 1 HAS 24 ZERO HOURLY COUNTS HR01: 0 HR02: 0 HR03: 0 HR04: 0 HR05: 0 HR06 :0 HR07: 0 HR08: 0 HR09: 0 HR10: 0 HR11: 0 HR12: 0 HR13: 0 HR14: 0 HR15: 0 HR16: 0 HR17: 0 HR18: 0 HR19: 0 HR20: 0 HR21: 0 HR22: 0 HR23: 0 HR24: 0 DIR: N
75-0175-1	04-27-2015	ATRLANE: 2 HAS 24 ZERO HOURLY COUNTS HR01: 0 HR02: 0 HR03: 0 HR04: 0 HR05: 0 HR06 :0 HR07: 0 HR08: 0 HR09: 0 HR10: 0 HR11: 0 HR12: 0 HR13: 0 HR14: 0 HR15: 0 HR16: 0 HR17: 0 HR18: 0 HR19: 0 HR20: 0 HR21: 0 HR22: 0 HR23: 0 HR24: 0 DIR: N
75-0175-1	04-27-2015	ATRLANE: 3 HAS 24 ZERO HOURLY COUNTS HR01: 0 HR02: 0 HR03: 0 HR04: 0 HR05: 0 HR06 :0 HR07: 0 HR08: 0 HR09: 0 HR10: 0 HR11: 0 HR12: 0 HR13: 0 HR14: 0 HR15: 0 HR16: 0 HR17: 0 HR18: 0 HR19: 0 HR20: 0 HR21: 0 HR22: 0 HR23: 0 HR24: 0 DIR: S
75-0175-1	04-27-2015	ATRLANE: 4 HAS 24 ZERO HOURLY COUNTS HR01: 0 HR02: 0 HR03: 0 HR04: 0 HR05: 0 HR06 :0 HR07: 0 HR08: 0 HR09: 0 HR10: 0 HR11: 0 HR12: 0 HR13: 0 HR14: 0 HR15: 0 HR16: 0 HR17: 0 HR18: 0 HR19: 0 HR20: 0 HR21: 0 HR22: 0 HR23: 0 HR24: 0 DIR: S
87-0178-1	04-27-2015	ATRLANE: 5 HAS 9 ZERO HOURLY COUNTS HR01: 0 HR02: 0 HR03: 0 HR04: 0 HR05: 0 HR06 :0 HR07: 0 HR08: 0 HR09: 0 DIR: S
55-0207-1	04-27-2015	ATRLANE: 1 HAS 4 ZERO HOURLY COUNTS HR04: 0 HR05: 0 HR06 :0 HR24: 0 DIR: N
33-0237-1	04-27-2015	ATRLANE: 1 HAS 3 ZERO HOURLY COUNTS HR02: 0 HR03: 0 HR24: 0 DIR: N
33-0237-1	04-27-2015	ATRLANE: 2 HAS 2 ZERO HOURLY COUNTS HR04: 0 HR05: 0 DIR: S
34-0239-1	04-27-2015	ATRLANE: 1 HAS 2 ZERO HOURLY COUNTS HR01: 0 HR23: 0 DIR: E
34-0239-1	04-27-2015	ATRLANE: 2 HAS 3 ZERO HOURLY COUNTS HR01: 0 HR02: 0 HR03: 0 DIR: W
54-0245-1	04-27-2015	ATRLANE: 1 HAS 2 ZERO HOURLY COUNTS HR01: 0 HR03: 0 DIR: N
97-0267-2	04-27-2015	ATRLANE: 1 HAS 2 ZERO HOURLY COUNTS HR03: 0 HR04: 0 DIR: S
05-0272-1	04-27-2015	ATRLANE: 1 HAS 15 ZERO HOURLY COUNTS HR01: NULL HR02: NULL HR03: NULL HR04: NULL HR05: NULL HR06 :NULL HR07: NULL HR08: NULL HR09: NULL HR10: NULL HR11: NULL HR12: NULL HR13: NULL HR14: NULL HR15: NULL DIR: E
05-0272-1	04-27-2015	ATRLANE: 2 HAS 15 ZERO HOURLY COUNTS HR01: NULL HR02: NULL HR03: NULL HR04: NULL HR05: NULL HR06 :NULL HR07: NULL HR08: NULL HR09: NULL HR10: NULL HR11: NULL HR12: NULL HR13: NULL HR14: NULL HR15: NULL DIR: W
35-0279-1	04-27-2015	ATRLANE: 4 HAS 3 ZERO HOURLY COUNTS HR03: 0 HR04: 0 HR05: 0 DIR: W
15-0295-1	04-27-2015	ATRLANE: 4 HAS 3 ZERO HOURLY COUNTS HR01: 0 HR05: 0 HR07: 0 DIR: N
47-0365-1	04-27-2015	ATRLANE: 2 HAS 2 ZERO HOURLY COUNTS HR01: 0 HR02: 0 DIR: N
48-0368-1	04-27-2015	ATRLANE: 5 HAS 24 ZERO HOURLY COUNTS HR01: 0 HR02: 0 HR03: 0 HR04: 0 HR05: 0 HR06 :0 HR07: 0 HR08: 0 HR09: 0 HR10: 0 HR11: 0 HR12: 0 HR13: 0 HR14: 0 HR15: 0 HR16: 0 HR17: 0 HR18: 0 HR19: 0 HR20: 0 HR21: 0 HR22: 0 HR23: 0 HR24: 0 DIR: S
48-0368-1	04-27-2015	ATRLANE: 6 HAS 24 ZERO HOURLY COUNTS HR01: 0 HR02: 0 HR03: 0 HR04: 0 HR05: 0 HR06 :0 HR07: 0 HR08: 0 HR09: 0 HR10: 0 HR11: 0 HR12: 0 HR13: 0 HR14: 0 HR15: 0 HR16: 0 HR17: 0 HR18: 0 HR19: 0 HR20: 0 HR21: 0 HR22: 0 HR23: 0 HR24: 0 DIR: S
48-0368-1	04-27-2015	ATRLANE: 7 HAS 24 ZERO HOURLY COUNTS HR01: 0 HR02: 0 HR03: 0 HR04: 0 HR05: 0 HR06 :0 HR07: 0 HR08: 0 HR09: 0 HR10: 0 HR11: 0 HR12: 0 HR13: 0 HR14: 0 HR15: 0 HR16: 0 HR17: 0 HR18: 0 HR19: 0 HR20: 0 HR21: 0 HR22: 0 HR23: 0 HR24: 0 DIR: S

48-0368-1	04-27-2015	ATRLANE: 8 HAS 24 ZERO HOURLY COUNTS HR01: 0 HR02: 0 HR03: 0 HR04: 0 HR05: 0 HR06 :0 HR07: 0 HR08: 0 HR09: 0 HR10: 0 HR11: 0 HR12: 0 HR13: 0 HR14: 0 HR15: 0 HR16: 0 HR17: 0 HR18: 0 HR19: 0 HR20: 0 HR21: 0 HR22: 0 HR23: 0 HR24: 0 DIR: S
55-0376-1	04-27-2015	ATRLANE: 6 HAS 24 ZERO HOURLY COUNTS HR01: 0 HR02: 0 HR03: 0 HR04: 0 HR05: 0 HR06 :0 HR07: 0 HR08: 0 HR09: 0 HR10: 0 HR11: 0 HR12: 0 HR13: 0 HR14: 0 HR15: 0 HR16: 0 HR17: 0 HR18: 0 HR19: 0 HR20: 0 HR21: 0 HR22: 0 HR23: 0 HR24: 0 DIR: W
16-9951-1	04-27-2015	ATRLANE: 4 HAS 8 ZERO HOURLY COUNTS HR01: 0 HR02: 0 HR03: 0 HR04: 0 HR21: 0 HR22: 0 HR23: 0 HR24: 0 DIR: E

The following county site unitno atrlane have been excluded due to reverse laning or configurations 75033615,75033616,79992911,79992912,72010915,72010916, 17036111,03035117,03035118,03035115,03035116,10010617,10010618,10010619,97042115,97042116,97042915,97042916,86035715,86035716, 86035717,86035718,16994813,87026614,87026615,87026616,55034913,94019513,10037314

Appendix J. TMAS 2.0 QUALITY CONTROL CHECKS

STATION DATA

- Duplicates within the batch
- Duplicates against the National Database
- Fatal errors
  - no S or 1 in the 1st digit of the record
  - record length less than 167 characters
  - no station ID in the record (columns 4-9)
- Critical errors occur if:
  - blank or invalid direction or lane
  - blank or invalid functional classification
  - blank or invalid state code
  - improper vehicle classification designated (column 24-25)
  - (all critical errors are correctable in TMAS)
- Caution flags include:
  - missing Latitude/Longitude
  - missing Year Established
  - missing route number
  - missing number of lanes for volume, classification or weight
  - missing HPMS Sample, NHS or type of sensor
  - (all caution errors are correctable in TMAS)
- Warning flags occur if:
  - any two records that have all digits being exact duplicates will have one record removed

VOLUME DATA (TMG 3-CARD) - MONTHLY

- Duplicates within the batch
- Fatal errors occur if:
  - no 3 in the 1st digit of the record
  - record length less than 141 characters
  - no station ID in the record (columns 6-11)
  - no corresponding station in National Database
- Critical errors occur if:
  - record includes 7 or more consecutive zero hours
  - every DOW (day of week) not present for the given site/month/year
  - record includes any zero hour volume with one or more boundary with over 50 vehicles
  - 24 hours of data not in a given record
  - any hourly volume exceeds the max per hour per lane value
  - directional splits check show unbalanced directional volumes greater than 10% variance from 50%
  - Monthly Average Daily Traffic (MADT) from same month previous year not within 20%
  - State marks data as restricted in column 141
- Warning flags occur if:
  - any two records that have all digits being exact duplicates will have one record removed

CLASSIFICATION DATA (TMG C-CARD) - MONTHLY

- Duplicates within the batch
- Fatal error occurs if:
  - no C in the 1st digit of the record
  - record length less than number of characters based on station data field 15
  - no station ID in the record (columns 4-9)
  - no corresponding station in National Database
- Critical errors occur if:
  - volume checks done on all classification data – see volume section above
  - all classification data utilizes the station file algorithm for vehicle classification (23) and classification system for vehicle classification (24-25) for determining the length of the given record.
- Caution flags occur if:
  - maximum percentage by classification by day check (done by direction)
  - historical check for 6 weeks of prior approved data based on the same DOW for each class of vehicle by day
  - any historical quality control check where insufficient historical data is available
- Warning flags
  - any two records that have all digits being exact duplicates will have one record removed

WEIGHT DATA (TMG W-CARD) - MONTHLY

- Duplicates within the batch
- Fatal error occurs if:

- no W in the 1st digit of the record
- record length less than 39 characters
- no station ID in the record (columns 4-9)
- any record with more than 25 axles will not be kept in TMAS 2.0

Critical error occurs if:

- none

Caution flags

- total weight (25-28) not equal to the sum of all axle weights
- every axle weight not within acceptable range (1 kip to 50 kip)
- any inter-axle spacing not within acceptable range (1’ to 50’)
- sum of axle spacings by vehicle classification not within acceptable range
- number of axles by vehicle class exceeded
- historical check for 8 weeks of data using the steering axle weight average (SAWA) by day by lane check based on the same DOW for class 9 vehicles
- historical check for 8 weeks of data using the average tandem axle spacing (ATS) average by day by lane based on the same DOW for classes 8-13 vehicles
- any historical quality control check where insufficient historical data is available

Warning flags

- any record with between 13 and 25 will not be processed in TMAS 2.0 but will be placed in a special database.
- any two records that have all digits being exact duplicates will have one record removed