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Guidelines for Portable Weight-In-Motion (WIM) System Installation and Traffic Data Analysis: Instructor's Guide

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Cooperative Research Program

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GUIDELINES FOR PORTABLE WEIGHT-IN-MOTION (WIM) SYSTEM INSTALLATION AND TRAFFIC DATA ANALYSIS

Instructor's Guide

by

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DISCLAIMER

This research was performed in cooperation with the Texas Department of Transportation (TxDOT) and the Federal Highway Administration (FHWA). The contents of this report reflect the views of the authors, who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official view or policies of the FHWA or TxDOT. This report does not constitute a standard, specification, or regulation.

This report is not intended for construction, bidding, or permit purposes. The researcher in charge of the project was Lubinda F. Walubita.

The United States Government and the State of Texas do not endorse products or manufacturers. Trade or manufacturers' names appear herein solely because they are considered essential to the object of this report.

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LIST OF ABBREVIATIONS

AADT	Average annual daily traffic
AASHTO	American Association of State Highway and Transportation Officials
ADT	Average daily traffic
ALD	Axle Load Distribution
ATHWLD	Average ten heaviest wheel loads daily
EB	Eastbound
ESAL	Equivalent single axle load
FHWA	Federal Highway Administration
FM	Farm-to-Market Road
FPS	Flexible pavement system
GVW	Gross vehicle weight
Hp-WIM	Hybrid portable Weight-in-Motion
IH	Interstate
LEF	Load equivalency factor
MAF	Monthly adjustment factor
MS	Microsoft
M-E	Mechanistic empirical
N/A	Not Available
PVMNT	Pavement
PZT	Piezoelectric
SB	Southbound
SH	State Highway
T-DSS	Traffic data storage system
TF	Truck factor
TRS	Traffic Recording System
TTI	Texas A&M Transportation Institute
TxACOL	Texas asphalt concrete overlay design
TxDOT	Texas Department of Transportation
TxME	Texas Mechanistic-Empirical pavement design
US	United States
USB	Universal Serial Bus
VCD	Vehicle classification distribution
WB	Westbound
WIM	Weigh-in-motion

SECTION I. INSTRUCTION

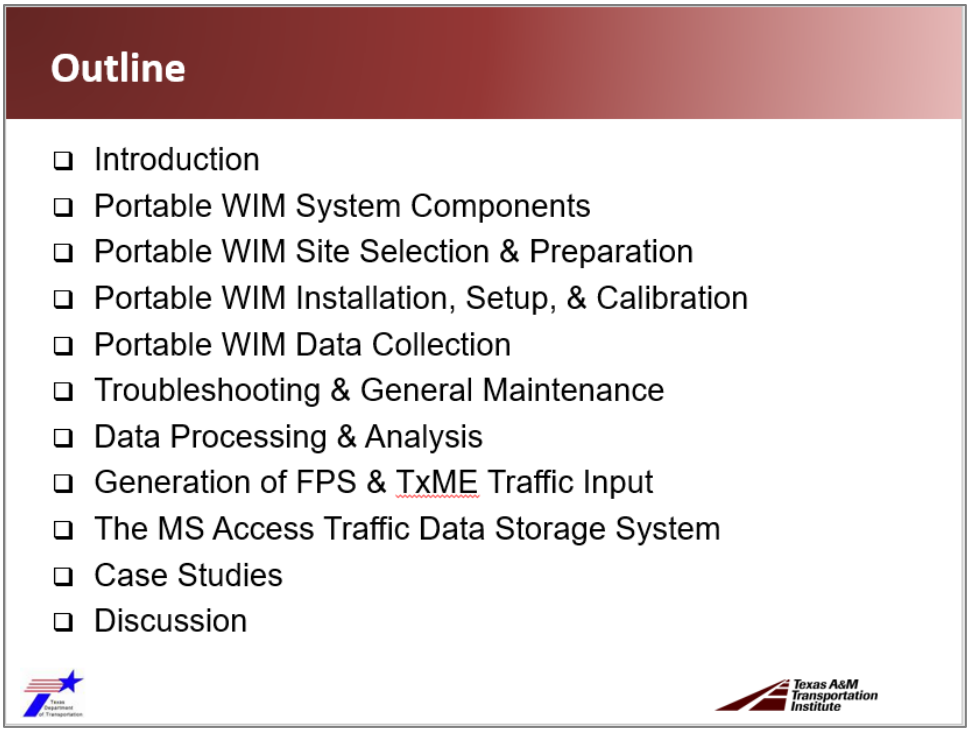
As the portable weight-in-motion (WIM) technology has been successfully explored and practically used to collect site-specific traffic data in Texas Department of Transportation Research Project 0-6940 *Develop System to Render Mechanistic-Empirical Traffic Data for Pavement Design*, this standardized guideline was developed to aid users understand more thoroughly the portable WIM system deployment and its operation for traffic data collection. This guideline can be used as a main guide for the portable WIM system implementation on Texas highways.

The training workshop is a half-day course designed to cover:

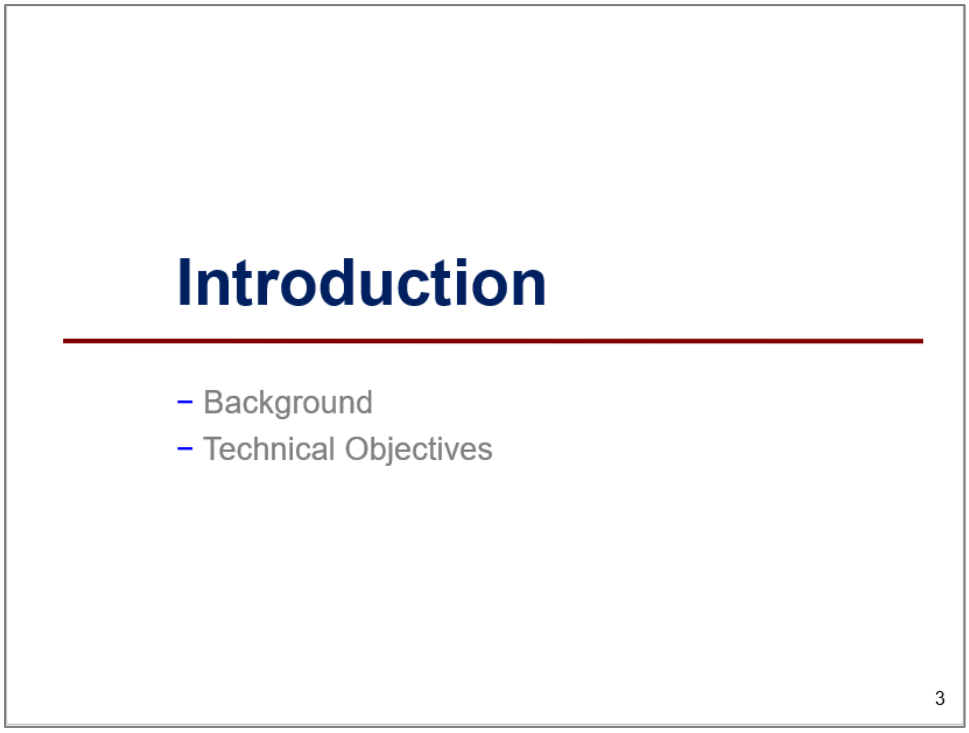
- Portable WIM components and the required accessories.
- Preparation of the portable WIM installation and highway site selection.
- Portable WIM setup, installation, calibration, maintenance, uninstallation, and troubleshooting.
- Automated macros for processing and analyzing portable WIM traffic data, such as volume, speed, vehicle classification, and weight data.
- Automated macros for generating Flexible Pavement Design System (FPS) and Texas Mechanistic-Empirical Flexible Pavement Design System (TxME) traffic input data for pavement design.
- The MS Access Traffic Data Storage System (T-DSS).
- Demonstration case studies.

SECTION II. COURSE MODULE

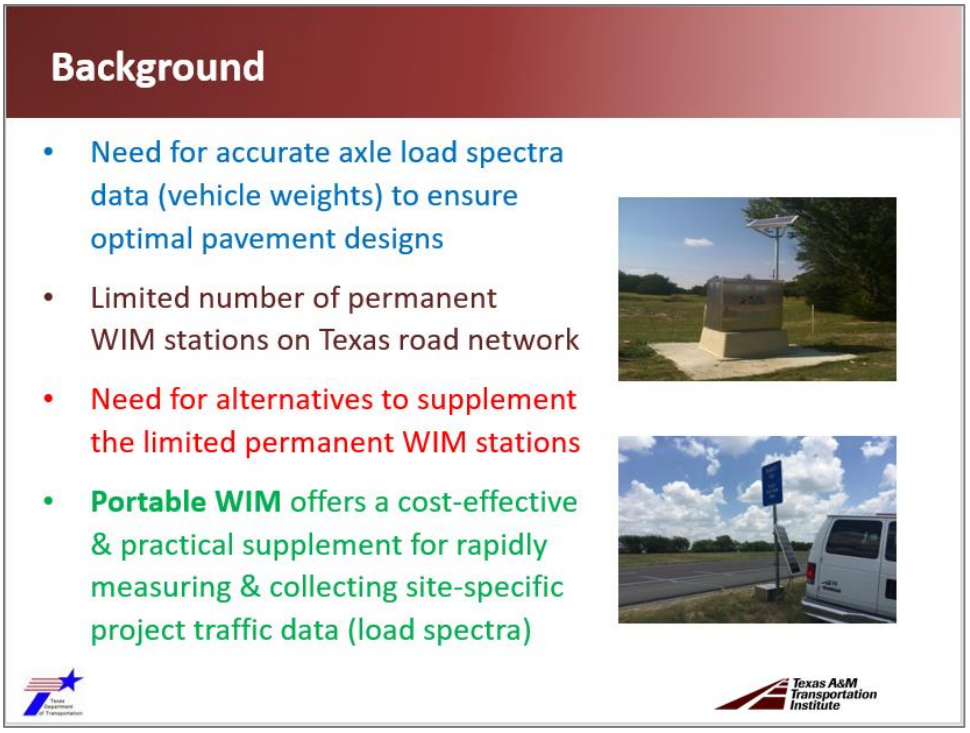
Key Message	Training title
Interactive	In this workshop, we will review the methodologies for implementing portable Weigh-in-Motion (WIM) technologies on Texas highways.
Notes	N/A



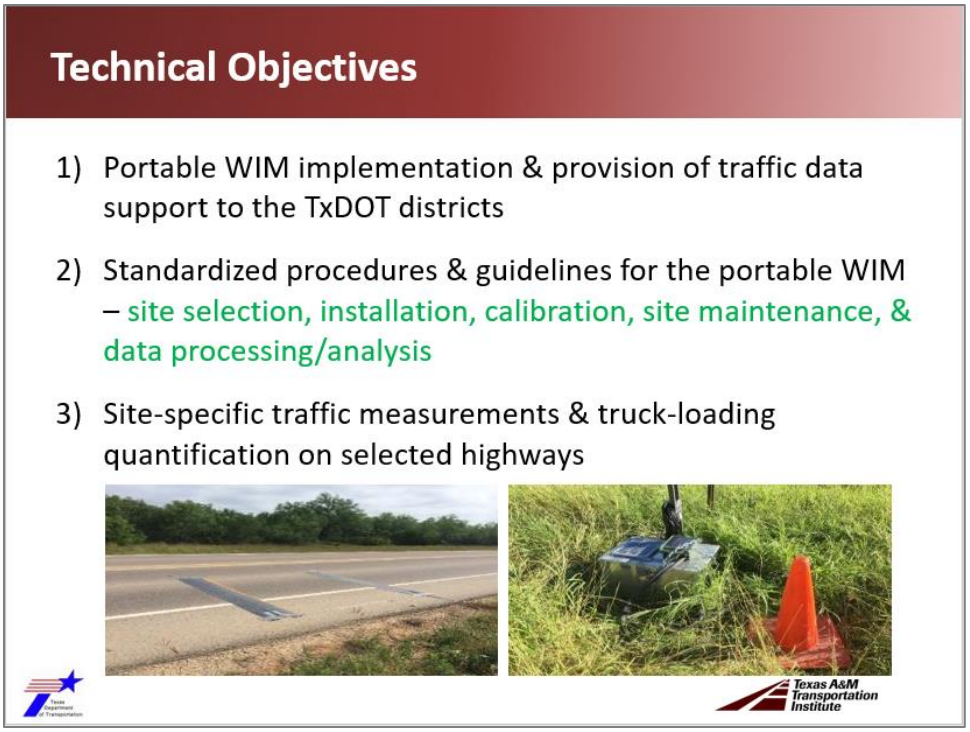
Key Message	Agenda
Interactive	This workshop includes mainly 11 parts: • Introduction • Portable WIM System Components • Portable WIM Site Selection & Preparation • Portable WIM Installation, Setup, & Calibration • Portable WIM Data Collection • Troubleshooting & General Maintenance • Data Processing & Analysis • Generation of FPS & TxME Traffic Input • The MS Access Traffic Data Storage System • Case Studies • Discussion
Notes	N/A



Key Message	Introduction
Interactive	In this section, we are going to review the background and technical objectives of the implementation of portable WIM technology on Texas highways.
Notes	N/A



Key Message	Background
Interactive	Portable WIM technology needs to be implemented on Texas highways for the following reasons: a) Need for accurate load spectra data (vehicle weights) to ensure optimal pavement designs. b) Limited number of permanent WIM stations on Texas road network. c) Need for alternatives to supplement the limited permanent WIM stations. d) Cost-effective tool & practical supplement for rapidly measuring & collecting site-specific traffic data (load spectra).
Notes	N/A



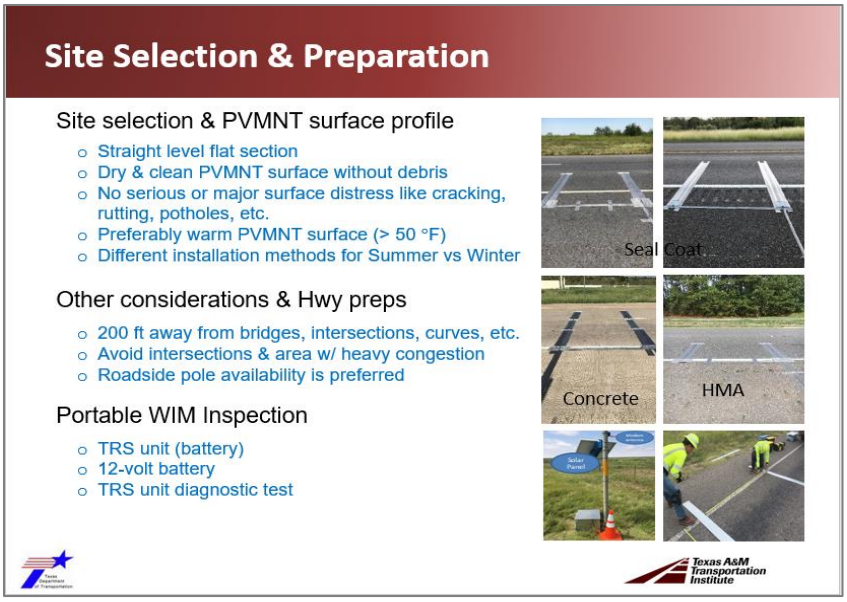
Key Message	Technical Objectives
Interactive	The following are the objectives of this project: a) Portable WIM implementation & provision of traffic data support to the TxDOT districts. b) Standardized procedures & guidelines development for the portable WIM – site selection, installation, calibration, site maintenance, & data processing/analysis. c) Site-specific traffic measurements & truck-loading quantification on selected highways.
Notes	N/A

Key Message	Portable WIM System Components
Interactive	This section will describe the components of portable WIM system, generally categorized as main system components & additional accessories.
Notes	N/A

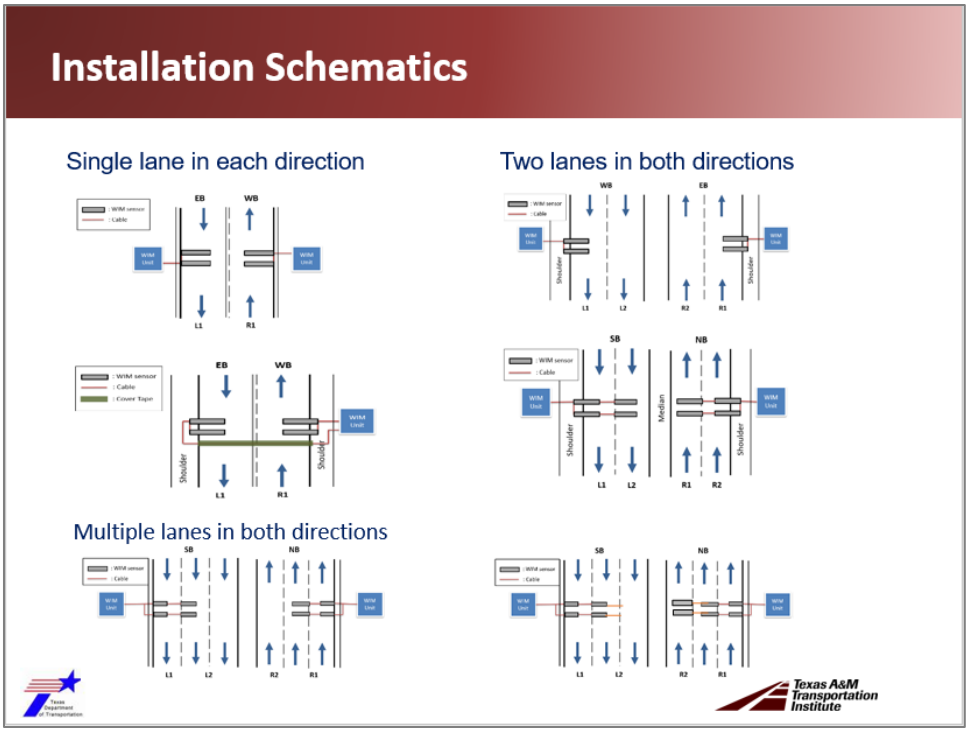
Key Message	Main System Components
Interactive	An enhanced hybrid portable WIM (Hp-WIM) system typically consists of the following components: a) Data logger/recorder – TRS unit b) Piezoelectric (PZT) sensors c) Piezo-channel box & modem d) Solar panel & battery (12V) e) Mastic & pocket tapes f) Static weigh scales g) Off-the-shelf custom-made (in-house) components including metal-plates h) Metal-protective box i) Customized solar charger controller
Notes	The Hp-WIM system is grouped into two categories: - Commercial items which are originally bought from the manufactures without any customization or modification by TTI team (TRS unit, PZT sensors, piezo-channel box, solar panel, 12-volt battery, tapes, static scales) - In-house customized items (metal plates, end cap metal covers, metal-protective box, solar charger controller)

Key Message	Additional Accessories
Interactive	In addition to Hp-WIM system, additional components to complement portable WIM technology includes: a) Modem Communication System b) Accessories & Hand Tools
Notes	A modem requires a modem antenna, power cable, COM cable, & antenna cable in order to function. Accessories & hand tools include nails, hammer, lock & key, scissor, shovel, duct tape, wrench, safety gears (helmet, vest, safety shoes), etc.

Key Message	Portable WIM Site Selection & Preparation
Interactive	This section will provide explanation for the site selection & preparation of portable WIM, including the installation schematics.
Notes	N/A



Key Message	Site Selection & Preparation
Interactive	There are several criteria to be considered for site selection involving the surface profile of the pavement, including: a) Metal plates should be installed on flat, clean, and dry pavement without any distresses such as cracking and rutting. b) Preferably warm pavement surface (> 50°F) due to mastic tapes specification which require a minimum temperature of 55°F. c) Winter installations require the use of torch kit to heat up both tapes and pavement surface and more extra road tape strips on the middle of the sensors. Other considerations for site selection include: a) Site needs to be 200 ft away from bridges, intersections, curves, etc. to ensure all vehicle axles (steering and rear axles) pass through the sensors. b) Avoid intersections & area with heavy congestion to capture continuous flow of traffic. Also, avoid installing in an area where vehicles will stop, accelerate, or slow down on the sensors c) Roadside pole availability is preferred due to the needs of mounting a solar panel and attaching a modem antenna The portable WIM inspection includes inspecting the TRS unit battery, 12-volt battery, and diagnostic test on the TRS unit to check its functionality.
Notes	N/A



Key Message	Installation Schematics
Interactive	The following are various installation schematics that are applicable in different road configurations, including: a) Single lane in each direction b) Two lanes in both directions c) Multiple lanes in both directions
Notes	Installation schematics vary depending on the location conditions, amount of WIM units placed on the site of the highway, and total lanes for each direction. Cover tapes are required if only one WIM unit is used.

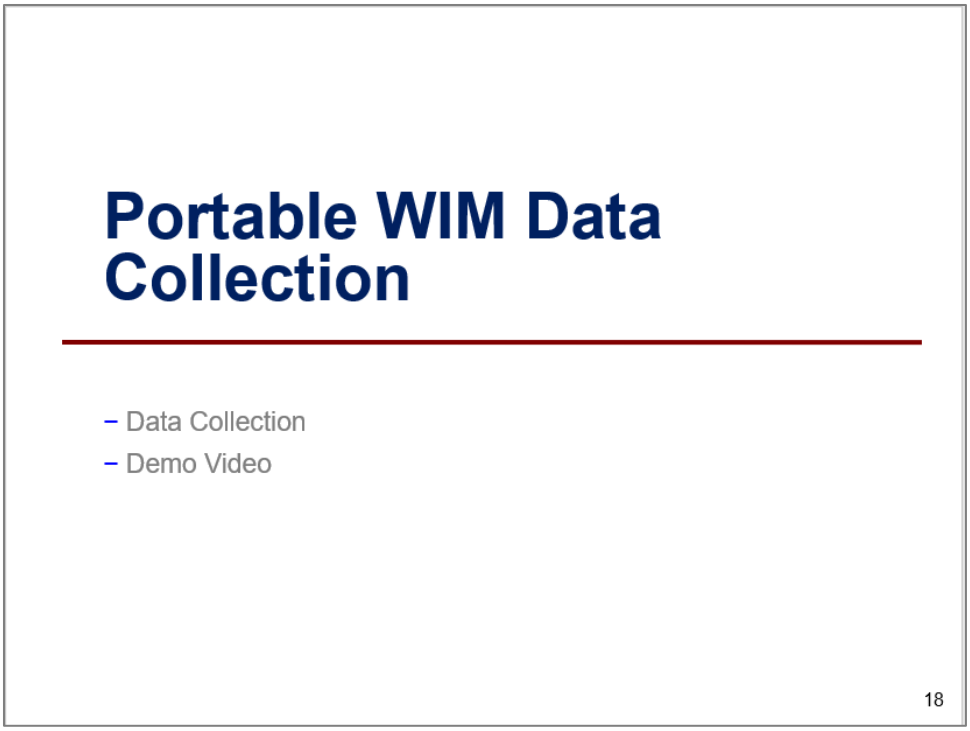
Key Message	Portable WIM Installation, Setup, & Calibration
Interactive	The following section will provide explanation on the installation process of portable WIM, TRS setup, calibration, & removal when the portable WIM will no longer be used.
Notes	N/A

Key Message	Portable WIM Installation
Interactive	This slide will present an instruction video for installing a portable WIM system. Depending on the environment or condition of the site, some things may need to be changed/improvised. Always apply engineering judgment on each of the step of portable WIM installation.
Notes	In addition to the video, detailed guidelines for installation can be found in the Portable WIM Installation workshop material.

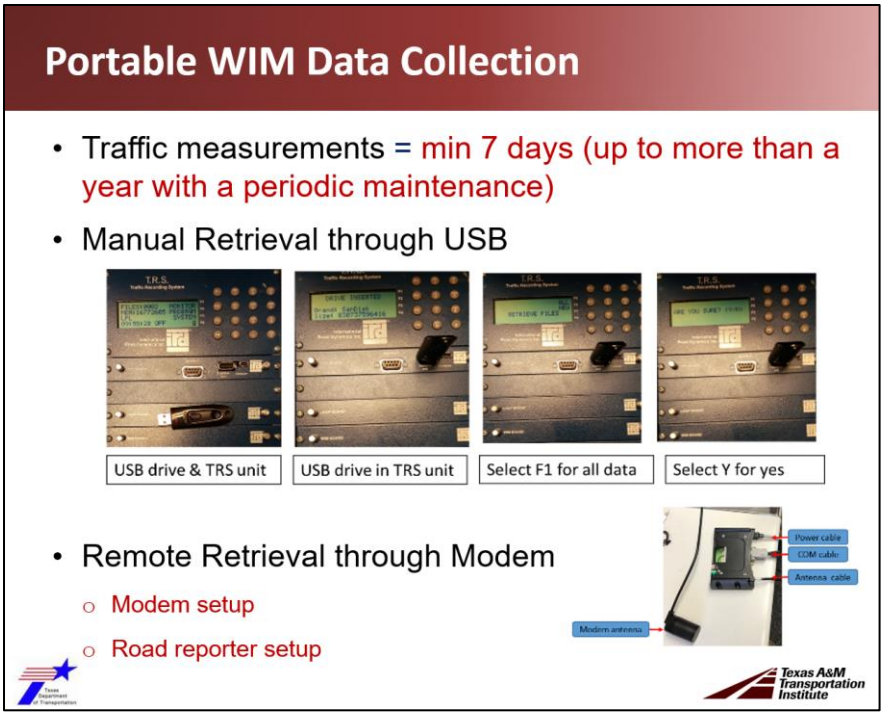
Key Message	Portable WIM Calibration
Interactive	These images show the process of portable WIM calibration, most notably onsite calibration. Other methods of calibration include unit auto self-calibration & post calibration. Performing an initial on-site manual calibration can greatly reduce time it takes for auto-calibration of the sensors. The calibration factor is manually set for each axle sensor using a test vehicle with known axle weights and axle spacing as shown in the figures. As for the auto calibration option, TRS unit can automatically calibrate axle weights using a statistical method to keep a running average of the front axle weights of a specified vehicle class (typically, FHWA class 9 vehicle is used as a reference). In addition, post calibration primarily serves as a supplement and verification of the on-site calibration and is generally conducted off-site during data processing.
Notes	N/A

Key Message	Onsite Calibration (Corpus Christi)
Interactive	This is an example of onsite calibration performed on a portable WIM site in Corpus Christi, which utilized different classes of vehicles, including Class 06, 09, & 10.
Notes	N/A

Key Message	Portable WIM Removal
Interactive	Removing a portable WIM installation includes the following process: a) Cut the road tapes using utility knife and heavy-duty scissors b) Pull the plates using crowbars c) Discard used materials (importantly nails) d) Remove all portable WIM system components The image shows the condition of the road once the installation is removed.
Notes	N/A

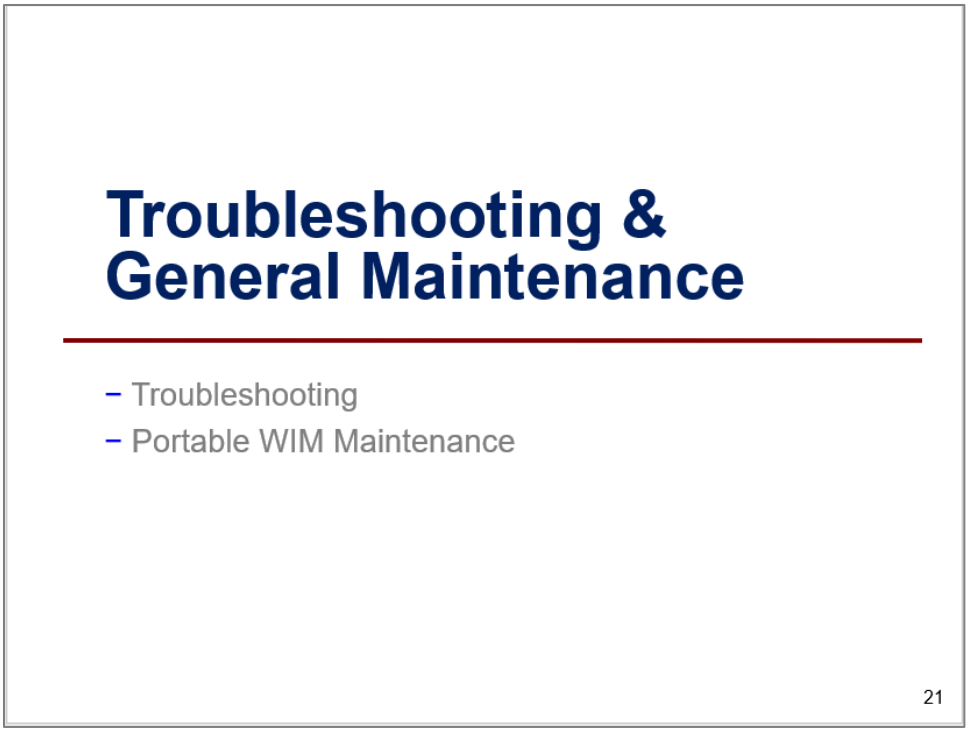


Key Message	Portable WIM Data Collection
Interactive	The following section will describe the data collection process of portable WIM. A demo video will also be included.
Notes	N/A

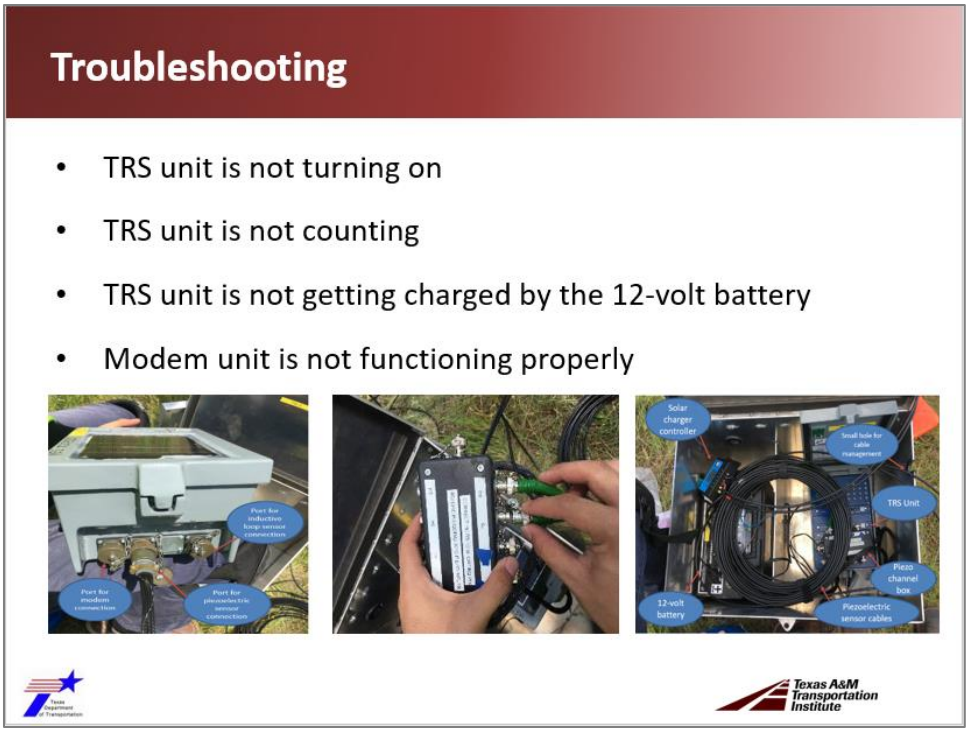


Key Message	Portable WIM Data Collection
Interactive	The portable WIM collects data of traffic measurement for a minimum of 7 days and up to more than a year with a periodic maintenance. Retrieval of data can be done through either USB or Modem. Road reporter II software is required to be installed on the computer in order to retrieve the data remotely thru modem.
Notes	The slide includes the imaged process of Retrieval through USB.

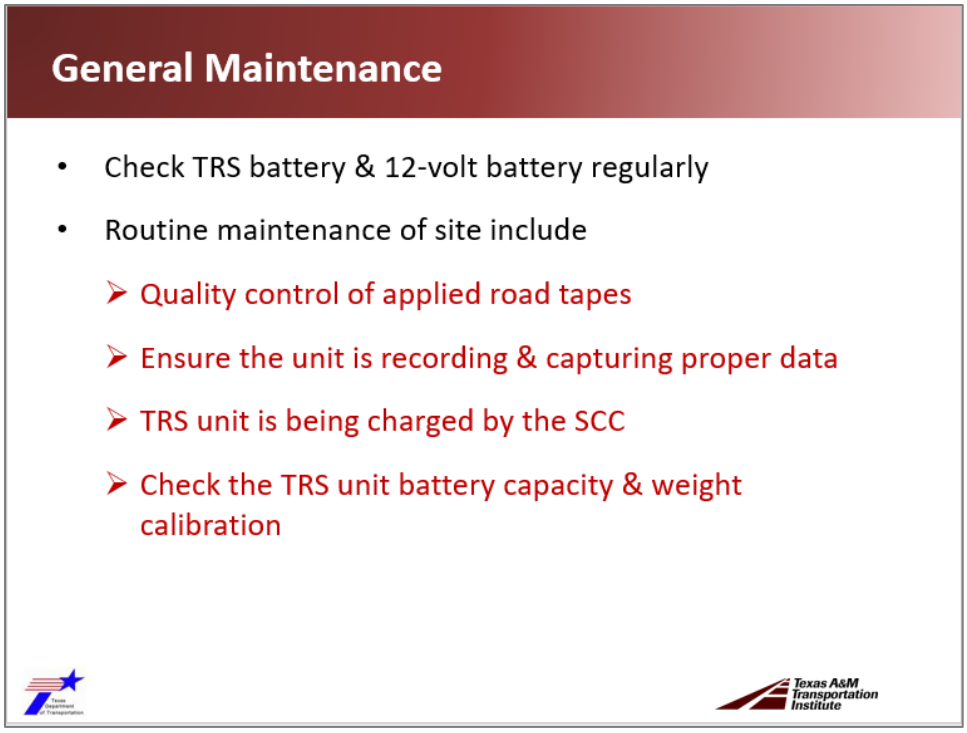
Key Message	TRS Data Collection (Demo in US 87 Site)
Interactive	The following video features the process of how TRS unit collecting traffic in US 87 site (Austin District).
Notes	N/A



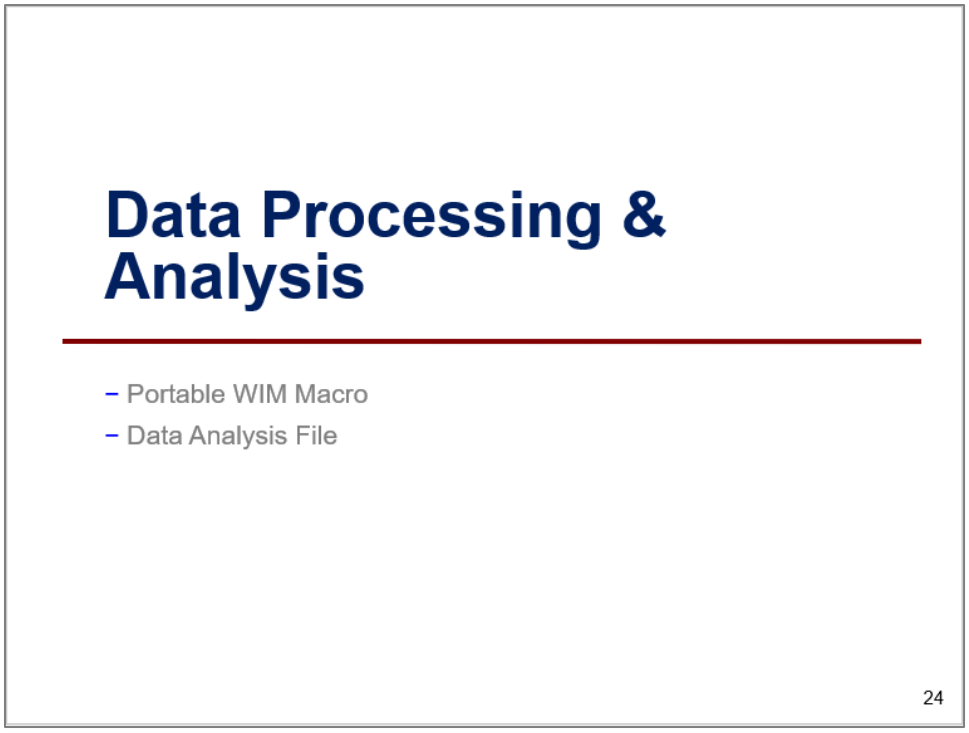
Key Message	Troubleshooting & General Maintenance
Interactive	The following section will explain the steps for troubleshooting potential issues & the maintenance of portable WIM sites.
Notes	N/A



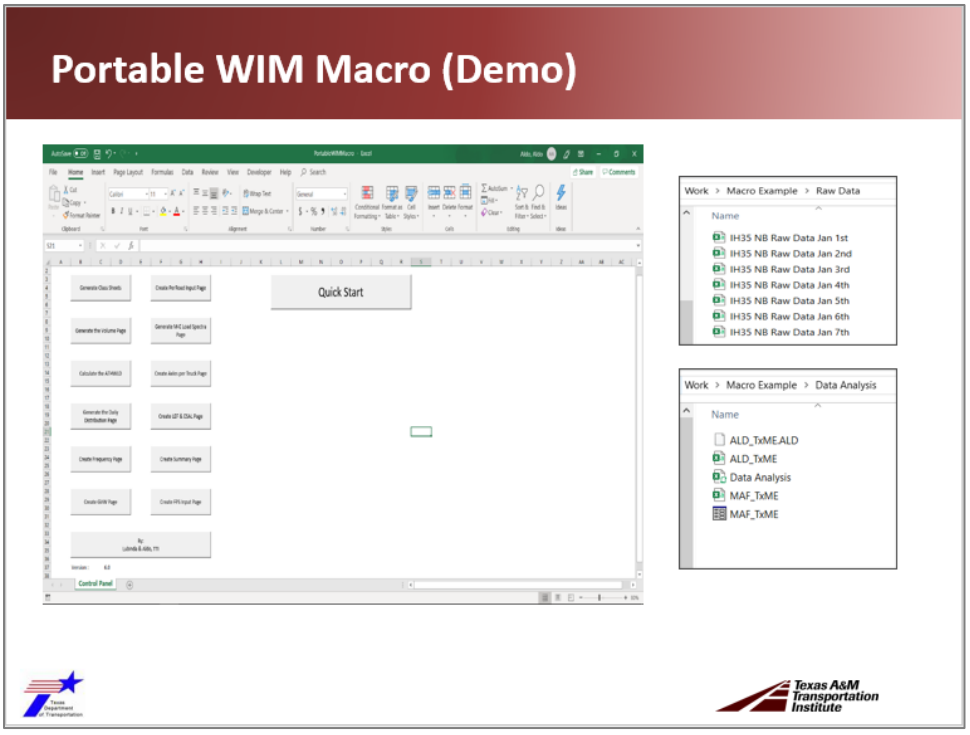
Key Message	Troubleshooting
Interactive	Potential issues that may occur in portable WIM sites include: a) TRS unit is not turning on. b) TRS unit is not counting. c) TRS unit is not getting charged by the 12-volt battery d) Modem unit is not functioning properly
Notes	Included in the slides are images showing a portable WIM installation in good condition for comparison.



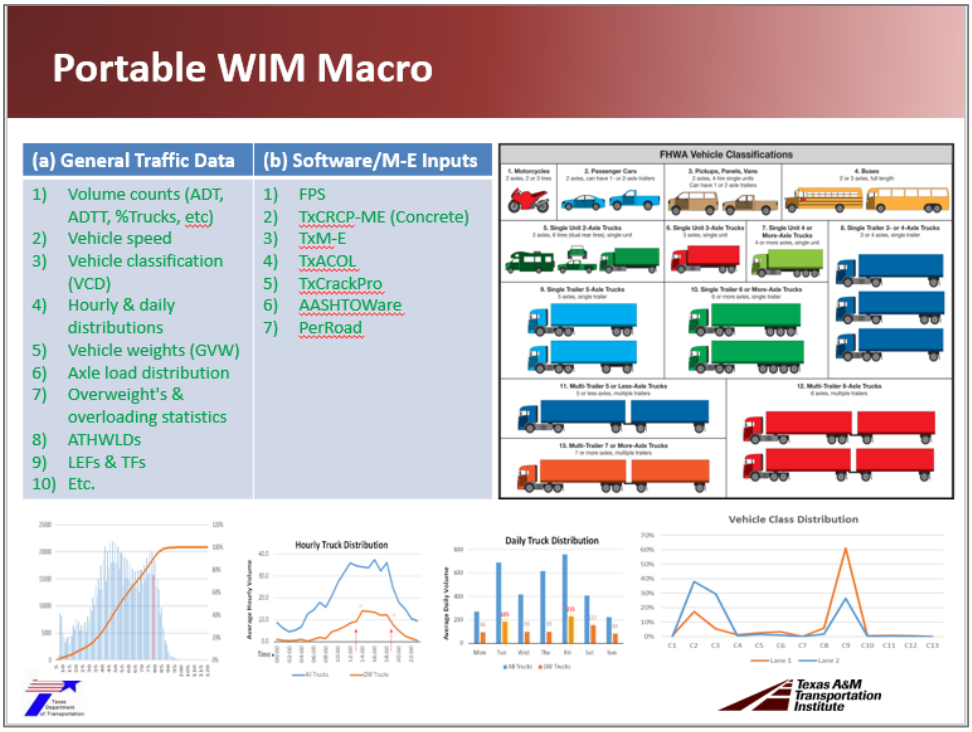
Key Message	General Maintenance
Interactive	There are several maintenances need to be performed to ensure that the portable WIM continues to collect data regularly, including: a) Check TRS battery & 12-volt battery are fully charged b) Routine maintenance of site include: • Quality control of applied road tapes. If some part of the road tapes are worn out, additional tapes need to be applied. • Ensure the unit is recording & capturing proper data by checking the retrieved data from the computer. • TRS unit is being charged by the SCC. Ensure SCC cables are installed properly and is functioning properly. • Check the TRS unit battery capacity & weight calibration. Ensure the TRS unit battery capacity is above 7 volt and portable WIM system is continuously well-calibrated.
Notes	N/A



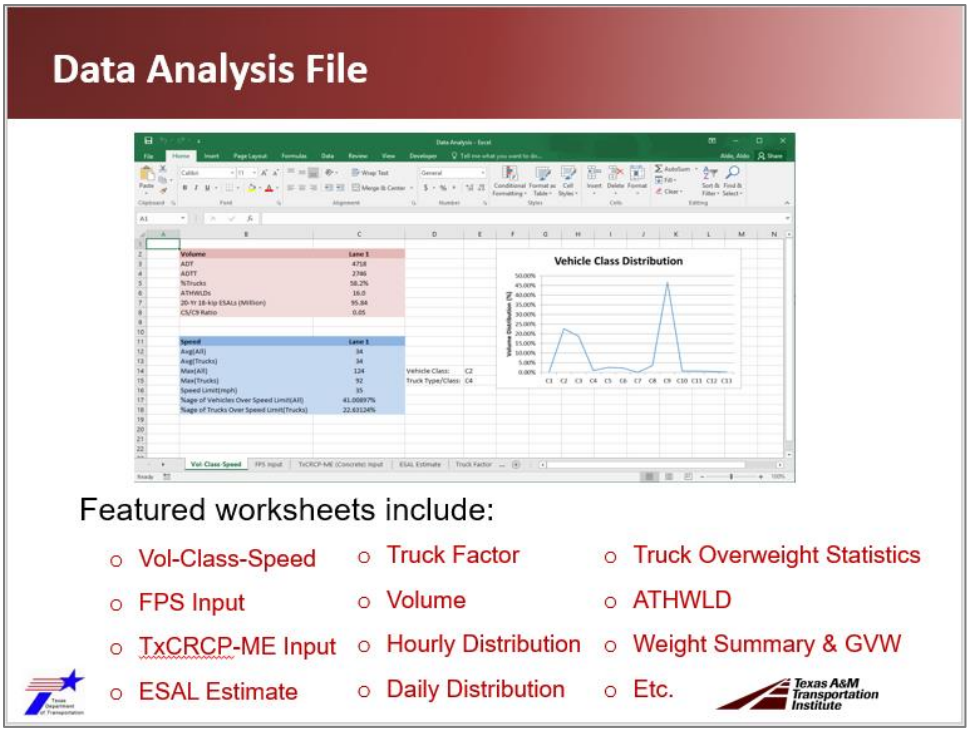
Key Message	Data Processing & Analysis
Interactive	The following section will provide explanation for data processing, including the Macro for portable WIM data, & data analysis.
Notes	N/A



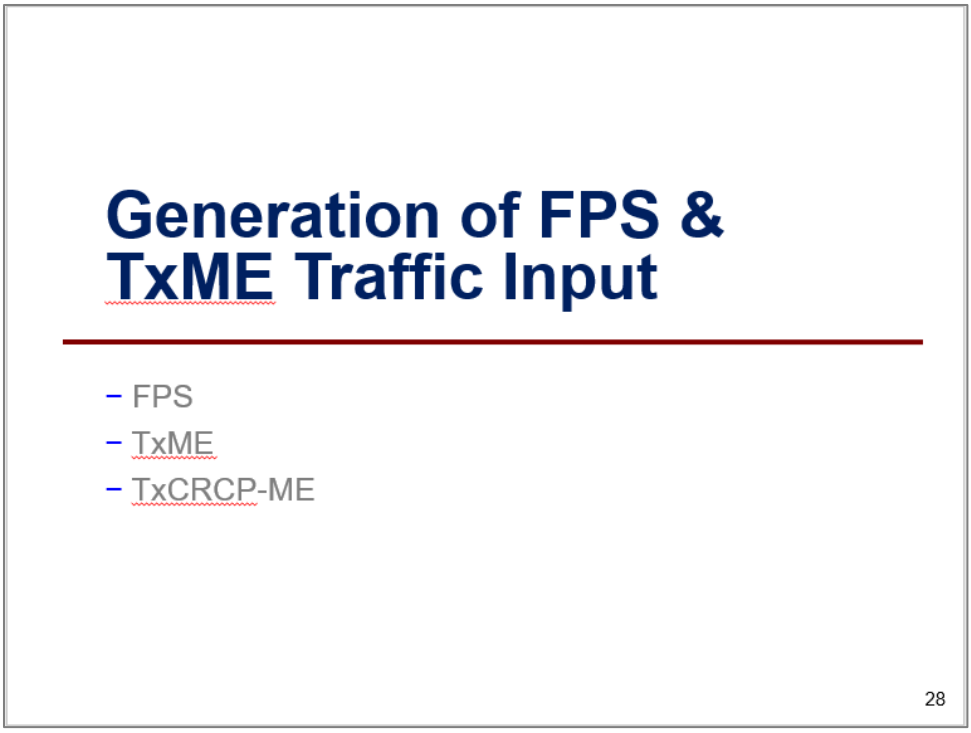
Key Message	Portable WIM Macro (Demo)
Interactive	Automated data processing utilizes the portable WIM macro developed by TTI team and requires the raw data from the TRS unit to generate Mechanistic-Empirical (M-E) compatible traffic data. The portable WIM macro is managed in MS Excel VBA platform. The main screen menu of portable WIM macro is shown on the slide. There are several buttons on the main screen of the program. The left side of the screen shows several options with different functions. These options allow more specific and customized data analysis if the user desires to do so. The right side of the screen shows an option labeled Quick Start, which allows user to do the complete data analysis process. Generally, it is recommended for users to select the Quick Start option since all data can be generated in one single process. Other figures located on the right side show examples of exported raw data files that serves as an input to the macro and the output files generated by the portable WIM macro.
Notes	A demonstration of the portable WIM Macro will be provided.



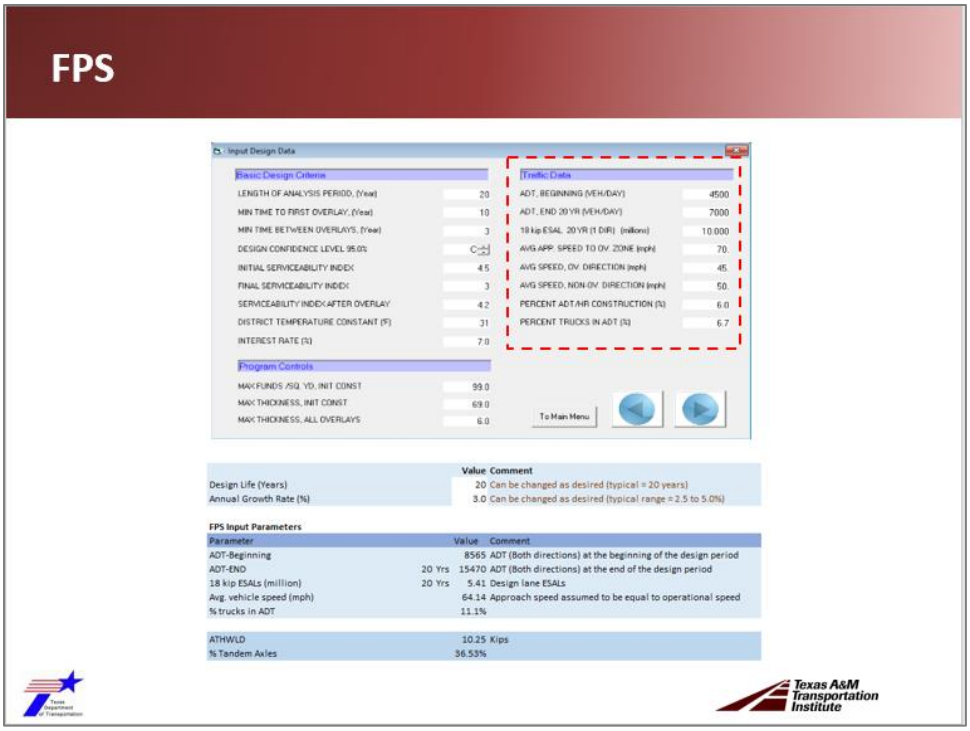
Key Message	Portable WIM Macro
Interactive	Based on the portable WIM traffic volume, speed, classification, and weight data, the pertinent traffic parameters were calculated as listed in the table: - Traffic volume data: ADT, ADTT, %Truck - FHWA vehicle classification - Hourly and daily vehicle distribution - Growth rate - Gloss vehicle weights (GVW) - Axle load distribution - Overweight and overloading statistics - Average ten heaviest wheel loads daily (ATHWLD) - Load efficiency factor (LEF), etc. These computed/generated traffic parameters are used as traffic inputs for the flexible and rigid pavement design programs, like FPS, TxCRCP, and other M-E design software.
Notes	N/A



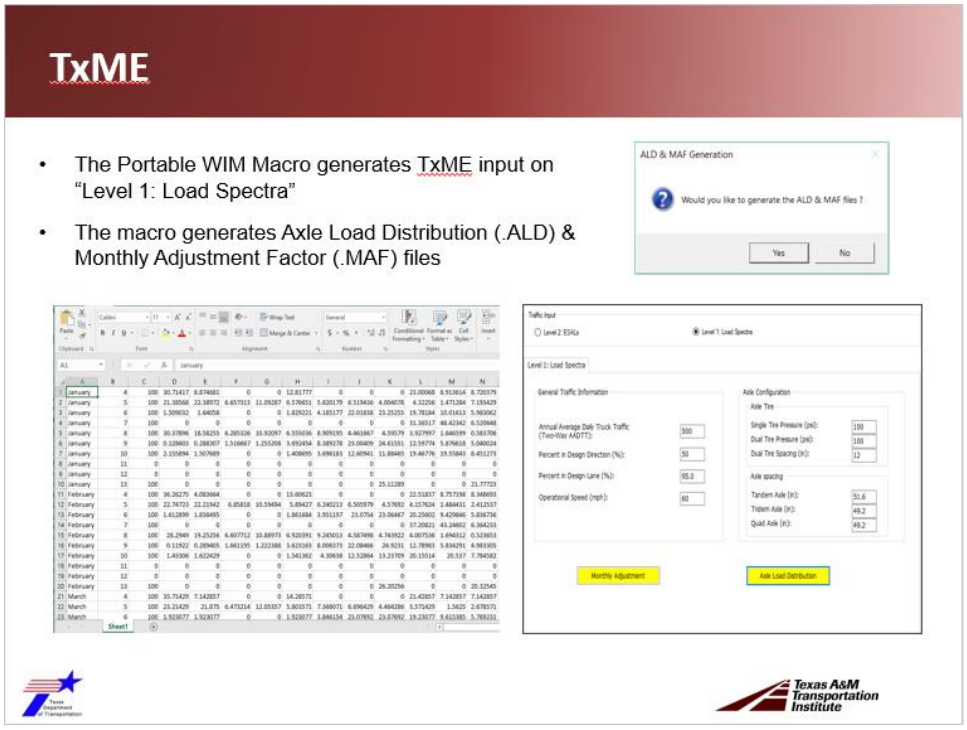
Key Message	Data Analysis File
Interactive	The following is an example of an output file of portable WIM data analysis obtained from portable WIM macro. Analyses may include Vol-Class-Speed, FPS Input, TxCRCP-ME Input, ESAL Estimate, Truck Factor, Volume, Hourly Distribution, Daily Distribution, Truck Overweight Statistics, ATHWLD, Weight Summary & GVW, etc.
Notes	A demonstration of obtaining portable WIM data analysis output from portable WIM macro will be provided.



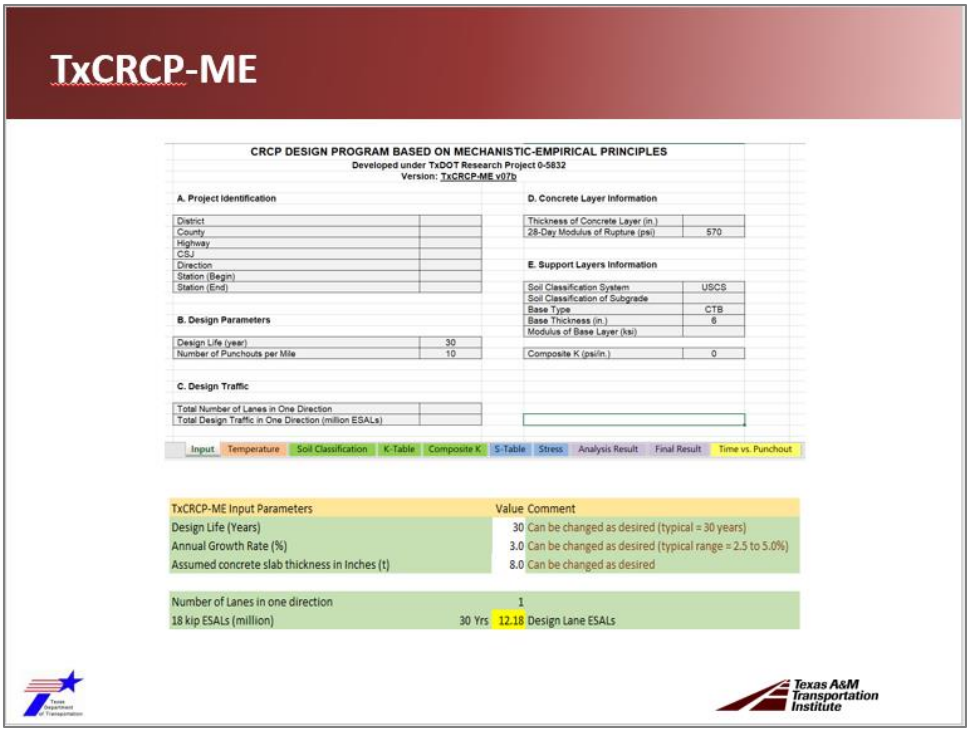
Key Message	Generation of FPS & TxME Traffic Input
Interactive	The following section will present the process of generating FPS & TxME Traffic Input from portable WIM Macro.
Notes	N/A



Key Message	FPS traffic data inputs
Interactive	The slide shows the screenshot of FPS traffic data input. The users can enter the traffic parameters including ADT at beginning and end 20 years, 18-kips ESAL, and % truck using the traffic data from the portable WIM macro data analysis output.
Notes	A demonstration of obtaining FPS inputs from portable WIM macro will be provided.

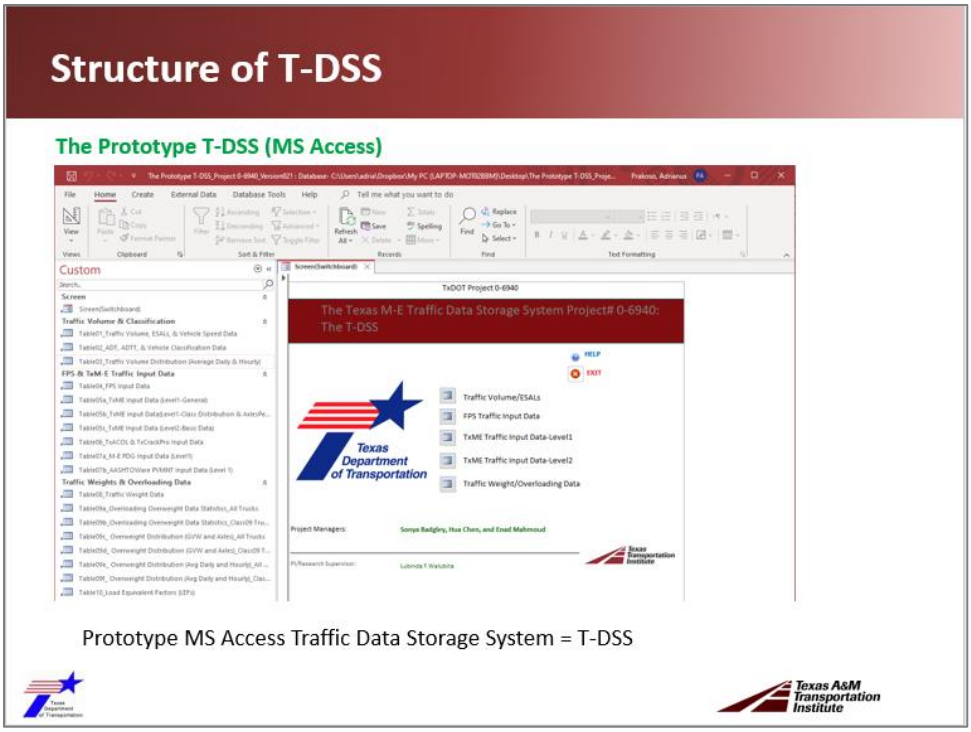


Key Message	TxME traffic data inputs
Interactive	The following is an example of TxME input generated by the Portable WIM Macro, which generates Axle Load Distribution (.ALD) & Monthly Adjustment Factor (.MAF) files.
Notes	A demonstration of obtaining TxME inputs from portable WIM macro will be provided.

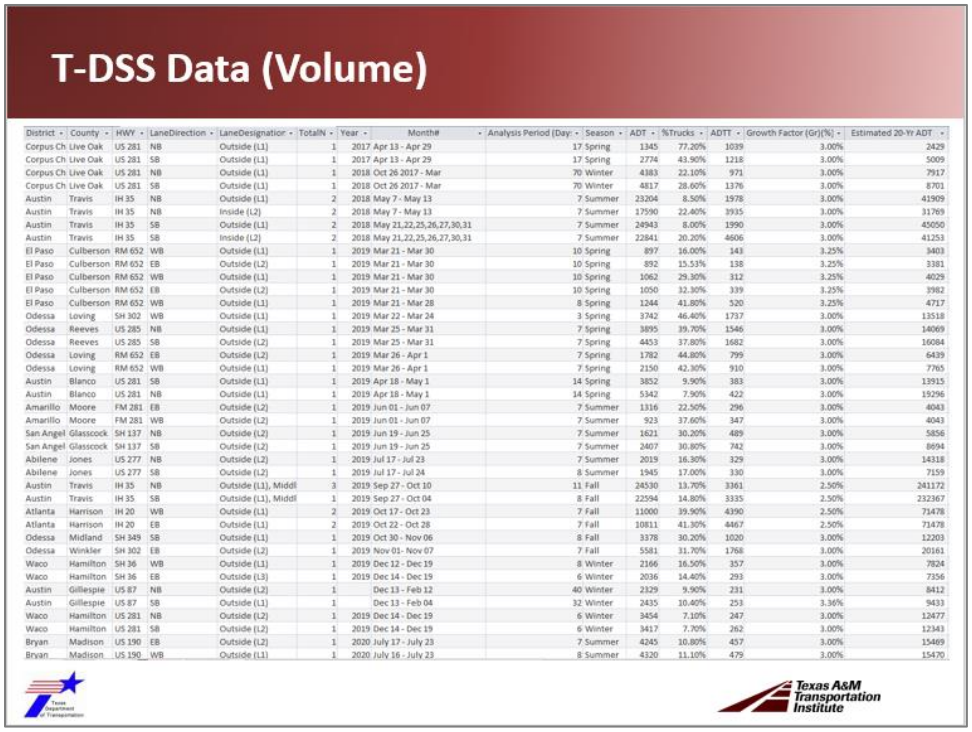


Key Message	TxCRCP-ME traffic data inputs
Interactive	The following is an example of input parameters for TxCRCP-ME generated from Portable WIM Macro. The users can enter the design traffic in one direction (million ESALs) using the traffic data from the portable WIM macro data analysis output.
Notes	A demonstration of obtaining TxCRCP-ME inputs from portable WIM macro will be provided.

Key Message	The MS Access Traffic Data Storage System
Interactive	The following section will explain the MS Access Traffic Data Storage System (T-DSS), including its structure, traffic volume & classification, FPS Traffic Input, & traffic weights & overloading data.
Notes	N/A

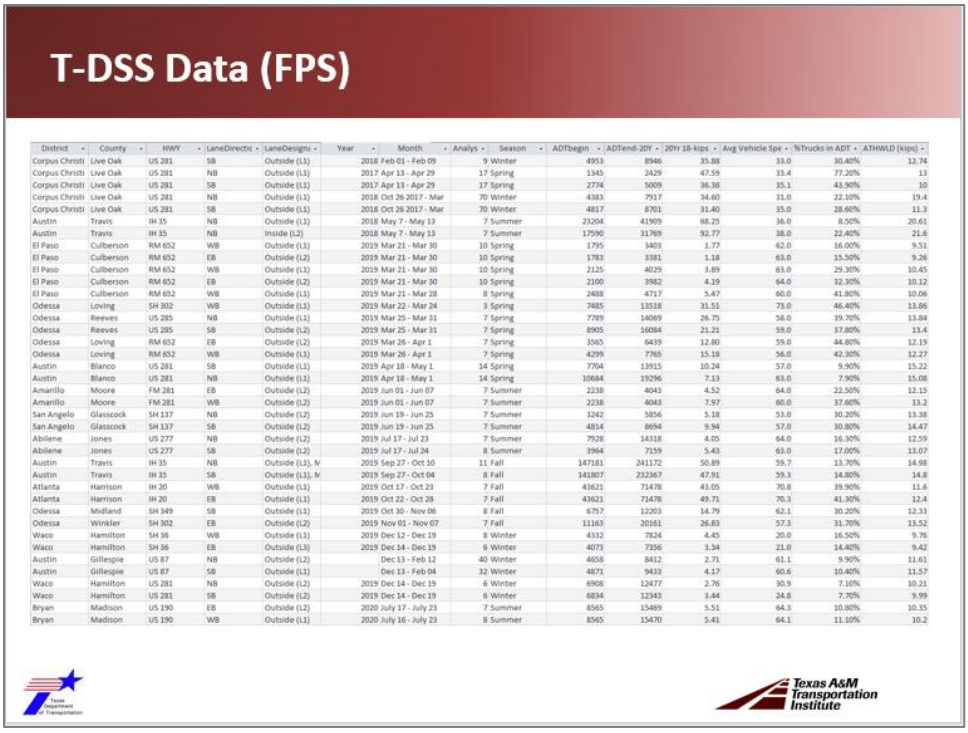


Key Message	Structure of T-DSS
Interactive	The M-E traffic data storage system (The T-DSS) was developed, being maintained and managed in the user-friendly MS Access platform to provide M-E traffic data support for the FPS and other M-E software. The Microsoft Access was selected as the platform for the T-DSS because the Access is compatible with most computer machines and the engineers are conversant with MS office package. The data are arranged and stored in tabular format along with zipped attachments such as MAF and ALD files. The main traffic data tables are: - Tables 01-03: Traffic volume and classification data (TxCRCP-ME input data). - Table 04: FPS input data. - Table 05: TxME input data. - Table 06: TxACOL and TxCrackPro data. - Table 07: M-E PDG and AASHTOWare input data.
Notes	The T-DSS Access file will be shown.



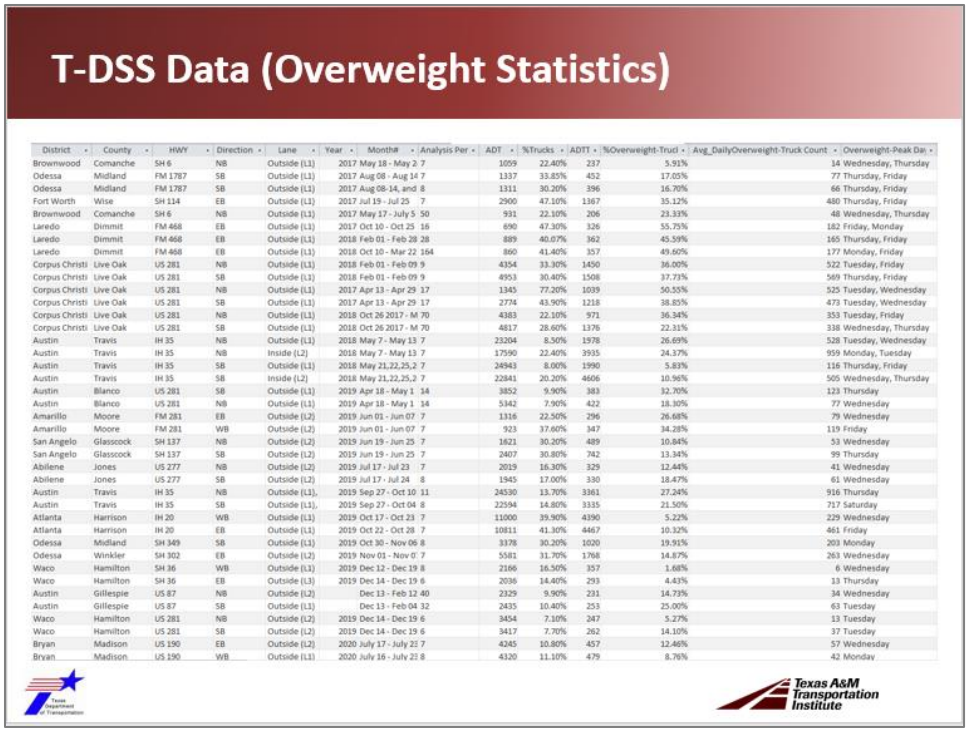
District	County	HWY	LaneDirection	LaneDesignatior	TotalN	Year	Month#	Analysis Period (Day:	Season	ADT	%Trucks	ADTT	Growth Factor (Gr)(%)	Estimated 20-Yr ADT
Corpus Ch	Live Oak	US 281	NB	Outside (L1)	1	2017	Apr 13 - Apr 29	17	Spring	1345	77.20%	1039	3.00%	2429
Corpus Ch	Live Oak	US 281	SB	Outside (L1)	1	2017	Apr 13 - Apr 29	17	Spring	2774	43.90%	1218	3.00%	5009
Corpus Ch	Live Oak	US 281	NB	Outside (L1)	1	2018	Oct 26 2017 - Mar	70	Winter	4383	22.10%	971	3.00%	7917
Corpus Ch	Live Oak	US 281	SB	Outside (L1)	1	2018	Oct 26 2017 - Mar	70	Winter	4817	28.60%	1376	3.00%	8701
Austin	Travis	IH 35	NB	Outside (L1)	2	2018	May 7 - May 13	7	Summer	23204	8.50%	1978	3.00%	41909
Austin	Travis	IH 35	NB	Inside (L2)	2	2018	May 7 - May 13	7	Summer	17590	22.40%	3935	3.00%	31769
Austin	Travis	IH 35	SB	Outside (L1)	2	2018	May 21,22,25,26,27,30,31	7	Summer	24943	8.00%	1990	3.00%	45050
Austin	Travis	IH 35	SB	Inside (L2)	2	2018	May 21,22,25,26,27,30,31	7	Summer	22841	20.20%	4606	3.00%	41253
El Paso	Culberson	RM 652	WB	Outside (L1)	1	2019	Mar 21 - Mar 30	10	Spring	897	16.00%	143	3.25%	3403
El Paso	Culberson	RM 652	EB	Outside (L2)	1	2019	Mar 21 - Mar 30	10	Spring	892	15.53%	138	3.25%	3381
El Paso	Culberson	RM 652	WB	Outside (L1)	1	2019	Mar 21 - Mar 30	10	Spring	1062	29.30%	312	3.25%	4029
El Paso	Culberson	RM 652	EB	Outside (L2)	1	2019	Mar 21 - Mar 30	10	Spring	1050	32.30%	339	3.25%	3982
El Paso	Culberson	RM 652	WB	Outside (L1)	1	2019	Mar 21 - Mar 28	8	Spring	1244	41.80%	520	3.25%	4717
Odessa	Loving	SH 302	WB	Outside (L1)	1	2019	Mar 22 - Mar 24	3	Spring	3742	46.40%	1737	3.00%	13518
Odessa	Reeves	US 285	NB	Outside (L1)	1	2019	Mar 25 - Mar 31	7	Spring	3895	39.70%	1546	3.00%	14069
Odessa	Reeves	US 285	SB	Outside (L2)	1	2019	Mar 25 - Mar 31	7	Spring	4453	37.80%	1682	3.00%	16084
Odessa	Loving	RM 652	EB	Outside (L2)	1	2019	Mar 26 - Apr 1	7	Spring	1782	44.80%	799	3.00%	6439
Odessa	Loving	RM 652	WB	Outside (L1)	1	2019	Mar 26 - Apr 1	7	Spring	2150	42.30%	910	3.00%	7765
Austin	Blanco	US 281	SB	Outside (L1)	1	2019	Apr 18 - May 1	14	Spring	3852	9.90%	383	3.00%	13915
Austin	Blanco	US 281	NB	Outside (L1)	1	2019	Apr 18 - May 1	14	Spring	5342	7.90%	422	3.00%	19296
Amarillo	Moore	FM 281	EB	Outside (L2)	1	2019	Jun 01 - Jun 07	7	Summer	1316	22.50%	296	3.00%	4043
Amarillo	Moore	FM 281	WB	Outside (L2)	1	2019	Jun 01 - Jun 07	7	Summer	923	37.60%	347	3.00%	4043
San Angel	Glasscock	SH 137	NB	Outside (L2)	1	2019	Jun 19 - Jun 25	7	Summer	1621	30.20%	489	3.00%	5856
San Angel	Glasscock	SH 137	SB	Outside (L2)	1	2019	Jun 19 - Jun 25	7	Summer	2407	30.80%	742	3.00%	8694
Abilene	Jones	US 277	NB	Outside (L2)	1	2019	Jul 17 - Jul 23	7	Summer	2019	16.30%	329	3.00%	14318
Abilene	Jones	US 277	SB	Outside (L2)	1	2019	Jul 17 - Jul 24	8	Summer	1945	17.00%	330	3.00%	7159
Austin	Travis	IH 35	NB	Outside (L1), Middl	3	2019	Sep 27 - Oct 10	11	Fall	24530	13.70%	3361	2.50%	241172
Austin	Travis	IH 35	SB	Outside (L1), Middl	1	2019	Sep 27 - Oct 04	8	Fall	22594	14.80%	3335	2.50%	232367
Atlanta	Harrison	IH 20	WB	Outside (L1)	2	2019	Oct 17 - Oct 23	7	Fall	11000	39.90%	4390	2.50%	71478
Atlanta	Harrison	IH 20	EB	Outside (L1)	2	2019	Oct 22 - Oct 28	7	Fall	10811	41.30%	4467	2.50%	71478
Odessa	Midland	SH 349	SB	Outside (L1)	1	2019	Oct 30 - Nov 06	8	Fall	3378	30.20%	1020	3.00%	12203
Odessa	Winkler	SH 302	EB	Outside (L2)	1	2019	Nov 01- Nov 07	7	Fall	5581	31.70%	1768	3.00%	20161
Waco	Hamilton	SH 36	WB	Outside (L1)	1	2019	Dec 12 - Dec 19	8	Winter	2166	16.50%	357	3.00%	7824
Waco	Hamilton	SH 36	EB	Outside (L3)	1	2019	Dec 14 - Dec 19	6	Winter	2036	14.40%	293	3.00%	7356
Austin	Gillespie	US 87	NB	Outside (L2)	1		Dec 13 - Feb 12	40	Winter	2329	9.90%	231	3.00%	8412
Austin	Gillespie	US 87	SB	Outside (L1)	1		Dec 13 - Feb 04	32	Winter	2435	10.40%	253	3.36%	9433
Waco	Hamilton	US 281	NB	Outside (L2)	1	2019	Dec 14 - Dec 19	6	Winter	3454	7.10%	247	3.00%	12477
Waco	Hamilton	US 281	SB	Outside (L2)	1	2019	Dec 14 - Dec 19	6	Winter	3417	7.70%	262	3.00%	12343
Bryan	Madison	US 190	EB	Outside (L2)	1	2020	July 17 - July 23	7	Summer	4245	10.80%	457	3.00%	15469
Bryan	Madison	US 190	WB	Outside (L1)	1	2020	July 16 - July 23	8	Summer	4320	11.10%	479	3.00%	15470

Key Message	T-DSS Data (Volume)
Interactive	This slide shows an example of populated traffic volume data in the T-DSS collected from portable WIM systems installed throughout Texas.
Notes	N/A



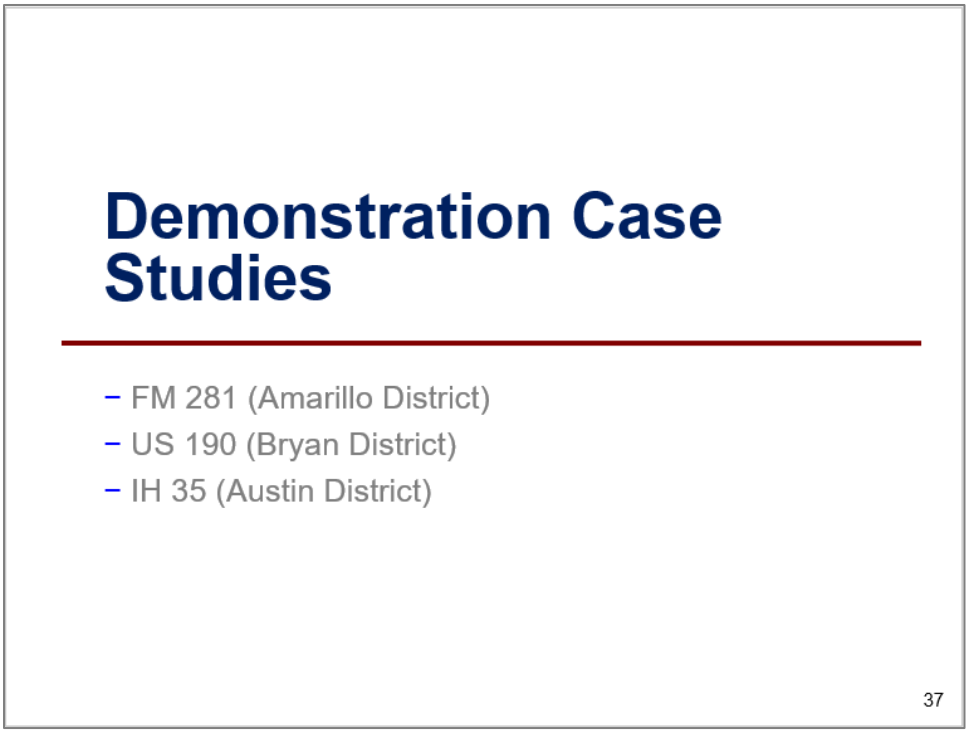
District	County	HWY	LaneDirectic	LaneDesignc	Year	Month	Analys	Season	ADTbegin	ADTend-20Y	20Yr 18-kips	Avg Vehicle Spe	%Trucks in ADT	ATHWLD (kips)
Corpus Christi	Live Oak	US 281	SB	Outside (L1)	2018	Feb 01 - Feb 09	9	Winter	4953	8946	35.88	33.0	30.40%	12.74
Corpus Christi	Live Oak	US 281	NB	Outside (L1)	2017	Apr 13 - Apr 29	17	Spring	1345	2429	47.59	33.4	77.20%	13
Corpus Christi	Live Oak	US 281	SB	Outside (L1)	2017	Apr 13 - Apr 29	17	Spring	2774	5009	36.38	35.1	43.90%	10
Corpus Christi	Live Oak	US 281	NB	Outside (L1)	2018	Oct 26 2017 - Mar	70	Winter	4383	7917	34.60	31.0	22.10%	19.4
Corpus Christi	Live Oak	US 281	SB	Outside (L1)	2018	Oct 26 2017 - Mar	70	Winter	4817	8701	31.40	35.0	28.60%	11.3
Austin	Travis	IH 35	NB	Outside (L1)	2018	May 7 - May 13	7	Summer	23204	41909	68.25	36.0	8.50%	20.61
Austin	Travis	IH 35	NB	Inside (L2)	2018	May 7 - May 13	7	Summer	17590	31769	92.77	38.0	22.40%	21.6
El Paso	Culberson	RM 652	WB	Outside (L1)	2019	Mar 21 - Mar 30	10	Spring	1795	3403	1.77	62.0	16.00%	9.51
El Paso	Culberson	RM 652	EB	Outside (L2)	2019	Mar 21 - Mar 30	10	Spring	1783	3381	1.18	63.0	15.50%	9.26
El Paso	Culberson	RM 652	WB	Outside (L1)	2019	Mar 21 - Mar 30	10	Spring	2125	4029	3.89	63.0	29.30%	10.45
El Paso	Culberson	RM 652	EB	Outside (L2)	2019	Mar 21 - Mar 30	10	Spring	2100	3982	4.19	64.0	32.30%	10.12
El Paso	Culberson	RM 652	WB	Outside (L1)	2019	Mar 21 - Mar 28	8	Spring	2488	4717	5.47	60.0	41.80%	10.06
Odessa	Loving	SH 302	WB	Outside (L1)	2019	Mar 22 - Mar 24	3	Spring	7485	13518	31.51	73.0	46.40%	13.86
Odessa	Reeves	US 285	NB	Outside (L1)	2019	Mar 25 - Mar 31	7	Spring	7789	14069	26.75	58.0	19.70%	13.84
Odessa	Reeves	US 285	SB	Outside (L2)	2019	Mar 25 - Mar 31	7	Spring	8905	16084	21.21	59.0	37.80%	13.4
Odessa	Loving	RM 652	EB	Outside (L2)	2019	Mar 26 - Apr 1	7	Spring	3565	6439	12.80	59.0	44.80%	12.19
Odessa	Loving	RM 652	WB	Outside (L1)	2019	Mar 26 - Apr 1	7	Spring	4299	7765	15.18	56.0	42.30%	12.27
Austin	Blanco	US 281	SB	Outside (L1)	2019	Apr 18 - May 1	14	Spring	7704	13915	10.24	57.0	9.90%	15.22
Austin	Blanco	US 281	NB	Outside (L1)	2019	Apr 18 - May 1	14	Spring	10684	19296	7.13	63.0	7.90%	15.08
Amarillo	Moore	FM 281	EB	Outside (L2)	2019	Jun 01 - Jun 07	7	Summer	2238	4043	4.52	64.0	22.50%	12.15
Amarillo	Moore	FM 281	WB	Outside (L2)	2019	Jun 01 - Jun 07	7	Summer	2238	4043	7.97	60.0	37.60%	13.2
San Angelo	Glasscock	SH 137	NB	Outside (L2)	2019	Jun 19 - Jun 25	7	Summer	3242	5856	5.18	53.0	30.20%	13.38
San Angelo	Glasscock	SH 137	SB	Outside (L2)	2019	Jun 19 - Jun 25	7	Summer	4814	8694	9.94	57.0	30.80%	14.47
Abilene	Jones	US 277	NB	Outside (L2)	2019	Jul 17 - Jul 23	7	Summer	7928	14318	4.05	64.0	16.30%	12.59
Abilene	Jones	US 277	SB	Outside (L2)	2019	Jul 17 - Jul 24	8	Summer	3964	7159	5.43	63.0	17.00%	13.07
Austin	Travis	IH 35	NB	Outside (L1), lv	2019	Sep 27 - Oct 10	11	Fall	147181	241172	50.89	59.7	13.70%	14.98
Austin	Travis	IH 35	SB	Outside (L1), lv	2019	Sep 27 - Oct 04	8	Fall	141807	232367	47.91	59.3	14.80%	14.8
Atlanta	Harrison	IH 20	WB	Outside (L1)	2019	Oct 17 - Oct 23	7	Fall	43621	71478	41.05	70.8	39.90%	11.6
Atlanta	Harrison	IH 20	EB	Outside (L1)	2019	Oct 22 - Oct 28	7	Fall	43621	71478	49.71	70.3	41.30%	12.4
Odessa	Midland	SH 349	SB	Outside (L1)	2019	Oct 30 - Nov 06	8	Fall	6757	12203	14.79	62.1	30.20%	12.33
Odessa	Winkler	SH 302	EB	Outside (L2)	2019	Nov 01 - Nov 07	7	Fall	11163	20161	26.83	57.3	31.70%	13.52
Waco	Hamilton	SH 36	WB	Outside (L1)	2019	Dec 12 - Dec 19	8	Winter	4332	7824	4.45	20.0	16.50%	9.76
Waco	Hamilton	SH 36	EB	Outside (L1)	2019	Dec 14 - Dec 19	6	Winter	4073	7356	3.34	21.0	14.40%	9.42
Austin	Gillespie	US 87	NB	Outside (L2)		Dec 13 - Feb 12	40	Winter	4658	8412	2.71	61.1	9.90%	11.61
Austin	Gillespie	US 87	SB	Outside (L1)		Dec 13 - Feb 04	32	Winter	4871	9433	4.17	60.6	10.40%	11.57
Waco	Hamilton	US 281	NB	Outside (L2)	2019	Dec 14 - Dec 19	6	Winter	6908	12477	2.76	30.9	7.10%	10.21
Waco	Hamilton	US 281	SB	Outside (L2)	2019	Dec 14 - Dec 19	6	Winter	6834	12343	3.44	24.8	7.70%	9.99
Bryan	Madison	US 190	EB	Outside (L2)	2020	July 17 - July 23	7	Summer	8565	15469	5.51	64.3	10.80%	10.35
Bryan	Madison	US 190	WB	Outside (L1)	2020	July 16 - July 23	8	Summer	8565	15470	5.41	64.1	11.10%	10.2

Key Message	T-DSS Data (FPS)
Interactive	This slide shows an example of populated FPS data in the T-DSS collected from portable WIM systems installed throughout Texas.
Notes	N/A

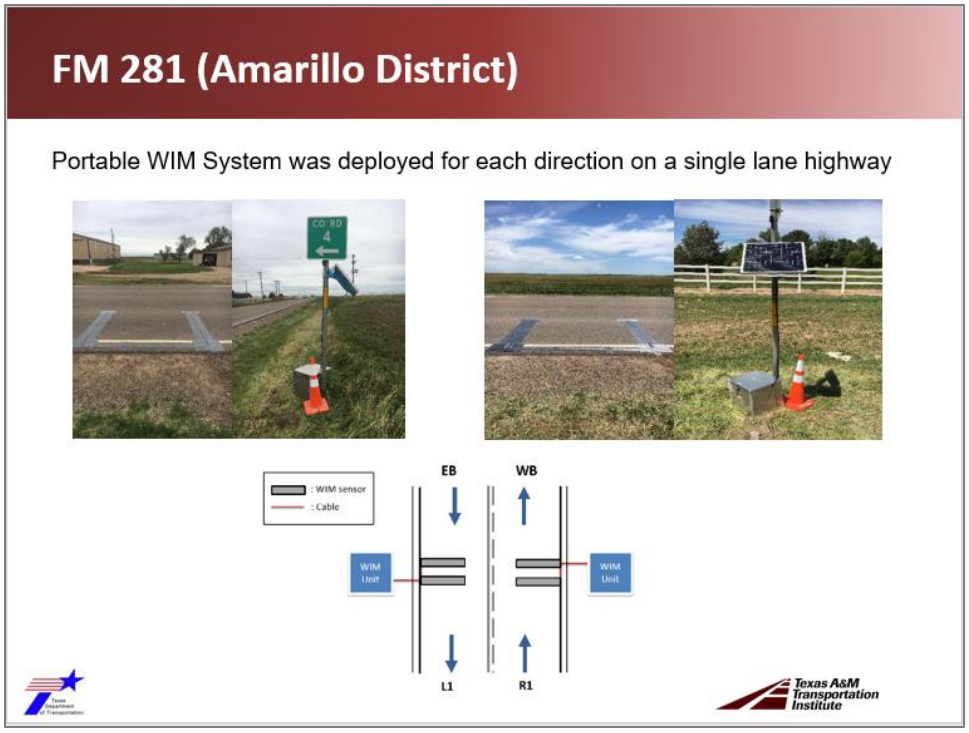


District	County	HWY	Direction	Lane	Year	Month#	Analysis Per	ADT	%Trucks	ADTT	%Overweight-Truci	Avg_DailyOverweight-Truck Count	Overweight-Peak Da
Brownwood	Comanche	SH 6	NB	Outside (L1)	2017	May 18 - May 2	7	1059	22.40%	237	5.91%	14	Wednesday, Thursday
Odessa	Midland	FM 1787	SB	Outside (L1)	2017	Aug 08 - Aug 14	7	1337	33.85%	452	17.05%	77	Thursday, Friday
Odessa	Midland	FM 1787	SB	Outside (L1)	2017	Aug 08-14, and	8	1311	30.20%	396	16.70%	66	Thursday, Friday
Fort Worth	Wise	SH 114	EB	Outside (L1)	2017	Jul 19 - Jul 25	7	2900	47.10%	1367	35.12%	480	Thursday, Friday
Brownwood	Comanche	SH 6	NB	Outside (L1)	2017	May 17 - July 5	50	931	22.10%	206	23.33%	48	Wednesday, Thursday
Laredo	Dimmit	FM 468	EB	Outside (L1)	2017	Oct 10 - Oct 25	16	690	47.30%	326	55.75%	182	Friday, Monday
Laredo	Dimmit	FM 468	EB	Outside (L1)	2018	Feb 01 - Feb 28	28	889	40.07%	362	45.59%	165	Thursday, Friday
Laredo	Dimmit	FM 468	EB	Outside (L1)	2018	Oct 10 - Mar 22	164	860	41.40%	357	49.60%	177	Monday, Friday
Corpus Christi	Live Oak	US 281	NB	Outside (L1)	2018	Feb 01 - Feb 09	9	4354	33.30%	1450	36.00%	522	Tuesday, Friday
Corpus Christi	Live Oak	US 281	SB	Outside (L1)	2018	Feb 01 - Feb 09	9	4953	30.40%	1508	37.73%	569	Thursday, Friday
Corpus Christi	Live Oak	US 281	NB	Outside (L1)	2017	Apr 13 - Apr 29	17	1345	77.20%	1039	50.55%	525	Tuesday, Wednesday
Corpus Christi	Live Oak	US 281	SB	Outside (L1)	2017	Apr 13 - Apr 29	17	2774	43.90%	1218	38.85%	473	Tuesday, Wednesday
Corpus Christi	Live Oak	US 281	NB	Outside (L1)	2018	Oct 26 2017 - M	70	4383	22.10%	971	36.34%	353	Tuesday, Friday
Corpus Christi	Live Oak	US 281	SB	Outside (L1)	2018	Oct 26 2017 - M	70	4817	28.60%	1376	22.31%	338	Wednesday, Thursday
Austin	Travis	IH 35	NB	Outside (L1)	2018	May 7 - May 13	7	23204	8.50%	1978	26.69%	528	Tuesday, Wednesday
Austin	Travis	IH 35	NB	Inside (L2)	2018	May 7 - May 13	7	17590	22.40%	3935	24.37%	959	Monday, Tuesday
Austin	Travis	IH 35	SB	Outside (L1)	2018	May 21,22,25,2	7	24943	8.00%	1990	5.83%	116	Thursday, Friday
Austin	Travis	IH 35	SB	Inside (L2)	2018	May 21,22,25,2	7	22841	20.20%	4606	10.96%	505	Wednesday, Thursday
Austin	Blanco	US 281	SB	Outside (L1)	2019	Apr 18 - May 1	14	3852	9.90%	383	32.70%	123	Thursday
Austin	Blanco	US 281	NB	Outside (L1)	2019	Apr 18 - May 1	14	5342	7.90%	422	18.30%	77	Wednesday
Amarillo	Moore	FM 281	EB	Outside (L2)	2019	Jun 01 - Jun 07	7	1316	22.50%	296	26.68%	79	Wednesday
Amarillo	Moore	FM 281	WB	Outside (L2)	2019	Jun 01 - Jun 07	7	923	37.60%	347	34.28%	119	Friday
San Angelo	Glasscock	SH 137	NB	Outside (L2)	2019	Jun 19 - Jun 25	7	1621	30.20%	489	10.84%	53	Wednesday
San Angelo	Glasscock	SH 137	SB	Outside (L2)	2019	Jun 19 - Jun 25	7	2407	30.80%	742	13.34%	99	Thursday
Abilene	Jones	US 277	NB	Outside (L2)	2019	Jul 17 - Jul 23	7	2019	16.30%	329	12.44%	41	Wednesday
Abilene	Jones	US 277	SB	Outside (L2)	2019	Jul 17 - Jul 24	8	1945	17.00%	330	18.47%	61	Wednesday
Austin	Travis	IH 35	NB	Outside (L1),	2019	Sep 27 - Oct 10	11	24530	13.70%	3361	27.24%	916	Thursday
Austin	Travis	IH 35	SB	Outside (L1),	2019	Sep 27 - Oct 04	8	22594	14.80%	3335	21.50%	717	Saturday
Atlanta	Harrison	IH 20	WB	Outside (L1)	2019	Oct 17 - Oct 23	7	11000	39.90%	4390	5.22%	229	Wednesday
Atlanta	Harrison	IH 20	EB	Outside (L1)	2019	Oct 22 - Oct 28	7	10811	41.30%	4467	10.32%	461	Friday
Odessa	Midland	SH 349	SB	Outside (L1)	2019	Oct 30 - Nov 06	8	3378	30.20%	1020	19.91%	203	Monday
Odessa	Winkler	SH 302	EB	Outside (L2)	2019	Nov 01 - Nov 0	7	5581	31.70%	1768	14.87%	263	Wednesday
Waco	Hamilton	SH 36	WB	Outside (L1)	2019	Dec 12 - Dec 19	8	2166	16.50%	357	1.68%	6	Wednesday
Waco	Hamilton	SH 36	EB	Outside (L1)	2019	Dec 14 - Dec 19	6	2036	14.40%	293	4.43%	13	Thursday
Austin	Gillespie	US 87	NB	Outside (L2)		Dec 13 - Feb 12	40	2329	9.90%	231	14.73%	34	Wednesday
Austin	Gillespie	US 87	SB	Outside (L1)		Dec 13 - Feb 04	32	2435	10.40%	253	25.00%	63	Tuesday
Waco	Hamilton	US 281	NB	Outside (L2)	2019	Dec 14 - Dec 19	6	3454	7.10%	247	5.27%	13	Tuesday
Waco	Hamilton	US 281	SB	Outside (L2)	2019	Dec 14 - Dec 19	6	3417	7.70%	262	14.10%	37	Tuesday
Bryan	Madison	US 190	EB	Outside (L2)	2020	July 17 - July 23	7	4245	10.80%	457	12.46%	57	Wednesday
Bryan	Madison	US 190	WB	Outside (L1)	2020	July 16 - July 23	8	4320	11.10%	479	8.76%	42	Monday

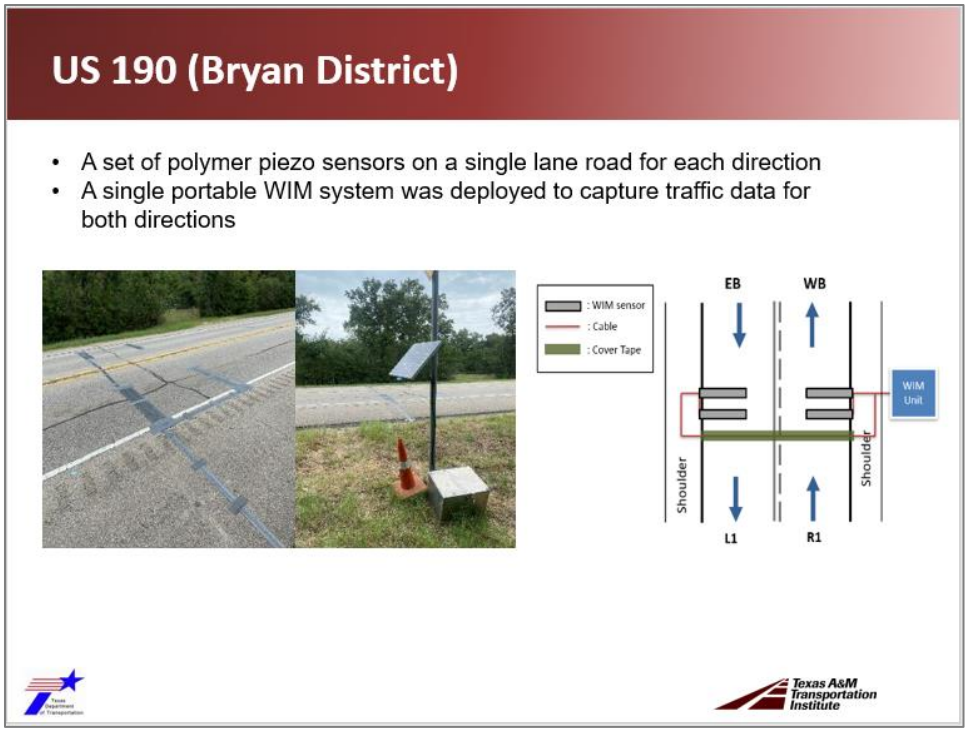
Key Message	T-DSS Data (Overweight Statistics)
Interactive	This slide shows an example of populated additional overweight vehicles data in the T-DSS collected from portable WIM systems installed throughout Texas.
Notes	N/A



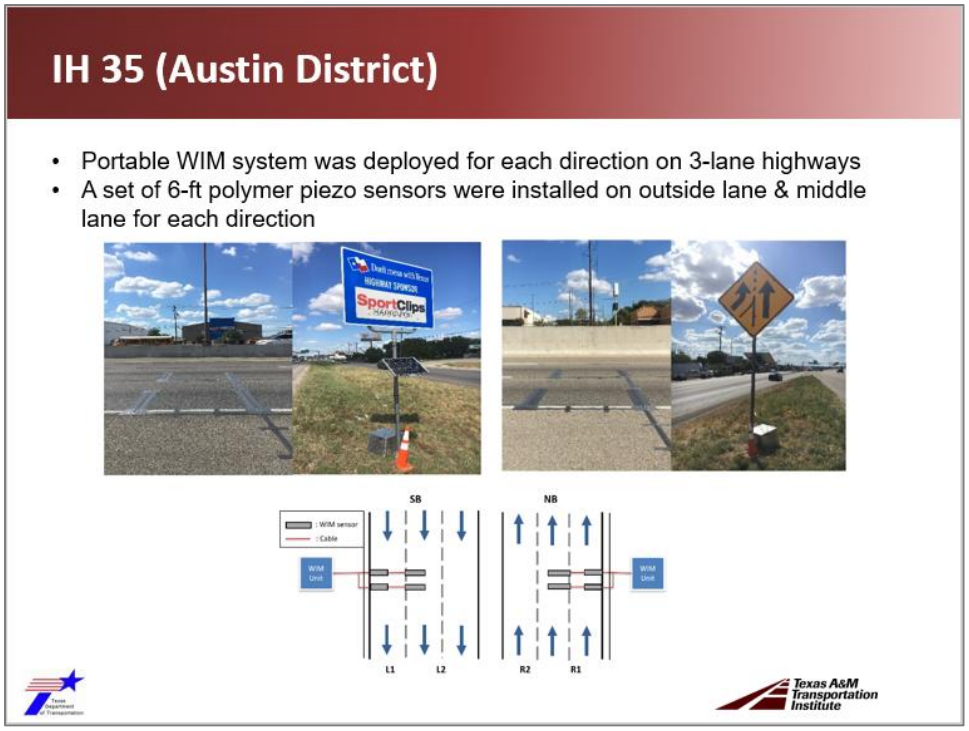
Key Message	Demonstration Case Studies
Interactive	The following section will show demonstration of case studies of portable WIM sites, including FM 281 (Amarillo District), US 190 (Bryan District), & IH 35 (Austin District).
Notes	N/A



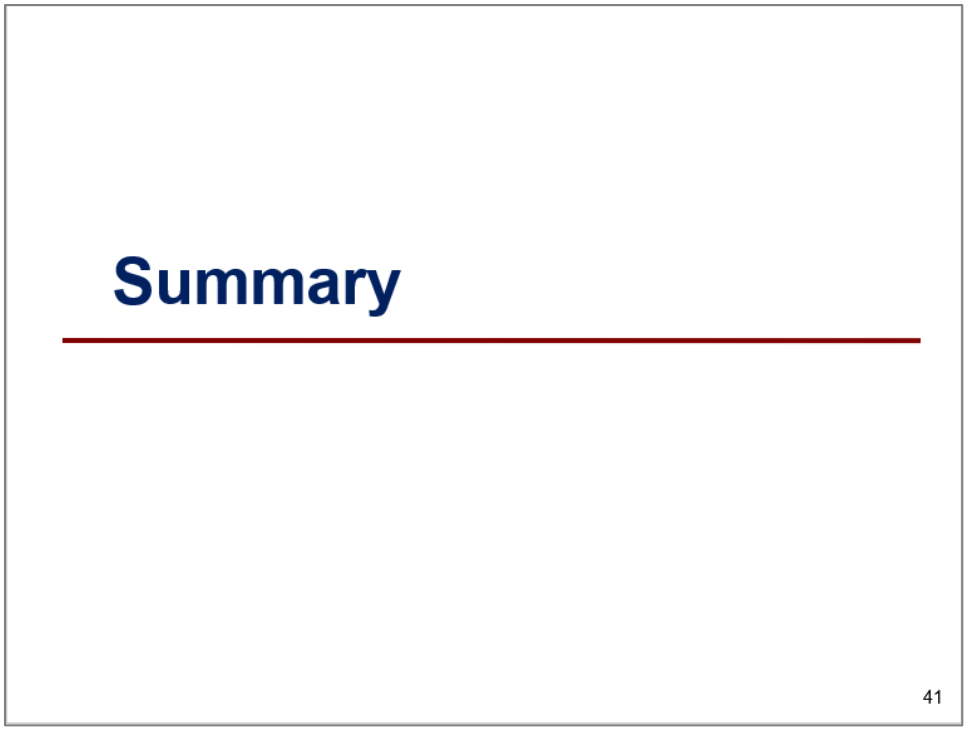
Key Message	FM 281 (Amarillo District)
Interactive	This slide shows a portable WIM installation on FM 281 in Amarillo District in 2019. Portable WIM system was deployed for each direction on a single lane highway. Since there was no wide shoulder on the site location, 6-ft polymer piezo sensors were used in this case. Modem systems for both directions were installed as well to enable users to access real-time portable WIM traffic data, monitor the functionality of the deployed portable WIM system, and retrieve the traffic data remotely. Pavement surface was flat without any distress and far from any intersections; therefore, the site location was ideal for portable WIM installation. In addition, the installation was performed during summer season and the temperature was above 55°F; therefore, torch kit was not used to heat up the tapes and the pavement surface and there were no additional road tape strips applied on the center of the sensors.
Notes	N/A



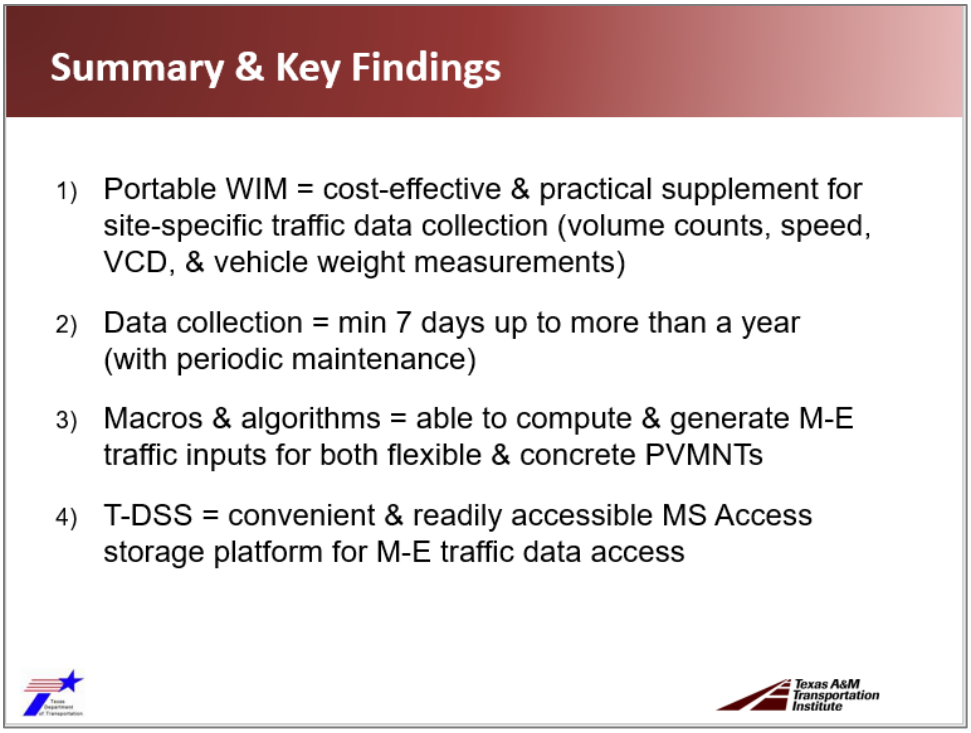
Key Message	US 190 (Bryan District)
Interactive	This slide shows a portable WIM installation on US 190 in Bryan District in 2020. A set of polymer piezo sensors were installed on a single lane road for each direction and only a single portable WIM system was deployed to capture traffic data for both directions (TRS unit was located on eastbound direction). Since there were rumble strips located on the shoulder near outside lane, 6-ft polymer piezo sensors were used in this case. Using 8-ft sensors may cause a problem because placing 8-ft sensors will overlap the shoulders, reaching the rumble strip areas, and due to a gap between rumble strip and metal plate, water may enter the road tape and underneath the plates, causing moisture damage to the adhesive. Even though the installation was performed during summer season and the temperature was above 55°F, there was rutting with a very low severity level on the pavement surface where the sensors were going to be installed. Therefore, additional road tape strips were added on the center of the sensors for extra protection of the sensors being detached from the road. In addition, the site location was far from any intersections; therefore, the site location was ideal for portable WIM installation.
Notes	N/A



Key Message	IH 35 (Austin District)
Interactive	This slide shows a portable WIM installation on IH 35 in Austin District in 2019. A set of 6-ft polymer piezo sensors were installed on outside lane and middle lane for each direction. Due to very high traffic volume on IH 35, portable WIM system installation was conducted during midnight (09:00 PM until 02:00 AM) on weekdays. Pavement surface was flat without any distress and far from any intersections; therefore, the site location was ideal for portable WIM installation. In addition, the installation was performed during fall season and the temperature was above 55°F; therefore, torch kit was not used to heat up the tapes and the pavement surface and there were no additional road tape strips applied on the center of the sensors.
Notes	N/A



Key Message	Summary
Interactive	This section will summarize the presentation regarding portable WIM installation.
Notes	N/A



Key Message	Summary & Key Findings
Interactive	1) Portable WIM can be a cost-effective & practical supplement for site-specific traffic data collection (volume counts, speed, VCD, & vehicle weight measurements). 2) Data collection has to be conducted min 7 days up to more than a year (with periodic maintenance such as quality control of applied tapes and checking the portable WIM system components whether the TRS unit and other main components are still functioning properly). 3) Portable WIM macro developed by the TTI team is able to compute & generate M-E traffic inputs for both flexible & concrete pavements, collected from the TTI Hybrid-portable WIM system. 4) T-DSS is am Access-based database platform developed by TTI team used to populate ready-to-use traffic data collected from portable WIM systems installed throughout Texas and can be conveniently accessed.
Notes	N/A

Key Message	Comments & Discussions
Interactive	N/A
Notes	N/A

TRAINING EVALUATION FORM

for participants in the Workshop for TxDOT Project 5-6940-01
Implementation of Portable Weigh-In-Motion (WIM) Technology on Texas Highways

Date:

Training Location:

Trainer:

Instructions: Please indicate your level of agreement with the statements listed below in Q#1–7.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1. The objectives of the training were clearly defined.	O	O	O	O	O
2. The topics covered were relevant to me.	O	O	O	O	O
3. The materials were helpful.	O	O	O	O	O
4. This training experience will be useful in my work.	O	O	O	O	O
5. The trainer was knowledgeable about the training topics.	O	O	O	O	O
6. The time allotted for the training was sufficient.	O	O	O	O	O
7. The meeting room and facilities were adequate and comfortable.	O	O	O	O	O

8. What did you like most about this training?

9. What aspects of the training could be improved?

10. Please share other comments here:

Thank you for your feedback!