Event ID: 2767090
Event Started: 10/26/2015 12:52:13 PM ET

Please stand by for real-time captions. Good afternoon I'm Blair and I will be a conference operator today. Would like to welcome everyone to the Smarter Work Zones showcase Queue warnings conference call. (Operator instructions) you may begin your conference.

Good afternoon or good morning depending on where you are. Welcome to the fourth webinar in the Smarter Work Zones webinar series. My name is Nicole and I will moderate today's webinar. Before I go any further I want to let those of you know who were calling in that you will need to mute your computer speakers or else you will be hearing the audio over the computer. We will have four presenters today. Todd Peterson, Gerald Ullman, Ted Nemsky, and Chris Brookes. Todd Peterson is a transportation specialist on the work some management team and the office of operations. He specializes in data-driven management of traffic operations and innovative strategies. He is currently the lead champion for promoting work stone ITS strategies.

Jerry Ullman is a Texas A&M Texas Institute is a senior research engineer at the Texas A&M Texas Institute and leads the work zone and dynamic message fun research program. Since joining TTI he has been the principal investigator for numerous studies, traffic control device effectiveness, and traveler information systems. He was the primary author of work stone ITS implementation guide and is a member of the FHA Smarter Work Zones implementation team.

Ted Nemsky is an engineer and currently the construction engineer for I. district 8 in Collinsville. During his 30 year career he has worked as a rest of engineer and supervising field them for -- engineer in the district 8 construction section. He is also a bridge inspection engineer in the district 8 euro. He served as a chair onto centers for transportation research projects and currently serves as a member of the Illinois work stone.

Chris Brookes is a Michigan Department of Transportation work zone delivery engineer. He has been with the department for over seven years. Prior to that he worked in the University region where he gained experience working in designs construction and traffic safety. He is a member of the FHWA smarter zone implementation. Today's seminar will last 90 minutes with 60 minutes allocated for speakers and 30 minutes for a Q&A section. Send your questions to everyone and indicate which prisoner your question is for. During the presentation speakers cannot

answer questions. We will answer questions again at the end of all the presentations in addition, if time allows we will open the phone lines for questions and commerce -- comments. You can download the documents in the lower right-hand corner of the screen. The presentation will be available online within the next few weeks.

FHWA does not certify participation in online courses for continuation education credit. Please contact your professional no certification Board for recording requirements. I am not going to turn it over to Todd Peterson. Todd?

Okay, thank you Nicole. We're going to talk -- this is the fourth in a series of seminars we've been conducting on Smarter Work Zones. This being the fourth webinar, we have had three prior to this which are all archived and available online if you'd like to go back and catch up. We also have several schedules as you can see in the bottom half of the screen. All of these are being recorded and archived and will be available on the link that you see at the bottom of the screen.

The focus is Queue Warning Systems which is one of the technology applications of Smarter Work Zones and we will talk about what that means in a little bit. I want to give a brief overview of the Smarter Work Zones technology initiative in a little bit more about Queue Warning Systems and that will get onto some examples of that the presenters have for you today.

Smarter Work Zones, no what we mean when we say that? A Smarter Work Zones sounds like smart highways which tends to be IPS. It includes two components technology applications and project coordination given -- Smarter Work Zones address policies, business practices, business processes, used to improve work zone operations to reduce crashes and congestion thereby improving safety and mobility. That is really the objective. Take some of these innovative approaches to reducing crashes and congestion using tools such as Queue Warning Systems.

I mentioned the two parts of Smarter Work Zones and it's really two things that can work separately or in concert with each other. The first part being project coordination which is the proactive planning of multiple projects towards the goal of reducing the cumulative effect of congestion from multiple projects I combining activities to reduce the work stone impacts. And the technology application side is the actual use of hardware in the field to improve the communication of data regarding work zone traffic impacts towards achieving goals such as Queue and speed management. Will be focusing on that today.

More about technology application. Is the use of ITS for dynamically managing work zones and what we are trying to get to with technology application is not just

communicating basic information to drivers, we want to take it to the different level and make sure that the information that is being developed is dynamic, based on real-time conditions on the road, and communicating actionable information to drivers. Of what we mean by actionable is it is information that a driver can use to change their behind -- behavior in response to a real time, what is happening in real time on the street.

I'm sorry, I just lost network connectivity.

I'm back on. Again, the idea of behind providing actionable information is that is -- it's more than saying there's roadwork ahead, we want to be able to tell drivers that traffic has stopped 2 miles ahead, there's a 15 minute delay on this route, and thereby communicate to the dryers that you need to do something in response to this information. That's what technology application is all about.

So the goals for the Smarter Work Zones initiative through this program and there's two goals, in the first is that by eight and there's two goals, in the first is that by 8 December 2016, 35 the state DOT swell have implemented the business processes for implementing work stone ITS as described in the work stone ITS implementation guide. The implementation guide as a resource of federal Highway has in its available online. It's downloadable. You can see it on the lower right-hand portion of your screen. It provides a six step process that you can walk through to implement work stone ITS. We will come back to that later.

This is the business process side. The back office processes that an agency needs to have in place in order to facilitate the actual implementation of work zone ITS an agency processes.

The second part of the technology application goal is using the system and implementing work zone ITS in 35 states by 2016. The first goal is having the business process goal in place and the second is 35 states actually implemented in the field. We are close to implementing both of those.

With that, I'm going to turn it over to Gerald Ullman. Wait we’re going to talk about Queue Warning Systems first.

Queue Warning Systems are one of the tools in the technology applications toolkit. It is geared towards alerting drivers regarding downstream reductions in speed and typically if you have a work stone with a capacity constraint, going to end up with some kind of backup. In the worst case, what you can see is accused of traffic forming and sometimes they get so long they go back past the initial warning signs. When that

happens you have a dangerous condition where cars are traveling it freeway speed and all of a sudden they are encountering the stopped skewered traffic or slowed queue of traffic with no warning whatsoever. It's obviously a dangerous situation particularly when large trucks are in the mix. They take longer reaction times and longer time to stop. The last thing you want is a car traveling it freeway speed or a truck traveling it freeway speed running into the back of a stopped queue. It is one of the more significant safety issues that agency space and try to mitigate regarding word zones -- work zones.

The components of a Queue Warning Systems, their separate parts to it, the first is some sort of sensor device to measure the speed of traffic on the approach to the work stone. You may have several sensor devices spaced back starting back at the capacity constraint where the Midshipman -- lane merges for example in ideally extending back to the limits of anticipated cues will be. So the system can pick up not only that there's a slowdown in traffic occurring but where that slowdown is happening. It can relay that information back upstream and it is important for a driver to know if the traffic is slowing down 3 miles ahead or if it's slowing down over the next hell. The more sensors you have out there, the more detail and better accuracy in conveying that information to drivers.

That information is conveyed typically by portable changeable message signs. The process of speed detection and traffic management, and agency might want to be monitoring was happening in the field so there may be cameras placed out there to make sure that the placement of the sensors is actually picking up the limits of the queue. Rumble strips have also been used as a supplement to driver awareness components and those can be placed upstream of the work stone and help get the drivers attention. Typically paired up with the location of the PCMS. That was used -- without I'm going to turn it over to Gerald Ullman. He will lead us off on the examples with the discussion of the I-35 example.

Thanks, Todd. Good afternoon good morning depending on where you are. Happy to be here to give you an overview of the key warning system planning design implementation and effectiveness on the I-35 project in central Texas. I'm sure most of you have heard about this activity that's been going on for several years now. It's fairly large commitment to rebuild, white and the last remaining section in taxes of I-35 that is not at least three lanes in each direction. This is around the Waco district and predominantly our world corridor. There are some cities like Waco, Temple, that are more urbanized but for the most part, it's a fairly world part of the state. There is a lot of traffic. Mostly large trucks and General passenger vehicle travel as well. Most of which is going through the corridors so there's starting at one end of this 96 miles in going to the other in one direction or the other. It's a pretty significant travel route

from that standpoint. As we've gotten under way with this effort were looking for ways to how we can maximize the benefit to the pop like during -- public during construction. There was ever to can VL a comprehensive system with a number items -- number of items you see here. What I want to talk to you today about is the one component that dealt with the real-time. As you go through this it's a good example of how the application of the framework of the work stone implementation guide provides a good step-by-step thinking through the issues and what you are trying to come -- accomplished. It has been successful in addressing the needs that we are seeing for the corridor.

The starting of the process itself is always making sure everyone understands what the needs are. Certainly will were talking work cells, were worried about the traveling public and the effect on travelers. As you can see, we mentioned the recognition that there is a lot of long-distance travelers traveling at high speeds. They are in their cars for a couple of hours or more at a time and they are acclimated to the high-speed moving along almost like highway hypnosis. You kind of get into a system in your attention span, unfortunately, that tends to Wayne a little bit when you're making long trips at the same speed and moving along in a world environment. We have established a restriction on laying closures on the main lanes because of the significant amount of traffic on there. It is important that any late closures would have to occur at night. That would do a lot to mitigate the potential for significant delays in congestion but there's still were locations within the core door that even working at night would most likely Institute or initiate some level of queuing. Not always a big queue, it might be a half-mile or so for an hour or so but it could occur. In some locations it would be more significant like several hours in duration and several miles long. Others it would not occur at all. The work in between the type of traveling you have, the fact that laying closures may or may not be creating cues on any given night, we now we had a situation where queues developed or resulted because of a link closure probably is probably going to be unexpected. It's not a recurrent thing that would happen night after night. At the same time, the other key user need that had to be considered in this initiative was that of the contractors and text. There was an aggressive contract schedule and they had proposed it in that manner and to make those aggressive milestones proposing lots of work going on simultaneously throughout the project limits like working in the median and outside on the frontage and working but -- between the freeway they were going to be every place during most of the projects. What this meant was the equipment -- the ability to put out this equipment was not going to be very feasible. The contractors would have to work around the delay or probably a possibility of moving stuff, and knocking it over because they were going to retain their aggressive scheduling. On top of that the recognition that the link closures, there would be quite a few that would occur in the core door but they were going to be at one location night after night. It was one

location in a project here and maybe another one for another week or so and maybe the other direction. And you multiply that across all the different projects that were in the corridor and you can quickly see that the link closure activity was distributed up and down the core door. As a result, placing a lot of equipment to try to capture all of that in a more stationary environment just was not going to be feasible. And adding to that it could create queues from the contractor TxDOT perspective other than a more permanent system was going to be needed. The concept of operations was why not try to deploy a something very portable. When this idea came about, I was aware of a couple vendors that had some equipment that could be deployed quickly and picked up equally quickly. And it would provide a fairly accurate and quick response and detects it -- detection of queues and subsequent notification of thank you presence upstream. So that was basically what was agreed upon and TxDOT said let's go ahead and use that type of approach. It would be put out where it was needed on the nice that it was needed where it was needed as part of traffic control. At the end of the night bring it out so it's not in the way and affecting any kind of activities. And then put it where it needs to be the next night. So from that concept to fork week -- for key questions popped up. If we do something like this house a going to work? There are four key items that had to be addressed. How are we going to know when and where laying closures would occur given that there were multiple contractors working in multiple locations in the corridor. We needed a way to keep track of find out a keep track of those in at the same time we needed a mechanism for when they were notified and the information about when and where they're going to be was obtained and then determine whether that would be a location where there is a chance that acute would form. We would need some protection so when they're planning to do the work there would be low probability of a queue forming. And that we would need that system. And then how do you configure the actual system itself? How many fences do you need? How far back was a spacing? What are the thresholds for activating? And then the fourth one that came up was recognizing that this is a world corridor or and people are very set in their driving mode and probably not paying attention. Are we going to make sure they see the messages and know that there is a queue ahead. That had to be worked out.

As far as notifying or identifying when a where laying closures occur, a system -- notification system was established. Some of the coding was borrowed from the Houston district TxDOT tran * operations had a module to keeping -- keeping track of incidents and laying closures as part of their day-to-day traffic management capabilities. We modified that a little bit it introduced that into the I-35 corridor as a way to track and identify precisely when, where, directions and those kinds of things of link closures.

As far as the assessment, we were a little bit fortunate in that the core door as I said earlier is fairly world and not a lot of feasible alternative routes. Ramp spacing as far apart. It operates in almost a -- a pipe analogy. We recognize that we could use a very simple input-output analysis to decide whether or not without a queue would form and then try to estimate in general terms how far away it would work. In an urban area where there were lots of alternatives and routes that approach would not have worked but it did for the I-35 corridor. This process integrated into the notification subsystem so that we some I can put in there was an -- a closure coming up. And that we can pull up with data was available wider it -- whether it was in ADT number or if it was a real-time traffic sensor nearby that could be used to access the real-time expected volume dated compared to capacity and generate an estimate of its a queue well occur and how far back.

Here's an example. The thing I would point you to was that in addition to a best guess analysis recognizing that volumes flexure way from night tonight, last Tuesday we think next Tuesday is a nice indicator and approximation of what we would expect for next Tuesday, but it probably will be a little bit different. We also factored demands up so that if we were awful little bit what might happen and then we can get a factor of safety in terms of we probably won't see a queue but if things are rough a little bit we might. If we do think we're going to have a queue, we think it's going to grow in the senses, maybe up to a mile, if were awful little bit it might be going as far as to when a half miles. So that gave everyone a little bit more information and being ready to deal with variations in what was expected.

After that, the third item as far as the configuration, perform simulation analyses as far as sensor spacing, center location, system update frequency, and the logistic thresholds for acute detection.

-- Queue detection.

It's a configuration like you see here of putting a sensor right at the link closure bottleneck location, the beginning of the merge is very critical because that is where we expect a queue to start. Even if we had a very brief one at least we would be -- have a high probability of detecting it. And that we would need another one to further verify and to check the potential of congestion. Once a queue got beyond that, increasing the spacing to about a mile apart. This was deemed satisfactory for performance purposes. Developing a logic, you probably can't read the logic there but that table shows this piece of sensors and what the appropriate traffic message would be on the warning message upstream. And also, we could determine one way to get people to wake up, if you will, and see the warning message and if it was active with the use of some rumble strips placed. One upstream of the sign in the other place

where it was expected the maximum length of queue would occur so that there would be auditory and vibratory alert in addition to the warning message there. There was a number of analyses and variation of links of the system. Ultimately we went with a simple plan and then a more extensive plan of the queues are extended longer than we would like them to be. And so the idea, this is often referred to as a plan one, basically something that will protect up to 3 1/2 miles of queuing and we try to keep it within 2 1/2. And then plan to would be at the maximum queue went beyond the 3 1/2 miles, that there would be a second message board with additional sensors and this would be something that would provide queue warning all the way up to a queue that my grow to 7 1/2 miles. Theoretically you could extend this in an incremental fashion even if you thought it would be a 13 mile queue. Just replicate and go backwards in that regard.

As far as a procurement, the next step in the assessment process, because it was going to be tied directly to contractor decisions on when and where they wanted to do laying closures, it made the most sense to tie it to the purchasing use of the contracts themselves. So they were deployed as an indirect procurement by the contractor through the construction contracts themselves. We did have a name initial plan that we were going to have the bids on a per night or per deployment basis and then we found out that the contractors were not comfortable and had not uses technology enough to be able to provide comparative bids and so that option was rolled back and we went with the deployment or bid mechanism of mobilization price for the equipment itself and then an eight per deployment price for the additional time for taking out and bringing back. The original once had to be change ordered him because a couple of contracts were already in place. They were included as regular bid items in the latter projects that were left. Not every contractor was asked to probe -- procure one as part of mobilizations. As we will indicate on the next slide, the same sub current -- subcontractor was on many projects. Each contractor would bid there deployment night costs and then depending on whether they asked for a system or not they would provide the mobilization costs. It's been ongoing since 2013. They would put out a more than 300 link closure nights to date. The results have been positive. We were able to look at the first 200 of them but at least on the first 200 nights, if you think about it less than one year’s worth of exposure that we've gotten with these, we are seeing crash reductions from what we would have expected if we did not have a system deployed and there's a methodology that we followed to do that but relative to what without would've happened to what actually did happen we did see between an 18% of 45% reduction in total crashes. The crashes that did occur were, as you can see in the graph, were less severe. And also, much fewer of them ended up being the rear end crash type. It does show that the systems are affecting driver behavior at least with the data we have so far and have a positive effect. We try to amateur rise the benefits for typical federal Highway comprehensive cat -- crash numbers to the data

on these nights and then turn it back around and normalize it to a per night benefit, if you well. We ended up with $6600 and $10,000 a night and crash cost savings, reduced crash cost values over the night so far. Has been very effective.

That's what I had to present. My contact information is right here. I we going to questions are moving on quite

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Were going to questions.

First I'm going to share a poll with everyone. Please take a moment to answer the polling question that is up on your screen. In the past year how many times did your agency seek use that it ended beyond the limits of the work some like before the first sign? Please select one answer.

Our first question to you, Jerry are one of the outputs of the delay queue length estimates. Is it calculated as time delay queue length.

We do both. And input-output analysis is simple. It's volume man and subtract our capacity out the differences. Number of stored vehicles that we apply very simple average link to get a queue length. We also have some very simple, based on linear speed flow model, that we can use to approximate what we think the delays will be for those queue links. They do not tend to be, were not close always but the decision to deploy queue warning is based mostly on the fact that we think there will be a queue and then the estimates of the length of the queue. That were closer to actually happens.

Thank you. Our next question is what type of detection device was used? How does the communicate? What was the power supply

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The systems are, there are two types of systems out there. They are both self-contained the Texans, radar-based detection systems that have battery and small microprocessors GPS location communication capabilities. They are communicating through that to a server, the speed data they detect they only to throwing objects beads are the that's what we're using for these systems. A slow speed indicating a queue was present at high speeds it not. And then the back-office systems that they sent the data to turn around and activate the portable message signs and put up the appropriate message based upon the logic put into the system.

Thank you. Next question is what training did you do it from with contractors to be able to have the traffic control subcontractors to deploy the tech knowledge he? Did they develop a specification for queue monitoring?

TxDOT did develop a special specification for queue monitoring . It was not a specific contractor training, the nice thing that worked out was a majority of the contractors use the one subcontractor who was very interested in the technology and willing to learn about it. So they went through some training with the system that the subcontractor chose to use. And that's where the training occurred. The contractors themselves but a different system and they also got some training by the vendor for the use of that system. So that's how it worked.

Next question is how effective are accurate was the system and detecting the Qs? Was this be that the sensors the tactic, what was the speed that the sensors detected?

No. The speeds that were detected, we used average speeds. Because of the way that the system, the concept of operations was envisioned and design, the Qs were detected, I don't know that we've got independent data, but comparing other data sources with those systems, I think 99% of the Qs that did occur were detected very quickly. And the thresholds of the average speeds the sensors were detecting anything below a 55 was enough to trigger a slow speed message and then as speeds drop of four and then as speeds drop of 440 per -- miles per hour the messages were switched to stop traffic message in the distance to the expected queue.

We have a two-part question. Were the contractor change orders as part of the enhance collaboration efforts were there contractor change orders as part of an enhance collaboration effort and how many full-time positions were there to maintain the processes?

To maintain the processes, that's an easy one, right now we have a mobility coordinator. Anyone who said in on the webinar last week or so one of the jobs that the mobility coordinators does is keeping track of all the link closures are that are occurring in making sure they get entered into this is some so that estimates can be made. So right now for multiple Krahn -- contracted the full-time position. Up -- with just wanted to project the probably wouldn't take a full time person. It's an automated system and then decisions are made whether the queue warning system will be used. And criminally above what gets done for traffic control on the link closures side of things I think it's minimal. The person we have is making sure the link closures are getting into the database. As far as a contractor change orders, the collaboration efforts, I think the contractors with the effort to start the whole process came about recognized the concern in risks of Reverend crashes in the Qs were very open to the idea of something that would reduce that risk. So when TxDOT talk to the contractors they said they were going to be some change orders in the contractors were very open

to it and did their best to get good bits then and something that TxDOT can be comfortable with an executed it that way.

What is the additional time it takes to set up the queue detection system in the field?

I wish I had folks that were doing that here. I think it's fairly minimal. I think it's within, they're pulling out of most cases a second portable changeable message sign and then putting out for simple sensors that are pretty much point and shoot and turn on. So maybe 15 minutes. Maybe a little longer. The rumble strips take a little more time because that's done as a moving operation. That is probably also a 20 minute activity to get those out each night as well.

The next question is what has TxDOT seen as an average bid for a uses the UWS on the deployment basis.

I knew you were going to ask that. I'm going to throw out some numbers that are approximate. If you want to spend the time to try to go through the TxDOT average bid price, you can probably find more accurate numbers. For the systems themselves, the mobilization costs for a system of two signs and eight sensors up to a large when when they procure those, they are in the $170,000 range for mobilization costs and then the per night deployments are within the $700-$900 per night additional cost.

How to the Queues estimates compare with what is observed in the field?

Overall, it's a function of how accurate the volume data that we have available. Some nights we are pretty accurate and some nights we will be off by 20% or 30%. That is why it's important for us to have, worst case scenario, just to get a range of what we think we would expect. So that is what varies. When we are close to a sensor, and the numbers on a given night are close to what we've seen in the past, we can do pretty well. But that is not always the case.

The taxes utilize law enforcement officers within the construction zones? If so, could the speeds measured be used for enforcement? Would you consider having law enforcement interaction with the length of queue detection?

Texas does use, the contractors do hire off-duty officers for the link closure operations to be a presence. Some of the contractors use them in different ways. The way that some of, at least one of the systems, they are more of a sampling thing. The ability to use them for enforcement purposes, has not been discussed. I probably would not encourage city there. I think there would be a lot of questions about doing so. I would hate to see the credibility and value that a queue warning system is having be

corroded because it's being used for enforcement purposes. I think you would need to look at a separate activity for something like that.

The last question is could this be done with*stated instead of sensors?

That's a good question. I think there are some folks across the country that are looked at that. That's a mixture of probe data was be data from probe vehicles. Depending on the corridor, and more importantly, that granularity of the data that's being procured would dictate whether or not you could use it for this purpose. The more granular you get, the more precise and responsive to Qs that you would be but that comes at a price. And that lower prices you get broader segments, if you well of average indirect -- index data and I do not think there is a yes or no answer there. I know that there has not been or I'm not aware of an example what -- where that has occurred yet. That would be the issue that I would be worried about most significantly. The responsiveness and you would have to get down to the detail in terms of granularity, segment leading -- lands and things like that.

We're going to move on to our next presenter. Ted Nemsky .

Thank you and good afternoon. I like to start out with a little background information on how we jumped back after we had a bad experience with their first try and 26. In 2006 we made our first attempt at using that near St. Louis and it failed miserably. Many due to sell technology constraints at the time. The message boards would take too long to update in the information we provided on that was virtually useless. At that time we vowed not to use it again because we got so many complaints. In July 2010, a seven vehicle multiple vitality crash occurred in a very rural section of Illinois. This accident occurred in the queue of one of our research and projects it evolved for tractor trailers. An unexpected queue can surprise drivers.

At that same time we were preparing plans for of rehabilitation project along a busy corridor of two lanes of I-55 between St. Louis and Chicago. It involve maintaining one lane of traffic and due to the extensive delays that we anticipated it required the contractor to work 24 seven. We also had to ongoing projects that involve significant link closure along that same core dork. -- Corridor door.

Are regional engineer provided us our design group with two directives. Do something to reduce the risk of having an accident which occurred on I-50 Do something to reduce the risk of having an accident which occurred on I-57 and come up with a way of informing travelers of delays and suggests alternate route. All of us were skipped the boat that skeptical given our previous experience and didn't know if

we can accomplish East directives. We did move forward investigating the use of one sense it was the only way we can see that we could meet those directives.

In our discussion and from our prior experience we realize we would need a system that could collect real-time data, automatically analyze the data, and a drivers with real-time delays, stopped traffic conditions and suggests alternate route options.

We did my research and interviewed several ITS smart work some vendors and develop a special provision that would allow at least two vendors to meet. Once the contract was led the system included coverage of the contract project limits but also included smart zone were coverage over the projects we had shown on the earlier slide. It did not make sense to spend the money to make one zone safe where to others word. It covered over 30 miles of interstate and utilize them in a three portable changeable message signs which is one every mile in each direction was several it additional at every traffic decision point. It included 56 stop a speed centers and included a 6 mile lead into the first project in each direction to cover the anticipated Queues.

Once I was set up and tested drivers were alerted wanted to miles upstream of any detected queue. Alternating stopped traffic ahead and be prepared to stop messages were displayed when traffic slowed below 40 miles an hour. We also provided anticipated delay times that approach to each works out in every traffic decision point.

The system also provided -- during the 2010 and 2011 seasons we had five major projects along the same core door.

During the 2010 season for these projects had active lane closures. We did not have a smart work phone in place during the season.

During the 2011 season, three of the project that the reactive link closures but we did have a smart work so and it was in place and operational during the entire construction season.

We don't often get a chance to compare the impact since it's rare to have a quarter of work spanning two years what with the one without a Smarter Work Zones system. But that's what we had here. We saw this as an opportunity to try to do an apples to apples comparison are as close as you can get. We pulled up all of our reported accident data for this corridor for these two calendar years of filtered out all but the rear end accident since these are the only types of accidents they cueing alerts us and has designed to help prevent.

And analyzing the data we developed a table. The first line basically shows we had the same number of miles with link closures each year from 2010 to 2011. The second line is the number of days for each project were link closures were in place. If we had to reactive projects, and each had a link closure, we counted it since you would have the potential for three Qs to develop it -- at different locations. The show that we had 52% more in 2011 in 2010. The third line in the table is a line that shows the total vehicle exposure and is the calculation of the ADT by the number of link closure days. The shows we had 25% more exposure in 2011 in 2010 property damage accidents were reduced by 14% in the injury accidents were reduced by 11%. We did not see any reduction in number of fatalities. Overall there was a reduction in cueing type by over 14%. If you analyze this data for vehicle exposure you would probably see an even greater reduction in the number of accidents.

From our experience we have learned that we need to first of all develop statewide special provisions that will allow for competition from all of our vendors. We need to establish guidelines for the utilization of these systems so we don't useful blown expensive systems when they're not necessary. You can use something more for a day-to-day type of operation. We also recognize that no system is perfect at this point. There is always some delay in communicating with motor rest. Until we get them in our cars, they will be real-time. And that based on our past projects we've seen that the cost of smart zone systems costs on the average 2.5% of our contract costs. And we do realize the benefit of reduction in cueing type accident when Smarter Work Zones to utilize. This past years we have utilize Smarter Work Zones on all of our interstate projects that of lasted more than a few months and we also use an on-call Smarter Work Zones contract to cover interstate project lasting lesson that time so we could use some where we thought we might need them. It was not on every interstate but if we saw that we needed them, we can call out and have them set one up.

That's pretty much it for experiences in Illinois. I'm going to turn it over to Chris Brookes to talk about Michigan's experiences.

Thank you, Ted. I'm going to go through and talk a little bit about a couple different projects done a Michigan and cover the evolution of the Smarter Work Zones in queue detection a Michigan. Our first project was in I-94 and Sargent Road. A busy section with a lot of freight traffic. And looking at the project we knew we were going to have multiple miles of delay. In doing that, in the design process, you can see that there was a lot of new ramps and interchanges. The MOT went down to only two weeks of actual closure. We really minimize the impact but still felt it was a large enough impact I have a queue detection system appear. In doing so, we had the detection system on here and have some lessons learned as you can see from the map. We wanted to make sure that we put the plans on the PCMS we can have traffic make an

actual decision and give the motorist the information so they can make some of their own decisions. We make sure that the PCMS was where it motorist could detour from the work based upon information that was given.

Some of the things we learn from this project. As you say we really had to PCMS boards there. I went out there looking for the board · okay I'll see what it looks like and drove through the project once and did not see the board. So I thought maybe I missed it and drove through it again and did not see the PCMS board again. So I called someone and set are you sure they put the boards up? I drove through again and finally side and what happened was the PCMS board was placed by a rest area on ramp were semi-trucks were coming on and I missed it. So from there we have learned to put the PCMS boards on both sides of the road because someone who was not looking -- was out looking for the boards we knew that other people were seeing them too. And one of the other things that came up was making sure you have a set list of messages for different scenarios. As you heard earlier, the different time frames, there can be a lot of times when free flow traffic will be on the corridor or and so what is the message or send it to the public? And that something that happened on this project. The project was about a year and a half long but we only needed the system for two weeks. That was not clearly defined in the contract documents so we ended up paying for the system for the entire project lands instead of just the two weeks that we needed it. Make sure you define than length of use for those systems during the contract process. If we want to add cameras for additional backup locations and see what traffic is behaving like, that is something that we have now changed. We have added rumble strips so that if you dismiss the board then you will feel that vibration. And we've looked at the system sending messages to our traffic engineer so that they would know and get a better idea to alert and look so we knew what was taking place.

From that project, we had another project which was is short-term project. This was a CPM project on I-94 and we were shutting the section down for a long weekend in deterring traffic. We did this on eastbound and westbound for two weekends. On the westbound we had a stop traffic advisory system put up there for the two separate weekends. Here's a screenshot and layout of the system itself. Traffic was being detour it up US 23. And then we had our PCMS boards space and locations on both sides of the roadway so traffic a D tour and it worked out great in regards to I-94 but as you can see, on US 12 Michigan Avenue, traffic was deterring there and then coming up Highway 23. We don't have any sensors on US 23. We had too many people D tour and then we had a seven car pileup on US 23 because people were not knowing about the queue. That was another big lesson that we learned. We have to make sure to account for where were sending our traffic too. So US 23 was more of a traffic issue the first weekend. We use the shorter-term system and not as robust was

sensors. It took us is in two hours to set up. There were nine sensors. And driving through, we did realize the traffic did slow down after reading the traffic stop message ahead. It does not do a good job of calming the traffic. The PCMS boards on both sides of the roadway are major benefit. We did see traffic behave much more accordingly with PCMS sensors on both sides .

So going to our latest project with we currently have out there is 5.6 miles of reconstruction on I-75. It is normally a three lane section. The MOT had it down to two lean -- lanes in each section. Multiple bridges, multiple upgrades, multiple changes. Some of the things that we did were determining the need. And how we determine if we did needed. As you can see, our crash data for the past 5 to 10 years is up there. We ran straight crashes are the top green line and has been our most predominate crash type in Michigan works owns. It's always something were concerned about and looking at. Historically when we looked at this project location, there was an average of seven crashes per month that were out there. And looking at some of the data in our predicted analysis, traffic would be able to be maintained with about a three minute delay. Not much of a queue if traffic was flowing smoothly. But what happened if there was a crash, special event or special construction interference it causes a slowdown in going from a three lane section down to a two lane section. We were expecting a crash frequency increase so we wanted to have it out there and that is when we looked at it we determine the system would not be needed every single day. It wouldn't always be on but when it was on own -- it could potentially save some lives. And that was our focus on this one. A good tool to use to help you determine if a system is warranted or worth it, is the ITS simplification guide. If you look at page 25 and 26 it allows you to think about some things and score your projects. This is something that's very useful to see if your project warrants that and give you a baseline skill to compare other projects to. It gives you a little bit of a comparison method.

Another lesson that we learned on this project was what happens between design and putting it out there? Once again this is one of those things that was talked about in the design phase and looked at as we don't really have a delay. When it came to a peer review team, we looked at it and said there probably is a need for sensors in the system out here. As you can see, the big thing was that we wanted try and motorcycles use the left lane instead of the right lane to help with merging traffic since it was down to two lanes with this being a heavily traveled truck corridor. We also wanted to make sure we had that message on there for the free flow so it was a useful message and a lot of the PCMS boards were not just sitting there not being utilized . This help with the flow of traffic through that's own. You can also see how we have the sensors spaced and how were covering both sides of road weighed. We made sure we had the

Lake of Highway 275 with the section on there's so we didn't have a faults sense of security with telling people not to slow down on that link at the freeway.

Going from the south to the north we had a system set up there too. One of the things we looked out with the message we were displaying on the last board. It says slow traffic half-mile I had to not giving a distance. Just watch for traffic backups. We just wanted people to slow down because it's a short time to react. We look to changing that one just to -- the threshold we use was 45 miles per hour to 15 miles to 15 miles per hour . 45 mile-per-hour speeds in our works owns were common and that is sometimes a free flow of speed. We did not want us -- to send a faults message.

We definitely want to plan your design phase. You want to know we are senses are, have an optimal message plan and have them at locations where there's diversion points. This is something you can standardize. This is something Michigan has been looking at the come with some standard plans but ultimately each project is different in the scale is what is needed can fluctuate by a traffic volumes and your locations. You also need to make sure that the people designing the messages in working with the system fully understand its capabilities and how it works and what messages can be sent on to the boards. So these messages were a decision that was made by knowing which sensors that can be sent to and knowing those board locations. One of the things that some of the others of talked about are the option of a statewide contract or on an as needed basis. That is something that Michigan has not done yet but feels like it's something were working towards a more probably test that a pilot due to the fact of if you have one person doing multiple projects, there's less of a learning curve. Jesses once the one subcontractor knows that information, and has it set up to do it, it's a lot easier to work with them and you can have a better project. How to handle the downtime in messages, do we always want that static message up there? Developing a statewide project is something that really does help so people know how long a message can stay on a message board. And then ultimate determine if the system was successful. On some of this project we had such a small exposure time the crash data that we did look at was such a small window what it was hard to tell with just a few weekends and weeks. Hopefully on this one on a longer-term project will have a better idea of what actually happened out there although we are comparing a three links section to a two lane section so we don't have the luxury of the apples to apples comparison but we should still be able to get a pretty good idea of how successful the system was out there.

With that, I'm going to turn it over to Todd Peterson to wrap up before we answer any questions. Take it away tide.

Thanks, Chris. The call, should we go ahead with the wrap up before questions?

Yes. Just go through the last couple slides in the will take the last two questions we have.

Okay. So in support of the Smarter Work Zones initiative we've set up a project worksite that highlights the Smarter Work Zones initiative and provide some links to useful information both the project coordination and technology applications slide of the initiative and it gets into a lot of detail. It also has the webinars including the information today, resources, documents, guidance and that sort of thing. It's a good one stop shop for all your information about what we're doing regarding Smarter Work Zones and guidance to help you as agencies in your implementation. The link is posted there and is on the work so safety worksite. It's there and available for everyone.

One of the foundational guides that we talked about already, on the technology applications side of things in the intelligent transportation side of things is the ITS implementation guide. It was published in 2014 and it has really been serving for a foundational document and guidance. We're trying to get our states together on how to implement works own ITS. It is not the six step process I mentioned earlier but the guide is designed to walk you through those steps that you can follow when considering what your needs are and whether ITS is a good solution for you in making sure that whatever systems you're looking to procure are going to accomplish the goals that you have set for the project. They provide some guidance on procurement design systems and implementing them and then suggests a continuous improvement process for evaluating the effectiveness of the systems. Did they accomplish the goals that they set out to in the beginning and you can use that information in improving implementation the next time around. It's a good soup to nuts discussion of the whole process. It works on an agency perspective and there's a lot of good guidance and there. If you doing Queue Warning Systems or any other application you should get a copy of this. You can download it here as part of the materials associated with this website. You can also get it on the clearinghouse. It's a great document.

We have a ton of other resources on here. Some ITS case studies where you're comparing your document to the implementation guide. Those are available online. You can download the presentation and Daniel have access to these links. Another resource we have specifically related to Queue Warning Systems is a publication developed that works on safety grounds which provides specific guidance on using Queue Warning Systems for Queue safety and that's available as a download here with this presentation.

With that, I think that covers our discussion of resources. There are a number of webinar coming up. Number five is a focus on budget coordination on November 2 and then another technology application case study where will look at variable speed limits and dynamic word late -- dynamic lane merges. On November 12. We also have some regional peer exchanges. We just completed the one on the minute -- Mid-America in Iowa and there were three remaining that we will cover in the next few months. If you're available to attend knows, it's a great opportunity to share your experiences with your peers and get some information about where the people are in this process.

The clearinghouse website is available for providing a good one stop shop online for a lot of guidance. If you're looking for something and you're not sure where to find it, check out the clearinghouse web light. You will probably find it in there.

Next up will be the questions and answers. Thank you for all your attendance and we will turn it back to Nicole for questions.

Thank you, Todd. Our first question is for Ted. Any consideration for when they communication to vehicles by way of Bluetooth? The display would be color, distance and speed.

I know it talking to the vendors, and tell they can get something where they can do it we won't be able to use it. I know they're looking at that right now but I don't know if any of the other presenters could speak on that but it might be worth asking.

I do have a little bit. I got an email from one of the guys to put together the function traveler information system on I-35 and because of the way Bluetooth connects, it won't ever is a two-way communication port is what he tells me.

What particular products/vendors reviews and what did you think of the performance? I believe this is directed to Ted.

I can answer for our section on I-55 and to other places in Illinois. We had two vendors mostly. From my experiences and tell you put the system up and actually test it, you put it up and it doesn't really go through its test until you get traffic backed up and you start to see where the messages are. They were pretty responsive and changing it will we did find problems. They would jump right on a change it. I now or district 9 was happy regarding icon because it could be set up quickly. I would say our overall experience thus far has been good.

I'm going to open the phone lines. If you'd like to ask a question, --. (Operator instructions)

You should before data for your current project, do you have any other data to share?

We don't have any official data. We're waiting for the year to end to gather some of that. Some of the anecdotal data I have is that they have seen, when there's been something out there, they have been seeing a reduction in secondary cash it -- crashes. They've also seen in May comments about how successful we are with getting the trucks over and to the left lanes with the multiple signs out there. That is something that they said. The multiple messages, they felt that there's a need to get over so a lot of trucks are driving in that lane which does make it easier for traffic to merge in that area.

Another question is why are you concerned about keeping motorcycles in the left lane?

The reason for this is with the configuration that we have out there, were leading up to on ramps and locations like that there are times where that right lane will have to transfers rumble strips so we wanted to make sure that the motorcycles were out of that area so they would not have to interact with the rumble strips and rough surfaces of the roadway. Without it would be safer for them to be in the left lane where there was a smoother path of travel. Spivak

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We don't have any questions at this point. We're waiting for people to type in their questions.

-- We are waiting for people to type in their questions.

(Operator instructions)

Could you please elaborate on how to get support from the law enforcement on the implementation of these devices?

Do any of our presenters want to tackle the question regarding the law enforcement support?

In Michigan we have the ability to pay for law enforcement in our work zones. It's something that making them aware and giving them and letting them know what the system is somewhat it saying out there. And law enforcement, with the traffic incident management things going on, the secondary crashes is a big thing and focusing on the

need for the reduction of the secondary crashes, maybe not the first initial crash, can help you get a buy in from law enforcement and have them out there. That would be my biggest way to get help and support in the buy-in from law enforcement is focusing on the secondary crush information.

And I'll just add, this is Todd, in addition to the obvious benefit of the Queue Warning Systems to help prevent the initial crashes or any subsequent secondary incidents resulting from work some congestion and getting the buy-in from the law enforcement community is that these systems are not providing any information that is designed to be enforceable. It is not saying speed limit is -- is not setting speed limits or anything like that. It's just advising traffic conditions downstream. The enforceability of the system is more an issue for variable speed limits and well-being getting into that on the next webinar. So that's the other side of it.

To vendors were mentioned. Are there other QWS vendors?

This is Ted. Those are the two we worked with an Illinois. I'm sure there are others. I don't know if one of the other speakers would like to let us know? Speed --

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Quote -- some of the others I'm aware of our ATS I, and Del cam. I have not worked with Del cam on a project. Our first one was at sea. The others we use were for Mac and icon as well.

Thank you. We've gone through other questions. I don't see any new ones. I think we will go ahead and close out. The recording will be available online in the next 2 to 3 weeks. I will send an email to everyone who is registered once it's available.

The next Smarter Work Zones webinar will be on Monday, November 2. The name is Smarter Work Zones program based project coordination. The registration link is at the top of those slide that is currently up. I will also send out an invitation in the next day or so for anyone who was on our distribution list. I'd like to thank our presenters and everyone for attending. Please enjoy the rest of your day.

This concludes today's conference call. You may now disconnect.
