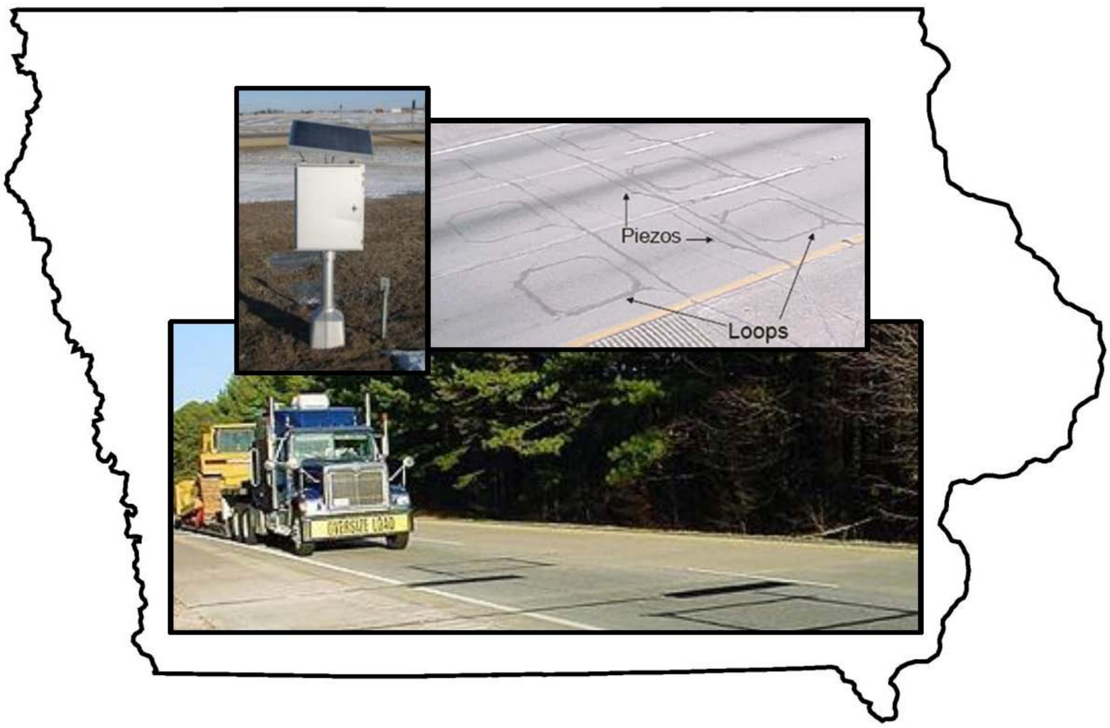
Telemetrics Guide



Last Updated: March 2014

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IOWA DOT
SMARTER | SIMPLER | CUSTOMER DRIVEN

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ACRONYMS

AASHTO − American Association of State Highway and Transportation Officials

AADT − Annual Average Daily Traffic

AADTT − Annual Average Daily Truck Traffic

ADR – Automatic Data Recorder

ASTM – American Society for Testing and Materials

ATR − Automatic Traffic Recorder

CCP – Continuous Count Program

CCS − Continuous Count Station

CFR – Code of Federal Regulations

CU – Combination Vehicle

DHV – Design Hour Volume

DOT – Department of Transportation

DOW – Day-of-Week

ESAL – Equivalent Single Axle Loadings

FHWA − Federal Highway Administration

GVW – Gross Vehicle Weight

HPMS − Highway Performance Monitoring System

IT – Information Technology

ITS – Intelligent Transportation System

IVR – Individual Vehicle Record

LEFs – Load Equivalency Factors

LTPP – Long-Term Pavement Performance

MADT − Monthly Average Daily Traffic

MEPDG – Mechanistic-Empirical Pavement Design Guide

MPO – Metropolitan Planning Organization

PHV – Peak Hour Volume

PPM – Policy and Procedures Manual

PV – Passenger Vehicle

ROW – Right of Way

SHRP – Strategic Highway Research Program

SU – Single-Unit Vehicle

TCS – Traffic Control System

TOD – Time-of-Day

TMG − Traffic Monitoring Guide

TMAS − Travel Monitoring Analysis System

TRADAS© − TRAffic **DA**ta **S**ystem

VMT − Vehicle Miles Traveled

WIM − Weigh-in-motion

GLOSSARY

Annual Average Daily Traffic (AADT) − the total volume of traffic passing a point or segment of a highway facility in both directions for one year divided by the number of days in the year (HCM 2000).

Annual Average Daily Truck Traffic (AADTT) − the total volume of truck traffic on a highway segment for one year, divided by the number of days in the year.

Automatic Traffic Recorder (ATR) – This is a traffic counter that is placed at specific locations to record the distribution and variation of traffic flow by hour of the day, day of the week, and/or month of the year. The ATR may be used to collect data continuously at a permanent site or at any location for shorter periods.

Axle – The axis oriented transversely to the nominal direction of vehicle motion, and extending the full width of the vehicle, about which the wheel(s) at both ends rotate (ASTM E1318).

Axle Load – The sum of all tire loads of the wheels on an axle; a portion of the gross vehicle weight (ASTM E1318).

Continuous Count Station (CCS) – A permanent counting site that provides 24 hours a day and 7 days a week of data for either all days of the year or at least for a seasonal collection.

Directional Distribution − The directional split of traffic during the peak or design hour, commonly expressed as percent in the peak and off-peak flow directions.

Factor – A number that represents a ratio of one number to another.

Gross Vehicle Weight (GVW) – the total weight of the vehicle or the vehicle combination including all connected components; also, the sum of the tire loads of all wheels on the vehicle (ASTM E1318).

Inductive loop – an electromagnetic communication or detection system which uses a moving magnet to induce an electrical current in a nearby wire. A use for inductive loops is as vehicle presence indicators.

Lane Occupancy – the ratio of the sum of the lengths of the vehicles to the length of the road section in which those vehicles are present.

Monthly Average Daily Traffic (MADT) – For a CCS site that operates 365 days per year without failure, the MADT can be computed by averaging each day of the week and then average the 7-days to get the monthly average.

Peak hour – Hour of the day with the most traffic, usually during morning and evening commute times.

Piezoelectric sensor − A device that uses the piezoelectric effect to measure pressure, acceleration, strain or force by converting them to an electrical charge. The prefix piezo is Greek for 'press' or 'squeeze'.

Seasonality Factor – Seasonal (or Monthly) factors are used to correct for seasonal bias in short duration counts.

Single Axle Load – the total load transmitted to the road surface by the tires of all wheels lying between two parallel transverse vertical planes 3.3 feet apart, extending across the full width of the vehicle; a portion of the gross-vehicle weight (ASTM E1318).

Speed – the average speed of all vehicles observed during a count session.

Telemetry – is the highly automated communications process by which measurements are made and other data collected at remote or inaccessible points and transmitted to receiving equipment for monitoring.

Traffic Count − A record of the number of vehicles, people aboard vehicles, or both, that pass a given checkpoint during a given time period.

Traffic Counter – Any device that collects vehicular characteristics data (such as volume, classification, speed, weight).

Travel Monitoring Analysis System (TMAS) – the FHWA provided online software used by States, MPO's and cities to submit data for Federal purposes.

Vehicle – Assembly of one or more units coupled for travel on a highway; vehicles include one powered unit and may include one or more unpowered full-trailer, or semi-trailer units.

Vehicle Classification – The FHWA vehicle typology separates vehicles into categories, or classes, depending on whether they carry passengers or commodities. There are 13 vehicle classes identified by FHWA.

Vehicle Length – Overall length of a vehicle measured from the front bumper to the rear bumper.

Vehicle Miles Traveled (VMT) – A unit to measure vehicle travel made by a private vehicle, such as an automobile, van, pickup truck, or motorcycle. Each mile traveled is counted as one vehicle mile regardless of the number of persons in the vehicle.

Volume – the number of vehicles observed during a count session.

Weigh-in-motion (WIM) – A device with the type of technology that is capable of recording the weight of a moving vehicle.

Weight – the vehicle weight per axle per axle spacing.

PART 1 – INTRODUCTION

Chapter 1 − General

The purpose of this guide is to describe the Iowa DOT's Permanent Continuous Count Program (CCP) and provide documentation of the process.

The Federal Highway Administration (FHWA) requires every state to submit a Highway Performance Monitoring System (HPMS) report annually that contains roadway characteristics and traffic data per the United States Code of Federal Regulations (CFR) title 23, 420.105(b). This information is used in determining the funding for state highway projects. The Iowa Department of Transportation's (Iowa DOT) Traffic Monitoring Program supports the HPMS and internal offices such as Highway Design, Operations, Planning, Construction, and Right of Way (ROW).

The Iowa DOT maintains a traffic monitoring program consisting of both continuous and short-term traffic counts. Both types of counts are conducted by the Iowa DOT in accordance with the FHWA's Traffic Monitoring Guide (TMG) and the American Association of State Highway and Transportation Officials (AASHTO) Guidelines for Traffic Data Programs.

The Telemetrics team is responsible for administering the CCP. The program is extremely important and is the base of the Iowa DOT's Traffic Monitoring System. The program includes all traffic data collection sites (continuous count stations (CCS), long-term pavement performance (LTPP), weigh-in-motion (WIM) and StopWatch+) on the interstate and primary systems. The Telemetrics team is responsible for the installation, upgrade, repair, and maintenance of all the data collection hardware and for the collection, processing, analysis, summarization and reporting of traffic count data.

The major reports resulting from the Continuous Count Program are:

- Vehicle Miles Traveled
- Iowa Automatic Traffic Recorder Report
- Rural Interstate Speed Information
- ATR Location Map

All major reports are available on the Iowa DOT website: http://www.iowadotmaps.com

Note: In the past, the equipment and sites where referred to as "ATR" (Automatic Traffic Recorder) but to distinguish the unit from the site the Traffic Monitoring Guide (TMG) has started an effort to encourage the community to refer to the sites as Continuous Count Stations (CCS). For the remainder of this document all sites will be referred to as Continuous Count Stations or CCS except where it references an existing document that uses Automatic Traffic Recorder or ATR.

PART 2 – IOWA DOT'S PERMANENT CONTINUOUS COUNT STATIONS

Chapter 2 − Permanent Sites

The Continuous Count Station (CCS) system collects continuous vehicle-type classification data, which is a fundamental component of the Traffic Monitoring System.

2.1. CCS Devices

The CCS traffic counters are permanent devices that continuously and automatically collect various traffic data (e.g., volume, speed, vehicle length, and three length-based classifications (1'-21', 22'-39', 40'+) by direction and lane and retrieved throughout the year. They are designed to continuously record the distribution and variation of traffic flow in distinct time periods (e.g., by 5 min., 15 min., hour of the day, day of the week, and month of the year from year to year).

The Iowa DOT uses two different types of CCS sensor devices: non-intrusive devices that are placed at the edge of the roadway, and embedded devices that are placed in or under the pavement in each travel lane perpendicular to the direction of travel. Currently, the Iowa DOT uses three types of permanent CCS devices:

- SmartSensor HD from Wavetronix LLC is the Iowa DOT's newest non-intrusive automatic traffic counting sensor device (see Figure 2.1). The devices are positioned at the edge of the roadway and mounted on poles (See Figure 2.2).

Figure 2.1: SmartSensor HD Device

Figure 2.2: SmartSensor Radar Unit

The SmartSensor HD uses radar technology (see Figure 2.3) to collect volume, speed, and three classifications based on vehicle length:

1 - Passenger Vehicle (PV)

2 - Single Unit Vehicle (SU)

3 - Combination Vehicle (CU)

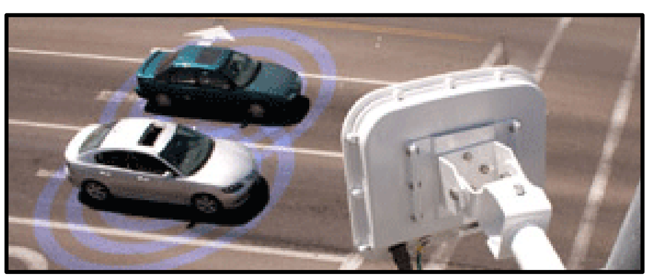


Figure 2.3: SmartSensor Radar Technology

- Inductive loops are the most commonly used in-pavement sensor detector in current practice. They are embedded in the pavement (see Figure 2.4) and use a combination of resistance, inductance and capacitance to collect data. A single inductive loop collects volume only and multiple inductive loops collect volume, speed and three classifications based on vehicle length.

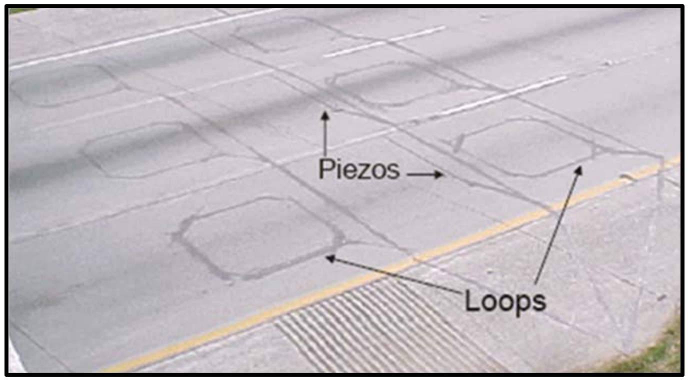


Figure 2.4: Embedded Loop and Piezo Sensors

An inductive loop detector system consists of three components: a loop (saw-cut), loop extension wire and a detector. See Figure 2.5 below for the basic diagram of an inductive loop detection system.

The inductive loop is buried in a saw-cut channel in the traffic lane. The loop is a continuous run of wire that enters and exits from the same point. The two ends of the loop wire are connected to the loop extension cable at the curb line, which connects to the detector that is located in a cabinet adjacent to the roadway.

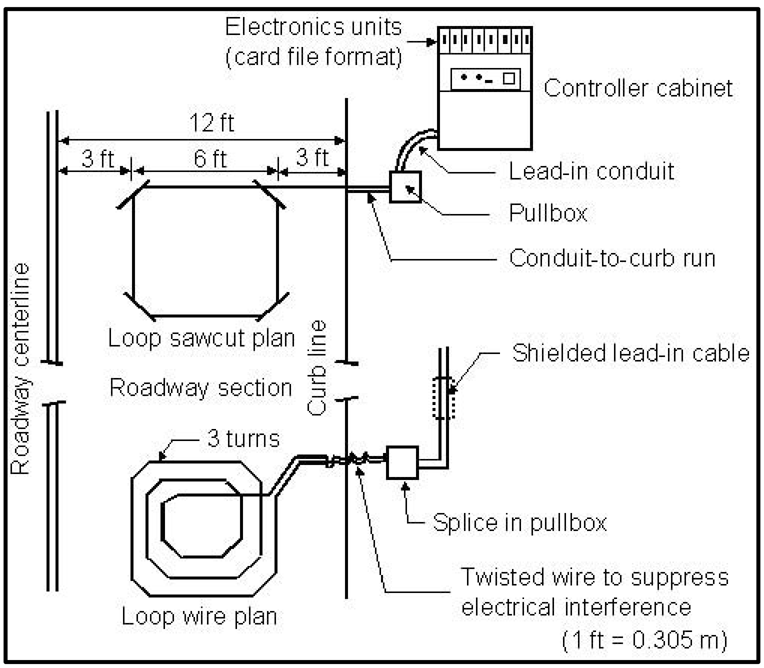


Figure 2.5: Schematic of an Inductive Loop Sensor

How it Works:

The detector powers the loop causing a magnetic field in the loop area. The loop resonates at a constant frequency that the detector monitors. When a vehicle moves over the loop, the frequency increases. This increase in frequency is sensed and converted into a signal.

- A Piezo Class 2 non-WIM sensor from Measurement Specialties, Inc. is an axle detection sensor that is embedded in the pavement (see Figure 2.4).

  A piezo sensor is a device that utilizes the piezoelectric system (see Figure 2.6) to measure changes in pressure, compression, acceleration, impact or vibration using piezoelectricity (a phenomenon in which materials generate a voltage when deformed) by converting the electrical charge into a signal.

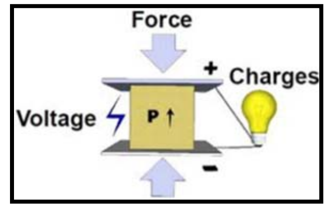


Figure 2.6: Piezoelectric System

  Piezo sensors are typically used in conjunction with inductive loops in either a piezo-loop-piezo (PLP) or a loop-piezo-loop (LPL) configuration (see Figure 2.4).

  - In a PLP configuration the piezo sensors count axles, axle spacings and vehicle class based on timing between the upstream and downstream piezo. The inductive loop is used to determine the length of the vehicle, volume and speed.
  - In a LPL configuration the upstream loop is used to detect vehicles (volume) and alert the system of an approaching vehicle. The downstream loop is used to determine speed, length and axle spacings based on timing. The piezo sensor measures the axles as the vehicle crosses it and provides classification counts.

  In combination, the Piezo sensor and inductive loops will collect volume, speed, 13-classifications (See Figure 2.7) and three length-based classifications (i.e., 1’- 21’, 22’- 40’, 41’ and greater).

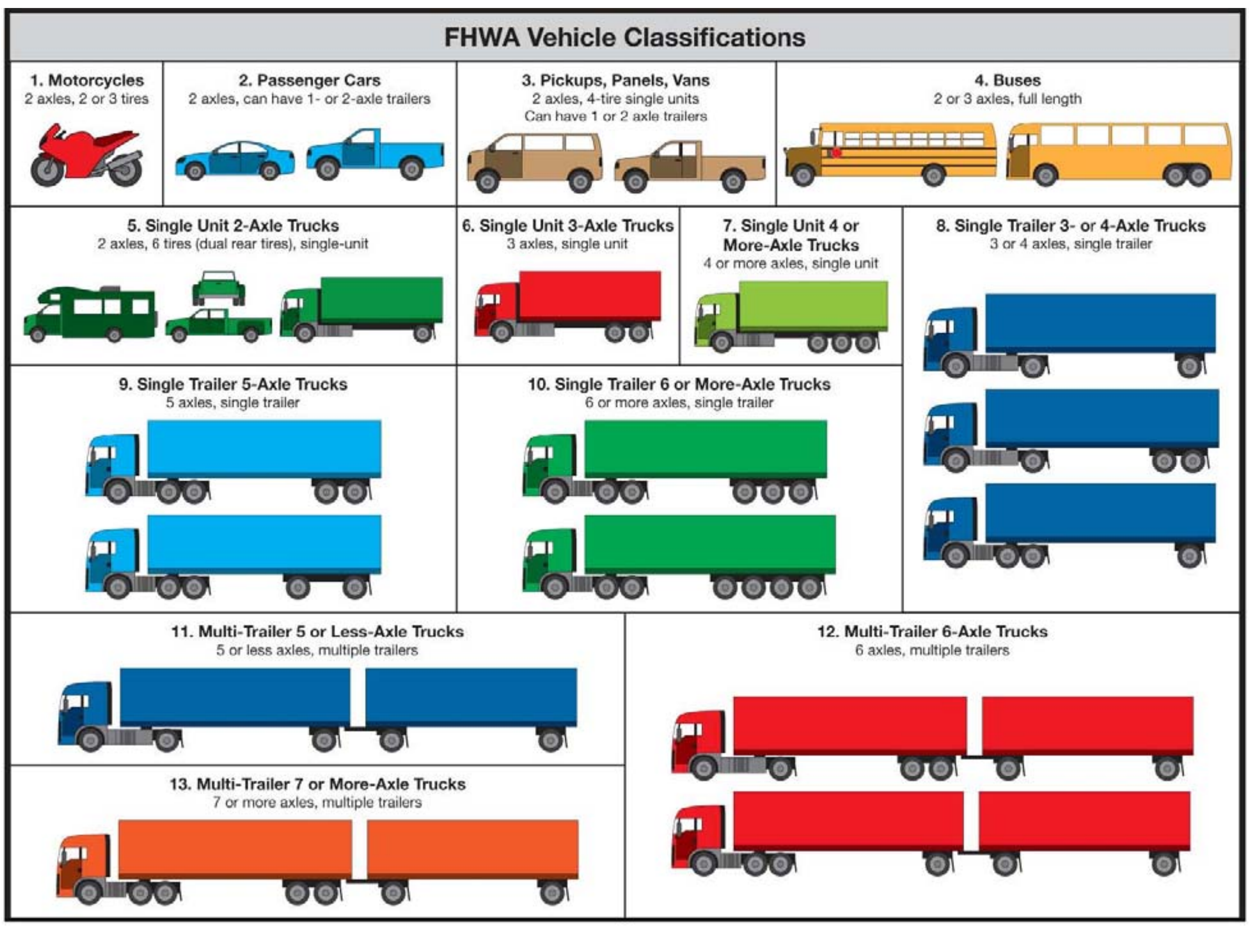


Figure 2.7: FHWA Vehicle Classifications chart

The sensors transmit to an Automatic Data Recorder (ADR) that is located in a cabinet adjacent to the roadway. Currently, the Iowa DOT uses the ADR-2000 counter/classifier unit by Peek Traffic Corporation (see Figure 2.8). The counter/classifier is the industry standard for field-hardened, reliable and easily adapted traffic counters. The ADR-2000 includes vehicle detection sensor inputs, data storage modules, and sensor modules that can be custom programmed to collect a large variety of traffic counting and classification data.

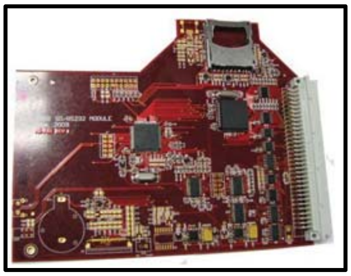


Figure 2.8: ADR-2000 Module

The ADR cabinet adjacent to the roadway also contains the surge protection, power supply, and wireless communication device (see Figure 2.9).

Figure 2.9: ADR Cabinet

The Iowa DOT has maintained CCS locations in varying amounts since 1935. Currently, the Iowa DOT's statewide Continuous Count Program (CCP) consists of 174 active devices. All stations produce vehicle volume data; however, some CCS collect additional types of data depending upon their equipment and sensors. The system continues to expand at the rate of approximately two new sites per year on average. The distributions of active devices by functional class within Iowa are detailed in Table 2.1 and shown in Figure 2.10.

Table 2.1: Iowa's Permanent Continuous Automatic Traffic Recorder Locations

Functional Class	CCS	Volume, Speed & Vehicle Classes 1-13 (LPL or PLP)	Volume, Speed & Vehicle Classes 1-3 (Loop-Loop or Radar)	Volume Only (Loop)
Rural Interstate system	20	10	10	0
Municipal Interstate system	11	4	3	4
Rural Primary system	78	42	35	1
Municipal Primary system	25	4	11	10
Rural Secondary system	26	7	7	12
Municipal Street system	14	4	2	8
Total	174	71	68	35

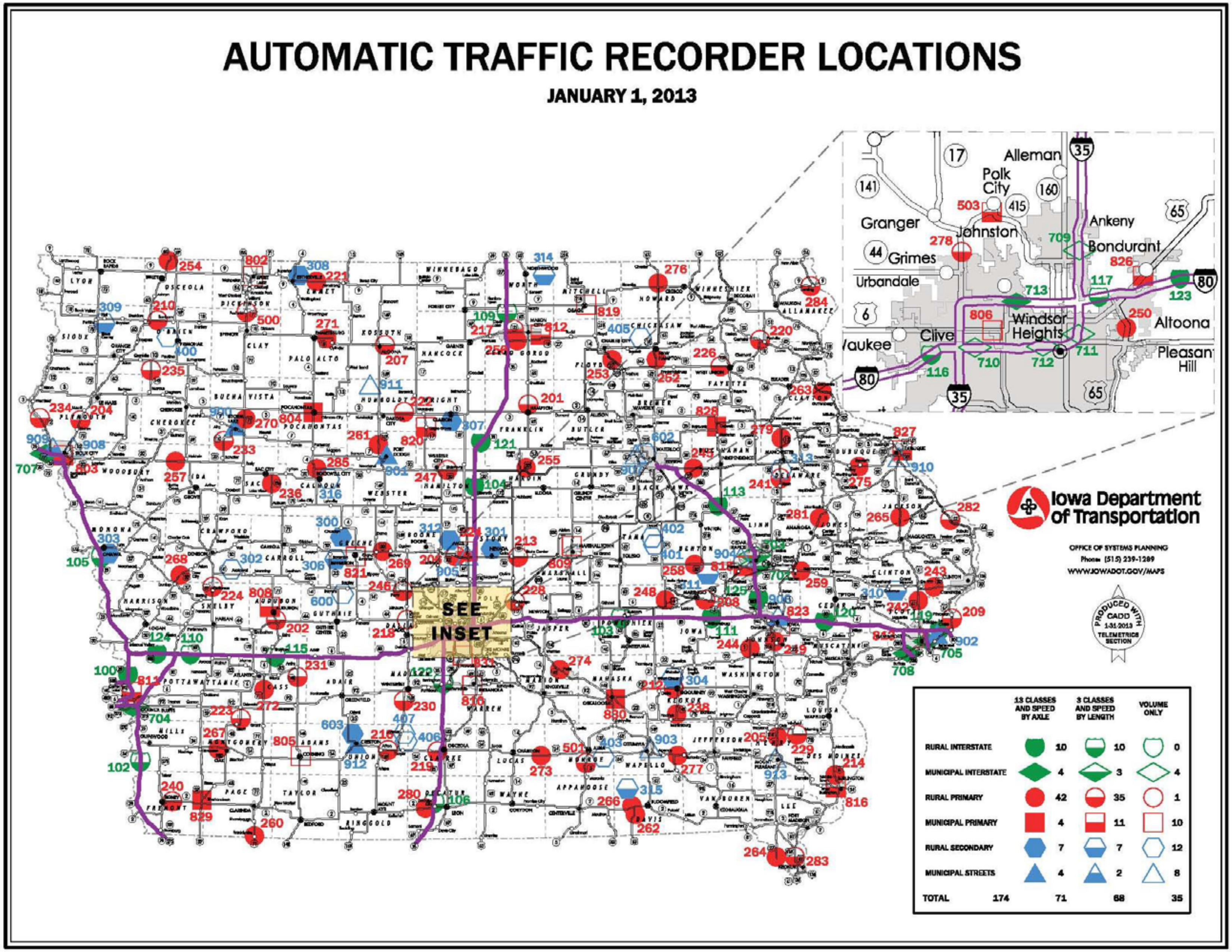


Figure 2.10: Automatic Traffic Recorder Locations (January 1, 2013)

2.2. CCS Site Selection

The Iowa DOT has used CCS devices for many years to monitor traffic at specific locations around the state. They are located throughout the State for a variety of reasons. In many cases, CCS locations are selected to measure specific trends. This is often the case where it is important to monitor a given traffic movement with a high degree of accuracy or where a specific location provides an accurate measure of traffic activity.

Some CCS sites exist because the State has historically monitored trends at specific locations. The reasons these locations were initially selected may or may not be currently known. The fact that a long history of data exists at these locations provides a reason for continuing to collect data. The long-term trend information is valuable in its own right.

Many other CCS locations are selected semi-randomly, as part of an effort to monitor general travel trends within specific categories of roads.

The selection of new CCS sites should be based on the needs of the data collection program. Some data collection needs to consider include:

- The need to collect data in regions that are poorly represented;
- The need to collect data on specific facilities of high importance (e.g., interstate highways or other national highway system routes) or
- The need to collect data for research projects or other special needs.

2.3. CCS Data

CCS traffic data plays a significant role in all roadway related operational, maintenance and planning systems. The data is used to assess transportation needs and system performance as well as to develop planning and programming recommendations. It is important in the design of highway projects and in the analysis of land use planning impacts and economic development.

The Iowa DOT's permanent CCP collects data 24 hours per day, 365 days per year if possible. However, there are situations that prevent data from being collected continuously such as lane or road closures, construction, communication interruptions, hardware malfunctions, wear of loops or piezos, or inclement weather.

The program monitors four types of data that is collected by direction, lane, date and real time of passage:

- Volume - the number of vehicles observed during a count session.
- Classification - vehicles grouped by axle configuration into the 13 Federal vehicle classifications.
- Speed - the average speed of all vehicles observed during a count session.
- Weight – the vehicle weight per axle per axle spacing.

Data from the permanent counters is used for:

1) Converting/factoring/seasonally adjusting short term counts to estimate Annual Average Daily Traffic (AADT) volumes;
2) Providing generalized Peak Hour Volume (PHV) and Design Hour Volume (DHV) factors;
3) Monitoring monthly and annual traffic trends;
4) Providing input to traffic management and traveler information systems;
5) Providing long-term growth factors; and
6) Understanding time-of-day (TOD), day-of-week (DOW) and seasonal travel patterns.

CCS data generates millions of records. All the information is easily accessible and is used to answer questions such as:

- How does day of the week travel compare?
- What time and day do the highest traffic volumes occur?
- What is the hourly relationship for accident studies?
- What are the travel patterns on holidays?
- What are the changes in travel caused by fuel shortages, fuel prices, recessions, and other major socioeconomic changes?
- What are the relationships of vehicle types within various time relationships (e.g., daily, weekly, vs. weekend, annual)?

The data is collected, processed and distributed by the methods outlined in the following sections.

2.4. CCS Collection

The Iowa DOT collects data daily via telemetry. Telemetry is the process of measuring data at the source and transmitting it automatically. See Figure 2.11 for a schematic of the Telemetry process.

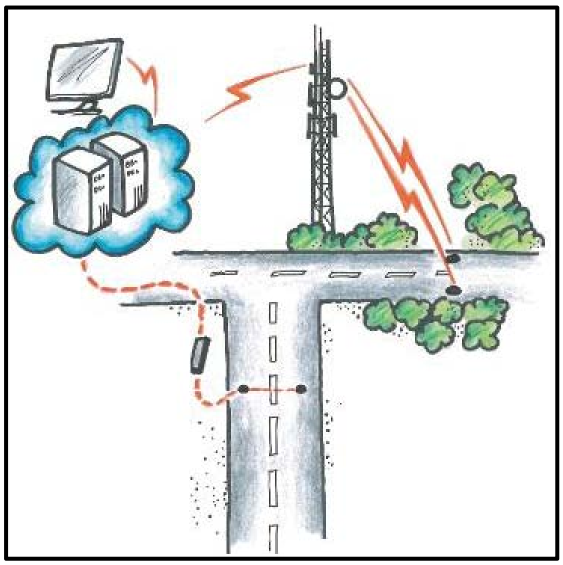


Figure 2.11: Telemetry Process

Data collection is polled daily in two ways, manual polling and auto polling. The Iowa DOT uses three data collection software products for the polling process:

- SmartSensor™ Manager is the manual polling platform for Wavetronix. It is used to monitor, configure, collect, and store traffic data.

- TOPS (Traffic, Operations & Planning Software) by Peek Traffic Corporation is the manual polling data processing tool. Its main role is to allow a central computer to retrieve data files from the on-site software unit (ADR-2000). After retrieval, TOPS allows an operator to archive, report on, export, and further process the data.

- While TOPS is the manual polling platform for generating reports, VIPER™ is the auto-polling platform. The VIPER™ (Vehicular Information Processing, Export and Reporting) software package by Peek Traffic Corporation is a central data collection and processing tool that helps process and manage data generated by advanced traffic counters. Viper™ is designed to automate data retrieval, automatically process data to common data formats, support modern communication protocols, and archive data per user definitions without additional user interaction.

Each permanent site is polled and downloaded daily. Each morning, Iowa DOT staff checks the data for any obvious problems. The most basic checks include the following:

- Are the communications working?
- Is the counter collecting data?
- Are both the date and time correct?
- Has the counter been collecting data continuously since the previous polling?
- Is there any file corruption, and if so did it come from the transfer or the counter memory?
- Are all lanes accounted for?

When problems in the polling of traffic data are detected, the Iowa DOT's Communications staff is notified and will evaluate the equipment's operation and make the necessary repairs. See Figure 2.12 for an example of equipment that is not operating correctly.

Once the traffic data has been checked and considered good, it is entered into the TRADAS© software for further processing.

Figure 2.12: Equipment Problem

2.5. CCS Processing

CCS data processing is performed by TRADAS© (TRAffic DAta System) from Chaparral Systems Corporation. TRADAS© is a traffic data collection and analysis program used for managing traffic count data. The program provides traffic data collection, three levels of quality control (device, channel, and count), data summarization, standard and ad hoc reporting, and database management. TRADAS© is designed to meet the data processing requirements of AASHTO's Guidelines for Traffic Data Programs and incorporates the recommendations of the Federal Highway Administration's (FHWA's) Traffic Monitoring Guide (TMG).

TRADAS© is the primary software used by the Iowa DOT to create all traffic count reports and records. It is also used to generate special reports that are requested by internal staff and external customers (e.g., engineering consultants, educational research facilities, metropolitan planning organizations (MPOs) and other government agencies).

TRADAS© automatically detects CCS devices and processes, analyzes, validates and generates all continuous traffic data for volume, speed, classification, and weight. Each data file is then summarized and processed through a series of quality checks based on AASHTO, FHWA and user defined standards before being loaded into an Oracle database. See Figure 2.13 for an example of a TRADAS© length report.

Iowa Department of Transportation

Daily Length Distribution for 02/04/2014 through 02/04/2014

Site Names: 503
County: Polk
Funct. Class: Rural Minor Arterial
Location: IA 415 0.5 MI W OF NW POLK CITY RD POLK CITY

	Roadway	Neg DIR	Pos DIR
0-23	4,399	2,249	2,150
23-41	104	49	55
42-217	38	18	20
Total	4,541	2,316	2,225

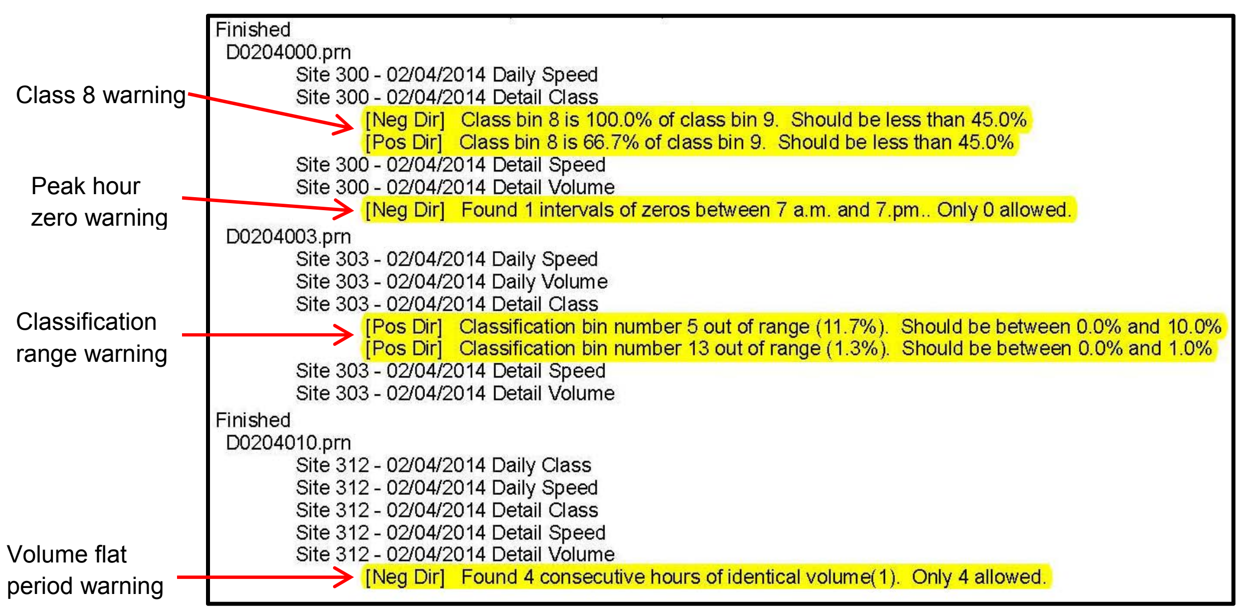
Figure 2.13: TRADAS© Example

CCS Quality Control Data Checks

The following are typical data checks to be performed when reviewing and editing traffic data:

- Checking that all lanes and directions for each station are processed, edited and submitted at the same time.
- Checking that counts contain distinct AM and PM peaks that can be easily verified graphically.
- Peak hour zero search – checking that there are no hourly intervals with zero vehicles during the AM peak (6:00 to 9:00) and the PM peak (3:00 to 7:00) periods.
- Consecutive zero period check – looking for time ranges where a lane has more consecutive zero hours than the established thresholds set in the polling software.
- Volume range check – looking for volumes that are outside the minimum and maximum threshold ranges as set in the polling software.
- Midnight/noon comparison – comparing midnight and noon volumes to confirm the noon value is greater than the midnight value.
- Volume flat period check – looking for ‘flat’ periods of no change in volume, a site is flagged if more than 4 consecutive hours have the same value.
- Volume directional split check – Comparing directional volumes to identify an excessively high volume in one direction and an unusually low volume in the opposite direction. The current polling software uses a 2:1 ratio (66% / 33% split) as a default.
- Volume percent range – looking for periods that deviate by 50% or more from the hourly average.
- Classification range check – looking for classification bins that are out of range. A site is flagged if it falls outside the established thresholds set in the polling software.
- Class 8 check – looking for too many class 8 vehicles in relation to class 9 vehicles. Currently, the default maximum is 45 % class 8’s to class 9’s.

Locations that fall outside the established ranges are flagged with warnings. They are displayed in a text document that is sorted by site, date and direction. See Figure 2.14 for an example of locations that have been flagged with warnings.



Finished
D0204000.prn
Site 300 - 02/04/2014 Daily Speed
Site 300 - 02/04/2014 Detail Class
[Neg Dir] Class bin 8 is 100.0% of class bin 9. Should be less than 45.0%
[Pos Dir] Class bin 8 is 66.7% of class bin 9. Should be less than 45.0%
Site 300 - 02/04/2014 Detail Speed
Site 300 - 02/04/2014 Detail Volume
[Neg Dir] Found 1 intervals of zeros between 7 a.m. and 7.pm.. Only 0 allowed.
D0204003.prn
Site 303 - 02/04/2014 Daily Speed
Site 303 - 02/04/2014 Daily Volume
Site 303 - 02/04/2014 Detail Class
[Pos Dir] Classification bin number 5 out of range (11.7%). Should be between 0.0% and 10.0%
[Pos Dir] Classification bin number 13 out of range (1.3%). Should be between 0.0% and 1.0%
Site 303 - 02/04/2014 Detail Speed
Site 303 - 02/04/2014 Detail Volume
Finished
D0204010.prn
Site 312 - 02/04/2014 Daily Class
Site 312 - 02/04/2014 Daily Speed
Site 312 - 02/04/2014 Detail Class
Site 312 - 02/04/2014 Detail Speed
Site 312 - 02/04/2014 Detail Volume
[Neg Dir] Found 4 consecutive hours of identical volume(1). Only 4 allowed.

Figure 2.14: TRADAS© warnings

If the checks reveal data that is suspect, further investigation must be conducted to determine if the data is faulty and what course of action to take (e.g., deletion of a bad interval, repair of faulty equipment or discard the entire count).

2.6. CCS Factors

One of the primary uses of CCS data is to calculate factors, which are used to adjust short-term counts to reflect annual traffic conditions. Another reason is to develop statewide annual growth factors and annual average daily truck traffic (AADTT) factors.

TRADAS© summarizes CCS data and generates factors that include seasonal, DOW, axle correction, growth (K & D), and monthly adjustment volume and truck factors.

2.7. CCS Distribution

After the data is checked for quality and processed, Iowa DOT staff uses the data to provide on-demand statistics and generate monthly, quarterly, mid-year and yearly reports. TRADAS© reports are generated through the RoadRunner interface. Monthly and yearly reports are produced and published on the DOT Website as read-only files. Only data that passes rigid validity and quality checks are used in developing the published reports.

All CCS reports can be accessed on the DOT Website at: http://www.iowadotmaps.com/

2.8. CCS Process

The Iowa DOT has a yearly process for collecting CCS data. The major milestones are shown in Figure 2.15 and have been described below.

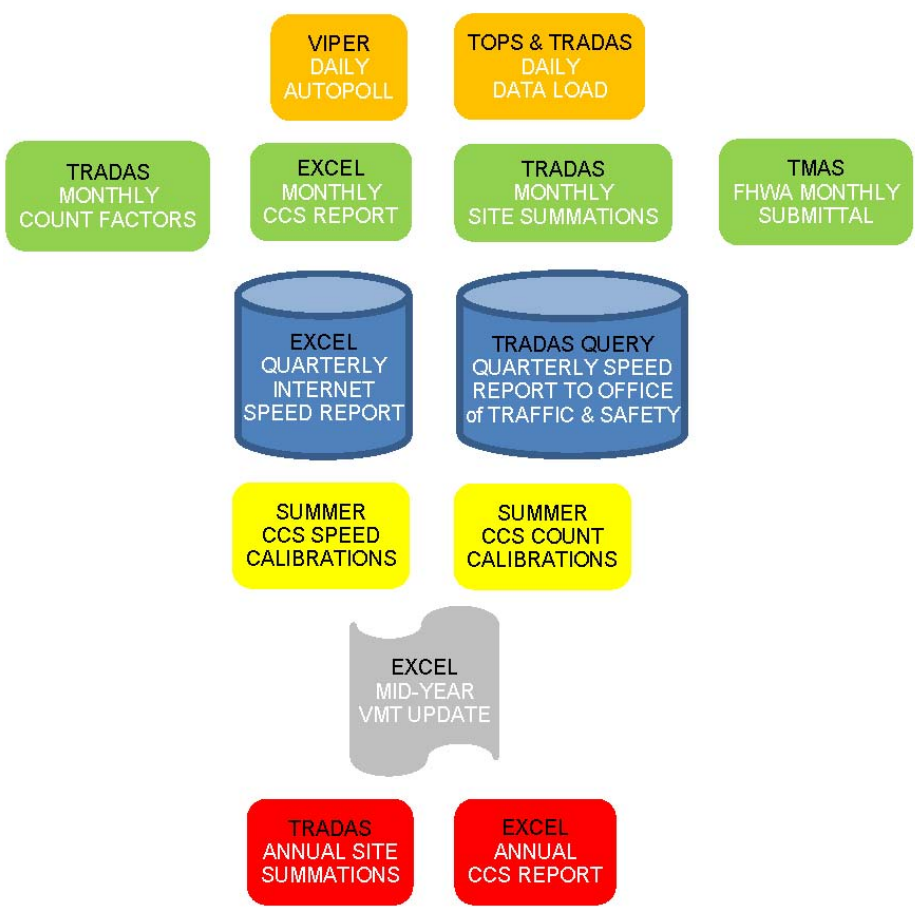


Figure 2.15: Yearly Continuous Count Station (CCS) Process

Daily Auto Polling

Volume, speed, and classification raw data is loaded daily from the CCS unit in the field onto the DOT server.

Daily Data Loading

Once in TRADAS© the data is converted to an accepted format for use in developing traffic patterns such as day of the week and seasonality.

Monthly Count Factors

Monthly count factors are used to correct for month of year bias in short duration counts. Data collected from CCS are loaded daily into TRADAS© and converted into count factors. Typical count factors generated will include:

- Hourly
- Daily
- Seasonal
- Seasonal Truck
- Daily Truck
- Hourly Truck
- Axle Correction

Monthly CCS Report

The monthly reports provide a general overview of traffic volume trends on different road classifications and a summary of the average daily traffic recorded at each of the CCS sites. The report is published each calendar month and can be accessed on the Iowa DOT's internet and intranet site.

The monthly report is available on the Iowa DOT website: http://www.iowadotmaps.com

The ATR Monthly Report includes the following items:

- Traffic Volume Variations
- ATR Map – See Figure 2.10 for the most recent ATR map, which is updated in December of each year. The map illustrates the location and capabilities of each location.
- Graphs
  - Monthly Traffic Variations
  - Cumulative monthly Traffic Variations
- Comparison of Estimated Vehicle Miles Traveled (VMT) By System
- Estimated VMT (current year)
- Comparison of the Monthly Average Daily Traffic (MADT) for each month at each location comparing current year to previous year.

Monthly Site Summations

In accordance with the FHWA's TMG guidelines, the daily data loaded into TRADAS© is summarized into monthly averages for volume, speed, and classification studies. The information is used in the monthly ATR reports, to generate monthly ADT's, to develop travel trends and determine capacity analysis.

FHWA Monthly Submittal

Each month the Iowa DOT reports the traffic data collected by the permanent CCS to the FHWA as part of the Highway Performance Monitoring System (HPMS). The HPMS is a national highway transportation database and analytical simulation system that collects data on the extent, condition, performance, traffic and operating characteristics of the Nation's highways. The data collected supports local, state, and federal transportation officials in adequately planning and administering safe and efficient transportation systems. In addition, the HPMS serves as a primary component for determining the federal transportation funding apportionment allocated to states.

The TRADAS© system is used to generate all of the traffic data required to be reported to FHWA as detailed in the TMG. The data is loaded through the Travel Monitoring Analysis System (TMAS) on the FHWA website.

Quarterly Speed Submittal

Each quarter the Iowa DOT reports the speed data collected to the Office of Traffic & Safety as part of the Speed Monitoring Program. The purpose of the program is to provide reliable data to be used in highway design, speed trend analyses, and collision analysis. See Figure 2.16 for an example of the quarterly speed report.

Each quarter represents intervals of the previous three months:

First Qtr. – January submittal is for months October, November and December

Second Qtr. - April submittal is for months January, February and March

Third Qtr. - July submittal is for months April, May and June

Fourth Qtr. - October submittal is for months July, August and September

Federal Quarterly Speed Report for Iowa

Federal Fiscal Period:	3rd	Qtr	2013
Calendar Period:	2nd	Qtr	2013
State Fiscal Period.	4th	Qtr	2013

	State Location Number		Vehicle speed										
			40 mph and below	41-45 mph	46-50 mph	45-55 mph	56-60 mph	61-65 mph	66-70 mph	71-75 mph	76-80 mph	81-85 mph	86 mph and above
SPEED LIMIT 55	3	Vehicle count	32	131	674	4367	13069	14396	6510	1867	348	52	12
	4		41	78	682	3446	7937	7472	4559	1434	246	71	12
	15		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	17		4	5	17	170	735	764	204	42	17	1	2
	18		17	10	26	143	365	176	38	12	3	0	3
	19		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	20		16	7	21	116	360	240	76	13	3	1	3
	21		3	1	3	47	341	271	109	28	9	8	3
	22		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	23		0	1	8	68	266	217	55	11	4	1	0
	24		11	22	93	468	940	328	31	4	1	0	0
	25		19	6	12	93	503	448	116	16	3	0	0
	26		1	4	15	52	246	214	61	14	3	1	1
	27		8	2	3	42	279	174	40	20	12	2	0
	28		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	29		3	1	22	116	161	103	42	8	3	0	0
	30		17	13	40	74	113	81	15	4	0	0	0
	31		10	14	14	50	157	113	22	6	2	0	0
	33		0	0	8	175	1292	732	97	21	8	2	1
	34		3	2	5	33	107	67	37	7	5	1	0
	35		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	36		7	9	30	105	86	25	5	2	0	0	0
	37		3	4	11	37	78	84	28	4	2	1	0
	38		8	8	11	75	194	86	31	13	8	0	1
	39		7	2	16	88	355	246	40	7	1	1	0
	40		11	8	65	248	320	127	18	7	3	1	1
	41		5	4	5	56	377	712	377	78	35	8	5
	Summary	Vehicles observed	226	332	1781	10069	28281	27076	12511	3618	716	151	44
		% exceeding					55 mph ---- 85.37%	60 mph ---- 52.02%	65 mph ---- 20.09%	70 mph ---- 5.34%	75 mph ---- 1.07%	80 mph ---- 0.23%	85 mph ---- 0.05%
SPEED LIMIT 60	2	Vehicle count	16	156	1189	6616	15176	11984	2682	413	64	8	10
	Summary	Vehicles observed	16	156	1189	6616	15176	11984	2682	413	64	8	10
		% exceeding						60 mph ---- 39.57%	65 mph ---- 8.29%	70 mph ---- 1.29%	75 mph ---- 0.21%	80 mph ---- 0.05%	85 mph ---- 0.03%
SPEED LIMIT 65	6	Vehicle count	0	0	9	42	158	1282	2407	1856	508	52	17
	14		0	3	3	26	160	580	1528	1145	324	29	9
	16		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	32		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	42		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	Summary	Vehicles observed	0	3	12	68	318	1862	3935	3001	832	81	26
		% exceeding							65 mph ---- 77.68%	70 mph ---- 38.86%	75 mph ---- 9.26%	80 mph ---- 1.06%	85 mph ---- 0.26%
SPEED LIMIT 70	7	Vehicle count	2	0	0	4	27	327	1195	4260	4027	500	61
	8		2	1	4	25	126	696	1271	2183	1670	399	143
	9		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	10		3	3	12	42	294	1294	2390	1962	1129	294	59
	11		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	12		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	13		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	Summary	Vehicles observed	7	4	16	71	447	2317	4856	8405	6826	1193	263
		% exceeding								70 mph ---- 68.38%	75 mph ---- 33.94%	80 mph ---- 5.97%	85 mph ---- 1.08%

Figure 2.16: Federal Quarterly Speed Report for Iowa

Summer CCS Count and Speed Calibrations

Each May through September staff assures the CCS units are collecting accurate data. Each CCS site is validated by comparing a manual count for the same time period to the CCS. Validation checks are performed on a 3-year cycle. The quality control check ensures the CCS units accuracy and maintains the integrity of the Iowa DOT's Traffic Monitoring System. Based on the validation check, the programming of the CCS may be changed as necessary.

The CCS unit validation is done by comparing the CCS unit in the field against a radar unit.

Mid-Year VMT Report

The Iowa DOT computes and reports VMT for the roadway network in Iowa on June 1 of every year. The purpose of the report is to provide reliable data on VMT trends and demands on Iowa's transportation network. The report is used by other agencies (e.g., Motor Vehicle Division for determining fatality rates per VMT) and is an HPMS submittal requirement. See Figure 2.17 for an example of the mid-year VMT report.

IOWA DEPARTMENT OF TRANSPORTATION
ESTIMATED 2012 VEHICLE MILES OF TRAVEL
(IN 1,000,000'S)

	RURAL				MUNICIPAL				**STATE**
MONTH	INTERSTATE	PRIMARY	SECONDARY	TOTAL	INTERSTATE	PRIMARY	STREETS	TOTAL	**TOTAL**
JANUARY	359	607	373	**1339**	205	281	536	**1022**	**2361**
FEBRUARY	382	641	424	**1447**	219	281	558	**1058**	**2505**
MARCH	412	704	454	**1570**	230	310	606	**1146**	**2716**
APRIL	408	703	453	**1564**	219	299	586	**1104**	**2668**
MAY	465	770	525	**1760**	227	340	617	**1184**	**2944**
JUNE	481	750	477	**1708**	231	329	562	**1122**	**2830**
JULY	507	752	459	**1718**	217	334	546	**1097**	**2815**
AUGUST	496	724	442	**1662**	234	317	587	**1138**	**2800**
SEPTEMBER	431	723	489	**1643**	224	296	592	**1112**	**2755**
OCTOBER	433	695	444	**1572**	216	286	596	**1098**	**2670**
NOVEMBER	403	643	403	**1449**	205	271	539	**1015**	**2464**
DECEMBER	327	536	311	**1174**	157	243	479	**879**	**2053**
TOTAL	5104	8248	5254	**18606**	2584	3587	6804	**12975**	**31581**

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Figure 2.17: Example Mid-Year VMT Report

Annual Site Summations

The daily data loaded into TRADAS© is summarized into yearly averages for volume, speed, and classification studies. The site summations are an HPMS submittal requirement. The information is used in the yearly ATR reports, to generate AADT's, to develop factors (growth and K & D), to develop travel trends and to determine capacity analysis.

Annual CCS Report

The annual report provides a summary of the traffic data collected on Iowa roads. The report examines the traffic volume trends on different road classifications and a summary of the average daily traffic recorded at each of the CCS sites. The report is published each calendar year and can be accessed on the Iowa DOT's internet and intranet site.

The annual report is available on the Iowa DOT website: http://www.iowadotmaps.com

The ATR Annual Report includes the following items:

- Traffic Volume Variations
- Graphs
  - Percent Change in Traffic – Base Year 1980
  - MADT as a Percent of AADT
  - DOW ADT as a Percent of AADT
  - Rural MADT as a Percent of AADT
  - Rural DOW ADT as a Percent of AADT
  - Municipal MADT as a Percent of AADT
  - Municipal DOW ADT as a Percent of AADT
  - Hourly Distribution of Daily Traffic

  These charts are very useful in explaining general travel trend patterns.
- Summary of Analysis of Thirtieth Highest Hour (the K-factor portion of AADT)
- Comparison of the ADT for each Station, comparing current year to the previous 10 years.
- ATR Map – See Figure 2.10 for the most recent ATR map, which is updated in December of each year. The map illustrates the location and capabilities of each location.

CCS Deliverables

Iowa's Permanent Continuous Count System generates multiple deliverables for both internal and external stakeholders. Figure 2.18 shows the CCS deliverables and their stakeholders.

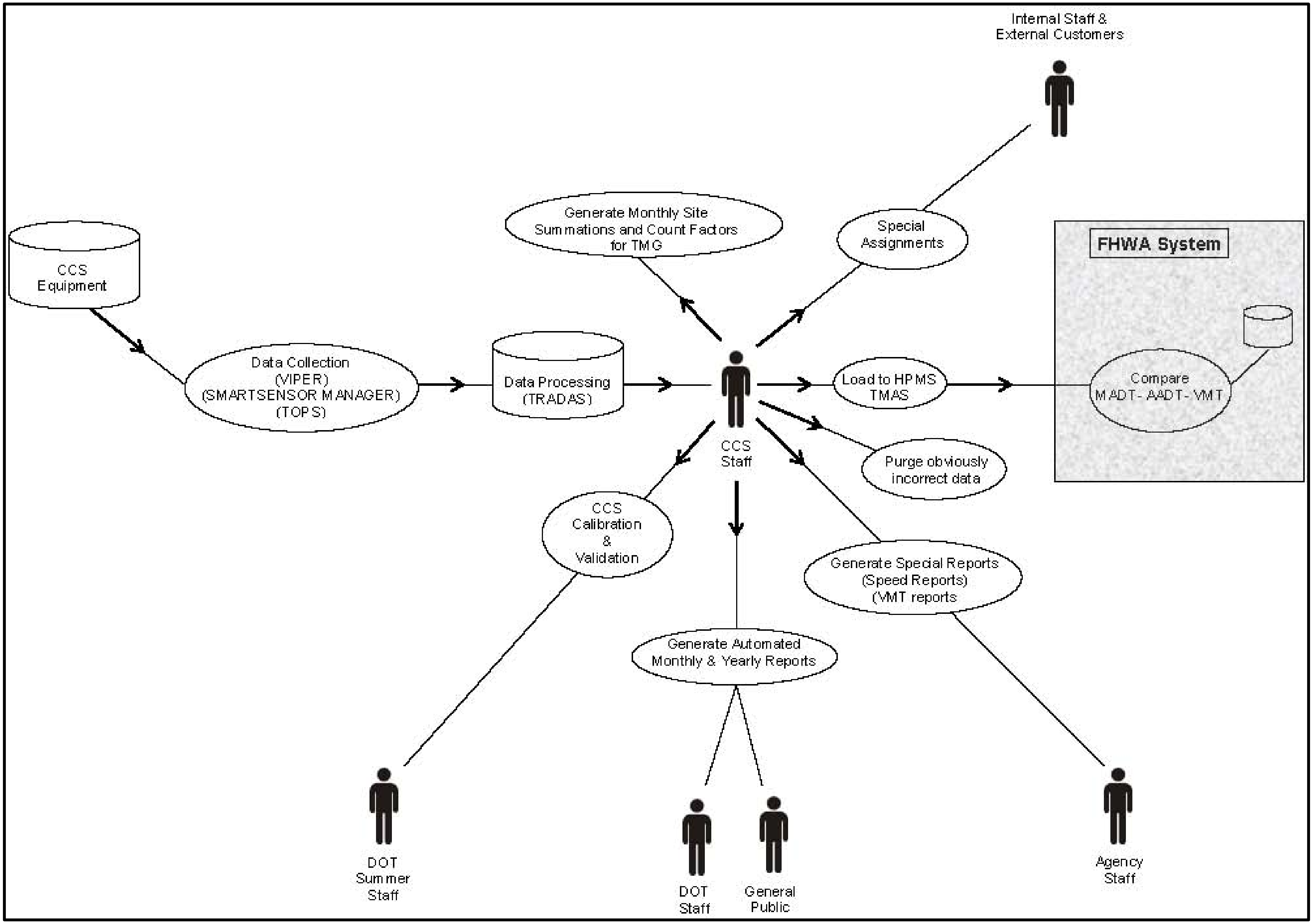

Figure 2.18: Yearly CCS Process

PART 3 – IOWA DOT'S PERMANENT WEIGH-IN-MOTION SYSTEM

Chapter 3 − Weigh-in-Motion Sites

The Weigh-in-motion (WIM) system collects continuous truck weight and vehicle-type classification data, both of which are fundamental components of the Traffic Monitoring System. The WIM data is also essential to the Pavement Management System, particularly with the implementation of the new Mechanistic Empirical Pavement Design Guide (MEPDG).

3.1. WIM System Devices

The WIM systems are permanent devices that continuously and automatically collect truck weight by direction and lane and retrieved throughout the year.

The Iowa DOT uses WIM Class 1 sensors (by Measurement Specialties, Inc.) that are embedded in each travel lane perpendicular to the direction of travel as shown in Figure 3.1).

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Figure 3.1: Embedded Weigh-in-Motion Sensors

The WIM systems utilize piezo sensors to detect a vehicles weight. A piezo sensor is a device that utilizes the piezoelectric system (see Figure 3.2) to measure changes in pressure, compression, acceleration, impact or vibration using piezoelectricity (a phenomenon in which materials generate a voltage when deformed) by converting the electrical charge into a signal.

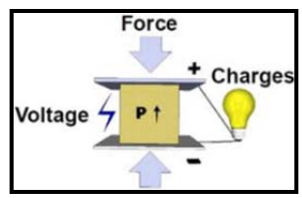

Figure 3.2: Piezoelectric System

The typical system consists of a piezo-loop-piezo (PLP) configuration (see Figure 3.3). The WIM sites are set up to capture and record axle weights and gross vehicle weight as trucks drive over the roadway sensors at normal traffic speed.

- In a PLP configuration the piezo sensors count axles, axle spacings, weight and vehicle class based on timing between the upstream and downstream piezo. The inductive loop is used to determine the length of the vehicle, volume and speed.

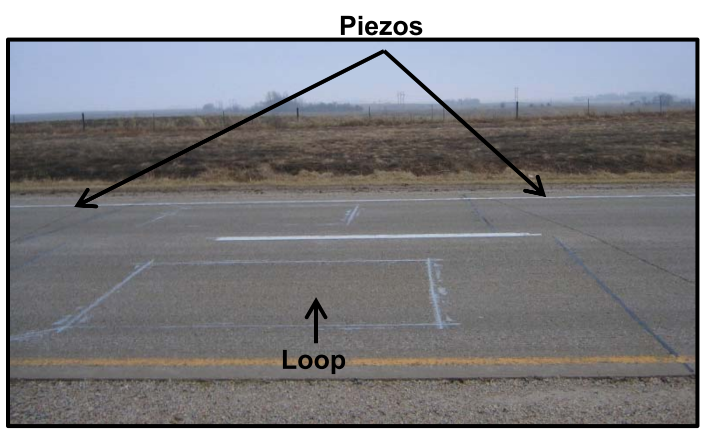

Figure 3.3: Embedded Loop and Piezo Sensors

The sensors transmit to an Automatic Data Recorder (ADR) that is located in a cabinet adjacent to the roadway. Currently, the Iowa DOT uses the ADR-2000 counter/classifier unit (see Figure 3.4) and a WIM card (see Figure 3.5) by Peek Traffic Corporation.

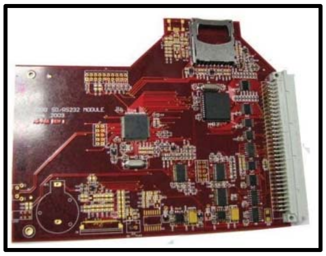

Figure 3.4: ADR-2000 Module

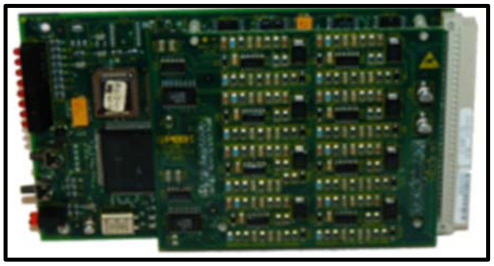

Figure 3.5: WIM Card

The WIM card enables the ADR unit to weigh heavy commercial vehicles while they travel at high speeds, while simultaneously retaining the full functionality of the ADR series of counters/classifiers. By installing two subsurface piezoelectric weighing sensors the following types of data can be accurately collected: arrival time, vehicle speed and classification, gross vehicle weight, volumetric flow, individual axle weights and spacings, overload indications, Equivalent Single Axle Loadings (ESALs), gap and headway, and per vehicle records.

The ADR cabinet adjacent to the roadway also contains the surge protection, power supply, and wireless communication device (see Figure 3.6).

Figure 3.6: ADR Cabinet

The WIM program for the Iowa DOT is maintained by the Telemetrics team. Currently, the Iowa DOT maintains 40 WIM sites. The distributions of active devices by functional class within Iowa are detailed in Table 3.1 and shown in Figure 3.7.

Table 3.1: Iowa's Weigh-in-Motion locations

Functional Class	WIM	Truck Weight Studies Only	Truck Weight Study and Long Term Pavement Performance Project	Long Term Pavement Performance Project Only
Rural Interstate system	8	4	4	0
Municipal Interstate system	3	2	0	1
Rural Primary system	29	24	4	1
Total	40	30	8	2

According to the Federal Highway Administration's (FHWA's) Traffic Monitoring Guide (TMG), a State should have 5 – 8 permanent sites for each group of functional class. For the WIM System there is need for additional sites on the municipal interstate system. There is an ongoing effort to locate additional sites to expand coverage on the municipal interstate system.

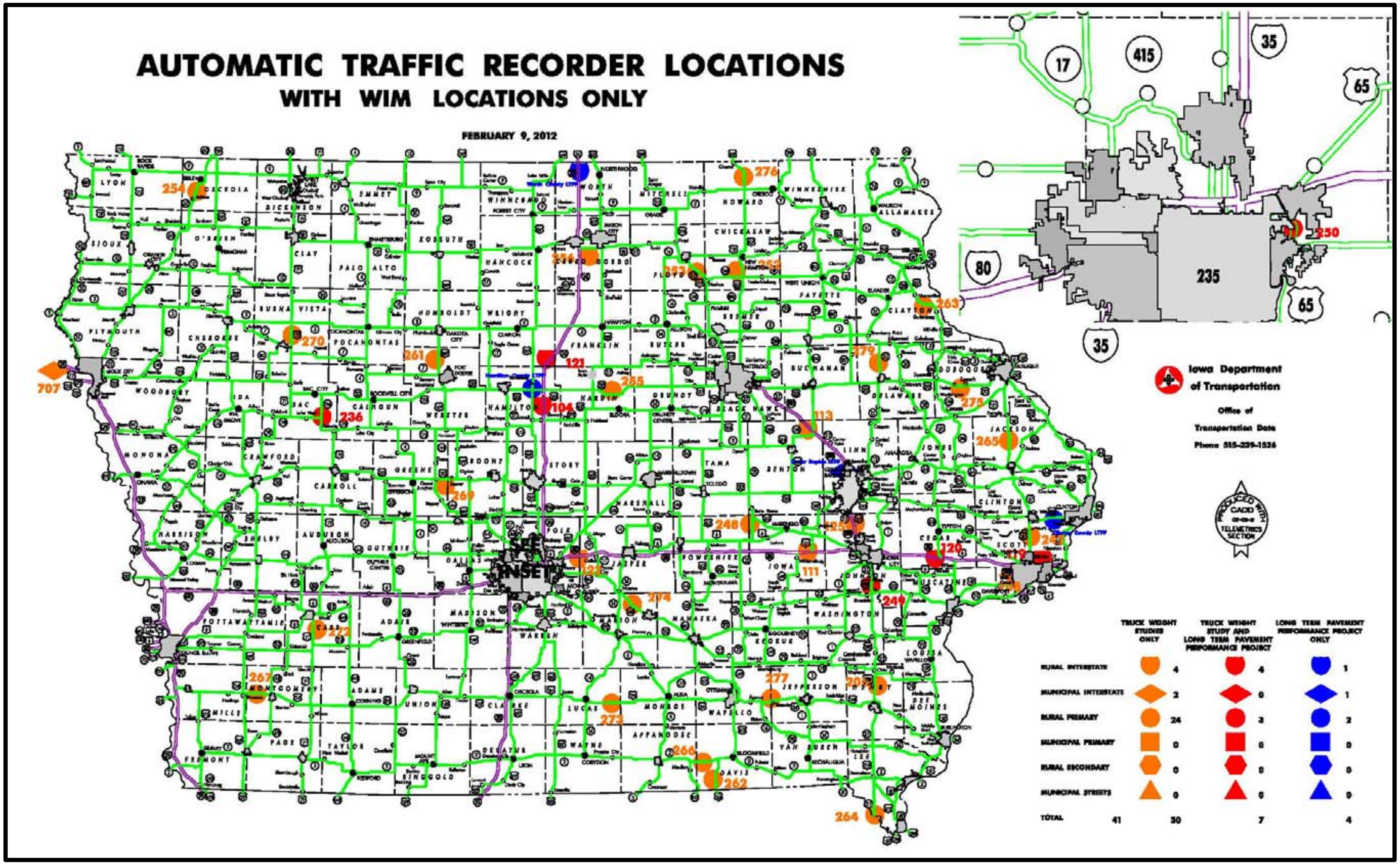

Figure 3.7: **Weigh-in-Motion Locations (February 9, 2012)**

3.2. WIM Site Selection

The selection of new WIM sites should be based on the needs of the data collection program and the site characteristics of the roadway sections that meet those needs. Some data collection needs to consider include:

- The need to obtain more vehicle weight data on certain segments of roads.
- The need to collect data in regions that are poorly represented.
- The need to collect data on specific facilities of high importance (e.g., interstate highways or other national highway system routes).
- The need to collect data for research projects or other special needs.
- The need to collect weight information on specific commodity movements.

However, just because a roadway section meets some or all of the above needs does not necessarily make it a good WIM site. See Figure 3.8 for an example of a poor WIM location.

When selecting an adequate site for the WIM location it is also very important to consider the general characteristics of a potential site. In addition to the data collection needs, all WIM sites should provide the following:

- Adequate geometric design (i.e., horizontal curvature, roadway grade, cross slope, lane width and markings);
- Good pavement condition (i.e., pavement that is smooth, flat and that has enough strength to adequately support axle weight sensors);
- Adequate drainage;
- Sufficient truck traffic at the site to justify a WIM installation;
- Straight segments with no weaving;
- Areas with no congestion, where vehicles travel at constant speeds;
- Safe environment (i.e., the area must provide space to store the installation equipment (e.g., backhoe, large trucks) and install the WIM equipment);
- Equipment space (i.e., there must be enough room for the cabinet beyond the roadway or in the medium); and
- Access to power and communications.

Knowledge of site characteristics is important when validating and analyzing the data. Having a good understanding of the site characteristics can help explain any data abnormalities.

Figure 3.8: Poor WIM location

3.3. WIM Data

WIM data plays a significant role in all roadway related highway, operational, maintenance and planning systems. The data is used to assess transportation needs and system performance as well as to develop planning and programming recommendations. It is important in the design of bridges, determination of pavement thicknesses, consideration of legislative and regulatory issues, and in the analysis of land use planning and economic development impacts.

The Iowa DOT's WIM system collects data on a permanent and continuous 24 hours per day, 365 days per year. The system monitors four types of data that is collected by direction, lane, date and real time of passage:

- Volume − the number of vehicles observed during a count session.
- Speed − the average speed of a vehicle observed during a count session.
- Weight – the vehicle weight per axle per axle spacing.
- Classification − vehicles grouped by axle configuration into the 15 Federal vehicle classifications.

  For WIM sites, the Iowa DOT implemented a modification to the FHWA vehicle classification system with the addition of two vehicle classifications. This change brings the total number of vehicle classifications recognized by FHWA to 15 (See Figure 3.9). The changes to the vehicle classifications are described as follows:

  - Class 14 is not used
  - Class 15 is for vehicles not meeting the axle configurations and/or weights set for classifications 1 through 14 and vehicles unclassified due to system error.

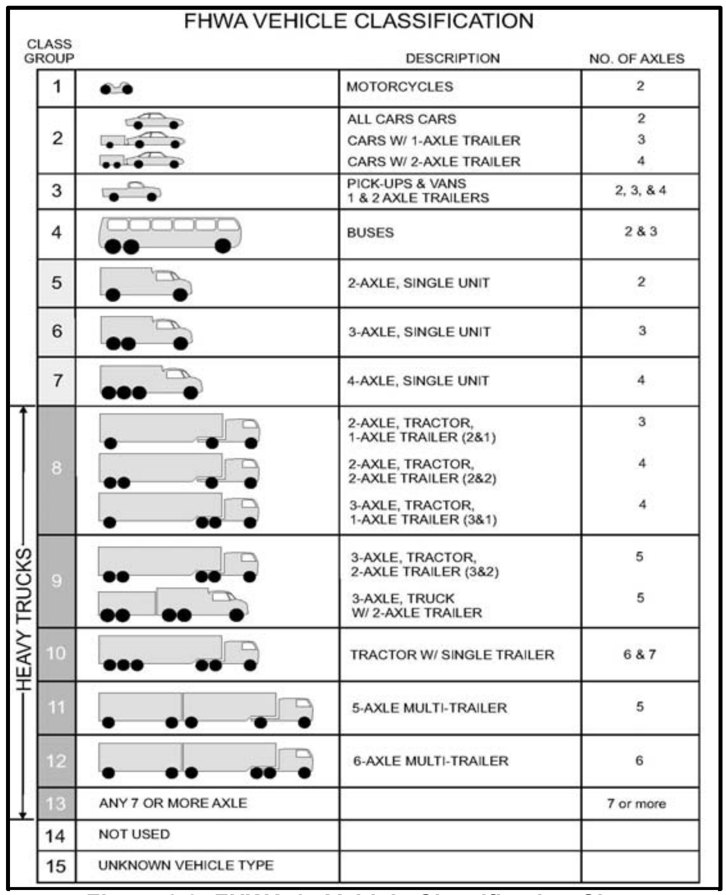

Figure 3.9: FHWA 15 Vehicle Classification Chart

Data from the permanent WIM counters is used for:

1) Averaging truck percentages for each functional class of roadway.
2) Generating special reports from raw data, those include:
   - Class by Hour or Day of the Month
   - Speed by Hour or by Class
   - Gross Vehicle Weight (GVW) by Class
   - Over-Weight data by Hour or Day by Class
   - Single/Tandem/Tridem Axle weights

3) Generating ESAL and Load Equivalency Factors (LEFs) that are used in determining the depth of pavement sections.
4) Understanding time-of-day (TOD), day-of-week (DOW), seasonal travel and truck travel patterns.
5) Understanding truck traffic characteristics (i.e., empty vs. loaded trends, seasonal variations, unique vehicles (see Figure 3.10) and traffic operating characteristics).

Figure 3.10: Example of an Oversized Load

WIM data generates millions of records. All the information is easily accessible and is used to answer questions such as:

- How does day of the week travel compare?
- What time and day do the highest truck traffic volumes occur?
- What is the hourly relationship for accident studies?
- What are the travel patterns on holidays?
- What are the changes in travel caused by fuel shortages, fuel prices, recessions, and other major socioeconomic changes?
- What are the relationships of vehicle types within various time relationships (e.g., daily, weekly, vs. weekend, annual)?

The data is collected, processed and distributed by the methods outlined in the following sections.

3.4. WIM Collection

Traffic data is collected via telemetry from all the permanent traffic data collection sites statewide. See Figure 3.11 for an image showing the Telemetry process.

The raw data is downloaded remotely on a daily basis by manual polling. The Iowa DOT uses TOPS (Traffic, Operations & Planning Software) by Peek Traffic Corporation as the manual polling data processing tool. After retrieval, TOPS allows the WIM analyst to archive, export, and further process the data.

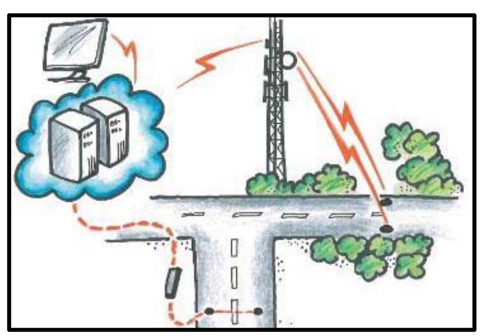

Figure 3.11: Telemetry Process

The processed data is used to:

- View generated reports.
- Generate and view error reports including time down, system access, auto-calibration, and improperly completed records.
- Transfer selected raw data files or generated reports.
- Set up and initiate the generation of summary reports on data previously collected by the system.

The TOPS Commander program allows the users to access the ADR-2000 hardware directly to perform specific tasks. Tasks that can be performed include:

- Resetting the Auto Calibrate.

  The Iowa DOT resets the following items:

  - Class - Class 9
  - Axle Number - 1
  - Target Value – 10,000 pounds (the average steering axle weight on a Class 9 truck). The target value is set specifically for each WIM location and direction.

  The auto calibrate values are updated on an approximate per hour truck volume. The minimum for low volume roads is 20 vehicles/hour and the maximum for high volume roads is 100 vehicles/hour.

- Retrieving data and configuration files.
- Monitoring site and hardware operation.

3.5. WIM Processing

WIM data processing is performed by TRADAS© (TRAffic DAta System) from Chaparral Systems Corporation. TRADAS© is a traffic data collection and analysis program used for managing traffic count data. The program is capable of generating daily, weekly, monthly, or continuous summary reports in hourly increments based on vehicle speed, classification, ESAL, and weight summaries on a lane-by-lane or directional basis.

TRADAS© is the software program used by the Iowa DOT to create all WIM reports that are requested by internal staff and external customers (e.g., engineering consultants, educational research facilities, metropolitan planning organizations (MPOs) and other government agencies).

TRADAS© analyzes and validates all continuous traffic data files. Each data file is then summarized and processed through a series of quality checks based on AASHTO, FHWA's Traffic Monitoring Guide and user defined standards before being loaded into an Oracle database.

3.6. WIM Data Validation Process

This section explains how the WIM analyst validates the data through quality control checks and monitors the WIM system's operation. The steps include:

- Accessing the system from the office and performing initial real-time checks.
- Reviewing data reports to determine if the WIM system is consistently operating properly and within the operating range of the system (i.e., traffic moving through the site at consistent speeds within each lane).
- Accessing the system from the office to perform system diagnostics if the data indicates that the system is not operating correctly.

Real-Time Checks

Real-time checks are intended to verify that the system is operating correctly by identifying any significant ongoing system problems and data files which contain significant amounts of missing and/or invalid data. Each morning, the WIM analyst views live traffic to ensure all lanes are working and classifying properly. Below are the basic checks to answer:

1. Are the communications working?
2. Is the system collecting data?
3. Is the system's time and date correct?
4. Do the stored files appear to be complete and the file sizes appropriate?
5. Has the counter been collecting data continuously since the previous polling?
6. Do the classifications, axle spacings, speeds and weights appear to be reasonable?
7. Are all lanes accounted for?

The real-time monitoring checks are intended to catch obvious and ongoing problems with the system (see Figure 3.12 for a site that has an ongoing loop problem). If there are no obvious problems, the data from each site is downloaded and checked for problems that are not so obvious or occur intermittently.

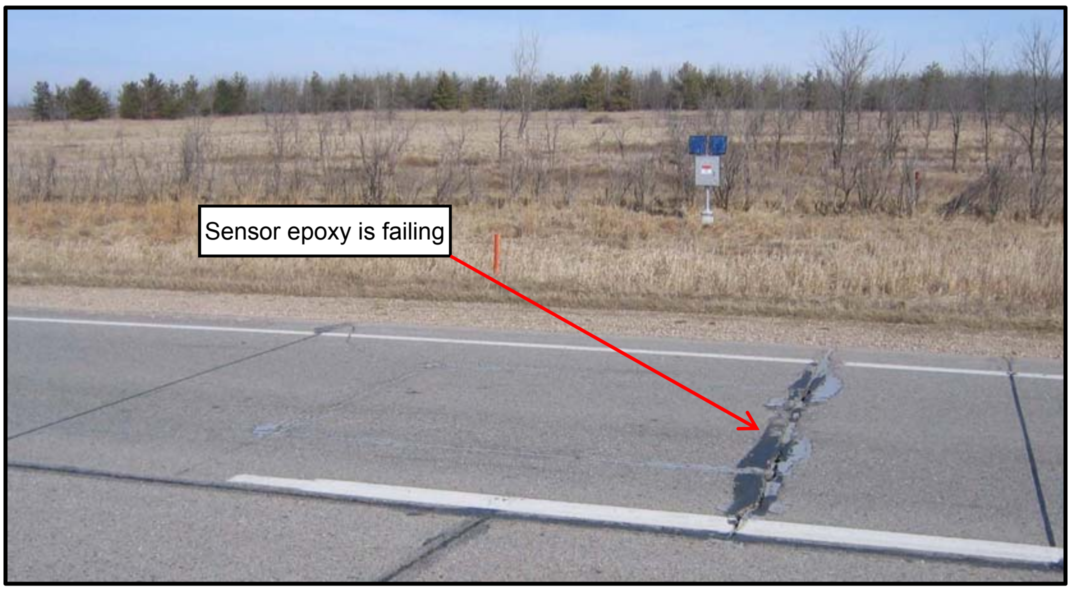

Figure 3.12: Bad Loop Sensor

WIM Data Report Quality Control Checks

Weigh-in-motion (WIM) systems can provide massive amounts of valuable data; however, the data must be checked regularly in order to identify problems at the WIM site.

One type of quality control check is the monthly WIM distribution graphs that are used to visually identify "unusual occurrences" in the traffic data. These simple distribution graphs show each site's GVW, Steering Axle Weight and Drive Tandem Spacing.

The Iowa DOT's distribution graphs are shown for Class 9 trucks because they account for the highest percentage of trucks on Iowa's roadways. The examples below are for a 3-S-2 single Trailer 5 axle Class 9 truck.

GVW distribution graph – typically shown in the form of two (2) peaks. The first peak represents trucks, which range from 25,000 to 35,000 pounds. The second peak represents loaded trucks, which range from 70,000 to 80,000 pounds. See Figure 3.13 for an example of a valid distribution graph (left-hand side) and an invalid distribution graph (right-hand side).

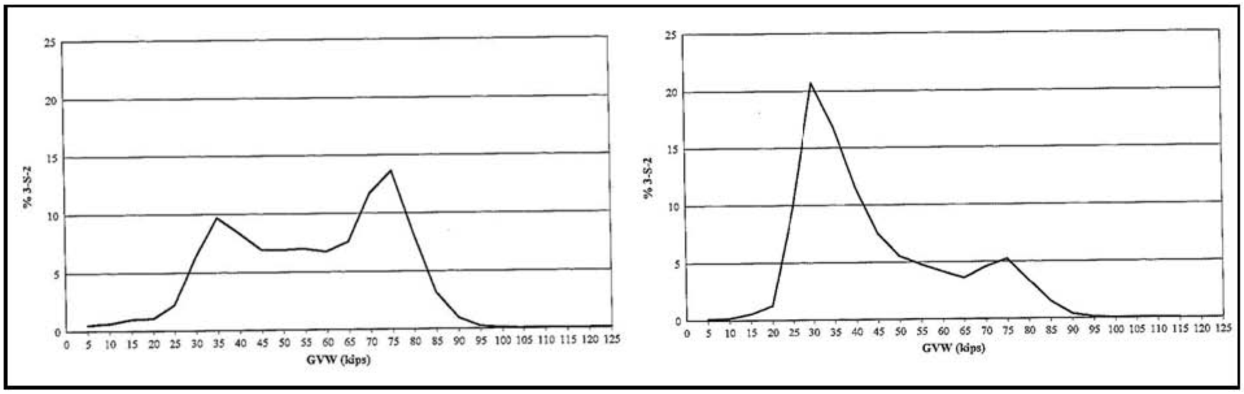

Figure 3.13: Sample GVW Distribution Graph

Steering Axle Weight distribution graph - typically shown in the form of a single peak. The steering axle for Class 9 vehicles should have consistent weight ranging from 8,500 to 12,000 pounds. See Figure 3.14 for an example of a valid distribution graph (left-hand side) and an invalid distribution graph (right-hand side).

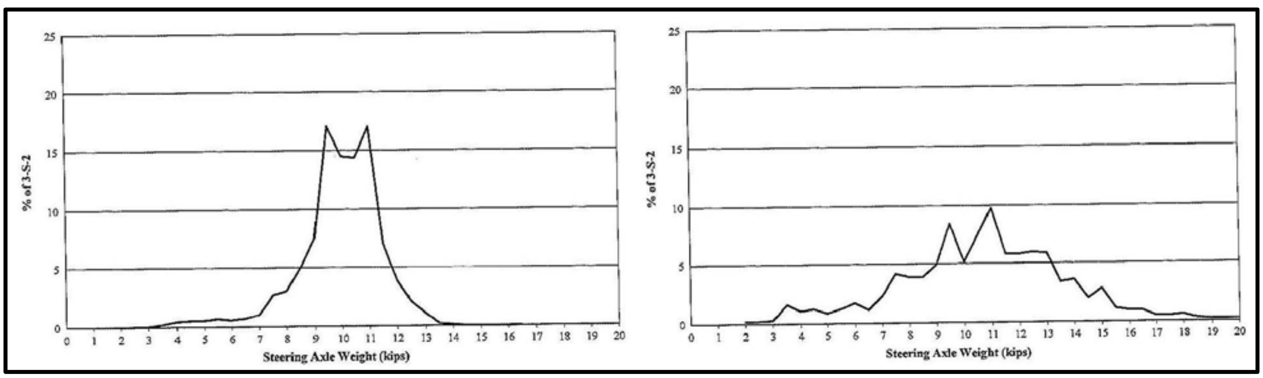

Figure 3.14: Sample Steering Axle Weight Graph

Drive Tandem Spacing distribution graph - typically shown in the form of a single peak. The average spacing for a drive tandem for a type 3S2 vehicle should be around 4.3 feet. See Figure 3.15 for an example of a valid distribution graph (left-hand side) and an invalid distribution graph (right-hand side).

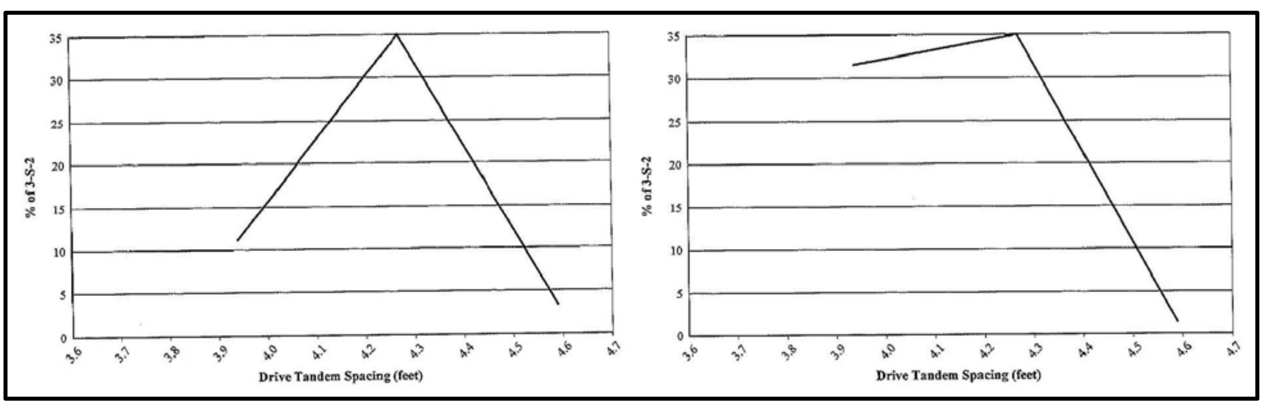

Figure 3.15: Sample Drive Tandem Spacing Graph

If the distribution graphs show “unusual occurrences” it is most likely due to invalid data, the site being out of calibration, the result of unusual traffic patterns or site malfunctions.

Other WIM quality control data checks to perform include:

- Checking that all directions for each station are processed, edited and submitted at the same time.
- Consecutive zero period check – looking for time ranges where a lane has more than 11 consecutive zero hours.
- Volume directional split check – Comparing directional volumes to identify an excessively high volume in one direction and an unusually low volume in the opposite direction. The current polling software uses a 2:1 ratio (66% / 33% split) as a default.
- Class 8 check – looking for too many class 8 vehicles in relation to class 9 vehicles. Currently, the default maximum is 45 % class 8’s to class 9’s.
- Invalid Axle Spacing – looking for high numbers of vehicles that failed due to invalid axle spacing.
- Invalid Axle Weight − looking for high numbers of vehicles that failed due to invalid axle weight.
- Checking the site summaries for average ESAL factors for each lane.

Locations that fall outside the established ranges are flagged with warnings. They are displayed in a text document that is sorted by site, date and direction for each IVR (Individual Vehicle Record) and WIM. See Figure 3.16 for an example of locations that have been flagged with warnings.

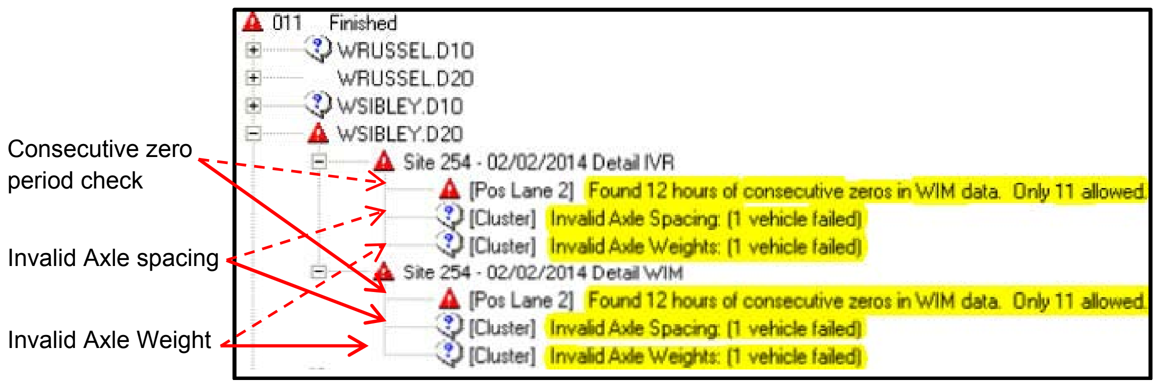

Figure 3.16: TRADAS© WIM Warnings

To ensure there are no problems at the WIM sites, the above data checks must be performed regularly.

Diagnostic Quality Control Checks

If real-time or quality control data checks suggest a problem with a system's operation, the WIM analyst should remotely access the system and perform a check of the system's setup parameters and the settings for any component that might be causing the problem.

To ensure the WIM units accuracy, it is important to determine the cause of the system’s problems. Data analyses should be performed to determine how often the problem is occurring, at what time of day, under what conditions and if the problem is caused by improper system settings, by traffic conditions or by environmental conditions.

If problems are detected, the Iowa DOT’s WIM analyst will make adjustments to the system. Once adjustments have been made, real-time traffic checks should be performed to ensure that the vehicles are weighing and classifying properly.

3.7. WIM Calibration Process to Verify a Site is Working Properly

All WIM sites need to be calibrated to verify they are working properly. Below are the guidelines for when WIM sites should be calibrated:

- New WIM sites

  New sites are calibrated as part of the installation process. Typically, new sites are calibrated the year following installation. This allows the WIM analyst time to observe the unit and the data being collected. Having a good understanding of the site characteristics can help the analyst explain any calibration abnormalities.

- Repaired WIM sites

  Repaired sites are calibrated several months after being repaired. This allows the WIM analyst time to observe how the repaired unit is operating.

- Existing WIM sites

  Existing sites are calibrated on a 3-year cycle.

Before a site is calibrated, it must be evaluated to confirm that the WIM components have passed the testing requirements. The tests include:

1. Ensuring that roadway sensors send signals to the ADR-2000 and that the ADR-2000 converts those signals into useable data; and
2. Ensuring the loop and weight sensor combination records vehicle classification and axle counts.

After the testing procedure is successfully completed then the calibration test is performed. The Iowa DOT's calibration test requires the use of two Class 9 vehicles (three-axle tractor and two-axle trailer). The trucks must have an air-ride suspension and be in good mechanical condition. The first truck is loaded with a non-shifting load weighing between 35,000 and 40,000 pounds. The second truck is loaded with a non-shifting load weighing between 75,000 and 80,000 pounds. See Figure 3.17 for pictures of trucks that have been used to calibrate Iowa DOT WIM sites.

Figure 3.17: Calibration Trucks

Prior to the test, the calibration trucks must be weighed on a certified scale and the weights (GVW, steering axle, drive tandem axles and trailer tandem axles) recorded.

After the trucks weights are recorded, the calibration trucks are driven over each lane of the site to be calibrated 20 times. Each sensor records the GVW, axle weights, speed, axle spacing and total length. The data from the 20 passes is downloaded into a confidence level spreadsheet. The data is averaged and assessed to ensure it falls within the ASTM E1318-09 tolerances (see Table 3.2).

Table 3.2: ASTM Functional Performance Requirements for WIM Systems

Function	Tolerance for 95% Compliance
Gross Vehicle Weight (GVW)	+/- 10%
Axle Load	+/- 20% (Iowa DOT uses a tolerance of +/- 15%)
Speed	+/- 1 mph
Axle Spacing	+/- 0.5 ft.

3.8. Distribution

After the data is processed and validated, Iowa DOT staff uses the data to provide on-demand statistics and generate monthly and yearly reports. TRADAS© reports are generated through the RoadRunner interface. Only data that passes rigid validity and quality checks are used in developing the reports.

3.9. LTPP

The Iowa DOT participates in the Long Term Pavement Performance (LTPP) program. The LTPP program was established to collect pavement performance data as one of the major research areas of the Strategic Highway Research Program (SHRP). The Iowa DOT's participation includes WIM sites at 10 current LTPP locations. Classification, weight, and volume data is processed for these sites in the same manner as described above and then submitted to the DOT's LTPP representative. Since 1991, the Federal Highway Administration (FHWA) has continued the management and funding of the program.

3.10. FHWA Submittal

Each month the Iowa DOT reports the validated traffic data collected by the permanent WIM sites to the FHWA as part of the Highway Performance Monitoring System (HPMS). The monthly submittal includes a class by day of the month summary, class by axle weight summary, class by GVW summary, and a site summary. Each year the monthly data is summarized and submitted to FHWA. The data collected supports local, state, and federal transportation officials in adequately planning and administering safe and efficient transportation systems.

PART 4 – IOWA DOT'S STOPWATCH+ PROGRAM

Chapter 4 – Real-Time Traffic Monitoring

The impetus for real-time traffic monitoring began as part of the 2005 Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) bill. In 2009, the SAFETEA-LU bill expired. It was extended 10 times until the newest transportation bill, MAP-21 (Moving Ahead for Progress in the 21st Century), was passed and signed into law. The real-time system management information program has been continued under MAP-21.

In 2010, the real-time system management information program was established. The program requires all States to monitor, in real time, traffic and travel conditions of all major highways. The program's goal is to provide the capability to monitor in real-time and provide a means of sharing the data with other state and local governments and with the traveling public. The real-time data is used to improve the security of the surface transportation system, to address congestion problems, to support improved response to weather events and surface transportation incidents, and to facilitate national and regional highway traveler information.

4.1. StopWatch+ Program

The StopWatch+ program collects real time traffic data information, which is a fundamental component of a real-time system management information program. In addition to data collection, other key aspects of the program include data sharing, data integration and the operational use of the resulting information. StopWatch+ is a comprehensive, cost effective, data gathering program.

The Iowa DOT's program is an expansion of the Continuous Count Program (CCP). In addition to the capabilities of the existing CCP, the StopWatch+ Program will allow users to do the following:

- View data quicker.
- Collect real-time data simultaneously with the collection of historical data without compromising the data.
- View data through the Iowa DOT website.

4.2. StopWatch+ Devices

The StopWatch+ program uses the existing sensors and Automatic Data Recorder (ADR) collection hardware. With StopWatch+ the ADR-2000 continues to collect historical data for operational, maintenance, and planning purposes while at the same time reporting real-time traffic data to the DOT website and traffic centers. The traffic centers currently reporting real-time traffic data are:

- Iowa DOT's Intelligent Transportation System (ITS) for Des Moines Area Traffic Management Centers (See Section 6).
- Iowa DOT's Emergency Operations Center.
- The National Incident Management System.

The StopWatch+ is a simple software add-on to the ADR-2000 by PEEK Traffic Corporation. Each ADR-2000 counter/classifier unit either already has the StopWatch+ firmware loaded (version v5.4 or later) or is capable of having it retrofitted to older versions with minor upgrades. To activate StopWatch+, a Peek representative simply needs to unlock it from the unit. Once activated, the StopWatch+ application will process volume, speed and lane occupancy data in 15-minute intervals.

Additional benefits of the StopWatch+ application are:

- One device performs the work of two.
- Easy set up and operation.
- Real-time StopWatch+ application runs simultaneously and independently.

- Both the historical and StopWatch+ applications can be configured independently.
- Can process data in both directions of a lane allowing monitoring of lane reversals.
- Requires minimal maintenance.

The Telemetrics team maintains the StopWatch+ program for the Iowa DOT. Currently, the Iowa DOT has installed and activated 83 StopWatch+ sites. It is anticipated that by the end of 2013 all Continuous Count Station (CCS) sites will be upgraded. The distributions of active devices that are capable of collecting real-time data by functional class within Iowa are detailed in Table 4.1 and shown in Figure 4.1.

Table 4.1: Iowa's StopWatch+ locations

Functional Class	StopWatch+	Volume, Speed & Vehicle Classes 1-13 (LPL or PLP)	Volume, Speed & Vehicle Classes 1-3 (Loop-Loop or Radar)
Rural Interstate system	15	9	6
Municipal Interstate system	4	2	0
Rural Primary system	55	40	13
Municipal Primary system	9	2	2
Total	83	53	21

According to Federal Highway Administration's (FHWA's) Traffic Monitoring Guide (TMG), a State should have 5 – 8 permanent sites for each group of functional class. For the StopWatch+ Program there is need for additional sites in municipal areas. There is an ongoing effort to locate additional sites to expand coverage on the municipal system.

4.3. StopWatch+ Site Selection

Evaluation of the current CCS infrastructure is the basis for StopWatch+ site selection. StopWatch+ sites are selected based on the ability to provide quality and useful real-time data. Generally, the program will be limited to Metropolitan Planning Organization (MPO) locations. See Figure 4.1 for possible real-time traffic integration sites.

Other things to consider when selecting a StopWatch+ site include:

- Sites that need equipment or configuration improvements.
- Locations that require a minimal amount of work to make them real-time ready.

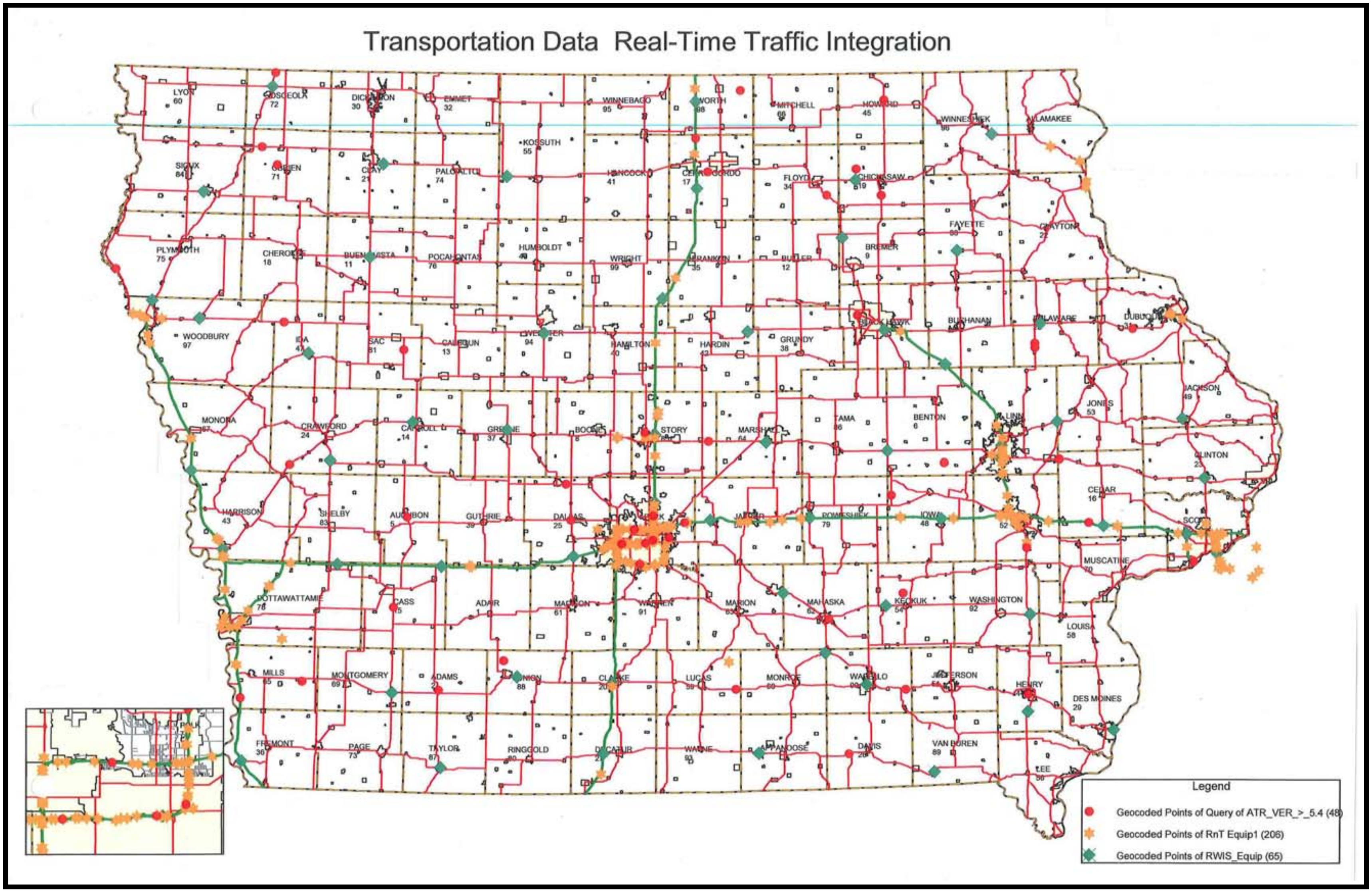

Figure 4.1: Transportation Data Real-Time Traffic Integration Map

4.4. StopWatch+ Data

StopWatch+ data will play a significant role in all roadway related highway, operational, maintenance and planning systems. Real-time information will assist in improving responses to weather events, transportation incidents, assess system performance and facilitate national and regional traveler information.

The Iowa DOT's StopWatch+ program will collect real-time data on a permanent and continuous 15-minute interval. The program will collect three types of data:

- Volume - the number of vehicles observed during a count session.
- Speed - the average speed of a vehicle observed during a count session.
- Lane Occupancy – the ratio of the sum of the lengths of the vehicles to the length of the road section in which those vehicles are present.

The StopWatch+ data can be combined into individual flow totals, lane totals, directional totals or an overall site total.

The 15-minute interval data is available in 6-hour increments (i.e., 12 AM to 6 AM, 6 AM to 12 PM, 12 PM to 6 PM, 6 PM to 12 AM). Only the most recent increment is stored and available. Each 6-hour increment overwrites the previous 6-hour increment.

Data from the StopWatch+ Program can be used for:

1) Making decisions about traffic and travel conditions;
2) Understanding travel time patterns and improving travel time reliability;
3) Observing congestion in real-time;
4) Improving the overall operational performance; and
5) Monitoring traffic speeds.

The data is collected, processed and distributed by the methods outlined in the following sections.

4.5. StopWatch+ Collection

StopWatch+ real-time traffic data is collected remotely via telemetry (see Figure 4.2) from all the permanent traffic data collection sites statewide. The operating and reporting software the Iowa DOT uses is TransCore's TransSuite® Traffic Control System (TCS). The TCS will allow users to pull, manipulate and display data on Google maps. The data is provided in a simple format for importing into existing systems. Since it reports real-time data, not stored files, the application needs no stand-alone end user software for viewing data.

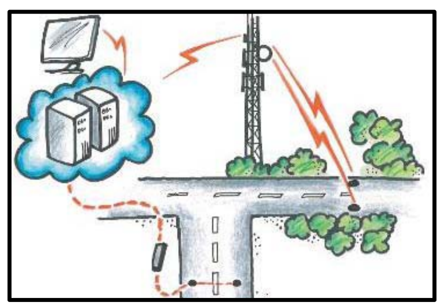

Figure 4.2: Telemetry Process

When problems in the collection of traffic data are detected, the Iowa DOT's Communications staff is notified and will evaluate the equipment's operation and make the necessary repairs.

The collection and sharing of traffic data is a joint venture between the Telemetrics team and the Intelligent Transportation System (ITS) office.

4.6. StopWatch+ Distribution

Currently, StopWatch+ data is downloaded and distributed remotely to the Intelligent Transportation System (ITS) Office and the Iowa DOT website. Eventually, the data will be viewable on the 511 website.

PART 5 – IOWA ONE-CALL

Chapter 5 – One-Call System

Whether trenching a field, planting a tree or digging a foundation, Iowa law requires everyone to locate underground utilities before digging. The law states that if you are excavating, including digging, you must call Iowa One Call at least 48 hours in advance (of your digging) in order to minimize the risk of damaging any type of underground facilities (electric, gas, communications/television, water and sewer).

Since January 1, 1993, all owners and operators of underground facilities are required by Iowa State law to participate in Iowa One Call. Iowa One Call handles more than 400,000 calls and coordinates more than two million locate requests each year throughout Iowa. See Figure 5.1 for an example of a One-Call locate request.

```
            From Iowa One Call 1.563.884.7761 Mon Sep 23 12:08:44 2013 CST Page 2 of 4




Iowa One Call                     SEQUENCE NUMBER 0015   CDC = W13
Request # 132661419                 IOC Sent: Date: 09/23/13  At: 1156
*****************************
*  COMPLIANT                *    Messages Sent To Office(s) as follows:
*****************************
AT2=AT&T TRANSMISSI/CAB=CABLE ONE      /FBR=FIBERCOMM, L.C./INS=IOWA NETWORK SE/
LL1=LONGLINES      /MAF=MIDAMERICAN ENE/MC1=MCI            /MD8=MIDAMERICAN ENE/
SIC=SIOUX CITY, CIT/SOS=SOUTH SIOUX CIT/US1=CENTURYLINK LOC/W13=IOWA DEPARTMENT/
W14=IOWA DEPARTMENT/

Beginning Work Date:  09/25/13      Time of Day: 1145  Duration: 2 WEEKS
Location:  County: WOODBURY         City: SIOUX CITY                In City: Y
Address: 0 DACE AVE
Near Intersection: S FLOYD BLVD
Township:                           Section:    1/4-Section:
GPS Lat/Long:   .         .
Excavation Type:   Trenching:         Boring: Y       Plowing:
                   Backhoe:    Y      Blasting: N     Other:
                   Marked in White: N
Extent of Work: INSTALL FIBER  LINE, SET HAND HOLES
     LOCATE ON NORTH SIDE OF INTERSECTION WITHIN 100 FT OF WEST ROW OF FLOYD
     GOING NORTH  TO NORTH SIDE OF GORDON DR, NORTH SIDE OF THE BRIDGE
     AND THEN WEST TO THE EAST SIDE OF COURT ST ALONG THE BRIDGE ON THE
     NORTH SIDE WITHIN 100 FT
BTC AM: Y PM: Y AFTER 5:00: Y      Appointment:          at
Excavator: LAPOINTE UTILITIES, INC.
Address: 4819 235TH ST N; FOREST LAKE, MN  55025
Phone: 612-282-6806
Email: toddhultman@yahoo.com
Work For: INS                           Ph:     612-282-6806
Caller:  TODD HULTMAN                   Fax:
Contact: TODD HULTMAN                   Alt Ph:

***************************************************************************
Upgrade to receiving your locates via email today!  Email ialead@occinc.com
with your company name or CDC code indicating you want to upgrade to email
delivery.
IOC Received: 09/23/13 Time: 1144       By:     iamary
```

Figure 5.1: Iowa One-Call Locate Request example

When Iowa One Call receives a request, they notify all participating operators who have facilities in the area of the excavation. The Telemetrics team receives all requests that fall within a predetermined perimeter (see Figure 5.2).

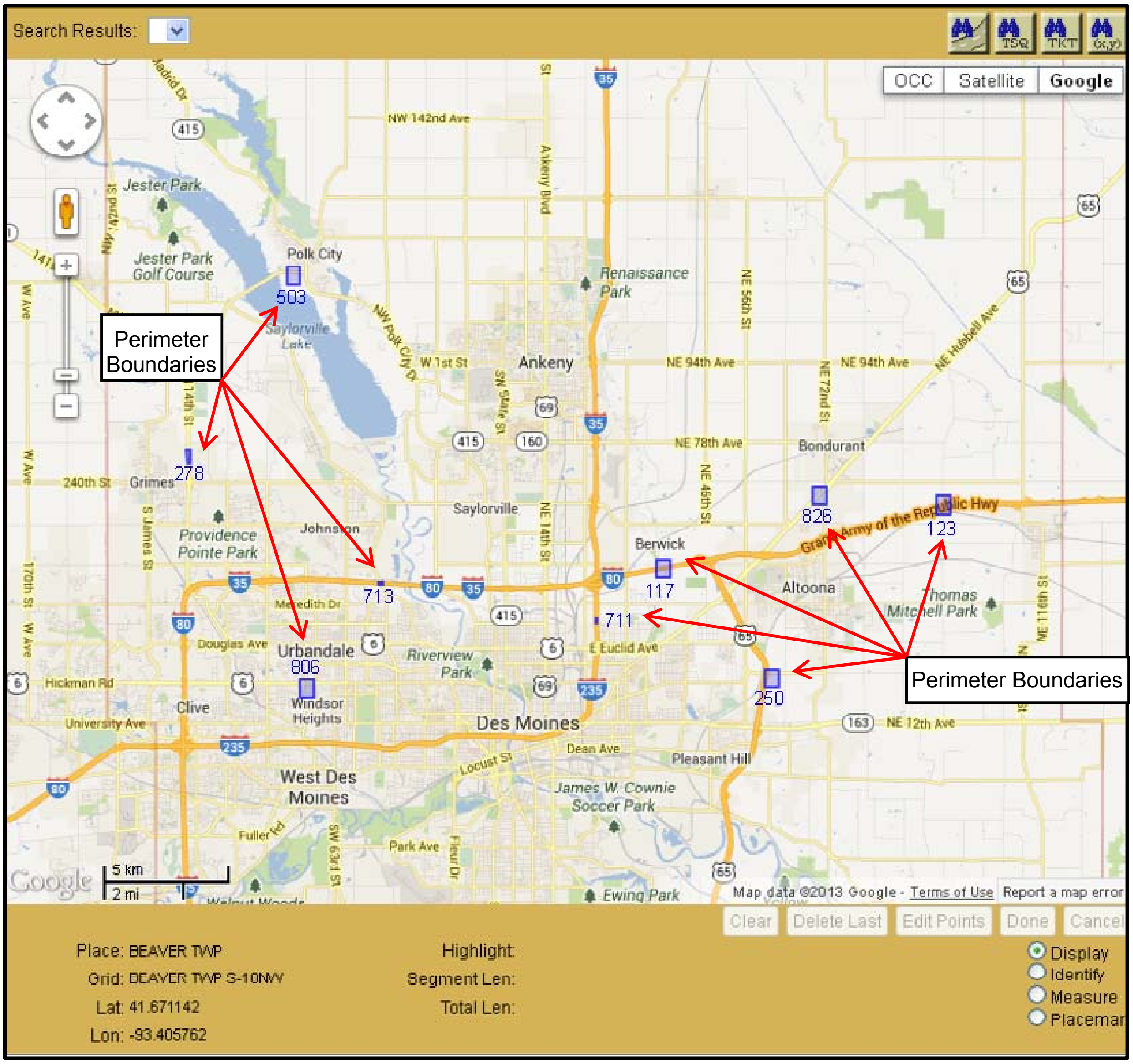

Figure 5.2: Perimeter Boundary Map example

Each request received by the Telemetrics team must be processed within the day that the request is received. The team reviews each request to determine if the underground work will affect the Continuous Count Station (CCS) equipment. If it does, they notify the Communications staff who will go to the site and either mark the location with paint or flags or temporarily pull the equipment. If it does not, they report the decision to Iowa One Call and document the decision.

In emergencies, when 48-hour advance notice is not possible, all participating operators who have facilities in the area of the excavation will receive a non-compliant notice. This means work is already underway and if you have a facility in the area it may have already been impacted.

PART 6 – IOWA DOT'S INTELLIGENT TRANSPORTATION SYSTEM

Chapter 6 – ITS Sites

The Intelligent Transportation System (ITS) collects continuous vehicle-type classification data in Metropolitan areas. The data collected expands the Continuous Count Program (CCP).

6.1. ITS Devices

The ITS traffic counters are permanent devices that continuously and automatically collect volume, speed and lane occupancy data. The data is collected by direction and lane and retrieved throughout the year.

The ITS automatic traffic counting sensor devices are non-intrusive and mounted at the edge of the roadway on roadside poles (See Figure 6.2).

Currently, the Iowa DOT uses SmartSensor HD from Wavetronix LLC (See Figure 6.1).

Figure 6.1: SmartSensor HD Device

Figure 6.2: ITS Pole Mounted Sensor

The SmartSensor HD uses radar technology (see Figure 6.3) to collect data.

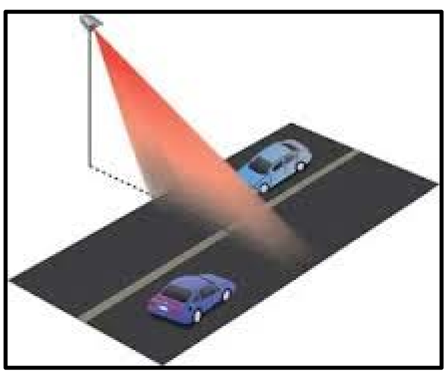

Figure 6.3: SmartSensor Radar Technology

Click 100 from Wavetronix LLC uses a contact closure module (see Figure 6.4) to collect data from the SmartSensor and translates it into a signal the Automatic Data Recorder (ADR) can read.

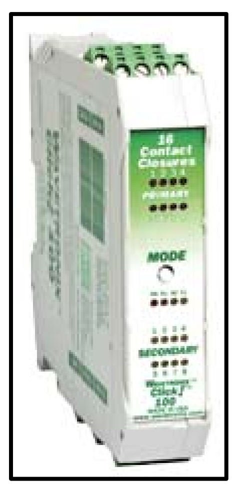

Figure 6.4: Click 100 Module

6.2. Intelligent Transportation System (ITS) Locations

ITS has traffic counters located throughout five Metropolitan Planning Organizations (MPOs): Council Bluffs, Des Moines, Iowa City, Quad Cities, and Sioux City. Currently, data is being collected only from the Des Moines sites. See Figure 6.5 for a map of Des Moines ITS sites.

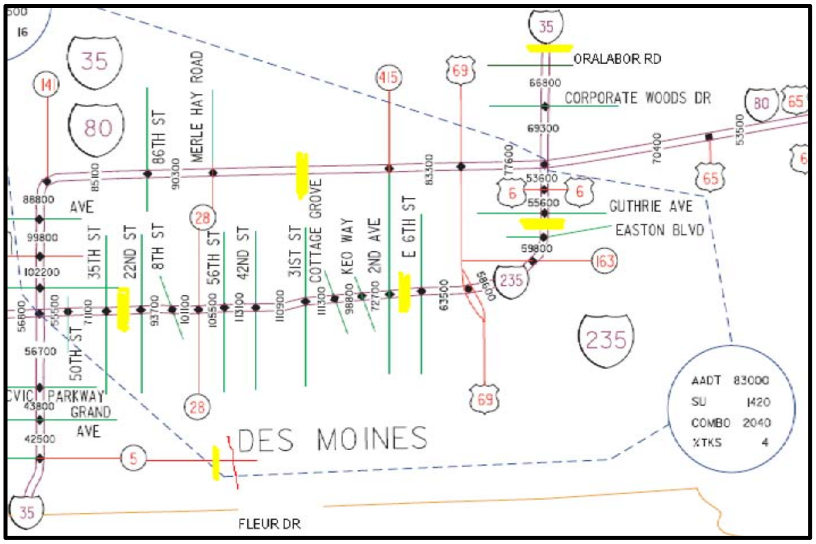

Figure 6.5: Des Moines ITS Sites

At the present time, Des Moines has six ITS sites collecting volume only data.

PART 7 – CCP ORDER PROCESS

Chapter 7 – Equipment Order Procedure

This procedure outlines the critical elements required to order Continuous Count Program (CCP) equipment. The outline provides an organized, structured process for ordering equipment. Policies and Procedures Manual (PPM) 010.01 governs the equipment ordering process for the Iowa DOT.

7.1. Telemetrics Team

The role of the Telemetrics team in the supply order process involves:

1. Evaluating the current system/inventory yearly to determine future needs.
2. Compiling a list of items to be purchased. The list should include:
    - Items to be added to the system.
    - Items needed to repair the current equipment.
3. Submitting the list each January to the Office of Systems Planning for approval.

7.2. Office of System Planning

After the list is received from the Telemetrics team, the role of the Office of Systems Planning in the supply order process involves:

1. Reviewing the list and obtaining the appropriate approvals.
2. Separating the list between “unplanned” equipment purchases and planned purchases.

    “Unplanned” purchase - The Office of Systems Planning can order CCP equipment costing $1,000 or less without going through the equipment procurement process. This type of purchase is charged to the offices cost center. To order “unplanned” equipment, the office must initiate a Requisition with a detailed product description, picture of product and a justification of need.

    Planned purchase – CCP equipment must be approved as a part of the Information Technology Procurement Plan. A request for inclusion of an item must be submitted to the user’s IT Support Team. If approved, the IT division will coordinate the requisition of the equipment.

7.3. IT Division

After the Information Technology Procurement Plan is approved, the role of the IT Division in the supply order process involves:

1. Initiating a Requisition for the equipment.
2. Obtaining approval of the Requisition.
3. Assigning the Requisition an equipment number and submitting to the Office of Purchasing.

7.4. Office of Purchasing

After an approved Requisition is received, the role of the Office of Purchasing in the supply order process involves:

1. Determining the appropriate method of procurement (formal advertising, limited solicitation or negotiation).
2. Preparing the necessary bid documents.
3. Analyzing the bids received.
4. Preparing a Staff Action when required.

5. Making the purchase.
6. Monitoring the vendor's performance.

7.5. Office of Support Services – Equipment Services

After the order has been purchased, the role of the Office of Support Services – Equipment Services in the supply order process involves:

1. Sending an equipment number tag, a serial number form, and distributing instructions to the location that will take receipt of the equipment.

   For CCP equipment, The Distribution Center will deliver the equipment to the Office of Communications.

PART 8 – IOWA DOT'S CONTINUOUS COUNT PROGRAM BUDGET

Chapter 8 – Equipment Budget

This section outlines the critical components of the Continuous Count Program (CCP) budget. The Information Processing (IP) Plan governs the equipment budget for the Iowa DOT.

8.1. The Information Processing (IP) Plan

The IP Plan is published annually and is based on the agency's information technology needs. The IP Plan serves as a decision-making guide and as a work document for the IT Division's support teams. It also serves as a tool to plan for future expenditures toward the agencies strategic information technology goals.

The IP plan can be found at http://dotnet/FY14InformationProcessingProgramandPlan.pdf

8.2. IP Steering Committee

The IP Steering committee provides direction for the agency's data processing. The committee is composed of the agency's management team and is responsible for reviewing and approving the IP Plan for each fiscal year and monitoring the progress on the plan to ensure the agencies goals are met.

8.3. IP Plan development

The IP Plan includes all equipment that costs more than $500. This includes ATR and Weigh-in-Motion (WIM) equipment. The IP Plan forms what is commonly termed the "C through G Plan."

ATR and WIM equipment is categorized as type "F" equipment. Per PPM 010.01, *F Equipment* includes radio and telecommunications equipment, office/business machines, audio/visual and reproduction equipment, and traffic instrumentation.

8.4. IP Plan funding

Funding for information technology needs is identified after an evaluation of all equipment needs. All agency equipment is purchased through a revolving fund. This fund recovers costs from divisions and offices through equipment depreciation, the sale of equipment at auction and by the Iowa General Assembly.

The 2014 IP Plan includes $360,000 for Type "F" equipment for the Planning, Programming and Modal Division. That includes:

- Mandated funds of $300,000 for the expansion of an existing system and is reserved for new sites only. The $300,000 is divided between ATR equipment ($200,000) and WIM equipment ($100,000).

- Critical replacement funds of $60,000 for ATR equipment repair. This includes unplanned equipment needs identified during the plan year that if not replaced there would be a loss of service.

8.5. Future directions for Iowa DOT's information technology

Many of the Iowa DOT's current projects will drive the agency's future information processing needs to provide increased customer service and satisfaction.

PART 9 – IOWA DOT'S CONTINUOUS COUNT PROGRAM EXPANSION

Chapter 9 – Program Expansion

The Iowa DOT is interested in expanding the Continuous Count Program (CCP) by coordinating with other available count programs.

Count programs are also conducted by MPOs, cities, counties, consultants and other transportation organizations. Each count program is responsible for the cost of equipment, installation and operation.

Determining how best to obtain, summarize, and report the shared data will be determined by the Iowa DOT's traffic monitoring staff. They will also be responsible for ensuring the data's accuracy and making it available to users.

The data from these programs will supplement and expand the CCP.

APPENDIX

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Wavetronix website. http://www.wavetronix.com/en/

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