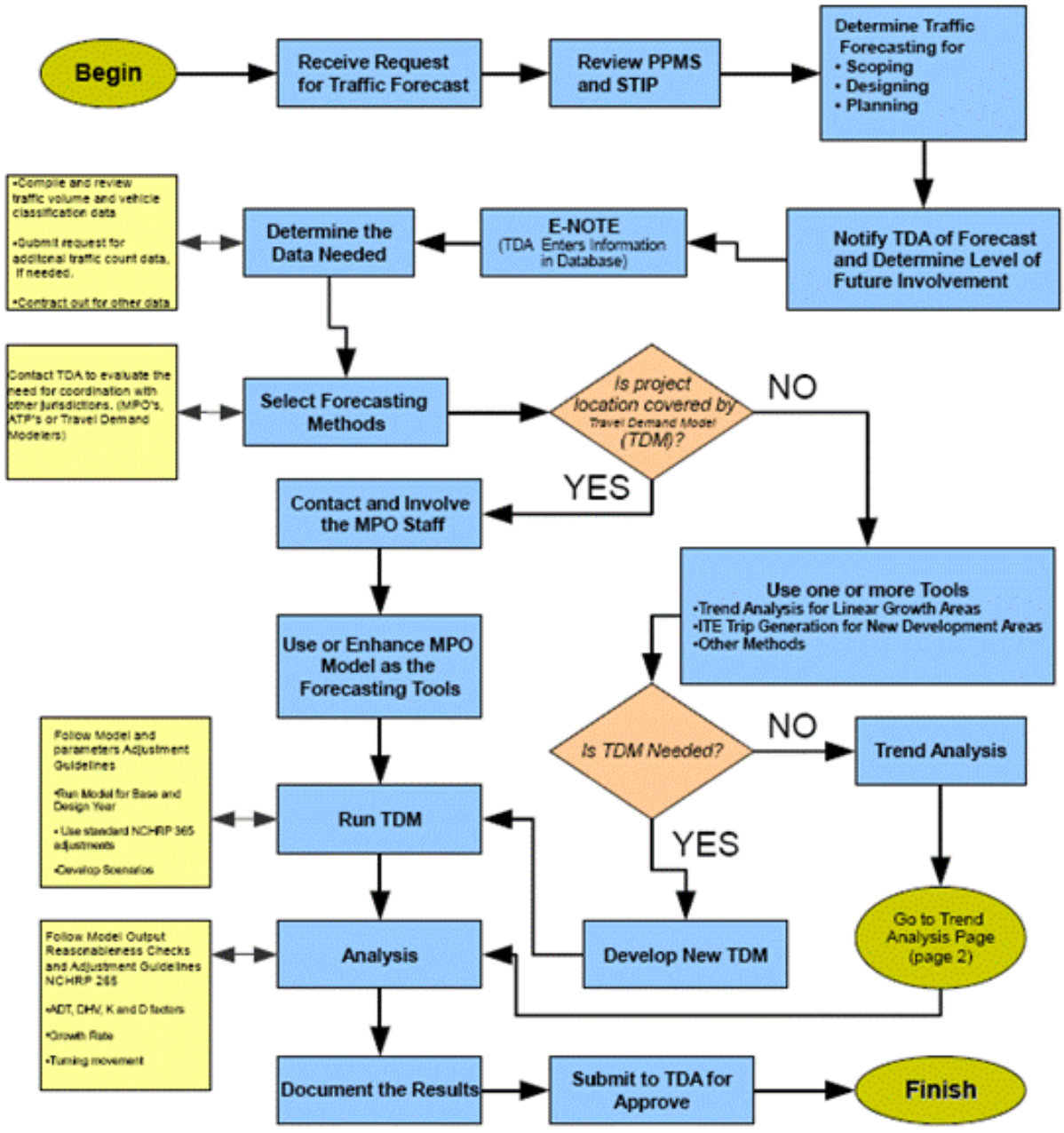
Mn/DOT Procedure Manual for Forecasting Traffic on Minnesota's Highway Systems

Prepared by:
Traffic Forecasts and Analysis Section
Mn/DOT Office of Transportation Data and Analysis
May 2012

Traffic Forecasting Process For Mn/DOT Projects



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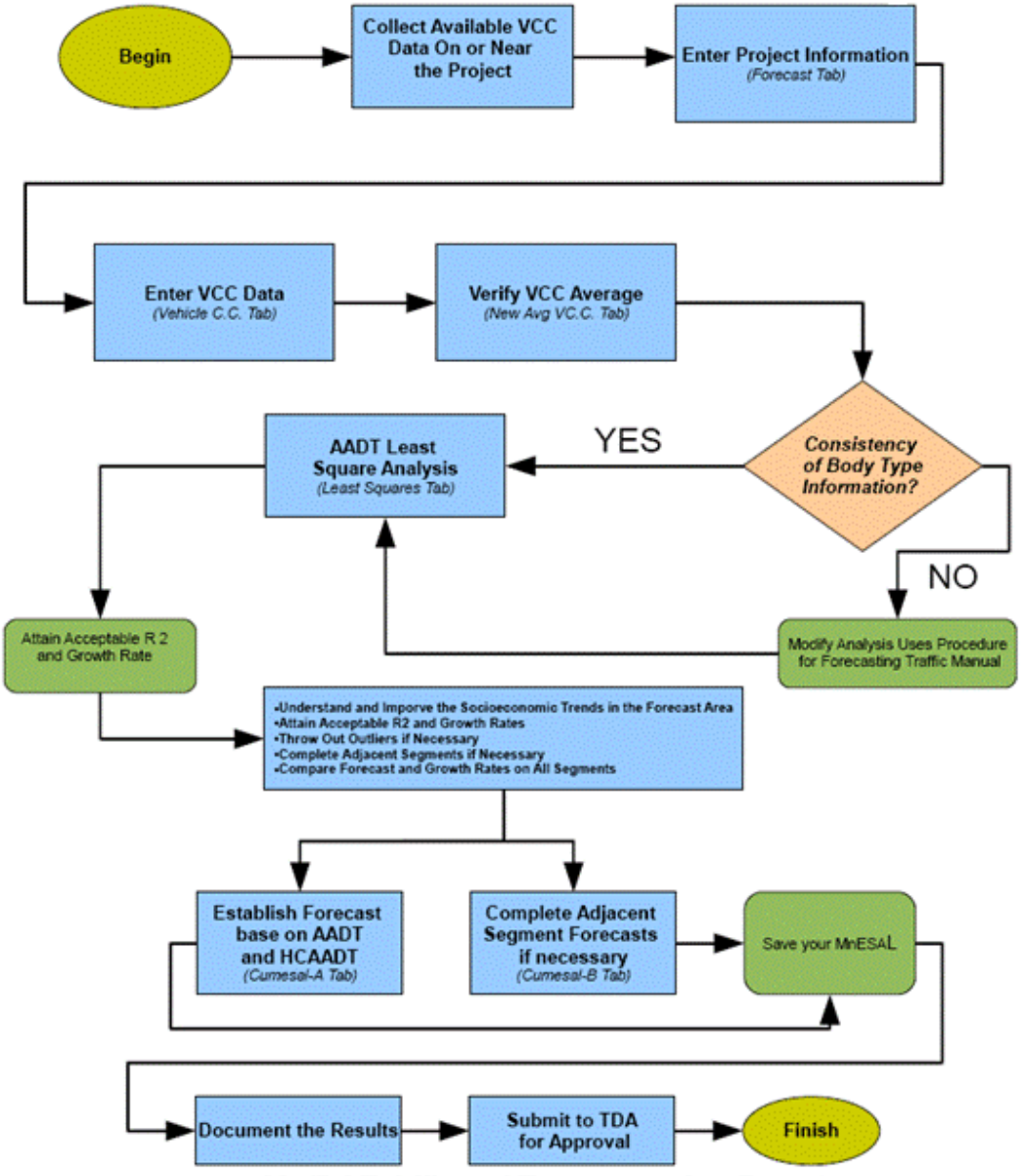
MnESAL Analysis Procedure



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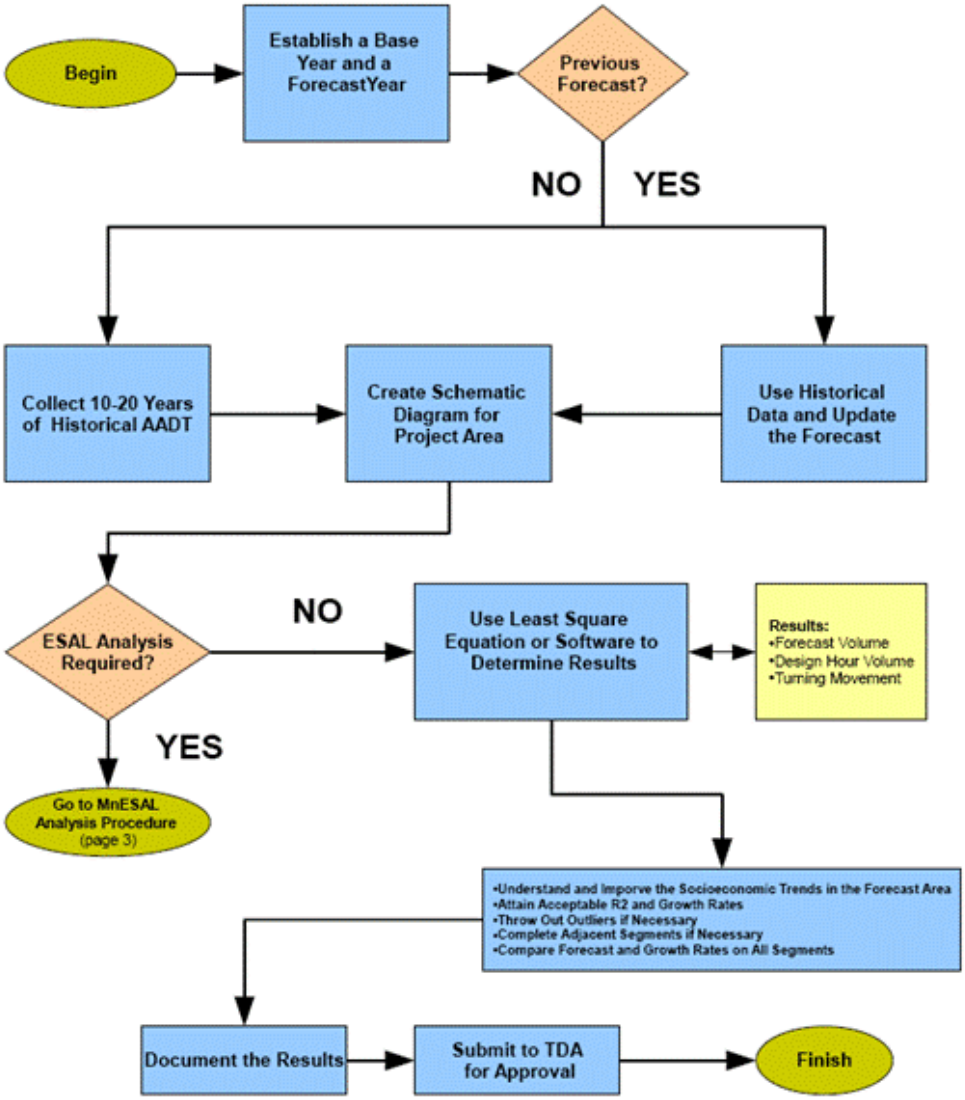
Trend Analysis



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ABOUT THIS DOCUMENT

Please contact Tom Nelson at 651 366-3868 (Thomas.nelson@state.mn.us) or Shannon McGrath at 651 366-3878 (shannon.mcgrath@state.mn.us) if you have any questions or comments on the following material. We welcome your comments, suggestions, and feedback. Any changes and revisions will be added to future editions of this report. We strive to broaden the sphere of this manual to include traffic forecasting related topics and welcome any and all ideas. This manual was originally prepared in July 2002, and has been revised in December 2002, March 2003, August 2004, August 2005, March 2006, August 2008, April 2010, and January 2012.

Traffic forecasting functions of the Minnesota Department of Transportation (Mn/DOT) are centralized. Mn/DOT has district traffic forecasters that have been trained by the Office of Transportation Data and Analysis (TDA). They have the responsibility of preparing project level traffic forecasts. After TDA approval, a traffic forecast is dispersed to our various customers and clients – designers and engineers who use the traffic forecasts for a multitude of design applications. TDA will continue to develop and improve the traffic forecasting process. This Mn/ DOT Procedure Manual for Forecasting Traffic on Minnesota's Highway Systems and the MnESAL program are some of the products on the TDA Web Page. Check out all TDA products at http://www.dot.state.mn.us/traffic/data/index.html

OVERVIEW

A basic element of roadway design is the estimation of the ESALs, where an ESAL is defined as a load of 18,000 pounds on a single axle, the cumulative loadings which a specific facility will encounter over its design life. This helps to determine the structural design. The ESAL estimate is calculated by forecasting the traffic the road will be subjected to over its design life, then converting the traffic to a specific number of ESAL based on the composition of that traffic. A typical ESAL consists of:

1. Traffic count. A traffic count is used as a starting point for ESAL estimation. Most urban areas have some amount of historical traffic count record. If not, simple traffic tube counts are relatively inexpensive and quick. In some cases, designers may have to use approximate estimates if no count data can be obtained.

2. A count or estimate of the number of heavy vehicles. This usually requires some sort of vehicle classification within the traffic count.

3. An estimated traffic (and heavy vehicle) growth rate over the design life of the pavement. A growth rate estimate is required to convert a single year traffic count into the total traffic experienced over the pavement design life.

4. Appropriate factors to convert truck traffic ESALs.

5. An ESAL forecast, which will apply the distribution of heavy vehicles to the traffic forecast and apply the ESAL factors to calculate the cumulative ESAL loadings for specific time periods, typically 20 to 50 years. Passenger cars are often ignored in ESAL calculations because the ESAL for a passenger car is typically very small, .00001 ESALS per car.

Typically, the forecasts of truck traffic are calculated from historical observations of truck counts and the trending of those observations into the future. The distribution of trucks by axle and body type is taken from an appropriate observation of truck classifications. The ESAL factors by truck axle and body type are those provided by Mn/DOT for its projects.

In typical pavement replacement projects, forecasts can be expected to be extrapolated from historical observations. This is true in Greater Minnesota. In the Metro area, future travel demand is being forecast by utilizing the Metropolitan Planning Organization's Travel Demand Model. Under Federal transportation regulations, the Metropolitan Council, the regional planning agency serving the Twin Cities seven-county metropolitan area, as the region's MPO, is responsible for maintaining a travel demand model. This model can consider the impact of highway design changes and regional travel patterns in developing future volumes for highway facilities.

Generally, the models produced by the Met Council and other local Minnesota agencies do not produce ESALS, rather, they may hire consultants to produce results that will often be verified and authenticated by MnDOT's Traffic Forecast Section.

INTRODUCTION

This procedures manual is intended to be used as a guide for preparing traffic and load projections on Minnesota's roadway systems. The loads calculated are Equivalent Single Axle Loads (ESALS). Highway designers need these forecasts to ensure proper geometric and structural designs. While the geometric design is generally based on forecasted traffic volumes, the structural design is based on the ESAL forecast.

This manual encompasses changes and enhancements in the procedure used to forecast ESALS over the past several years. There has been a revised MnESAL spreadsheet that has undergone several upgrades since the change from the initial Lotus version. The ESAL factors in the spreadsheet reflect the most recent data provided by the Office of Transportation Data and Analysis (TDA). The current MnESAL program is an updated Excel spreadsheet that has been undergoing change as new techniques surface to streamline the forecasting process.

This manual contains a step-by-step approach to traffic forecasting. It also contains pertinent background information and terminology to aid the forecaster in doing a complete and thorough job.

This manual also contains discussions of such terms as Annual Average Daily Traffic (AADT), Heavy Commercial AADT (HCAADT), Tractor Semi Trailers (TSTs), Equivalent Single Axle Loads (ESALs), Design Hour volume (DHV), Weighing-in-Motion sites (WIM), Automatic Traffic Recorders (ATRs), etc. Knowledge of these terms is extremely important in understanding the traffic forecasting process.

The following procedures will help standardize the techniques used by traffic forecasters throughout the state. This will help establish uniform forecasting methodologies that take advantage of existing and future sources of data. They will be entered into a central database, which will allow for storing and retrieving traffic forecast information. This will help to coordinate forecasts between districts when projects abut or overlap district boundaries.

Traffic forecasting, both volume and load forecasts play an important role in corridor planning, geometric design, structural pavement design, safety analysis, benefit cost analysis, access management, and environmental analysis and mitigation. The Traffic Forecasts & Analysis Section is developing new traffic forecasting methods involving data and technology.

There soon will be new requirements in the forecasting process. Mechanistic design, which applies seasonal variations in gross weight and heavy commercial vehicle volumes, and requires axle load spectra to develop roadway is being developed. Also, enhanced vehicle class, WIM, Piezo, and commodity movement data and technologies for collecting this data will be developed in the future. Traffic forecasters need to be informed about new developments and technologies involving the traffic forecasting process.

This manual should help the forecaster follow a uniform and consistent method as well as provide for reasonable and accurate forecasts. The importance of using current and historical data appropriate to individual projects is paramount. The forecaster should have a good understanding of travel behavior principles, math and statistics, a knowledge of pavement design process, design thresholds and implications of traffic forecast results and a knowledge of applicable statewide trends and past forecasts.

TRAFFIC TERMINOLOGY AND DEFINITIONS

Annual Average Daily Traffic (AADT) – the estimate of daily traffic on a road segment that represents the total traffic on a segment that occurs in a one-year period divided by 365.

Average Daily Traffic (ADT) – a 24-hour traffic volume that should be qualified by stating a time period, (e.g., average summer weekday, summer weekend, June weekday, etc). Unfortunately, ADT is sometimes used interchangeably with AADT. The terms ADT and AADT mean completely different things. AADT means average daily traffic for the year (the average traffic over the 365 day period). ADT, for example refers to

average daily traffic for the month. One may say the ADT for July is 800 while the AADT is 600 for the year. In this case the average traffic for July is 800 and could be 400 in January.

Average Summer Weekday Traffic (ASWDT) – the average Monday through Friday traffic volume on a road segment from June through August.

Heavy Commercial Annual Average Daily Traffic (HCAADT) – The estimate of daily heavy commercial traffic on a road segment that represents the total heavy commercial traffic on the segment that occurs in a one year period divided by 365. Heavy commercial traffic is defined as all vehicles with at least two axles and six tires.

Average Daily Load (ADL) – the estimate of a daily load on a roadway segment calculated from the daily total vehicle type multiplied by their appropriate ESAL factors.

Axle Load – the total load transmitted by all wheels in a single, tandem, or tridem axle configuration extending across the full width of the vehicle.

Maximum Loaded Vehicle – a heavy commercial vehicle type that is usually loaded to the legal gross weight limit. Examples of this would be: gravel trucks, grain trucks, tank trucks, etc. The presence of these body types in the traffic mix can indicate the need to use ESAL factors higher than the default values.

Design Hour Volume (DHV) – the traffic for a selected hour of the day - usually the 30th highest hour of the year for Greater Minnesota and the peak hour for the Metro Area.

Design Lane Factor (DLF) - Design Lane Factor is a factor to estimate traffic volume and truck components on heaviest traveled lanes for the purposes of ESAL estimation.

Directional Distribution (DD) – the split of traffic by direction for a selected period of time, usually the design hour.

Vehicle Classification – the classification of traffic by vehicle types, *i.e. cars, pickups, 3 axle semis, etc.).*

Vehicle Type Breakdown – the vehicle mix in a traffic volume with the following distinctions; *cars, pickups, motorcycles, 2 axle single units, 3 or more single units, 3 axle semis, 4 axle semis, 5 or more axle semis, buses, heavy single unit trucks with heavy trailers, and twin trailer semis.*

Annual Design Lane ESAL – the estimate of the total ESAL in the design lane of a roadway segment for a period of one year. This is usually reported for the base and design years of a construction project.

ESAL factor – a numeric factor that represents the average effect of each vehicle type on the pavement, based on the equivalent load concept. The concept relates the effect axles

in different configurations and magnitudes have on pavement performance as compared to the effect of a single 18,000-pound axle. These ESAL factors can vary with roadway segments and season.

Weigh in Motion (WIM) – a permanent device that continually collects and stores axle weight data. This device also collects total number of vehicles, axle spacing, length, speed, and vehicle type data. There are 15+ sites in 2012.

Tube Counters – The portable devices used to count axles and classify vehicles based on their axle spacing.

Automatic Traffic Recorders, ATR – Currently, there are 70+ devices with loops in the pavement that collect traffic volume and sometimes vehicle classification and or speed data. All are being calibrated and tested to ensure accuracy of classification on a yearly basis. These are continuous vehicle type classifiers (often called Piezos due to the type of sensor used in classifying) that are located at ATR sites.

TRAFFIC DATA SOURCES AND HOW THEY ARE PRODUCED:

AADT

ATRs –(Automatic Traffic Recorders) – Inductance loops or Piezo – 70+ sites on all types of roads, continuous and automatic, access at least once a week via telemetry; base for count (AADT) program. From them, adjustment factors are developed for short duration tube counts; then seasonal adjustment factors are produced. Speed data is collected at several sites. Products are annual ATR reports (rural and 7 County Metro Area), design hour volume, directional distribution, and historical AADTs. WIM sites can be considered ATRs.

Again, ATRs and WIMS are permanently installed and collect data 24 hours a day, 365 days per year. ATRs use loops and piezo sensors to collect volume data (1 loop), volume and speed (2 loops), and volume, speed, and classification data (2 r piezo sensors). WIMs collect volume data, speed, classification and weight data (Two Kistler piezo sensors and two loops).

Seasonal adjustment factors are developed from ATRs by using cluster analysis.

Axle correction factors – used on trunk highways only. They are developed from analyzing available vehicle class counts, then using judgment and supporting data to fit them together. They were first used in 1986 and each year they are revised.

Approximately 32,500 total short duration traffic count locations are counted on varying cycles. About ½ of Trunk Highways and ¼ or Local roads are counted each year. Forty-eight hour volume counts are taken during the weekdays

between April and October. Districts and local governments take the counts and provide the Traffic Forecasts and Analysis Section with the raw data.

Processing of counts to determine AADT – 48 hour tube counts have appropriate seasonal adjustment factors and axle adjustment factors applied. They are compared to previous cycle counts, compared to one another, and the final determination is made. Estimates are made for those locations where counts were not taken.

Transportation Information System (TISO) –Now in Oracle. Bridge data also included. All AADTs are coded into it; we make estimates for years which were not counted based on annual growth trends at ATRs and in other counties counties.

Principal users – forecasters for design (number of lanes, capacity during peak hours), programmers who schedule construction projects, safety engineers, preliminary design engineers, FHWA, etc.

Vehicle Classification – Distribution of Vehicles by Type

Tube counter and non-intrusive devices – pneumatic tube counters are used by district, county, city, and TDA personnel to gather data at about 32,000 locations during a four-year cycle. Single-tube counters yield volume data, while dual-tube counters gather volume and vehicle classification data. Non-intrusive devices, Waveronix units and TIRTL infrared systems, are used at locations where tube counters are impractical.

Manual counts – Taken for 16 hours (6am to 10pm) on two different weekdays (usually outstate Mn); data is collected by direction; body types are noted; Metro interstates are usually counted for 8 hours (8am – 4pm).

Tube Counts – Timemark and Diamond Tally 6's are used. Two tubes measure speed and hence axle spacing (which is the basis for classifying) - sometimes used for special studies, 48 hours, weekdays, between April and October, by lane and body type. These are pneumatic tubes placed across the roadway surface to count axles and measure axle spacings. Personnel from the Office of Transportation Data & Analysis collect this data.

WIM sites(seventeen permanent) – International Road Dynamics (IRD), piezo technology (Kistler quartz sensor); classifies based on axle configuration in combination with weight on front axle; continuous data accessed weekly via telemetry; no body types. Products include ESAL factors for truck types; axle weights, spacing, speed, length of vehicle, seasonal adjustment factors for adjusting short duration vehicle classification counts and summary reports available upon request. WIM systems operate 24 hours a day, 365 days a year.

As a result, they collect a large amount of data. The data collected by the WIM system is recorded as individual records. Both cars and trucks are monitored.

Update Sites –about 1000 sites, six year cycle, most on trunk highways; counted summer only – manual or tube classification (16 or 48 hours).

Piezo Sites -Vehicle class installations using Piezo sensors. The purpose is to collect continuous vehicle class data. These sites are used to produce factors for adjusting short-term vehicle class counts (manual or tube) to HCAADT (by vehicle type). We are currently testing and evaluating the "WAVETRONIX" vehicle classification system. This uses radar to classify vehicle types by length and will be used to replace the manual count system currently used. Both WIM and Piezo sites are used to track HCAADT trends.

Special Requests – Primarily for forecasters, approximately 20 per year.

Processing of counts to determine vehicle class –Manual Counts –adjust 16 hour counts using monthly/seasonal factors developed from count data at permanent Piezo and WIM sites. This adjusts for the missing eight hours at night and the effects of weekends. This adjustment is made to bring the manual counts up to AADT and HCAADT. Tube Counts are 48-hour counts also adjusted to AADT and HCAADT based on factors developed from count data at permanent Piezo and WIM sites.

Vehicle Class Program – 200 tube sites per year and about 40 manual sites per year.

Products – Include HCAADT flow map, HCAADT component in TIS, vehicle classification reports, and axle correction factors. The following are vehicle class count categories by number:

a. 1000,7000-9000	*update every 6 years (summer)*
b. 2000	*special request*
c. 3000	*special CSAH (County State Aid Highway)*
d. 4000-6000	*CSAH/County Road*

Overview of Traffic Data Collection Equipment

The Traffic Forecasting and Analysis Section relies on several different data collection devices to gather the traffic data necessary to produce all of the various products our customers request. The types of traffic information we produce include volume, including peak hour and directional distribution, classification or

vehicle type, (e.g. motorcycles, cars, buses, 2 axle single unit trucks, 5 axle semis, etc.) and weight data.

The most frequently used device is the pneumatic tube counter and it is used by district, county, city and TDA personnel to gather data at approximately 32205 locations over a two, four, or 12 year cycle. There are two types of tube counters that we employ, a single tube, volume only counter and a two tube counter that is capable of gathering volume and vehicle classification data. The vehicle classification data is developed by measuring the vehicle's axle configurations and spacings and then it is fit into a Mn/DOT class scheme or algorithm. At locations where the use of tube counters is impractical or unsafe we use non-intrusive devices to collect volume and classification data such as the WaveTronix radar unit and the TIRTL infrared system. All of these types of counts are generally taken for a period of 48 hours from Monday 12:00 PM to Friday 12:00PM and in the months from April through October.

The other system used is the permanently installed automatic traffic recorder (ATR) which comes in 4 different configurations, each of which have different costs and collect different types of data. All of the ATR's collect data 24 hours a day, seven days a week and 365 days per year. This makes the ATR the most valuable component of our traffic data collection system because from them we get complete coverage and can establish the hourly, daily, weekly and monthly variations of the traffic flow. Using the ATR data we can accurately adjust shorter duration counts to annual average daily traffic (AADT) volumes. First and the least expensive of the ATR's is the single loop/lane ATR from which we get only continuous volume data. Included in this group are loop detectors managed by the Regional Transportation Management Center (RTMC). Second is the two loop/lane counter from which we get volume and speed data. The next ATR in the hierarchy is the Piezo ATR from which we obtain classification data along with the volume and speed. Finally, at the very top of all of the ATR's is the weigh-in–motion system. This system in addition to all of the other types of data mentioned also gives us weight data for each axle of all of the vehicles recorded.

The Office of Transportation Data & Analysis supplies the districts and counties with the tube counters and pays for the installation and maintenance of the ATR's. All of this data is entered into a database and is available in raw and adjusted form to our clients through our website or is provided by our analysts if special requests are made.

2008 NEW TRAFFIC COUNTING SCHEDULE

Cycle 1: 2006, 2010, 2014, 2018 **+ Cycle 3 Off Cycle Trunks**

4-Beltrami	34-Kandiyohi	63-Red Lake
8-Brown	38-Lake	67-Rock
9-Carlton	42-Lyon	71-Sherburne
16-Cook	45-Marshall	72-Sibley
21-Douglas	46-Martin	77-Todd
26-Grant	48-Mille Lacs	79-Wabasha
33-Kanabec	55-Olmsted	84-Wilkin

Cycle 2: 2007, 2011, 2015, 2019 **+ Cycle 4 Off Cycle Trunks**

5-Benton	39-Lake of the Woods	61-Pope
11-Cass	47-Meeker	64-Redwood
15-Clearwater	52-Nicollet	65-Renville
18-Crow Wing	53-Nobles	69-St. Louis
22-Faribault	56-Otter Tail	74-Steele
25-Goodhue	57-Pennington	85-Winona

Cycle 3: 2008, 2012, 2016, 2020 **+ Cycle 1 Off Cycle Trunks**

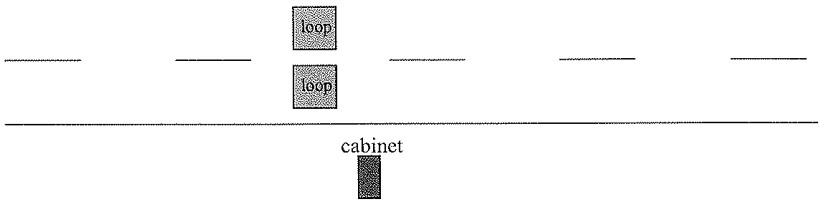
1-Aitkin	32-Jackson	59-Pipestone
3-Becker	36-Koochiching	66-Rice
6-Big Stone	37-Lac Qui Parle	68-Roseau
12-Chippewa	41-Lincoln	78-Traverse
17-Cottonwood	44-Mahnomen	80-Wadena
28-Houston	50-Mower	81-Waseca
29-Hubbard	54-Norman	83-Watonwan
30-Isanti	58-Pine	86-Wright

Cycle 4: 2009, 2013, 2017, 2021 **+ Cycle 2 Off Cycle Trunks**

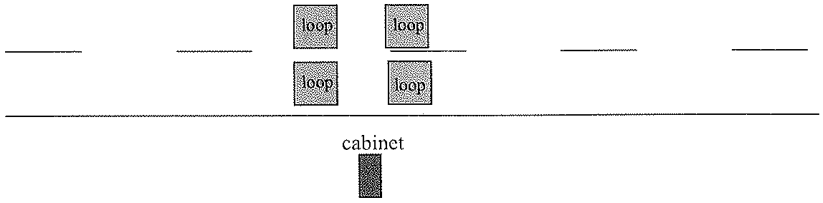
7-Blue Earth	31-Itasca	60-Polk
13-Chisago	35-Kittson	73-Stearns
14-Clay	40-LeSueur	75-Stevens
20-Dodge	43-McLeod	76-Swift
23-Fillmore	49-Morrison	87-Yellow Medicine
24-Freeborn	51-Murray	

Mn/DOT's Office of Transportation Data & Analysis is involved with the collection of different types of traffic data including, volume, speed, classification and weight. To gather this data we employ sensors that are embedded in the roadway surface such as magnetic loops, piezo-electric and Kistler piezos. These sensors are all located at sites where we have a cabinet with power and phone lines. From time to time the sensors stop working for one reason or another and we want to be able to replace the old equipment with new sensors. We also are interested in installing piezo sensors at locations where we currently have only loops. We have sites in both the seven county metro area and in greater Minnesota. The following diagrams will show the different layouts that will be encountered by an installation crew.

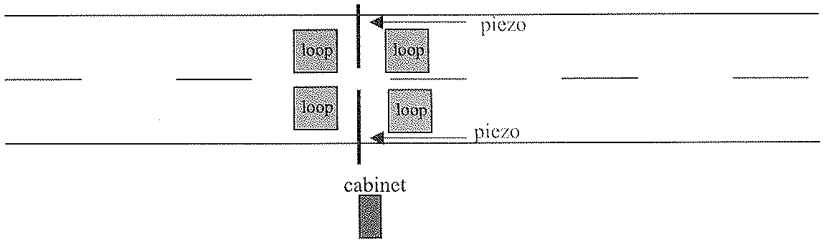
One loop per lane (volume) site



Two loops per lane (speed and volume) site



Two loops and two per lane (Classification, speed and volume) site



In the first diagram we would be interested in one of the following procedures, replace one or more of the existing loops, adding additional loops or adding additional loops and installing 2 piezos per lane. In the second diagram we would want to replace one or more loops and/or install two piesos per lane. In the third diagram we would want to replace one or more loops or piezos. Finally, we may want to install loops and piezos at a site where we do not have any equipment installed, including the cabinet, power and phone.

ROAD SYSTEM DESIGNATIONS

01	Interstate
02	U.S. Highway
03	State Trunk Highway
04	CSAH
05	MSAS
06	County MSAS
07	County Road
08	Township Road
09	Unincorporated Township Road
10	Municipal Road
11	National Park Road
12	National Forest Road
13	Indian Service Road
14	State Forest Road
15	State Park Road
16	Military Road
17	National Monument Road
18	National Wildlife Road
19	Frontage Road
20	State Game Preserve Road
21	Leg
22	Ramp
23	Private Road

Truck Weight

The historic method was to stop trucks and weigh them statically. Weigh-in-Motion (WIM) uses Kistler Quartz sensors at all active sites. These provide for continuous, automatic data that is accessed via telemetry. The data collected consists of axle weights, gross weight, axle spacing, length of vehicle, vehicle type, speed, time, lane, and ESALS. Currently, WIM data are used to adjust vehicle class and is available by individual records. WIM data are used as a source of ESAL factors on the trunk highway system.

ESALS (discussed previously) are calculated based on weights of individual axles or groups of axles; not based on gross weight.

Processing of weight data is done by vendor software, which produces summary tables. The purpose is to produce WIM reports that may or may not require editing to calculate ESAL factors for the year.

General Guidelines regarding Data Sources and Traffic Terminology

In general, a 16-hour vehicle class count taken on a weekday from 6am to 10pm will have about the same volume as the HCAADT for the year at that site.

1. The 16-hour period referred to above will have about 90% of the volume occurring in the 24 hours. It will have about 92% of the cars and 75% of the 5 axle semis.

2. Axle correction factors at a given site have generally been stable over the last 10 or 15 years.

3. An ATR count can be used in conjunction with a vehicle classification count (which may have been taken at the same site) to determine traffic trends.

4. On average, on rural trunk highways, 5 axle semis comprise about 25% of the truck traffic on low volume routes and about 75% on high volume routes.

5. Generally, higher volume routes are growing faster than lower volume routes. This applies to both rural and urban areas.

6. When going from a rural area into a town on a trunk highway, trucks comprise between 2 and 7% of the increase in traffic. When there is a small increase (2%) in trucks, there are very few 5 axle semis. When there is a larger increase (7%), there are significantly more 5 axle semis.

General Traffic Behavior and Flow Theory

1. Volumes generally do not change dramatically from year to year. Changes tend to remain small (single digit percentages) as people generally drive the same routes year after year. Volumes can change if a large generator appears or disappears, or if the condition of the route is improved or if it deteriorates substantially. Recently, we have seen that fuel prices influence driving behavior also. District personnel could verify changes in the condition.

2. The probable change in traffic from one year to another can be quantified by analyzing the ATRs grouped by functional class or some other grouping. An ATR on or close to a forecasted project will be a better source to analyze historical changes in AADT than the traffic counts shown on the maps or CD-
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3. ROM. The percentage changes can then be applied to other segments along the project route.

4. The magnitude of the change from year to year varies more on low volume roads than it does on high volume roads. Low volume routes have a wider fluctuation in growth rates than high volume routes; thus traffic is more stable from year to year on the high volume routes. For example, the rural interstate shows a shift of about 2 or 3% while the rural CSAHs have a change of 5 or 6%. As a general guideline, trunk highway traffic in Greater Minnesota averages between 2 to 3 % growth a year while the 7 County Twin Cities Metro Area traffic can grow from 3 to 4% annually. Recently, however, traffic volume growth has slowed down with increasing gas prices and a slower growing economy. Travel on Minnesota's roadways has decreased since December 2007. The year 2009 continued to see a decline in volume at most ATR stations as the state and nation experienced decreased travel, continuing a trend that began in November 2007. In 2010 there was in increase in volume at the majority of ATR stations as both the state and nation experienced an increase in vehicle travel. This was the first time since 2007 that Minnesota's yearly ATR count surpassed the total from the previous year.

5. Our present system of counting and classifying traffic usually involves counting only once at a location for 48 or 16 hours during the year. The forecaster may have a difficult time in determining if the count is in fact valid. Two counts, taken at different times of the year are much better while three are better still. If two counts agree, that is probably the correct volume. If they do not agree, one still does not know the correct volume. That is why up to four cycles of vehicle class data are averaged – representing up to 20 years of historical volumes. The forecaster needs to see if there are consistent patterns and similar vehicle class percentages.

6. When volumes change along a route over time, the change should be quite uniform, either percentage-wise or in terms of absolute volume. For example, there should not be traffic increases of 500, 25, and 150 on three adjoining segments where the base year traffic volumes are similar. The change in absolute

volume can be applied when the base year volumes along the route do not vary substantially. In those cases where the base volumes do vary a significant amount, percentages should be used either solely or in combination with absolute values. Differences in volume between adjacent segments should remain constant over time as long as traffic generators remain constant in the area. If the forecaster is unable to get recounts to verify the change in traffic, the whole series of counts taken on the road should be examined. Any counts, which show a substantial change in volume from the rest of the group, should not be used. All others should be averaged and the resulting change in volume should be applied to all segments.

7. When the history of traffic volumes for a given location has an erratic pattern, the most probable estimate of traffic over that period of years is a straight line drawn through those points (least squares). The least squares program (MnESALS) predicts future 20 year AADT as a per year growth over the base year. A constant slope (or volume) is assumed over the future 20-year period. That is not assumed to be a constant geometric percent increase. The assumption is that traffic grows in a linear fashion. For example, the 2020 volume divided by the 2000 volume may show 50% growth. We take the 50% growth and divide it by 20 years to get the per year growth rate over the base year. This number should be fairly constant along segments of a project.

8. In general, the sharper the angle of the turn from one road to another, the smaller the percentage and number of vehicles making that turn. Usually, those vehicles desiring to make that movement will have made it prior to reaching that sharp turn. The exceptions are when there are physical barriers preventing that turn or a lack of alternate roads to use prior to making that turn. Conversely, a high percentage of traffic makes the other movement.

9. A majority of the traffic, which is traveling on a minor road, will turn onto an intersecting major road when it reaches it. A small percentage of the traffic will continue on the minor road, crossing the major road. Traffic from minor roads feed onto major roads.

10. A majority of traffic on a given route goes straight through an intersection. Drivers select routes to travel, which maximize the straight stretches of road they use and minimize the number of turns. Zig-zag patterns are avoided in favor of straight line patterns.

11. Traffic diversions due to construction sometimes result in the establishment of new patterns.

12. Traffic sometimes “disappears” when a major construction project is underway. It cannot be accounted for by looking at alternative routes. The apparent explanation is that these trips must be discretionary and do not take place. They are suspended until construction is complete.

13. Traffic volumes should split close to 50-50 by direction for a 24-hour period. However, the traffic split on unique sections of roadway can be unbalanced.

ESAL Forecasting Reminders

There is a small "safety factor" built into the formulas in the MnESAL spreadsheet. This is provided in case of future changes in truck regulations and changes to truck weight laws. In Excel, there is a slight rounding up of two digit numbers (eg: 20 year inclusive is actually 21 years).

There are no tube counts for vehicle classification prior to 1994. You may want to look closely at tube data prior to 1996 also; you may want to drop those counts if they look out of line with more recent counts because of issues with the emerging technology of that time,

There are currently piezo vehicle class counters on Inter-regional corridor routes (high and medium priority IRC routes). Analysis of this data has allowed us to examine our adjustment factors for short duration vehicle class counts.

Older vehicle class counts in the 1000's have two sets of data for each year. Due to limited resources, we will not count any site more than once in any year.

Locater maps to determine the exact location of each vehicle class count are mailed to the districts in early spring of each calendar year.

County Road Thresholds - Thresholds for county roads less than 1 million ESALS can contain the following categories*:*

0-250,000 ESALS – Low
250,000 – 600,000 ESALS – Medium
600,000 – 1,000,000 ESALS – High

Trunk Highway Thresholds – Thresholds for trunk highways can be categorized into the following ESAL ranges;

0-300,000 – Very Low
300,000 -1,000,000 - Low
1,000,000 – 7,000,000 - Medium
7,000,000 – 10,000,000 – High (choice of bituminous or concrete)
10,000,000 and > - Concrete

MinniESAL Traffic Forecast Program

-for use on County and City projects

GENERAL INFORMATION

Date:	November 2, 2010
Forecasted by:	Tom Nelson
City or County:	Nicollet
Project #:	5203-85
Project Description:	MC
Route:	TH 14
Base Year (i.e., opening to traffic):	2015
Number of Lanes (both directions):	4

HISTORICAL AADT (minimum of two years)

Year	AADT
1988	4750
2009	13000

Regression Results:
R^2 = 1.0
Growth Rate = 2.6 %

Base Year AADT	**2015**	**15360**
20-year AADT	**2035**	**23210**

VEHICLE CLASSIFICATION

Please select one of the following:

- [x] Site Specific VCC Data
- [ ] URBAN (2005 Default VC Data - 3.9% HCADT)
- [ ] RURAL (2005 Default VC Data - 8.9% HCADT)

Vehicle Type	"A" Segment Forecast: Vehicle Class %	"A" Segment Forecast: Base Year Volume	Truck ESAL Factors: FLEXIBLE	Truck ESAL Factors: RIGID
2AX-6TIRE SU	2.5%	390	0.25	0.24
3AX+ SU	1.0%	156	0.58	0.85
3AX TST	0.3%	41	0.39	0.37
4AX TST	0.4%	56	0.51	0.53
5AX+ TST	6.7%	1029	1.13	1.89
TR TR, BUSES	0.4%	62	0.57	0.74
TWIN TRAILERS	0.1%	13	2.40	2.33
	11.4%			

"20" Year Flexible Forecast	**7,114,000**	**ESALs**
"20" Year Rigid Forecast	**11,146,000**	**ESALs**
"35" Year Rigid Forecast	**22,023,000**	**ESALs**

Questions? Please contact Mn/DOT's Traffic Forecasting Section (651-366-3868)

http://www.dot.state.mn.us/stateaid/sa_esal.html

State Aid ESAL Traffic Forecast Calculator - 11/15/2010

This ESAL calculator is for use with default Heavy Commerical Traffic values**; click sheet "2" below if you wish to enter your own Heavy Commercial Traffic values.**

Instructions: All yellow boxes require an input value.
Dropdown choices are provided for Base Year (C18), Number of Lanes (C19), and AADT Range (C20).
You must click on cell (C18) or (C19) or (C20) to access the dropdown choices.

General Information

Date		
Forecast Performed by		
Name of County or City		
Project Number		
Project Description		
Route Number		
Base Year (i.e. opening to traffic)	2009	
Number of Lanes (both directions)	1	
AADT Range	Rural: 1-300	
Historical AADT (enter a minimum of two years)	**Year**	**AADT**
Enter oldest traffic data here		
Enter second oldest traffic data here		
Enter third oldest traffic data here		
Enter fourth oldest traffic data here		
Base Year AADT	2009	
20-Year AADT	2029	
35-Year AADT	2044	
Growth Rate		

Vehicle Type	Vehicle Class %	ESAL Factors Flexible	Rigid
2AX-6TIRE SU	4.71%	0.25	0.24
3AX+SU	2.24%	0.58	0.85
3AX TST	0.35%	0.39	0.37
4AX TST	0.71%	0.51	0.53
5AX+TST	3.81%	1.13	1.89
TR TR, BUSES	1.45%	0.57	0.74
TWIN TRAILERS	0.01%	2.40	2.33
Total	**13.28%**	**NA**	**NA**

20-Year Flexible Forecast =
20-Year Rigid Forecast =
35-Year Flexible Forecast =
35-Year Rigid Forecast =

For State Aid questions and information, please contact Joe Thomas (Mn/DOT State Aid) at 651-366-3831.
For ESAL programming questions and information, please contact Tom Nordstrom (Mn/DOT Pavement Management) at 651-366-5537.

ESALS, MNESALS PROGRAM, AND TRAFFIC FORECASTING

ESALS

First explained on page 9, ESALS are the current measure for quantifying the decrease in ride quality of a roadway over time. An ESAL should be thought of as a damage factor rather than a load. AASHTO defines an ESAL as "one 18-kip (18000 lb.) single axle load application which will have an equivalent effect upon the performance of the pavement structure." The result will be a relative decrease in ride quality. Hence, an ESAL factor is the average damage one vehicle has on the roadway. It varies with location and commodity. An ESAL depends on structure (5) and terminal serviceability (2.5). An ESAL combined with an R-value (to be discussed later) determines structural design. At this time, a new program/model called MnPAVE is being developed which will eventually have load spectra as a traffic input rather than ESALS. MnPAVE is the name given to the new software for flexible pavement design purposes. It uses mechanistic/empirical methods to help design flexible pavements; in the MnPAVE model inputs such as climate, road structure, and load spectra will be used to determine potential pavement designs. Thus, in the future, ESALs may no longer be produced; rather, we will be providing designers with traffic input necessary to use the new AASHTO pavement design software.

MNESAL Program

At the heart of the traffic forecasting procedure is an Excel program developed to calculate ESALS and standardize forecasting methods. The MnESALS program is the documentation of Mn/DOT's traffic volume and load forecasting procedures. The current version is called "Nov 2011 MnESAL" and is available upon request from the Traffic Forecasting Unit of the Office of Transportation Data and Analysis. There is a documentation tab in the spreadsheet that elaborates on details discussed here and it also appears in this manual. The MnESAL program has been updated and is continually being modified as new techniques and suggestions from users are incorporated.

Inputs into the MnESAL program include:

1. Historic traffic volumes (20 years)
2. Historic vehicle classification breakdowns (20 years)
3. Axle load equivalency factors
4. Descriptive data including design lane factor

Outputs from the MnESAL program include:

1. Projected average annual daily traffic (AADT) – base and design year
2. Projected heavy commercial distribution (HCAADT) – base and design year by vehicle type
3. Total 20 and 35 year design-lane cumulative ESALS (flexible and rigid)
4. Documentation of work performed and assumptions incorporated into the forecast (traffic growth, land-use, etc)

What is Traffic Forecasting?

Traffic forecasting is the production of future traffic volumes and loads on a specific roadway segment. The projections are derived by trending historic data and considering the effects that future changes in the socio-economic factors will have on the particular segment.

The most common requests for traffic forecasts are:

1. Base and design year annual average daily traffic (AADT)
2. Design hour volumes (DHV) with associated directional distribution (DD)
3. Base year and design year heavy commercial annual average daily traffic (HCAADT)
4. 20 and 30 year cumulative equivalent single axle loads (ESALS)

Traffic Forecasting Procedure

The basic steps in doing a traffic forecast consist of the following:

1. A determination of what is needed
2. A check of the forecast database for previous forecasts
3. Assemble the appropriate data
4. Determine base/design year AADTs
5. Calculate vehicle type percentages
6. Create ESAL report and documentation
7. Submit copy of report to Office of TDA and they will:
    a. Enter forecast into statewide database
    b. Put location on Metro and Greater Minnesota GIS maps for inclusion onto Mn/DOT's web page
    c. Keep a file of all forecasts produced by the districts
    d. Return approved forecast to the district

What is needed by the requester and the forecaster?

The requester of a forecast needs to provide the forecaster with certain basic elements, even if the forecast is not on the Program & Project Management System (PPMS)

The requester needs:

1. AADT – current and future. Also, design hour volume, directional distribution, and turning movements may be needed
2. HCAADT – current and future
3. ESALS – (load spectra in the future)
4. Time constraints

The forecaster needs:

1. Time constraints – date forecast needs to be completed/approved
2. Trunk highway number and project limits – termini and reference points helpful
3. State project number and type of project (e.g., 5010-01 and major construction).
4. Letting date
5. County

6. Project manager
7. List of past forecasts in the area
8. Forecast number – districts use sequential numbering system depicting forecast, district, year and number, (example: F6-0215)

Traffic Forecasting Procedure – Overview

This manual cannot attempt to cover every situation that you may encounter in traffic forecasting. There are different considerations for each project and each project has to be approached individually. Some districts and areas, such as Rochester or the Metro area may use modeling as well as traditional forecasting methods. Any technique is acceptable as long as the guidelines and parameters of this manual are used and your work is documented.

Each project will have a different set of needs and data requirements, but certain procedures should always be followed. For example, the forecaster may need to consult the video log, may need to take short counts, or may need to drive around the project and take an inventory of potential truck generators, residential streets, manufacturing plants, etc. The forecaster may want to contact various databases on the WEB (Demographers Website for projected population, employment, housing unit growth, etc) and talk to city and county officials regarding the area. In short, the amount of time and effort put into a forecast will determine its accuracy. Utilizing every possible data resource can further help. Make sure to keep copies of all documentation for future use.

This manual will describe a basic approach to traffic forecasting and provide specific examples and techniques that should be followed. It is fully intended that the Office of Transportation Data and Analysis, Traffic Forecast Unit will continue to provide the expertise and knowledge and assistance to the districts. Since the MnESAL program is in Excel, an elementary knowledge of Excel is required to properly use the program.

Resources and Materials Required by the Districts

The Office of Transportation Data and Analysis is the repository for much of the data needed for traffic forecasting. For the past several years, each district has been and will continue to receive the resources necessary to do a thorough job of traffic forecasting. All forecasters should have the following materials at their disposal:

1. Yearly manual or tube vehicle class count sheets by individual site by year – some counts may have the 16 or 24-hour expansion worksheets in front of the counts. In these cases, the forecaster should run through the process of expanding the raw counts to make sure their numbers agree with the previously expanded sheet. Currently, MnDOT districts are responsible for all vehicle class counts using pneumatic tubes. They will then notify the central office as to the location of the special counts, so they can be incorporated into our database. We will still be doing our regular manual count program every summer, but we need to incorporate special counts into our program to account for all vehicle class sites. Each district will receive new individual vehicle class count sheets usually

between September and February, or as completed. Any forecaster can contact the Traffic Forecast Unit to check on the status of a particular vehicle class count. The raw data may be available even if it hasn't been sent to the districts. Vehicle class counts from 1993 onward are available in Microsoft Access. Any "problem" counts from this period can be requested by contacting the Traffic Forecast Section of TDA. Some counts are less than 16 hours and are factored to 16 hours.

2. Vehicle Class Site Maps – are located on the TDA web site and are updated annually (http://www.dot.state.mn.us/traffic/data/data-products.html). If you have any questions as to a specific vehicle class count map, please call the Traffic Forecast Unit. Maps should also include locations of ATRs WIMs, and continuous classifiers in all Mn/ DOT districts.

3. Traffic Volume Maps -Each forecaster should have traffic volume maps from 1990-2010 at their disposal – some hard copy (recent) and some microfiche (historical). The TDA web site has count maps as well as county and municipal coverage counts. All details pertaining to the Traffic Monitoring Program can be accessed through our web site.

Obtaining AADT

The official AADT is published each spring from the previous year's data collection cycle (i.e. data is collected in 2011 and published spring of 2012). Each year approximately ½ half of all the trunk highways are counted. The counting schedule can be found at: http://www.dot.state.mn.us/traffic/data/coll-methods.html.

Official AADT can be viewed in several ways by going to our web site at:
http://www.dot.state.mn.us/traffic/data/tma.html

- Traffic Mapping Application (AADT and HCAADT):
- GIS Traffic Volume Shapefile (AADT and HCAADT):
- PDF Traffic Volume Maps:
- Excel Traffic Volume Table:

Draft AADT can now also be viewed as it becomes available in the fall of the year it is counted. These values are considered DRAFT ONLY and so have the potential of changing before the official product is released in the spring.

Those that have been using TDA's online mapping tool at http://gisservices.dot.state.mn.us/Traffic-Data/ will find a couple of big improvements have been made as of February 14, 2012.

1. Login and password are no longer required
2. Official AADT and HCAADT layers have been added.

This tool is similar to the Interactive Basemap, but this application displays:

Automatic Traffic Recorder Sites
Weigh in Motion Sites
Vehicle Classification Sites
Total Volume Traffic Segments
Total Volume Traffic Count Locations
Draft AADT (when and where available)
Official AADT
Official HCAADT

If you have any questions, comments or would like further information on using any of the above mentioned mean of accessing AADT please feel free to contact our office:

- Christy Prentice, 651-366-3844 or Christy.Prentice@state.mn.us
- Carson Gorecki, 651-366-3850 or Carson.Gorecki@state.mn.us

4. Vehicle Class History – dating back to 1986- for all tube and manual counts. The history contains the vehicle class count locations, route, description, district and county. Each January a new vehicle class history will be prepared and sent out to each district. The TDA web site also has a version downloadable in Excel format. An "asterisk" will indicate the following year's scheduled count locations.

5. Special Requests for Vehicle Class Counts – Each February, the Traffic Forecast Units will send each district forecaster a note asking for any special request for the upcoming summer count season. If you know of a particular project in your district that does not have recent or appropriate data, you may want to have it counted as a special count. In the future, Central Office, the district, or a combination of both may collect this data.

6. Please notify the Traffic Forecast Section if you need vehicle class counting equipment for any counts. For example, a forecaster may want a count during sugar beet harvest season. The forecaster may want a one-week count on a particular route to measure the impact of additional heavy trucks.

7. Your vehicle class counts should include information back 20 years. Data collected prior to 20 years is no longer required in a forecast.

8. Historical Count maps and/or Microfiche dating back 20 years (1990). Among the forecaster's resources there should be a microfiche card reader for looking at historical AADT counts. You may also have a hard copy of recent count maps. Our web site can also be used to locate traffic volumes. In addition to these trunk highway counts, it is often necessary to look at historical non-trunk highway counts (i.e. county coverage of CSAHs, MSAHs, CRs, etc). The District State Aid Office should have this information. Usually, these counts are taken on a 4-year

cycle. The Traffic Forecast Unit can be contacted for help in securing these historical county coverage volumes. Twin City Metro historical count maps are on the 52 series set and are available in hard copy. In addition, cities over 5000 population back to 1984 should also be available on microfiche in the district. Current county counts are also available from the TDA web site.

9. Copies of all previous forecasts - copies of approved and submitted forecasts should be kept in the district office. If the forecaster needs to retrieve a copy of a previous forecast, or a neighboring district's forecast, please contact The Traffic Forecast Unit for help. We will locate or check in our statewide database for previous forecasts on or near your specific project area.

TRAFFIC FORECAST PROCEDURES / STEP BY STEP FORECASTING PROCESS

1. Preliminary Information

The first step in the traffic forecasting process is to determine the exact limits of the project from the project manager or the PPMS program listing. Some projects where forecasts are requested will not be in the PPMS database. In this case, the minimum information needed is the year of the project letting, the termini and the description of the project.

To see projects in PPMS, proceed to the Mn/Dot Internal Web page (http://ihub.ots/projdev/pmu/index.html) (*example 1*). The URL comes from the MN/DOT internal web site. Proceed to the Technical Support web site and then to the Project Management page. Next, proceed to the Project Activity Schedules, and then click the district that contains the project. That will take the forecaster to the desired SP number. Then, copy the information below to a separate sheet and include with the documentation. Be careful not to select extra data on the sheet.

The important elements here (to be placed on the first tab of your MnESALs and your project sketch) are SP number, highway, district, county, base year (year when road is open to traffic), project manager, program, type, beginning and ending reference point, and physical description. The forecaster may chose to open the MnESAL program at this point.

Please note that since this example, the MNESAL has been updated several times with a variety of minor changes. However, the example in this manual is still relevant as the basic concepts remain the same. The changes in the spreadsheet and current version will be detailed later in this manual. The CURRENT VERSION of the MnEsal will reside on TDA's website and is at located at the back of this manual.

Example 1
Mn/DOT Internal Project Management Activity Schedule

SP: 2315-15 **Proj Seq: 42268** **Hwy: 16** Top of 6

SP: 2315-15 **HWY:** 16 **CNTY:** Fillmore **STATUS:** Planned **ORG.LET:** 1-25-13 **CUR.LET:** 1-25-13
DESCRIPTION: MEDIUM BITUMINOUS MILL AND OVERLAY FROM TRACY RD. (SPRING VALLEY) TO W. JCT. T.H. 52 - BETTER ROADS FOR MINNESOTA CANDIDATE - 2013
PROGRAM: RS **WRK TYPE:** Pvmnt Resurf and Rehab **ORG.COST:** $4,754,000
MI: 15.895 **BEG.RF.PNT:** 214+00.893 **COST EST CHANGE:** **CUR.COST:**
FY: 13 **END RF.PNT:** 231+00.020 **AUTH DATE:** **AGREE AMT:**
BUS LIAISON: **PARCELS:** **RELOCS:** **R/W COST:**
PREL. PROJ. MGR: Rezac, Jake **FIN. DES. PROJ. MGR:** Rezac, Jake **RES. ENG:** Lovelace,Gary
DESIGN ENG: Kempinger, Mike **FUND DESIGNATORS:** **PLANS READY DATE:**
JOB NUMBERS: 2301-12: P=T6A153, 2302-17: P=T6A154, 2315-15: P=T6A152
ASSOCIATED SPs: 2301-12, 2302-17
EST. CONST START: 5-1-13 **EST. CONST FIN:** 9-1-13 **TRAFFIC IMPACT:** Low Traffic Impact

2. Sketch

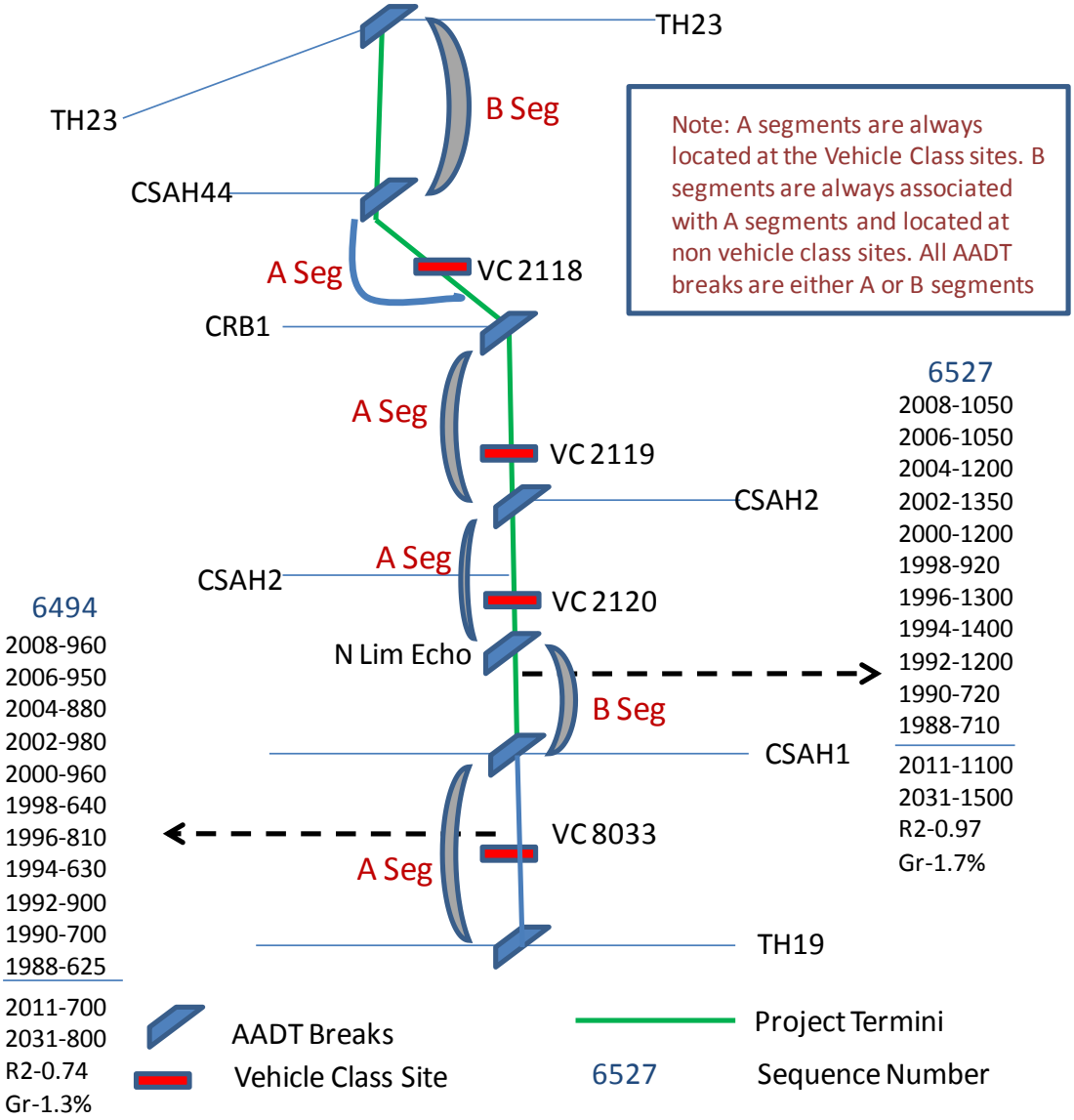
Next, take the information discussed above and create a sketch of the project area. During the course of the traffic forecast, the sketch is the single most important "piece of paper" you will refer to during the process *(example 2)*. Initially, the forecaster may use the most current AADT maps (hard copy or TDA web site). For Greater Minnesota use the county maps showing the AADTs and in the 7 County Metro Area, use the 52 series maps. Place the most current traffic volumes on the sketch. Include the full length of the project termini. If the project crosses trunk highway boundaries, be sure to include the next trunk highway break in your sketch. This is important for vehicle class site determination. Always end your sketch with a trunk highway junction at each end.

Example 2- Sketch –F8-1002

TH 67 Historic Traffic Volumes

TH67 from Th23 to Echo
SP 8707-51
Yellow Medicine County, map 2 of 2
MP32.571 - 49.42
Letting Date 3/30/10
Project Manager – Karnowski
F8-1002
Base Year 2011, Forecast Year 2031

VC 8033
Years 2006, 1998, 1992, 1986



Example 2 contains a "completed sketch" similar to what the sketch should look like when you start the ESAL forecast. Initially, the forecaster should concentrate on

producing a traffic forecast for AADT. In the above example, there is a sketch, complete with verbal description of the project and other pertinent data contained on the PPMS report. Include all AADT breaks within the project termini out to the nearest trunk highway breaks. At every junction, it will be necessary to compile historic counts (in two year increments) using 20 years of data. A variety of count maps and microfiche cards with historical counts can be used during the trend analysis.

Always begin with the MOST recent count. From about 1994 to 1980, there were more count sites taken and that will be reflected on the older microfiche cards. For example, where there will be one count between AADT breaks on the 2008 count maps, there may have been three, or four, or any number between the same AADT breaks for 1994. The forecaster should take the "physical location" of the older counts and match it up with the recent counts. In other words, don't average the older counts – pick one location on the map or microfiche closest to the 2006, 2004, 2002, or 2000 count location. This is a critical phase in AADT forecasting, since using AADTs from different locations can affect the 20-year AADT projections. As of 2012, the current MnESAL goes from 1990 to 2010 on the sketches and on the least square. The example shown above goes from 1988 to 2008.

On the sketch there are several other terms that will be discussed later. For now, it is sufficient to know that we will add "A" and "B" segment information as well as vehicle class site information on the sketch as we continue through the step-by-step forecasting process. Besides all vehicle class location sites, it will be necessary to look on the map and include all ATRs and WIMs. Note any of these sites adjacent to the project, or further along the trunk highway for future reference. Also, on the sketch, a 20 year AADT projection as well as a statistical value called R squared (a statistical measure of goodness of fit) and annual AADT growth over the 20 year AADT forecast have been added.

The letting date is used to determine the base year that is essentially the project completion date. If the letting year is late in the year - October, November, or December, it is likely the project will not be completed until the following year. For example, if a project shows a letting date of 11/20/11, we probably would calculate the base year as 2012 and the forecast year (design year) as 2032. However, a major project may have a letting year of 2012, and may not open until two or three years later; in this case, it is the responsibility of the forecaster to contact the project manager to determine the base year.

Thus, the starting point in developing a forecast for a project is to determine the current or base year AADT. All other items to be forecasted flow either directly or indirectly from the AADT. If the project is on a new alignment, include that on your sketch also. You may prefer to indicate that by use of a dotted line.

In most cases, the assumption will be made that the most recent historic counts are the most accurate. We will compare the AADTs to each other and to other AADTs along the project. This must be done because no individual count is necessarily correct. We will eventually adjust the AADT so that the best estimate of future traffic is obtained. It may

be desirable to look at traffic counts on parallel routes to determine the growth rate in the corridor. This helps place things in perspective.

One final word on AADT - the AADT on your sketch maps represents the traffic volume between two locations. The counts are usually located at the junction of trunk highways or at the corporate limits of towns. A problem can arise when strip development occurs at the edge of towns and traffic significantly increases as a result. The traffic beyond the development may not have increased nearly as rapidly. This is one reason why the forecaster should obtain local knowledge of the area or visit the area and make short counts. In addition, a check of the video log of the project area can yield further information on the number of lanes traffic generators, and traffic patterns.

3. MnESAL Spreadsheet –Forecast Tab

At this point in the forecasting process, the forecaster may want to open the MnESAL spreadsheet and begin filling in the first tab. A downloadable version of this in EXCEL format is located on the TDA website at :
http://www.dot.state.mn.us/traffic/data/data-products.html

Detailed information on the use of MnESAL begins on page 30 of this report. In order to avoid corrupting the original spreadsheet, the forecaster should immediately save a different file name than MnESAL. In our continuing TH67 example, the forecaster may want to save the forecast with the following typical name: TH67-F8-1002-.xls (the name of the trunk highway and the sequential number of the forecast for that particular district). *Example 3* shows the first tab on the bottom left of the MnESAL spreadsheet called "Forecast". The tabs are basically filled in from left to right, with the "Documentation" tab on the far left.

4. Vehicle Class Site, WIM, ATR

Vehicle type determination is the next step. The source of heavy commercial traffic (HCAADT) is the manual and tube vehicle classification counts. *Example 4* shows the location of our sample project. Vehicle class site locations can be found on the TDA website at: http://www.dot.state.mn.us/traffic/data/data-products.html.
Note the location of VCC site 8033 on our sketch. This VCC site, as well as other sites used in the forecast would also be put on your final sketch. Any WIM or ATR sites would show up on your district vehicle class maps. The forecaster should put the location of the vehicle class sites on the sketch.

5. Previous Forecasts

At this point, the forecaster may check for any previous forecasts in the area. The Traffic Forecast and Vehicle Classification Unit may be contacted or the forecaster may browse the maps on TDA's website (www.dot.state.mn.us/traffic/data/html/forecast.html) Forecasts in the area, or on similar stretches of trunk highway should be consulted for consistency of AADT, HCAADT, and ESAL flow.

6. Vehicle Class History

After determining the appropriate vehicle class site, the forecaster should look at the vehicle class history. The history and location of vehicle class sites can be obtained from the TDA web site at (www.dot.state.mn.us/traffic/data/data-products.html#class). The forecaster should list the four most recent count years (there may be only one if it is a special count). In example 2, VCC #8033 was counted in the years 2006, 1998, 1992 and 1986.

7. Vehicle Class Counts and Vehicle Types

Collect copies of the raw counts from the vehicle class count books in your office. If you are missing some, contact the Traffic Forecast and Vehicle Class Unit. E*xample 5* - Hourly Vehicle Class Count for site 8033(shown on your sketch) shows the 2006 tube vehicle class count used in the sample forecast. The manual (16 hour) and tube (48 hour) counts will have different formats, but the vehicle type breakdown information at the bottom of the page is identical.

Example 3- Forecast Tab – F8-1002

MNESALS Spreadsheet

MINNESOTA DEPARTMENT OF TRANSPORTATION

MEMO

Transportation Data and Analysis
395 John Ireland Boulevard - MS 450
St. Paul, Minnesota 55155

Phone: (651) 366-3856
Fax: (651) 366-3886

April 20, 2010

To: Michael Lownsbury

From: Gene Hicks
Section Director
Traffic Forecasting and Analysis, MS 450

Subject: TRAFFIC FORECAST

Route Type:	MN TRUNK	Beg Pt	32.571
Route Num	67	End Pt	49.42
Letting Date:	2011	SP#	8707-51
Program Category:	RS	Forecast #	F8-1002
Project Manager:	KARNOSKI	County:	YELLOW MEDICINE
		District:	8
		Miles:	16.834

Project Limits: TH23 TO ECHO

Enclosures (check those that apply):

	Project map	X	VCL expansion worksheet
X	Least squares analysis	X	Cumulative ESAL Report
X	Cumulative ESAL worksheet, Segment A		Other (describe)
X	Cumulative ESAL worksheet, Segment B		Other (describe)
X	AADT and/or DHV traffic schematic diagram		

REMARKS:

TEST OF NEWEST MNESAL

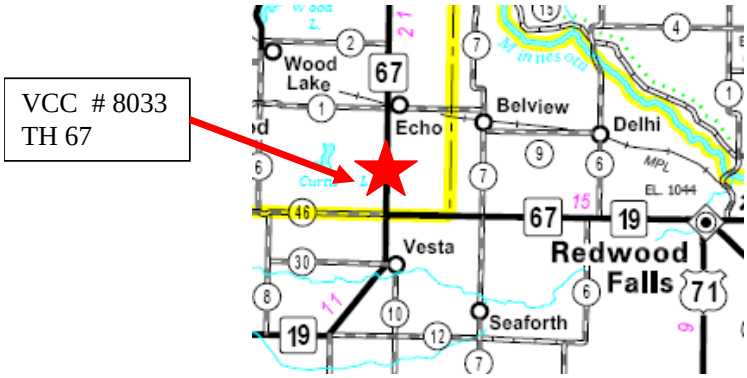
Example 4- Vehicle Class Location Map –F8-1002

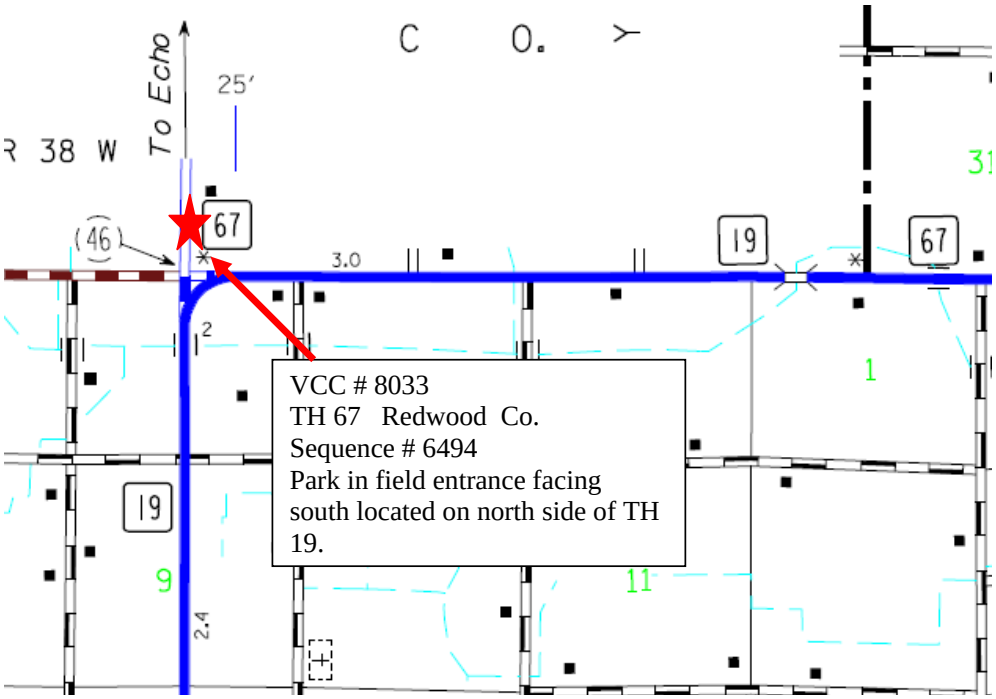
VCC # 8033

District 8

TH 67 (North of Jct TH 19 & 67)

Redwood County Sheet 1 Sequence # 6494





Your vehicle class count notebooks should contain data to 1986. They may be in the form of three ring binder notebooks or printout versions for those in the 1980's. In either case, the raw data, in a 16-hour (manual) or 48-hour (tube) format, should have vehicle type breakdowns into eight categories (including passenger cars) summarized at the bottom of the page. The difference is that the tube counts DO NOT have body type breakdowns, whereas the manual counts do. *Example 5* shows the format of a typical tube vehicle class count and *Example 6* shows a typical manual count.

Note that the semis are split into tank, dump, grain, stake, other, and 6 axles.
During a forecast, it is IMPORTANT to find the body type in at least one count year at a vehicle class site. Then the forecaster will know when to split heavies; that is, allowing for higher ESAL factors for routes where there are more grain, tank, dump, and stake trucks. Those types of semis are usually heavier than the "other" category and need to be accounted for in your forecast. A later discussion will show how the body type affects the ESAL forecast.

As far as vehicle classification, it is important to know that the vehicle class count manuals in your district office have different vehicle classification groupings and totals. There is a FHWA classification scheme and a Mn/DOT vehicle classification scheme. For purposes of traffic forecasting, we use a classification scheme based on eight vehicle types. Those eight types are groupings of multiple vehicle types shown as totals at the bottom of vehicle class sheets from 1993 to the present (see bottom of *example 5 and example 6 on the following two pages*).

Example 5- Vehicle Class Site 8033 –2006 Tube- F8-1002

Site 8033 **Route** TH 67 **Description** N OF JCT TH19 & TH67 **County** REDWOOD **DIS** 8

	DAT	TIME	M-CYCL	CAR	P/U	BUS/HTWT	2AXSU	3AXSU	4+AXSU	3 +4SEMI	5AXSEMI	6+AXSEMI	TWINS	TWINS	TWINS	OTHER
South	10/24/05	12:00	0	11	8	0	1	0	0	0	4	0	0	0	0	
	10/24/05	13:00	0	9	3	0	1	1	0	0	1	0	0	0	0	
	10/24/05	14:00	0	12	7	0	0	0	0	1	3	0	0	0	0	
	10/24/05	15:00	0	24	1	1	0	0	0	0	4	0	0	0	0	
	10/24/05	16:00	0	27	11	0	1	1	0	0	2	0	0	0	0	
	10/24/05	17:00	0	13	6	0	0	1	0	0	3	1	0	0	0	
	10/24/05	18:00	0	13	1	0	0	0	0	0	1	0	0	0	0	
	10/24/05	19:00	0	7	3	0	1	0	0	0	0	0	0	0	0	
	10/24/05	20:00	0	9	3	0	0	0	0	0	2	0	0	0	0	
	10/24/05	21:00	0	4	0	0	0	0	0	0	0	0	0	0	0	
	10/24/05	22:00	0	2	1	0	0	0	0	0	0	0	0	0	0	
	10/24/05	23:00	0	0	0	0	0	0	0	0	0	0	0	0	0	
	10/25/05	0:00	0	0	1	0	0	0	0	0	1	0	0	0	0	
	10/25/05	1:00	0	0	0	0	0	0	0	0	0	0	0	0	0	
	10/25/05	2:00	0	1	0	0	0	0	0	0	0	0	0	0	0	
	10/25/05	3:00	0	0	0	0	0	0	0	0	1	0	0	0	0	
	10/25/05	4:00	0	0	0	0	0	0	0	0	0	0	0	0	0	
	10/25/05	5:00	0	2	1	0	0	0	0	0	0	0	0	0	0	
	10/25/05	6:00	0	9	4	0	0	0	0	1	1	0	0	0	0	
	10/25/05	7:00	0	16	8	0	3	0	0	0	1	0	0	0	0	
	10/25/05	8:00	0	11	9	0	0	0	0	0	3	0	0	0	0	
	10/25/05	9:00	0	6	3	0	1	0	0	0	5	0	0	0	0	
	10/25/05	10:00	0	11	1	0	1	0	0	0	4	0	0	0	0	
	10/25/05	11:00	0	6	0	0	0	0	0	0	4	0	0	0	0	
	10/25/05	12:00	0	6	9	0	0	0	0	0	10	0	0	0	0	
	10/25/05	13:00	0	13	7	0	0	0	0	0	1	0	0	0	0	
	10/25/05	14:00	0	6	3	0	0	0	0	0	3	0	0	0	0	
	10/25/05	15:00	0	9	5	0	0	1	0	0	3	0	0	0	0	
	10/25/05	16:00	0	21	9	0	1	0	0	0	1	0	0	0	0	
	10/25/05	17:00	0	14	11	0	0	0	0	0	1	0	0	0	0	
	10/25/05	18:00	0	10	2	0	0	0	0	0	1	0	0	0	0	
	10/25/05	19:00	0	7	11	0	0	0	0	0	0	0	0	0	0	
	10/25/05	20:00	0	10	2	0	0	0	0	0	0	0	0	0	0	
	10/25/05	21:00	0	5	2	0	2	0	0	0	0	0	0	0	0	
	10/25/05	22:00	0	4	3	0	0	0	0	0	1	0	0	0	0	
	10/25/05	23:00	0	0	0	0	0	0	0	0	0	0	0	0	0	
	10/26/05	0:00	0	0	0	0	0	0	0	0	0	1	0	0	0	
	10/26/05	1:00	0	0	0	0	0	0	0	0	0	0	0	0	0	
	10/26/05	2:00	0	0	0	0	0	0	0	0	0	0	0	0	0	
	10/26/05	3:00	0	0	0	0	0	0	0	0	0	0	0	0	0	
	10/26/05	4:00	0	2	0	0	0	0	0	0	2	0	0	0	0	
	10/26/05	5:00	0	1	1	0	1	0	0	0	5	0	0	0	0	
	10/26/05	6:00	0	7	5	0	0	0	0	0	3	0	0	0	0	
	10/26/05	7:00	0	17	6	0	2	0	0	0	0	0	0	0	0	
	10/26/05	8:00	0	17	6	0	0	0	0	0	3	3	0	0	0	
	10/26/05	9:00	0	11	10	0	1	0	0	0	1	0	0	0	0	
	10/26/05	10:00	0	9	5	0	1	0	0	0	2	0	0	0	0	
	10/26/05	11:00	0	0	0	0	0	0	0	0	0	0	0	0	0	
	DIRECTION TOTALS		0	362	168	1	17	4	0	2	77	5	0	0	0	
	% of Total Vehicles			49%	44%	20%	40%	36%		50%	49%	42%				
	SITE TOTALS		0	734	380	5	43	11	0	4	158	12	0	0	0	1347

Veh. Type Breakdown for ESAL Calc	MotoCycl	PASS VEH	2 AX SU	3+ AX SU	3 AX SEMI	4 AX SEMI	5+ AX SEMI	TRKTLR/BUS	TWINS	TOTAL	%HC
	0	557	22	6	1	1	85	2	0	674	17.4%

Example 6- Vehicle Class Site 8033 – 1998 Manual- F8-1002

SITE 8033 **ROUTE** TH 67 **DESCRIPTIO** N OF JCT TH19 & TH67 **COUNTY** REDWOOD **DIST** 8 **RECORDER** CCL

				Single Units					*Semis*											*Trailers*		*Twins*	
								Heavies															
	Begin Hour	Date	Pass. Vehicle	2ax	2ax tan	3ax plu	3ax+ tank	3ax	3ax tan	4ax	4ax tan	5ax dum	5ax tan	5ax grai	5ax stlo	5ax stu	5ax othe	6ax+	Bus	HTWT	HTWT Tank	T5ax+	Total Vehicle
South	6:00	05/26/98	27	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	29
	7:00	05/26/98	19	1	0	0	0	0	0	0	0	2	0	0	0	0	0	0	1	0	0	0	23
	8:00	05/26/98	16	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	17
	9:00	05/26/98	15	2	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	19
	10:0	05/26/98	18	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	19
	11:0	05/26/98	18	1	0	0	0	0	0	0	0	2	1	0	0	0	4	0	0	0	0	0	26
	12:0	05/26/98	20	0	0	1	0	0	0	0	0	0	1	0	0	0	2	0	0	0	0	0	24
	13:0	05/26/98	31	0	0	0	0	0	0	2	0	0	0	0	1	0	0	0	0	0	0	0	34
	14:0	05/24/98	12	1	0	0	0	0	0	0	0	3	0	0	0	2	2	0	0	0	0	0	20
	15:0	05/24/98	24	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	1	0	0	0	27
	16:0	05/24/98	25	0	0	1	0	0	0	0	0	3	1	0	0	0	0	0	0	0	0	0	30
	17:0	05/24/98	29	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	31
	18:0	05/24/98	11	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	13
	19:0	05/24/98	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15
	20:0	05/24/98	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9
	21:0	05/24/98	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
	Directional Totals:		295	5	0	4	0	0	0	2	0	16	4	0	1	3	10	0	2	0	0	0	342
	Site Totals:		596	13	0	5	1	0	0	2	0	52	11	0	3	4	24	2	4	0	0	0	717

16 Hour Totals for Calculating ESALS by Month:	*Pass. Vehicles*	*2 Axle SU*	*3+ Axle SU*	*3 Axle Sem*	*4 Axle Sem*	*5+ Axle Sem*	*Trk Trl/Bu*	*Twin*	*Total Veh*	*Hc %*
	596	13	6	0	2	96	4	0	717	16.9%

In summary, there are vehicle class counts in various formats and groupings of vehicle types from 1970 to the present, in either manual or tube formats. From 1993 to the present, there should be summary totals of the eight vehicle groupings on the bottom of the reports. In the case of a 2-lane roadway, the summary totals will be on the bottom of one sheet, and on a 4 lane there will be two totals for each vehicle class site in these eight groupings.

From 1978 to 1992, the forecaster will see vehicle class counts in a variety of different formats. Some will contain body types on eight hour count sheets, some will have separate body type sheets, and some will be 24 hour sheets that are in reality 16 hours (since the midnight to 6am period will have zeros), and some count sheets will have manual totals on top of the count sheets.

The vehicle class counts you will encounter from 1990 until the present time will NEED TO BE EXPANDED in your MnESAL spreadsheet. The data from 1980 to 1989 HAS ALREADY BEEN EXPANDED, and should be contained in one of your resource books. This will save the forecaster a lot of work. However, body type information will need to be collected on all data prior to 1990 to evaluate the split into heavies (again, the heavies being tank, dump, grain and stake trucks when on a timber or granite route). Vehicle class output from 1993 to the present is available in an Access database.

Examples 7, 8, and 9 show various older vehicle classification schemes and body type reports (not from our sample forecast). For our forecasting procedures, combine all different vehicle classifications into the eight classification types. In every older vehicle format, it may be necessary to manually or with a calculator combine all truck types into our basic categories. The forecaster then "expands" these counts into AADT and HCAADT. The body type information is used ONLY FOR THE 5 AXLE SEMI CATEGORIES.

The Eight Vehicle Types used in Traffic Forecasting:

a. Type 1 - Cars or Passenger vehicles – includes motorcycles, pickups and cars. This category includes cars pulling recreational or light trailers and all standard pickup trucks; also includes 2 axle 4 tire single unit vehicles. This could be pickups, vans, panels, motor homes, carryalls, etc. Any 2 axle 4 tire single unit vehicle pulling recreational or other trailers are included in this classification.

b. Type 2 – Two Axle Single Unit Trucks – includes all 2 axle 6 tire trucks. This includes all vehicles on a single frame, having 2 axles and dual rear wheels.

c. Type 3 - Three Plus Axle Single Unit Trucks – includes 3 or more axle single unit trucks. This includes all vehicles on a single frame having 3 or 4+ axles.

d. Type 4 – Three Axle Semis – Consists of all semis with 3 axles consisting of two units, one of which is the tractor and the other is a trailer.

e. Type 5 – Four Axle Semis – Consists of all semis with 4 axles consisting of two units, one of which is the tractor and the other is a trailer

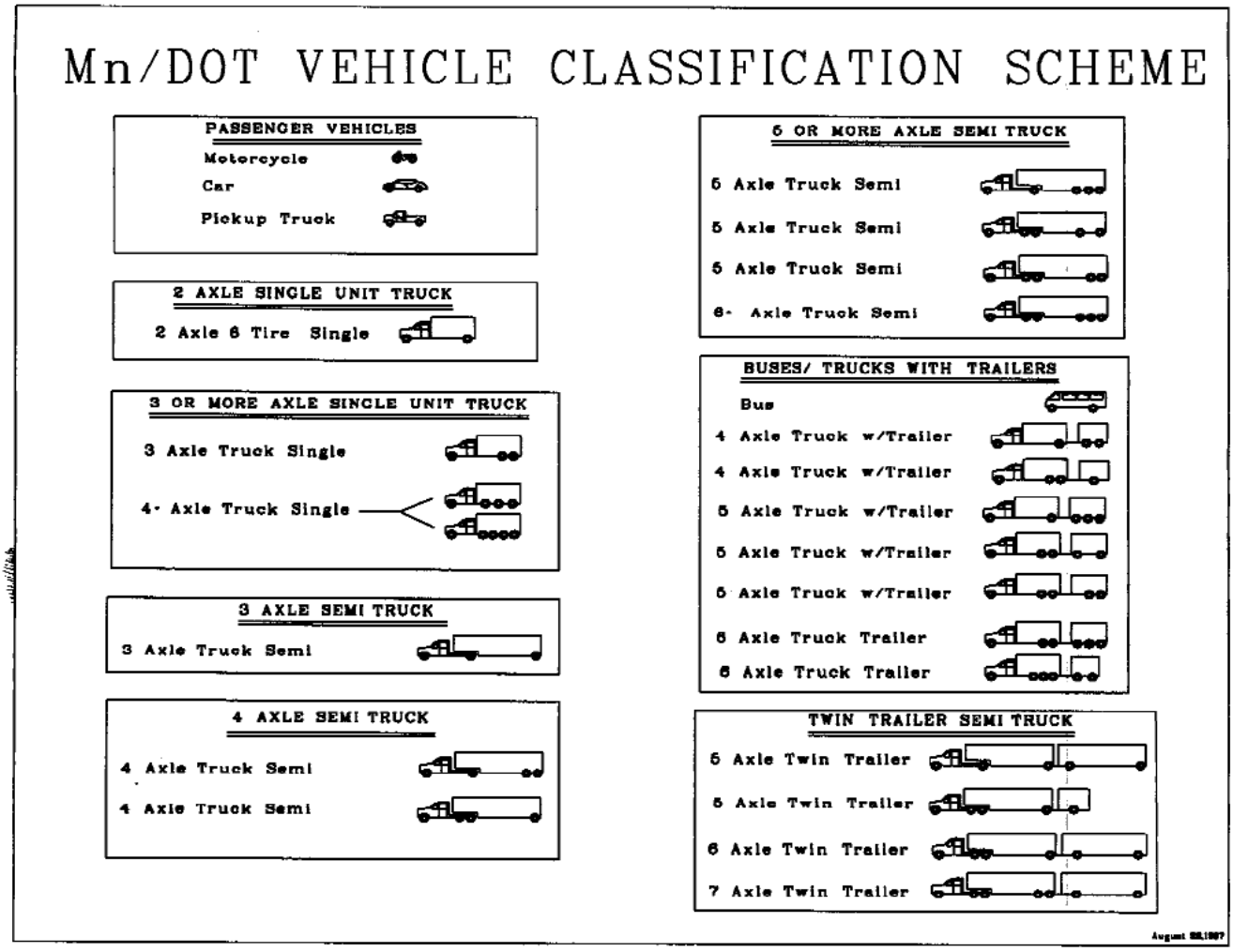
f. Type 6 – Five Plus Axle Semis – Consists of all semis with 5 or more axles consisting of two units, one of which is a tractor and the other is a trailer.

g. Type 7 – Heavy Truck with Trailer / Bus – This category includes buses and heavy trucks with trailers. A heavy truck with trailer can have 3 or more axles.

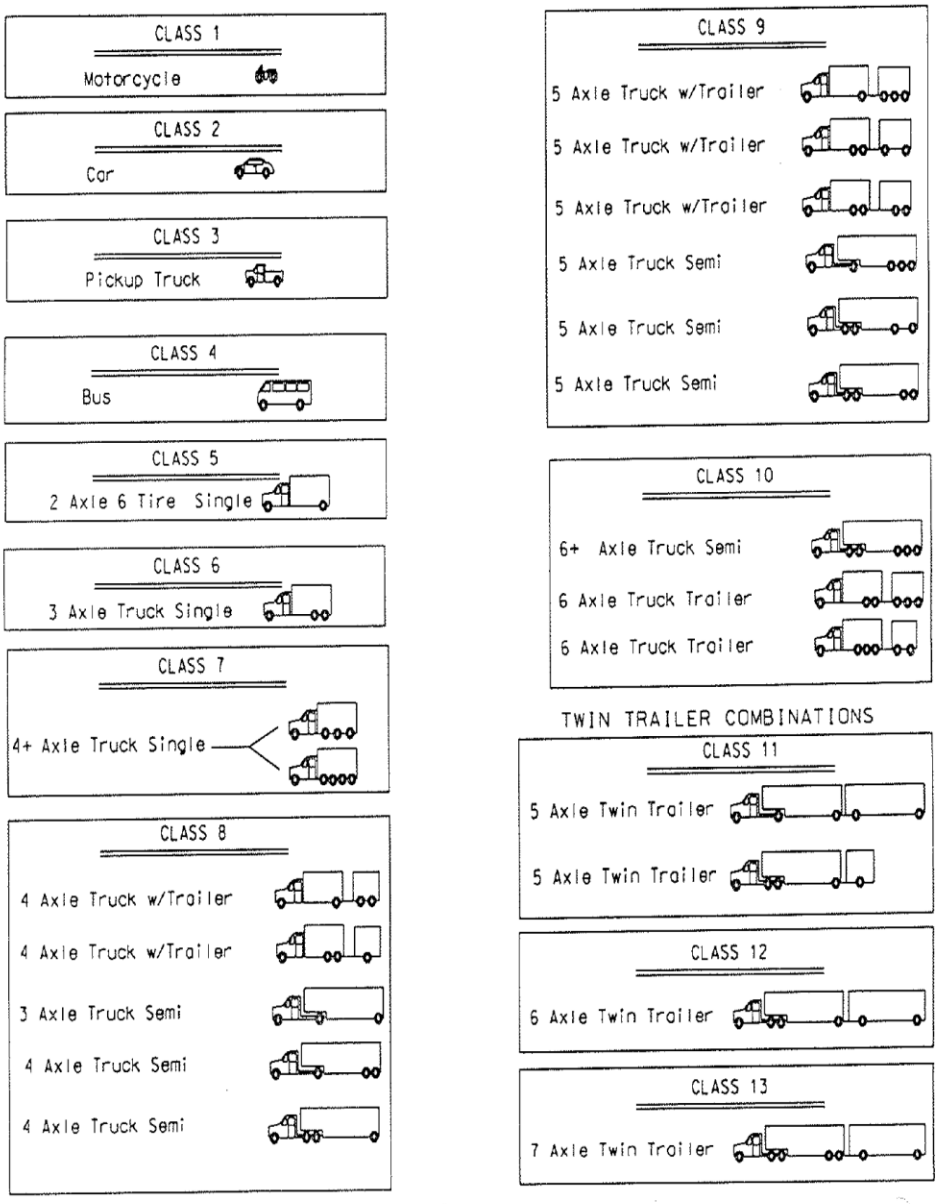
h. Type 8 – Twins – These are semis with two separate trailers. Twins can have 5 or more axles

Figure 1-Truck Types

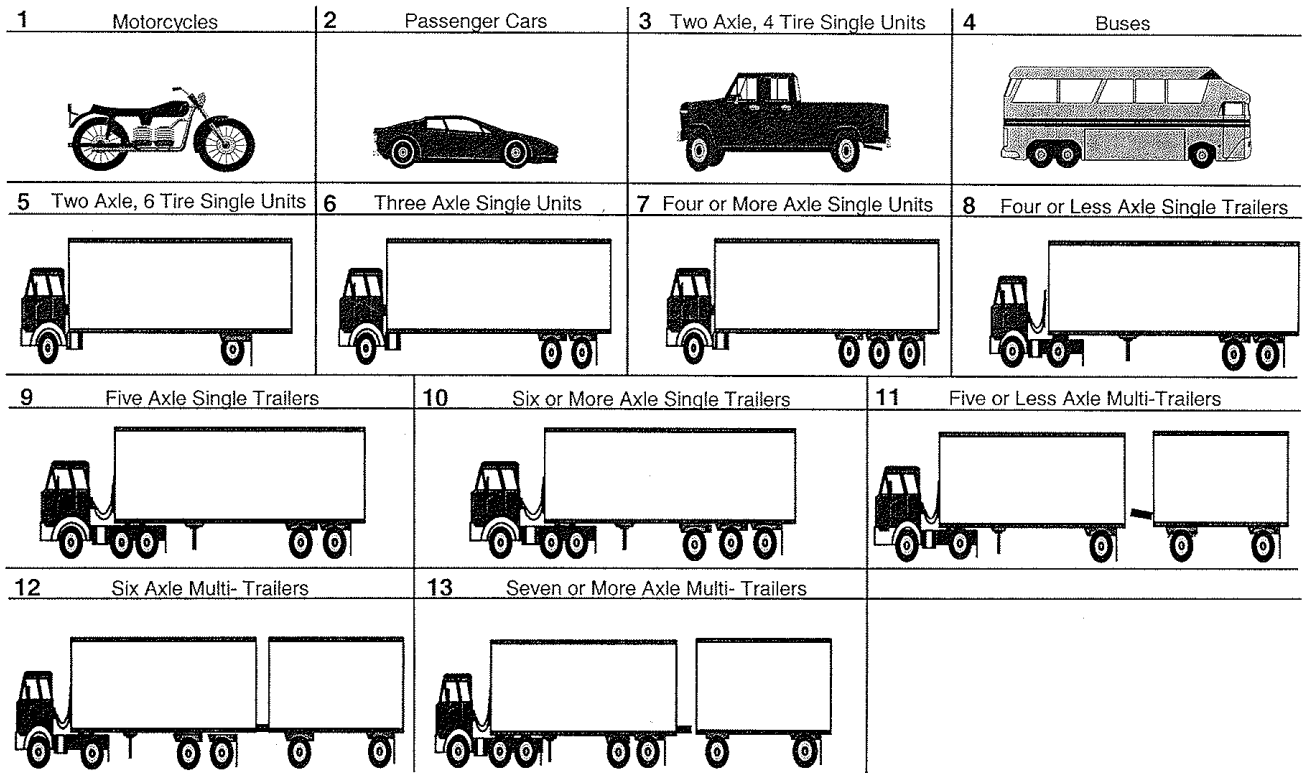
Truck Types Used In TrafficForecasting



FHWA CLASSIFICATION SCHEME



FHWA VEHICLE CLASSIFICATIONS



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12/11/2014

Federal Standards Conversion
to MnDOT Vehicle Class Format

	Type
Cars —	1+2+3
2ASU —	5
3+ASU —	6+7
3ASemi —	8 x .35
4ASemi —	8 x .65
5+ASemi —	9+10
*TT/Bus —	4
Twins —	11+12+13

VEHICLE CLASS GROUPINGS FOR FORECASTING

PASSVEH = [BIKES]+[CARS]+[PICKUPS]
CLASS 1 + 2 + 3

2AXSU = 2AXSU
CLASS 5

3+AXSU = [3AXSU]+[4+AXSU]
CLASS 6 + 7

3AXSEMI = .35*[3&4SEMI]
CLASS 8 * 0.35

4AXSEMI = .65*[3&4SEMI]
CLASS 8 * 0.65

5+AXSEMI = [5AXSEMI]+[6+AXSEMI]
CLASS 9 + 10

TRKTRLR/BUS = BUS&HTWT
CLASS 4

TWINS = [TWINS1]+[TWINS2]+[TWINS3]
CLASS 11 + 12 + 13

Example 7- Vehicle and Body Type Report (1992)

HOURLY COUNTS BY VEHICLE TYPE

HO9
KLA

STUDY_____8 LOCATION #____740
DIRECTION___9-COMBINED HOURS_____14-21
CYCLE_____1-SUMMER DAY OF WEEK___2-WEEKDAY

HR	TOT VEH	TOT TRKS	CARS & PNLS PKPS	SINGLE UNIT TRUCKS 2AX	3AX	4+AX	BUS	SEMIS 3AX	4AX	5AX	6+AX	TRUCK TRAILERS 4AX	5AX	6+AX	TW.TR. 5AX	6AX
14	233	7	226	7	0	0	0	0	0	0	0	0	0	0	0	0
15	336	8	328	8	0	0	0	0	0	0	0	0	0	0	0	0
16	401	8	393	5	0	0	3	0	0	0	0	0	0	0	0	0
17	332	4	328	3	0	0	1	0	0	0	0	0	0	0	0	0
18	283	0	283	0	0	0	0	0	0	0	0	0	0	0	0	0
19	209	1	208	1	0	0	0	0	0	0	0	0	0	0	0	0
20	208	0	208	0	0	0	0	0	0	0	0	0	0	0	0	0
21	166	1	165	1	0	0	0	0	0	0	0	0	0	0	0	0
	2168	29	2139	25	0	0	4	0	0	0	0	0	0	0	0	0

DATE(S):HOUR___08/11/92: 14-21

Default 2

VEHICLE AND BODY TYPE

STUDY_____8 LOCATION #_____740
DIRECTION___9-COMBINED DATE(S) & HOURS__08/11/92: 14-21
CYCLE_____1-SUMMER
HOURS_____14-21
DAY OF WEEK_2-WEEKDAY

BODY TYPE

VEHICLE TYPE	TANK	STAKE	REFR	VAN	DUMP	PANEL	GRAIN	CATTLE	OTHER	TOTAL
2-AXLE TRUCK	0	8	1	14	0	2	0	0		25
3-AXLE TRUCK	0	0	0	0	0		0	0		0
4-AXLE TRUCK	0				0				0	0
3-AXLE SEMI		0		0					0	0
4-AXLE SEMI	0	0	0	0				0	0	0
5-AXLE SEMI	0	0	0	0	0		0	0		0
6-AXLE SEMI									0	0
4-AXLE HTWT									0	0
5-AXLE HTWT									0	0
6-AXLE HTWT									0	0
5-AXLE TW.TR.	0			0			0		0	0
6-AXLE TW.TR.									0	0
TOTAL	0	8	1	14	0	2	0	0	0	25

Example 8- Body Type Report (1990)

DATE: 1990. VEHICLE AND BODY TYPE BASED ON RAW DATA FOR

STUDY 7 LOCATION 126 TH 68 E OF JCT TH15 7 BROWN

1 DIRECTION(S) 1 CYCLE(S)

16 HOUR WEEKDAY COUNTS

BODY TYPE

VEHICLE TYPE		TANK	STAKE	REFRIG	VAN	DUMP	P/P	GRAIN	CATTLE	OTHER	TOTAL
CARS,PANELS + PICKUPS											
	VOLUME										2016
	PERCENT										
2 AXLE-6 TIRE TRUCKS											
	VOLUME	1	13	3	7	1	5	0	0		30
	PERCENT	3.3	43.3	10.0	23.3	3.3	16.7	0.0	0.0		
3 AXLE TRUCKS											
	VOLUME	0	1	0	3	5		1	1		11
	PERCENT	0.0	9.1	0.0	27.3	45.5		9.1	9.1		
4+ AXLE TRUCKS											
	VOLUME	0				1				0	1
	PERCENT	0.0				100.0				0.0	
BUSES											
	VOLUME							0*	0*	0	0
	PERCENT							0.0	0.0	0.0	
3 AXLE TRACTOR-SEMI TRLR											
	VOLUME		0		4					0	4
	PERCENT		0.0		100.0					0.0	
4 AXLE TRACTOR-SEMI TRLR											
	VOLUME	0	1	0	4				0	0	5
	PERCENT	0.0	20.0	0.0	80.0				0.0	0.0	
5 AXLE TRACTOR-SEMI TRLR											
	VOLUME	28	10	6	7	1		21	2		75
	PERCENT	37.3	13.3	8.0	9.3	1.3		28.0	2.7		
6+ AXL TRACTOR-SEMI TRLR											
	VOLUME										1
	PERCENT										
4 AXLE TRUCK TRAILER											
	VOLUME										0
	PERCENT										
5 AXLE TRUCK TRAILER											
	VOLUME										1
	PERCENT										
6+ AXLE TRUCK TRAILER											
	VOLUME										2
	PERCENT										
5 AXLE TWIN TRAILER											
	VOLUME	0			0			0		0	0
	PERCENT	0.0			0.0			0.0		0.0	
6+ AXLE TWIN TRAILER											
	VOLUME										1
	PERCENT										

NOTE - BLANKS INDICATE THAT DATA WAS NOT COLLECTED FOR THIS CATEGORY
*BUS BODY TYPES ARE COMMERCIAL + SCHOOL FOR GRAIN + CATTLE RESPECTIVELY

Example 9 - 16 Hour Raw Count (1990)

RAW DATA SUMMARY STUDY: 7 LOCATION: 126 TH 68 E OF JCT TH15 7 BROWN
DATE: 1990. DIRECTION: BOTH CYCLE: 1 DAY OF WEEK: WEEKDAY DATES: AM 7/13/90 PM 7/12/90

HOUR		TOTAL VEHICLES	TOTAL TRUCKS	CARS & PANELS PICKUP	2 AXLE 6 TIRE TRUCK	3 AXLE TRUCK	4+AXLE TRUCK	BUSES	3 AXLE SEMI	4 AXLE SEMI	5 AXLE SEMI	6+AXLE SEMI	4 AXLE TRUCK TRLR	5 AXLE TRUCK TRLR	6+AXLE TRUCK TRLR	5 AXLE TWIN TRLR	6+AXLE TWIN TRLR
12- 1 AM	VOLUME	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	PERCENT		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1- 2 AM	VOLUME	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	PERCENT		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2- 3 AM	VOLUME	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	PERCENT		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3- 4 AM	VOLUME	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	PERCENT		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4- 5 AM	VOLUME	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	PERCENT		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5- 6 AM	VOLUME	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	PERCENT		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6- 7 AM	VOLUME	83	4	79	0	0	0	0	0	0	3	0	0	1	0	0	0
	PERCENT		4.8	95.2	0.0	0.0	0.0	0.0	0.0	0.0	3.6	0.0	0.0	1.2	0.0	0.0	0.0
7- 8 AM	VOLUME	119	5	114	0	0	0	0	0	0	3	1	0	0	0	0	1
	PERCENT		4.2	95.8	0.0	0.0	0.0	0.0	0.0	0.0	2.5	0.8	0.0	0.0	0.0	0.0	0.8
8- 9 AM	VOLUME	111	9	102	4	1	0	0	1	3	0	0	0	0	0	0	0
	PERCENT		8.1	91.9	3.6	0.9	0.0	0.0	0.9	2.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9-10 AM	VOLUME	157	15	142	4	3	0	0	1	6	0	0	0	1	0	0	0
	PERCENT		9.6	90.4	2.5	1.9	0.0	0.0	0.6	3.8	0.0	0.0	0.0	0.6	0.0	0.0	0.0
10-11 AM	VOLUME	119	11	108	2	0	1	0	0	8	0	0	0	0	0	0	0
	PERCENT		9.2	90.8	1.7	0.0	0.8	0.0	0.0	6.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11-12 AM	VOLUME	134	8	126	1	1	0	0	0	6	0	0	0	0	0	0	0
	PERCENT		6.0	94.0	0.7	0.7	0.0	0.0	0.0	4.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12- 1 PM	VOLUME	133	12	121	3	0	0	0	0	9	0	0	0	0	0	0	0
	PERCENT		9.0	91.0	2.3	0.0	0.0	0.0	0.0	6.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1- 2 PM	VOLUME	140	6	134	2	0	0	0	0	4	0	0	0	0	0	0	0
	PERCENT		4.3	95.7	1.4	0.0	0.0	0.0	0.0	2.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2- 3 PM	VOLUME	154	13	141	4	0	0	0	0	9	0	0	0	0	0	0	0
	PERCENT		8.4	91.6	2.6	0.0	0.0	0.0	0.0	5.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3- 4 PM	VOLUME	176	14	162	6	1	0	0	2	0	5	0	0	0	0	0	0
	PERCENT		8.0	92.0	3.4	0.6	0.0	0.0	1.1	0.0	2.8	0.0	0.0	0.0	0.0	0.0	0.0
4- 5 PM	VOLUME	201	12	189	2	3	0	0	1	2	4	0	0	0	0	0	0
	PERCENT		6.0	94.0	1.0	1.5	0.0	0.0	0.5	1.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0
5- 6 PM	VOLUME	181	7	174	1	2	0	0	0	0	3	0	0	0	1	0	0
	PERCENT		3.9	96.1	0.6	1.1	0.0	0.0	0.0	0.0	1.7	0.0	0.0	0.0	0.6	0.0	0.0
6- 7 PM	VOLUME	150	6	144	1	0	0	0	0	1	4	0	0	0	0	0	0
	PERCENT		4.0	96.0	0.7	0.0	0.0	0.0	0.0	0.7	2.7	0.0	0.0	0.0	0.0	0.0	0.0
7- 8 PM	VOLUME	114	5	109	0	0	0	0	1	0	4	0	0	0	0	0	0
	PERCENT		4.4	95.6	0.0	0.0	0.0	0.0	0.9	0.0	3.5	0.0	0.0	0.0	0.0	0.0	0.0
8- 9 PM	VOLUME	97	0	97	0	0	0	0	0	0	0	0	0	0	0	0	0
	PERCENT		0.0	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9-10 PM	VOLUME	78	4	74	0	0	0	0	0	0	4	0	0	0	0	0	0
	PERCENT		5.1	94.9	0.0	0.0	0.0	0.0	0.0	0.0	5.1	0.0	0.0	0.0	0.0	0.0	0.0
10-11 PM	VOLUME	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	PERCENT		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11-12 PM	VOLUME	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	PERCENT		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	VOLUME	2147	131	2016	30	11	1	0	4	5	75	1	0	1	2	0	1
	PERCENT		6.1	93.9	1.4	0.5	0.0	0.0	0.2	0.2	3.5	0.0	0.0	0.0	0.1	0.0	0.0

One last note on the data collection phase for vehicle class counts -- from 1993 to the present, all vehicle class counts are available via Access or Excel. The Traffic Forecast Section can send electronically any output of tube or manual counts from 1993 to the present. In 1993, there were only manual counts; from 1994 to the present, there is a mix of manual and tube counts. 1980 to 1992 counts have to be expanded, but they are not available on computer.

8. Other Data Sources

After gathering all the vehicle class data for a particular traffic forecast, the forecaster may want to look at a few other data sources, such as the State Demographic Office (www.demography.state.mn.us), the Minnesota Department of Employment and Economic Security (www.deed.state.mn.us), Metropolitan Planning Organizations (MPOs), Area Transportation Partnerships (ATPs), Regional Development Commissions (RDCs), and City or County Traffic Engineers. City and county planners can provide useful information about land use planning and projected developments, and county engineers may provide information about future county projects that may cause detours and changes in traffic patterns along a trunk highway. The State Demographic Office can provide useful information on population, household, labor force, and income data by county and city (as well as projections) and the Minnesota Department of Economic Security has useful information on employment by industry and region.

9. Raw Vehicle Class Count Data

At this point, the forecaster should have all the historical vehicle class data arranged from most recent to oldest, a sketch with historical AADT, AADT breaks, vehicle class count site locations, and pertinent PPMS data. Beginning with the most recent vehicle class count, the next step is to expand raw data into HCAADT. During this step, it is important to remember that we are basing a yearly HCAADT on a 16 or 48-hour traffic count, a snapshot in time. We assume this is representative of the month in which the count was taken.

Again, the "forecasting process" assumes that the raw data taken at that site on a typical weekday can be expanded to represent an average daily vehicle type breakdown for the entire year. With the use of three or four points in a 20-year period, the assumption is that the traffic patterns are consistent over time, and although AADT usually increases over time, the vehicle percentages usually remain constant. Studies have shown that although the vehicle class count represents 16 to 48 hours of an entire year, in general it is representative of the average weekday traffic for a given month of the year.

10. Forecast Worksheet

Continuing our sample forecast on TH67, we have started filling out the "Forecast" tab in MnESALS (*example 3*) from the PPMS information in *example 1* and have obtained a typical vehicle class raw data report for vehicle class site 8033 *(examples 5 and 6*). The forecaster will notice the next four tabs to the right are virtually identical, allowing you to complete four vehicle class expansions. This will be accomplished by using one or more worksheets on the MnESAL - "16-24 Vehicle C.C. 1" through "16-24 Vehicle C. C.4" tabs of the spreadsheet program (example 10).

Example 10 - 2006 Vehicle Class Expansion Worksheet
MNESALS F8-1002

16 HR. OR 24 HR. VEHICLE CLASS COUNT EXPANSION WORKSHEET 1

SITE NUMBER: 8033 **COUNTY:** YELLOW MEDICINE

SITE DESCRIPTION: NORTH OF TH19 AND TH67

PROJECT SP#: 8707-51 **YEAR OF COUNT ->:** 2006

MONTH NUMBER OF COUNT: 10 - October **CONSTRAIN AADT ->:** 950

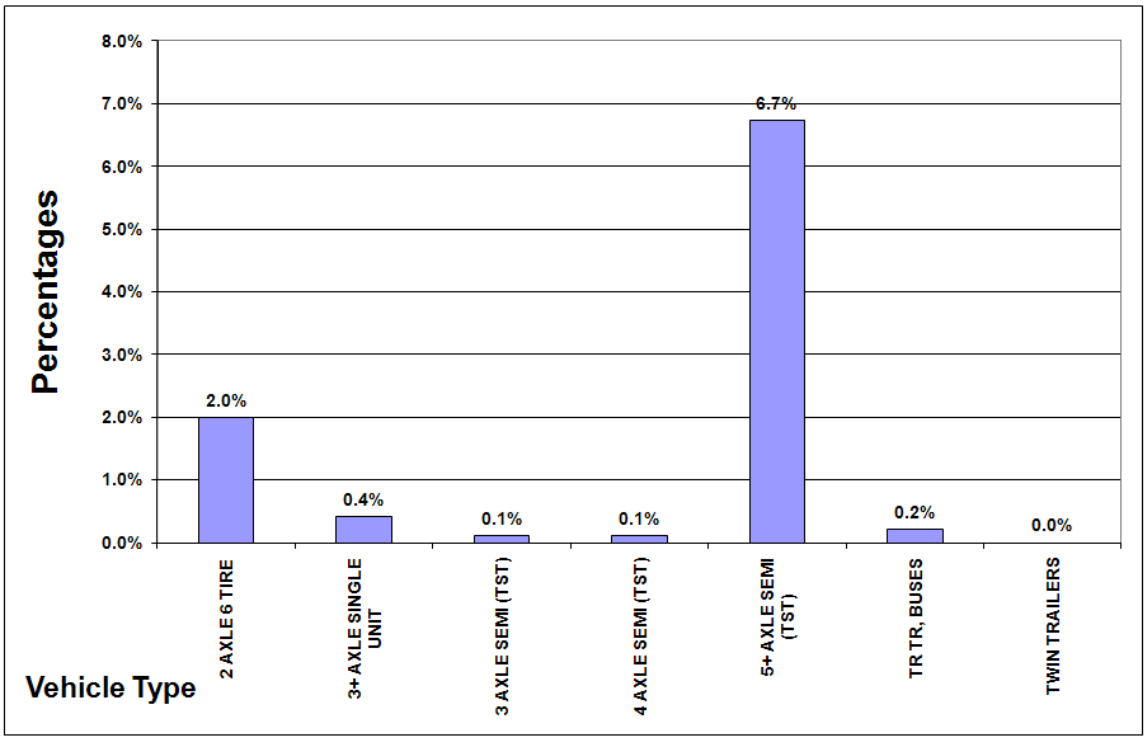
16 or 24 HR 24

VEHICLE TYPE	RAW COUNT	AADT ADJ FACTOR		ADJUSTED RAW	VEH. TYPE PERCENTS	A.C.F.
CARS AND PICKUPS	557	#N/A		859		0.83
2 AXLE 6 TIRE	22	0.88		19	2.0%	
3+ AXLE SINGLE UNIT	6	0.66		4	0.4%	
3 AXLE SEMI (TST)	1	1.04		1	0.1%	
4 AXLE SEMI (TST)	1	1.04		1	0.1%	
5+ AXLE SEMI (TST)	85	0.75		64	6.7%	
TR TR, BUSES	2	0.85		2	0.2%	
TWIN TRAILERS	0	0.80		0	0.0%	
TOTALS ---------->	674	-------->	1.4	950	9.6%	(%HC)

DO YOU HAVE THE CORRECT RURAL OR URBAN FACTOR?

8033

NORTH OF TH19 AND TH67



You Have Selected the Rural Factor

11. Expansion of Vehicle Class Count Data and Axle Correction Factors

In this example, the forecaster will expand the 2006 vehicle class count at site 8033. The bar graphs on the bottom of the page portray the eight vehicle class categories discussed above. Those numbers are placed on the "Vehicle Class Count Expansion Worksheet" in your MnESAL in the column labeled " Raw Count" (*example 10*). The information at the top of the expansion worksheet can be obtained from the class count sheet and / or the sketch, i.e. site number, site description, project S.P#., month number of count and 16 or 24 hours (16 hours in this case since it is a manual count and not a tube count).

The "Year of Count" is the year of that particular vehicle class count (in this case, 2006). The term "Constrained AADT" means the AADT obtained for that year on the sketch (in this case, the 2006 AADT which is 950. Next, enter 950 on the spreadsheet. The concept of the constrained AADT is to insure that the adjusted vehicle count matches the AADT. Thus, the "raw" vehicle type percents are adjusted for the month the count is taken to develop adjusted HCAADT (seasonally adjusted volumes – called "Adjusted Raw").

The factors used to adjust the raw counts were originally developed from data collected at weigh in motion (WIM) sites and have been updated in 2010. For example, the 5+ axle semi count taken in October is 85 (*example 10*). When adjusted for the entire year, the "adjusted" number is 64 (this means that in October, 5 + axle semi volumes are 25% higher than the average day for the year so the semis are adjusted downward to represent the entire year; conversely, if the month is changed from October (10) to June (1), a higher factor results. The graph at the bottom of the expansion worksheets is a representation of the adjusted vehicle type percents. In the MnESAL spreadsheet, the column vehicle type percents are automatically transferred to the next sheet, the "Vehicle Class Count Averages Worksheet."

12. Seasonal Adjustment Factors for Vehicle Class Counts

Seasonal adjustment factors for vehicle classification counts are used to adjust short duration vehicle class counts to annual average daily volume (AADT). The previous factors in the MNESAL spreadsheet were developed in the 1980's. They were developed using the five weigh in motion (WIM) sites we had at that time. The factors were averaged from each of the five locations. This resulted in adjustment factors for each vehicle type by month for Monday through Friday counts. In 2007, we revisited the adjustment factors based on 15 continuous classification counter (referred to as CCC, or AVC) sites. In 2010, we updated the adjustment factors based on the average of 2007, 2008, and 2009 data from 7 WIMs and 16 CCC sites.

For estimating equivalent single axle loads (ESALS), the eight vehicle categories need to be adjusted for the month of the year and the effects of weekend traffic. These adjustment factors are derived from CCC and WIM sites and can be applied to the raw counts in the MNESAL program. The factors, when multiplied times the raw counts, produce an estimate of AADT by vehicle type.

All the data from CCC and WIM sites for 365 days are used. Some CCC and WIM sites might not be operating for the entire year. In that case, the missing data is taken from the previous year.

Once the factors were produced, they were categorized into urban and rural areas. These factors were used to adjust the 24 hour counts to AADT. The evaluation of factors was done by comparing the 2007, 2008, and 2009 factors with the average of 2007, 2008 and 2009 factors and factors in different area types. After the evaluation was completed, the rural and urban factors were selected to be used in the MNESAL spreadsheet.

The 16 hour adjustment factors were used to adjust 16 hour counts to 24 hours for each of Mn/DOT's 8 vehicle types. These factors were developed from CCC sites from 1998 to 2008. The 16 hour traffic volume is the summation of each vehicle type counted from 6:00 AM to 10:00 PM. The 16 hour factors were obtained from the summation of 24 hour volumes by vehicle type divided by the 16 hour volume for each vehicle type. Once all the factors are produced, the 24 hour volume is obtained from the 16 hour counts multiplied by the seasonal factors for each vehicle type.

The following table documents the production of 16 hour adjustment factors for each vehicle type

16 HOUR PERIOD	6AM-10PM	24 HOUR	Percent 16 of 24	Factor
CARS+PICKUP	19066481	20869944	91.36%	**1.09**
2ASU	665126	717022	92.76%	**1.08**
3+ASU	266453	286046	93.15%	**1.07**
3A Semi	70757	77490	91.31%	**1.10**
4A Semi	131406	143909	91.31%	**1.10**
5+A SEMI	842025	985345	85.45%	**1.17**
TT/BUS	198387	216505	91.63%	**1.09**
TWINS	37099	48151	77.05%	**1.30**

There is a command to choose from four groups of factors based on 16 hour urban, 16 hour rural, 24 hour urban, or 24 hour rural areas in the MNESAL spreadsheet. The traffic forecasting section in Mn/DOT's central office will notify the district traffic forecasters of the updated adjustment factors, and will explain how developing and improving the seasonal adjustment factors will improve the accuracy of traffic forecasts. As more data becomes available and a need develops for county road seasonal adjustment factors, they too will be produced.

Figure 2 – 24 Hour Vehicle Type Adjustment Factors

The following tables show the 24 hour seasonal adjustment factors for MnDOT's eight vehicle type categories in urban and rural areas for the new MNESAL, 2007-2009 data and the previously used MNESAL factors. The green tables are an average of 07-09 data.

2010 24 Hour Seasonal Adjustment Factors for Urban Areas in MNESAL

Body Type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
CARS+PICKUP	1.11	1.07	1.05	0.99	0.95	0.95	0.90	0.87	0.92	0.95	1.00	1.09
2ASU	0.97	0.92	0.92	0.87	0.79	0.85	0.80	0.77	0.77	0.78	0.83	0.92
3+ASU	1.14	1.16	1.15	0.92	0.73	0.73	0.65	0.65	0.62	0.65	0.77	1.04
3A Semi	1.29	1.16	1.18	0.97	0.82	0.82	0.75	0.67	0.70	0.81	0.87	1.22
4A Semi	1.29	1.16	1.18	0.97	0.82	0.82	0.75	0.67	0.70	0.81	0.87	1.22
5+A SEMI	0.93	0.95	0.92	0.84	0.75	0.76	0.69	0.70	0.70	0.75	0.85	0.98
TT/BUS	1.31	1.19	1.10	0.96	0.80	0.76	0.70	0.66	0.66	0.76	0.92	1.35
TWINS	0.93	0.91	0.91	0.81	0.77	0.83	0.76	0.72	0.73	0.79	0.86	0.95

2010 24 Hour Seasonal Adjustment Factors for Rural Areas in MNESAL

Body Type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
CARS+PICKUP	1.23	1.19	1.18	1.11	0.93	0.89	0.82	0.84	0.92	0.98	1.05	1.20
2ASU	1.04	1.03	1.01	0.94	0.81	0.84	0.81	0.83	0.87	0.88	0.96	1.01
3+ASU	1.30	1.31	1.17	1.03	0.79	0.68	0.76	0.71	0.65	0.66	0.82	1.10
3A Semi	1.35	1.35	1.34	1.13	0.78	0.77	0.71	0.78	0.86	1.04	1.27	1.47
4A Semi	1.35	1.35	1.34	1.13	0.78	0.77	0.71	0.78	0.86	1.04	1.27	1.47
5+A SEMI	0.89	0.85	0.86	0.84	0.79	0.78	0.80	0.78	0.72	0.75	0.82	0.91
TT/BUS	1.80	1.72	1.46	1.07	0.73	0.72	0.66	0.70	0.74	0.85	1.08	1.66
TWINS	1.13	0.95	0.98	0.88	0.79	0.77	0.74	0.75	0.71	0.80	0.80	0.93

2009 24 Hour Seasonal Adjustment Factors for Urban Areas												
Body Type	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
CARS+PICKUP	1.10	1.10	1.08	0.97	0.92	0.90	0.88	0.86	0.97	0.95	0.96	1.09
2ASU	1.03	0.96	0.97	0.84	0.78	0.79	0.79	0.76	0.84	0.76	0.81	0.87
3+ASU	1.08	1.22	1.16	0.89	0.69	0.64	0.64	0.60	0.64	0.69	0.79	0.99
3A Semi	1.47	1.27	1.31	0.96	0.83	0.80	0.76	0.70	0.70	0.76	0.80	1.12
4A Semi	1.47	1.27	1.31	0.96	0.83	0.80	0.76	0.70	0.70	0.76	0.80	1.12
5+A SEMI	0.99	0.98	0.95	0.82	0.72	0.67	0.66	0.65	0.74	0.75	0.83	1.00
TT/BUS	1.25	1.26	1.17	0.89	0.74	0.68	0.65	0.62	0.66	0.74	0.89	1.33
TWINS	1.04	1.03	1.05	0.82	0.76	0.77	0.69	0.67	0.74	0.86	0.88	0.99

2009 24 Hour Seasonal Adjustment Factors for Rural Areas												
Body Type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
CARS+PICKUP	1.19	1.18	1.16	1.01	0.87	0.87	0.80	0.85	0.88	0.93	0.98	1.22
2ASU	1.18	1.11	1.03	0.94	0.83	0.85	0.82	0.82	0.90	0.89	1.01	1.05
3+ASU	1.36	1.30	1.17	1.03	0.75	0.74	0.76	0.69	0.62	0.68	0.86	1.03
3A Semi	1.42	1.42	1.37	1.19	0.73	0.71	0.70	0.76	0.78	0.98	1.12	1.36
4A Semi	1.42	1.42	1.37	1.19	0.73	0.71	0.70	0.76	0.78	0.98	1.12	1.36
5+A SEMI	0.84	0.81	0.89	0.85	0.84	0.83	0.77	0.83	0.70	0.77	0.79	0.89
TT/BUS	1.86	1.70	1.44	1.05	0.67	0.76	0.61	0.76	0.79	0.95	1.11	1.57
TWINS	1.12	0.93	1.06	0.91	0.83	0.72	0.64	0.79	0.74	0.86	0.85	0.93

2008 24 Hour Seasonal Adjustment Factors for Urban Areas												
Body Type	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
CARS+PICKUP	1.13	1.07	1.07	1.02	0.95	1.00	0.91	0.88	0.95	0.94	0.98	1.06
2ASU	0.99	0.88	0.93	0.91	0.80	0.85	0.81	0.80	0.78	0.78	0.81	0.94
3+ASU	1.14	1.05	1.14	0.98	0.72	0.70	0.64	0.69	0.64	0.66	0.78	1.14
3A Semi	1.29	1.11	1.21	1.04	0.78	0.80	0.71	0.65	0.75	0.79	0.99	1.45
4A Semi	1.29	1.11	1.21	1.04	0.78	0.80	0.71	0.65	0.75	0.79	0.99	1.45
5+A SEMI	0.93	1.00	0.93	0.90	0.74	0.77	0.69	0.75	0.71	0.75	0.81	1.02
TT/BUS	1.26	0.99	0.97	0.97	0.72	0.73	0.68	0.72	0.72	0.75	0.98	1.56
TWINS	0.86	0.86	0.86	0.86	0.78	0.81	0.77	0.77	0.77	0.75	0.80	0.96

2008 24 Hour Seasonal Adjustment Factors for Rural Areas												
Body Type	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
CARS+PICKUP	1.18	1.13	1.15	1.19	0.95	0.92	0.85	0.85	0.94	0.97	1.06	1.18
2ASU	0.90	0.89	0.92	0.91	0.72	0.83	0.77	0.82	0.89	0.94	0.92	1.02
3+ASU	1.19	1.20	1.06	1.12	0.81	0.70	0.81	0.74	0.63	0.60	0.73	1.03
3A Semi	1.05	1.08	1.16	0.97	0.71	0.79	0.69	0.90	1.04	1.26	1.58	1.77
4A Semi	1.05	1.08	1.16	0.97	0.71	0.79	0.69	0.90	1.04	1.26	1.58	1.77
5+A SEMI	0.85	0.84	0.84	0.86	0.74	0.80	0.85	0.76	0.70	0.76	0.80	0.91
TT/BUS	1.50	1.40	1.39	1.05	0.64	0.67	0.66	0.67	0.72	0.82	1.13	1.83
TWINS	0.86	0.97	0.94	0.80	0.68	0.73	0.74	0.79	0.70	0.93	0.79	0.96

2007 24 Hour Seasonal Adjustment Factors for Urban Areas												
Body Type	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
CARS+PICKUP	1.10	1.04	1.02	0.98	0.98	0.95	0.90	0.89	0.85	0.98	1.05	1.13
2ASU	0.90	0.92	0.88	0.84	0.80	0.91	0.80	0.75	0.67	0.81	0.88	0.95
3+ASU	1.19	1.20	1.15	0.88	0.79	0.84	0.68	0.67	0.58	0.61	0.74	1.00
3A Semi	1.12	1.10	1.03	0.90	0.84	0.86	0.79	0.67	0.67	0.89	0.83	1.08
4A Semi	1.12	1.10	1.03	0.90	0.84	0.86	0.79	0.67	0.67	0.89	0.83	1.08
5+A SEMI	0.87	0.88	0.86	0.81	0.79	0.83	0.71	0.71	0.66	0.75	0.90	0.94
TT/BUS	1.41	1.33	1.16	1.03	0.93	0.86	0.77	0.62	0.59	0.78	0.88	1.17
TWINS	0.89	0.85	0.82	0.75	0.78	0.91	0.83	0.72	0.70	0.75	0.89	0.88

2007 24 Hour Seasonal Adjustment Factors for Rural Areas												
Body Type	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
CARS+PICKUP	1.31	1.26	1.22	1.13	0.97	0.88	0.81	0.84	0.95	1.03	1.13	1.20
2ASU	1.04	1.08	1.07	0.97	0.88	0.85	0.85	0.83	0.81	0.83	0.93	0.96
3+ASU	1.34	1.44	1.28	0.93	0.81	0.61	0.71	0.69	0.70	0.70	0.85	1.25
3A Semi	1.57	1.54	1.49	1.22	0.90	0.82	0.73	0.68	0.74	0.88	1.10	1.27
4A Semi	1.57	1.54	1.49	1.22	0.90	0.82	0.73	0.68	0.74	0.88	1.10	1.27
5+A SEMI	0.98	0.90	0.86	0.82	0.78	0.72	0.77	0.75	0.76	0.74	0.88	0.93
TT/BUS	2.05	2.06	1.55	1.11	0.87	0.74	0.71	0.67	0.70	0.79	1.01	1.58
TWINS	1.42	0.95	0.94	0.94	0.86	0.87	0.83	0.66	0.69	0.61	0.76	0.89

Previously Used Seasonal Adjustment Factors

Body Type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
CARS+PICKUP	1.14	1.06	1.04	0.99	0.94	0.87	0.87	0.83	0.92	0.96	0.99	1.02
2ASU	1.19	1.07	1.06	0.92	0.74	0.72	0.80	0.78	0.65	0.72	0.87	1.00
3+ASU	1.09	1.05	1.29	1.15	0.72	0.60	0.70	0.65	0.61	0.63	0.84	1.06
3A Semi	1.18	1.13	1.31	0.94	0.66	0.68	0.75	0.73	0.72	0.86	0.93	1.27
4A Semi	1.04	1.00	1.09	0.94	0.71	0.66	0.71	0.63	0.76	0.75	0.85	1.03
5+A SEMI	1.00	0.94	0.94	0.87	0.75	0.69	0.80	0.69	0.70	0.74	0.78	0.91
TT/BUS	1.19	1.07	1.06	0.92	0.74	0.72	0.80	0.78	0.65	0.72	0.87	1.00
TWINS	1.00	0.94	0.94	0.87	0.75	0.69	0.80	0.69	0.70	0.74	0.78	0.91

13. Basic Procedure for Mn/DOT's MnESAL Spreadsheet in Excel

The URBAN vehicle types discussed on the Cumesal-B sheet (see page ??) were developed primarily for use in the Seven County Metropolitan Area. They can also be used for segments that are near cities with over 5,000 population. Please use caution in that only one set of defaults should be used for each "B" segment. You can mix urban and rural default percentages in the same forecast as the route dictates.

The Spreadsheet is called Nov 2011 MnESAL.xlsb. This requires only a basic knowledge of Excel to use. There are many steps that should make data entry easier, as there are automatic calculations that carry-over from one spreadsheet to another. The user should make a backup in case the original is corrupted or saved inadvertently.

The MnESAL spreadsheet is divided into 11 worksheets or tabs (4 of which are similar).

* Forecast – the sheet to enter basic data that copies to other worksheets
* 16-24 Vehicle C.C. 1, 2, 3, and 4 – four sheets - automatically transfers numbers to the New Average vehicle C. C. sheet – note that the drop down menus for urban and rural factors and month
* New Avg Vehicle C. C. – a vehicle class count average worksheet that can be utilized manually or automatically, or both – transfers average vehicle percent
* Least Squares
* Cumesal – A
* ESAL Report – A
* Cumesal – B
* ESAL Report - B

The entire worksheet is protected. You are not able to type (by mistake) in fields that require no data or text entry. All manual entries will be in blue. Cells with black typeface mean that the cell is locked, or protected and contains either a calculated number or a protected label. The order of worksheets should be the logical order or sequence of events for doing the traffic forecast. You can unprotect an individual worksheet or the whole workbook, but be careful in typing into certain calculated cells. To unprotect an individual worksheet go to Review-Unprotect Sheet. To protect the sheet or workbook, Review- Protect Sheet.

The New Avg. Vehicle C.C. offers the most flexibility and has quite a few links to other sheets. It can be used manually or automatically or a combination of both. The average percent column transfers heavy commercial percents directly to the A segment worksheet (it also carries over 5-axle split information if the bottom part of the sheet (Heavy 5 ax Semi) portion is filled out. The worksheet also automatically averages axle correction factors, which can be used on the least squares worksheet from 1986 onward. This sheet has formulas in the Pct columns that will calculate the percent of vehicle types as well as formulas to determine average numbers of vehicle and the percents. It allows from one to four entries.

To calculate averages properly (Avg Num and Avg Pct), make sure that any of the unused columns containing the # symbol are erased. Do not worry about the formulas being erased. You will be saving a copy of the main file and will be able to re-create all formulas. The year and type of count (16 or 24) are automatically transferred from information in each of the four vehicle class expansion worksheets if you chose to use it. Also, the four 16-24 hr expansion worksheets correspond to each of the four columns on the Vehicle Class Count Averages Worksheet and will automatically transfer values.

To see how the spreadsheet works, you may want to "blank" out all entries, print out a hard copy and do all the calculations manually; then enter them on the computer to compare results. If you have to average two vehicle class counts in your expansion procedure, you will have to enter the numbers manually, and just let the computer calculate the percents (example: you have two 24 hour counts taken in August and July and want to average them both).

If there is more than one "A" segment in the traffic forecast, you will probably find it easier to create a new file for each additional A segment. There probably will not be many occasions in which you will have multiple "A" segments. Or, you may just prefer to save one file and not save your "work" on the spreadsheet as you proceed onward.

Continuing with our discussion of the Vehicle Class Count Expansion Worksheet and factors, the sample on the next page of a typical expansion worksheet describes some of the fields previously discussed visually shows the concepts discussed relating to vehicle class count data.

The next several pages show samples of older vehicle class counts and their different formats. The concept of "heavies" is shown on these pages (which will be discussed later in this report). Basically, out of several classes of five axle semis, we classify certain body types as "heavies". As far as forecasting, "heavies" mean certain body types such as dump, stake tank, and grain trucks which are usually heavier than "other" five axle semis and thus have higher damage factors.

Clarification of Fields - VCC Expansion Worksheet

16 HR. OR 24 HR. VEHICLE CLASS COUNT EXPANSION WORKSHEET 1

SITE NUMBER: 7139 **COUNTY:** RENVILLE

SITE DESCRIPTION: EAST OF TH4

PROJECT SP#: 6511-38 **YEAR OF COUNT ->:** 2006

MONTH NUMBER OF COUNT: Oct **CONSTRAIN AADT ->:** 3650

16 or 24 HR 16

Adjusted based on hours and month

Area type must be selected for correct adjustment factors

(•) RURAL ( ) URBAN

AADT on the flow map for year and count

VEHICLE TYPE	RAW COUNT	AADT ADJ FACTOR	ADJUSTED RAW	VEH. TYPE PERCENTS
CARS AND PICKUPS	3111	#N/A	2818	
2 AXLE 6 TIRE	109	0.90	98	2.7%
3+ AXLE SINGLE UNIT	87	0.74	65	1.8%
3 AXLE SEMI (TST)	10	0.97	10	0.3%
4 AXLE SEMI (TST)	4	0.98	4	0.1%
5+ AXLE SEMI (TST)	723	0.87	626	17.2%
TR TR, BUSES	29	0.89	26	0.7%
TWIN TRAILERS	3	0.86	3	0.1%
TOTALS ---------->	4076	------>	3650	22.8% (%HC)

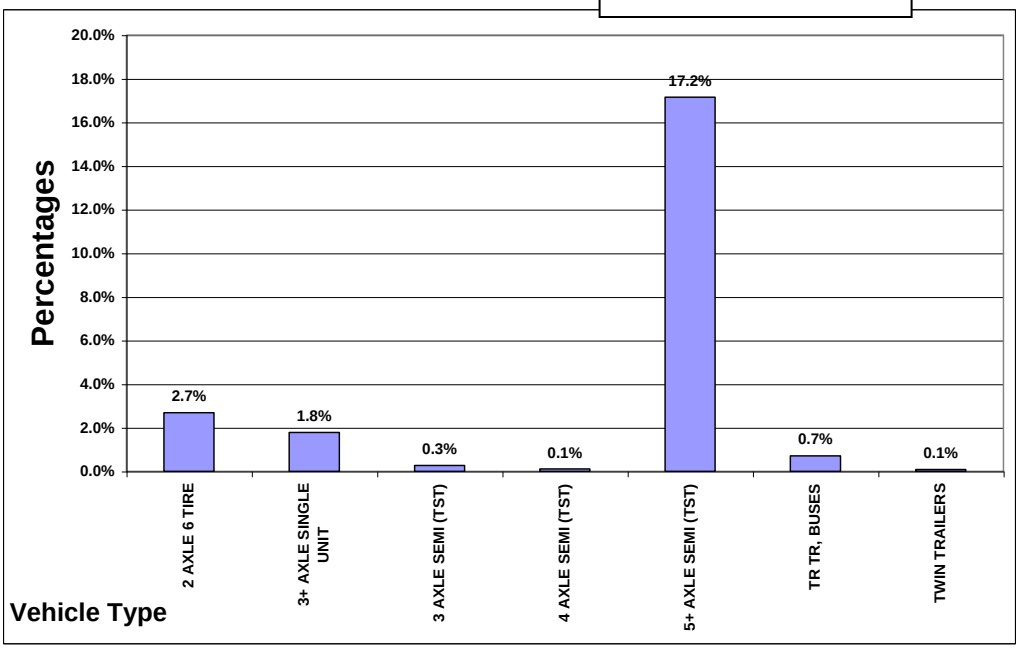
A.C.F. 0.78

Note: The URBAN adjustment factors were developed primarily for use in the Seven County Metropolitan Area. They can also be used for other cities with over 5,000 population.

Raw counts adjusted to HCAADT %

Factors based on new studies

Normally within the range of 0.8 – 1.2



The raw count multiplied by the AADT adjustment factor produces the adjusted raw. The adjusted raw AADT is constrained with the AADT in the count year. There are 48 sets of factors for urban and rural for each month of the year. They are used in determining the adjusted heavy commercial traffic for each expansion worksheet. The adjusted raw is divided by the constrained AADT to produce the vehicle type percents.

For clarification, there are four different formats for manual vehicle classification counts that go back to 1982. The following pages are examples of the four different formats. They are as follows:

1 Covers the years 2001 to present – These are in Microsoft Access

2 Covers the years 1993 to 2000 – These are in Paradox (and Access)

3 Covers the years 1991 and 1992 – Not in a computer database

4 Covers the years from 1982 to 1990 – Not in a computer database

2001 and 2002 Vehicle Class Count Example

SITE: 1705 **ROUTE:** I-35 **DESCRIPTION** S OF JCT TH97 AT TRUCK WEIGHING LO **COUNTY:** ANOKA **DIST:** 9 **RECORDER:** TWP

				Single Units					*Semis*				*Heavies*							*Trailers*			*Twins*	
	Begin Hour	Date	Pass. Vehicle	2ax	2ax tank	3ax plus	3ax+ tank	3ax	3ax tank	4ax	4ax tank	5ax dump	5ax tank	5ax grain	5ax stlo	5ax stun	5ax other	6ax+	Bus	HTWT	HTWT Tank	T5ax+	Total Vehicles
South	6:00	8/16/01	0	14	0	15	0	0	0	1	0	0	5	2	8	4	18	14	2	6	0	0	89
	7:00	8/16/01	0	21	0	9	0	2	0	3	0	2	3	2	10	0	20	6	2	5	0	0	85
	8:00	8/16/01	0	24	1	16	2	3	0	1	0	3	9	3	11	2	29	9	0	4	0	2	119
	9:00	8/16/01	0	30	0	14	0	1	0	5	0	0	7	5	11	4	37	13	1	5	0	1	134
	10:00	8/16/01	0	31	0	14	0	1	0	6	0	3	3	5	7	4	47	13	6	6	1	0	147
	11:00	8/16/01	0	34	0	16	1	0	0	4	0	1	5	5	17	9	38	14	3	4	0	1	152
	12:00	8/16/01	0	31	0	12	1	3	0	2	0	0	11	3	14	10	38	14	4	4	0	1	148
	13:00	8/16/01	0	30	0	13	0	1	0	1	0	0	4	3	14	8	29	13	4	4	0	0	124
	14:00	8/20/01	0	33	2	12	0	1	0	3	0	4	3	1	14	7	38	21	0	3	0	0	142
	15:00	8/20/01	0	36	0	12	1	7	0	2	0	2	2	0	7	5	39	14	7	3	0	1	138
	16:00	8/20/01	0	30	0	7	0	0	0	5	0	4	6	2	10	4	19	17	0	5	1	0	110
	17:00	8/20/01	0	17	0	2	0	1	0	7	0	1	5	0	8	0	21	1	1	2	0	0	66
	18:00	8/20/01	0	11	0	5	0	0	0	3	0	0	2	3	3	2	27	3	2	0	0	1	62
	19:00	8/20/01	0	7	0	8	0	1	0	1	0	0	2	3	3	2	20	1	2	2	0	0	52
	20:00	8/20/01	0	8	0	1	0	1	0	0	0	0	7	0	8	0	28	0	0	0	0	1	54
	21:00	8/20/01	0	8	0	4	0	0	0	0	0	0	5	0	3	4	16	0	0	0	0	1	41
	Directional Totals:		0	365	3	160	5	22	0	44	0	20	79	37	148	65	464	153	34	53	2	9	1663
	Site Totals:		0	716	6	332	8	50	0	96	1	80	170	90	253	173	907	301	70	108	3	11	3375

16 Hour Totals for Calculating ESALS by Month:	*Pass. Vehicles*	*2 Axle SU*	*3+ Axle SU*	*3 Axle Semi*	*4 Axle Semi*	*5+ Axle Semi*	*Trk Trl/Bus*	*Twins*	*Directional Split*
	0	722	340	50	97	1974	181	11	1.45%

If stakes are included in the heavy mix(note: only use stakes loaded) then we calculate as follows: 766/1974 = 38.8%. Adding the tanks, dumps, stakes, and grain equals 766 divided by the total 5 ax and 6 ax+ semis. Including stakes makes this a heavy truck route and splits the semis into 'Maximum" and "Other" on your MnESAL spreadsheet (see Timber Map, Fig 12). Not including stake trucks means that the route is not split – 341/1974 equals 17.3%. This does not reach the default 30% split that causes the software to split the heavies on the MnESAL.

1993 to 2000 Vehicle Class Count Example

2/24/98 1997 BODY TYPE REPORT BASED ON PRELIMINARILY ADJUSTED VEHICLE CLASSIFICATION COUNT FOR LOCATION 8724 PAGE 2

Route Description County
TH 41 S OF JCT TH5 CARVER

				++++ Single Units ++++									++++++Heavies+++++							++ Truck ++			
																					Trailers		Twins
Direction	Beghour	Date	Passenger Vehicles	2ax	2ax tank	3ax+	3ax+ tank	3ax	3ax tank	4ax	4ax tank	5ax dump	5ax tank	5ax grain	5ax stlo	5ax stun	5ax other	6ax+	Bus	HTWT	HTWT tank	5ax+
South	600	8/04/93	605	9	1	8		2									2	7	1	2		
South	700	8/04/93	878	12	1	19		1				5		4			4	21		1		
South	800	8/04/93	411	26		23	1			1		4		3	1		2	8	3	4		
South	900	8/04/93	233	12		12		1				4	1		1	2	6	5		1		
South	1000	8/04/93	325	12		20		2		1		3	1		2		5	6	3	4		
South	1100	8/04/93	404	17	1	29				2		5		4	2		4		3	4		
South	1200	8/04/93	416	25		15				7		5	4	4	3		3	3		4		
South	1300	8/04/93	431	18	1	24		4		3		10	1	3	1		31	5	2	7		
South	1400	8/02/93	384	15	1	21		2		2		3			1	1	2	4		3		
South	1500	8/02/93	535	12		24		3		2		3				1	7	3		3		
South	1600	8/02/93	707	11	1	21		4		2		5	1		2		2	6		5		
South	1700	8/02/93	668	7	1	11		3		1		5	3	1	1		2	8	4	4		
South	1800	8/02/93	383	4	1	2		1				1	1				1	3	3	4		
South	1900	8/02/93	315	4		2		1						1			2	1		5		
South	2000	8/02/93	275	1									1				1	1				
South	2100	8/02/93	260					1					1				1					
DIRECTIONAL TOTALS			7230	185	8	231	1	25	0	21	0	53	14	20	14	4	75	81	19	51	0	0
LOCATION TOTALS			14455	381	10	473	4	48	0	54	0	59	35	34	45	6	118	130	38	98	0	2

16 HOUR TOTALS FOR	CARS	2 AXLE SU	3+ AXLE SU	3 AXLE SEMI	4 AXLE SEMI	5+ AXLE SEMI	TRK TRL/BUS	TWINS
CALCULATING ESALS BY MONTH	14455	391	477	48	54	427	136	2

= split heavies

128 / 427 = 30.0 %

In the above example, we calculate the number of dumps, tanks, and grain and divide by the total number of 5 ax and 6+ ax semis. Take 128 / 427 = 30%. In this case, we split our heavies, which is done automatically after entering 30% on the New Avg Vehicle Class Count sheet in the MnESAL spreadsheet.

1991 to 1992 Vehicle Class Count Example – Sheet 1

HOURLY COUNTS BY VEHICLE TYPE

STUDY_____9 LOCATION #____018
DIRECTION___9-COMBINED HOURS_____06-13
CYCLE_____1-SUMMER DAY OF WEEK___2-WEEKDAY

HR	TOT VEH	TOT TRKS	CARS PNLS PKPS	SINGLE UNIT TRUCKS 2AX	3AX	4+AX	BUS	SEMIS 3AX	4AX	5AX	6+AX	TRUCK TRAILERS 4AX	5AX	6+AX	TW.TR. 5AX	6AX
06	57	12	45	3	1	0	1	0	0	7	0	0	0	0	0	0
07	85	22	63	2	1	2	0	0	0	15	0	2	0	0	0	0
08	106	22	84	2	5	2	2	0	0	11	0	0	0	0	0	0
09	109	24	85	4	0	0	0	0	0	19	0	1	0	0	0	0
10	144	26	118	8	1	0	0	0	0	16	0	1	0	0	0	0
11	113	27	86	10	1	0	0	0	1	15	0	0	0	0	0	0
12	129	24	105	1	1	0	0	0	0	21	0	0	1	0	0	0
13	180	35	145	5	2	2	0	2	1	21	1	1	0	0	0	0
	923	192	731	35	12	6	3	2	2	125	1	5	1	0	0	0

DATE(S):HOUR___08/06/92: 06-13

VEHICLE AND BODY TYPE

STUDY_____9 LOCATION #_____018
DIRECTION___9-COMBINED DATE(S) & HOURS__08/06/92: 06-13
CYCLE_____1-SUMMER
HOURS_____06-13
DAY OF WEEK_2-WEEKDAY

BODY TYPE

VEHICLE TYPE	TANK	STAKE	REFR	VAN	DUMP	PANEL	GRAIN	CATTLE	OTHER	TOTAL
2-AXLE TRUCK	0	15	1	7	3	4	5	0		35
3-AXLE TRUCK	0	3	0	1	5		3	0		12
4-AXLE TRUCK	0				5				1	6
3-AXLE SEMI		1		1					0	2
4-AXLE SEMI	0	1	0	1				0	0	2
5-AXLE SEMI	0	8	4	13	1		98	1		125
6-AXLE SEMI									1	1
4-AXLE HTWT									5	5
5-AXLE HTWT									1	1
6-AXLE HTWT									0	0
5-AXLE TW.TR.	0			0			0		0	0
6-AXLE TW.TR.									0	0
TOTAL	0	28	5	23	14	4	106	1	8	189

The above is sheet one of two – an example of a 16-hour count. Note that this is 8 hours only. We need to add the heavy total on this sheet to the total on the next sheet. Some of these counts are by direction (above example is combined). There could be up to 4 sheets.

1991 to 1992 Vehicle Class Count Example – Sheet 2

HOURLY COUNTS BY VEHICLE TYPE

STUDY_____9 LOCATION #____018
DIRECTION___9-COMBINED HOURS_____14-21
CYCLE_____1-SUMMER DAY OF WEEK___2-WEEKDAY

HR	TOT VEH	TOT TRKS	CARS PNLS PKPS	SINGLE UNIT TRUCKS 2AX	3AX	4+AX	BUS	SEMIS 3AX	4AX	5AX	6+AX	TRUCK TRAILERS 4AX	5AX	6+AX	TW.TR. 5AX	6AX
14	136	18	118	2	1	1	0	0	0	13	0	1	0	0	0	0
15	160	18	142	3	2	0	0	0	0	13	0	0	0	0	0	0
16	159	18	141	5	0	0	0	2	0	11	0	0	0	0	0	0
17	138	6	132	2	0	0	0	0	0	4	0	0	0	0	0	0
18	114	6	108	0	2	0	0	0	0	4	0	0	0	0	0	0
19	89	6	83	1	2	1	0	0	0	2	0	0	0	0	0	0
20	61	3	58	0	1	0	0	1	0	1	0	0	0	0	0	0
21	52	3	49	0	0	0	0	0	0	2	0	1	0	0	0	0
	909	78	831	13	8	2	0	3	0	50	0	2	0	0	0	0

DATE(S):HOUR___08/05/92: 14-21

VEHICLE AND BODY TYPE

STUDY_____9 LOCATION #_____018
DIRECTION___9-COMBINED DATE(S) & HOURS__08/05/92: 14-21
CYCLE_____1-SUMMER
HOURS_____14-21
DAY OF WEEK_2-WEEKDAY

BODY TYPE

VEHICLE TYPE	TANK	STAKE	REFR	VAN	DUMP	PANEL	GRAIN	CATTLE	OTHER	TOTAL
2-AXLE TRUCK	0	5	0	4	0	3	1	0		13
3-AXLE TRUCK	0	0	0	0	3		5	0		8
4-AXLE TRUCK	0				1				1	2
3-AXLE SEMI		1		0					2	3
4-AXLE SEMI	0	0	0	0				0	0	0
5-AXLE SEMI	(3)	5	2	12	(0)		(27)	1		50
6-AXLE SEMI									0	0
4-AXLE HTWT									2	2
5-AXLE HTWT									0	0
6-AXLE HTWT									0	0
5-AXLE TW.TR.	0			0			0		0	0
6-AXLE TW.TR.									0	0
TOTAL	3	11	2	16	4	3	33	1	5	78

This is the second 8 hours from the same vehicle class site. Adding the tank, dump, and grain on both sheets, we get 129 trucks. Divide by the total number of 5+ axle semi trucks (176 - all 5 and 6 or more axle semis). The resultant percent is 73.3%. In this example, we split the heavies, and the number is transferred to the MnESAL.
In the older counts, use half of the total stakes if not listed if loaded or unloaded.

1982 to 1990 Vehicle Class Count Example

DATE: 1990. VEHICLE AND BODY TYPE BASED ON RAW DATA FOR

STUDY 7 LOCATION 31 TH 14 E OF SOUTH DAK BORDER 8 LINCOLN

1 DIRECTION(S) 1 CYCLE(S)

16 HOUR WEEKDAY COUNTS

BODY TYPE

VEHICLE TYPE		TANK	STAKE	REFRIG	VAN	DUMP	P/P	GRAIN	CATTLE	OTHER	TOTAL
CARS,PANELS + PICKUPS											
	VOLUME										588
	PERCENT										
2 AXLE-6 TIRE TRUCKS											
	VOLUME	1	9	1	8	0	1	7	0		27
	PERCENT	3.7	33.3	3.7	29.6	0.0	3.7	25.9	0.0		
3 AXLE TRUCKS											
	VOLUME	5	1	0	0	0		2	0		8
	PERCENT	62.5	12.5	0.0	0.0	0.0		25.0	0.0		
4+ AXLE TRUCKS											
	VOLUME	0				0				0	0
	PERCENT	0.0				0.0				0.0	
BUSES											
	VOLUME							3*	4*	0	7
	PERCENT							42.9	57.1	0.0	
3 AXLE TRACTOR-SEMI TRLR											
	VOLUME		0		3					0	3
	PERCENT		0.0		100.0					0.0	
4 AXLE TRACTOR-SEMI TRLR											
	VOLUME	0	0	0	0				0	0	0
	PERCENT	0.0	0.0	0.0	0.0				0.0	0.0	
5 AXLE TRACTOR-SEMI TRLR											
	VOLUME	(1)	6	11	18	(5)		(10)	4		55
	PERCENT	1.8	10.9	20.0	32.7	9.1		18.2	7.3		
6+ AXL TRACTOR-SEMI TRLR											
	VOLUME										2
	PERCENT										
4 AXLE TRUCK TRAILER											
	VOLUME										1
	PERCENT										
5 AXLE TRUCK TRAILER											
	VOLUME										1
	PERCENT										
6+ AXLE TRUCK TRAILER											
	VOLUME										0
	PERCENT										
5 AXLE TWIN TRAILER											
	VOLUME	4			0			0		0	4
	PERCENT	100.0			0.0			0.0		0.0	
6+ AXLE TWIN TRAILER											
	VOLUME										0
	PERCENT										

DO NOT SPLIT < 307-

NOTE - BLANKS INDICATE THAT DATA WAS NOT COLLECTED FOR THIS CATEGORY
*BUS BODY TYPES ARE COMMERCIAL + SCHOOL FOR GRAIN + CATTLE RESPECTIVELY

In the above example (not on a timber route), simply add the tanks, dumps, and grain trucks (16) and divide by the total 5ax and 6 ax semis (57). The calculations show 47.3%, which is automatically transferred to the MnESAL spreadsheet.

Axle Correction Factor

The last concept discussed on the vehicle class expansion worksheet will be the axle correction factor (ACF). This term, discussed briefly in the Data Sources section of this manual, is represented by the number 0.83 on the expansion worksheet (*example 10)*. The axle correction factor adjusts older tube counts to correct AADT to account for trucks. The changes have been accounted for in a kind of "reverse" method in the MnESAL spreadsheet. In 2010, the concept disappeared from the "Least Squares "portion of the MnESAL (to be discussed later). The following chart should help or clarify this concept.

Figure 3 – ACF

Axle Correction Factor

(Adjusts older tube counts to correct AADT to account for trucks)

Example of total vehicles in 24 hour period

	Tot Veh	x	Num Axles	Tot Axles
Cars	1000	x	2	2000
2 axle su	100	x	2	200
3+ axle su	50	x	3	150
3axle semi	25	x	3	75
4axle semi	25	x	4	100
5+ axle semi	300	x	5	1500
TT/Bus	50	x	4	200
Twins	50	x	5	250
	1600			

19XX-1984 Single Tube

↓

Old inaccurate method prior to 1986 (an assumed 2 axles per/veh would yield)

↓

4475 / 2 = 2238 instead of the 1600 vehicles which were actually there

To correct for this, one needs to apply an axle correction factor. In this case, the ACF is determined by dividing 1600/2238, which = .71. Thus, 2238 x .71 = 1600 vehicles

14. Vehicle Class Count Averages Worksheet

The next tab to the right of the four expansion worksheets is the Vehicle Class Count Averages Worksheet, called "New Avg Vehicle C.C." (example 11) . This is probably the SINGLE MOST IMPORTANT WORKSHEET in working through the MnESAL program.

Example 11 - Vehicle Class Count Averages Worksheet F8-1002

Vehicle Class Count Averages Worksheet

VCC Site Num. 8033
MN TRUNK 67
Description NORTH OF TH19 AND TH67

		16-24 Vehicle C.C.1		16-24 Vehicle C.C.2		16-24 Vehicle C.C.3		16-24 Vehicle C.C.4			
	Type	Year	Pct	Year	Pct	Year	Pct	Year	Pct	Avg Truck Volumes	Avg Vehicle Pctages
		2006		1998		1992		1986			
	Man/Tube	tube		Manual		Manual		tube			
1	Cars	859	90.42%	531	82.97%	838	93.11%	512	85.33%	685	87.96%
2	2 ASU	19	2.00%	12	1.88%	14	1.56%	37	6.17%	21	2.90%
3	3+ASU	4	0.42%	4	0.63%	4	0.44%	9	1.50%	5	0.75%
4	3ASemi	1	0.11%	0	0.00%	0	0.00%	3	0.50%	1	0.15%
5	4ASemi	1	0.11%	2	0.31%	1	0.11%	9	1.50%	3	0.51%
6	5+Asemi	64	6.74%	88	13.75%	41	4.56%	28	4.67%	55	7.43%
7	TT/BUS	2	0.21%	3	0.47%	2	0.22%	2	0.33%	2	0.31%
8	Twins	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%
Total		950	9.58%	640	17.03%	900	6.89%	600	14.67%		12.04%
Total Heavy Comm		91		109		62		88		88	100.00%
Heavy 5+ Ax Semi*					68.8%		53.0%		36.4%		52.73%
Axle Corr Factor			0.83		0.82		0.90		0.91		0.87

* Heavy 5+ Ax Semi = Tank, Dump, Grain,and Stake Loaded
When the Tank, Dumps, & Grains and loaded stakes are 30% or more of the 5 axle semis, then split into max and other categories (AUTOMATICALLY DONE) ---------->
Check out tube counts prior to 1996 carefully, body types are N/A prior to 1982, don't use tube collected previous to 1990.

Heavy 5 Axle Semi Split	
3.92%	Max
3.51%	Others
SPLIT	

NOTE: IF LESS THAN 4 ENTRIES, BE SURE
TO DELETE YEAR AND PCT COLUMN
DO NOT USE 0, LEAVE BLANK.
USER MUST THEN COPY THE FORMULA IN THE
PCT COLUMNS BACK TO THE APPROPRIATE COLUMN

There has been a change on the split policy as of 2008. Forecasters should include loaded stakes in the calculation and ½ of stakes if it is not known whether the stakes are loaded or unloaded --in addition to tank, dump and grain trucks (all districts).

The adjusted raw data from *example 10 (p51)* for 2006 is automatically transferred to column one and 1998 to column 3, and 1992 to column 5, and 1986 to column 7 (*example 11*). There is some rounding in the MnESAL process; however, the actual numbers carry out to the proper decimal place. In this example, we have three cycles of data. The "averages worksheet" allows for expansion of four cycles of vehicle class data - the maximum number of vehicle class counts for one vehicle class site that the forecaster should need. Simply tab to the right to allow up to four vehicle class count expansions. Four cycles of vehicle class count 8033 are shown above, 2006, 1998 and 1992, and 1986.

Determination of Heavy Vehicle Split Information for "Heavy" 5-axle semis

Earlier in the Forecasting Manual, we have discussed the "splitting" of the 5+ axle semis into heavy / other trucks. The rule of thumb is that we add up the tank, dump, grain, and stakes (if on a timber route – usually in Districts 1, 2, and 3) and divide by the total number of 5 and 6-axle semis. If the mix of heavies is 30% or more, it is automatically split on the MnESAL and carried through to the Averages Worksheet and the A segment worksheet. More recently, as of 2010 we are discounting the timber route and using all loaded stakes in the calculations of heavies – regardless of district. On older counts, stakes may not be differentiated between loaded and unloaded. SIMPLY TAKE HALF OF ALL STAKES in this instance and add them to the heavies.

As previously discussed, when expanding older counts – from 1980 to 1989 - the procedure is slightly different. The forecaster has previously been expanding raw 16 and 24 hour counts to AADT and HCAADT. Older counts have already been expanded to HCAADT. All that is required is to enter them onto one of the four "vehicle class count expansion worksheets" in a slightly different method. This process will still transfer counts directly to the "vehicle class count averages worksheet". Remember to enter historic vehicle class information from the newest to the oldest in a left to right manner, with the oldest counts to the right. In this case, enter all the data as before but leave the MONTH NUMBER OF COUNT BLANK. Also, unprotect the worksheet and enter a "1.00" in each cell of the AADT ADJ FACTOR column. *Example 12* shows this procedure (Note: this is not part of the sample forecast).

Example 12 - Entering Expanded vehicle class information on the Vehicle Class Count Expansion Averages Worksheet

SITE NUMBER: 2131 **COUNTY:** ISANTI/KANABEC
SITE DESCRIPTION: N OF ISANTI / KANABEC COUNTY LINE
PROJECT SP#: 3002-09/10 3303-43 **YEAR OF COUNT ->:** 1990
MONTH NUMBER OF COUNT: **CONSTRAIN AADT ->:** 1000
16 or 24 HR 24

VEHICLE TYPE	RAW COUNT	AADT ADJ FACTOR		ADJUSTED RAW	VEH. TYPE PERCENTS		A.C.F.
CARS AND PICKUPS	829	1.00		829			0.87
2 AXLE 6 TIRE	53	1.00		53	5.3%		
3+ AXLE SINGLE UNIT	14	1.00		14	1.4%		
3 AXLE SEMI (TST)	4	1.00		4	0.4%		
4 AXLE SEMI (TST)	7	1.00		7	0.7%		
5+ AXLE SEMI (TST)	72	1.00		72	7.2%		
TR TR, BUSES	21	1.00		21	2.1%		
TWIN TRAILERS	0	1.00		0	0.0%		
TOTALS ---------->	1000	-------->	1.0	1000	17.1%	(%HC)	

On the example above (not related to our sample forecast) always enter 24 in the 16 or 24 hour column and leave the month blank. This is because the older counts are already factored up to AADT; this is reflected in the total column where the total raw count and

adjusted raw and constrained AADT is 1000. The forecaster is not expanding anything here, simply transferring another historical vehicle count to the averages worksheet in the easiest possible manner.

If the traffic forecasting project requires the use of more than one vehicle class averages worksheet (which means more than one vehicle class site will be used to complete the traffic forecast) there is a different set of requirements in the use of the MnESAL in the traffic forecasting procedure. Our sample forecast will **include only the use of one vehicle class site**; however, there will be instances during the forecasting process where more than one "vehicle class count averages worksheet" will be needed to complete the forecast. This will be discussed later. In this case, manual manipulation of this sheet is allowed for. Suffice it to say here that THE FORECASTER SHOULD PRINT OUT EVERY PAGE OF THE MNESAL DURING THE COURSE OF THE FORECAST. This is because not every MnESAL page can be saved. It is ESSENTIAL TO HAVE A HARD COPY OF EVERY PAGE FOR DOCUMENTATION PURPOSES.

The more familiar the forecaster is with Excel, the easier it will be to "manipulate" the vehicle class averages worksheet. For example, you may "save" the work at any time or print a page and "not save" the work so you can recall the spreadsheet in a previous format. Or, you can print out a page, then do several "undos" to recall previous worksheets. Or, if desired (which may be easier for some forecasters), you may want to save another Excel file to account for another vehicle class site).

Another way to handle multiple A segments, incorporated into our 2012 MnESAL, is the technique of redoing the Vehicle Averages Worksheet by copying the formatting on that sheet if the forecaster uses less than the given four cycles of counts. If, for example, your first A segment has only one cycle of data, you can work through the entire MnESAL(calculating all A and B segments), then go back to the Vehicle Class Count Averages Worksheeet and copy all the formatting from the first cycle of data to the other desired columns (will require a little copying and pasting formulas).

In any case, feel free to call the Traffic Forecasting Section at any time during any or all portions of the forecasting process. Personnel from the Traffic Forecast Section will be available to answer questions and help you work through any task. For additional information on the use of the MnESAL, refer to the documentation section of the MnESAL on the last tab to the left in your spreadsheet.

Whether the forecaster uses one, two, three, or four historical vehicle class counts, all of the vehicle class data and percentages are transferred automatically from the individual expansion worksheets. There is one exception. The forecaster must manually add the percentages of heavies calculated on the raw data i.e. THE SPLIT OF TANK, DUMP, GRAIN, AND LOADED STAKES--- AND MANUALLY PLACE THEM ON THE ROWS THAT SAY "HEAVY 5+ AX SEMI" at the second from the bottom row of the "vehicle class count averages worksheet" (see bottom of *example 11)*.

As per our previous discussions, the split only occurs for a manual count. Directly enter the percentage the tank, dump, grain, loaded stakes (half if not known) is of total 5+ axle semis as per *example 11* (68.8% & 53.0% & 36.4%) - for an average of 52.73%).

The axle correction factor on the last row of the spreadsheet will automatically transfer from the expansion worksheet to the Least Squares worksheet (discussion to follow). There should be a number and a percent for every vehicle class count used in order for the "averages worksheet" to properly function.

Any "#" signs to the right of data will cause the averages columns to not work. Simply erase or delete any entries where the "#" shows up. Formulas can be "put back in appropriate columns" by copying the formulas in the "Pct" categories from one to another. This spreadsheet is flexible and allows for a lot of manual manipulation if need be. The important column to use, the one which will eventually be transferred onward will be the very last column on the right, the "Average Vehicle Percentages."

The forecaster may have anywhere from one to four years of data on the vehicle class count averages worksheet, depending on the number of years the vehicle class site was counted. For example, if the count was a special count, there may be only one count (one year of data). There may also be a "bad" count, which may have to be discarded, or there may be four years of good historical data. In any case, the forecaster will have to determine how much of the historical class count information to use in the actual ESAL forecast. To determine "good data", it is necessary to look at all of the numbers and percents of vehicle class types for consistency. If the percents look fairly consistent during all years, and the raw numbers are similar or show a consistent trend, the forecaster may use all of the information on the averages worksheet.

For instance, continuing on our sample forecast, a cursory analysis of *example 11* reveals data for 2006, 1998, 1992, and 1986. This first thing we notice is a small AADT that has fluctuated over the past 20 years. HCAADT percentages have also fluctuated – this often happens with a low AADT – (10% in 2006, 17% in 1998, 7% in 1992, and 15% in 1986). Pay particular attention to the percentage of 5 axle semis, since they have the most significant effect on ESAL forecasting. In this case the numbers are fairly small and don't vary by much, although the percents jump all around the place. Many times, in a high AADT segment, the opposite will occur.

In this example the forecaster will average all vehicle class data and use the percents in the averages column for heavy commercial percents. The forecaster also may choose to drop all but the most current data (2006). This example is not typical. Usually, the heavy commercial percents will not vary significantly as does the volume of trucks. Unless road construction has occurred, or bypasses have affected traffic patterns, this worksheet usually remains pretty constant. It is when volumes are "all over the place" that requires additional "judgment" by the traffic forecaster.

Again, there may be instances that there have been improvements in the road or an adjacent segment of road has been improved or a change in geometrics has occurred that

changes the traffic pattern. In that case, the forecaster will have to determine what year or group of years to use. A field visit may be necessary if the forecaster suspects that the most recent data at the vehicle class site reflects current conditions.

In other words, at this point, the forecaster will have to decide what historic vehicle class data to use. The purpose of using as many years as possible is that the vehicle class count is a snapshot in time – only 16 hours or 48 hours of the whole year. Since it is not known for sure whether the information is representative, the more information collected the better. If historic data shows a consistent trend or pattern, the forecaster has more "faith" that the count represents real traffic patterns. The forecaster should visit the site and observe what is going on if there is any doubt or discrepancy in the historical vehicle class data.

When analyzing two or more cycles of vehicle class counts (count cycles at the same vehicle class site over a period up to 20 years), most often the forecaster will average all years together and use the average calculated on the Vehicle Class Count Averages Worksheet. Those average heavy commercial percentages are then transferred to the A segment worksheet for distribution based on current and future AADT.

In most cases, the forecaster will use the average of historical vehicle class data; however, when the raw numbers and percent distributions "aren't consistent", the forecaster will use judgment as to which counts to use and which to eliminate. Usually, as AADT increases, the vehicle percentages will remain similar, although the "actual" numbers of heavy commercial vehicles may increase. The following example shows some alternative scenarios the forecaster may use when analyzing the vehicle Class Averages Worksheet

Vehicle Class Count Averages Worksheet

VCC Site Num. 8784
TH TH55
Site Description SE of TH101

		16-24 Vehicle C.C.1		16-24 Vehicle C.C.2		16-24 Vehicle C.C.3		16-24 Vehicle C.C.4			
	Type	**Year**	**Pct**	**Year**	**Pct**	**Year**	**Pct**	**Year**	**Pct**	**Avg Truck Volumes**	**Avg Vehicle Pctages**
		1998 Tube		1991 Manual		1986 Tube					
1	**Cars**	23758	*95.03%*	18812	*96.47%*	15655	*94.94%*				*95.48%*
2	**2 ASU**	407	*1.63%*	389	*1.99%*	445	*2.70%*			*414*	*2.11%*
3	**3+ASU**	137	*0.55%*	44	*0.23%*	177	*1.07%*			*119*	*0.62%*
4	**3ASemi**	53	*0.21%*	22	*0.11%*	20	*0.12%*			*32*	*0.15%*
5	**4ASemi**	103	*0.41%*	33	*0.17%*	34	*0.21%*			*57*	*0.26%*
6	**5+Asemi**	322	*1.29%*	192	*0.98%*	143	*0.87%*			*219*	*1.05%*
7	**TT/BUS**	163	*0.65%*	8	*0.04%*	16	*0.10%*			*62*	*0.26%*
8	**Twins**	57	*0.23%*	0	*0.00%*	0	*0.00%*			*19*	*0.08%*
Total		*25000*	*4.97%*	*19500*	*3.53%*	*16490*	*5.06%*				*4.52%*
Total Heavy Comm		*1242*		*688*		*835*				*922*	*100.00%*
Heavy 5 Ax Semi*					26.9%		25.3%				26.10%
Axle Corr Factor			0.96		0.98		0.98				0.97

* Heavy 5 Ax Semi = Tank, Dump, Grain (and Stake if on Timber route-Dist 1,2, or 3)
When the Tank, Dumps, & Grains and sometimes stakes are 30% or more of the 5 axle semis, then split into max and other categories (AUTOMATICALLY DONE) ---------->
Check out tube counts prior to 1996 carefully; body types are N/A prior to 1982

Heavy 5 Axle Semi Split	
0.27%	Max
0.77%	Others
DON'T SPLIT	

NOTE: IF LESS THAN 4 ENTRIES, BE SURE
TO DELETE YEAR AND PCT COLUMN
DO NOT USE 0, LEAVE BLANK.
USER MUST THEN COPY THE FORMULA IN THE
PCT COLUMNS BACK TO THE APPROPRIATE COLUMN
FOR HELP CALL MARK LEVENSON - 651 -296-8535 OR TOM NELSON - 651-297-1197.

In the example on the previous page (not related to our sample forecast), the forecaster has several options:

1. Average all 3 years
2. Drop the 1991 and 1986
3. Drop the 1986
4. Drop the 1998
5. Take a current count of heavy trucks at the site to determine which counts are more valid; in this example, the forecaster may count trucks for an hour or two and compare the same hours on the most recent vehicle class count. This will not only give you heavy split information, but it will give you an idea of which year(s) vehicle class counts are more reflective of current conditions.

The total heavy commercial percentages are fairly close. If that was the only criteria used, the forecaster may average all 3 years of data, producing about a 4.5% heavy commercial percentage. Since AADT is decreasing the further back you go (logical trend), the total heavy commercial percentage seems logical.

On close examination, the individual vehicle type numbers and percents vary. Notice the most important vehicle type – the five axle semis and notice the disparity in numbers and percent. Often, the percent will remain stable as the numbers will change; that is ok, since what we really are concerned with is the average vehicle percent, which we are applying to the base year and forecast year AADT.

But, the forecaster sees some "funny" numbers in the 3+ axle category (137 for 1998 and 44 for 1991), the 4 axle semi category (103 in 1998 and quite a bit less in 1991 and 1986), the 5+ axle semi category (322 in 1998 and 192 in 1991), and the TT/Bus and Twins (which show much higher numbers in 1998 than previous years).

Thus, averaging all three years worth of data might not be quite right for the individual classes. Note 1998 is a tube count and the 1991 is a manual count (10 years old). WHAT IS GOING ON? Is the gap between 1998 and 1991 too far? Does the 1998 reflect what is currently going on? Is the 1998 count overestimated?

SOLUTION: Take a one hour count at the VC site to determine the number of 5 axles(you could also do a class count of other heavy vehicles, but, just counting the 5 axle semis may give you an indication which data is correct). For this project a one hour directional count (2-3 pm—a high heavy truck hour) at VC site 8784 was taken with the following results(this is a 4-lane): 37 five-axle semis were counted at the site. Analysis of a 48 hour vehicle class data at VC8784 revealed the following 5-axle semis:

Direction	2pm-3pm(1^{st} 24 hour period)	2pm-3pm(2^{nd} 24 hour period) /2 = Average	
N	17	13	15
N	4	4	4
S	5	5	5
S	14	19	17
		Average 2-way total	41

A one-hour count showed approximate 37 five-axle semis.

In recapping what we have done, we first determined that VC data for 1998 was 41 five-axle semis (similar to 37). A quick glance at hourly data for VC 8784 for 1991 reveals 20 5-axle semis in the hour.

CONCLUSION: the one-hour count revealed the 1998 data closest to our current count. Therefore, we will drop the older counts and go with the 1998 data (shown below). As long as the forecaster documents his or her conclusion and follows forecasting procedures, there is no wrong answer. Another forecaster may have used a different technique and used all three years. As long as there is a valid reason for the judgment, the forecast will be accepted in most cases. It is the lack of documentation that may result in not approving a forecast.

Vehicle Class Count Averages Worksheet

VCC Site Num. 8784
TH TH55
Site Description SE of TH101

		16-24 Vehicle C.C.1		16-24 Vehicle C.C.2		16-24 Vehicle C.C.3		16-24 Vehicle C.C.4			
	Type	**Year**	**Pct**	**Year**	**Pct**	**Year**	**Pct**	**Year**	**Pct**	**Avg Truck Volumes**	**Avg Vehicle Pctages**
		1998 Tube									
1	**Cars**	23758	*95.03%*								*95.03%*
2	**2 ASU**	407	*1.63%*							*407*	*1.63%*
3	**3+ASU**	137	*0.55%*							*137*	*0.55%*
4	**3ASemi**	53	*0.21%*							*53*	*0.21%*
5	**4ASemi**	103	*0.41%*							*103*	*0.41%*
6	**5+Asemi**	322	*1.29%*							*322*	*1.29%*
7	**TT/BUS**	163	*0.65%*							*163*	*0.65%*
8	**Twins**	57	*0.23%*							*57*	*0.23%*
Total		*25000*	*4.97%*								*4.97%*
Total Heavy Comm		*1242*								*1242*	*100.00%*
Heavy 5 Ax Semi*			26.1%								26.10%
Axle Corr Factor			0.96								0.96

* Heavy 5 Ax Semi = Tank, Dump, Grain (and Stake if on Timber route-Dist 1,2, or 3)
When the Tank, Dumps, & Grains and sometimes stakes are 30% or more of the 5 axle semis, then split into max and other categories (AUTOMATICALLY DONE) ---------->
Check out tube counts prior to 1996 carefully; body types are N/A prior to 1982

Heavy 5 Axle Semi Split	
0.34%	Max
0.95%	Others
DON'T SPLIT	

NOTE: IF LESS THAN 4 ENTRIES, BE SURE
TO DELETE YEAR AND PCT COLUMN
DO NOT USE 0, LEAVE BLANK.
USER MUST THEN COPY THE FORMULA IN THE
PCT COLUMNS BACK TO THE APPROPRIATE COLUMN
FOR HELP CALL MARK LEVENSON - 651 -296-8535 OR TOM NELSON - 651-297-1197.

Note that we used the heavy split information from the manual counts and inserted the value (26.1%) under the 1998 count.

15. Least Squares Worksheet

At this stage of the forecasting process all of the necessary historical traffic data and vehicle class data has been collected. All of the data needed to continue to do the ESAL forecast should be contained on the SKETCH *(example 2)* and the VEHICLE CLASS COUNT AVERAGES WORKSHEET *(example 11)*. On the MnESAL spreadsheet, the traffic forecaster has worked from left to right through the first six tabs. The next tab to the right is the "Least Squares" sheet. This sheet has undergone the most change from the previous MnESAL versions. On this sheet the forecaster will analyze the historic and current AADT and project it from the base year to the design year (example: 2011 base year to 2031 design year).

The forecaster needs to manually fill in the "Location" and "Base Year." The MnESAL spreadsheet then transfers the "Route", "SP#", "Date" and the "Forecast Year." This sheet will most likely be used multiple times. Print out this sheet and retain hard copies of each segment. *Example 13* is our continuing sample project on Trunk Highway 67 and is the A segment in our sample project (VC 8033), with the termini from TH19 to CSAH1.

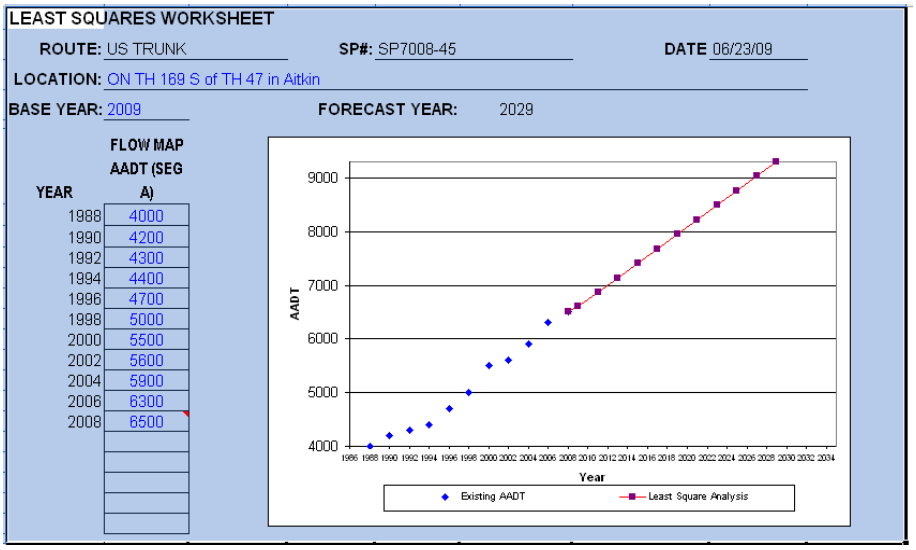
On the Least Squares sheet on the following page there are several modifications from previous versions. We have modified our traditional least squares (linear regression) method of AADT forecasting (where there is no model) to include county factors which modify traffic growth. A study completed in 2009 by TDA indicated a need to apply individual county growth factors to AADT projections to adequately reflect socio economic data trends.

Historically linear regression is the method that has been used to project traffic volumes in non-metropolitan areas of Greater Minnesota. In the Minneapolis-Saint Paul Metropolitan Area, and to a limited extent in other metropolitan areas, travel demand is estimated using models based on information such as roadway and transit networks, and population, land use and employment data.

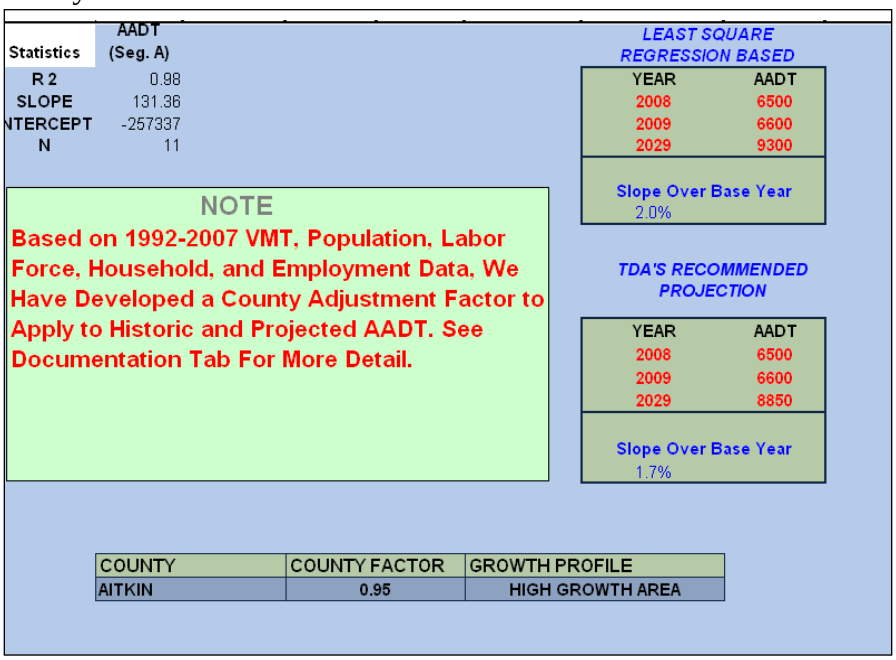
Linear regression is the most widely used forecasting method. It is a technique for fitting a straight line to data. It is also called regression, least squares, or trend analysis. This method projects that future traffic will grow at a constant rate based on a calculated rate from historic data. TDA has been using linear regression to estimate future traffic in rural areas since the 1950's. Linear regression is still being used today by most state Departments of Transportation.

The recent economic recession, increase in gas prices, and aging of the population significantly impacted motorists' driving behavior. Motorists made fewer trips, and used carpooling, and public transportation more often. Traffic growth has decreased in recent years. Projecting future traffic volumes has become a major challenge for traffic forecasters, transportation planners, and transportation engineers since driving behavior has changed. In response to this challenge various enhancements to the current forecasting methods have been investigated and evaluated for use in non-metropolitan areas of the state.

In the following example, it is important to compare future AADT's with and without applying county factors. The blue dots are historical AADT's and the pink dots are future AADT's. The latest Least Squares Worksheet starts at 1990 and goes to 2010.



The above graph shows that when using the country factor the AADT's are not growing as fast as they did without the factor. This is due to the socioeconomic inputs for this county.



The above shows the lower portion of the MNESAL Least Square Worksheet. This area provides the forecast the option of selecting a future AADT's based on either historical data or historical data factored by the county's socioeconomic data. Notice the difference in the 2029 AADT's and the slopes. Whatever the forecaster chooses to do, he/she should document their procedures.

For the first time in the recent past of our nation, traffic volumes appear to be leveling off or even slightly decreasing. This phenomenon can be caused by many factors and this is an attempt to incorporate some of these variables into the forecasting process, with the ultimate objective of improving the accuracy of traffic forecasting. Based on past and projected county level socioeconomic data including; population, labor force, employment and the number of households the county factors were developed for use in traffic forecasts outside of metropolitan areas. The forecaster has the option to accept, deny or adjust the county factors depending upon the expected future use of the roadway. It is highly recommended that whatever the forecasters choose to do, they should document the procedure in the 'Remarks' area of the Forecast Tab in MNESAL.

Since Mn/DOT does not have a statewide travel demand model, we will continue to rely on regression analysis for forecasting traffic volume. The Multi-linear regression is the preferred method to meet statewide traffic volume growth forecasting. Combined with socioeconomic data it provides a consistent statewide forecasting framework. The natural logarithm method is preferred when the county growth profile is in low growth and medium growth categories. The average method has some statistical uncertainties.

The county factors will be updated annually based on new VMT and socioeconomic data. TDA will provide documentation and training for district traffic forecasters to ensure that they understand how to apply the county factors and develop the most accurate projected AADTs.

Future investigations under consideration include; incorporation of intra-county socioeconomic data, land use variables, total lane miles and functional classification to improve Mn/DOT's forecasting process.

Continuing our sample forecast below, notice the effect that the factor for Yellow Medicine County has on our forecast. In most instances, the forecaster has the option to use either the least square regression based projection or the projections in the "TDA Recommended" box. Historically, in the traffic forecasting process, we have usually used a minimum growth of one percent. Many segments of roadways, mainly smaller rural trunk trunk highways with slow or no growth may show a decrease in traffic over the 20 year forecasting period. Since we don't forecast a decrease, we usually "modify" our projections to show at least some growth, enabling some degree of safety in our traffic projections to protect roadways ("built in safety factors").

In many cases, the interpretation of the least squares historic traffic projection data has the most significant effect on a traffic forecast, since often times this is most subjective part of the traffic forecasting process, and there is often no one correct answer. Ten different traffic forecasters may produce ten different interpretations of historic data. The point is to be within certain ranges of statistical relevance. Normally, we have thrown out "outliers" from the least squares process (that is, what appears to be obvious "bumps" in historical traffic change (increase or decrease) to achieve a R2 (statistical measure of reliability) of at least 70. This has to go hand in hand with the normal fluctuation of traffic up or down. That means that traffic does not always have to increase historically,

and that true projections have to include upturns and downturns. The current acceptable method is to enter ALL historic data and see what the R2 is. If it is 70 or over, use it. If it is under, the spreadsheet can be modified and outliers can be removed until the threshold of 70 is reached. Sometimes, that may not even happen, no matter how much "manipulation" of the least squares sheet is undertaken. In this case, depending on the projected AADT, the forecaster may want to use a minimum of .5 or 1% growth from the most recent year (base year) and project that outward to 20 years.

In our sample forecast, the least squares regression shows a 1.7% growth (slope over base year), while "TDA's recommended" shows a slower growth (with the Yellow Medicine county factor indicating that projections should be reduced by 13%) –See factor of 0.87 at bottom of sheet. If the forecaster used either factor, TDA would not have a problem with either choice. One choice reflects lower growth and one choice reflects slightly higher growth. In this instance, the higher growth was used to increase ESALS slightly for an added small safety factor. Oftentimes, the forecaster may want to use an average of the two projections if he/she feels that is more appropriate for this particular forecast and or section of roadway.

In the least squares AADT section of our sample forecast below, notice that three years worth of data were thrown out and that the R2 is 0.82 - within acceptable statistical limits. Again, the higher growth was used on this segment. Additional segments along this forecast would require the same analytical concepts applied to the A segment.

The forecaster will have to perform a least squares analysis for each segment, that is, each AADT break that has historic counts. Included on the sketch are all historic volumes. The AADT base year and forecast year data as well as the "R squared" and growth rate should be manually entered on the sketch (*example 2*) for each segment.

The important thing to remember is, "THE FORECASTER HAS TO COMPLETE A LEAST SQUARES ANALYSIS FOR EVERY AADT SEGMENT ALONG THE PROJECT AND AT THE VEHICLE CLASS SITE. THE VEHICLE CLASS SITE MAY NOT ALWAYS BE CONTAINED WITHIN THE PROJECT LIMITS.

In our traffic forecast example, F8-1002, there are five segments to do least square analysis and a possibility of using any combination of one, two, three, or four A segments and their associated B segments, which we will discuss in the next section, where we will be doing the actual ESAL calculations derived from previous data in the MnESAL spreadsheet.

Some forecasting reminders and protocol changes for 2012:

One procedural change we would like is that on all least squares sheets we would like all years filled in from the historic data you have collected on your sketch; then start slowly removing outliers until 0.7 is achieved.. We are not striving for the best fit, that is, not taking out all outliers that are higher than more recent counts.. Rather, we want to more accurately forecast the actual historic ups and downs of 20 years of traffic

roadways. That is why we have a dampening factor, or a county reduction factor on the least squares sheet. Previously, we used to take out all outliers to try to achieve the highest possible r2. However, the recent decline in traffic growth has caused us to rethink the least squares sheet. If at possible, try to start with all counts for 20 years and then begun the gradual outlier reduction of needed. In a lot of cases, 0.7 will be reached with the usual ups and downs of historic traffic data. No need to strive for a .9 or higher to just to make a better fit.

Please use 20 years of historical data on your sketches, so it will be easier to complete the Least Squares Worksheet. In most cases, we can provide you with older data– no older than 1988 needed. We have a microfiche machine to look up old historic counts for you or can find the count data in one of our reference documents.

Attached is a reference spreadsheet which should help you in obtaining older historic counts for your traffic forecasts. It contains many counts from 1988, 1990, and 1992, etc that should help make your sketch and least squares sheets more complete, and establish a longer historic timeline for each segment. It is not complete, so, again, if you need older counts that are missing in this spreadsheet, please contact myself, Shannon, or Tom. Note that the 2011 counts are not on the attached spreadsheet.

The 2011 traffic counts are almost final (April 25, 2012). In preparation of ALL your traffic forecasts, call Christy Prentice at 651 366 3844 to determine their availability and if you have any question as to the most recent counts for your project. The odd years that trunk highway traffic counts will be appearing due to the staggered cycle make the Least Squares Worksheet a little funky. However, there are 11 entries on the current sheet from 1990 to 2010. Just retype in the current year over the existing year for now and the MnESAL will work fine. For example, if you have a 2009 count instead of a 2008, just type in the year 2009 over the 2008 or if you have 2011 count, just type in the year 2011 over the 2010 and the Least Square will recalculate the trend data accordingly. The trouble can arise if you add a new line, say add 2011 after the 2010. That will make the Least Squares sheet malfunction.

Example 13 -Least Squares Worksheet–Segment 1-F8-1002

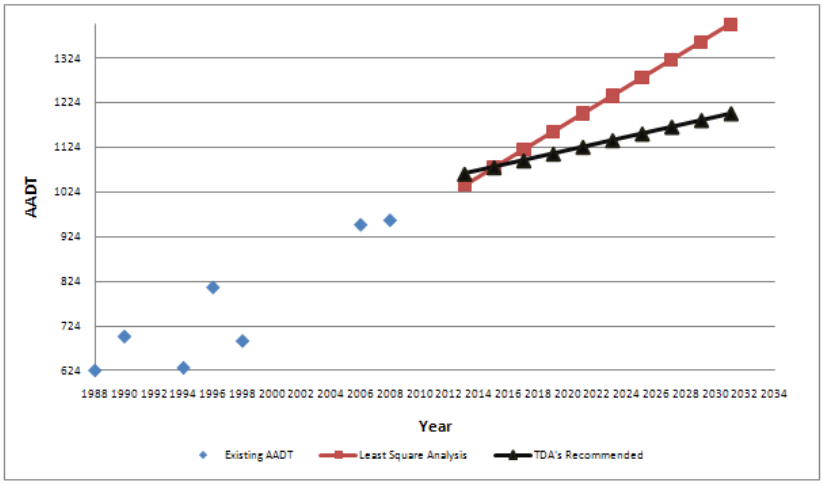
LEAST SQUARES WORKSHEET

ROUTE: MN TRUNK 67 **SP#:** 8707-51 **DATE** 04/21/10

LOCATION: TH19 T0 CSAH1

BASE YEAR: 2011 **FORECAST YEAR:** 2031

YEAR	FLOW MAP AADT (SEG A)
1988	624
1990	700
1992	
1994	630
1996	810
1998	690
2000	
2002	
2004	
2006	950
2008	960



LEAST SQUARES BASED FORECASTS:

Year	AADT (Seg. A)	Calc	ADT Calc
2008	950	10	960
2011	1000		1010
2031	1340		1350

Statistics	AADT (Seg. A)
R 2	0.81
SLOPE	16.97
INTERCEPT	-33122
N	7

NOTE

Based on 1992-2007 VMT, Population, Labor Force, Household, and Employment Data, We Have Developed a County Adjustment Factor to Apply to Historic and Projected AADT. See Documentation Tab For More Detail.

LEAST SQUARE REGRESSION BASED

YEAR	AADT
2008	1000
2011	1000
2031	1400

Slope Over Base Year
1.7%

TDA'S RECOMMENDED

YEAR	AADT
2008	1000
2011	1050
2031	1200

Slope Over Base Year
0.7%

COUNTY	COUNTY FACTOR	GROWTH PROFILE
YELLOW MEDICINE	0.87	LOW GROWTH AREA

16. A and B Segment Concept

From the Least Squares Worksheet, our focus will be on the next four tabs, which are the heart of the MnESAL spreadsheet. *This is where the forecaster will determine the ESAL forecast. The ESAL procedure is used to design both flexible (bituminous) and rigid (concrete) pavements*.

The concept of the "A" segment and "B" segment is shown on the sketch *(example 2)*. The "A" segment" is the segment that contains the vehicle class site. In our sample forecast, there are multiple A segments; A segments may or may not be contained within the project limits. Even if the "A" segment is **not** contained within the project, it is still necessary to include it on your sketch along with all historic traffic volumes. There are brackets on the AADT segment contained within the "A" segment and also around the "B" segment" on our sketch. The "B" segment is the "rest of the project." Think of the "B" segment as a series of AADT breaks along the project that do not contain vehicle class sites.

In our sample forecast there are four "A"segments and one "B" segment. We will discuss the use of multiple "A" segments and multiple "B" segments later. Suffice it to say, that the "A" and "B" segment are interrelated. A "B" segment is tied to a specific "A" segment. An "A" segment can stand-alone; a "B" segment cannot. *Example 14* is the next tab to the right – Cumesal A.

The sample project used in this forecast is an actual project completed in April of 2010. Before we continue, please refer to the sketch again, Example 2. As noted in our preliminary discussion of A and B segments, the sketch shows one A segment, VC 8033(which we use in the actual forecast and three other vehicle class sites, numbered 2120, 2129 and 2118. Those are actual "special" vehicle class sites counted and were not used in this forecast (being older class counts). They perhaps would have been used if there was A MAJOR TRUNK HIGHWAY BREAK between the termini of this project. But, since these counts were not used, they were treated as B segments to the VC site 8033. In other words, VC 8033 was the A segment and the other four segments are all B segments attached it site 8033. This should clarify itself in the ensuing discussions of the A and B segment.

17. Cumulative ESAL Worksheet A

The "Cumulative ESAL Worksheet A" represents a culmination of everything completed to this point. It takes elements from previous worksheets and incorporates many of the terms and information covered in the previous pages of this manual. From this point throughout the rest of the forecasting process, the forecaster will primarily use all the information on the sketch (*example 2*) and the vehicle class count averages worksheet (*example 11*). After placing all the information from the least squares worksheet onto the sketch, the Cumulative ESAL Worksheet A is ready to be filled out. Much of the information has been transferred automatically to this sheet --the SP#, the Date, Route and Vehicle Class Site #.

THIS INFORMATION REPRESENTS THE INFORMATION COLLECTED FROM THE HISTORICAL ANALYSIS OF THE VEHICLE CLASS SITE. The data from the vehicle class count averages worksheet *(example 11),* the last column of percentages, has been transferred to the ESALS worksheet *A (example 14*). It is shown under Base Year Proportions for each heavy commercial type. The percentages have been truncated to one decimal place. If the information indicated that heavies should have been split, that also would be transferred to the worksheet.

The forecaster has to fill in # Lanes and the Location. Note that the segment containing the vehicle class site is the same and has the same location as the appropriate Least Squares Worksheet (*example 13*). Every location and segment description is usually measured between AADT breaks. As a consequence, the vehicle class site segment location is often used interchangeably as the segment description. In reality, they are the same thing since the AADT does not change (for traffic forecasting purposes) either at the vehicle class site or the segment. For forecasting purposes, always describe the segment limits at the point where AADT changes.

In addition to location and number of lanes, the Vehicle Class Year and AADT need to be filled out. That is simply the most recent year of data used in the vehicle class count averages worksheet (*example 11).* In this case, 950 AADT from 2006 on the sketch is used. The Base Year and Forecast Year have been automatically transferred so that all the forecaster needs to fill out is the AADT for the Base Year (2011) and the Forecast Year (2031) -- in this case, 1000 and 1400 respectively (from the sketch).

When the AADT has been filled out, the worksheet will calculate 20 year cumulative flexible and rigid ESALS – the values being 732,000 and 1,185,000. Previously in this manual we discussed what an ESAL is. ESAL worksheet A takes all the information previously collected and calculates the above ESALS, with some rounding occurring. Again, this worksheet takes the vehicle percents from the Vehicle Class Count Averages Worksheet and calculates a Base Year and a Future Year Volume. To see how ESAL worksheet A calculates, for example, simply take the base year AADT (1000) and multiply it by the 5AX+TST (Max – 3.9%, and Other – 3.5%). The resultant numbers combined are 74. That is the Base Year (year 2011) HCAADT for the 5 + axle semi

category. Furthermore, doing the same calculation for the Forecast Year AADT (1400), you get the Future Volume category for the 5 + axles (105). The HCAADT totals are then placed in two different places on the worksheet along with the total HCAADT percentages for all the truck categories.

The ESAL factors at the bottom of the ESALS Worksheet A were first derived from groundwork laid by AASTHO road tests in the 1950s and 1960s and then refined using WIM data from three WIM sites in the 1980s

Example 14- Cumulative ESALS Worksheet A – F8-1002

CUMULATIVE ESALS WORKSHEET **SEGMENT A**

SP#:	8707-51				
ROUTE:	MN TRUNK 67	**# LANES:**	2	**DATE:**	04/21/10
LOCATION:	TH19 TO CSAH1				
VCL SITE #:	8033				

	YEAR	AADT	INIT CALC HCADT	CONSTRN HCADT	INIT CALC 5AX TST	CONSTRAIN 5AX TST
VEH.CLASS YR.:		950	110	0.0%	---	---
BASE YEAR:	2011	1000	120		74	
FORECAST YEAR:	2031	1400	170		104	

BASE YEAR PROPORTIONS		BASE YR. VOLUME	% TREND	FORECAST %	FUTURE VOL.
2AX-6TIRE SU	2.9%	29	1	2.9%	41
3AX+ SU	0.7%	7	1	0.7%	11
3AX TST	0.2%	2	1	0.2%	2
4AX TST	0.5%	5	1	0.5%	7
5AX+ TST	0	0	1	0.0%	0
(5AX+ TST MAX)	3.9%	39	1	3.9%	55
(5AX+ TST OTH)	3.5%	35	1	3.5%	50
TR TR, BUSES	0.3%	3	1	0.3%	4
TWIN TRAILERS	0.0%	0	1	0.0%	0

SUMMARIES:		AADT	HCADT	HCADT %	20 YR DESIGN LANE CUMULATIVE ESAL
0	**COUNT:**	950	110	11.6%	|
2011	**FORECAST:**	1000	120	12.0%	**********
2031	**FORECAST:**	1400	170	12.1%	

		FLEXIBLE	RIGID
DESIGN LANE FACTOR:	0.5	**732,000**	**1,185,000**
		**********	**********

ADDITIONAL OUTPUTS:

	BASE %	FORECAST %	ESAL FACTORS FLEXIBLE	RIGID
2AX-6TIRE SU	2.9%	2.9%	0.25	0.24
3AX+ SU	0.7%	0.8%	0.58	0.85
3AX TST	0.2%	0.1%	0.39	0.37
4AX TST	0.5%	0.5%	0.51	0.53
5AX+ TST	0.0%	0.0%	1.13	1.89
(5AX+ TST MAX)	3.9%	3.9%	2.40	4.07
(5AX+ TST OTH)	3.5%	3.6%	0.87	1.44
TR TR, BUSES	0.3%	0.3%	0.57	0.74
TWIN TRAILERS	0.0%	0.0%	2.40	2.33

Notes:

Sample Worksheet Example with Notes

CUMULATIVE ESALS WORKSHEET **SEGMENT A**

SP#: 0804-73
ROUTE: TH14 **# LANES:** 4 **DATE:** 01/00/00
LOCATION: 12TH ST NORTH TO 7TH ST N
VCL SITE #: VCC 9060

	YEAR	AADT	INIT CALC HCADT	CONSTRN HCADT	INIT CALC 5AX TST	CONSTRAIN 5AX TST
VEH.CLASS YR.:	2000	17400	1290	0.0%	---	---
BASE YEAR:	2004	18200	1350		582	
FORECAST YEAR	2024	24000	1780		768	

Use volumes from sketch

Latest VC count

BASE YEAR PROPORTIONS		BASE YR. VOLUME	% TREND	FUTURE %	FUTURE VOL.
2AX-6TIRE SU	2.6%	474	1	2.6%	625
3AX+ SU	0.5%	91	1	0.5%	120
3AX TST	0.1%	18	1	0.1%	24
4AX TST	0.2%	36	1	0.2%	48
5AX+ TST		0	1	0.0%	0
(5AX+ TST MAX)	1.5%	274	1	1.5%	361
(5AX+ TST OTH)	1.7%	310	1	1.7%	409
TR TR, BUSES	0.8%	146	1	0.8%	192
TWIN TRAILERS	0.0%	0	1	0.0%	0

These all can be manually changed

SUMMARIES:		AADT	HCADT	HCADT %	20 LANE CUMULATIVE ESAL	YR DESIGN
2000	COUNT:	17400	1290	7.4%	|	|
2004	FORECAST:	18200	1350	7.4%	**********	**********
2024	FORECAST:	24000	1780	7.4%		

		FLEXIBLE	RIGID
DESIGN LANE FACTOR:	0.45	5,462,000	8,511,000
		**********	**********

20 Year Cumulative ESALS

ADDITIONAL OUTPUTS:

	BASE %	FORECAST %	ESAL FACTORS FLEXIBLE	RIGID
2AX-6TIRE SU	2.6%	2.6%	0.25	0.24
3AX+ SU	0.5%	0.5%	0.58	0.85
3AX TST	0.1%	0.1%	0.39	0.37
4AX TST	0.2%	0.2%	0.51	0.53
5AX+ TST	0.0%	0.0%	1.13	1.89
(5AX+ TST MAX)	1.5%	1.5%	2.40	4.07
(5AX+ TST OTH)	1.7%	1.7%	0.87	1.44
TR TR, BUSES	0.8%	0.8%	0.57	0.74
TWIN TRAILERS	0.0%	0.0%	2.40	2.33

Regular Loaded (other)

AASHTO guide for design of pavements. See Fig 15 – ESAL equivalence factors

Notes:

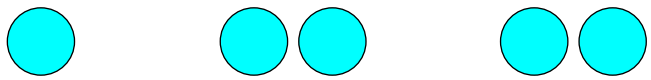
. The ESAL concept can be explained a little easier by the illustration below:

Figure 4 – ESAL CONCEPTS

ESALs and 1 fully loaded 5-axle semi (80,000 lbs)

Axle Group	Weight	Flexible ESAL Factor
✍ Front	12,000	0.19
✍ Tandem	34,000	1.10
✍ Tandem	34,000	1.10
	80,000	2.39 ESAL Factor

Example: 5 axle semis only! (design lane)
If we have 50/day over a 20 year period:
50 veh x 7308 days in 20 years x 2.40 (flex ESAL factor) = 876,960 ESALS



12,000 .2 Front | 34,000 1.1 Tandem | 34,000 1.1 Tandem = 2.4

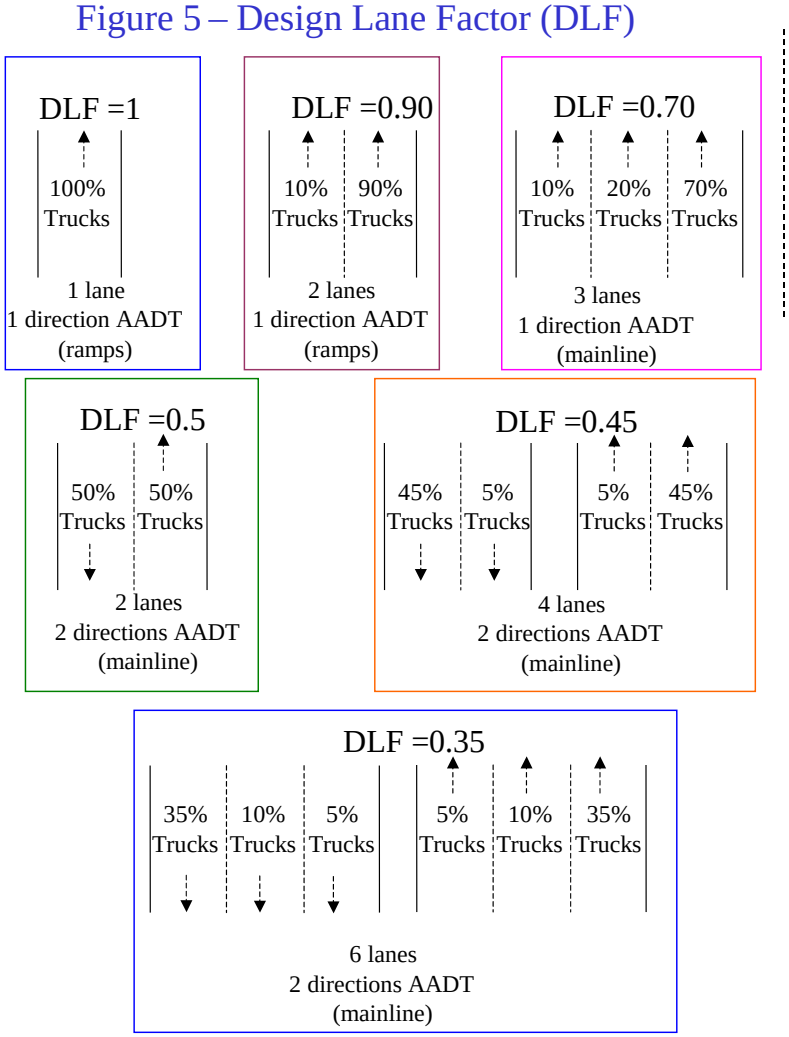
Note: 1 ESAL is equal to the damage to a flexible pavement caused by one 18,000 axle load

Figure 4 (previous page) shows how the 2.4 or 2.39 ESAL factor is calculated on the ESAL Worksheet A. In this example, 50 fully loaded 5-axle semis per day over the 20-year period of a bituminous roadway produce 876,960 ESALS. Compare this to our sample forecast (example 14) that produces only732,000 ESALS. In this comparison, 50 fully loaded 80,000 pound semis alone produce more ESALS than all the trucks in our sample forecast.

There is one more concept on this worksheet that has been mentioned earlier in the manual – the Design Lane Factor (DLF). In the middle of the ESAL Worksheet A (example 14) is a number of 0.5 for design lane factor. That number is generated automatically when the forecaster enters the number of lanes for the project. One word of caution: If the existing roadway is 2 lanes, for example, and the future improvement is for four or six lanes, enter that number on the # lanes portion of the worksheet.

We used two lanes in our sample forecast – that translates into a DLF of 0.5. FORECASTS ARE DONE FOR THE DESIGN LANE ONLY. The illustration below shows various configurations and the appropriate design lane factors. Design Lane Factor is a factor to estimate traffic volume and truck components on heaviest traveled lanes for the purposes of ESAL estimation. A word of caution: if the A segment has a different number of lanes than the project area, contact the C.O. for guidance.

Figure 5 – Design Lane Factor (DLF)



18. Cumulative ESAL Report A (see updated 2012 redesigned sheet discussed later)

The next tab to the right is called the Cumulative ESALS Report A; it shows on the MnESAL as "ESAL Report-A." Most of the information is transferred from previous spreadsheets. All that is required to enter is the author's district, name and the length of the segment. The length can be measured or estimated from any map legend. *Example 15* is a continuation of our sample forecast. There is little to do on this worksheet, as it is mainly a summary and grouping of the information from the ESAL worksheet A. ESAL Report A summarizes the base and design year AADT as well as the design lane AADT. In this case, the design lane AADT is half of two-way AADT. The heavy commercial vehicles are also grouped into total Single Units (sum of 2 plus 3 and 4+ axle single units), 5 axle + TSTs, and total TSTs (sum of 3, 4 and 5+ axle semis). This is for the base and design year also.

There is also an annual ESAL summary and summaries for various time periods. There is also a 35 cumulative ESAL summary. In most cases, the 20 year cumulative Flexible 732,000 and Rigid 1,185,000 ESALs (in bold on the MnESAL spreadsheet) are what designers look for.

19. Cumulative ESAL Worksheet B

Moving to the right towards the last two tabs, we have a "Cumulative ESALs Worksheet B" and a "Cumulative ESALS Report B" – these are similar to the previous two "A" worksheets. The "B" segment or the "B" concept is shown on the original sketch *(example 2)* – the "B" segment is any segment that does not contain a vehicle class count location. There can be multiple B segments. Each "B" segment usually "belongs to" its adjacent "A" segment. In other words, the "B" segment concept is a way to project truck traffic along the portion of the trunk highway that does not contain a vehicle classification site.

Since there cannot be a vehicle class segment on every section of roadway we have to tie the vehicle classification site to other segments of a particular project. That is the purpose of the B segment.

Example 16 is the "Cumulative ESALS Worksheet B" for our sample forecast. On this sheet, the number of lanes and the location should be entered. In addition, the AADT for the Base Year and the Forecast Year (similar to the A worksheets) has to be entered. The information is contained on the sketch *(example 2)*. Similar to A segments, the location of B segments are determined by AADT changes.

The ESAL B worksheet was redesigned in 2010 for more clarification. When B segment ESALS and AADT vary significantly from each other with no trunk highway junction in between segments, then the difference may be mainly cars. In these instances, the default B segment percentages MAY NEED TO BE ADJUSTED to reflect logical addition or subtraction of trucks, or to smooth out the volume of trucks between all B segments. When something other than OK appears in the yellow and or green boxes in the Base Year or Forecast Year boxes, the percentages of trucks needs to be changed. You can

unprotect the B worksheet and alter your truck percentages to make the forecast segments more consistent.

Example 15 - Cumulative ESALS Report A - F8-1002

CUMULATIVE ESAL REPORT - A

DATE: 04/21/10

ROUTE #: MN TRUNK 67 **DISTRICT:** 8 **SP#:** 8707-51

FORECAST #: F8-1002 **COUNTY:** YELLOW MEDICINE **MILES:**

DESCRIPTION: TH19 TO CSAH1

AUTHOR'S DISTRICT: ---> C.O. **AUTHOR:** LEVENSON

TRAFFIC SUMMARY

BASE YEAR NUMBER OF LANES (two way): 2

	BASE YEAR --->	2011	DESIGN YEAR ---->	2031	GROWTH / YR (SIMPLE %)
AADT: two-way		1000		1400	2.0%
design-lane		500		700	2.0%
HCADT: two-way		120		170	2.1%
SINGLE UNITS:two-way		40		50	1.3%
TST'S: two-way		81		114	2.0%
5 Ax +: two-way		74		105	2.1%

ESAL SUMMARY

ANNUAL DESIGN LANE ESAL

FLEXIBLE:	25,753	36,456	+
RIGID:	41,705	59,070	+

CUMULATIVE DESIGN-LANE ESALS (10 TON) **Design-lane factor:** 0.5

DESIGN YEAR	DESIGN-LANE TST'S	ESALS FLEXIBLE	ESALS RIGID
2021	49	350,000	567,000
2026	53	533,000	864,000
2031	57	**732,000**	**1,185,000**
** OR ** DESIGN YEAR		^^^^^^^^^^^^^^^	^^^^^^^^^^^^^^^
2032	58	744,000	1,206,000
2033	59	757,000	1,226,000
2034	59	769,000	1,246,000
2035	60	782,000	1,267,000
2036	61	795,000	1,287,000

35 YEAR CUMULATIVE ESAL USING--> 2011 **AS THE BASE YEAR**

2046	1,416,000	2,294,000
	^^^^^^^^^^^^^^^	^^^^^^^^^^^^^^^

APPROVED BY: _____ **DATE:** _____

Example 16 - Cumulative ESALS Worksheet B – F8-0803

CUMULATIVE ESAL WORKSHEET **SEGMENT B**

SP#: 8707-51

ROUTE: MN TRUNK 67 **# LANES:** 2 **DATE:** 04/21/10

LOCATION: CSAH1 TO NORTH CITY LIMITS ECHO

	YEAR	AADT			CALCULATED HCADT	CONSTRAIN HCADT
BASE YEAR:	2011	1100	100	**DIFFERENCE**	130	0
FORECAST YEAR:	2031	1500	100	**DIFFERENCE**	180	0

INCREMENTAL HCADT ON SEGMENT B (2000-2004 Local Road Studies)

BASE YEAR PROPORTIONS		**BASE YR. VOLUME**	**% TREND**	**FORECAST %**	**FUTURE VOL.**
2AX-6TIRE SU	3.1%	3	1	3.1%	3
3AX+ SU	1.3%	1	1	1.3%	1
3AX TST	0.4%	0	1	0.4%	0
4AX TST	0.6%	1	1	0.6%	1
5AX+ TST	2.8%	3	1	2.8%	3
(5AX+ TST MAX)	0.0%	0	1	0.0%	0
(5AX+ TST OTH)	0.0%	0	1	0.0%	0
TR TR, BUSES	0.6%	1	1	0.6%	1
TWIN TRAILERS	0.1%	0	1	0.1%	0

SUMMARIES: ***RURAL*** 0 **ADDED** **COMBINED** **20 YR DESIGN**

		AADT	**HCADT %**	**HCADT %**	**LANE CUMULATIVE ESAL**	
BASE YEAR:	2011	100	9.0%	11.7%	|	|
FORECAST YEAR:	2031	100	9.0%	11.9%	**********	**********
DESIGN LANE FACTOR:		0.5			**FLEXIBLE**	**RIGID**
		SEGMENT B INCREMENT ONLY:			25,000	37,000
		SEGMENT A + SEGMENT B:			**757,000**	**1,222,000**
					**********	**********

ADDITIONAL OUTPUTS:

	BASE %	**FORECAST %**	**ESAL FACTORS FLEXIBLE**	**RIGID**
2AX-6TIRE SU	3.0%	3.0%	0.25	0.24
3AX+ SU	1.0%	1.0%	0.58	0.85
3AX TST	0.0%	0.0%	0.39	0.37
4AX TST	1.0%	1.0%	0.51	0.53
5AX+ TST	3.0%	3.0%	1.13	1.89
(5AX+ TST MAX)	0.0%	0.0%	2.40	4.07
(5AX+ TST OTH)	0.0%	0.0%	0.87	1.44
TR TR, BUSES	1.0%	1.0%	0.57	0.74
TWIN TRAILERS	0.0%	0.0%	2.40	2.33

BSEGment

BASE YEAR		**FORECAST YEAR**
OK	Subtraction  of Trucks	OK
OK	Addition  of Trucks	OK

ESAL Worksheet B contains *new urban and rural default percentages)* determined by previous studies. In most cases, the forecaster will use those percentages for the B segment. The underlying assumption has been to utilize heavy truck percentages developed 15 to 20 years ago and updated in 2005 from vehicle class counts taken on county roads and city streets. The previous default was 5.9% -for both rural and urban. The 2010 default heavy commercial percentages are 3.9% urban and 8.9% rural (example 16). ***PLEASE NOTE THAT AS OF 2012, THE DEFAULT PERCENTAGES HAVE BEEN CHANGED. THEY APPEAR IN THE NEXT SECTION.*** Again, these are trucks that are "predicted" to enter and exit trunk highways from CSAHs, city streets and county roads. In our sample forecast, F8-1002 we used rural defaults.

USE THE RURAL OR URBAN PCT'S BELOW FOR TYPE OF FORECAST

ENTER RURAL OR URBAN BELOW

rural

ENTER RURAL OR URBAN IN COLUMN J3

VEHICLE TYPE	Urban	Rural
2AX-6TIRE SU	1.70%	3.10%
3AX+ SU	0.50%	1.30%
3AX TST	0.10%	0.40%
4AX TST	0.10%	0.60%
5AX+ TST	1.00%	2.80%
TR TR, BUSES	0.50%	0.60%
TWIN TRAILERS	0.00%	0.10%
TOTAL	*3.90%*	*8.90%*

Note: The URBAN vehicle types were developed primarily for use in the Seven County Metropolitan Area. They can also be used for segments that are near cities with over 5,000 population.

CAUTION: USE ONLY ONE SET OF DEFAULTS ON EACH "A" SEGMENT

The "B" segment represents the "addition" or "subtraction" of trucks on the trunk highway system to or from other road systems. Thus, the "B" concept is a way to forecast traffic and ESALS along a portion of trunk highway using vehicle class data from another road segment. The current default factors as shown on the MnESAL spreadsheet may be subject to change as more analysis on the county road system is undertaken.

In the sample forecast, the forecaster takes the base and design year AADT from the B segment on the sketch *(example 2*) – 1100 and 1500 respectively and places them on the appropriate line on ESAL Worksheet B. When this is done, *the MnESAL automatically calculates the addition or subtraction of trucks from the "A" segment.*

On our Worksheet B, the additional 8.9% trucks are added to the A segment resulting a small increase of 25,000 ESALS (*example 16* – "Segment B Increment Only"). The 25,000 ESALS plus the 732,000 ESALS on the A Worksheet results in the ESAL value on the B Worksheet of 757,000 ESALS (20 year flexible). In this example, -100 AADT on the B segments multiplied by the default percentage (3.1%) of 2 axle 6 tire single unit results in a plus three 2 axle 6 tire vehicles – which, adding from the A value (29) produces an actual 32 in the base year (*example 16* - "Base Yr. Volume"). The subtraction of AADT on the "B" segment is calculated the same way - that is, if 100 vehicles are taken away from the B, simply multiply -100 by 3.1% for a net loss of three 2 axle 6 tire vehicles.

When the B Segment AADT is less than the A Segment AADT, there will be negative values under the "Base Yr Volume" on ESAL Worksheet B. This means that a drop in AADT from the A segment to the B segment results in a decrease in heavy truck volumes between the A and B segments. The spreadsheet automatically calculates the difference in AADT and then applies the default percentages to the truck volumes. Occasionally, the MnESAL program may "take away" more trucks than exist on the A segment during the A to B segment calculation of trucks. If this situation occurs, it is up to the forecaster to "manually adjust" (lower the B segment percentages) until enough trucks remain on the A segment to account for the difference. Again, the assumption is that between the A and B segment, any change in AADT results in a loss or gain of heavy commercial traffic of 3.9 or 8.9% of the difference between the A and B segment (if you use rural or urban).

The default percentage concept is not rigid. This is up to the judgment of the individual forecaster. For example, if there is a sand and gravel pit or a grain facility on a county road that produces or generates additional heavy truck traffic, those heavy trucks can be added to the mix. Examples of this will be shown later. The forecaster may prefer to take short counts or drive along any county roads or local streets that intersect the project to get a sense of the traffic flow.

The video log should be consulted in each and every project. It can produce valuable insight as to the character change of the roadway in question, and also clarify the number of lanes and land use along the project.

20. Cumulative ESAL Report B (see updated 2012 redesigned sheet discussed later)

The last tab to the right before the documentation on the MnESAL is the "Cumulative ESALS Report B" (*example 17*). This sheet is virtually identical to Cumulative ESAL Report A and is automatically generated. On Report B the only areas to be filled in are the miles, author's district and the author.

On many forecasts, there are multiple B segments. Again, since the MnESAL can save only one B and one A segment, it is important to *PRINT OUT EVERY A AND B SEGMENT GENERATED DURING PRODUCTION OF THE MNESALS REPORT*. The forecaster may chose not to use all the A and B segments generated in a report for the final segments, but it is important to save hard copies of all the A and B segments generated during a forecast and attaching them to the final documentation.

Example 17 Cumulative ESAL Report B – F8-1002

CUMULATIVE ESAL REPORT - B

DATE: 04/21/10

ROUTE #: MN TRUNK 67 **DISTRICT:** 8 **SP#:** 8707-51

FORECAST #: F8-1002 **COUNTY:** YELLOW MEDICINE **MILES:** _____

DESCRIPTION: CSAH1 TO NORTH CITY LIMITS ECHO

AUTHOR'S DISTRICT: ---> C.O. **AUTHOR:** LEVENSON

TRAFFIC SUMMARY

BASE YEAR NUMBER OF LANES (two way): 2

	BASE YEAR --->	2011	DESIGN YEAR ---->	2031	GROWTH / YR (SIMPLE %)
AADT: two-way		1100		1500	1.8%
design-lane		550		750	1.8%
HCADT: two-way		130		180	1.9%
SINGLE UNITS:two-way		40		60	2.5%
TST'S: two-way		85		118	1.9%
5 Ax +: two-way		77		108	2.0%

ESAL SUMMARY

ANNUAL DESIGN LANE ESAL

FLEXIBLE:	26,825	37,528	+
RIGID:	43,272	60,638	+

CUMULATIVE DESIGN-LANE ESALS (10 TON) **Design-lane factor:** 0.5

DESIGN YEAR	DESIGN-LANE TST'S	ESALS FLEXIBLE	ESALS RIGID
2021	51	363,000	587,000
2026	55	553,000	892,000
2031	59	**757,000**	**1,222,000**
** OR ** DESIGN YEAR		^^^^^^^^^^^^^^^	^^^^^^^^^^^^^^^
2032	60	769,000	1,242,000
2033	61	782,000	1,263,000
2034	61	795,000	1,283,000
2035	62	807,000	1,304,000
2036	63	820,000	1,324,000

35 YEAR CUMULATIVE ESAL USING--> 2011 **AS THE BASE YEAR**

2046	1,459,000	2,357,000
	^^^^^^^^^^^^^^^	^^^^^^^^^^^^^^^

APPROVED BY: _____ **DATE:** _____

Example 18- ***NEW*** Cumulative ESAL Report A and B

As discussed previously, the MnESAL has undergone changes since the previous version of this manual. A newly designed cumulative ESAL Report A sheet has been redesigned for more clarity and for better usage for our clients. The 20 and 35 year ESAL has been retained, but we have added additional 20 year ESAL calculations using the same base year with different design years. In this way, we can now determine the 10, 15, 25, 30, and 35 year ESALS (see below).

CUMULATIVE ESAL REPORT - A

DATE: 02/21/12

ROUTE #: MN TRUNK 62 **DISTRICT:** 7 **SP#:** 1704-27

FORECAST #: F7-1203 **COUNTY:** COTTONWOOD **MILES:**

DESCRIPTION: CSAH40(MURRAY CO) TO CSAH19(COTTONWOOD CO)

AUTHOR'S DISTRICT: ---> C.O. **AUTHOR:** LEVENSON

TRAFFIC SUMMARY

BASE YEAR NUMBER OF LANES (two way): 2

BASE YEAR --->	2013	DESIGN YEAR ---->	2033	GROWTH / YR (SIMPLE %)
AADT: two-way	1050		1450	1.9%
design-lane	530		730	1.9%
HCADT: two-way	160		220	1.9%
SINGLE UNITS:two-way	60		80	1.7%
TST'S: two-way	89		123	1.9%
5 Ax +: two-way	80		111	1.9%
ESAL SUMMARY				
ANNUAL DESIGN LANE ESAL				
FLEXIBLE:	27181		37749	+
RIGID:	41660		57813	+

CUMULATIVE DESIGN-LANE ESALS (10 TON) **Design-lane factor:** 0.5
FOR VARIABLE TIME PERIODS

BASE YEAR	DESIGN YEAR	TIME PERIOD	DESIGN-LANE TST'S	ESALS FLEXIBLE	ESALS RIGID
2013	2023	10 Year	53	367,000	563,000
2013	2028	15 Year	57	558,000	855,000
2013	**2033**	**20 Year**	**62**	**764,000**	**1,170,000**
2013	2038	25 Year	66	984,000	1,507,000
2013	1080	30 Year	70	1,219,000	1,867,000
2013	**2048**	**35 Year**	**74**	**1,469,000**	**2,250,000**

APPROVED BY: _____ **DATE:** _____

Also, a newly designed cumulative ESAL Report B sheet has been redesigned for more clarity and for better usage for our clients. The 20 and 35 year ESAL has been retained, but we have added additional 20 year ESAL calculations using the same base year with different design years. In this way, we can now determine the 10, 15, 25, 30, and 35 year ESALS (see below).

CUMULATIVE ESAL REPORT - B

DATE: 02/21/12

ROUTE #: MN TRUNK 62 **DISTRICT:** 7 **SP#:** 1704-27

FORECAST #: F7-1203 **COUNTY:** COTTONWOOD **MILES:** _____

DESCRIPTION: WEST LIMITS WINDOM TO WINDOM

AUTHOR'S DISTRICT: ---> C.O. **AUTHOR:** LEVENSON

TRAFFIC SUMMARY

BASE YEAR NUMBER OF LANES (two way): 2

BASE YEAR --->	2013	DESIGN YEAR ---->	2033	GROWTH / YR (SIMPLE %)
AADT: two-way	950		1200	1.3%
design-lane	480		600	1.3%
HCADT: two-way	150		200	1.7%
SINGLE UNITS:two-way	50		70	2.0%
TST'S: two-way	85		113	1.6%
5 Ax +: two-way	77		103	1.7%

ESAL SUMMARY

ANNUAL DESIGN LANE ESAL

FLEXIBLE:	26,003	34,800	+
RIGID:	39,937	53,476	+

CUMULATIVE DESIGN-LANE ESALS (10 TON) **Design-lane factor:** 0.5

FOR VARIABLE TIME PERIODS

BASE YEAR	DESIGN YEAR	TIME PERIOD	DESIGN-LANE TST'S	ESALS FLEXIBLE	ESALS RIGID
2013	2023	10 YEAR	50	347,000	534,000
2013	2028	15 YEAR	53	525,000	807,000
2013	**2033**	**20 YEAR**	**57**	**715,000**	**1,099,000**
2013	2038	25 YEAR	60	917,000	1,409,000
2013	2043	30 YEAR	64	1,132,000	1,739,000
2013	**2048**	**35 YEAR**	**67**	**1,359,000**	**2,088,000**

APPROVED BY: _____ **DATE:** _____

As previously mentioned, a new set of B segment defaults has been incorporated into the latest MnESAL (2012 version). Urban defaults have been changed from 3.9% to 3.6% and rural defaults have been changed from 8.9% to 10.1% (see below).

USE THE RURAL OR URBAN PCT'S BELOW FOR TYPE OF FORECAST

ENTER RURAL OR URBAN BELOW

RURAL

Check cells A42-F48

ENTER RURAL OR URBAN IN COLUMN J3

VEHICLE TYPE	Urban	Rural
2AX-6TIRE SU	1.52%	3.17%
3AX+ SU	0.46%	1.64%
3AX TST	0.09%	0.28%
4AX TST	0.12%	0.50%
5AX+ TST	0.89%	3.26%
TR TR, BUSES	0.47%	1.20%
TWIN TRAILERS	0.02%	0.02%
TOTAL	*3.57%*	*10.07%*

Note: The URBAN vehicle types were developed primarily for use in the Seven County Metropolitan Area + Chisago Cty. They can also be used for segments that are near cities with over 5,000 population.

CAUTION: USE ONLY ONE SET OF DEFAULTS ON EACH "A" SEGMENT

The chart below shows default percentages by AADT range. This should only be used in special projects and is not normally used by traffic forecasters.

RURAL / URBAN COUNTY STATE AID HIGHWAYS (CSAH) HEAVY COMMERCIAL PERCENTAGES

RURAL AADT RANGE	CAR	2ASU	3+ASU	3ASEMI	4ASEMI	5+ASEMI	TT/BUS	TWINS	TOTAL	HC PCT
1-300	86.72%	4.71%	2.24%	0.35%	0.71%	3.81%	1.45%	0.01%	100.00%	13.28%
301-750	86.56%	3.44%	2.17%	0.39%	0.69%	5.32%	1.40%	0.03%	100.00%	13.44%
751-1500	90.53%	3.69%	1.71%	0.33%	0.57%	2.10%	1.03%	0.02%	100.00%	9.47%
1500>	91.39%	2.32%	1.24%	0.16%	0.32%	3.33%	1.23%	0.01%	100.00%	8.61%

URBAN AADT RANGE	CAR	2ASU	3+ASU	3ASEMI	4ASEMI	5+ASEMI	TT/BUS	TWINS	TOTAL	HC PCT
1-300	95.60%	1.60%	0.40%	0.40%	0.40%	0.40%	1.20%	0.00%	100.00%	4.40%
301-750	92.53%	3.70%	1.62%	0.14%	0.24%	1.23%	0.48%	0.07%	100.00%	7.47%
751-1500	94.71%	2.14%	0.98%	0.19%	0.30%	0.94%	0.71%	0.02%	100.00%	5.29%
1500>	96.44%	1.52%	0.46%	0.09%	0.12%	0.89%	0.47%	0.02%	100.00%	3.56%

Note: Data from 2007 and 2008 County State Aid Study (Mankato State University) and 1986 to 2002 vehicle class data (Mn/DOT)
Urban is defined as the area within the boundaries of a city with 5000 or more population and the Twin Cities Metropolitan Area

DESIGN HOUR VOLUME and AADT

The requester may ask for design hour volumes - which are not part of the MnESAL spreadsheet. The term design hour volume (DHV) and 30th highest hour are often used interchangeably in rural highway design. They are derived from the 30th highest hour of the year. It is generally expressed as a percentage of the AADT.

Automatic Traffic Recorders (ATR's) are the only source from which you can obtain DHV. It is best to check several ATRs located near the project, and/or what you feel are similar routes before making the decision on what percent to use. The most current Continuous Traffic Recorder Report is available from the TDA website (2009) http://www.dot.state.mn.us/traffic/data/atr/atr.html). Historical AADT at all ATR stations by number by route system is available in the front of the ATR book. Figure 6 is an illustration of page 1 of the 2000 ATR book. As discussed previously, ATR data can be used for historical trend information. Figure 7 is also from the 2000 ATR book – it is a DHV hourly summary report from ATR 356. DHV is available by direction, but usually the request will be for both directions.

If, for example ATR 356 were near our sample forecast, one would go to the 30th highest hour (again, this is for non Twin City Metro Area forecasts) and see that the DHV is 9.4% of the AADT and the directional split is 42/58. On the bottom of the page, notice that there is a DHV summary as well as AADT for that ATR.

Figure 8 is also from the 2000 ATR book, and it is a monthly breakdown of AADT by direction at a particular ATR site – in this case, ATR 464. Note the AADT for year 2000 and year 1999 and the monthly variation. Please note this is the monthly variation for AADT, and not HCAADT. Figure 9 shows hourly data at a sample ATR station. This information is available upon request from the Traffic Forecast and Analysis Section.

Design hour volume is similar to what is commonly called peak hour volumes – used primarily in discussions about the Twin City Metro area. In Greater Minnesota, we refer to peak hour volumes as DHV or the 30th highest hour. This information can be found in each ATR report, under specific ATR numbers and routes – by direction and both directions. For forecasting, the DHV can only be known at a specific ATR. The forecaster will have to determine "similar" attributes of the traffic in your project area and apply it to the appropriate site where an ATR is located. ATR data is also available by month and hour.

A study of historic ATR data revealed that the average DHV is from 8% in town to 10-13% out of town. If nothing else is known, the further distance from a town in Greater Minnesota, the higher the percent DHV (assumes decreasing volumes outside of a town).

For example, you may want to know the DHV at a project on TH15. There is no ATR in the project area. A quick scan of the ATR map in the book will reveal ATRs around the state. It will be the task of the forecaster to determine an ATR that has similar characteristics to the project area in question, such as similar AADT, similar

characteristics as to whether the route is recreation, farm to market, grain traffic, seasonal traffic, nature of traffic, etc.

As a general rule of thumb, the DHV percent is anywhere from 8 to 13%. That means that the 30th highest hour in a typical segment of rural trunk highway may be 10% of AADT. If the AADT is 3000 on TH15, for example, and you determine the DHV both directions 10% -- then the DHV is 300. That means you would design the roadway for the 30th highest hour – which would mean a maximum of 300 vehicles per hour – in both directions.

Figure 6 – Annual Daily Traffic at Station Locations

STA. NO.	1980	1982	1984	1986	1988	1990	1992	1994	1996	1997	1998	1999	2000	STA. NO.
OUTSTATE MUNICIPAL C.S.A.H.														
001	1673	1747	1535	1576	1619	1818	1816			948	993	996	1040	001
002		1280	1209	1281	1329	1266	1319	1345	1313	1241	1207	1313	1256	002
003	2281	2127		3744	3633	4087	4478	4445	4699	4884	4907	4915	4708	003
006	429	586		395	465	468	332	252	227	224	214	203	198	006
007	1132	1094		776	794	733	725	753	699	816	874	902	860	007
008	583	603		651	619		518	557	569	580	580	605	616	008
009	695	767	812	1050	1150	1337	1204	1159	1054	1115	1187	1188	1168	009
010	1010	1011		1327	1538	1817	1834	1811	1989	2025	2097	2120	2084	010
012	1315			1521	1648	1536	1485							012
013	1520	1421	1490	1723	1769	1749	1675	1837	1823	1906	1929	1927	1886	013
014	1371			1462	1306	1390	1327	1302	1362	1414	1344	1317	1330	014
028							10635	10202	10918	10132	9994	10114	10348	028
OUTSTATE RURAL C.S.A.H.														
050	1974			2341	2538	2581	2742	3144	3236	3298	3587	3749	3657	050
051	264	240		376	420	488	582	502	543	478	503	529	531	051
052	308	355	363	389	429	439	465	454	478	502	551	539	557	052
053	343	448		400	399	387	443		420	472	469	447	436	053
054		218	164	283	201	214	218		261	304	309	315	305	054
055	421	427	486	516	587	644	656	686	744	766	847	909	891	055
056	346	357		348	384	390	386		401	407	412	390	384	056
057				1135	1261	1274	1399	1438	1487	1586	1653	1653	1588	057
OUTSTATE MUNICIPAL TRUNK HIGHWAYS														
100		22662			28998	32970	35016	44623	40942	42674	41891	41791	41313	100
101					20816					28952	26342	27338	27503	101
102	34975	32465	32679		42333	49101	52544	53953	55063	54001	56658	58330	58805	102
103	19201	18966	18948		34338	35492	38194	40862	38928	41813	43036	43290	43516	103
104	15056	14397			23907	26349	28058	30092	30914		32086	32347	32054	104
110		12681		17110	18180	20407	20456	30092	23622	24513	24914	26584	25028	110
OUTSTATE RURAL TRUNK HIGHWAYS														
164	5877	5354	5710	5946	6410	7143	7456	8017	7917	8742	8963	9051	9219	164
166	3464	3222	3433	3351	3769	3937	4145	4227	4352	4525	4642	4753	4733	166
170	2331		2525	2557	2685	2899	3071	3230	3262	3418	3633	3573	3412	170
172	8279	7914		9835	10193	10599	11425		12102	12361	13049	13539	13377	172
179	1256	1273		1348	1276	1416	1561	1350	1664	1722	1756	1922	1831	179
187			9604	10103	11762	12331	12739		14229	15664	17049	17896	18427	187
188	11731	12304			16567	18248			21722	23858	25335	25540	23786	188
195									1980	2051	2103	2161	2147	195
197	3031		2915		2934	2932	3459	3627	3722	3746	3943	4066	4017	197
198		1606	2136	1911	1853	2012			2256	2553	2378	2502	2479	198
199	1182	1108	1169	1186	1227	1164	1272	1410	1372	1507	1529	1461	1449	199
204	3848	3997	4418	4976	5818	6152	7936	8448	8911	9101	9417	9441	9430	204
207	1031	1051		1116	1179	1236	1698	1810	1792	1901	1854	1908	1834	207
209	911	778	776	719	680	724	686	690	696	709	701	734	685	209
210	706	688	770	810	877		994		1119	1095	1105	1120	1107	210
211	2419	2353	2561	2623	2795	3139	3180	3352	3463	3555	3614	3707	3820	211
212	8006	8763	9383	9977	10647	11291	12208	12127	12413	14212	16090	17754	18140	212

Figure 7 – Highest Hourly Volume Summary –ATR 356

Run on Thursday, February 15, 2001 at 11:12.

Minnesota Department of Transportation (Mn/DOT)
Continuous Count Station (ATR) Report -- 2000
Highest Hourly Volume Summary

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Station 356, TH 7, W OF WILLISTON RD in MINNETONKA, HENNEPIN County, Metro District.

	East bound					West bound					Both Directions					
Highest Hour	Traffic Volume	Date	Day	Hour	Percent of AADT	Traffic Volume	Date	Day	Hour	Percent of AADT	Traffic Volume	Date	Day	Hour	Percent of AADT	Percent Dir. Distr.
1	3,177	02/07	Mon	07-08 AM	14.6	2,766	05/17	Wed	05-06 PM	12.2	4,620	05/04	Thu	05-06 PM	10.4	41/59
2	3,177	02/14	Mon	07-08 AM	14.6	2,760	05/16	Tue	05-06 PM	12.2	4,608	05/16	Tue	05-06 PM	10.4	40/60
3	3,177	02/21	Mon	07-08 AM	14.6	2,750	05/03	Wed	05-06 PM	12.2	4,593	05/02	Tue	05-06 PM	10.3	40/60
4	3,177	02/28	Mon	07-08 AM	14.6	2,745	05/02	Tue	05-06 PM	12.1	4,560	05/17	Wed	05-06 PM	10.3	39/61
5	3,159	01/03	Mon	07-08 AM	14.5	2,738	05/04	Thu	05-06 PM	12.1	4,544	05/03	Wed	05-06 PM	10.2	39/61
6	3,159	01/10	Mon	07-08 AM	14.5	2,728	05/01	Mon	05-06 PM	12.1	4,450	01/24	Mon	07-08 AM	10.0	71/29
7	3,159	01/17	Mon	07-08 AM	14.5	2,620	05/05	Fri	05-06 PM	11.6	4,439	05/01	Mon	05-06 PM	10.0	39/61
8	3,159	01/24	Mon	07-08 AM	14.5	2,569	04/17	Mon	05-06 PM	11.4	4,396	05/05	Fri	04-05 PM	9.9	42/58
9	3,159	01/31	Mon	07-08 AM	14.5	2,569	05/05	Fri	04-05 PM	11.4	4,359	05/05	Fri	05-06 PM	9.8	40/60
10	3,157	02/02	Wed	07-08 AM	14.5	2,568	04/10	Mon	05-06 PM	11.4	4,326	04/28	Fri	05-06 PM	9.7	41/59
11	3,157	02/09	Wed	07-08 AM	14.5	2,561	04/28	Fri	05-06 PM	11.3	4,285	04/27	Thu	05-06 PM	9.6	41/59
12	3,157	02/16	Wed	07-08 AM	14.5	2,549	03/13	Mon	05-06 PM	11.3	4,271	04/13	Thu	05-06 PM	9.6	41/59
13	3,157	02/23	Wed	07-08 AM	14.5	2,537	04/28	Fri	04-05 PM	11.2	4,267	01/04	Tue	05-06 PM	9.6	43/57
14	3,144	02/01	Tue	07-08 AM	14.4	2,535	05/17	Wed	04-05 PM	11.2	4,266	04/06	Thu	05-06 PM	9.6	41/59
15	3,144	02/08	Tue	07-08 AM	14.4	2,523	04/27	Thu	05-06 PM	11.2	4,263	04/14	Fri	05-06 PM	9.6	41/59
16	3,144	02/15	Tue	07-08 AM	14.4	2,520	05/03	Wed	04-05 PM	11.1	4,250	04/17	Mon	05-06 PM	9.6	40/60
17	3,144	02/22	Tue	07-08 AM	14.4	2,509	04/13	Thu	05-06 PM	11.1	4,250	05/17	Wed	04-05 PM	9.6	40/60
18	3,144	02/29	Tue	07-08 AM	14.4	2,505	03/21	Tue	05-06 PM	11.1	4,249	04/10	Mon	05-06 PM	9.6	40/60
19	3,084	01/05	Wed	07-08 AM	14.1	2,505	08/28	Mon	05-06 PM	11.1	4,247	04/11	Tue	05-06 PM	9.6	41/59
20	3,084	01/12	Wed	07-08 AM	14.1	2,504	04/06	Thu	05-06 PM	11.1	4,241	04/28	Fri	04-05 PM	9.5	40/60
21	3,084	01/19	Wed	07-08 AM	14.1	2,498	04/14	Fri	05-06 PM	11.0	4,235	05/03	Wed	04-05 PM	9.5	40/60
22	3,084	01/26	Wed	07-08 AM	14.1	2,497	05/16	Tue	04-05 PM	11.0	4,203	03/30	Thu	05-06 PM	9.5	41/59
23	3,050	02/03	Thu	07-08 AM	14.0	2,495	07/21	Fri	05-06 PM	11.0	4,202	04/26	Wed	05-06 PM	9.5	41/59
24	3,050	02/10	Thu	07-08 AM	14.0	2,494	04/11	Tue	05-06 PM	11.0	4,201	01/11	Tue	05-06 PM	9.5	43/57
25	3,050	02/17	Thu	07-08 AM	14.0	2,484	03/30	Thu	05-06 PM	11.0	4,195	03/23	Thu	05-06 PM	9.4	41/59
26	3,050	02/24	Thu	07-08 AM	14.0	2,483	05/02	Tue	04-05 PM	11.0	4,195	05/04	Thu	04-05 PM	9.4	41/59
27	2,932	02/04	Fri	07-08 AM	13.4	2,482	05/04	Thu	04-05 PM	11.0	4,191	02/29	Tue	07-08 AM	9.4	75/25
28	2,932	02/11	Fri	07-08 AM	13.4	2,476	03/23	Thu	05-06 PM	10.9	4,188	02/28	Mon	07-08 AM	9.4	76/24
29	2,932	02/18	Fri	07-08 AM	13.4	2,476	07/19	Wed	05-06 PM	10.9	4,188	03/21	Tue	05-06 PM	9.4	40/60
30	2,932	02/25	Fri	07-08 AM	13.4	2,476	08/31	Thu	05-06 PM	10.9	4,178	04/07	Fri	05-06 PM	9.4	42/58
31	2,926	01/04	Tue	07-08 AM	13.4	2,472	01/18	Tue	04-05 PM	10.9	4,175	02/22	Tue	07-08 AM	9.4	75/25
32	2,926	01/11	Tue	07-08 AM	13.4	2,462	04/26	Wed	05-06 PM	10.9	4,172	05/16	Tue	04-05 PM	9.4	40/60
33	2,926	01/18	Tue	07-08 AM	13.4	2,459	08/03	Thu	05-06 PM	10.9	4,168	02/01	Tue	07-08 AM	9.4	75/25
34	2,926	01/25	Tue	07-08 AM	13.4	2,457	11/01	Wed	05-06 PM	10.9	4,160	03/17	Fri	05-06 PM	9.4	42/58
35	2,914	01/07	Fri	07-08 AM	13.4	2,450	05/01	Mon	04-05 PM	10.8	4,158	05/02	Tue	04-05 PM	9.4	40/60
36	2,914	01/14	Fri	07-08 AM	13.4	2,446	01/04	Tue	05-06 PM	10.8	4,153	04/25	Tue	05-06 PM	9.3	42/58
37	2,914	01/21	Fri	07-08 AM	13.4	2,443	07/25	Tue	05-06 PM	10.8	4,143	03/13	Mon	05-06 PM	9.3	38/62
38	2,914	01/28	Fri	07-08 AM	13.4	2,439	03/22	Wed	05-06 PM	10.8	4,142	02/15	Tue	07-08 AM	9.3	76/24
39	2,913	01/06	Thu	07-08 AM	13.4	2,439	11/27	Mon	05-06 PM	10.8	4,134	03/09	Thu	05-06 PM	9.3	42/58
40	2,913	01/13	Thu	07-08 AM	13.4	2,436	08/08	Tue	05-06 PM	10.8	4,132	02/09	Wed	07-08 AM	9.3	76/24
50	2,829	03/22	Wed	07-08 AM	13.0	2,415	03/09	Thu	05-06 PM	10.7	4,104	04/04	Tue	05-06 PM	9.2	43/57
60	2,787	03/02	Thu	07-08 AM	12.8	2,401	04/14	Fri	04-05 PM	10.6	4,070	01/10	Mon	07-08 AM	9.2	78/22
80	2,719	04/25	Tue	07-08 AM	12.5	2,376	09/28	Thu	05-06 PM	10.5	4,014	02/23	Wed	07-08 AM	9.0	79/21
100	2,572	05/19	Fri	07-08 AM	11.8	2,349	03/20	Mon	04-05 PM	10.4	3,967	03/10	Fri	04-05 PM	8.9	42/58
130	2,348	06/07	Wed	07-08 AM	10.8	2,330	05/05	Fri	03-04 PM	10.3	3,907	04/26	Wed	07-08 AM	8.8	70/30
500	1,811	12/01	Fri	08-09 AM	8.3	2,051	03/15	Wed	03-04 PM	9.1	3,561	01/14	Fri	06-07 PM	8.0	49/51
1000	1,599	05/13	Sat	12-01 PM	7.3	1,776	05/09	Tue	03-04 PM	7.9	3,279	07/25	Tue	07-08 AM	7.4	69/31
	AADT: 21,823					AADT: 22,632					AADT: 44,455					
	Hour1 /AADT: 14.6 %					Hour1 /AADT: 12.2 %					Hour1 /AADT: 10.4 %					
	Hour30 /AADT: 13.4 %					Hour30 /AADT: 10.9 %					Hour30 /AADT: 9.4 %					
	Hour100/AADT: 11.8 %					Hour100/AADT: 10.4 %					Hour100/AADT: 8.9 %					

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Figure 8 – Average Monthly Volume Summary –ATR 464

Run on Wednesday, February 14, 2001 at 15:03.

Minnesota Department of Transportation (Mn/DOT)
Summary of Continuous Count Station Data (ATRs)
Average Monthly Volumes

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	Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	YTD 12/31	Annual Average
Station 464, CSAH 19, .1 MI E OF TH61 in MAPLEWOOD, RAMSEY County, Metro District.															
East	2000	10,144	10,392	11,028	11,307	11,390	11,565	10,617	11,368	11,015	11,070	11,188	12,355	11,122	11,122
	1999	9,305	10,167	10,726	11,440	11,068	11,369	10,474	11,459	11,004	11,592	11,652	12,945	11,105	11,105
	%	9.0	2.2	2.8	-1.2	2.9	1.7	1.4	-0.8	0.1	-4.5	-4.0	-4.6	0.2	0.2
Percent Estimated Data	2000	0.0	0.0	0.0	2.6	0.0	0.0	9.3	0.0	0.0	3.2	41.0	0.0	4.6	4.6
	1999	10.1	50.0	0.0	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.8	4.8
West	2000	10,491	9,960	10,574	10,763	10,747	11,059	10,191	10,984	10,770	10,814	10,787	12,169	10,779	10,779
	1999	8,909	9,729	10,229	10,852	10,474	11,004	10,592	11,132	10,542	10,782	11,033	13,179	10,711	10,711
	%	17.8	2.4	3.4	-0.8	2.6	0.5	-3.8	-1.3	2.2	0.3	-2.2	-7.7	0.6	0.6
Percent Estimated Data	2000	1.7	0.0	0.3	2.6	0.0	0.7	9.4	0.0	0.0	3.2	41.0	0.0	4.9	4.9
	1999	10.3	50.0	0.0	1.4	0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.0	4.9	4.9
Both	2000	20,636	20,352	21,602	22,070	22,137	22,625	20,808	22,352	21,786	21,884	21,975	24,524	21,902	21,902
	1999	18,214	19,895	20,955	22,292	21,542	22,373	21,066	22,591	21,546	22,374	22,685	26,124	21,816	21,816
	%	13.3	2.3	3.1	-1.0	2.8	1.1	-1.2	-1.1	1.1	-2.2	-3.1	-6.1	0.4	0.4
Percent Estimated Data	2000	0.9	0.0	0.1	2.6	0.0	0.3	9.3	0.0	0.0	3.2	41.0	0.0	4.8	4.8
	1999	10.2	50.0	0.0	1.4	0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.0	4.8	4.8
Station 465, MSAS 32, .1 MI S OF ST CLAIR AVE in ST PAUL, RAMSEY County, Metro District.															
North	2000	6,176	6,670	6,783	7,132	7,555	7,593	7,107	7,334	7,423	7,206	6,899	6,551	7,035	7,035
	1999	5,964	6,588	6,615	7,030	7,074	7,363	6,722	6,632	7,068	7,024	6,894	6,660	6,801	6,801
	%	3.6	1.2	2.5	1.5	6.8	3.1	5.7	10.6	5.0	2.6	0.1	-1.6	3.4	3.4
Percent Estimated Data	2000	0.0	17.2	100.0	100.0	2.4	0.0	24.6	12.9	100.0	3.6	0.0	0.0	29.9	29.9
	1999	2.4	0.6	0.0	0.0	0.0	0.0	33.3	17.5	0.1	2.4	0.0	0.0	4.8	4.8
South	2000	5,880	6,401	6,677	6,893	7,109	7,230	6,804	6,893	7,088	6,865	6,560	6,218	6,717	6,717
	1999	5,614	6,279	6,304	6,741	6,852	7,054	6,421	6,352	6,590	6,668	6,584	6,383	6,486	6,486
	%	4.7	1.9	5.9	2.3	3.8	2.5	6.0	8.5	7.6	3.0	-0.4	-2.6	3.6	3.6
Percent Estimated Data	2000	0.0	17.2	100.0	100.0	2.4	0.1	24.6	13.8	100.0	4.0	0.0	0.1	30.1	30.1
	1999	3.0	1.8	1.1	0.0	0.0	0.0	24.2	18.7	0.0	2.6	0.0	0.0	4.3	4.3
Both	2000	12,056	13,071	13,460	14,025	14,664	14,822	13,911	14,226	14,511	14,070	13,458	12,769	13,752	13,752
	1999	11,578	12,868	12,918	13,772	13,926	14,417	13,143	12,984	13,658	13,692	13,478	13,043	13,287	13,287
	%	4.1	1.6	4.2	1.8	5.3	2.8	5.8	9.6	6.2	2.8	-0.1	-2.1	3.5	3.5
Percent Estimated Data	2000	0.0	17.2	100.0	100.0	2.4	0.1	24.6	13.4	100.0	3.8	0.0	0.1	30.0	30.0
	1999	2.7	1.2	0.5	0.0	0.0	0.0	28.8	18.1	0.1	2.5	0.0	0.0	4.6	4.6

Figure 9 – Hourly Volume Summary –ATR 8

Minnesota Department of Transportation
Continuous Count Station Edited Data for January

11:08 Thursday, March 28, 2002 1

Station 8, Direction East, January

DATE	DAY	HR1	HR2	HR3	HR4	HR5	HR6	HR7	HR8	HR9	HR10	HR11	HR12	HR13	HR14	HR15	HR16	HR17	HR18	HR19	HR20	HR21	HR22	HR23	HR24	TOTAL
Jan 1, 2002	Tuesday	3	12	4	4	4	3	1	3	3	4	7	6	16	13	10	19	12	17	11	9	8	10	16	5	200
Jan 2, 2002	Wednesday	2	0	0	1	0	3	7	14	13	19	27	22	23	21	39	25	21	22	16	16	13	10	0	6	320
Jan 3, 2002	Thursday	2	0	2	0	2	4	6	50	33	15	9	21	18	21	22	34	33	33	61	20	13	20	3	0	422
Jan 4, 2002	Friday	4	1	1	0	0	3	5	39	28	31	18	28	20	15	21	40	47	94	76	48	25	49	25	28	646
Jan 5, 2002	Saturday	6	7	3	1	0	2	11	8	9	18	27	17	18	21	19	23	20	10	15	16	16	8	14	8	297
Jan 6, 2002	Sunday	2	4	2	0	0	1	2	6	16	13	15	6	15	9	12	21	11	5	27	15	19	12	9	1	223
Jan 7, 2002	Monday	1	0	0	0	1	2	6	50	25	22	15	15	15	12	26	46	29	25	18	8	8	5	4	3	336
Jan 8, 2002	Tuesday	2	2	2	0	0	4	6	52	24	27	16	19	23	19	24	39	46	82	53	36	8	42	6	5	537
Jan 9, 2002	Wednesday	0	0	0	0	0	4	9	42	32	25	16	16	21	14	24	35	31	20	34	12	11	5	4	2	357
Jan 10, 2002	Thursday	0	1	0	0	0	3	3	54	19	16	18	19	22	11	14	25	50	30	13	9	8	8	11	4	338
Jan 11, 2002	Friday	0	1	0	0	0	2	7	50	37	16	15	25	28	17	19	33	34	30	11	8	6	11	5	2	357
Jan 12, 2002	Saturday	1	7	2	1	1	1	4	20	36	25	19	8	19	16	11	14	12	16	13	11	7	9	13	12	278
Jan 13, 2002	Sunday	6	6	3	3	0	2	2	2	19	4	18	7	8	14	17	17	22	13	19	10	7	16	1	2	218
Jan 14, 2002	Monday	0	1	0	0	1	1	9	46	22	14	17	12	27	22	27	35	39	51	68	28	25	18	2	2	467
Jan 15, 2002	Tuesday	4	1	0	0	0	2	6	47	23	20	17	18	28	24	19	33	37	20	8	9	6	19	12	3	356
Jan 16, 2002	Wednesday	1	0	1	1	1	3	8	48	24	10	24	14	30	16	20	28	34	31	23	12	13	5	8	6	361
Jan 17, 2002	Thursday	1	5	1	0	1	2	4	54	26	21	16	14	38	22	22	32	41	25	19	18	10	5	10	7	394
Jan 18, 2002	Friday	2	3	0	0	0	2	8	23	19	18	14	15	23	21	16	21	26	19	25	10	13	9	4	3	294
Jan 19, 2002	Saturday	5	1	0	4	3	2	3	24	13	17	16	17	10	16	14	13	20	14	22	14	16	19	8	4	275
Jan 20, 2002	Sunday	10	1	3	1	0	2	1	6	6	14	34	9	18	13	15	10	8	13	30	10	14	10	8	9	245
Jan 21, 2002	Monday	3	3	0	1	1	1	5	18	10	19	11	16	13	18	29	27	23	54	65	25	18	12	4	3	379
Jan 22, 2002	Tuesday	3	1	1	0	0	2	6	49	18	15	23	17	21	13	19	33	43	22	10	10	3	17	11	6	343
Jan 23, 2002	Wednesday	1	3	1	0	1	0	7	51	23	16	16	11	14	15	20	31	20	27	9	10	8	9	3	0	296
Jan 24, 2002	Thursday	0	0	1	0	1	3	7	62	20	16	14	12	23	9	29	33	34	25	17	12	8	13	8	0	347
Jan 25, 2002	Friday	1	0	0	0	1	3	4	49	18	11	13	13	18	12	21	28	37	112	68	30	15	18	15	3	490
Jan 26, 2002	Saturday	7	2	1	0	0	0	1	11	10	13	18	15	16	8	12	14	13	18	14	12	12	7	8	6	218
Jan 27, 2002	Sunday	9	8	7	1	0	0	3	4	15	12	25	12	8	9	9	10	19	18	16	10	14	16	4	4	233
Jan 28, 2002	Monday	0	0	1	0	0	3	6	67	22	25	14	13	22	17	19	28	26	23	25	6	6	13	2	0	338
Jan 29, 2002	Tuesday	0	2	0	0	0	3	10	54	19	18	17	16	21	18	19	33	17	76	63	17	16	6	3	1	429
Jan 30, 2002	Wednesday	1	3	0	1	0	2	9	51	25	20	21	19	15	12	15	35	33	28	26	23	5	6	3	4	357
Jan 31, 2002	Thursday	3	2	1	0	1	7	7	52	20	16	9	20	23	15	20	29	33	27	23	11	6	1	7	2	335

AVERAGES:	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Weekday	Weekend	All Days
	380	373	338	367	447	267	230	381	249	343

Figure 10 – Continuous Counting Sites – Statewide

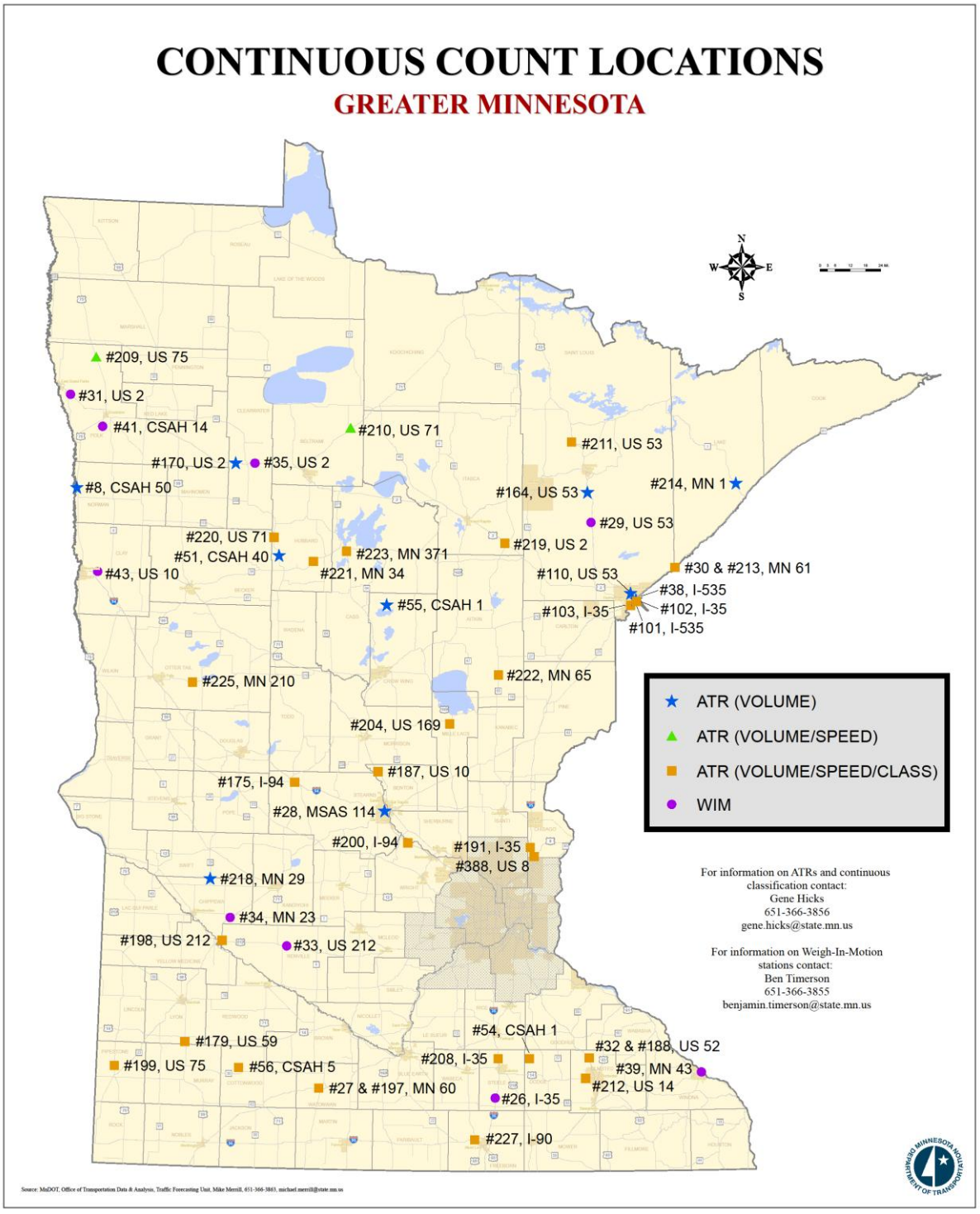


Figure 11 Continuous Counting Sites – Metro Area

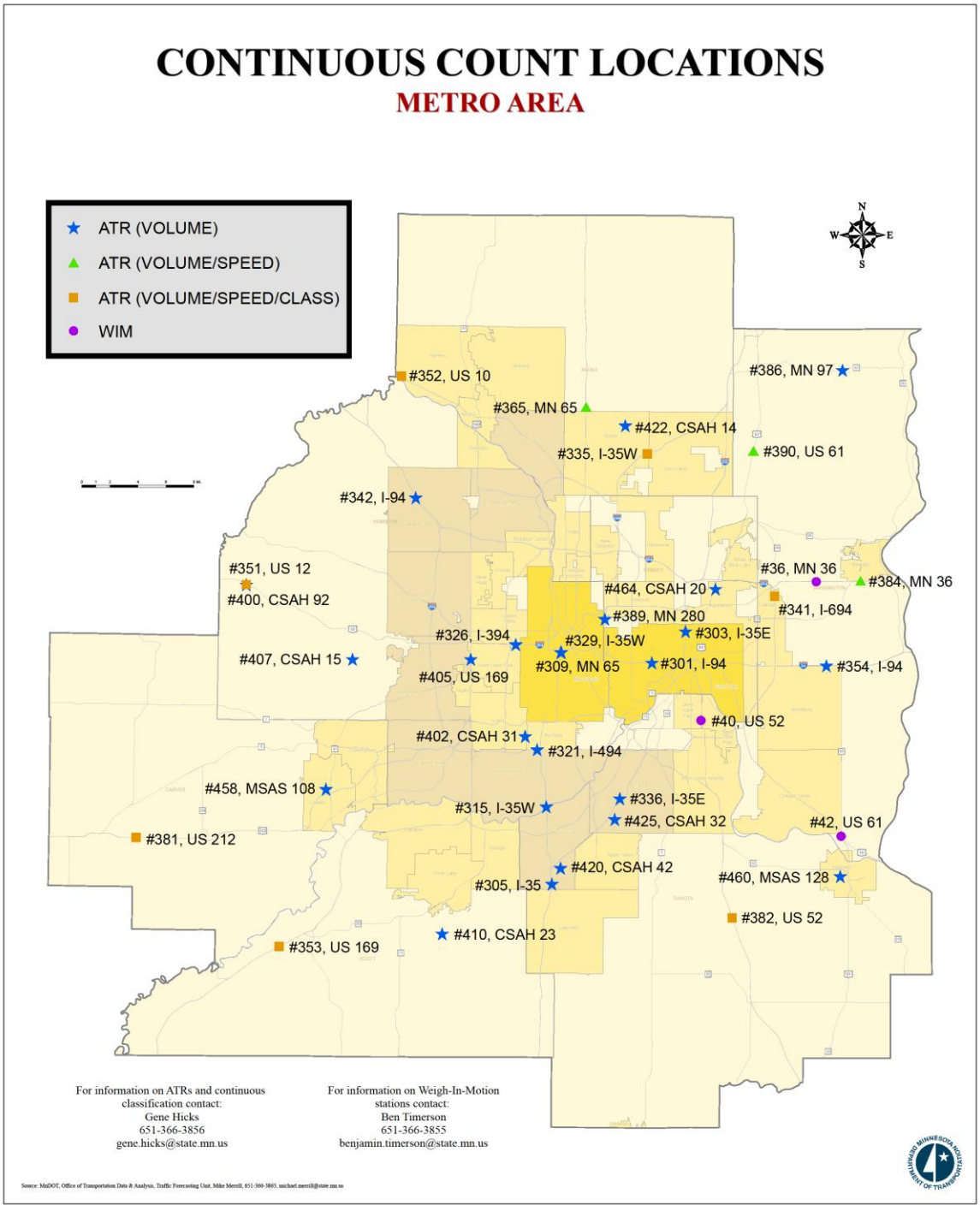
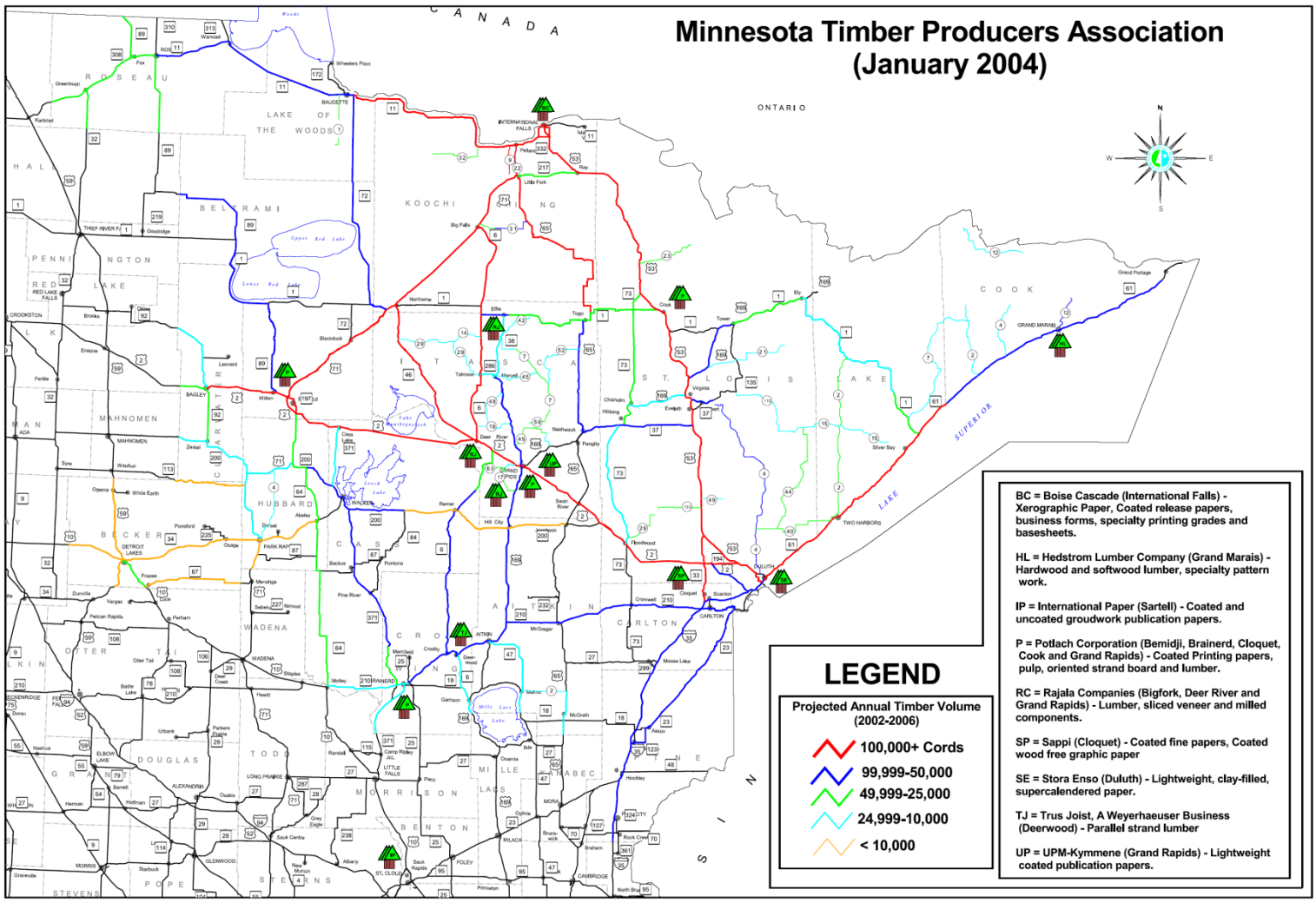
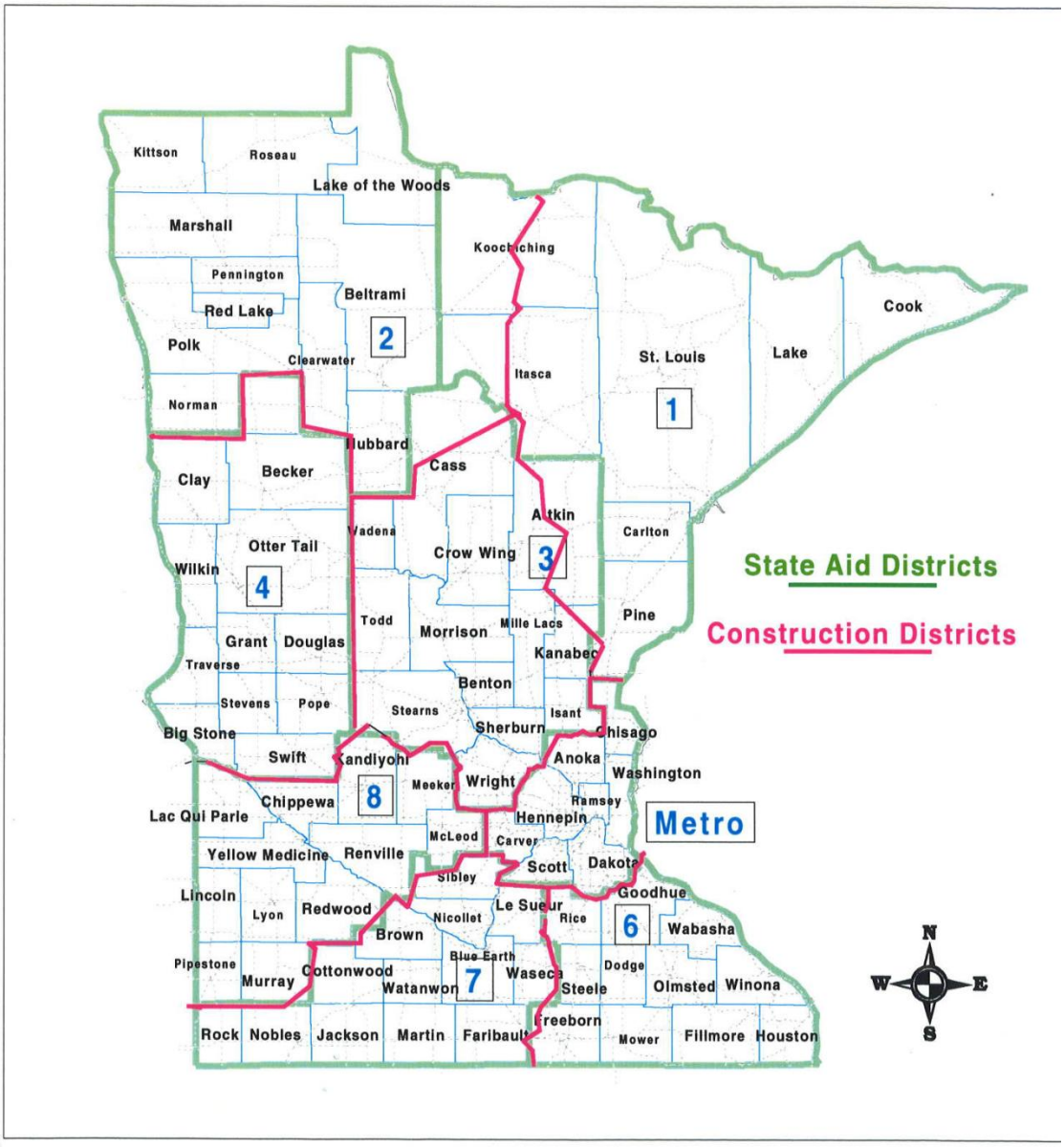


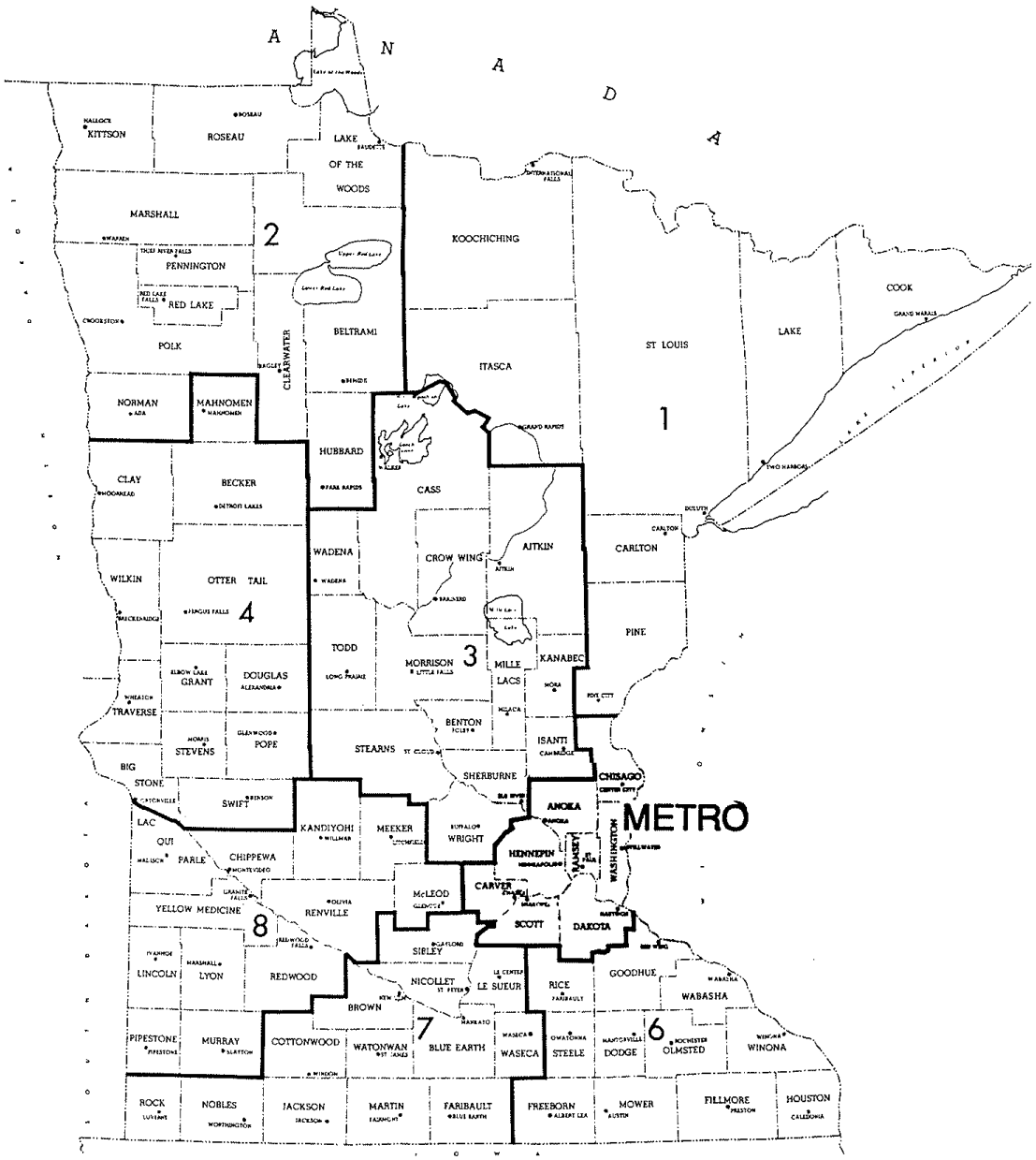
Figure 12 – Heavy Truck Route (Stake Trucks)



Mn/DOT State Aid & Const. Districts



Mn/DOT Districts



Special Heavy Truck Study – District 2 (This data reflected in raw vc data)

District Two's ESAL Adjustments

VCC#	Adjustment
7058	Add 41 5A Semis @ Max 20 Load
7057	Add 31 5A Semis @ Max 15 Load
"	Add 39 4A Single Units
7056	Add 1 5A Semi Max
"	Add 6 4A Single Units
8299	Add 27 5A Semis Max 14
	" 10 4A Single Units
7053	Add 1 5A Semi Max
1209	Add 34 5A Semis Max 17
	51 4A Single Units
1607	Add 78 5A Semis 39 Max
	32 4A Single Units
8245	Add 48 4A Single Units
8244	Add 48 ~~#~~ 48 4A Single Units
8241	Add 8 4A Single Units
8240	Add 17 5A Semis 9 Max
	Add 8 4A Single Units
8242	Add 17 5A Semis 9 max
	Add 8 4A Single Units
7426	Add (9) 5A Semis 5 Max
	Add 11 4A Single Units
9203	Add 119 5A Semis 60 Max
	Add 11 4A Single Units
9204	Add 60 5A Semis 30 Max
	Add 11 4A Single Units

D-2 ESAL Adjustments (Cont.)

VCC#	Adjustment
9205	Add 65 5A Semis @ 32 Max
	Add 5 4A S.U.'s
2094	Add 10 5A Semis 5 @ Max
	Add 14 4A SU
9227	Add 34 5A Semis 17 @ Max
	Add 51 4A S.U.
9225	Add (2) 5A Semis 1@ Max
9226	Add 1 5A Semi @ Max
	Add 26 4A SU
2010	Add 1 5A Semi @ Max
	Add 26 4A SU

FORECASTING TECHNIQUES, TIPS, HELPFUL HINTS & MISC

Addition of trucks above and beyond vehicle class site information

Example 1- adding additional trucks to a traffic forecast due to local knowledge-
During the course of a traffic forecast, the forecaster may have knowledge through counts, observation or talking with local officials that additional trucks should be added to a forecast over and above the vehicle class counts. If, for example, a vehicle class count is taken in the spring and it is suspected that the fall harvest may affect the count, additional trucks may be added to the project. This happens frequently on the county road system.

In our first example, the forecaster knows that 66 2-way additional 5-axle semis should be added to vehicle class count 9205 to account for sugar beet movements. We will assume this number will be spread out over the entire year. We are also going to observe that the 66 semis should be split (see previous discussion regarding heavy trucks) into "maximum" (fully loaded 80,000 pound trucks at a ESAL factor of 2.4) and "other" less than fully loaded at an ESAL factor of 0.87. See the bottom of ESAL worksheet A or B for these factors. In our examples we always use flexible (not rigid factors).

We are going to discuss only the A segment portion of the MnESAL, not the 16-24 vehicle expansion worksheet or the average vehicle class count worksheet. The forecaster should unprotect ESALS worksheet A by going to TOOLS –UNPROTECT—WORKSHEET in Excel. This will allow the forecaster to manually change the percents under the Base Year Proportions column. In this example, assume the following percentages have already been calculated on your Worksheet A and that 8.7% 5-axle semis have already been split automatically on your averages worksheet and transferred to the A segment. Assume there are already 70 five axle semis and we are going to add 66.

5 Ax+ TST	0	0	
5 Ax+ TST Max	4.5%	30 +33	
5 Ax+ TST Other	4.2%	40 +33	(70 existing)

With the worksheet unprotected, manually "adjust" the percentage upwards until the resultant truck volumes look like the following:

5 Ax+ TST	0	0	
5 Ax+ TST Max	7%	63	
5 Ax+ TST Other	9%	73	(70 existing + 66 new) = 136

In this example, we have manipulated the percentages on the MnESAL to account for additional trucks. This procedure can likewise be done on Worksheet B – thus increasing or decreasing the 3.9 or 5.9% heavy commercial default percentage by unprotecting the worksheet and manipulated the percents. *Once the percents have been manually adjusted; the formatting that automatically transferred the vehicle percents from the*

averages worksheet to the A segment worksheet is gone; however, many forecasters find it more advantageous to do multiple A segments by just changing the heavy commercial vehicle percents with each change in vehicle class site used. In this way you can document (print) all A segments and it will eliminate some additional work, ultimately saving time. Again, more familiarity with Excel may allow the forecaster to simply save every change in the A segment worksheet to another file (if he or she wants a computer record of every A segment change or more than one vehicle class site).

Example 2 of adding additional trucks to a traffic forecast due to local knowledge-
In another example of adding vehicles to the mix, let us say the forecaster obtains information of a construction project involving trucks generated from two gravel pits that will add 35 five + axle semis to the mix. In this case, we are going to prorate the number of vehicles by duration. In a similar instance, the forecaster may know that there will be a two-month construction project, or a three-month harvest season. In this example, instead of five days, the construction project is six days a week; in addition, we have obtained information that the project will last for about nine months.

The forecaster may then calculate 35 five-axle trucks per day times six days per week times 31 weeks totals 6510 five-axle semis. We then proceed to divide 6510 by 365 days a year to determine the additional 5+ axle semis added to the mix. The resultant 18 five+ axle semis per day have been prorated for 9 months into a HCAADT for 5+ axle semis.

Taking the next step, we can take the 18 five-axle semis and calculate that they are one-way trips. Multiplying the 18 semis by two equals 36. Then, we may calculate that these trucks are using two gravel pits and that involves a certain amount of back and forth traffic. Finally, if we divide the 36 semis by two gravel pits we decide that about 18-20 additional 5+ axle semis should be added to the mix. Similar to previous example, we go right to the A Worksheet, unprotect it and manually increase the 5+ axle semi percent until the additional 20 are accounted for.

The above two examples show the type of judgment and logic that can be applied to any traffic forecast. As long as there is adequate analysis applied to a forecast and the reasons can be documented with valid research, there are no wrong assumptions applied to a traffic forecast. As long as the MnESALs procedure is followed correctly and there are no procedural errors, any professional judgment on any individual traffic forecast should be valid. There are no shortcuts to doing a complete and thorough job. When adding trucks, it is important to keep in mind the heavy aspect of the trucks. From our previous material, we have learned that *we split grain trucks, tank trucks, dump trucks and stake trucks on timber routes (figure 12) if the number on our vehicle class site is 30% or more*. If the forecaster suspects that the route in question may carry grain, gravel, liquids, timber, etc, short duration manual counts should be performed to make that determination. *Figure 13* shows samples of some various types of "heavy" trucks.

Use of Short Traffic Counts in a Traffic Forecast

In the discussions above, we talk about adding trucks to the mix. Previously, this manual has touched upon the importance on taking short counts and visiting the project area to increase personal knowledge of the area. This section discusses short traffic count methods and techniques that the Traffic Forecast Section uses to determine hourly percentages and enhance short counts. In essence, the forecaster can take short counts of all traffic, short counts of just heavy commercial traffic or short counts of a particular vehicle type (5-axle semis). The forecaster may also consider requesting an additional tube or manual count from the district or central office – depending on who does the traffic counting.

The following is an example of adjusting a short (less than 16 hour) count. This example is 29th Street South in St. Cloud (next to the County Highway Department). Other than using a short count, it follows the traditional technique of a traffic forecast outlined in this manual. It assumes a base year of 2001 and a forecast year of 2021. Please note the comments on the REMARKS section of the Memo page.

Subject: TRAFFIC FORECAST

Route: 28th Street South
Letting Date: May 2, 2021
Program Category: Resurfacing
Project Manager: Gene Skok

SP#
Forecast # F-Stearns-01
County: Stearns
District: 3
Miles: 0.2

Project Limits: 28th Street in St Cloud next to County Highway Department

Enclosures (check those that apply):

x	Project map		VCL expansion worksheet
	Least squares analysis		Cumulative ESAL Report
x	Cumulative ESAL worksheet, Segment A		Other (describe)
	Cumulative ESAL worksheet, Segment B		Other (describe)
x	AADT and/or DHV traffic schematic diagram		

REMARKS:

Assume 2% year traffic growth (typical outstate growth rate)
Assume 11 to 12 AM auto traffic is 5.9% of the 16 hour (6 AM to 10 PM) (from 1999 tube study)
Assume11 to 12 AM truck traffic is 8.6 percent of the 16 hour (6 AM to 10 PM) (6am -10pm is roughly 90% ot the 24 hr traffic)

This is an example of an ESAL forecast that we would prepare if we were to do a vehicle class count on a road in your county

(5.9% and 8.6% no's based on arc 99 study

This is a 20 year ESAL forecast with a base year of 2001 and a forecast year of 2021

Due to the proximity of the gravel pit we split the 5 axle truck traffic to reflect the heavier loads
NOTE THAT THIS IS AN EXAMPLE ONLY. WITH DATA COLLECTED FOR ONE HOUR.

For this forecast, a one hour tube count (11am to 12 noon) was taken in May and then grouped into the eight vehicle types used for forecasting:

VEH TYPE	1 HR				
PASS VEH	322	/	.059	=	5450
2 AX SU	19	/	.086	=	250
3+AX SU	25	/	.086	=	300
3 AX SEMI	2	/	.086	=	25
4 AX SEMI	4	/	.086	=	50
5+ AX SEMI	20	/	.086	=	250
TRKL TRLR/BUS	6	/	.086	=	70
TWINS	0	/	.086	=	0
TOTAL	398				

Previous studies have shown that the 16-hour raw count from 6am to 10pm is approximately 90% of the 24 - hour volume. Hourly tables are included in *figures 24-26.* In this case, we will expand the class count from one hour to reflect 16 hours counted in May.

Using information from a previous study of vehicle class sites done in the Traffic Forecast Section, it was determined that in the 11am to 12 noon hour trucks were 8.6% of the 16 hour count and cars were 5.9% of the raw 16 hour count *(figure 26).* Then (above), we divide those percents to determine a 16-hour count (similar to the manual vehicle class sites we have looked at previously).

The forecaster now has all the information to complete the 16 to 24 hour vehicle class expansion worksheet (see below).

16 HR. OR 24 HR. VEHICLE CLASS COUNT EXPANSION WORKSHEET 1

SITE NUMBER: 6326 **COUNTY:** Stearns

SITE DESCRIPTION: 28th Street in St Cloud

PROJECT SP#: 0 **YEAR OF COUNT ->:** 2001

MONTH NUMBER OF COUNT: 5 **CONSTRAIN AADT ->:** 6400

16 or 24 HR 16

VEHICLE TYPE	RAW COUNT	AADT ADJ FACTOR		ADJUSTED RAW	VEH. TYPE PERCENTS		A.C.F.
CARS AND PICKUPS	5450	#N/A		5642			0.92
2 AXLE 6 TIRE	250	0.78		196	3.1%		
3+ AXLE SINGLE UNIT	300	0.76		227	3.5%		
3 AXLE SEMI (TST)	25	0.69		17	0.3%		
4 AXLE SEMI (TST)	50	0.80		40	0.6%		
5+ AXLE SEMI (TST)	250	0.89		223	3.5%		
TR TR, BUSES	70	0.78		55	0.9%		
TWIN TRAILERS	0	0.89		0	0.0%		
TOTALS ---------->	6395	-------->	1.0	6400	11.8%	(%HC)	

6326

28th Street in St Cloud

Since there is only one vehicle class count in our forecast, there is no real need to use the vehicle class count averages worksheet. The forecaster could go straight to the A segment worksheet and input the vehicle percentages and the appropriate AADT to produce the ESAL forecast. Again, in this example of a city street where no historical counts were available, a forecaster could use this method to produce a forecast. We recommend a minimum of an eight-hour count that covers the morning or afternoon peak hours (i.e., 6am-9am or 3pm to 6pm). This example or method could be used on streets and roadways where no count data is available.

Vehicle Class Count Averages Worksheet

VCC Site Num. 6326
TH 28 TH
Description 28th Street in St Cloud

		16-24 Vehicle C.C.1		16-24 Vehicle C.C.2		16-24 Vehicle C.C.3		16-24 Vehicle C.C.4			
	Type	**Year**	**Pct**	**Year**	**Pct**	**Year**	**Pct**	**Year**	**Pct**	**Avg Truck Volumes**	**Avg Vehicle Pctages**
		2001									
	Man/Tube	Manual									
1	**Cars**	5642	*88.16%*								*88.16%*
2	**2 ASU**	196	*3.06%*							*196*	*3.06%*
3	**3+ASU**	227	*3.55%*							*227*	*3.55%*
4	**3ASemi**	17	*0.27%*							*17*	*0.27%*
5	**4ASemi**	40	*0.63%*							*40*	*0.63%*
6	**5+Asemi**	223	*3.48%*							*223*	*3.48%*
7	**TT/BUS**	55	*0.86%*							*55*	*0.86%*
8	**Twins**	0	*0.00%*							*0*	*0.00%*
Total		*6400*	*11.84%*								*11.84%*
Total Heavy Comm		*758*								*758*	*100.00%*
Heavy 5 Ax Semi*			40.0%								40.00%
Axle Corr Factor			0.92								0.92

* Heavy 5 Ax Semi = Tank, Dump, Grain (and Stake if on Timber route-Dist 1,2, or 3)
When the Tank, Dumps, & Grains and sometimes stakes are 30% or more of the 5 axle semis, then split into max and other categories (AUTOMATICALLY DONE) ---------->
Check out tube counts prior to 1996 carefully, body types are N/A prior to 1982, don't use tube collected previous to 1990.

Heavy 5 Axle Semi Split	
1.39%	Max
2.09%	Others
SPLIT	

NOTE: IF LESS THAN 4 ENTRIES, BE SURE
TO DELETE YEAR AND PCT COLUMN
DO NOT USE 0, LEAVE BLANK.
USER MUST THEN COPY THE FORMULA IN THE
PCT COLUMNS BACK TO THE APPROPRIATE COLUMN
FOR HELP CALL MARK LEVENSON - 651 -296-8535 OR TOM NELSON - 651-297-1197.

Since we are producing an ESAL at a specific site, we will be doing an A segment only. No need for a B segment with just one location or junction. The assumption used will be a 2% growth rate per year. It is also assumed that the land use and growth patterns will not change and no new truck generators are planned; therefore a 2% growth rate over 20 years translates into multiplying the 2001 AADT by 1.4 (2% per year times 20 years). The 2001 AADT we have calculated multiplied by 1.4 is roughly the 9000 AADT

number that is entered on the A segment worksheet. See both the A segment Worksheet and A Segment Report below for the completed ESAL forecast.

CUMULATIVE ESALS WORKSHEET **SEGMENT A**

SP#: 0
ROUTE: 28th Street So **# LANES:** 2 **DATE:** 04/09/02
LOCATION: 28th Street in St Cloud
VCL SITE #: 6326

	YEAR	AADT	INIT CALC HCADT	CONSTRN HCADT	INIT CALC 5AX TST	CONSTRAIN 5AX TST
VEH.CLASS YR.:	2001	6400	760	0.0%	---	---
BASE YEAR:	2001	6400	760		223	
FORECAST YEAR:	2021	9000	1070		314	

BASE YEAR PROPORTIONS		BASE YR. VOLUME	% TREND	FUTURE %	FUTURE VOL.
2AX-6TIRE SU	3.1%	197	1	3.1%	277
3AX+ SU	3.5%	228	1	3.5%	320
3AX TST	0.3%	17	1	0.3%	24
4AX TST	0.6%	40	1	0.6%	56
5AX+ TST	0	0	1	0.0%	0
(5AX+ TST MAX)	1.4%	89	1	1.4%	126
(5AX+ TST OTH)	2.1%	134	1	2.1%	189
TR TR, BUSES	0.9%	55	1	0.9%	78
TWIN TRAILERS	0.0%	0	1	0.0%	0

SUMMARIES:		AADT	HCADT	HCADT %	20 YR DESIGN LANE CUMULATIVE ESAL
2001	**COUNT:**	6400	760	11.9%	|
2001	**FORECAST:**	6400	760	11.9%	**********
2021	**FORECAST:**	9000	1070	11.9%	**********

		FLEXIBLE	RIGID
DESIGN LANE FACTOR:	0.5	**2,972,000**	**4,502,000**
		**********	**********

ADDITIONAL OUTPUTS:

	BASE %	FORECAST %	ESAL FACTORS FLEXIBLE	RIGID
2AX-6TIRE SU	3.1%	3.1%	0.25	0.24
3AX+ SU	3.6%	3.6%	0.58	0.85
3AX TST	0.3%	0.3%	0.39	0.37
4AX TST	0.6%	0.6%	0.51	0.53
5AX+ TST	0.0%	0.0%	1.13	1.89
(5AX+ TST MAX)	1.4%	1.4%	2.40	4.07
(5AX+ TST OTH)	2.1%	2.1%	0.87	1.44
TR TR, BUSES	0.9%	0.9%	0.57	0.74
TWIN TRAILERS	0.0%	0.0%	2.40	2.33

Notes:

CUMULATIVE ESAL REPORT - A

DATE: 04/09/02

ROUTE #: 28th Street **DISTRICT:** 3 **SP#:** 0

FORECAST #: F-Stearns-01 **COUNTY:** STEARNS **MILES:** _____

DESCRIPTION: 28th Street in St Cloud

AUTHOR'S DISTRICT: ---> C.O. **AUTHOR:** Levenson

TRAFFIC SUMMARY

BASE YEAR NUMBER OF LANES (two way): 2

BASE YEAR --->	0	DESIGN YEAR ---->	20	GROWTH / YR (SIMPLE %)
AADT: two-way	6400		9000	2.0%
design-lane	3200		4,500	2.0%
HCADT: two-way	760		1,070	2.0%
SINGLE UNITS:two-way	430		600	2.0%
TST'S: two-way	280		395	2.1%

ESAL SUMMARY

ANNUAL DESIGN LANE ESAL

FLEXIBLE:	104,826	147,855	+
RIGID:	158,792	224,049	+

CUMULATIVE DESIGN-LANE ESALS (10 TON) **Design-lane factor:** **0.5**

DESIGN YEAR	DESIGN-LANE TST'S	ESALS FLEXIBLE	ESALS RIGID
10	169	1,424,000	2,157,000
15	183	2,168,000	3,284,000
20	198	**2,972,000**	**4,502,000**
**** OR ** DESIGN YEAR**			
21	200	3,022,000	4,579,000
22	203	3,073,000	4,656,000
23	206	3,123,000	4,732,000
24	209	3,174,000	4,809,000
25	212	3,225,000	4,886,000

35 YEAR CUMULATIVE ESAL USING--> 0 **AS THE BASE YEAR**

35	5,745,000	8,705,000

APPROVED BY: _____ **DATE:** _____

(FOR PROJECT AADTS AND DESIGN HOUR VOLUMES PLEASE REFER TO PREVIOUSLY APPROVED FORECASTS OR ATTACHED TRAFFIC FLOW DIAGRAMS.)

Another way to factor a short duration count would be to use a nearby vehicle class count site. Suppose, for example you had a traffic forecast with one A segment and several B segments. If you wanted to count the traffic along any B segment you could compare the newly counted short duration count with the same hours at the vehicle class site. The forecaster then could calculate the percent particular hours are of the 16 or 24 count at the vehicle class site and similarly apply those percents to a new count.

After expanding the short duration count, there would be another vehicle class site to use. That means the forecaster could use another A segment in place of a B segment. Also, if the project crosses a trunk highway that has no vehicle class site at another junction, you could still use the short duration count and expand it the same way. Remember, the B segment is the default heavy commercial that is added and subtracted along a project with a change in AADT, and any count data is better than using the default.

To aid the forecaster in heavy truck recognition, the following are examples of some typical truck types. Moving from left to right, top to bottom are two examples of "heavy" single unit truck types: 4 axle single unit, 3 axle single unit (the ESAL factors can be changed manually for these truck types if necessary). The next four are examples of heavy truck body types that should be "split": dump, grain, stake, and tank. The last photo is "other" (usually not split unless it is known what commodity is being carried.

Figure 13 Heavy Truck Types

Traffic Forecast Example using Short Counts

The following is an example of a forecast done "creatively" from a short count and is for illustrative purposes only. It is merely an example of the type of judgment that can be used in the traffic forecasting process. In this instance, while the VC site was in the area, it was too far removed from the project area to be representative of the traffic on that segment. This is another example of judgment an experienced forecaster may have to use when the information available is not good enough, too far removed from the project, or the time frame of the requestor does not allow time to take a 16 hour manual or 48 hour tube count. *In actuality, a one-hour count is not enough. The percentage each hour is of the 24 hour total varies by vehicle type. TDA has done some studies that show averages for the entire state. Caution must be utilized in using statewide averages.*

This was an actual project, located on TH101 – a bridge replacement over Bluff creek where traffic was restricted (no semis were allowed on the roadway). The 2000 AADT was 3500 (estimated 3700 for year 2002). The following vehicles were recorded during a one hour period from 10-11am

2ax su	3ax su	Bus	Cars	
7	3	1	217	=228 total vehicles

Thus, 7/228 = 3.1%, 3/228=1.3%, 1/228=0.4%, 217/228=95.2%
We have now calculated the percentage each vehicle type was of the total vehicles at that site during the 10-11am period. Taking the next step, we multiple our known AADT(3700) by the vehicle type percents to get an "estimated" 24 hour count.

2ax su	3ax su	Bus	Cars
3700 x 3.1%=114	3700 x 1.3%=48	3700 X 0.4%=15	3700 x 95.2%=3322

We then expand the count for September and use the 2002 AADT to constrain. Since this is our only vehicle class count data, these percents are the values at our A segment. We could contact TDA for typical percents by hour for all vehicle types.

16 HR. OR 24 HR. VEHICLE CLASS COUNT EXPANSION WORKSHEET 1

SITE NUMBER: 8728 **COUNTY:** 0

SITE DESCRIPTION: BR 1822 Over Bluff Creek N of JCt TH212

PROJECT SP#: 0 **YEAR OF COUNT ->:** 2002

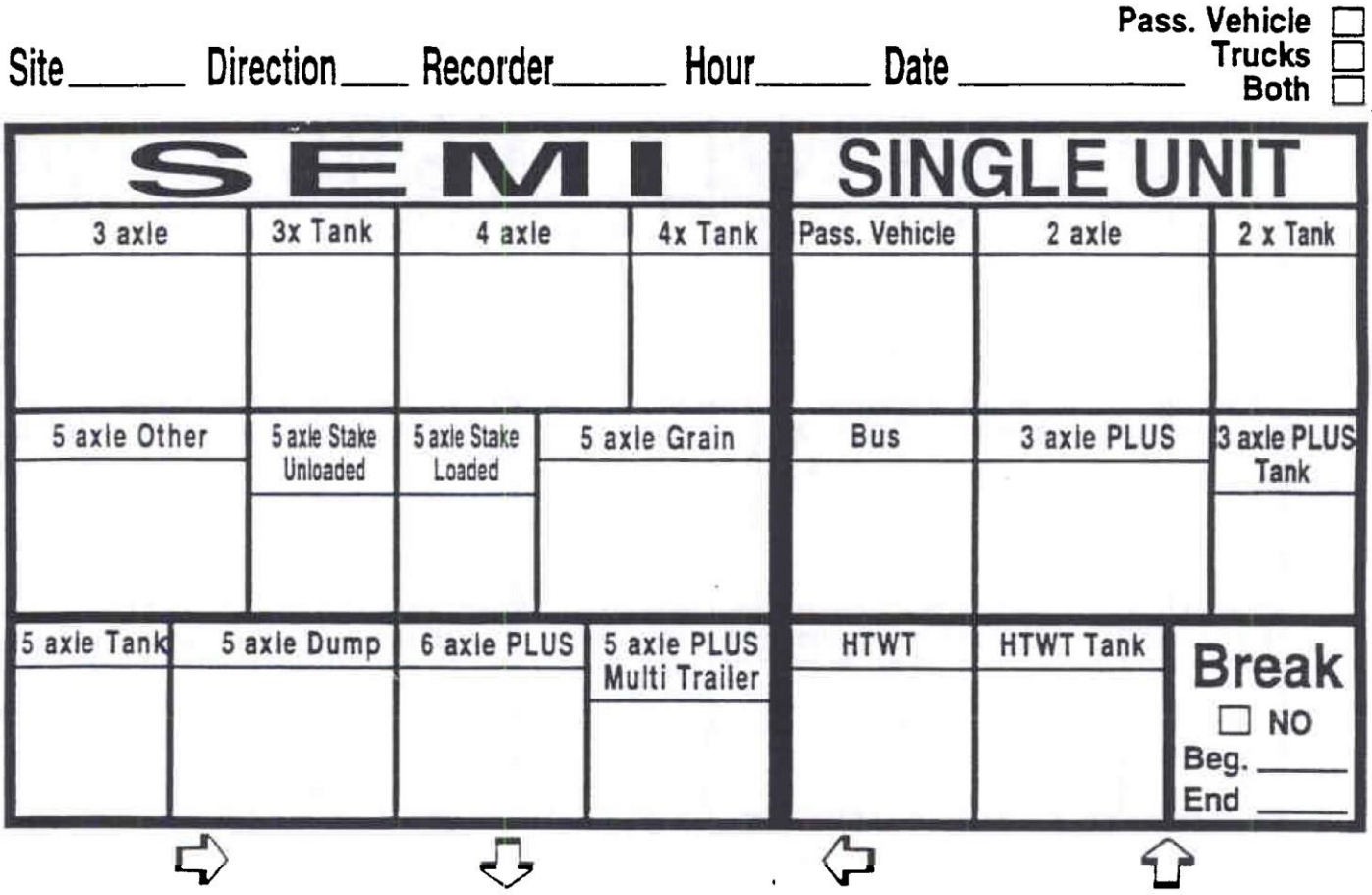
MONTH NUMBER OF COUNT: 9 **CONSTRAIN AADT ->:** 3700

16 or 24 HR 24

VEHICLE TYPE	RAW COUNT	AADT ADJ FACTOR		ADJUSTED RAW	VEH. TYPE PERCENTS		A.C.F.
CARS AND PICKUPS	3322	#N/A		3587			0.99
2 AXLE 6 TIRE	114	0.65		74	2.0%		
3+ AXLE SINGLE UNIT	48	0.61		29	0.8%		
3 AXLE SEMI (TST)	0	0.72		0	0.0%		
4 AXLE SEMI (TST)	0	0.76		0	0.0%		
5+ AXLE SEMI (TST)	0	0.70		0	0.0%		
TR TR, BUSES	15	0.65		10	0.3%		
TWIN TRAILERS	0	0.70		0	0.0%		
TOTALS ---------->	3499	-------->	1.1	3700	3.1%	(%HC)	

If you are taking a short count, you may find it useful to use some version of the form below. They are available from the Traffic Forecasting Analysis Unit:

Figure 14-Traffic Recorder Count Sheets



Use of Additional Trucks in a Traffic Forecast

Another traffic forecast example involves the addition of more than one heavy vehicle type added to the mix. The traffic forecaster may get requests to help or assist in the preparation of local or county road forecast involving some of the procedures discussed above. The next traffic forecast consists of one forecast and three alternative scenarios. Each scenario shows how with local knowledge, ESALS can increase (or perhaps decrease in another scenario). For illustrative purposes, "A" segment worksheets with a discussion of each is included. The final forecast involves the addition of 250 trucks in Kandiyohi County due to knowledge of beet hauling on the project. It involves the addition of 3 axle single unit trucks – fully loaded (causes the ESAL factor to be increased from .58 to 1.7), and the addition of fully loaded 5 axle semis (ESAL factor at the max of 2.4)

The first iteration is a traditional forecast using two years of data at one vehicle class site, an assumed 2% growth per year, and a 2001 letting date/base year with a 2021 forecast year.

CUMULATIVE ESALS WORKSHEET **SEGMENT A**

SP#:	34-601-25				
ROUTE:	CSAH 1	**# LANES:**	2	**DATE:**	04/10/02
LOCATION:	TH7 TO SOUTH KANDIYOHI COUNTY LINE				
VCL SITE #:	3011				

	YEAR	AADT	INIT CALC HCADT	CONSTRN HCADT	INIT CALC 5AX TST	CONSTRAIN 5AX TST
VEH.CLASS YR.:	1999	670	60	0.0%	---	---
BASE YEAR:	2001	800	80		22	
FORECAST YEAR:	2021	1200	110		32	

BASE YEAR PROPORTIONS		BASE YR. VOLUME	% TREND	FUTURE %	FUTURE VOL.
2AX-6TIRE SU	3.2%	27	1	3.2%	37
3AX+ SU	1.9%	16	1	1.9%	22
3AX TST	0.3%	2	1	0.3%	3
4AX TST	0.5%	4	1	0.5%	6
5AX+ TST	2.7%	23	1	2.7%	31
(5AX+ TST MAX)	0.0%	0	1	0.0%	0
(5AX+ TST OTH)	0.0%	0	1	0.0%	0
TR TR, BUSES	0.6%	5	1	0.6%	7
TWIN TRAILERS	0.4%	3	1	0.4%	4

SUMMARIES:		AADT	HCADT	HCADT %	20 YR DESIGN
1999	**COUNT:**	670	60	9.0%	**LANE CUMULATIVE ESAL**
2001	**FORECAST:**	800	80	10.0%	| |
2021	**FORECAST:**	1200	110	9.2%	********** **********
					FLEXIBLE **RIGID**
DESIGN LANE FACTOR:		0.5			**281,000** **394,000**
					********** **********

ADDITIONAL OUTPUTS:

	BASE %	FORECAST %	ESAL FACTORS FLEXIBLE	RIGID
2AX-6TIRE SU	3.4%	3.1%	0.25	0.24
3AX+ SU	2.0%	1.8%	0.58	0.85
3AX TST	0.3%	0.3%	0.39	0.37
4AX TST	0.5%	0.5%	0.51	0.53
5AX+ TST	2.9%	2.6%	1.13	1.89
(5AX+ TST MAX)	0.0%	0.0%	2.40	4.07
(5AX+ TST OTH)	0.0%	0.0%	0.87	1.44
TR TR, BUSES	0.6%	0.6%	0.57	0.74
TWIN TRAILERS	0.4%	0.3%	2.40	2.33

Notes:

The above worksheet represents the "traditional" non adjusted ESAL Worksheet A. This was based on a tube count – which, as known from previous information, has no body type split information. An ESAL of 281,000 would thus be produced if "nothing else" was known, or there was no local knowledge, or the site wasn't visited. However, even if the project site was visited and a short count was taken (in "non sugar beet hauling season"), results similar to the tube count would be encountered (few additional trucks). In this forecast, the count was taken in July and the additional loads did not appear until September and continued through the following February. This is illustrative of the

importance not only of visiting the site, but knowing and finding out about the roads in your district and/ or county – even knowing what season or month traffic will be affected.

CUMULATIVE ESALS WORKSHEET **SEGMENT A**

SP#: 34-601-25
ROUTE: CSAH 1 **# LANES:** 2 **DATE:** 04/10/02
LOCATION: TH7 TO SOUTH KANDIYOHI COUNTY LINE
VCL SITE #: 3011

	YEAR	AADT	INIT CALC HCADT	CONSTRN HCADT	INIT CALC 5AX TST	CONSTRAIN 5AX TST
VEH.CLASS YR.:	1999	670	160	0.0%	---	---
BASE YEAR:	2001	1050	240		189	
FORECAST YEAR:	2021	1450	340		261	

BASE YEAR PROPORTIONS		BASE YR. VOLUME	% TREND	FUTURE %	FUTURE VOL.
2AX-6TIRE SU	0.0%	0	1	0.0%	0
3AX+ SU	5.2%	54	1	5.2%	76
3AX TST	0.0%	0	1	0.0%	0
4AX TST	0.0%	0	1	0.0%	0
5AX+ TST	0.0%	0	1	0.0%	0
(5AX+ TST MAX)	18.0%	186	1	18.0%	264
(5AX+ TST OTH)	0.0%	0	1	0.0%	0
TR TR, BUSES	0.0%	0	1	0.0%	0
TWIN TRAILERS	0.0%	0	1	0.0%	0

SUMMARIES:		AADT	HCADT	HCADT %	20 YR DESIGN LANE CUMULATIVE ESAL
1999	**COUNT:**	670	160	23.9%	
2001	**FORECAST:**	1050	240	22.9%	|
2021	**FORECAST:**	1450	340	23.4%	**********

	FLEXIBLE	RIGID
DESIGN LANE FACTOR: 0.5	**2,797,000**	**4,689,000**
	**********	**********

ADDITIONAL OUTPUTS:

	BASE %	FORECAST %	ESAL FACTORS FLEXIBLE	RIGID
2AX-6TIRE SU	0.0%	0.0%	0.25	0.24
3AX+ SU	5.1%	5.2%	1.70	2.70
3AX TST	0.0%	0.0%	0.39	0.37
4AX TST	0.0%	0.0%	0.51	0.53
5AX+ TST	0.0%	0.0%	1.13	1.89
(5AX+ TST MAX)	17.7%	18.2%	2.40	4.07
(5AX+ TST OTH)	0.0%	0.0%	0.87	1.44
TR TR, BUSES	0.0%	0.0%	0.57	0.74
TWIN TRAILERS	0.0%	0.0%	2.40	2.33

Notes:

For illustrative purposes, the above ESAL Worksheet A has been modified to show the effect of heavy trucks only. Note that the 2,797,000 ESALS generated by the trucks alone is about 10 times that of the first iteration (281,000 ESALS). This also shows the effect that heavy trucks have on the roadway. Note that 2001 and 2021 AADT has been increased from the previous ESAL Worksheet A – from 800 to 1050 and 1200 to 1450 respectively. Also, the 3 axle + SU ESAL factors have been manually increased from .58 and .85 to 1.7 and 2.7 respectively. The 5 axle semis are calculated to be fully loaded,

with an ESAL of 2.4. The change in ESAL factors will automatically generate the increased ESALS.

The final ESAL Worksheet A uses the additional trucks for the 3AX + SU category and 5 AX+ TST MAX (above) as well as the 1st iteration percents calculated from the vehicle class site. Of importance, again, is the fact that the other vehicle types together do not generate as many ESALS as the fully loaded 5 axle semis and the maximum loaded 3+ axle single unit vehicles. The ESALS on our final iteration only increased slightly from the heavy truck ESAL Worksheet A (2,797,000 compared to 3,091,000 ESALS).

CUMULATIVE ESALS WORKSHEET **SEGMENT A**

SP#:	34-601-25				
ROUTE:	CSAH 1	**# LANES:**	2	**DATE:**	04/10/02
LOCATION:	TH7 TO SOUTH KANDIYOHI COUNTY LINE				
VCL SITE #:	3011				

	YEAR	AADT	INIT CALC HCADT	CONSTRN HCADT	INIT CALC 5AX TST	CONSTRAIN 5AX TST
VEH.CLASS YR.:	1999	670	210	0.0%	---	---
BASE YEAR:	2001	1050	320		217	
FORECAST YEAR:	2021	1450	450		300	

BASE YEAR PROPORTIONS		BASE YR. VOLUME	% TREND	FUTURE %	FUTURE VOL.
2AX-6TIRE SU	3.2%	33	1	3.2%	47
3AX+ SU	5.2%	54	1	5.2%	76
3AX TST	0.3%	3	1	0.3%	4
4AX TST	0.5%	5	1	0.5%	7
5AX+ TST	2.7%	28	1	2.7%	39
(5AX+ TST MAX)	18.0%	186	1	18.0%	264
(5AX+ TST OTH)	0.0%	0	1	0.0%	0
TR TR, BUSES	0.6%	6	1	0.6%	9
TWIN TRAILERS	0.4%	4	1	0.4%	6

SUMMARIES:		AADT	HCADT	HCADT %	20 YR DESIGN LANE CUMULATIVE ESAL
1999	**COUNT:**	670	210	31.3%	|
2001	**FORECAST:**	1050	320	30.5%	**********
2021	**FORECAST:**	1450	450	31.0%	**********

		FLEXIBLE	RIGID
DESIGN LANE FACTOR:	0.5	**3,091,000**	**5,095,000**
		**********	**********

ADDITIONAL OUTPUTS:

	BASE %	FORECAST %	ESAL FACTORS FLEXIBLE	RIGID
2AX-6TIRE SU	3.1%	3.2%	0.25	0.24
3AX+ SU	5.1%	5.2%	1.70	2.70
3AX TST	0.3%	0.3%	0.39	0.37
4AX TST	0.5%	0.5%	0.51	0.53
5AX+ TST	2.7%	2.7%	1.13	1.89
(5AX+ TST MAX)	17.7%	18.2%	2.40	4.07
(5AX+ TST OTH)	0.0%	0.0%	0.87	1.44
TR TR, BUSES	0.6%	0.6%	0.57	0.74
TWIN TRAILERS	0.4%	0.4%	2.40	2.33

Notes:

Again, when adding trucks to the mix, the forecaster will find the easiest method is to change the desired percents to reach the desired number of trucks – in that way, the

formatting is preserved that calculates future volumes and ESALS. Below is the final memo or cover page of the sample forecast discussed above. The forecaster should include similar information under the Remarks section for forecast assumptions.

From: GEORGE M. CEPRESS P.E.
STATE TRAFFIC FORECAST ENGINEER
CENTRAL OFFICE, MAIL STOP 450

Subject: TRAFFIC FORECAST

Route:	CSAH 1	SP#	34-601-25
Letting Date:	2001	Forecast #	F-KANDIYOHI-1
Program Category:		County:	KANDIYOHI
Project Manager:	MIKE HOFER	District:	8
		Miles:	
Project Limits:	TH7 TO SOUTH KANDIYOHI COUNTY LINE		

Enclosures (check those that apply):

- [ ] Project map
- [ ] Least squares analysis
- [ ] Cumulative ESAL worksheet, Segment A
- [ ] Cumulative ESAL worksheet, Segment B
- [ ] AADT and/or DHV traffic schematic diagram
- [ ] VCL expansion worksheet
- [ ] Cumulative ESAL Report
- [ ] Other (describe)
- [ ] Other (describe)

REMARKS:

ASSUME 2% YEAR TRAFFIC GROWTH
THIS ESAL FORECAST ASSUMES 2001 AS LET/BASE YEAR AND 2021 AS FORECAST YEAR
ADDITIONAL LOAD INFORMATION PROVIDED BY MIKE HOFER, KANDIYOHI COUNTY
VEHICLE CLASS SITES INFORMATION BASED ON SITE 3011 USED - 1998 & 1999 (EXPANDED)
800 AADT ASSUMED FOR 2001 (BASED ON HISTORIC AADT COUNTS FROM CSAH 1 S OF TH 7)
ADDING 188 5 AXLE SEMIS TO THE MAX CATEGORY
ADDING 55 TO THE 3AX+SU CATEGORY
ADDING 250 (188+55) AADT TO THE LETTING DATE AND BASE YEAR

For information that requires knowledge of vehicles loaded above the average weight, the forecaster must consult the AASHTO Guide for Design of Pavement. That information is available upon request from the Traffic Forecast Section

The following two tables (figure 15) are examples of ESAL factors for flexible pavement for single and tandem axles:

ESAL FACTORS AND THRESHOLDS IN DESIGN

Figure 15 – ESAL Equivalence Factors

18-KIP AXLE EQUIVALENCE FACTORS
FLEXIBLE PAVEMENT, P-2.5

Gross Axle Load (lbs.)	SN = 5 Single Axles	Tandem Axles
1,000	0.00002	
2,000	.00018	
3,000	.00072	
4,000	.00209	
5,000	.00500	
6,000	.01043	
7,000	.0196	
8,000	.0343	
9,000	.0562	
10,000	.0877	0.00688
11,000	.1311	.01008
12,000	.189	.0144
13,000	.264	.0199
14,000	.360	.0270
15,000	.478	.0360
16,000	.623	.0472
17,000	.796	.0608
18,000	1.000	.0773
19,000	1.24	.0971
20,000	1.51	.1206
21,000	1.83	.148
22,000	2.18	.180
23,000	2.58	.217
24,000	3.03	.260
25,000	3.53	.308
26,000	4.09	.364
27,000	4.71	.426
28,000	5.39	.495
29,000	6.14	.572
30,000	6.97	.658
31,000	7.88	.753
32,000	8.88	.857
33,000	9.98	.971
34,000	11.18	1.095
35,000	12.50	1.23
36,000	13.93	1.38
37,000	15.50	1.53
38,000	17.20	1.70
39,000	19.06	1.89
40,000	21.08	2.08
41,000	23.27	2.29
42,000	25.64	2.51
43,000	28.22	2.75
44,000	31.00	3.00
45,000	34.00	3.27
46,000	37.24	3.55
47,000	40.74	3.85

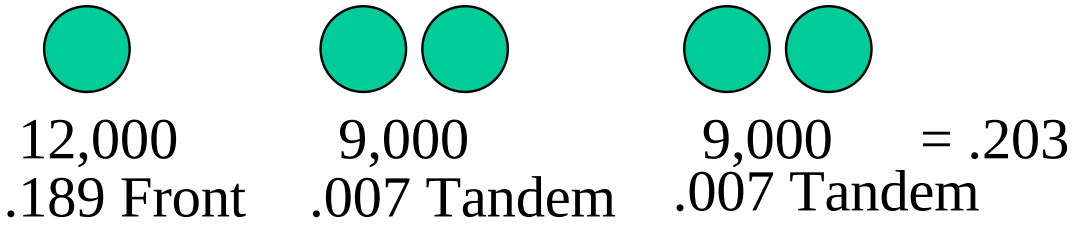
18-KIP AXLE EQUIVALENCE FACTORS
FLEXIBLE PAVEMENT, P-2.5

SN = 5

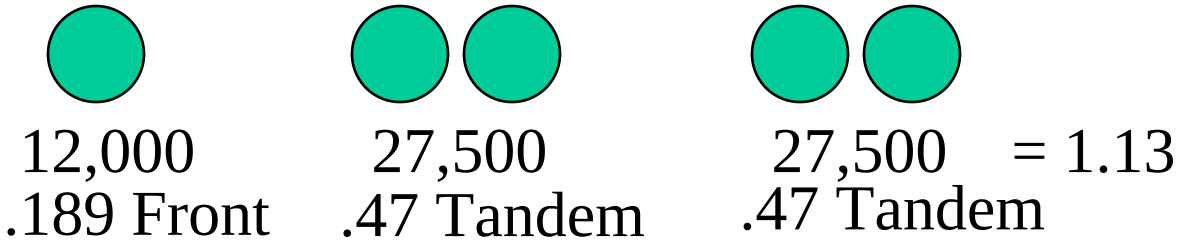
Gross Axle Load (lbs.)	Single Axles	Tandem Axles
48,000	44.50	4.17
49,000	48.54	4.51
50,000	52.88	4.86
51,000		5.23
52,000		5.63
53,000		6.04
54,000		6.47
55,000		6.93
56,000		7.41
57,000		7.92
58,000		8.45
59,000		9.01
60,000		9.59
61,000		10.20
62,000		10.84
63,000		11.52
64,000		12.22
65,000		12.96
66,000		13.73
67,000		14.54
68,000		15.38
69,000		16.26
70,000		17.19
71,000		18.15
72,000		19.16
73,000		20.22
74,000		21.32
75,000		22.47
76,000		23.66
77,000		24.91
78,000		26.22
79,000		27.58
80,000		28.99

The following is a sample of how to use the ESAL factors above:
On the above tables, you will see that 12,000 pounds on a single axle has an ESAL factor of .189 – rounded to .2 and 34,000 pounds on a tandem has a factor of 1.095 - rounded to 1.1. That portrays a fully loaded 80,000 pound 5 axle semi. The next sketch shows a typical example of an empty 5-axle semi. The ESAL factor is quite a bit lower. Below we see the addition of .2 + 1.1 + 1.1 = 2.4

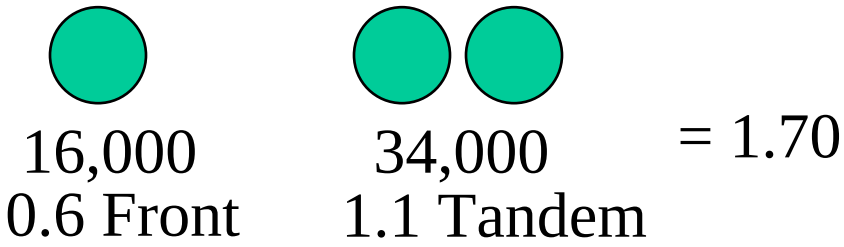
12,000 .2 Front | 34,000 1.1 Tandem | 34,000 1.1 Tandem = 2.4



The following sketch shows a sample configuration of the 5-axle TST as represented in the MnESAL when heavies are not split – ESAL factor of 1.13. This is showing a typical 5 axle semi that weights about 67,000 pounds



The next example is that the 3 axle single unit truck that we changed from a default of 0.58 to 1.70 in our CSAH 1 example (in Kandiyohi County). We assumed these 3 axle trucks were "heavy" fully loaded 3 axle single unit trucks hauling sugar beets. A typical weight of a truck of this type may be around 50,000 pounds (depending upon axle spacing).



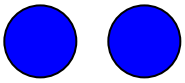
All of the above illustrations show the need for on site inspection when the body type mix is questionable or information at the vehicle class site is not adequate. Thus the forecaster does not want to underestimate the effects of heavy trucks on a project. This could lead to a low ESAL forecast and an under-designed roadway, which could lead to early pavement failure. The importance of proper fieldwork in an ESAL forecast cannot be over emphasized. The forecaster must calculate that the time spent on a forecast is justified when comparing the costs of a poorly constructed road.

Truck Weights, Axles Configuration and ESALS

The below table is our standard ESAL factors on the MnESAL

	ESAL FACTORS	
	FLEXIBLE	RIGID
2AX-6TIRE SU	0.25	0.24
3AX+ SU	0.58	0.85
3AX TST	0.39	0.37
4AX TST	0.51	0.53
5AX+ TST	1.13	1.89
(5AX+ TST MAX)	2.40	4.07
(5AX+ TST OTH)	0.87	1.44
TR TR, BUSES	0.57	0.74
TWIN TRAILERS	2.40	2.33

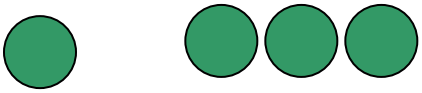
The maximum weight allowable on a single axle is 20000 pounds 

The maximum weight allowable on a tandem is 34000 pounds 

The maximum weight allowable on a tridem is about 42000-43000 pounds 

During the course of a traffic forecast, it will often be necessary to change ESAL factors for various vehicle types when information becomes available. For example, local knowledge regarding heavy truck routes, gravel or grain truck movements, lumber or stake trucks, etc. can often be obtained by on site inspections. In most cases we vary the 5-axle semi factors as far as maximum and other. In some cases, such as gravel hauling routes, single unit dump trucks (2, 3 and 4 axle single units) are fully loaded to the legal limits. The forecaster should recalculate the ESAL factors.

Pages 94 through 96 in the manual discuss single and tandem axle weights and various ESAL configurations and how ESALS are calculated. The table below also includes tridem axles, often found on 4-axle single unit dump trucks. For example, a typical "loaded 4-axle single unit gravel truck may have a configuration something like the following example:



15,000 pounds .478 Front | 42,000 pounds .595 Tridem | =1.073, or 1.1 ESAL Factor - Flexible

Since the default for a 3+ single axle unit is .58, we see that a typical loaded 4 axle single unit has an ESAL factor of about 1.1. The forecaster then would manually change the flexible ESAL on the worksheet by un-protecting the worksheet and changing the number. Note the effect on the ESALS when you "adjust" the ESAL factors. The numbers could change significantly if there were large numbers of these gravel trucks in your project area.

For a heavy 3-axle single unit gravel truck we may have the following configuration. The default ESAL is the same as the above example, .58 flexible.

12,000 pounds	34,000 pounds	
.189 Front	1.095 Tandem	=1.284, or 1.3 ESAL Factor – Flexible

The information below are average rough figures derived from the State Patrol and can be used in determining the weights for 2, 3, and 4 axle "reasonably" loaded single unit gravel dump trucks. The numbers include GVW (gross vehicle weight), front axle and rear group. Again, from this weight, we can use the information from the tandem and tridem ESAL equivalent tables included in this report.

1. 2-axle dump truck -33,000 GVW. Up to 13,000 steering axle, 20,000 drive axle
2. 3-axle dump truck - 45,000 GVW. Up to 13,000 steering axle, 34,000 tandem
3. 4-axle dump truck – 57,000 GVW. 14,000+ on steering axle, 43,000 tridem

The following example shows how the above information may be used to adjust the default ESAL factors for single unit trucks and the possible range of ESALS. The ultimate result in the following examples is to increase the ESAL factor for single axle unit trucks based on known number of heavy gravel trucks added to the mix.

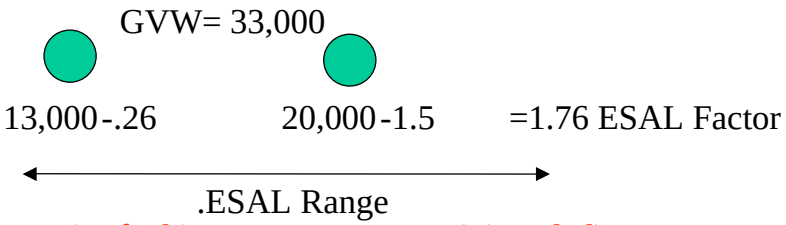
In calculating ESALS, we mainly talk about Flexible ESALS. In actuality, the Rigid ESAL, always higher on the MnESAL worksheets is the concrete equivalent to the bituminous number. These numbers do not relate to one another. They are results of the formula used in the process that develops these factors. The summation of total vehicle volumes by class are equal, the only difference is in the results of the formula.

The next page shows examples of single unit truck ESAL ranges as well as a sample page from the Pavement Manual of a triple axle load equivalency factor.

Single Unit Truck ESAL Ranges

Sample = 200 heavy trucks, 100 unloaded trucks

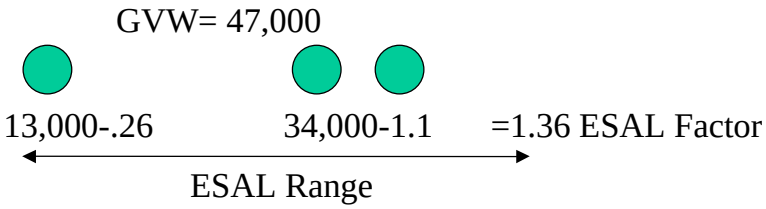
Example of how to modify default ESAL values for 2,3, and 4 axle single unit loaded gravel trucks



1. .25 (Default) .1.76 (Loaded)
2. 100 trucks *.25=25 200 trucks *1.76=352
3. Average Daily ESAL = 25 +352 = 377
4. 377 Average Daily ESAL / 300 = ***1.26 (Avg ESAL)***

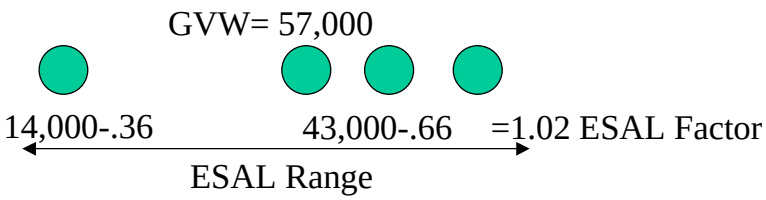
The weighted ESAL factors in these examples would replace default ESAL values

3ax su



1. .58 (Default) 1.36 (Loaded)
2. 100 trucks *.58=58 200 trucks *1.36=272
3. Average Daily ESAL = 58 +272 = 330
4. 330 Average Daily ESAL / 300 = ***1.1(Avg ESAL)***

4ax su



1. .58 (Default) 1.02 (Loaded)
2. 100 trucks *.58=58 200 trucks *1.02=204
3. Average Daily ESAL = 58 +204 = 262
4. 262 Average Daily ESAL / 300 = ***0.87 (Avg ESAL)***

Table D.6. Axle load equivalency factors for flexible pavements, triple axles and p_t of 2.5.

Axle Load (kips)	Pavement Structural Number (SN)					
	1	2	3	4	5	6
2	.0000	.0000	.0000	0000	.0000	.0000
4	.0002	.0002	.0002	0001	.0001	.0001
6	.0006	.0007	.0005	0004	.0003	.0003
8	.001	.002	.001	.001	.001	.001
10	.003	.004	.003	.002	.002	.002
12	.005	.007	.006	.004	.003	.003
14	.008	.012	.010	.008	.006	.006
16	.012	.019	.018	.013	.011	.010
18	.018	.029	.028	.021	.017	.016
20	.027	.042	.042	.032	.027	.024
22	.038	.058	.060	.048	.040	.036
24	.053	.078	.084	.068	.057	.051
26	.072	.103	.114	.095	.080	.072
28	.098	.133	.151	.128	.109	.099
30	.129	.169	.195	.170	.145	.133
32	.169	.213	.247	.220	.191	.175
34	.219	.266	.308	.281	.246	.228
36	.279	.329	.379	.352	.313	.292
38	.352	.403	.461	.436	.393	.368
40	.439	.491	.554	.533	.487	.459
42	.543	.594	.661	.644	.597	.567
44	.666	.714	.781	.769	.723	.692
46	.811	.854	.918	.911	.868	.838
48	.979	1.015	1.072	1.069	1.033	1.005
50	1.17	1.20	1.24	1.25	1.22	1.20
52	1.40	1.41	1.44	1.44	1.43	1.41
54	1.66	1.66	1.66	1.66	1.66	1.66
56	1.95	1.93	1.90	1.90	1.91	1.93
58	2.29	2.25	2.17	2.16	2.20	2.24
60	2.67	2.60	2.48	2.44	2.51	2.58
62	3.09	3.00	2.82	2.76	2.85	2.95
64	3.57	3.44	3.19	3.10	3.22	3.36
66	4.11	3.94	3.61	3.47	3.62	3.81
68	4.71	4.49	4.06	3.88	4.05	4.30
70	5.38	5.11	4.57	4.32	4.52	4.84
72	6.12	5.79	5.13	4.80	5.03	5.41
74	6.93	6.54	5.74	5.32	5.57	6.04
76	7.84	7.37	6.41	5.88	6.15	6.71
78	8.83	8.28	7.14	6.49	6.78	7.43
80	9.92	9.28	7.95	7.15	7.45	8.21
82	11.1	10.4	8.8	7.9	8.2	9.0
84	12.4	11.6	9.8	8.6	8.9	9.9
86	13.8	12.9	10.8	9.5	9.8	10.9
88	15.4	14.3	11.9	10.4	10.6	11.9
90	17.1	15.8	13.2	11.3	11.6	12.9

The information describes ESAL thresholds of bituminous pavement used in our final ESAL submittals – less than 1 million ESAL, 1 to 3 million ESALS, 3-10 million ESALS, and 10-30 million ESALS. Careful consideration should be given when forecasts are at or near thresholds. A little more attention to detail should be undertaken to determine if any particular forecast should go into or below any given threshold.

Figure 16 –Design Criteria for Bituminous Pavement

Design Criteria 2360 (Gyratory Mixes including SMA)

For Combined 2360/2350 (Gyratory/Marshall) Specification Rev. 01/14/08

20 yr. ESAL's [6] Design Lane X 10^6		Non Wear (>100 mm (4") from surface)	Wear (≤ 100mm (4") from surface)
All	Specify [2]	SPNWB_30_[5]	SPWEB_40_[5][7] SPWEB_30_[7][8] SMWEE640H[9]
	Option to Specify	Agg. Size A, C	Agg. Size A

Where: SP= conventional gyratory; SM= stone matrix asphalt gyratory; WE=wear; NW=non-wear

General Notes:

1. Minimum Lift thickness:
   - Agg. **Size A** (12.5 mm **(1/2") Maximum**, 9.5 mm Nominal) – 25 mm (1") minimum*
   - Agg. **Size B** (19.0 mm **(3/4") Maximum**, 12.5 mm Nominal) – 40 mm (1 ½") minimum
   - Agg. **Size C** (25.0 mm **(1") Maximum**, 19.0 mm Nominal) – 60 mm (2 ½") minimum
   - *All wear courses shall be at least 40 mm (1 ½") thick minimum.

2. Aggregate sizes specified and options listed should be used unless lift thickness precludes a larger aggregate size. Except for SMA and unless otherwise designated in the Special Provisions, the Contractor has the option to supply recycled mixture. With the approval of the Engineer, the Contactor may supply a gradation with a smaller max. aggregate size than that specified, i.e. size A in lieu of size B.

3. Specify size A when course/lift is less than 40 mm (1 ½").

4. Typical Sections should delineate individual lifts/courses and thicknesses.

5. For mainline paving select the asphalt binder grade from the most current PG Guidelines.
   For shoulders where traffic is allowed, generally, use the same binder grade as the mainline.
   For shoulders where traffic is prohibited select either PG 52 - 34 or PG 58 - 28 by matching the mainline low PG number. **I.E.. Mainline PG 64 - 28=> Shoulder PG 58 - 28**

6. For slow traffic consider selecting a higher mix type and/or higher high temperature binder grade. For shoulders where traffic is allowed consider selecting a higher mixture type.

7. For new construction, including cold inplace recycle (CIR), reclaiming, and reconstruction, specify PG XX-34 in the top 100 mm (4") of the pavement structure.

8. Designation for wear mixture placed on shoulders - Note: 3.0 % air voids. The term Wear applies to all wearing courses (mainline and shoulder).

9. Specify minimum PG 70-28 (H) for SMA mixtures. Use SMA on final wearing surface only (1.5"-2" lift).

Mixture Designation Example: **SPWEB440E**

Type	Lift	Max Agg. Size	Traffic Level (ESAL's X 10^6)	Air Voids	Binder Grade	Specialty Grade
SP	***WE***	A (SP 9.5)	2 (<1.0)	30 (3.0)	Standard Grade	Specialty Grade
SM	NW	***B (SP 12.5)***	3 (1 - 3)	***40*** (4.0)	B = PG 58 - 28	A = PG 52 -34
		C (SP 19.0)	***4*** (3 - 10)		C = PG 58 - 34	H = PG 70 - 28
		E (SMA)	5 (10 - 30)		***E = PG 64 - 28***	
			6 (SMA)		F = PG 64 - 34	
					L = PG 64 - 22	

The format for 2360 Pay Items will be as follows:

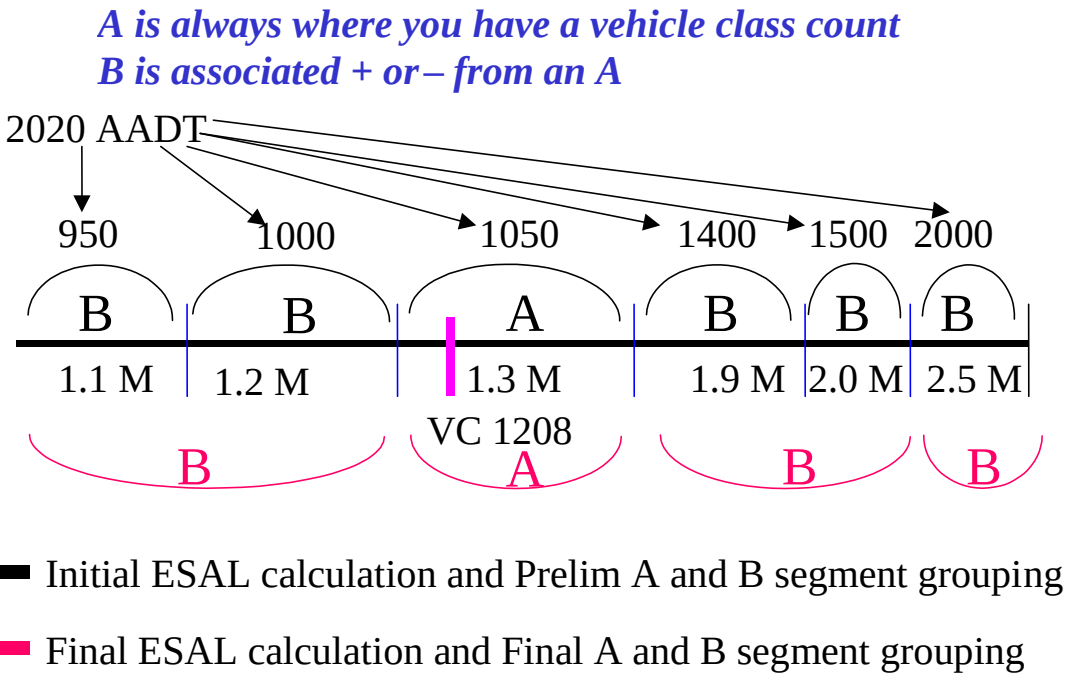
2360.501 Type SP __._ _____Course Mixture (_,_).....metric ton (English ton)

An example of the pay item for the above mixture designation is:

2360.501 Type SP**12.5 Wearing** Course Mixture (**4**,**E**).....metric ton (English ton)

Note: Number in parenthesis denotes the traffic level and the letter denotes the PG grade.

A and B Segment Concepts

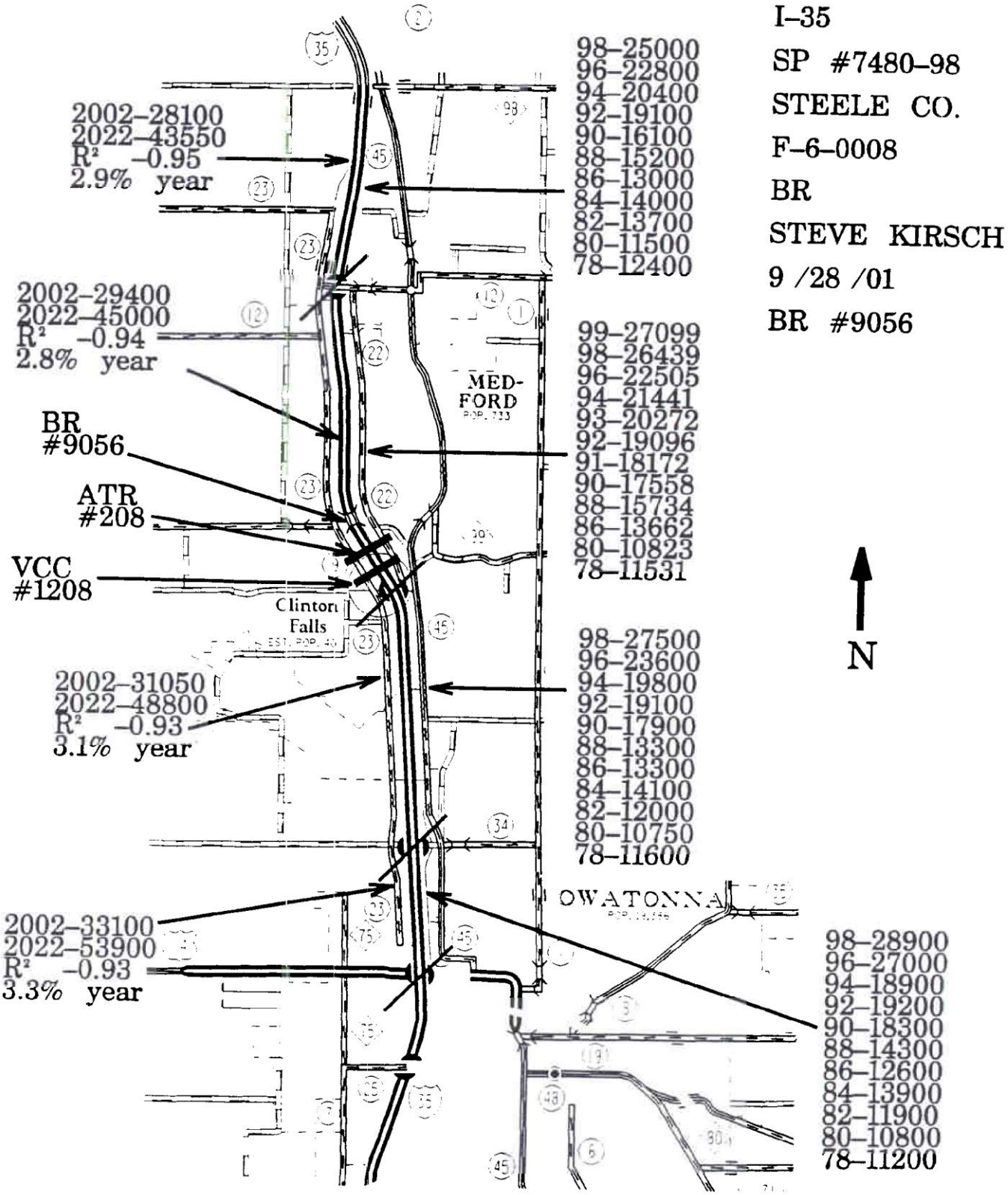


The above example shows a typical A and B segment configuration. Notice the A segment is between sets of B segments. They are all tied to the single A segment (vehicle class site 1208 – parent to child). The data is at the A segment. The B segments represent segments where vehicle class data is unknown – but where we will project ESALs based on the MnESAL spreadsheet program.

To further clarify and expand upon the A and B segment concept, the above illustration shows how a completed ESAL forecast by individual A and B segments may be represented. Our preliminary ESAL forecast results in one A and five B segments. Note that on either side of the A segment the ESALS are similar and the AADT is similar. A consistent pattern of AADT and ESALS usually occurs within parameters of each trunk highway junction and thus any large variation in AADT and ESALS within a project should (particularly B segments) should be looked at carefully.

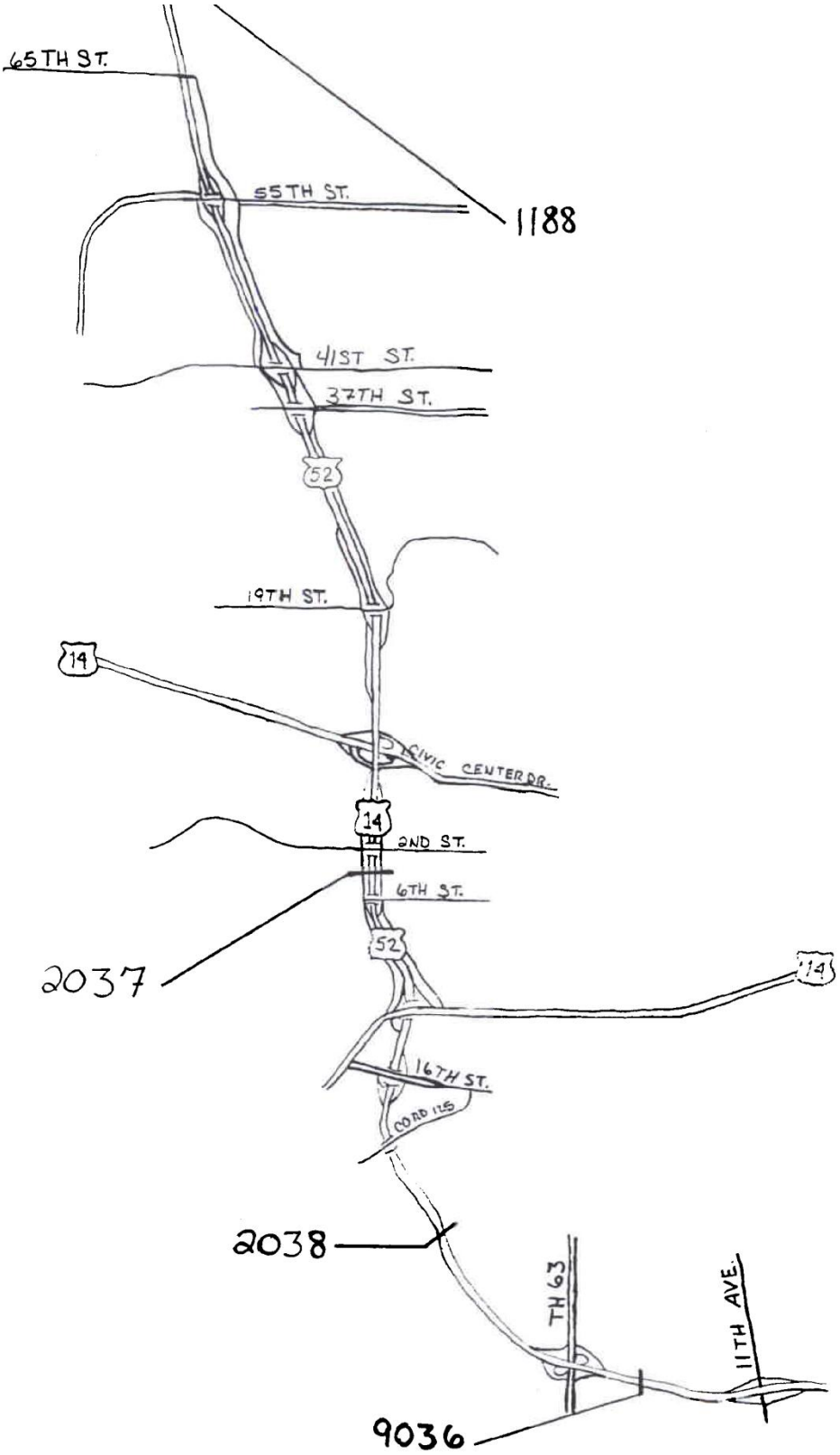
The following "computerized" sketch is an example of one A segment (VCC 1208) , three B segments and an ATR. An analysis of historical traffic data at ATR 208 should compare favorably with the historic AADT gathered from maps, CDROMS, or TDA web pages. If the forecaster has CAD or ARCVIEW experience, it may be easier to use an actual map of the project for your sketch and enhance it like the I-35 example below.

Figure 17 –Sample Sketch of I-35 Project



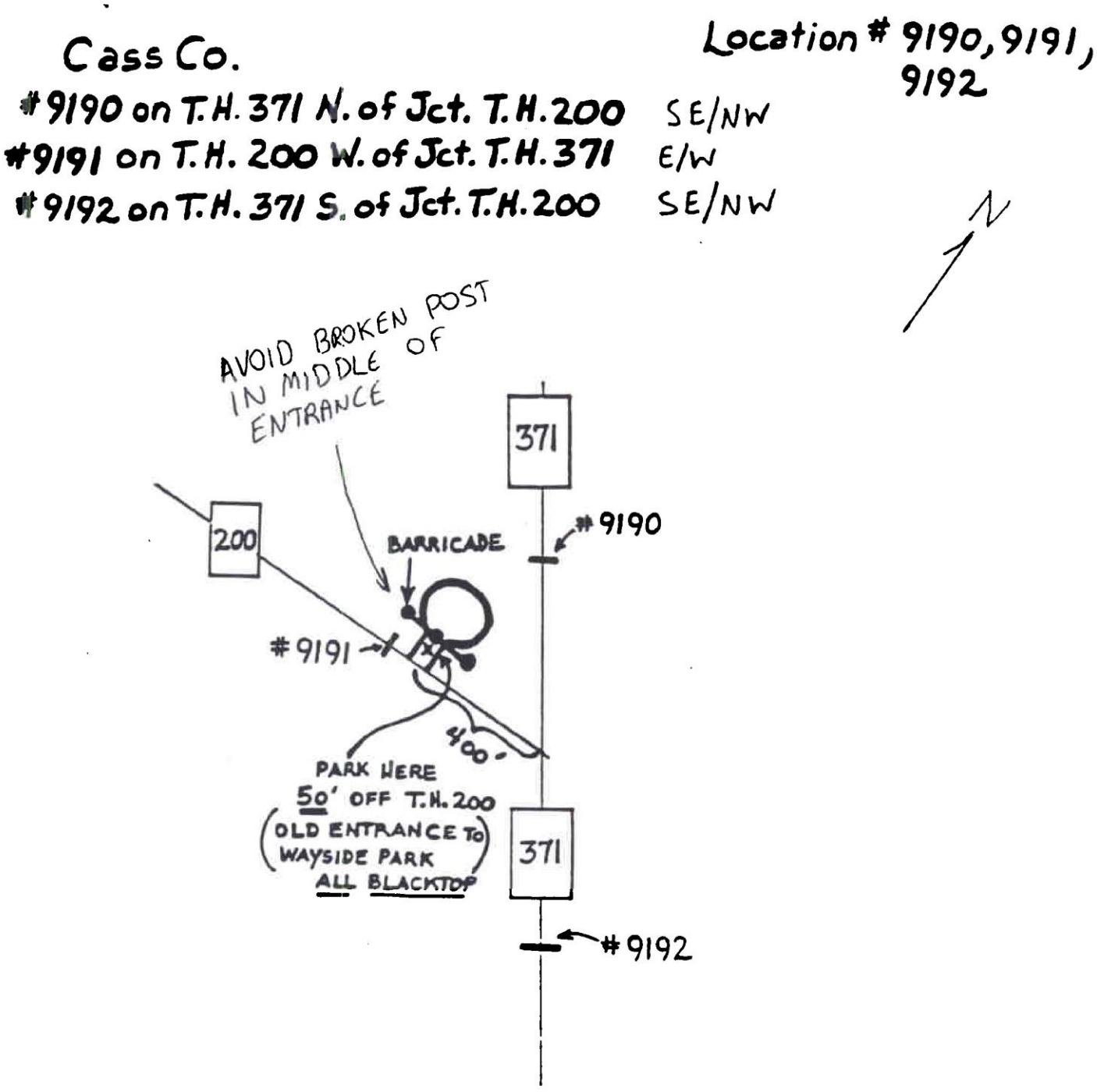
This sketch of a Rochester area project contained four vehicle class sites (four A segments) and numerous B segments. Each city street had an AADT break.

Figure 18 –Sample Sketch of TH52 in Rochester



On many traffic forecast projects it may be difficult to determine the exact location of the vehicle class site. The description will be available on your vehicle class history, but for placing on a map on a detailed project such as the one above, it may be necessary or helpful to request a map or sketch of the area. They have recently been sent out to district traffic forecasters. Below is a sample of three vehicle class sites in Cass County. The sketches are very precise and useful in determining specific locations.

Figure 19–Sample Vehicle Class Site Location Map



Rochester, TH52 Example, Modeling, 3-Legged Intersections, and Land Use

Figure 20 shows the detail that can be involved in a traffic forecast. As previously mentioned, a field trip to a project of this magnitude is recommended. The forecaster may find it handy to make a rough land use sketch of the area to judge current conditions *(figure 23).* This land use sketch shows the type of information that may be helpful as you prepare a traffic forecast.

On a more complex forecast, it may be necessary to use a combination of A segments, default B segments, and A segments with default percentages for local non trunk streets. In the Rochester forecast, historical counts had to be collected on all cross streets and expanded. This was the only way to check out the traffic volumes predicted by the Rochester traffic model.

When there are several vehicle class counts and intersecting major routes, it may be necessary to combine vehicle class counts and take the averages of two or more vehicle class sites. It is important that the forecaster look at all vehicle class percentages and numbers of trucks in a complex forecast. In many cases, there is a logical flow of trucks, and often, one vehicle class site will conflict with another. Again, counts may need to be taken to achieve consistent results.

In the Rochester forecast there were 16 different combinations of vehicle class sites or 16 A segments used as well as default (5.9% HC) percentages. If the forecast involves city streets or local roads off a mainline trunk highway, there will be instances where the forecaster will determine that the default percentages will not work. A decision may be made to use a combination of default percentages and percentages from a nearby vehicle class site if it seems that truck traffic may exit or use that particular ramp or city street.

One must be careful not to solely use traffic modeling output without carefully comparing the results to actual current counts. There is no shortcut for examining each and every road and trunk highway that intersects with a project and collecting all the historic data available. Once again, the data collection phase of an ESAL and traffic forecast is the most important aspect of the process.

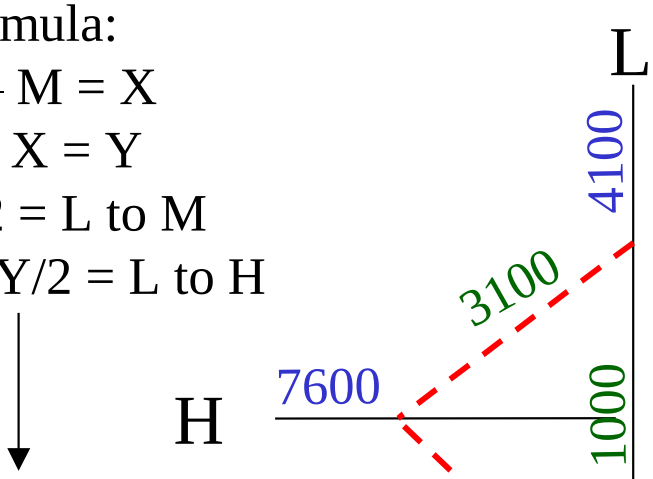
Figure 22 will assist the forecaster in calculating turns on a 3-legged intersection where two legs are known. This will assist in distributing AADT and HCAADT and estimating traffic flows. If the forecaster has heavy commercial volumes at three trunk highway junctions, this method will help determine the direction of the volumes. It is also a way to "calibrate" or verify truck percentages if, for example, the forecaster has vehicle class data at two junctions and wants to determine the heavy truck movements.

During a complicated forecast such as the Rochester TH52 example, the three legged technique was used to determine truck flow from vehicle class sites on TH14 west of TH52, TH14 east of TH52, TH14/TH52 south of north junction TH14, and TH52 south of south junction TH14. There may be occasions when the forecaster may use several average vehicle class count worksheets. This makes analyzing truck flow patterns more complicated. Then, the forecaster may use 3-legged technique to determine truck flow.

Figure 20 -Sample of a 3 legged intersection

Formula:

1 H – M = X
2 L – X = Y
3 Y/2 = L to M
4 X+Y/2 = L to H



H

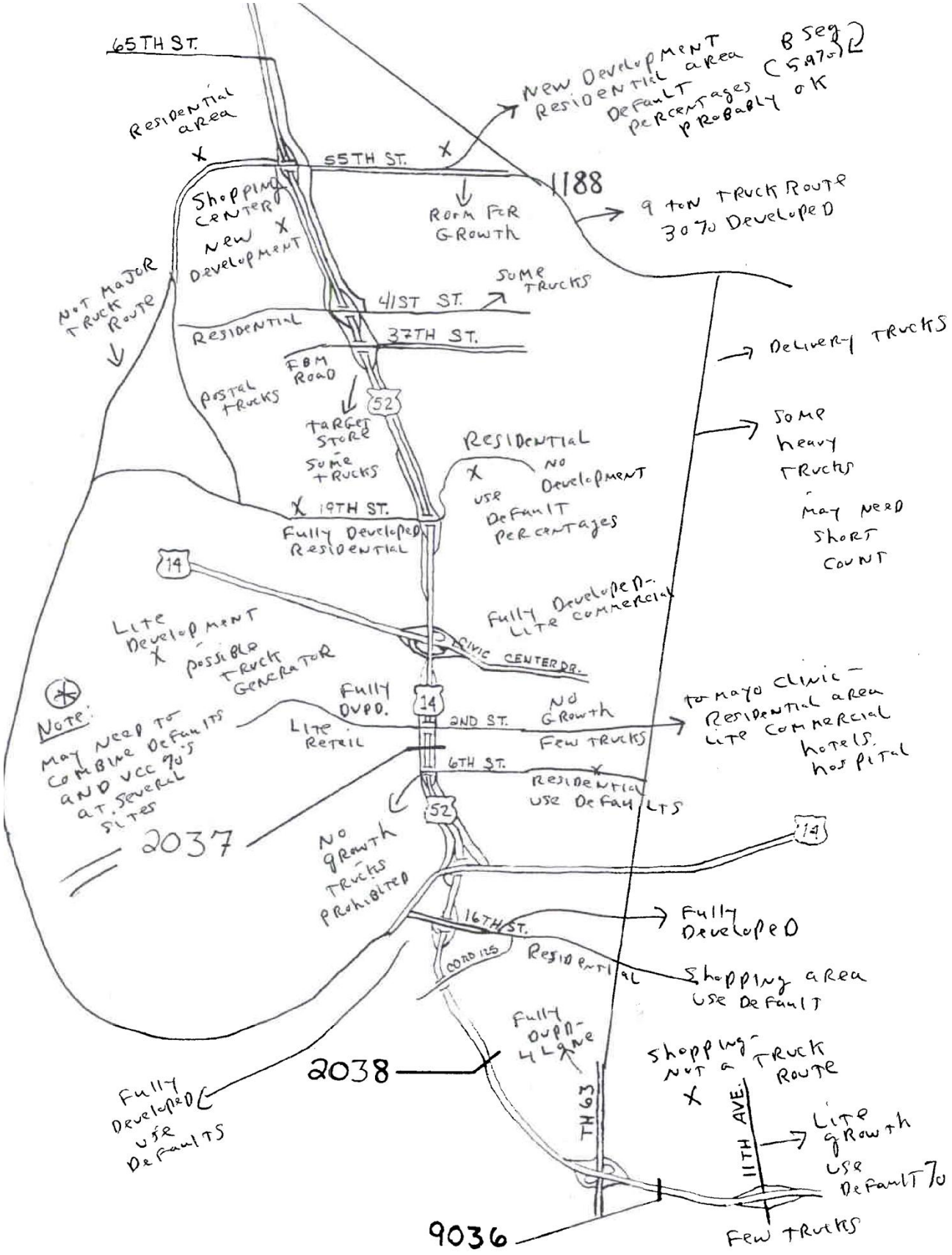
1 7600-5500=2100
2 4100-2100=2000
3 2000/2=1000
4 2100+1000 = 3100

H = High volume
L = Low volume
M = Medium volume

Unknown turns
5500 Given
3100 From formula
4500 Calculated by default

The schematic drawing below illustrates the type of information the forecaster should know on most projects. In general, a drive along the project route and connecting local roads will prove invaluable. Existing land use information will help the forecaster in determining the nature of the affected areas. A determination whether the project contains residential land, commercial property, strip malls, truck stations, open space for development, likely truck routes, etc. will be extremely helpful to the forecaster.

Figure 21 –TH52 Rochester Land Use Sketch



Traffic Trends and Hourly Distribution – Cars and Trucks

The following historical charts and tables should assist the traffic forecaster in the data collection phase of the process. The next four charts and tables show the following: About 90% of the total traffic in the 24 hour period occurs during the 6:00 A.M. to 10:00P.M. time- frame, (hours covered in a typical 16 hr manual vehicle class count.) The next chart shows the percent each hour is of the raw 16-hour count for cars and trucks (discussed previously in this report). Additional trend data can be found in the appendix.

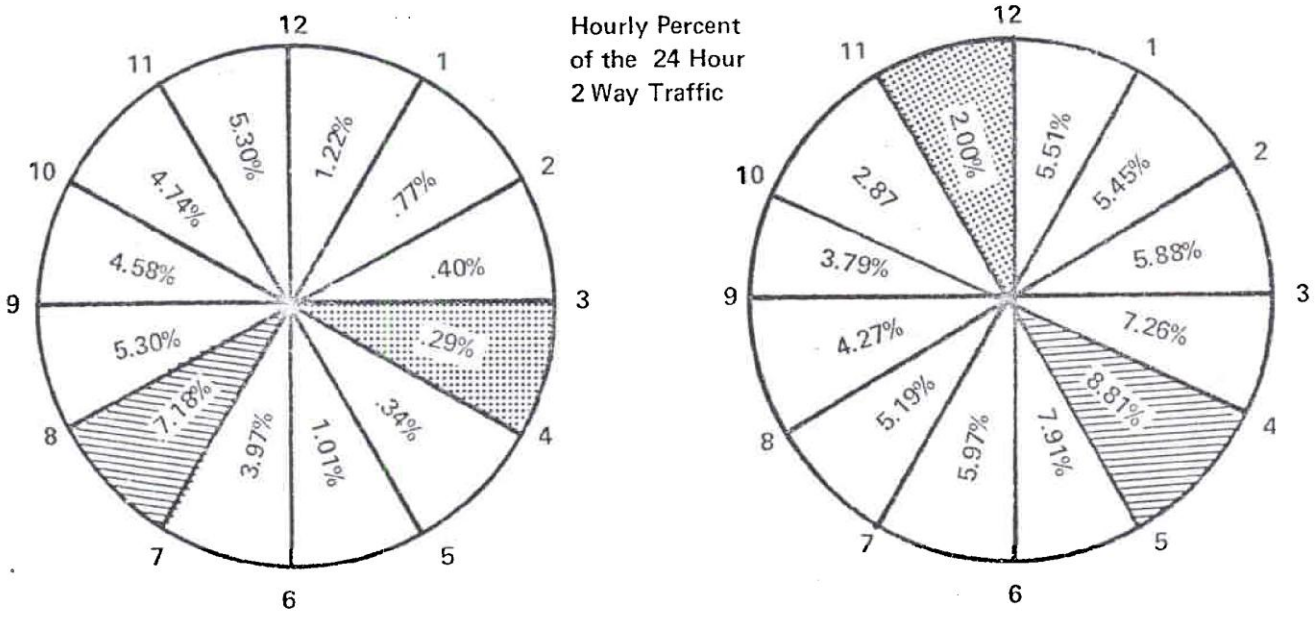
Figure 22 – Historic Traffic Trends –Metro Area

In examining traffic patterns in the seven county twin cities metropolitan area, certain trends in hourly vehicle travel emerged. This issue deals with another trend associated with the movement of people and goods, namely hourly distribution of total traffic.

In 1981, a total of 1,840 locations were analyzed with a total 24 hour vehicle count of 16,289,870 broken down into hourly totals. These 1,840 locations were distributed by county within the metro area for the following counties:

County	Number of Sites Sampled
Anoka	180
Carver	68
Dakota	335
Hennepin	371
Ramsey	628
Scott	56
Washington	202
Total	1,840

The percent of total 2- way traffic is fairly constant on an hour by hour basis for each county. For example, the charts presented below portray the seven county average hourly vehicle percent breakdown for the 24 hour period.



TWIN CITIES SEVEN COUNTY METRO AREA

HOURLY NONDIRECTIONAL DISTRIBUTION OF TOTAL TRAFFIC BY PERCENT

HOUR	ANOKA	CARVER	DAKOTA	HENN.	RAMSEY	SCOTT	WASH.	TOTAL	
12-1A	1.29	1.12	1.28	1.11	1.30	1.25	1.21	1.22	
1-2	.79	.76	.82	.69	.82	.77	.74	.77	
2-3	.45	.44	.44	.34	.40	.54	.48	.40	
3-4	.34	.44	.34	.25	.26	.52	.31	.29	
4-5	.42	.45	.41	.30	.28	.63	.38	.34	
5-6	1.38	1.42	1.06	.98	.81	1.52	1.07	1.01	
6-7	5.07	4.57	3.98	4.16	3.31	4.45	4.02	3.97	
7-8	6.95	6.33	6.91	7.55	7.16	5.94	6.99	7.18	A.M. PEAK
8-9	4.72	5.23	5.26	5.74	5.10	5.39	5.02	5.30	
9-10	4.42	5.47	4.74	4.72	4.31	5.51	4.55	4.58	
10-11	4.57	5.58	4.94	4.70	4.62	5.58	4.83	4.47	
11-12N	4.95	5.61	5.40	5.25	5.40	5.51	5.21	5.30	
12-1	5.13	5.40	5.64	5.38	5.75	5.44	5.39	5.51	
1-2	5.18	5.81	5.57	5.37	5.57	5.44	5.32	5.45	
2-3	5.77	6.02	5.88	5.78	6.00	6.11	5.95	5.88	
3-4	7.22	7.00	7.09	7.25	7.44	7.11	6.98	7.26	
4-5	8.85	8.42	8.36	8.63	9.26	8.42	8.79	8.81	P.M. PEAK
5-6	7.92	7.38	7.70	8.09	7.88	7.35	7.85	7.91	
6-7	6.16	5.61	5.97	6.04	5.86	5.85	6.03	5.97	
7-8	5.13	4.66	5.20	5.12	5.30	4.92	5.26	5.19	
8-9	4.39	3.95	4.35	4.11	4.35	4.11	4.48	4.27	
9-10	3.99	3.61	3.80	3.73	3.82	3.28	3.89	3.79	
10-11	2.95	2.79	2.84	2.78	2.93	2.64	3.06	2.87	
11-12P	1.95	1.97	2.02	1.92	2.08	1.71	2.18	2.00	
TOTAL	99.99	100.04	100.00	99.99	100.01	99.99	99.99	100.01	
SITES	180	68	335	371	628	56	202	1840	
6A-10P-16	90.42	90.65	90.79	91.62	91.13	90.41	90.56	91.11	
6A-6P-12	70.75	72.82	71.47	72.62	71.80	72.25	70.90	71.89	
6A-9A-3	16.74	16.13	16.15	17.45	15.57	15.78	16.03	16.45	
3P-6P-3	23.99	22.80	23.15	23.97	24.58	22.88	23.62	23.98	
HIGH CONSECUTIVE 8 HOURS	51.36	51.25	51.61	51.79	53.16	51.23	51.57	52.09	
4-6PM HIGH 2	16.77	15.08	16.06	16.72	17.14	15.77	16.64	16.72	

The consistency of county wide traffic volumes becomes evident in examining the percent totals by hourly groupings for each of the seven counties.

The main conclusion drawn is that roughly 90% of the total traffic in the 24 hour period occurs during the 6:00 A.M. to 10:00 P.M. time frame.

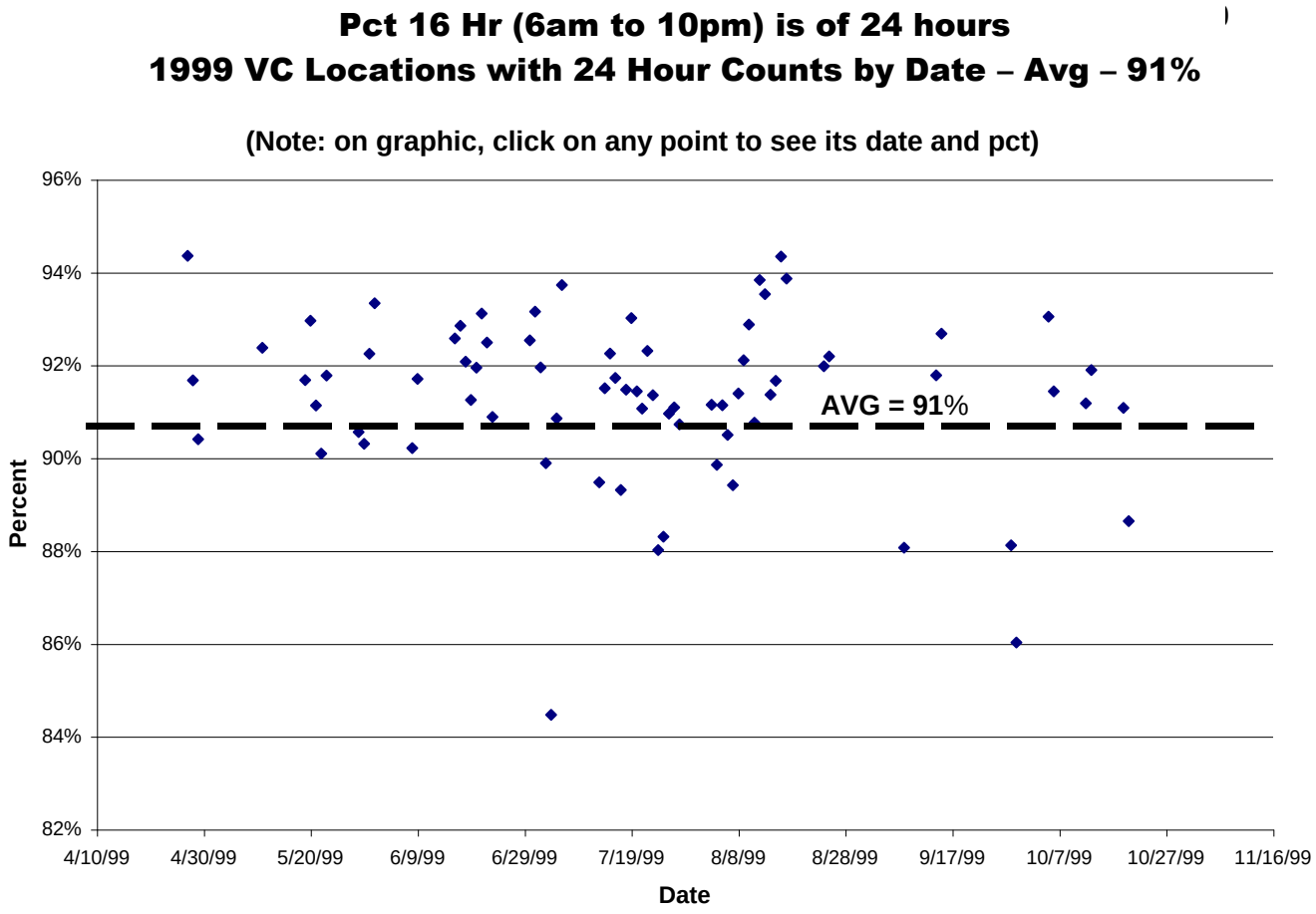
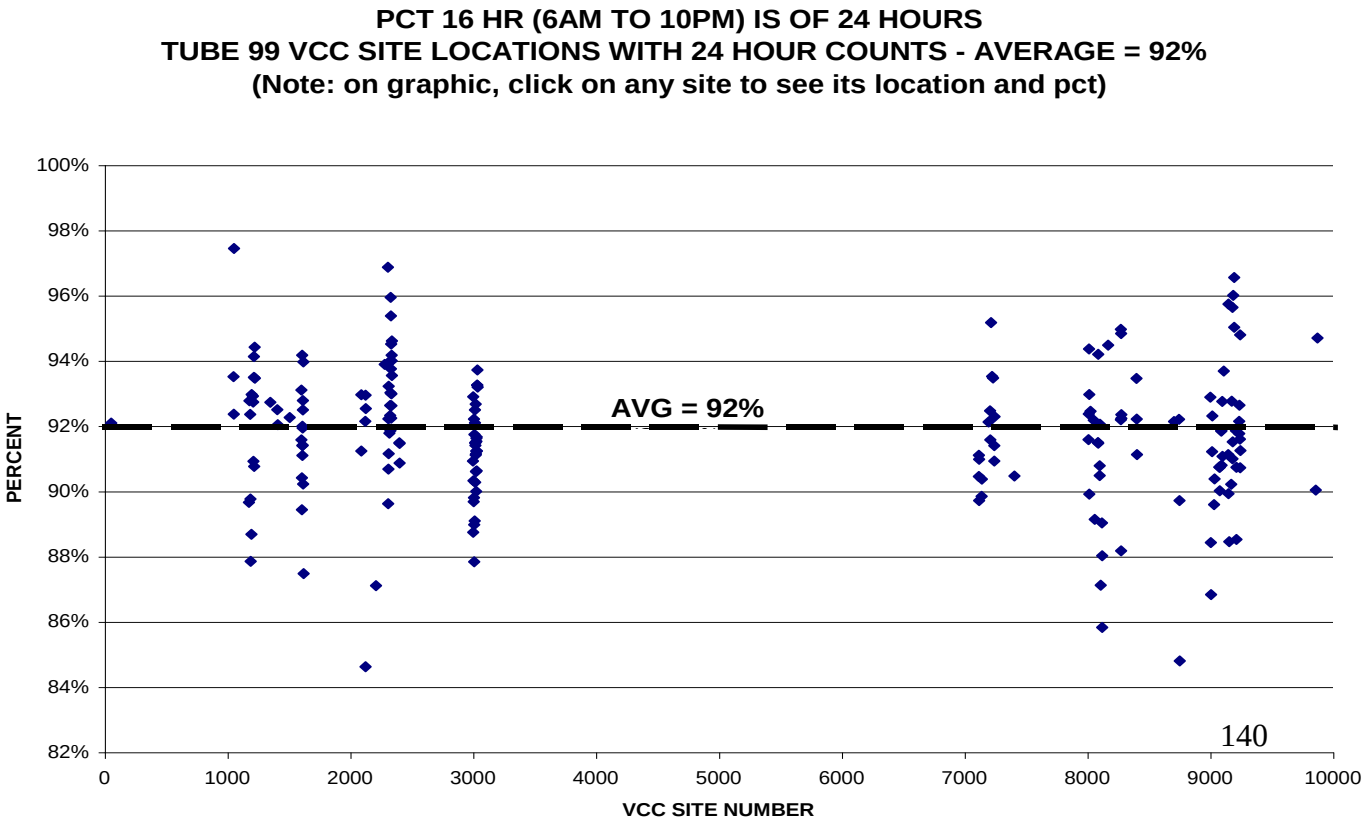


Figure 23 – % 16 Hours of 24 Hours by Date & AADT



As previously discussed, in taking a short count, the forecaster could use this guideline in expanding short counts to 16 hour raw counts.

Figure 24 – Percent 16 Hours of 24 Hours –Cars & Trucks

Percentage each hour is of raw 16 hour counts – Trucks and Cars – based on 1999 vehicle classification study

Trucks		Cars	
• 6-7am	5.1%	• 6-7am	6.0%
• 7-8	5.9	• 7-8	7.2
• 8-9	8.2	• 8-9	5.9
• 9-10	8.8	• 9-10	5.4
• 10-11	8.8	• 10-11	5.4
• 11-noon	8.6	• 11-noon	5.9
• 12-1pm	8.4	• 12-1pm	6.2
• 1-2	8.9	• 1-2	6.5
• 2-3	8.4	• 2-3	6.7
• 3-4	6.8	• 3-4	8.1
• 4-5	5.6	• 4-5	8.6
• 5-6	4.6	• 5-6	8.4
• 6-7	3.9	• 6-7	6.8
• 7-8	3.0	• 7-8	4.9
• 8-9	2.6	• 8-9	4.1
• 9-10	2.3	• 9-10	3.6

Default Heavy Commercial Percents and County Forecasts

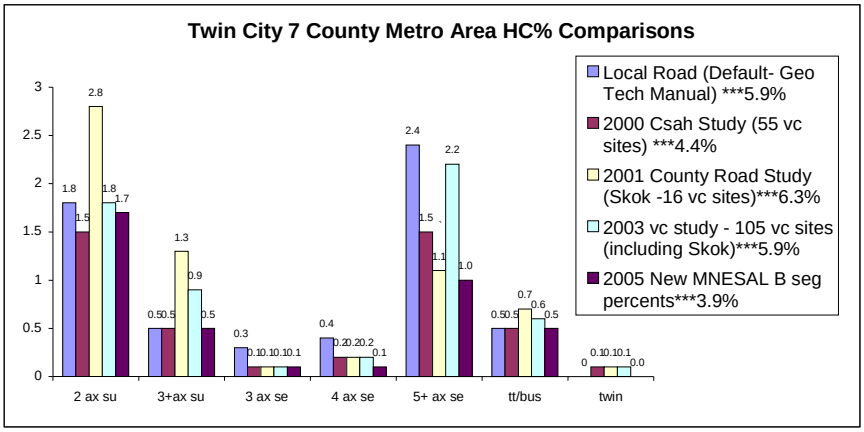
In our previous discussions regarding default percentages currently in use on the B segment, it has been noted that defaults are used when nothing else is known. The 5.9% heavy commercial number that was in use for years has been changed. As of 2011 we use an urban percentage of ***3.6%*** and a rural percentage of ***10.1%.*** The following chart shows a variety of past studies and their heavy commercial percents. The previous percentages for the B segment are shown in the last row.

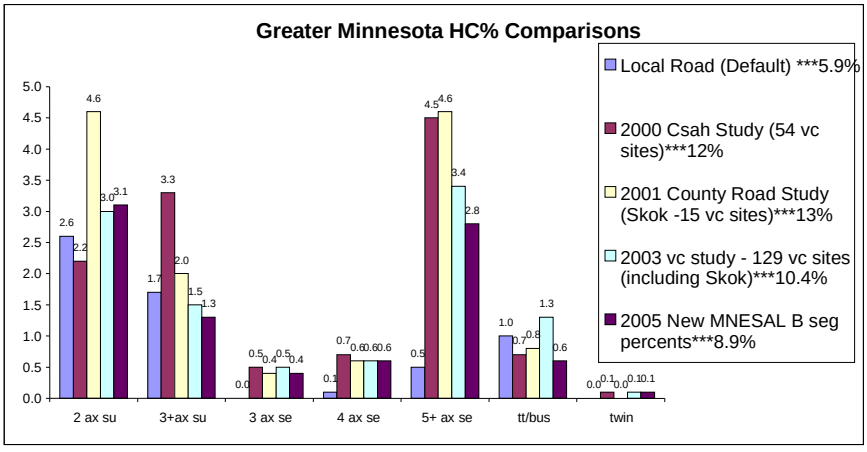
Figure 25 – Historical Heavy Commercial Percent Comparisons

County Heavy Commercial Percent Studies Comparison
Average expanded non TH counts (CSAH, CR, Local VC sites)

TWIN CITIES 7 COUNTY METRO AREA	2 ax su	3+ax su	3 ax se	4 ax se	5+ ax se	tt/bus	twin	hc %
Local Road (Default- Geo Tech Manual) *** 5.9%	1.8	0.5	0.3	0.4	2.4	0.5	0	5.9
2000 Csah Study (55 vc sites) *** 4.4%	1.5	0.5	0.1	0.2	1.5	0.5	0.1	4.4
2001 County Road Study (Skok -16 vc sites)*** 6.3%	2.8	1.3	0.1	0.2	1.1	0.7	0.1	6.3
2003 vc study - 105 vc sites (including Skok)*** 5.9%	1.8	0.9	0.1	0.2	2.2	0.6	0.1	5.9
2005 New MNESAL B seg percents*** 3.9%	1.7	0.5	0.1	0.1	1.0	0.5	0	3.9

GREATER MINNESOTA	2 ax su	3+ax su	3 ax se	4 ax se	5+ ax se	tt/bus	twin	hc %
Local Road (Default) *** 5.9%	2.6	1.7	0.0	0.1	0.5	1.0	0.0	5.9
2000 Csah Study (54 vc sites)*** 12%	2.2	3.3	0.5	0.7	4.5	0.7	0.1	12.0
2001 County Road Study (Skok -15 vc sites)*** 13%	4.6	2.0	0.4	0.6	4.6	0.8	0.0	13.0
2003 vc study - 129 vc sites (including Skok)*** 10.4%	3.0	1.5	0.5	0.6	3.4	1.3	0.1	10.4
2005 New MNESAL B seg percents*** 8.9%	3.1	1.3	0.4	0.6	2.8	0.6	0.1	8.9





In preparation of county forecasts, some counties have used various defaults and some have used various percents, some from the Geo-technical and Pavement Manual. Different studies undertaken by the Traffic Forecast Section show the variability of local road heavy commercial percents In all previous studies, Greater Minnesota has higher default truck percentages than Metro (obviously, this is affected by the higher AADT and subsequent lower truck percentages in the Metro area)

It also appears that the percentage of 5 axle semis has been underestimated in both Metro and Greater Minnesota. The best policy is to perform a vehicle classification count on the road segment with unknown heavy commercial truck volumes. In addition, counts taken during harvest time on county roads can have inflated ESALS for that time period. The seasonal results have to be tempered with AADT and HCAADT.

The chart below shows results of 22 county forecasts and the resultant total heavy commercial percent by our 8 categories (see total in far right column). There are wide swings in heavy commercial percents, often swayed by counts during harvest versus non-harvest time.

Figure 26 – County Forecasts Heavy Commercial Percents

County	Route	Description	2 ASU	3+ ASU	3 A Semi	4 A Semi	5+ A Semi	TT/Bus	Twins	Total
RAMSEY	CSAH59	CRF TO CSAH96	1.57%	0.14%	0.09%	0.16%	0.12%	0.28%	0.01%	2.37%
RAMSEY	CSAH49	CSAH96 TO BIRCH LANE S	1.43%	0.21%	0.04%	0.07%	0.20%	0.54%	0.01%	2.50%
RAMSEY	CSAH96	CSAH51(LEXINGTON) TO TH10	2.34%	0.63%	0.08%	0.14%	0.34%	0.65%	0.03%	4.21%
RAMSEY	CENTURY AVENUE	LAKE ROAD TO LOWER AFTON	1.52%	0.87%	0.03%	0.07%	0.17%	0.38%	0.01%	3.05%
RAMSEY	CRF (CSAH12)	TH61 TO BELLAIRE AVENUE	1.94%	0.11%	0.04%	0.07%	0.03%	0.26%	0.01%	2.46%
RAMSEY	CSAH19 (CRD)	CLEVELAND TO FAIRVIEW	1.24%	0.54%	0.08%	0.15%	0.56%	0.36%	0.01%	2.94%
RAMSEY	CRI (CSAH3)	SHUTTA RD TO LEXINGTON	1.27%	0.11%	0.03%	0.05%	0.08%	0.56%	0.00%	2.10%
RAMSEY	CRI (CSAH3)	SHUTTA RD TO LEXINGTON	0.93%	0.09%	0.01%	0.02%	0.05%	0.38%	0.00%	1.48%
PENNINGTON	CSAH27/CSAH2	TH1 TO TH92	6.33%	0.67%	0.67%	1.33%	8.83%	1.17%	0.00%	19.00%
PENNINGTON	CSAH27/CSAH2	TH1 TO TH92	5.13%	0.50%	0.38%	0.63%	6.13%	1.00%	0.00%	13.77%
MARSHALL	CSAH54/CSAH28	TH89 TO TH1	4.63%	0.88%	0.50%	0.88%	7.50%	1.25%	0.00%	15.64%
CARVER	CSAH20	WATERTOWN TO HENN. CO. LINE	2.98%	0.73%	0.14%	0.24%	0.41%	0.56%	0.00%	5.06%
CARVER	CSAH10	CSAH11 TO TH5 IN WACONIA	3.47%	2.22%	0.12%	0.20%	1.43%	0.55%	0.11%	8.10%
CARVER	CSAH10	CSAH11 TO TH5 IN WACONIA	3.97%	1.58%	0.16%	0.29%	1.32%	0.68%	0.08%	8.08%
CARVER	CSAH18	TH41 TO CSAH101	3.33%	1.00%	0.11%	0.18%	0.30%	1.00%	0.09%	6.01%
CARVER	CSAH11	CSAH10 TO TH5	6.12%	5.40%	0.17%	0.31%	4.36%	1.79%	0.40%	18.55%
CARVER	CSAH11	CSAH10 TO TH5	2.90%	3.50%	0.10%	0.10%	2.50%	1.10%	0.20%	10.40%
CARVER	CSAH33	TH7 TO N. CO LINE	5.40%	1.67%	0.23%	0.40%	2.58%	0.88%	0.02%	11.18%
CARVER	CSAH33	TH7 TO N. CO LINE	4.66%	2.00%	0.20%	0.34%	2.59%	0.68%	0.05%	10.52%
OLMSTED	CR104	CR117 TO TH14	7.29%	3.06%	0.24%	0.35%	1.29%	0.82%	0.24%	13.29%
OLMSTED	CR117	TH30 TO N JCT CR117/CR104	4.57%	0.57%	0.00%	0.00%	2.29%	1.14%	0.00%	8.57%
WRIGHT	CSAH12	TH12 TO TH25	4.93%	7.17%	0.27%	0.43%	1.90%	1.23%	0.03%	15.96%
WRIGHT	CSAH12	TH12 TO TH25	2.79%	1.07%	0.07%	0.12%	0.79%	0.74%	0.02%	5.60%
CHIPPEWA	CSAH6	TH7 TO TH29	4.00%	1.33%	0.59%	1.11%	7.48%	0.44%	0.00%	14.95%
CHIPPEWA	CSAH6	TH7 TO TH29	6.44%	4.30%	0.67%	1.19%	12.81%	0.44%	0.00%	25.85%
CHIPPEWA	CSAH15/CSAH20	WEST CO LINE TO TH7	3.85%	0.31%	0.15%	0.31%	0.92%	0.15%	0.00%	5.69%
CHIPPEWA	CSAH15/CSAH20	WEST CO LINE TO TH7	2.90%	0.52%	0.19%	0.32%	2.58%	0.19%	0.06%	6.76%
CHIPPEWA	CR38	CR5 TO TH23	3.60%	1.07%	0.13%	0.27%	0.93%	0.73%	0.00%	6.73%
CHIPPEWA	CSAH10	TH40 TO N CO LINE	3.44%	2.15%	0.43%	0.86%	6.67%	0.43%	0.00%	13.98%
CHIPPEWA	CSAH4	TH23 TO TH7	2.95%	4.63%	0.74%	1.16%	3.16%	0.63%	0.00%	13.27%
CHIPPEWA	CSAH4	TH23 TO TH7	5.47%	1.21%	0.37%	0.68%	5.11%	1.89%	0.21%	14.94%

TRAFFIC MONITORING PROGRAM OVERVIEW

Traffic Volume Program Overview (as of 2010)

- Traffic Volume information is used for many purposes:
  - Statewide estimation of annual Vehicle Miles Traveled (VMT)
  - Annual reporting of VMT and AADT estimates to the Federal Highway Administration (FHWA) for use in Federal level travel analysis and determination of funds.
  - Traffic volume data is used in the formula for annual allocation of state funds for roadway maintenance and construction on the County and Municipal State Aid road system.
  - Providing information to help facilitate decision making for planners, engineers, forecasters, businesses, and the general public.
- The Traffic Monitoring Program produces AADT estimates for approximately 33,000 count locations.
  - 4,500 on Trunk Highways
  - 13,500 on County State Aid Highways
  - 6,500 on County Roads
  - 8,500 on Municipal State Aid Roads
- There are several methods used to collect Traffic Data:
  - Short Duration Counts (48 hours)
    - 32,500+ total volume sites
      - Collects traffic volumes
      - Majority of locations
    - 1,200+ Vehicle Classification sites
      - Collects traffic volumes and categorizes by vehicle type
    - 20 + in-pavement sensors
      - Collects traffic volumes
  - Automatic Traffic Recorder-ATR (Continuous)
    - 29 + with Piezos
      - Collects vehicle type, speed and volume
    - 49 + with Loops
      - Collects traffic volumes
  - Weigh in Motion System -WIM (Continuous)
    - 10 + sites
      - Collects vehicle weight, type, speed and volume
  - Regional Traffic Management Center-RTMC Total Volume (Continuous)
    - 240 + annual duration vehicle counts
      - Primary purpose is traffic management
      - Data is stored, processed and converted to an AADT
- The majority of traffic data is collected by Mn/DOT District staff, but some Counties and Cities, especially in the Metro, submit their own count data.

- Approximately ½ of the Trunk Highway locations and ¼ of the Local System locations are counted each year (see Traffic Counting Schedule).
- Most traffic counting occurs between April and October of each year. The Official Traffic Volume Maps are then posted to the web the following spring.

Traffic Counting Schedule (as of 2010)

Greater Minnesota

- Approximately ½ of the Trunk Highway locations and ¼ of the Local System locations are counted each year. This results in all Counties in Greater Minnesota having their Trunk Highways counted every two years and Local System Roads every four years.
    - Trunk Highways are major roadways such as Interstates, US Trunk Highways, and State Trunk Highways.
    - Local System Roads are any other roadway designated as a CSAH (County State Aid Highway), CR (County Road), or MSAS (Municipal State Aid Street).
    - Starting in 2010 most County Roads will be counted on a 12 year cycle.
- In 2008 a new traffic counting schedule was approved. The purpose of this effort was to evenly distribute the number, and location of the Counties being counted in each year or "cycle."
- **New 2008 Traffic Counting Schedule**
    - A given County will have **both** the Local System Roads and Trunks counted in the "cycle" or year under which it is listed.
    - This same County will have **only** its Trunks counted in the "off cycle" or "in between year."
    - Example: Aitkin County is in Cycle 3. Therefore, in 2008 both Trunk and Local System counts are scheduled. Then in 2010, or the "off cycle," Aitkin County will have only the Trunk Highways counted.
    - Off Cycle Cities
        - In addition to counting in "on cycle" years, the Cities of Northfield, Rochester, Sartell, and St. Cloud count their MSAS routes themselves in "off cycle" years
- **Pre-2008 Traffic Counting Schedule**
    - Trunk Highways were counted every two years on the even years in all Counties in Greater Minnesota.
    - A given County had its Local System Roads counted in the year under which it is listed.

Metro (Anoka, Carver, Dakota, Hennepin, Ramsay, Scott, Washington)

- Trunk Highways are counted over a two year period and information is published in the even years.
- CSAH and CR counts are provided by the Counties and the information is published in the odd years.
- MSAS counts are provided by the Municipalities and the information is published every two or four years according to the "Metro Municipal Traffic Counting Schedule"

2008 NEW TRAFFIC COUNTING SCHEDULE

Cycle 1: 2006, 2010, 2014, 2018 + Cycle 3 Off Cycle Trunks

4-Beltrami	34-Kandiyohi	63-Red Lake
8-Brown	38-Lake	67-Rock
9-Carlton	42-Lyon	71-Sherburne
16-Cook	45-Marshall	72-Sibley
21-Douglas	46-Martin	77-Todd
26-Grant	48-Mille Lacs	79-Wabasha
33-Kanabec	55-Olmsted	84-Wilkin

Cycle 2: 2007, 2011, 2015, 2019 + Cycle 4 Off Cycle Trunks

5-Benton	39-Lake of the Woods	61-Pope
11-Cass	47-Meeker	64-Redwood
15-Clearwater	52-Nicollet	65-Renville
18-Crow Wing	53-Nobles	69-St. Louis
22-Faribault	56-Otter Tail	74-Steele
25-Goodhue	57-Pennington	85-Winona

Cycle 3: 2008, 2012, 2016, 2020 + Cycle 1 Off Cycle Trunks

1-Aitkin	32-Jackson	59-Pipestone
3-Becker	36-Koochiching	66-Rice
6-Big Stone	37-Lac Qui Parle	68-Roseau
12-Chippewa	41-Lincoln	78-Traverse
17-Cottonwood	44-Mahnomen	80-Wadena
28-Houston	50-Mower	81-Waseca
29-Hubbard	54-Norman	83-Watonwan
30-Isanti	58-Pine	86-Wright

Cycle 4: 2009, 2013, 2017, 2021 + Cycle 2 Off Cycle Trunks

7-Blue Earth	31-Itasca	60-Polk
13-Chisago	35-Kittson	73-Stearns
14-Clay	40-LeSueur	75-Stevens
20-Dodge	43-McLeod	76-Swift
23-Fillmore	49-Morrison	87-Yellow Medicine
24-Freeborn	51-Murray	

Observations Based on Analysis of 5 Axle Semi Data from Mn/DOT's WIM sites

1. Vehicle Class
    a. The highest volume routes, which are generally the Interstate, show the least amount of seasonal variation in volume.
    b. Lower volume routes have a higher degree of variability and seasonal patterns.
    c. Truck volumes continue to increase. Growth rates have been difficult to estimate because of discontinuance of the use of bending plate sensors in the late 1990's..
    d. Truckers will avoid permanent enforcement stations. A significant number of trucks take another route to avoid the St. Croix Weigh Station.

2. Weight
    a. Weights do not appear to have increased between 1992 and 1997 but may have increased somewhat from 1997 to 2005.
    b. Weights are quite often similar from one year to another at a given site
    c. Post 1997 information is limited because of removal of all ending plate weight sensors in Minnesota. Five new quartz sensor-equipped sites have been placed since 2002 and more are planned for the future.

3. Thoughts about the future
    a. Annual total ESALS may continue to increase. This is due to increasing numbers of trucks and, to some extent, increasing weights of trucks.
    b. If truck weights were to increase, it would probably mean that more empty or partially loaded trucks were finding additional weight to carry. It would probably not mean that those that were already fully loaded were taking on an even greater load.
    c. Because of the repeatability of truck volumes and weights, we could collect data for one week in each season of the year and in most cases have a good handle on vehicle class and weight, if good portable WIM equipment were available.
    d. We may want to consider having some WIM sites operate continuously for many years to monitor trends in volume and weight
    e. The weights/ESAL factors that we see at each site are dependent on the mix of body type and the loads they are carrying (stating the obvious). Figuring this out for those sites where we do not have WIM is often a challenge.

Figure 27– Traffic Forecast Personnel Roster

TRAFFIC FORECASTING CONTACTS 2/21/2012

DISTRICT	CONTACTS/FORECASTER	LOCATION	PHONE	FAX
1	JAMES MILES	DULUTH TRAFFIC - MS 010	218-725-2789	218-725-2817
2	STACI CANN JAMES BITTMAN	MATERIALS -MS 020 BEMIDJI	218-755-6541 218-755-6543	218-755-6531 218-755-6512
3	GERRY BUSCHER CHAD DEMENGE DARREN NELSON	BRAINERD SOILS - MS 030	218-828-5751 218-828-5800 218-828-5749	218-828-5815
4	BRUCE BRYNGELSON SARA MANINGA	DETROIT LAKES MATERIALS -MS 040	218-846-3614 218-846-3659	218-846-7984
6	TRACY SCHNELL	ROCHESTER MS 060	507-286-7599	507-285-7279
7	DEBRA YATES SCOTT THOMPSON	MANKATO TRAFFIC - MS 070	507-304-6197 507-304-6156	507-304-6119
8	MIKE LOWNSBURY	WILLMAR MS 080	320-214-6397	320-231-6305
METRO DIVISION	JIM HENRICKSEN MICHAEL CORBETT	METRO PLANNING MS 050	651-234-7782 651-234-7793	651-234-7786
TRANSP. DATA AND ANALYSIS	TOM NELSON MARK LEVENSON GENE HICKS	300 N TRAFFIC FORECASTING AND ANALYSIS MS 450	651-366-3868 651-366-3862 651-366-3856 651-366-3856	651-366-3886

Figure 28– TDA Personnel and Phone Numbers

TELEPHONE NUMBERS
TRANSPORTATION DATA AND ANALYSIS
** MAIL STOP 450**
GENERAL INFORMATION NUMBER 366-3888
FAX NUMBER 366-3886

April 2, 2012

ADMINSTRATION

Isackson, Cassandra- Office Director	366-3882
Cell Phone	651-331-1693
Kyne, Josephine	366-3871
Stein, Jocelyn	366 3854
Tsimikas, Paul	366-3864

GEOGRAPHIC INFO & MAPPING

Saholt, Jeff- Section Director	366-3885
Gahr, Bill (part time)	366-3850
Hamann, Gus	366-3853
Lanoux, Bill	366-3861
Sanda, Amy	366-3842
Schlosser, Richard (part time)	366-3875
Tschida, Andrew	366-3890

DATA SYSTEMS & COORDINATION

Morey, Peter- Section Director	366-3872
Basney, Todd	366-3841
Carlson, Chuck	366-3843
Chen, Miin	366-3845
Companion, Carole	366-3846
Delisi, Chuck	366-3848
Hesselroth, Denise	366-3852
Kuhn, Josh	366-3884
Patnode, Scott	366-3870
Pearson, Jesse	366-3881
Rockwood, Amelia	366-3873
Schlegal, Lynna	366-3874
Trcka, Andy	366-3877
Featherstone, Luke	366-3858
Her, Tongkou	366-3875
Wade, Malcolm	366-3847
Wilm, John (shared w/WIM)	366-3876
Wolbeck, Bob	366-3880

WEIGH DATA & EGINEERING COORDINATION

Timerson, Ben- Section Director	366-3855
Moir, Bruce	366-3865
Novak, Mark	366-3869
Wilm, John (shared w/ DSC)	366-3876

TRAFFIC FORECASTING & ANALYSIS

Hicks, Gene- Section Director	366-3856
Flinner, Mark	366-3849
Forbes, Megan	366-3883
Holasek, Tarin	366-3857
Levenson, Mark (part time)	366-3862
Merrill, Michael	366-3863
McGrath, Shannon	366-3878
Nelson, Tom	366-3868
Prentice, Christy	366-3844
Ramic, Almin	366-3858
Wei, Chu	366-3851

MISCELLANEOUS NUMBERS

Henkel, Tim (Division Director)	366-4829
Cowin, Brenda	366-3536
Metzger, Kristin (Budget)	366-3016
Davis Johnson, Linda (Business Manager)	366-4842
Campel, Connie (Insurance/ Benefits)	366-3393
Bissonette, Gaylene (Train./ Conf. Regis.)	366-3030
Edwall, Karen (Cell Phone Needs)	366-3087
Madigan, Heather (HR Rep)	366-3394
Lockhart, Lisa (Pmts/ Accts Payable)	366-3055
Gellerman, Tom	366-3667
Janisch, Dave (Pavement Mgmt)	366-5567
Kjonaas, Rick (State Aide)	366-3082
Lendway, Julie (Payroll)	366-3084
Moore, Betty (Expense Reports)	366-3027

Lendway, Julie (Payroll)	366-3084
Moore, Betty (Expense Reports)	366-3027

MISCELLANEOUS NUMBERS (CONT'D)

Thoen, Jane (Purchasing Rep.)	366-3088
Tkachuck, Jane (Reprographics)	366-3089
Tobritzhofer, Ruth (Payroll Admin)	366-3090
Vang, Bob (chairs, lights, water, mice etc.)	366-3095
Wilson, Lori (HR Staffing/ Recruitment)	366-3374

MISCELLANEOUS NUMBERS for Various Locations etc.

Arden Hills Training Center	366-5252
Conference Room 360	366-5019
Desktop Support (7:30am - 4:30pm)	651-355-0200
Mail Room	366-3051
Map Sales (Burdell Buss)	366-3017
MNDOT Library	366-3791
RCA Hot Line	366-3020
Reprographics	366-3068
Supplies/Inventory (Michelle Travers)	366-3091
Central Office Front Desk (1st Flr. Lobby)	366-3037
MNDOT Information Number	651-296-3000
Garage	366-3553
CAPITAL SECURITY DESK	651-296-2100

LAN SUPPORT- network operations- 366-4000 P1067

Weinberger, Paul	366-3094
Dreyer, Mark	366-4038
Close, Jim	366-4030
Ross, Dan	366-4077

C.O. WORKERS COMP/ SAFETY

VanderVeer, Leslie (On-the-Job- Injuries)	366-3094
Bottolfson, Judy (Safety/ Ergonomics)	651-234-7427

TDA WEB PAGE INFORMATION

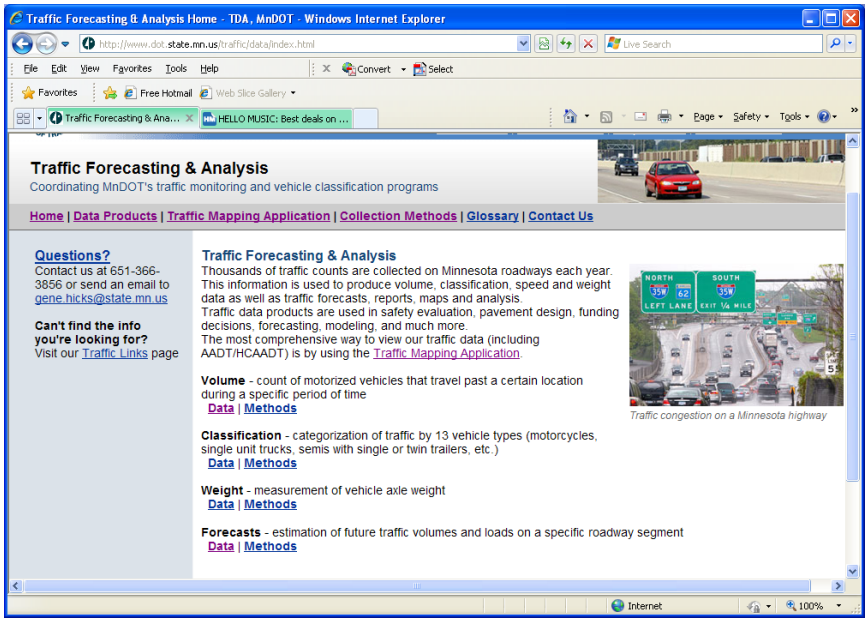
The following web pages are from Mn/DOT's Office of Transportation Data and Analysis Section and pertain to traffic forecasts, maps, and spreadsheets. The forecast maps, both Metro and Greater Minnesota are a valuable resource of previous and current forecasts. A record of traffic forecasts from 2000 through 2011 is shown by ESAL range on the maps. Forecasts prior to 1995 are contained in records in the Traffic Forecasts and Analysis Section. Every January, the traffic forecasts from the previous year are added to our map and put on our web site

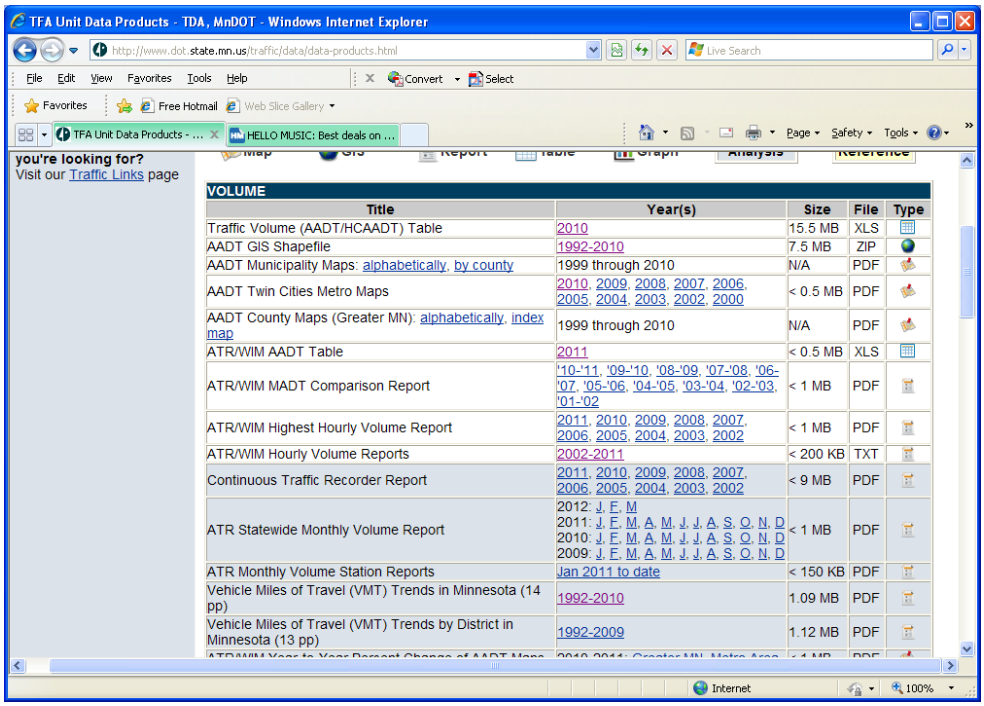
The web sites contain information on traffic counts, flow maps, vehicle weight analysis, roadway history, project log information, etc. In addition, recent traffic volumes for Metro and Greater Minnesota are available by county.

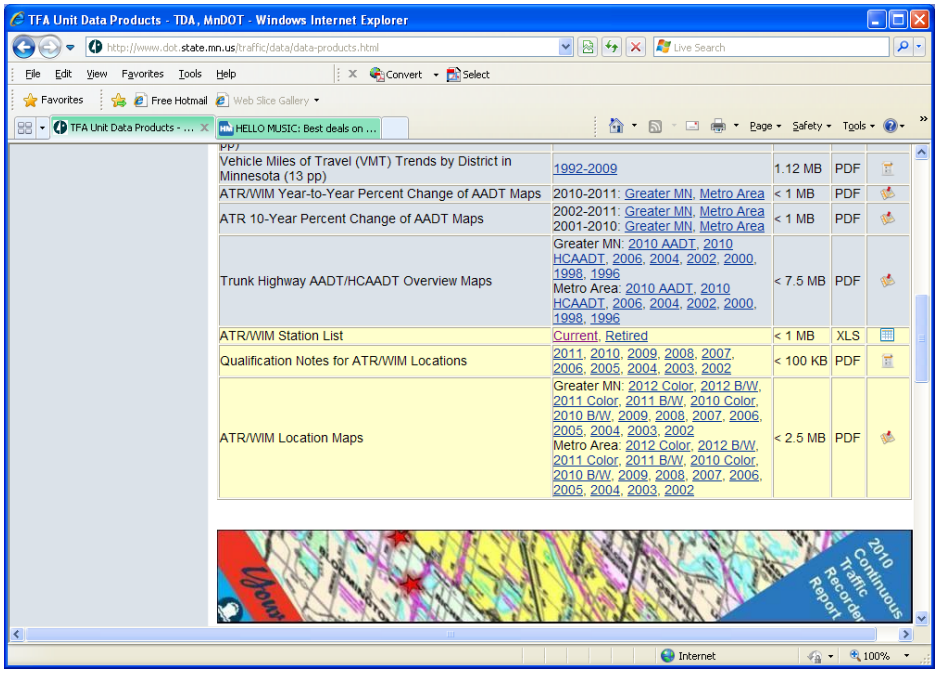
There are maps for vehicle classification sites, automatic traffic recorder sites, weigh-in-motion sites and continuous classifier sites. These maps and all other information may be printed and are useful in obtaining the location of vehicle class sites where there is individual forecasts.

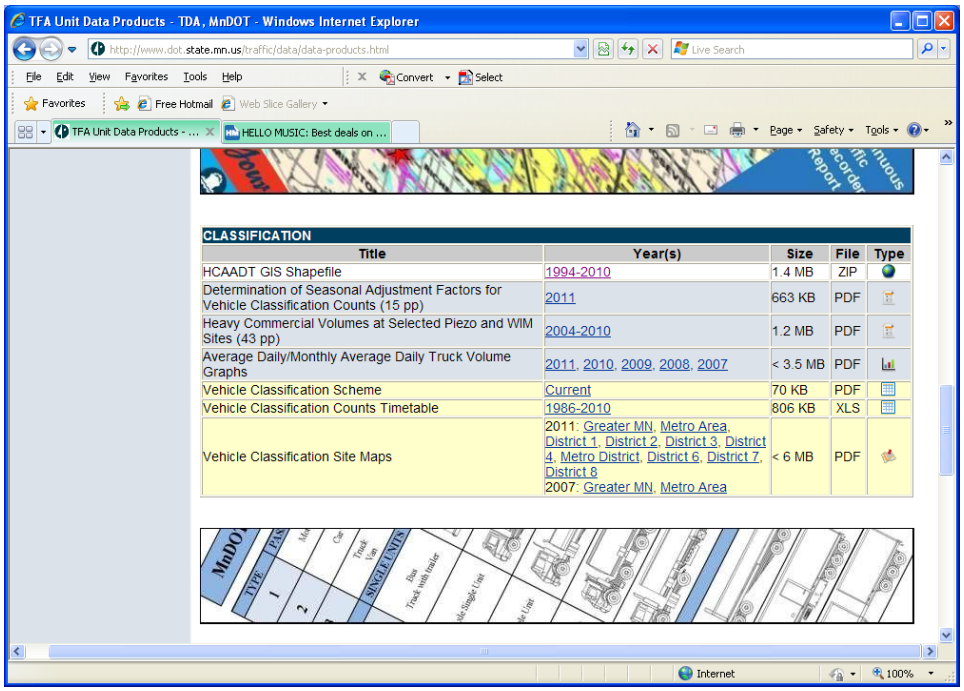
There is a downloadable version of this manual as well as a version of the MnESAL program in Excel. In addition, an Excel spreadsheet containing vehicle class history back to 1986 is also downloadable.

As of April, 2011, the main web page for the Office of Transportation Data and Analysis is http://www.dot.state.mn.us/traffic/data/index.html. The following are screen shots of our recently revamped Traffic Forecasting and Analysis Webpage.



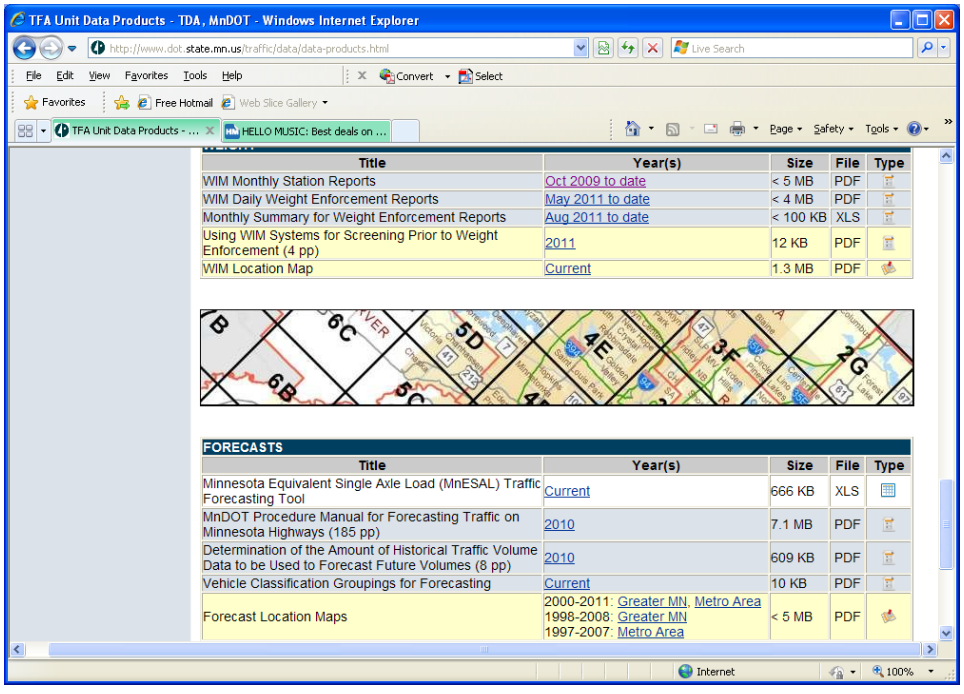

TFA Unit Data Products - TDA, MnDOT - Windows Internet Explorer
http://www.dot.state.mn.us/traffic/data/data-products.html
you're looking for?
Visit our Traffic Links page
VOLUME
Title | Year(s) | Size | File | Type
Traffic Volume (AADT/HCAADT) Table | 2010 | 15.5 MB | XLS
AADT GIS Shapefile | 1992-2010 | 7.5 MB | ZIP
AADT Municipality Maps: alphabetically, by county | 1999 through 2010 | N/A | PDF
AADT Twin Cities Metro Maps | 2010, 2009, 2008, 2007, 2006, 2005, 2004, 2003, 2002, 2000 | < 0.5 MB | PDF
AADT County Maps (Greater MN): alphabetically, index map | 1999 through 2010 | N/A | PDF
ATR/WIM AADT Table | 2011 | < 0.5 MB | XLS
ATR/WIM MADT Comparison Report | '10-'11, '09-'10, '08-'09, '07-'08, '06-'07, '05-'06, '04-'05, '03-'04, '02-'03, '01-'02 | < 1 MB | PDF
ATR/WIM Highest Hourly Volume Report | 2011, 2010, 2009, 2008, 2007, 2006, 2005, 2004, 2003, 2002 | < 1 MB | PDF
ATR/WIM Hourly Volume Reports | 2002-2011 | < 200 KB | TXT
Continuous Traffic Recorder Report | 2011, 2010, 2009, 2008, 2007, 2006, 2005, 2004, 2003, 2002 | < 9 MB | PDF
ATR Statewide Monthly Volume Report | 2012: J, F, M
2011: J, F, M, A, M, J, J, A, S, O, N, D
2010: J, F, M, A, M, J, J, A, S, O, N, D
2009: J, F, M, A, M, J, J, A, S, O, N, D | < 1 MB | PDF
ATR Monthly Volume Station Reports | Jan 2011 to date | < 150 KB | PDF
Vehicle Miles of Travel (VMT) Trends in Minnesota (14 pp) | 1992-2010 | 1.09 MB | PDF
Vehicle Miles of Travel (VMT) Trends by District in Minnesota (13 pp) | 1992-2009 | 1.12 MB | PDF


TFA Unit Data Products - TDA, MnDOT - Windows Internet Explorer
Vehicle Miles of Travel (VMT) Trends by District in Minnesota (13 pp) | 1992-2009 | 1.12 MB | PDF
ATR/WIM Year-to-Year Percent Change of AADT Maps | 2010-2011: Greater MN, Metro Area | < 1 MB | PDF
ATR 10-Year Percent Change of AADT Maps | 2002-2011: Greater MN, Metro Area
2001-2010: Greater MN, Metro Area | < 1 MB | PDF
Trunk Highway AADT/HCAADT Overview Maps | Greater MN: 2010 AADT, 2010 HCAADT, 2006, 2004, 2002, 2000, 1998, 1996
Metro Area: 2010 AADT, 2010 HCAADT, 2006, 2004, 2002, 2000, 1998, 1996 | < 7.5 MB | PDF
ATR/WIM Station List | Current, Retired | < 1 MB | XLS
Qualification Notes for ATR/WIM Locations | 2011, 2010, 2009, 2008, 2007, 2006, 2005, 2004, 2003, 2002 | < 100 KB | PDF
ATR/WIM Location Maps | Greater MN: 2012 Color, 2012 B/W, 2011 Color, 2011 B/W, 2010 Color, 2010 B/W, 2009, 2008, 2007, 2006, 2005, 2004, 2003, 2002
Metro Area: 2012 Color, 2012 B/W, 2011 Color, 2011 B/W, 2010 Color, 2010 B/W, 2009, 2008, 2007, 2006, 2005, 2004, 2003, 2002 | < 2.5 MB | PDF
2010 Continuous Traffic Recorder Report



CLASSIFICATION

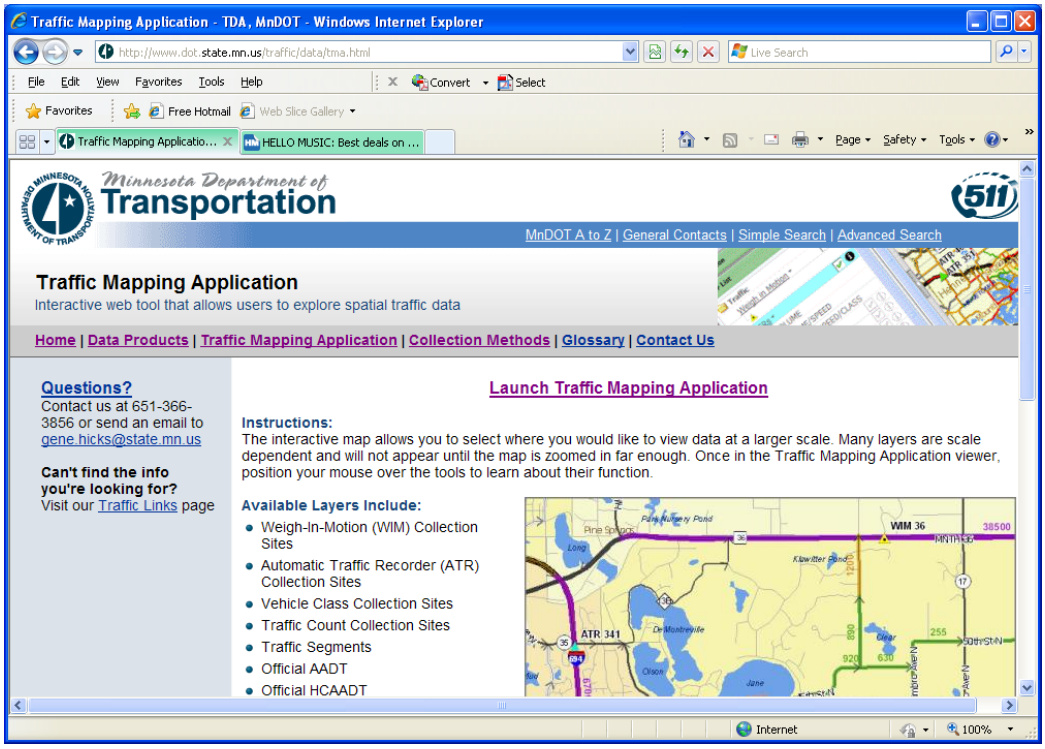
Title	Year(s)	Size	File	Type
HCAADT GIS Shapefile	1994-2010	1.4 MB	ZIP	
Determination of Seasonal Adjustment Factors for Vehicle Classification Counts (15 pp)	2011	663 KB	PDF	
Heavy Commercial Volumes at Selected Piezo and WIM Sites (43 pp)	2004-2010	1.2 MB	PDF	
Average Daily/Monthly Average Daily Truck Volume Graphs	2011, 2010, 2009, 2008, 2007	< 3.5 MB	PDF	
Vehicle Classification Scheme	Current	70 KB	PDF	
Vehicle Classification Counts Timetable	1986-2010	806 KB	XLS	
Vehicle Classification Site Maps	2011: Greater MN, Metro Area, District 1, District 2, District 3, District 4, Metro District, District 6, District 7, District 8 2007: Greater MN, Metro Area	< 6 MB	PDF	

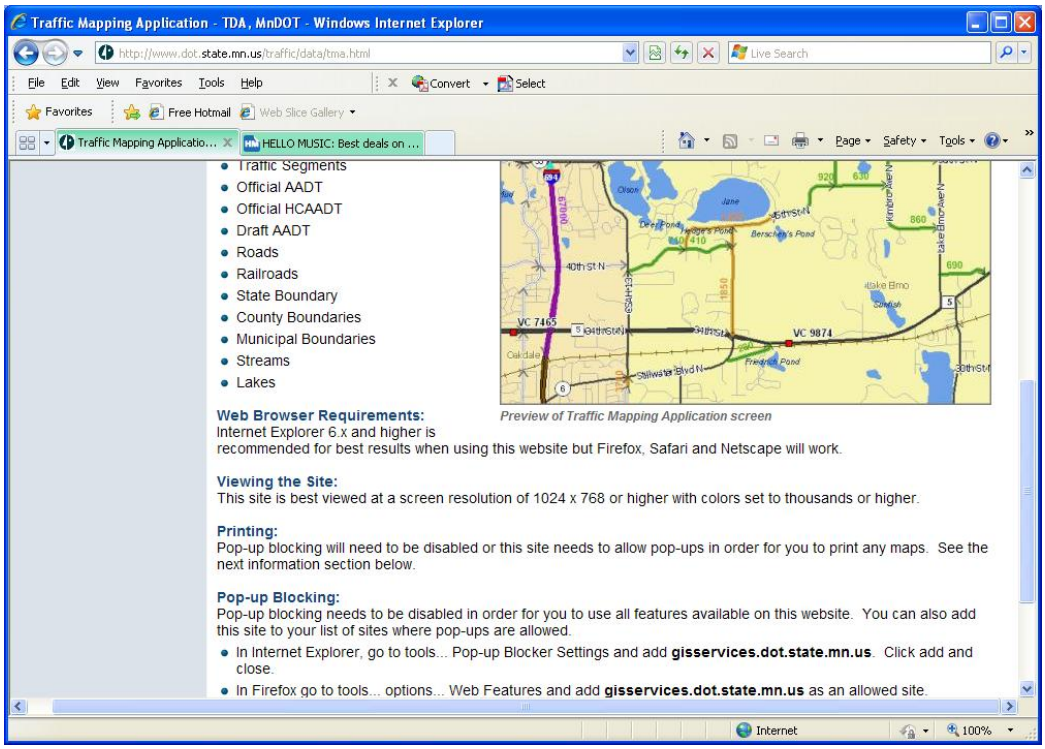


Title	Year(s)	Size	File	Type
WIM Monthly Station Reports	Oct 2009 to date	< 5 MB	PDF	
WIM Daily Weight Enforcement Reports	May 2011 to date	< 4 MB	PDF	
Monthly Summary for Weight Enforcement Reports	Aug 2011 to date	< 100 KB	XLS	
Using WIM Systems for Screening Prior to Weight Enforcement (4 pp)	2011	12 KB	PDF	
WIM Location Map	Current	1.3 MB	PDF	

FORECASTS

Title	Year(s)	Size	File	Type
Minnesota Equivalent Single Axle Load (MnESAL) Traffic Forecasting Tool	Current	666 KB	XLS	
MnDOT Procedure Manual for Forecasting Traffic on Minnesota Highways (185 pp)	2010	7.1 MB	PDF	
Determination of the Amount of Historical Traffic Volume Data to be Used to Forecast Future Volumes (8 pp)	2010	609 KB	PDF	
Vehicle Classification Groupings for Forecasting	Current	10 KB	PDF	
Forecast Location Maps	2000-2011: Greater MN, Metro Area 1998-2008: Greater MN 1997-2007: Metro Area	< 5 MB	PDF	


Traffic Mapping Application - TDA, MnDOT - Windows Internet Explorer
http://www.dot.state.mn.us/traffic/data/tma.html
Minnesota Department of Transportation
511
MnDOT A to Z | General Contacts | Simple Search | Advanced Search
Traffic Mapping Application
Interactive web tool that allows users to explore spatial traffic data
Home | Data Products | Traffic Mapping Application | Collection Methods | Glossary | Contact Us
Questions?
Contact us at 651-366-3856 or send an email to gene.hicks@state.mn.us
Can't find the info you're looking for?
Visit our Traffic Links page
Launch Traffic Mapping Application
Instructions:
The interactive map allows you to select where you would like to view data at a larger scale. Many layers are scale dependent and will not appear until the map is zoomed in far enough. Once in the Traffic Mapping Application viewer, position your mouse over the tools to learn about their function.
Available Layers Include:
Weigh-In-Motion (WIM) Collection Sites
Automatic Traffic Recorder (ATR) Collection Sites
Vehicle Class Collection Sites
Traffic Count Collection Sites
Traffic Segments
Official AADT
Official HCAADT
WIM 36
38500
ATR 341


Traffic Mapping Application - TDA, MnDOT - Windows Internet Explorer
Traffic Segments
Official AADT
Official HCAADT
Draft AADT
Roads
Railroads
State Boundary
County Boundaries
Municipal Boundaries
Streams
Lakes
VC 7465
VC 9874
Preview of Traffic Mapping Application screen
Web Browser Requirements:
Internet Explorer 6.x and higher is recommended for best results when using this website but Firefox, Safari and Netscape will work.
Viewing the Site:
This site is best viewed at a screen resolution of 1024 x 768 or higher with colors set to thousands or higher.
Printing:
Pop-up blocking will need to be disabled or this site needs to allow pop-ups in order for you to print any maps. See the next information section below.
Pop-up Blocking:
Pop-up blocking needs to be disabled in order for you to use all features available on this website. You can also add this site to your list of sites where pop-ups are allowed.
In Internet Explorer, go to tools... Pop-up Blocker Settings and add gisservices.dot.state.mn.us. Click add and close.
In Firefox go to tools... options... Web Features and add gisservices.dot.state.mn.us as an allowed site.

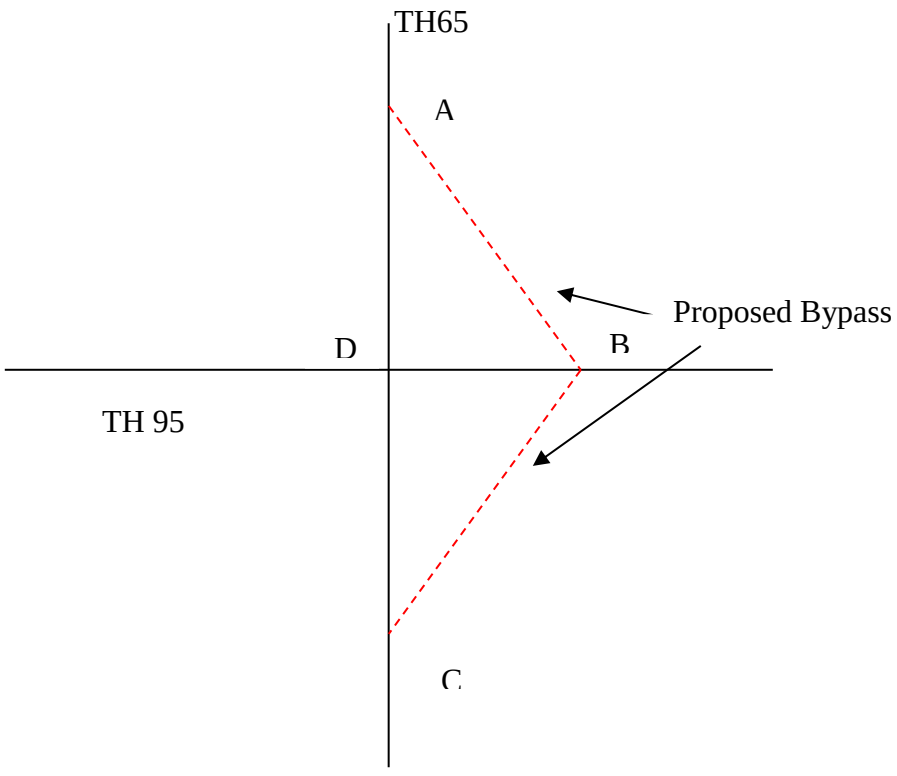
Traffic Forecasting for Proposed (non-existent) Roadways

This section is designed to outline the procedures for completing traffic and load forecasts on new roadways such as ***bypasses, new alignments or new routes*** for which there is no existing route serving a similar trip purpose.

Bypass

A bypass is generally constructed around a city for the purpose of removing through traffic from the local street network. Our bypass example was recently constructed on a portion of trunk highway 65 around the east side of the city of Cambridge in Isanti County. The problem of congestion through town, especially at the intersection of TH 95 and TH 65, will hopefully be eliminated by the construction of the bypass. To properly design the bypass structurally and geometrically, the designers needed to know the base year and design year projected traffic volumes and the 20 and 35 year cumulative ESALS. When projecting traffic and vehicle type distributions for a road that does not exist, the analyst has no historic data to use… or does he/she? The answer of course is a resounding yes.

The traffic that currently uses TH 65 going through the center of town is the maximum number of vehicles that could be assigned to the new bypass or alternate route. However, not all traffic is through traffic; (i.e., traffic that does not stop in town, rather it goes through to a destination outside of the town) the problem is how much of the traffic is through traffic? The schematic diagram below shows the general layout for the bypass.



How do we determine the percent of through traffic?

Before you can determine the through traffic percentage you need to know a few things about the bypass: 1) termini, 2) access points, 3) travel time in relation to old route, and 4) future development plans adjacent to the bypass. In general, the larger the town or city the fewer the number of through trips it will have. From experience, we have learned that small towns, (i.e., less than 5000 population) will usually have from 70 to 85 percent through trips. The only reliable way to determine the through trip percentage is to perform an origin/destination, (O-D) study.

Origin and destination studies can be accomplished by a *license plate matching study,* a *driver interview or by following vehicles to find their destinations*. A license plate matching study is performed by recording the license plates of vehicles entering and leaving the study area and also at pertinent locations within the study area. In the example above, license plates should be recorded for both directions of traffic at points A, B, C and D. Ideally the study should run from 6 AM – 9 AM,
10 AM – 2 PM and 3 PM – 6PM. Unfortunately, with resources diminishing, you may not be able to collect data for that length of time. At a minimum, data should be collected during either the AM or PM peak period and for 2 hours during the off-peak period of 10 AM – 2 PM.

Once the data has been collected, matches can be determined and the through trips can be assigned to the bypass. In the example above, vehicles that travel from points A to C, C to A, A to B, B to A, B to C or C to B within a specified amount of time, can be assigned to the bypass. Using the data collected at points A, B, C and D you can determine the percentages of vehicles that are through trips and those that have a destination in town.

Once the percentages have been calculated they can be applied to the base and design year AADTs that should be projecte using least squares regression analysis.
For the above example let's assume that at point A we collected license plate data from 1000 southbound vehicles and 1000 northbound vehicles in the 10 hours prescribed above. Assume that the AADT at this location is 4000 and that data collected yielded the following matches: A-B, B-A = 500, A-C,C-A = 1300, A-D, D-A = 1960. The next step would be to double all of the point-to-point movements, thus bringing the 2000 counted vehicles up to the 4000 AADT. All of the vehicles that travel from points A to C or C to A can be assigned to the entire length of the bypass. Vehicles that travel through points A and B or B and A can be assigned to the A to B portion of the bypass.

Similarly, vehicles traveling from points B to C or C to B can be assigned to the C to B portion of the bypass. Some portion of the vehicles that pass through points A and D and C and D that turn east at D can be assigned to the appropriate portion of the bypass if their destinations were near the bypass. Also, vehicles that appeared at A or C and passed through D but not C or A may be assigned to portions of the bypass depending on the destinations, the access and the decrease in trip time caused by using the usually faster bypass.

The only other vehicles that should be considered for assignment to the bypass are the additional trips that will be generated by new construction of businesses and residential

developments that locate near the bypass after it is built. To answer these questions the analyst has to get information from the city regarding zoning and plans for the land development adjacent to the bypass. Those additional vehicle trips generated from new development can be calculated using the Institution of Transportation Engineers' (ITE), manual on Trip Generation. The ITE manual is organized by development type and gives the average number of trips generated by square footage or number of employees for businesses and by dwelling type for residential developments.

New Alignment

The second type of forecast where the road does not currently exist is the new alignment. When forecasting future traffic and loadings for a new alignment the analyst must know if the in place alignment will remain or if it is to be closed. The other issue to consider is whether or not the access points remain the same. If the access points change vehicles must be reassigned to the appropriate road segments. If the current alignment is going to be closed, all traffic that is currently using the route can be reassigned to the new alignment. The analyst should produce this type of forecast in the same manner as any other major construction project. If the old alignment is going to remain open to traffic an O-D study is necessary and the forecasting method for a bypass should be used.

New Route

The last type of new road construction is the new route with no existing route serving the same trip purpose. In this case, all of the traffic must be assigned by using trip generation information from the ITE manual and heavy commercial types and volumes using the appropriate defaults plus the addition of trucks based on the proposed developments. If the traffic forecaster needs clarification on any of the material covered in this section the Traffic Forecasts Unit is available for consultation and training.

Use of Vehicle Class Data on non-existing Roadways

On any new road, route, or bypass, there will be judgment as to which and how many vehicle class sites to use to represent all or portions of new roadways or new alignments. The forecaster may use, for example, averages of two vehicle class site location percentages to represent the movement on a particular roadway, ramp or street. It is important to distinguish where, or what vehicle class site the truck movements originate from and where they are going. This will ultimately help determine the vehicle type percents affecting any particular roadway. The Rochester example used in this manual discusses uses of multiple vehicle class sites affecting different segments of roadways. On a non-existing section or road, it will be important to consider all vehicle class site information, where exactly the site is located, and how to distribute the volumes or percentages between existing and non-existing roadways.

Summary of Vehicle Classification Program, Parent Child classification, and Vehicle Classification Hourly Distribution factors and Percents

Minnesota's vehicle classification program is designed to gain an understanding of the volume and type of heavy commercial vehicles that are utilizing the Minnesota's portion of the National Highway System as well as other trunk highways, CSAHs, county roads and MSASs in Minnesota. This is being accomplished through an integrated system of data collection devices that include both continuous and short-duration counting methods. Vehicle classification data is collected from weigh-in-motion, continuous classifiers, tube counters and manual counts. The data collected is archived in an Access database for analysis and reporting purposes.

There is a Parent/ Child heavy commercial relationship established for all trunk highway traffic segments where no classification has taken place. All vehicle classifiers collect data on vehicle type (FHWA 13 classes) and are stored in the database by hour. Body type data are available for all data manually collected and speed data is available on request at all sites. Tube counts are set for 48 hours and manual counts are taken for 16 hours (6AM – 10PM), although we are taking shorter manual counts on certain routes and using factors for the remainder of the hours. The short duration classification counts are adjusted to annual average daily traffic volumes by using factors developed from continuous counters.

These factors take into account the variations of truck volumes by month and day of week. The parent/child relationships developed will enable us to automate the process for the production of heavy commercial vehicle type volumes at all Highway Performance Monitoring System segments. The Office of Transportation Data & Analysis has plans to install an additional 8 Kistler WIMs and 40 continuous classification systems in the next five years.

An analysis of hourly counts from the vehicle class program, particularly tube counts, has revealed certain hourly trends when all sites are taken in the aggregate. In a discussion of traffic forecasting techniques, besides the use of short counts and on-site visual analysis, there are always going to be situations when it is helpful to have guidelines as to hourly distribution of traffic. Often, when nothing else is known, the traffic forecaster can study the tables below and determine trends by vehicle types by hour of the day.

By taking any one particular hour, or a group of hours, one can get a feel for the hourly distribution of any truck type by "factoring" that hour up to 24 hours to compare it with AADT or other 24 hour tube counts. Example: say you had a one hour count of five plus axle semis in rural Minnesota (8:00-9:00 Am for example), and that count was 24. If the forecaster wanted a ballpark estimate (not knowing anything else), he or she could use the chart on the next page. Looking at the 8:00 AM hour, we see that hour represents 6.14% of the five axle traffic of the 24 hour period. The factor is 16.30. By multiplying 25 by 16.30 we get an estimate of the 24 hour five plus axle semi volume as 408. Again, this is strictly another analysis tool and should not be used in a project level analysis. The tables below are a statistical average of ten years worth of trend data from the vehicle class tube counts taken between 1998 and 2008. Further information regarding hourly distribution of truck traffic can be obtained by contacted the Traffic Forecasting Section.

VEHICLE CLASS DATA TUBE COUNT FACTORS - 1998-2008

Hourly Distribution of traffic by vehicle type

Note: For 24 hour estimated raw traffic, multiply the one hour count by the factor in the right hand column

TIME	Tot Veh	Factor	Pass Veh	Factor	2axsu	Factor	3+axsu	Factor	3ax semi	Factor	4ax semi	Factor	5+ax semi	Factor	TT/BUS	Factor	Twins
12:00 AM	0.79%	126.67	0.76%	131.17	0.54%	183.66	0.64%	155.29	0.82%	122.18	0.82%	122.18	1.50%	66.81	0.85%	117.16	2.14%
1:00 AM	0.54%	184.75	0.50%	199.89	0.43%	231.82	0.64%	155.46	0.73%	136.16	0.73%	136.16	1.31%	76.21	0.73%	137.20	1.84%
2:00 AM	0.43%	235.21	0.37%	268.01	0.40%	249.05	0.61%	163.74	0.67%	148.19	0.67%	148.19	1.29%	77.73	0.67%	149.31	2.35%
3:00 AM	0.46%	216.40	0.40%	251.68	0.51%	196.12	0.65%	153.21	0.80%	125.30	0.80%	125.30	1.50%	66.87	0.77%	129.88	2.61%
4:00 AM	0.86%	116.29	0.79%	126.15	0.92%	109.07	0.96%	104.02	1.16%	85.85	1.16%	85.85	1.99%	50.29	1.02%	98.28	3.32%
5:00 AM	2.41%	41.43	2.40%	41.60	2.45%	40.76	1.81%	55.19	2.01%	49.65	2.01%	49.65	2.88%	34.67	2.06%	48.60	3.52%
6:00 AM	4.76%	20.99	4.82%	20.77	4.98%	20.06	3.93%	25.44	3.74%	26.72	3.74%	26.72	4.06%	24.65	4.62%	21.63	4.14%
7:00 AM	6.43%	15.55	6.50%	15.39	6.53%	15.32	6.32%	15.83	5.68%	17.59	5.68%	17.59	5.13%	19.51	6.74%	14.84	5.79%
8:00 AM	5.52%	18.13	5.38%	18.60	7.06%	14.16	7.80%	12.82	6.47%	15.47	6.47%	15.47	6.14%	16.30	7.37%	13.57	4.60%
9:00 AM	5.13%	19.50	4.91%	20.35	6.88%	14.54	8.11%	12.33	6.69%	14.96	6.69%	14.96	6.80%	14.72	7.19%	13.91	4.16%
10:00 AM	5.19%	19.27	4.97%	20.13	6.72%	14.87	8.45%	11.83	7.01%	14.26	7.01%	14.26	7.01%	14.26	7.12%	14.05	4.11%
11:00 AM	5.51%	18.17	5.31%	18.83	6.85%	14.59	8.42%	11.88	7.26%	13.78	7.26%	13.78	7.05%	14.18	7.25%	13.79	4.30%
12:00 PM	5.74%	17.42	5.60%	17.87	6.84%	14.61	7.90%	12.66	7.16%	13.97	7.16%	13.97	6.87%	14.55	7.15%	13.98	4.07%
1:00 PM	5.85%	17.10	5.71%	17.52	6.98%	14.33	8.32%	12.02	7.27%	13.76	7.27%	13.76	6.70%	14.94	7.09%	14.10	4.21%
2:00 PM	6.41%	15.60	6.33%	15.80	7.29%	13.71	8.24%	12.13	7.41%	13.50	7.41%	13.50	6.51%	15.36	7.69%	13.01	4.60%
3:00 PM	7.43%	13.47	7.48%	13.36	7.52%	13.30	7.32%	13.67	7.40%	13.51	7.40%	13.51	6.11%	16.38	7.92%	12.62	6.10%
4:00 PM	8.17%	12.24	8.38%	11.93	7.14%	14.01	6.25%	16.01	7.15%	13.98	7.15%	13.98	5.49%	18.23	6.82%	14.65	6.67%
5:00 PM	7.98%	12.54	8.29%	12.06	6.08%	16.44	4.59%	21.77	6.18%	16.17	6.18%	16.17	4.66%	21.46	5.17%	19.34	7.13%
6:00 PM	5.98%	16.71	6.22%	16.09	4.48%	22.32	3.05%	32.75	4.39%	22.78	4.39%	22.78	3.97%	25.16	3.60%	27.76	4.92%
7:00 PM	4.38%	22.85	4.53%	22.06	3.15%	31.78	1.99%	50.25	3.05%	32.74	3.05%	32.74	3.42%	29.26	2.40%	41.72	3.93%
8:00 PM	3.65%	27.43	3.78%	26.45	2.40%	41.60	1.38%	72.42	2.50%	40.01	2.50%	40.01	2.98%	33.53	1.90%	52.60	3.87%
9:00 PM	3.04%	32.94	3.15%	31.76	1.86%	53.90	1.08%	92.24	1.95%	51.34	1.95%	51.34	2.57%	38.88	1.60%	62.56	4.43%
10:00 PM	2.07%	48.37	2.12%	47.26	1.20%	83.10	0.84%	119.14	1.41%	70.78	1.41%	70.78	2.24%	44.61	1.27%	78.73	4.15%
11:00 PM	1.29%	77.28	1.30%	77.18	0.78%	128.75	0.69%	145.72	1.07%	93.38	1.07%	93.38	1.84%	54.34	1.00%	99.91	3.02%

SITE (All)
YEAR (All)

TIME

Data	12:00 AM	1:00 AM	2:00 AM	3:00 AM	4:00 AM	5:00 AM	6:00 AM	7:00 AM	8:00 AM	9:00 AM	10:00 AM	11:00 AM	12:00 PM	1:00 PM	2:00 PM	3:00 PM	4:00 PM	5:00 PM	6:00 PM	7:00 PM	8:00 PM	9:00 PM	10:00 PM	11:00 PM	Grand Total
Sum of AUTOS	159109	104407	77870	82923	165438	501658	1005042	1356299	1121806	1025463	1036769	1108602	1167676	1191496	1321115	1561954	1749896	1731128	1297146	946016	789111	657052	441641	270417	20869944
Sum of 2AXSU	3904	3093	2879	3656	6574	17593	35741	46793	50637	45307	48210	49129	49065	50048	52287	53896	51170	43627	32118	22559	17237	13302	8628	5569	717022
Sum of 3+AXSU	1842	1840	1747	1867	2750	5183	11242	18071	22305	23204	24179	24080	22586	23794	23578	20928	17871	13138	8733	5693	3950	3101	2401	1963	286046
Sum of 3ASEMI	634	569	523	618	903	1561	2900	4405	5010	5181	5432	5623	5546	5633	5742	5737	5542	4791	3402	2367	1937	1509	1095	830	77490
Sum of 4ASEMI	1178	1057	971	1149	1676	2898	5387	8181	9304	9623	10089	10442	10301	10460	10663	10655	10291	8898	6317	4395	3597	2803	2033	1541	143909
Sum of 5+AXSEMI	14748	12929	12677	14735	19593	28420	39976	50506	60469	66957	69116	69466	67720	65974	64147	60167	54060	45907	39159	33676	29384	25341	22086	18132	985345
Sum of BUS&HTWT	1848	1578	1450	1667	2203	4455	10009	14592	15952	15560	15408	15701	15487	15351	16640	17152	14775	11196	7798	5189	4116	3461	2750	2167	216505
Sum of TWINS	1030	885	1132	1259	1598	1696	1994	2789	2216	2001	1977	2072	1962	2029	2217	2935	3213	3434	2370	1891	1864	2135	1998	1454	48151
TOTAL	184293	126368	99249	107874	200735	563464	1112291	1501546	1287699	1197296	1211180	1285115	1340343	1364785	1496389	1733424	1906818	1862119	1397043	1021786	851196	708704	482632	302073	23344412

SITE (All)
YEAR (All)

HOURLY DISTRIBUTION BY PERCENT OF TOTAL VEHICLES

	12:00 AM	1:00 AM	2:00 AM	3:00 AM	4:00 AM	5:00 AM	6:00 AM	7:00 AM	8:00 AM	9:00 AM	10:00 AM	11:00 AM	12:00 PM	1:00 PM	2:00 PM	3:00 PM	4:00 PM	5:00 PM	6:00 PM	7:00 PM	8:00 PM	9:00 PM	10:00 PM	11:00 PM	Grand Total
Sum of AUTOS	0.76%	0.50%	0.37%	0.40%	0.79%	2.40%	4.82%	6.50%	5.38%	4.91%	4.97%	5.31%	5.60%	5.71%	6.33%	7.48%	8.38%	8.29%	6.22%	4.53%	3.78%	3.15%	2.12%	1.30%	100.00%
Sum of 2AXSU	0.54%	0.43%	0.40%	0.51%	0.92%	2.45%	4.98%	6.53%	7.06%	6.88%	6.72%	6.85%	6.84%	6.98%	7.29%	7.52%	7.14%	6.08%	4.48%	3.15%	2.40%	1.86%	1.20%	0.78%	100.00%
Sum of 3+AXSU	0.64%	0.64%	0.61%	0.65%	0.96%	1.81%	3.93%	6.32%	7.80%	8.11%	8.45%	8.42%	7.90%	8.32%	8.24%	7.32%	6.25%	4.59%	3.05%	1.99%	1.38%	1.08%	0.84%	0.69%	100.00%
Sum of 3ASEMI	0.82%	0.73%	0.67%	0.80%	1.16%	2.01%	3.74%	5.68%	6.47%	6.69%	7.01%	7.26%	7.16%	7.27%	7.41%	7.40%	7.15%	6.18%	4.39%	3.05%	2.50%	1.95%	1.41%	1.07%	100.00%
Sum of 4ASEMI	0.82%	0.73%	0.67%	0.80%	1.16%	2.01%	3.74%	5.68%	6.47%	6.69%	7.01%	7.26%	7.16%	7.27%	7.41%	7.40%	7.15%	6.18%	4.39%	3.05%	2.50%	1.95%	1.41%	1.07%	100.00%
Sum of 5+AXSEMI	1.50%	1.31%	1.29%	1.50%	1.99%	2.88%	4.06%	5.13%	6.14%	6.80%	7.01%	7.05%	6.87%	6.70%	6.51%	6.11%	5.49%	4.66%	3.97%	3.42%	2.98%	2.57%	2.24%	1.84%	100.00%
Sum of BUS&HTWT	0.85%	0.73%	0.67%	0.77%	1.02%	2.06%	4.62%	6.74%	7.37%	7.19%	7.12%	7.25%	7.15%	7.09%	7.69%	7.92%	6.82%	5.17%	3.60%	2.40%	1.90%	1.60%	1.27%	1.00%	100.00%
Sum of TWINS	2.14%	1.84%	2.35%	2.61%	3.32%	3.52%	4.14%	5.79%	4.60%	4.16%	4.11%	4.30%	4.07%	4.21%	4.60%	6.10%	6.67%	7.13%	4.92%	3.93%	3.87%	4.43%	4.15%	3.02%	100.00%
TOTAL	0.79%	0.54%	0.43%	0.46%	0.86%	2.41%	4.76%	6.43%	5.52%	5.13%	5.19%	5.51%	5.74%	5.85%	6.41%	7.43%	8.17%	7.98%	5.98%	4.38%	3.65%	3.04%	2.07%	1.29%	100.00%

SITE (All)
YEAR (All)

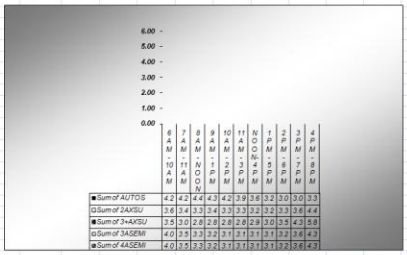
FOUR HOUR CONSECUTIVE COUNTING PERIODS - TOTAL VOLUME

FOUR HOUR PERIOD	6AM-10AM	7AM-11AM	8AM-NOON	9AM-1PM	10AM-2PM	11AM-3PM	NOON-4PM	1PM-5PM	2PM-6PM	3PM-7PM	4PM-8PM
Sum of AUTOS	4508520	4540247	4292640	4338510	4504543	4788889	5242241	5824461	6364093	6340124	5724186
Sum of 2AXSU	182478	194947	197283	195711	196452	200529	205296	207401	200980	180811	149474
Sum of 3+AXSU	74822	87759	93768	94049	94639	94038	90886	86171	75515	60670	45435
Sum of 3ASEMI	17497	20029	21246	21783	22234	22544	22658	22653	21812	19472	16101
Sum of 4ASEMI	32494	37196	39458	40454	41292	41866	42079	42076	40507	36161	29902
Sum of 5+AXSEMI	217908	247048	266008	273259	272276	267307	258008	244348	224281	199293	172802
Sum of BUS&HTWT	56113	61512	62621	62156	61947	63179	64630	63918	59763	50921	38958
Sum of TWINS	9000	8983	8266	8012	8040	8280	9143	10394	11799	11952	10908

SITE (All)
YEAR (All)

16 HOUR PERIOD - 6AM TO 10PM

16 HOUR PERIOD	6AM-10PM	6AM-10PM	6AM-10PM	6AM-10PM	6AM-10PM	6AM-10PM	6AM-10PM	6AM-10PM	6AM-10PM	6AM-10PM	6AM-10PM
Sum of AUTOS	19066481	19066481	19066481	19066481	19066481	19066481	19066481	19066481	19066481	19066481	19066481
Sum of 2AXSU	665126	665126	665126	665126	665126	665126	665126	665126	665126	665126	665126
Sum of 3+AXSU	266453	266453	266453	266453	266453	266453	266453	266453	266453	266453	266453
Sum of 3ASEMI	70757	70757	70757	70757	70757	70757	70757	70757	70757	70757	70757
Sum of 4ASEMI	131406	131406	131406	131406	131406	131406	131406	131406	131406	131406	131406
Sum of 5+AXSEMI	842025	842025	842025	842025	842025	842025	842025	842025	842025	842025	842025
Sum of BUS&HTWT	198387	198387	198387	198387	198387	198387	198387	198387	198387	198387	198387
Sum of TWINS	37099	37099	37099	37099	37099	37099	37099	37099	37099	37099	37099



SITE (All)
YEAR (All)

FOUR HOUR FACTOR (FOUR HOUR DIVIDED BY 16 HOUR)

FACTOR	6AM-10AM	7AM-11AM	8AM-NOON	9AM-1PM	10AM-2PM	11AM-3PM	NOON-4PM	1PM-5PM	2PM-6PM	3PM-7PM	4PM-8PM
Sum of AUTOS	4.23	4.20	4.44	4.39	4.23	3.98	3.64	3.27	3.00	3.01	3.33
Sum of 2AXSU	3.64	3.41	3.37	3.40	3.39	3.32	3.24	3.21	3.31	3.68	4.45
Sum of 3+AXSU	3.56	3.64	2.84	2.83	2.82	2.83	2.93	3.09	3.53	4.39	5.86
Sum of 3ASEMI	4.04	3.53	3.33	3.25	3.18	3.14	3.12	3.12	3.24	3.63	4.39
Sum of 4ASEMI	4.04	3.53	3.33	3.25	3.18	3.14	3.12	3.12	3.24	3.63	4.39
Sum of 5+AXSEMI	3.86	3.41	3.17	3.08	3.09	3.15	3.26	3.45	3.75	4.23	4.87
Sum of BUS&HTWT	3.54	3.23	3.17	3.19	3.20	3.14	3.07	3.10	3.32	3.90	5.09
Sum of TWINS	4.12	4.13	4.49	4.63	4.61	4.48	4.06	3.57	3.14	3.10	3.40

SITE 98-08
YEAR 98-08

98-08 HISTORICAL V.C. TUBE COUNT HOURLY DISTRIBUTION

1998-2008 vc tube	12:00 AM	1:00 AM	2:00 AM	3:00 AM	4:00 AM	5:00 AM	6:00 AM	7:00 AM	8:00 AM	9:00 AM	10:00 AM	11:00 AM	12:00 PM	1:00 PM	2:00 PM	3:00 PM	4:00 PM	5:00 PM	6:00 PM	7:00 PM	8:00 PM	9:00 PM	10:00 PM	11:00 PM	Grand Total
Sum of AUTOS	0.76%	0.50%	0.37%	0.40%	0.79%	2.40%	4.82%	6.50%	5.38%	4.91%	4.97%	5.31%	5.60%	5.71%	6.33%	7.48%	8.38%	8.29%	6.22%	4.53%	3.78%	3.15%	2.12%	1.30%	100.00%
Sum of 2AXSU	0.54%	0.43%	0.40%	0.51%	0.92%	2.45%	4.98%	6.53%	7.06%	6.88%	6.72%	6.85%	6.84%	6.98%	7.29%	7.52%	7.14%	6.08%	4.48%	3.15%	2.40%	1.86%	1.20%	0.78%	100.00%
Sum of 3+AXSU	0.64%	0.64%	0.61%	0.65%	0.96%	1.81%	3.93%	6.32%	7.80%	8.11%	8.45%	8.42%	7.90%	8.32%	8.24%	7.32%	6.25%	4.59%	3.05%	1.99%	1.38%	1.08%	0.84%	0.69%	100.00%
Sum of 3ASEMI	0.82%	0.73%	0.67%	0.80%	1.16%	2.01%	3.74%	5.68%	6.47%	6.69%	7.01%	7.26%	7.16%	7.27%	7.41%	7.40%	7.15%	6.18%	4.39%	3.05%	2.50%	1.95%	1.41%	1.07%	100.00%
Sum of 4ASEMI	0.82%	0.73%	0.67%	0.80%	1.16%	2.01%	3.74%	5.68%	6.47%	6.69%	7.01%	7.26%	7.16%	7.27%	7.41%	7.40%	7.15%	6.18%	4.39%	3.05%	2.50%	1.95%	1.41%	1.07%	100.00%
Sum of 5+AXSEMI	1.50%	1.31%	1.29%	1.50%	1.99%	2.88%	4.06%	5.13%	6.14%	6.80%	7.01%	7.05%	6.87%	6.70%	6.51%	6.11%	5.49%	4.66%	3.97%	3.42%	2.98%	2.57%	2.24%	1.84%	100.00%
Sum of BUS&HTWT	0.85%	0.73%	0.67%	0.77%	1.02%	2.06%	4.62%	6.74%	7.37%	7.19%	7.12%	7.25%	7.15%	7.09%	7.69%	7.92%	6.82%	5.17%	3.60%	2.40%	1.90%	1.60%	1.27%	1.00%	100.00%
Sum of TWINS	2.14%	1.84%	2.35%	2.61%	3.32%	3.52%	4.14%	5.79%	4.60%	4.16%	4.11%	4.30%	4.07%	4.21%	4.60%	6.10%	6.67%	7.13%	4.92%	3.93%	3.87%	4.43%	4.15%	3.02%	100.00%

1998 to 2008 all vc sites - 16 hr as pct of 24 hr and factor

16 HOUR PERIOD	6AM-10PM	24 HOUR	Pct 16 of 24	Factor
Sum of AUTOS	19066481	20869944	91.36%	1.09
Sum of 2AXSU	665126	717022	92.76%	1.08
Sum of 3+AXSU	266453	286046	93.15%	1.07
Sum of 3ASEMI	70757	77490	91.31%	1.10
Sum of 4ASEMI	131406	143909	91.31%	1.10
Sum of 5+AXSEMI	842025	985345	85.45%	1.17
Sum of BUS&HTWT	198387	216565	91.63%	1.09
Sum of TWINS	37099	48151	77.05%	1.30

The above discussion is mostly related to our vehicle class tube counting program. The manual count program is equally important, although in recent years with the advent of more computerized and machine driven counts (as opposed to a manual recorder using a manual recording device), we are doing less and less of manual counts. Most of the manual counts in past years have been 16 hour duration counts. Lately, we have been using shorter counts and factoring them up to 16 hours. As discussed earlier, the advantage of manual counts is in allowing the forecaster and user to study body types, mainly as applicable to the semi category, rather than single unit trucks.

Normally, as a general rule, discounting seasonal variation, a 16 hour count is roughly 90% of the 24 hour total – that is, between the hours of 6AM and 10PM, about 90% of the 24 hour traffic occurs. It is important to note that in any discussion of hourly distribution involving total vehicles and automobiles, the patterns can be very similar. This is because of the large amount of auto traffic compared to heavy commercial traffic.

This can skew graphics. In any case, it is important to differentiate charts that portray total vehicles, total automobiles, and total trucks (since the first two will often appear the same in so far as percent distribution). The table below shows this relationship between 16 and 24 hour vehicle class counts

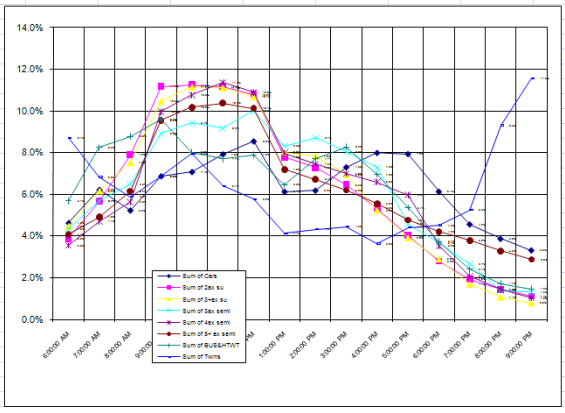
1998 to 2008 all vc sites - 16 hr as pct of 24 hr and factor				
16 HOUR PERIOD	6AM-10PM	24 HOUR	Pct 16 of 24	Factor
Sum of AUTOS	19066481	20869944	91.36%	1.09
Sum of 2AXSU	665126	717022	92.76%	1.08
Sum of 3+AXSU	266453	286046	93.15%	1.07
Sum of 3ASEMI	70757	77490	91.31%	1.10
Sum of 4ASEMI	131406	143909	91.31%	1.10
Sum of 5+AXSEMI	842025	985345	85.45%	1.17
Sum of BUS&HTWT	198387	216505	91.63%	1.09
Sum of TWINS	37099	48151	77.05%	1.30

Notice that roughly 90% of total traffic occurs between 6AM to 10PM, with the exception of twin trailers and five plus axle semis. This relationship has been fairly constant over the years.

Dir	(All)
Site	(All)
Year	(All)
Month	(All)
Weekday	(All)
Day	(All)

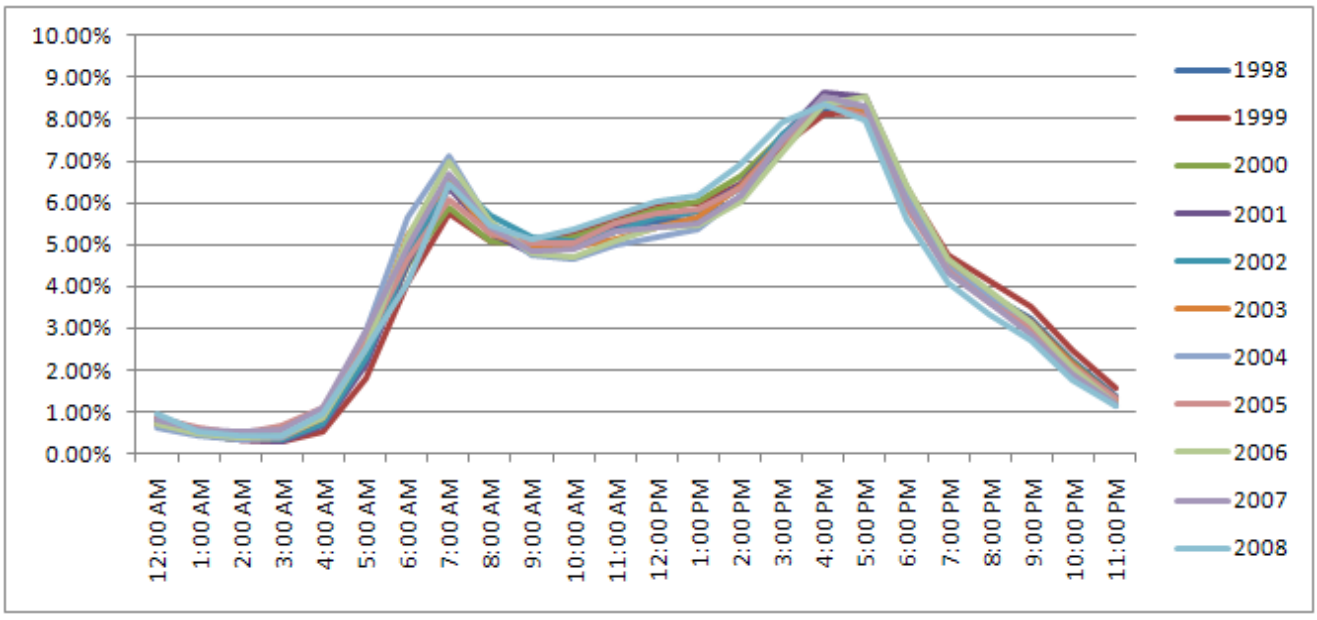
	BH															
Data	6:00:00 AM	7:00:00 AM	8:00:00 AM	9:00:00 AM	10:00:00 AM	11:00:00 AM	12:00:00 PM	1:00:00 PM	2:00:00 PM	3:00:00 PM	4:00:00 PM	5:00:00 PM	6:00:00 PM	7:00:00 PM	8:00:00 PM	9:00:00 PM	Grand Total
Sum of Cars	272159	366140	307440	404041	416157	465813	502549	360365	363691	429534	470062	466825	360736	268268	227306	195001	5876087
Sum of 2ax su	4653	6807	9472	13413	13504	13385	12947	9341	8736	7754	6396	4828	3354	2312	1719	1336	119957
Sum of 3+ax su	2878	3967	4847	6745	7184	7161	6885	5167	5041	4475	3372	2520	1868	1093	683	511	64397
Sum of 3ax semi	303	396	453	622	657	639	698	580	607	560	509	319	256	186	96	91	6972
Sum of 4ax semi	399	528	634	1120	1209	1277	1224	897	838	786	741	669	398	232	163	116	11231
Sum of 5+ ax semi	11833	14231	17827	27676	29484	30057	29339	20855	19457	17963	16091	13815	12191	10994	9505	8340	289658
Sum of BUS&HTWT	2012	2922	3113	3401	2845	2728	2796	2289	2728	2934	2465	1899	1325	852	608	520	35437
Sum of Twins	403	316	272	318	368	296	267	191	200	206	168	204	209	243	431	535	4627

	6:00:00 AM	7:00:00 AM	8:00:00 AM	9:00:00 AM	10:00:00 AM	11:00:00 AM	12:00:00 PM	1:00:00 PM	2:00:00 PM	3:00:00 PM	4:00:00 PM	5:00:00 PM	6:00:00 PM	7:00:00 PM	8:00:00 PM	9:00:00 PM	Grand Total
Sum of Cars	4.6%	6.2%	5.2%	6.9%	7.1%	7.9%	8.6%	6.1%	6.2%	7.3%	8.0%	7.9%	6.1%	4.6%	3.9%	3.3%	100.0%
Sum of 2ax su	3.9%	5.7%	7.9%	11.2%	11.3%	11.2%	10.8%	7.8%	7.3%	6.5%	5.3%	4.0%	2.8%	1.9%	1.4%	1.1%	100.0%
Sum of 3+ax su	4.5%	6.2%	7.5%	10.5%	11.2%	11.1%	10.7%	8.0%	7.8%	6.9%	5.2%	3.9%	2.9%	1.7%	1.1%	0.8%	100.0%
Sum of 3ax semi	4.3%	5.7%	6.5%	8.9%	9.4%	9.2%	10.0%	8.3%	8.7%	8.0%	7.3%	4.6%	3.7%	2.7%	1.4%	1.3%	100.0%
Sum of 4ax semi	3.6%	4.7%	5.6%	10.0%	10.8%	11.4%	10.9%	8.0%	7.5%	7.0%	6.6%	6.0%	3.5%	2.1%	1.5%	1.0%	100.0%
Sum of 5+ ax semi	4.1%	4.9%	6.2%	9.6%	10.2%	10.4%	10.1%	7.2%	6.7%	6.2%	5.6%	4.8%	4.2%	3.8%	3.3%	2.9%	100.0%
Sum of BUS&HTWT	5.7%	8.2%	8.8%	9.6%	8.0%	7.7%	7.9%	6.5%	7.7%	8.3%	7.0%	5.4%	3.7%	2.4%	1.7%	1.5%	100.0%
Sum of Twins	8.7%	6.8%	5.9%	6.9%	8.0%	6.4%	5.8%	4.1%	4.3%	4.5%	3.6%	4.4%	4.5%	5.3%	9.3%	11.6%	100.0%

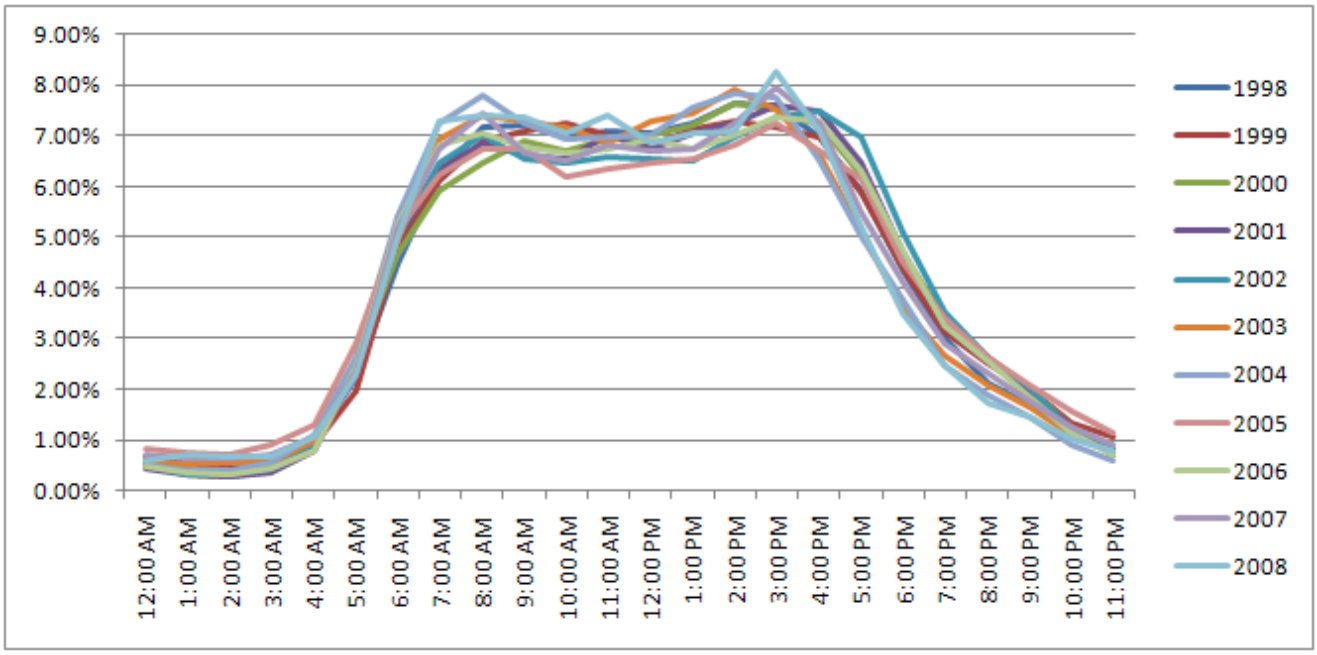


HISTORICAL HOURLY TRENDS – 1998 - 2008

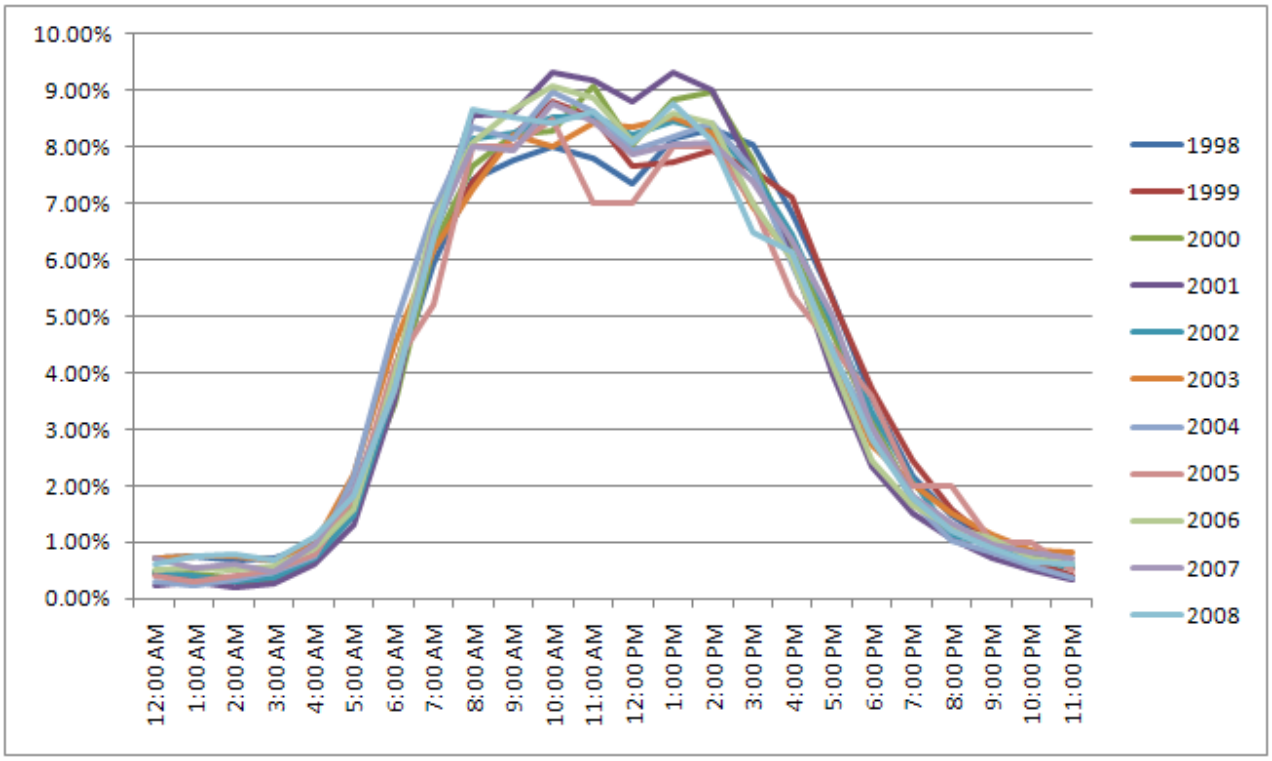
Auto – Hourly Percent of the 24 Hour Period



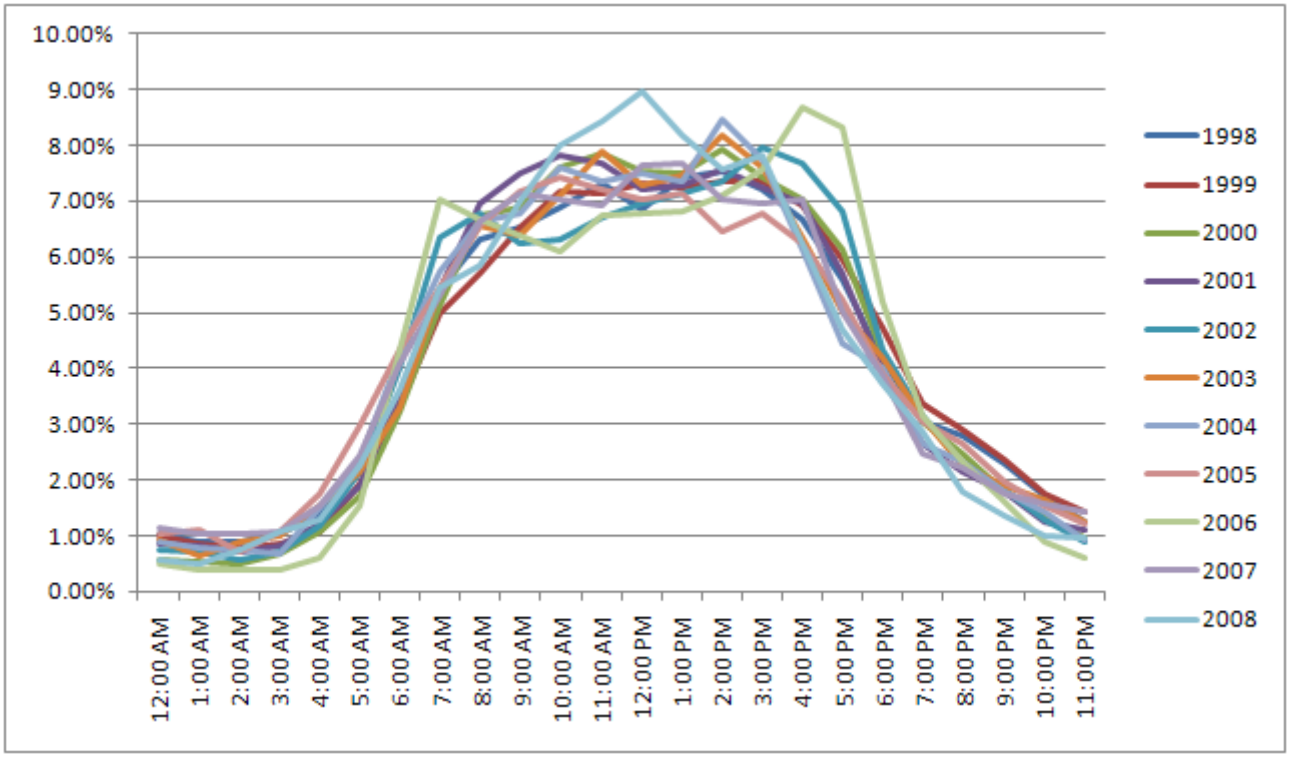
2 Ax Su – Hourly Percent of the 24 Hour Period



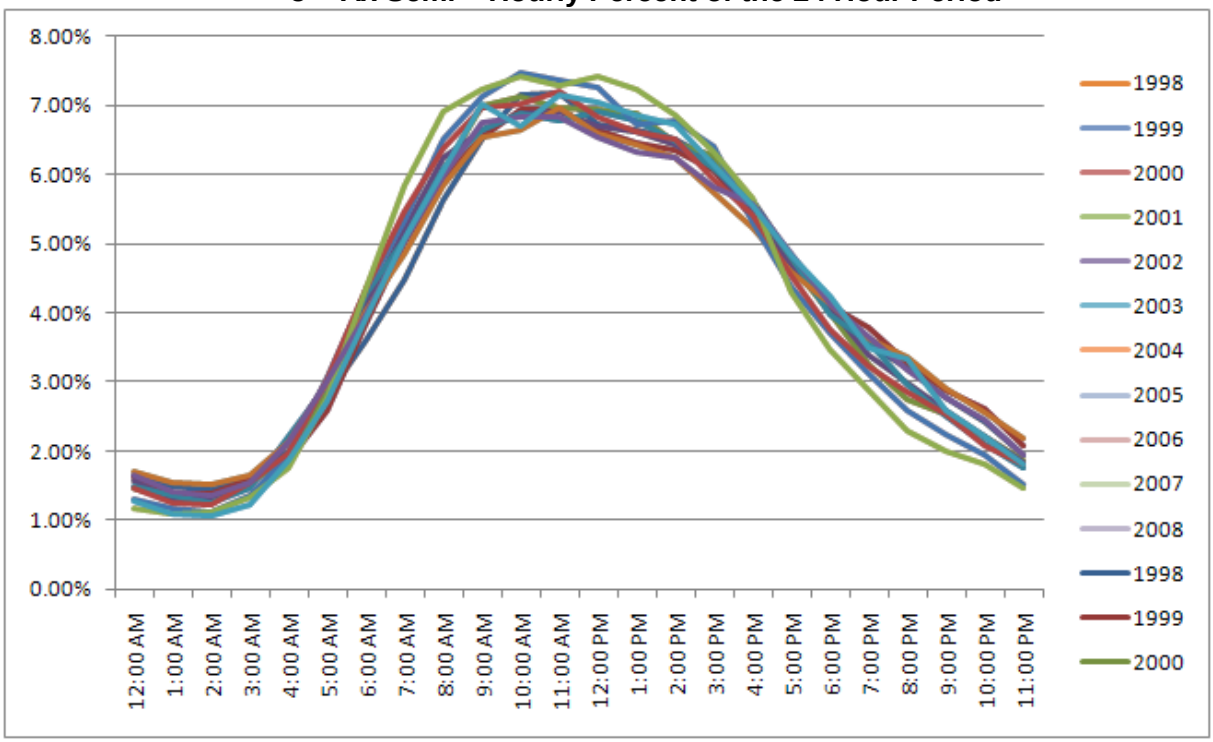
3 + Ax Su – Hourly Percent of the 24 Hour Period



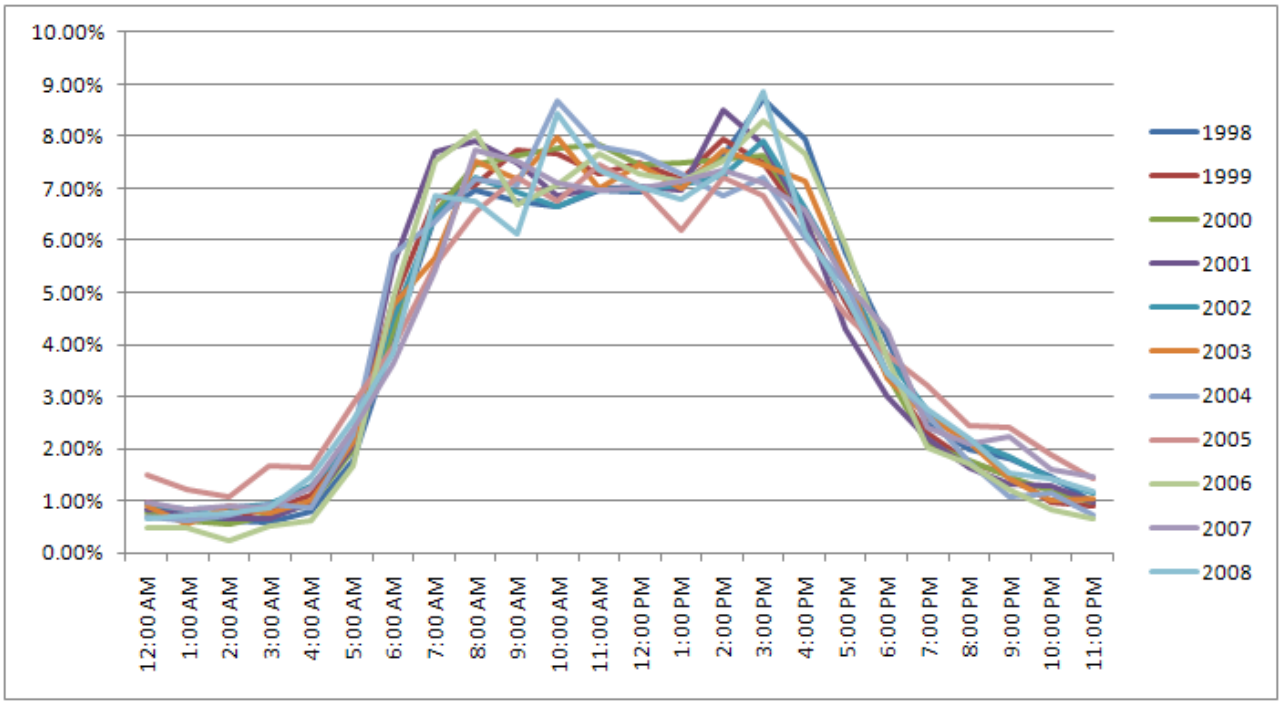
3 & 4 Ax Semi – Hourly Percent of the 24 Hour Period



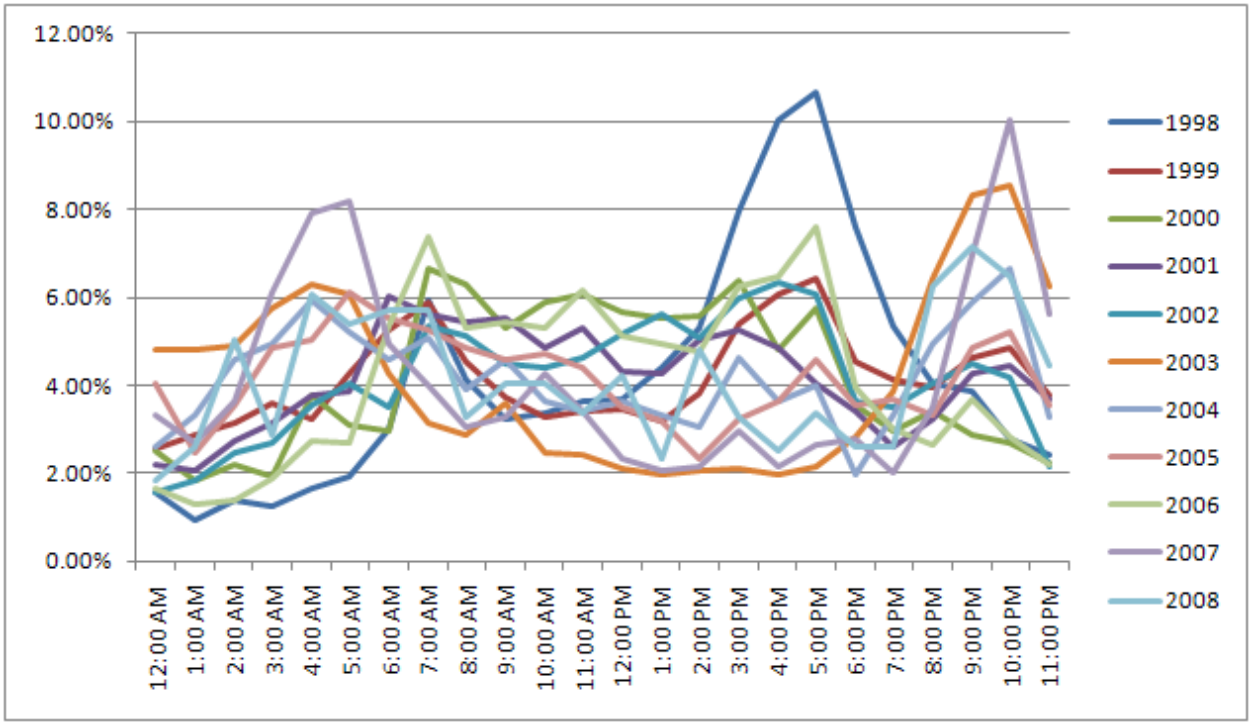
5 + Ax Semi – Hourly Percent of the 24 Hour Period



Bus and Heavy Truck w/ Trailer – Hourly Percent of the 24 Hour Period



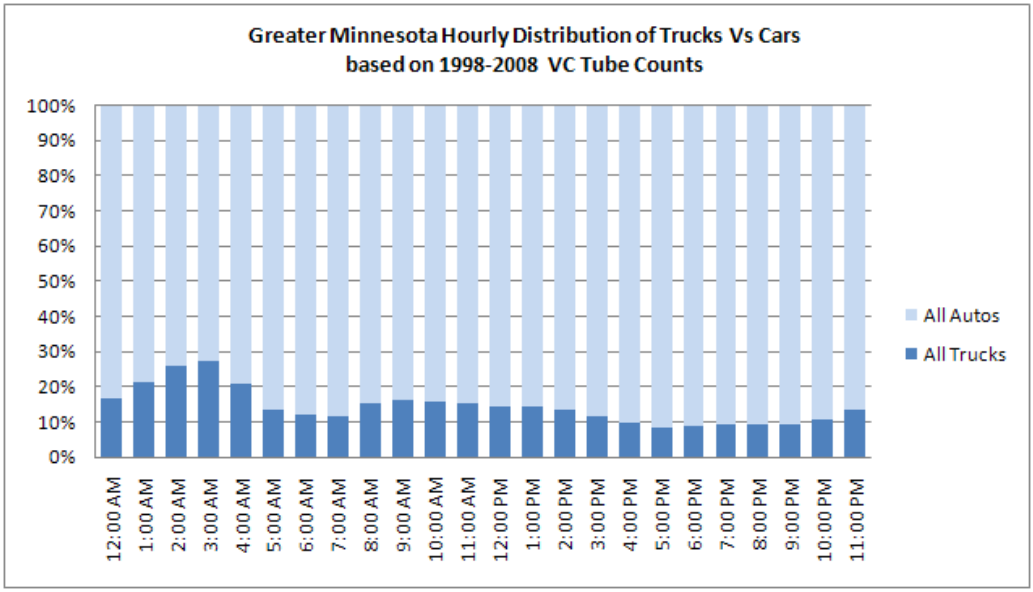
Twin Trailer – Hourly Percent of the 24 Hour Period

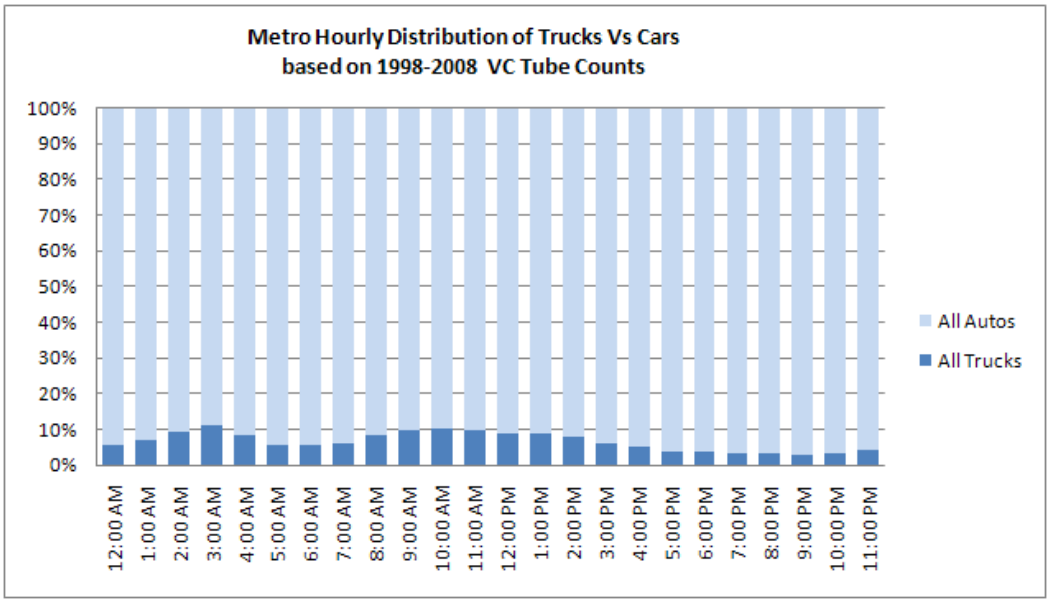


The preceding seven charts portray a consistent daily pattern of traffic flow on an hour-by-hour basis over the typical week-day period by selected vehicle classification sites (weekends are excluded from this data since most of our traffic is counted on weekdays). Similar distributions are evident when comparing this data to older data presented elsewhere in this manual. The data is a compilation of ten years of hourly tube counts taken by Mn/DOT between 1998 and 2008. The last chart above shows the erratic nature of the twin trailer category. There have never been enough of them counted over the last several years to establish any trend – as evidenced by the haphazard hourly distribution pattern shown.

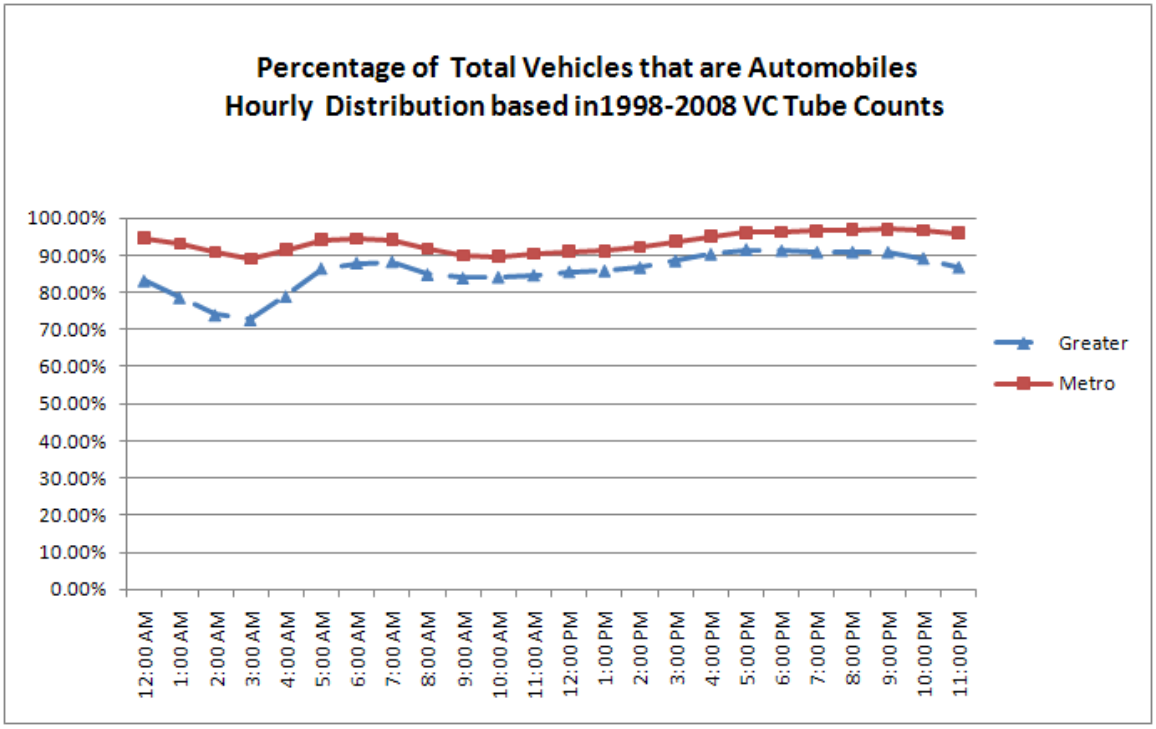
Autos (which include pickup trucks) have an A.M. and a P.M. peak (usually around 7am in the morning and 4-5pm in the afternoon). Conversely, trucks display more of a bell-shaped traffic pattern – with more trucks between the hours or 8am through 3 pm (off peak rush hour). ***To summarize, the charts above show that each vehicle is X% of that specific vehicle type for 24 hours, i.e. of all 5 axles, x% occurs at xx time (the universe of 5 axles is 100***%).

The following charts show the percent each vehicle is of hourly traffic for the 24-hour period. Unlike the previous charts portraying percent of the 24 hour total traffic by vehicle type, the following charts show the percent vehicles are of any particular hour. The data is a summation of 1998 through 2008 vehicle class tube counts and shows broad averages for selected vehicle types. Of note in the graphics is the trend of larger semis traveling between midnight and 5am – obviously avoiding the main stream of general car flow. Also note that the delivery type trucks – two and 3 axle single units- operate mid-day (between the am and pm peak hour for commuter traffic. The percents presented on the following tables are average percents, not representative of actual volumes. For example, on a lesser-traveled trunk highway in greater Minnesota there could be 20 total vehicles between 3 and 4 am and 5 five axle semis during the hour (meaning during that hour 20% of all traffic is 5 axle semis). Greater Minnesota has on average lower AADT, which usually produces a higher percent of trucks than in the Metro (following charts).

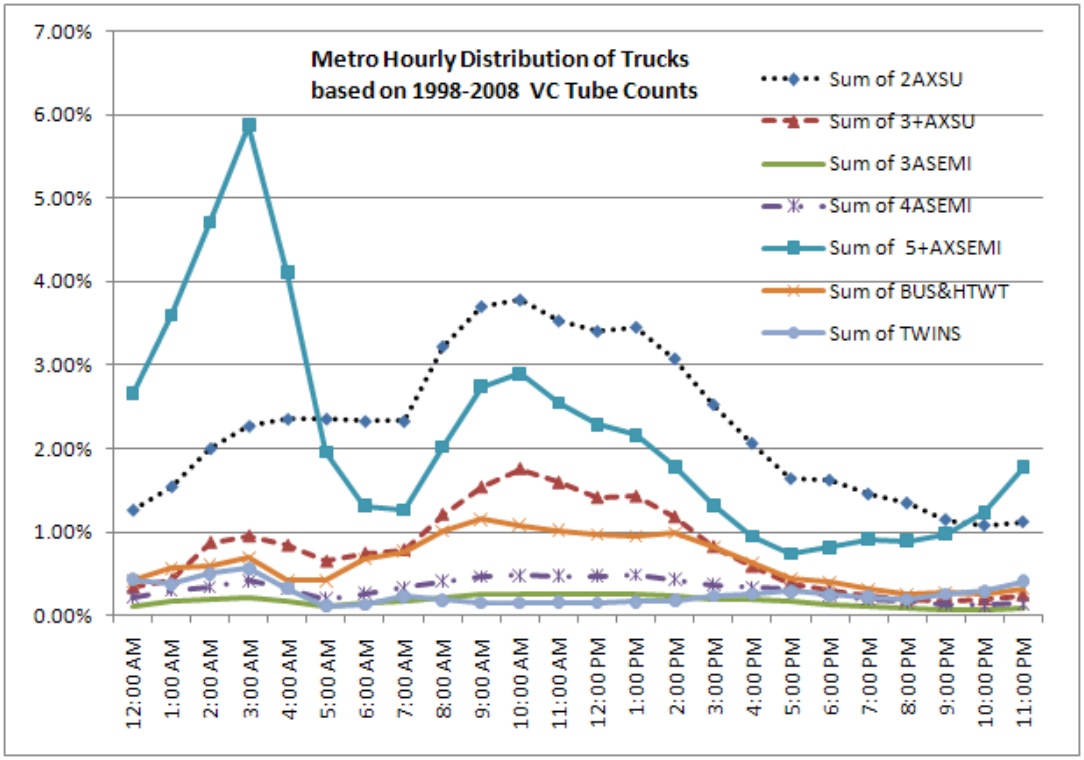


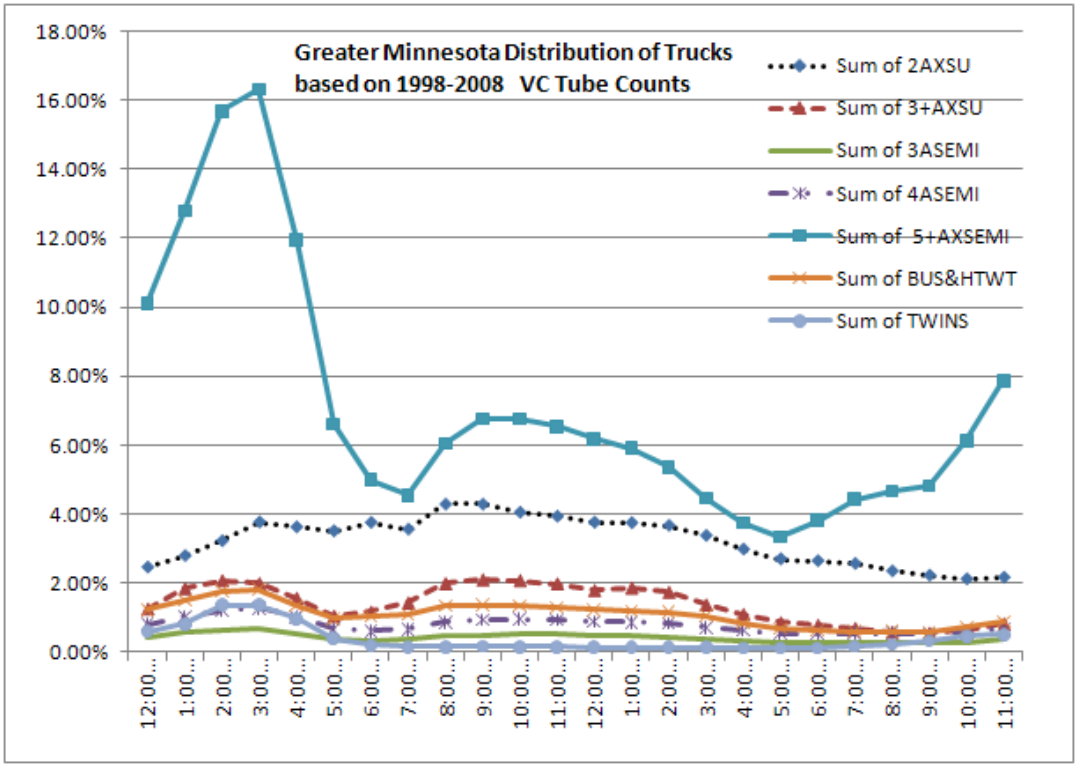


The following chart reveals the trend that in the Metro Area (Seven County Twin Cities Metropolitan Area) the higher AADT is shown as a percentage of total traffic.



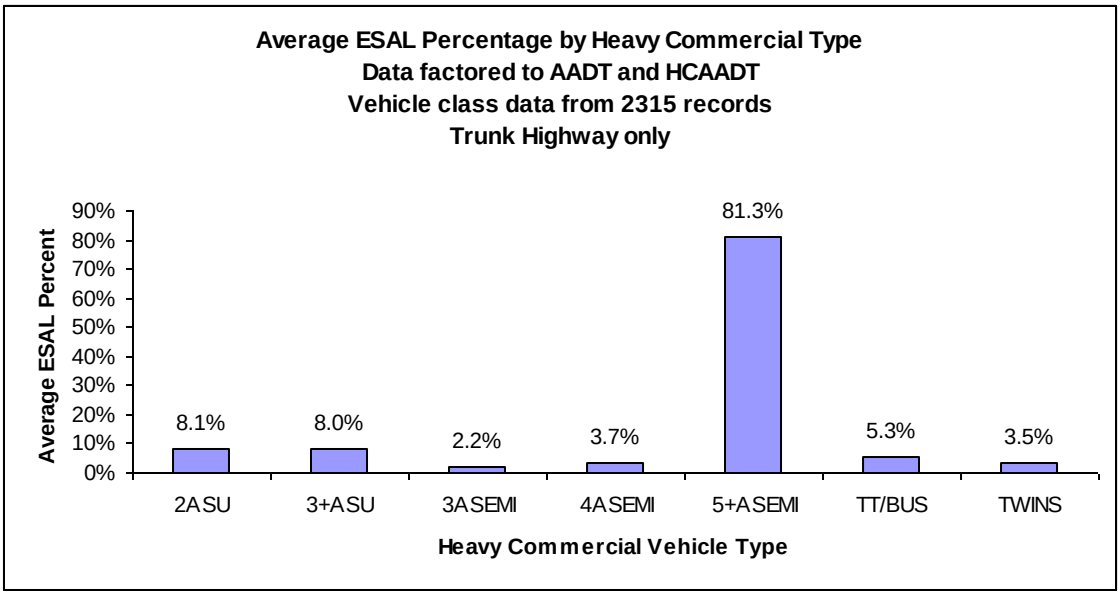
The following two charts show in detail the individual truck types as a percent of the hourly distribution of traffic. Note that in the Metro area trends are similar – although higher percentages in Greater Minnesota are consistent throughout truck categories.

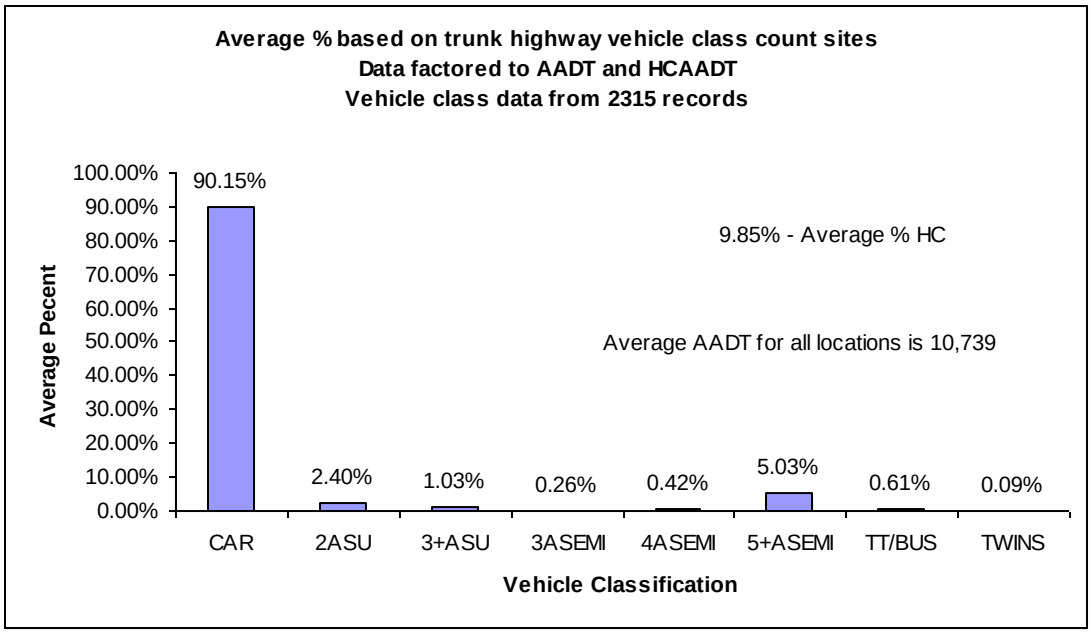




Of all truck types, the five-axle semis have the most effect on roadways. The following chart shows how dominant the five-axle category is on pavement design compared to other truck classifications. Whether partially or fully loaded, five-axle semis, more than any other vehicle type, cause the most damage to roadways (over 80%).

An average of selected vehicle class sites shows a few other trends. The five-axle semi category makes up about half of all heavy trucks and cars comprise about 90% of the total traffic stream. In project specific analysis, averaging percents would probably be not statistically valid and weighted averages should be used. In many cases, analysis of percents can distort the fact that higher percent changes and variations most often occur in lower volume routes. Conversely, higher volume roadways may have smaller percent changes in volumes. Caution should be used when making comparisons using raw volumes and/or raw percents.





TRANSIT, BUS AND ESALS INFORMATION

Recent research has shown that in many cases ESALS have been underestimated for buses – particularly heavy loaded regular MTC buses and articulated MTC buses. Information from MTC states that a regular MTC bus is 40 feet, weights about 29,000 pounds empty and about 35,000 pounds full (150 pound person with 43 seats). The empty weight is distributed as follows – 19,000 pound rear, 10,000 pound front axle.

An articulated MTC bus has 3 axles and is 60 feet long, weights 41,500 pounds empty and 51,000 pounds full (150 pound person with 65 seats). The empty weight is distributed as follows – 25,000 pounds rear (heaviest with the refrigeration and transmission on the rear axle), and the front two axles about 8,200 pounds each. Our current default ESAL for buses (which we lump in with truck trailers) is .57 flexible and .74 rigid.

What these means from a forecasting viewpoint is that if you know your route is a bus lane facility and contains these type of buses, you may probably want to increase the ESAL factors for these vehicles. As you know from previous sections of the manual, pages can be un-protected and the MnESAL can be manipulated manually. In this case, merely change the factor value on the bottom of the A or B worksheet. The following shows the principles discussed above and various ESAL factors.

Obviously, the ESAL value for a bus lies somewhere in between the minimum and the maximum. The ESALs below indicate our default values are low and TDA will be revisiting the bus factor in the near future.

Typical MTC City bus ESAL Calculations

29,000 lbs empty
35,000 lbs full

= 1.33 ESAL Empty
= 2.44 ESAL Full

Empty - 19000 lbs - 1.24 ESAL
Full - 22000 lbs - 2.18 ESAL

Empty - 10000 lbs -.0877 ESAL
Full - 13000 lbs - .264 ESAL

41,500 lbs empty
51,000 lbs full

= 3.60 ESAL Empty
= 5.70 ESAL Full

Empty - 25000 lbs – 3.53 ESAL
Full - 28000 lbs – 5.39 ESAL

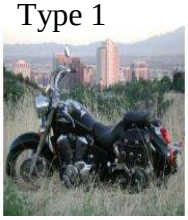
Empty - 8250 lbs - .035 ESAL
Full - 11250 lbs - .155 ESAL

Empty - 8250 lbs - .035 ESAL
Full - 11250 lbs - .155 ESAL

Mn/DOT Vehicle Classification Scheme

Passenger Vehicles

Type 1



Type 2

Type 3

Buses/ Truck with Trailer – Type 4

2 Axle Single Unit Truck – Type 5

3 Axle Single Unit Truck – Type 6

4+ Axle Single Unit Truck -Type 7

3 & 4 Axle Semi Truck – Type 8

5 Axle Semi Truck – Type 9

6+ Axle Semi Truck – Type 10

Twin Trailer Semi Truck – Type 11,12,13

5 Axle Semi -Split Tandem -Type 16

The Mn/DOT scheme for classifying vehicles is shown in the above picture. Among Mn/DOT's vehicle classifying programs, there are manual counts, tube counts, "Tirtl" counts, and Piezo counts. Trucks are counted and grouped in different methods. For manual counts, as previously stated, body type is recorded since manual counts are visually recorded by an individual. Other counting devices cannot determine the body type – only the number of axles that fit a standard classification. For traffic forecasting purposes, we use 8 vehicle types – they consist of the following categories grouped from the 13 categories shown above.

Vehicle Class Groupings For Forecasting

1) Passenger vehicles = Type 1 + Type 2 + Type 3 (Motorcycles + Cars + Pickups)

2) Truck Trailers and Buses = Type 4 (both categories are combined)

3) 2 Axle Single unit = Type 5 (2 axle single unit trucks)

4) 3 + Axle Single unit = Type 6 + Type 7 (3 + 4+ axle single unit trucks)

5) 3 Axle Semi = Type 8*.35 (3 + 4 axle semi)

6) 4 Axle Semi = Type 8*.65 (3 + 4 axle semi)

7) 5 + Axle Semi = Type 9 + Type 10 (5 + 6+ axle semi)

8) Twin Trailers = Type 11 + Type 12 + Type 13 (sum of 3 types of twin trailers)

Pavement Selection Process and ESALS – Additional Information (From Technical Memorandum No. 04-06-MAR-01, 2004, Engineering Services Division

The pavement selection process has three categories that a project may fall into: District, Informal, and Formal. They are discussed below:

1. *District Process* – where short projects meet the following criteria:
    a. Two-Lane Roadways – Projects less than 2 miles long
    b. Projects less than 30,000 square yards

The projects length/size listed above are determined using only the driving lanes, no turn lanes, parking lanes or auxiliary lanes.

2. *Informal Proces*s - involves determining the pavement type based on the amount of traffic, as measured by the length-weighted Bituminous Equivalent Standard Axle Loads (BESALs), and the sub grade soil strength.

Informal Flexible: Projects where the 20-year design lane BESALS (flexible / bituminous) are 7 million or less and the design sub grade R-value is greater than 40. Projects in this category will be constructed with bituminous.

Informal Rigid: Projects where the 20-year design lane BESALS exceed 10 million. Projects in this category will be constructed with concrete.

3. *Formal Process* – All projects not meeting the Informal criteria listed above. The pavement type will be determined by a detailed cost estimate

Pavement Selection Process and Design Options

20 Year Design Lane BESALs	**Subgrade Soil R-Value**	**Process Type Design(s)**	**Description of Design(s)**
1,000,000 or less	>40	Informal Flexible Design #6	Flexible - Aggregate Base (BAB) Flexible - Deep Strength (BDS)
1,000,000 or less	<=40	Formal Design #3 & 6	Rigid - Aggregate Base Flexible - Aggregate Base (BAB) Flexible - Deep Strength (BDS)
1,000,001 to 7,000,000	>40	Informal Flexible Design #4 & 5	Flexible - Aggregate Base (BAB) Flexible - Deep Strength (BDS)
1,000,001 to 7,000,000	<=40	Formal Design #1,2,4 & 5	Rigid - Open Graded Base Rigid - Selected Granual Flexible - Aggregate Base (BAB) Flexible - Deep Strength (BDS)
7,000,001 to 10,000,000	All Values	Formal Design #1,2,4 & 5	Rigid - Open Graded Base Rigid - Selected Granual Flexible - Aggregate Base (BAB) Flexible - Deep Strength (BDS)
Over 10,000,000	All Values	Informal Rigid Design #1 and 2	Rigid - Aggregate Base Rigid - Open Graded Base

Miscellaneous Tips, Hints, and Information related to Traffic Forecasting

- Raw data on trunk highway sections are stored using "route-true mileage." The reference post is calculated by a program based on the log point listing location of the RP signs and the location of what we are looking at. Also, having True Mileage lets us plot our data on a map in Arc View.

- Check B segments for "smoothness." In many cases, large increases in AADT within any given B segment can cause large variations in ESAL segment B values. This is partly due to the use of default percentages on the B segment. These percentages are only averages and can be changed if determined by the forecaster. However, if you suspect the large variation in B segment volumes are cars, then there will be less variation of total truck volumes along the route and the ESALS should be more uniform. Be aware of any LARGE swings in ESALS when comparing A and B segments.

- Currently, about 90% of all counts are tube counts (unless the location is impossible geometrically or structurally to count). Special requests and body type data will often necessitate manual counts. If it is unsafe to set tubes, a variety of non-intrusive devices exist. Contact TDA for consultation.

- ATRs are the basis for adjustment factors used to take 48 hour tube counts and 16 hour manual counts and factor them up to AADT. A SAS program is used to analyze data from the ATRs to look for similar characteristics—called clustering.

- On the B segment worksheet (bottom), there is a new message for adding or subtracting too many trucks from the A segment. If you try to subtract more than half of what exists on the A segment, that error will show up. Always try to make sure you do not "take away" more vehicles by individual class from the B segment then exist on the A. Remember, the B segments adds or subtracts vehicles from the A segment using two default values. The percents may have to "modified" to make sure every B segment "makes sense" when comparing to the A segment.

- Tube counts are set for 48 hours and manual counts are taken for 16 hours (6AM-10PM). The short duration classification counts are adjusted to annual average daily traffic volumes using factors developed from the continuous counters. These factors take into account the variations of truck volumes by month and day of week. The parent/child relationships developed have enabled the automation of the process for the production of heavy commercial vehicle type volumes at all HPMS segments. The Office of Transportation Data and Analysis has plans to install additional

Kistler WIMs and continuous classification systems over the next five years.

- Of the majority of recent tube counts taken in the passenger car class, 69.8% of vehicles were classified as cars, 29.2% as pickups, and 1% as motorcycles. That distribution is pretty much valid throughout the entire spectrum of class counts for type 1, 2, and 3 classifications.

- In certain groupings, truck with trailers and buses are classified the same. Currently, the distribution (again, pretty much similar throughout all data bases) is 81.1% buses and 18.9% trucks with trailers.

- Based on an average of all vehicle class count locations (mainly trunk highways and a few local roads), heavy trucks comprise about 10% of the traffic compared to 90% autos, pickups and motorcycles – of those 10% trucks, about 5% are 5 and 6 axle semis, with the next largest category 2 axle single unit trucks (at about 2.5%). The remaining truck categories usually average less than 1%.

- When doing a "back cast" or a forecast of ESALS over a prior 20 year period (say from 1984 to 2004), simply change the MnESAL forecasting program to the desired 20 year interval to obtain cumulative ESALs over a particular roadway for a specified time. Be sure and get all AADT for the years desired. For example, if you wanted to arrive at the total of cumulative ESALS over a stretch of road between 1992 and 2002, do the forecast in the regular way, only use the base year as 1992 and the forecast year as 2002 on the A or B segment of the MnESAL spreadsheet (and, of course, collect the appropriate vehicle class information).

- Just to reiterate body type data gives us a better idea of the weights of the individual truck types. We adjust these raw counts with factors that take the month of the count and the weekend volumes into account to give us a heavy commercial annual average daily traffic volume (HCAADT). The continuous classification data gives us the adjustment factors and the WIM data gives us the actual weights for every axle as it passes over the scales.

The charts and tables below compare an urban and rural vehicle type distribution for vehicle class data. Note the similar distribution pattern between interstate and arterial on urban and rural routes for the 2008 travel activity by functional system and the consistency over the years in this distribution pattern.

Functional System	Motorcycles	Passenger Cars	Light Trucks	Buses	Single Unit Trucks	Combination Trucks
Rural Interstate	0.80%	59.54%	25.35%	0.36%	2.54%	11.42%
Rural Other Arterial	0.83%	63.49%	26.82%	0.27%	3.29%	5.29%
Rural Other *	0.96%	66.92%	28.00%	0.35%	2.33%	1.44%
Urban Interstate	0.82%	65.42%	27.83%	0.30%	2.43%	3.19%
Urban Other Arterial	0.86%	66.25%	28.21%	0.31%	2.42%	1.95%
Urban Other *	0.97%	67.66%	28.30%	0.32%	1.78%	0.97%

* Indicates the historic Vehicle Class DATA from 1986 to 2008 (used for this analysis)

2007 Travel Activity by Vehicle Type by Functional System-Prepared by TDA 5-27-08 (Based on 2007 Vehicle class Data)

Percent

Functional System	Motorcycles	Passenger Cars	Light Trucks	Buses	Single Unit Trucks	Combination Trucks
Rural Interstate	0.87%	60.81%	25.44%	0.22%	2.15%	10.50%
Rural Other Arterial	0.92%	64.48%	26.97%	0.23%	2.86%	4.53%
Rural Other	0.96%	66.92%	28.00%	0.35%	2.33%	1.44%
Urban Interstate	0.92%	64.51%	26.99%	0.27%	2.69%	4.61%
Urban Other Arterial	0.96%	66.85%	27.97%	0.25%	2.25%	1.73%
Urban Other	0.97%	67.66%	28.30%	0.32%	1.78%	0.97%

Decimal

Functional System	Motorcycles	Passenger Cars	Light Trucks	Buses	Single Unit Trucks	Combination Trucks
Rural Interstate	0.0087	0.6081	0.2544	0.0022	0.0215	0.1050
Rural Other Arterial	0.0092	0.6448	0.2697	0.0023	0.0286	0.0453
Rural Other	0.0096	0.6692	0.2800	0.0035	0.0233	0.0144
Urban Interstate	0.0092	0.6451	0.2699	0.0027	0.0269	0.0461
Urban Other Arterial	0.0096	0.6685	0.2797	0.0025	0.0225	0.0173
Urban Other	0.0097	0.6766	0.2830	0.0032	0.0178	0.0097

Trunk Highway Rural/Urban 1986-2009 HC average percents by vehicle type based on historic VC tube counts

AREA	Sum of 2ASU	Sum of 3+ASU	Sum of 3ASEMI	Sum of 4ASEMI	Sum of 5+ASEMI	Sum of TT/BUS	Sum of TWINS	Sum of AADT
RURAL	149984	56668	17079	29115	404402	36380	9111	6682735
URBAN	562694	210793	37494	63400	939298	127450	19540	33844712
#N/A	536	68	33	49	640	73	15	26100

AREA	Sum of 2ASU	Sum of 3+ASU	Sum of 3ASEMI	Sum of 4ASEMI	Sum of 5+ASEMI	Sum of TT/BUS	Sum of TWINS	Sum of AADT	
RURAL	2.24%	0.85%	0.26%	0.44%	6.05%	0.54%	0.14%	100.00%	**10.52%**
URBAN	1.66%	0.62%	0.11%	0.19%	2.78%	0.38%	0.06%	100.00%	**5.79%**

	RURAL	URBAN
Sum of 2ASU	2.24%	1.66%
Sum of 3+ASU	0.85%	0.62%
Sum of 3ASEMI	0.26%	0.11%
Sum of 4ASEMI	0.44%	0.19%
Sum of 5+ASEMI	6.05%	2.78%
Sum of TT/BUS	0.54%	0.38%
Sum of TWINS	0.14%	0.06%
	10.52%	5.79%

For this purpose, the definition of urban and rural has changed
urban is cities>5000, 7 Co Met Area plus Chisago County
rural is all else
information from Tom R determinatioin of VC sites and their Rural Urb definition

RURAL / URBAN COUNTY STATE AID HIGHWAYS (CSAH) HEAVY COMMERCIAL PERCENTAGES

RURAL AADT RANGE	CAR	2ASU	3+ASU	3ASEMI	4ASEMI	5+ASEMI	TT/BUS	TWINS	TOTAL	HC PCT
1-300	86.72%	4.71%	2.24%	0.35%	0.71%	3.81%	1.45%	0.01%	100.00%	13.28%
301-750	86.56%	3.44%	2.17%	0.39%	0.69%	5.32%	1.40%	0.03%	100.00%	13.44%
751-1500	90.53%	3.69%	1.71%	0.33%	0.57%	2.10%	1.03%	0.02%	100.00%	9.47%
1500>	91.39%	2.32%	1.24%	0.16%	0.32%	3.33%	1.23%	0.01%	100.00%	8.61%

URBAN AADT RANGE	CAR	2ASU	3+ASU	3ASEMI	4ASEMI	5+ASEMI	TT/BUS	TWINS	TOTAL	HC PCT
1-300	95.60%	1.60%	0.40%	0.40%	0.40%	0.40%	1.20%	0.00%	100.00%	4.40%
301-750	92.53%	3.70%	1.62%	0.14%	0.24%	1.23%	0.48%	0.07%	100.00%	7.47%
751-1500	94.71%	2.14%	0.98%	0.19%	0.30%	0.94%	0.71%	0.02%	100.00%	5.29%
1500>	96.44%	1.52%	0.46%	0.09%	0.12%	0.89%	0.47%	0.02%	100.00%	3.56%

Note: Data from 2007 and 2008 County State Aid Study (Mankato State University) and 1986 to 2002 vehicle class data (Mn/DOT)
Urban is defined as the area within the boundaries of a city with 5000 or more population and the Twin Cities Metropolitan Area

Rural / Urban County State Aid Highways (CSAH) Heavy commercial percentages

AREA	Sum of 2ASU	Sum of 3+ASU	Sum of 3ASEMI	Sum of 4ASEMI	Sum of 5+ASEMI	Sum of TT/BUS	Sum of TWINS	Sum of AADT
RURAL	6604	3416	578	1049	6784	2493	38	208135
URBAN	21840	6631	1312	1774	12755	6702	269	1434353

AREA	Sum of 2ASU	Sum of 3+ASU	Sum of 3ASEMI	Sum of 4ASEMI	Sum of 5+ASEMI	Sum of TT/BUS	Sum of TWINS	Sum of AADT	
RURAL	3.17%	1.64%	0.28%	0.50%	3.26%	1.20%	0.02%	100.00%	10.07%
URBAN	1.52%	0.46%	0.09%	0.12%	0.89%	0.47%	0.02%	100.00%	3.58%

Note: Data from 2007 and 2008 County State Aid Study (Mankato State University) and 1986 to 2002 vehicle class data (Mn/DOT)
Urban is defined as the area within the boundaries of a city with 5000 or more population and the Twin Cities 7 Count Metropolitan Area plus Chisago Cnty

We have established defaults for the local road system. Once again, that defines our B section. However, the A segment, being the vehicle class site location, usually will have actual data. From our historical data bases, we have created the above chart to be used as guideline. We don't encourage defaults usage on the trunk highway system. However, if little else is known and time may be short, and a count is impossible or impractical, the table on page 178 shows what the average percents by rural and urban on the TRUNK HIGHWAY system. NOT TO BE CONFUSED WITH LOCAL ROAD DEFAULTS shown above. These are merely information and guidelines, as they show the average rural and urban percentages as a conglomerate on all trunk highways in Minnesota (merely an average). This is presented for informational usage only and should not be used in place of actual vehicle class counts..

Additional historical vehicle class distribution by functional information is shown below to show the consistency of these trends over time

Vehicle Class Distribution - Based on 2005 Vehicle Class Data

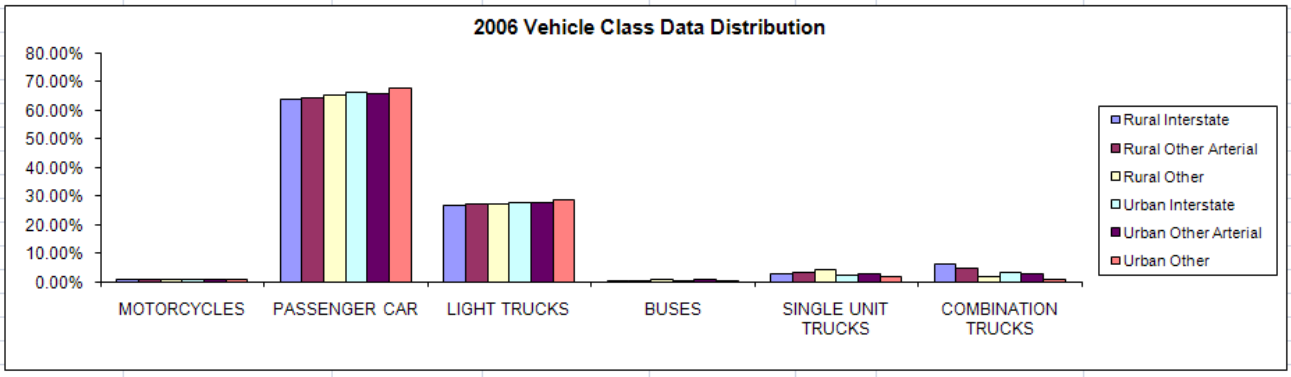
RURAL/URBAN	FUNCTIONAL SYSTEM	MOTORCYCLES	PASSENGER CAR	LIGHT TRUCKS	BUSES	SINGLE UNIT TRUCKS	COMBINATION TRUCKS
Rural	Interstate	0.83%	57.88%	24.21%	1.12%	3.13%	12.82%
Rural	Other Arterial	0.89%	62.12%	25.99%	0.60%	4.52%	5.88%
Rural	Other	0.88%	61.72%	25.82%	0.38%	8.79%	2.42%
Urban	Interstate	0.96%	66.92%	28.00%	0.20%	1.63%	2.30%
Urban	Other Arterial	0.96%	67.02%	28.04%	0.42%	2.11%	1.45%
Urban	Other	0.96%	66.87%	27.98%	0.35%	2.00%	1.84%

Vehicle Class Distribution - Based on 2006 Vehicle Class Data

RURAL/URBAN	FUNCTIONAL SYSTEM	MOTORCYCLES	PASSENGER CAR	LIGHT TRUCKS	BUSES	SINGLE UNIT TRUCKS	COMBINATION TRUCKS
Rural	Interstate	0.91%	63.58%	26.60%	0.25%	2.46%	6.20%
Rural	Other Arterial	0.92%	64.28%	26.89%	0.25%	2.97%	4.69%
Rural	Other	0.93%	65.19%	27.27%	0.52%	4.22%	1.86%
Urban	Interstate	0.94%	65.90%	27.57%	0.30%	2.18%	3.10%
Urban	Other Arterial	0.94%	65.47%	27.39%	0.53%	2.91%	2.76%
Urban	Other	0.97%	67.71%	28.33%	0.34%	1.93%	0.73%

Vehicle Class Distribution - Based on 1986 through 2006 Vehicle Class Data

RURAL/URBAN	FUNCTIONAL SYSTEM	MOTORCYCLES	PASSENGER CAR	LIGHT TRUCKS	BUSES	SINGLE UNIT TRUCKS	COMBINATION TRUCKS
Rural	Interstate	0.88%	61.57%	25.75%	0.39%	2.16%	9.25%
Rural	Other Arterial	0.91%	63.81%	26.69%	0.42%	3.20%	4.96%
Rural	Other	0.96%	66.92%	28.00%	0.35%	2.33%	1.44%
Urban	Interstate	0.94%	65.95%	27.59%	0.27%	2.06%	3.19%
Urban	Other Arterial	0.95%	66.58%	27.85%	0.34%	2.27%	2.01%
Urban	Other	0.97%	67.66%	28.30%	0.32%	1.78%	0.97%



SAMPLE FORECAST INFORMATION

Note the topics addressed in the REMARKS section of the MnESAL in the example below. In this section the forecaster should discuss any related documentation that explains what he or she did in the preparation of the traffic forecast.

MINNESOTA DEPARTMENT OF TRANSPORTATION

MEMO

Transportation Data and Analysis
395 John Ireland Boulevard - MS 450
St. Paul, Minnesota 55155
Phone: (651) 296-1740
Fax: (651) 296-3311

September 22, 2005

To: GENE HICKS
SECTION DIRECTOR
TRAFFIC FORECASTING AND ANALYSIS -MS 450

From: Mark Levenson
Traffic Forecast Section

Subject: TRAFFIC FORECAST

Route:	TH19	SP#	4205-35
Letting Date:	November 17, 2006	Forecast #	F8-0501-U
Program Category:	RC	County:	LYON
Project Manager:	KNUTSON	District:	8
		Miles:	0.9
Project Limits:	TH23 TO TWP 205 CROSSING IN MARSHALL		

Enclosures (check those that apply):

	Project map	X	VCL expansion worksheet
X	Least squares analysis	X	Cumulative ESAL Report
X	Cumulative ESAL worksheet, Segment A		Other (describe)
	Cumulative ESAL worksheet, Segment B		Other (describe)
X	AADT and/or DHV traffic schematic diagram		

REMARKS:

Used vc site 2557 - counted once in 2004. In addition, a 2005 count was taken in the project area which has been currently processed. According to the district, a new high school will generate 1000 AADT around the time of the letting date for this project. Thus, we have added 1000 to the A segment future volume

Note the depth of information provided on the REMARKS section of the cover letter below.

MINNESOTA DEPARTMENT OF TRANSPORTATION

MEMO

Transportation Data and Analysis
395 John Ireland Boulevard - MS 450
St. Paul, Minnesota 55155

Phone: (651) 296-0217
Fax: (651) 296-3311

September 19, 2005

To: Bill Langston
District 8
Traffic Forecaster

From: Mark Levenson
Traffic Forecaster
C.O.

Subject: TRAFFIC FORECAST

Route: Th12/TH15 Junction
Letting Date: 2004
Program Category:
Project Manager:
Project Limits: Interstection of TH15 and TH12

SP#
Forecast #
County: Meeker / McLeod
District: 8
Miles:

Enclosures (check those that apply):

	Project map		VCL expansion worksheet
	Least squares analysis		Cumulative ESAL Report
	Cumulative ESAL worksheet, Segment A		Other (describe)
	Cumulative ESAL worksheet, Segment B		Other (describe)
	AADT and/or DHV traffic schematic diagram		

REMARKS:

Bill, this information is for your perusal. Four VC sites were used in this analysis. VCC 7406 had some problems with the 1997 count taken during construction season and some of the 1996 counts seem to be inaccurate. I have enclosed a preliminary forecast on each of the four legs of the project. Please call me and we can discuss any questions you have on this information. All of the information is attached. The VC counts appear to be more stable on TH12. The truck volumes on TH15 just south of TH12 are a B segment, taken from the A seg on TH15 just north of TH7. Truck patterns should probably be similar, as reflected in the B segment; However, I recommend you take some short truck counts on TH15 and compare the volumes with those of the older vehicle class counts. The latest VC counts on all legs are 1997 (old?)

Notice in the example below the necessity for a field visit.

MINNESOTA DEPARTMENT OF TRANSPORTATION

MEMO

Transportation Data and Analysis
395 John Ireland Boulevard - MS 450
St. Paul, Minnesota 55155

Phone: (651) 296-0217
Fax: (651) 296-3311

September 19, 2005

To: Rus Maki
Traffic Forecaster
Metro Division

From: GEORGE M. CEPRESS P.E.
STATE TRAFFIC FORECAST ENGINEER
CENTRAL OFFICE, MAIL STOP 450

Subject: TRAFFIC FORECAST

Route:	TH55	SP#	2723-109
Letting Date:	April 25, 2003	Forecast #	F-M-0216
Program Category:	RS	County:	Hennepin
Project Manager:	Scott	District:	Metro
		Miles:	3.53
Project Limits:	Old Rockford Road to I-494		

Enclosures (check those that apply):

	Project map	x	VCL expansion worksheet
x	Least squares analysis	x	Cumulative ESAL Report
x	Cumulative ESAL worksheet, Segment A		Other (describe)
x	Cumulative ESAL worksheet, Segment B		Other (describe)
x	AADT and/or DHV traffic schematic diagram		

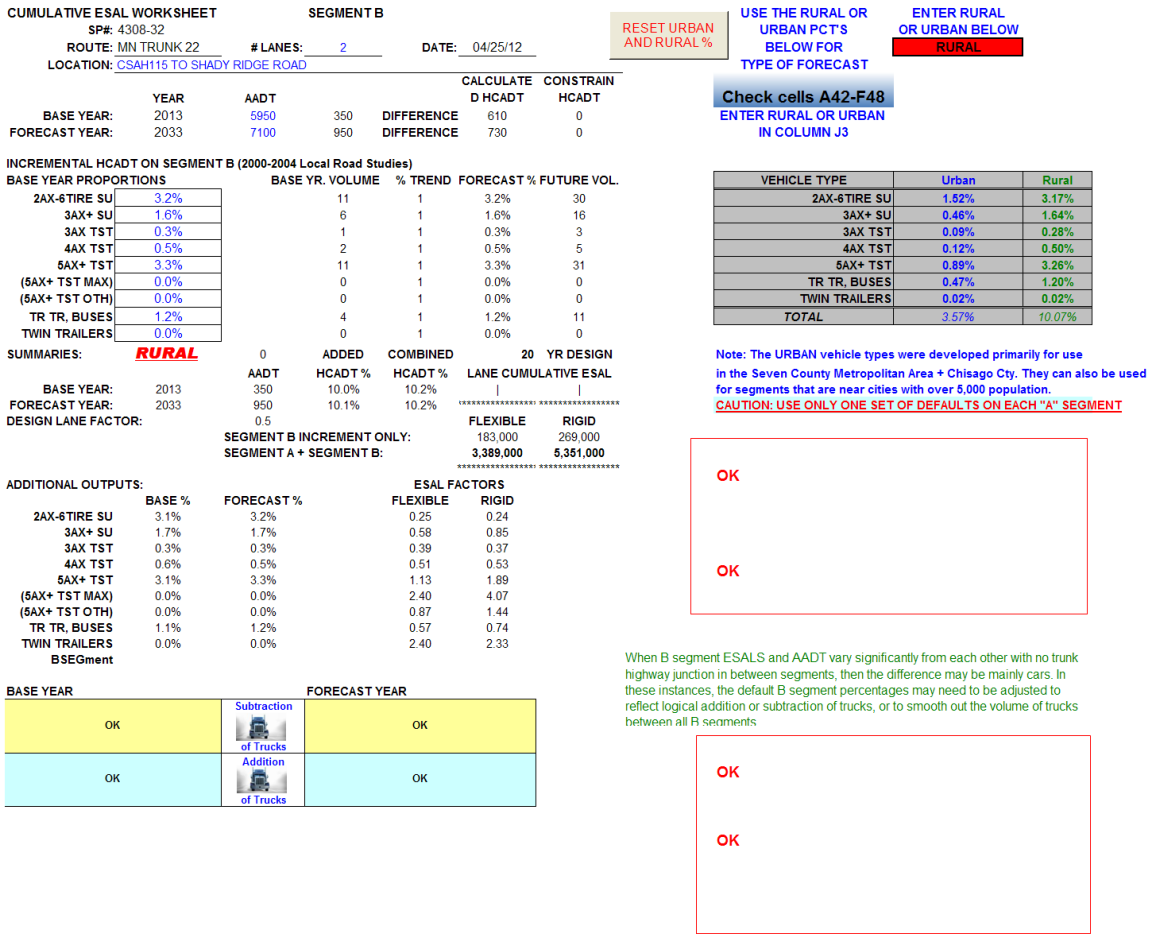
REMARKS:

For this project, vehicle class sites 8785 and 8784 were used. Due to discrepancies between the 1998 data and the next most recent - 1991 - a field trip and 5 axle semi counts resulted in dropping the older vehicle class counts. The on site observation was more in line with the 1998 tube counts and verified the 5 axle numbers - resulting in higher ESALS which reflects the current traffic on TH55 West Of I-494. It should be noted the high number of 4 axle semis observed on this site - which the older counts did not reflect, but were reflected in the 1998 counts.

CC: DAVE JANISCH
FILE

NEW CUMULATIVE ESAL WORKSHEET B EXAMPLE (2012)

The below is an example of the "New" Rural and Urban Default spreadsheet for the B segment. Simply type in "rural" or "urban" in the RED cell; this transfers automatically the appropriate vehicle percentage value into the Base Year Proportions column on the Cumulative ESAL Worksheet – Segment B



CUMULATIVE ESAL WORKSHEET — SEGMENT B

SP#: 4308-32
ROUTE: MN TRUNK 22 # LANES: 2 DATE: 04/25/12
LOCATION: CSAH115 TO SHADY RIDGE ROAD

RESET URBAN AND RURAL %

USE THE RURAL OR URBAN PCT'S BELOW FOR TYPE OF FORECAST

ENTER RURAL OR URBAN BELOW: RURAL

Check cells A42-F48

ENTER RURAL OR URBAN IN COLUMN J3

	YEAR	AADT			CALCULATED HCADT	CONSTRAIN HCADT
BASE YEAR:	2013	5950	350	DIFFERENCE	610	0
FORECAST YEAR:	2033	7100	950	DIFFERENCE	730	0

INCREMENTAL HCADT ON SEGMENT B (2000-2004 Local Road Studies)

BASE YEAR PROPORTIONS		BASE YR. VOLUME	% TREND	FORECAST %	FUTURE VOL.
2AX-6TIRE SU	3.2%	11	1	3.2%	30
3AX+ SU	1.6%	6	1	1.6%	16
3AX TST	0.3%	1	1	0.3%	3
4AX TST	0.5%	2	1	0.5%	5
5AX+ TST	3.3%	11	1	3.3%	31
(5AX+ TST MAX)	0.0%	0	1	0.0%	0
(5AX+ TST OTH)	0.0%	0	1	0.0%	0
TR TR, BUSES	1.2%	4	1	1.2%	11
TWIN TRAILERS	0.0%	0	1	0.0%	0

VEHICLE TYPE	Urban	Rural
2AX-6TIRE SU	1.52%	3.17%
3AX+ SU	0.46%	1.64%
3AX TST	0.09%	0.28%
4AX TST	0.12%	0.50%
5AX+ TST	0.89%	3.26%
TR TR, BUSES	0.47%	1.20%
TWIN TRAILERS	0.02%	0.02%
TOTAL	*3.57%*	*10.07%*

Note: The URBAN vehicle types were developed primarily for use in the Seven County Metropolitan Area + Chisago Cty. They can also be used for segments that are near cities with over 5,000 population.
CAUTION: USE ONLY ONE SET OF DEFAULTS ON EACH "A" SEGMENT

SUMMARIES: RURAL — 0 ADDED — COMBINED — 20 YR DESIGN

		AADT	HCADT %	HCADT %	LANE CUMULATIVE ESAL	
BASE YEAR:	2013	350	10.0%	10.2%		
FORECAST YEAR:	2033	950	10.1%	10.2%		
DESIGN LANE FACTOR:		0.5			FLEXIBLE	RIGID
		SEGMENT B INCREMENT ONLY:			183,000	269,000
		SEGMENT A + SEGMENT B:			3,389,000	5,351,000

OK

OK

ADDITIONAL OUTPUTS:

	BASE %	FORECAST %	ESAL FACTORS FLEXIBLE	RIGID
2AX-6TIRE SU	3.1%	3.2%	0.25	0.24
3AX+ SU	1.7%	1.7%	0.58	0.85
3AX TST	0.3%	0.3%	0.39	0.37
4AX TST	0.6%	0.5%	0.51	0.53
5AX+ TST	3.1%	3.3%	1.13	1.89
(5AX+ TST MAX)	0.0%	0.0%	2.40	4.07
(5AX+ TST OTH)	0.0%	0.0%	0.87	1.44
TR TR, BUSES	1.1%	1.2%	0.57	0.74
TWIN TRAILERS	0.0%	0.0%	2.40	2.33
BSEGment				

When B segment ESALS and AADT vary significantly from each other with no trunk highway junction in between segments, then the difference may be mainly cars. In these instances, the default B segment percentages may need to be adjusted to reflect logical addition or subtraction of trucks, or to smooth out the volume of trucks between all B segments

BASE YEAR		FORECAST YEAR
OK	Subtraction of Trucks	OK
OK	Addition of Trucks	OK

OK

OK

The red boxes with the OK will show up with an error message if 50% or more of the traffic is added or subtracted from the A segment. In most cases the error message reflects large changes in aadt between the A and B segments. This usually indicates a necessity for smoothing out the B segment or the need for another vehicle class site. In many instances, large increases in Greater Minnesota in traffic occurs when leaving or approaching cities. Most of this traffic is cars, as truck traffic usually is more constant between B segments. When these error messages occur, it is necessary that the forecasters compare the 50 percent rule of addition or subtraction for each truck category until the error message disappears.

NEW CUMULATIVE ESAL REPORT B EXAMPLE (2012)

The report cover of the A and B segment has been changed to simplify ESAL ranges for the end user of the traffic forecast. There has been some confusion previously as to the the increments of the ESAL time periods. Now, the designer will be able to determine the ESALS in five year time periods as well as the annual design lane ESALS. Also of note is that there are hidden files on the A and B report cover page(A47-G99 and A50 to G101). These normally are not used by the traffic forecasters, as they contain built in formulas and data relationships within the spreadsheet.

CUMULATIVE ESAL REPORT - B

DATE: 04/25/12

ROUTE #: MN TRUNK 22 **DISTRICT:** 8 **SP#:** 4308-32

FORECAST #: F8-1203 **COUNTY:** MCLEOD **MILES:** _____

DESCRIPTION: CSAH115 TO SHADY RIDGE ROAD

AUTHOR'S DISTRICT: ---> C.O. **AUTHOR:** LEVENSON

TRAFFIC SUMMARY

BASE YEAR NUMBER OF LANES (two way): 2

BASE YEAR --->	2013	DESIGN YEAR ---->	2033	GROWTH / YR (SIMPLE %)
AADT: two-way	5950		7100	1.0%
design-lane	2980		3550	1.0%
HCADT: two-way	610		730	1.0%
SINGLE UNITS:two-way	170		220	1.5%
TST'S: two-way	382		444	0.8%
5 Ax +: two-way	336		389	0.8%

ESAL SUMMARY

ANNUAL DESIGN LANE ESAL

FLEXIBLE:	133,931	154,203	+
RIGID:	211,783	243,230	+

CUMULATIVE DESIGN-LANE ESALS (10 TON) **Design-lane factor:** 0.5
FOR VARIABLE TIME PERIODS

BASE YEAR	DESIGN YEAR	TIME PERIOD	DESIGN-LANE TST'S	ESALS FLEXIBLE	ESALS RIGID
2013	2023	10 YEAR	207	1,712,000	2,706,000
2013	2028	15 YEAR	214	2,536,000	4,006,000
2013	**2033**	**20 YEAR**	**222**	**3,389,000**	**5,351,000**
2013	2038	25 YEAR	230	4,269,000	6,739,000
2013	2043	30 YEAR	238	5,178,000	8,172,000
2013	**2048**	**35 YEAR**	**245**	**6,115,000**	**9,649,000**

APPROVED BY: _____ **DATE:** _____

NEW CUMULATIVE ESAL WORKSHEET A EXAMPLE (2012)

CUMULATIVE ESALS WORKSHEET **SEGMENT A**

SP#:	4308-32				
ROUTE:	MN TRUNK 22	**# LANES:**	2	**DATE:**	04/25/12
LOCATION:	TH22(W JCT TH7) TO CSAH115				
VCL SITE #:	7142				

	YEAR	AADT	INIT CALC HCADT	CONSTRN HCADT	INIT CALC 5AX TST	CONSTRAIN 5AX TST
VEH.CLASS YR.:	2009	5200	530	0.0%	---	---
BASE YEAR:	2013	5600	570		326	
FORECAST YEAR:	2033	6150	630		358	

BASE YEAR PROPORTIONS		BASE YR. VOLUME	% TREND	FORECAST %	FUTURE VOL.
2AX-6TIRE SU	2.1%	116	1	2.1%	129
3AX+ SU	0.7%	40	1	0.7%	44
3AX TST	0.3%	16	1	0.3%	18
4AX TST	0.5%	27	1	0.5%	29
5AX+ TST	0	0	1	0.0%	0
(5AX+ TST MAX)	3.5%	196	1	3.5%	216
(5AX+ TST OTH)	2.3%	129	1	2.3%	142
TR TR, BUSES	0.6%	33	1	0.6%	36
TWIN TRAILERS	0.2%	14	1	0.2%	15

SUMMARIES:		AADT	HCADT	HCADT %	20 YR DESIGN LANE CUMULATIVE ESAL
2009	**COUNT:**	5200	530	10.2%	|
2013	**FORECAST:**	5600	570	10.2%	**********
2033	**FORECAST:**	6150	630	10.2%	

		FLEXIBLE	RIGID
DESIGN LANE FACTOR:	0.5	**3,206,000**	**5,082,000**
		**********	**********

ADDITIONAL OUTPUTS:			ESAL FACTORS	
	BASE %	FORECAST %	FLEXIBLE	RIGID
2AX-6TIRE SU	2.1%	2.1%	0.25	0.24
3AX+ SU	0.7%	0.7%	0.58	0.85
3AX TST	0.3%	0.3%	0.39	0.37
4AX TST	0.5%	0.5%	0.51	0.53
5AX+ TST	0.0%	0.0%	1.13	1.89
(5AX+ TST MAX)	3.5%	3.5%	2.40	4.07
(5AX+ TST OTH)	2.3%	2.3%	0.87	1.44
TR TR, BUSES	0.6%	0.6%	0.57	0.74
TWIN TRAILERS	0.3%	0.2%	2.40	2.33

Notes:

NEW CUMULATIVE ESAL REPORT A EXAMPLE (2012)

CUMULATIVE ESAL REPORT - A

DATE: 04/25/12

ROUTE #: MN TRUNK 22 **DISTRICT:** 8 **SP#:** 4308-32

FORECAST #: F8-1203 **COUNTY:** MCLEOD **MILES:**

DESCRIPTION: TH22(W JCT TH7) TO CSAH115

AUTHOR'S DISTRICT: ---> C.O. **AUTHOR:** LEVENSON

TRAFFIC SUMMARY

BASE YEAR NUMBER OF LANES (two way): 2

	BASE YEAR --->	2013	DESIGN YEAR ---->	2033	GROWTH / YR (SIMPLE %)
AADT: two-way		5600		6150	0.5%
design-lane		2800		3080	0.5%
HCADT: two-way		570		630	0.5%
SINGLE UNITS:two-way		160		170	0.3%
TST'S: two-way		368		405	0.5%
5 Ax +: two-way		325		358	0.5%
ESAL SUMMARY					
ANNUAL DESIGN LANE ESAL					
FLEXIBLE:		129804		142795	+
RIGID:		205722		226426	+

CUMULATIVE DESIGN-LANE ESALS (10 TON) **Design-lane factor:** 0.5
FOR VARIABLE TIME PERIODS

BASE YEAR	DESIGN YEAR	TIME PERIOD	DESIGN-LANE TST'S	ESALS FLEXIBLE	ESALS RIGID
2013	2023	10 Year	193	1,639,000	2,598,000
2013	2028	15 Year	198	2,413,000	3,826,000
2013	**2033**	**20 Year**	**203**	**3,206,000**	**5,082,000**
2013	2038	25 Year	207	4,016,000	6,367,000
2013	5630	30 Year	212	4,845,000	7,682,000
2013	**2048**	**35 Year**	**216**	**5,692,000**	**9,025,000**

I-35E TRAFFIC FORECAST USING DEFAULT HOURLY PERCENTAGES

Another real world example of a traffic forecast in which the vehicle class site was not applicable and a traffic count was necessary is the portion of I-35E from Shepard Road to Kellog Boulevard in the Twin Cities Area. In a section of this recent project, the vehicle class site was in the same trunk highway segment, but was not applicable since a portion of the project was restricted – allowing only 2 axle single unit trucks and buses. Since the project would require an actual forecast of trucks using the facility, and since illegal trucks were reported and counted during this time, it was decided to forecast the ESALS with two scenarios – one using allowed vehicles only and the other forecast including illegal vehicles using the restricted roadway.

Using default factors developed for individual vehicle types (shown below for the Twin Cities Metropolitan area), we are able to take short counts and factor them up to the average percent each vehicle type is of a specific hour. In this instance, we need not count passenger cars since there would be too many and there were 4 loop detectors in the section of the road that captured ***total*** traffic. We simply counted and classified the number of trucks and subtracted them from the total vehicles to arrive at the cars and pickups (4,513).

We counted and classified traffic from 10am to 11am and completed the vehicle classification shown below. Using default expansion factors we factored up the one-hour to count to 24 hours. Note that the overweight 5 axle semis are included in this iteration for ESAL calculations only. We thus will arrive at percent heavy commercial for our traffic forecasting vehicle types, which we will run through our factoring program on the MnESAL spreadsheet. Note the 4,567 traffic total on all loop detectors shown on the next page.

Loop Detector 24 hour volumes for the I-35E project at Shepard Road

EXAMPLE OF FACTORING UP ONE HOUR COUNT TO 24 HOUR USING VEHICLE CLASS COUNT AVERAGES FOR TWIN CITY METRO AREA
DATA WAS AVERAGE OF 2000 THROUGH 2004 VEHICLE CLASS TUBE COUNTS

SUBJECT: TRAFFIC FORECAST CALCULATIONS

Route: I35E
Letting Date: 02/27/2009
Program Category: Preservation
Project Manager: Richard Martig

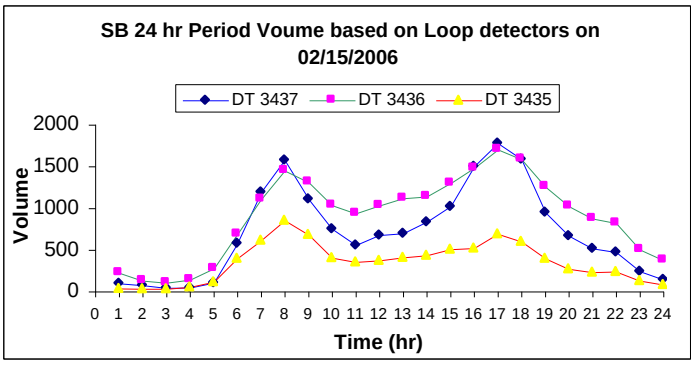
SP: 6280-320
Forecast #:
County: Ramsey
District: Metro
Miles: 3.95

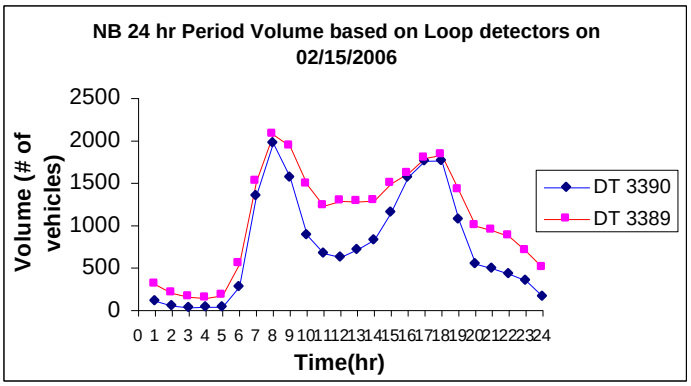
Project Limits: On I-35E from Shepard Road to Kellogg Blvd.
Time: 10:00-11:00 am

NB+SB	1hr % of 24 Hour		1 hr/ 24 hr %	Forecast 24hour count
CARS AND PICKUPS	4513	4.59%	98340	98340
2 AXLE 6 TIRE	24	7.12%	337	337
3+ AXSU	0	8.22%	0	0
3 AXLE SEMI	0	6.43%	0	0
4 AXLE SEMI	0	6.41%	0	0
5+ AXLE SEMI	3	8.35%	36	36
TR, TR, BUSES	27	7.87%	343	343
TWIN TRAILERS	0	4.86%	0	0
TOTALS	4567		99056	99056

Loop Detector 24 hour volumes for an I35E project at Shephard Road

Time	Det 3437	Det 3436	Det 3435	Det 3390	Det 3389	Total
1:00	99	224	35	109	305	772
2:00	75	132	31	53	201	492
3:00	45	104	32	33	158	372
4:00	46	142	54	40	144	426
5:00	105	276	115	39	175	710
6:00	579	687	399	276	549	2490
7:00	1195	1107	614	1352	1517	5785
8:00	1578	1449	853	1975	2073	7928
9:00	1110	1312	682	1568	1934	6606
10:00	753	1033	406	888	1487	4567
11:00	557	937	353	672	1230	3749
12:00	677	1031	372	626	1287	3993
13:00	699	1116	410	714	1282	4221
14:00	835	1139	435	827	1292	4528
15:00	1020	1299	508	1157	1492	5476
16:00	1502	1480	520	1569	1610	6681
17:00	1781	1703	691	1760	1791	7726
18:00	1586	1588	599	1764	1831	7368
19:00	952	1258	398	1075	1420	5103
20:00	669	1025	270	549	995	3508
21:00	517	877	231	493	942	3060
22:00	472	820	239	429	874	2834
23:00	241	501	130	353	702	1927
12:00	146	377	82	164	500	1269
Total	17239	21617	8459	18485	25791	91591





Additional products available in the Office of Transportation Data and Analysis

The Traffic Forecast Section has additional traffic forecasting related products and services for use by the Districts and others who request planning information. Besides a multitude of information available on our TDA website, additional products are on hand and available for use on demand. Among the products are:

1. Planning tool – Every year, as part of a federal requirement, TDA produces 20 year projections on every segment of roadway in Minnesota – AADT and HCAADT. As a byproduct of this annual effort, the Traffic Forecasting Section enhances that information to produce a more complete traffic planning tool. As well as 20 year projections by highway sequence number, additional fields include county, route system, location description, route number, route identification, beginning and ending reference point, vehicle class site, historical AADT in two year increments from 1992 until the present, an annual growth rate based on least squares linear regression, heavy commercial percent and current and projected traffic out to twenty years, and 20 year projected ESALS. This tool is a resource for planners, private citizens, and governmental agencies. However, other than actual historical data, the future year volume estimates are to be used for SYSTEM WIDE PLANNING OR DISTRICT PLANNING PURPOSES ONLY. They are not to be used for project specific analysis or project level forecasting.

2. Expanded historical vehicle class data by site –Every year, with the addition of new vehicle class count data, a historical record is kept and updated with the new information. This spreadsheet, updated in the Traffic Forecast Section annually, contains the same expanded data derived from the MnESAL process. It is the output from the expansion of raw counts that shows up on the "Vehicle Class Count Averages Worksheet." It serves mainly as a tool for the central office to speed up the review process for traffic forecasts produced by the districts. However, any district is welcome to contact Traffic Forecasting for verifying their information with our in house data. It serves as good double checking method. We call this reference tool our ESAL forecasting tool. It replaces the old ESAL PDF maps we previously sent to the soils folks in the district for preliminary ESSAL planning for resurfacing and reconditioning projects.

Among the current and future updates relating to forecasting are the following:

1. Interactive Traffic Data Map – The Traffic Forecasting and Analysis Section is currently working with the EGIS office to develop an interactive web-based mapping application that will include AADT, HCADT, and data collection site locations for volume data, vehicle classification data, automatic traffic recorders, and weigh-in-motion data. Vehicle classification site locations will allow users to reference ESAL estimates, forecasts and other information

provided in the Planning Tool. We have an estimated release date of fall, 2010. Additional information will be provided as it becomes available.

2. Traffic Forecast Map – A method for presenting completed traffic forecasts is in development. This data will likely be presented in an electronic format and is expected to be available in late 2010.

3. In addition to downloading the GIS shapefiles, Interactive Basemap may be used to view the new AADT and HCAADT data, as well as all historical data.

4. Our new website, updated in April of 2012 has a lot of the elements of 1,2, and 2 discussed above

5. A new method for roundabout forecasting is being developed currently and can be obtained from the Traffic Forecasting and Analysis Section. Contact Tom Nelson at 651 366 3868.

6. As of May 2012, the Traffic Forecasting and Analysis will gradually implementing a new data warehousing software system that will provide a set of automated tools for managing travel monitoring data. It will completely change how this office does business. Please check out the following link for more information regarding this future implementation product .http://chapsys.com/tradas_summary.html.

If you have any questions, comments on the Traffic Forecasting Manual, please contact Tom Nelson at 651 366 3868, Shannon McGrath at 651 366 3878, or Gene Hicks at 651 366 3856.