# Midwest RPO/LADCO
# Mobile Source Needs Assessment

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January 16th, 2004.

Draft LADCO Mobile source needs assessment 1/16/2004

# Introduction

The purpose of this document is to provide a foundation for discussions between Metropolitan Planning Organizations(MPOs), State Departments of Transportation(DOT's), and State Environmental Agencies. This document is not intended to replace existing EPA guidance only to supplement it with further detail for development of inventories that can be used for more highly resolved urban scale modeling inventories. US-EPA guidance attempts to guide users in the creation of county level typical day emissions inventories. This document is to act as a starting point for future discussions on the data requirements and deliverables of the organizations involved.

LADCO requires its inventories to be more finely resolved for chemical transport modeling so that emissions are spatially distributed to a finer resolution than the county for non-attainment areas. Additionally, the inventories required for modeling must be resolved to specific hours of specific days based on that day's meteorology. It is important to recognize that temporal variation in emissions can be as important as total mass of emissions to the photochemical models. Photochemical models are sensitive to the ratio of different pollutants such as Hydrocarbons(HC) and Nitrogen Oxides(NOX). In previous studies in California the differences in HC and Nitrogen on the weekends have been shown to make ozone formation more likely on weekends. The change has been attributed to the significant reduction in the number of Heavy Duty Diesel Vehicles on the roads which make up a significant portion of the overall NOX emissions while they make up a much smaller percentage of the HC emissions. We do not yet have evidence this is true in the midwest but it is something we are looking at. From this example it is clear that we need to resolve not just total emissions but also the variety of temporal variations in activity that can effect emissions.

## Description of Photochemical Inventory Modeling Process

Emissions inventory development for photochemical modeling is done differently than for seasonal or annual estimates that are part of the SIP inventory development process. The difference arise from the needs to generate day and hour specific estimates from a specific modeling cell. This separates the problem into 2 parts spatial allocation of emissions and temporal allocation of emissions.

The reason we need to spatially allocate emissions is that a photochemical models cut the study area into uniform 36, 12, or 4 Kilometer cells where all emissions activity is combined with meteorologic data to estimate rates of atmospheric chemistry and pollution formation. Typically the county level emissions inventory is separated into the sub-county cells based on the fraction of a given activity or land use in that cell. So if a cell has 20% of the counties human population then it will get 20% of the personal solvent use or if a single cell had 50% of the linear miles of urban interstates then it would also get 50% of the urban interstate automobile emissions. It is important to recognize that large interstates often do not have an even density of traffic within a county so this method might result in over-estimation of emissions in some cells and under estimation in other cells. This method also assumes that all interstates

have the same number of lanes of traffic so a cell with an 8 lane expressway would get the same emissions/mile as a cell with a 4 lane expressway. It is clear from this example that if those spatial differences were severe enough that a photochemical model might have difficulty reproducing reality.

LADCO uses the HPMS coding scheme set by federal highways to define functional class. These codes are used to classify US Census Bureau TIGER road networks into usable spatial surrogates. Where there are no discreet link based networks supplied the TIGER line files are use to allocate county wide VMT down to individual links based on the distribution of linear miles of roads in that functional class.

Table 1. Functional Classes

| Area Type | Facility Type | HPMS Functional Class |
|---|---|---|
| 0 | 1 | 01 - Rural Interstate |
| 0 | 2 | 02 - Rural Principal Arterial |
| 0 | 6 | 06 - Rural Minor Arterial |
| 0 | 7 | 07 - Rural Major Collector |
| 0 | 8 | 08 - Rural Minor Collector |
| 0 | 9 | 09 - Rural Local |
| 1 | 1 | 11 - Urban Interstate |
| 1 | 2 | 12 - Urban Freeway & Expressway |
| 1 | 4 | 14 - Urban Principal Arterial |
| 1 | 6 | 16 - Urban Minor Arterial |
| 1 | 7 | 17 - Urban Collector |
| 1 | 9 | 19 - Urban Local |

Temporal allocation of emissions is a more difficult problem to tackle. Because the photochemical models use the emissions for a given hour we must assure that the models are able to accurately calculate emissions by hour. This can be very important in the early morning when transportation emissions can be caught close to the ground below the low nocturnal mixing layer. Proper temporal allocation should be used to resolve the differences between the hourly activity on weekends versus

weekdays for heavy duty diesel vehicles. The three most common data elements needing discrete temporal profiles are Vehicle Miles Traveled(VMT), Vehicle Speed, and Vehicle Type Mix (Mix of cars to trucks). The temporal scales used to vary emissions are: Monthly, Day of week, and Hour of the day. These temporal profiles are hierarchical so that the variation can be portrayed as the hourly distribution of VMT by day of the week and by month of the year. A good example of where this might occur is a rural summer tourist destination where you would expect July Sunday afternoon VMT to be a substantial portion of the weekly VMT whereas January Sunday afternoon VMT would be significantly lower portion of the weekly and daily emissions. If you follow this to its logical conclusion you can expect that for each road type(say 8) in a region you could have an hourly profile of emissions for each day of the week and each month of the year for a total of 8 * 7 * 12 = 672 different temporal profiles of VMT. While this is likely for an area rich in data it is more common to show the values for 4 seasons and weekday, Friday, Saturday, Sunday for a total of 16 profiles. You might also expect that different functional classes have different profiles so that you may have road types 1 and 2 using a different temporal distribution than the rest of the road types. Often these temporal profiles are not available for every county but for consistency and statistical accuracy based on the number of traffic counts counties are pooled together so that the different non-attainment or geographic areas are pooled into groups of counties.

## Inclusion of MOBILE6 into emissions modeling process

USEPA's Mobile6 model is use by LADCO to calculate emissions. The estimates needed by LADCO differ from those calculated for SIP purposes because they must reflect the conditions at a discrete point in time under a specific set of meteorological conditions. Because of the number of Mobile6 runs necessary Mobile6 has been modified to calculate emissions in a more computationally efficient manner. We expect that given the difference in needs the emissions estimates generated by LADCO are going to differ from those generated by the State and MPO for SIP and conformity purposes. In spite of these differences it is important that the information used in both exercises can be traced back to the same fundamental VMT information and that the only differences are in the temporal and spatial allocation of these emissions estimates. LADCO is working to make the process of making the tools used to calculate emissions for photochemical modeling more transparent and usable for the transportation community. The primary way we will do this is by making the modeling tools publicly available and inexpensive to run.

Currently Mobile6 is incorporated into the process as an emissions factor generator that is executed by a larger mobile source model named MOVEM. MOVEM is responsible to combine all of the VMT and vehicle attribute data and fill in any missing data with various default values. MOVEM must generate the following values for every road type, cell, hour, and county in the domain.

VMT
Vehicle Speed

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Vehicle Mix
Temperature
Daily Max Temperature
Daily Minimum temperature
Hot and Cold Start Distribution or number of Starts

To understand the emissions estimates MOVEM will generate we must understand the values it will generate for any specific day. Once the vehicle activity is compiled and completed, MOVEM will then run MOBILE6 to generate a set of emissions factors. These emissions factors are then multiplied by the appropriate VMT to calculate emissions. Finally the Emissions estimates are speciated into the different chemical species needed by the photochemical models.

## Defining Data Needs into Classes

We have broken down the needs we will have into classes. The specific class that a state is able to attain for a given area will be effected by resources, availably of data, and proximity to an urban area with an ozone or PM2.5 non-attainment. Each class contains a list of data elements that define that class.

## Class 1. HPMS VMT

Class 1 Mobile Source inventories are inventories that meet the minimum requirements under US EPA=s Consolidated Emissions Reporting Rule(CERR). This includes county based HPMS with default speeds by HPMS facility Type and a complete Mobile 6 Input File.

| Data Type | Spatial | Temporal | Mobile6 Enhancements |
|---|---|---|---|
| VMT | County Total VMT by Facility Type | Seasonal VMT by Facility Type | |
| Speed | Urban/Rural Speed by facility type. | No Speed variation | |
| Fleet Mix | Statewide Average Mix | No mix change by season/day of week | Vehicle mix embedded in mobile6 |

## Class 2.HPMS VMT with Improved Temporal

A Class 2 mobile source inventory is the minimal practical inventory for chemical transport modeling. It contains improved temporal allocation from Class 1 inventories. Often these improvements are based on traffic count information. Spatial allocation for class 2 inventories does not exceed that of a class 1 inventory. LADCO would like to see all areas include the data for a Class 2 inventory

| Data Type | Spatial | Temporal | Mobile6 Enhancements |
|---|---|---|---|
| VMT | County Total VMT by Facility Type | VMT differs by season or month by facility type. Day of week variation in VMT is included as well as hour of the day distribution by day of the week. | |
| Speed | Urban/Rural Speed by facility type. | Speed variation by hour for heavily congested urban roads is included. | |
| Fleet Mix | Urban/Rural Vehicle Mix | Mix of Cars/Trucks by hour of the day and day of the week are included | Vehicle mix embedded in mobile6 |

## Class 3. Statewide Travel network.

A class 3 mobile source inventory begins to include specific links of road for major highways as well as all the information included in the class 2 inventory. A class 3 inventory would commonly be a statewide road network of interstates and state highways with minimal link specific VMT mix and speed information. It may contain more advanced temporal information like VMT or vehicle mix by hour from traffic counts for some of the links. This would be the preferred option for all LADCO states outside the urban non-attainment areas. It is unclear that outside urban areas exceeding this class will significantly improve model performance.

| Data Type | Spatial | Temporal | Mobile6 Enhancements |
|---|---|---|---|
| VMT | County Total VMT by Facility Type for arterial, local and collector facility | VMT differs by season or month by facility type. Day of week variation in | |

| | | | |
|---|---|---|---|
| | types. VMT by link for interstates and other highways. | VMT is included as well as hour of the day distribution by day of the week. | |
| Speed | Urban/Rural Speed by facility type for arterial, local and collector facility types. Link specific speeds for Interstates and other highways. | Speed variation by hour for heavily congested urban roads is included. | |
| Fleet Mix | Urban/Rural Vehicle Mix for arterial, local and collector facility types. Vehicle mix supplied by link for important interstates by hour. | Mix of Cars/Trucks by hour of the day and day of the week are included | Vehicle mix embedded in mobile6 |

## Class 4. Urban Travel Demand Model Network.

A class 4 inventory would include the standard outputs of an urban travel demand model. This would include each link of road as a discrete link with VMT and Speed by time period that has been modified to fit a semi-smooth distribution. These networks may also contain information by traffic analysis zone for trip starts and stops by hour. Class 4 networks are desirable for large urban non-attainment areas with a population of more than 500,000. LADCO will attempt to obtain networks from the following areas. Chicago, Milwaukee, Gary, Detroit, St Louis, Indianapolis, Cleveland, and Cincinnati. Other possible cities include Louisville, and Minneapolis.

| Data Type | Spatial | Temporal | Mobile6 Enhancements |
|---|---|---|---|
| VMT | County Total VMT by Facility Type for collector and non-modeled VMT. VMT by link for arterials and above. Freeway ramps modeled as discrete links. | VMT differs by month by facility type. Day of week variation in VMT is included as well as hour of the day distribution by day of the week. | Average start/stop information included in mobile6 by hour to show hot/cold start distribution. |
| | | | |

| | | | |
|---|---|---|---|
| Speed | Link specific speeds for all links. Speed should reflect actual speed but often reflects posted speed or un-congested speeds. | Speed variation by hour based on modeled time period. Some smoothing applied. May not reflect weekends | |
| Fleet Mix | Vehicle mix supplied road types and shows validation technique | Mix of Cars/Trucks by hour of the day and day of the week are included by facility type | Vehicle mix embedded in mobile6 |

## Class 5. Enhanced Urban Travel Demand Model

This inventory is based on the best possible urban travel demand model. It is unclear that many travel demand models can even meet these requirements. This would be the gold standard of travel demand models for emissions inventory development. It includes polygonal data on trip ends(Starts/Stops) like class 4 networks. It also includes vehicle type classifications by link by hour. The only way to do this would be to explicitly model freight external and internal to the urban area. These models include weekend congestion and describe the differences in freight and heavy duty diesel vehicles by day of week and hour. These inventories may only be valuable for the worst non-attainment areas with the most complex pollution regimes and atypical travel patterns like significant transportation hubs. These only tend to be cities where the population exceeds 2.5 Million.

| Data Type | Spatial | Temporal | Mobile6 Enhancements |
|---|---|---|---|
| VMT | County Total VMT by Facility Type for collector and non-modeled VMT. VMT by link for arterials and above. | VMT differs by month by facility type. Day of week variation in VMT is included as well as hour of the day distribution by day of the week. | Average start/stop information included in mobile6 by hour to show hot/cold start distribution. |
| Trip Starts/Stops | Shapefiles of the TAZs are included along with information on the number of starts/stops per TAZ | Starts and stops are allocated by hour and day of the week. | Mobile 6 input files reflect the options that zone specific starts/stops are in use. |
| Speed | Link specific speeds | Speed variation also | |

| | | | |
|---|---|---|---|
| | reflect significant congestion conditions resulting in < 10mph mean speeds. Speeds are validated with on the ground measurements. | includes vehicle type distribution to reflect vehicle speed differences by vehicle type. | |
| Fleet Mix | Link specific vehicle mix as a result of travel surveys and field measurements. | Fleet mix varies by day of week and hour of day for individual links. | |

LADCO will plan meetings with each MPO and State DOT to discuss needs and answer any questions about MPO specific implementation issues.

## RPO Data Exchange Protocol for Mobile sources

LADCO/Midwest RPO is one of five regional planning organizations that cover different parts of the United States. Their responsibility is to assist their own States and Tribes in the development of Regional Haze State Implementation Plans. The RPOs have designed a data exchange protocol for the many different types of data that RPO=s will generate to assure that consistent tools can be developed to utilize and analyze the data. The RPO Data exchange protocol can be found at. http://www.ladco.org/tech/emis/protocol/protocol.html . We will be putting the travel data from the MPO=s in the RPO Mobile Source Protocol Format. LADCO is working with the state of Michigan to develop a AHow To Guide for the RPO Data exchange Protocol@ to assist groups in the incorporation of their data into the format. The types of questions we will be answering include portrayal of complex temporal data, and inclusion of links specific networks.

## Reflection of HPMS Data In Process.

USEPA=s Guidance on emissions inventories for mobile sources insists on using the total VMT specified in the HPMS system as the benchmark for VMT Estimates. We would be ready to discuss how reflective HPMS vmt is of reality for the different areas of the states. It might be necessary to modify the VMT estimates from different sources to reflect HPMS or to have strong justification for varying from HPMS.

## Traffic Counts And Measurement Data For Temporal Profiles

It is clear from previous statements that LADCO will be looking for traffic count information to build complex temporal information. We will need to develop a plan for analyzing each state and MPO=s available traffic count information to generate the needed information. LADCO expects that analysis of

this data will be the responsibility of  LADCO and the state environmental agencies.

## Survey Form

Attached to this document are 3 survey forms for your consideration. They are to act as a guide for future discussion with the MPOs, DOTs, and EPAs. It would be helpful as part of the future discussions to be able to discuss the different questions and think about how different cells in the tables would be populated.

If you have any questions about this document feel free to contact Mark Janssen at LADCO at janssen@ladco.org or 847-296-2184

## LADCO Data Availability Checklist.Traffic Count Data. PTR and other Measurement methods

Who is the primary DOT contact person for this data.

The most important task for LADCO will be to obtain VMT by Hour by day of the week by month of the year. Do you forsee any problems with using the data to accomplish this.

Would LADCO be responsible for summarizing your data or would
We get raw data to analyze it ourselves _____

Is traffic count data available summed to the hour?

Does the data separate passenger vehicles from HDDV.

Does the data contain vehicle speed data.

Are link/segments from the count data able to be matched to links from the travel networks?

## LADCO Data Availability Checklist. Class 1 and 2 Transportation Data. HPMS/ County Average Data

| Data Type | Data Source | By Functional Class | Seasonal Temporal | Daily Temporal by season | Hourly Temporal day/season | Delivery Date |
|---|---|---|---|---|---|---|
| Vehicle Miles Traveled | | | | | | |
| Vehicle Speed | | | | | | |
| Vehicle Mix | | | | | | |
| | | | | | | |
| Other Data Types | Vehicle Age | Trip Length | Significant Upset Events in 2001-2003 | Future Year Projections | | |
| | | | | | | |
| | | | | | | |

## LADCO Data Availability Checklist. Class 3,4, and 5 Transportation Data. Travel Demand Model/ Statewide Network checklist.

Travel Demand Model Used. _____
Latest Update Year_____
Projection Years _____
Are heavy duty vehicle modeled separately_____
VMT Comparison to HPMS_____
Validation Studies on vmt/speed_____
Geographic projection system used(UTM, State Plane, Lat/Lon)_____
What Geographic unit are TAZs defined by _____
Are Ramps Modeled as discreet links_____
Are trip end by TAZ available_____
Are weekends:

- Modeled discretely_____
- Averaged in with other days_____
- Only weekdays are modeled. _____

| Data Type | Data Source | By Functional Class | Seasonal Temporal | Daily Temporal by season | Hourly Temporal day/season | Delivery Date |
|---|---|---|---|---|---|---|
| Vehicle Miles Traveled | | | | | | |
| Vehicle Speed | | | | | | |
| Vehicle Mix | | | | | | |
| Starts/Stops | | | | | | |
| | | | | | | |
| Other Data Types | Vehicle Age | Trip Length | Significant Upset Events in 2002 | Future Year Projections | Alternate future year scenarios | |
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Draft LADCO Mobile source needs assessment 1/16/2004

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