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Henderson County Hazardous Materials Commodity Flow Study

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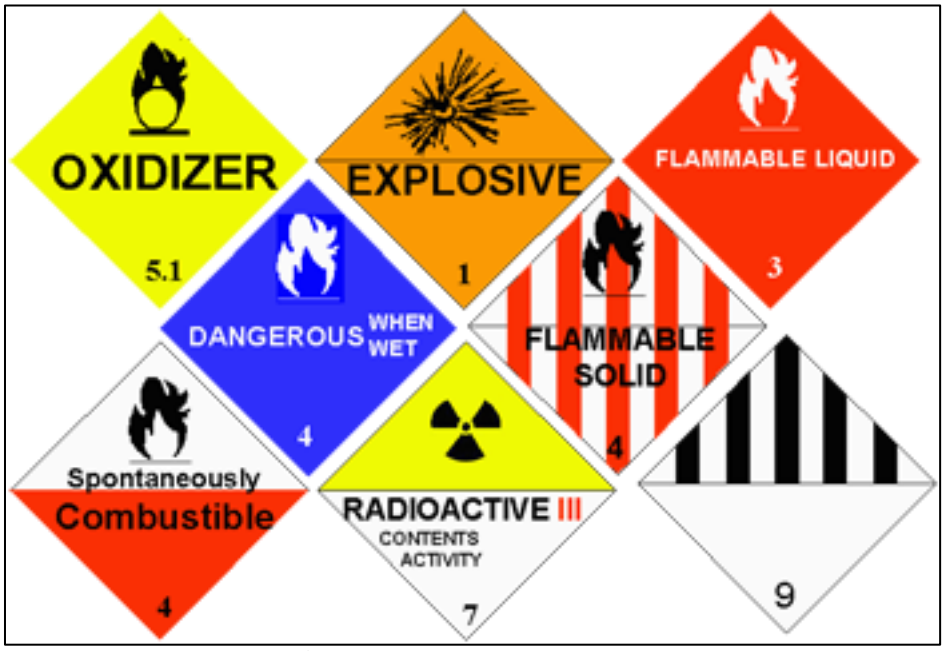
Henderson County Hazardous Materials Commodity Flow Study

Final Report

September 18, 2013



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Prepared by:

WKU

EMERGENCY MANAGEMENT
EM
HENDERSON COUNTY

Henderson County Hazardous Materials Commodity Flow Study

This project was completed by Western Kentucky University

In partnership with

Henderson County Emergency Management and

Henderson County Local Emergency Planning Committee

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The Henderson Fire Department, through Fire Chief Daniel Froehlich, supported this study. Chief Froehlich's insights into hazardous materials transportation routes aided in developing sites for placard surveys. With his direction, we were able to acquire monitoring sites that ensured the safety of students and helped implement the study without interruptions. We appreciate his support throughout the study.

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Chapter 1

Introduction

This report presents the results of a Hazardous Materials (Hazmat) commodity flow study for Henderson County, Kentucky. Study components were conducted by Western Kentucky University in partnership with Henderson County Emergency Management (HCEM) and Henderson County Local Planning Committee (LEPC). Location of Henderson County and the City of Henderson in Kentucky are shown in Figure 1.1. In addition, data from an Audubon Parkway placard survey, conducted in July of 2013 for Daviess County, were used in the analysis for this report. Hazardous materials transported through Henderson County were monitored at the following sites during the study period:

- U.S. Highway 41 (Hwy 41), North and Southbound lanes at Audubon State Park
- CSX Railroad Bridge (CSX), North and Southbound lanes at Sunset Park near the Ohio River and Downtown Henderson
- U.S. Highway 60 (Hwy 60), East and Westbound lanes at Henderson Community College
- Kentucky Route 136/425 (KY 136/425), East and Northbound lanes respectively at Henderson Community College
- Audubon Parkway (Aud Pkwy), East and Westbound lanes at Second Overpass East of West of Owensboro

The purpose of this report is to present information on patterns of hazardous materials commodity flow along Hwy 41, Hwy 60, ST 136/425, Audubon Parkway, and the CSX railway, as observed during the period of May 28, 2013 to August 27, 2013. This report also summarizes incidents involving hazardous materials over the previous 11 years and 8 months, November 2001 to July 2013, in Henderson County. Finally, the study assessed survey information collected from fixed facilities that shipped and received hazardous materials in Henderson County.

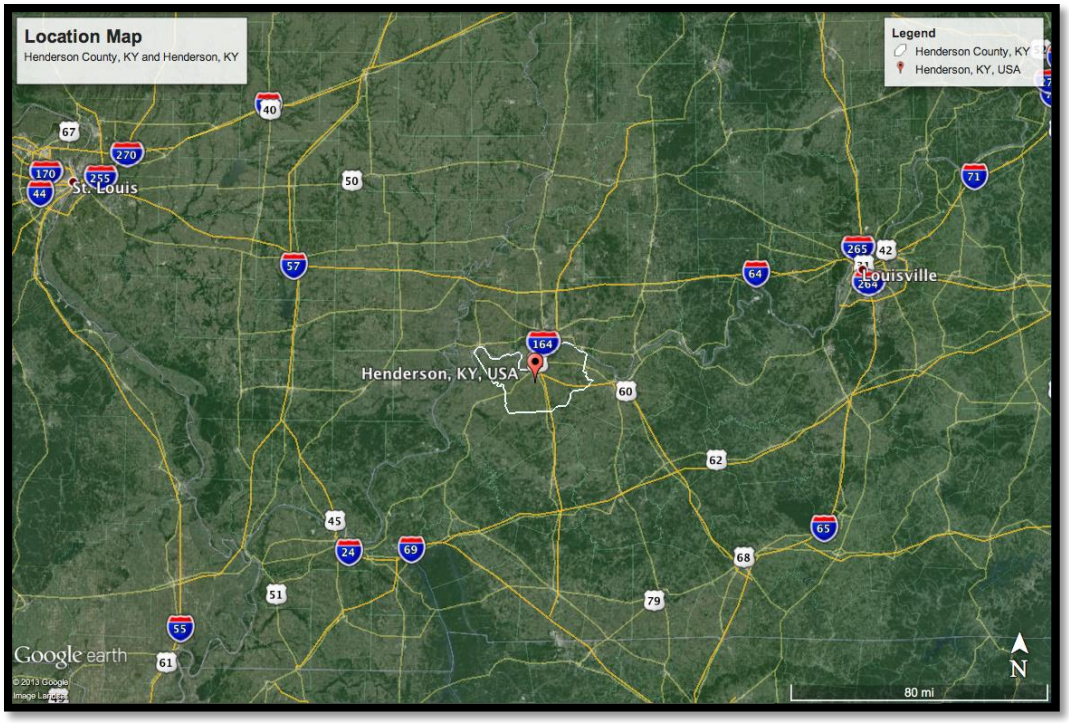

Figure 1.1. Location of Henderson County and the City of Henderson in Kentucky.

The results obtained through this commodity flow study can serve as a source of information to increase hazardous materials incident preparedness for Henderson County and its citizens. Data collected can aid in the emergency planning and response process for specific hazardous materials incidents. Emergency preparedness techniques, such as risk assessment and scenario forecasting, can be used to address potential incidents to aid in development of contingency plans for emergency response

i. Background

Commodity flow studies have a primary goal of identifying the transport of specific goods through the transportation systems of a specific area (Taylor, 2010). Commodity, as defined by the EPA, is any physical good moving or any good being transported (U.S. EPA, 2010). In this particular study, hazardous materials are the commodities of interest and are defined in the following ways:

- US Department of Transportation: "Any substance or material in any form or quantity which poses an unreasonable risk to safety and health and to property when transported in commerce," (US DOT, 1991).

- US EPA: "Any material, which when discharged into the environment, may be harmful to the public health or welfare of the United States," (U.S. EPA, 2010).

According to the EPA, a material is considered hazardous if it displays one or more of the following characteristics (U.S. EPA, 2010):

- Ignitability: Can create fires under certain conditions. e.g. fuels which catch fire, and friction-sensitive substances.
- Corrosivity: Is acidic and capable of corroding metal.
- Reactivity: Can create explosions or toxic fumes, gases, or vapors when exposed or mixed with water.
- Toxicity: Is harmful or fatal when ingested, breathed, or absorbed by the skin.

Hazardous materials categories include:

- Explosive Substances: will release pressure, gas, and heat when exposed to sudden shock, heat, or high pressure. e.g. Explosives, fuel, ammonium nitrate.
- Flammable and Combustible Substances: either liquid or solid, that can be easily ignited. e.g. petroleum substances.
- Toxic Materials (Poisons): can cause injury or death when they enter the bodies of living organisms; can be classified by chemical nature or toxic action. e.g. heavy metals, cyanides, irritants.
- Oxidizers: supply oxygen to support normally non-flammable materials. e.g. fertilizers (oxides).
- Radioactive Materials: emit harmful rays and particles with their decay. e.g. plutonium, cobalt.
- Etiological Materials: cause disease or infection. e.g. microbes which cause rabies, botulism, tetanus.

ii. Study Area

Components of this study, to include placard surveys and fixed facility surveys were conducted in Henderson County, Kentucky. Sites for placard surveys in Henderson County are shown in Figure 1.1. Henderson County hazardous materials incident data analyzed for this report were collected by HCEM and acquired by WKU. Placard survey data presented in this report for the Audubon Parkway were collected by WKU from a site in Daviess County during a recent Daviess County Hazardous Materials Commodity Flow

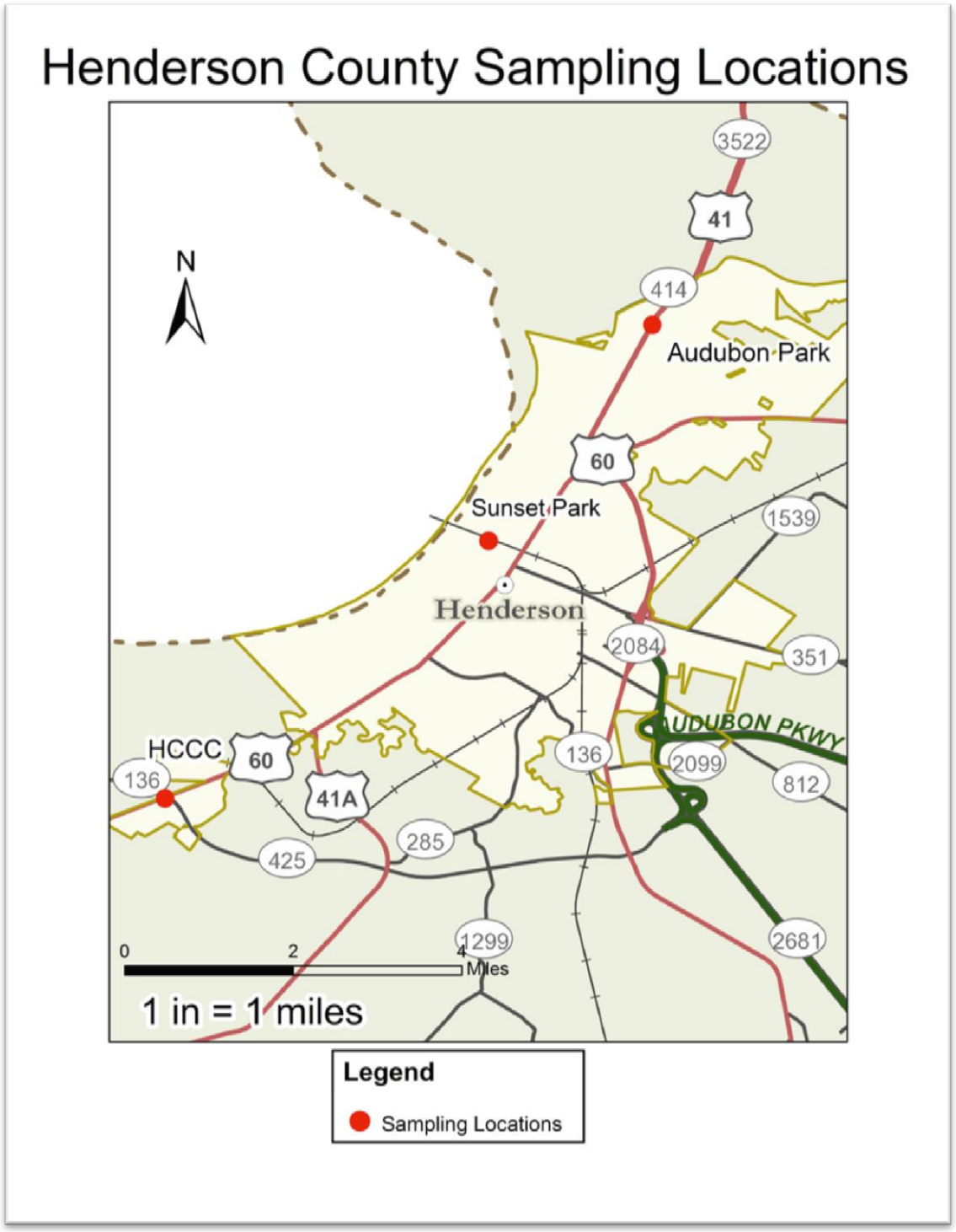

Figure 1.2. Sampling locations for placard surveys conducted in Henderson County, Kentucky.

Study, July 15-19, 2013 (Taylor et al., 2013). The monitoring sites for placard surveys are described below.

U.S. Highway (Hwy) 41 is a part of the United States Highway system, running from north to south for roughly 2000 miles. Hwy 41 begins in Copper Harbor, Michigan and ends in Miami, Florida. Speed limits for U.S. Hwy 41 vary depending on the section of the road. The speed limit for U.S. Hwy 41 at the WKU sampling location in Henderson County was 45 mph.

U.S. Hwy 60 is a major part of the U.S. Highway System spanning some 2,670 miles as it travels east to west across the country. Hwy 60 begins in Virginia Beach, Virginia and ends at Brenda, Arizona. Depending on the section of Hwy 60, speed limits vary. During the WKU study, the section of highway monitored had a 55 mph speed limit.

KY Route 136 begins in Harford KY, and ends in Alzey Bottoms of Kentucky, just across the River from Mt Vernon, Indiana. Kentucky Route 136 is part of the Kentucky Highway system, running from east to west. At the monitoring site on Route 136 the speed limit was 35 mph.

Another roadway monitored during the study was KY Route 425. Route 425 is a bypass around Henderson, KY, connecting KY 136 with the Pennyrile Parkway. The speed limit on KY 425 at the monitoring site, and during the study, was 55 mph.

The Audubon Parkway is one of nine Parkways in the Kentucky State Parkway System. Audubon Parkway connects Owensboro KY, at its eastern terminus, to Henderson Kentucky at its western terminus. A placard survey was conducted on the Audubon Parkway in Daviess County during a recent Daviess County Hazardous Materials Commodity Flow Study (Taylor et al., 2013). Audubon Parkway's speed limit is 70 mph along its entire 23.4 miles of roadway. However, during the Daviess County study, Audubon Parkway was under construction with a speed limit of 60 mph.

Monitoring of a railway was accomplished for Henderson County, Kentucky. The CSX Railroad Bridge crosses the Ohio River between Henderson, KY and Evansville, IN. This CSX rail line, once operated by the historic L&N Railroad, was constructed in 1885 and rebuilt to its current configuration in 1937. The CSX Rail Bridge is a vital commodity flow route between Southern Indiana and Northwestern Kentucky.

iii. Data Collection Methods

Data collection methods included placard surveys, at highway sites and a railway road site, fixed facility surveys, and analysis of Hazmat incidents. Data collection in Henderson County occurred from May 27, 2013 to June 24, 2013. Methods for each component of the study are described below.

Placard Surveys

Roadway placard surveys were conducted at two locations in Henderson, County, near Audubon State Park, Hwy 41 northbound and southbound lanes, and at Henderson County Community College, at the junction of Hwy 60, and Routes 425 and 136. Data from a roadway placard survey along the Audubon Parkway in Daviess County was used in the results of this report. A plan for sharing data was agreed upon by HCEM and Daviess County Emergency Management (DCEM) in order to reduce costs, maximize efficiency, and provide greater data coverage. This site was located approximately 3 miles west of the eastern terminus of the Parkway near Owensboro, KY. Finally, a placard survey of the railroad crossing the CSX Bridge in Henderson, Kentucky was completed from a vantage point in Sunset Park. Placard survey locations were chosen for their proximity to major transportation routes through Henderson County and for safety of observers.

Each placard survey consisted of 40 observation hours. Surveys were carried out during the months of May through July. Hours of observation were selected to note daily and temporal differences in the transportation of hazardous materials through the study area. Observations were made by graduate students of Western Kentucky University, Department of Public Health, Environmental Health Science program. Two observers were located at each monitoring site in order to avoid bias in recording of data. All lanes of traffic were monitored at each location. Placard observations at the monitoring sites consisted of recording the date, time, placard ID number, multiple placards, and type of vehicle/trailer on a placard survey data sheet (Appendix 2).

With all necessary safety precautions, a team of two observers monitored each site for a five-day period. A typical monitoring day consisted of an 8-hour observation period. The monitoring periods totaled 160 observation hours. Monitoring dates and times for each site are presented below:

- U.S. Hwy 41, north and southbound, at Audubon State Park entrance, May 28-31, 2013 and June 17, 2013. Observation period was from 07:00 to 15:00 each day
- Intersections of Hwy 60, and Routes 136 and 425, near Henderson Community College, June 10-14, 2013. Observation period was from 07:00 to 15:00 each day
- Audubon Parkway, east and westbound, approximately 3 miles west of the eastern terminus near Owensboro, KY, July 15-19, 2013. Observation period was from 07:00 to 15:00 each day
- CSX Railway, northbound and southbound, at Sunset Park in Henderson, KY, June 3-7, 2013. Observation period was from 07:00 to 15:00 each day

During the monitoring hours the observers recorded the following variables: time of day, date, number of placarded vehicles, day of the week, location, Hazmat ID number, presence of multiple hazmat placards, type(s) of hazardous materials transported, type of vehicle/ trailer/ railcar, and the state listed on the license plate, if possible.

Hazmat Incidents Analysis

An analysis of Hazmat incident data for Henderson County was completed in this study. Incident data used for this analysis was collected by HCEM from November 2001 to June 2013. Incidents of interest were those that occurred in Henderson County and involved commercial motor vehicles transporting hazardous materials. This information was used to map the recent history of recorded Hazmat incidents. A methodology for mapping incidents and identifying densities of incidents was applied with the use of ESRI ArcGIS Spatial Analyst software (ESRI, 2011). The methodology consisted of mapping incident data and using a point density algorithm to show clusters of points using a color intensity method, much like is used in a radar system to indicate the intensity of storms.

Point density modeling was accomplished through ESRI ArcGIS ArcMap (2011) by detecting overlapping point areas as clusters. In this method, each incident point was buffered with a circular area that had a diameter of 1.0 mile. A 1.0 mile diameter was chosen due to the spatial scale of incidents. Incidents within a 0.5 mile or less separation, at the county scale, were detected as a cluster with the selected diameter.

It was found through screening, that application of a greater than 1.0 mile buffer width would result in loss of clusters along significant travel corridors. Each incident cluster was color-coded with increasing intensity. For example, an isolated incident point, only one incident, would have a color of green, a cluster of 3 incidents would have a color of yellow, and a cluster of six or more incidents would have a color of red. In this manner, the map indicates areas with multiple overlapping incidents. This methodology can be used to quickly assess hotspots for Hazmat incidents.

Fixed Facility Survey

The fixed facility survey, developed by WKU, consisted of 35 response items (Appendix 1) designed to collect data from Henderson County facilities that ship and receive hazardous materials. General information on the facility, trends in hazardous materials shipped and received, and frequency of specific hazardous materials shipped and received were the topics of interest.

Fixed facility surveys were administered with the assistance of HCEM. Surveys were emailed to fixed facilities throughout the study area and returned to HCEM. Returned surveys were collected and delivered to WKU for data processing. WKU graduate students created an Access database for storage and organization of survey data. Survey data were analyzed with SPSS and Excel to determine Hazmat shipping and receiving trends.

iv. Report Organization

The first chapter of the report provides an introduction to the study, a description of methods, and other pertinent information. In the second chapter, a detailed summary of transportation incident reports is provided. Results from the placard surveys are presented in the third, fourth, fifth, sixth, and seventh chapters of this report. Chapter eight illustrates the results of the fixed facility survey, as well as describing the appropriate responses for incidents involving these materials. Chapter nine includes the summary of results and recommendations. Appendices include a copy of the survey that was sent to fixed facilities, a list of placard IDs observed, and a list of the most common roads used by facilities to reach/leave the study area.

Chapter 2

Analysis of Incident Reports for Henderson County 2001 -- 2013

Analysis of Hazmat incident reports indicated trends of incidents that took place between November 2001 and June 2013. This includes the patterns of occurrence and identification of challenges in incident preparedness. Results of this analysis provide HCEM, LEPC, and stakeholders with information regarding the types of hazardous materials commonly involved in commercial motor vehicle incidents in Henderson County. Analysis also provided the most likely types of incidents such as spills, leaks, vehicle crashes, etc. A point density map of the data utilizing ESRI ArcGIS Spatial Analyst software (2011), was created to elucidate areas that have reoccurrence of incidents. Lastly, the evaluation of incident data enables emergency managers and LEPCs to evaluate areas with greater risks in conjunction with the hazardous materials detected during the Hazmat commodity flow survey.

i. Hazmat incidents from 2001 -- 2013

Data consisted of incidents, which were reported between 2001 and 2013 in Henderson County. A total of 141 incidents were reported that required emergency response for vehicle accidents, leaks, and spills. A map was produced through point density analysis of incidents that occurred (Figure 2.2). This analysis created a density surface based upon the number of buffered incidents that overlap in a defined area. The density model in the ESRI ArcGIS Spatial Analyst system (2011) was confined to 1.0 mile circular buffers around each incident point. In this manner, the system created a density layer where high densities of incidents were spatially related to transportation corridors. Density was color-coded, in much the same way as the radar image of a storm, to provide a more accurate view of high-density incident areas.

As shown in Figure 2.1, greater incident densities, areas with multiple incidents, were detected along the Hwy 41 corridor, and incidents were concentrated in the zone south of the Hwy 41 corridor. Another area with a concentration of six or more incidents occurred in Spottsville, KY near the Hwy 60 corridor. Areas of increased intensity indicate a record of multiple incidents and an increased risk of future incidents.

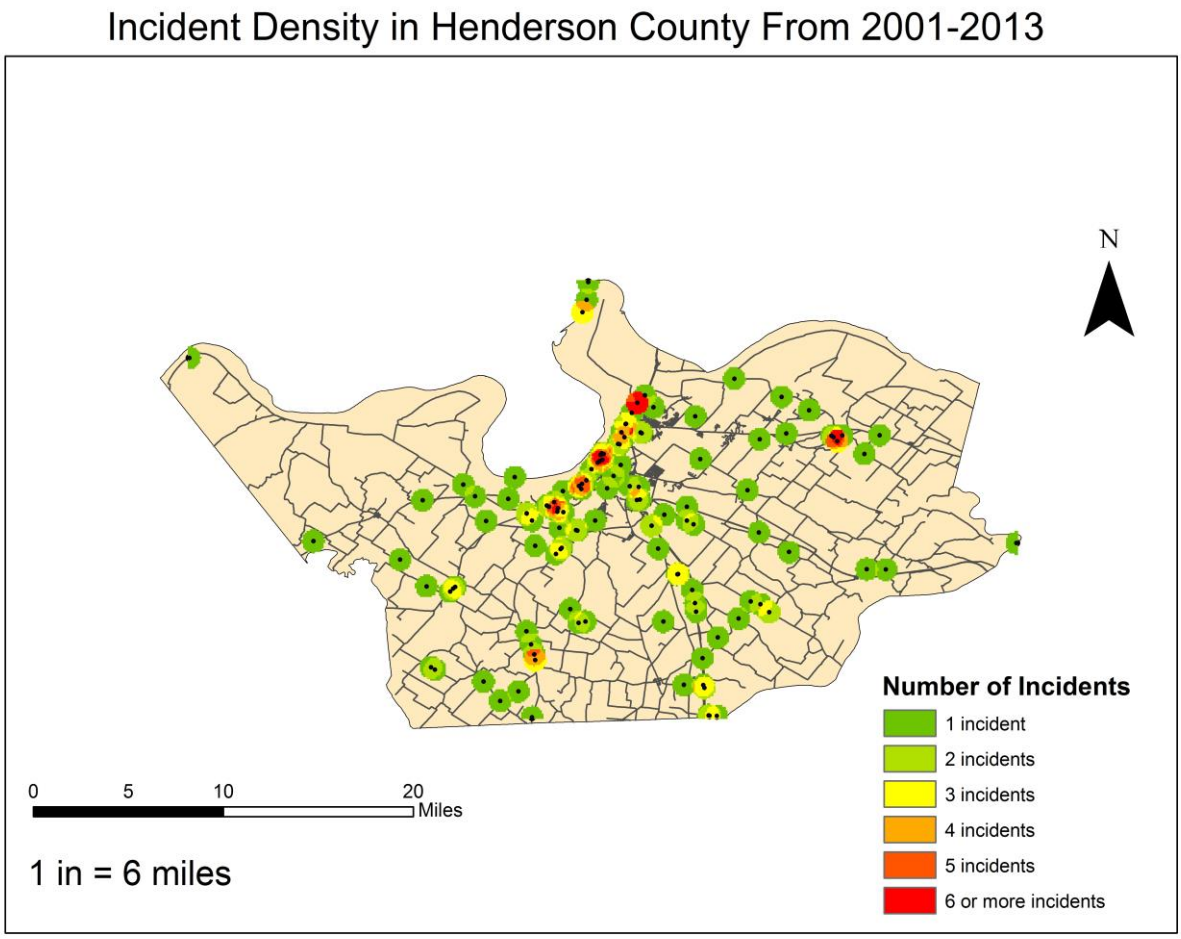

Figure 2.1. Density map of Hazmat incidents in Henderson County, 2001-2013

The numbers of incidents that have occurred each year over the period of record for this study are shown in Figure 2.2. A maximum of 21 incidents occurred in 2007, followed by 17 in 2004, and 15 in 2010. The complete years of record for the dataset analyzed were from 2002 to 2012. During these years, the minimum number of incidents in a year was five, this occurred in 2011. From the time period of 2002 through 2007 the average number of incidents per year was about 14 (14.2). In the period from 2008 through 2012 the average number of incidents per year was about 9 (8.8). The standard deviation in the number of incidents per year, for the period 2002 through 2012, was 4.6 or about 5 incidents. This indicates that the database is quite variable in the number of incidents from year to year. Based on the data, it is reasonable to expect about 8 incidents or more each year.

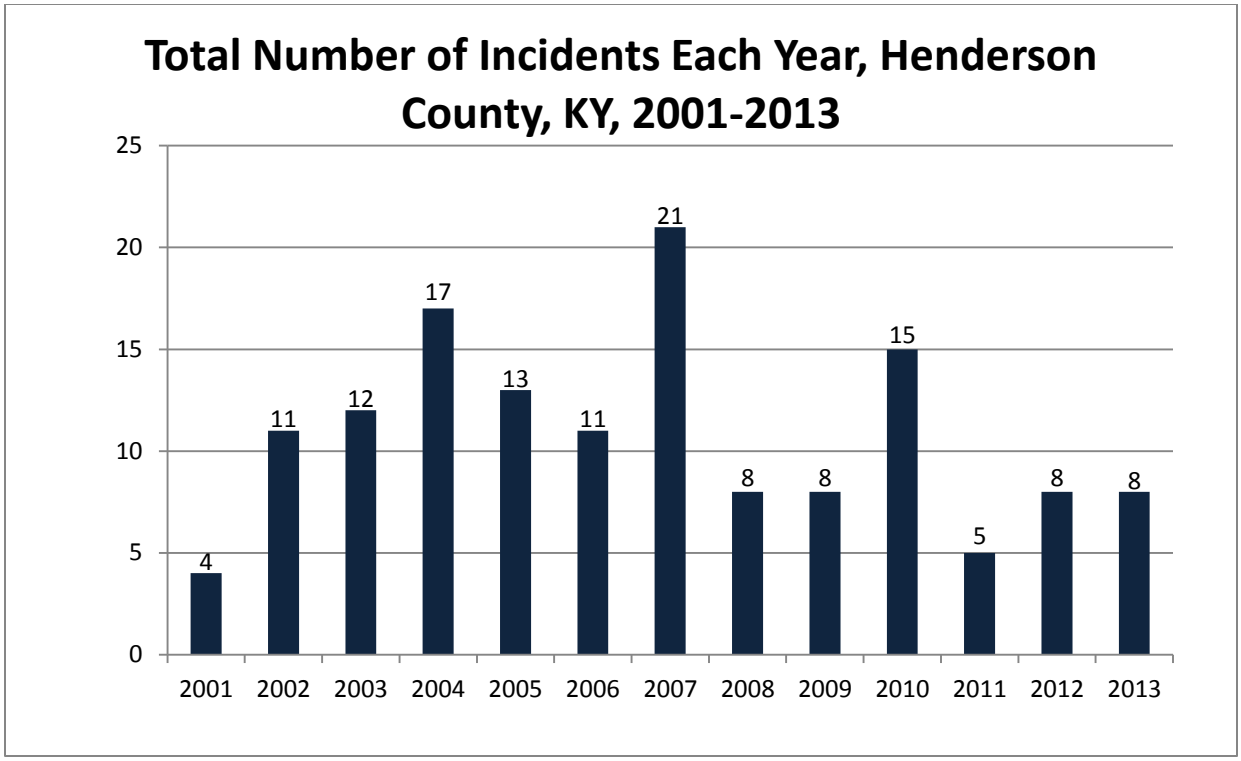

Figure 2.2. Total number of incidents each year in Henderson County from 2001-2013

Note: Data for 2013 are through July and data for 2001 are for the months November and December. Therefore the data presented or 2001 and 2013 are not the total number of incidents for those years.

ii. Hazmat cases in the Henderson County

The type of emergency and hazardous materials transported ultimately determines the appropriate emergency response. Five types of incidents were reported between 2001 and 2013 (Figure 2.3). Leaks accounted for 36.9% of all incidents reported, followed by Motor vehicle crashes (32.6%), Spills (24.1%), and others accounted for 6.4%. Typically, hazardous materials transport occurrences are broken into incidents and accidents. Incidents are considered to be leaks, spills and other occurrences that actually release a hazardous material. Accidents, on the other hand, are motor vehicle accidents that involve a transporter of hazardous materials and do not result in a release. In this report, we are using incidents to include all occurrences that involve a vehicle transporting a hazardous commodity, whether there is a release or not. The reason for this is all occurrences involving hazardous materials are significant when determining the risk to the community.

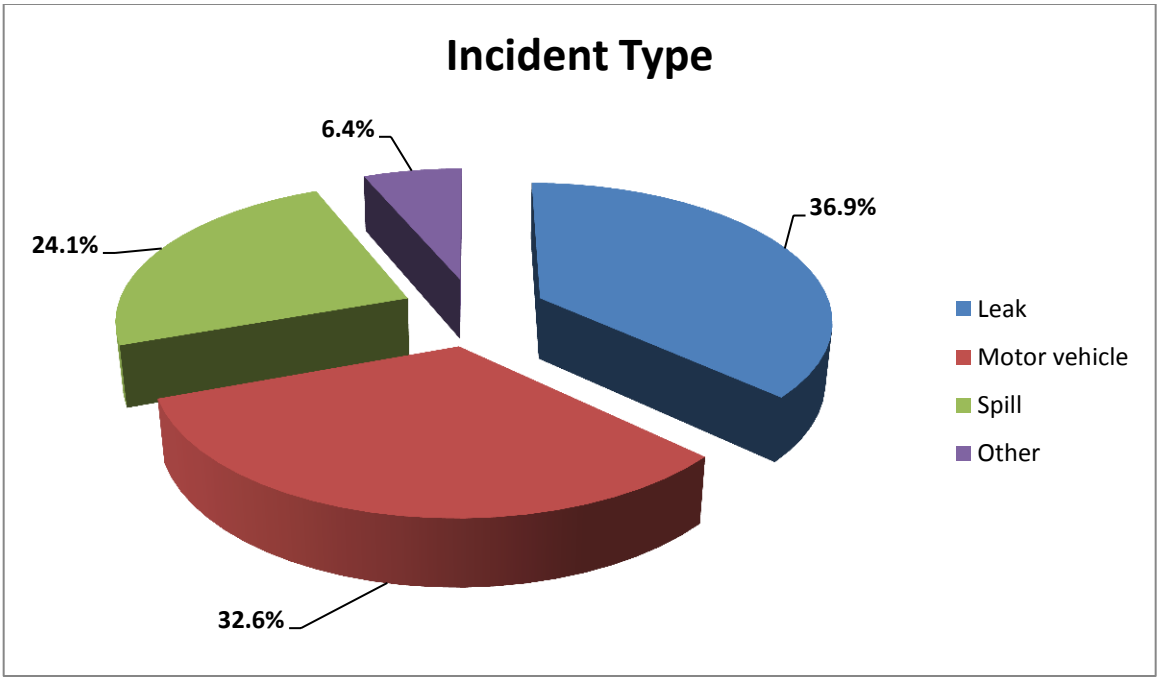

Figure 2.3. Types of incident occurrence from the years 2001 -2013

Numerous classes of materials were identified in the incident reports. As shown in Figure 2.4, the most common materials identified were diesel fuel (29.1%), Oil (20.6%), and Natural Gas (17.7%). Unspecified materials accounted for 8% of reported incidents, while all other materials accounted for 24.8%.

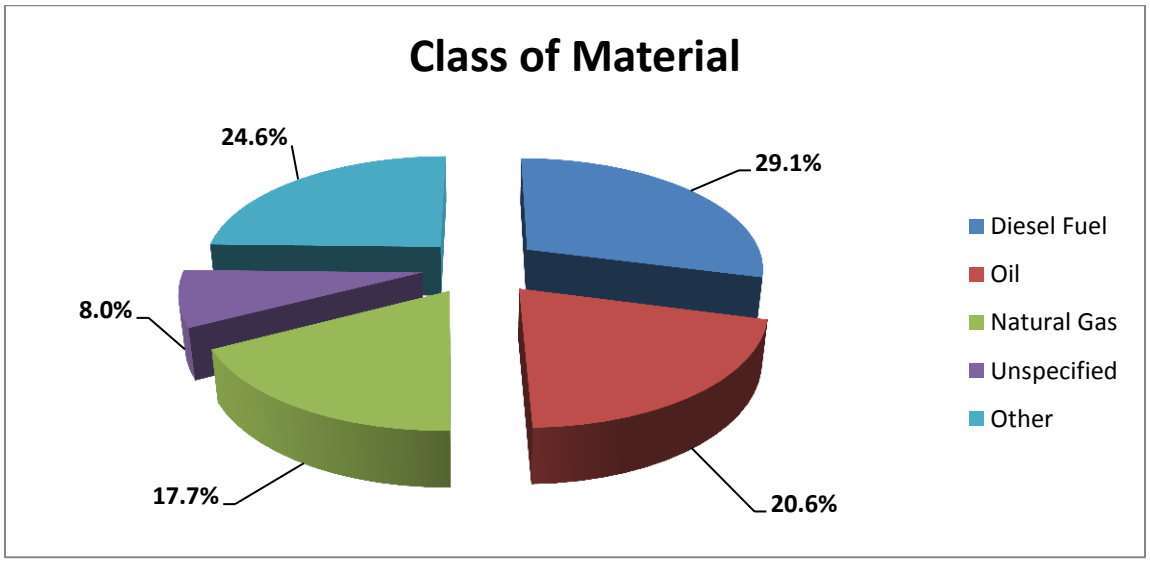

Figure 2.4. Various classes of materials identified in the incidents from the years 2001-2013

Chapter 3

Results of U.S. HWY 41 Placard Survey

Placard monitoring for HWY 41 was completed the week of May 28-31. The monitoring did not begin on May 27th due to it being Memorial Day. An additional monitoring day was added on June 17th. During the 5 days of monitoring, a total of 929 placarded vehicles were observed on both southbound and northbound lanes (Figure 3.1). The number of vehicles transporting hazardous materials was similar on the northbound lane (470) compared to the southbound lane (459) of Hwy 41. The average number of vehicles transporting hazardous materials per hour was nearly equivalent between the northbound (11.8 vehicles per hour) and southbound lanes (11.5 vehicles per hour) (Figure 3.2).

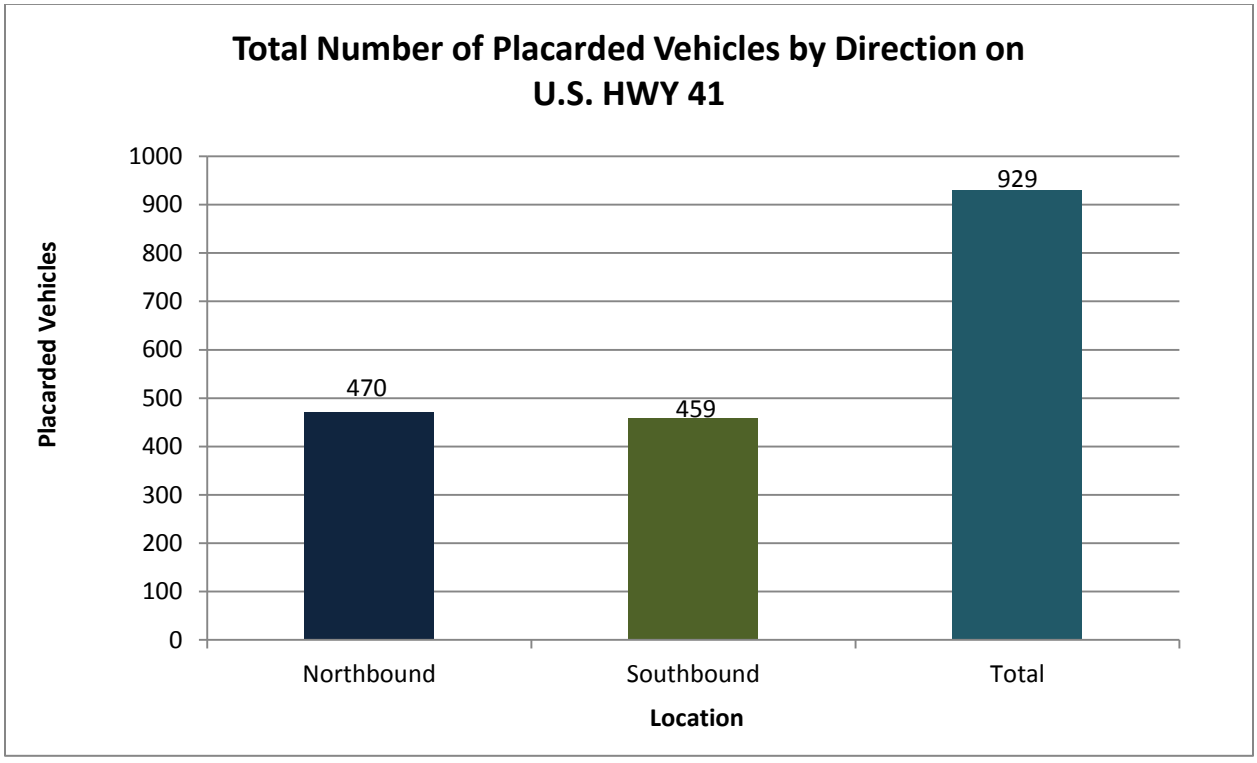

Figure 3.1. Placarded commercial vehicles observed on U.S. Hwy 41.

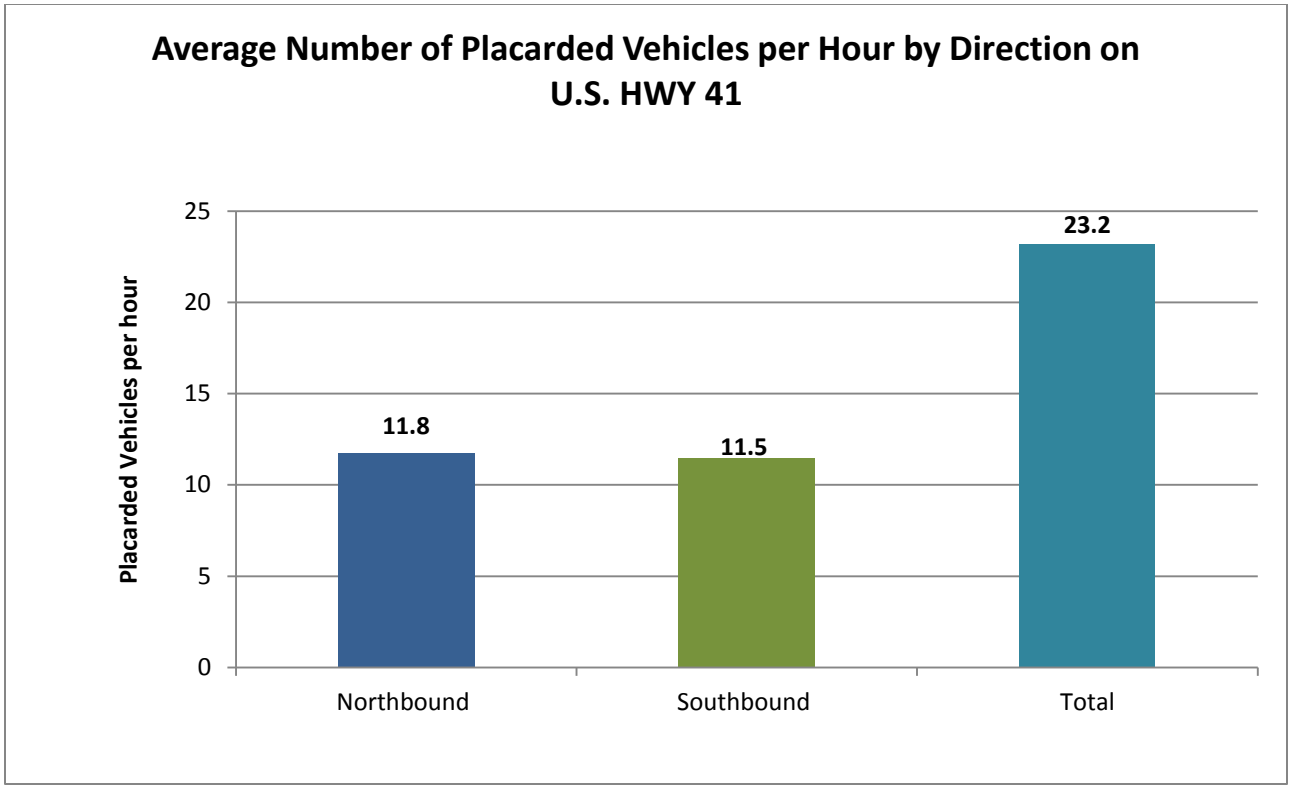

Figure 3.2. Placarded vehicle flow rate per hour

i. Load of placarded vehicles by day

Observed hazmat commodity flow rates for Hwy 41 varied each monitoring day (Figure 3.3). Total hazardous materials transported across HWY 41 peaked on Tuesday, with an average of 14.0 vehicles per hour northbound and 12.6 vehicles per hour southbound. A peak in northbound placarded vehicles also occurred on Thursday with 13.8 vehicles per hour. Placarded vehicles traveling in the southbound direction were observed to be more consistent, ranging from an average of 10.1 to 12.6 vehicles per hour. The lowest average placarded vehicle rate northbound was seen on Monday, with 9.4 vehicles per hour. Placarded vehicle traffic was lowest on Monday and Friday, while the middle of the week, Tuesday, Wednesday and Thursday, exhibited the highest rates of placarded vehicle traffic.

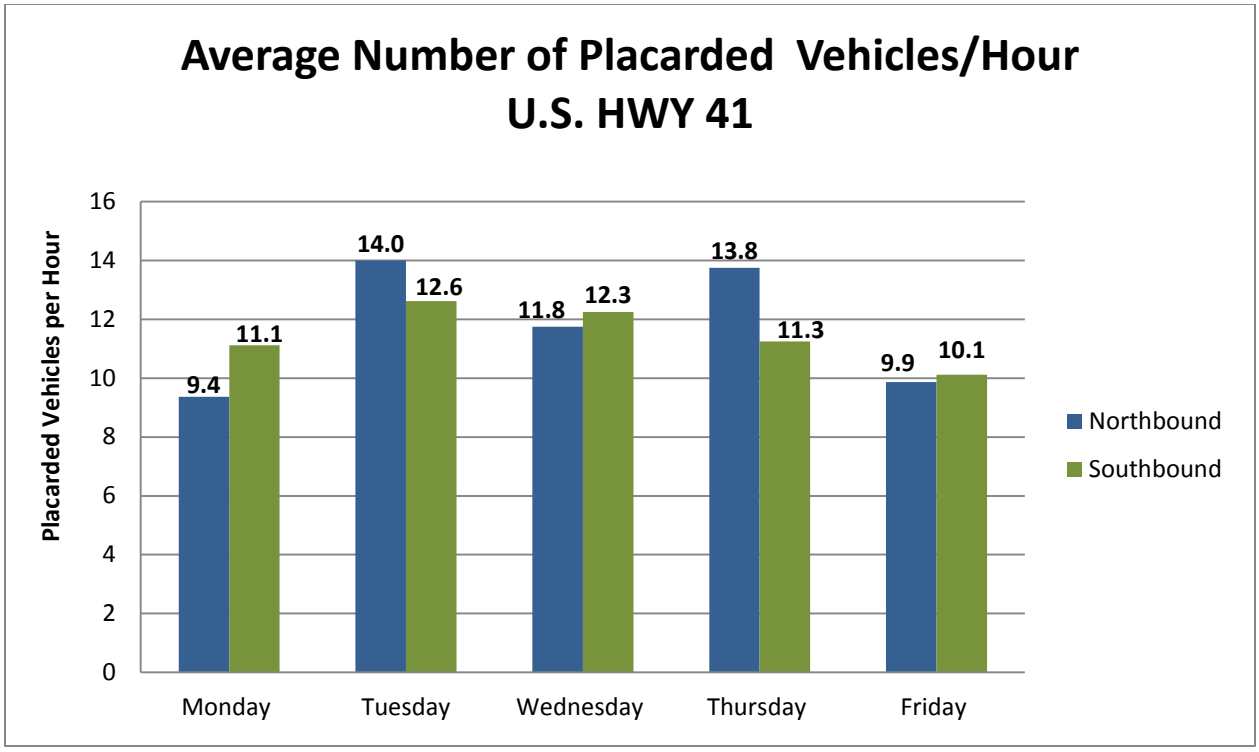

Figure 3.3. Placarded vehicle frequency per hour by day of the week

iii. Placarded vehicle frequency by time of day for HWY 41

Variations in the frequency of hazardous materials transported were analyzed with reference to time of day (Morning, Midday, and Afternoon). The time of day is important in order to correlate hazardous materials vehicle movement with the expected times of traffic congestion and availability of emergency responders. By analyzing these variations, risk profiles for hazardous materials transport can be projected by time of day.

In order to analyze the frequencies of hazardous materials transported within a day, the monitoring hours at each observation point were divided into three separate periods. Total placarded vehicles observed during each period were divided by the number of monitoring hours for the period to time weight the results. For example, if the total placarded vehicles observed for a period was 100, and the period was two hours, the time-weighted average would be 50 placarded vehicles per hour. This created time-weighted morning, midday, and afternoon scenarios:

Period 1 (Morning): 07:00 to 10:00

Period 2 (Midday): 10:01 to 13:00

Period 3 (Afternoon): 13:01 to 15:00

As shown in Figure 3.4, the flow rate of hazardous materials was observed to increase throughout the day for the northbound lane, from 51 vehicles per hour in the Morning period to a maximum of 65 vehicles per hour in the afternoon period. Results for southbound commodity flow showed a near constant rate of 57, 58, and 57 placarded vehicles per hour for each of the daily periods. In general, the daily trend for U.S. Hwy 41 was that the commodity flow rate, placarded vehicles per hour, increased through afternoon. This trend to increasing or stable hazmat commodity flow rates throughout the day is unique and should be accounted for in emergency preparedness planning.

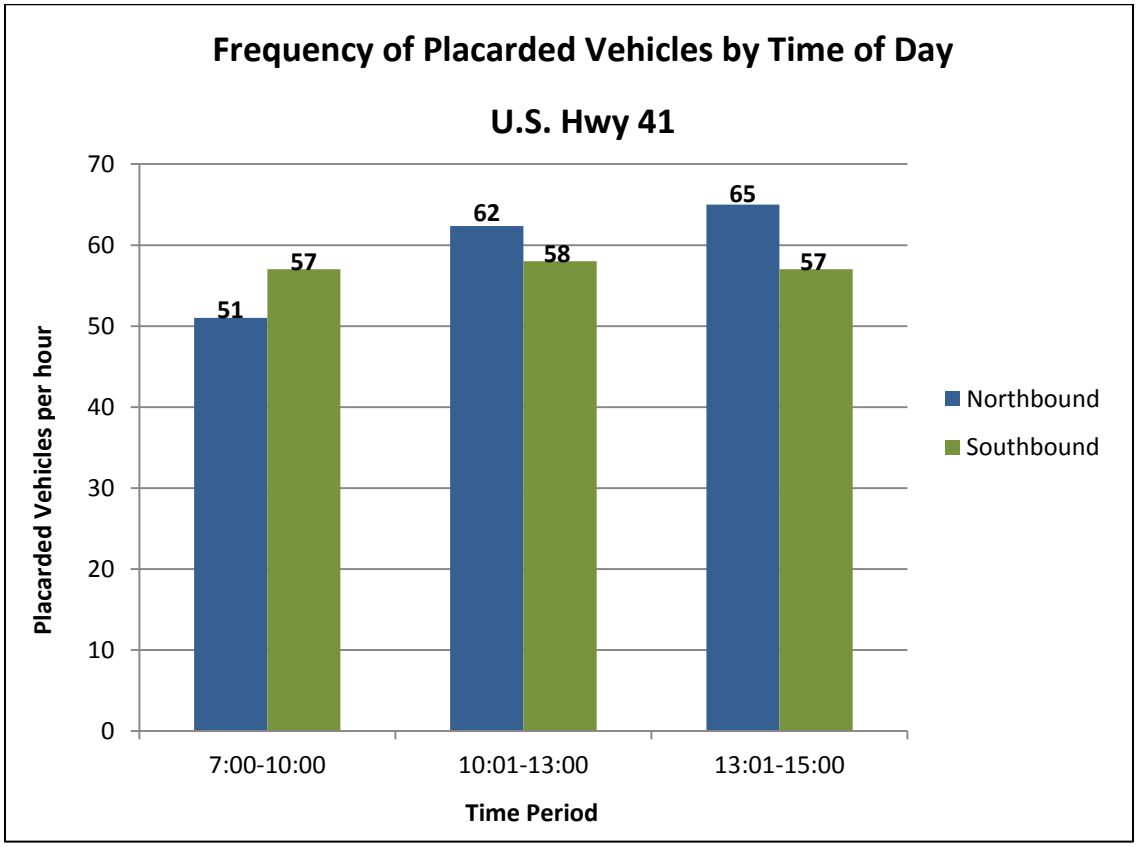

Figure 3.4. Frequency of Hazardous materials by time of the day as observed on Hwy 41.

iii. Composition of Hazardous Materials Transported

The composition (%) of hazardous materials observed on Hwy 41 northbound during the study period is displayed in Figure 3.5. Gasoline (Placard ID 1203) was the most frequently transported material, accounting for 22.2% of the total hazardous materials observed. Other commonly observed materials included Alcohols (Placard ID 1987) at 9.2%, Anhydrous Ammonia (Placard ID 1005) at 6.2%, Propane (Placard ID 1075) at 5.0%, and Corrosives Class 8 at 3.8%. All other less frequently observed placards were grouped together as "Other" which accounted for 53.7% of all placards. Specific materials that make up the "Other" category are presented in Appendix 3.

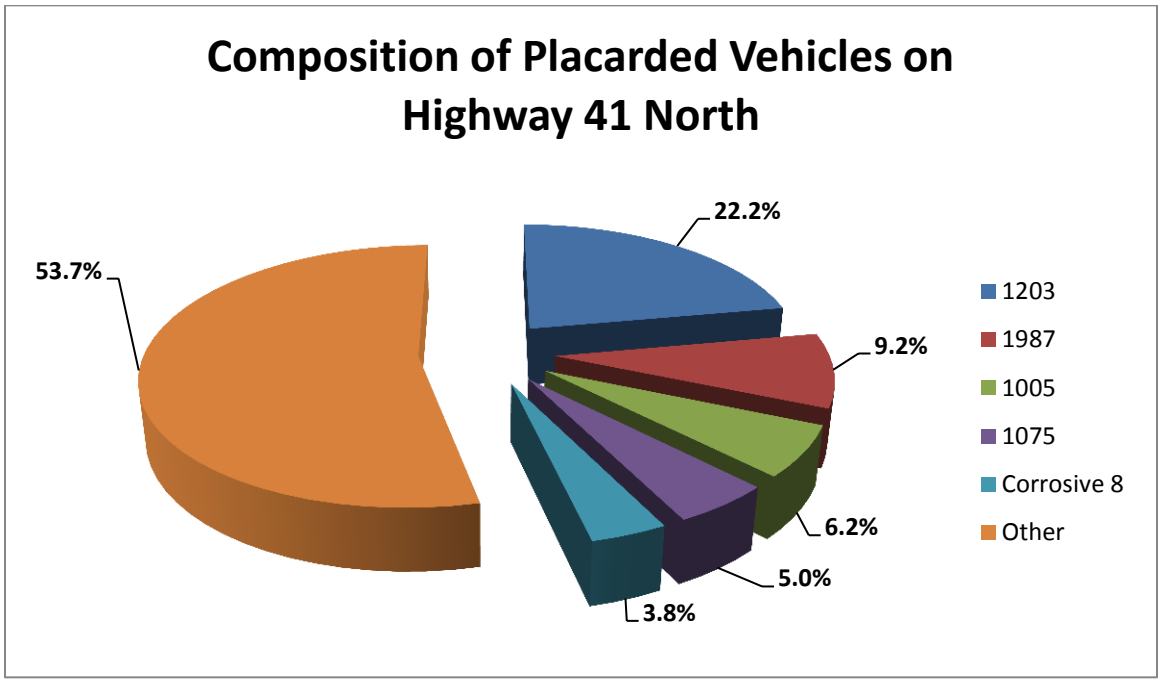

Figure 3.5. Composition of hazardous materials being transported on northbound Hwy 41 by percentage of total load

As shown in Figure 3.6, gasoline (Placard ID 1203) was the most frequently transported hazardous material on Hwy 41 southbound, at 22.1% of the total hazardous materials placards observed. Other commonly observed materials included Alcohols (Placard ID 1987) at 12.82%, Anhydrous Ammonia (Placard ID 1005) at 7.1%, Propane (Placard ID 1075) at 6.3%, and Ethanol and Gasoline mixture with more than10% ethanol (Placard ID 3475) at 6.3%. All other less frequently observed placards were grouped

together as “Other”, which accounted for 45.4% of all placards. A list of “Other” materials can be found in Appendix 4.

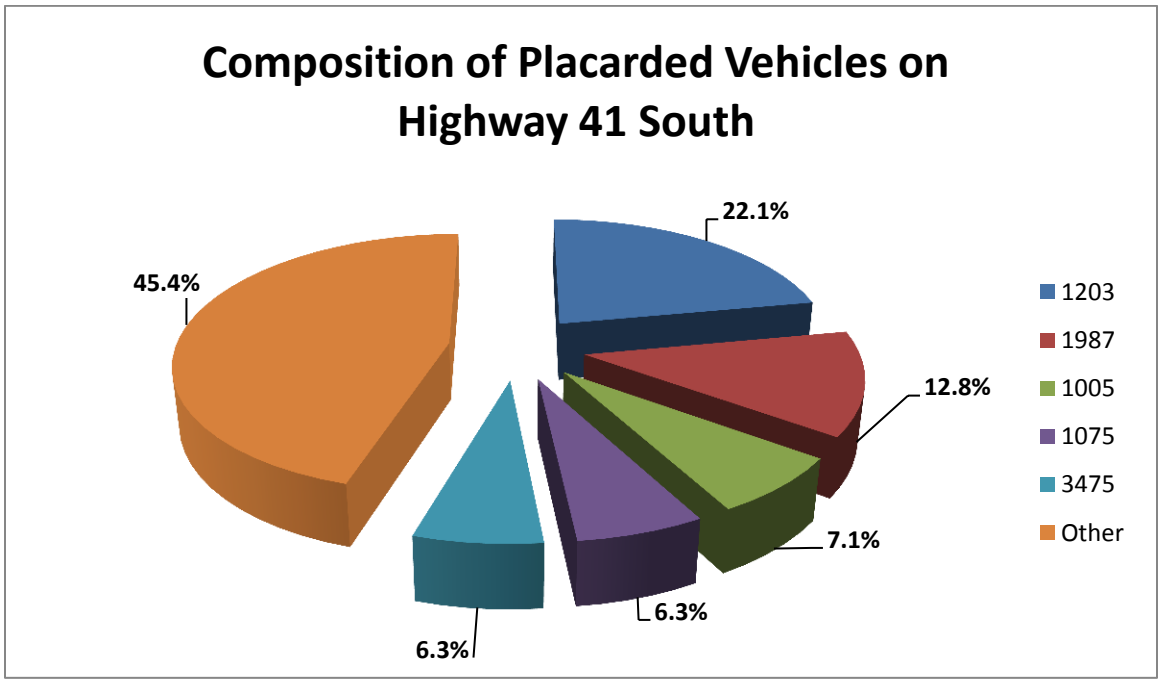

Figure 3.6. Composition of hazardous materials being transported on southbound Hwy 41 by percentage of total placards.

Chapter 4

Results of CSX Railroad Bridge Placard Survey

Observations of the CSX Railroad Bridge were made to determine the frequency of hazardous materials transported, for the monitoring period June 3-7, 2013. Total placarded railcars observed transporting hazardous materials was 221, on both northbound and southbound lines (Figure 4.1). The average number of placarded railcars per hour observed on both north and southbound lines was 5.5 per hour (Figure 4.2). Overall, there were a much greater number of placarded railcars transporting hazardous materials on the southbound line of the CSX Railroad (185 railcars) compared to northbound (36 railcars). Similarly, the average number of placarded railcars per hour was greater southbound, 4.6 railcars per hour, compared to northbound, 0.9 railcars per hour. Southbound trains showed about five times the average number of placarded railcars observed on the northbound trains.

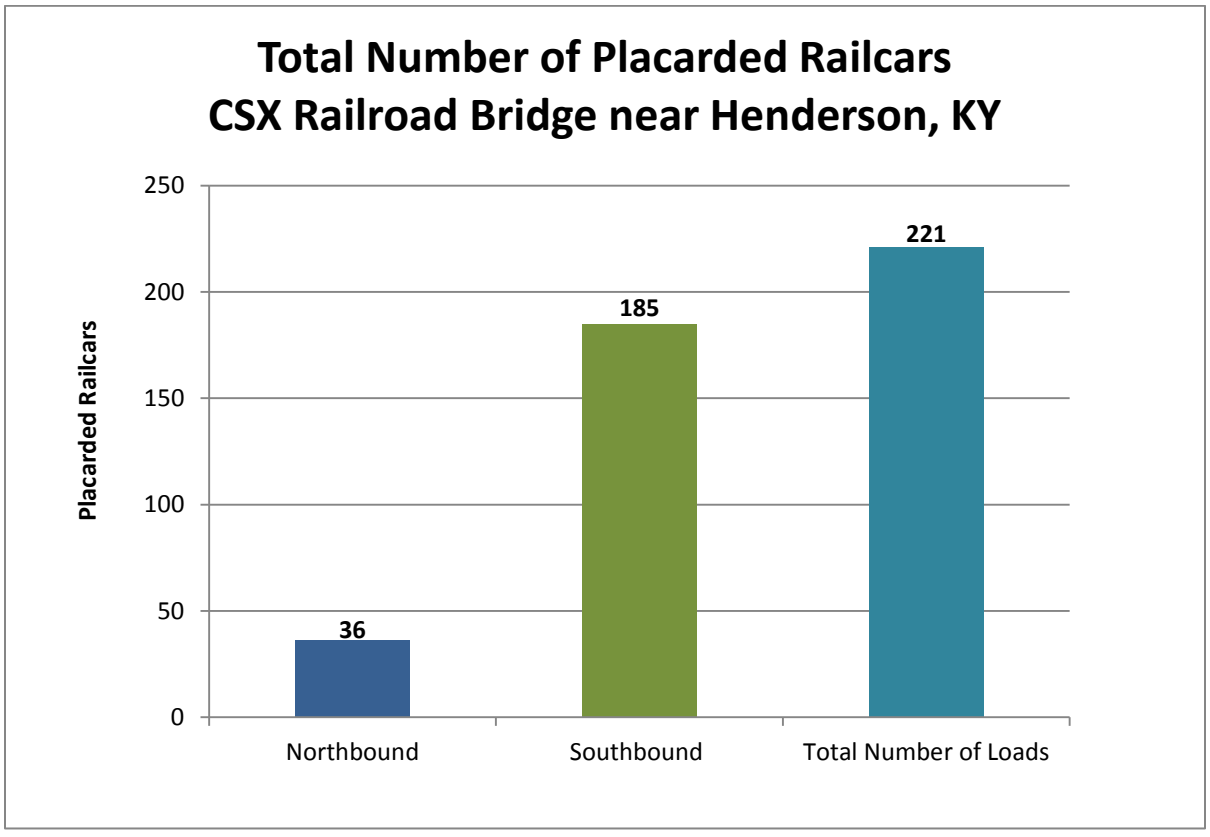

Figure 4.1. Placarded railcars observed on CSX Railroad Bridge

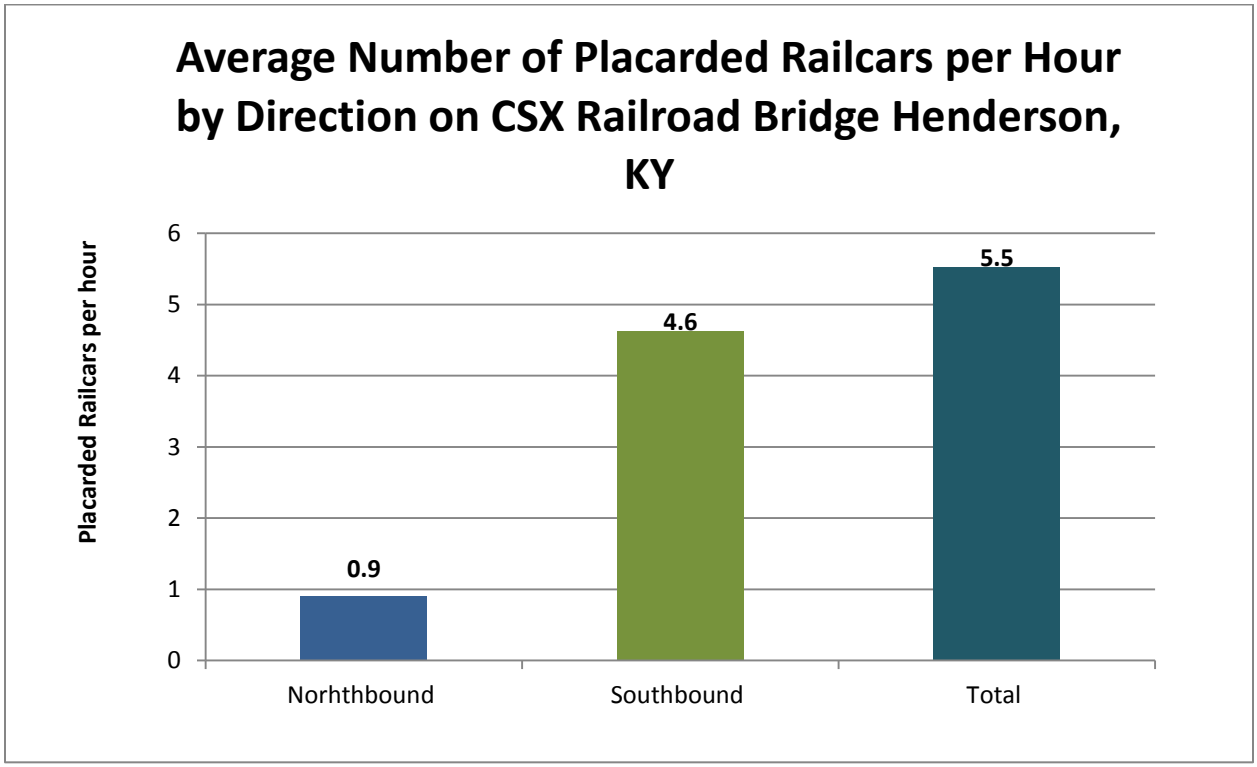

Figure 4.2. Placarded railcar frequency per hour on CSX Railroad Bridge

i. Load of placarded railcars by day

Hazardous materials transport showed differences throughout the week (Figure 4.3). Total hazardous materials observed on the CSX Railroad Bridge peaked on Wednesday, with an average of 18.1 railcars per hour southbound. The peak in the northbound line, 3.0 railcars per hour, was observed on Monday (Figure 4.3). The least commodity flow rates were witnessed on Tuesday with zero (0) observed placarded railcars on the northbound line and only 0.4 railcars per hour observed on the southbound line. Thursday showed zero (0) observed placarded railcars on the northbound line and 0.8 railcars per hour on the southbound line. It should be noted that railroad transport of hazardous materials is sporadic and not as predictable as highway traffic.

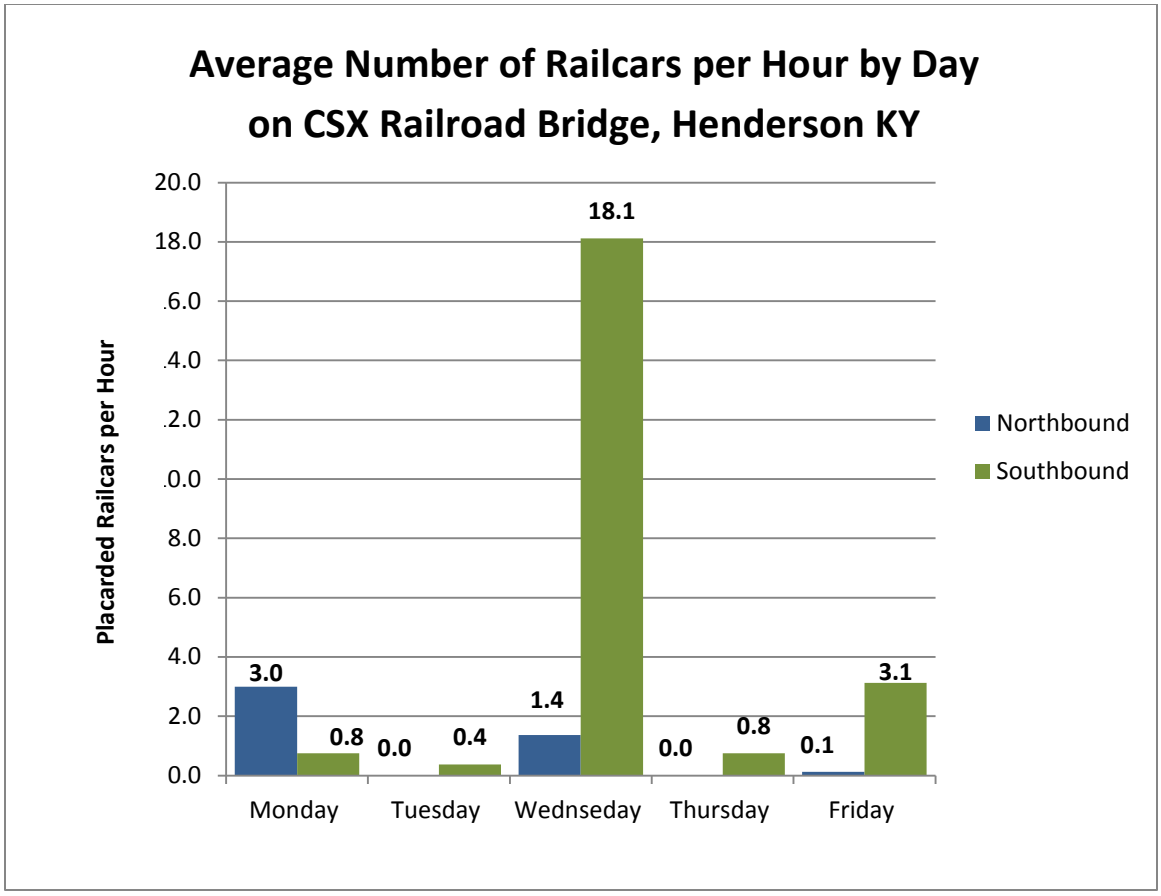

Figure 4.3. Placarded railcar frequency per hour by day of the week

ii. Placarded railcar Frequency by time of day

In order to analyze the hourly frequency of hazardous materials transport, the monitoring hours at each observation point were divided into three separate periods. This creates the following three time periods:

Period 1 (Morning): 7:00 to 10:00

Period 2 (Midday): 10:01to 13:00

Period 3 (Afternoon): 13:01 pm to 15:00

As shown in Figure 4.4, the maximum rate of placarded railcars was observed during the afternoon period with 53.0 railcars per hour moving southbound and 3.0 per hour moving northbound. For both north

and southbound lines, the least rates of placarded railcars were seen in the midday, with 6.0 and 8.3 railcars per hour respectively.

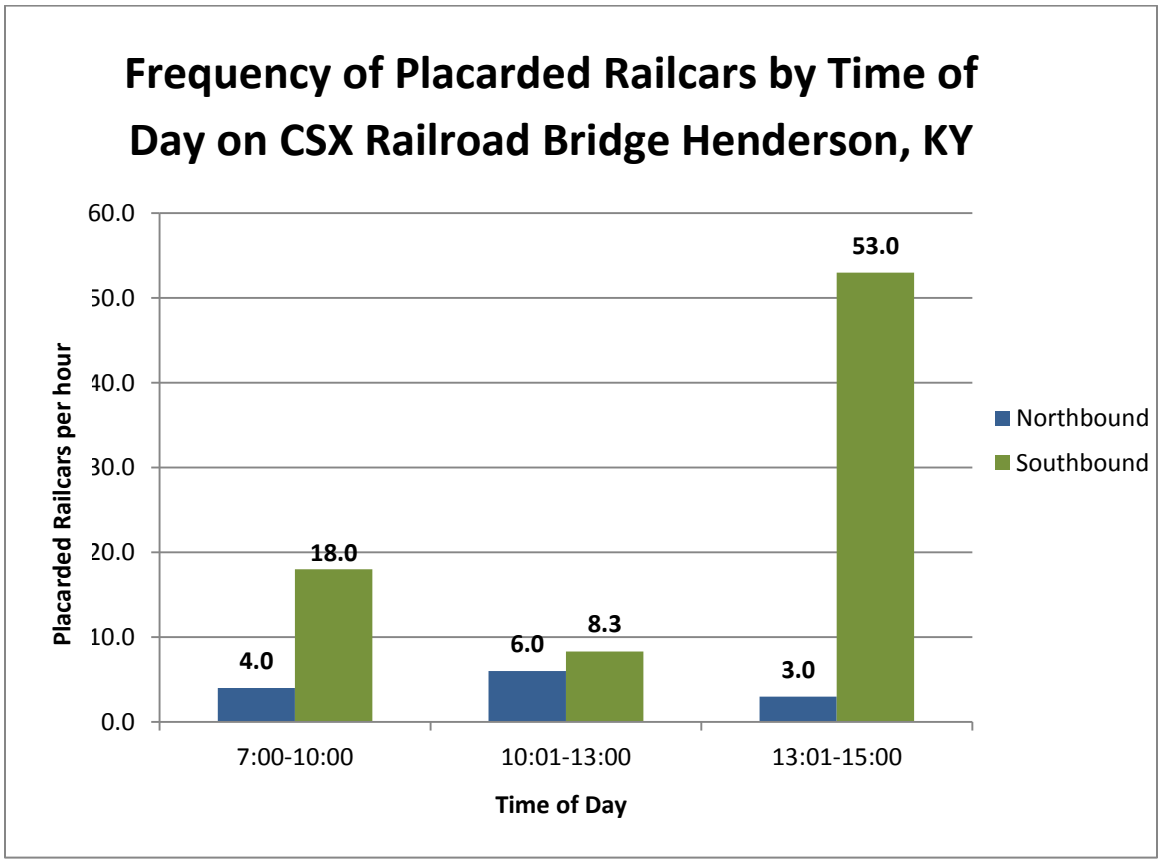

Figure 4.4. Frequency of Hazardous materials by time of the day on CSX Railroad Bridge.

iii. Composition of Hazardous Materials transported on CSX Railroad Bridge

Analysis of the placard data was used to assess the composition (%) of materials being transported on both northbound and southbound lines of the CSX Railroad Bridge. As shown in Figure 4.5 Chlorine, Placard ID 1017 was the most frequently transported material on the northbound line, accounting for 36.1% of the total hazardous materials observed during the observation period. Other commonly observed materials included Alcohol (Placard ID 1987) 27.8%, and Propane (Placard ID 1075) 8.3%. All other observed hazardous materials were put in the "Other" category, which accounts for 27.8% of the total observed placarded vehicles for the northbound line. A table with the frequency of placards observed northbound during the CSX Railroad Bridge placard survey is presented in Appendix 5.

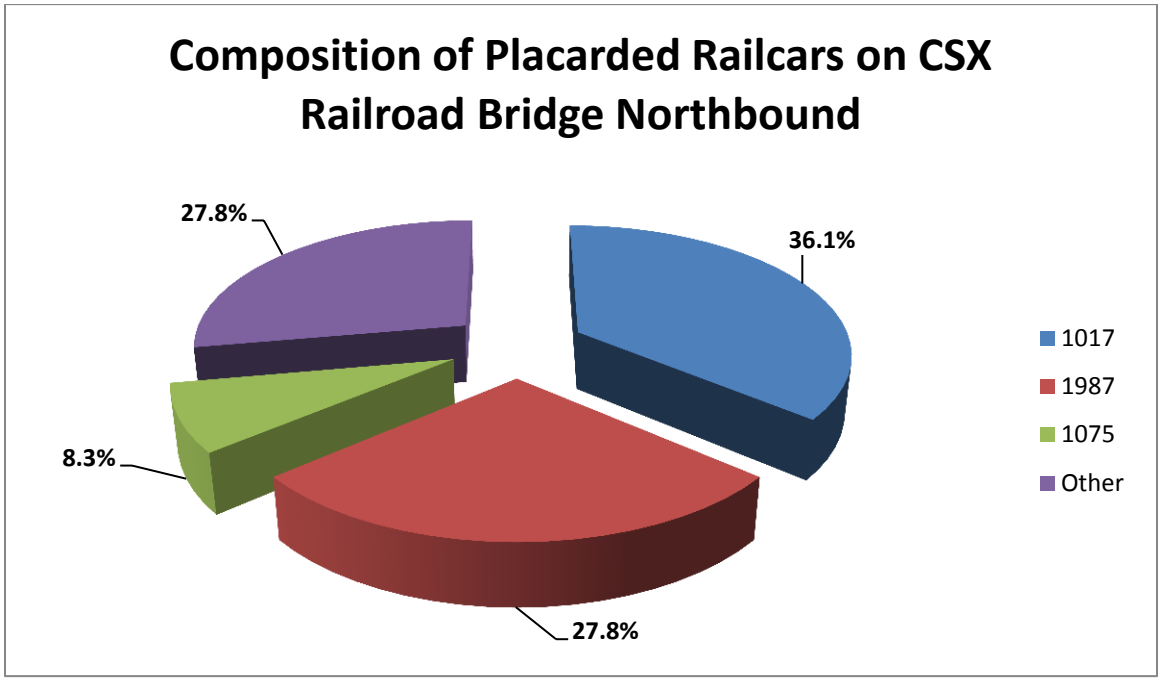

Figure 4.5. Composition of hazardous materials being transported on CSX Railroad Bridge northbound by percentage of total load.

Unlike the northbound line of the CSX Railroad Bridge, Alcohol (Placard ID 1987) was the most frequently transported material on the southbound line, accounting for 58.2% of the total hazardous materials observed (Figure 4.6). Other frequently observed materials included Sulfuric Acid (Placard ID 1830) 5.8%, Chlorine (Placard ID 1017) 4.8%, Phosphoric Acid (Placard ID 1805) 3.2% and Carbon Dioxide refrigerated liquid (Placard ID 2187) accounting for 3.2%. The "Other" category indicates all other observed materials, which accounted for 24.9% of all observed placarded vehicles on the southbound line. A table with the frequency of placards observed southbound during the CSX Railroad Bridge placard survey is presented in Appendix 6.

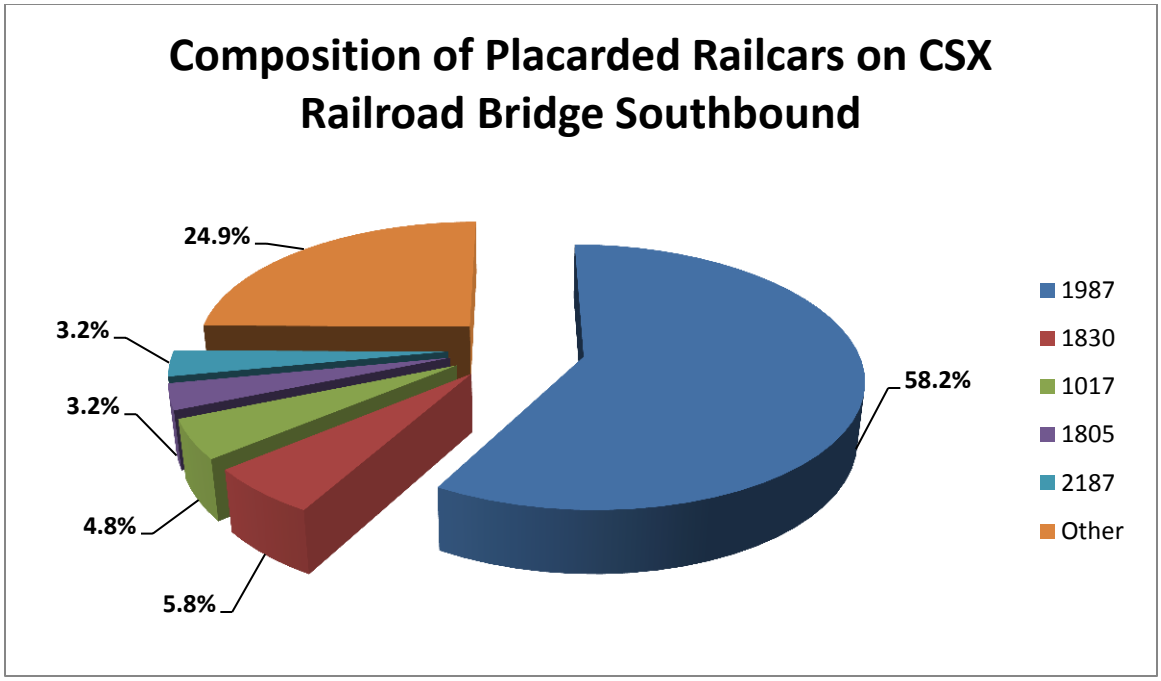

Figure 4.6. Composition of hazardous materials being transported CSX Railroad Bridge southbound by percentage of total load.

Chapter 5

Results of U.S. Highway 60 Placard Survey

Observations on U.S. Hwy 60 were made to determine the frequency of hazardous materials transported, for the monitoring period June 10-14. Total placarded vehicles that transported hazardous materials, on both east and westbound lines, were 154 (Figure 5.1). The average number of placarded vehicles observed on both east and westbound lanes was approximately 3.9 vehicles per hour (Figure 5.2). Overall, there were a greater number of vehicles transporting hazardous materials on the westbound lane of U.S. Hwy 60 (101 vehicles) compared to eastbound (53 vehicles). Similarly, the average number of placarded vehicles per hour was slightly greater on westbound lane, (2.5 vehicles per hour), compared to eastbound lane, (1.3 vehicles per hour).

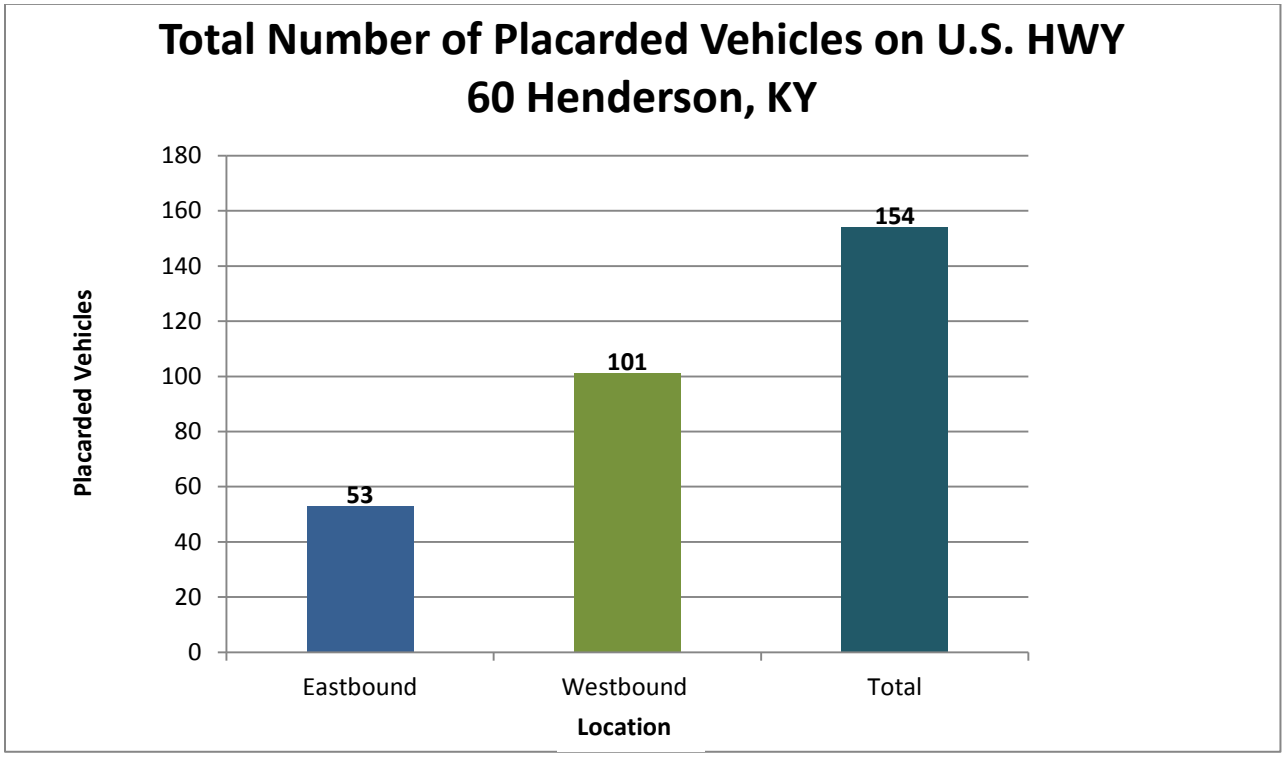

Figure 5.1. Placarded commercial vehicles observed on U.S. Hwy 60

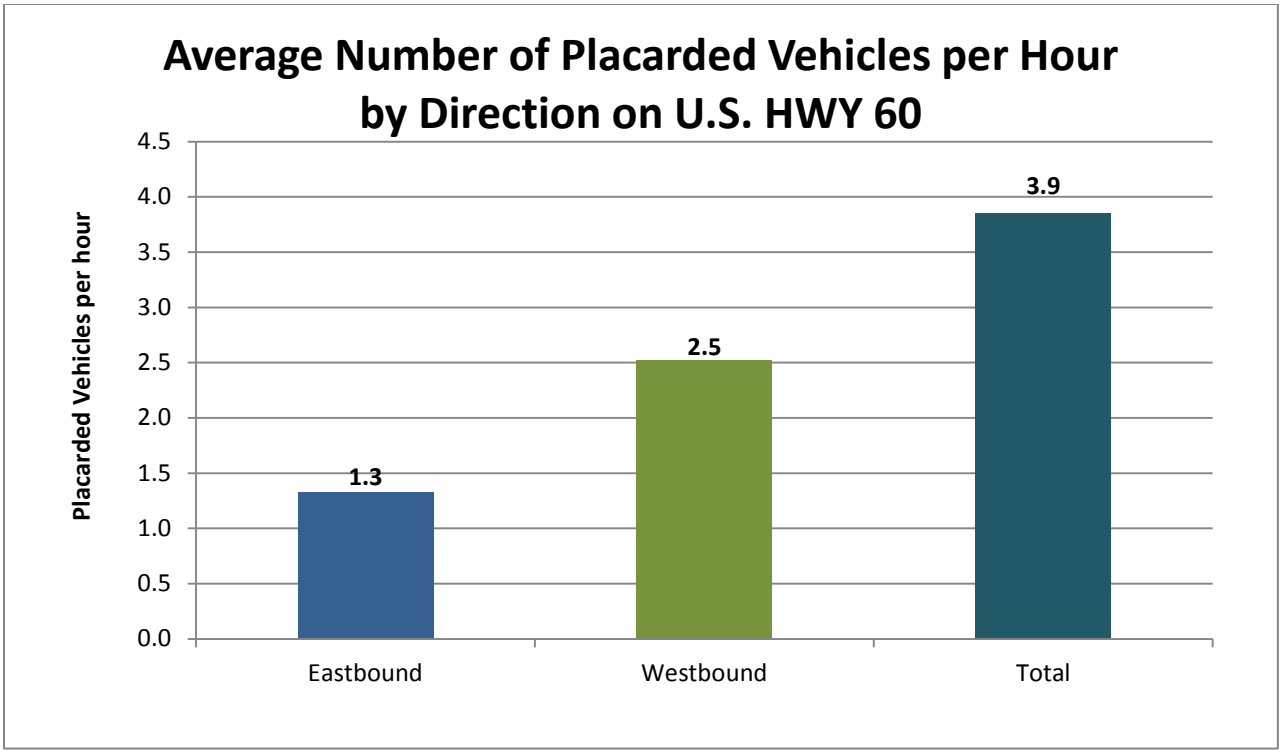

Figure 5.2. Placarded vehicles per hour by direction on U.S. Hwy 60

i. Load of placarded vehicles by day

Hazardous materials transport showed differences throughout the week (Figure 5.3). Total hazardous materials transported on U.S. Hwy 60 peaked on Tuesday, with an average of 3.4 vehicles per hour westbound and 1.6 vehicles per hour eastbound. The lowest overall commodity flow rate was witnessed on Thursday with 1.5 vehicles per hour westbound and 1.1 vehicles per hour eastbound. Monday showed the increased averages with 3.1 vehicles per hour westbound and 1.6 vehicles per hour eastbound. Wednesday had the third highest averages with Friday being fourth. The minimum rate for eastbound occurred Wednesday with 0.9 placarded vehicles per hour.

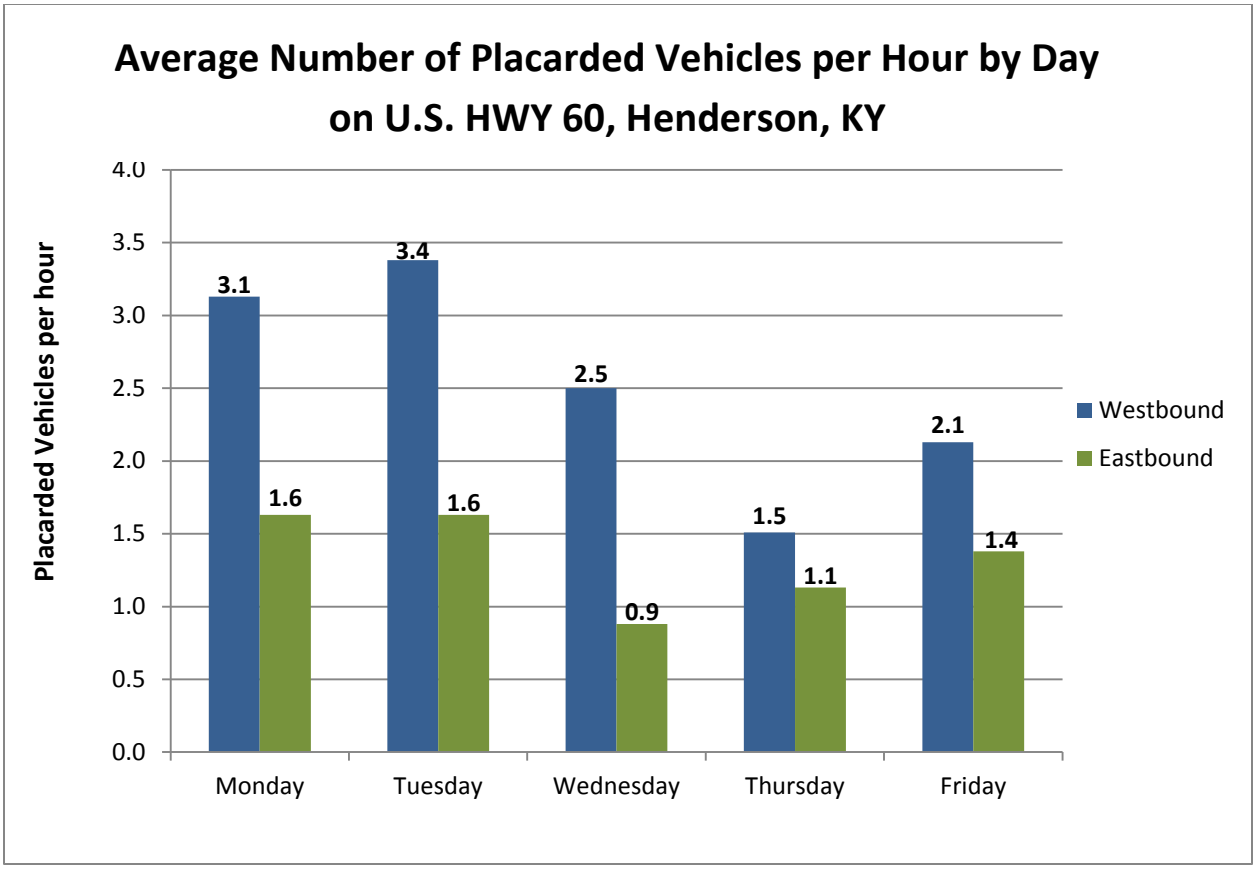

Figure 5.3. Placarded vehicles per hour by day of the week and direction on U.S. Hwy 60

ii. Placarded vehicle Frequency by time of day on U.S. Hwy 60

In order to analyze the hourly frequency of hazardous materials transported, the monitoring hours at each observation point were divided into three periods as follows:

Period 1 (Morning): 7:00 to 10:00

Period 2 (Midday): 10:01to 13:00

Period 3 (Afternoon): 13:01 pm to 15:00

As shown in Figure 5.4, the maximum rate of placarded vehicles per hour for U.S. Hwy 60 was observed during the morning period, with 7.7 and 15.0 placarded vehicles per hour, eastbound and westbound, respectively. For both eastbound and westbound lanes, the lowest rate of placarded vehicles was seen in the afternoon, with 4.5 and 9.5 placarded vehicles per hour. A decreasing trend was apparent throughout the day, as shown in the results.

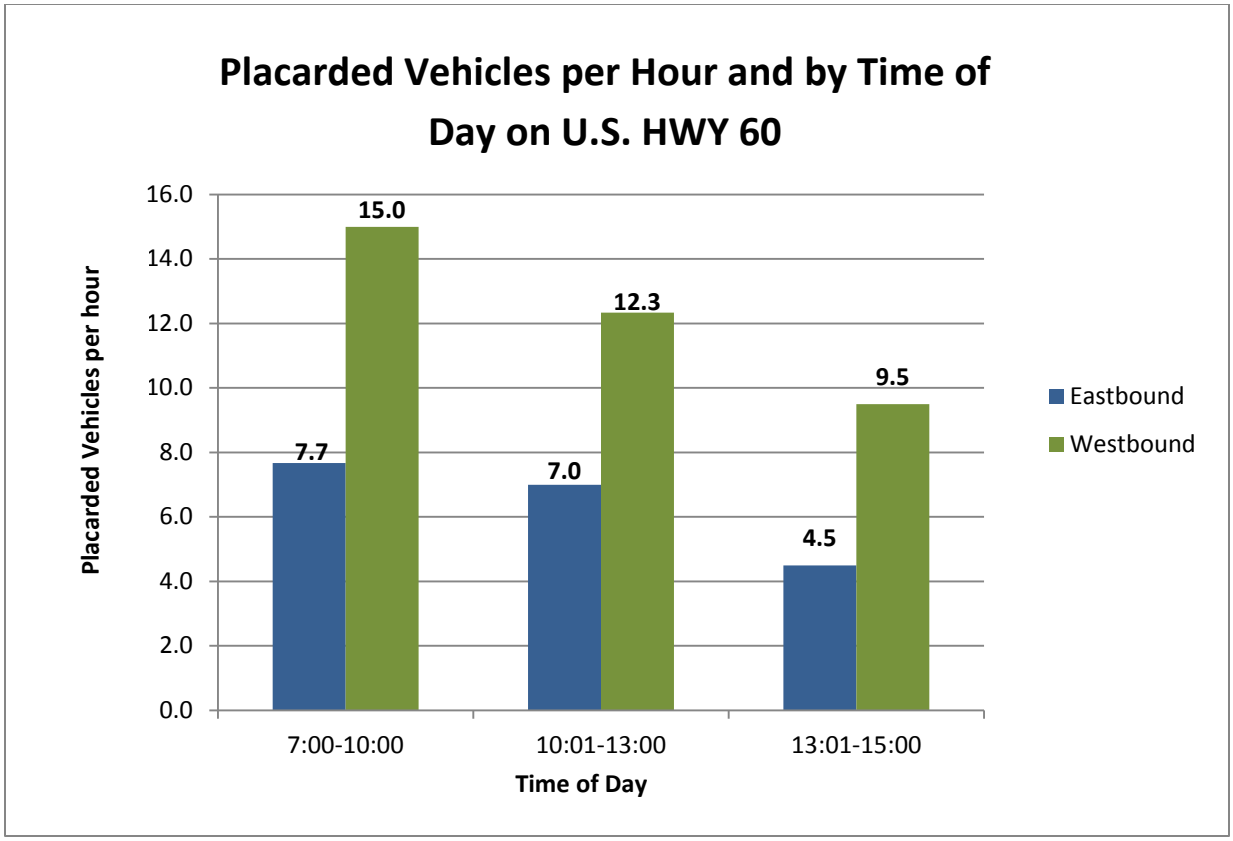

Figure 5.4. Frequency of Hazardous materials by time of the day as observed on Hwy 60.

iii. Composition of Hazardous Materials transported on U.S. Hwy 60

Analysis of the placard data was used to assess the composition (%) of materials being transported on both westbound and eastbound lanes of U.S. Hwy 60. As shown in Figure 5.5, Anhydrous Ammonia, Placard ID 1005, was the most frequently transported material eastbound, accounting for 23.0% of the total hazardous materials observed. Other common hazardous materials included Gasoline (Placard ID 1203) 21.3%, Propane (Placard ID 1075) 9.8%, Petroleum Crude Oil (Placard ID 1267) 6.6% and Non-Flammable gases accounting for 6.6%. All other observed hazardous materials were put in the "Other" category, which accounts for 32.8% of the total observed placarded vehicles for the eastbound lane of U.S. Hwy 60. A table with the frequency of placards observed eastbound during the Hwy 60 placard survey is presented in Appendix 7.

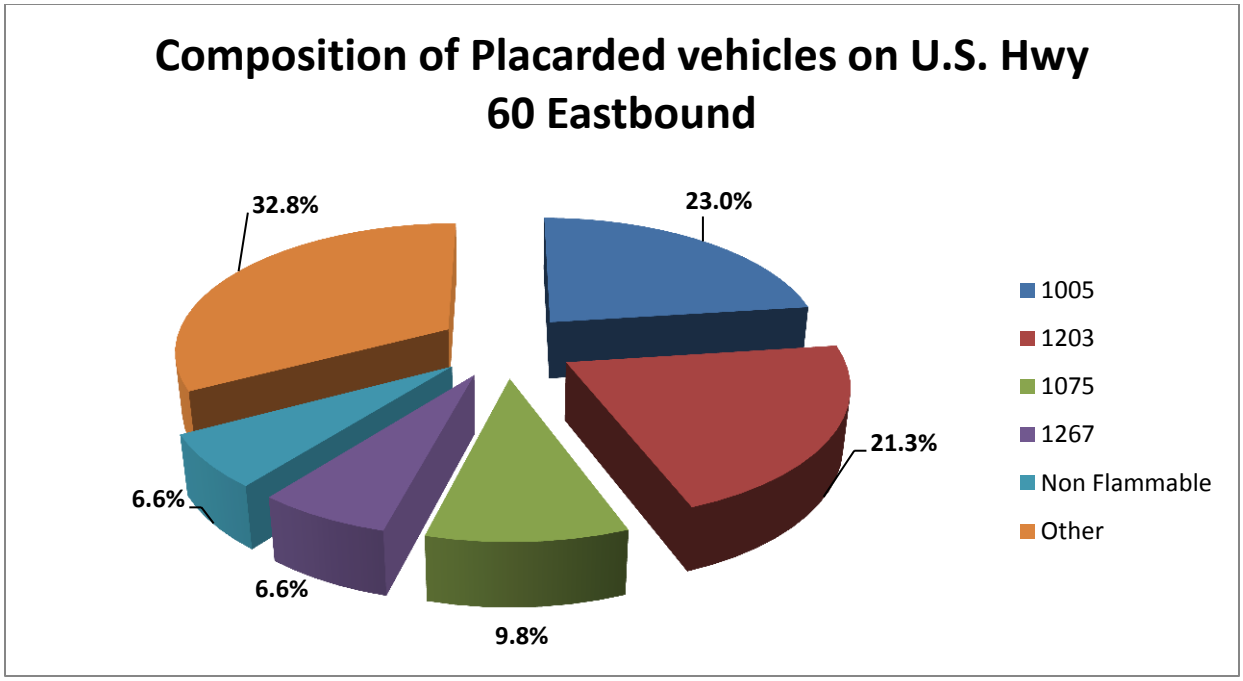

Figure 5.5. Composition of hazardous materials transported on Hwy 60 Eastbound by percentage of total load.

Just like the eastbound lane of U.S. Hwy 60, Anhydrous Ammonia, Placard ID 1005, was also the most frequently transported material on the westbound lane, accounting for 41.8% of the total hazardous materials observed (Figure 5.6). Other frequently observed materials included Gasoline (Placard ID 1203) 12.7%, Propane (Placard ID 1075) 6.4 %, Flammable (gases) and Non-Flammable (gases), both accounting for 6.4% each. All other observed hazardous materials were grouped together in the "Other" category, which accounts for 26.4% of the total number of observed placards for westbound U.S. Hwy 60. A table with the frequency of placards observed westbound during the Hwy 60 placard survey is presented in Appendix 8.

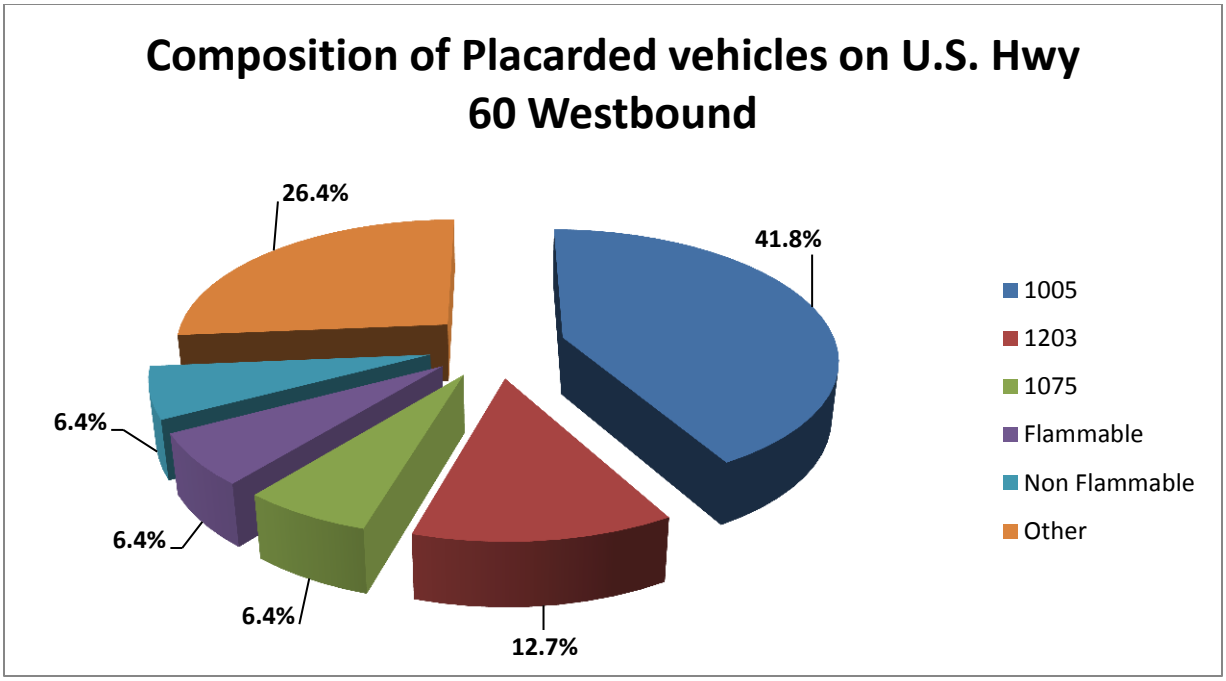

Figure 5.6. Composition of hazardous materials transported on Hwy 60 Westbound by percentage of total load.

Chapter 6

Results of State Road 136E/425N Placard Survey

State Road KY 136E/425N was monitored to observe the frequency of hazardous materials transported during the week of June 10-14. A total of 442 placarded vehicles transporting hazardous materials were observed on both 136 eastbound and 425 northbound (Figure 6.1). The average number of vehicles observed on 136 eastbound was 4.5 vehicles per hour. The average for 425 northbound was approximately 6.5 vehicles per hour (Figure 4.2). Overall, there were a greater number of vehicles transporting hazardous materials on 425 northbound (261) than on 136 eastbound (181).

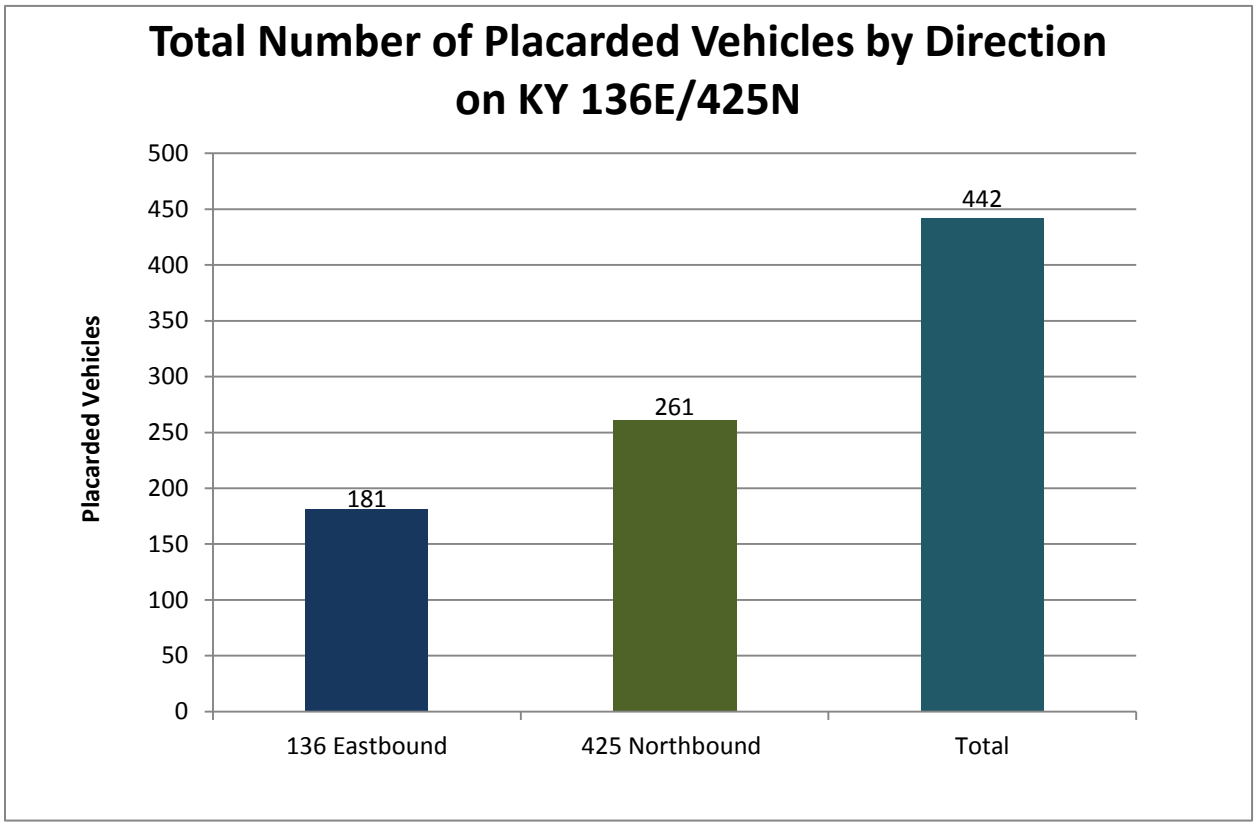

Figure 6.1. Placarded commercial vehicles observed on KY 136E/425N

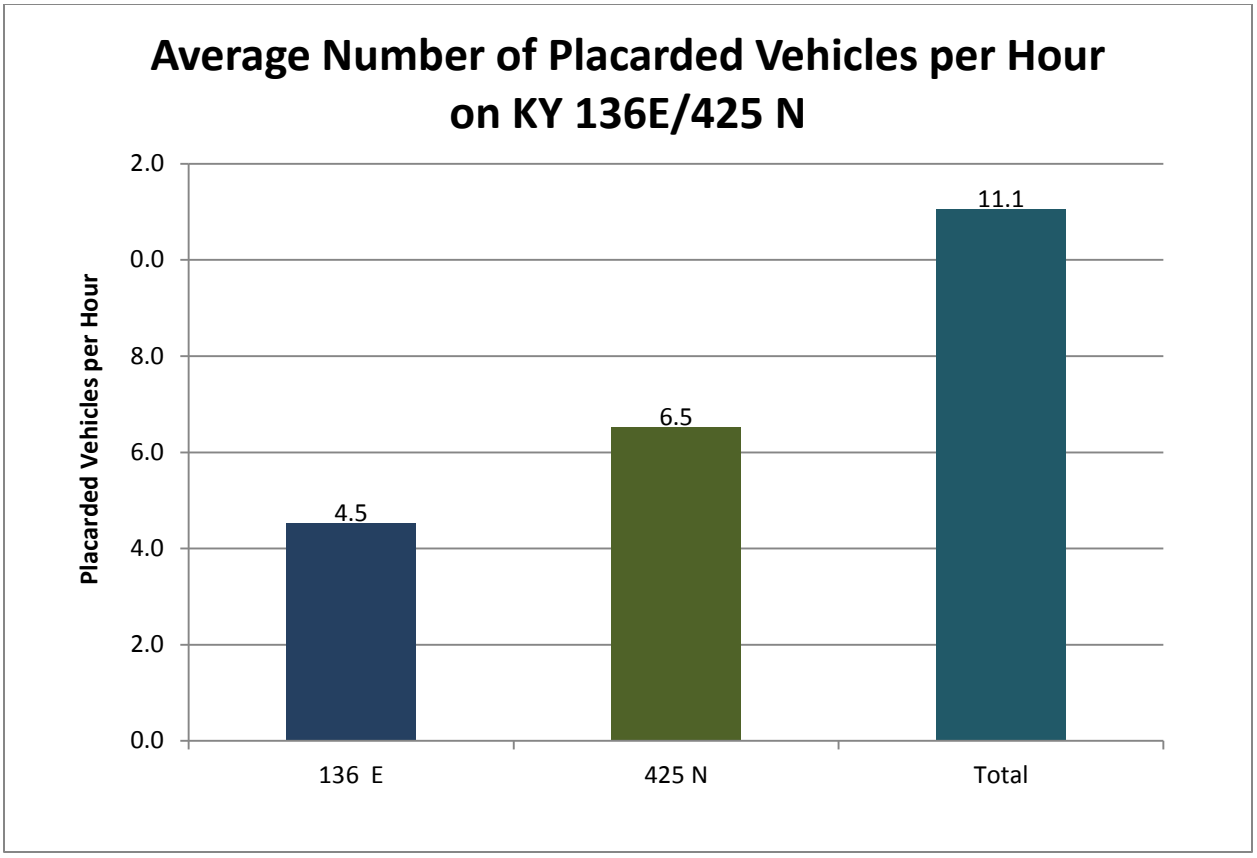

Figure 6.2. Placarded vehicles per hour on KY 136E/425N

i. Load of placarded vehicles by day

The rates of hazardous materials transported throughout the study week are presented in Figure 6.3. Hazardous materials transport peaked on Wednesday for KY 425N, with an average of 7.0 vehicles per hour. A maximum rate for KY 136E occurred on Friday at 5.8 vehicles per hour but KY 425 northbound saw its lowest average of the week that day at 6.0 placarded vehicles per hour. The lowest overall commodity flow rate for KY 136 eastbound was observed on Monday with 3.4 placarded vehicles per hour. Placarded vehicle rates on KY 136E/425N were rather consistent during midweek.

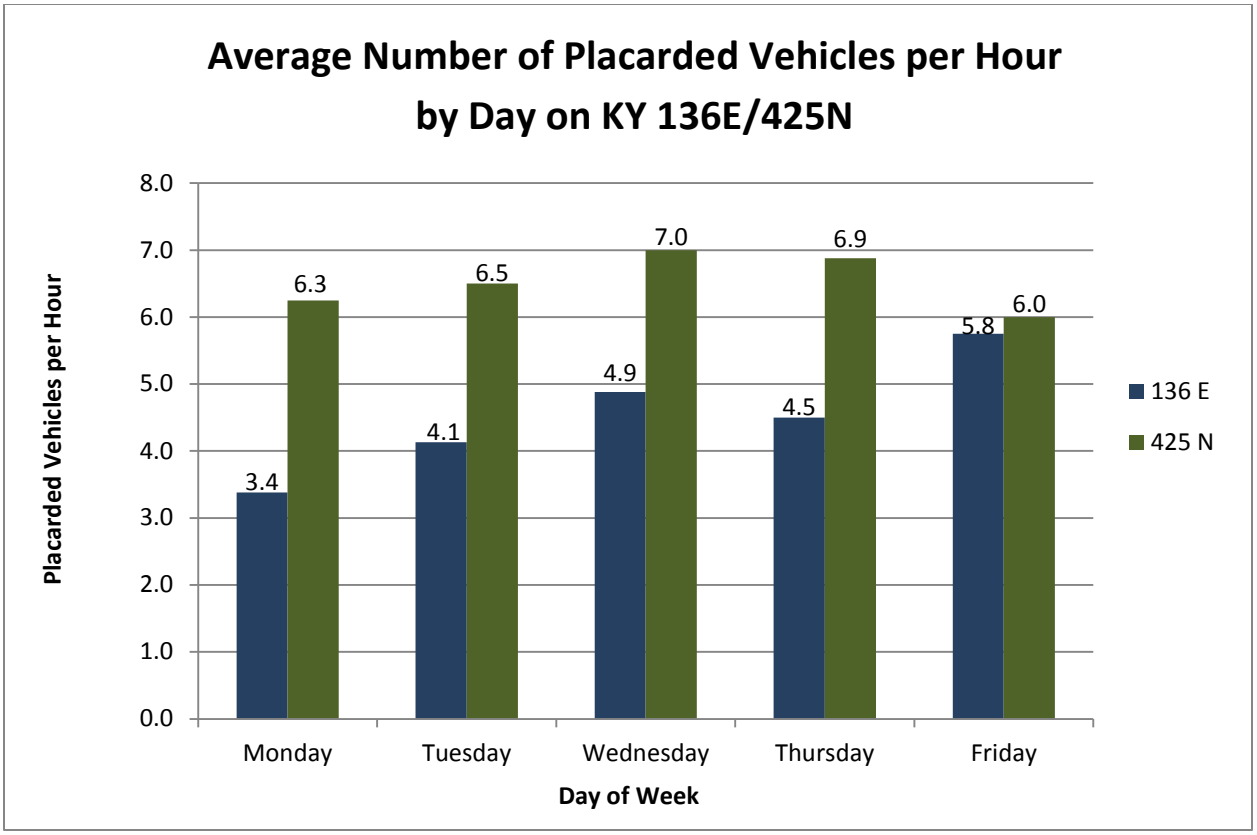

Figure 6.3. Placarded vehicle frequency per hour by day of the week on KY 136E/425N

ii. Placarded vehicles per hour by time of day on KY 136E/ 425N

In order to analyze the hourly frequency of hazardous materials transport, the monitoring hours at each observation point were divided into three separate periods. This creates the following three time periods:

Period 1 (Morning): 7:00 to 10:00

Period 2 (Midday): 10:01to 13:00

Period 3 (Afternoon): 13:01 pm to 15:00

As shown in Figure 6.4, the maximum rate of placarded vehicles per hour for KY 136E/425N was observed during the midday period with 40.7 placarded vehicles per hour on 425 northbound and 28.7 placarded vehicles per hour on 136 eastbound. The least rate of placarded vehicles per hour was observed in the afternoon for 425N (19.5) and in the morning and afternoon for 136E (19.0).

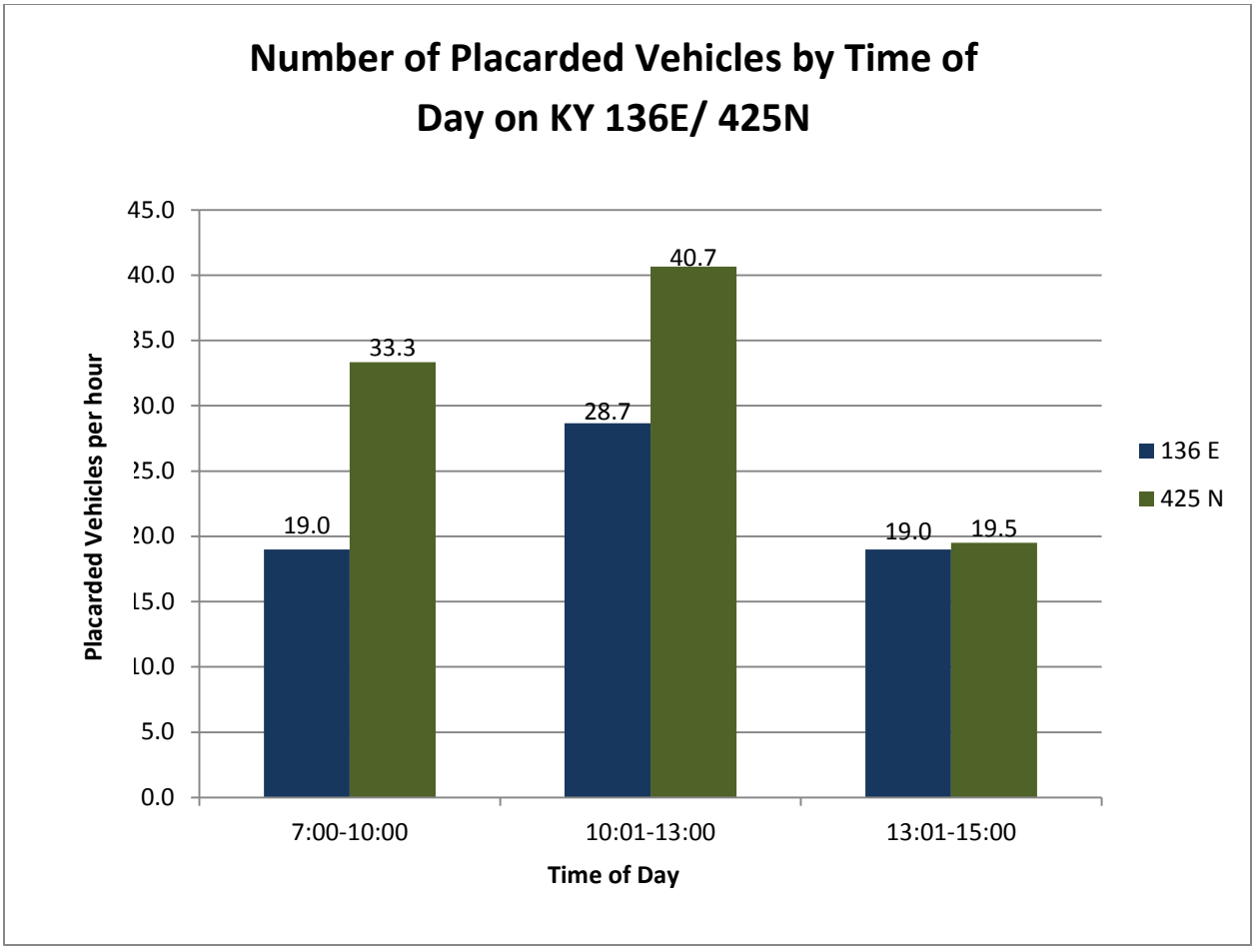

Figure 6.4. Placarded vehicles per hour by time of the day as observed on KY 136E/425N

iii. Composition of Hazardous Materials transported on KY Road 136E/ 425N

Analysis of the placard data was used to assess the materials being transported on both 136 eastbound and 425 northbound. As shown in Figure 6.5, Gasoline, Placard ID 1203, was the most frequently transported material on 136 eastbound, accounting for 19.5% of the total hazardous materials observed. Other commonly observed materials on 136 eastbound included Anhydrous Ammonia (Placard ID 1005) 12.6%, Propane (Placard ID 1075) 6.1%, Sulfuric Acid (Placard ID 1830) 5.6% and Corrosives (class 8) accounting for 5.6%. All other observed hazardous materials were put in the "Other" category, which accounts for 50.7% of the total observed placarded vehicles for KY 136E. A table with the frequency of placards observed eastbound during the KY 136 placard survey is presented in Appendix 9.

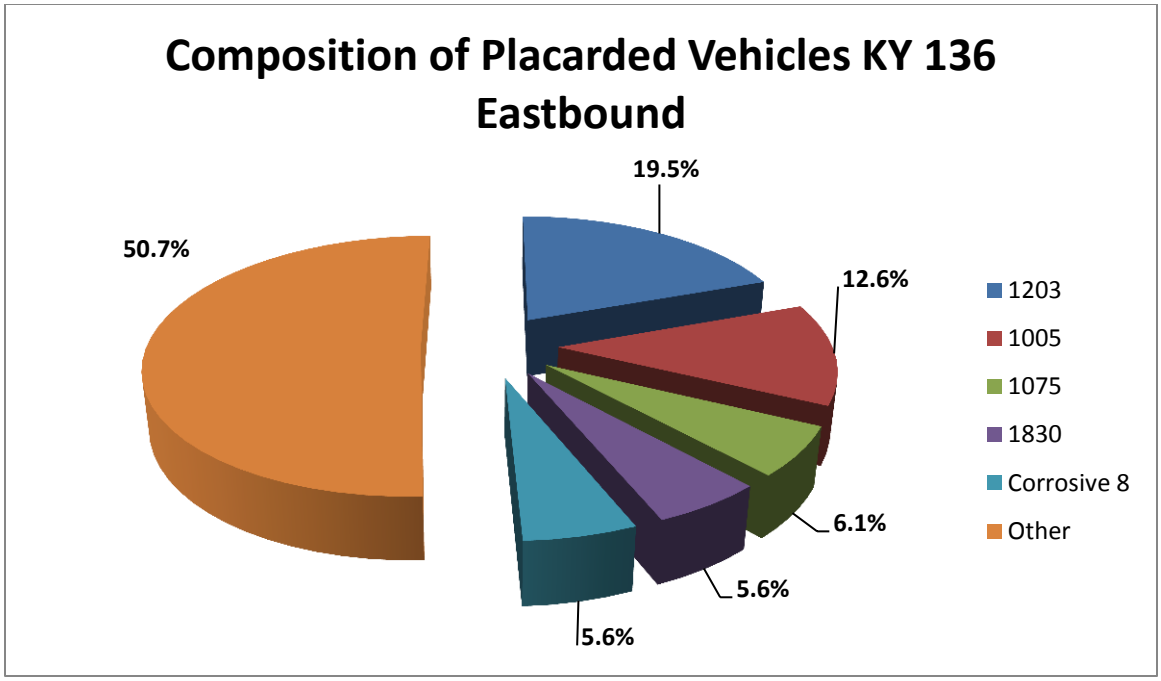

Figure 6.5. Composition of hazardous materials transported on KY 136E by percentage of total load.

Unlike 136 eastbound, Anhydrous Ammonia, Placard ID 1005, was the most frequently transported material on 425 northbound, accounting for 32.2% of the total hazardous materials observed (Figure 6.6). Other frequently observed materials included Gasoline (Placard ID 1203) 18.9%, Hypochlorite solution (Placard ID 1791) 5.3%, Caustic Soda (Placard ID 1824) 4.7% and Corrosives (class 8) accounting for 4.7%. All other observed hazardous materials were grouped together in the "Other" category which accounts for 34.2% of the total number of observed placards for 425 northbound. A table with the frequency of placards observed northbound during the KY 425 placard survey is presented in Appendix 10.

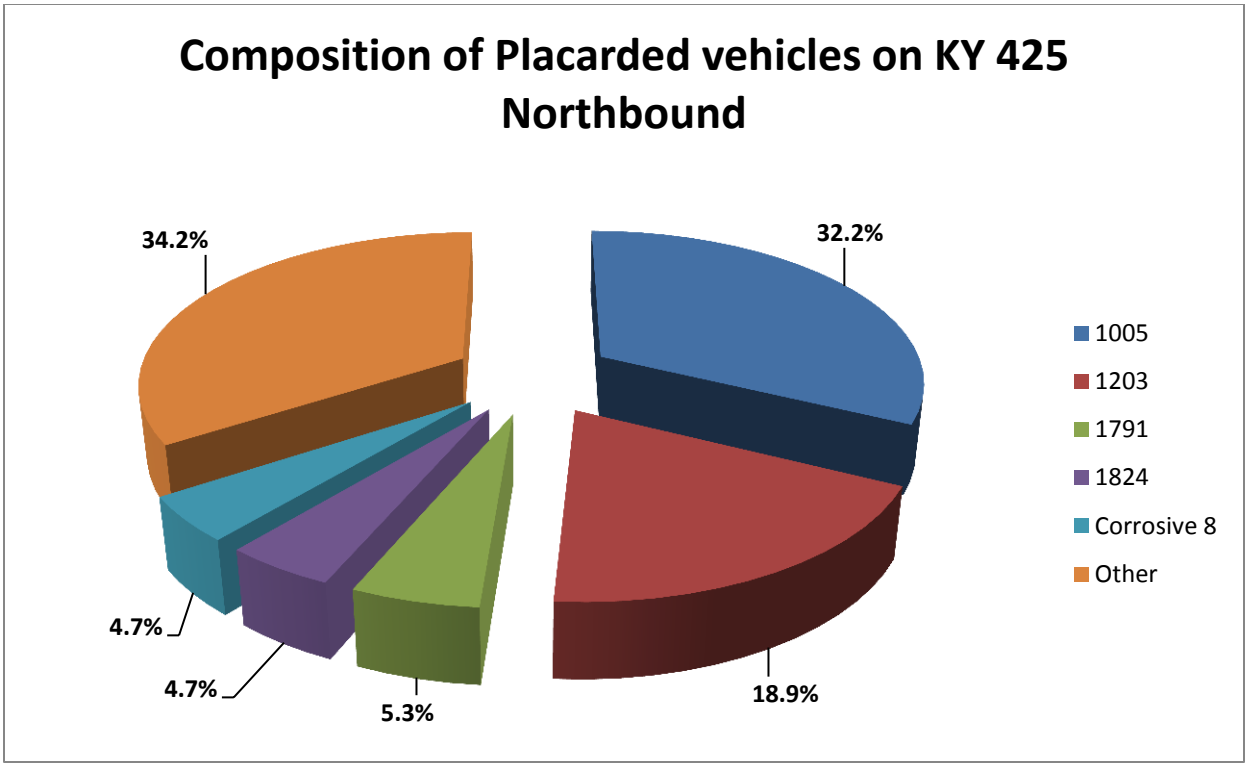

Figure 6.6. Composition of hazardous materials transported on KY 425 Northbound by percentage of total load.

Chapter 7

Results of Audubon Parkway Placard Survey

The Audubon Parkway was monitored to observe the frequency of hazardous materials transported, for the monitoring period July 15 through 19, 2013. The total number placarded vehicles east and westbound observed transporting hazardous materials was 212 (Figure 7.1).

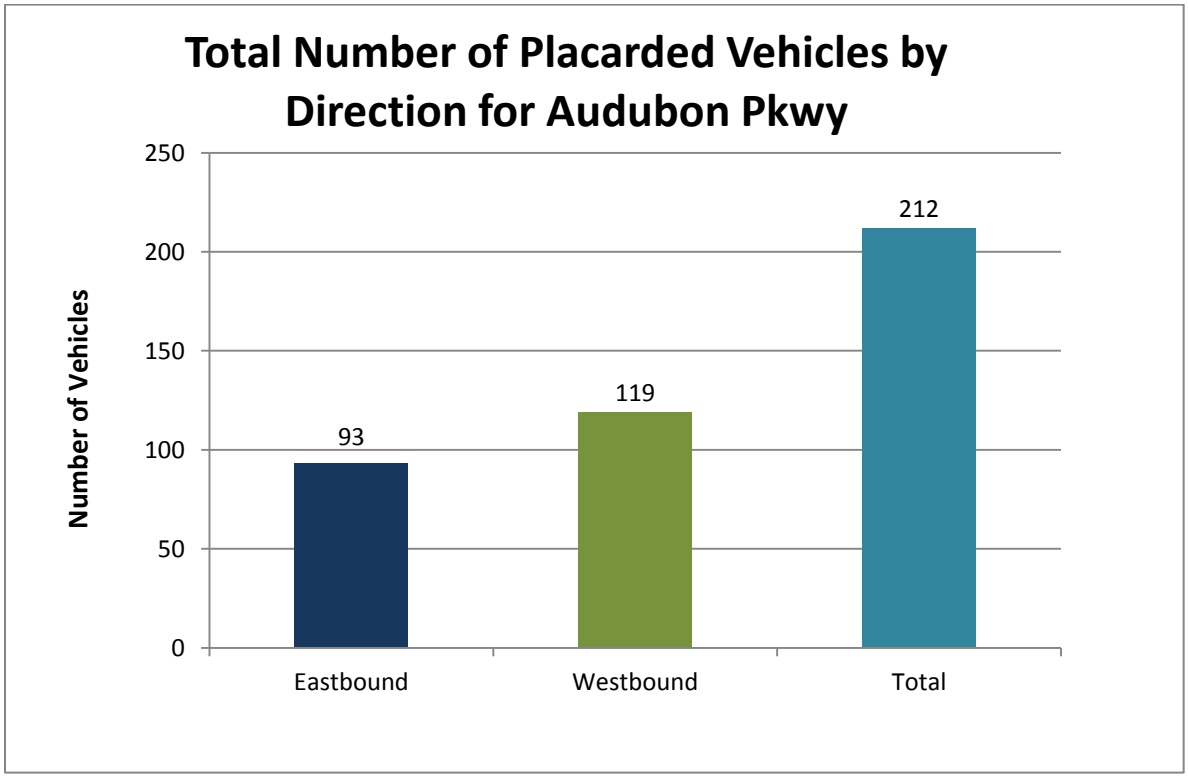

Figure 7.1. Placarded commercial vehicles observed on Audubon Parkway

The average number of vehicles observed on both east and westbound lanes per hour was approximately 5.3 vehicles per hour (Figure 7.2). Overall, there were a greater number of vehicles transporting hazardous materials on the westbound lane of Audubon Pkwy (119 vehicles) compared to eastbound (93 vehicles). Similarly, the average number of placarded vehicles per hour was slightly greater westbound lane (3.0 vehicles per hour) compared eastbound (2.3 vehicles/ hour).

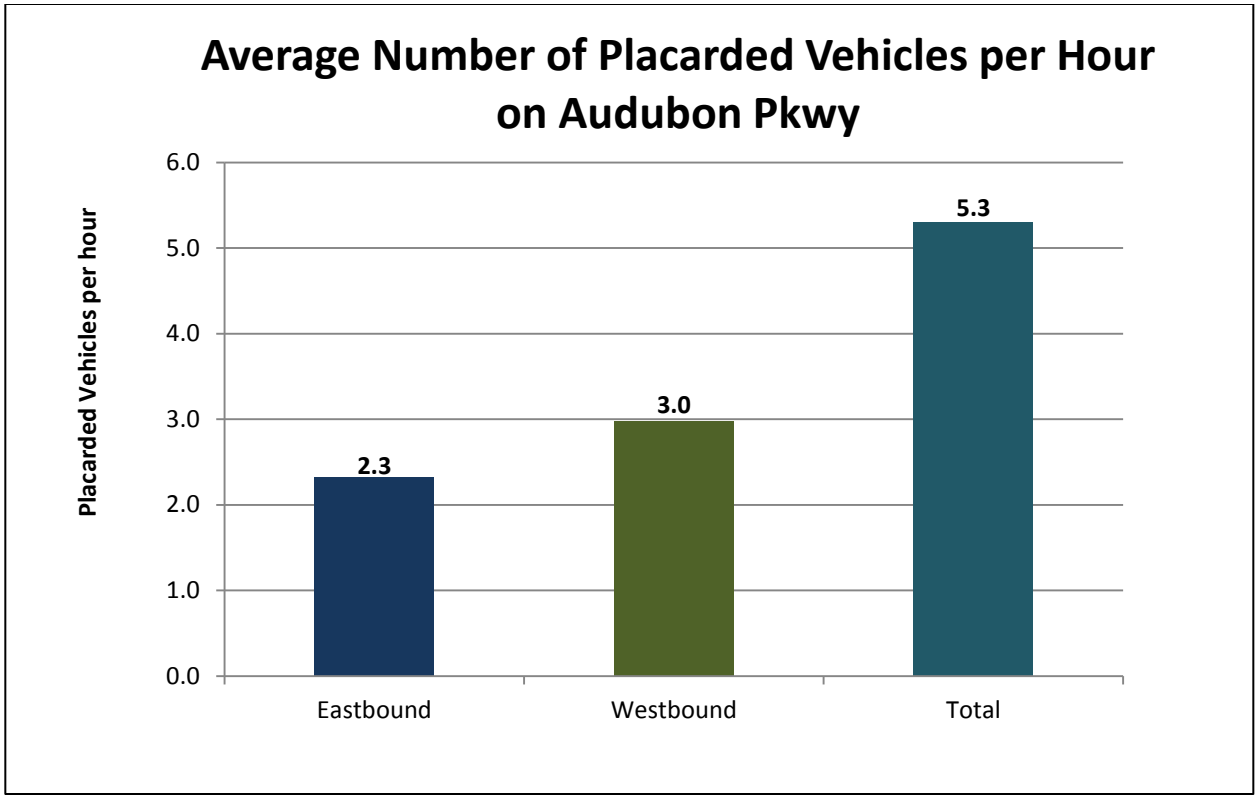

Figure 7.2. Placarded vehicle frequency per hour on Audubon Parkway

i. Load of placarded vehicles by day

The rate of hazardous material transport on Audubon Parkway for the study week is presented in Figure 7.3. Total hazardous materials transport on the Audubon Pkwy peaked on Wednesday, with an average of 3.5 placarded vehicles per hour westbound and 2.6 vehicles per hour eastbound. The lowest overall commodity flow rates were observed on Friday with 2.8 and 1.8 placarded vehicles per hour. Tuesday and Thursday tied for the second highest averages with 2.8 vehicles per hour westbound and 2.8 vehicles per hour eastbound on Tuesday, and 3.3 vehicles per hour westbound, and 2.3 vehicles per hour east bound on Thursday. The general trend in the commodity flow was an increase through Wednesday and then a decrease through Friday.

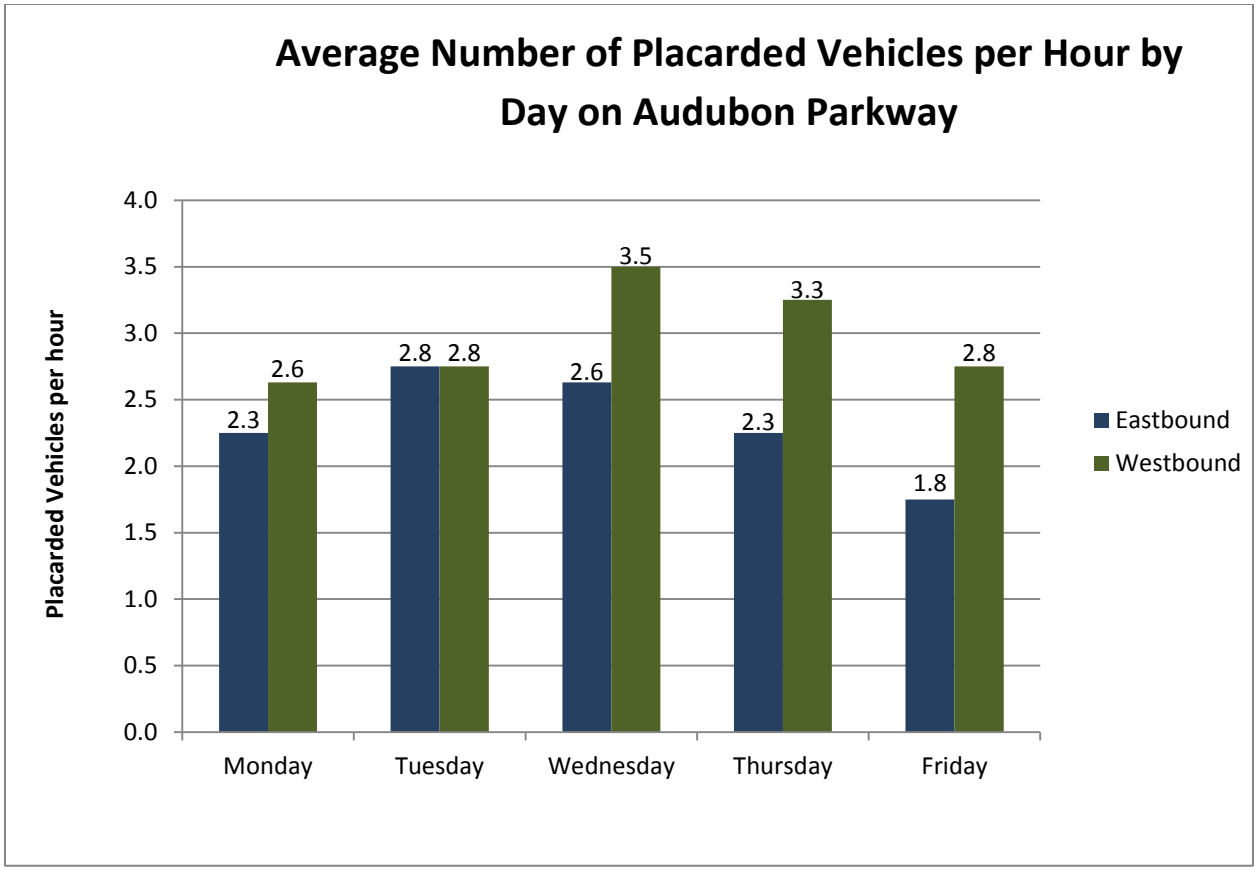

Figure 7.3. Placarded vehicle frequency per hour by day of the week on KY Audubon Parkway

ii. Placarded vehicle Frequency by time of day on Audubon Parkway

In order to analyze the hourly frequency of hazardous material transport, the monitoring hours at each observation point were divided into three separate periods. This creates the following three time periods:

Period 1 (Morning): 7:00 to 10:00

Period 2 (Midday): 10:01 to 13:00

Period 3 (Afternoon): 13:01 to 15:00

As shown in Figure 7.4, the maximum rate of placarded vehicles per hour for the Audubon Pkwy was observed in the mornings with 15.0 eastbound and 18.0 westbound. For both lanes the lowest rates were of placarded vehicles per hour were observed in the afternoon, with 6.5 and 11.0 placarded vehicles per hour. Hazmat commodity flow rates for both lanes of traffic showed a decreasing trend throughout the day.

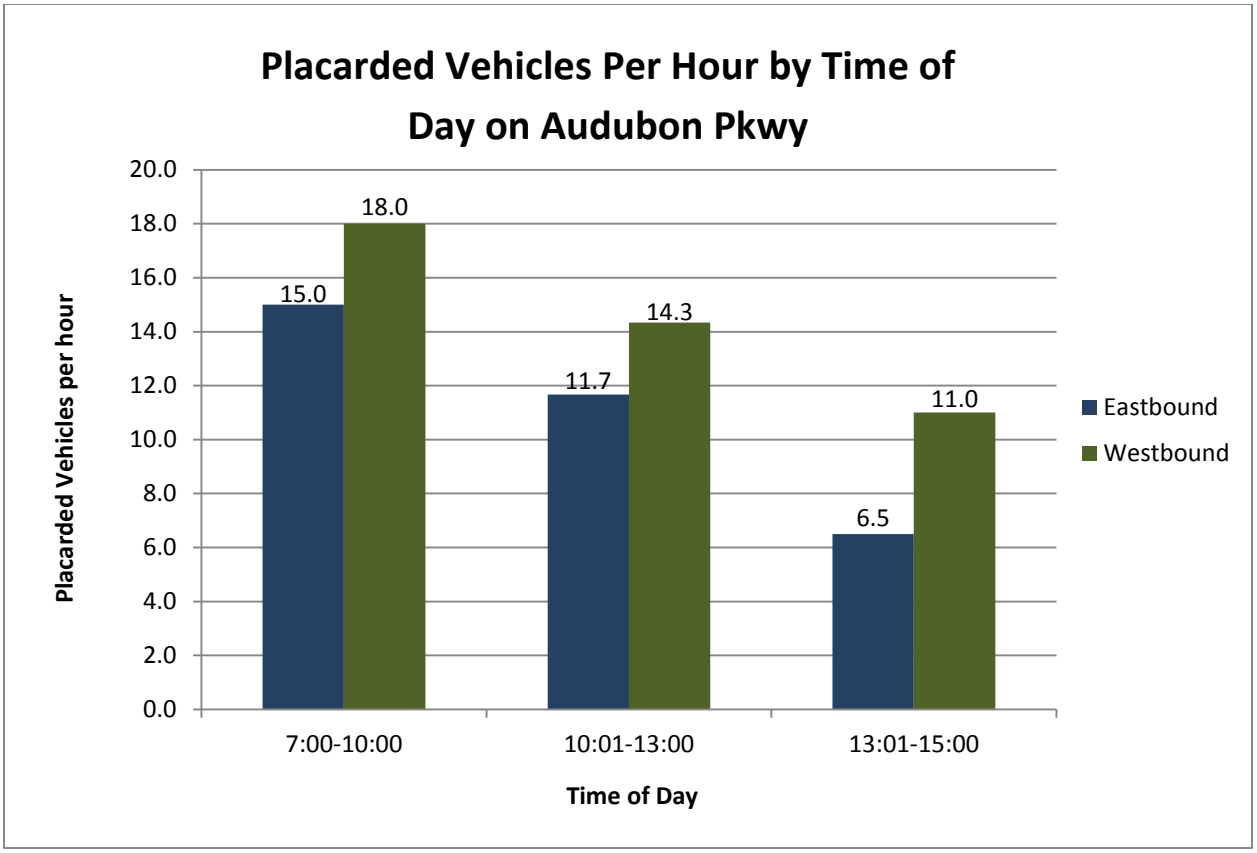

Figure 7.4. Placarded vehicles per hour by time of the day as observed on Audubon Pkwy

iii. Composition of Hazardous Material transported on Audubon Parkway

The composition (%) of hazardous materials transported by vehicles on Audubon Parkway Eastbound is displayed in Figure 7.5. Gasoline (Placard ID 1203) was the most frequently transported material on eastbound Audubon Pkwy, accounting for 16.7% of the total hazardous material observed. Other commonly observed materials included Propane (Placard ID 1075) at 12.3%, Flammable 3 at 8.9%, Crude Oil (Placard ID 1267) at 7.9%, and Corrosives Class 8 at 6.1%. All other less frequently observed placards were grouped together as "Other" which accounted for 49.1% of all placards. A table with the frequency of placards observed eastbound during the Audubon Parkway placard survey is presented in Appendix 11.

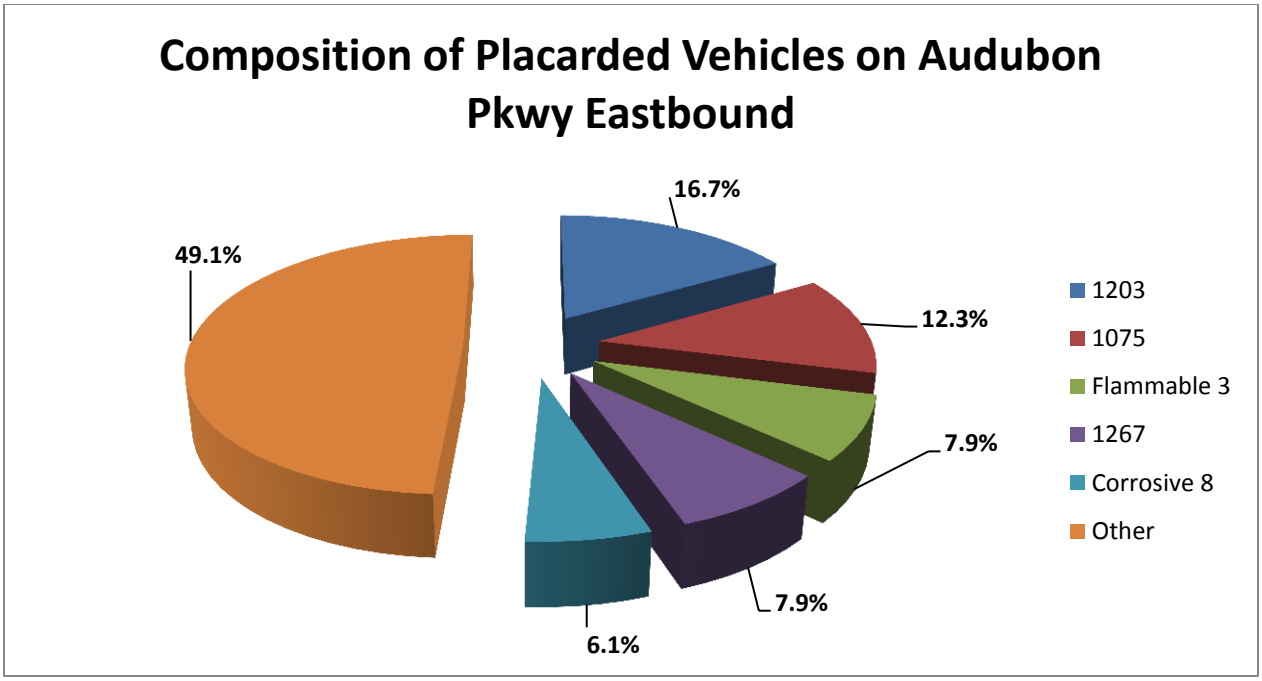

Figure 7.5. Composition of hazardous materials transported on Audubon Parkway eastbound by percentage of total load.

Just like the eastbound lane of Audubon Parkway, Gasoline with Placard ID 1203, was also the most frequently transported material on the westbound lane, accounting for 18.1% of the total hazardous material observed (Figure 7.6). Other frequently observed materials include Combustible Liquid, (Placard ID 1993) 12.5%, Ammonium Nitrate (Placard ID 2067) 11.1%, Propane (Placard ID 1075) 4.9% and Sodium Hydroxide (Placard ID 1824), accounting for 4.9% each. All other observed hazardous materials were grouped together in the "Other" category, which accounts for 48.6% of the total number of observed placards for westbound Audubon Parkway. A table with the frequency of placards observed westbound during the Audubon Parkway placard survey is presented in Appendix 12.

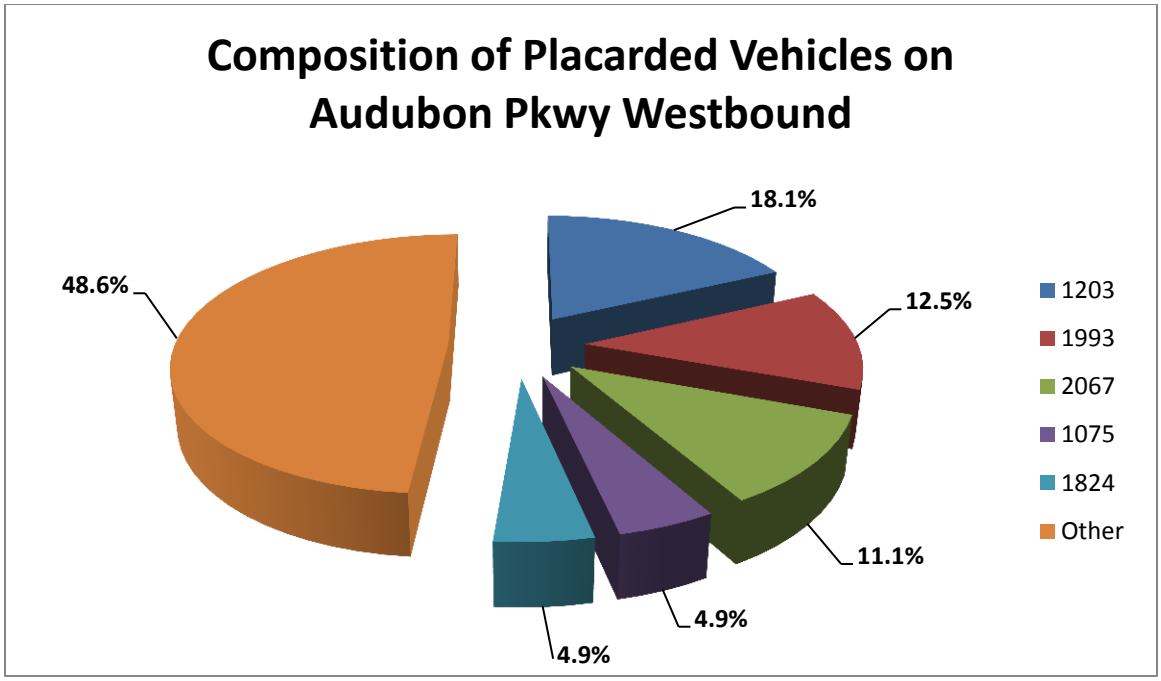

Figure 7.6: Composition of hazardous materials being transported on Audubon Parkway westbound by percentage of total load

iv. Top five most observed placard

Analysis of the placard data was used to determine the top five most commonly transported hazardous materials in the Henderson county area. As shown in figure 7.7, Gasoline (1203) was the most commonly transported material with 18.3% of the total placards. Placard ID: 1005 (Anhydrous Ammonia) was the second most commonly observed placard at 13.0%, followed by ID: 1987 (Alcohols) at 12.0%. Propane (ID: 1075) and Corrosive 8 rounds out the top five with 4.8% and 3.8% respectively. All other observed hazardous materials that individually account for less than 3.8% were grouped together in the "Other" category. This category accounted for 48.1% of the total number of observed placards for Henderson County.

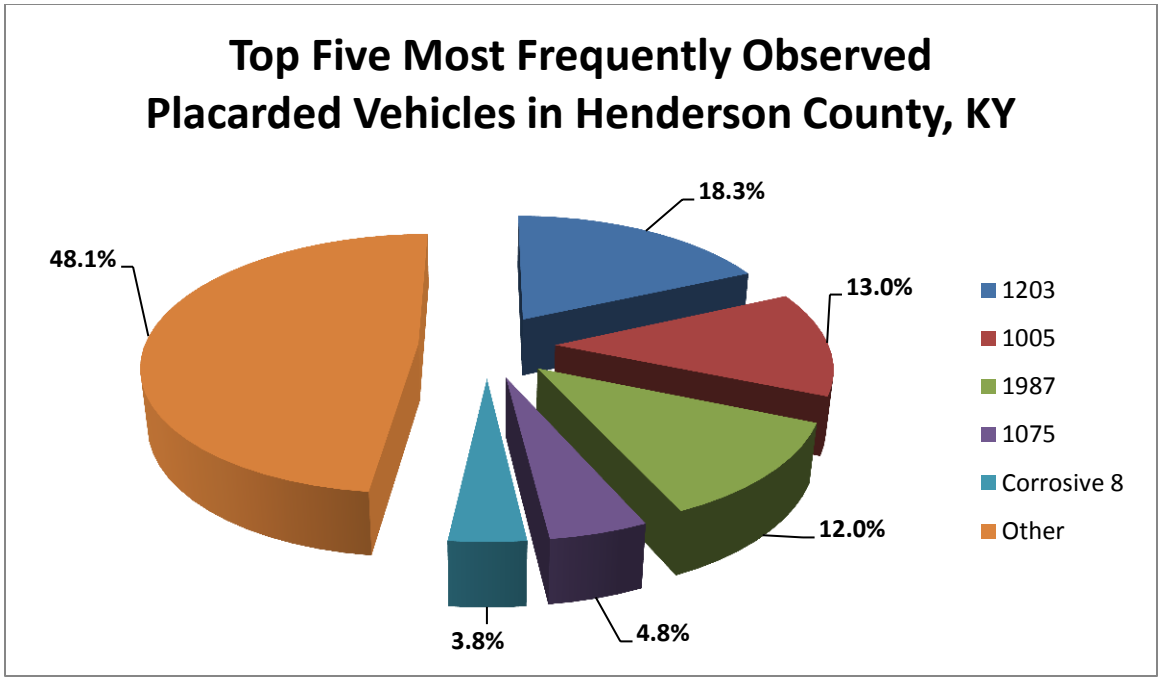

Figure 7.7 Top five most commonly transported hazardous materials in Henderson County

Chapter 8

Results of Fixed Facilities Hazardous Commodity Transport Survey

A survey of the fixed facilities that ship, receive, and use hazardous materials was administered through HCEM. Survey data were collected from 14 fixed facilities within the Henderson County. The Kentucky Emergency Response Commission monitors these facilities, as they store large amounts of hazardous materials. In some instances, hazardous materials could exceed the threshold planning capacity of the EPA's "Extremely Hazardous Materials". Emergency planning for hazardous materials incidents should be based on knowledge of fixed facilities use of trucking, both timings and routes, along with the types and quantities of hazmat shipped and received. Other modes of transportation such as rail and barge should be included if used by the fixed facilities.

In order to investigate the travel of hazardous materials to and from fixed facilities, the survey consisted of a voluntary questionnaire. Surveys were mailed to environmental health and safety managers in May 2013. The questionnaire was designed to document the origins and destinations of hazardous material commodities interacting with fixed facilities, within the study corridor. Surveys were returned to HCEM. The results were assessed to portray the types of hazardous materials transported.

Information requested in the questionnaire included the following categories:

- Frequency of Hazmat Shipments
- Routine of Hazmat shipments
- Total quantities of hazardous materials
- Origins/Destinations of shipments
- Timing of Hazmat shipments
- Composition of Hazmat shipments
- Recent Trends

i. Fixed facilities and hazardous materials

A total of 14 industrial facilities responded to the survey. Most of the responding industries ship and receive hazardous materials. It is essential to know the type of hazardous materials transported, as well as their regular periods of shipment. Survey results evaluated the most common substances transported, their origins and destinations, as well as trends in transportation over the last five years, i.e. 2008-2012. HCEM can utilize the fixed facility survey results, in conjunction with the hazmat commodity flow survey, to assess preparedness for hazardous materials incidents within Henderson County. An important aspect of this survey was to determine if facilities transported hazardous materials on legal holidays. Facilities, which indicated that they do not carry hazardous materials, were discarded from the results.

ii. Fixed Facility Locations

Survey questions, regarding the location of facilities based on city, state, and county, were provided to local industries. These data were used to assess hazardous materials commodity imports and exports in the Henderson County study area. All 14 facilities that responded to the survey were based in Kentucky, with some having corporate offices in other states.

Questions in the survey addressed the most common mode of hazardous materials transport to and from the facilities. All 14 facilities reported using trucks as a major source of hazardous materials transport, and some of the facilities reported using railroad and/or other means of transportation. The survey included questions requiring the facilities to give information about the number of placarded trucks that leave or arrive at their facilities. Routes of hazardous materials transport were requested in the questionnaire. Location, by zip code, of the 14 facilities is shown in Figure 8.1. Approximately, 85.7% of all facilities were located within the 42420 zip code, with 14.3% located in the 42452 zip code.

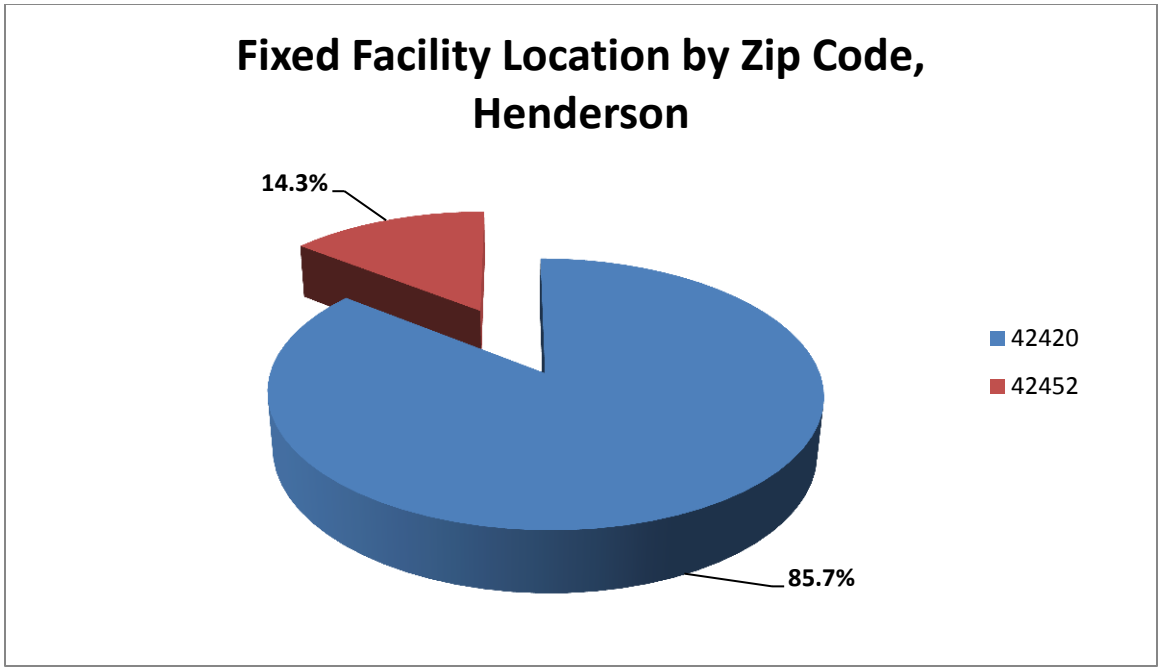

Figure 8.1.Fixed facility locations by zip code

iii. Time pattern for receiving hazardous materials shipments

One of the questions on the survey asked the facilities to respond with the number of placarded vehicles that arrive and depart from their facilities. This information provided an overview of the movement of hazmat vehicles by frequency for shipping/receiving. When hazardous materials received over the past five years are compared, it was observed that the bulk of receiving is from Monday through Friday (Figure 8.2) as reported by the facilities.

Fixed facilities were also asked to give information on the most common shipment periods. Results are shown in Figure 8.3. Information submitted indicated that 4 facilities had no routine time of shipment. The most common time of day for shipments of hazardous materials was during normal working hours, between 06:00 – 16:00.

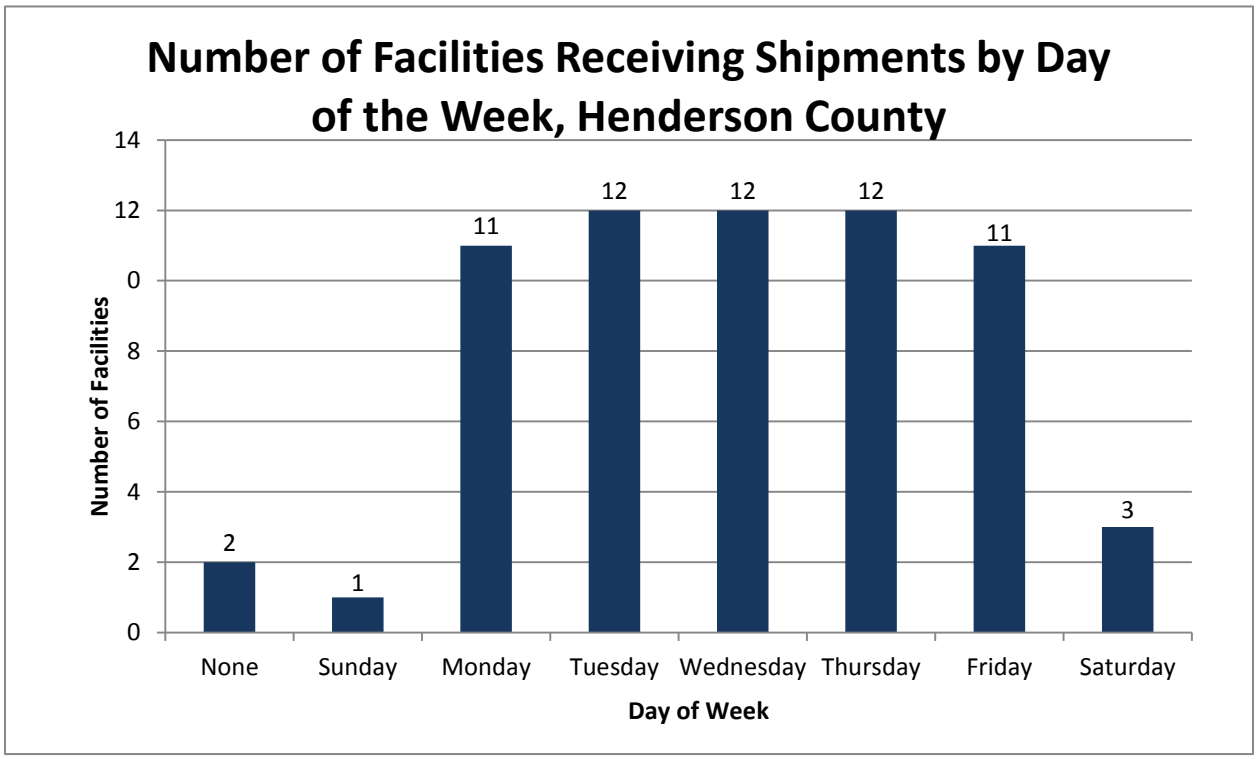

Figure 8.2. Number of facilities shipping by day of week

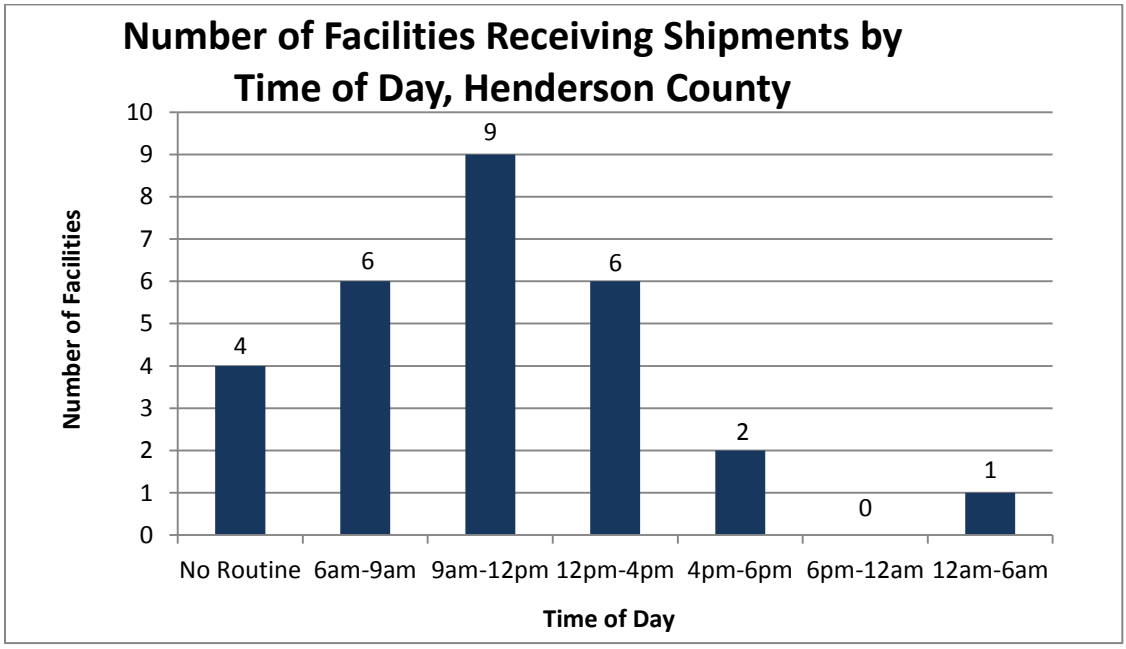

Figure 8.3. Time pattern, by day, for receiving hazardous materials

The facilities were asked if they received or shipped hazardous materials on legal holidays. Six facilities, which make up 42.9% of all responding facilities, ship or receive hazardous materials on legal holidays (Figure 8.4). This may be a contingency to plan for, as altered traffic patterns may change the operation parameters of placarded vehicles, thus increasing the chances of incidents.

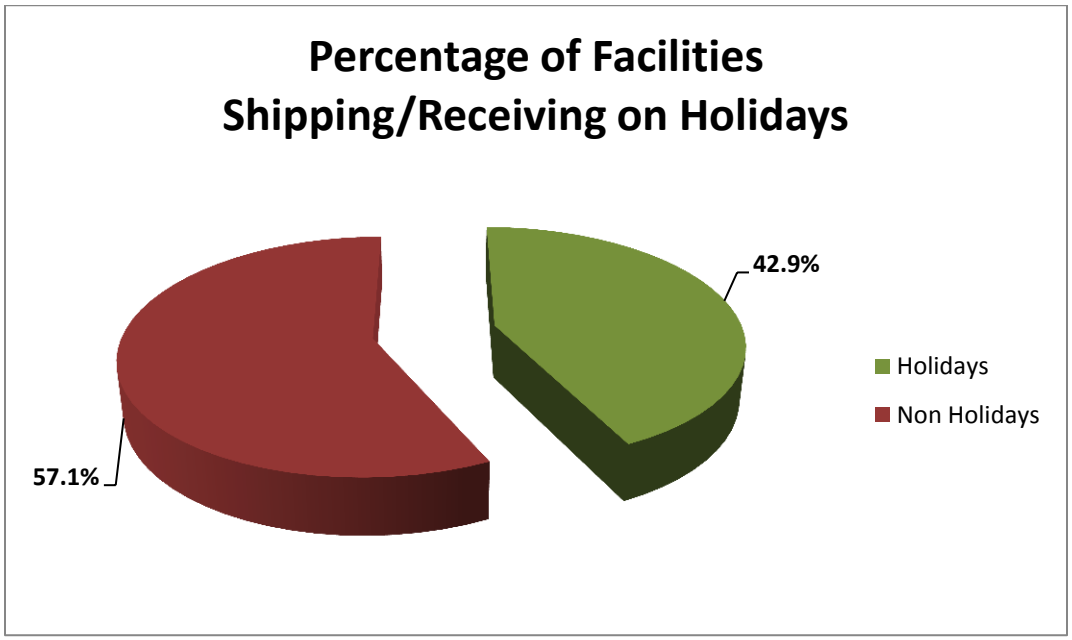

Figure 8.4. Shipping and receiving on holidays

iv. Time pattern for shipments from facilities

Facilities were asked to report on time patterns for shipping hazardous materials. Three facilities reported Saturday and two facilities reported Sunday as routine shipment days (Figure 8.5). Six facilities reported that they had no routine period of shipment by day. The typical shipment pattern reported by day was during the workweek, Monday through Friday (Figure 8.5). Time of day patterns for hazardous material shipments showed a trend towards standard working hours, between 06:00 and 16:00 (Figure 8.6). Five facilities reported there was no routine time of day for shipments.

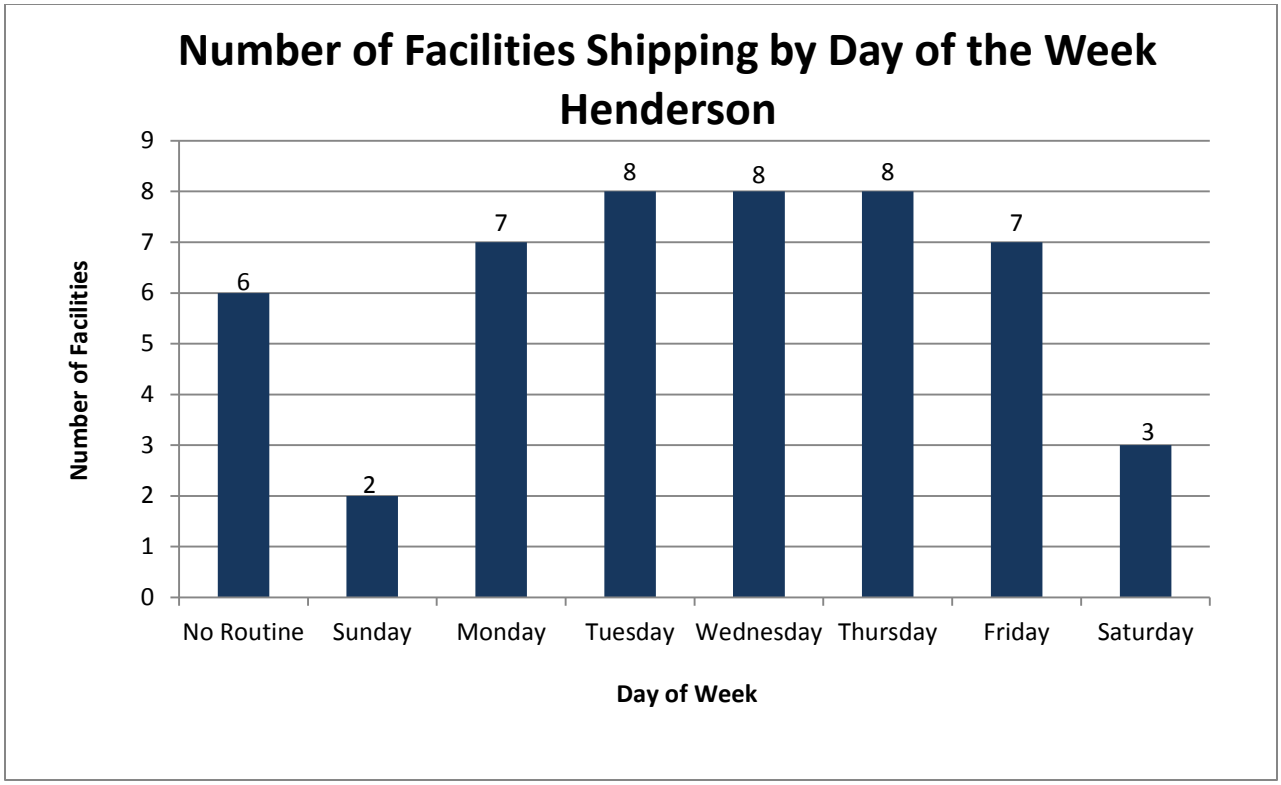

Figure 8.5. Number of facilities shipping by day of week

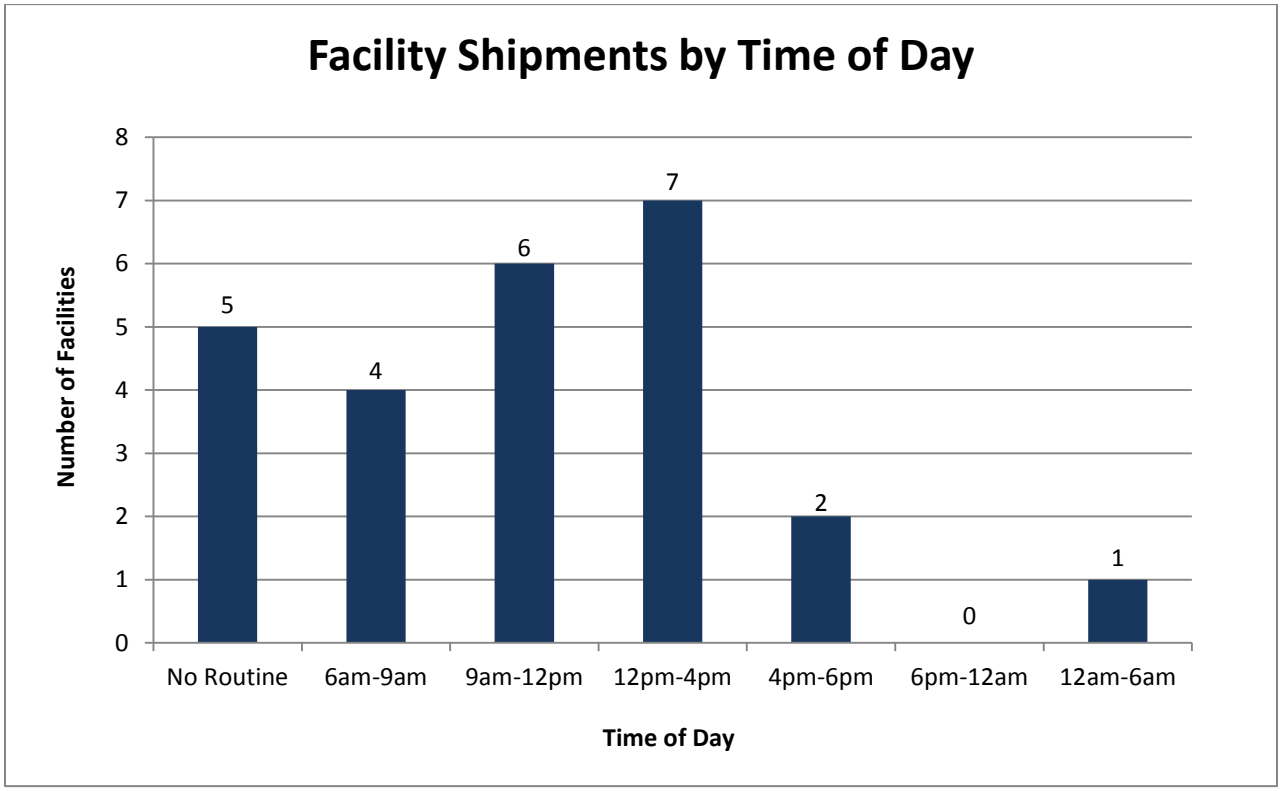

Figure 8.6. Number of facilities shipping by time of the day

v. Materials Data Analysis

Survey questions were designed to obtain information about the five most frequently shipped hazardous materials from each facility. Respondents listed a total of 42 hazardous materials that were transported during the 5-year period, January 2008 through December 2012. Survey questions addressed the most common cities and states that hazardous materials are transported to, including seasonal transportation. Out of the 42 hazardous materials listed, Anhydrous Ammonia, Chlorine, Paint, and Sulfuric Acid were 40.5% of the hazardous materials composition (Figure 8.7).

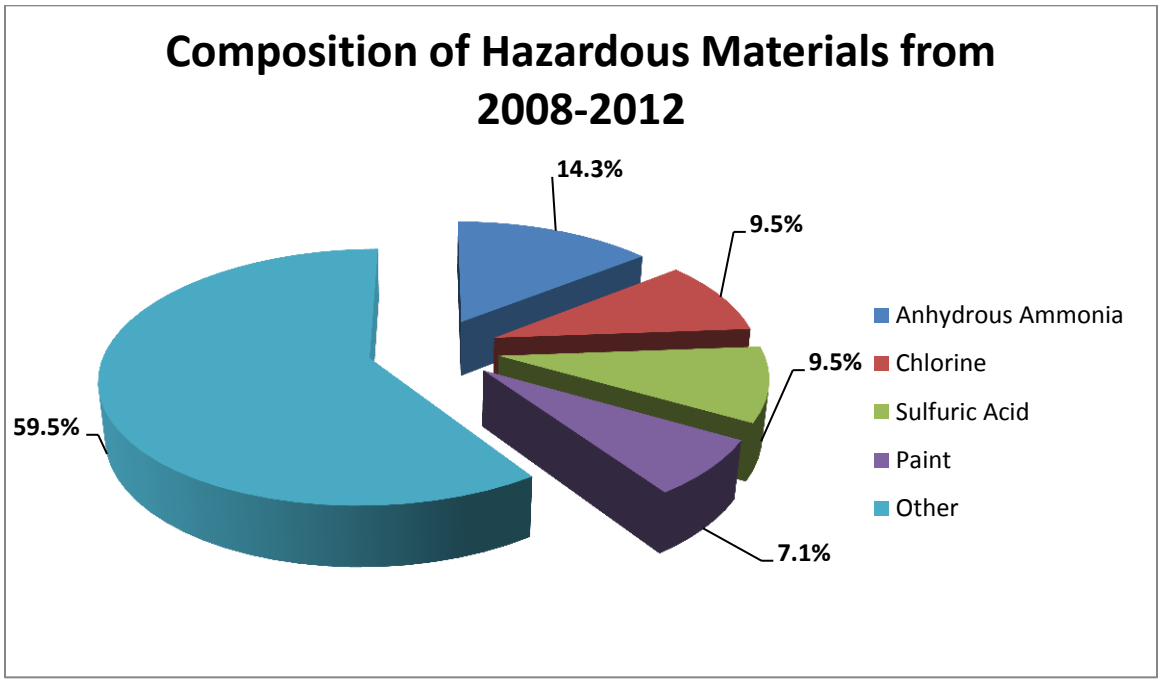

Figure 8.7. Composition of hazardous materials being transported

Information on seasonal transportation of hazardous materials was sought through the questionnaire. Facilities provided the most common seasons of the year during which hazardous materials are transported (Figure 8.8). For the facilities that responded, 24 chemicals were reported to be variable in transport throughout the year.. The supply period is based on the demand for their produced materials. The amount of materials transported was lowest between July and September while January through June is the highest.

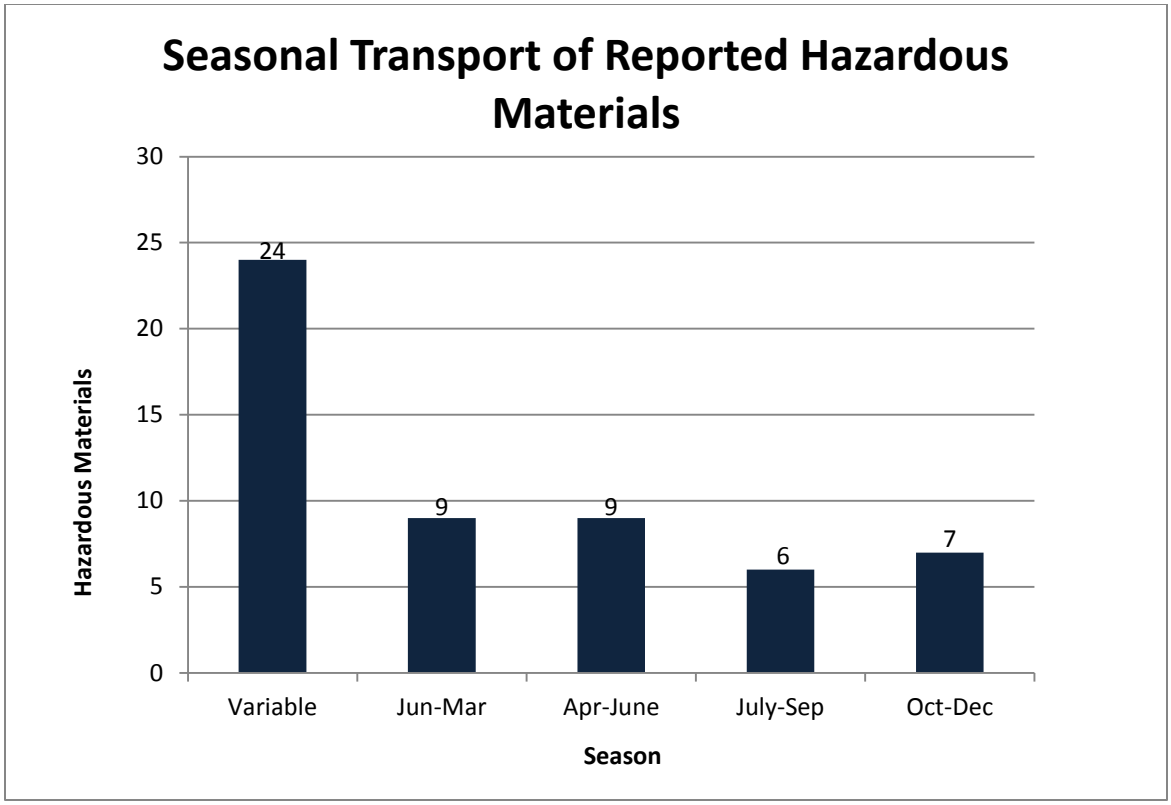

Figure 8.8. Frequency of season of shipping of hazardous materials

Survey results included information as to the origin and destination of hazardous materials, to and from the responding facilities. States where the hazardous materials were both imported from and exported to included Tennessee, Indiana, Kentucky, Missouri, and three other states (Figure 8.9). Hazardous materials were imported from the reporting facilities as far away as Pennsylvania. A total of 11 states were reported as the origins of hazardous materials coming into the study area (Figure 8.10). More facilities receive shipments from Kentucky and Indiana than other states.

Destination states were indicated in the survey by the reporting facilities. Figure 8.11 shows the states that hazardous materials are shipped to from the Henderson County study area. Survey responses indicated that Kentucky and Indiana were the states that receive most shipments from facilities in the study area. Facilities also reported shipping hazardous materials to the states of Illinois, Missouri, Arkansas, and New Jersey.

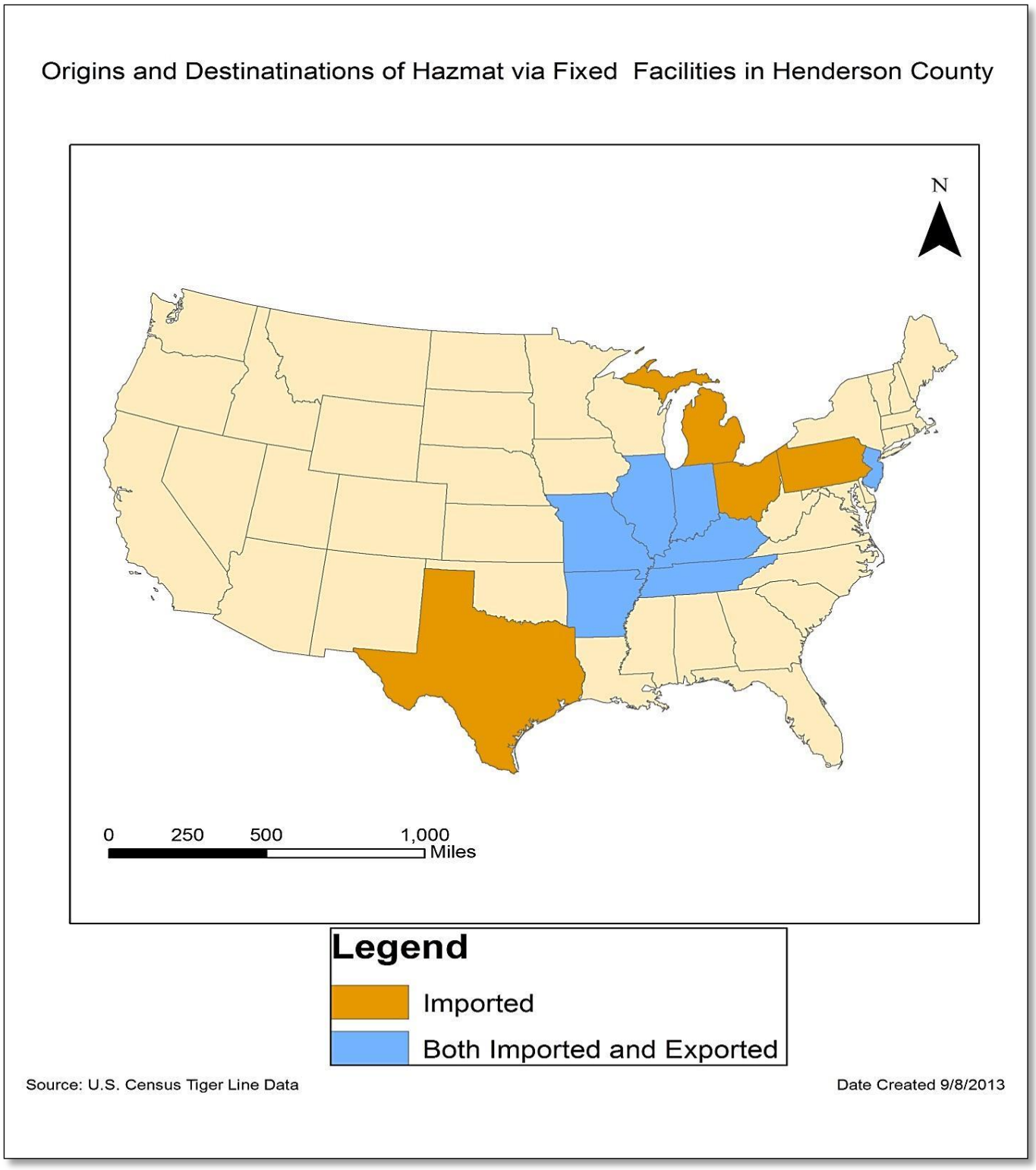

Figure 8.9. Origins and Destinations of Hazmat

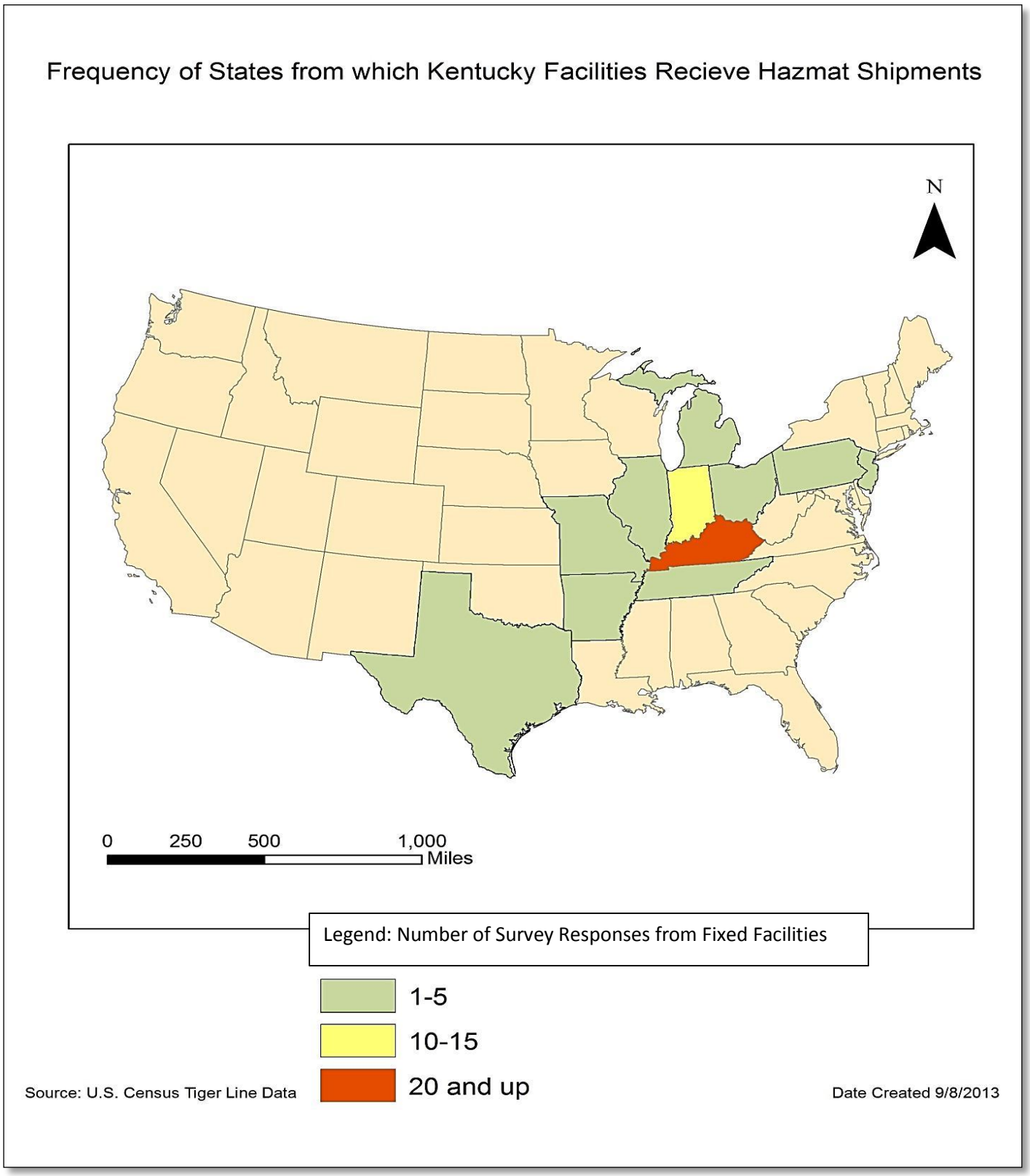

Figure 8.10. Frequency of KY facilities Receiving Hazmat

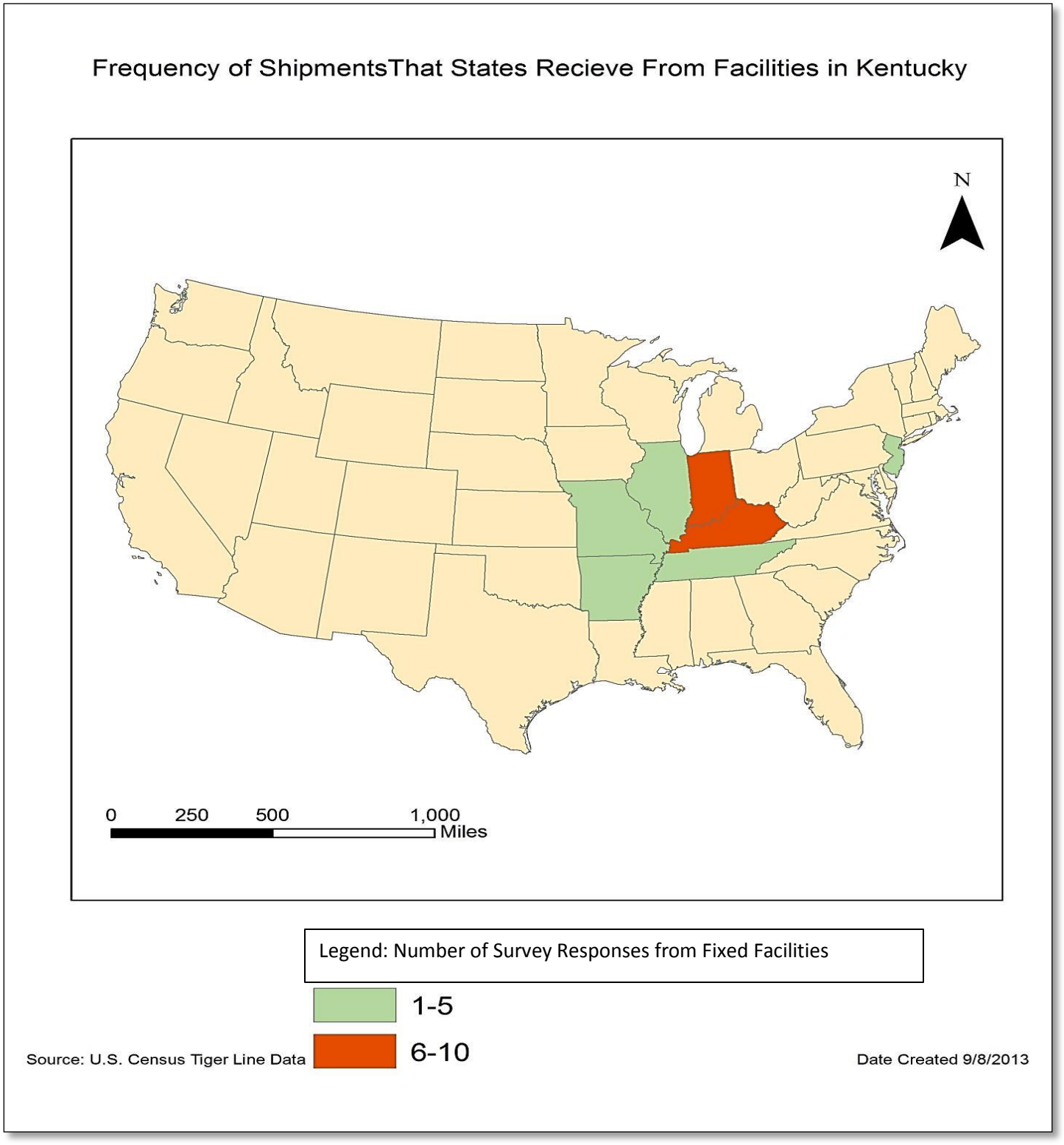

Figure 8.11. States from which KY facilities Revive Hazmat

Chapter 9

Summary and Recommendations

Hazardous materials are an important part of contemporary American society. As with other commodities, hazardous materials are produced, transported, stored, used, and discarded. Hazardous materials that are released due to highway, railroad, and other incidents pose a threat to the environment and human health. Incidents with hazardous materials can take place at any time, from their production to their disposition. This study clarifies the quantities and types of hazardous materials that are transported on U.S. 41, CSX Railroad Bridge, U.S. 60, KY136/ 425 in Henderson County, Kentucky. Likewise, information is provided on the timing of hazmats transported, which is critical for emergency preparedness.

It is essential to prepare communities, both large and small, for potential hazardous material incidents. Hence, it is important to initiate building of a knowledge base of the types and quantities of hazardous materials being transported to, from, and through a respective jurisdiction. In addition to their relative frequencies, the timings, and routes of hazardous materials are important to construct adequate emergency response preparedness. Emergency response planning should be predicated on an accurate interpretation of hazardous materials movements through a community. The capability of emergency response organizational schemes, contingency plans, equipment inventories and purchases, and personal training must be assessed in the light of this information.

This report provides information necessary to build a database of knowledge that can be utilized for emergency planning, response, and management of the flow of hazardous materials through Henderson County, KY. Communicating this information to emergency responders, emergency management and LEPC personnel could enable effective, and efficient emergency preparedness capability. Coordination of emergency response will be critical to adequately protect human health and environment from the potential impacts of the hazardous materials documented. It is hoped that results and recommendations of this report would serve a useful guide for HCEM and LEPC to better prepare, and protect the community.

The empirical results that are summarized below are based on the following:

- A thirteen-year hazardous materials incident history from November 2001 – July 2013, which was reported by Henderson County Emergency Management Agency to WKU.

- A fixed facility survey sent out to all facilities that handle hazmat in the Henderson County area.

- Hazardous materials commodity flow data collected by placard surveys on Hwy 41, CSX Railroad, Hwy 60 and KY 136/425, and Audubon Pkwy.

The following section summarizes the results obtained in chapters 2, 3, 4, 5, 6, and 7 and provides recommendations which can be used as a guidance tool for emergency preparedness related to hazardous material transportation and incidents:

Result 1:

During the period of November 2001 – July 2013 a total of 141 incidents involving hazardous materials were reported to the Henderson County Emergency Management.

Recommendation 1.1:

The emergency response committee should index general economic activity as a predictor of commodity transport. Data shows that transport volume corresponds to the number of incidents. Periods of recovery after a sustained economic lull may be particularly dangerous periods in the study corridor.

Recommendation 1.2:

Henderson County Emergency Management should inform local emergency responders as to the most observed placard ID numbers in surveys, incidents, and from other data sources. This would ensure that responders are prepared for incidents involving the most transported hazardous materials. Also, emergency management planning should take all hazardous materials observed into account.

Result 2:

The majority of hazmat incidents include spills and vehicular accidents along the study corridor.

Recommendation 2:

It is important to update the drivers about the current rules and regulations, and safety norms. Strict rules should be implemented for speed control in this corridor, **especially Hwy 41**. Logbooks should be thoroughly checked to make sure the drivers do not overwork, and speed limits for trucks should be restricted to 35 mph or less on Hwy 41. Trucks overtaking other vehicles on highways should be fined. A system of automated signage, especially along Hwy 41 may improve safety.

Result 3:

Commodity flow rates of hazardous materials were greatest during mid-week and during normal work hours.

Recommendation 3:

It is extremely important for emergency responders to be familiar with the peak days and times with reference to the transportation of hazardous materials. This will ensure better alertness and preparedness in case an incident occurs during these time periods. Extra emergency responders should be on call during the aforementioned peak timing in order to ensure quick and efficient response. One potential problem in areas with volunteer emergency responders is that these responders are usually working other jobs during these peak times for hazardous material transport. A system needs to be devised to improve incident response in these areas.

Result 4:

Common types of hazardous materials transported across the study corridor varied by roadway. Hwy 41 is unique in terms of commodity flow, as the rate stays relatively constant throughout the day. The CSX Railroad commodity flow varied greatly in both directions. Also, a review of the list of the "other category" in the appendices of this report is needed.

Recommendation 4:

Responders should review the most common types of hazardous materials that were transported via each study corridor and develop emergency response plans for the related materials. It is extremely important to train emergency responders with reference to these materials. Annual training should be established for incidents involving ID 1203, 1005, 1987 and 1075. Additionally, risk assessments and contingency plans should be developed in the areas with the greatest densities of incidents, **Hwy 41**, in case an evacuation or extensive response is needed.

Result 5:

From chapter 8, Fixed Facilities Survey, it is clear that there are a number of facilities that ship and receive hazmats in the Henderson County area.

Recommendation 5:

It is very important for local responders in the Henderson County area to be trained to deal with a range of hazardous materials incidents. Proper training equipment and PPE should be kept in place. Each responder should review the hazardous materials that have been observed in this report and be trained and prepared to respond to each one. A training exercise should be developed for the Hwy 41 corridor. Additionally, scenarios with multiple hazmats should be practiced.

Result 6:

Transportation of the majority of hazardous materials was observed to take place during weekdays, and between working hours of 6 am-4 pm. This corresponds to the morning and evening rush hours of public traffic. Additionally, this corresponds to school bus hours.

Recommendation 6:

Facilities should be requested to change their hours of shipments to mid-day, early morning or early evening. This will limit the risk to the public during traffic rush hour.

Result 7:

Monitoring was restricted to daylight hours due to budget and time restrictions for the project. Additionally, barge commodity loads of hazardous materials were not included due to difficulty in obtaining data.

Recommendation 7:

A placard survey should be completed in Henderson County that includes monitoring during the late evening, 18:00-22:00, through the night, 22:00-02:00, and into the early morning hours, 02:00-06:00. Currently, the rate of commodity flow is unknown for these time periods in the study area. A daylight barge commodity flow pilot study should be completed to begin to assess the load of hazardous materials transported by this mode of transportation.

Chapter 10

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