8-28-2014

Madison County, Kentucky Hazardous Materials Commodity Flow Analysis

Dr. Ritchie D. Taylor
Western Kentucky University, ritchie.taylor@wku.edu

Dr. Vijay Golla
Western Kentucky University, vijay.golla@wku.edu

Jacqueline Brown
Western Kentucky University

Bryan Makinen

Carl Richards

See next page for additional authors

Authors
Dr. Ritchie D. Taylor, Dr. Vijay Golla, Jacqueline Brown, Bryan Makinen, Carl Richards, and Michael Bryant

MADISON COUNTY, KENTUCKY HAZARDOUS MATERIALS COMMODITY FLOW ANALYSIS

FINAL REPORT

August 28, 2014

http://www.phmsa.dot.gov/public/definitions

Prepared by:

This project was completed by

Western Kentucky University in partnership with Madison County Local Emergency Planning Committee

Authors

Dr. Ritchie Taylor, Ph.D.

Dr. Vijay Golla, Ph.D.

Ms. Jacqueline Brown

Western Kentucky University

College of Health and Human Services

Department of Public Health

&

Bryan Makinen

Carl Richards

Michael Bryant

Madison County Local Emergency Planning Committee

Acknowledgements

WKU would like to give a special thanks to Michael Bryant for his assistance in acquiring monitoring sites and arranging safe locations for our students. He was instrumental in the execution of the project. We would also like to thank Bryan Makinen for his support during this process. Lastly, we appreciate the leadership of Carl Richards and the tremendous staff he has developed at Madison County Emergency Management Agency.

In regards to our students, we would like to say a special thank you to Tyler Kelley and Carl Weller for the tireless hours they spent in the field collecting placard data. Their contribution to this project was much appreciated.

Finally, we would like to thank Kentucky Emergency Management for their support of the project. Their leadership has enabled multiple hazardous materials commodity flow studies to be conducted throughout Kentucky. Also, we would like to recognize the U.S. Department of Transportation for funding and support.

Funding for this Project Provided by

Kentucky Division of Emergency Management

Frankfort, Kentucky

and

http://www.phmsa.dot.gov/grants-state-programs

Table of Contents

List of Figures

Chapter 1

Chapter 2

Chapter 3

Chapter 1: Introduction

The results of a commodity flow analysis of hazardous materials for KY Highway 21 (KY-0021) and KY Highway 627 (KY-0627) conducted by Western Kentucky University, in partnership with the Madison County Local Emergency Planning Committee (LEPC), are presented within this report. This report specifically focuses on the portions of these highways located in Madison County, Kentucky. Figure 1.1 shows the location of Madison County in relationship to the state of Kentucky.

The purpose of this report is to present information regarding the patterns of hazardous materials transportation along KY-0021 and KY-0627 as observed from August 4, 2014 through August 15, 2014. This report also provides an analysis of incidents involving hazardous materials over the period of 2005 through 2014 in Madison County. Finally, this report summarizes these observations and provides recommendations based on these observations.

The commodity flow analysis was necessary in order to provide the Madison County LEPC with information about hazardous materials transport patterns so that they can better prepare for potential incidents and releases of hazardous materials along KY-0021 and KY-0627. Analysis of hazmat incidents in Madison County provided an evaluation of significant hotspots where further risk assessments should be conducted. The data collected will assist in the emergency planning process by providing valuable information about frequently observed hazardous materials within the duration of the study.

1.1 Background

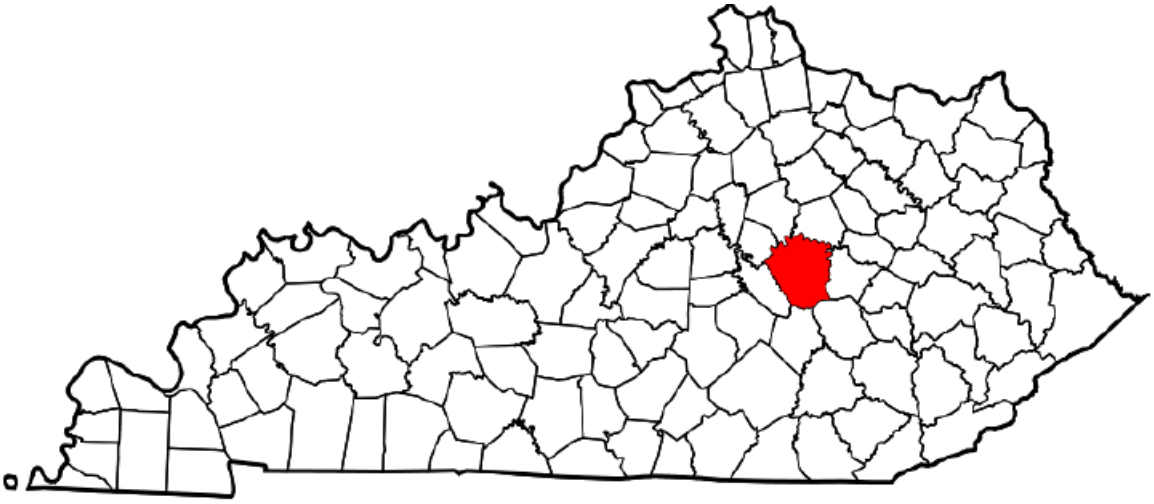
The purpose of commodity flow studies is to identify the transport of specific goods through the transportation system of a specified area (Taylor et al., 2010). The EPA defines a commodity as any good being moved or transported (U.S. EPA, 2010). The commodities of interest within this study were hazardous materials and Madison County was the specific area. Hazardous materials 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).

In addition, 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.
- Corrosivitiy: 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.



http://upload.wikimedia.org/wikipedia/commons/a/a3/Map_of_Kentucky_highlighting_Madison_County.svg

Figure 1.1 Location of Madison County in Kentucky

Hazardous material categories include (Transportation):

- 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 3solid 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. plutonium cobalt.
- Etiological Materials: cause disease or infection. e.g. germs that causes rabies, botulism, and tetanus.

1.2 KY-0627 & KY-0021 in Madison County, Kentucky

KY-0627 is a highway in Madison County that, according to the Kentucky Transportation Cabinet (KYTC, 2013), begins at KY-3055/US-25 and ends at the Madison and Clark County line. The portion of KY-0627 in Madison County is approximately 6 miles long and intersects with Interstate 75 near mile marker 95 (KYTC, 2013). In Figure 1.2 below the location of KY-0627, in relation to Madison County, can be seen in the top center portion.

The location of KY-0021 in relation to Madison County can also be seen in Figure 1.2 below, the lower left corner. KY-0021 begins at KY-0052 and ends at the Jackson County line (KYTC, 2013). The portion of KY-0021 that goes through Madison County is approximately 16 miles long, travels through the city of Berea, KY and intersects with I-75 near mile marker 76.

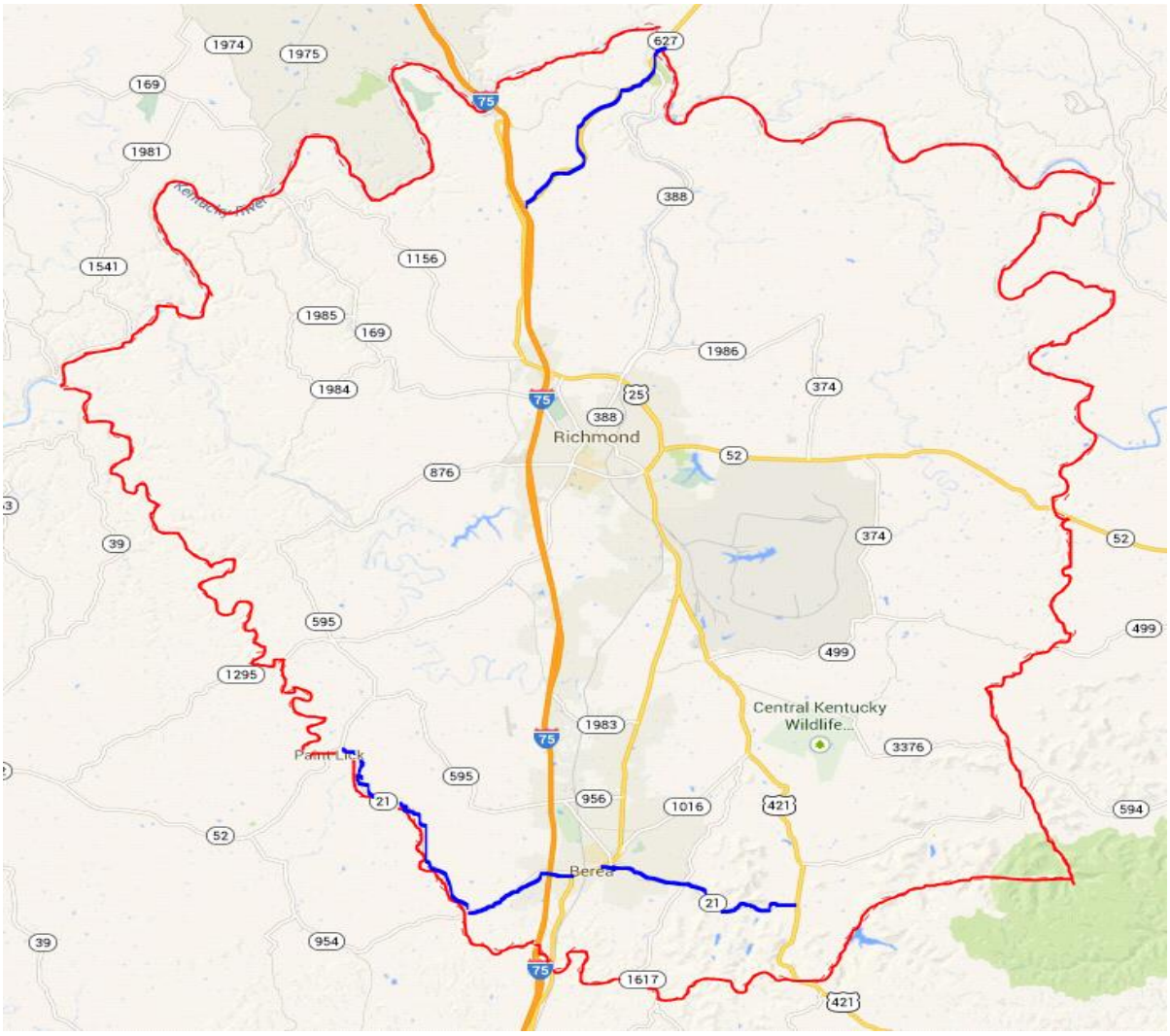


Figure 1.2 Location of KY-0021 and KY-0627 in Madison County, KY

In the past, Dr. Vijay Golla and Dr. Ritchie Taylor of WKU have conducted hazardous materials commodity flow studies in Madison County, Kentucky, the I-75 corridor, (Golla et al., 2011) and Warren County, Kentucky (Taylor et al., 2010). These studies were the basis on which the current Madison County study was conducted. Data collection sources for this study included a placard surveys. Data were used to evaluate the hazardous materials being transported by trucks via KY-0021 and KY-0627 (East and West bound lanes). Each of these primary sources of data collection is summarized below.

1.3 Data Collection Methods

ROADWAY PLACARD SURVEY

Placard survey monitoring stations were selected along each route by WKU faculty in consultation with Madison County Local Emergency Planning Committee (LEPC). A monitoring station was established for KY-0627, both north and sound bound lanes, at the Madison County Volunteer Fire Department, approximately ½ mile east of I-75. The monitoring station for KY-0021 was located within the city of Berea at the junction of KY-0021 and KY-0025.

With all necessary safety precautions in place, a team of two observers monitored each site for a total of five days (Monday – Friday). A monitoring day consisted of an 8-hour observation period. KY-0021 was monitored from August 4th thru August 8th from 8:00 AM to 4:00 PM (8:00 – 16:00). KY-0627 was monitored from August 11th thru August 15th from 7:00 AM to 3:00 PM (7:00 – 15:00). This created a total of 80 hours of observation for each highway with 40 hours for each lane (East-West bound or North-South bound).

Hazmat Incidents Analysis

An analysis of Hazmat incident data for Madison County was completed in this study. Madison County Emergency Management collected hazmat incidents data used for this analysis from 2005 through 2014. Incidents of interest were those that occurred in Madison 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, evaluating significant incidents clustering, calculating spatial statistics, and identifying densities of incidents or hot spots was applied with the use of ESRI ArcGIS Spatial Analyst software (ESRI, 2011). The methodology consisted of mapping incident data and using spatial statistics to evaluate if significant clusters of incidents occurred. If significant clustering was detected, a hot spot analysis was conducted by integrating and concentrating points, then applying a spatial analysis that shows hot spot areas that are statistically significant. Identified hot spots are areas that the LEPC should conduct further risk assessments to evaluate potential incidents with detected hazmat commodities.

Spatial analysis methodology was applied to produce point concentration and hot spot maps. Point concentration maps indicate areas where multiple hazmat incidents have occurred. A hot spot map was produced to show areas with statistically significant clusters of incidents. These maps provide a visual indication of higher risk hazmat incident areas.

1.4 Organization of the Report

The first section of the report provides an introduction to the study, a description of the methods used, and other important information. In the second section of the report information is provided regarding the analysis of the placard survey for KY-0021. The third section of the report provides information for the placard survey conducted along KY-0627. Analysis of the hazmat incident data is presented in the fourth section. Finally, in the fifth section of the report, the results are summarized and recommendations are specified based on these results. In the appendices a list of placard IDs observed during the placard survey has been provided.

Chapter 2: Analysis of the KY-0021 Placard Survey

The placard survey consisted of 80 monitoring hours within the KY-0021 corridor, with 40 monitoring hours occurring on the East bound side and 40 hours occurring on the West bound side. This monitoring took place in 8-hour increments between August 4, 2014 and August 8, 2014 with all monitoring occurring Monday through Friday. This monitoring schedule was established to ensure that daily and temporal differences in hazardous material transport could be elucidated. Observers, located at each monitoring site, were students from Western Kentucky University's Environmental Health Science program. Each observer recorded information that included: date, time, type of truck, and all placard identification information.

2.1 Aggregate Truck Frequencies in the KY-0021 Corridor

In order to ensure that the focus of the study remained on hazardous material transport, students were asked to only collect data on placarded trucks. This allowed students to focus more thoroughly on the placarded data and helped to ensure that all placarded trucks were properly recorded. Information about total traffic frequency for KY-0021 was collected from the Kentucky Transportation Cabinet (KYTC). In 2013, the annual average daily traffic (AADT) for KY-0021 in Berea near I-75 was 14,200 vehicles with 4.85% of this traffic being the single and combination truck volume as a percentage of AADT (KYTC, 2013). This translates to roughly 689 trucks as the average daily traffic flow.

The total number of placarded trucks on KY-0021 during the study period, as show in Figure 2.1, was 22, with 16 recorded for the East bound lane and 6 recorded for the West bound lane. As shown in Figure 2.2 an average of less than 1 truck was recorded for both East and West bound lanes and for KY-0021 as a whole. When extrapolated, it is estimated that the number of placarded trucks per day on KY-0021 would be approximately 7 (0.28 avg. placarded trucks per hour observed x 24 hours = 6.72). This means that on a 24-hour daily basis hazmat trucks make up roughly 1.02% of the truck traffic or 0.05% of the total daily traffic on KY-0021 in Madison County. When comparing the total placarded truck traffic and the average hourly placarded truck traffic for East and West bound lanes there is only a small difference in the number of trucks, with East bound lanes containing the highest amount.

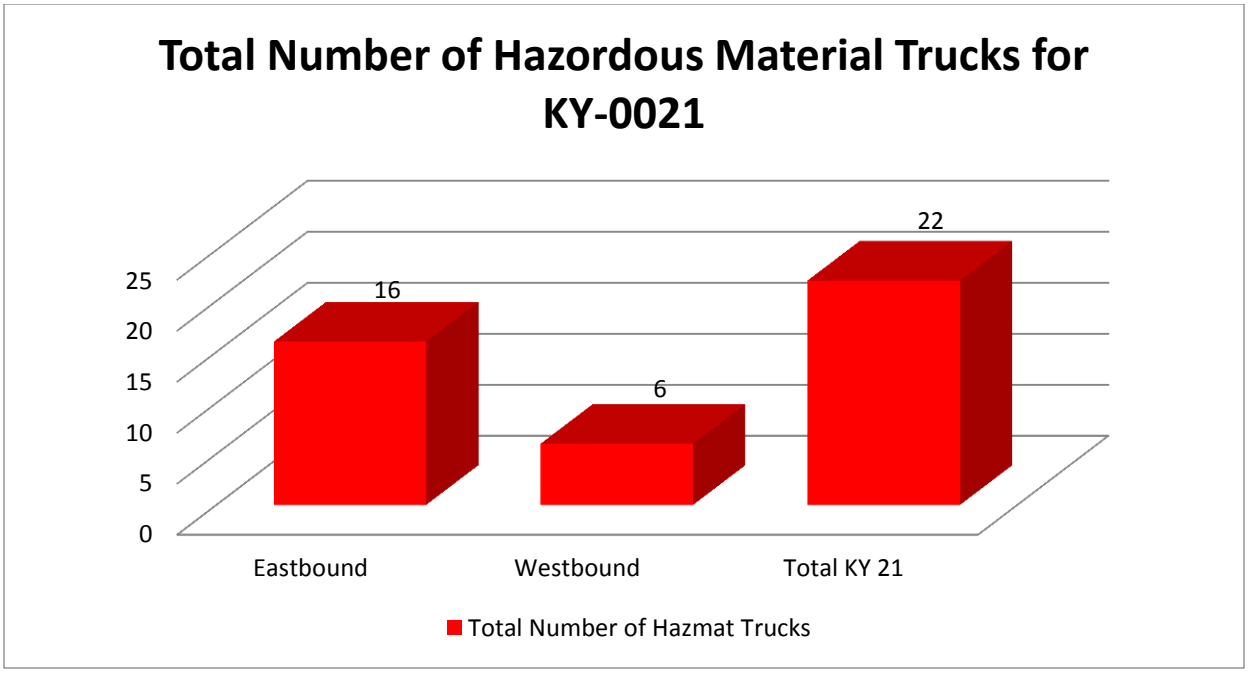


Figure 2.1 Placarded commercial trucks observed in the KY-0021 corridor

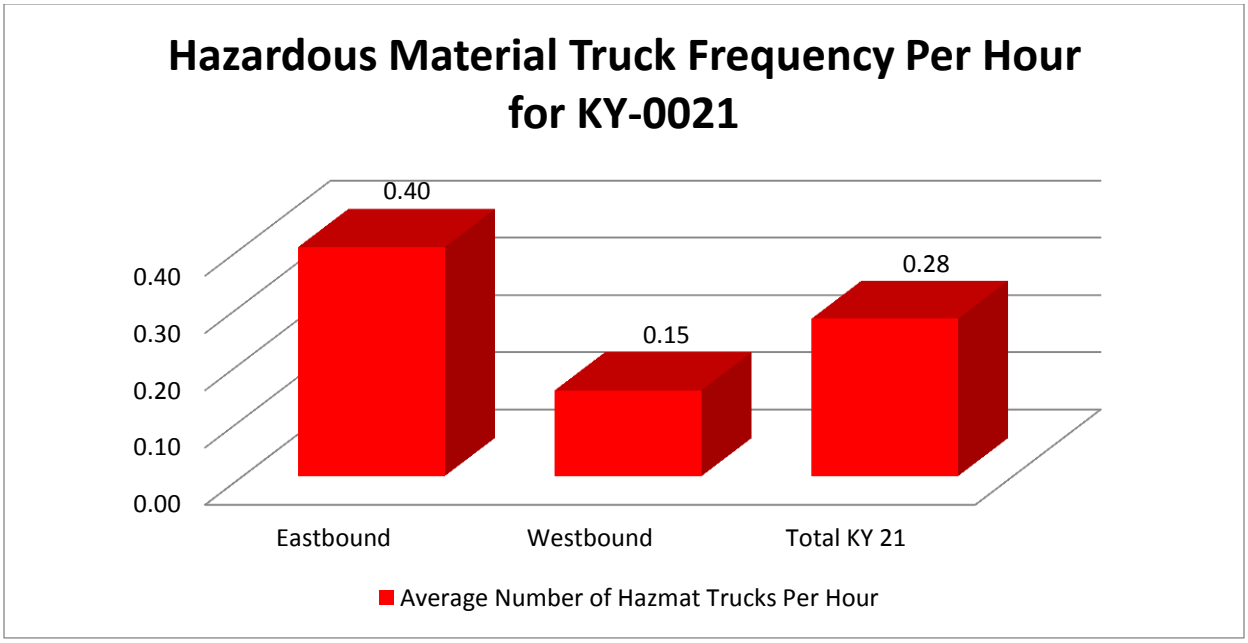


Figure 2.2 Placarded commercial trucks observed per hour on KY-0021

2.2 Truck Frequencies by Day of the Week

Monitoring hours on KY-0021 were scheduled on all five weekdays (Monday – Friday) in order to determine if differences existed in the placarded truck traffic depending on the day of the week. On KY-0021 each weekday was monitored once.

As shown in Figure 2.3, differences did exist based on the day of the week when observations were made. Mondays had an hourly average of 0.63 trucks while all other weekdays had 0.25 or less as an hourly average. Tuesdays hourly average of 0.13 was the lowest followed by Thursday and Friday, which both had hourly averages of 0.19 placarded trucks. A similar pattern can be seen in Figure 2.4 that shows the average number of placarded trucks per day for East and West bound lanes according to day of the week. Both East and West bound lanes had the highest number of placarded trucks on Monday with the lowest for East bound lanes occurring on Tuesday and the lowest for West bound lanes occurring on Thursday.

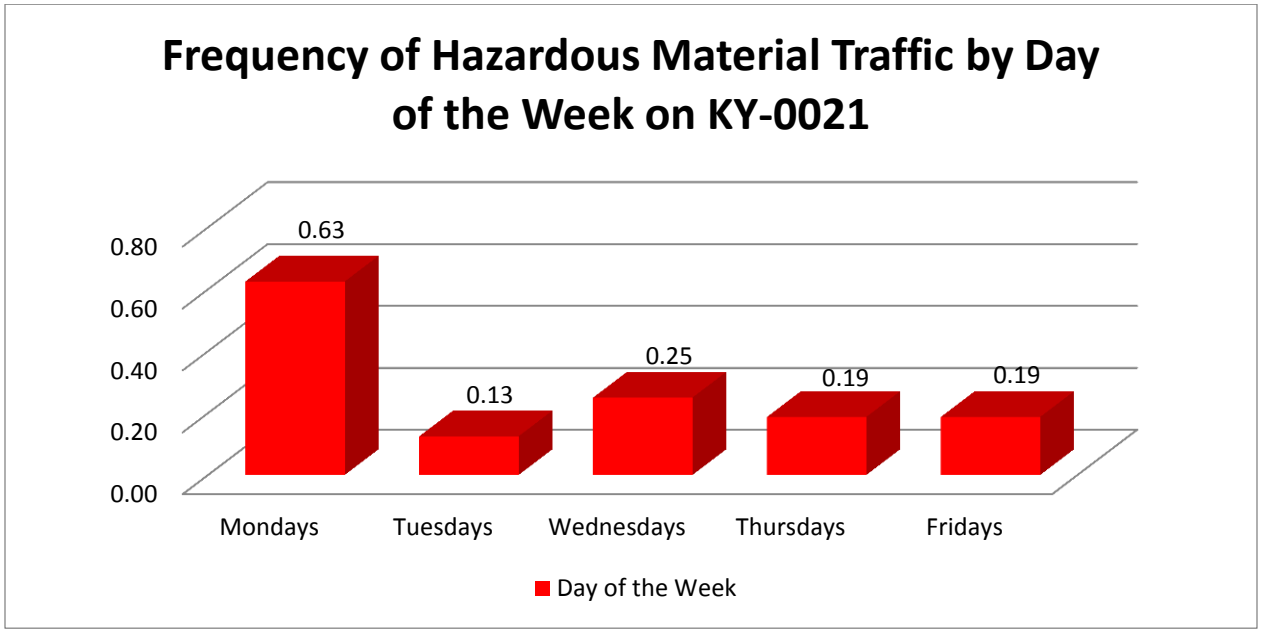


Figure 2.3 Placarded commercial truck traffic hourly averages by day of the week

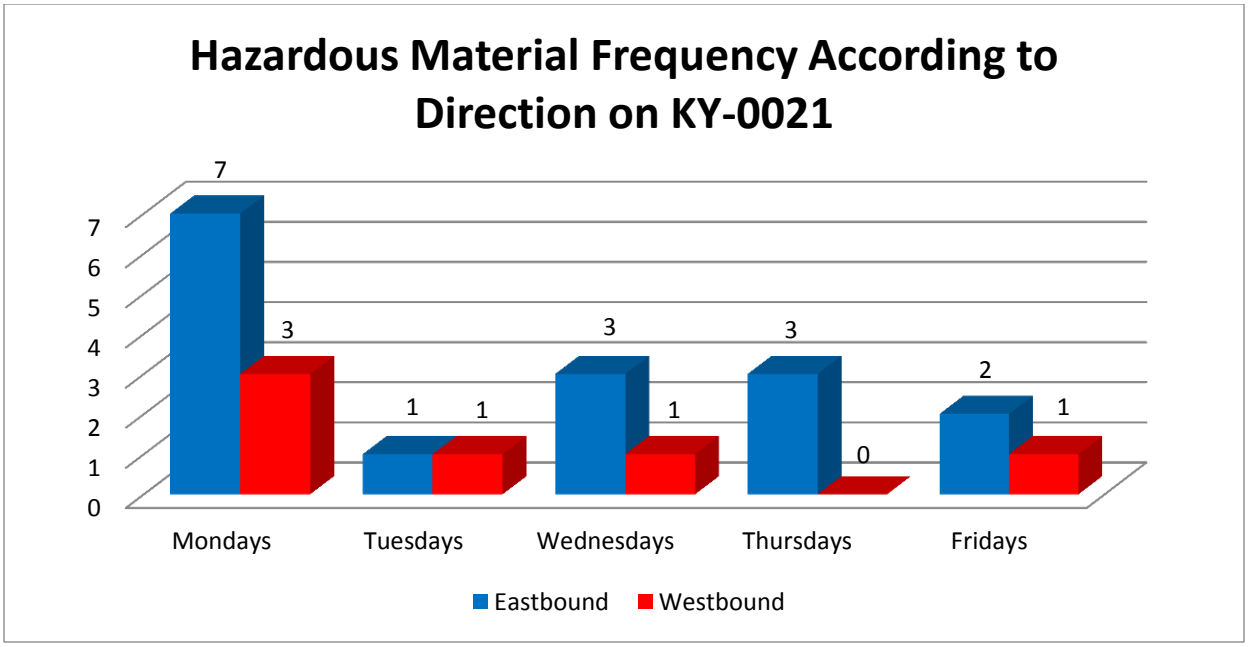


Figure 2.4 Average placarded commercial truck traffic on East and West bound lanes of KY-0021 by day of the week

2.3 Truck Frequencies by Time of Day

Time of day was recorded for each placarded truck observed so that comparisons could be made to determine if differences existed based on this. In order to analyze differences in placarded truck traffic based on time of day, the observation hours were split into four groups. These divisions were the same for both West and East bound lanes and are as follows:

Period 1 (Early Morning): 8:00 – 10:00
Period 2 (Late Morning): 10:01 – 12:00
Period 3 (Early Afternoon): 12:01 – 14:00
Period 4 (Late Afternoon): 14:01 – 16:00

As shown in Figure 2.5, overall the highest truck volume for the study period was observed in the late morning and late afternoon hours, 7 and 6 respectively, with the lowest overall volume being observed in the early morning hours, 4. The East bound lanes follow the same pattern with the highest volume seen in the late morning, 5, and the lowest volume seen in the early morning, 3. The West bound lanes differ slightly with the highest volume seen in the late morning and late afternoon hours, 2 and 2 respectively, and the lowest volume seen in the early morning and early afternoon hours, 1 and 1 respectively.

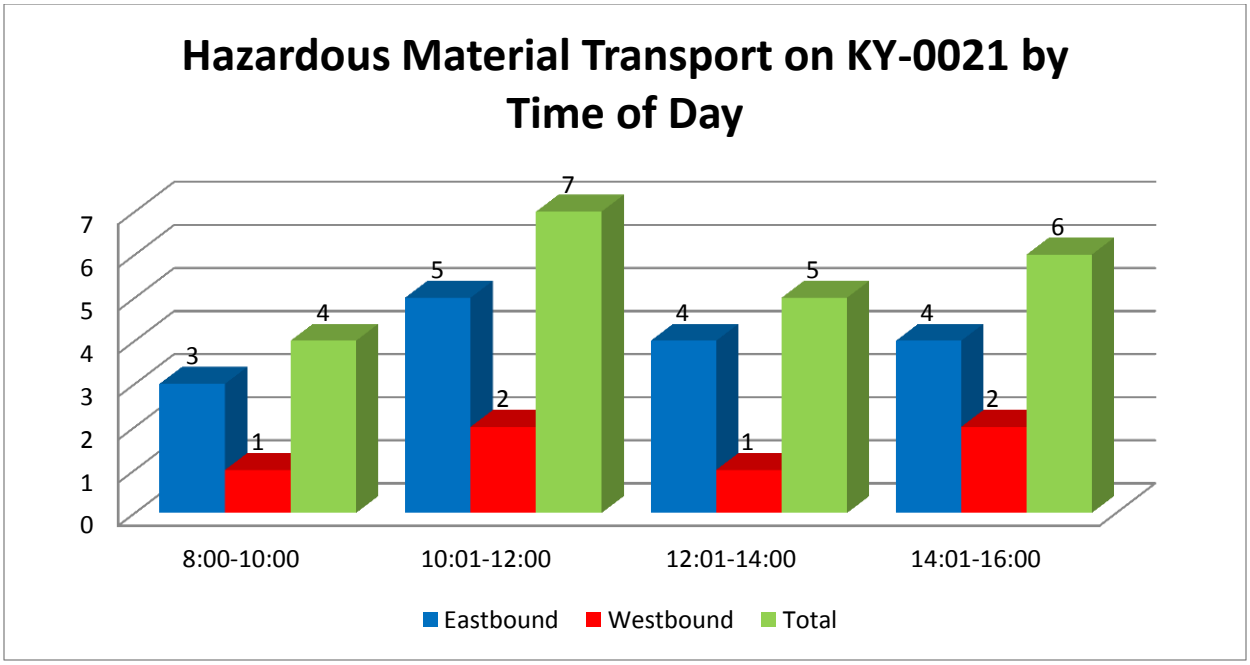


Figure 2.5 Placarded commercial truck traffic observed in the KY-0021 corridor by time of day

2.4 Composition of Hazardous Materials Being Transported

Analysis of the placard data was performed to assess what materials were being transported within the KY-0021 corridor. Based on Figure 2.6, the most frequently transported hazmat for East bound lanes was Petrol / Gasoline (ID no. 1203). Other frequently transported hazmats on the East bound lane of KY-0021 included Flammable Gases / Propane (ID no. 1075), Non-Flammables, and Flammables. Figure 2.6 also shows that 40% of all the placards observed on East bound lanes were ID no. 1203, 20% were ID no. 1075, and 15% were classified as "other."

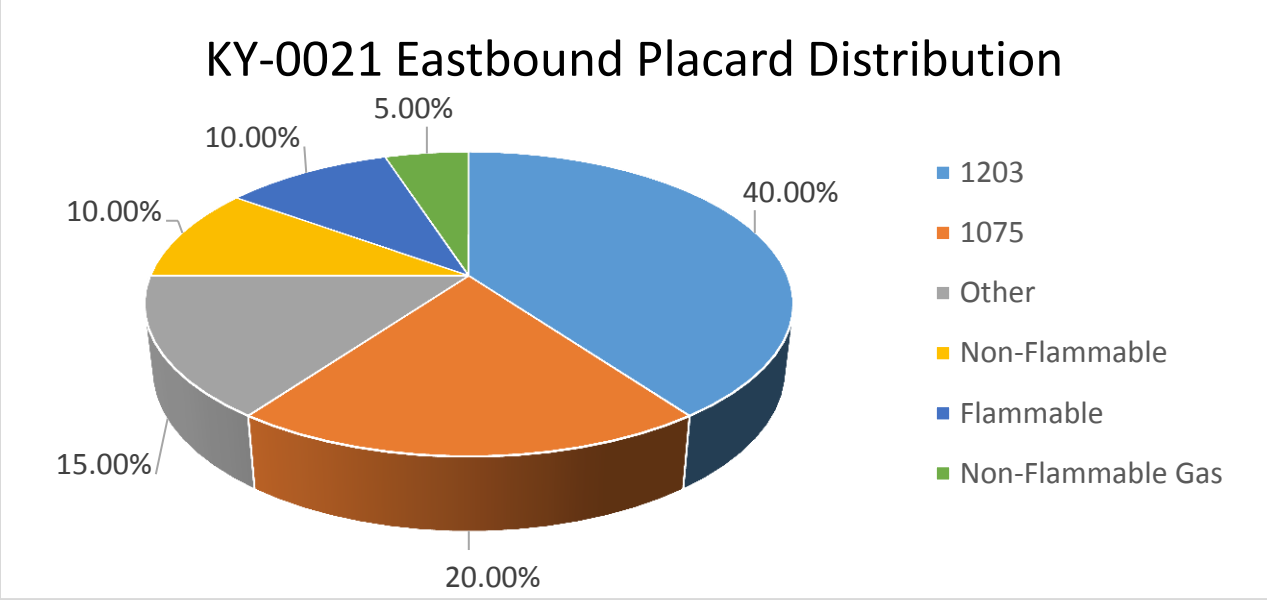


Figure 2.6 Distribution of placard numbers on KY-0021 East bound as percentages of grand total

Analysis of the West bound lanes of KY-0021 were performed the same way as the analysis for the East bound lanes. Based on Figure 2.7, the most frequently transported hazmat was also Petrol / Gasoline (ID no. 1203) with this compromising 42.86% of all total observed placards. Other frequently transported hazmats also included Combustible Liquids / Diesel Fuel (ID no. 1993), Corrosives, Flammables and Non-Flammables.

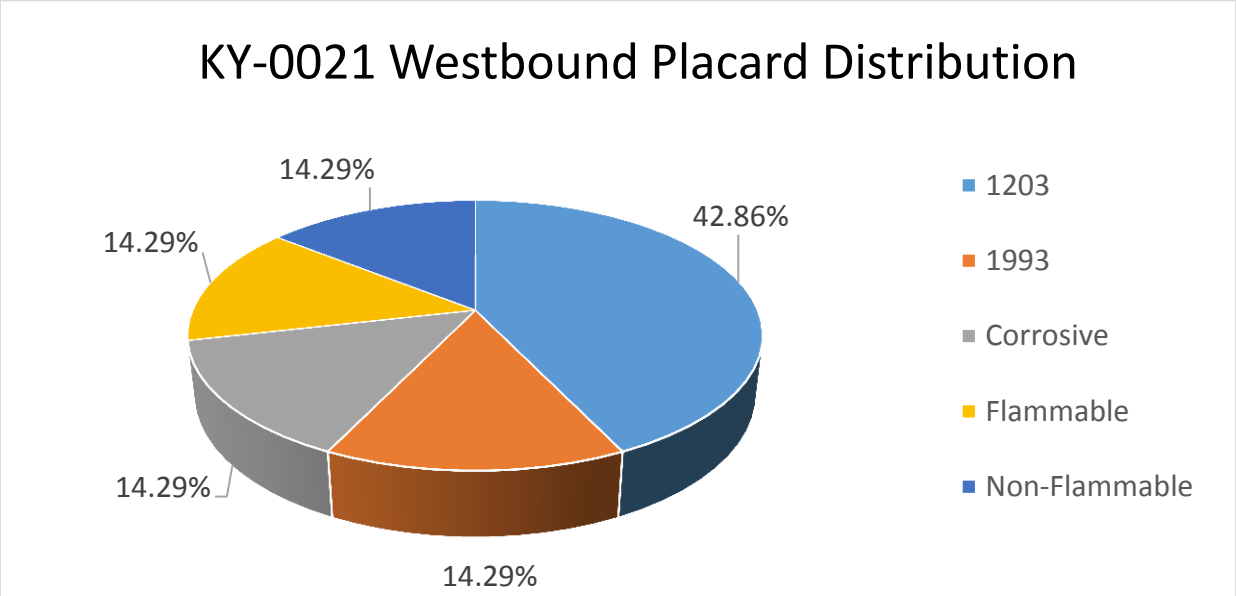


Figure 2.7 Distribution of placard numbers on KY-0021 West bound as percentages of grand total

2.5 Recommended Responses to the Frequently Transported Hazardous Materials

By observing the most common placard identification numbers it is possible to determine the most frequently recurring guide number that would be needed if an accident were to take place. A significant number of trucks only contained labels, which indicated the 'nature' or 'Class' of the hazardous material being transported, instead of containing a four-digit placard number. In order to ensure accuracy of the guide numbers only placard numbers were considered and labels were eliminated. The guide number, retrieved from the US DOT (2012) Emergency Response Guidebook, will help in preparing for hazmat accidents and training the emergency response teams.

The most frequent guide number for both East and West bound lanes of KY-0021 in Madison County is 128 (Flammable Liquids, Water Immiscible) as shown in Figure 2.8 and 2.9. This guide number encompassed 45% of observed placards for East bound lanes and 57% of observed

placards for West bound lanes. Other frequent guide numbers for East bound lanes included 115 (Gasses – Flammable) and 125 (Gasses – Corrosive).

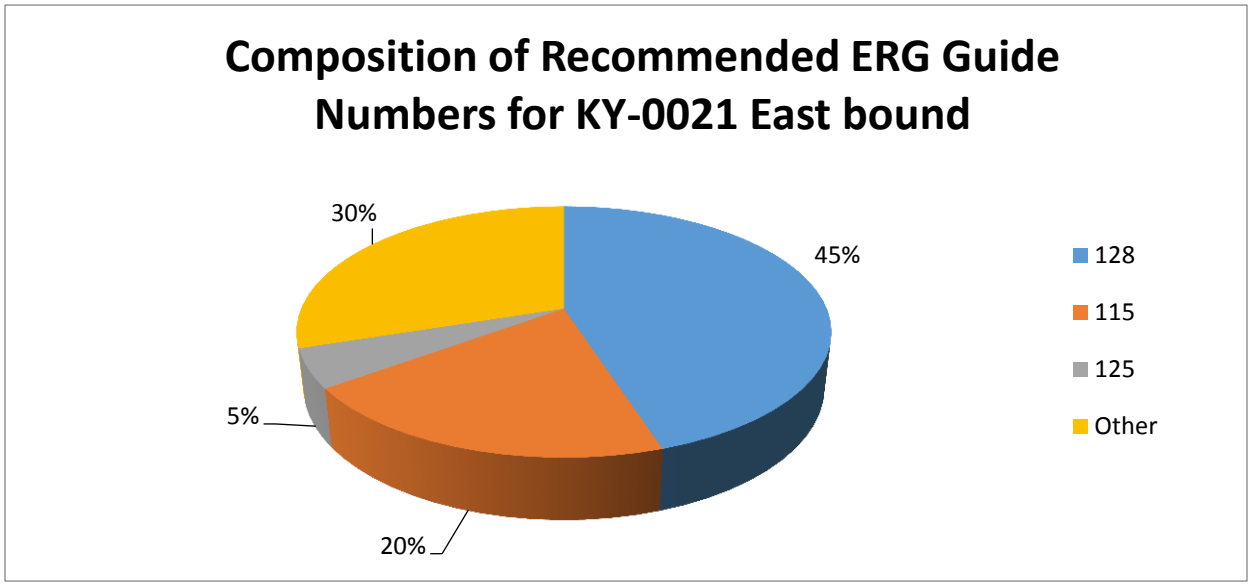


Figure 2.8 Composition of the most frequently used ERG's for East bound lanes

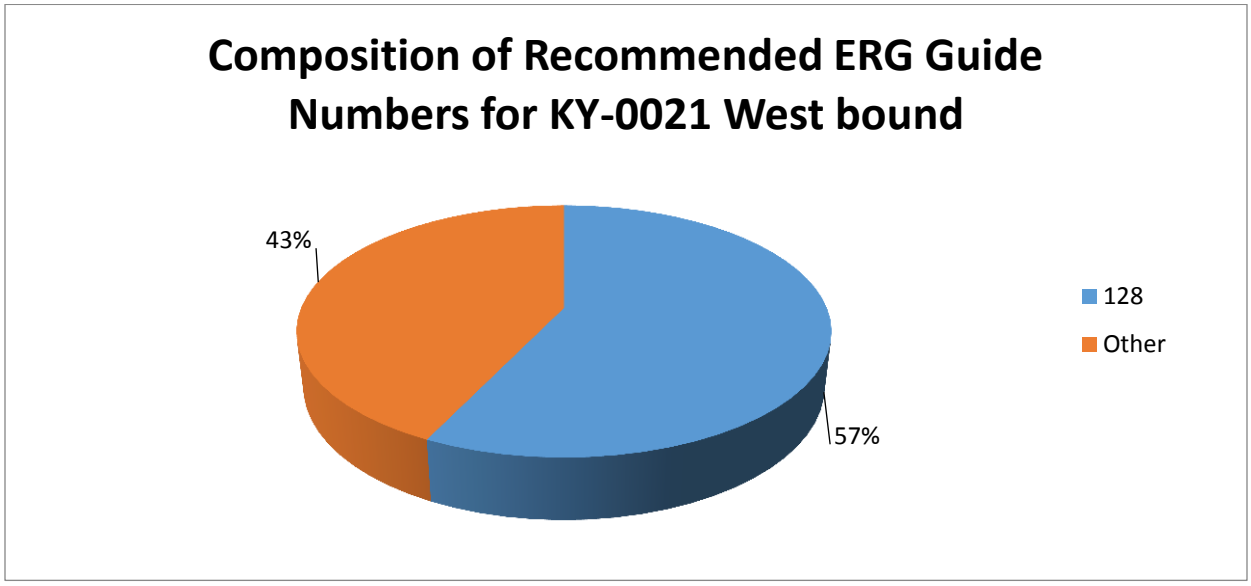


Figure 2.9 Composition of the most frequently used ERG's for West bound lanes

Chapter 3: Analysis of the KY-0627 Placard Survey

The placard survey consisted of 80 monitoring hours within the KY-0627 corridor, with 40 monitoring hours occurring on the North bound side and 40 hours occurring on the South bound side. This monitoring took place in 8-hour increments between August 11, 2014 and August 15, 2014 with all of the monitoring occurring on weekdays (Monday-Friday). This monitoring schedule was set up in order to ensure that daily and temporal differences could be recorded in hazardous material transport. Observers, located at each monitoring site, were undergraduate students from Western Kentucky University's Environmental Health Science program. Each observer recorded information that included: date, time, type of truck, and all placard identification information.

3.1 Aggregate Truck Frequencies in the KY-0627 Corridor

In order to ensure that the focus of the study remained on hazardous material transport, students were asked to only collect data on placarded trucks. This allowed students to focus more thoroughly on the placarded data and helped to ensure that all placarded trucks were properly recorded. Information about total traffic frequency for KY-0627 was collected from the Kentucky Transportation Cabinet (KYTC). In 2013, the annual average daily traffic (AADT) for KY-0627 in Madison County was 6,370 vehicles with 10.9% of this traffic being the single and combination truck volume as a percentage of AADT (KYTC, 2013). This translates to roughly 694 trucks as the average 24-hour daily traffic flow.

The total number of placarded trucks on KY-0627 during the study period, as show in Figure 3.1, was 130, with 64 recorded for the North bound lane and 66 recorded for the South bound lane. As shown in Figure 2.2, an average of approximately 2 trucks per hour was recorded for both North and South bound lanes and for KY-0627 as a whole. When extrapolated, it is estimated that the number of placarded trucks per 24-hour day on KY-0627 would be approximately 48 (2 avg. hazmat placarded per hour x 24 hours = 48). This means that on a 24-hour daily basis hazmat trucks make up roughly 6.92 % of the daily truck traffic or 0.75% of the total daily traffic on KY-0627 in Madison County. When comparing the total placarded truck traffic and the average hourly placarded truck traffic for North and South bound lanes there is only a very small difference in the number of trucks, with South bound lanes containing the highest amount.

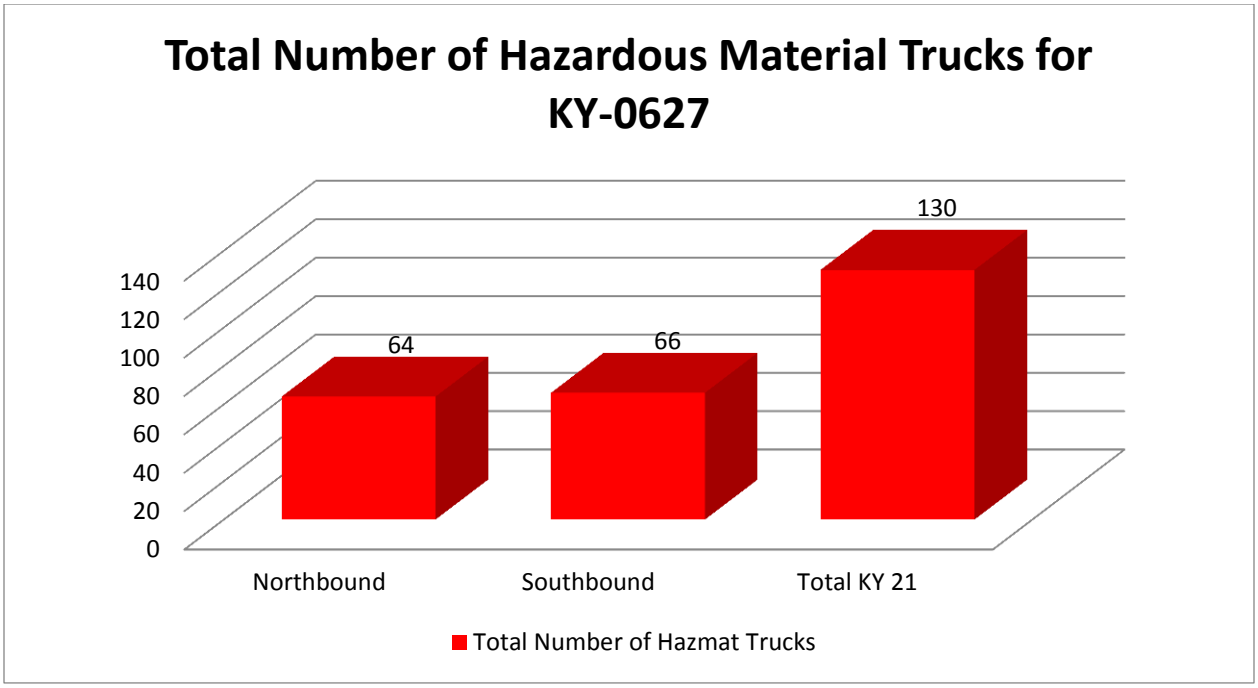


Figure 3.1 Placarded commercial trucks observed in the KY-0627 corridor

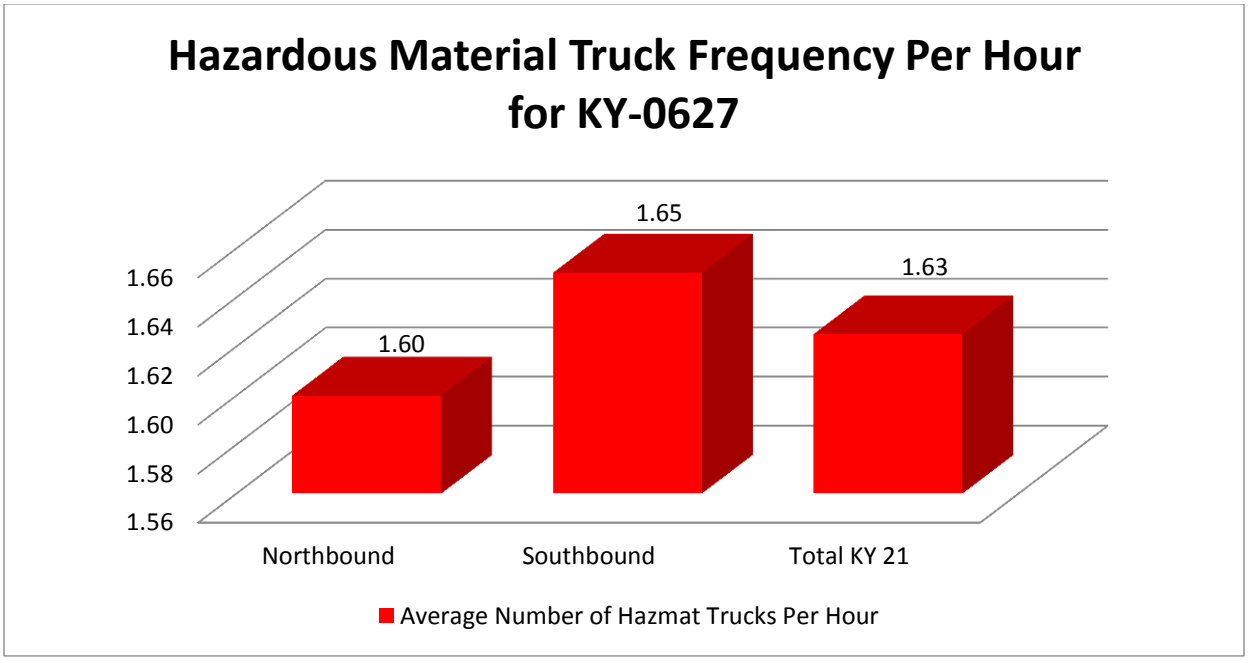


Figure 3.2 Placarded commercial trucks observed per hour on KY-0627

3.2 Truck Frequencies by Day of the Week

Monitoring hours on KY-0627 were scheduled on all five weekdays (Monday – Friday) in order to determine if differences existed in the placarded truck traffic depending on the day of the week. On KY-0627 each weekday was monitored once.

As shown in Figure 3.3, differences did exist based on the day of the week when observations were made. The highest per hour average was seen on Thursday and Monday, 2.06 and 1.94 respectively. The lowest per hour average was on Wednesday when the hourly average was less than 1, 0.88 to be exact. A similar pattern can be seen in Figure 3.4, which shows the average number of placarded trucks per day for North and South bound lanes, according to day of the week. Both North and South bound lanes had the lowest traffic volume on Wednesday. The highest traffic volume for North bound lanes was on Tuesday and for South bound lanes on Thursday.

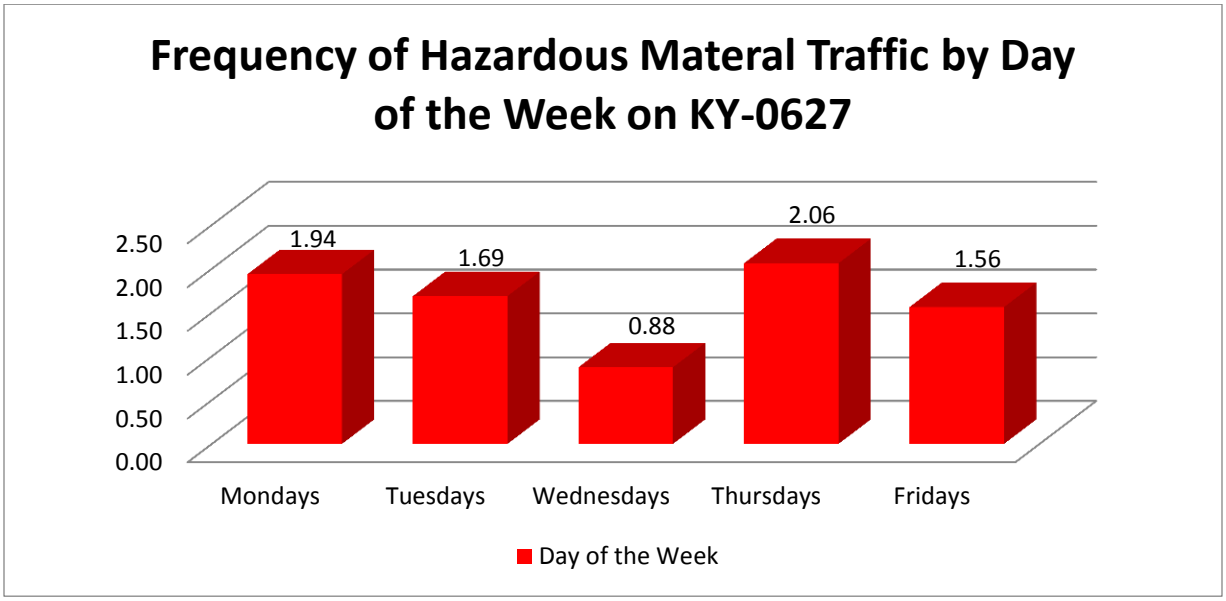


Figure 3.3 Placarded commercial truck traffic hourly averages by day of the week

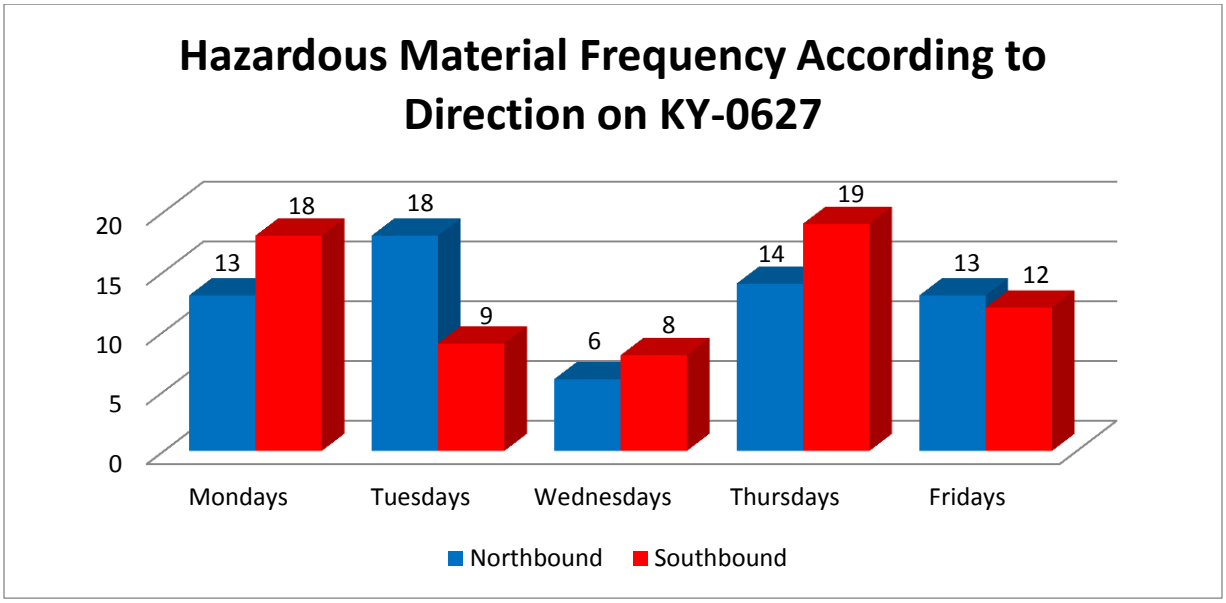


Figure 3.4 Average placarded commercial truck traffic on North and South bound lanes of KY-0627 by day of the week

3.3 Truck Frequencies by Time of Day

Time of day was recorded for each placarded truck observed so that comparisons could be made to determine if differences existed based on this. In order to analyze differences in placarded truck traffic based on time of day, the observation hours were split into four groups. These divisions were the same for both North and South bound lanes and are as follows:

Period 1 (Early Morning): 7:00 – 9:00
Period 2 (Late Morning): 9:01 – 11:00
Period 3 (Early Afternoon): 11:01 – 13:00
Period 4 (Late Afternoon): 13:01 – 15:00

As shown in Figure 3.5, overall the highest truck volume for the study period was observed in the late morning hours, 44, with the lowest overall volume being observed in the early morning hours, 24. The North and South bound lanes follow this same pattern with the late morning hours having the highest volume, 25 and 19 respectively, and the early morning hours having the lowest volume, 11 and 13 respectively.

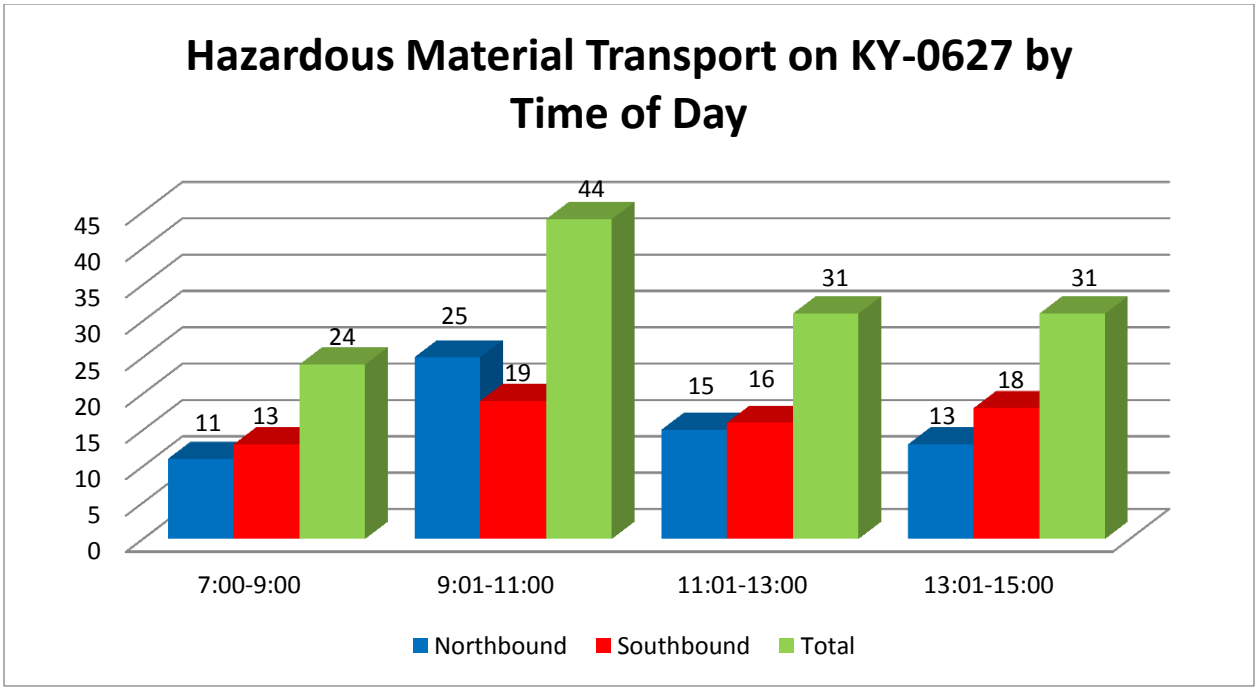


Figure 3.5 Placarded commercial truck traffic observed in the KY-0021 corridor by time of day

3.4 Composition of Hazardous Materials Being Transported

Analysis of the placard data was performed to assess what materials were being transported within the KY-0627 corridor. Based on Figure 3.6, the most frequently transported hazmat for North bound lanes was Petroleum Crude Oil (ID no. 1267). Other frequently transported hazmats on the North bound lane of KY-0627 included Petrol / Gasoline (ID no. 1203), Elevated

Temperature Liquids (ID no. 3257), Explosives and Flammable Gases / Propane (ID no. 1075). Figure 3.6 also shows that 25.35% of all the placards observed on East bound lanes were ID no. 1267, 19.72% were ID no. 1203, and 11.27% were 3257.

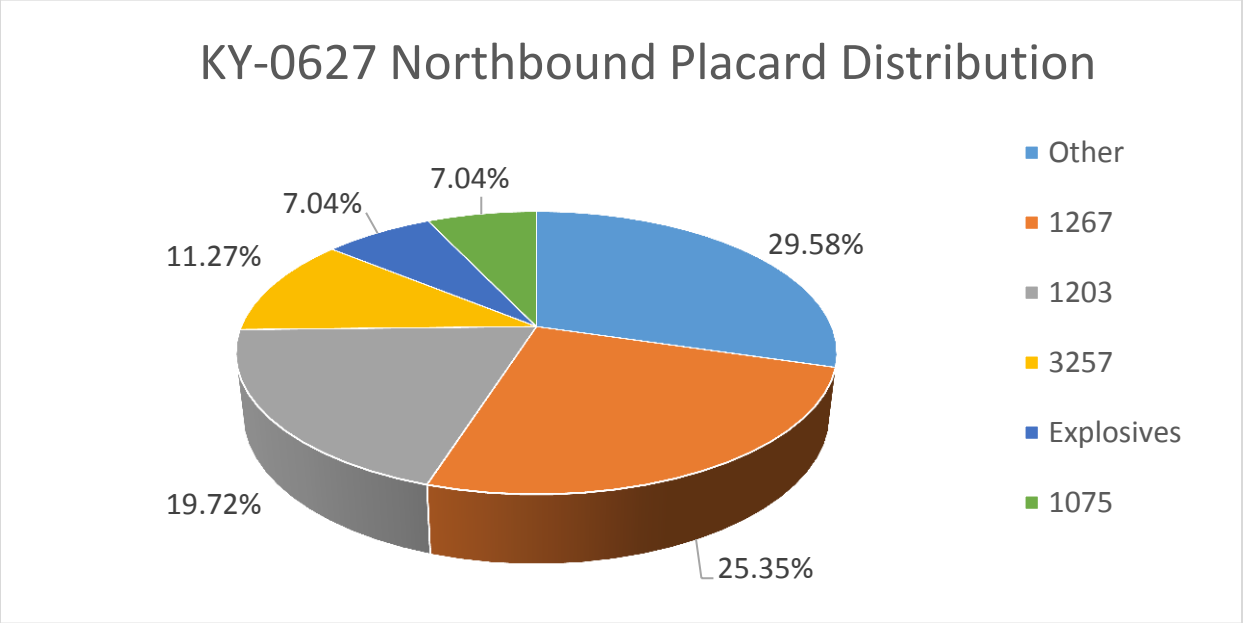


Figure 3.6 Distribution of placard numbers on KY-0627 North bound as percentages of grand total

Analysis of the South bound lane of KY-0627 was performed identical to the analysis for the North bound lane. As shown in Figure 3.7, the most frequently transported hazmat was also Petroleum Crude Oil (ID no. 1267) with this compromising 31.43% of all total observed placards. Other frequently transported hazmats also included Petrol / Gasoline (ID no. 1203), Flammable Gases / Propoane (ID no. 1075), Combustible Liquids / Diesel Fuel (ID no. 1993), and Elevated Temperature Liquids (ID no. 3257).

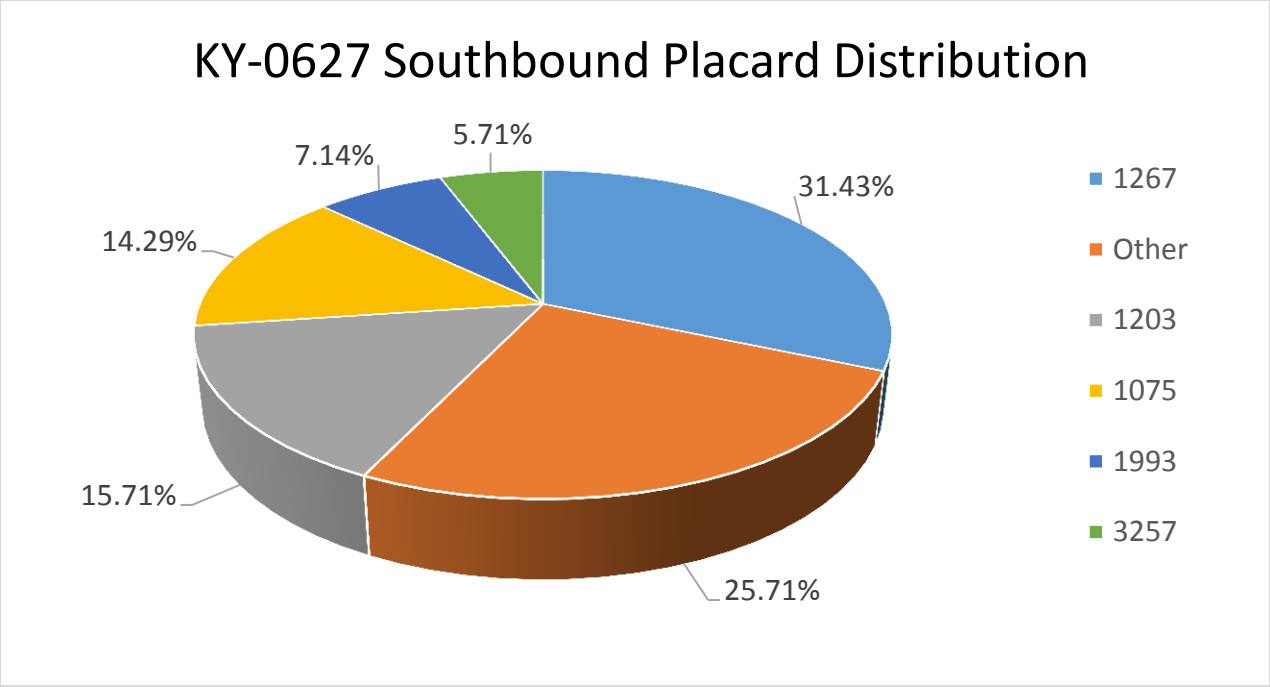


Figure 3.7 Distribution of placard numbers on KY-0627 South bound as percentages of grand total

3.5 Recommended Responses to the Frequently Transported Hazardous Materials

By observing the most common placard identification numbers it is possible to determine the most frequently recurring guide number that would be needed if an accident were to take place. A significant number of trucks only contained labels, which indicated the 'nature' or 'Class' of the hazardous material being transported, instead of containing a four-digit placard number. In order to ensure accuracy of the guide numbers only placard numbers were considered and labels were eliminated. The guide number, retrieved from the US DOT (2012) Emergency Response Guide, will help in preparing for hazmat accidents and training the emergency response teams.

The most frequent guide number for both the North and South bound lanes of KY-0627 in Madison County is 128 (Flammable Liquids, Water Immiscible) as shown in Figure 3.8 and 3.9. This guide number encompassed 59% of observed placards for North bound lanes and 60% of the observed placards for South bound lanes. Some other frequent guide numbers for both North and South bound lanes included 115 (Gasses – Flammable), 154 (Substances – Non-Combustible), and 120 (Gases, Inert). Exclusive to North bound lanes is guide number 130 (Flammable Liquids) and exclusive to South bound lanes is guide number 171 (Substances – Low to Moderate Hazards).

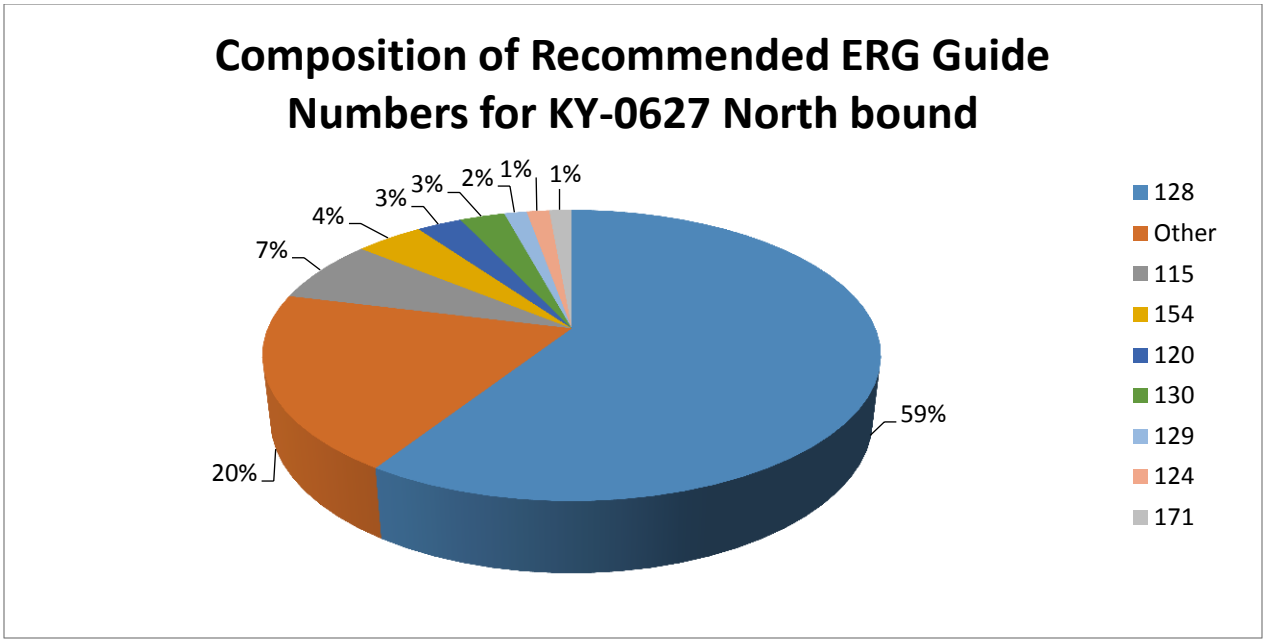


Figure 3.8 Composition of the most frequently used ERG's for North bound lanes

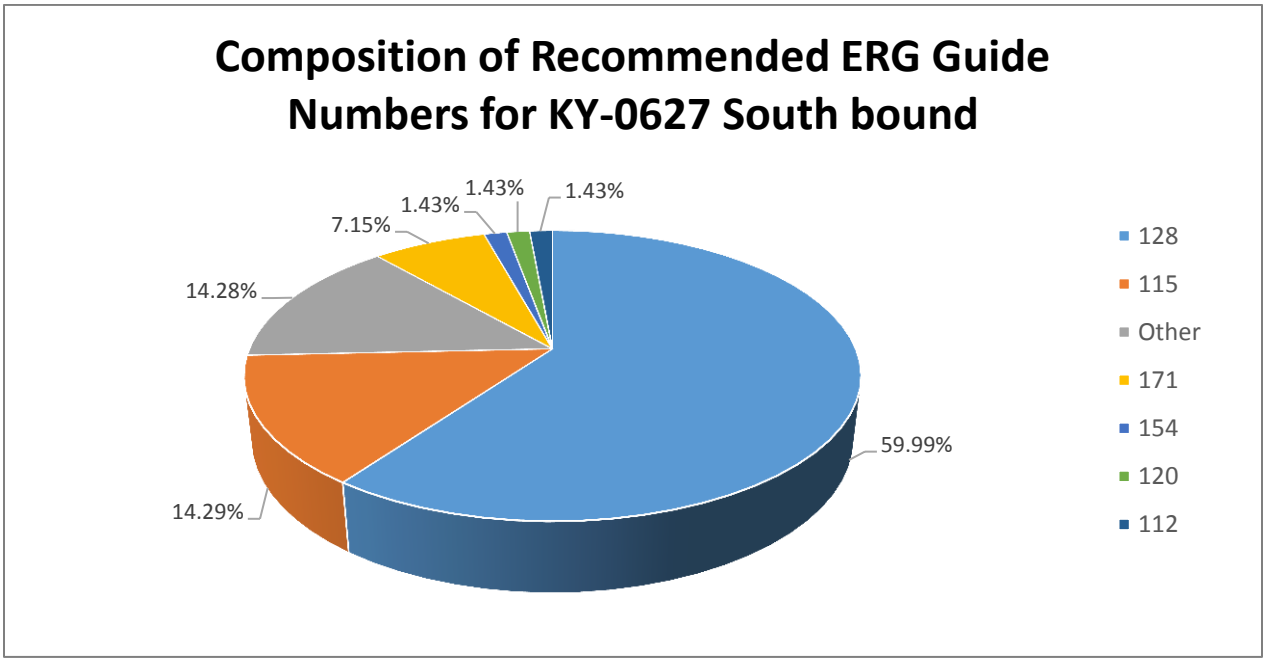


Figure 3.9 Composition of the most frequently used ERG's for South bound lanes

Chapter 4: Analysis of Hazmat Incidents

Analysis of hazmat incidents reported by the LEPC designated trends that took place between 2005 and 2014. This includes location of incidents, patterns of occurrence, and identification of risks to hazmat incident preparedness. Results of this analysis provide the LEPC and stakeholders with information regarding the location, reoccurrence, and 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. Spatial analysis of the data was completed utilizing ESRI ArcGIS Spatial Analyst software (2011) to determine if statistically significant clustering of hazmat incidents has occurred in Madison County during the study data period of 2005 - 2014. In other words, are there areas of clustered or concentrated hazmat incidents in Madison County during the time period under study? Point concentration and hot spot analyses were conducted to elucidate areas that have reoccurrence of incidents. Lastly, the evaluation of incident data enables emergency managers and the LEPC to evaluate areas with a higher concentration of incidents and thus a greater risk in conjunction with the hazardous materials detected during the Hazmat commodity flow survey.

4.1 Hazmat Incidents in Madison County, KY, 2005 – 2014

Data consisted of incidents, which were reported between 2005 and 2014 in Madison County. A total of 78 incidents were reported that required emergency response for vehicle spills that released materials such as diesel fuel, oil, coolant, and liquid sulphur (Figure 4.1). The primary hazardous materials released were diesel fuel (73%), oil (10.1%), hydraulic fluid (7.9%), and coolant (6.7%). Hazmat incidents occurred on roadways throughout Madison County as shown in Figure 4.2. The majority of incidents occurred on I-75 (46.8%).

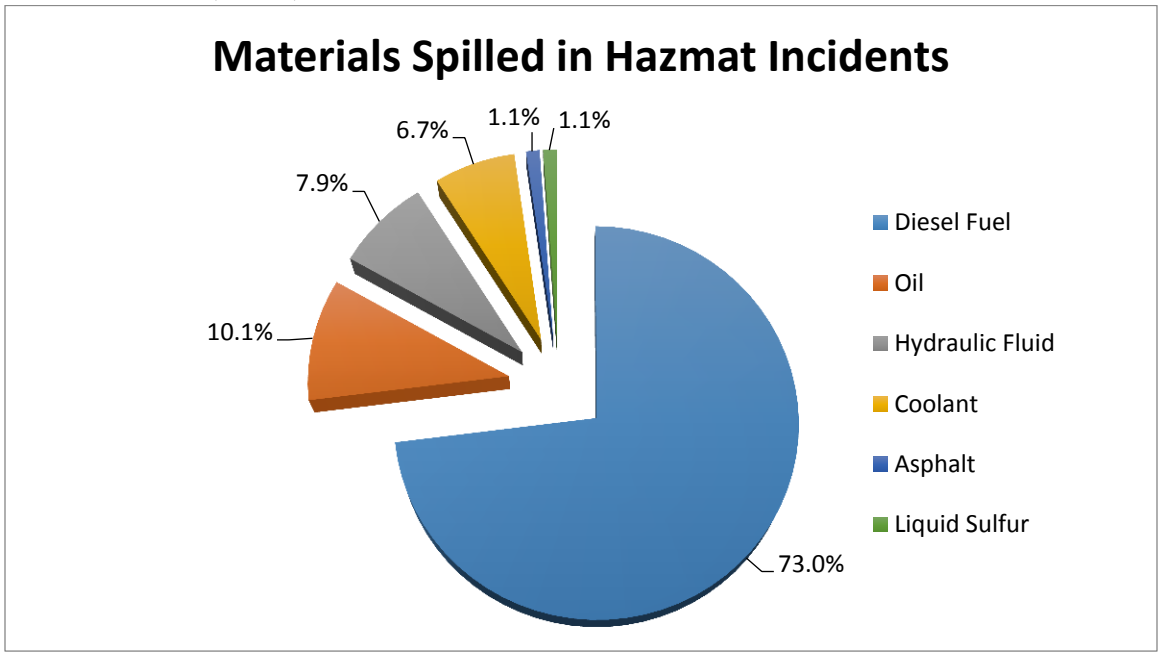


Figure 4.1. Materials spilled in Madison County hazmat incidents, 2005 – 2014.

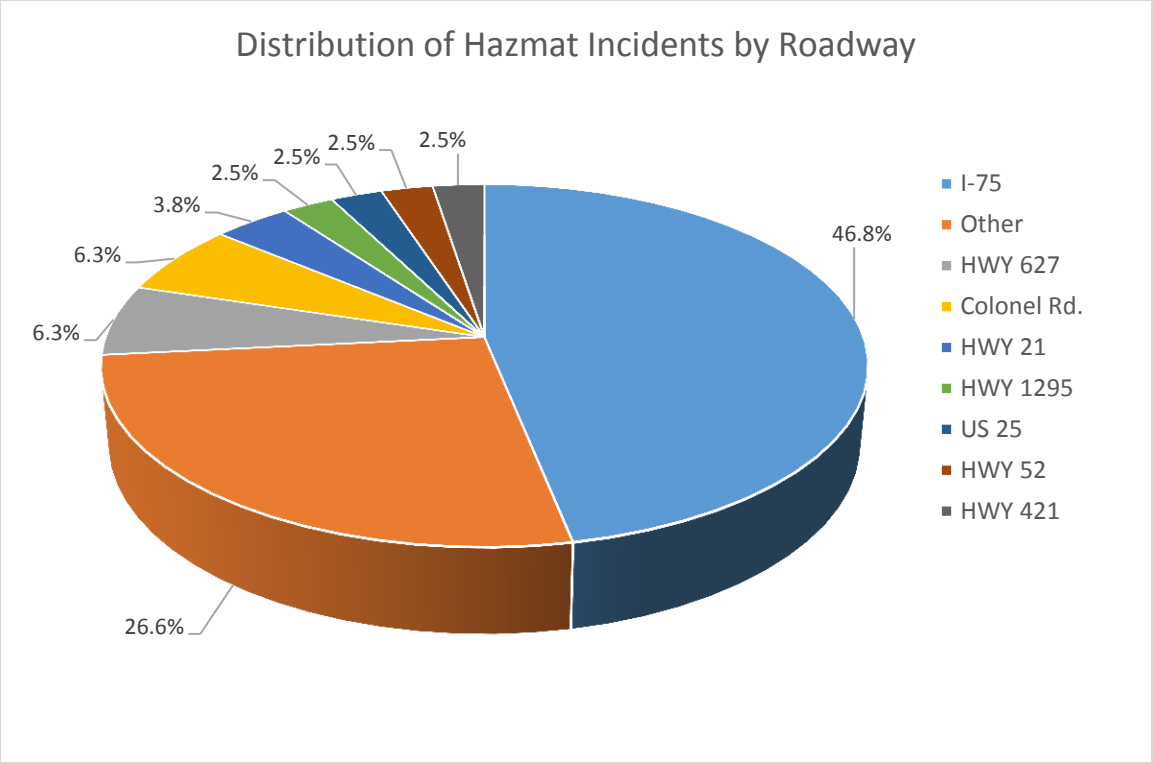


Figure 4.2. Distribution of hazmat incidents by roadway in Madison County, KY, 2005 - 2014.

4.2 Spatial Analysis of Hazmat Incidents

Hazmat incidents were observed to occur on primary roadways throughout Madison County (Figure 4.3). The map was produced through point density analysis of incidents that occurred. This analysis was completed to show points and areas where multiple incidents had occurred. Without density modeling several incidents could occur at the same point and be visualized on a map as a single point. This modeling does not indicate a statistically significant cluster of points. However, Figure 4.3 provides visualization of the distribution of hazmat incidents throughout Madison County from 2005 through 2014. 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.

To further explore the spatial distribution of hazmat incidents in Madison County, KY a pattern analysis was completed to detect the occurrence of incident clusters. This analysis produced a statistic to evaluate the clustering of incident points. A significant result indicates that the clustering pattern is not random, the points are dispersed (z-score ≥ 1.96) or the points are clustered (z-score ≤ -1.96). The Results of the pattern analysis, average nearest neighbor, indicated that the distribution of incidents in Madison County showed statistically significant clustering (Figure 4.4). The z-score for this analysis was -7.75 (p-value = 0.0000) and indicated a highly significant clustering of incidents. This analysis did not indicate the location of clustering, but that the incidents are in a clustered pattern.

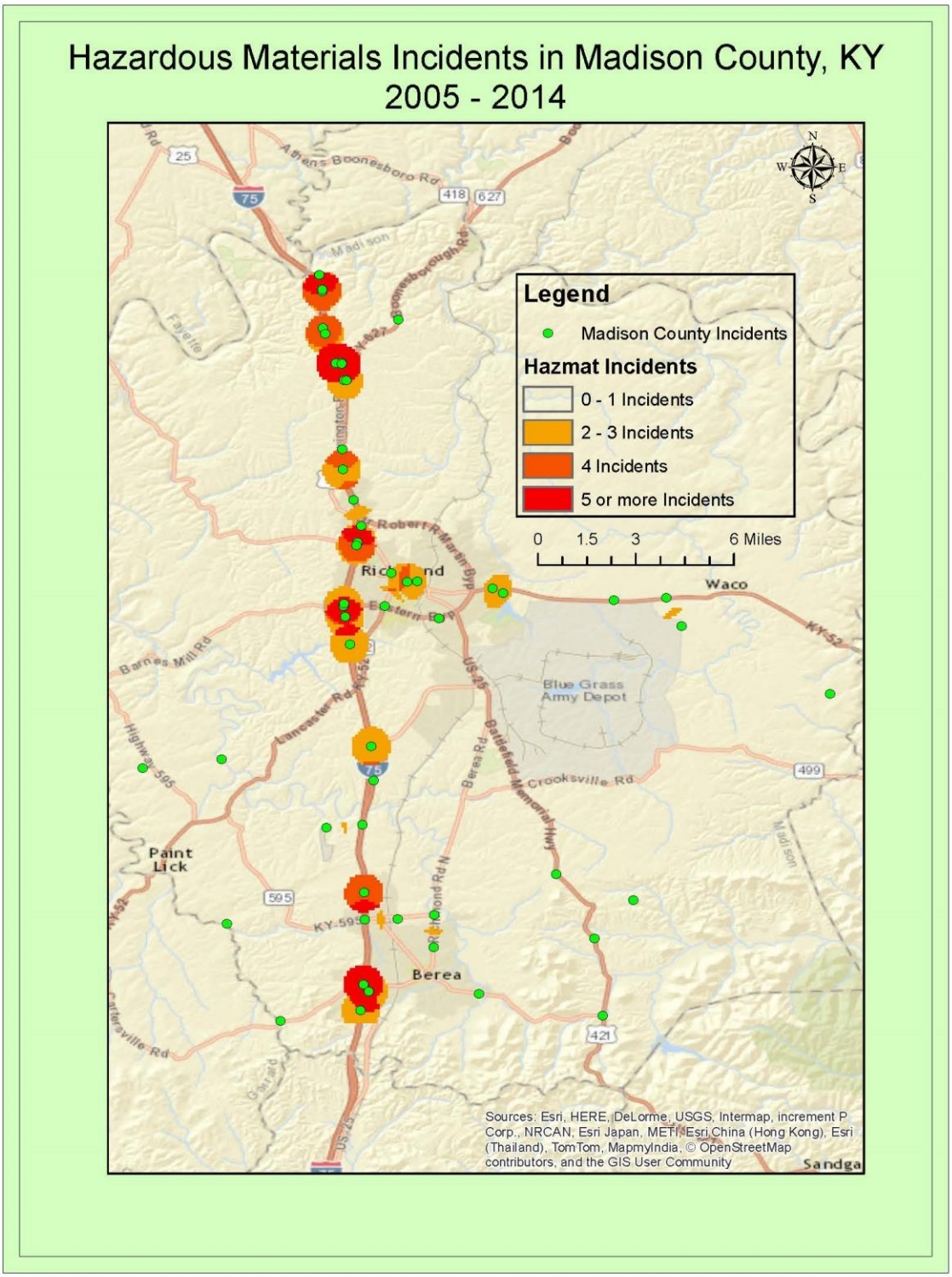


Figure 4.3. Occurrence of hazmat incidents in Madison County, KY, 2005-2014. Density mapping is used to indicate points and areas with multiple incidents. Areas with multiple incidents are shaded to indicate the number of incidents. Points with multiple incidents would be visualized as a single point on the map without density modeling.

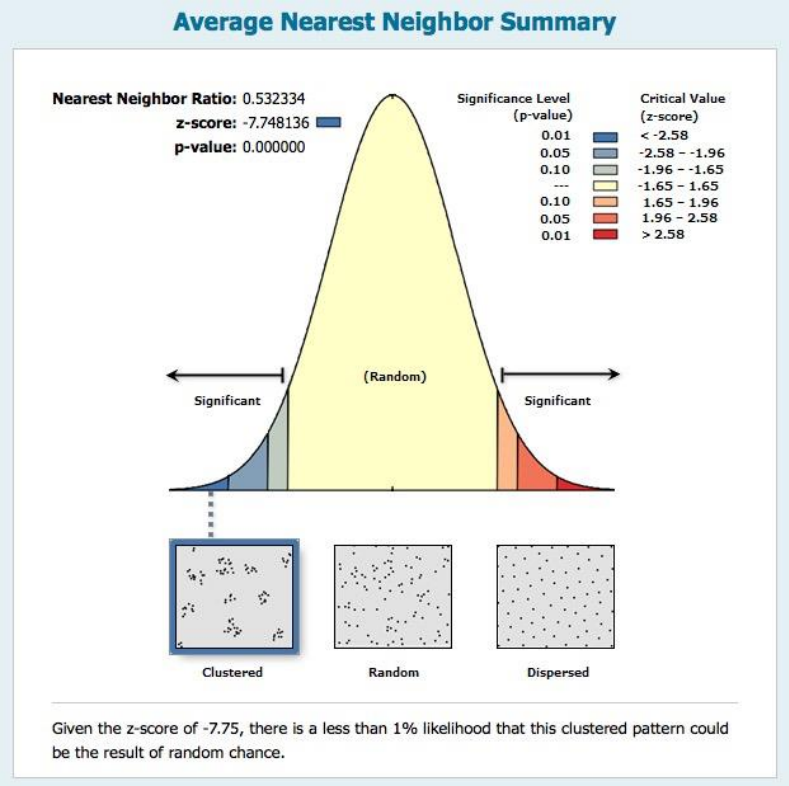


Figure 4.4. Results of spatial pattern analysis via average nearest neighbor in ArcMap (ESRI, 2011). The z-score of -7.75 indicates that there is less than 1% likelihood that the clustered pattern of hazmat incidents could be the result of random chance. The p-value is approximately 0.0 and is significant ($\alpha = 0.05$).

4.3 Hazmat Incident Hot Spots

To further elucidate the areas where significant clustering of incidents occurred further analysis was performed. The first step was to integrate points that were within a 1,000-foot tolerance interval. In this manner, points in close proximity or occurring at or near the same geographic coordinate were integrated into a single point that retained the count of points integrated in the connected database table. Following point integration, point collection is completed to graphically present locations with multiple incidents integrated into a single (Figure 4.5). Larger points and a color gradient show points with multiple incidents integrated. The legend shows the number of incidents integrated in each point. As shown, locations along I-75 have the greatest concentrations of incidents. These sites had a greater occurrence of incidents and represent a higher risk for hazardous materials preparedness. Further risk preparedness should be conducted for these sites by utilizing modeling to prepare response plans for known hazmats observed in this and a previous hazmat commodity flow study.

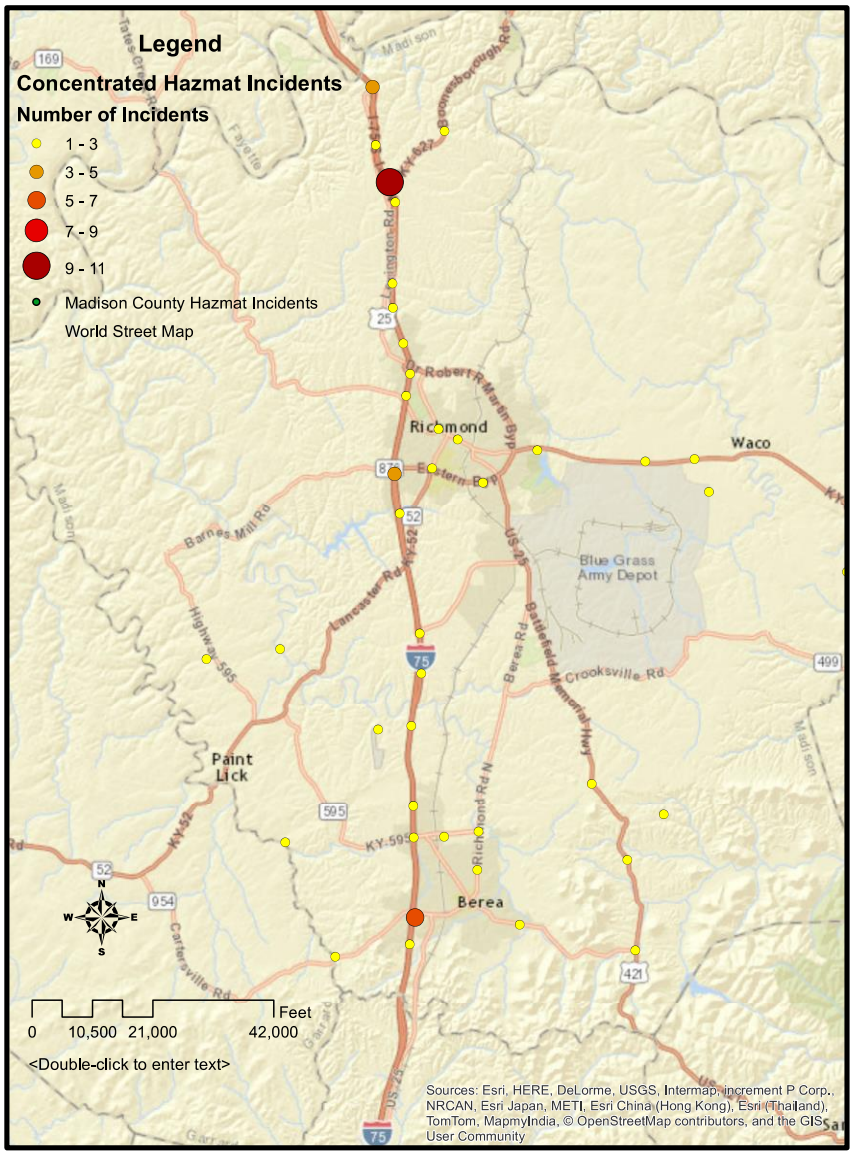


Figure 4.5. Concentrated hazmat incidents collected through point integration in ArcMap (ESRI, 2011). Larger points and a color gradient show points with multiple incidents integrated. The legend shows the number of incidents integrated in each point.

To complete the spatial assessment of hazmat incidents a final hot spot analysis was conducted with in the ArcMap (Esri, 2011) environment. A hot spot analysis indicates statistically significant clusters of points, incidents, or incident sites that show greater clustering when compared to all points in the spatial area. A z-score is produced for each collected point that may represent multiple incidents. As shown in Figure 4.6, the most significant area of clustering

as indicated by significant z-scores (p-value ≤ 0.05), was along or near the I-75 corridor and near the junction with 627. According to the hot spot analysis, this area had the most significant clustering of incidents for the 2005-2014 dataset. No other areas showed significant clusters as detected by the hot spot analysis. It should be noted that these are statistical results and incidents were observed to occur throughout Madison County along I-75 and primary highways.

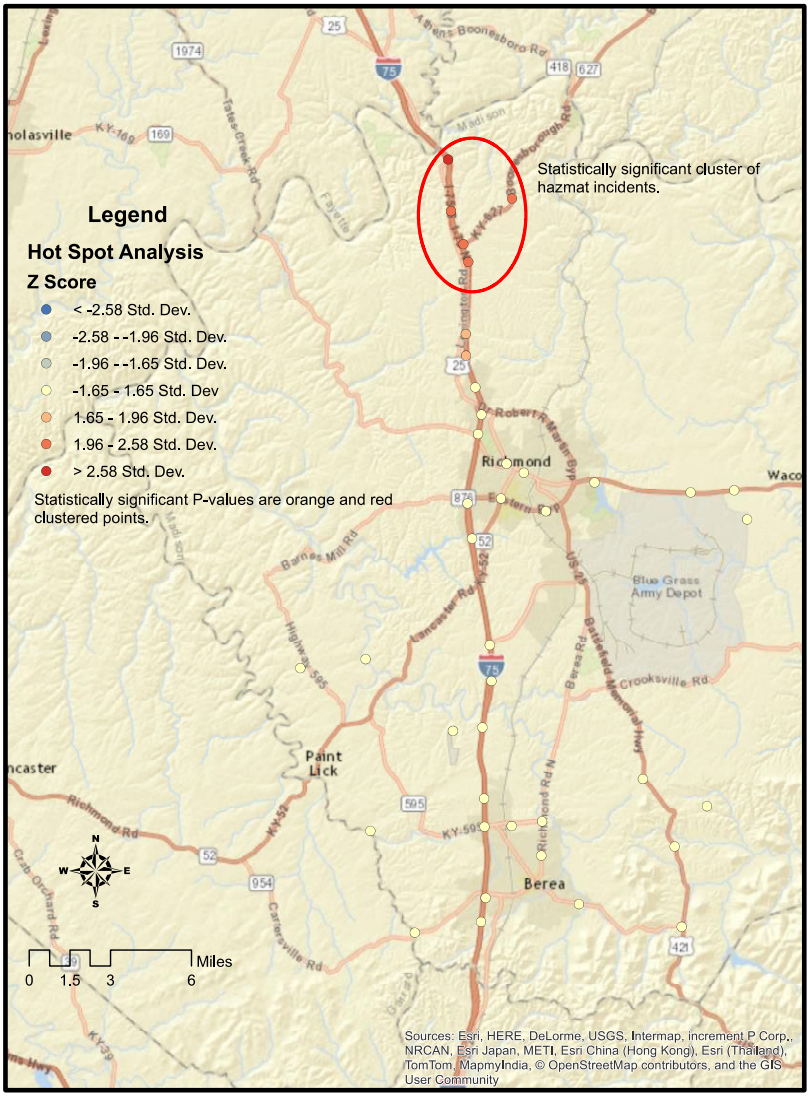


Figure 4.6. Hot spot analysis of collected incident points. Statistically significant clustering is indicated by point's shaded orange or red. These are points with a significant z-score (p-value ≤ 0.05).

Chapter 5: Conclusion

Hazardous materials are an important and necessary part of the American society. In order to produce needed resources hazardous materials have to be produced, transported, stored, used and discarded. This poses a threat to the environment and human health when incidents occur and hazardous materials are released. Incidents with hazardous materials can occur at any time in their lifecycle, from production to disposition. This study helps to give an accurate account of the quantities and types of hazardous materials being transported in the Madison County area of Kentucky. In addition, timing of transport is also provided to the LEPC, which is essential for emergency preparedness.

Both communities large and small must be educated about the care that needs to be taken when working with hazardous materials. Hence, it is critical to construct a knowledge base that concerns certain types of hazardous materials that are transported into, out of, and through a certain jurisdiction. In addition to the frequencies of hazmats it is also important to determine the timings and routs that are taken in order to further prepare for emergency response. The Emergency Response Planning committee must be based on an adequate account of these elements of hazmat movements. The sufficiency of emergency response organization schemes, equipment inventories and purchases, and personal training can only be assessed with the knowledge of this type of information.

This report works to create an accurate starting point, and begins to develop the necessary knowledge base about the transportation of hazardous materials through the Madison County jurisdiction. An initial line of incident response before an even can be established by communicating this information to emergency responders. Emergency response coordination will be essential to adequately protect human health and the environment from the potential impacts of the documented hazardous materials. The results and recommendations of this report will hopefully prove to be a useful guide in preparing emergency responders.

This study focuses on highway transportation of hazardous materials. The empirical results that are summarized below are based on the following:

- Commodity flow data collected by placard surveys on KY-0021
- Commodity flow data collected by placard surveys on KY-0627

The following section summarizes the results obtained in chapters 2 and 3 and gives recommendations which can be used as a guidance tool for emergency preparedness:

Result 1:
The frequency of hazardous material transport was noticeably higher on KY-0627 versus KY-0021. KY-0627 averaged approximately two placarded trucks per hour while KY-0021 averaged less than one placarded truck per hour.

Recommendation 1:
This warrants an increased need for the emergency responders to be vigilant around the KY-0627 corridor since it is a more popular route for hazardous materials.

Result 2:
The most commonly transported hazardous materials for KY-0627 and KY-0021 were Petroleum crude oil (ID no. 1267) and Petrol / Gasoline (ID no. 1203) respectively. This demonstrates the increased transportation of petroleum products between states

Recommendation 2:
This indicates an increased need for developing emergency response for petroleum related products in case of an incident. It is important to train emergency responders with reference to these products and to provide annual training for incidents involving ID 1267 or ID 1203.

Result 3:
The frequency of hazardous materials was recorded to be highest on Mondays and Thursdays as compared to the other weekdays. Also it was noted that the busiest time of day for both highways was the late morning period (9:00 – 12:00).

Recommendation 3:
It is essential for emergency responders to be familiar with peak days and times with reference to hazardous materials transport. This will ensure better alertness and preparedness in case of an incident occurring during these time periods. Extra emergency responders within these areas should be on call during the aforementioned peak timing in order to ensure efficient response. One potential problem in areas with volunteer emergency responders is that these responders are usually working other jobs during these peak times. A system needs to be created to improve incident response in these areas.

Result 4:
The most common ERG guide number recorded for both KY-0021 and KY-0627 was 128.

Recommendation 4:
It is important for Local Emergency responders to be properly trained for response to Guide no. 128. They should be updated with any changes that are made to this guide. Annual training for emergency responders should include a refresher on application of response guide 128 under various scenarios.

Result 5:
Hazmat incidents occurred throughout Madison county for the 2005 through 2014 time period along I-75 and primary highways.

Recommendation 5:
Locations of previous hazmat incidents should be evaluated for environmental factors that may result in an increased probability of incidents. Additionally, vehicle incidents should be evaluated for Madison County to determine is commercial and passenger incident patterns are similar. Similarities would indicate areas with increased risk of incidents and release of hazardous materials.

Result 6:
Concentrations of hazmat incidents occurred (2005 – 2014) along the I-75 corridor. Spatial statistical analysis showed that there was clustering of incidents in Madison County for the study period. Multiple incidents occurred in several locations as shown in Figure 4.5. Sites with multiple incidents should be included in incident response plans with risk assessments conducted through modeling of hazmat scenarios of high probability low risk, medium probability medium risk, and low probability low risks. These evaluations should assess risks to human and ecosystem health.

Chapter 5: References

Agency, E.P. (2010, March 10). *Wastes-Hazardous Wastes.* Retrieved July 20, 2010, from U.S. Environmental Protection Agency: http://www.epa.gov/osw/hazard/.

Golla, V., Taylor, R., Stanam, A., Chavan, P., & Ellis, C. (2011, August). *Madison county hazardous materials commodity flow analysis.* Retrieved from digitalcommons.wku.edu/public_hlth_fac_pub/1/.

Kentucky Transportation Cabinet (2013). *KYTC traffic count reporting system.* Retrieved from: http://datamart.business.transportation.ky.gov/EDSB_SOLUTIONS/CTS/Default.aspx.

Taylor, R. (2010). *Warren County, Kentucky Hazardous materials commodity flow analysis.* Retrieved August 12, 2010 from digitalcommons.wku.edu/public_hlth_fac_pub/1/.

Transportation, D. o. (1991). U.S. Department of Transportation Federal Motor Carrier Safety Administration. Retrieved July 20, 2010, from DOT: http://www.fmcsa.dot.gov/safety-security/hazmat/complyhmregs.htm#hm.