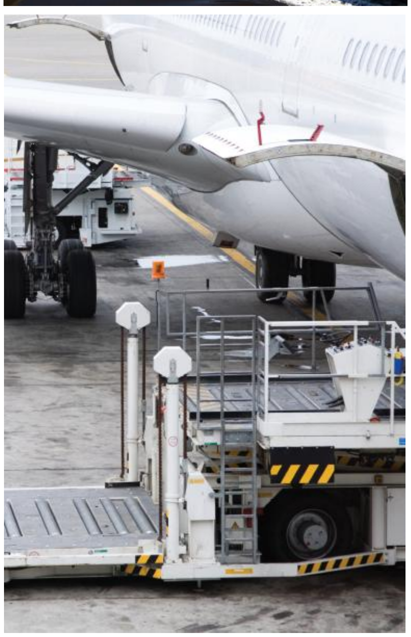
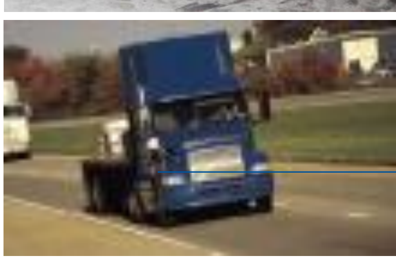
COASTAL REGION MPO



Technical Memorandum 2.5

FREIGHT NETWORK BOTTLENECK, SAFETY AND SECURITY ISSUES IDENTIFICATION

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1. INTRODUCTION

In this Technical Memorandum 2.5 of the CORE MPO Freight Transportation Plan Phase II, the freight network bottlenecks, and the safety and security hot spots are identified. The "hot spot" analysis identifies freight network locations of recurring operational impediments and/or outstanding safety concerns. Criteria-based ranking and discussion of characteristics are provided for these "hot spot" locations.

Identification of system deficiencies is a necessary first step towards effective planning for freight movements. The following sections discuss analysis results from two complementary approaches - identification of outstanding safety hazards, and identification of freight system bottlenecks. The network deficiencies identified in this analysis will lead to recommended solutions to improve inadequate freight infrastructure access in the final freight, goods and service plan.

2. SAFETY AND SECURITY

In Chapter 2 - Safety and Security, safety “hot spots” have been identified and analyzed. These hot spots are locations with high truck crashes or rail related accidents, including locations such as rail-roadway at-grade crossings as well as roadways with design deficiencies and/or operational issues. The safety guidance from the Moving Ahead with Progress in the 21st Century (MAP-21) and the Federal Highway Administration (FHWA) Highway Safety Improvement Program Manual include several methodologies to identify safety problems of the roadway network. These methods – referred to as “performance measures” – range from simple averages to advanced statistical algorithms. For rail, safety concerns include items such as truck/rail at-grade crossing crashes, train derailments, hazardous material spills, etc. Each problem identification method has different strengths and weaknesses, and has different data requirements for its applications.

State transportation departments, law enforcement agencies and municipalities identify and rank safety locations based on local importance and needs analysis. These organizations sometimes employ generalized safety index methodologies to compare safety improvements; however, these indices are not recommended for corridor or strategic improvement analysis. Safety indices of this type usually highlight the results rather than the causes of safety issues.

For the CORE MPO Freight Transportation Plan Phase II, the hot spot locations in the study area are derived from an understanding of overall crash densities, and a ranking of individual roadway segments based on crash characteristics. The detailed methodology can be found in Section 2.2.

2.1 Data

2.1.1 Georgia Department of Transportation (GDOT)

The GDOT statewide crash data was retrieved for the study area, which included the crash statistics of the last five years, from 2008 through 2012. This dataset was used to identify crash densities and "Hot Spot Segments" in the study area. The dataset was retrieved from the GDOT GEARS (Georgia Electronic Accident Reporting System) which collects reports as they are submitted electronically from police agencies across the state. The information includes crash records involving commercial vehicles, and non-commercial vehicle crashes. Crash locations and their associated characteristics represent the fundamental information considered during this analysis.

Over 3,100 tabular crash records were reported in the five-year dataset for the study area. Of these, 2,243 records contained the necessary spatial and attribute information to meet the data needs for the CORE MPO's freight transportation plan analysis. The analyses required crash records containing both location and crash type/severity information. Some records were lost due to lack of spatial location information (lat/long or GDOT LRS location), lack of attribute information (crash location present but no type information recorded), or complete records for crashes occurring outside the study area.

The crash density mapping uses reported crash location information (lat/lon) without further adjustment. For hotspot segment identification, the crash locations were adjusted to coincide with the GDOT LRS (Linear Referencing System) roadway network segment location nearest to their reported lat/lon information. Following the adjustment, the crash locations were assigned GDOT LRS location information, enabling comparison of crash attributes along with any GDOT LRS variables (roadway type, number of lanes, speed limit, AADT etc.). A case-by-case adjustment was made as necessary for crash locations near but not at roadway network intersections since it is required for this analysis that the crashes be associated with only one roadway segment. These adjustments reconcile the true location of a crash point given manual interpretation of associated attribute information in situations where LAT/LON plotted crashes on the intersection of two or more segments. Section 2.2 provides additional information on data processing.

2.1.2 Federal Railroad Administration (FRA)

The rail safety requirements are provided through a combination of federal and state laws. The Federal Railroad Administration (FRA) outlines most safety-related rules and regulations in the Rail Safety Act of 1970 and other legislation, such as the most recent Rail Safety Improvement Act of 2008. Most rail safety regulations can be found in Title 49 Code of Federal Regulations Parts 100-249.

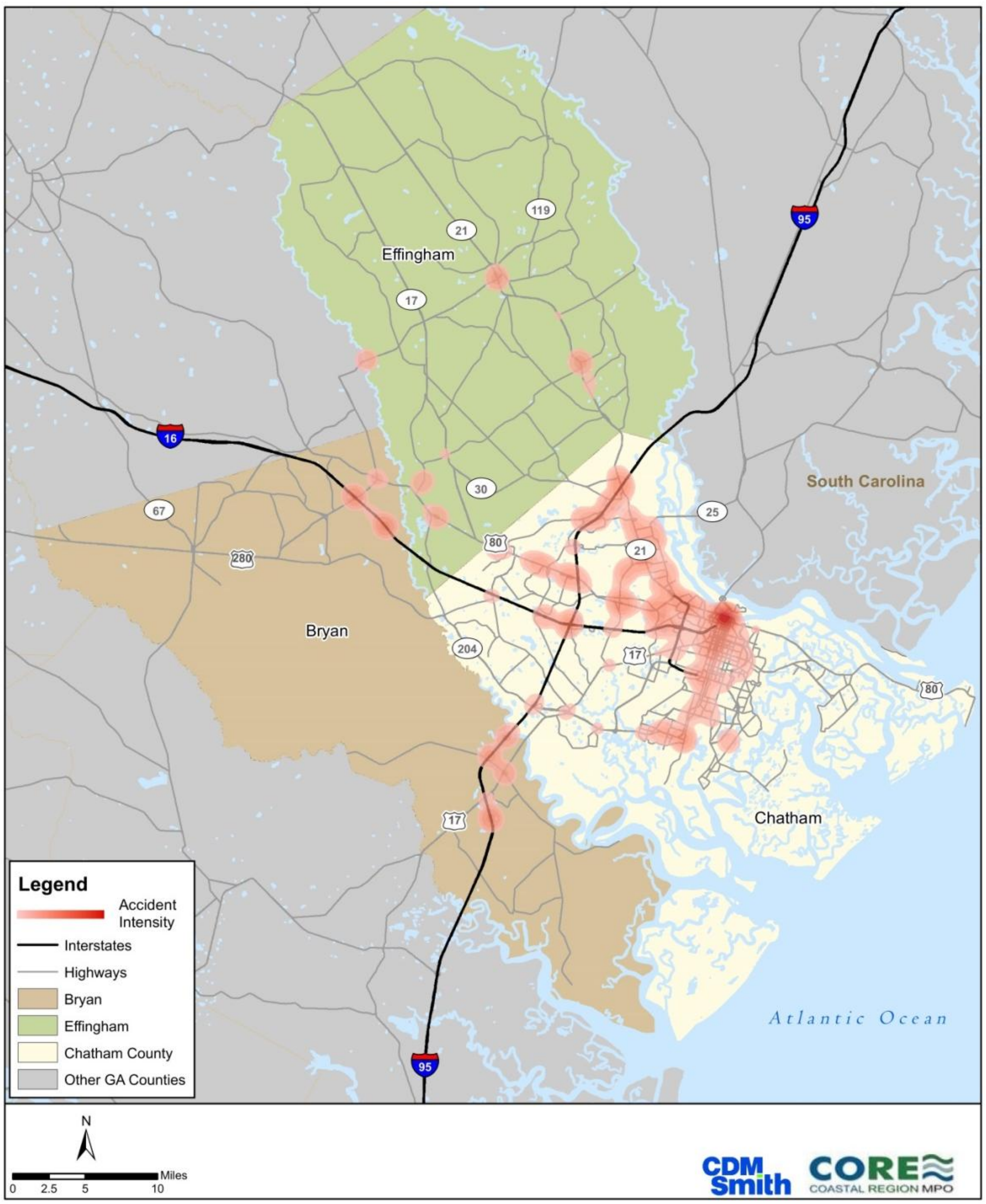
The FRA Office of Railroad Safety regulates safety for the Nation's railroad industry. The data inventory includes highway-rail crossings and accident information for all rail lines.

2.2 Methodology

2.2.1 Crash Density Mapping

The relative density of crashes in the study area was visualized using a Kernel Density Estimator approach, applied to the 2,243 crash locations which met the data specifications for the CORE MPO Freight Transportation Plan study area. The Kernel Density Estimators (KDE) for point spatial data, like the implementation (ArcGIS KDE Tool) used for this analysis, enable a smooth visualization of relative crash intensity across a raster surface. The mapped result of this approach is illustrated in Figure 1.

Figure 1 – Crash Location Density



The KDE tool (ArcGIS) uses a search radius and weight of each crash point to provide the intensity. For this analysis, a one-mile search radius was selected, and crash points were weighted according to the following type categories:

- Regular, "Police Department On-scene" crashes were counted as 1 Crash Unit;
- Injury crashes were counted as 5 Crash Units; and
- Fatality crashes were counted as 50 Crash Units.

Having captured this information, the KDE tool fitted a custom probability density function to the data, and then used this estimated curve, search radius, and crash unit's values to evaluate and record a sum of all crash unit contributions (the relative density) at each cell in a raster surface. See Appendix A for additional information on how this sum is calculated.

The mapped result shown in Figure 1 was used as a validation tool during interpretation of Hot Spot Segment Identification. The segments identified as hot spots are expected to fall within areas of high crash density and the comparison of hot spot segment locations was used to corroborate their status as hot spot segments.

2.2.2 Hot Spot Segment Identification

The Hot Spot Segment Identification method uses categorical scoring **(**see "accident severity index") combined with crash counts to rank unsafe locations along the freight network. A ranking of the top ten hot spot segments (exclusive of interstate segments[1]) resulted from this effort. This section details data processing for segments, categorical scoring, and crash counting steps used.

2.2.2.1 Data Processing and Definition of 'Segment'

To obtain the meaningful top ten hotspot roadway segments, a limit had to be set on the length of segments prior to any analysis. The goal of this analysis is to identify excessively unsafe segments in the freight network, thus the longer basemap segments from the GDOT Linear Referencing System (LRS) were too general for this purpose, due to the reduced usefulness of developing a crash severity index value for a full length segment. Additionally, basemap segments (default "blank canvas" spans of GDOT LRS segments) are artificial, long, and do not immediately reflect intuitive breaks in roadway facilities. For example, a single GDOT LRS segment may span the full length of SR 17 through the study area. The path of SR 17 through the study area probably exhibits changes in number of lanes, speed limits, directions, etc. To provide for a more specific assignment of crash severity index values, and therefore a more varied map output, segment lengths drawn from the GDOT's *tr_roads* feature class found in the GDOT_Statewide_Roads.mdb geodatabase were used. Segment lengths in *tr_roads* provide breaks at changes in roadway local name. The roadway local names appeared to provide both a greater degree of variance in the roadway segments, as well as provide a useful identifier for the segments.

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[1] The exclusion of interstate segments was intended to provide hot spot segment identification to local route segments, otherwise the interstate segments would have dominated the top ten hot spot segment list.

Once the GDOT LRS basemap segments were finalized, crash types/totals and facility type information were associated with each segment in the network. Since crash point locations were assigned GDOT LRS Begin/End Milepoint location information, crash locations were joined to the LRS and aggregated for crash types, counts, and facility types by roadway local names. The result was a table containing all necessary input information for applying the Accident Severity Index.

2.2.2.2 Crash Severity Index

A categorical scoring approach adapted from the Texas Freight Mobility Plan of March 2014 represented one of two inputs used to determine the final Top 10 Hot Spot Segments for the study area. Calculation of the Crash Severity Index is straightforward. For a given roadway segment along the LRS, the segment is first assigned two categorical scores: the first score is based on type and count thresholds for crashes occurring on the segment, and the second score is based on the facility type of the given segment. Each of these categorical scores ranges from 1 to 4, with 4 being the most severe. The final accident index is the average of the two categorical scores. For example, a roadway segment may have experienced one injury crash, and have been classified as a US Highway during the time period under study. The crash severity index for this segment would be returned as (2 + 3) / 2 = 2.5, which is moderate. Table 1 shows the index criteria.

Table 1 – Crash Severity Index Criteria Chart

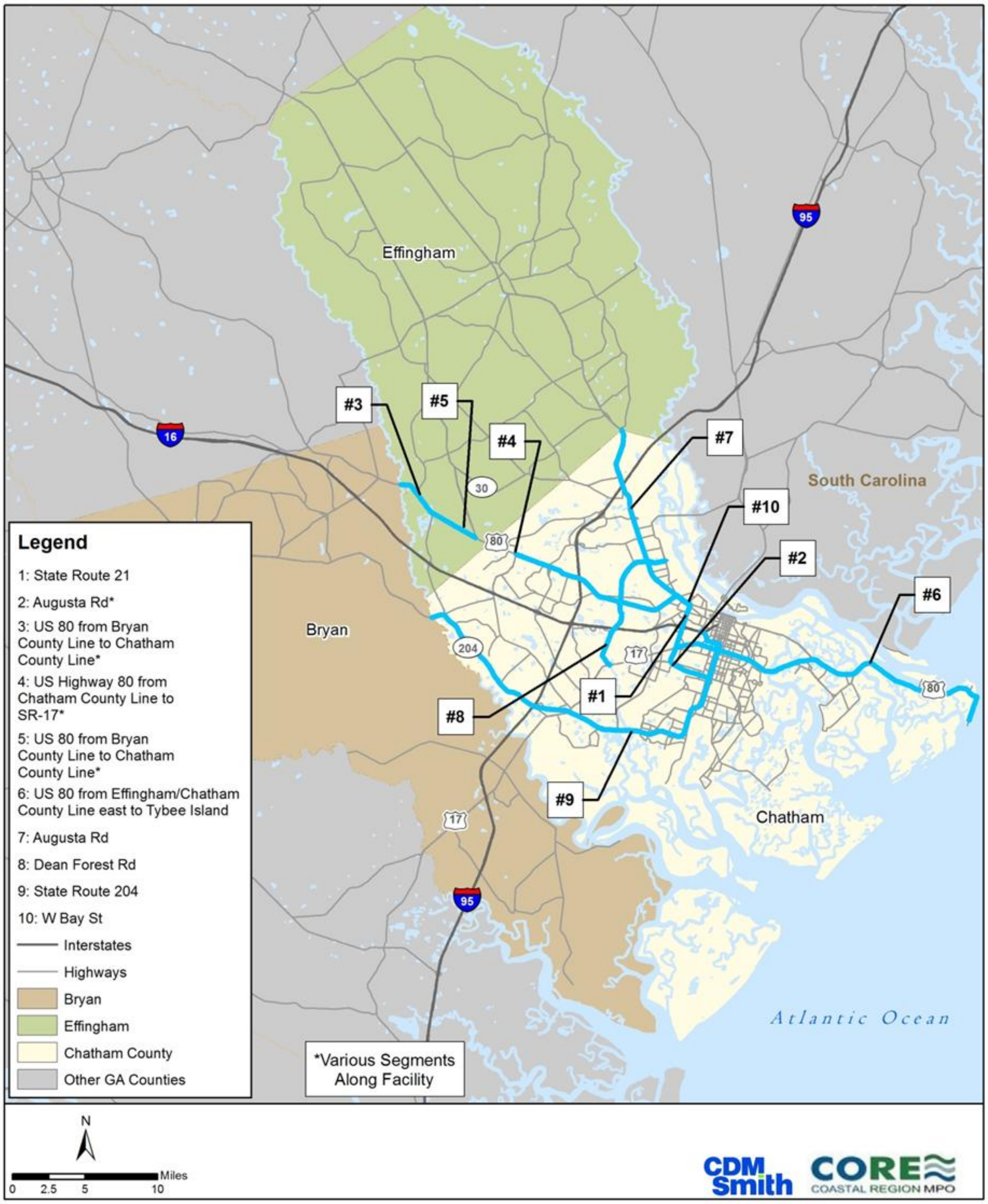
Rating	Crash Severity	Facility Type (FC)
1	PDO, 0 Fatalities, 0 Injuries	FC Lower than State Highway
2	0 Fatalities, 1 Injury	State Highway
3	0 Fatalities, >= 2 Injuries	US Highway
4	>= 1 Fatality	Interstate

2.2.2.3 Total Crash Counts and Final Ranking

The simple crash severity index criteria allowed for seven unique index value results. This caused many segments to have the same crash severity rating, making ranking difficult. An additional factor was necessary to further differentiate freight network segments in terms of their crash severity. To address this issue, the method applied an additional rule to sort segments with the same score by the total of all crash events occurring on the segment. The highest crash totals among the highest severity index scores assisted in determining the top ten hotspot segments.

2.3 Results

Figure 2 – Top Ten Hotspot Segments (Exclusive of Interstate Segments)



2.3.1 Top Ten Hot Spot Locations

Following the methodology discussed above, the following ten segments scored as the top ten.

Table 2 – Top Ten Hot Spot Locations

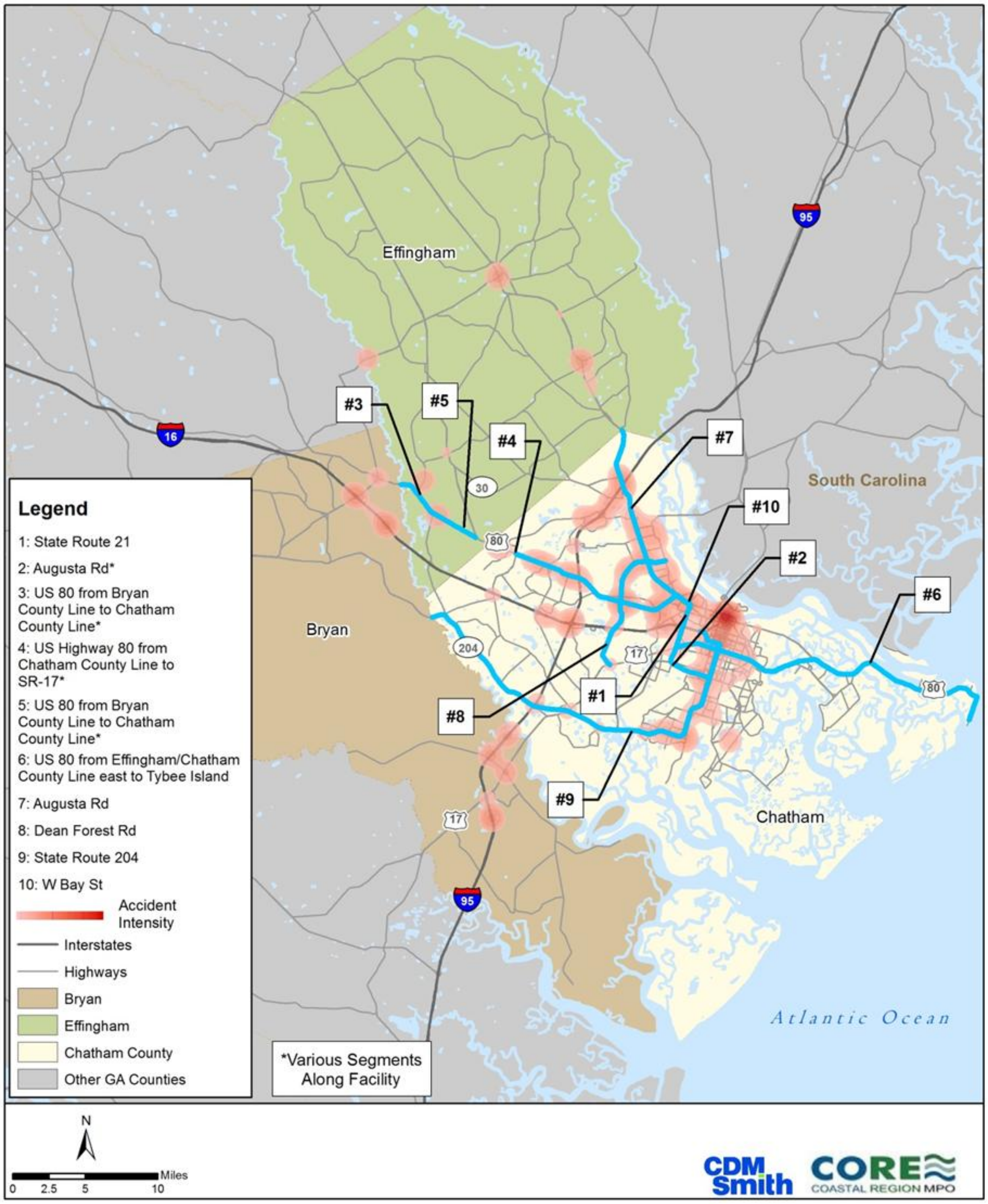
Rank	Segment Name	Scoring	Notes
1	Augusta Rd/GA-21	3.5, 184 crashes on-segment. See *Note	Burnseed Blvd to Mildred St
2	Augusta Rd/GA-21	3.5, 184 crashes on-segment. See *Note	Burnseed Blvd, east to GA-17 Intersection
3	US 80	3.5, 10 crashes on-segment	US 80 from Bryan County Line to Chatham County Line
4	US 80	3.5, 5 crashes on-segment See *Note	US 80 from Chatham County Line to SR-17
5	US 80	3.5, 2 crashes on-segment	US 80 from Bryan County Line to Chatham County Line
6	US 80	3.0, 184 crashes on-segment	US 80 from Effingham/Chatham County Line east to Tybee Island
7	Augusta Rd/GA-21	3.0, 184 crashes on-segment	From Chatham County Line to intersection with Main St (GA-25)
8	Dean Forest Rd	3.0, 109 crashes on-segment	From Ogeechee Rd (US-17) to Main St (GA-25)
9	State Route 204	3.0, 64 crashes on-segment	From Bryan/Chatham County Line to intersection with Ogeechee Rd (GA-25)
10	West Bay St	3.5, 184 crashes on-segment. See *Note	W Bay Street at the I-516/GA-25 Intersection

*Note – The crash dataset reported 184 crashes at a single location on the LRS network. Upon discussion this anomaly was attributed to data entry routines on the part of police/first responders. Since S Coastal Highway and Augusta Rd share an identical RCLINK segment identifier in the GDOT LRS, both segments inherited an identical crash count. Ranking between these particular segments was determined on the basis of shortest segment length; the theory being that if equal portions of 184 crashes were applied to each segment, S Coastal highway would have a higher crashes-per-mile. However, this distinction is tenuous and is essentially a means to avoid a perpetual tie for first place.

2.3.2 Overlay with crash densities

As a visual check to suggest a correlation between the KDE visualization of relative crash density and the locations of the top ten bottleneck segments, the KDE result was overlain with a map of the top ten hotspot segments.

Figure 3 – Top Ten Hotspot Segments Overlaid with Crash Density



The crash points used as inputs for KDE crash density mapping are input based on their absolute spatial location, and crash counts assisting in the ranking of top ten hotspot segments represent aggregate crash counts across the full length of a segment. With this in mind, Figure 3 may shed some light on the more specific locations of crashes as they occurred along the top ten segments. The map also shows a general correlation between the areas of higher crash intensity and the top ten segment locations.

2.3.2.1 Additional Locations from Freight Advisory Committee Meeting #1

At the first Freight Advisory Committee (FAC) Meeting in May 2014, the meeting participants were shown the Crash Intensity map as illustrated in Figure 1 and asked to comment if this map was accurate and what other crash locations should be added as potentially hazardous locations for freight movements. The participants identified the following additional locations for consideration.

Table 3 – Freight Advisory Committee (FAC) Identified Crash Locations

Locations	Comments
I-16 at Chatham Parkway	Crashes during the PM period
US 80 and SR 307	
I-95 at Jimmy Deloach Parrkway	Speed and geometric configuration of the segment
Rail Crossings along SR 21	Need roadway/rail grade separation
I-16 at SR 307	Geometry issues and congestion leading up to the intersection
Telfair and Dean Forest Road	School zone with young drivers crossing traffic on Dean Forest Road, and speed and light issues from I-16 interchange
SR 21 Corridor	Multiple locations along the corridor are a concern
Bay Street in Downtown Savannah	Freight/pedestrian conflicts

3. Bottlenecks

The performance of CORE MPO's freight transportation network is also determined by the number and severity of its bottlenecks. The bottlenecks highlighted in this memo were identified through the 2010 traffic survey conducted by GDOT[2]. The results of the survey led to the determination of the level of service (LOS) for each segment. The congested segments were classified as "marginally congested" or "congested" based on:

- AM and/or PM time period,
- Traffic direction,
- Level of service (LOS) grade from the survey, and
- Weighted according to the AADT on the segment.

A bottleneck is a roadway segment with particular and significant negative impacts on freight network performance. Bottlenecks are generally locations where capacities are inadequate to handle traffic flows, which impact the performance of freight network segments. Congestion, or the queuing/delay of freight movements, reduces the performance and dependability of the freight network in terms of serving freight traffic flows. This analysis identifies the most critical bottlenecks along the network as well as other areas where congestion exists and where bottlenecks may occur with increased demand.

Information describing the performance and dependability of existing infrastructure along the freight network assists decision-makers in identifying problem areas where delays in freight movement originate. Positive identification of delay-prone network segments promotes better prioritization of freight investment.

3.1 Data

3.1.1 Georgia Department of Transportation (GDOT)

The available GDOT time-congestion grades, Average Annual Daily Traffic (AADT) and level-of-service (LOS) data were collected for GDOT LRS segments in the three county study area. The AADT values were provided by GDOT as referenced to their LRS, and the LOS information was collected via the SkyComp web application. The AADT information is readily available for segments along the GDOT LRS in the three county study area; however, the LOS information was not available for all segments where AADT was available.

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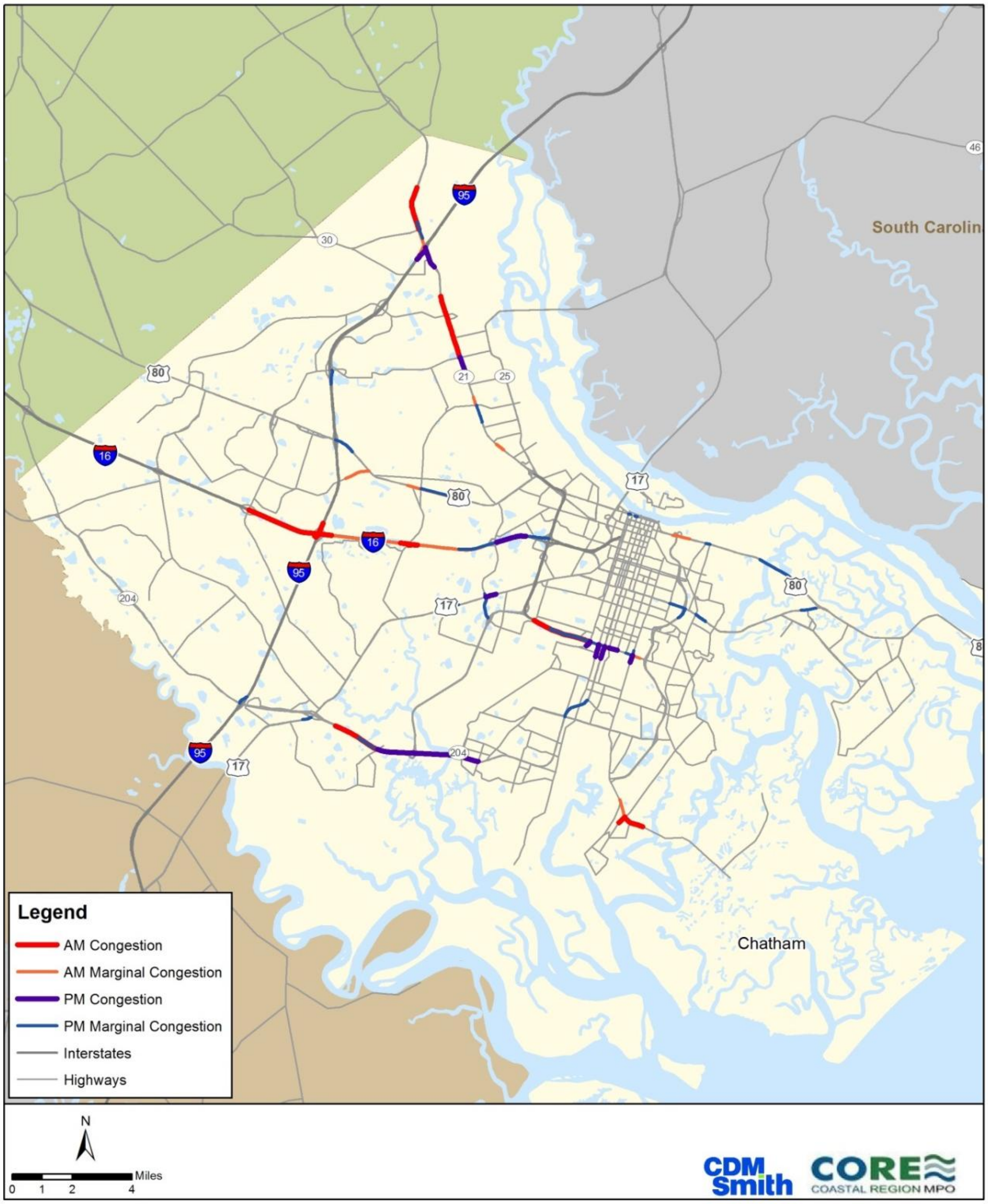
[2] http://www.dot.ga.gov/informationcenter/statistics/trafficsurvey/Pages/default.aspx

3.2 Methodology

Figure 4 – Bottleneck Locations throughout the Study Area



3.2.1 Data Processing

Following data collection, the available Levels of Service (LOS) information was categorized by time of day (AM/PM). The assignment of final LOS values to segments for analysis then followed the worst-case LOS value observed over the course of an entire day, for any given roadway direction. For example, if an eastbound segment showed a LOS of 'A' in the AM hours, but 'C' in the PM hours, the segment was coded as having a 'C' eastbound grade for purposes of the analysis and bottleneck selection. Initially, the LOS information provided by SkyComp did not carry GDOT LRS location information for segments. The SkyComp LOS information identifies segment spans via roadway limits in a tabular format. For example, the segment location is understood in terms of "SR 204 Eastbound" between "US 17" and "Veterans Pkwy." To allow for comparison and mapping of these values, the SkyComp LOS information was plotted manually along the GDOT LRS network using the provided limit texts. The resulting dataset relates LOS values to GDOT LRS milepoint location information for further analysis.

Once the AADT and LOS datasets were comparable in terms of GDOT LRS location, a unified table was created, relating GDOT LRS location information, segment name, AADT, and worst-case LOS for purposes of bottleneck selection. The bottleneck selection criteria were then chosen and applied to this dataset.

3.2.2 Selection Methodology

Following preparation of the input datasets, an AADT-weighted, LOS-based selection method was applied. The method ranked segments in terms of their potential to disturb efficient operation of the network. The highest severity segments were classified as "Congested" with lesser but still significant segments classified as "Marginally Congested." Results of this selection are displayed categorically on Figure 4.

3.2.2.1 GDOT Time Congestion Base Data

Time-congestion grades provided by GDOT represent the base dataset for this analysis, comprising the values used for the first-tier selection criteria. GDOT time-congestion grades allowed for initial filtration of roadway segments towards bottleneck identification. Results of this initial filtration underwent AADT/LOS-based selection methods discussed below.

3.2.2.2 Incorporation of AADT

AADT, or Average Annual Daily Traffic values represent the average daily traffic count for a roadway segment over the course of a 24-hour period. The AADT values were used as a weight factor in determining bottleneck status by roadway functional type (non-interrupted vs. interrupted), which is in turn a factor in determining the LOS ranking assigned to any given roadway segment.

3.2.2.3 LOS Analysis

Level of Service (LOS) represents an aggregate value used to communicate the quality of roadway traffic conditions to stakeholders and decision-makers. LOS uses an A-F grading system, with F representing the most severe negative traffic situation. For purposes of this analysis, the LOS values incorporated are themselves a product of the analysis performed by Skycomp Corporation. According to Skycomp*[3], two distinct approaches are employed in the determination of LOS values for roadway segments. Both approaches rely on the interpretation and analysis of remotely sensed imagery. For uninterrupted roadways such as freeways, repeat flyovers are conducted between the hours of 6:30 am and 9:30 am, and between 4:00pm and 7:00pm respectively. For these uninterrupted roadways, a traffic density unit is calculated as *passenger cars per lane per mile (pcplpm)* from which LOS values can be categorized. Higher levels of pcplpm translate to more severe LOS grades. For interrupted roadways, such as roadways with signalized intersections, an alternative proprietary approach calculates an adjusted pcplpm by approximating average travel time through interpreting the motion of groups of automobiles along the roadway segment.

LOS was incorporated into bottleneck selection by looking at morning (AM) and afternoon (PM) traffic volumes. For the two time periods, a three-hour assessment period was used. For AM, the three-hour timeframe was from 6:30am to 9:30am. For PM, the three-hour timeframe was from 4:30pm to 7:30pm. These are considered peak hours for traffic within the region. These LOS categories contributed to a ranking providing three potential classifications: non-congested, marginal congestion, and congestion. The results presented focus on those roadway segments that were classified as either marginal congestion or congestion depending on the time of day.

3.2.2.4 MAP - 21

It should be understood that the current method for identifying bottlenecks will be modified in the future. Moving Ahead for Progress in the 21st Century (MAP-21) contains several directives for the federal government to establish for the national transportation network. A primary directive of MAP-21 is the establishment of a performance-based and outcome-oriented program to assess transportation efficiency and effectiveness which would provide solutions consistent with achieving federal goals to improve the national transportation network. This includes the development of performance measures for freight transportation. The measures and targets used to identify bottlenecks for freight transportation must be consistent with federal freight performance measures. As MAP-21 guidance in regards to freight transportation performance was not available at the time this study was completed, they were not included in our methodology. Future iterations of this bottleneck identification analysis should incorporate available MAP-21 guidance.

3.2.2.5 Travel Time Data

Additionally, incorporation of the FHWA travel-time datasets was discussed as a possible component of the bottleneck identification methodology employed for this study. Collection and processing of this FHWA data was time and cost prohibitive for the scope of this initial effort. Should the bottleneck identification be updated or revisited at a later date, the incorporation of travel time as input data will provide a more comprehensive result.

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[3] http://www.dot.ga.gov/informationcenter/statistics/trafficsurvey/TrafficMaps/HTML_Slides/resources/methods.pdf

3.3 Results

Four categorical values for measuring congestion were associated with segments following application of the bottleneck analysis. The congestion intensity categories include: AM Congestion, AM Marginal Congestion, PM Congestion, and PM Marginal Congestion. For the purposed of this study, Congestion is a more severe condition than Marginal Congestion.

As shown in **Tables 4, 5, 6 and 7,** the Congestion categories can occur in any combination of Congestion/Marginal Congestion with respect to AM/PM travel periods. Following this logic, the worst possible situation for a bottleneck segment is Congestion occurring in both the AM and PM timeframes, shown in **Table 4**, which amounts to significant congestion experienced throughout the entire day along the segment.

No segments in the study area exhibited both AM and PM Congestion (congested all day).The lowest performing segment in the study area, Fort Argyle Road from Sweetwater Station Drive to King George Blvd, showed AM Congestion with PM Marginal Congestion. The second lowest performing segment, US 80 between Dean Forest Rd and Griffin Ave, showed both AM and PM Marginal Congestion (Marginally Congested all day).

Table 4 – AM Congestion with PM Marginal Congestion

Rank	Segment Name	Level of Service (Worst-Case Daily)	Notes
1	Fort Argyle Rd/Abercorn St	“F” for both Eastbound and Westbound Segments	From Sweetwater Station Drive to King George Blvd. This is the only facility showing AM Congestion and PM Marginal Congestion in the study area.

To provide a simple bottleneck severity ranking, segments analyzed considered AM/PM congestion and marginal congestion characteristics, and were grouped into the general rankings shown in **Table 5** below:

Table 5 – AM and PM Marginal Congestion

Rank	Segment Name	Level of Service (Worst-Case Daily)	Notes
1	US 80	“D” for Eastbound and “E” for Westbound	From Dean Forest Rd to Griffin Ave. This is the only facility showing AM and PM Marginal congestion in the study area.

Table 6 – AM Congestion

Rank	Segment Name	Level of Service (Worst-Case Daily)	Notes
1	Diamond Cswy	"F" for Northbound and "D" for Southbound	From Ferguson Ave to Pin Point Ave
2	Ferguson Ave	None Available	From Pin Point Ave to Diamond Cswy
3	Fort Argyle Rd	"F" for Eastbound and Westbound	From Ford Ave to Sweetwater Station Drive
4	I-16 Eastbound	"F" and "E" for Eastbound Segments	12 Segments included; From Pooler Parkway to I-95
5	I-16 Eastbound Ramp	"F" and "E" for Eastbound Segment	Ramp to Eastbound I-16 at Dean Forest Road

Table 7 – PM Congestion

Rank	Segment Name	Level of Service (Worst-Case Daily)	Notes
1	Abercorn St	"E" Eastbound and Westbound	From Janet Dr to East DeRenne Ave
2	Augusta Rd	"F" Northbound and Southbound	From Hendley Rd to I-95 NB Onramp
3	I-95 Off ramp	"A" and "B" for ramp segments	At Exit #109 to Augusta Rd
4	Ogeechee Rd	"D" and "F" for Eastbound and Westbound segments	Chatham Parkway to Red Gate Farms Rd
5	Waters Drive	"E" for Northbound and "C" for Southbound	From Althea Pkwy to E De Renne Ave

3.3.1 Additional Locations from Freight Advisory Committee Meeting #1

At the first Freight Advisory Committee (FAC) Meeting in May 2014, the meeting participants were shown the Bottleneck map as illustrated in **Figure 4** and asked to comment if this map was accurate and what other segments with congestion should be added as potential bottleneck locations for freight movements. The participants identified the following additional locations for consideration.

Table 8 – Freight Advisory Committee (FAC) Identified Bottleneck Locations

Location	FAC Comments
SR 307 to I-16	Main Port Authority Route
SR 307 to SR 21 to Jimmy DeLoach Pkwy to I-95	Main Port Authority Route
Brampton Road route to I-516	Main Port Authority Route
US 17 through Richmond Hill	
I-516 Corridor	Obsolete Design Standards
Pooler Pkwy/Airways Ave @ I-95	Potential Outlet Mall Development Mix between retail and freight traffic near Gulfstream Road Signal timing issue along Service Road (I-95 is city boundary for signal ownership)

4. NEXT STEPS

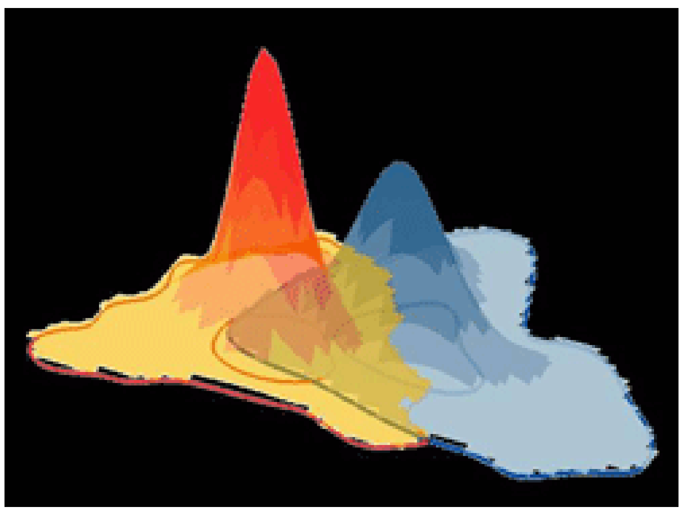
The final results and input from **Task 2.5** will help to identify and assess the needs in **Task 2.6**, ultimately feeding into the plan recommendations. The Freight Advisory Committee input will continue to be incorporated into the CORE MPO Freight Transportation Plan process, as an integral part of the development of the region's freight strategy.

APPENDIX A

KDE TOOL FUNCTION

For each input crash point involved in the KDE visualization, the KDE tool will overlay or drape a curve with a circular radius equal to the user defined radius, with the crash's unit value at its center, reducing in value towards the edge of the curve. The reduction in value follows the shape of the estimated probability density function (the curve). For each raster cell, the KDE tool will calculate the sum of all overlapping curves, summating the crash value contributions of each curve and recording the result into the raster cell. Because of this behavior, the KDE tool or KDE estimators as a whole, are sensitive to the selection of search radius. As an example, consider the following

- The search radius is 1 mile.
- a single fatality crash point may contribute '50 crash units' to a raster cell total at 'ground-zero,' but would only contribute maybe '20 crash units' to the total for that cell at a distance of 0.5 miles. The contribution of point locations to cell-by-cell totals is reduced with increasing distance from the point, with the reduction following the slope of the estimated probability density function.



If we imagine these two shapes as a 'Fatality Point' in red, and an 'Injury Point' in blue, we can see that the shapes' height, or contribution of 'Crash Units,' to underlying raster cells decreases as you move away from the crash point locations. If a raster cell were located at the overlap between these two shapes, it may receive 3.25 'crash units' from the blue crash and 15.50 'crash units' from the red crash, totaling 18.75 crash units recorded at the raster cell due to the overlap.