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Improving the Interstate Highway System

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Improving the Interstate Highway System

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Abstract

The Interstate Highway System is the primary transportation network of the United States. The Interstate Highway System has succeeded and failed in certain ways in connecting the United States. It is important that new interstate highways are added so that the United States will be better connected. Several criteria are involved in placing new interstates. New interstates should follow the grid pattern of the existing interstates, with one end of the interstate in between existing interstates so that the interstate starts/ends west of one interstate and east of another (odd-numbered), or north of one interstate and south of another (even-numbered). Population of unconnected county seats, existing roads, and the elevation of unconnected county seats determine where new proposed interstates are placed. This project uses ArcGIS Pro, Google Maps, and Google Earth to map the findings and to create a better linked United States so that people are connected more efficiently. The results may be used in such a way that the USDOT or state departments of transportation can plan for the future.

Keywords: interstate highway system, connecting United States, criteria involved, planning

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Introduction

The Interstate Highway System is the system of interstate freeways that connect the majority of the United States. Built by an act of President Eisenhower in 1956, the Interstate Highway System (IHS) sought to improve roads connecting the country. There have been previous attempts to connect the United States with a faster means of transportation. The earliest attempt to connect the United States involved the first federally-funded road, The National Road. Built between 1811 and 1834, from a congressional act in 1806, the National Road was mostly used by Conestoga wagons. The National Road connects Cumberland, Maryland and the Ohio River (Longfellow, 2017). After the National Road, canals and railroads, followed by the discovery of oil at the Drake Well in Pennsylvania, helped the United States enter the industrial age. The National Road is now closely followed by US 40, but I-70 and I-68 have replaced the purpose of US 40 from St. Louis, Missouri to Baltimore, Maryland.

In 1900, sixty percent of people lived in rural areas. Cyclists, who wanted to take away control from railroad monopolies and return power to farmers, initiated the Good Roads Movement to improve the condition of the roads (Boarnet, 2014). In 1903, Henry Ford put the automobile on the market creating the need for new roads, with only about twelve percent of roads being paved (Blas, 2010). The Lincoln Highway (replaced by multiple US highways, such as US 30 and US 50) was another project built early in 1913, as the first national highway planning effort (Boarnet, 2014). Later, lobbyists urged government officials to create a better road system, so President Wilson signed the Federal Aid Road Highway Act (FARHA) in 1916 which created the Bureau of Public Roads (BPR) (Blas, 2010). FARHA allotted $75 million to form a highway department between the federal government and the state governments; With

inflation that equates to about $1.8 billion today (Blas, 2010), (Inflation Calculator, 2019). These roads would become state routes such as OH-8. In 1921, the Federal Aid Highway Act created the US Numbered Highways such as US 40 and the famous US 66. States were required to designate seven percent of their roads to be part of the federal aid highway system (Boarnet, 2014).

During the Great Depression, President Franklin Roosevelt urged congress to pass a bill creating a national highway system in 1938 (Weber, 2012). He wanted "'[A] special system of direct interregional highways, with all necessary connections through and around cities, designed to meet the requirements of the national defense and the needs of a growing peacetime traffic of longer range'" (Weingroff, 1996). However, President Roosevelt was unsuccessful and decided to work on a smaller project, the Pennsylvania Turnpike, also known as I-76. In 1950, President Truman led funds away from highway development in order to fund the Korean Conflict (Blas, 2010).

Later, President Eisenhower remembered travelling in an army convoy in 1919 that travelled five miles an hour and frequently broke down due to the quality of roads, impressing upon him the need to improve the highway system of the US (Blas, 2010). In 1956, President Eisenhower passed the National Defense and Interstate Highway Act (NDIHA), which allocated $25 billion to the project or with inflation, $232 billion today (Inflation Calculator, 2019). From 1956-1969, NDIHA created 41,000 miles of interstate highways (Boarnet, 2014). Routes were designated to pass through cities rather than going around them since more traffic was determined to enter the Central Business District (CBD), or the downtown financial center. Also, there was significant traffic moving away from the cities so bypass routes were created (Weber,

2017). Spurs and belts were added later based on different traffic patterns. City size played a part in how the interstate highways were designed. Small cities would be bypassed entirely, with local routes providing access in the form of a spur (Weber, 2017). Medium-sized cities have both interstates into downtown and interstates to bypass downtown (Weber, 2017). In larger-sized cities, multiple routes would either be used to bypass the city (on a beltway or circumferential route) or head into downtown on a main route (Weber, 2017). As population in the United States grew, new interstate highways needed to be added.

Nowadays, the interstate highways fall into a grid. Odd-numbered routes are North-South oriented with lower numbers in the West such as I-5 and higher numbers in the East such as I-95. Even-numbered routes are East-West oriented with lower numbers in the South such as I-10 and higher numbers in the North such as I-90. Most of these routes follow this pattern with a few exceptions. For example, I-45 from Houston to Dallas, has both of its endpoints west of I-29's endpoints. This will be kept in mind when designating proposed routes. Also, the three-number routes, also called Auxiliary Routes, relate to the parent route and can be designed in three ways. First, auxiliary routes that act as spurs such as I-277 in Akron, Ohio, start from the main highway and head towards another location away from the main highway or connect two different highways. Second, auxiliary routes that act like bypasses such as I-475 in Toledo, Ohio, start on the main interstate, bypass a major city, and reconnect to the main interstate. Third, belts such as I-270 in Columbus, Ohio, go around cities. Belts are designed to circumvent major cities, while bypasses are designed to provide an alternative route to avoid cities or access downtown depending on how the parent routes are designed. I-75 in Florida avoids the Tampa-Clearwater-St. Petersburg metropolitan area, but I-275 acts as a bypass into these areas,

then reconnects with I-75 north of the metro area. In essence, all belts are bypasses, but not all bypasses are belts. Nevertheless, these routes can offer access to smaller cities in a metropolitan area.

Research Question

Overall, the Interstate Highway System has an interesting backstory and has greatly influenced the development of the United States. The current network has accomplished the goal of interconnecting major cities in the US. However, the Interstate Highway System needs significant improvement, as many counties have been left out of the system entirely. In 2000, thirty-three metro areas were left off the current Interstate Highway System network, but San Angelo, Texas was the only metro area left off both the 1950 and 2000 network plan (Weber, 2017). San Angelo, Texas is now connected with the Ports-to-Plains High Priority Corridor. The US Numbered Highways could be an option to expand the Interstate Highway System. To the casual motorist, the US numbered highways have lost their relevance, such as US 50, formally the primary route west as part of the Lincoln Highway (Repp, 2017). US 50 still exists in central Nevada where there are no interstates and the towns that US 50 serves could exist as rest areas or points of interest along the interstate. US 50 could be a basis for having an interstate and would still exist as an alternate to the highway. In the more rural sections of US 50, the interstate would be an upgrade or an alternate route to US 50. An example of an already upgraded US numbered highway is US 66. US 66 used to be the main route from Chicago to Los Angeles, passing around the Rockies to the south. US 66 still exists in places, but has mostly been replaced by I-55, I-44, and I-40.

Therefore, the research question is: *How can the Interstate Highway System be improved so that more of the United States is connected through interstates than it is currently?* This can be accomplished through limiting areas based on three criteria, which are having the county with a population of 50,000 or more, the roads in the county seat city boundaries are primary, and the county seat is above 100 feet in elevation. There are unconnected county seats that do not meet all three criteria, so those places will not be used for the creation of new routes.

Methodology

In order to answer the research question, TIGER Census Data (Topologically Integrated Geographic Encoding and Referencing) of current interstates and highways was used to create a basis for where proposed interstates could connect to the current system. These new interstates are either already planned by the USDOT (United States Department of Transportation) or proposed by myself based on network analysis. Using ArcGIS Pro, an upgraded version of ArcMap 10.6, maps were created to assist in answering answer the research question. Three criteria were considered in making these maps: population, existing roads, and elevation due to propensity for flooding. The criteria is explained in further detail below. Also, an attribute table (which is a table of attributes in a feature class containing numeric (which includes whole numbers and numbers with decimals) or text-based data that a user inputs once an object is created) was created using the TIGER Census Data (2016 Tiger/Line Shapefiles Roads, 2016). A sampling of the Attribute Table of Roads is placed below in Table 1.

Table 1. Attribute Table of Interstates. (Tiger/Line Shapefiles Roads, 2016). Created in 2019.

FID	Shape	LINEARID	FULLNAME	RTTYP	MTFCC	Shape_Len
0	Polyline	1103662626368	I-75	M	S1100	0
1	Polyline	1103662626717	I-75	M	S1100	0
2	Polyline	1105056901124	I-405	I	S1100	0
3	Polyline	1105056901128	I-405	I	S1100	0
4	Polyline	1105056901162	I-70	I	S1100	0
5	Polyline	1105056901210	I-405	M	S1100	0
6	Polyline	1105063298812	I-385	U	S1100	0
7	Polyline	1105063298813	I-385	U	S1100	0
8	Polyline	1103970863393	I-29	I	S1100	0
9	Polyline	1105063298850	I-95	M	S1100	0
10	Polyline	1105643501443	I-278	M	S1100	0
11	Polyline	1105643501517	I-390	M	S1100	0
12	Polyline	1105640135939	I-85	I	S1100	0
13	Polyline	1105640135941	I-85	I	S1100	0
14	Polyline	1105640135946	I-85	I	S1100	0
15	Polyline	1105640135947	I-85	I	S1100	0
16	Polyline	1105642725632	I-93	I	S1100	0
17	Polyline	1105642725689	I-95	M	S1100	0

Based on Table 1, there are multiple attributes in this table. The table actually has 12,065 entries, but only a sampling of the attribute table is presented here. The table shows the FID (the actual feature number in order of creation), the shape (in this case polyline), LINEARID (which is generated upon creation), the name of the interstate, the type of road (I, M, U which is determined by TIGER), MTFCC (MAF/TIGER Feature Class Code), and the shape length, which was not calculated. By creating this table, it provided data on how many current interstate polylines were in the TIGER shapefile, which was around 12,000. The polylines covered the North/East, and South/West, as well as Express Lanes and High Occupancy Vehicle lanes for every current interstate.

Continuing on, Google Earth was used to provide the locations of the center of county seats, in the form of placemarks, which was saved as a kmz. These county seats were not currently connected to the Interstate Highway System or any high priority corridors that could become interstates when certain conditions were met required by FHWA (FHWA, Design 2019). ArcGIS Pro was used to convert the kml (the export file for Google Earth features) to a point feature layer (a layer of points in ArcGIS Pro) in which to do network analysis on the county seats. County seats were based on three criteria: population over 50,000, yellow roads on Google Maps (primary), and elevation on Google Earth above 100 feet. Originally there was a larger set of county seats that met criteria 2 and 3, but after the spatial join, the county seats were narrowed down to the counties. The network analysis, which used the network from ArcGIS online, ascertained the shortest route in driving distance to reach the county seats from cities that have a population of over 100,000 (one city per metro area such as Los Angeles which is the only city for the Los Angeles-Riverside-San Bernardino metro area). Also, the near tool, which determines a distance value from one location to another and returns that value once computation is complete, was used to find wilderness areas that were located in a 25 mile radius from a county seat that met all three criteria as noted above (Download National Data Sets, 2019).

Network analysis, which calculates the shortest route between two areas based on given factors such as facilities, incidents, line barriers, point barriers, and polygon barriers, was used in order to solve and create the proposed new routes. An example of network analysis is if someone was almost out of gas and they needed to find the nearest gas station from their current location. The gas station would be the facility at which the network analysis will start from and the incident is the vehicle itself. A barrier could be a traffic jam that would impact travel time

and distance to the gas station. The network analysis calculates a route around the traffic jam in order to get to the gas station from the vehicles starting point.

The routes used in the network analysis were the roads used by ArcGIS Online, which is the online service used by ArcGIS to determine the closest facility. This was based on driving distance from the facilities to the incidents. For this project, the network analysis facilities used were state capitals and major cities, such as Pittsburgh, Charlotte, and Dallas. One city per metro area was used (i.e., Dallas-Fort Worth Metro Area would only get Dallas). The cities that were used for network analysis had at least 100,000 people in 2017. The incidents were county seats and the wilderness areas acted as polygon barriers.

First Criteria

The first criteria for determining interstate placement was population of unconnected areas. The US Census Bureau Factfinder Table lists population from the 2010 Census and estimates from July 1, 2010-July 1, 2017 for each county/borough/parish (Alaska has boroughs/census areas and Louisiana has parishes) of every state. Ideally, for this project, every county seat in the Contiguous US will be connected, excluding Alaska and Hawaii. Approximately to date, 50 percent of the counties in the United States have not been connected to the Interstate Highway System (US Census Bureau, 2018). Several county seats have been planned for connection to the interstate highway system in the future (FHWA High Priority Corridors, 2018).

Continuing, many of the unconnected counties are fairly populous, such as Collin County, Texas. However, some unconnected counties have small populations such as Medina County, Texas. For this project, counties have a minimum of 50,000 people in order to be

considered for new proposed routes. Some of the counties have interstates within their boundaries, but some of the county seats are not connected with interstates. A county seat is considered connected to the interstate if the interstate lies within the city limits of the county seat. Counties that do not currently have interstates connecting to their county seat, including future high priority corridors (HPC), were mapped based on the most recent population estimate of June 2017 (US Census Bureau, 2018). The most populous counties were symbolized with darker colors and counties with a smaller population with lighter colors on the county seat map (US Census Bureau, 2018). The county seats were spatially joined (which combines two different feature layers into one based on a similar field in the attribute table) so that the population of the county and county seats were the same, in order to be mapped effectively in ArcPro. The map of county seats is further discussed in the Results section of this paper. The graph of Population by County is below.

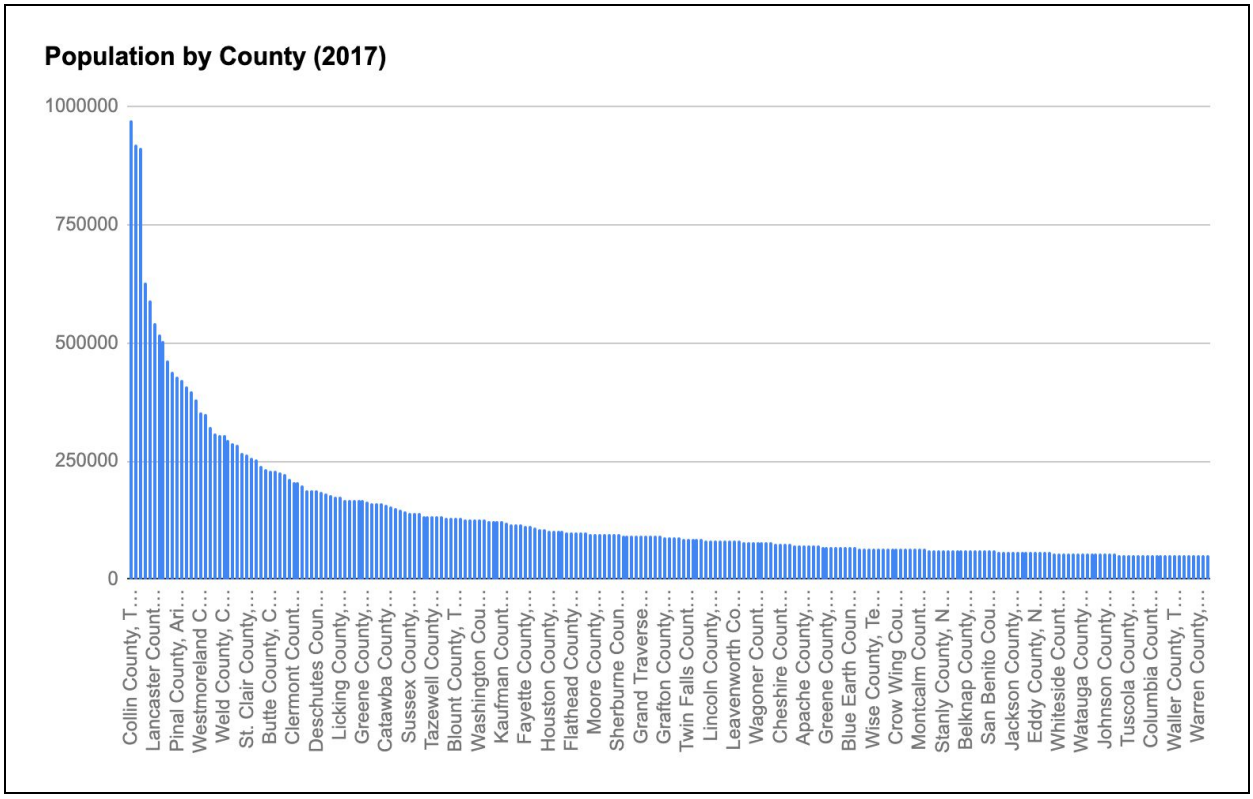

Figure 1. Graph of Population by County in 2017. Based on a spreadsheet from The US Census Bureau and American Fact Finder (2018).

Based on Figure 1, it is evident that the population of the counties is highly skewed towards the left, with only 96 counties having a population of 100,000 or more. Eight counties have a population of over 500,000. In order to effectively symbolize the county seat data, geometric interval, which calculates the interval based on a geometric progression such as 2, 4, 8, etc., was used. If the population had been evenly distributed, then a different way of symbolizing the data such as quantile or equal interval would have been more effective. Overall, there were 233 counties that met all three criteria in order to have their county seat(s) connected to the Interstate Highway System using Network Analysis.

Second Criteria

The second criteria for determining proposed interstate placement was previously existing roads of unconnected areas. These roads had to be either US numbered highways or state routes that already have portions of their entire length at interstate-standard (at least a two-lane, divided highway). For example, I-11 could be built as an upgrade to US 95 in Nevada, from Las Vegas to I-80 near Reno (FHWA High Priority Corridors, 2018). A high priority corridor is a road that could become an interstate when the criteria is met (FHWA, Design, 2019). Congress designates the routes as the high priority corridors. These areas will receive additional attention and may become interstates in the future when certain conditions are met. Previously existing roads were used as a basis for creating proposed interstates as upgrades instead of proposing all new routes.

Beginning with a list of counties not connected with current interstates or previously planned High Priority Corridors, Google Earth was used to plot county seats, which was saved as a kmz. Sometimes there are multiple county seats in a county and sometimes counties do not have county seat at all, as is the case with Virginia which uses independent cities as their county seats (County Seat, 2019) and (Counties in Virginia, 2019). The county seats were determined to have primary roads on Google Maps, within their city boundaries. Importing the kml into ArcGIS Pro, the points were converted into a layer. The population criteria was applied and only the counties that had a population over 50,000 were selected. Disregarding currently planned interstate highways, several numbers have not been used which are noted in Table 2 below.

Table 2. Unused Interstates. (FHWA, 2018).

Interstate Number	Orientation	General Placement
I-1	N-S	W of I-3
I-3	N-S	E of I-1, but W of I-5
I-6	E-W	N of I-4, but S of I-8
I-7	N-S	E of I-5, but W of I-9
I-9	N-S	E of I-7, but W of I-11
I-13	N-S	E of I-11, but W of I-15
I-18	E-W	N of I-16, but S of I-20
I-21	N-S	E of I-19, but W of I-23
I-23	N-S	E of I-21, but W of I-25
I-28	E-W	N of I-26, but S of I-30
I-31	N-S	E of I-29, but W of I-33
I-32	E-W	N of I-30, but S of I-34
I-33	N-S	E of I-31, but W of I-35
I-34	E-W	N of I-32, but S of I-36
I-36	E-W	N of I-34, but S of I-38
I-38	E-W	N of I-38, but S of I-40
I-42	E-W	N of I-40, but S of I-44
I-46	E-W	N of I-44, but S of I-48
I-47	N-S	E of I-45, but W of I-49
I-48	E-W	N of I-46, but S of I-50
I-50	E-W	N of I-48, but S of I-52
I-51	N-S	E of I-49, but W of I-53
I-52	E-W	N of I-50, but S of I-54

I-53	N-S	E of I-51, but W of I-55
I-54	E-W	N of I-52, but S of I-56
I-56	E-W	N of I-54, but S of I-58
I-58	E-W	N of I-56, but S of I-60
I-60	E-W	N of I-58, but S of I-62
I-61	N-S	E of I-59, but W of I-63
I-62	E-W	N of I-60, but S of I-64
I-63	N-S	E of I-61, but W of I-65
I-67	N-S	E of I-65, but W of I-69
I-92	E-W	N of I-90, but S of I-94
I-98	E-W	N of I-96, but S of I-100
I-100	E-W	N of I-98

Based on Table 2, any number larger than 100 would indicate an auxiliary route (spur, belt, or bypass) of any existing interstate or any of the new proposed routes to the Interstate Highway System, such as I-101. This would be an auxiliary route to I-1. This criteria will be expanded upon in later in this paper. In regards to current interstates, I-277 is an auxiliary route of I-77 that is a spur connecting I-77 and I-76 south of Akron, Ohio. All of the interstate numbers appearing in Table 2 were used when proposing new interstates based on the results of network analysis.

Third Criteria

The third criteria for determining interstate placement was the elevation of unconnected areas. For example, increasing sea level rise due to anthropogenic (human-caused) global climate

change causes the glaciers and ice caps to melt. This can cause increased flooding, increasingly powerful hurricanes, and storm surges. An affiliate of NOAA (North American Oceanic and Atmospheric Association), Climate.gov, states, "Higher 'background' water levels mean more deadly storm surges pushing inland, and more frequent 'nuisance flooding' will occur that is not necessarily dangerous, but costly and disruptive, as it is 300-900% more frequent than fifty years ago" (Linsey, 2018). Sea level rise could destroy some pre-existing infrastructure and could make building new interstates in low-lying coastal areas a waste of government resources. This includes proximity to areas vulnerable to storm surges which is likely to increase in strength and frequency throughout the upcoming decades.

Also, in terms of environmental factors, topography affects where proposed routes could be placed. Mountains are an important obstacle in deciding where an interstate could be routed. The interstate could circumvent the mountain or go right through it. For example, when building The Eisenhower Tunnel on I-70, it cost $490 million. The Eisenhower Tunnel was built at 11,000 feet above sea level through the moving of more than 500,000 cubic meters of hard rock in order to construct the tunnel (McDonald, 2018). Sometimes going through a mountain is just as costly as going around it, but there might not be any other options. Bridges and tunnels contribute to the additional cost of the interstate project. Some areas can be more susceptible to temperature and wind speeds. The Mackinac Bridge on I-75 in Michigan was designed for the cold temperatures and high wind speeds in the area. The bridge was built with the intention that it could sway eight meters in high wind conditions and had its foundation embedded 210 feet into the bedrock (McDonald, 2018).

Furthermore, avoiding environmentally-sensitive areas such as wilderness areas, which are areas or large tracts of public land maintained in their natural state and protected against intrusions such as roads and buildings, are important to keep in mind when determining interstate placement (Wilderness Areas, 2019). Wilderness areas can be parts of national parks, such as the Rocky Mountain Wilderness in Rocky Mountain National Park. Wilderness areas can also be separate areas, such as West Sister Island on Lake Erie in Ohio. In order to avoid ecological damage to these areas, the proposed interstates went around environmentally-sensitive areas.

Results

To answer the research question, *How can the Interstate Highway System be improved so that more of the United States is connected through interstates than it is currently?*, a substantial amount of maps were created using Geographic Information System tools and criteria as noted above. The first series of maps contain current interstates and planned high priority corridors. The second series of maps contain unconnected county seats. The third series of maps contain the results of network analysis. The fourth series of maps contain the new proposed interstates based on the network analysis results. Also, there are many regional maps included in the Appendix that aided in obtaining the research results.

Map of Current Interstates and Planned High Priority Corridors

All current interstates from TIGER (Topologically Integrated Geographic Encoding and Referencing) Census Data were mapped (Tiger/Line Shapefiles Roads, 2016). Some of these Congressional high priority corridors have been already designated as future interstates, while others have not (FHWA, 2018). The regional maps of Ohio, as well as Indiana and Michigan, show examples of the planned changes to the interstate highway system in terms of high priority

corridors, which are designated by Congress. When zoomed in to view the labels, the current interstates are marked with their I-Interstate number name, instead of the original name on the attribute table such as “so and so bridge.”

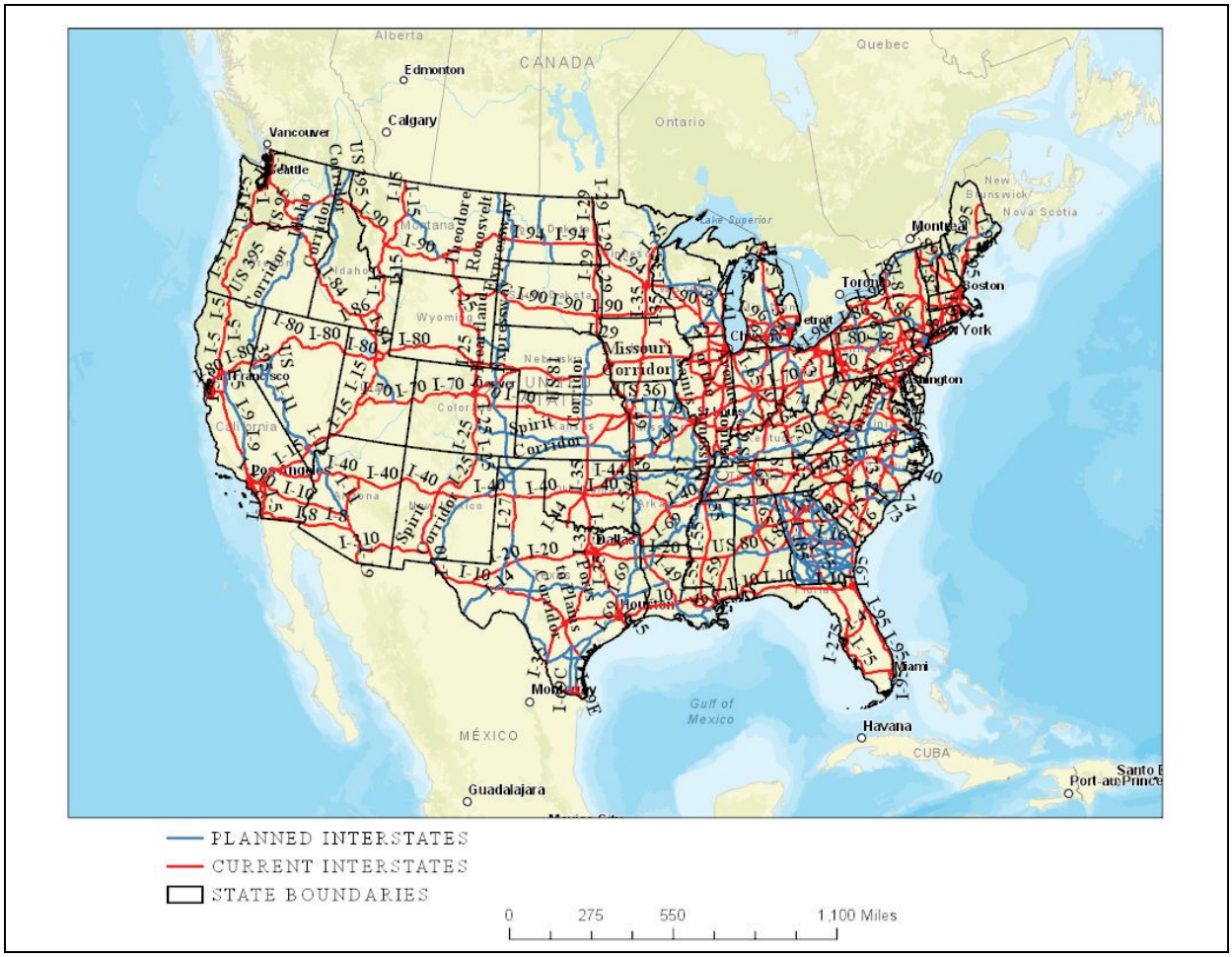

Figure 2. Current Interstates and Planned High Priority Corridors. (Tiger/Line Shapefiles Roads, 2016) and (FHWA, 2018).

The Current Interstates and Planned High Priority Corridors map was based on digitized routes from descriptions updated by FHWA in 2018 and the TIGER Primary Roads from 2016. The map shows where there currently are not as many interstates compared to areas with a large number of interstates. The Western United States, Northern Maine and parts of the South are not

covered by any interstates. Following the addition of planned high priority corridors, a large portion of Georgia and Missouri have the potential for new proposed interstate coverage.

The zoomed-in regional maps for Ohio, Indiana, and Michigan are placed below, labeled as Figures 3-6. The other regional maps needed to produce The Map of Current Interstates and Planned High Priority Corridors are provided in the Appendix (Figures 15-40).

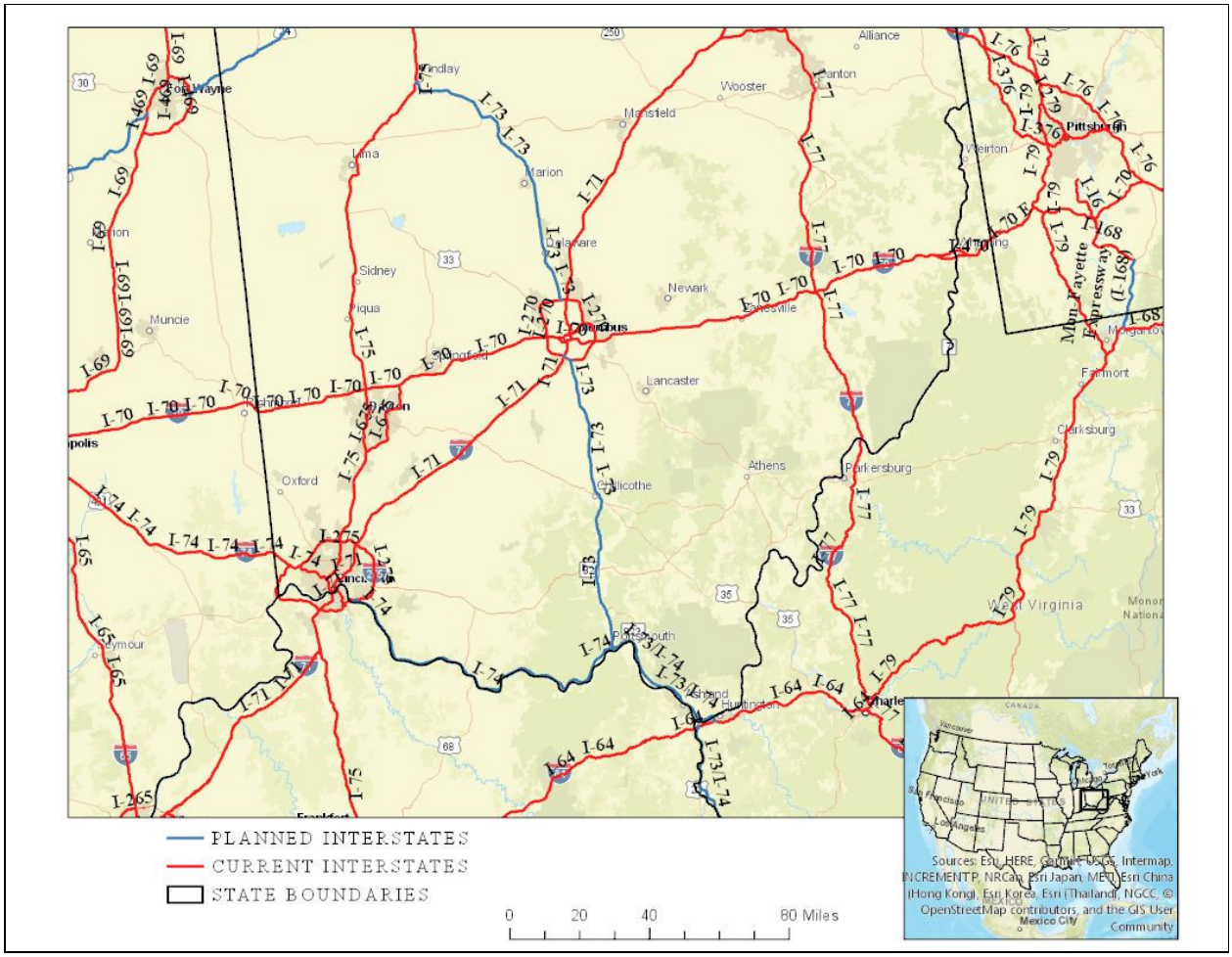

Figure 3. Map of Southern and Central Ohio with Interstates and Planned High Priority Corridors Marked. (Tiger/Line Shapefiles Roads, 2016) and (FHWA, 2018).

As noted by Figure 3, High Priority Corridor 5, which follows US 52 along the Ohio River towards Cincinnati (I-74) and US 23 towards Toledo (I-73) is very noticable. Both of the

portions of Corridor 3 are not currently designated as interstates by FHWA, but they could be designated as such once widening of US 52 and parts of US 23 are completed. At this time, there is not any further development of new interstates in Southern Ohio.

Figure 4. Map of NW Ohio, NE Indiana, and SW Michigan with Interstates and Planned High Priority Corridors Marked. (Tiger/Line Shapefiles Roads, 2016) and (FHWA, 2018).

As noted from Figure 4, there are three planned high priority corridors. High Priority Corridor 3 (I-73), as US 23 and a few other roads in Southern Michigan are designated as Corridor 3. Secondly, the Hoosier Heartland Corridor of US 24 connecting Central Indiana and

Toledo is also notable. Less noticeable is the Michigan-59 corridor from I-96 to I-94. All three of these high priority corridors currently do not meet the qualifications for becoming an interstate.

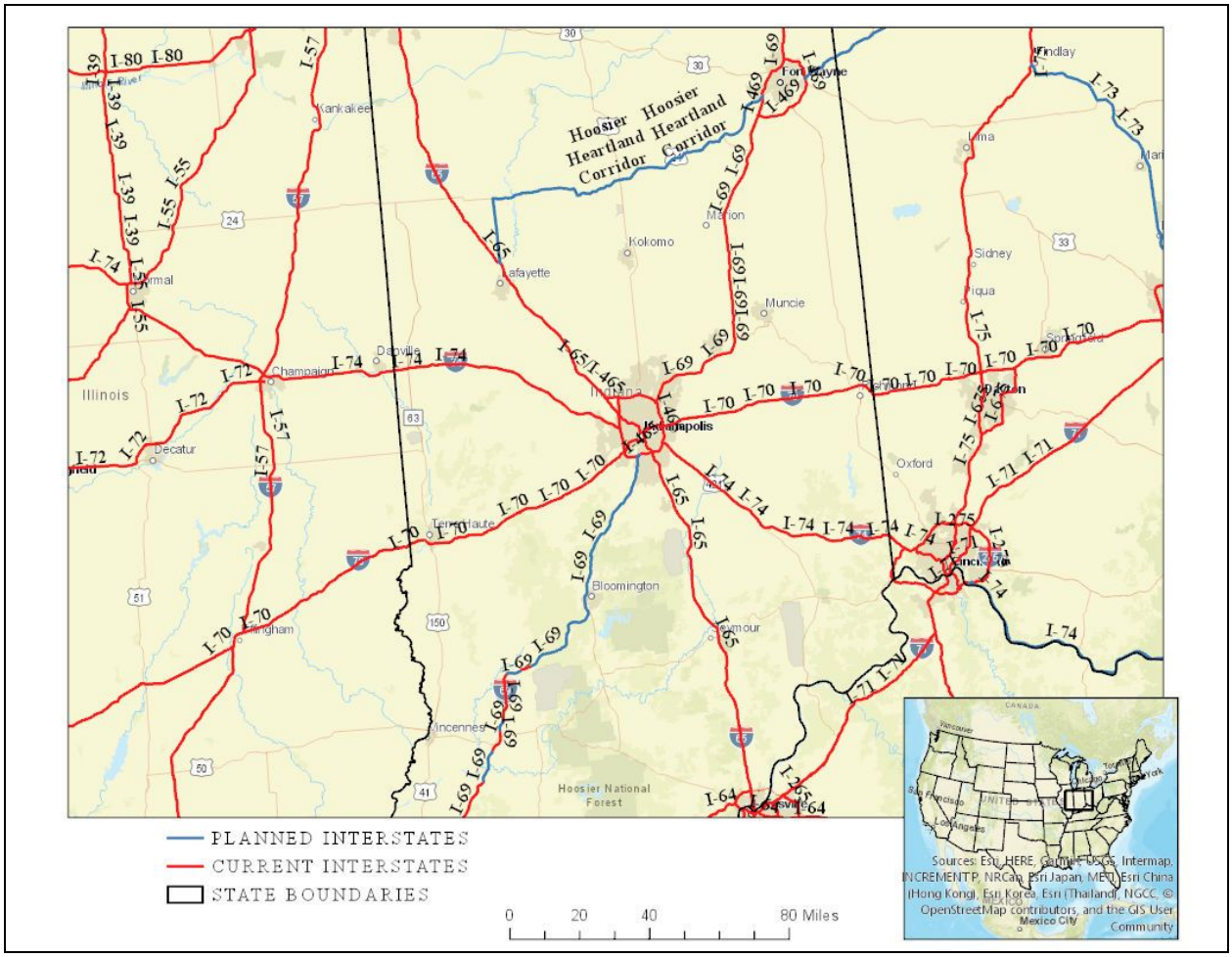

Figure 5. Map of Central Indiana with Interstates and Planned High Priority Corridors Marked. (Tiger/Line Shapefiles Roads, 2016) and (FHWA, 2018).

As noted from Figure 5, there are one-and-a-half planned high priority corridors in Central Indiana. First, the Hoosier Heartland Corridor from I-65 to Toledo using US 24 is notable. Secondly, the high priority corridor of I-69 is a half corridor, because I-69 (Corridor 18) is partially complete throughout the country, but mostly in Indiana and Michigan. I-69, once

completed, will start at the Mexican border near Brownsville, Texas and head to the Canadian Border northeast of Detroit, Michigan.

Figure 6. Map of Michigan with Planned High Priority Corridors and Interstates Marked. (Tiger/Line Shapefiles Roads, 2016) and (FHWA, 2018).

As noted by Figure 6, there is only one planned high priority corridor in Michigan. Corridor 5 (I-73) will parallel I-75 through North-Central Michigan and provide an interstate from Michigan State University in East Lansing to Central Michigan University in Mount Pleasant. Northwestern Michigan (lower peninsula) could use an interstate as there is not any current connection in the form of an interstate in that region.

Map of County Seats

The Map of County Seats consists of county seats that are not connected to the Interstate Highway System. The county seats were selected based on three criteria. First, the county population had to be at least 50,000. Second, the main roads, in the city boundary of the county seats, are primary roads which are yellow on Google Maps. Third, the county seats had to be above 100 feet of elevation due to problems with sea level rise that may occur in the future.

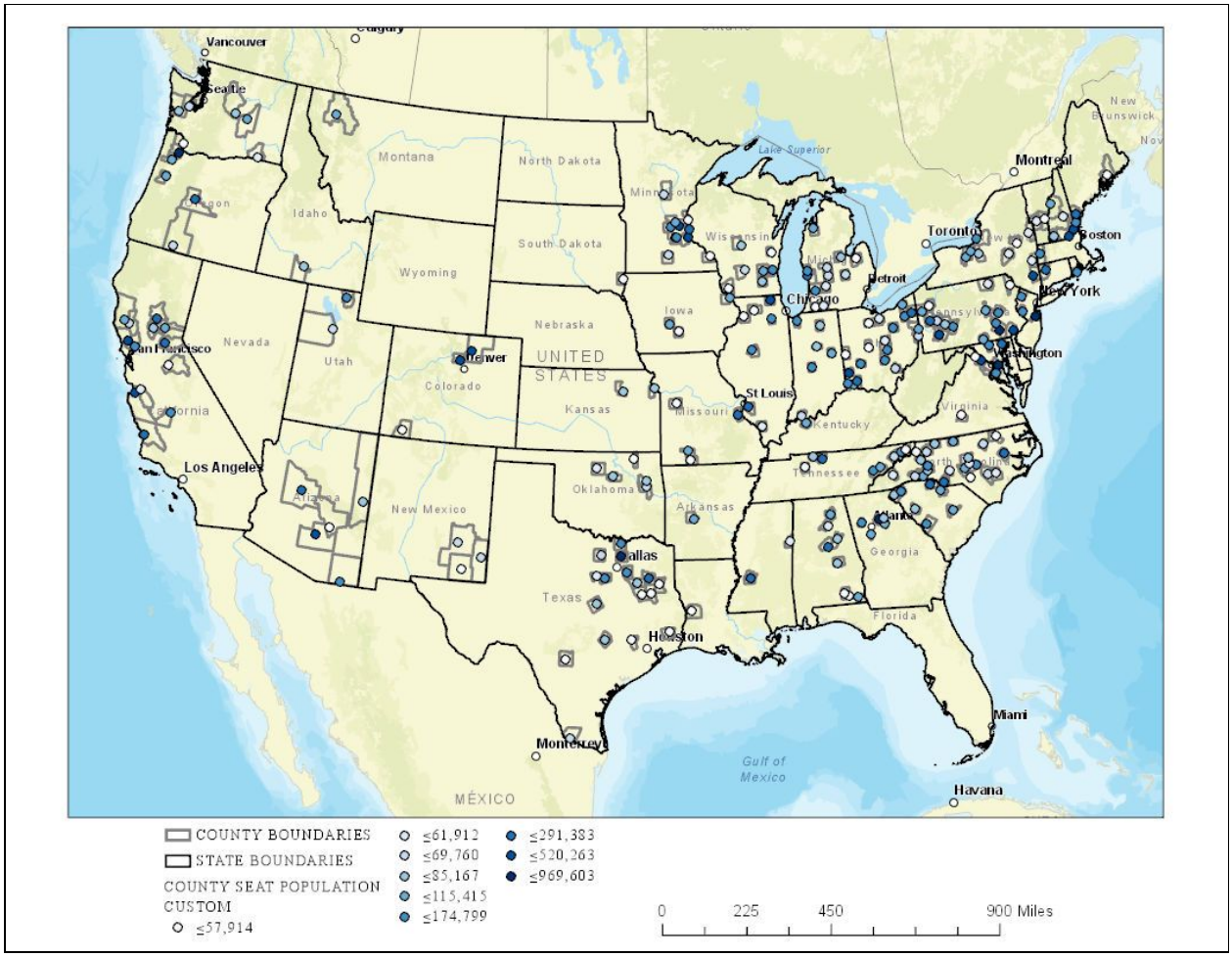

Figure 7. Map of County Seats Not Connected to the IHS. (US Census Bureau, 2018).

Based on Figure 7, there are significant clusters and significant dispersions of county seats throughout the United States. North Carolina, Ohio, Pennsylvania, California, Minnesota,

Michigan, and Texas have more than ten county seats that meet all three criteria. The regional maps of the county seats can be found in the Appendix (Figures 41-47).

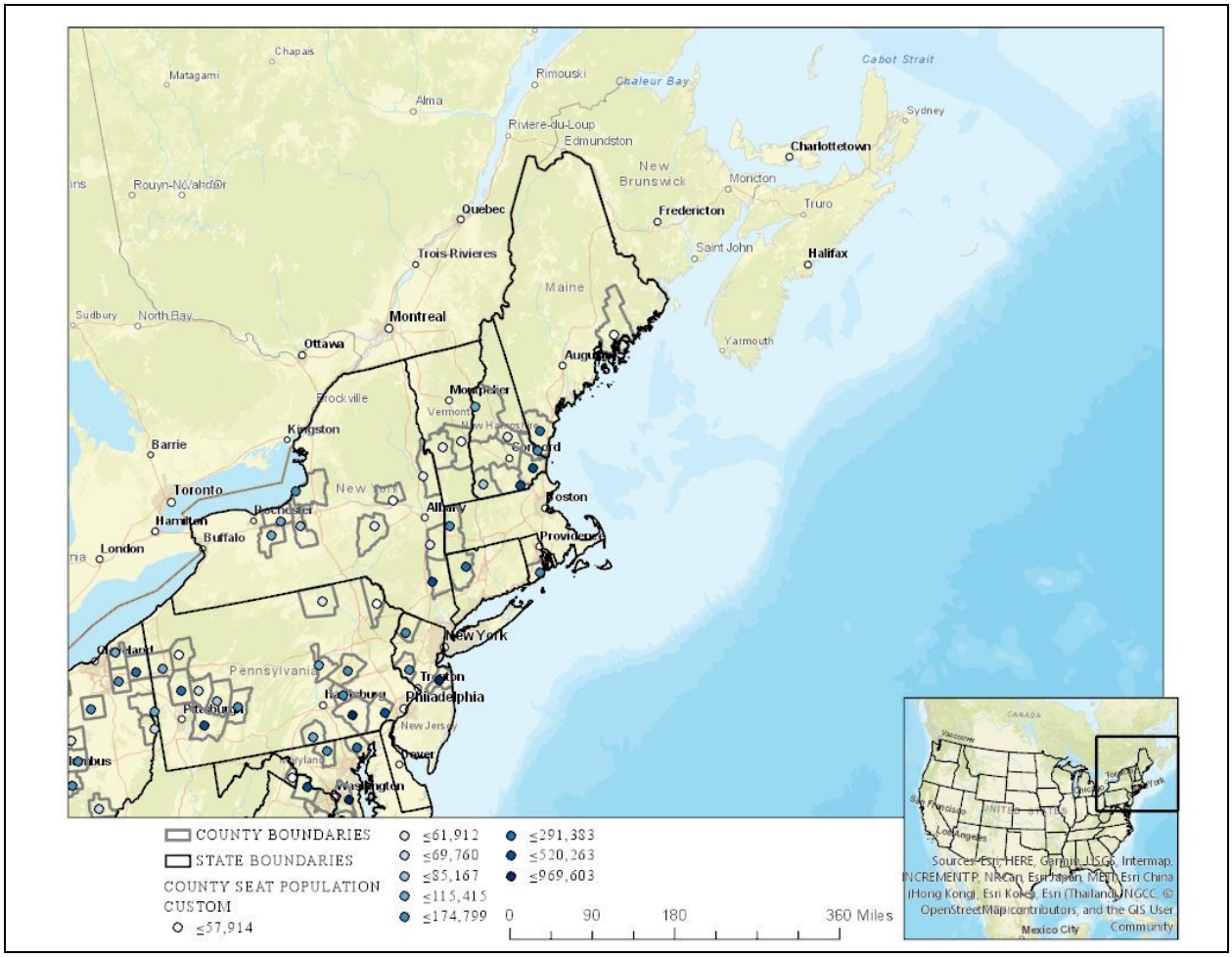

Figure 8. Map of County Seats in the Northeastern US. (US Census Bureau, 2018).

Based on Figure 8, the county seats that meet all three criteria are found mostly in Pennsylvania. Central Pennsylvania and upstate New York (near Watertown) are sparsely populated. The county seat in both Rhode Island and Northern Maine are just above the 100 foot elevation threshold. County seats in Pennsylvania are located around Pittsburgh and Philadelphia, with a few exceptions in the northeast portion of the state.

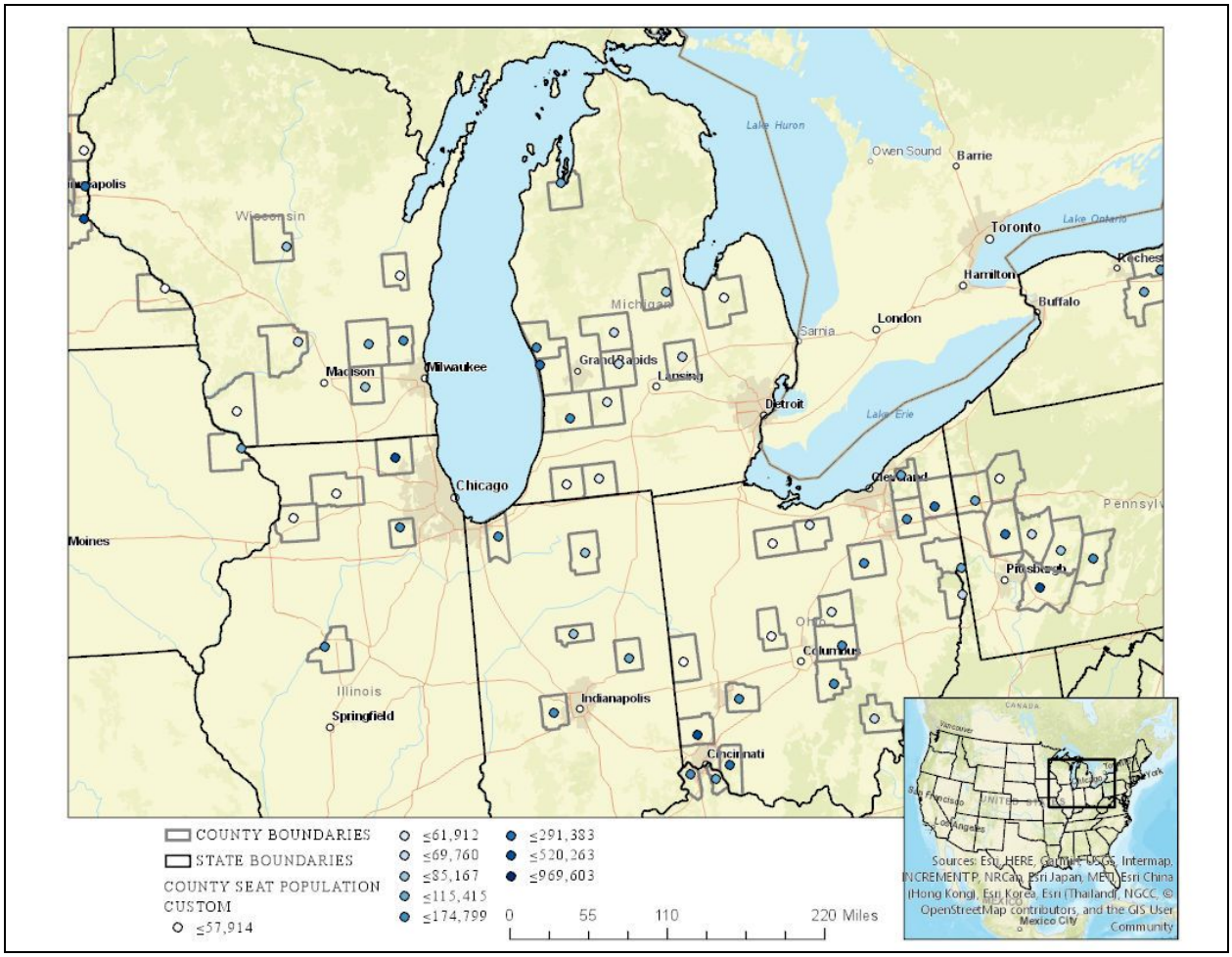

Figure 9. Map of County Seats in the Great Lakes Region. (US Census Bureau, 2018).

Based on Figure 9, Ohio and Michigan both have a large number of county seats that meet all three criteria. Wisconsin and Indiana both have many county seats. Illinois only has five that are visible in this portion of the county seats map.

Map of Network Analysis Results

The Map of Network Analysis Results consists of routes to county seats that have been neglected by the FHWA based on population, pre-existing roads, elevation, and wilderness areas. Shown first is an overall map of the results from Network Analysis, followed by regional maps.

The regional maps that cover Ohio, Indiana, and Michigan are displayed below with a description. All other regional maps can be found in the Appendix (Figures 48-56).

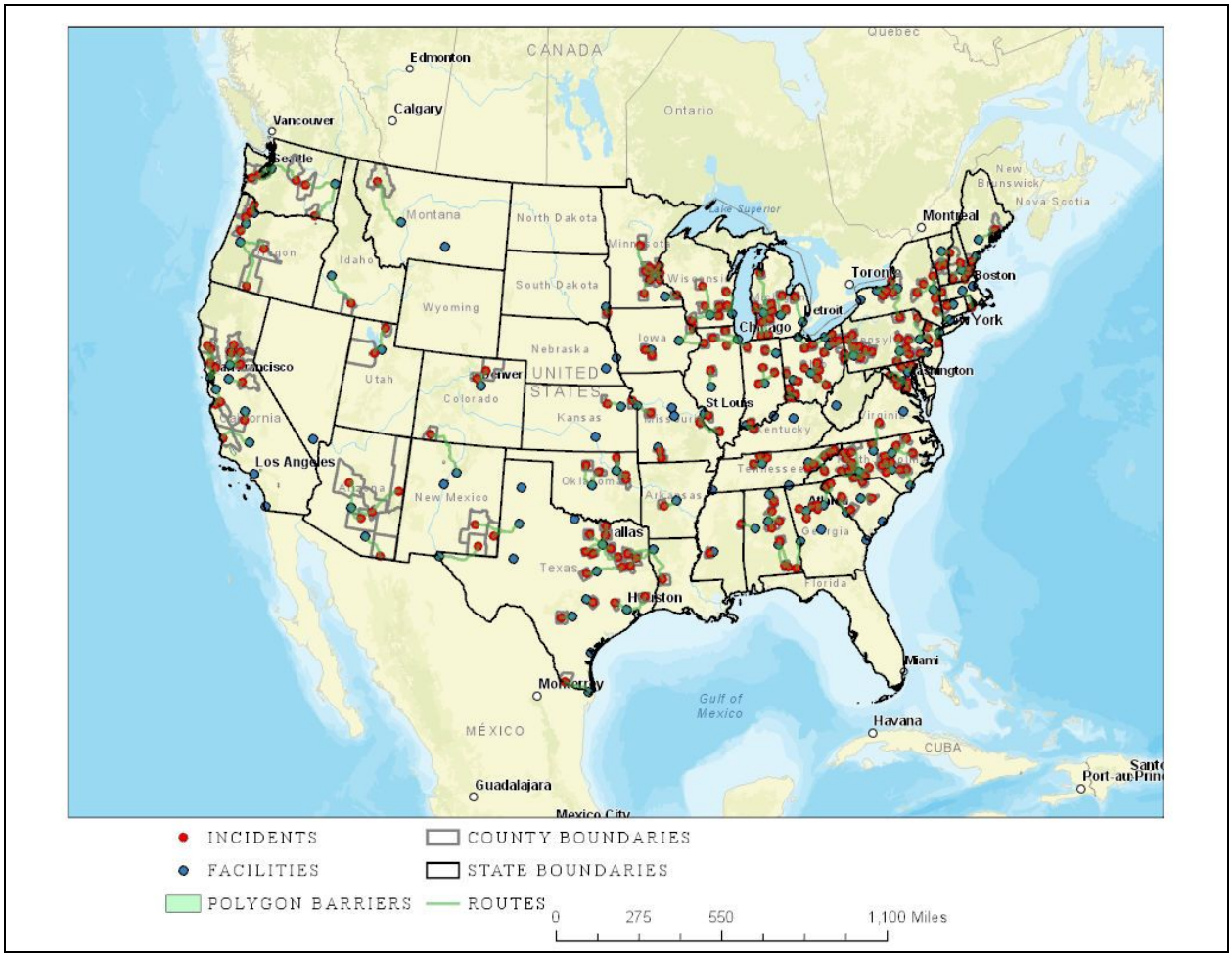

Figure 10. Results of Network Analysis using County Seats as Incidents and Certain Cities as Facilities, as well as Wilderness Areas as Polygon Barriers. (Chase A. Minor, 2019).

Based on Figure 10, there are several cities near unconnected county seats. A few cities, such as Los Angeles and Las Vegas are not used in the network analysis, since there are not any connections to county seats that are close enough to these cities. Most of the county seats are in the Great Lakes, East Coast, Southeast, Texas, California, and the Pacific Northwest regions.

The Rockies and the Northern Prairie are not used in the network analysis as much as the previously identified regions due to the lower population in those regions.

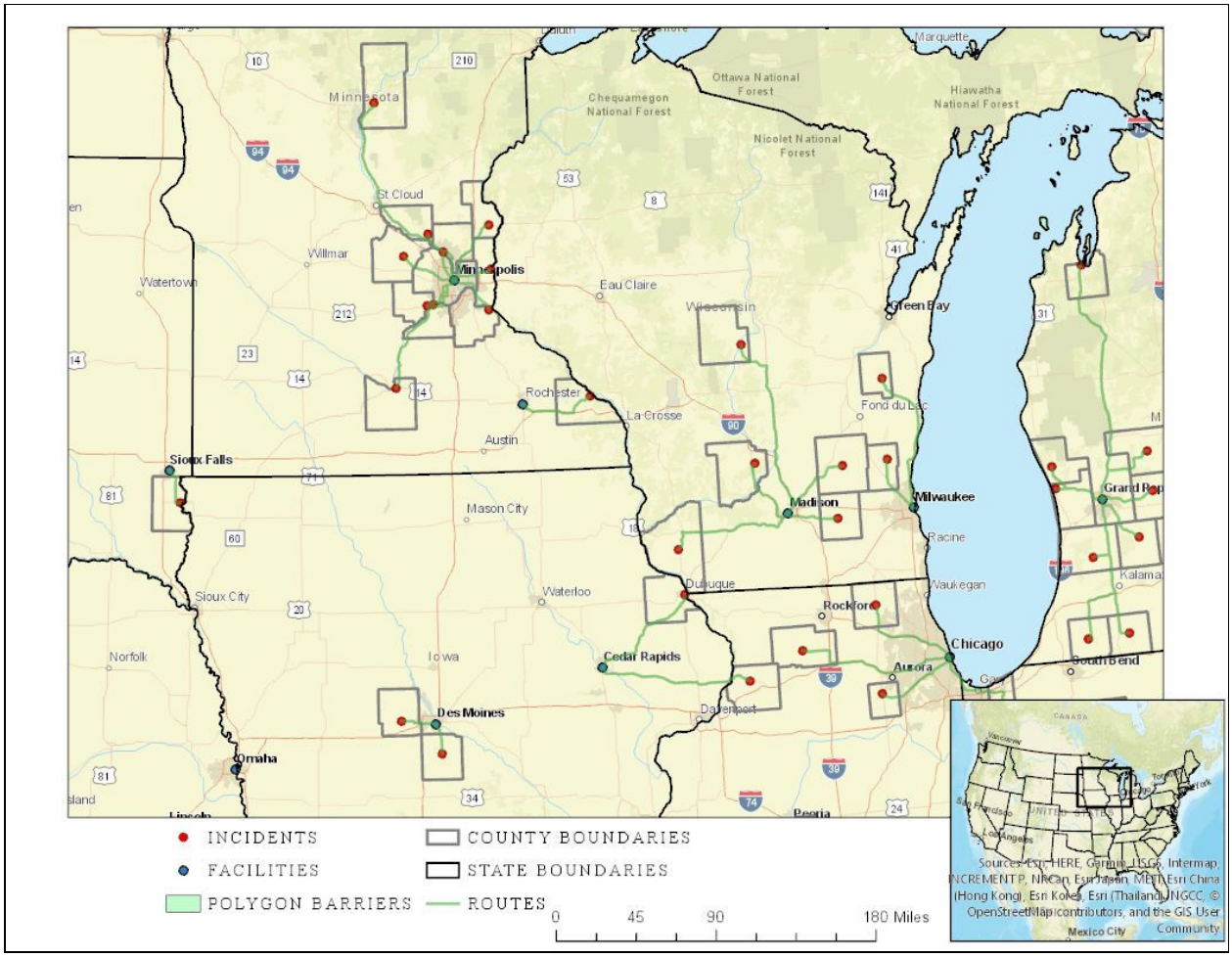

Figure 11. Results of Network Analysis in The Old Northwest. (Chase A. Minor, 2019).

Based on Figure 11, Minneapolis is connected to many county seats by the network. Grand Rapids and Madison have a few nearby county seats. Milwaukee and Lansing have two county seats, while Rochester only has one.

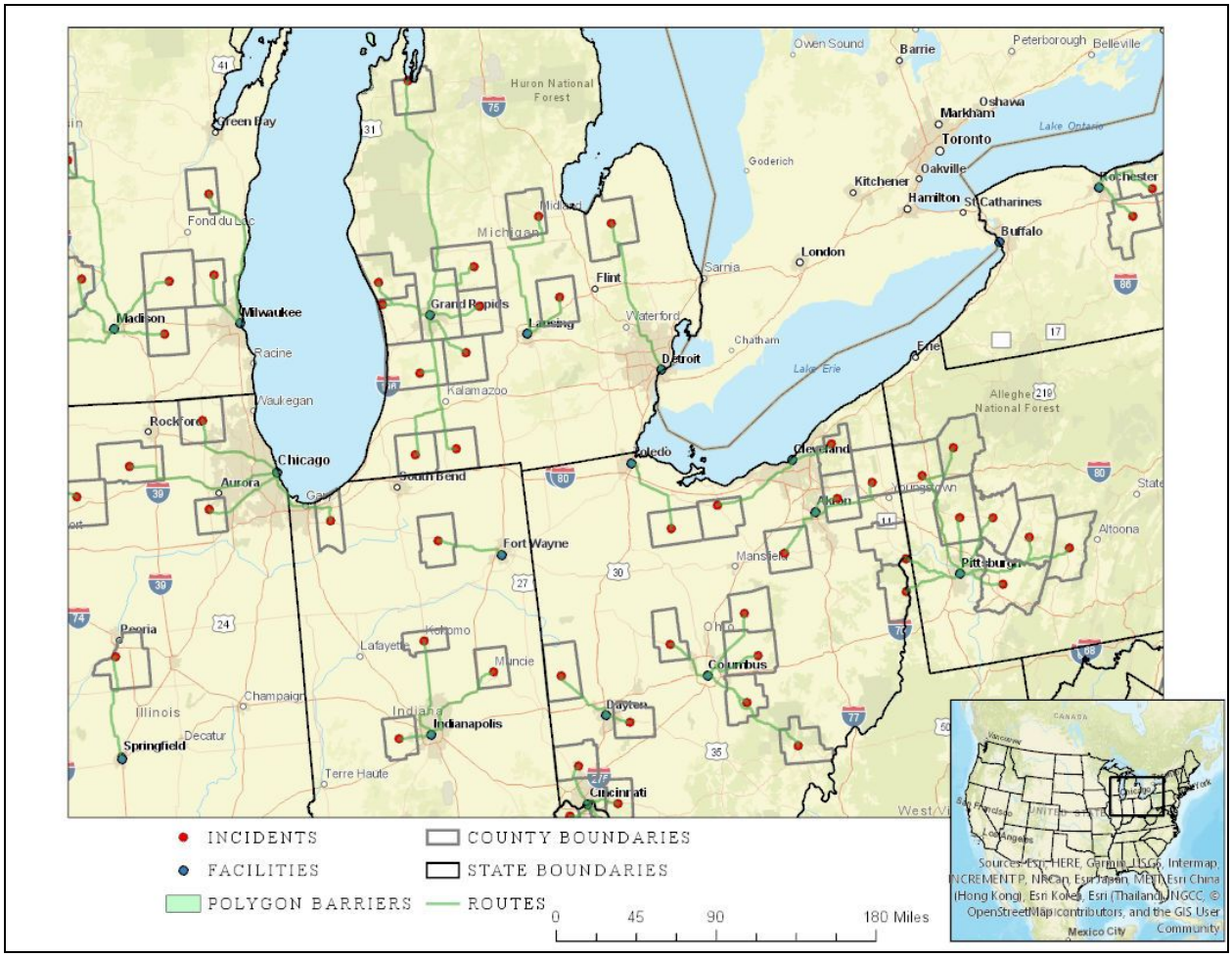

Figure 12. Map of Network Analysis Results in Great Lakes Region. (Chase A. Minor, 2019).

Based on Figure 12, Grand Rapids, Michigan, Columbus, Ohio, and Pittsburgh, Pennsylvania are connected to the most incidents. A few cities such as Lexington, Charleston, and Louisville are not used by the network. Some other cities have one or two county seats connected by the network.

Map of Proposed Interstates, Current Interstates, and Planned High Priority Corridors

The Map of Proposed Interstates, Current Interstates, and Planned High Priority Corridors contains an overall map of the new routes along with the planned interstates/HPC's

and the current interstates. Again, more regional maps can be found in the Appendix (Figures 57-70). The new proposed interstates are based on the results of Network Analysis, with some of the routes being traced, or digitized into a polyline feature class, from the results of the Network Analysis. Other proposed interstates could start at the current interstates and head to the county seats.

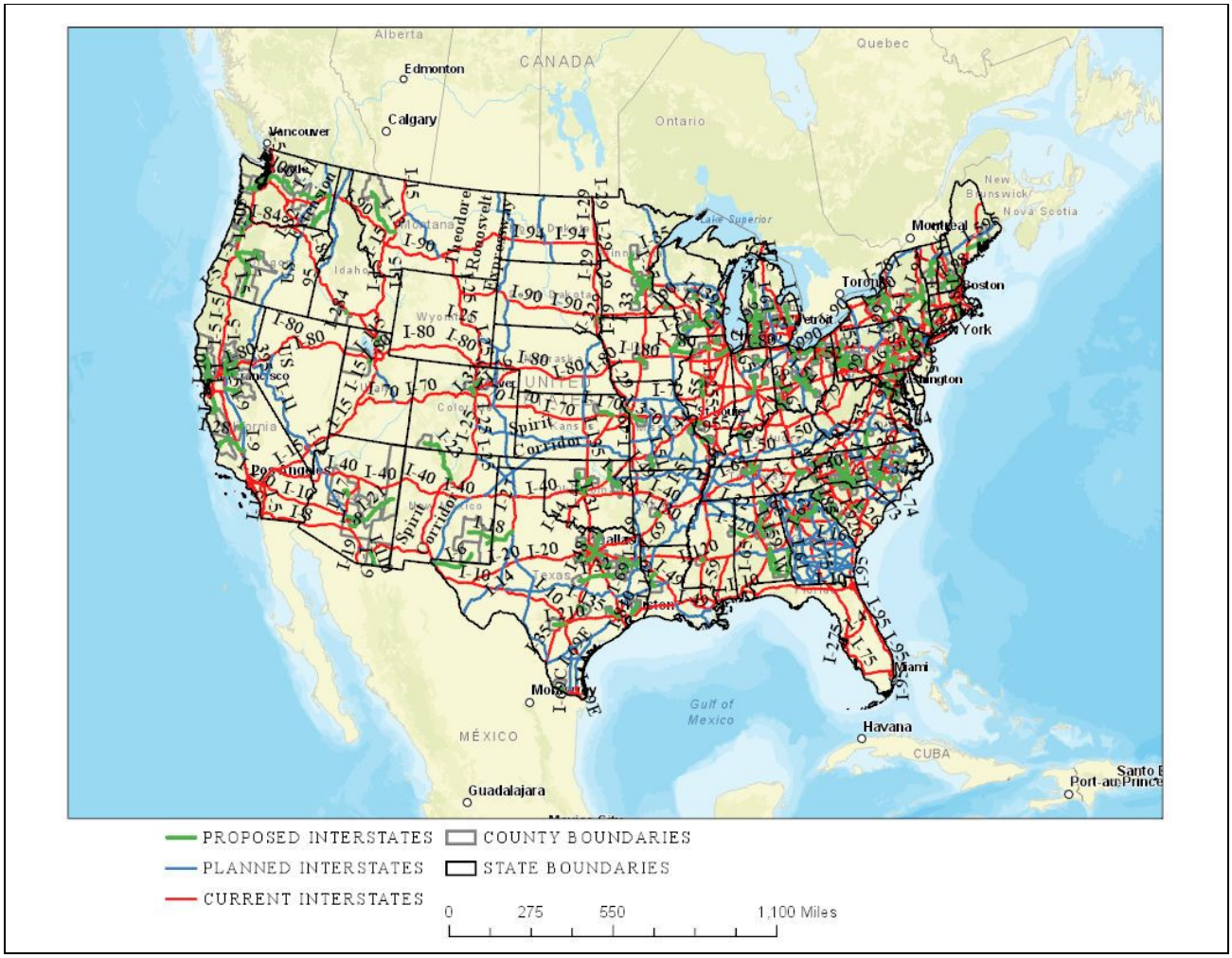

Figure 13. Overall New Proposed Interstates in the United States. (Tiger/Line Shapefiles Roads, 2016), (FHWA, 2018), and (Chase A. Minor, 2019).

Based on Figure 13, many routes suggested by the Network Analysis were used, but some were not. A few of the routes follow current interstates. Some of the routes were spurs to

the new proposed interstates that were created based on the results of network analysis. Below is an example of the new proposed interstates created for Ohio.

Figure 14. Map of Great Lakes Region with Proposed New Interstates, Current Interstates, and Planned High Priority Corridors. (Tiger/Line Shapefiles Roads, 2016), (FHWA, 2018), and (Chase A. Minor, 2019).

Based on Figure 14, there will be several new proposed interstates in the Great Lakes Region. There will be many routes around Pittsburgh, Columbus, and Cincinnati. Cleveland and Indianapolis will have a few new proposed interstates. There are not any areas where there is little interstate coverage.

Conclusions

Based on my findings, it is possible to connect all the county seats to the Interstate Highway System that meet certain criteria, such as having a population of 50,000 or more, connecting roads, and an elevation above 100 feet are added to the interstate highway system through the use of Network Analysis. For the reproducibility of the Network Analysis, different criteria can be used to determine where new routes could be proposed for placement. Any proposed route added to the Interstate Highway System must meet the requirements of FHWA and be at least two lanes in either direction with a median between each direction.

First, using a population of more than 50,000 as a criteria does have its limits, as several states are essentially eliminated from having any new connections as the counties are not populous enough. This number was chosen to limit the amount of county seats used for Network Analysis purposes but could be modified for future planning. For example, Pierre, South Dakota is the least populous capital city with a population of less than 14,000 (DADS, 2018). Wyoming, Nebraska, and North Dakota are all eliminated from having any new proposed routes due to low population. Kansas, West Virginia, Montana, Idaho, Mississippi, Arkansas, and Utah are all virtually eliminated by having only one or two county seats that meet the population criteria. Sparsely populated areas of the United States such as Northern Maine, the Appalachians, the Prairie region (both Dakotas, Nebraska, and Kansas), and the Western United States, are not used as much by the Interstate Highway System.

Also, using the current interstates as a basis for the proposed interstate routes is important to the overall connectivity of the United States. There are multiple instances of the same main interstate in different portions of the country, such as there are two I-76's, two I-84's two I-86's,

and two I-87's, that have no relation between the two interstates. Also, I-45 is completely west of I-29, as well as I-37 is completely west of I-45. This does not follow the current network's grid pattern. An attempt to follow the basic rules set by FHWA was demonstrated when designating the new proposed interstates for this project.

Continuing on, the 100 foot elevation criteria is a precaution, which was determined based on a city's elevation on Google Earth. It will be several years before the effects of sea level rise will be felt on the coastal regions of the United States, therefore, perhaps a current elevation of 50 feet would be safe for now. This would add several cities along the coasts to the proposed interstate routes. Changing what areas to avoid, such as national parks and wilderness areas, farther away from county seats, would most likely produce different results in the Network Analysis as well. This would also cause many other county seats to be connected to the Interstate Highway System.

Finally, it is extremely important to keep in mind the consequences of proposing new interstate routes. New proposed routes may cause gentrification and the displacement of people as homes may be destroyed in the process. There may be areas of the United States where building an interstate would not be possible due to high opposition of the people who live there. However, some people would like to see the FHWA take more interest in their cities so that potential road maintenance occurs. Others believe that it should be in the interest of the states themselves to want the FHWA to add a high priority corridor through certain areas. Also, construction in the new proposed areas must cause little to no ecological damage and the economic investment would have be reasonable. For example, US 33 connecting Columbus, Lancaster, Athens, and Marysville would be beneficial as a designated interstate. Starting in

Marysville, the interstate would use US 33 to I-270, then I-70, and head back on US 33 to reach Lancaster and Athens, as well as Logan (Figure 14). It is possible to connect numerous regions of the United States, especially since many of the roads that the new proposed interstates would replace, are already wide enough to be used as interstates. Bridges and tunnels would be necessary in certain regions, such as in I-28 from Bakersfield to San Luis Obispo and I-23 from Santa Fe to Durango, and the Appalachian Routes as well.

In closing, considerations of possible obstacles must also be given in order to accomplish the goal of increasing the overall connectivity of the US through the Interstate Highway System. Well thought out plans are a must. This project has determined that by using certain aspects of Geographic Information Systems (GIS) such as the near tool, selecting by attributes and creating a layer from the selected attributes, completing network analysis, tracing of the network analysis results, along with determining important criteria to limit where new interstates can be constructed, the Interstate Highway System can be improved so that more of the United States is connected through interstates than it is currently.

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Appendix

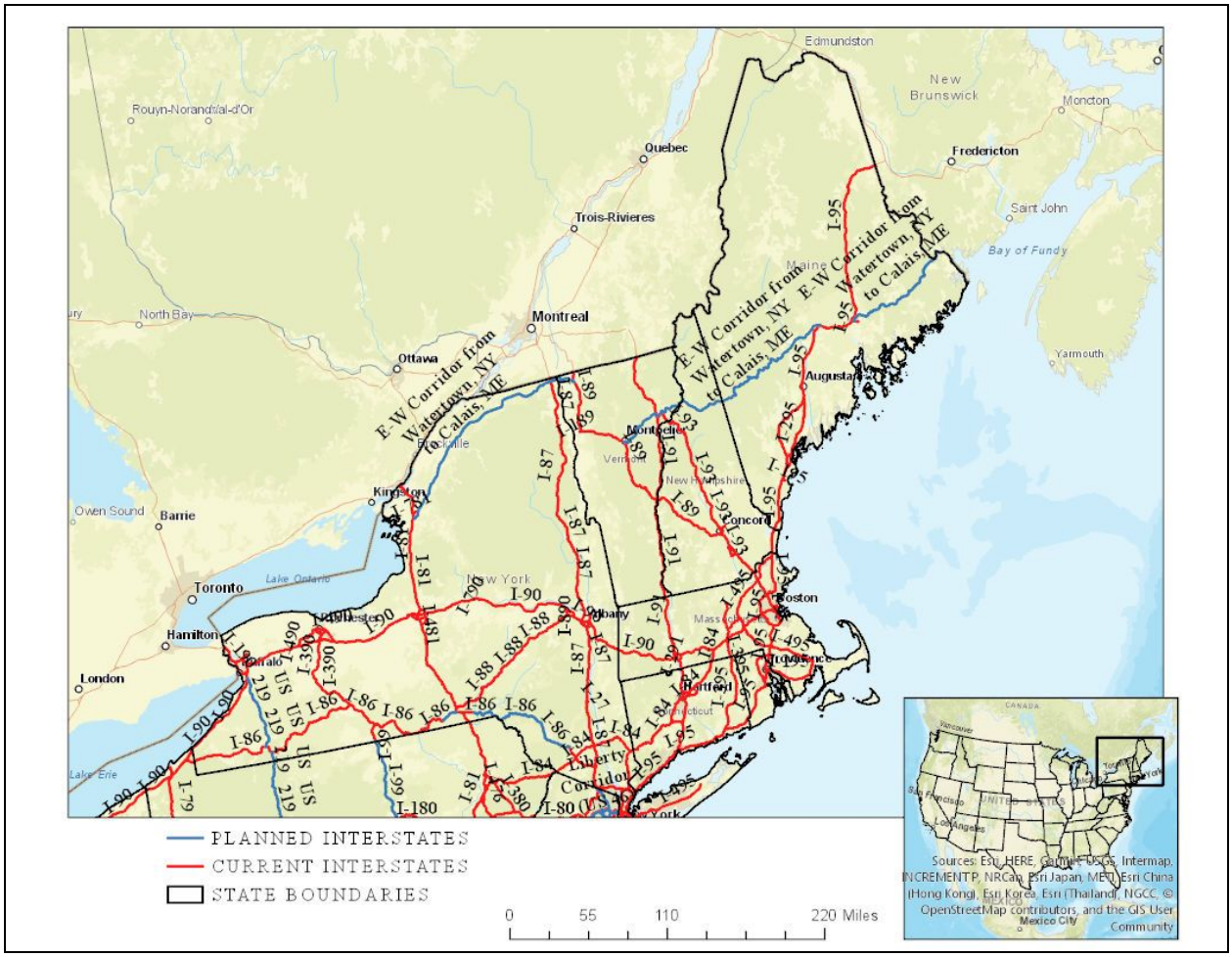

Figure 16. Map of the Northeast/New England with Interstates and Planned High Priority Corridors Marked.(Tiger/Line Shapefiles Roads, 2016) and (FHWA, 2018).

As noted by Figure 16, there are three new planned high priority corridors in this section of the country. First, the I-86 corridor from I-90 near Jamestown to I-87 NE of New York City is the longest route, is partially completed. Second, the I-99 corridor from Altoona, PA to I-86 near Painted Post, NY, is the second longest corridor in this region. Last, corridor 11, from Watertown, NY to the Canadian Border at Calais, ME is noteworthy; also the US 219 corridor

from Buffalo to I-80 can be seen in the lower left corner. The last two corridors are not yet designated interstates.

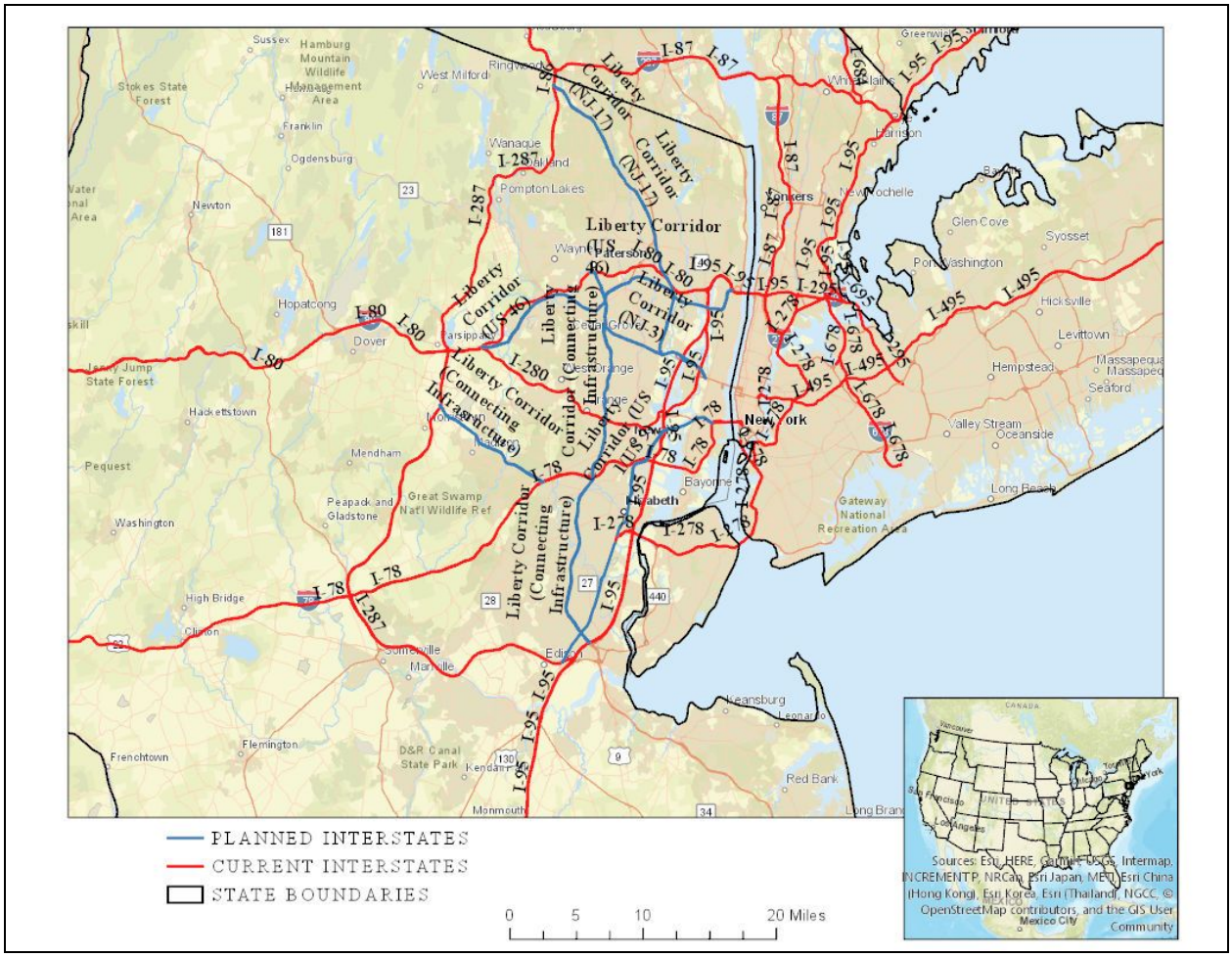

Figure 17. Map of NYC with Interstates and Planned High Priority Corridors Marked. (Tiger/Line Shapefiles Roads, 2016) and (FHWA, 2018).

As noted by Figure 17, there are several routes that all fall under the Liberty Corridor. The Liberty Corridor is designed to provide significant infrastructure to the NYC area and is broadly defined. The routes are designed to interconnect I-78, I-80, I-87, and I-95, but are not designated interstates themselves. The Garden State Parkway, US 1, US 9, and other routes make up the Liberty Corridor.

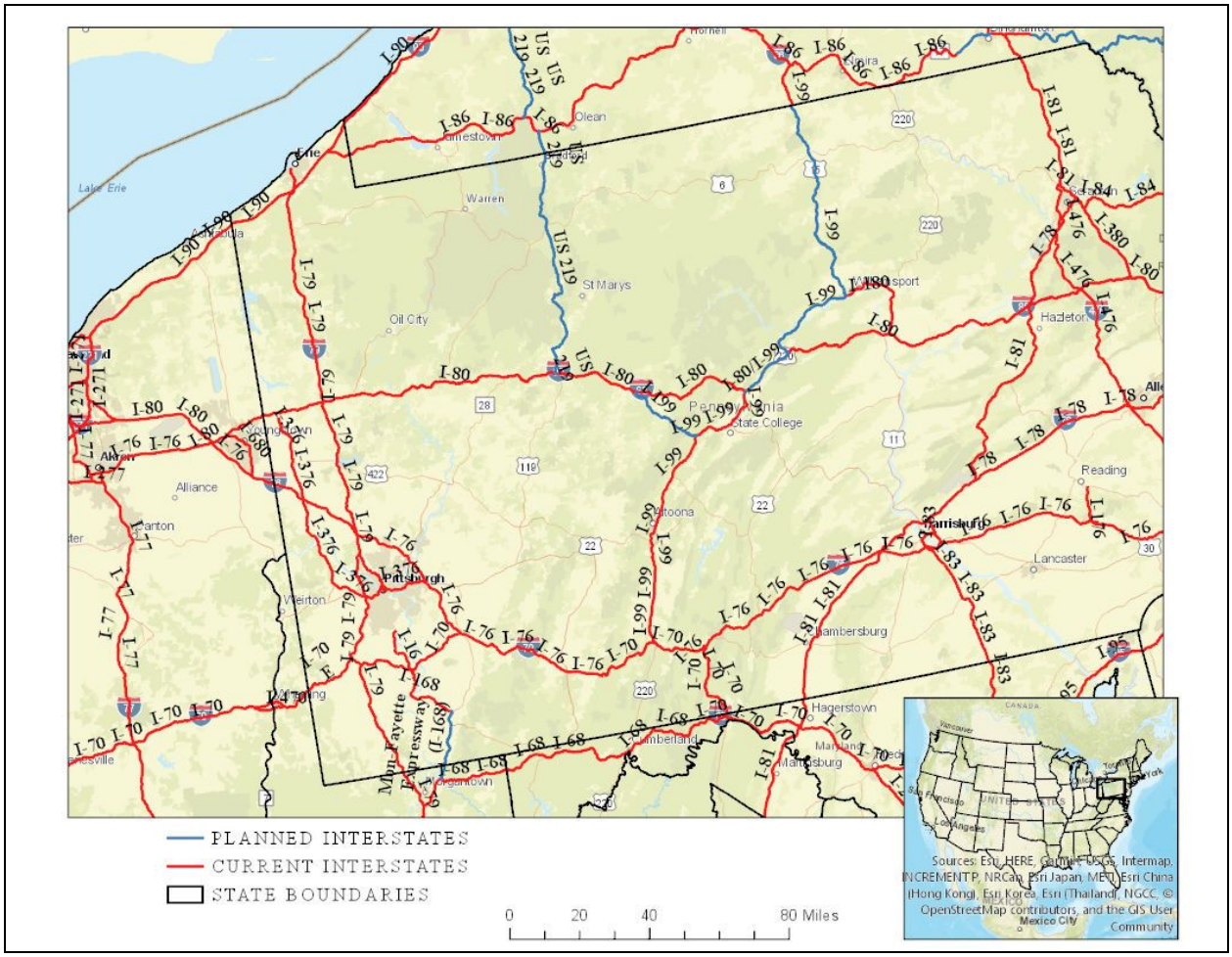

Figure 18. Map of Western Pennsylvania with Interstates and Planned High Priority Corridors Marked. (Tiger/Line Shapefiles Roads, 2016) and (FHWA, 2018).

Based on Figure 18, this area has two new high priority corridors. The I-99 Corridor, which is partially complete, starts at Bedford, Pennsylvania and ends at Painted Post, New York. The corridor is incomplete from I-80 around Bellefonte and will use US 220 up to Williamsport then US 15 to Lawrenceville. The I-99 corridor also uses US 322 as another connection between I-80 and I-99 near State College. Lastly, the US 219 corridor connects Buffalo and I-80, but is not currently designated as an interstate.

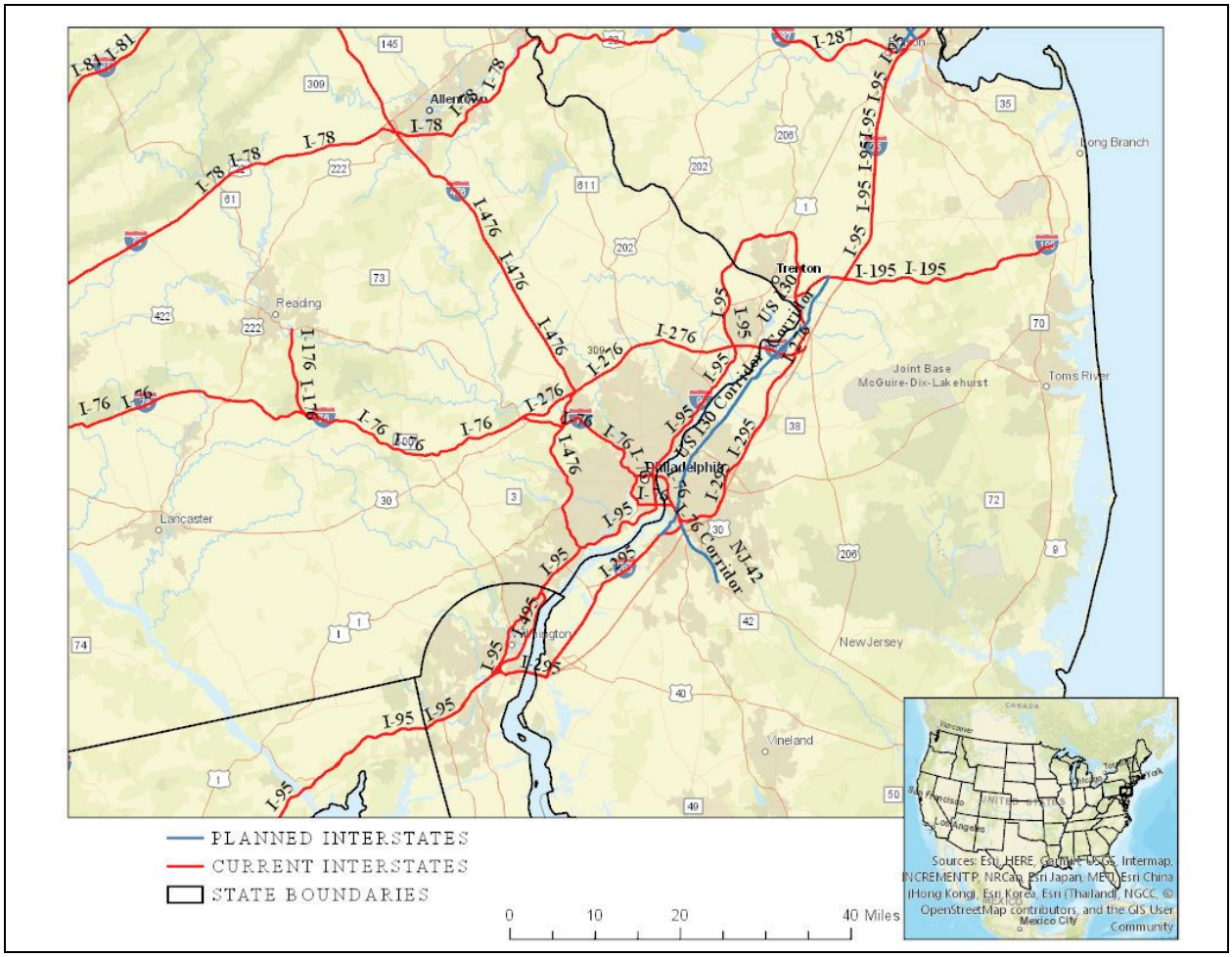

Figure 19. Map of Philadelphia area with Interstates and Planned High Priority Corridors Marked. (Tiger/Line Shapefiles Roads, 2016) and (FHWA, 2018).

As noted by Figure 19, there is one new high priority corridor. This corridor consists of infrastructure connecting the interstates around Philadelphia, Pennsylvania and a few of the interstates around Philadelphia are included in the corridor. Other than two new routes, there is little change in the Philadelphia area.

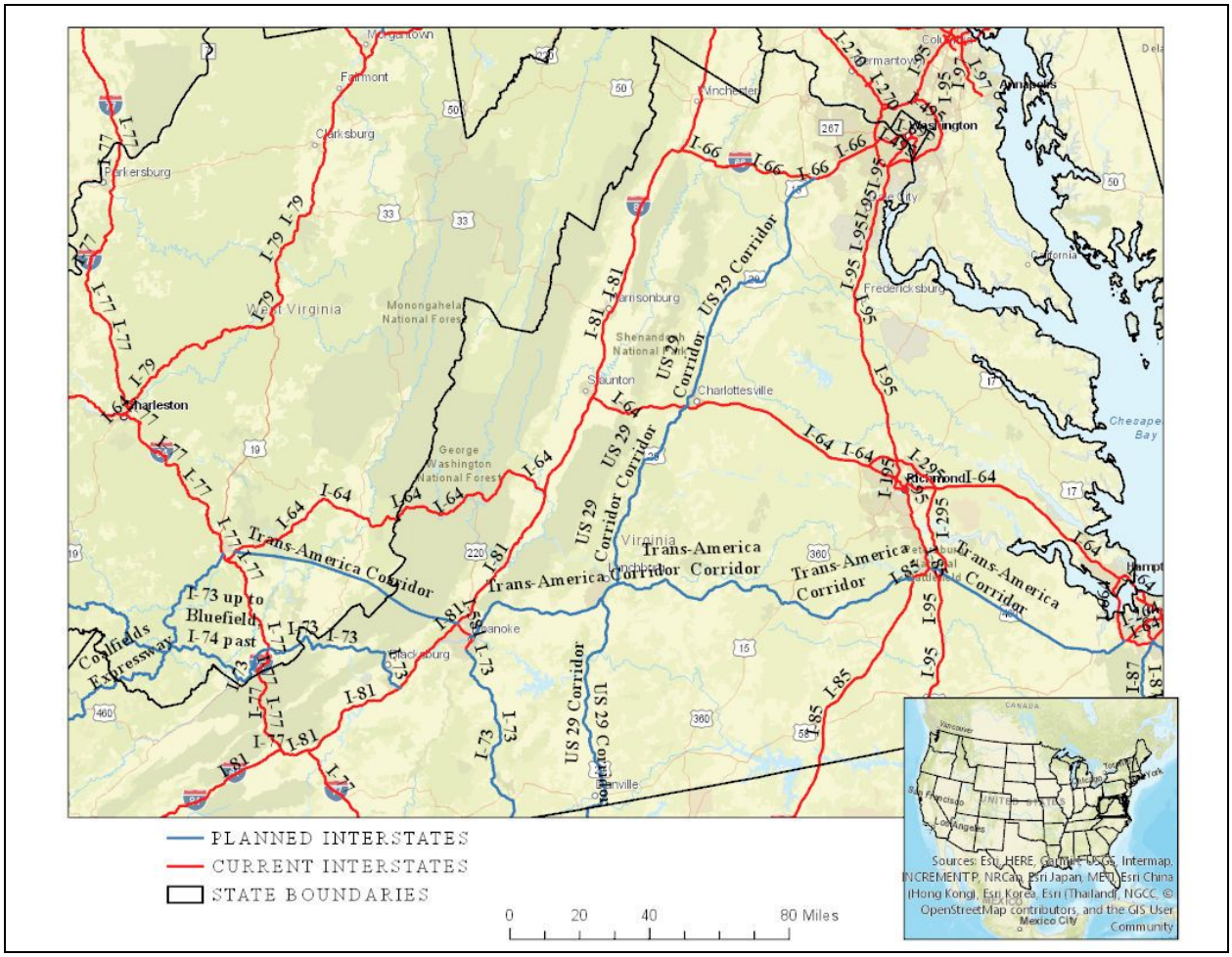

Figure 20. Map of Virginia with Interstates and Planned High Priority Corridors Marked. (Tiger/Line Shapefiles Roads, 2016) and (FHWA, 2018).

As noted by Figure 20, Virginia has three planned high priority corridors. The I-73/I-74 corridor is entirely designated as an interstate and will go around the Appalachian Mountains from Iowa to Myrtle Beach. The corridor uses I-581 and I-77 as part of the infrastructure. The Trans-America Corridor is not designated as an interstate through Virginia, but will connect the Hampton Roads Area and I-40 in New Mexico. The US 29 Corridor is designated as an interstate from Danville to Greensboro, but the rest of US 29 to Washington D.C. is not designated as an interstate.

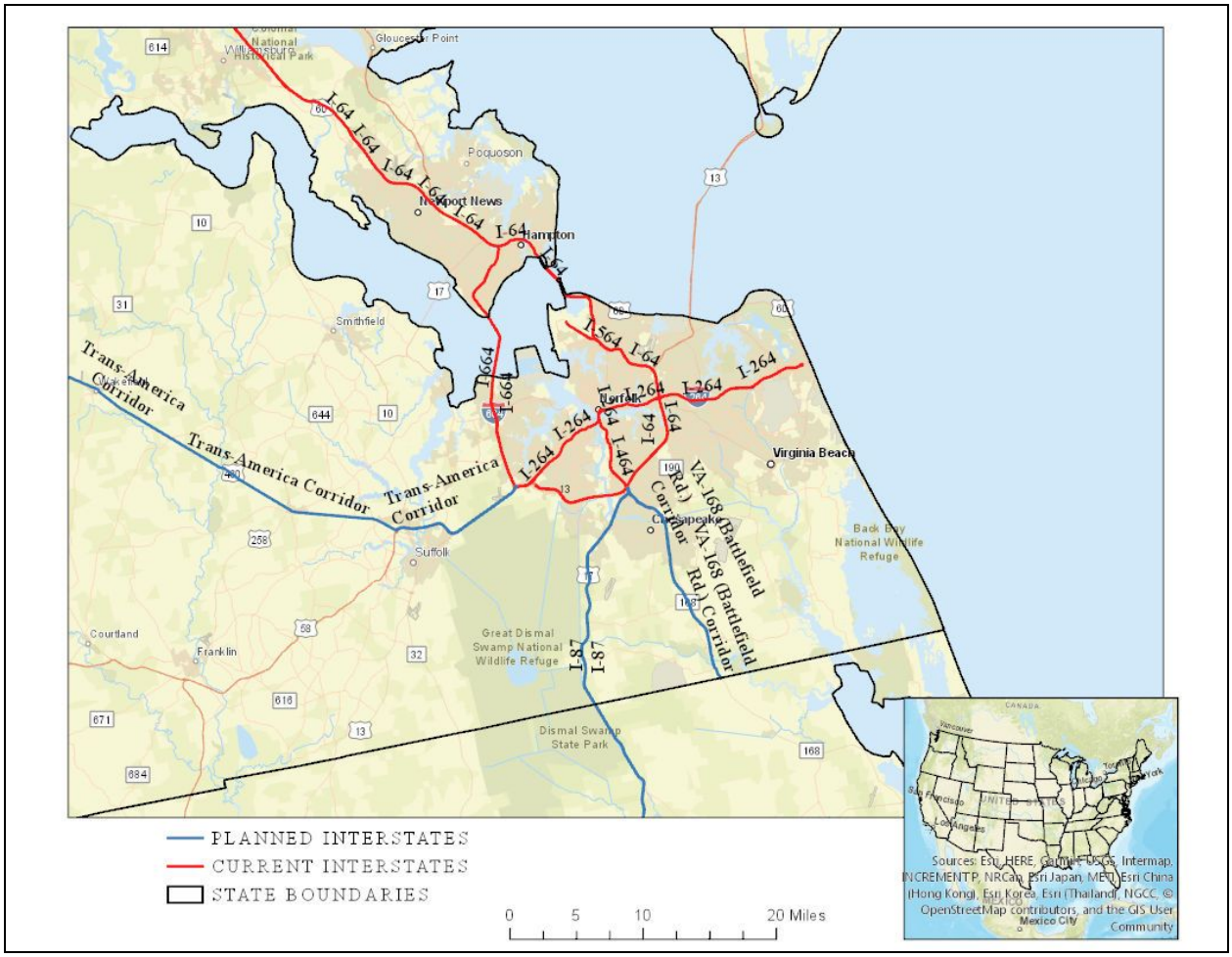

Figure 21. Map of Norfolk-Hampton Roads Area with Interstates and High Priority Corridors Marked. (Tiger/Line Shapefiles Roads, 2016) and (FHWA, 2018).

Based on Figure 21, there are three new high priority corridors in the Norfolk-Hampton Roads area. The Battlefield Road Corridor and Corridor 3, the Trans-America corridor, are both not designated as interstates. The I-87 corridor starts in Norfolk and heads south towards Raleigh. The cities around this area are all at or below 100 feet elevation and Norfolk experiences frequent flooding, so there are no county seats to be connected.

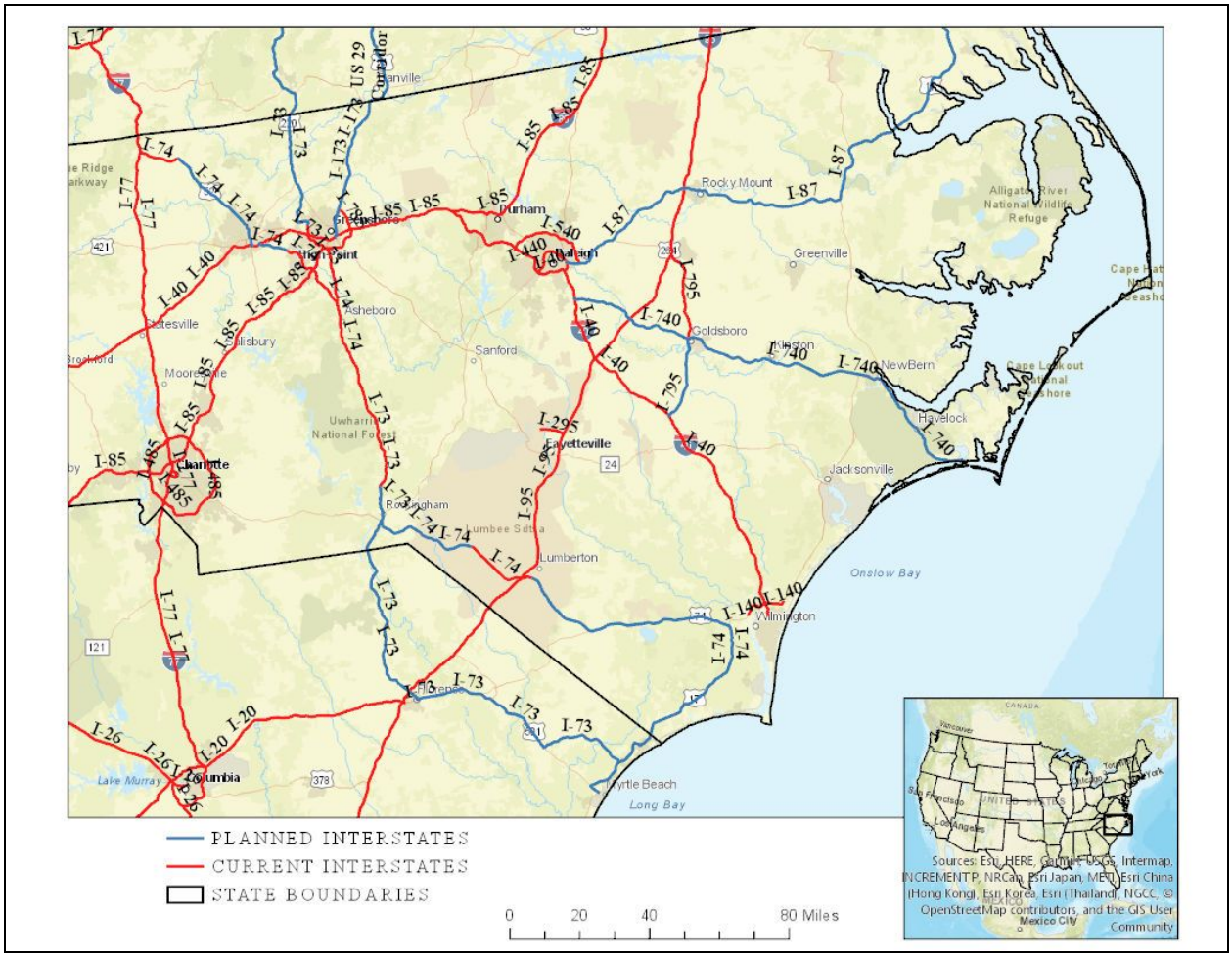

Figure 22. Map of Interstates and Planned High Priority Corridors in North Carolina. (Tiger/Line Shapefiles Roads, 2016) and (FHWA, 2018).

Based on Figure 22, North Carolina is highly connected with the addition of several high priority corridors. The I-73/I-74 corridor is partially completed throughout the state, but is meant to connect Myrtle Beach, Iowa, and the Canadian border at Sault Ste. Marie in Michigan. The US 70 Corridor connects Raleigh and the Outer Banks. The US 29 Corridor connects Greensboro and Washington, D.C., but only the portion up to Danville is designated as an Interstate. I-795 is completed as of 2019, but is meant to connect I-95 and I-40.

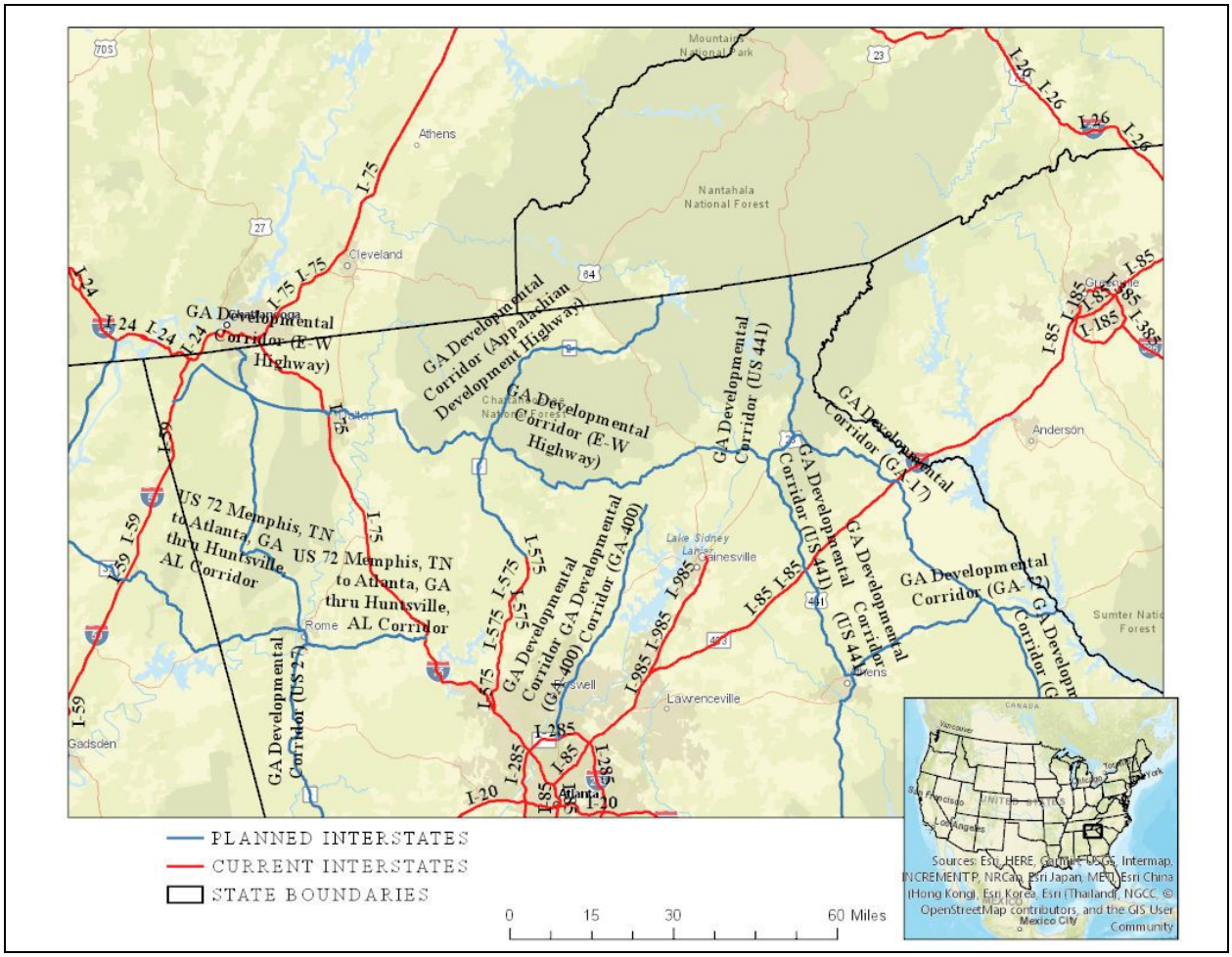

Figure 23. Map of Northern Georgia with Interstates and Planned High Priority Corridors Marked. (Tiger/Line Shapefiles Roads, 2016) and (FHWA, 2018).

Based on Figure 23, Northern Georgia gets a few new connections in the form of planned high priority corridors. The US 72 corridor connects Memphis and Atlanta by heading through Huntsville, Alabama and also includes a route up to Chattanooga, Tennessee. Several of the Georgia Developmental Corridors connect the more populous portions of Georgia, such as Athens, with the main Interstate Highway System.

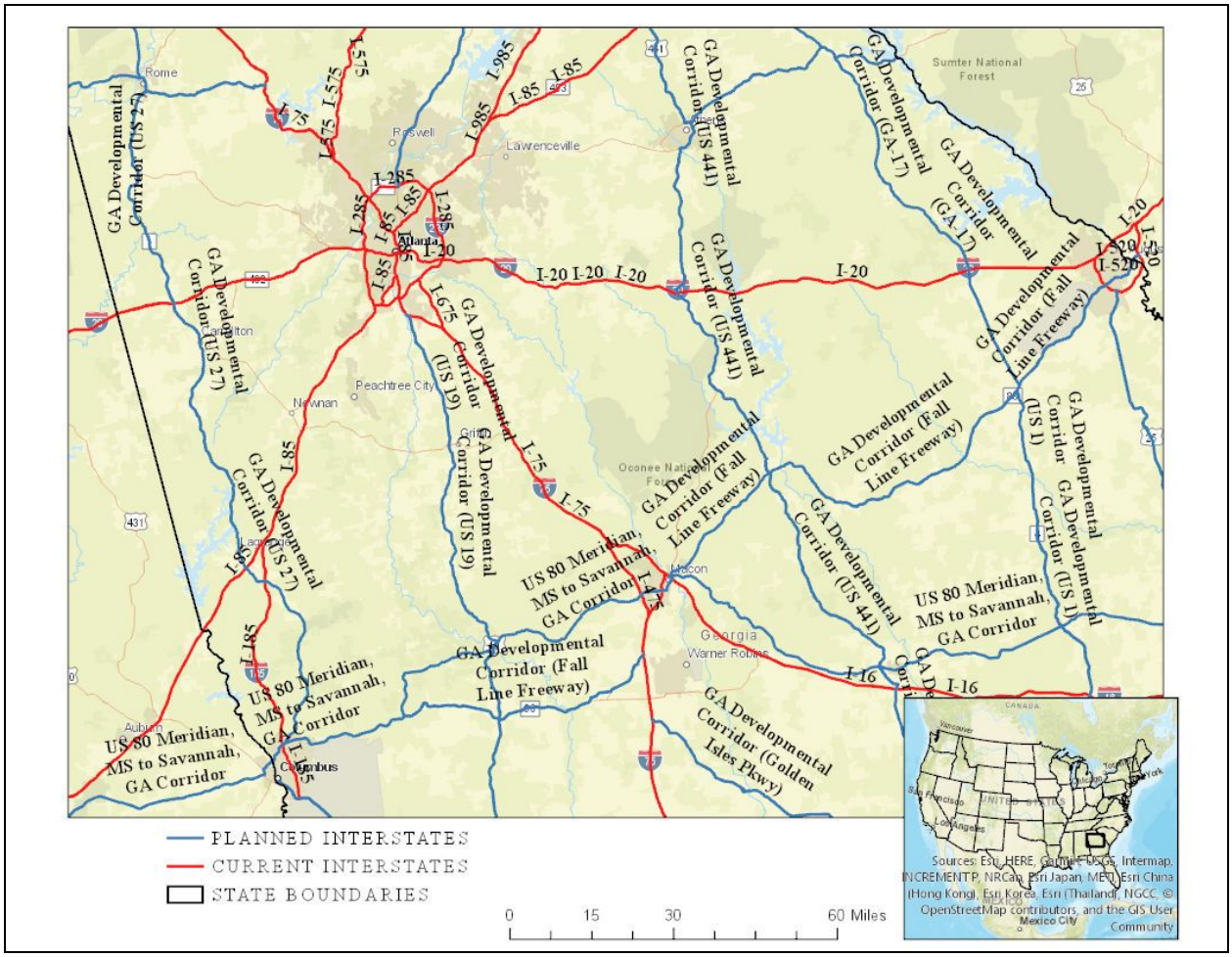

Figure 24. Map of Central Georgia with Interstates and Planned High Priority Corridors Marked. (Tiger/Line Shapefiles Roads, 2016) and (FHWA, 2018).

Based on Figure 24, there are many different routes that make up the Georgia Developmental Corridors. These planned high priority corridors connect the more populous portions of Georgia with the rest of the interstate highway system in the state. The Fall Line Freeway is the most important, as it will provide a connection between Columbus and Augusta.

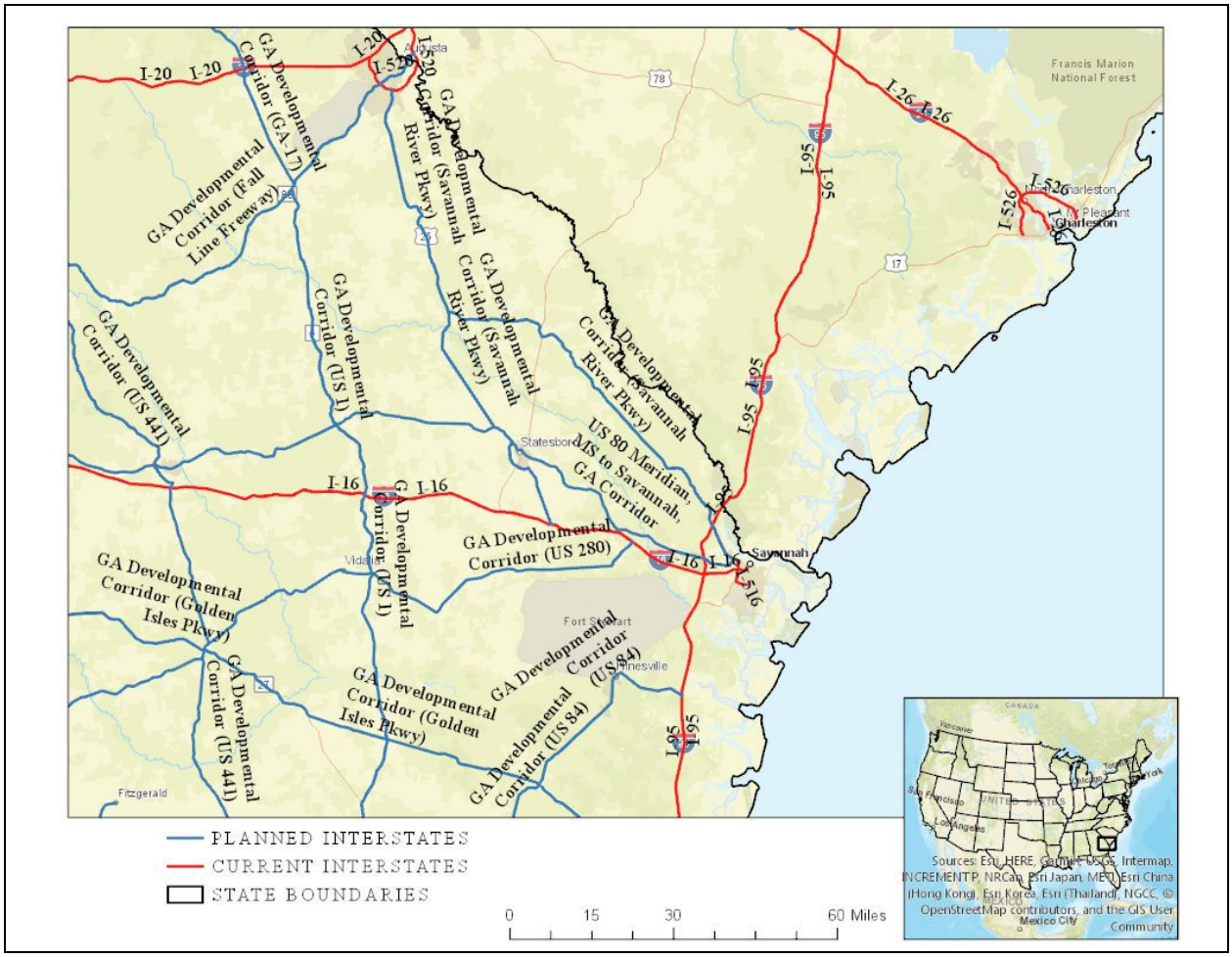

Figure 25. Map of Eastern Georgia with Interstates and Planned High Priority Corridors Marked. (Tiger/Line Shapefiles Roads, 2016) and (FHWA, 2018).

Based on Figure 25, Georgia is highly connected with new planned high priority corridors. The Golden Isles Parkway could be a great alternate route to I-16. Waycross and Statesboro could easily be connected to the IHS through these high priority corridors. Lastly, the Savannah River Parkway provides a connection between Savannah and Augusta.

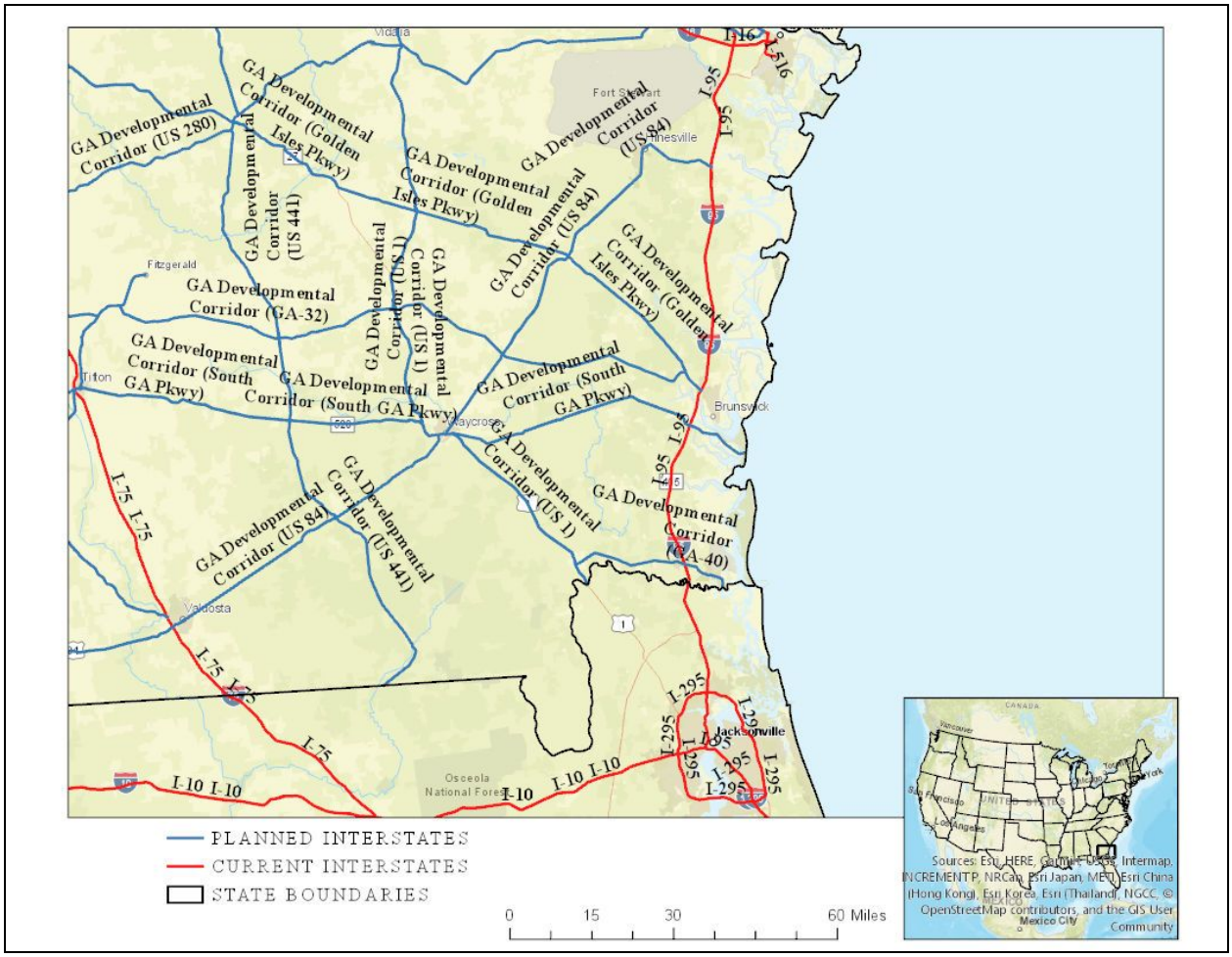

Figure 26. Map of Southeastern Georgia with Interstates and Planned High Priority Corridors Marked. (Tiger/Line Shapefiles Roads, 2016) and (FHWA, 2018).

Based on Figure 26, the South Georgia Parkway and the US 84 corridor are the two most important planned high priority corridors. These routes provide connections to I-95 and I-75 from Columbus and Valdosta. The US 1 Corridor and the US 41 Corridor can be additional N-S interstates that exist in between I-75 and I-95 through rural Georgia.

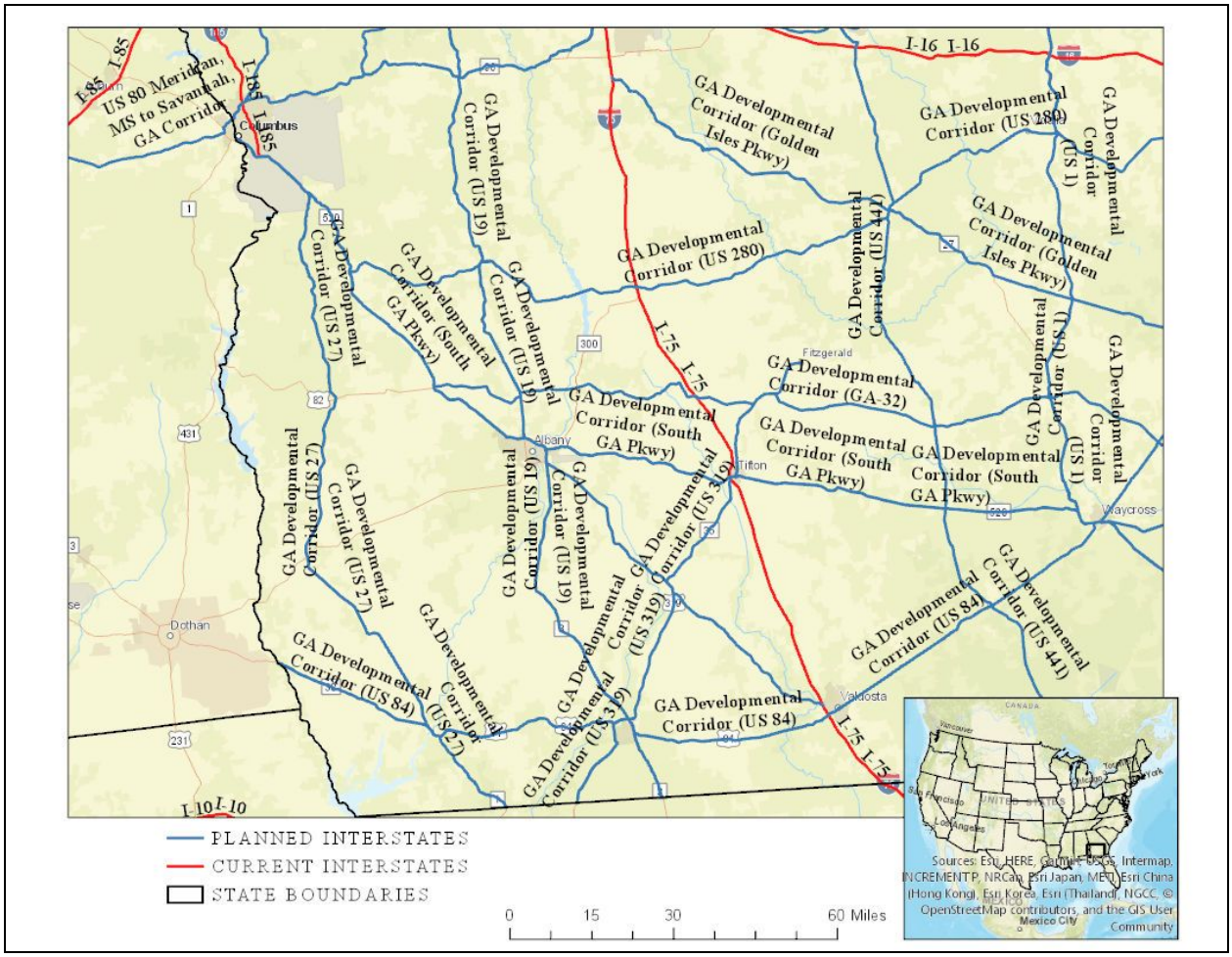

Figure 27. Map of Southwestern Georgia with Interstates and Planned High Priority Corridors Marked. (Tiger/Line Shapefiles Roads, 2016) and (FHWA, 2018).

Based on Figure 27, Albany has several planned high priority corridors. Previously, there was no connection to the IHS, but there are several new planned high priority corridors to make up for the lack of current connections. The US 84 Corridor and the Southern Georgia Parkway are also important connections throughout Georgia.

Figure 28. Map of with Interstates and Planned High Priority Corridors Marked. (Tiger/Line Shapefiles Roads, 2016)and (FHWA, 2018).

Based on Figure 28, the I-22 corridor is completed and designated as an interstate, connecting Birmingham and Memphis. The US 80 corridor connects Meridian and Savannah by means of Montgomery. The Birmingham Northern Beltline will most likely head through several residential areas, causing many problems for the people that live there.

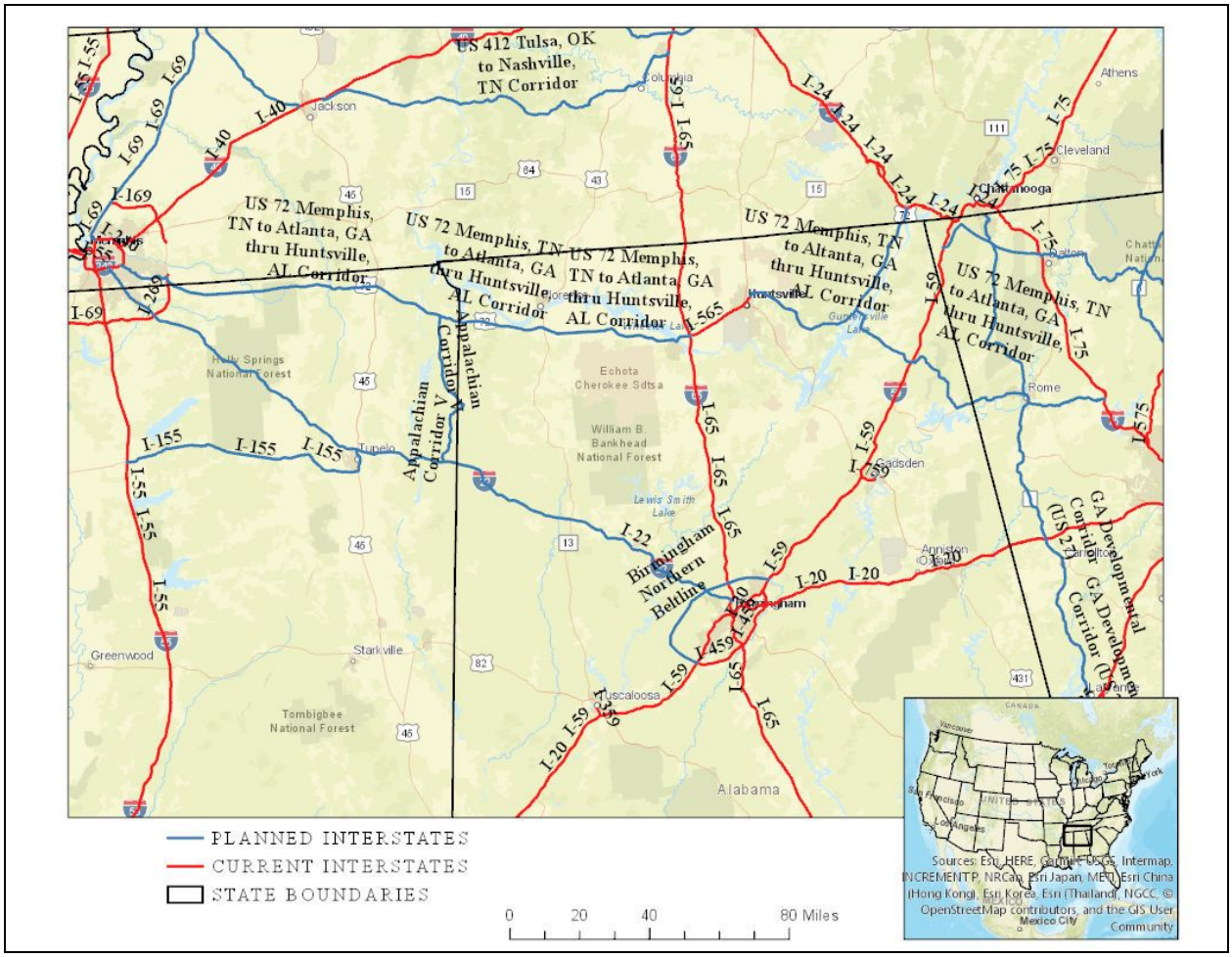

Figure 29. Map of with Alabama, Tennessee, and Mississippi with Interstates and Planned High Priority Corridors Marked. (Tiger/Line Shapefiles Roads, 2016) and (FHWA, 2018).

Based on Figure 30, Appalachian Corridor V is designated as an interstate from Tupelo, Mississippi to I-22. Appalachian Corridor V also extends up to US 72. The US 72 Corridor connects Memphis, Huntsville, Atlanta, and Chattanooga.

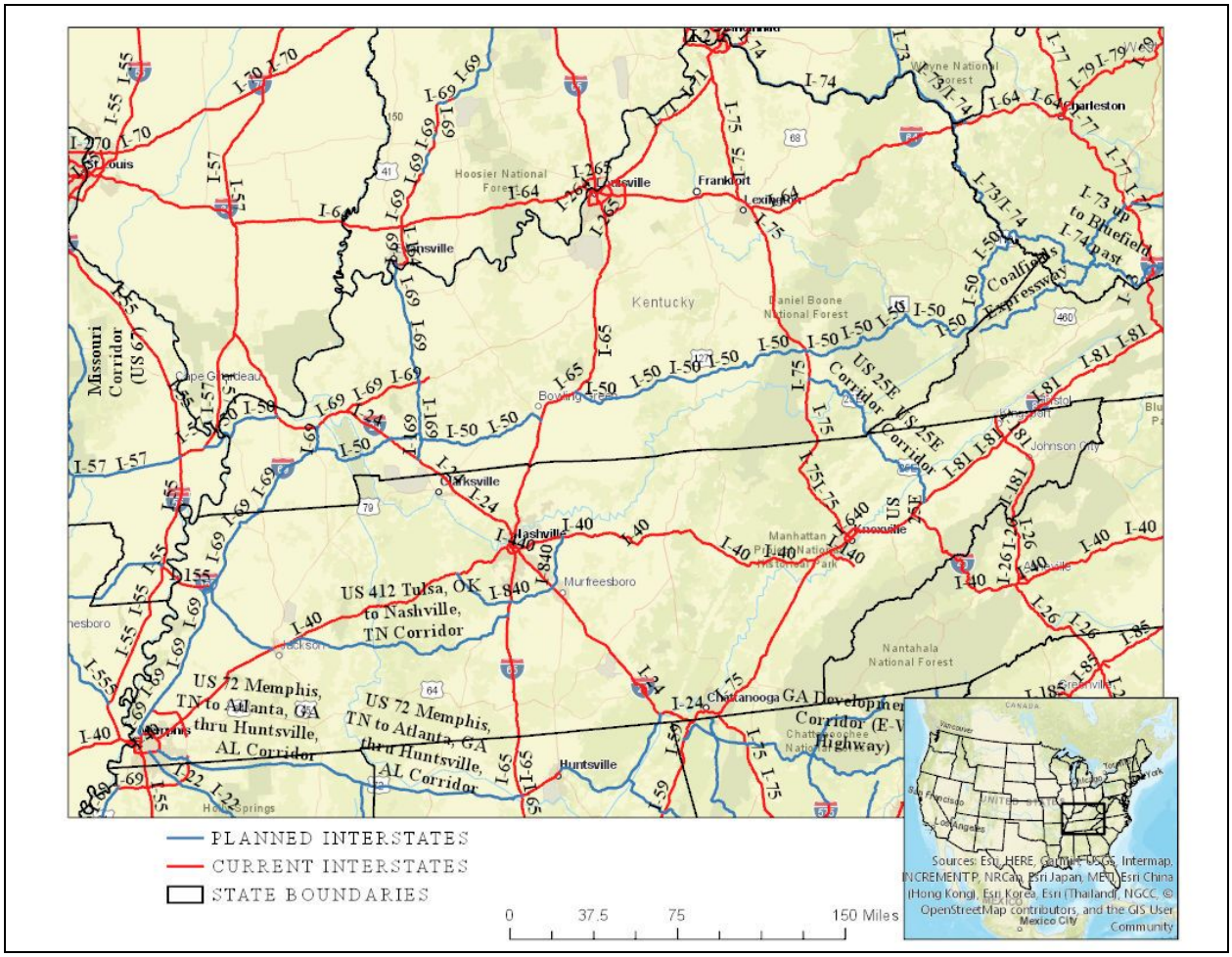

Figure 29. Map of with Interstates and Planned High Priority Corridors Marked. (Tiger/Line Shapefiles Roads, 2016) and (FHWA, 2018).

Based on Figure 29, The Trans-America Corridor is designated as I-50 throughout Kentucky. I-840 is completed as a bypass of Nashville. The US 412 Corridor connects Nashville and Tulsa, Oklahoma. The I-57 extension is noted in the bottom left. The I-69 corridor connects Texas to Michigan through Memphis and Kentucky and has a spur out to Hopkinsville, Kentucky.

Figure 30. Map of Missouri, Illinois, and Iowa with Interstates and Planned High Priority Corridors Marked. (Tiger/Line Shapefiles Roads, 2016) and (FHWA, 2018).

Based on Figure 30, Corridor 2, from St. Louis, MO to St. Paul, MN uses I-35 and I-80 Iowa in addition to following the Mississippi River in Missouri. The MO corridors connect the Trans-America corridor and the various Interstates in Missouri. Jefferson City is also connected to the interstate highway system making Pierre and Dover the only two state capitals not connected to the IHS in some way. There are not any high priority corridors or changes to Illinois.

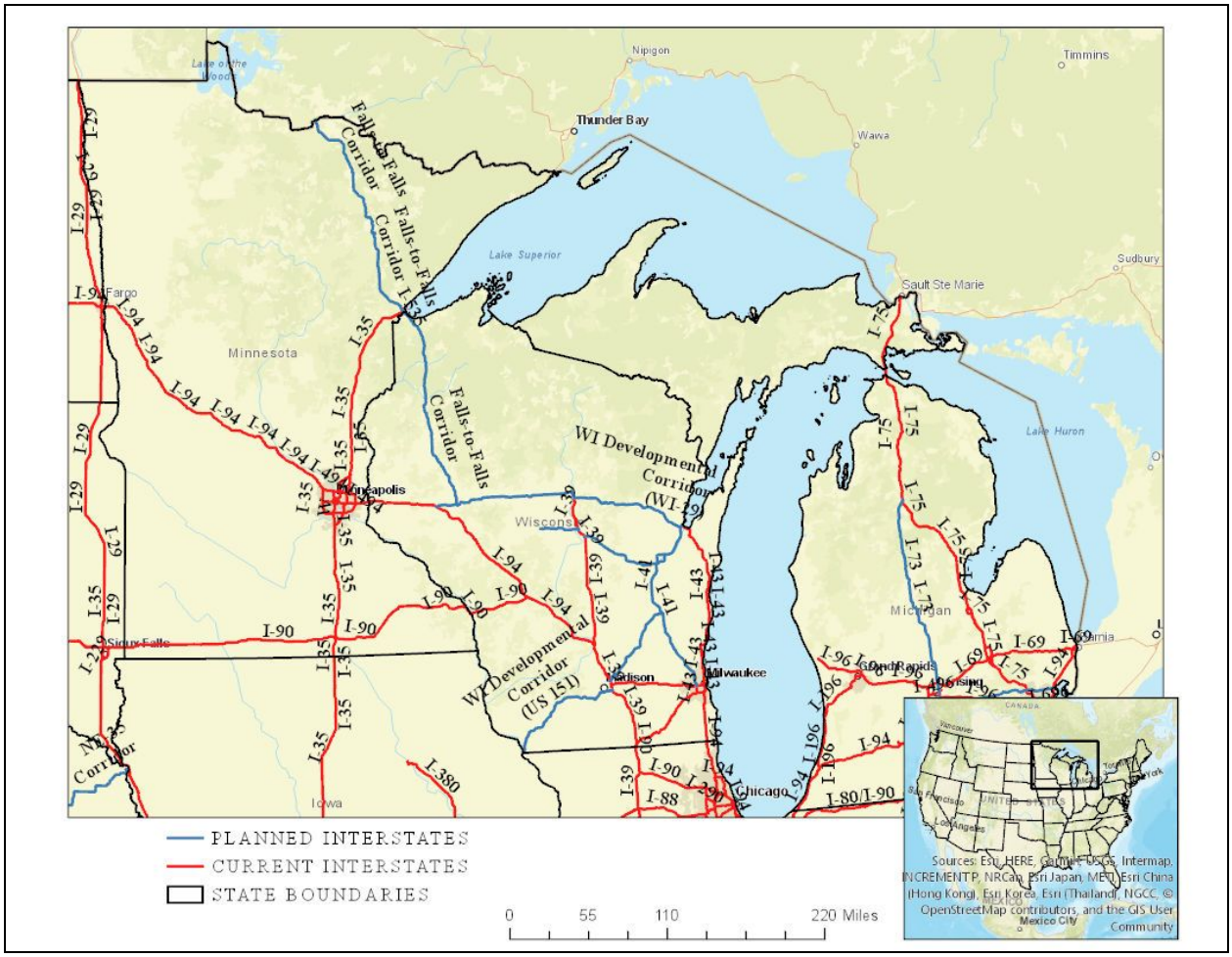

Figure 31. Map of Minnesota and Wisconsin with Interstates and Planned High Priority Corridors Marked. (Tiger/Line Shapefiles Roads, 2016) and (FHWA, 2018).

Based on Figure 31, the map of Wisconsin has a few changes, made by FHWA (2018). The I-41 corridor is completed from Milwaukee to Green Bay along the west side through Appleton. The Falls to Falls corridor connects International Falls, Minnesota and Chippewa Falls, Wisconsin. Wisconsin also has three developmental corridors which are Wisconsin-29, US 10, and US 151. These connect moderately populated cities in Wisconsin to currently connected cities of Green Bay, Milwaukee, and Madison. Northern Minnesota and the area northeast of

Duluth are sparsely populated, so there will not be any interstates through that area, according to FHWA (2018).

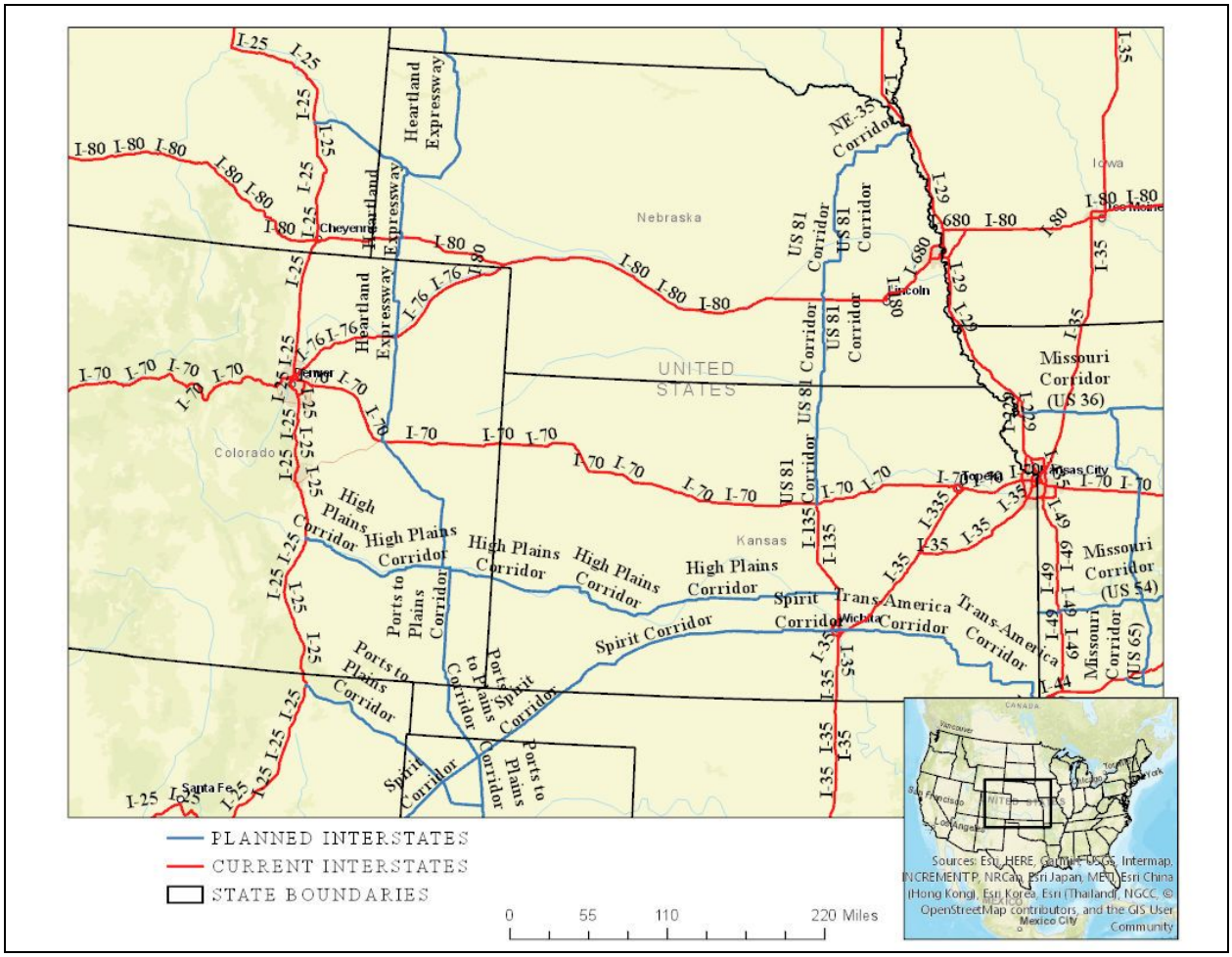

Figure 32. Map of The Great Plains with Interstates and Planned High Priority Corridors Marked. (Tiger/Line Shapefiles Roads, 2016) and (FHWA, 2018).

Based on Figure 32, there are only a few new additions to this part of the country. The US 81 corridor connects I-135 and I-29 near Sioux City, Iowa. The Heartland Expressway connects Denver and the Dakotas. The High Plains corridor connects Pueblo, Colorado and Newton, Kansas. The Ports to Plains corridor connects Texas and Colorado. The Spirit Corridor connects El Paso and Wichita.

Figure 33. Map of The Ozarks with Interstates and Planned High Priority Corridors Marked. (Tiger/Line Shapefiles Roads, 2016) and (FHWA, 2018).

Based on Figure 33, the I-69 corridor is the most dominant of all the high priority corridors. I-69 connects Mexico and Canada. The I-69 corridor also includes the I-530 extension at Monticello, Arkansas. I-49 connects Lafayette, Louisiana, Arkansas and Kansas City, Missouri. The Trans-America Corridor connects I-40 in New Mexico to the Hampton Roads area of Virginia. I-355 is completed as the Jonesboro Spur, and I-57 will have an extension to Little Rock, as well as an additional corridor to Jonesboro called Corridor 52. The US 412 corridor connects Tulsa and Nashville.

Figure 34. Map of Louisiana with Interstates and Planned High Priority Corridors Marked. (Tiger/Line Shapefiles Roads, 2016) and (FHWA, 2018).

Based on Figure 34, I-69 heads through this region. I-49 is the longest corridor, which when completed will connect New Orleans and Kansas City. The Louisiana-1 Corridor connects New Orleans to the Gulf of Mexico. Fort Polk gets a connection to Alexandria by means of Louisiana-28.

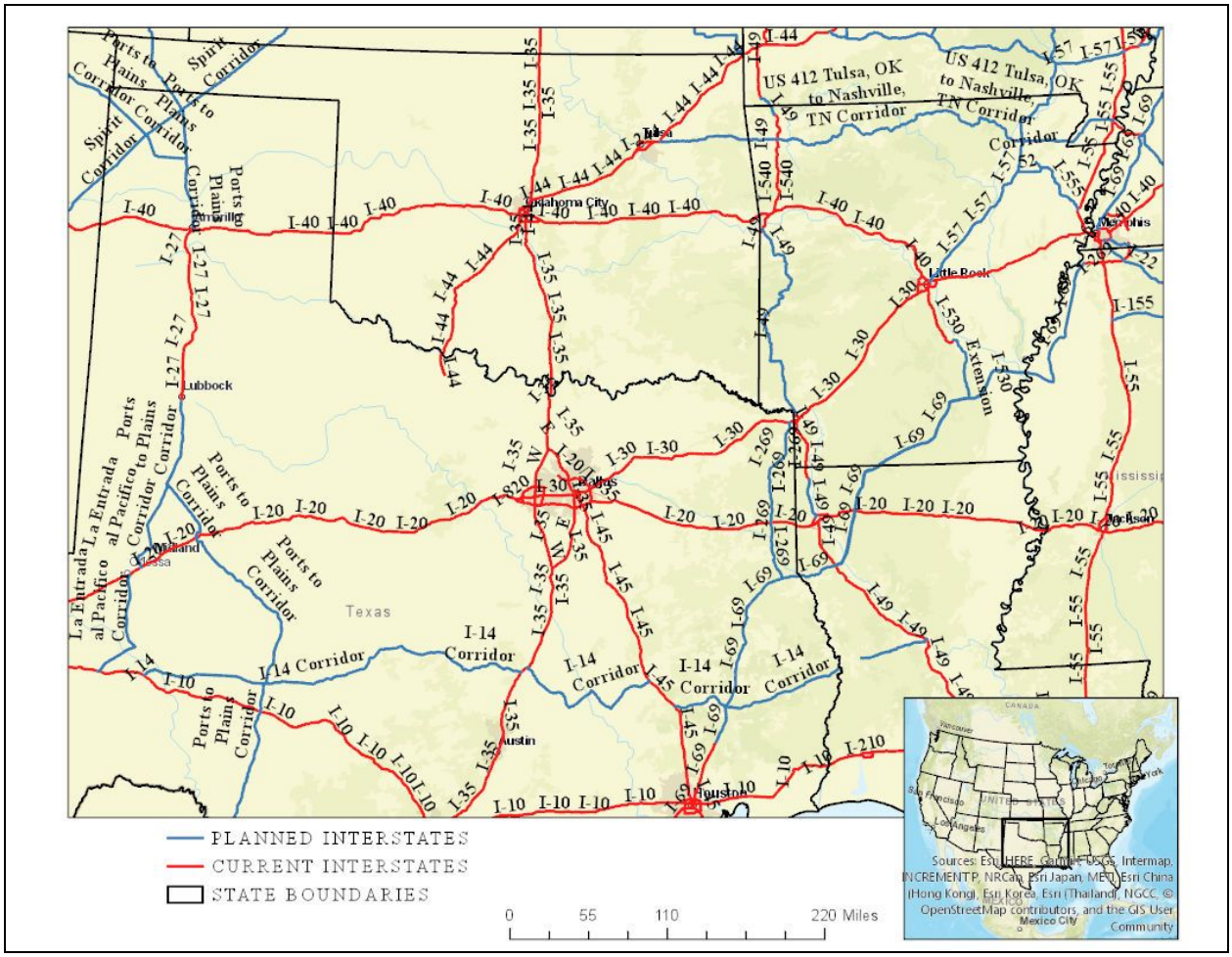

Figure 35. Map of South Central United States with Interstates and High Priority Corridors Marked. (Tiger Line Shapefile, 2016) and (FHWA, 2018).

Based on Figure 35, I-69 will split into two routes in Northeastern Texas, one heading into Louisiana and the other heading towards Texarkana. The I-14 corridor provides a necessary connection through Central Texas. The Ports to Plains Corridor can be an extension of I-27, if upgraded to interstate status.

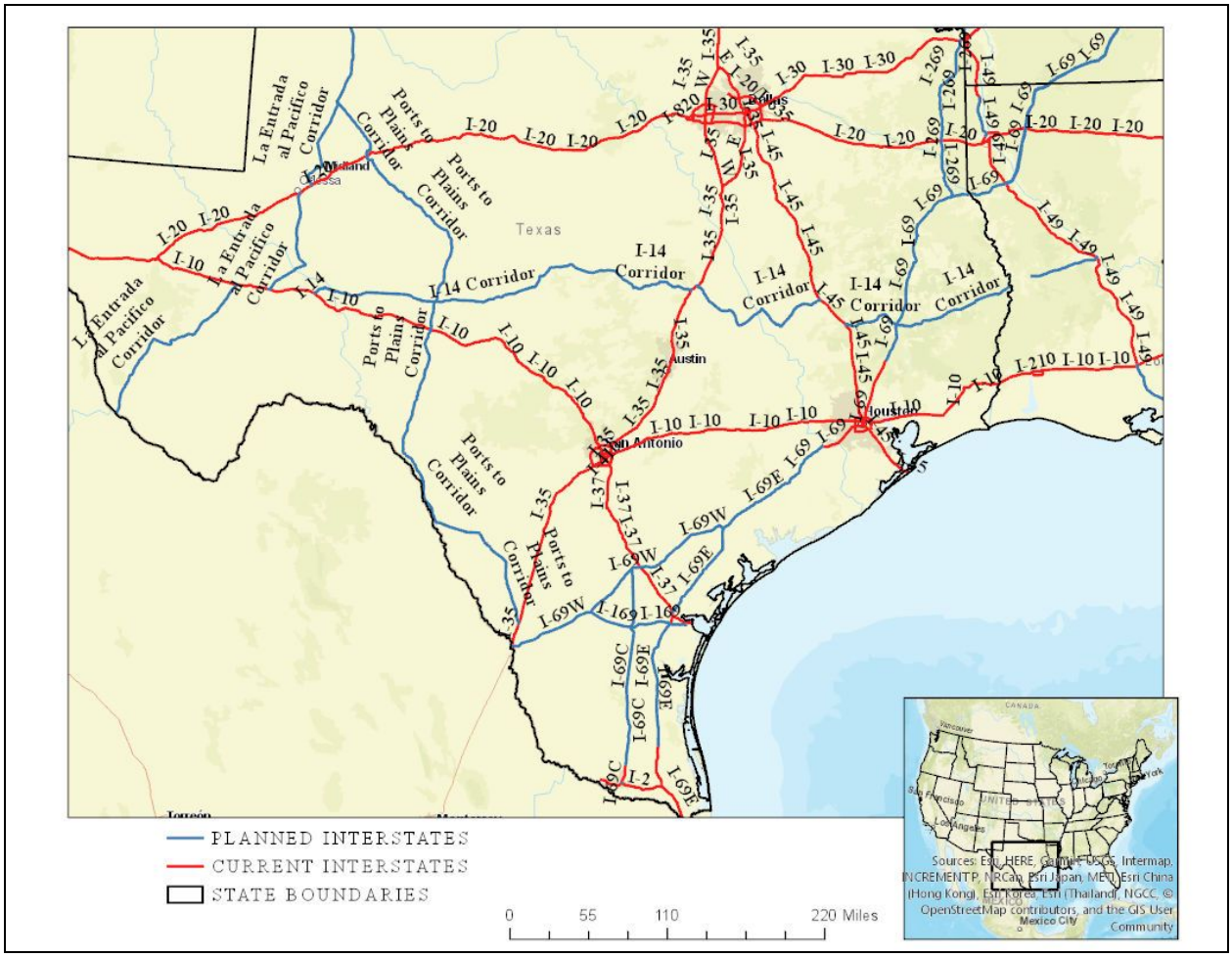

Figure 36. Map of Southern Texas with Interstates and Planned High Priority Corridors Marked. (Tiger/Line Shapefiles Roads, 2016) and (FHWA, 2018).

Based on Figure 36, I-69 will split into three portions south of Victoria. I-69E will head towards Brownsville, I-69C will head towards McAllen, and I-69W will head to Laredo. Laredo is also connected to Lubbock through the Ports to Plains Corridor, which could be an extension of I-27. The I-14 corridor also provides a necessary connection through Central Texas.

Figure 37. Map of the Southwestern United States with Interstates and Planned High Priority Corridors Marked. (Tiger/Line Shapefiles Roads, 2016) and (FHWA, 2018).

Based on Figure 37, the Ports to Plains Corridor, the Spirit Corridor, and the La Entrada Al Pacifico Corridor are all important in connecting Mexico and the rest of the interstate highway system. The I-11 corridor connects Phoenix and Las Vegas. Lastly, there is a corridor south of the Tucson Airport which connects I-19 and I-10.

Figure 38. Map of Montana, South Dakota, Wyoming, and North Dakota with Interstates and Planned High Priority Corridors Marked. (Tiger/Line Shapefiles Roads, 2016) and (FHWA, 2018).

Based on Figure 38, the Heartland Expressway connects I-70 and I-90. The Theodore Roosevelt Expressway connects Theodore Roosevelt National Park to the interstate highway system, as well as providing another connection to Canada. The El Camino Real Corridor mostly uses I-25, but also uses I-87 and a few Montana state routes to connect I-25 and I-15.

Figure 39. Map of the Pacific Northwest with Interstates and Planned High Priority Corridors Marked. (Tiger/Line Shapefiles Roads, 2016) and (FHWA, 2018).

Based on Figure 39, the US 95 and US 395 corridors are the only new additions to the interstate maps. The US 95 corridor is important in connecting I-84 and I-90 and provides Idaho with a connection between the northern and southern portions of the state. The US 395 corridor provides Eastern Oregon with a N-S route.

Figure 40. Map of California and Nevada with Interstates and Planned High Priority Corridors Marked. (Tiger/Line Shapefiles Roads, 2016) and (FHWA, 2018).

Based on Figure 40, the I-11 corridor and the California Farm to Market corridor, which it was designated as I-9, can both be seen in this map. The US 395 corridor starts in Reno and is mentioned in the previous map. It is important that Bakersfield and Fresno be connected to the interstate highway system sometime in the future, as it will provide an alternative route between Sacramento and Los Angeles to avoid Silicon Valley. Also, I-215 is complete around Las Vegas and there will be a connection between I-15 and I-70 in Utah using US 6.

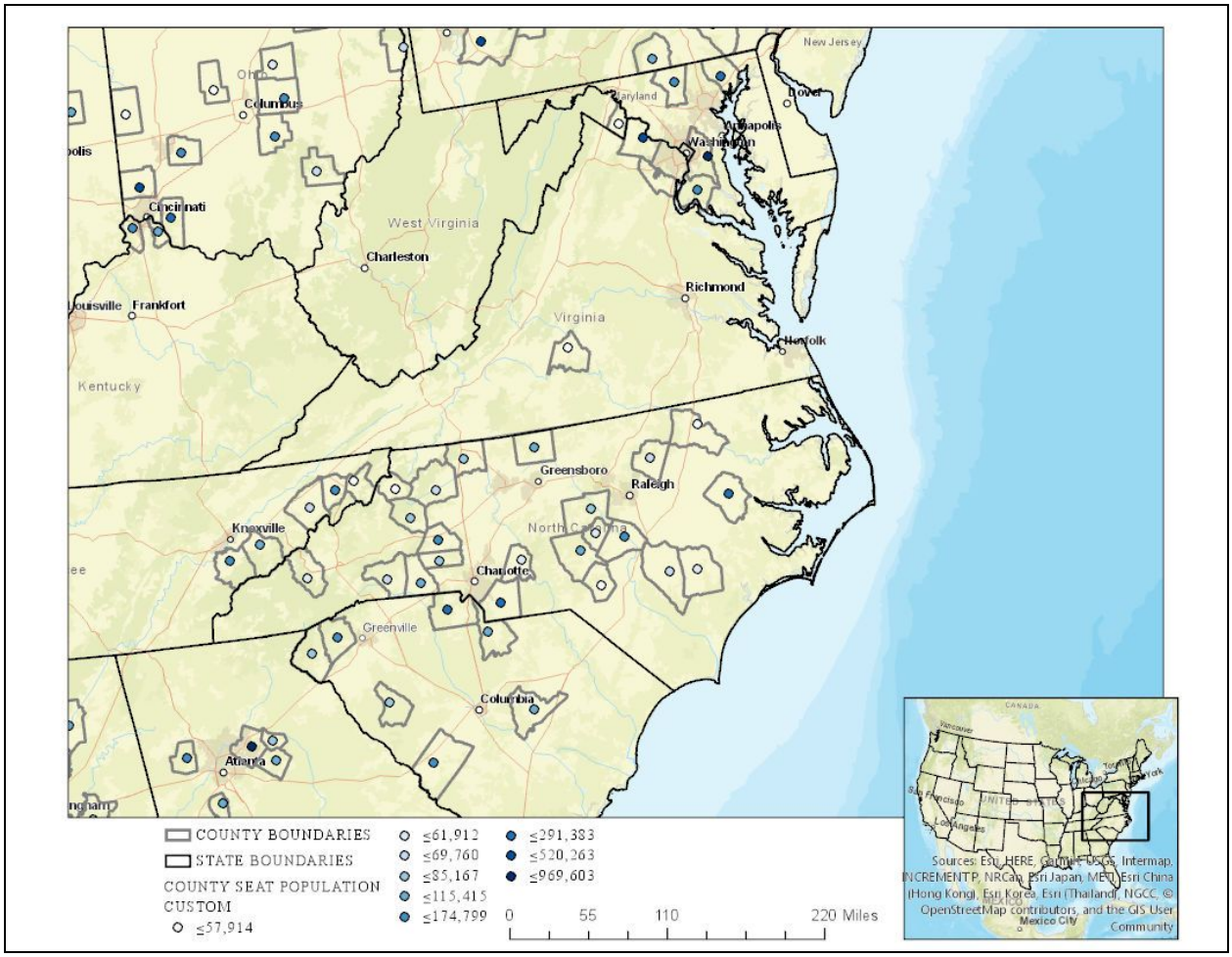

Figure 41. Map of County Seats in the Southeastern USA. (US Census Bureau, 2018).

Based on Figure 41, North Carolina contains the majority of the county seats in the region with 20. Three county seats meet all the criteria in Virginia and a large amount in Maryland. Only one county seat meets all the criteria in West Virginia, which is located near Washington, D.C.

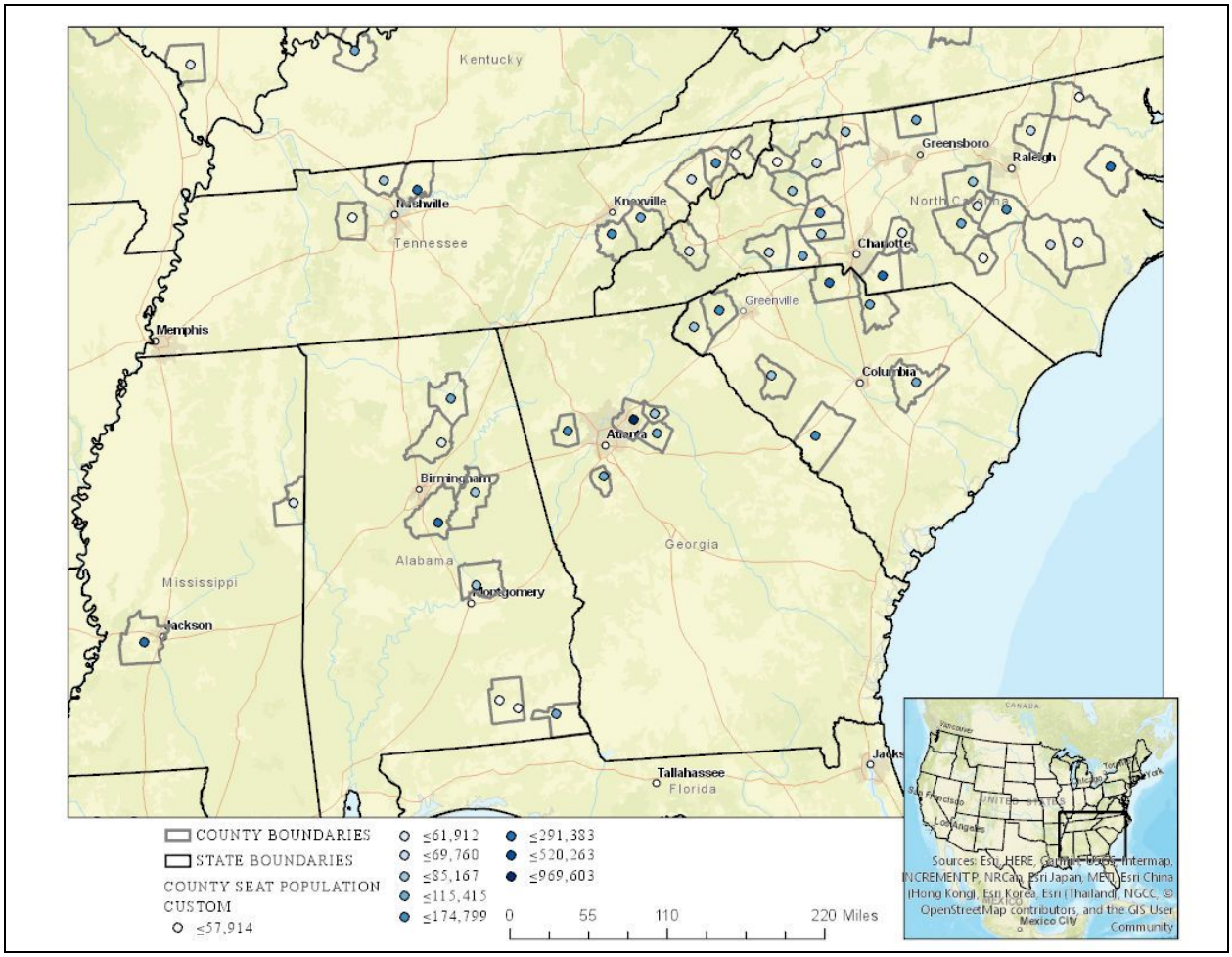

Figure 42. Map of County Seats in the Southeastern US. (US Census Bureau, 2018).

Based on Figure 42, Georgia's County Seats are mostly located around Atlanta. The county seats in South Carolina and Alabama are more spread out. Florida was not included in the Network Analysis because Florida will essentially become an island when the sea level rises in the future.

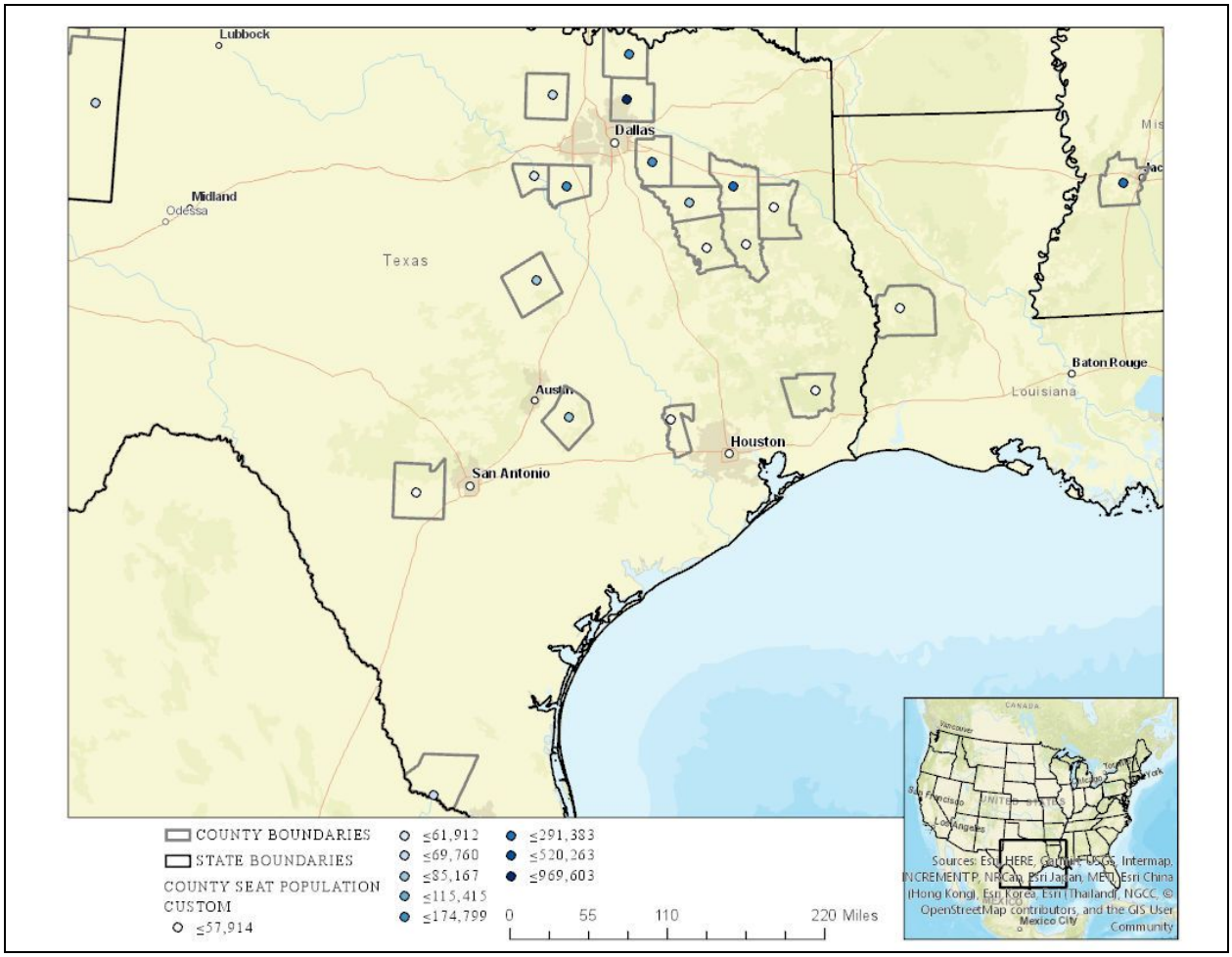

Figure 43. Map of County Seats in Mississippi, Louisiana, and Texas. (US Census Bureau, 2018).

Based on Figure 43, Texas has the majority of the county seats in the region. Most of the county seats in Texas are near Austin, San Antonio, Houston, or Dallas. Louisiana has one parish seat that lies near Fort Polk and the county seat for Mississippi is in the Jackson metropolitan area.

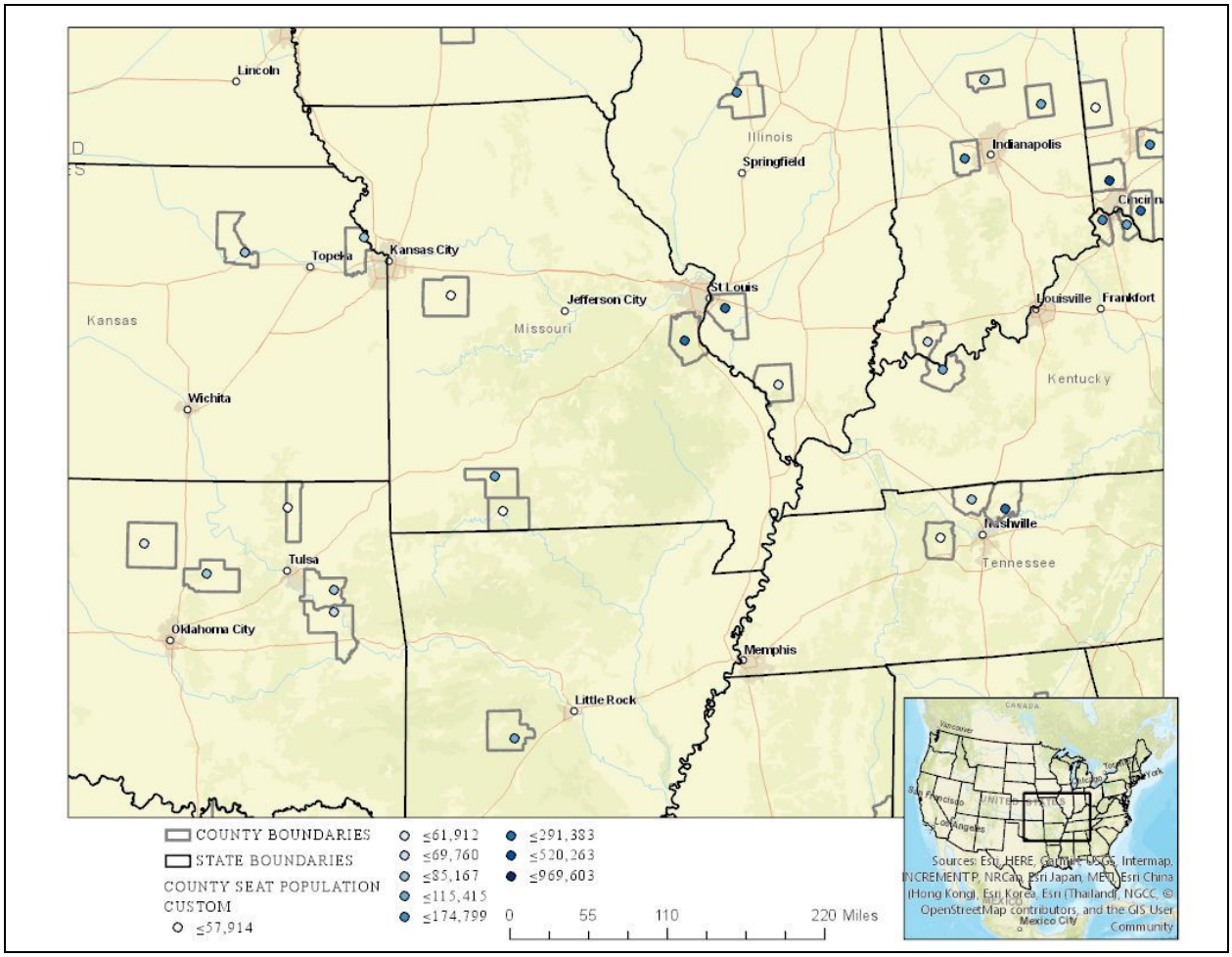

Figure 43. Map of County Seats in the Mississippi-Ohio River Confluence Region. (US Census Bureau, 2018).

Based on Figure 43, Tennessee has three county seats on this map which are located around Nashville. Missouri and Arkansas have county seats discussed in the previous map. The Owensboro metro area has two county seats and St. Louis has a few county seats near it.

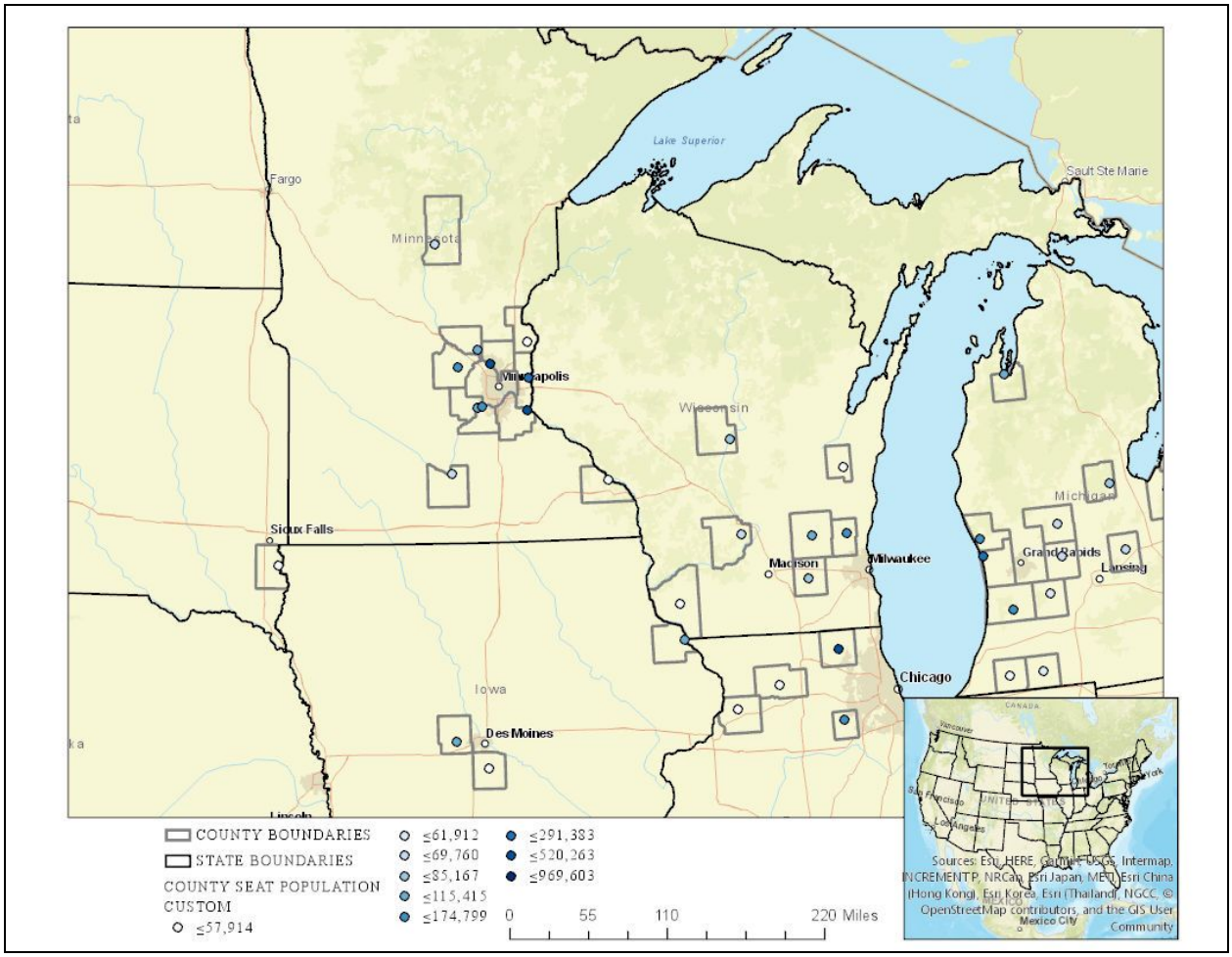

Figure 44. Map of County Seats in the Old Northwest. (US Census Bureau, 2018).

Based on Figure 44, Minnesota has the majority of county seats in the region. Most of the county seats are located in the Twin Cities metropolitan area. Iowa has county seats in Dubuque and near Des Moines. Wisconsin has scattered county seats and South Dakota has one county seat southeast of Sioux Falls.

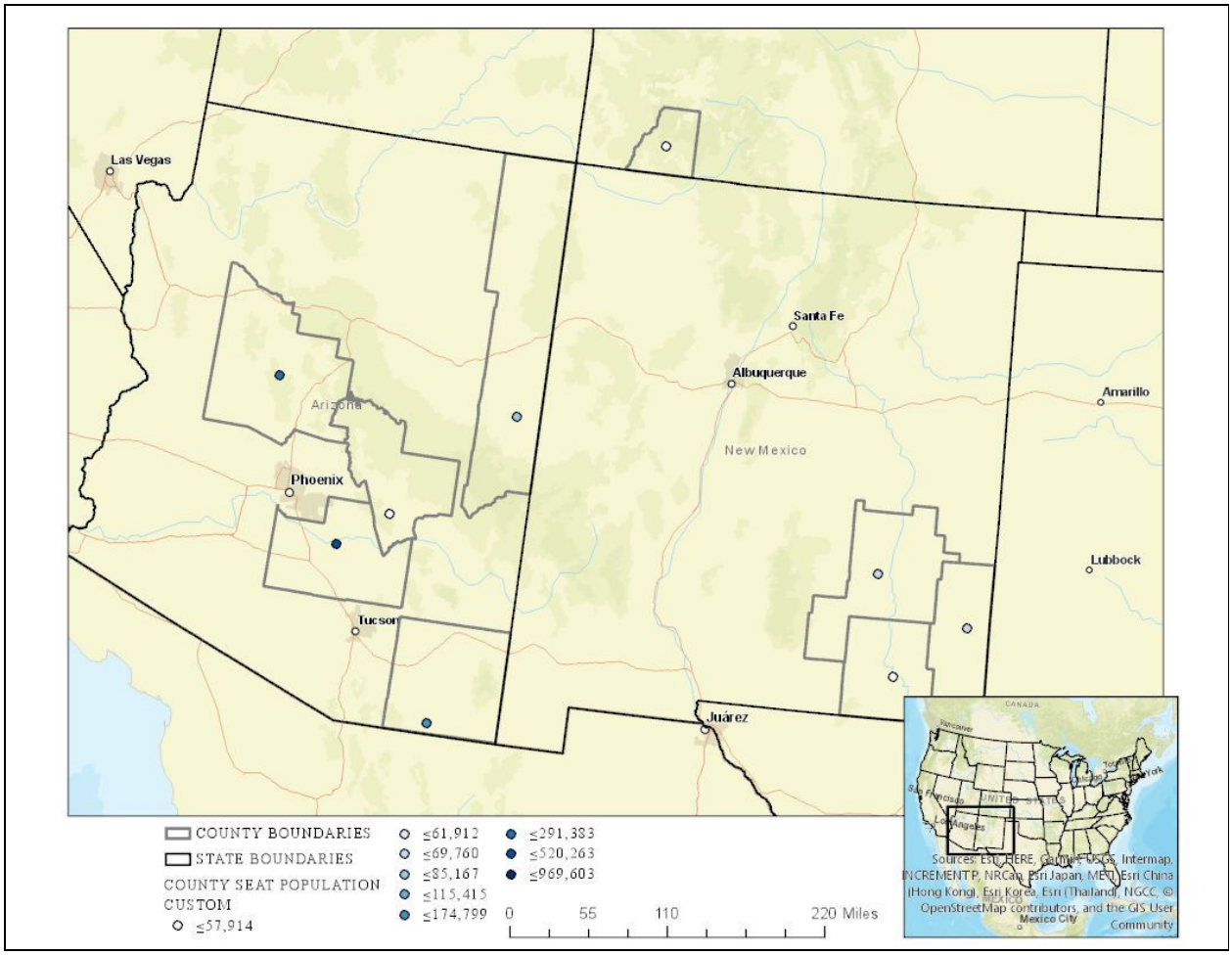

Figure 44. Map of County Seats in Arizona, Colorado, and New Mexico. (US Census Bureau, 2018).

Based on Figure 44, Arizona has the most county seats with five. New Mexico and Colorado both have three with Durango being just over the 50,000 population limit for San Juan

county. New Mexico's county seats are located in the southwestern corner of the state, where there is not any current interstate development.

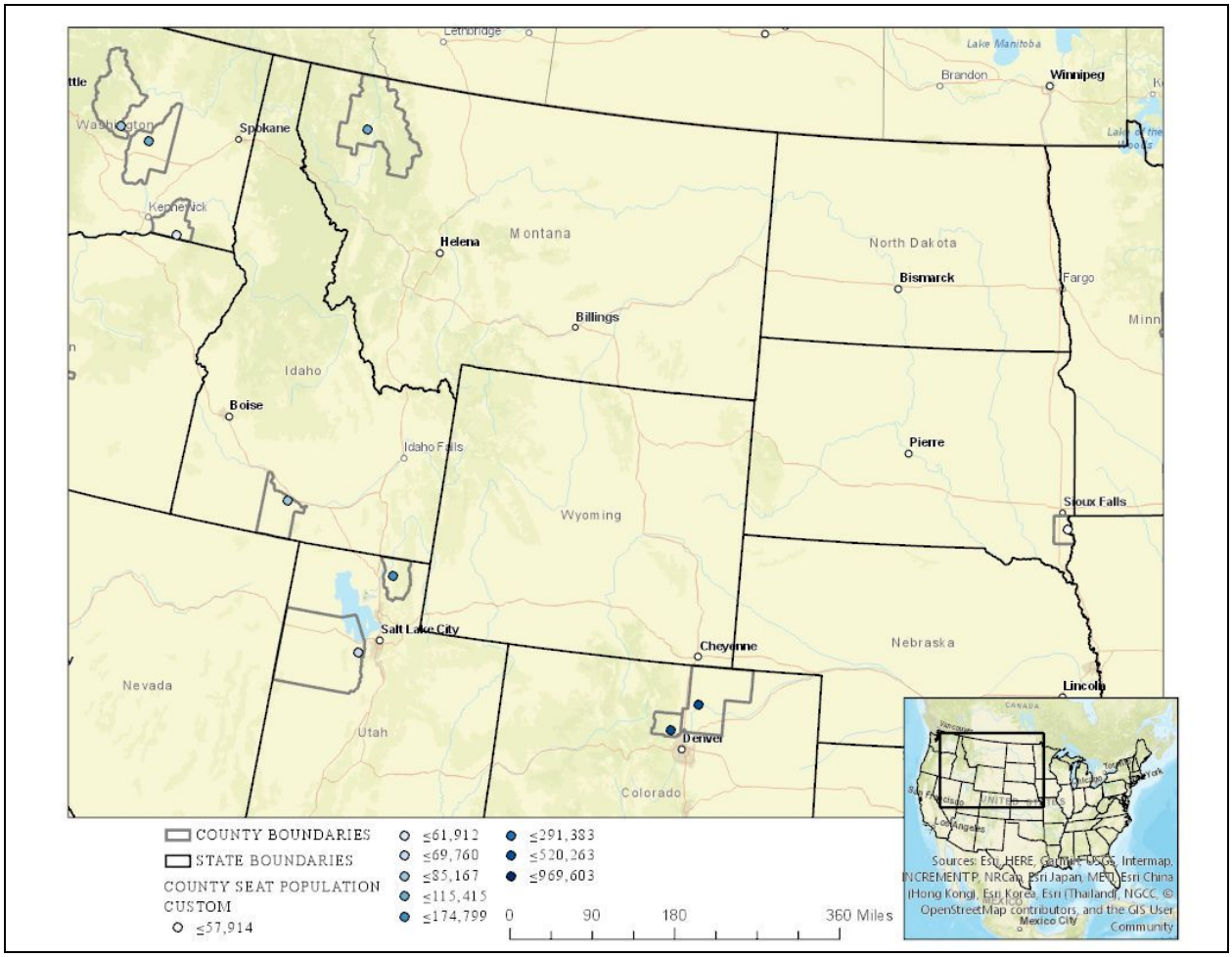

Figure 45. Map of County Seats in the Rocky Mountains. (US Census Bureau, 2018).

Based on Figure 45, The Rocky Mountains have a highly dispersed population. Denver has two county seats in Boulder and Greeley, and Utah has two county seats near Salt Lake City. Twin Falls in Idaho is the only county seat that meets all three criteria in Idaho and the same is true for Kalispell, Montana. Washington has several county seats shown in Figure 52.

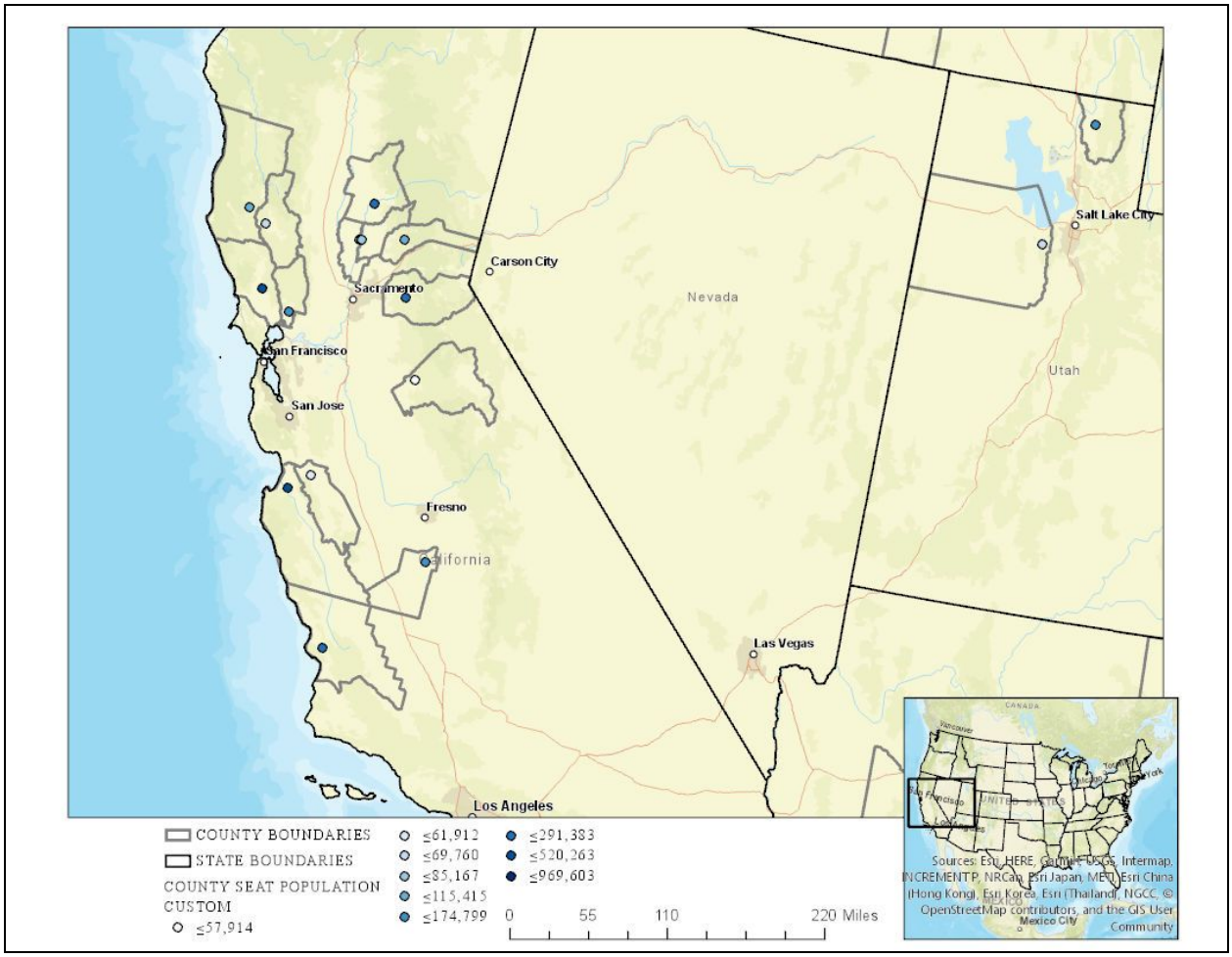

Figure 46. Map of County Seats in California. (US Census Bureau, 2018).

Based on Figure 46, California has a large portion of county seats that meet all three criteria. Four of the county seats can be found in the central portion of California. The rest of the county seats are found near San Francisco and Sacramento. Ventura and Santa Barbara would have been included if their elevation was above 100 feet.

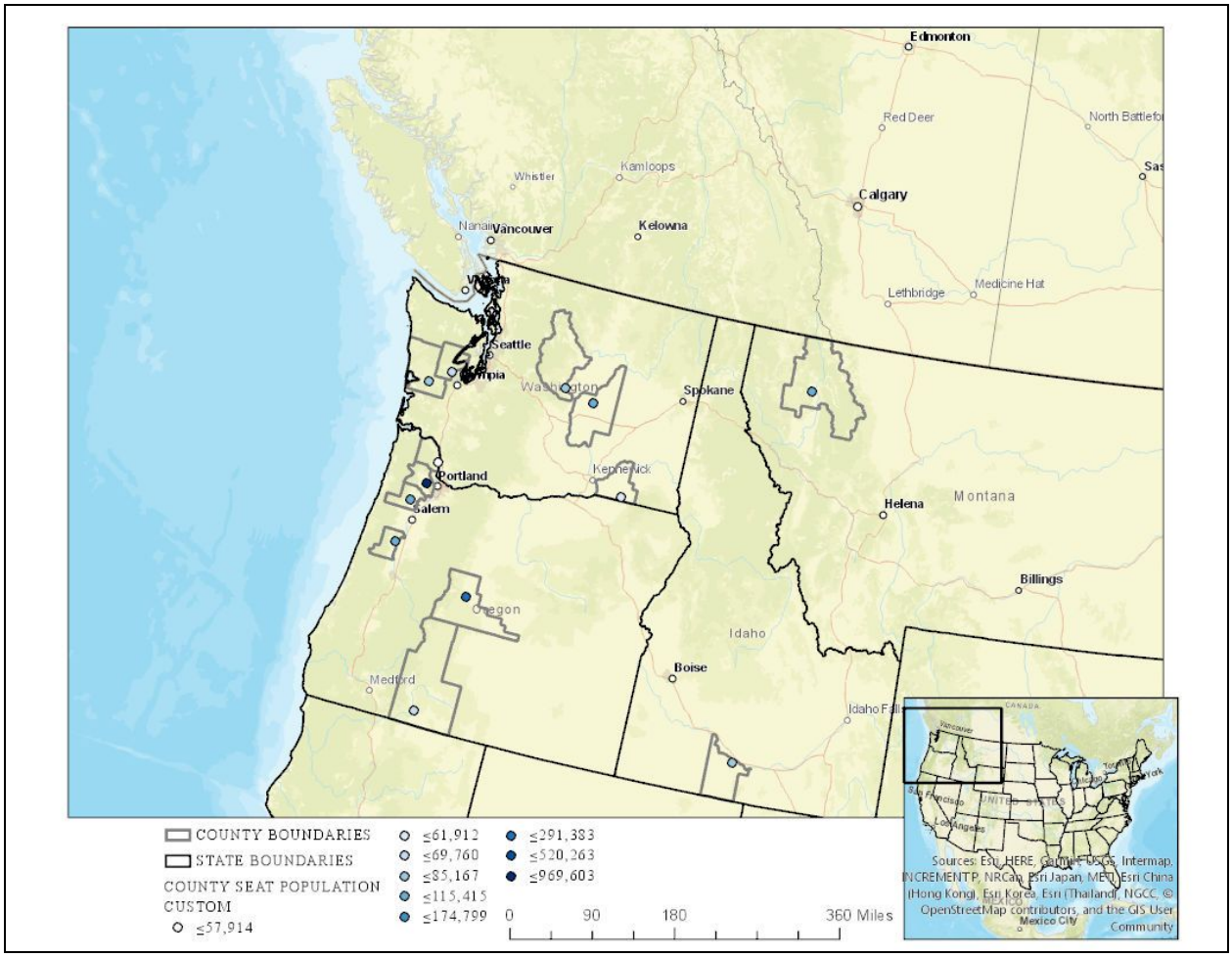

Figure 47. Map of County Seats in the Northwestern USA. (US Census Bureau, 2018).

Based on Figure 47, Washington has county seats scattered throughout the state. Oregon has county seats clustered in the Northwestern portion, while having Bend and Klamath Falls in the central portion. Klamath Falls barely meets the 50,000 population limit to be included.

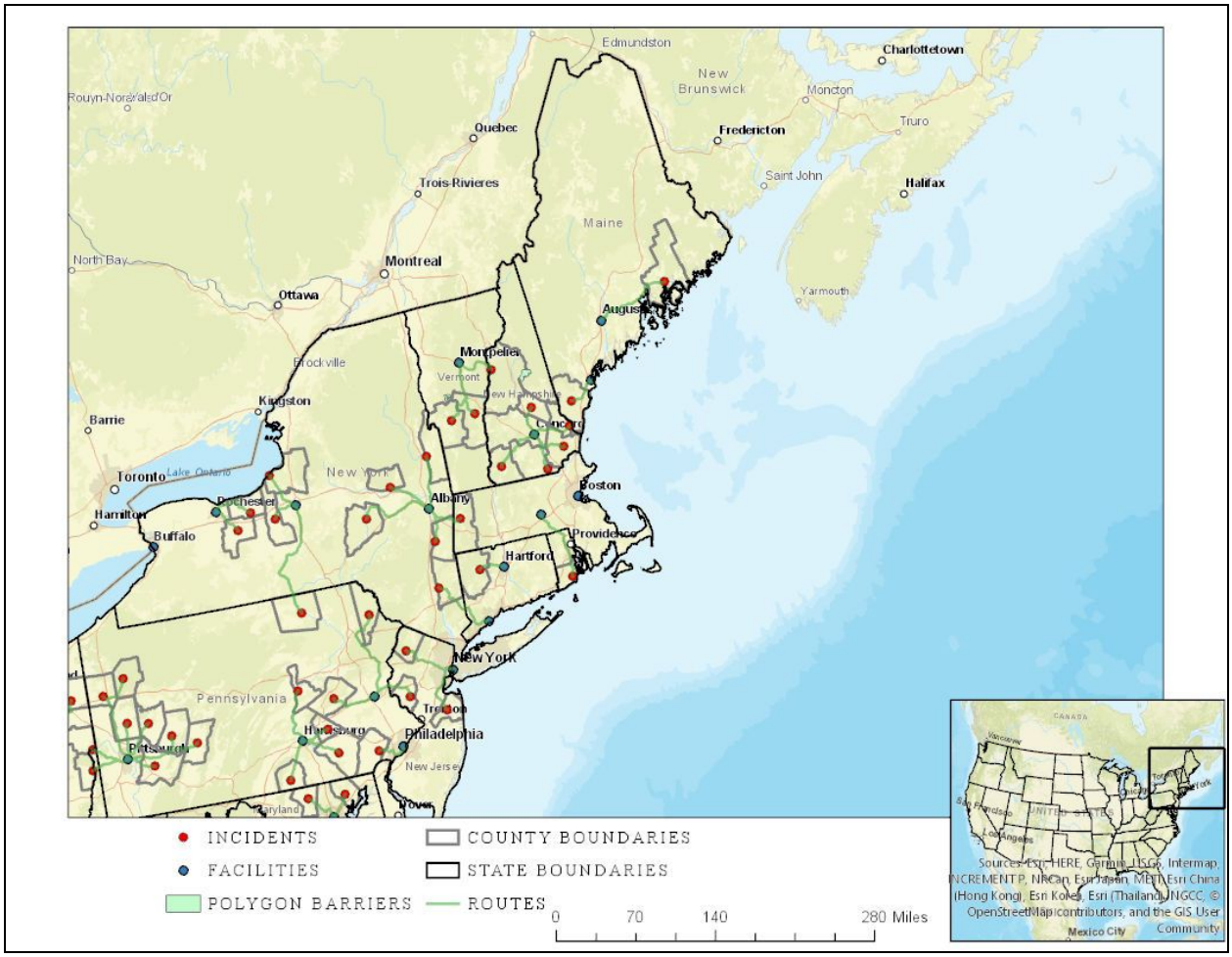

Figure 48. Network Analysis Results in the Northeastern USA. (Chase A. Minor, 2019).

Based on Figure 48, Boston and Buffalo are not used for any network. Albany and Concord, NH have the most routes. Montpelier and Syracuse have three cities. Allentown and Rochester both have two. Washington DC and Baltimore also have a few routes each, along with New York City. Hartford, Bridgeport, Worcester, Portland, and Augusta all have only one route.

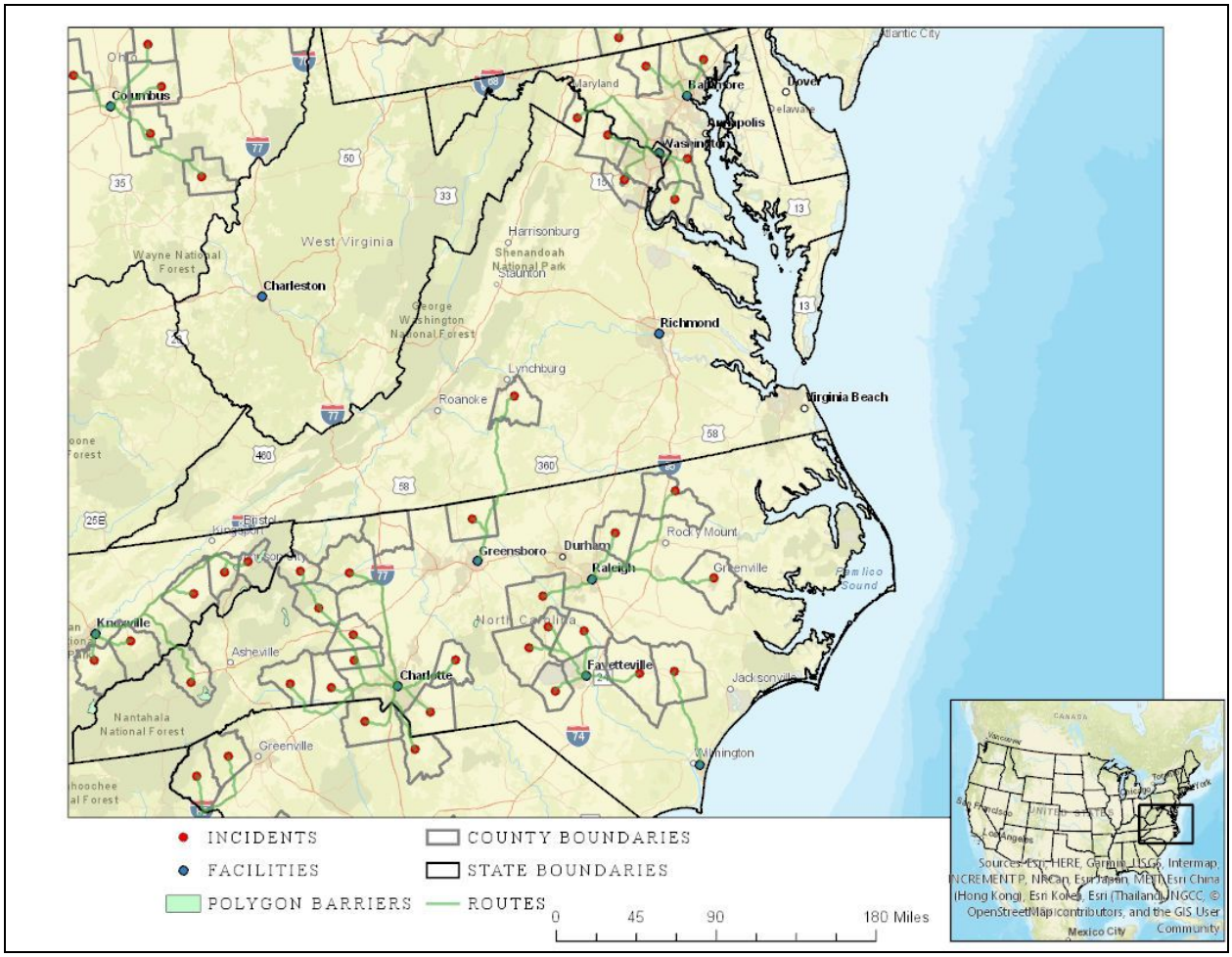

Figure 49. Map of Network Analysis Results in the Mid-Atlantic Region. (Chase A. Minor, 2019).

Based on Figure 49, a few cities are not used for any routes. Charlotte and Fayetteville, North Carolina have many county seats nearby. Greensboro connects to two incidents, while Wilmington only connects to one. Knoxville, Tennessee is connected to a good number of incidents, as well as Raleigh, Baltimore, and Washington, D.C. Richmond and Charleston are not used by the network.

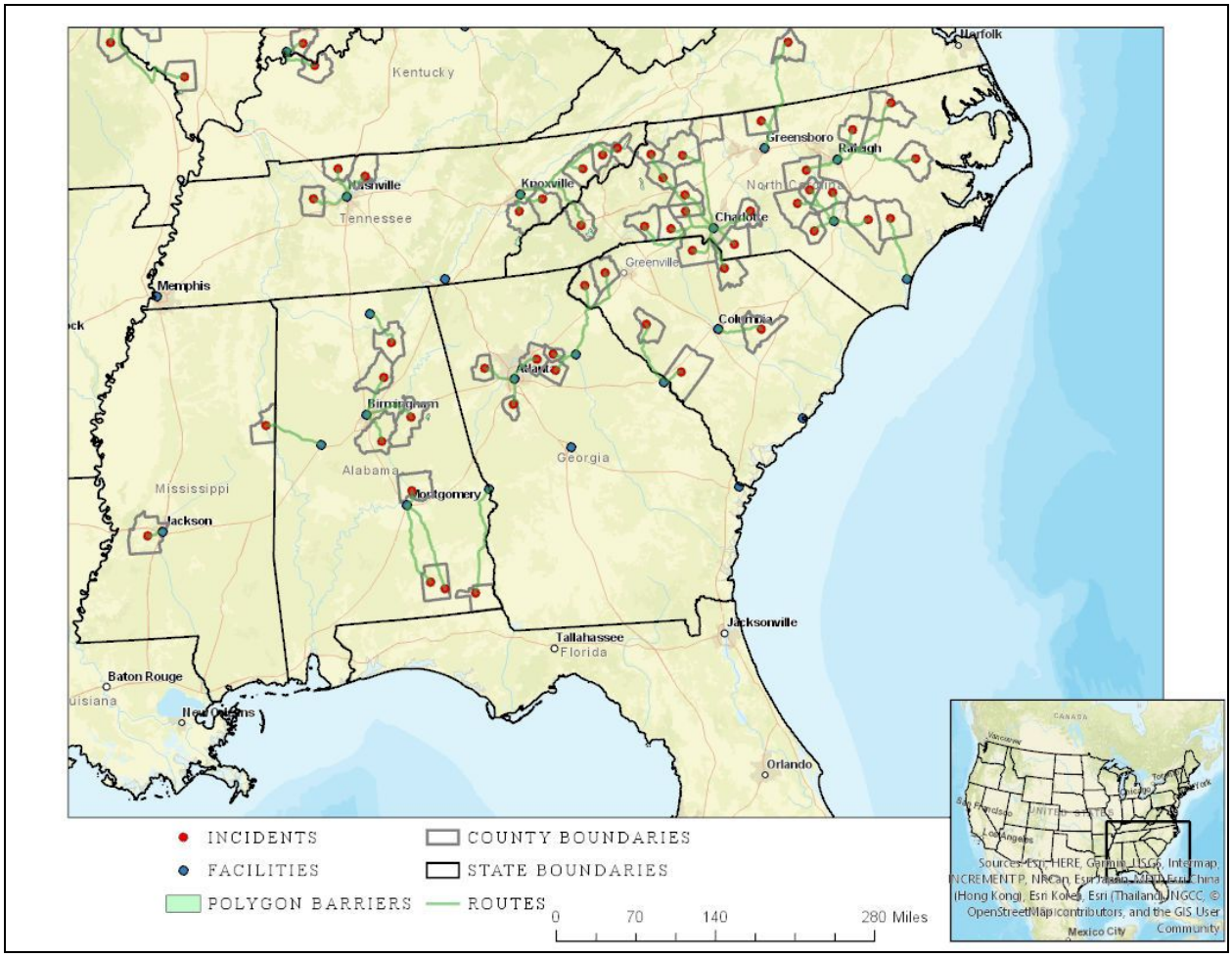

Figure 50. Map of Network Analysis in The South. (Chase A. Minor, 2019).

Based on Figure 50, Chattanooga, Memphis, Charleston, and Macon are not used by the Network Analysis. Jackson, Little Rock, and Shreveport each have one county seat nearby. Atlanta, Birmingham, Montgomery, Nashville, and Athens are connected to a reasonable number of county seats in the network.

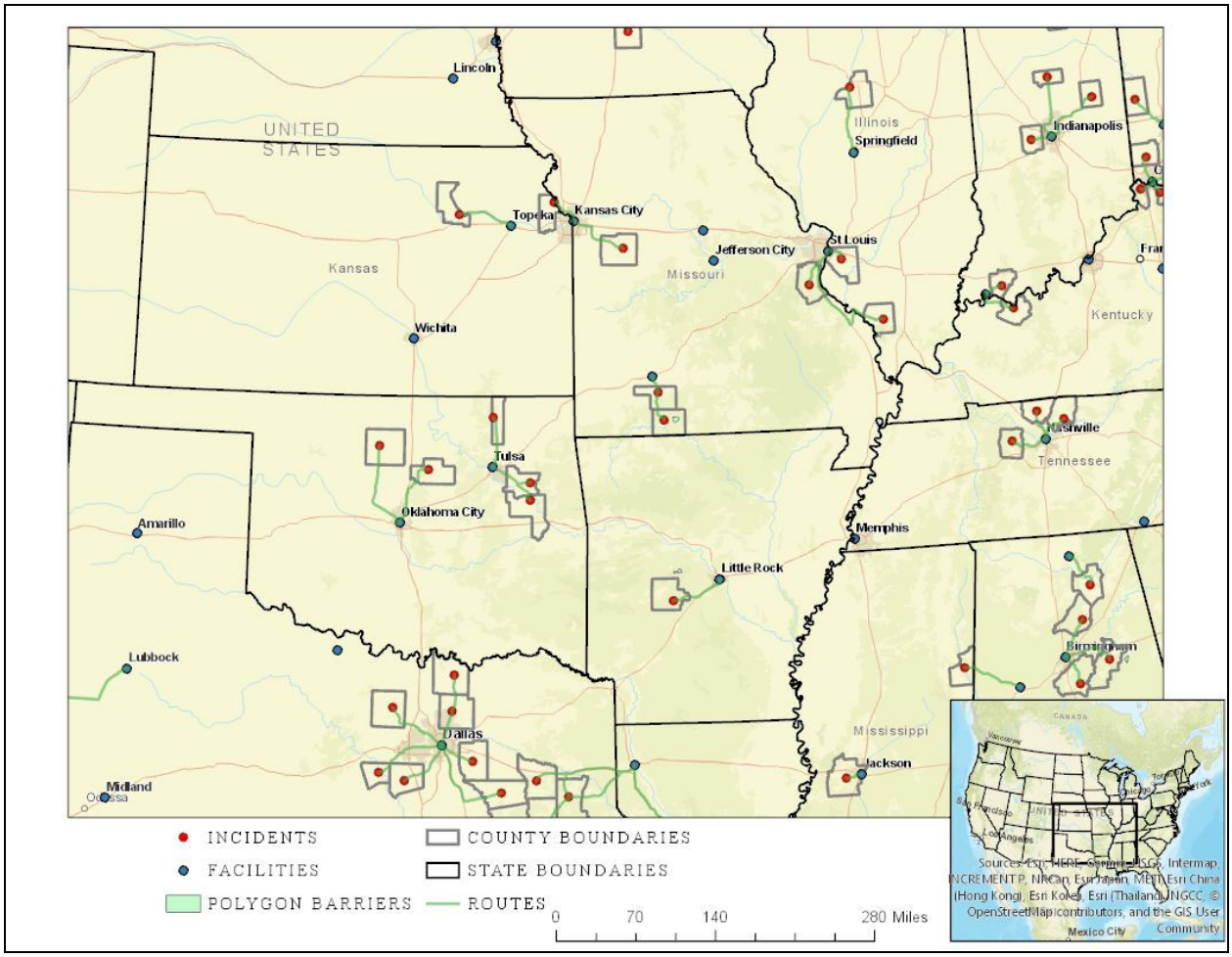

Figure 51. Results of Network Analysis in the South Central USA. (Chase A. Minor, 2019).

Based on Figure 51, Dallas has the majority of the routes. Memphis, Wichita Falls, Amarillo, and Midland are not used. Little Rock, Jackson, and Austin all have one route. Oklahoma City and Springfield, Missouri each have two, while Tulsa has three.

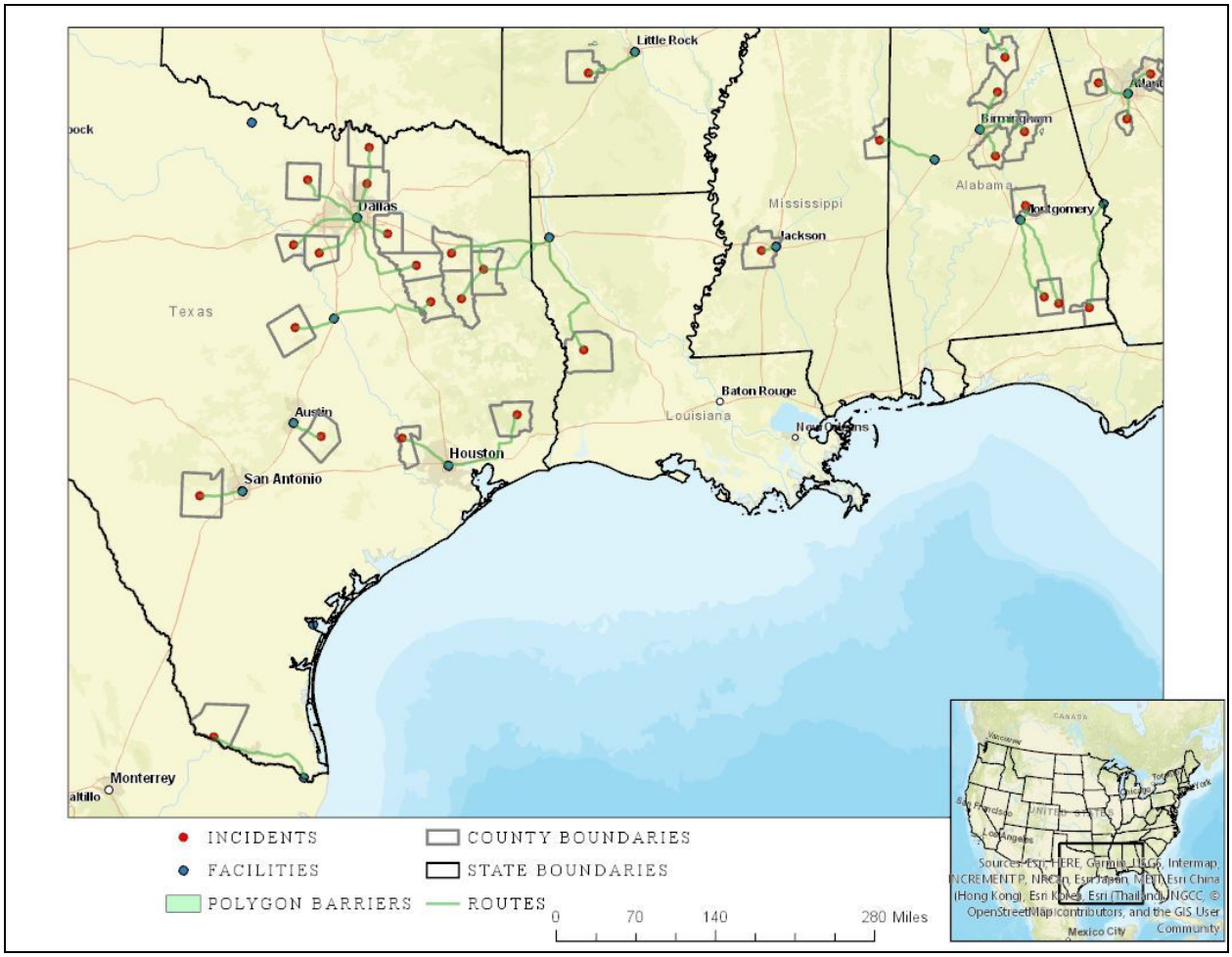

Figure 52. Results of Network Analysis in Southern Texas. (Chase A. Minor, 2019).

Based on Figure 52, Corpus Christi is not used by the network. Houston and Waco connect to two county seats. San Antonio, Brownsville, and Austin each connect to one county seat. Dallas and Shreveport have multiple connections each, but Wichita Falls is not used by the network.

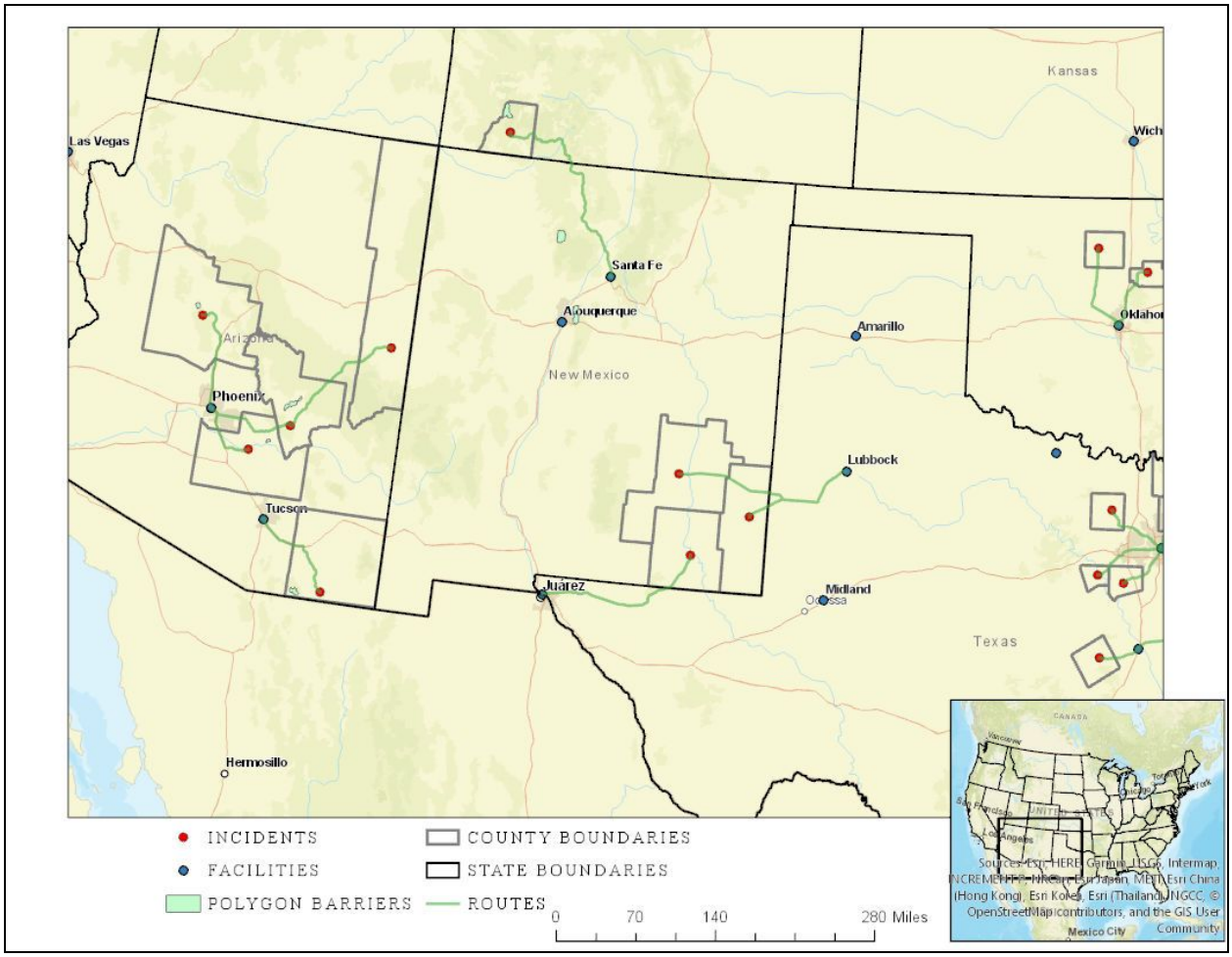

Figure 53. Map of Network Analysis Results in Southwest USA. (Chase A. Minor, 2019).

Based on Figure 53, Phoenix has the majority of routes. Amarillo, Midland, and Albuquerque are not used by the network. Durango is connected to Santa Fe. Tucson and El Paso both have one route. Lubbock has two nearby incidents. Phoenix has four routes.

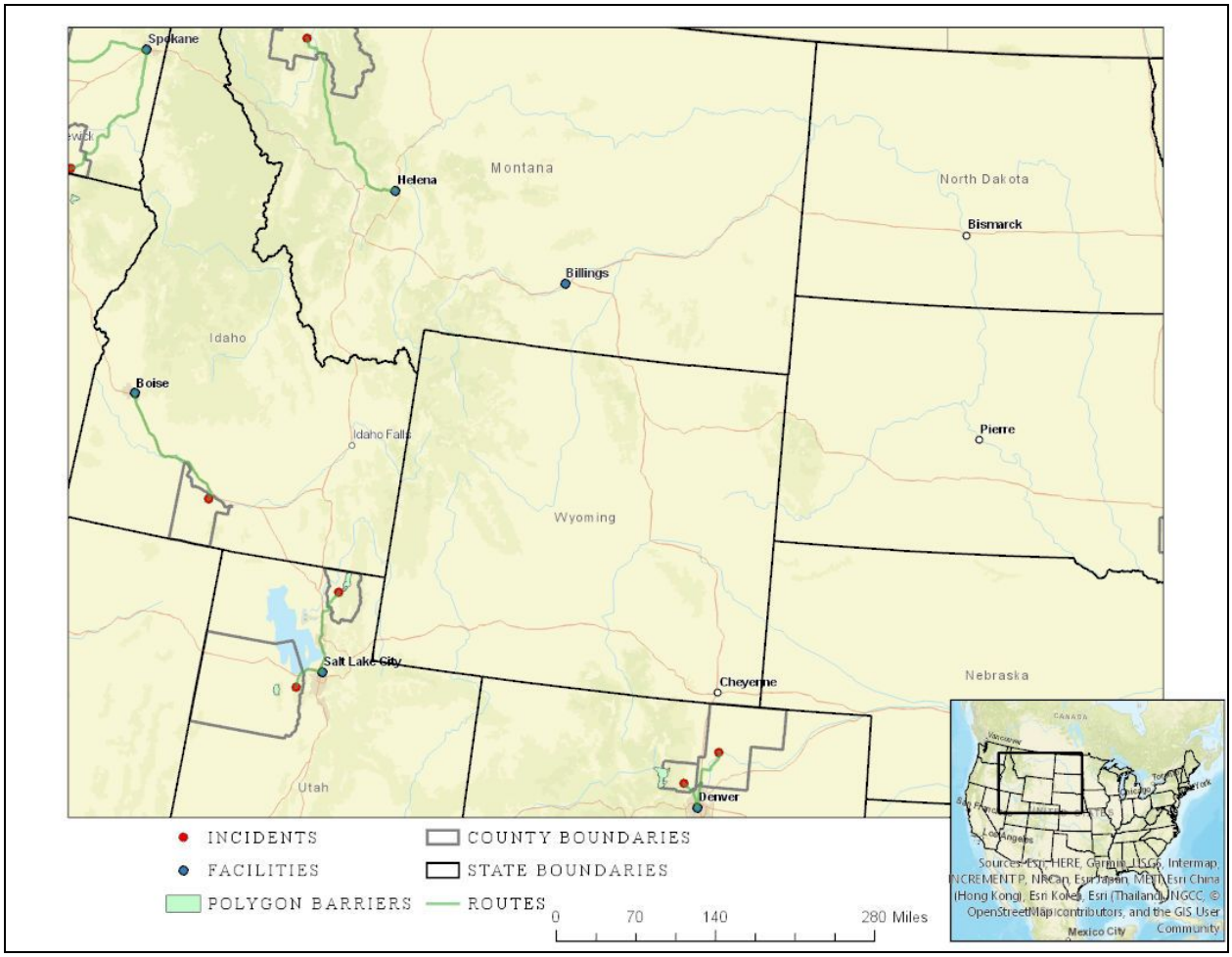

Figure 54. Network Analysis Results in the Rockies. (Chase A. Minor, 2019).

Based on Figure 54, Spokane, Salt Lake City, and Denver are connected to two county seats. Boise and Helena are connected to one county seat each. Billings is not used by the network.

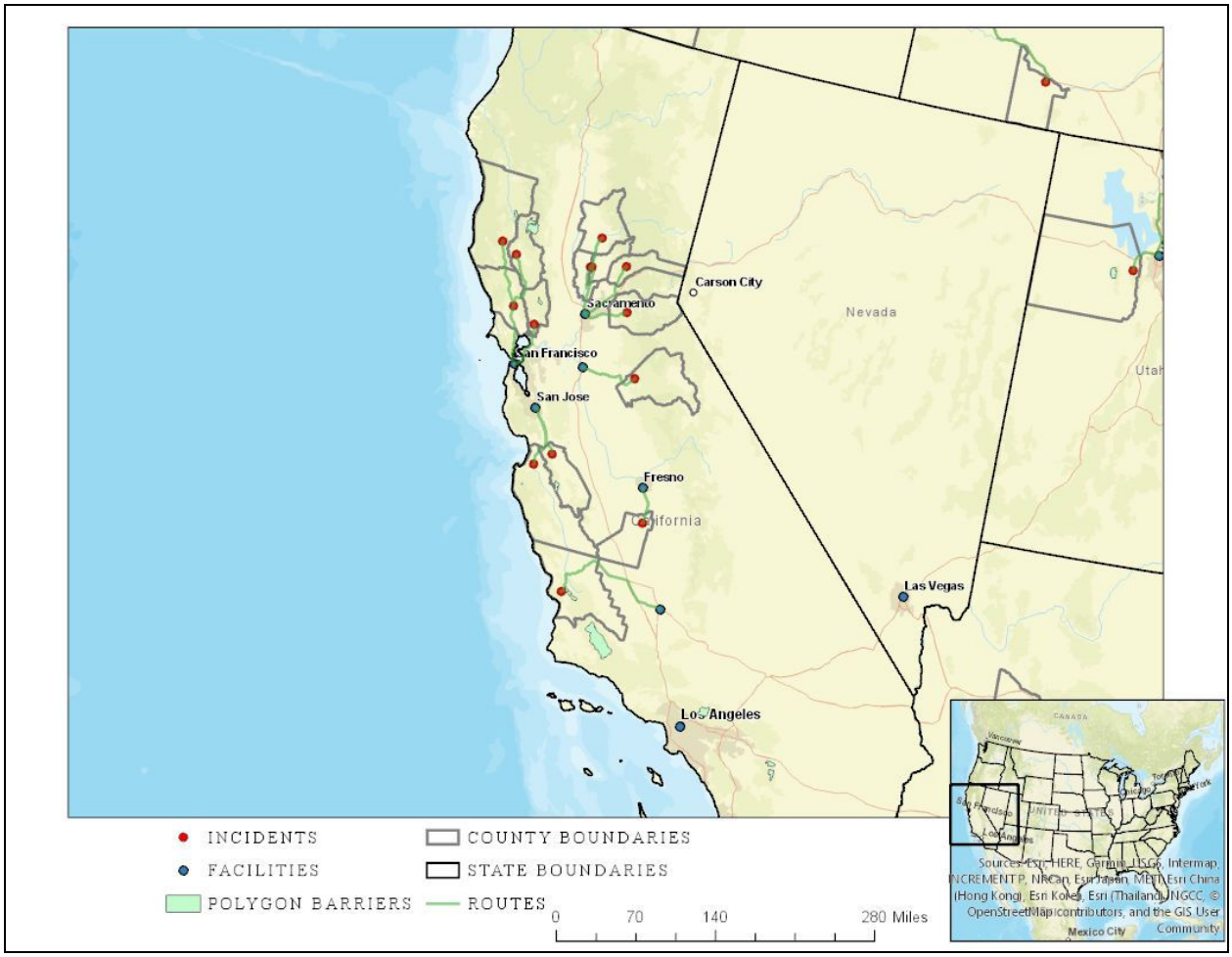

Figure 55. Map of Network Analysis Results in the Pacific Region of US. (Chase A. Minor, 2019).

Based on Figure 55, Las Vegas, Los Angeles, and San Diego were not used by the network. Fresno, Bakersfield, and Stockton each had one route. Sacramento had four, San Jose had two and San Francisco also has four.

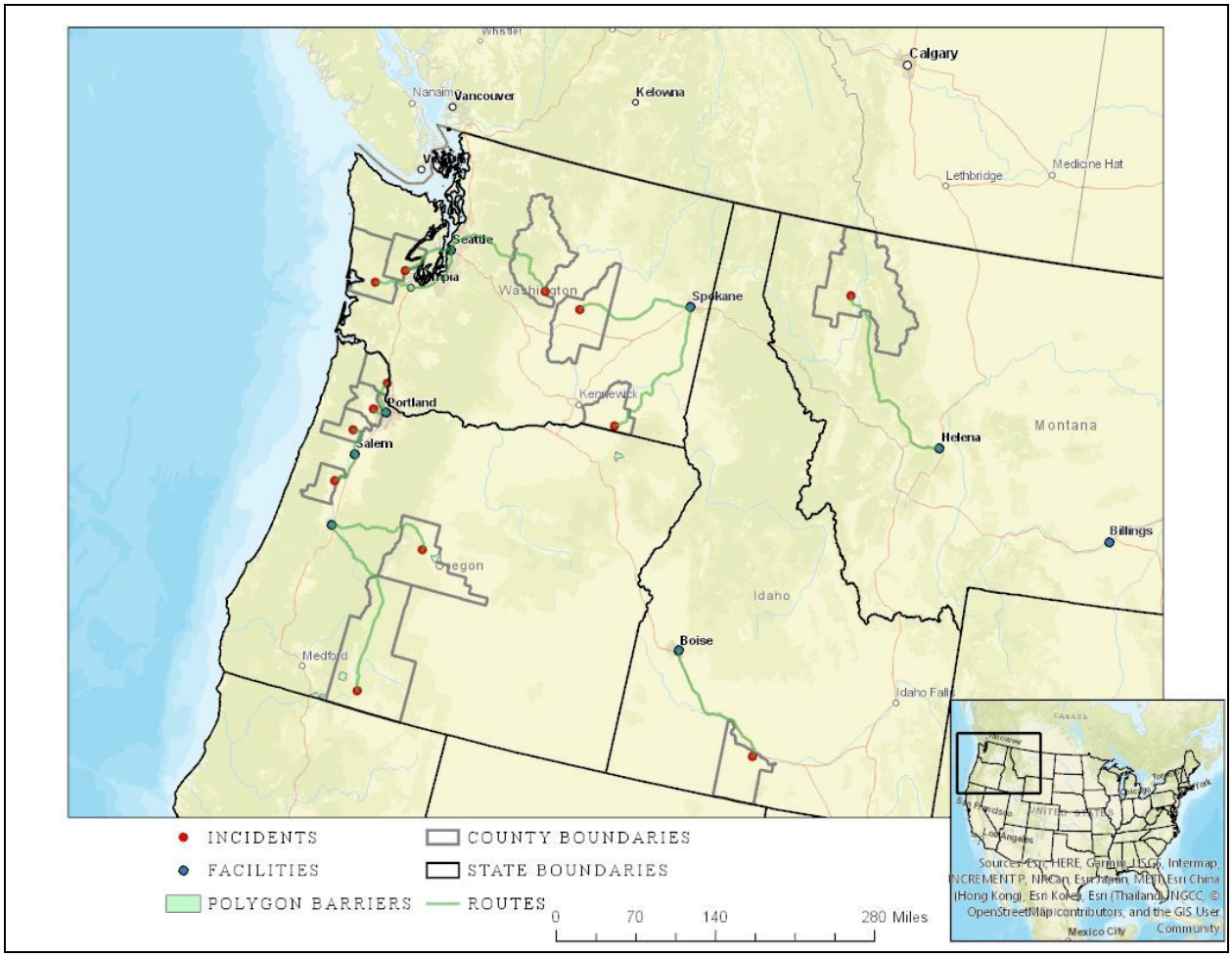

Figure 56. Map of Network Analysis Results in the Northwestern USA. (Chase A. Minor, 2019).

Based on Figure 56, Helena and Boise each have one route. Portland, Spokane, Eugene, and Salem each have two routes. Seattle has three routes. Billings was not used by the network.

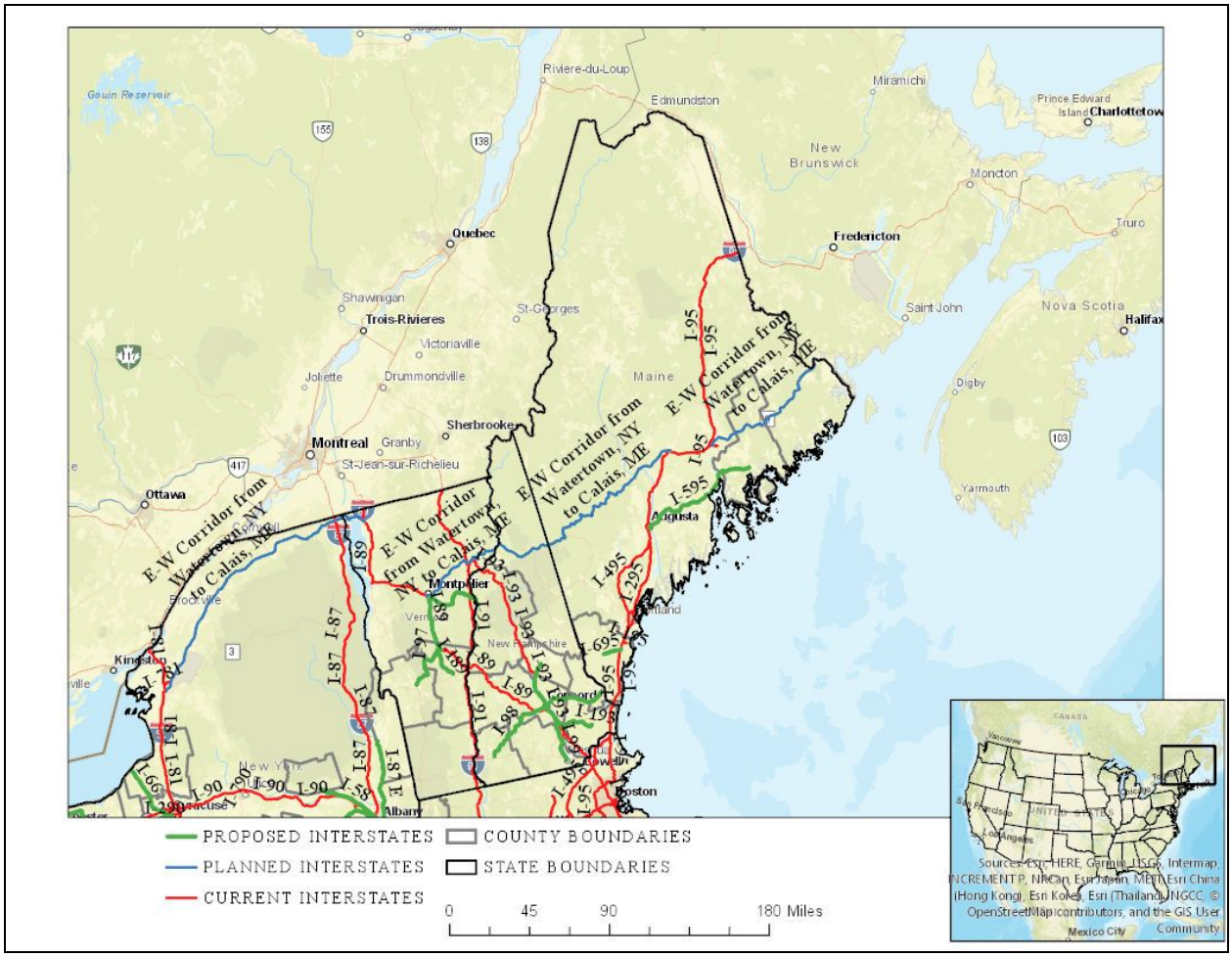

Figure 57. Map of New Proposed Interstates in New England. (Tiger/Line Shapefiles Roads, 2016), (FHWA, 2018), and (Chase A. Minor, 2019).

Based on Figure 57, there are several new proposed interstates in New England. The network analysis results have been combined as some of the routes have been joined into one new interstate for smoother connectivity between county seats and the connecting major city. Most of the new proposed interstates in New England are spurs. Northern Maine is not heavily populated, so it is unlikely that there will be any interstates in the future for this region.

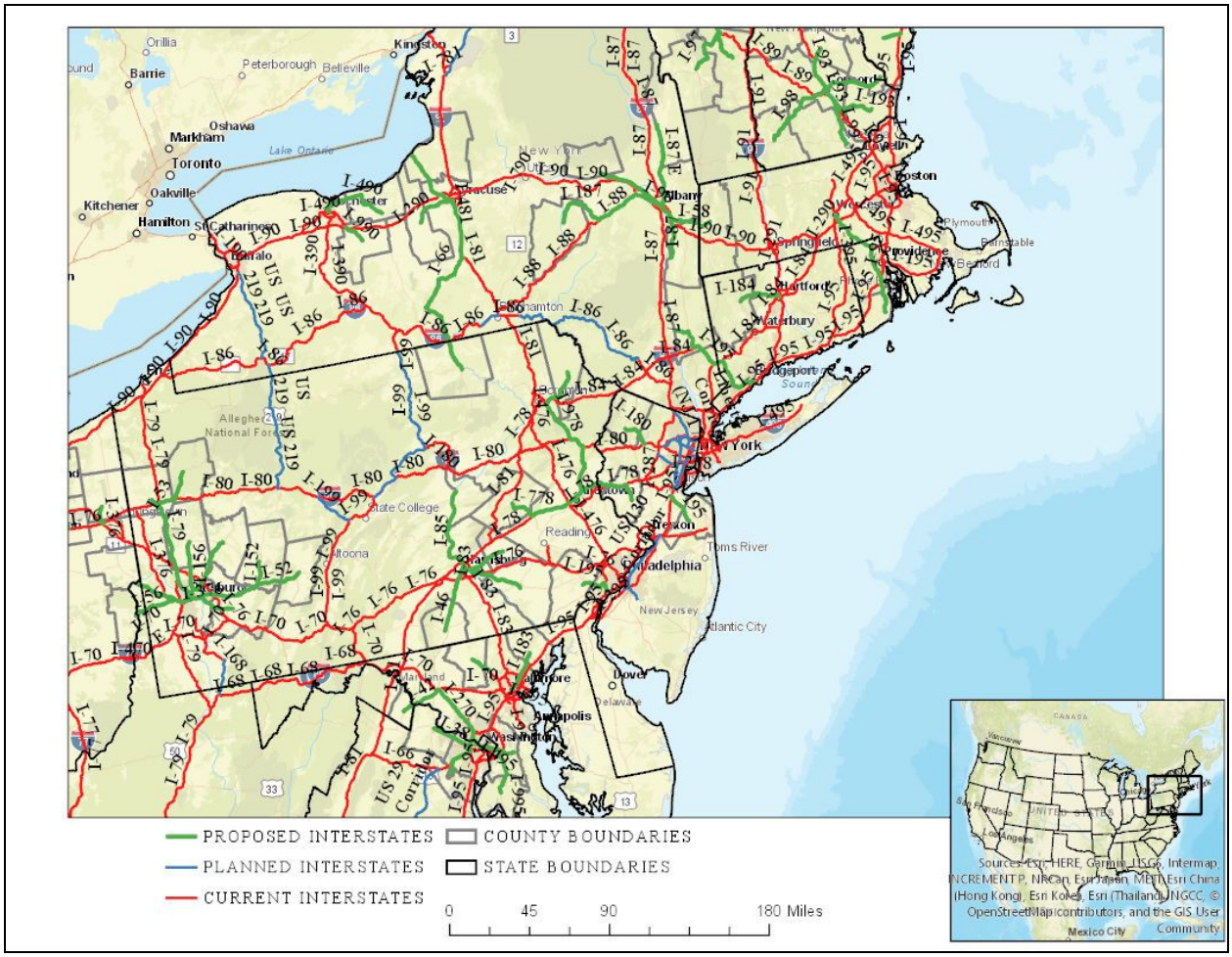

Figure 58. Map of New Proposed Interstates in the Mid-Atlantic Region. (Tiger/Line Shapefiles Roads, 2016), (FHWA, 2018), and (Chase A. Minor, 2019).

Based on Figure 58, some of the network analysis results have been combined into new proposed routes such as through Pittsburgh, Harrisburg, Allentown, and Albany. Some of the proposed routes are main interstates while the others are spurs. Northern Pennsylvania is currently not that populated, but eventually there could be an interstate through this area.

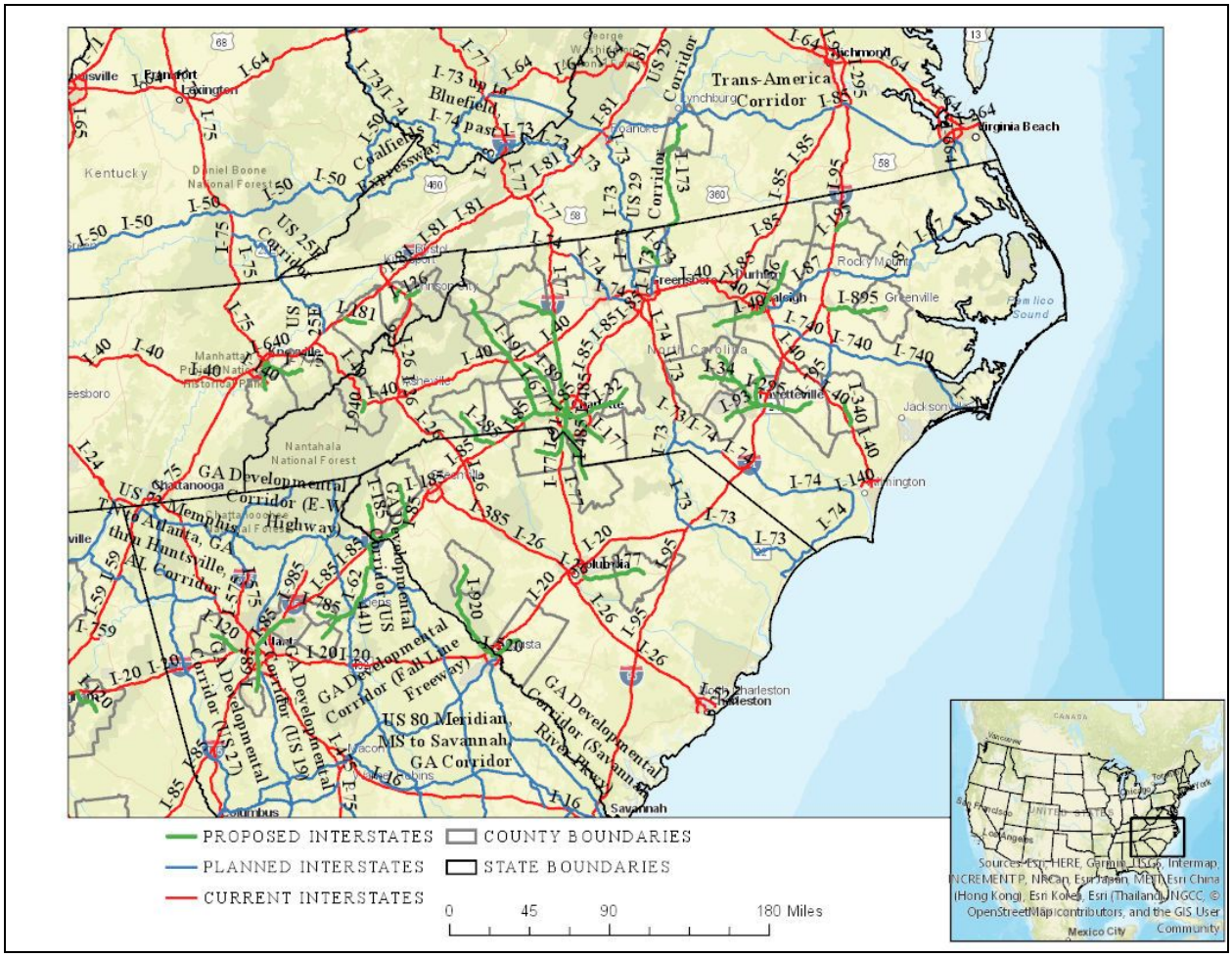

Figure 59. Map of New Proposed Interstates, Current Interstates, and Planned High Priority Corridors in the Southeast. (Tiger/Line Shapefiles Roads, 2016), (FHWA, 2018), and (Chase A. Minor, 2019).

Based on Figure 59, the Southeast region of the US has several proposed routes. The Coastal Region of the Southeast is likely to be flooded in the near future due to sea level rise, so there are not any new interstates connecting places like Charleston, Savannah, and Wilmington. Charlotte and Fayetteville are proposed to have multiple new interstates connect county seats on either side of Charlotte or Fayetteville. However, the Nantahala National Forest is a large blank space on the map, which could possibly be developed for interstate travel.

Figure 60. Map of New Proposed Interstates in The South. (Tiger/Line Shapefiles Roads, 2016), (FHWA, 2018), and (Chase A. Minor, 2019).

Based on Figure 60, the network analysis results were very diverse throughout this region. In Alabama, it was decided to designate I-61E and I-61W from Montgomery to Enterprise and Montgomery to Elba, respectively. It was also decided to have an extension of I-185 from Columbus to Dothan. The spur of I-20 from Tuscaloosa to Columbus, MS using US 82 could possibly continue using US 82 to reach Mississippi State University or even the University of Mississippi in Oxford.

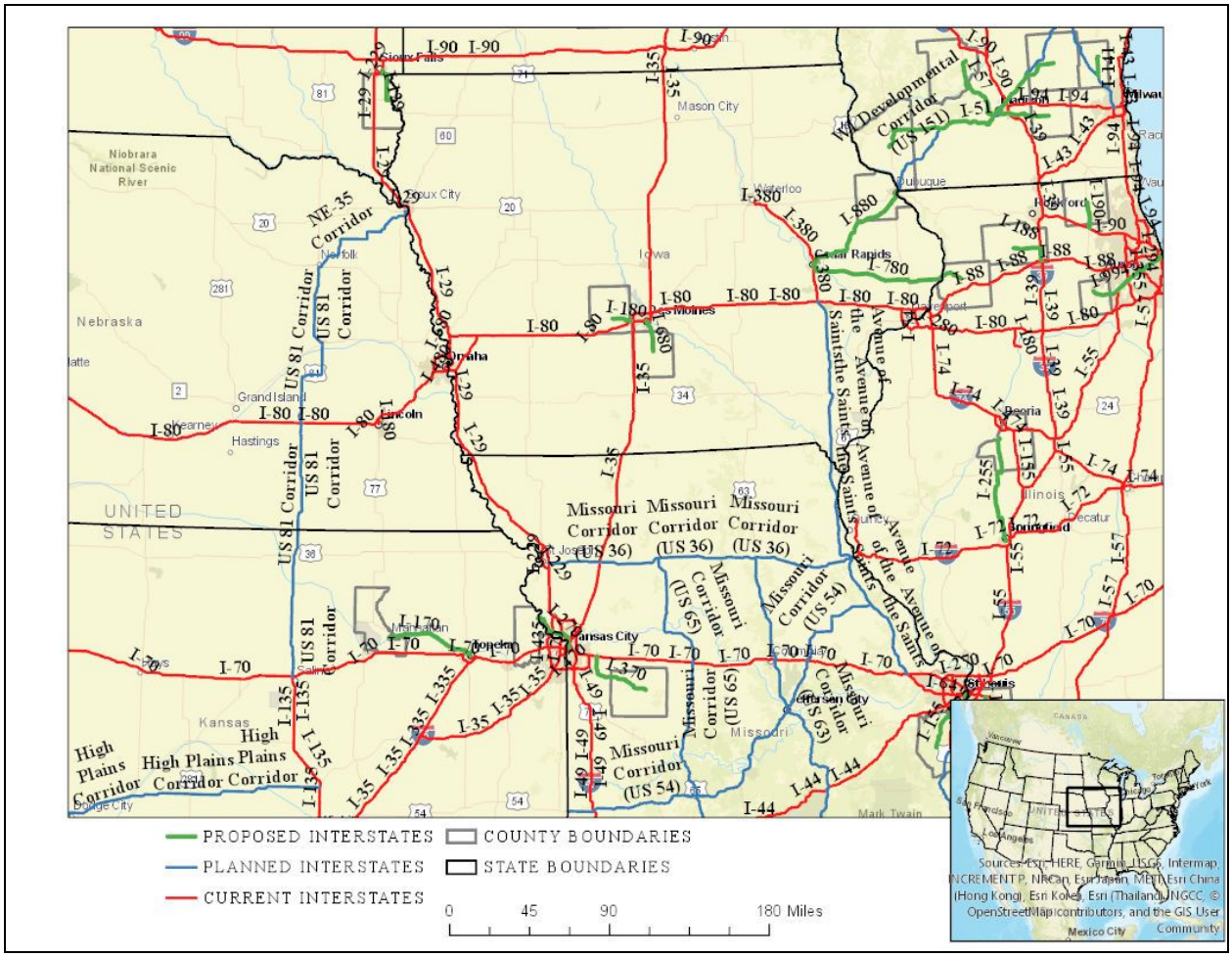

Figure 61. Map of New Proposed Interstates in the Midwestern USA. (Tiger/Line Shapefiles Roads, 2016), (FHWA, 2018), and (Chase A. Minor, 2019).

Based on Figure 61, Manhattan and Leavenworth will be proposed to have connectivity with spurs. Several spurs in Iowa and Illinois will be used to also connect the various county seats. Several places in Iowa, Kansas, and Missouri do not have enough of a population to be

connected to the interstate highway system based on the three criteria for this project.

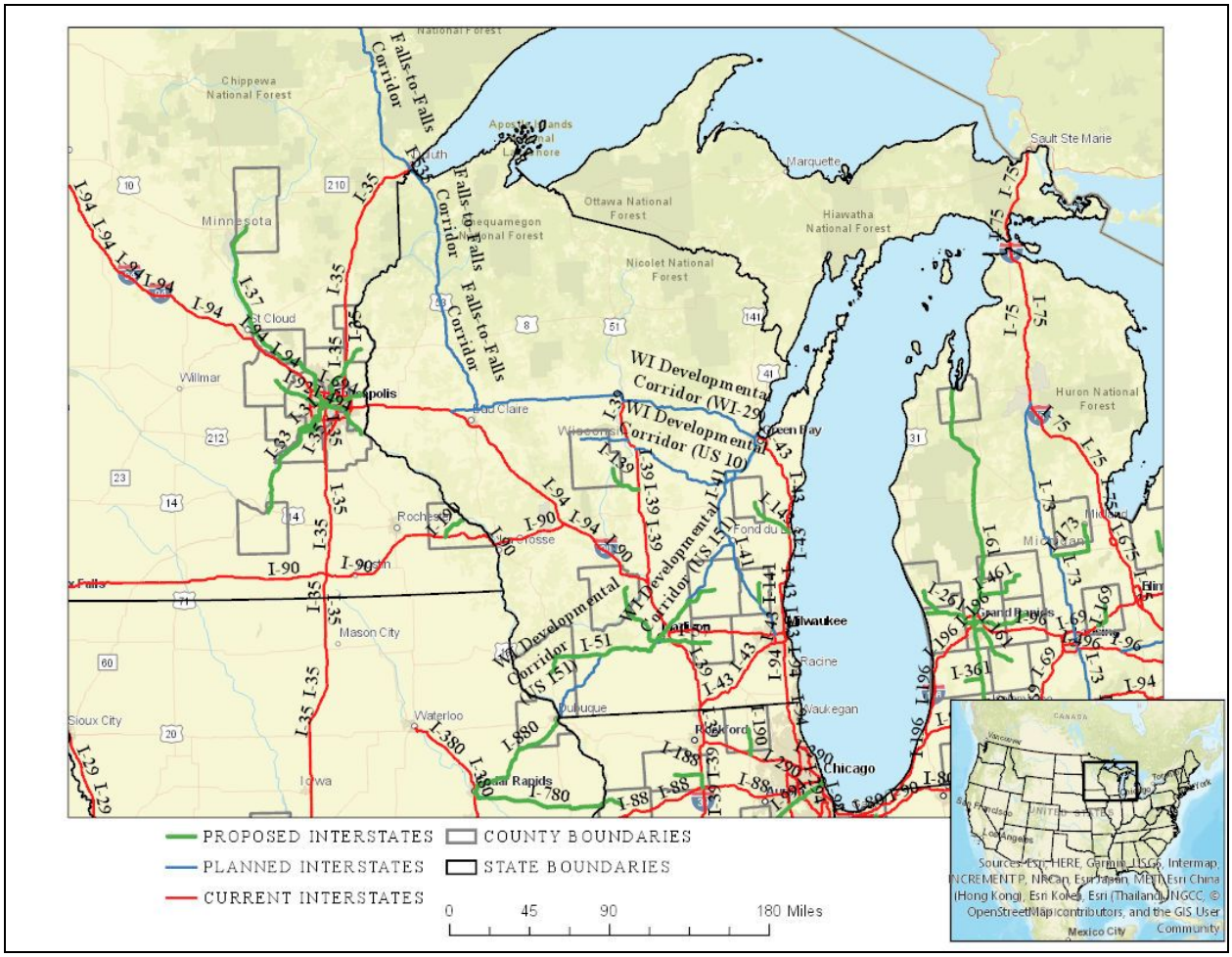

Figure 62. Map of New Proposed Interstates in the Old Northwest. (Tiger/Line Shapefiles Roads, 2016), (FHWA, 2018), and (Chase A. Minor, 2019).

Based on Figure 62, I-61 will be the proposed interstate connecting Southern Michigan to Traverse City. Several county seats in Michigan will either be connected through a main interstate or with spurs, as is the case with all of county seats in Indiana and Illinois. Wisconsin will have a mix of main interstates and spurs. It is also proposed that county seats in Minnesota be connected through spurs or main interstates.

Figure 63. Map of New Proposed Interstates in Tennessee, Kentucky, Arkansas, Mississippi, Alabama, Illinois, Indiana, and Missouri Area. (Tiger/Line Shapefiles Roads, 2016), (FHWA, 2018), and (Chase A. Minor, 2019).

Based on Figure 63, Nashville will have the most proposed connections, as well as Cincinnati. Several places do not have any interstate coverage, but these places are not heavily populated and thus have no need for interstates. This is mostly true in Southern Tennessee.

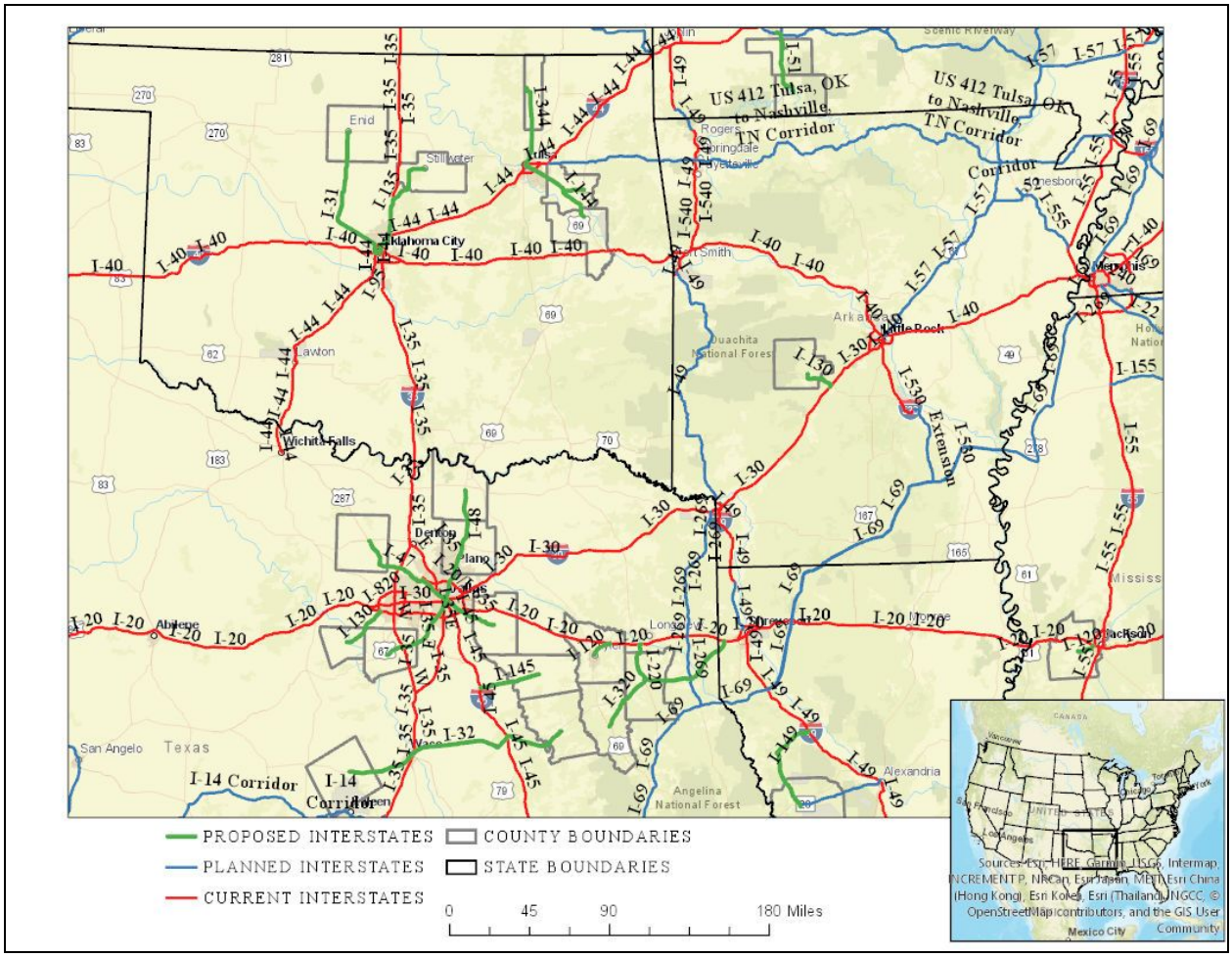

Figure 64. Map of New Proposed Interstates in the South Central United States. (Tiger/Line Shapefiles Roads, 2016), (FHWA, 2018), and (Chase A. Minor, 2019).

Based on Figure 64, Dallas will have multiple proposed interstates heading in either direction. I-32 will head through Waco to connect the nearest two county seats. I-2 will be extended to Rio Grande City. The rest of the county seats in Texas will be connected through spurs, as well as the county seat of Vernon Parish, Louisiana. The route heading from Little Rock, Arkansas to Hot Springs will be a spur of I-30. County seats near Oklahoma City and Tulsa will either be connected through a spur or by a main interstate. I-51 will connect Springfield and Ozark.

Figure 65. Map of New Proposed Interstates in Southern Texas. (Tiger/Line Shapefiles Roads, 2016), (FHWA, 2018), and (Chase A. Minor, 2019).

Based on Figure 65, it is proposed that I-32 will connect Waco and the two county seats that are nearby as performed by Network Analysis. I-2 will have an extension out to Rio Grande City and the other county seats near San Antonio and Houston will be connected using spurs. There are also several gaps where there could be interstates when these areas become populated enough.

Figure 66. Map of New Proposed Interstates in Denver. (Tiger/Line Shapefiles Roads, 2016), (FHWA, 2018), and (Chase A. Minor, 2019).

Based on Figure 66, it is proposed that Greeley and Boulder be connected through spurs of I-25. It is important to note that this portion of the county has a rough topography and is not highly populated, so it would not be cost effective to plan any new interstates through this region.

Figure 67. Map of New Proposed Interstates in The Rockies. (Tiger/Line Shapefiles Roads, 2016), (FHWA, 2018), and (Chase A. Minor, 2019).

Based on Figure 72, I-13 is proposed to connect Helena and Kalispell. Salt Lake City will have spurs out to Logan and Tooele. A spur of I-84 will connect Twin Falls. The rest of the region is not highly populated and has a very rough topography which prevents the need for interstates in the region.

Figure 68. Map of New Proposed Interstates in the Southwestern US. (Tiger/Line Shapefiles Roads, 2016) and (FHWA, 2018), and (Chase A. Minor, 2019).

Based on Figure 68, it is proposed that from Roswell to Lubbock will be I-18. I-118 will be a spur out to Clovis. I-6 will be a proposed main highway heading from El Paso, through the Guadalupe Mountains and Carlsbad Caverns National Park, and eventually reaching Carlsbad. I-21 is proposed to connect Phoenix, Globe, and St. John's. Florence, Prescott, and Bisbee will be connected by spurs. I-23 is proposed to connect Durango and I-25 in New Mexico.

Figure 69. Map of New Proposed Interstates in the Pacific Region of the US. (Tiger/Line Shapefiles Roads, 2016), (FHWA, 2018), and (Chase A. Minor, 2019).

Based on Figure 69, I-28 will connect San Luis Obispo and Bakersfield. Also, I-1 will use US 101, north of San Francisco, along the west coast, as will I-3, south of San Francisco. I-9 will be extended from Sacramento up to Oroville. Several spurs are proposed to connect Northern California's county seats.

Figure 70. Map of New Proposed Interstates in the Pacific Northwest. (Tiger/Line Shapefiles Roads, 2016), (FHWA, 2018), and (Chase A. Minor, 2019).

Based on Figure 70, Twin Falls will be connected to the interstate highway system through a proposed spur of I-84. Kalispell will be connected to Helena with I-17. I-11 will be used as the designation of two separate interstates, like I-87 in North Carolina and I-87 in New York. Montesano and Mason City will be connected to Seattle by spurs, along with some of the county seats to Portland and Salem. I-7 is proposed to connect Bend and Klamath Falls to Eugene. I-100 will connect Spokane and Seattle through Chelan and Wenatchee.