North Carolina Statewide Multimodal Freight Plan

Rail Profile

prepared for

North Carolina
Department of Transportation

prepared by

Cambridge Systematics, Inc.

with

AECOM

February 7, 2017

report

North Carolina Statewide Multimodal Freight Plan

Rail Profile

prepared for

North Carolina Department of Transportation

prepared by

Cambridge Systematics, Inc.
730 Peachtree Street NE, Suite 500
Atlanta, GA 30318

with

AECOM
701 Corporate Center Drive, Suite 475
Raleigh, North Carolina 27607

date

February 7, 2017

Table of Contents

List of Tables

List of Figures

List of Acronyms

AAR	Association of American Railroads
ABS	Automatic Block Signaling
AR	Aberdeen & Rockfish Railroad
ARRA	American Recovery and Reinvestment Act
ATW	Atlantic & Western Railway
BTS	Bureau of Transportation Statistics
CAGR	Compound Annual Growth Rate
CATS	Charlotte Area Transit System
CCX	Carolina Connector Intermodal Rail Terminal
CFR	Code of Federal Regulations
CFS	Commodity Flow Survey
CLNA	Coastal Carolina Railroad
CSXT	CSX Transportation
CTA	ORNL's Center for Transportation Analysis
CTC	Centralized Traffic Control
CTI	Commuter Train Interference
DBS	Debris
DCS	Signal Delays
DOD	Department of Defense
DSR	Slow Order Delays
FAF	Freight Analysis Framework
FAST	Fixing America's Surface Transportation Act
FRA	Federal Rail Administration
FRRCSI	Freight Rail and Rail Crossing Safety Improvement
FTI	Freight Train Interference
FY	Fiscal Year
GTP	Global TransPark
HazMat	Hazardous Materials
I-###	Interstate ###
LEHD	Longitudinal Employer-Household Dynamics

LOS	Level of Service
MAS	Multi-Agent System
MPO	Municipal Planning Organization
n.e.c.	Not Elsewhere Classified
N/S	No Signal
NC	North Carolina
NCDOT	North Carolina Department of Transportation
NCRR	North Carolina Railroad
NCSRP	North Carolina Statewide Rail Plan
NCVA	North Carolina & Virginia Railroad
NMFN	National Multimodal Freight Network
NS	Norfolk Southern
OD	Origin-Destination
ORNL	Oak Ridge National Laboratory
OTP	On-Time Performance
PTI	Passenger Train Interference
Q	Quarter, as in for a fiscal year
RPO	Rural Planning Organization
RR	Railroad
RSIA	Rail Safety Improvement Act
SARAH	
SEROps	Southeast Rail Operations Study
STB	Surface Transportation Board
STCC	Standard Transportation Commodity Code
STCG	Standard Classification of Transported Goods
STI	Strategic Transportation Investment Program
STRACNET	Strategic Rail Corridor Network
TN	Tennessee
TWC	Track Warrant Control
U.S.C.	United States Code
URCS	Uniform Rail Costing System
US	United States
USD	United States Dollars

USDOT	United States Department of Transportation
V/C	Volume-to-Capacity Ratio
VA	Virginia
VMT	Vehicle Miles Traveled
WTRY	Wilmington Terminal Railroad

1.0 Overview

1.1 Purpose

Rail transport is one of the five key modes of freight movement and can be singularly used or used as part of a multi-modal network. Detailed in this modal profile are the supply and demand sides of rail transport as they relate to North Carolina's (NC) economy and other transport networks. Both the current state of the mode and how it is expected to evolve into the future are discussed with a focus on needs as well as opportunities.

1.2 Methods and Data Overview

The rail modal profile is based primarily on the North Carolina Comprehensive State Rail Plan (AECOM, 2015) which extensively described the mode and its integration within the state of North Carolina. Key concepts and background remain the same in this report whereas the data have been updated for this plan to reflect current conditions and forecasts. When possible, new datasets from the same sources have been acquired so the data were collected and processed in the same manner and are hence comparable to the data presented in the North Carolina State Rail Plan. Table 1.1 shows a comparison of datasets used in the State Rail Plan and in this report.

Table 1.1 Dataset Comparison

North Carolina State Rail Plan	Rail Modal Profile
Bureau of Labor Statistics	Bureau of Labor Statistics
IHS Global Insight: 2011 Forecast	Cambridge Systematics: Economic Forecast
North Carolina Department of Transportation (NCDOT) Rail Track shapefile, 2014	NCDOT Rail Track shapefile, 2016
US Census, 2011 LEHD	US Census, 2014 LEHD
Freight Analysis Framework (FAF) 3.1	FAF 3.1 and FAF 4.1
Southeast Rail Operations Study (SEROps)	SEROps
American Association of Railroads, 2011, State Snapshot	American Association of Railroads, 2016, State Snapshot
National Transportation Atlas Database	National Transportation Atlas Database
Federal Railroad Administration (FRA) Office of Safety Statistics	FRA Office of Safety Statistics, NCDOT SARAH
Surface Transportation Board (STB) Waybill	STB Waybill
Strategic Transportation Investment Program 3 (STI 3)	STI 4
Amtrak Quarterly Reports	Amtrak Quarterly Reports

Other key references drawn upon include the following:

- Stakeholder interviews and Freight Advisory Committee records

- Evaluation of a Proposed Carolina Connector Intermodal Rail Terminal (CCX) in Rocky Mount, North Carolina (WSP|Parsons Brinkerhoff, 2016)
- North Carolina Maritime Strategy (AECOM, 2012)

1.3 Section Organization

The next, and second, section of this report is a look at the existing supply-side of rail freight in North Carolina. The state's rail network and major facilities are discussed in terms of infrastructure and capacity. In addition, how those connect to the broader transport system is shown. And finally, what services are offered and which companies provide services are mentioned.

The third section has descriptions of the existing demand-side of rail freight in North Carolina with a focus on network usage for rail freight activities as well as performance. The industries served and markets supported by rail transport are outlined. Moreover, rail transport safety is briefly covered.

The fourth section identifies various trends and forecasts (demographic, economic, transportation) that will help establish future freight rail markets and unmet needs in North Carolina.

The fifth, and final, section provides a needs assessment. This assessment identifies needs and opportunities for the North Carolina rail system and services that it offers, which in turn will help determine projects and future service to meet these unmet needs and emerging markets.

2.0 Inventory

Section two provides a description of the individual facilities and portions of national corridors that comprise North Carolina's railroad network capacity.

2.1 Facilities

The two types of railroad facilities discussed include the interconnected railroad system and the major rail facilities where freight can be loaded, unloaded, or transferred.

2.1.1 Railroad System

The railroad system in North Carolina consists of all the rail tracks, and operators. This system also includes where these lines intersect with roadways at public crossings.

Rail Lines

Today there are over 3,200 miles of railroad in North Carolina, serving 86 of the state's 100 counties. The state is served by two Class I railroads – Norfolk Southern (NS) and CSX Transportation (CSXT) and 20 short line railroads that connect businesses and industries to the Class I network. Some short lines are managed by regional railroads like Genesee and Wyoming[1], Watco (Blue Ridge Southern Railroad), and RJ Corman (Carolina Southern Railroad). In addition, the North Carolina Railroad (NCRR) Company owns and manages a 317-mile corridor extending from the Port of Morehead City to Charlotte. NS operates along the corridor through an operating and maintenance agreement. The freight rail network in North Carolina provides services to ports, power plants, mines, military installations, and industries including agriculture, forestry, plastics, furniture, food products, and chemicals. Figure 2.1 identifies railroad owners and operators in North Carolina and Table 2.1 shows the breakdown of route mileage.

[1] It oversees several short lines. In NC they include: Atlantic and Western Railway, Wilmington Terminal Railroad (WTRY), North Carolina & Virginia Railroad, and Chesapeake & Albemarle Railroad.

Figure 2.1 Track Ownership and Railroad Operators in North Carolina

Track Ownership and Railroad Operators in North Carolina

Interstate Highway
US Highway
Railroad Ownership
Short Line
Charlotte Area Transit System
Department of Defense
CSX Transportation
Norfolk Southern
CSX Transportation & Norfolk Southern
North Carolina RR Company
Rail Operator
[01] Great Smoky Mountains RR
[02] Blue Ridge Southern Railroad
[03] Thermal Belt Railway
[04] Caldwell County RR
[05] Alexander RR
[06] Yadkin Valley RR
[07] Charlotte Area Transit System
[08] Aberdeen Carolina & Western Railway
[09] Winston-Salem Southbound Railway
[10] High Point, Thomasville & Denton RR
[11] Carolina Coastal Railway
[12] Laurinburg & Southern Company
[13] Aberdeen & Rockfish RR
[14] Atlantic & Western Railway
[15] Clinton Terminal RR
[16] Wilmington Terminal RR
[17] North Carolina & Virginia RR
[18] Chesapeake & Albemarle RR
[19] R J Corman Railroad Co/Carolina Lines, LLC
[20] Cape Fear Railways
[21] Piedmont & Northern Railway
Camp Lejeune RR
CSX Transportation
Norfolk Southern

Table 2.1 Railroad Mileage in North Carolina

Rail Operator	Length (miles)	% of NC Rail Network
Class I Operators	*2,294.3*	*69.6%*
CSXT	1,081.7	32.8%
NS	1,212.6	36.8%
Short Line Operators	*956.3*	*29.0%*
Aberdeen & Rockfish Railroad (RR)	45.8	1.4%
Aberdeen Carolina & Western Railway	138.8	4.2%
Alexander RR	18.5	0.6%
Atlantic & Western Railway	11.0	0.3%
Blue Ridge Southern RR	71.5	2.2%
Caldwell County RR	22.1	0.7%
Cape Fear Railways	10.5	0.3%
Carolina Coastal Railway	172.2	5.2%
Carolina Southern RR	35.8	1.1%
Chesapeake & Albemarle RR	52.7	1.6%
Clinton Terminal RR	3.4	0.1%
Great Smoky Mountain RR	52.2	1.6%
High Point, Thomasville & Denton RR	31.8	1.0%
Laurinburg & Southern Company	27.9	0.8%
North Carolina & Virginia RR	54.7	1.7%
Piedmont & Northern Railway	14.7	0.4%
Thermal Belt Railway	8.4	0.3%
Wilmington Terminal RR	3.6	0.1%
Winston-Salem Southbound Railway	86.8	2.6%
Yadkin Valley RR	94.0	2.9%
Non-Class I, Non-Short Line Operators	*47.9*	*1.5%*
Camp Lejeune RR (Federal) (NS)	29.1	0.9%
Charlotte Area Transit System (CATS)	18.9	0.6%
Total North Carolina Mileage	**3,298.5**	**100.0%**

Source: NCDOT Rail Track shapefile, 2016

Two Class I freight railroad companies, CSXT and NS, operate approximately 70 percent of the state's rail system. Short lines and switching companies operate the remainder of the system. Of the over 2,300 route miles of Class I rail, 4 percent is double-tracked and 17 percent has sidings. The length, number, and placement of double track segments, passing sidings, and other rail network improvements add to overall capacity. As noted in the Southeast Rail Operations Study (SEROps) the majority of the Class I system can accommodate 286,000 lb. rail cars.

Generally, short lines along with lower volume Class I branch lines, provide access from industries, transload facilities, and ports in North Carolina to the higher volume north-south Class I network. According to the Southeast Rail Operations Study, much of the short line network in the southeast is not capable of handling 286,000 lb. rail cars. This is often due to needed bridge and rail upgrades.

At-Grade Roadway/Rail Crossings

Rail and roadway networks are spread across North Carolina. At locations where the networks cross, the rail lines are either above, below, or at-grade. Crossings are considered either public or private depending on the ownership of the roadway. For the purposes of this report, public at-grade crossings will be analyzed, as these locations provide the interaction between the driving public and railroads. A total of 3,575 of North Carolina's 6,271 at-grade crossings are public. Automatic warning devices are in-place at 72.6 percent of the at-grade public crossings in North Carolina. Of those crossings with automatic warning devices, gates are in-place at 86.9 percent. Approximately 981 at-grade public crossings remain unsignalized.[2]

North Carolina currently has five Quiet Zones, which mitigate the effects of train horn noise by allowing trains not to sound their horn at crossings if additional safety measures are in place. Two Quiet Zones are new, one on NS in Ashville and one on CSXT in Apex. Three of the Quiet Zones are pre-rule, one on NS in New Bern and two on CSXT in Rocky Mount.[3]

North Carolina has made a concerted effort to eliminate the hazards and operational inefficiencies associated with at-grade roadway/rail crossings. Since 1993, 276 crossings have been closed in North Carolina, of which 228 of these closures were at public crossings.

2.1.2 Major Rail Facilities

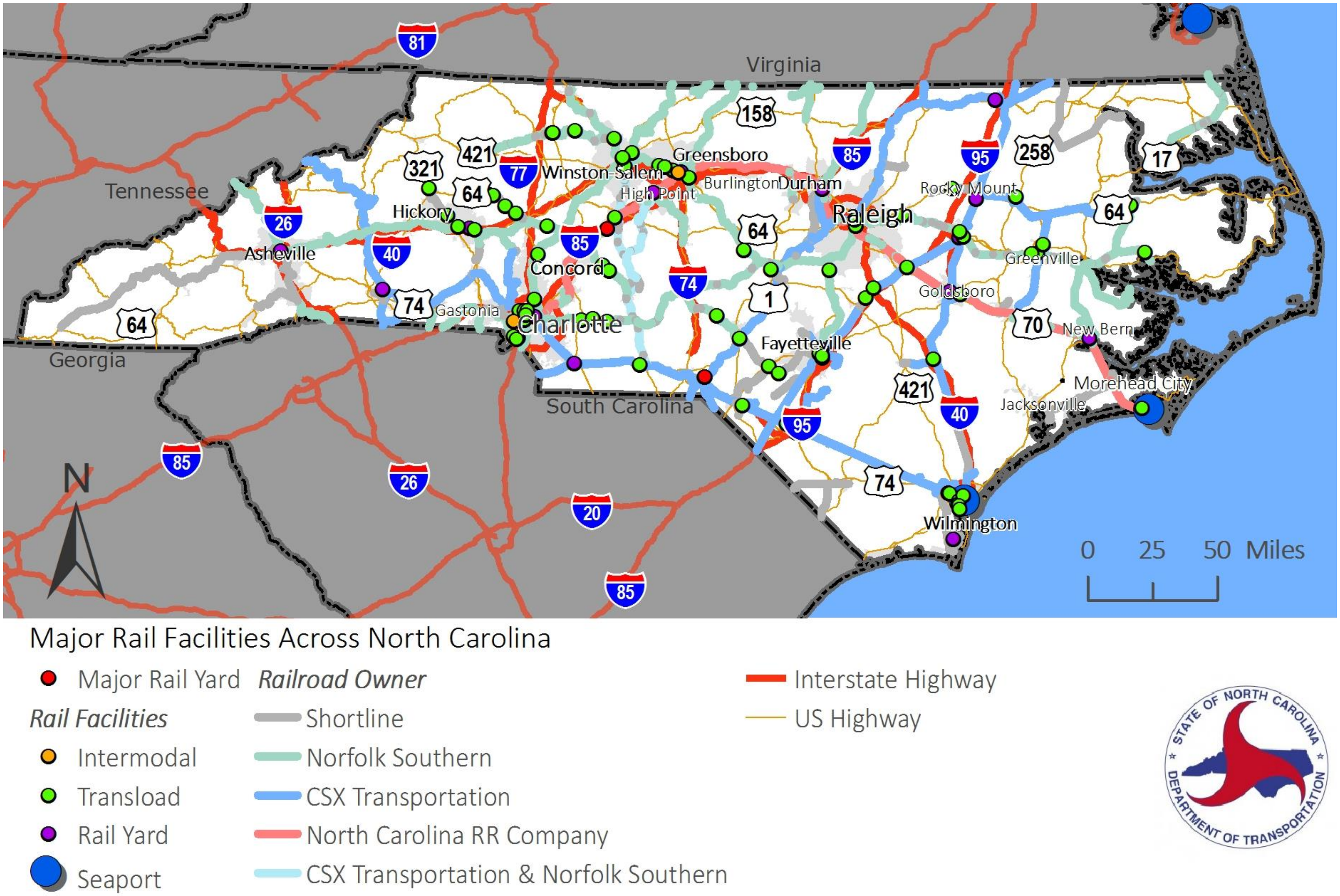
North Carolina's rail network includes two major classification yards, three intermodal terminals, two deep-water ports, and numerous transload facilities. The rail-served sites include proprietary industrial facilities and third-party for-hire terminals that may have their respective waterfront facilities, as well as more concentrated operations at inland locations. Figure 2.2 displays the locations of these facilities with respect to the rail network. Railroad freight movements are directly affected by the ease of connections and switching operations at state ports, barge and ocean terminals, and transload facilities, as well as connections with short lines and their industrial customers.

---

[2] Based on NCDOT SARAH database

[3] Federal Railroad Administration, *Quiet Zone Locations by City and State*, August 25, 2016

Figure 2.2 Major Rail Facilities across North Carolina



Major Rail Yards

CSXT's primary rail classification yard in North Carolina is located in Hamlet near the intersection of the Charlotte to Wilmington line and the Hamlet to Raleigh S Line. Other CSX classification yards in North Carolina include the Rocky Mount Yard and Fayetteville's Milan Yard along the busy A Line, Pinoca Yard serving the Charlotte area, the Raleigh Yard along the local route serving Hamlet to Norlina, and Davis Yard which serves the Wilmington area.

Linwood Yard, on the busy Atlanta, Georgia to Washington, DC mainline, is the hub for NS' operations in North Carolina. Other NS classification yards include Asheville, Charlotte, Pomona Yard serving Greensboro, Glenwood Yard serving the Raleigh area, and Selma, which serves eastern North Carolina.

Intermodal Facilities and Multi-modal Terminals

Intermodal rail terminals are facilities where large freight, generally in shipping containers, is transferred between rail and other modes of transportation. Intermodal rail transfers occur between rail and either highway or water transportation modes, usually trucks or ships. NS operates two of the three intermodal facilities in North Carolina – one in Greensboro, and a new facility located on the Charlotte-Douglas International Airport property in Charlotte. CSXT also operates an intermodal terminal located in Charlotte.

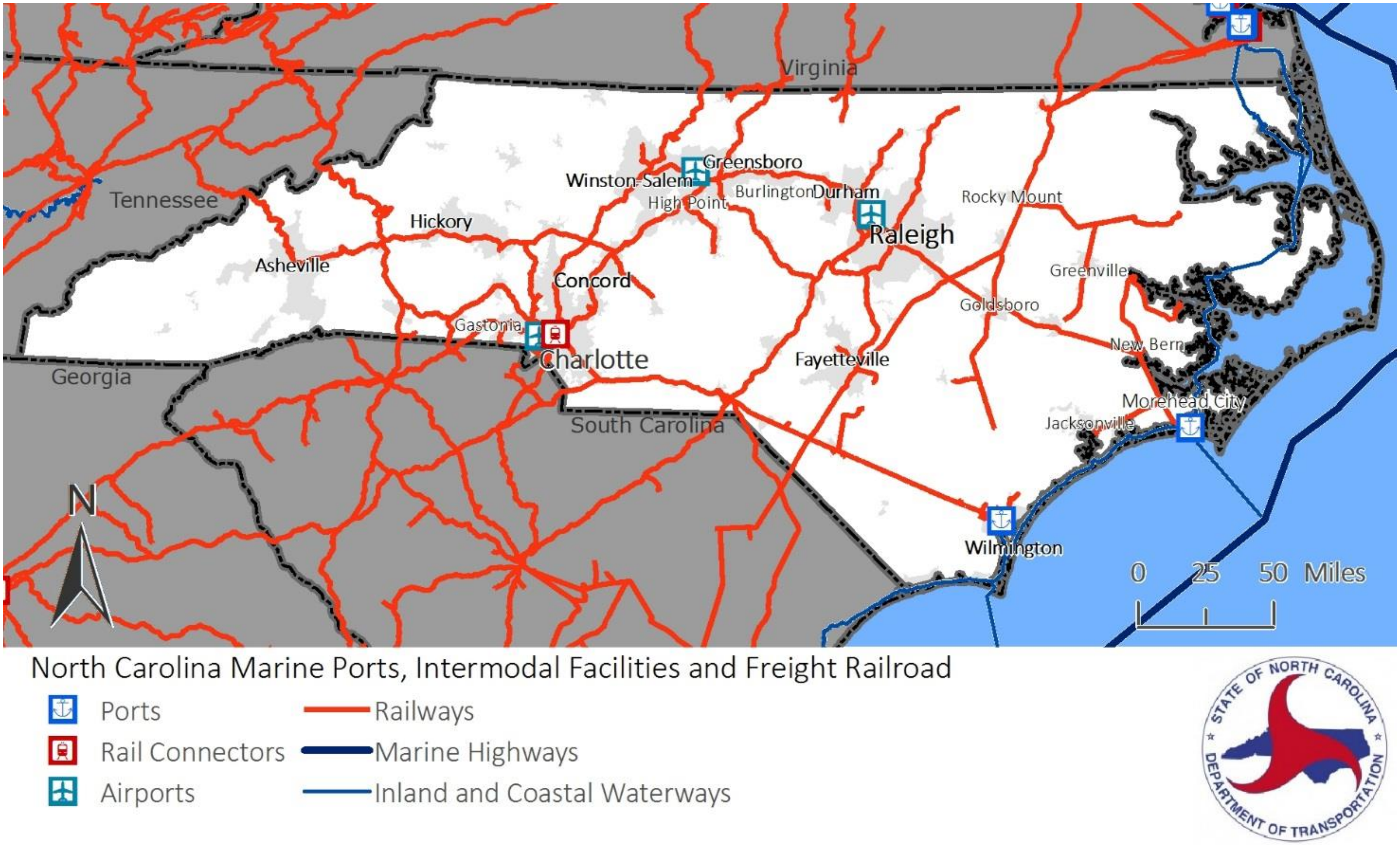
The North Carolina State Ports Authority operates the Piedmont Triad Inland Terminal and the Charlotte Inland Terminal. Inland terminals offer staging ground venues for transferring cargo between trucks or between modes. The Piedmont Triad Inland Terminal is located in southwest Greensboro, at the interchange of I-40 and I-73, and within 6 miles of the NS Greensboro Intermodal Terminal, where there is a Virginia International container station and Piedmont Triad International Airport. However, it is currently not in use. The Charlotte Inland Terminal is located north of Charlotte Douglas International Airport and one mile from the CSXT Charlotte Intermodal Terminal and eight miles from the new NS Intermodal Terminal.

Recently CSXT announced that it will be building an intermodal hub in Rocky Mount, North Carolina. The facility will be located on CSXT's north-south mainline, the A-Line, serving Raleigh and the Eastern North Carolina freight market as well as acting as a hub for the railroad's southeast and mid-Atlantic intermodal operations. As a result of agreements associated with the hub, the Port of Wilmington will now have rail intermodal service.

Ports/Marine

North Carolina operates state ports in Morehead City and Wilmington; both are served by a single Class I railroad company. The Port of Morehead City is served by NS along the NCRR-owned corridor that connects to Charlotte via the Triangle and Triad. The Port of Wilmington is served by CSXT with a connection to Charlotte that parallels the US 74 corridor. Coastal Carolina Railroad (CLNA) provides switching services at the Port of Morehead City and the WTRY does so at the Port of Wilmington. The Port of Morehead City serves bulk and breakbulk (goods that must be loaded individually, such as heavy equipment) freight and has no container cranes on site. The Port of Wilmington serves bulk and breakbulk freight but also has two berths dedicated to container service. Figure 2.3 shows the marine ports in North Carolina and their relationship to intermodal facilities and the freight rail network.

Figure 2.3 North Carolina Marine Ports, Intermodal Facilities, and Freight Railroad



2.2 Freight Significant Corridors

2.2.1 National Multimodal Freight Network

Section 70103 of title 49, United States Code (U.S.C.), which was established in section 8001 of the Fixing America's Surface Transportation (FAST) Act, directs the Under Secretary of Transportation for Policy (Under Secretary) to establish a National Multimodal Freight Network (NMFN) to:

- Assist States in strategically directing resources toward improved system performance for the efficient movement of freight on the NMFN.
- Inform freight transportation planning.
- Assist in the prioritization of federal investment.
- Assess and support federal investments to achieve the national multimodal freight policy goals.

As specified by the FAST Act, the Interim NMFN contains the freight rail systems of the Class I railroads as designated by the Surface Transportation Board and other strategic freight assets, including strategic intermodal facilities and freight rail lines of Class II and Class III railroads, designated by the Under Secretary as critical to interstate commerce. In addition, those routes critical to national defense, which are designated by the US Department of Defense's (DOD) Strategic Rail Corridor Network (STRACNET), are included in the Interim NMFN. These additional designations, which draw extensively from the Class II and Class III railroads, are necessary to promote network connectivity, which is vital for interstate commerce and national defense. The designation of the Interim NMFN consists of 104,296 rail route miles, which includes the entire Class I network of 95,200 route miles and 9,096 route miles of Class II and Class III railroad.

The Final NMFN will be established with the goal of: 1) Improving network and intermodal connectivity; and 2) using measurable data as part of the assessment of the significance of freight movement, including consideration of points of origin, destinations, and linking components of domestic and international supply chains. In designating the route miles and facilities on the Final NMFN, the Under Secretary shall have considered the following factors:

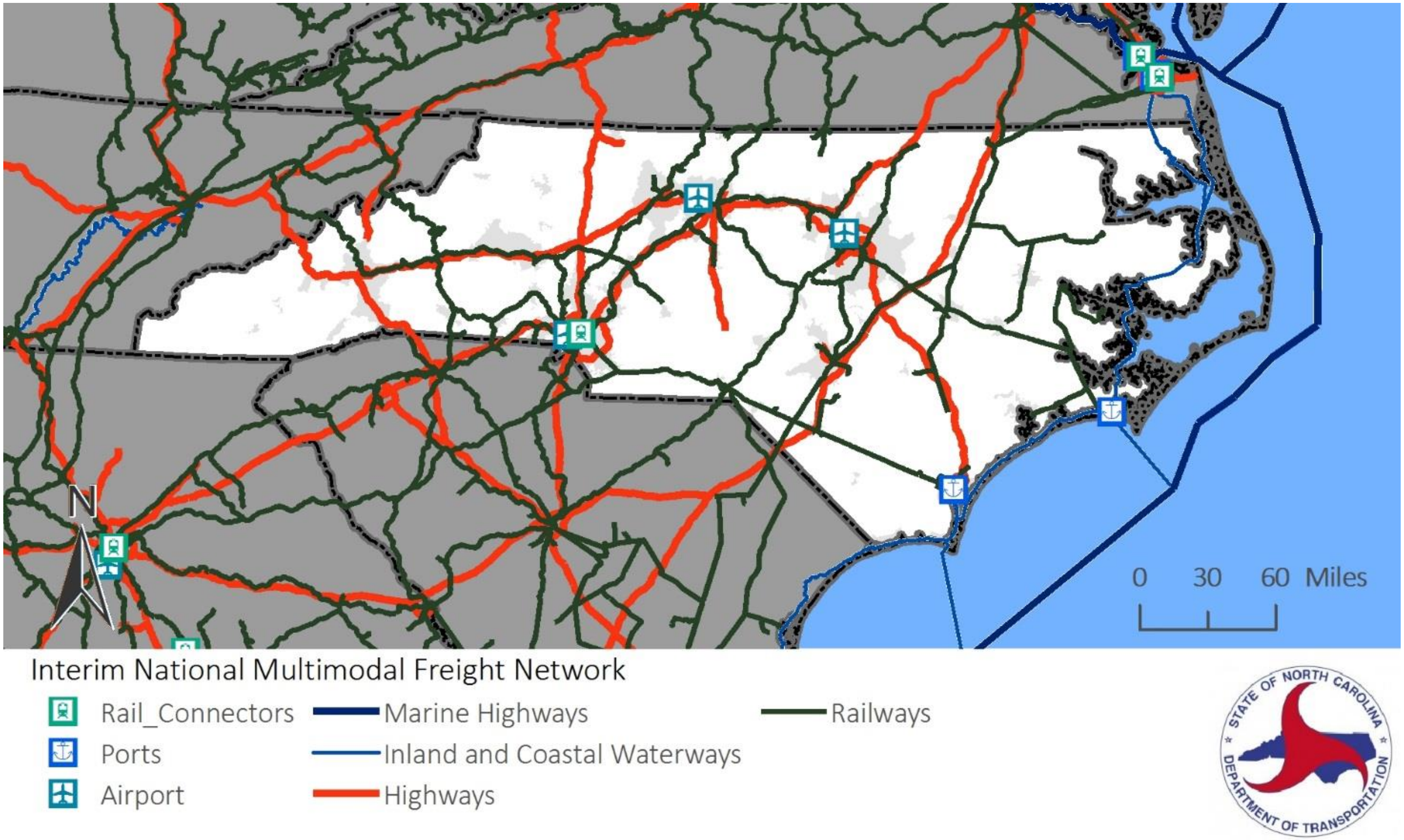
- Origins and destinations of freight movement within, to, and from the United States.
- Volume, value, tonnage, and the strategic importance of freight.
- Access to border crossings, airports, seaports, and pipelines.
- Economic factors, including balance of trade.
- Access to major areas for manufacturing, agriculture, or natural resources.
- Access to energy exploration, development, installation, and production areas.
- Intermodal links and intersections that promote connectivity.
- Freight choke points and other impediments contributing to significant measurable congestion, delay in freight movement, or inefficient modal connections.

- Impacts on all freight transportation modes and modes that share significant freight infrastructure.
- Facilities and transportation corridors identified by a multi-State coalition, a State, a State freight advisory committee, or an metropolitan planning organization (MPO), using national or local data, as having critical freight importance to the region.
- Major distribution centers, inland intermodal facilities, and first- and last-mile facilities.
- The significance of goods movement, including consideration of global and domestic supply chains.[4]

The rail portion of the Interim NMFN in North Carolina consists of 3,287 miles of multimodal rail freight network routes and four primary highway freight system intermodal connectors. Figure 2.4 depicts the Interim NMFN for North Carolina.

[4] Establishment of Interim National Multimodal Freight Network, 2016-13261, https://www.regulations.gov/document?D=DOT-OST-2016-0053-0001

Figure 2.4 Interim National Multimodal Freight Network



2.2.2 Intermodal Corridors

Two major rail corridors cross North Carolina, connecting the Interior US to international ports and allowing for cross-country and North American trade. These corridors continue to receive heavy investment from railroads and federal grants. As these investments continue, it broadens the state's access to global markets and lowers the cost of sourcing and shipping goods throughout the state.

Crescent Corridor

The Crescent Corridor is a 2,500-mile NS rail corridor supporting the supply chain from Memphis and New Orleans to New Jersey. Shown in Figure 2.5, the corridor includes NS's two primary rail lines paralleling I-85 through North Carolina and other Atlantic states and paralleling I-40/I-81 in eastern Tennessee. NS is planning and implementing a series of focused improvements to move more freight and to move it faster. Program components include new intermodal facilities in Memphis Tennessee, Birmingham Alabama, and Greencastle Pennsylvania. Some projects have been advanced in partnership with the United States Department of Transportation (USDOT) as well as state and local governments.

Figure 2.5 The Crescent Corridor

National Gateway Corridor

The National Gateway is a partnership between CSX, USDOT, and various state departments of transportation to better connect mid-Atlantic seaports to Midwest population centers. Shown in Figure 2.6, key freight rail corridors included in the program include the I-95/I-81 corridor between North Carolina and Baltimore MD, the I-70/I-76 corridor between Washington DC and northwest Ohio, and the I-40/Carolina Corridor between Wilmington North Carolina and Charlotte North Carolina. Among the National Gateway projects identified in North Carolina is the proposed expansion of the existing CSXT Charlotte intermodal terminal; advancement of this project requires that rail-related traffic impacts within Charlotte be satisfactorily addressed. Also, the planned Carolina Connector Intermodal Rail Terminal (CCX) in Rocky Mount will allow North Carolina to benefit from the improvements that have been made and are being made on the National Gateway Corridor. Virginia was recently awarded a FASTLANE grant for the Atlantic Gateway. The improvements will resolve bottlenecks north of North Carolina on the network and will allow for more fluid freight movements coming to the Southeast, specifically the future Rocky Mount terminal.

Figure 2.6 The National Gateway Corridor

2.2.3 North Carolina Statewide Rail Plan Freight Corridors

The State Rail Plan team conducted a more specific evaluation and analysis of the various rail corridors in the state. The first step in this corridor prioritization process was to define the various rail corridors across North Carolina. The corridors were defined by reviewing their ownership and end points of freight services within the state. Short lines were not included in the evaluation unless they were the primary connection to a port, intermodal facility, etc.

The corridor prioritization program serves two purposes. First it allows the rail needs to be further refined and spatially defined within corridors. For example, serving emerging freight markets has been identified as a need, and the corridor prioritization process accounts for those emerging markets that are most significant for the state and are served by specific corridors. Secondly, the corridor prioritization process helps define more specific programs and projects that are opportunities to meet those needs. Table 2.2 lists the corridors evaluated. The corridors are also shown in Figure 2.7.

Table 2.2 Rail Corridors in North Carolina

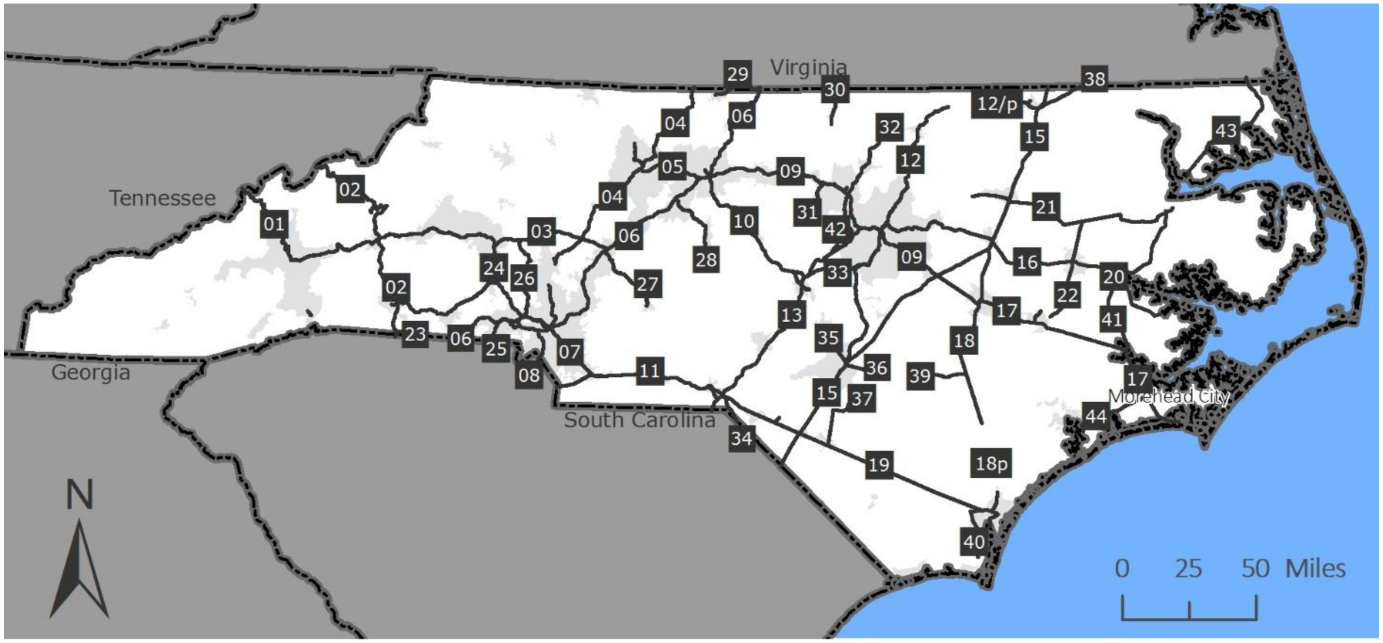
Corridor	Route	Railroad	Parallel Highway Route	Length (miles)
01	Tennessee state line to Asheville	NS	I-40	46
02	Tennessee state line to Charlotte	CSXT	I-85, US 221, US 321	173
03	Asheville to Salisbury	NS	I-40, US 70	148
04	Charlotte to Winston-Salem to VA state line	NS	I-40, I-77, US 311	129
05	Rural Hall to Winston-Salem to Greensboro	NS	I-40, US 52	39
06	SC state line to VA state line	NCRR/NS*	I-85, US 29	188
07	Charlotte to Monroe	CSXT	US 74, I-277	29
08	SC state line (from Columbia) to Charlotte	NS	I-77	25
09	Greensboro to Selma	NCRR/NS*	I-40, US 70	115
10	Greensboro to Gulf (Sanford)	NS	US 421	43
11	Monroe to Pembroke	CSXT	US 74	84
12	Raleigh to Norlina	CSXT	US 1	58
13	South Carolina state line to Hamlet to Raleigh	CSXT	US 1, I-440, NC 177	102
14	Raleigh to Fayetteville	NS	US 401	63
15	South Carolina state line to Virginia state line	CSXT	I-95	182
16	Raleigh to Greenville	CLNA	US 64, US 264	81
17	Selma to Morehead City	NCRR/NS*	US 70	113
18	Contentnea (Wilson) to Wallace	CSXT	US 117, US 13	105
19	Pembroke to Wilmington	CSXT	US 74	73
20	Greenville to Lee Creek	NS	NC 33	45
21	Rocky Mount to Plymouth	CSXT	US 13, US 64	65
22	Parmele to Greenville to Elmer	CSXT	NC 11, US 13	39
23	Cliffside to Bostic	CSXT	US 221	19
24	Newton south	NS	US 321	3
25	South Carolina state line to Gastonia	NS	US 29, US 321	8
26	Mount Holly to Terrell	CSXT	I-485, I-77, NC 150, NC 27	24
27	Albemarle to Salisbury	NS	US 29, US 52	29
28	Asheboro to High Point	NS	I-73, US 220, US 311, US 64	27
29	Eden to Virginia state line	NS	NC 14, NC 49, S 87, US 220, US 58	12
30	Roxboro to Virginia state line	NS	US 158, US 501	14

Corridor	Route	Railroad	Parallel Highway Route	Length (miles)
31	Carrboro to Hillsborough	NS	I-85, US 15, US 501	11
32	Oxford to Durham	NS	I-85, US 15, US 70	31
33	Fuquay Varina to Gulf	NS	NC 55, US 1, US 421	38
34	Hamlet to South Carolina state line	CSXT	NC 79, US 74	11
35	Spring Lake to Fort Bragg	CSXT	NC 87	7
36	Stedman to Fayetteville	CSXT	NC 24	8
37	Saint Pauls to Lumberton	CSXT	I-95, US 301, NC 87	22
38	Weldon to Virginia state line	CSXT	NC 35, US 158	18
39	Clinton to Warsaw	CSXT	NC 24	10
40	Leland North Carolina to Sunny Point	CSXT/DOD	US 17, US 421, US 74	22
41	Chocowinity to New Bern	NS	US 17	32
42	Durham to Apex	CSXT	I-40, NC 147, NC 55, US 1	20
43	Edenton to Virginia state line	C&A	US 17, NC 168	56

Source: NCSRP, 2015

Note: *NCRR owns the corridor from Charlotte to Greensboro to Morehead City, with operating rights leased to NS. NS owns the mainline corridor south of Charlotte and north of Greensboro.

Figure 2.7 North Carolina Rail Corridors



North Carolina Rail Corridors

\[01] TN state line to Asheville (NS)
\[02] Charlotte to TN state line (CSXT)
\[03] Salisbury to Asheville (NS)
\[04] Charlotte to Winston Salem to VA state line (NS)
\[05] Greensboro to Winston Salem to Rural Hall (NS)
\[06] SC state Line to VA state Line (NS)
\[07] Charlotte to Monroe (CSXT)
\[08] Charlotte to Columbia (NS)
\[09] Greensboro to Selma (NS)
\[10] Greensboro to Gulf (NS)
\[11] Monroe to Pembroke (CSXT)
\[12] Raleigh to Norlina (CSXT)
\[12/p] Norlina to Weldon (CSXT)
\[13] Hamlet to Raleigh (CSXT)
\[14] Faleigh to Fayetteville (NS)
\[15] VA state line to SC state line (CSXT)
\[16] Raleigh to Greenville (CLNA)
\[17] Selma to Morehead City (NS)
\[18] Contentnea to Wallace (CSXT)
\[18p] Walace to Wilmington Passenger Service
\[19] Pembroke to Wilmington (CSXT)
\[20] Greenville to Lee Creek (NS)
\[21] Rocky Mount to Plymouth (CSXT)
\[22] Parmele to Greenville to Elmer (CSXT)
\[23] Cliffside to Bostic (CSXT)
\[24] Newton south (NS)
\[25] SC state line to Gastonia (NS)
\[26] Mount Holly to Terrell (CSXT)
\[27] Albemarle to Salisbury (NS)
\[28] Asheboro to High Point (NS)
\[29] Eden to VA state line (NS)
\[30] Roxboro to VA state line (NS)
\[31] Carrboro to Hillsborough (NS)
\[32] Oxford to Durham (NS)
\[33] Fuquay-Varina to Gulf (NS)
\[34] Hamlet to SC state line (CSXT)
\[35] Spring Lake to Fort Bragg (CSXT)
\[36] Stedman to Fayetteville (CSXT)
\[37] Saint Pauls to Lumberton (CSXT)
\[38] Weldon to VA state line (CSXT)
\[39] Clinton to Warsaw (CSXT)
\[40] Leland, NC to Sunny Point (CSXT/DOD)
\[41] Chocowinity to New Bern (NS)
\[42] Durham to Apex (CSXT)
\[43] Edenton to VA state line
\[44] Camp Lejeune to Morehead City (NS/DOD)

Each of the rail corridors were analyzed using a variety of data to determine the overall significance of their needs for both freight and passenger service. The data used were based upon the Federal Railroad Administration (FRA) State Rail Plan Guidance and upon readily available data that could help differentiate conditions along each corridor. Different data were used to prioritize freight and passenger corridors, as seen in Table 2.3. A relative score was assigned for each corridor within each category, where 1 represented the lowest score and 5 represented the highest score. The scores help to show the importance of the freight or passenger corridor to the State.

Table 2.3 Data Used to Prioritize Corridor Needs

Freight Corridors
Current Data
Truck volumes on parallel highways
Train volumes on corridor – inbound, outbound and through
Commodities important to North Carolina economy
Connections to intermodal facilities, ports, major transloads
Connections to major activity centers
Location within STRACNET
Future Data
2040 truck volumes on parallel highways
Future train volumes on corridor – inbound, outbound and through
Emerging commodities important to North Carolina economy

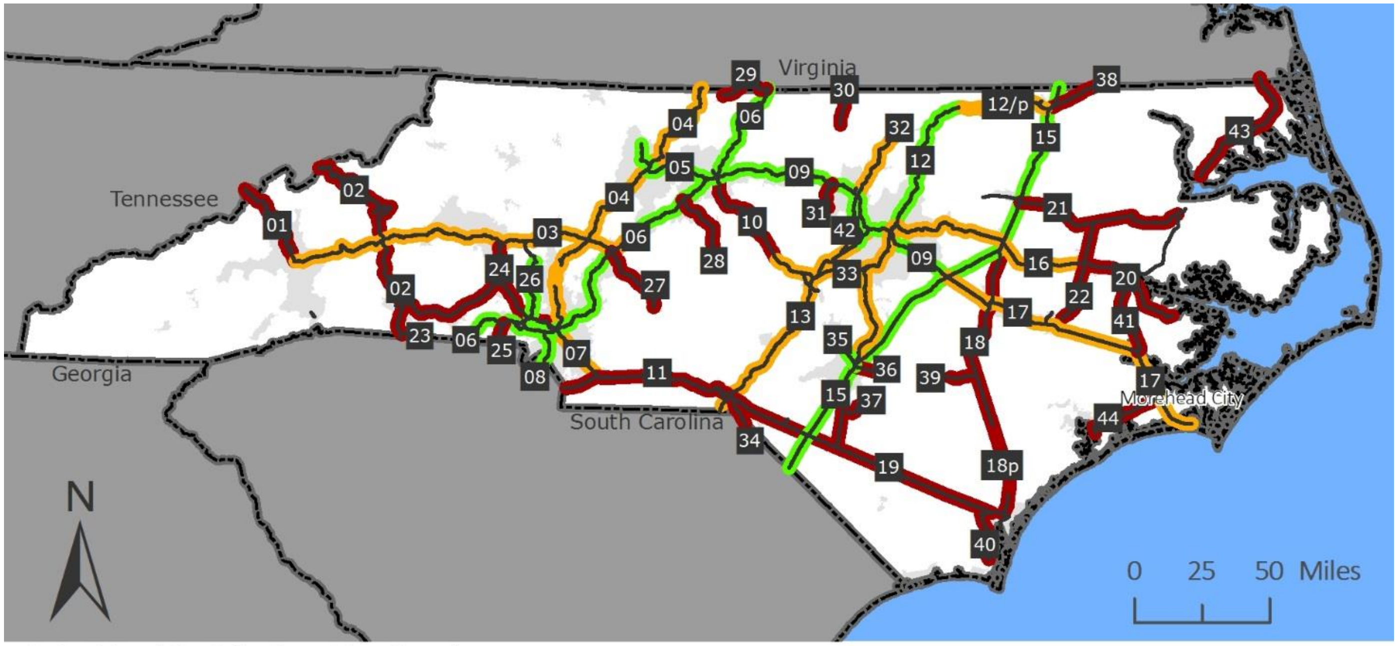
Source: NCSRP, 2015

The corridors were then grouped into three Tiers, based upon their comparative scores.

- Investment Program ("Tier" cell shown in green) –corridors with the highest relative ranking
- Stewardship Program ("Tier" cell shown in orange) –corridors with a medium relative ranking
- Active Monitoring Program ("Tier" cell shown in crimson) –corridors with the lowest relative ranking

Figure 2.8 shows the results of the freights needs prioritization.

Figure 2.8 Prioritized Freight Corridor Needs



Prioritized Freight Corridor Needs

- Investment Program
- Stewardship Program
- Active Monitoring Program

[01] TN state line to Asheville (NS)
[02] Charlotte to TN state line (CSXT)
[03] Salisbury to Asheville (NS)
[04] Charlotte to Winston Salem to VA state line (NS)
[05] Greensboro to Winston Salem to Rural Hall (NS)
[06] SC state Line to VA state Line (NS)
[07] Charlotte to Monroe (CSXT)
[08] Charlotte to Columbia (NS)
[09] Greensboro to Selma (NS)
[10] Greensboro to Gulf (NS)
[11] Monroe to Pembroke (CSXT)
[12] Raleigh to Norlina (CSXT)
[12/p] Norlina to Weldon (CSXT)
[13] Hamlet to Raleigh (CSXT)
[14] Faleigh to Fayetteville (NS)
[15] VA state line to SC state line (CSXT)
[16] Raleigh to Greenville (CLNA)
[17] Selma to Morehead City (NS)
[18] Contentnea to Wallace (CSXT)
[18p] Walace to Wilmington Passenger Service
[19] Pembroke to Wilmington (CSXT)
[20] Greenville to Lee Creek (NS)
[21] Rocky Mount to Plymouth (CSXT)
[22] Parmele to Greenville to Elmer (CSXT)
[23] Cliffside to Bostic (CSXT)
[24] Newton south (NS)
[25] SC state line to Gastonia (NS)
[26] Mount Holly to Terrell (CSXT)
[27] Albemarle to Salisbury (NS)
[28] Asheboro to High Point (NS)
[29] Eden to VA state line (NS)
[30] Roxboro to VA state line (NS)
[31] Carrboro to Hillsborough (NS)
[32] Oxford to Durham (NS)
[33] Fuquay-Varina to Gulf (NS)
[34] Hamlet to SC state line (CSXT)
[35] Spring Lake to Fort Bragg (CSXT)
[36] Stedman to Fayetteville (CSXT)
[37] Saint Pauls to Lumberton (CSXT)
[38] Weldon to VA state line (CSXT)
[39] Clinton to Warsaw (CSXT)
[40] Leland, NC to Sunny Point (CSXT/DOD)
[41] Chocowinity to New Bern (NS)
[42] Durham to Apex (CSXT)
[43] Edenton to VA state line
[44] Camp Lejeune to Morehead City (NS/DOD)

3.0 Network Usage and Performance

This section describes how and where the North Carolina railroad system currently operates. The ability of the rail network's capacity to accommodate demand from the industries and markets served is crucial to successful performance. Also described are known system deficiencies and safety concerns that affect the current rail capacity's ability to efficiently handle the demand.

3.1 Industries Served

Determining which industries use the rail mode and how they are served allows decision makers to better understand how rail improvements can impact certain portions of the economy. Also, understanding the geographic location of the demand provides insight into how North Carolina's economy may change in the future.

3.1.1 Employment

A comparison of employment by sector for North Carolina and the nation is provided in Table 3.1. North Carolina has either higher employment or near identical employment percentages to the nation in industries that potentially use rail, such as construction, manufacturing, trade/ transportation/ utilities, and leisure and hospitality. The only potential rail dependent industry where North Carolina is well below the national percentage is mining and logging.

Table 3.1 North Carolina and US Industry Sector Comparison

Industry Sector	Percent of Total NC Employment	Percent of Total US Employment
Education and Health Services	23.4%	23.4%
Trade, Transportation, and Utilities	19.8%	20.0%
Government	12.9%	11.6%
Manufacturing	11.1%	8.9%
Leisure and Hospitality	11.0%	11.1%
Professional and Business Services	7.2%	7.8%
Construction	4.4%	4.6%
Financial Activities	3.8%	4.1%
Information	1.8%	2.1%
Mining and Logging	0.1%	0.6%
Other Services	*4.5%*	*5.7%*

Source: Bureau of Labor Statistics, Quarterly Census of Employment and Wages, 2014

Manufacturing is a major generator of rail freight. As Figure 3.1 shows, manufacturing employers are located throughout the state, with the greatest concentrations in Hickory, Charlotte, the Triad, and the Triangle. Manufacturers are responsible for generating the majority of commodities within and from North Carolina. The top commodities by value produced in North Carolina include machinery, tobacco, textiles, pharmaceuticals, electronics, gasoline, and plastics/rubber.[5] In addition, manufactured foodstuffs, nonmetal mineral products, and wood products are top manufacturing commodities shipped within or from North Carolina by weight. Freight rail typically ships a number of these commodities or their product inputs, particularly machinery, chemicals, and minerals.[6]

The agriculture, forestry, fishing and hunting sector and mining and quarrying sector are other industries that utilize rail.[7] The map of agriculture, manufacturing, and mining jobs in Figure 3.1 shows a concentration of employers in the eastern part of the state where logging, hog farming, chickens, fishing, and crop production are present. Several of the top commodities shipped to, within, or from North Carolina by weight include agricultural products such as timber, wood pellets, soybeans, cereal grains, animal feed, and meat and seafood.[8] Freight rail typically transports bulk agricultural products such as grains and lumber as well as meats, prepared food, and other farm products.[9] Figure 3.1 shows the concentration of mining and quarrying employers in North Carolina. Gravel is the top commodity shipped within North Carolina by weight. Several mining operations are located on rail lines.

The energy market is one of the shifts underway that will directly affect the current petrochemical and petroleum resource / production / processing alignment. Crude oil by rail is only one dimension of the change. The emergence of Quebec and Louisiana as trading partners with North Carolina is due to the major shifts underway in crude oil and natural gas markets. The well-documented, long-term supply sources are now coming online at stable to increasing product prices. Reduced energy costs related to more domestically-produced energy are anticipated to help drive growth in manufacturing in North Carolina.

North Carolina is home to a niche chemicals industry, principally manufacturing packaging film converters and rigid packaging. Other products include synthetic fibers. Some of the plastics manufacturing is located in Asheville at Printpack, which manufactures rigid plastics packaging; CMI Plastics at Ayden which manufactures plastics for consumer products; and at Arclin in Moncure which manufactures building and construction plastic products, agriculture products, and floor surfaces. These are some of the many plastics manufacturers in North Carolina, and each of them has a good rail connection.

For intermodal container traffic, California and Illinois are the two most significant trading partners[10] for North Carolina by volume and value. Each represents significant rail network connections. We also see the growth in importance for North Baltimore, Ohio; Columbus, Ohio; Nashville, Tennessee; Memphis, Tennessee; and Atlanta, Georgia that are cities with strategic rail facilities and network connections.

---

5 NCDOT Rail Division Presentation to State Rail Plain Technical Advisory Committee. April 17, 2014. Data from Bureau of Transportation Statistics, Freight Data and Statistics.

6 Federal Railroad Administration. Freight Rail Background. March 1, 2012. http://www.fra.dot.gov/eLib/Details/L03011

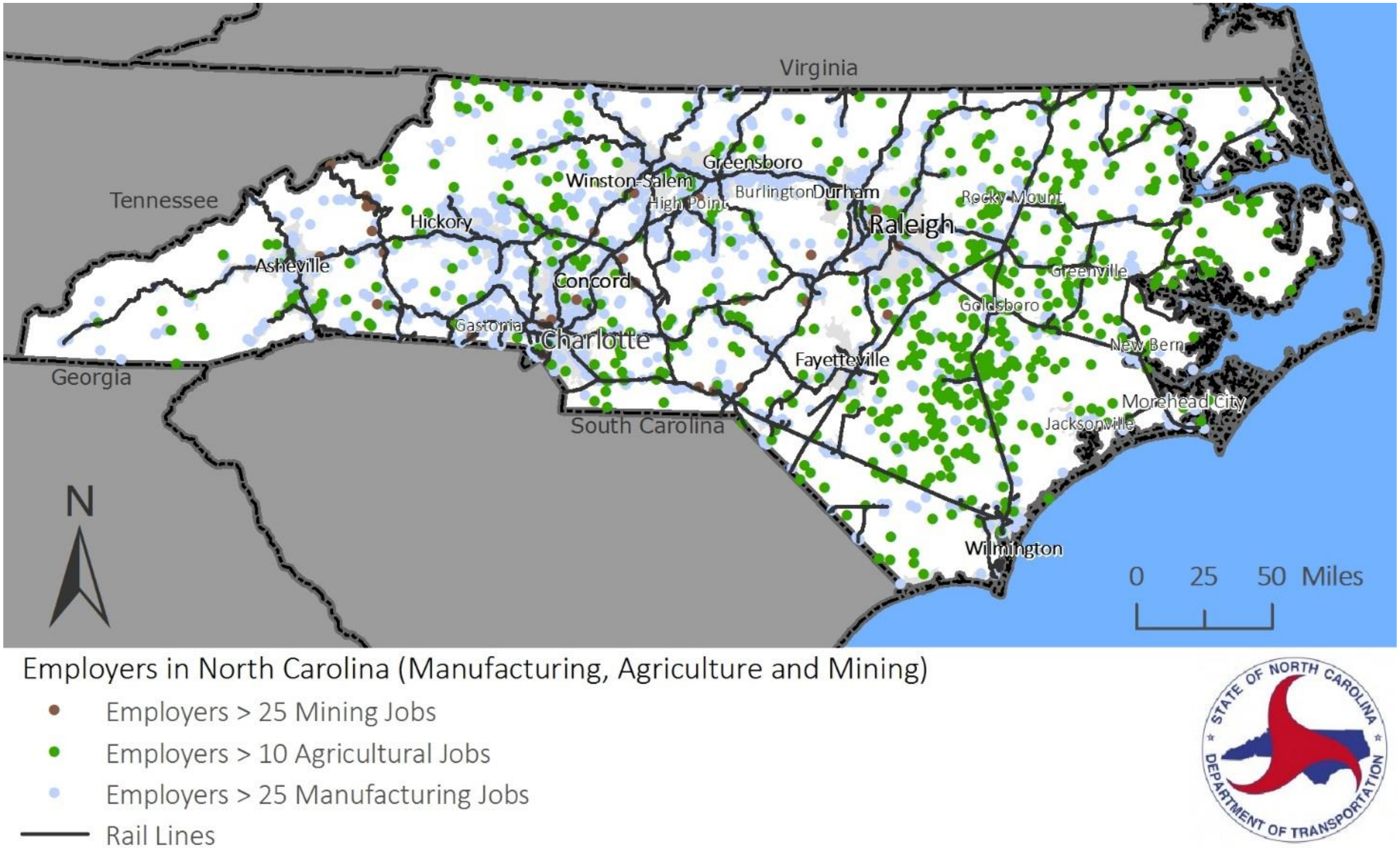
7 National Cooperative Freight Research Program. Freight Trip Generation and Land Use Report. Table 9 – NAICS Codes for freight-related sectors. 2012. http://onlinepubs.trb.org/onlinepubs/ncfrp/ncfrp_rpt_019.pdf

8 NCDOT Rail Division Presentation to State Rail Plain Technical Advisory Committee. April 17, 2014. Data from Bureau of Transportation Statistics, Freight Data and Statistics.

9 Union Pacific Railroad. Commodities Shipped website. Accessed April 11, 2014. https://www.uprr.com/customers/businessgroups.htm

10 Includes through-traffic

Figure 3.1 Employers in North Carolina (Manufacturing, Agriculture, and Mining)



3.1.2 Goods Movement Demand

Of the total rail freight tonnage moved in North Carolina, 10.4 percent is intermodal. Over half of rail flows terminate within the state. Through-traffic makes up about one-third of total rail traffic in terms of tons, and about 42 percent of the rail traffic in terms of railcars (Table 3.2), and more than half of the container traffic (Table 3.3).

Table 3.2 Summary of North Carolina Rail Traffic Totals, 2014

Direction	Tons (thousands)	% Tons	Units (thousands)	% Units	USD (millions)	% Values
Local	2,737	3.2%	30	2.0%	726	0.5%
Through	28,909	34.0%	618	41.7%	70,927	49.5%
Inbound	43,160	50.7%	570	38.5%	36,694	25.6%
Outbound	10,276	12.1%	265	17.9%	34,842	24.3%
Total	**85,082**		**1,483**		**143,188**	

Source: 2014 Confidential Carload Waybill Sample for North Carolina; Freight Analysis Framework version 4.1 (FAF4.1) Database; and analysis by Cambridge Systematics.

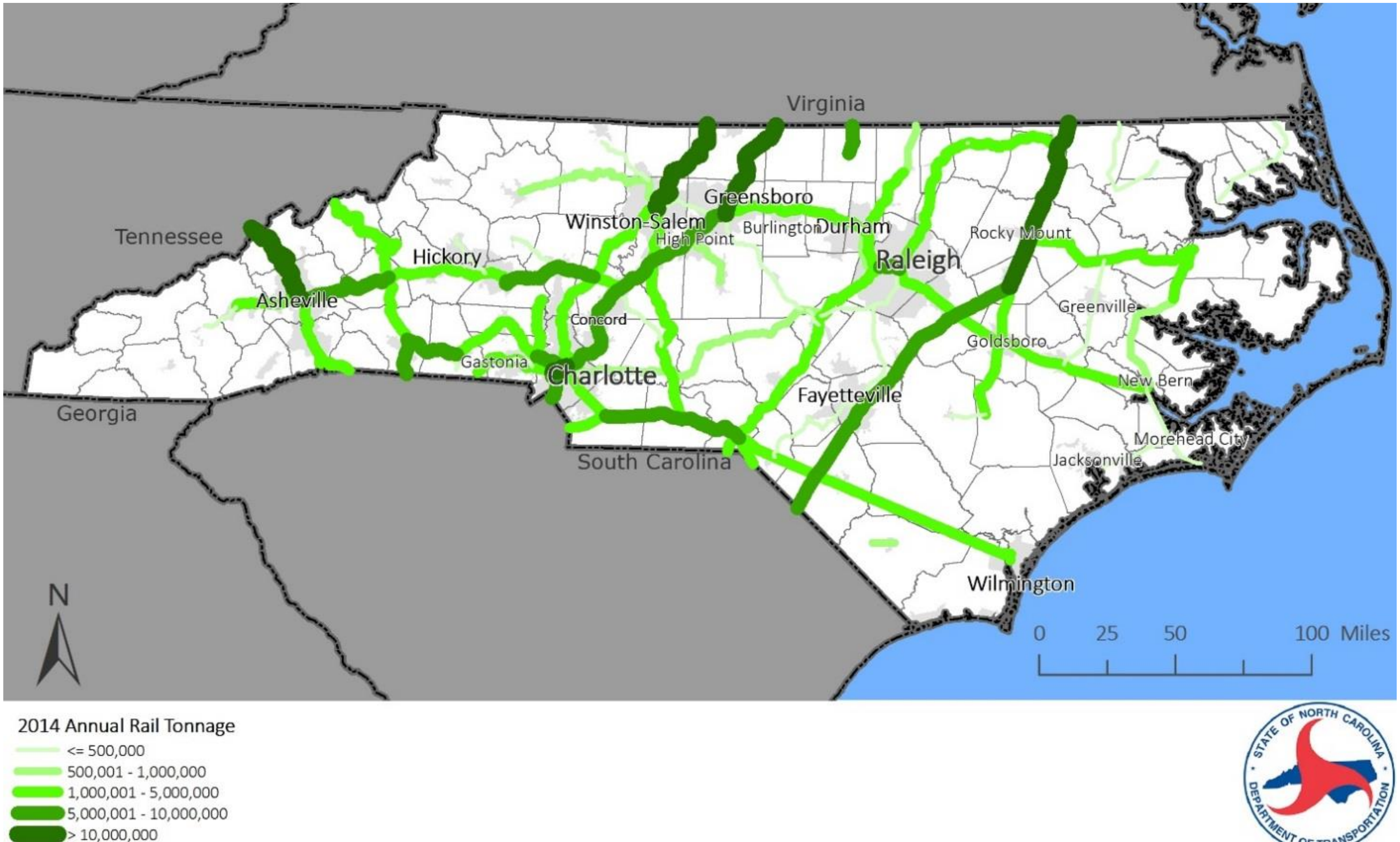
Table 3.3 Summary of North Carolina Intermodal Traffic Totals, 2014

Direction	Tons (thousands)	% Tons	Units (thousands)	% Units	USD (millions)	% Values
Through	4,920	55.3%	367	52.1%	60,413	52.7%
Inbound	1,773	19.9%	160	22.8%	23,353	20.4%
Outbound	2,197	24.7%	177	25.1%	30,802	26.9%
Total	**8,890**		**704**		**114,568**	

Source: 2014 Confidential Carload Waybill Sample for North Carolina; Freight Analysis Framework version 4.1 (FAF4.1) Database; and analysis by Cambridge Systematics.

Through-traffic is primarily on the north-south NS Crescent Corridor and CSXT's A Line. Generally, lower volume east-west Class I branch lines and short lines help connect North Carolina industries to the primary north-south Class I network. These branch lines-to-Class I-connections provide important national and international economic and transportation linkages for industries located in rural and small urban areas. Figure 3.2 presents approximate volumes on each corridor of the network. Most of the container traffic is north-south or south-north in North Carolina and that will continue with future infrastructure developments to the Crescent Corridor and the National Gateway Corridor.

Figure 3.2 Annual Tonnage Hauled on Rail Mainlines in North Carolina



Source: 2014 Confidential Carload Waybill Sample for North Carolina; Freight Analysis Framework version 4 (FAF4) Database; Oak Ridge National Laboratory's Rail Network based TRANSCAD Model for Assignment; Amtrak website; analysis by Cambridge Systematics

3.2 Markets Served

3.2.1 Market Overview

Currently there is a strong base in North Carolina for plastics and rigid packaging manufacturing. Due to natural gas developments in Marcellus shale, especially in the very active area at the southern tip of the region closest to West Virginia in addition to developments in the Utica markets, North Carolina will enjoy the benefits of cheaper natural gas due to close proximity. This will help fuel development in chemical manufacturing through lower cost of operating facilities and nearby supplies.

Similarly, across the United States, scrap metal exports via West Coast ports to Asia (e.g., China, Japan, and South Korea) are increasing. A number of factors contribute to an increasing use of re-engineered steel; from energy, emissions, and sustainability considerations to shortening of the production and supply chain schedules. Nucor, a steel producer, is based in North Carolina with several plant sites and operations. There is a potential to follow the manufacturing trend with more direct scrap steel exports as Asian manufacturing continues to move south and west to Indonesia and India, creating more Suez Canal traffic over cross-Pacific routes.

The intermodal market is growing faster than the gross domestic product in the United States. Historical bulk products, such as corn and soybeans, are moving to intermodal containers adding to the containers used to ship manufactured goods and products consumed by the growing population. Port facilities and rail networks across North America are important for North Carolina's inbound and outbound freight movements on intermodal corridors. These corridors provide access and connections between New Jersey, Memphis, New Orleans, Mid-Atlantic ports, and Midwestern markets. Through-traffic of containers depicts the importance of major intermodal hubs in Chicago, North Baltimore, and Columbus.

Coal traffic is expected to decline in part because of emissions constraints on power plants that will impact CSXT's route over the North Carolina mountains and the NS routes; resulting in a desire to capture more intermodal business. A reduction in coal shipments passing through and terminating in North Carolina will provide network capacity to accommodate growth in other commodities.

3.2.2 Trading Partners

A quick review of trading partner data by weight (most likely inclusive of rail-served commodities), Figure 3.3 and Figure 3.4 show that North Carolina's top trading partners for goods originating in the state are in the southeast, though Pennsylvania and Texas are also high on the list. It should be noted that the highest volumes remain within North Carolina when considering all modes. For trade to North Carolina, top partners, besides intrastate commerce, include nearby states. Evaluating trading partners by weight shipped is an important metric since trade by weight can be translated into truckloads and used to identify corridors where truck-to-rail diversion might be studied to relieve highway congestion. A review of trading partners by value still shows the southeastern state dominance (Figure 3.5 and Figure 3.6). But, additional states included are Texas, California, and some Midwest, and Northeast states.

Figure 3.3 Top Trading Partners – Trade from North Carolina, by Weight

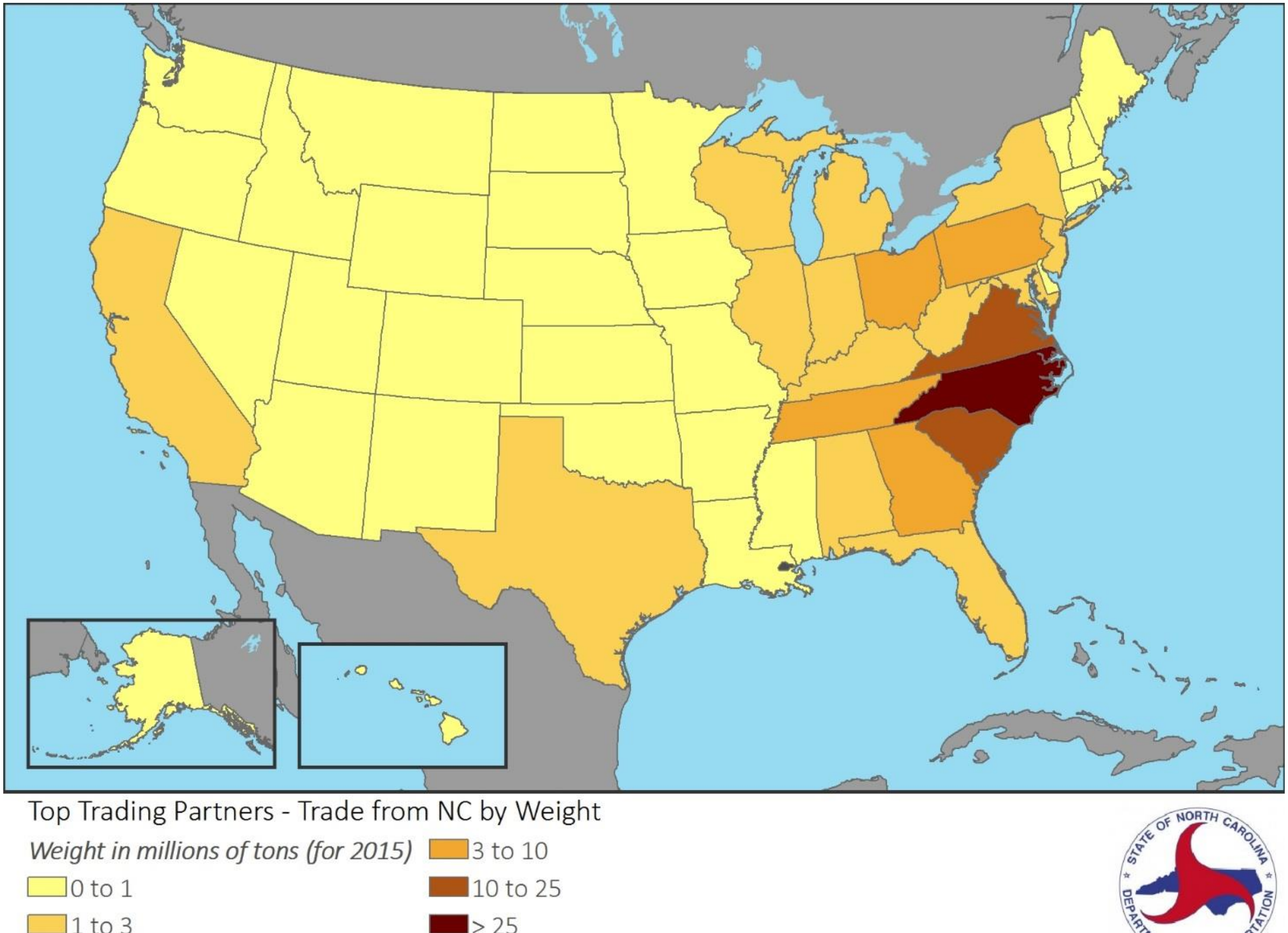


Figure 3.4 Top Trading Partners – Trade to North Carolina, by Weight

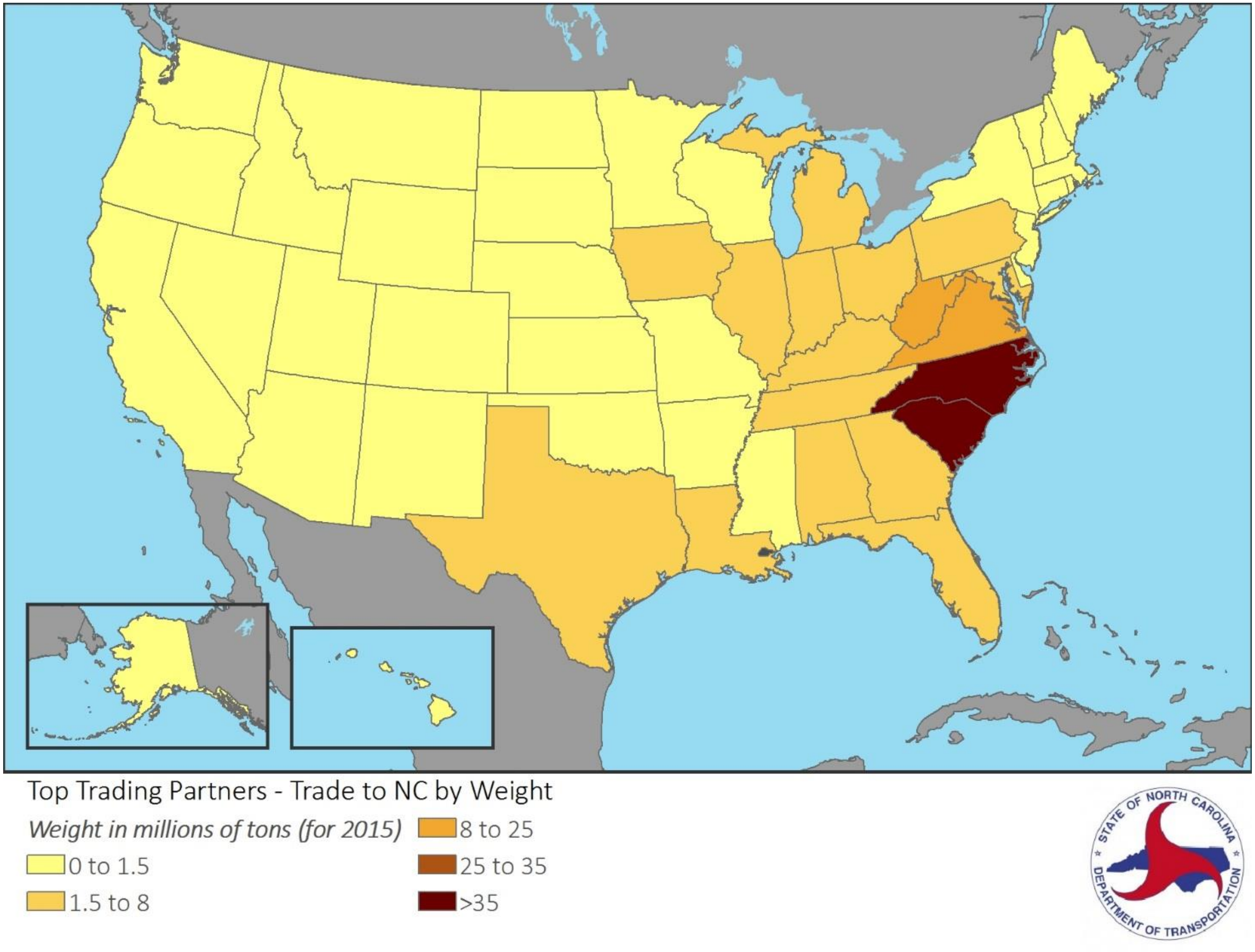


Figure 3.5 Top Trading Partners – Trade from North Carolina, by Value

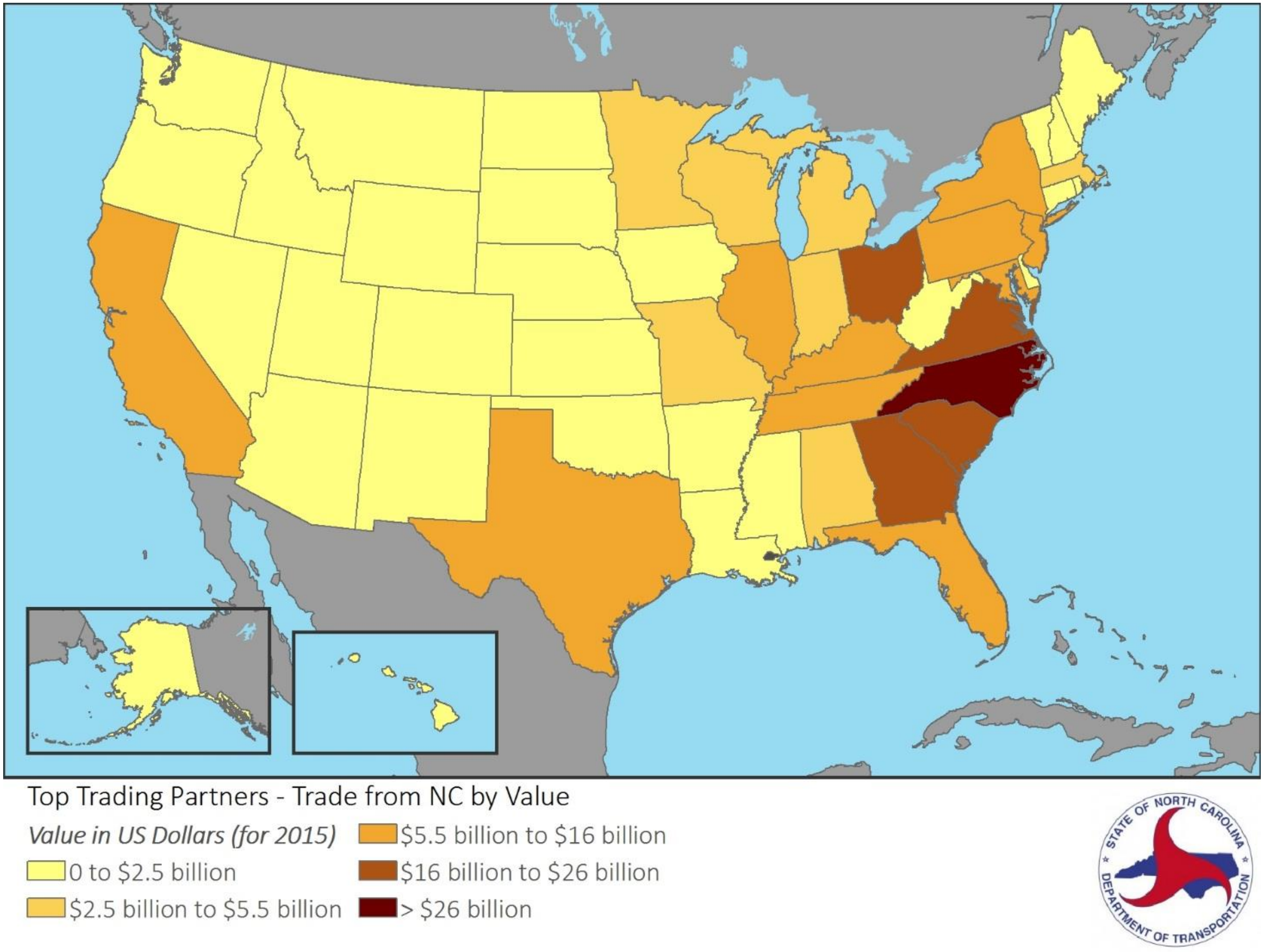
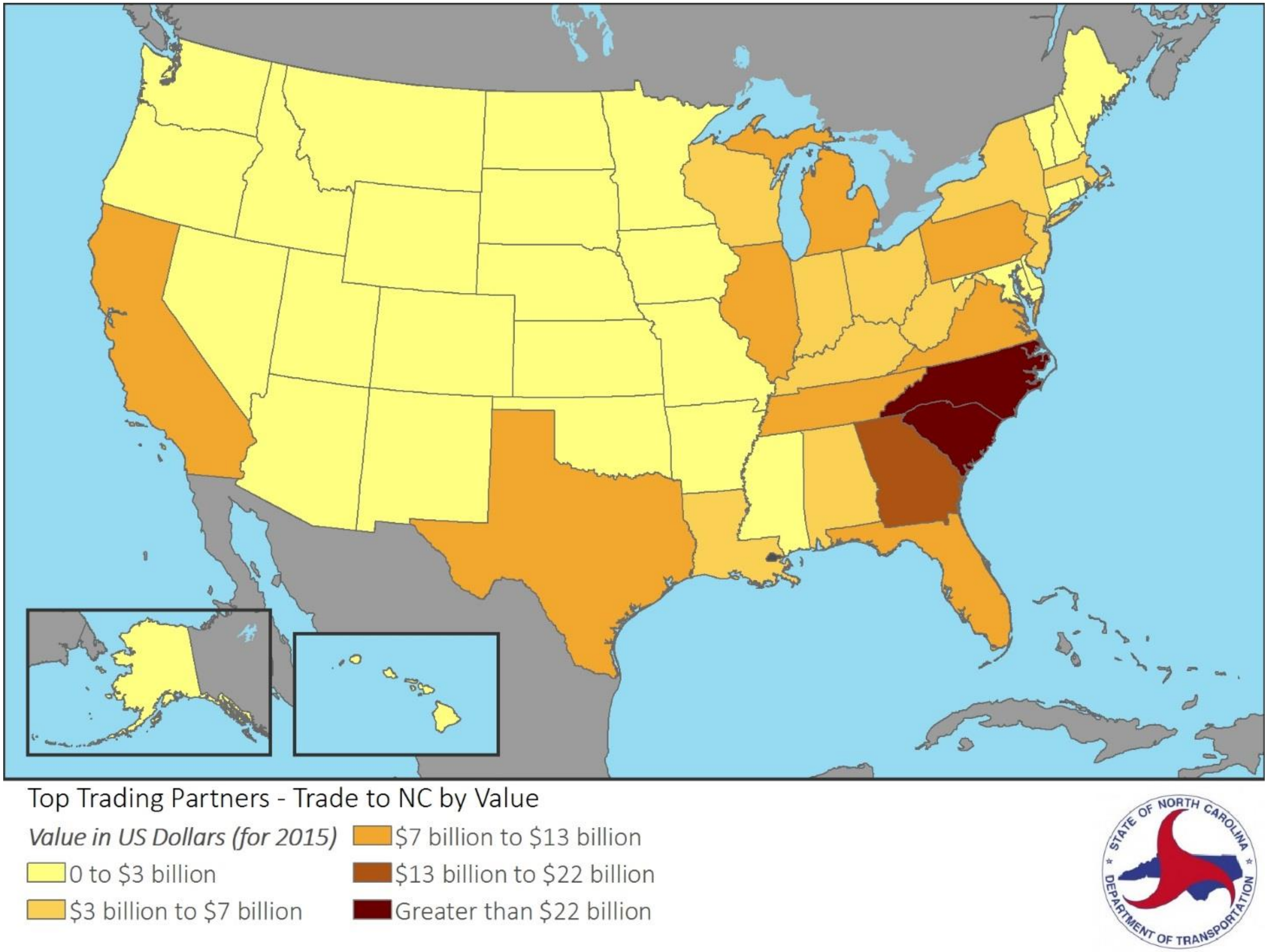


Figure 3.6 Top Trading Partners – Trade to North Carolina, by Value



3.2.3 Rail Traffic Generators

To understand the role of rail in shaping North Carolina's economy, it is important to take a brief look at the history of railroad development in the state. The first railroads were built in the United States during the 1830s with the majority of the rail network built during the second half of the 19th Century.[11] Several of North Carolina's larger cities, such as Durham and High Point, originated as railroad stops and went from being small outposts to growing manufacturing cities because of the railroad.[12] [13] The existing cities of Charlotte, Greensboro, Winston-Salem, Wilmington, Raleigh, and Asheville also experienced growth after the arrival of the railroad. The railroad's role in city development is especially important for North Carolina since navigable rivers played only a minor role in the development of the state's cities.[14]

Approximately 83 percent of North Carolina municipalities incorporated before 1900 have railroads intersecting their current-day municipal boundaries.[15] The cities of Charlotte, Greensboro, and Wilmington were important railroad hubs at this time. In 1900, a large number of small towns were evenly spaced along railroads throughout North Carolina. Many of these towns remain important commercial and civic land uses to this day. The arrival of the railroad also changed the land uses of the areas surrounding early North Carolina cities and towns as they adapted to producing cotton, tobacco, timber, and other profitable commodities that could be easily shipped by rail to markets and manufacturers.[16]

Some of the early industries that relied on rail are still present in North Carolina. Figure 3.7 shows the primary rail freight traffic generators in each MPO region.

---

[11] Association of American Railroads. A Short History of US Freight Railroads. April 2013. https://www.aar.org/keyissues/Documents/Background-Papers/A-short-history-of-US-Freight.pdf

[12] City of Durham. Durham History at a Glance. Accessed April 15, 2014 http://www.durham-nc.com/about/overview-facts-history/history_glance.php

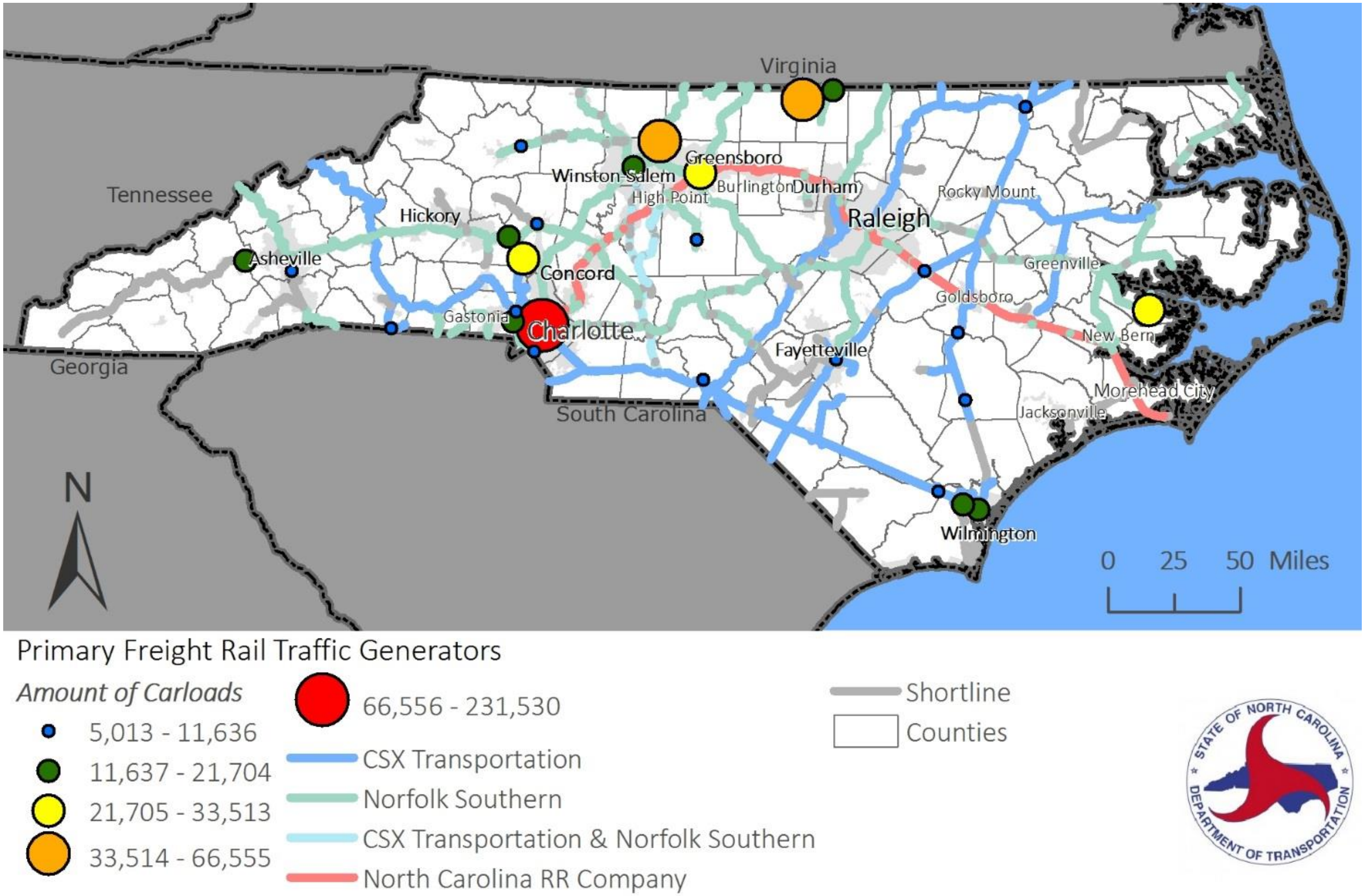
[13] High Point Museum. High Point and Furniture. Accessed April 15, 2014. http://highpointmuseum.org/furniture-history/

[14] Burke, James. North Carolina's First Railroads, A Study in Historical Geography. 2008. http://libres.uncg.edu/ir/uncg/f/Burke_uncg_0154D_10006.pdf

[15] Analysis on municipality data from North Carolina Department of Transportation GIS and railroad data from US DOT National Transportation Atlas Database.

[16] Association of American Railroads. A Short History of US Freight Railroads. April 2013. https://www.aar.org/keyissues/Documents/Background-Papers/A-short-history-of-US-Freight.pdf

Figure 3.7 Primary Freight Rail Traffic Generators



3.3 Level of Service

This section summarizes the results of an analysis of North Carolina's rail system capacity. Appendix A of this report describes in detail the methodology, analysis and results. The purpose of this analysis is to identify how projected trends in rail traffic will impact utilization of the State's mainline network, and the resulting service performance arising from changing volumes within the constraints of existing infrastructure. The results will be used as an input to the process of identifying rail-related investment needs in North Carolina's Statewide Multimodal Freight Plan.

In the absence of specific capacity data, a parametric analysis of line capacity was performed using a methodology that was initially developed for the Association of American Railroads' (AAR) National Rail Freight Infrastructure Capacity and Investment Study. Through the combination of data on origin-destination commodity flows and information on typical train operations (train length by type of train service), the daily train volumes are estimated by main line segment. These volumes are in turn compared to the estimated physical daily train capacity of each segment, of which the primary determinants consist of the number of tracks and signal system type. In a manner similar to the measurement of Level of Service (LOS) on highways, the ratio of estimated train volumes against available capacity provides an estimate of LOS for each segment of the rail network.

All of the data used for this effort was from public sources, principally the Surface Transportation Board's Waybill Sample, the FHWA's Freight Analysis Framework 4, and the Oak Ridge National Laboratory's rail network. The model was calibrated against available freight and passenger train volume data that was drawn from a variety of sources. Line capacity was examined in the context of current (2014) and projected (2045) levels, which correspond to the years of the investment study. Although the capacity analysis identifies known constraints on North Carolina's mainlines, bottlenecks in adjacent states that affect rail service performance in the state were not analyzed. Terminal capacity was considered but not included.

Rail network segment daily train volumes were compared to rail capacity in daily trains to calculate volume-to-capacity ratios (V/C). These were expressed as level-of-service (LOS) grades, the results of which are shown in Figure 3.8. The V/C ratios and the corresponding LOS grades are listed in Table 3.4.

Rail corridors operating at LOS A, B, or C are operating below capacity; they carry train flows with sufficient unused capacity to accommodate maintenance work and recover quickly from incidents such as weather delays, equipment failures, and minor accidents. Corridors operating at LOS D are operating near capacity; they carry heavy train flows with only moderate capacity to accommodate maintenance and recover from incidents. Corridors operating at LOS E are operating at capacity; they carry very heavy train flows and have limited capacity to accommodate maintenance and recover from incidents without substantial service delays. Corridors operating at LOS F are operating above capacity; train flows are unstable, and congestion and service delays are persistent and substantial. The LOS grades and descriptions correspond generally to the LOS grades used in highway system capacity and investment requirements studies.

Table 3.4 Volume-to-Capacity Ratios and Level of Service Grades

LOS Grade		Description	Volume/Capacity Ratios
A	Below Capacity	Low to moderate train flows with capacity to accommodate maintenance and recover from incidents	0.0 to 0.2
B			0.2 to 0.4
C			0.4 to 0.7
D	Near Capacity	Heavy train flow with moderate capacity to accommodate maintenance and recover from incidents	0.7 to 0.8
E	At Capacity	Very heavy train flow with limited capacity to accommodate maintenance and recover from incidents	0.8 to 1.0
F	Above Capacity	Unstable flows; service breakdown conditions	> 1.00

Source: Association of American Railroads, National Rail Freight Infrastructure Capacity and Investment Study, prepared by Cambridge Systematics, Inc., September 2007.

Note: LOS Grade F was further divided into F1 and F2 in this study, where F1 represents volume/capacity ratio ranging between 1 and 1.50, and F2 represents volume/capacity ratio greater than even 1.50. This was done to improve interpretation of the mapped volume/capacity data.

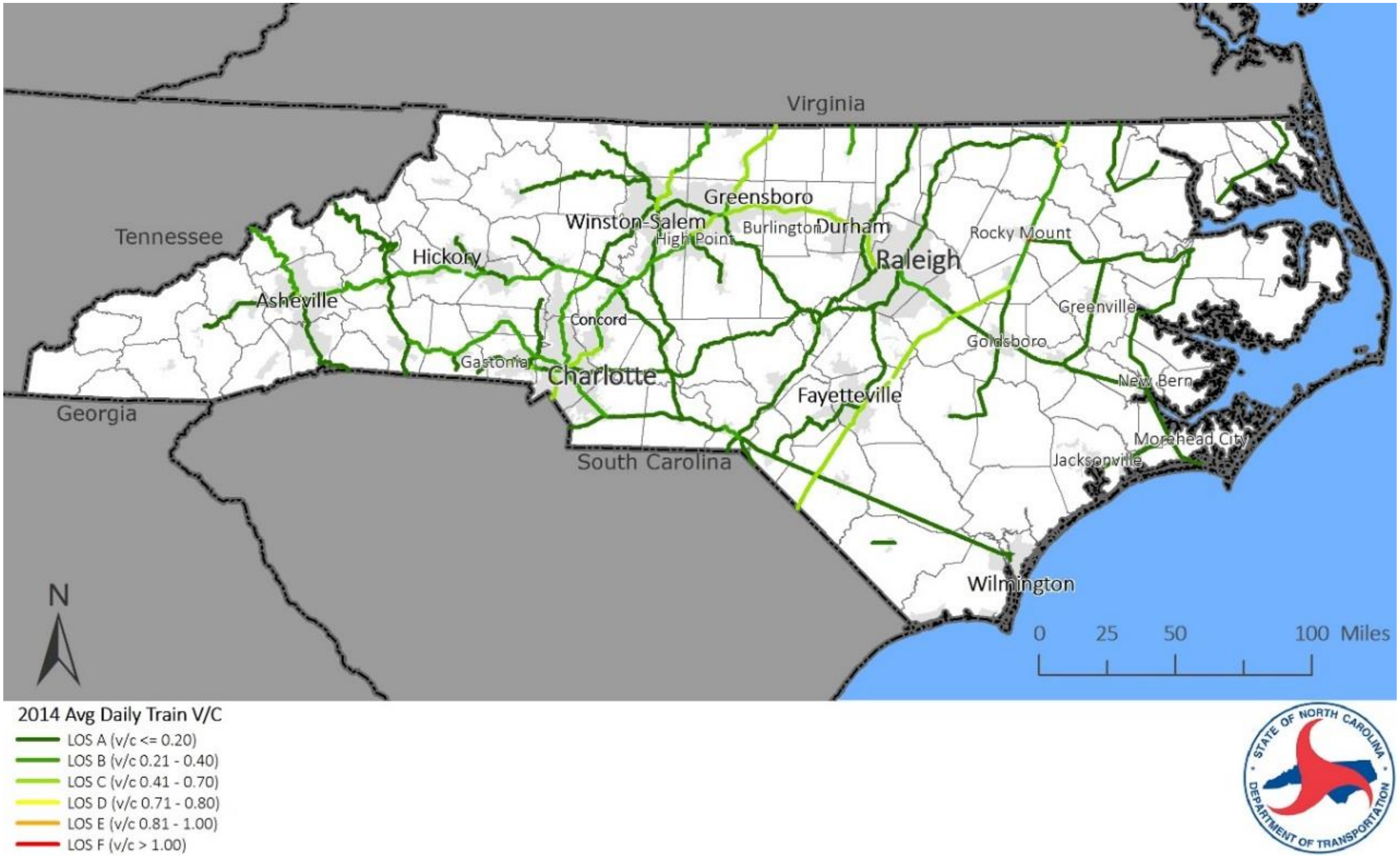
Figures 3.8 and 3.9 shows the results of volume-to-capacity analysis in 2014 and 2045. Tables 3.5 and 3.6 show the overall capacities for the mainline rail system for North Carolina in terms of miles, annual ton-miles, and daily train-miles by LOS grade in 2014 and 2045. In both years, the distributions over LOS grade are similar although the tonnage of rail flows is increasing, principally due to productivity gains that were assumed. These productivity gains are dependent on continued investment on rail mainlines to carry heavier cars and expansion of yards and sidings to handle longer trains in North Carolina and adjacent states.

Only 1.5 percent of rail line miles and approximately 5% of the ton-miles and train-miles are expected to operate at LOS grade of D or E or F by 2045. Particular rail mainline segments with LOS grade of D or E or F by 2045 are: Greensboro, North Carolina (NC) – High Point, NC, Kannapolis, NC – Charlotte, NC, and Charlotte, NC – Rock Hill, NC; all of these are on Norfolk Southern's (NS) main line between Atlanta and the northeast. In North Carolina, this line is currently the subject of a major capacity increase through the construction of double-track between Greensboro, NC to Charlotte, NC.[17] Once these improvements have been completed in 2017, the capacity constraints north of Charlotte are likely to be eliminated. In addition, particular rail mainline segments with LOS grade C need to be monitored over time. These include CSX's line between Selma, NC and Pembroke, NC, and NS' lines between Raleigh, NC and Greensboro, NC and between Greensboro, NC and Danville, Virginia. These segments will also be affected by increases in intercity passenger rail services.

Therefore, the analysis shows that besides the investments for continued productivity gains, the scale of investments to address volume-to-capacity issues in North Carolina are likely to be small and mostly local.

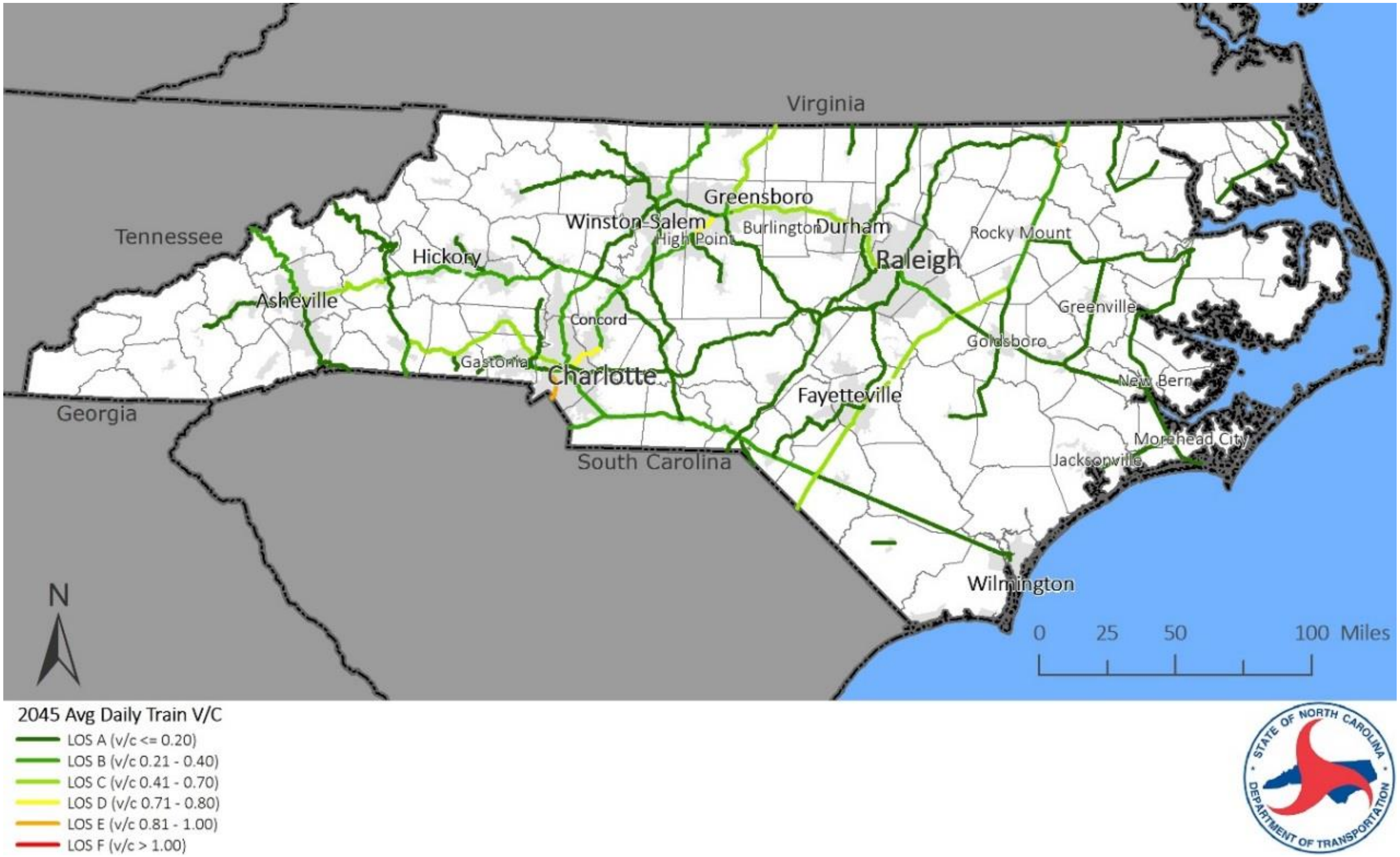
[17] NCDOT's Piedmont Improvement Program Website, https://www.ncdot.gov/projects/pip/ (last accessed on October 20, 2016)

Figure 3.8 Average Daily Volume-to-Capacity Ratio on Rail Mainlines, 2014



Source: 2014 Confidential Carload Waybill Sample for North Carolina; Freight Analysis Framework version 4 (FAF4) Database; Oak Ridge National Laboratory's Rail Network based TRANSCAD Model for Assignment; Amtrak website; analysis by Cambridge Systematics

Figure 3.9 Average Daily Volume-to-Capacity Ratio on Rail Mainlines, 2045



Source: 2014 Confidential Carload Waybill Sample for North Carolina; Freight Analysis Framework version 4 (FAF4) Database; Oak Ridge National Laboratory's Rail Network based TRANSCAD Model for Assignment; Amtrak website; analysis by Cambridge Systematics

Table 3.5 Miles, Ton-miles and Train-miles by LOS Category, 2014 Rail Mainline System in North Carolina

LOS Grade	Rail Line miles	% of Total	2014 Freight Rail Annual Ton Miles (in billions)	% of Total	2014 Freight Rail Avg. Daily Train Miles (in thousands)	% of Total
A (v/c <= 0.20)	1,881	70.7%	3,300	35.8%	3,032	26.4%
B (v/c 0.21-0.40)	509	19.1%	3,723	40.4%	4,903	42.7%
C (v/c 0.41-0.70)	269	10.1%	2,177	23.6%	3,517	30.7%
D (v/c 0.71-0.80)	1	0.0%	13	0.1%	19	0.2%
E (v/c 0.81-1.00)	0	0.0%	0	0.0%	0	0.0%
F (v/c > 1.00)	0	0.0%	1	0.0%	2	0.0%
TOTAL	2,660	100.0%	9,214	100.0%	11,473	100.0%

Source: 2014 Confidential Carload Waybill Sample for North Carolina; Freight Analysis Framework version 4 (FAF4) Database; Oak Ridge National Laboratory's Rail Network based TRANSCAD Model for Assignment; Amtrak website; analysis by Cambridge Systematics

Table 3.6 Miles, Ton-miles and Train-miles by LOS Category, 2045 Rail Mainline System in North Carolina

LOS Grade	Rail Line miles	% of Total	2045 Freight Rail Annual Ton Miles (in billions)	% of Total	2045 Freight Rail Avg. Daily Train Miles (in thousands)	% of Total
A (v/c <= 0.20)	1,770	66.6%	3,526	27.8%	2,682	20.5%
B (v/c 0.21-0.40)	529	19.9%	5,365	42.2%	5,687	43.5%
C (v/c 0.41-0.70)	321	12.1%	3,284	25.8%	3,922	30.0%
D (v/c 0.71-0.80)	27	1.0%	337	2.7%	573	4.4%
E (v/c 0.81-1.00)	13	0.5%	191	1.5%	193	1.5%
F (v/c > 1.00)	0	0.0%	2	0.0%	2	0.0%
TOTAL	2,660	100.0%	12,706	100.0%	13,060	100.0%

Source: 2014 Confidential Carload Waybill Sample for North Carolina; Freight Analysis Framework version 4 (FAF4) Database; Oak Ridge National Laboratory's Rail Network based TRANSCAD Model for Assignment; Amtrak website; analysis by Cambridge Systematics.

In addition to the projected demand in this analysis, some new or expanding intermodal terminals and carload industries are likely to induce rail traffic beyond what is projected by FAF4. CSX' new Carolina Connector Intermodal Rail Terminal intermodal yard near Rocky Mount brings a high capacity facility to the I-95 corridor in the eastern part of the state, and will be able to support local shippers as well as the Port of Wilmington. This yard is expected to handle 260,000 container lifts by the 5th year of operation.

Active plans to increase passenger service will also impact freight capacity. This includes the Piedmont Corridor service expansion presently underway, as well as the Southeast High Speed Rail initiative that envisions vastly increased service between Washington DC, Richmond, and North Carolina, on a combination of dedicated and joint use rail lines.

3.4 System Deficiencies

Deficiencies result from bottlenecks and constraints in railroad networks and operations. Bottlenecks are temporary time/money wasters that occur during a move versus constraints, which are fixed issues requiring infrastructure, policy, or other substantial changes and affect all moves on a route.

3.4.1 Bottlenecks

Bottlenecks, such as congestion, a stalled train on a single track line, a broken traffic signal, or not enough available container cranes to service a train were identified from the capacity/level-of-service analysis, Strategic Transportation Investment Program 4 (STI 4), North Carolina Statewide Rail Plan's (NCSRP) identified needs, and stakeholder interviews.

- STI 4
  - Extend Pomona Yard auxiliary track and add power turnouts.
  - Construct Jamestown siding extension to allow the local train to clear the mainline during switching operations.
  - Construct new siding at Sophia on the M Line to move cars out of High Point Yard and create room to allow the local train to clear the mainline.
  - Construct Kimberly Clark lead in Lexington, Davidson County. Allows the local train to clear the mainline track during switching operations, increasing network fluidity for freight and passenger traffic.
  - Construct track and structures to relocate the Piedmont, Carolinian, and Crescent passenger service off of the main line. This project will reduce freight rail congestion through uptown Charlotte and remove passenger trains from the Charlotte yard. This will dramatically increase freight train efficiency and increase capacity on the NS main line and yard facility, while eliminating switching delays due to passenger train activities.
  - Construct segments of double track, grade separations, and additional freight facility improvements to enhance freight rail capacity and service along the National Gateway Corridor, including improvements in the Upper Coastal Plain Rural Planning Organization (RPO).
- NCSRP
  - Construct Stouts siding extension (Union County) – 10,000 foot siding extension at Stouts.
  - Construct grade separation at Port of Wilmington – Construct grade separation at container yard gate.
  - Construct grade separation at Port of Wilmington – Construct grade separation at port's north gate.
  - Address short line bridge and infrastructure needs.

- Stakeholders
  - Port of Wilmington - Genesee and Wyoming applied for the North Carolina Department of Transportation (NCDOT) grants requesting 75 car lengths of track (3 lengths of 25 cars each) to be built. This is to serve current business levels.
  - Wadesboro, in the Charlotte to Wilmington CSXT corridor, is a congestion point. Because it is in an RPO of NCDOT's Division 10, obtaining funding for railroad projects is difficult.
  - Wilmington's chassis yard is managed by CMC. The area covers approximately 16 acres. The main gate could be a constraint with 7 lanes. Alternate configurations have been investigated.
  - CSXT A-line - A capacity issue exists on the A-line. The single track is prohibitive to efficient freight flow. Having to stop trains to serve existing and new customers ties up and delays service.
  - CSXT system improvements - To improve efficiency, CSXT desires improvements that allow for longer trains. The implementation of the Carolina Connector Intermodal Rail Terminal (CCX) will help by providing longer sidings.
  - Port of Morehead City – The port needs more covered areas for grain, rubber, and other cargo that cannot be unloaded in wet weather.

3.4.2 Constraints

A listing of constraints was derived from stakeholder interviews, STI 4, and NCSRP's identified needs. Examples of constraints include narrow tunnels, utility lines, and bridges restricting the ability for double-stacking or oversized loads, or track sections that cannot handle the 286,000 pound car weights.

- STI 4: Relocate Aberdeen Carolina and Western Railroad on new alignment from its current alignment at Sugar Creek Rd. heading southwest to intersect the North Carolina Railroad near Craighead Rd. This railroad runs in close proximity to the NCRR/ NS mainline line railway, and currently causes several operational complications and noise impacts within the area around these railroads. The City of Charlotte will complete a feasibility study on this project in early 2016.
- NCSRP
  - Albemarle Rail Line Upgrades – Upgrade rail parallel to US 52 in Albemarle (Stanly County) to allow for freight.
  - Upgrading and maintaining bridges on Class I Branch Lines.
  - For all short lines, upgrading tracks and bridges to accommodate 286,000 lb. rail cars is essential to retaining industries in the state, particularly the rural and small urban areas where short lines predominantly operate.
- Stakeholders: Port of Morehead City - The current bridge does not allow for railroad clearance, cutting off the PCS Phosphate side of the port from the main portside by rail.

3.5 Safety

NCDOT's Rail Division coordinates safety efforts through their Engineering Coordination and Safety Branch. Safety initiatives include planning and implementing crossing safety programs, inspecting and overseeing infrastructure, and promoting rail safety through public awareness and education. An overview of these efforts is provided in this section along with a brief explanation of the FRA's national oversight of railroad safety.

3.5.1 Rail Safety Initiatives in North Carolina

National Railroad Safety Oversight

The FRA has authority over rail safety across the nation. In this role, the FRA partners with the NCDOT to inspect rail infrastructure in five safety disciplines: hazardous materials, motive power and equipment, operating practices, signal and train control, and track. The NCDOT participates in the safety program and exercises inspections through a multi-year agreement with the FRA. In addition, the FRA supports rail safety programs through grants and loans, collects and maintains safety-related data, investigates incidents, conducts training and education, develops and shares safety-related information, and develops and enforces safety regulations.[18] Training is a major component of FRA's safety program. FRA training helps states to develop rail safety programs and helps inspectors to maintain technical proficiency.[19]

The NCDOT's safety programs conform to rules and regulations implemented by FRA including 49 Code of Federal Regulations (CFR) Part 234, Grade Crossing Safety, Including Signal Systems, State Action Plans, and Emergency Notification Systems and 49 CFR Part 212 State Safety Participation Regulations. In 2008, Congress passed the Rail Safety Improvement Act (RSIA), the first authorization of FRA's safety programs since 1994. The RSIA directs FRA to issue safety regulations for different areas related to railroad safety such as hours of service requirements for railroad workers, positive train control implementation, standards for track inspections, certification of locomotive conductors, and safety at highway-rail grade crossings.[20]

In July 2010, FRA released a Bridge Safety Standards Final Rule requiring railroad track owners to adopt and follow specific procedures to protect the safety of their bridges and to strengthen federal oversight of railroad bridge programs. The final rule requires rail carriers to perform the following:

- Implement bridge management programs that include, at minimum, annual inspections of railroad bridges.
- Conduct special inspections if the weather or other conditions warrant such inspections.
- Maintain an inventory of all railroad bridges and know their safe load capacities.
- Maintain design documents and document all repairs, modifications, and inspections of each bridge.

---

[18] Federal Railroad Administration. "Railroad Safety". Available: http://www.fra.dot.gov/Page/P0010. Visited: 24 April 2014.

[19] Federal Railroad Administration. State Rail Safety Participation. Available: http://www.fra.dot.gov/Page/P0014

[20] Federal Railroad Administration. "Rail Safety Improvement Act of 2008 (RSIA)." Available: http://www.fra.dot.gov/Page/P0395. Visited: 24 April 2014.

- Ensure bridge engineers, inspectors, and supervisors meet minimum qualifications.
- Make sure bridge inspections are conducted under the direct supervision of a designated railroad bridge inspector.
- Conduct internal audits of bridge management programs and inspections.[21]

The FRA has a number of grants and loans to support state safety programs. For example, the Railway-Highway Crossing Hazard Elimination Program provides funding for safety improvements at both public and private highway-rail grade crossings along federally-designated high-speed rail corridors. The FRA also supports a dedicated grant for Operation Lifesaver, a national not-for-profit rail safety organization.

Crossing Safety

The Rail Division's Crossing Hazard Elimination Program is responsible for maintaining a crossing inventory and analyzing data to identify the state's most pressing needs for crossing safety improvements. The program takes into account factors such as train volume, train speed, average daily vehicle traffic, school bus frequency, existing warning devices, the number of main-line tracks and side tracks in use, and the crossing's 10-year accident history (which is available from FRA Office of Safety Analysis)[22]. Information on each crossing is updated annually. The crossings with the highest indices are selected as candidates for improvement. Available funding dictates how many crossings are selected and assigned priorities for improvements. After the selected crossings have been added to the Crossing Hazard Elimination Program, the new projects are submitted to the North Carolina Board of Transportation for approval as additions to the State Transportation Improvement Program.[23]

Traffic Separation Studies is a nationally recommended practice in which NCDOT coordinates with MPOs, local communities, and affected businesses to develop recommendations for railroad-highway crossings. Short-term improvements (1-2 years) may include installing traffic control devices, realigning roadways, or closing crossings. Mid-term recommendations (2-5 years) might include building connector roads, realigning roadways, closing crossings, or relocating crossings. Long-term recommendations may include building bridges, underpasses or connector roads, and closing crossings.[24]

The NCDOT continues to make significant headway to improve crossing safety along the federally-designated southeast corridor from Raleigh to Charlotte. NCDOT partnered with NS to implement the Sealed Corridor Initiative in 1995 between Raleigh and Charlotte.[25] Together, the organizations have been working to install traffic control devices and implement crossing closures. In addition, in 2010 approximately $520 million American Recovery and Reinvestment Act (ARRA) funds were secured for the Piedmont

---

[21] United States Department of Transportation. "Federal Railroad Administration Railroad Bridge Safety Fact Sheet." February 2013.

[22] Federal Railroad Administration Office of Safety Analysis. Accessed June 5, 2014. http://safetydata.fra.dot.gov/OfficeofSafety/default.aspx

[23] North Carolina Department of Transportation Rail Division. Train Crossing Program. Accessed March 6, 2014. http://www.ncbytrain.org/safety/crossings.html

[24] North Carolina Department of Transportation. North Carolina Rail Plan 2000. January 2001.

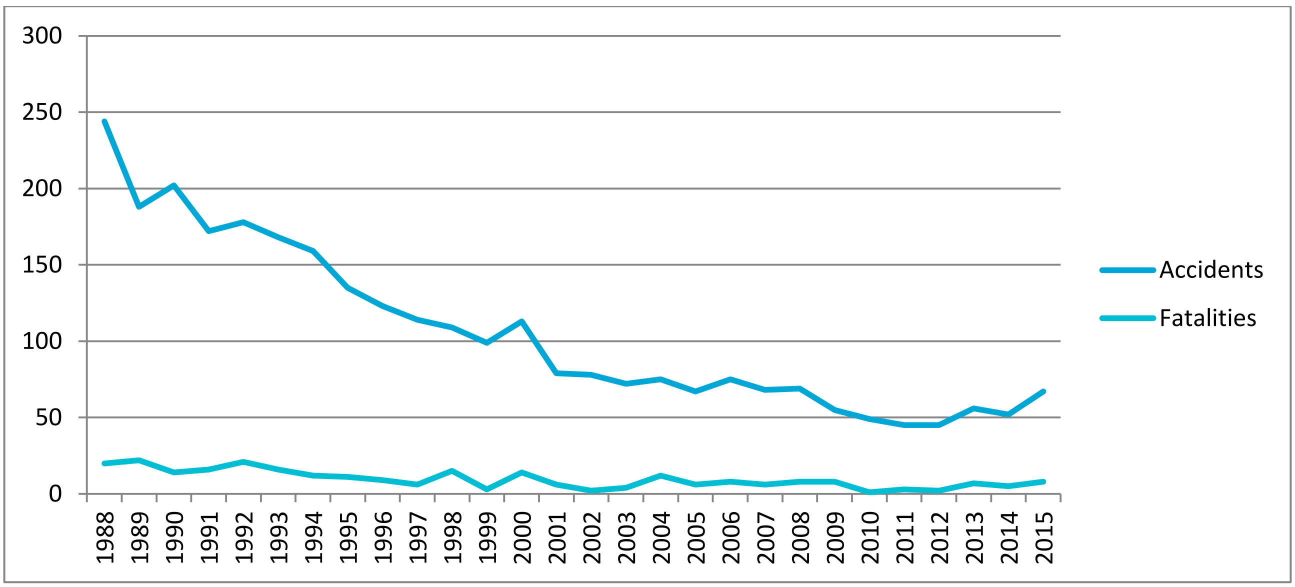
[25] North Carolina Department of Transportation. Sealed Corridor Program. Accessed March 6, 2014. http://www.ncbytrain.org/safety/sealed.html

Improvement Program, a series of planned rail and roadway investments between Raleigh and Charlotte aimed at improving safety and passenger rail travel times. The program is funding 23 crossing closures and 12 grade separation projects, in addition to other improvements.[26] All projects are planned to be completed by 2017.[27]

The NCDOT also uses funds from the Freight Rail and Rail Crossing Safety Improvement (FRRCSI) program to implement safety improvements on eligible rail/highway safety projects that are not funded by other programs. The Rail Division staff uses quantitative analysis to determine funding and to prioritize the projects.[28]

Crossing closure and crossing signalization projects are paying off in reducing the number of crashes between trains and automobiles. Between 2002 and 2013, NCDOT implemented 1,090 crossing signalization projects. As of 2013 NCDOT had completed 189 rail-highway crossing closure projects since 1992.[29] These projects and increased public awareness have led to substantial crash reductions. The number of annual crashes decreased 72.5 percent from 244 in 1988 to 67 in 2015 (Figure 3.10); in contrast, the state population increased by 49 percent over the last 23 years, from 6.6 million people in 1990 to 9.8 million people in 2013. Train accident casualties have also decreased over time and appear to have leveled off over the past few years. The Piedmont Improvement Program and other planned projects will continue to improve safety conditions.

Figure 3.10 North Carolina Highway-Rail Incidents and Fatalities (1988-2015)



Source: FRA Office of Safety Analysis

[26] North Carolina Department of Transportation. Piedmont Improvement Program. Accessed March 6, 2014. http://www.ncdot.gov/projects/pip/

[27] North Carolina Department of Transportation. “Piedmont Improvement Program.” Available: http://www.piedmontrail.biz/. Accessed 24 April 2014.

[28] Worley, Paul. Presentation to the NC Board of Transportation, February 5, 2014.

[29] North Carolina Department of Transportation – Paul Worley. North Carolina Projects Update NCAMPO Presentation. May, 17, 2013.

Inspection and Oversight

In addition to promoting railroad-highway crossing safety, the Rail Division promotes safety through inspecting rail infrastructure and vehicles. The Rail Division's Railroad Safety Enforcement Program partners with the FRA to inspect traffic control devices, thousands of rail cars and locomotives, and over 3,300 miles of railroad tracks in North Carolina. The Rail Division also coordinates with the Federal Transit Administration and local transit agencies to ensure existing and proposed local rail projects meet safety standards as part of the State Safety Oversight Program for Fixed Guideway and Rail Systems.[30] Currently the Charlotte Area Transit System (CATS) is the only transit agency operating a rail transit system (CATS Blue Line light rail), with an extension under construction.

Public Awareness and Education

NCDOT promotes rail safety public awareness through the Rail Division's BeRailSafe program. The program publishes informational materials and offers presentations.[31] BeRailSafe materials address safety around railroad tracks and stresses the message that railroads are not a shortcut, a trail, or a resting place. Presentations are typically targeted to school bus drivers, commercial drivers, sportsmen, adults, and children. NCDOT also promotes rail safety awareness through training law enforcement and emergency responders in railroad emergency and passenger equipment safety procedures.[32] The NCDOT BeRailSafe program complements ongoing public awareness activities of national groups such as Operation Lifesaver and its North Carolina Operation Lifesaver affiliate. Similar to BeRailSafe, Operation Lifesaver is a public information program dedicated to reducing injuries and fatalities at highway-rail crossings and on active rail lines. Operation Lifesaver maintains and publishes statistics about rail trespassing and crossing collisions and offers materials, videos, presentations, and training about education, enforcement, and engineering to promote rail safety.[33] NCDOT is an active board member of Operation Lifesaver. NCDOT also conducts safety blitzes at crossings to advise motorists and trucking companies prior to implementing train control and monitoring system increases using the multi-agents system (also known as MAS).

3.5.2 North Carolina Rail Accident Statistics

The following section provides a statistical review of rail safety in North Carolina over the past decade. It addresses the rail accident and incident trends and provides details as to the type of rail accidents, affected entities, and causes. Table 3.7 shows statistics for the total number of rail accidents and incidents in North Carolina over the past decade. These totals include train accidents, highway/rail incidents, and other accidents/incidents.

[30] North Carolina Department of Transportation. North Carolina Rail Plan 2009 Executive Summary.

[31] North Carolina Department of Transportation. BeRailSafe. Accessed March 6, 2014. http://www.berailsafe.org/

[32] North Carolina Department of Transportation – Paul Worley. North Carolina Projects Update NCAMPO Presentation. May, 17, 2013.

[33] Operation Lifesaver. Operation Lifesaver – About Us. Accessed March 6, 2014. http://oli.org/about-us

Table 3.7 Total Rail Accidents and Incidents in North Carolina

Total Rail Accidents/ Incidents	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Total
Total Events	215	188	206	167	175	165	162	214	202	194	**1,888**
Fatalities	29	27	27	23	19	16	16	25	24	22	**228**
Injuries	51	32	48	36	32	38	32	53	43	46	**411**

Source: FRA Office of Safety Analysis

Train Accidents in North Carolina

Train accidents include train derailments, collisions with other trains, and other events involving on-track rail equipment that result in fatalities, injuries, or monetary damage above a threshold set by FRA. Train accident statistics in the state over the past decade are provided in Table 3.8.

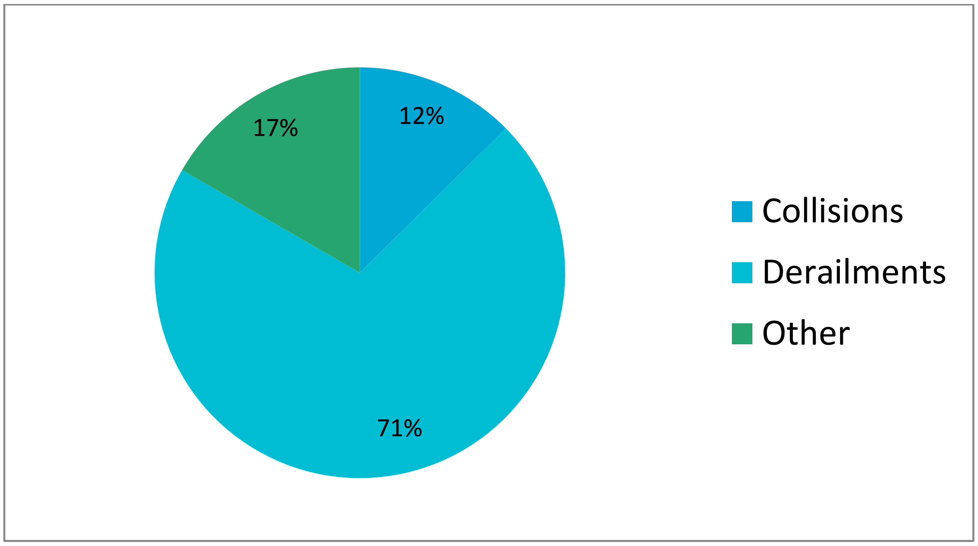
Table 3.8 Train Accidents in North Carolina

Train Accidents	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Total
Total Accidents	31	26	27	25	23	20	21	20	30	23	**246**
Fatalities	0	0	0	0	0	2	0	0	0	0	**2**
Injuries	1	0	2	0	1	2	0	1	0	0	**7**

Source: FRA Office of Safety Analysis

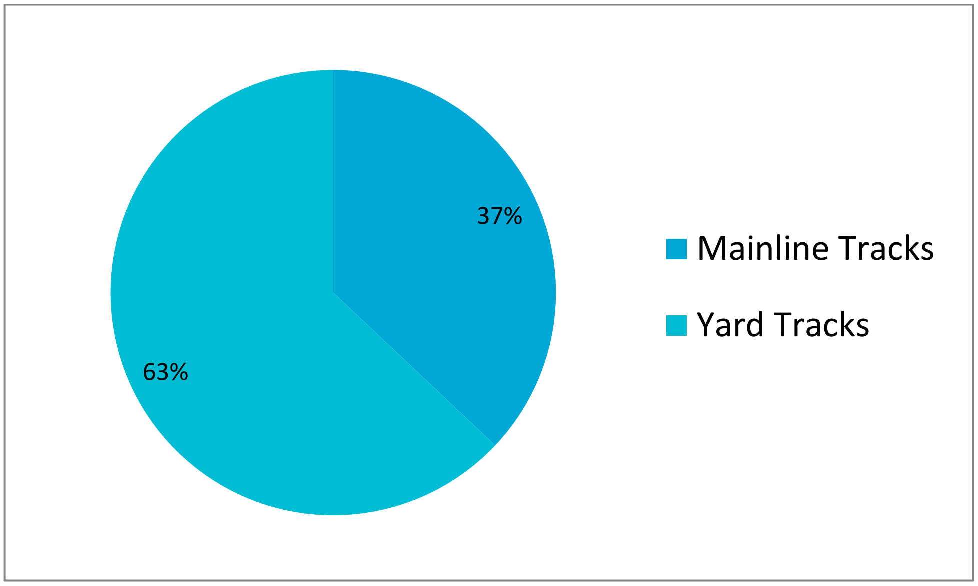
In Figure 3.11, rail derailments are shown to have been the dominant type of rail accidents in the state over the past 10 years. As shown in Figure 3.12, most rail accidents occurred on yard tracks as opposed to main line tracks. Human error and track defects were the leading causes of train accidents over the past decade, while equipment defects and miscellaneous causes comprised lesser shares of rail accidents in the state (Figure 3.13).

Figure 3.11 North Carolina Train Accidents, by Type (2006-2015)



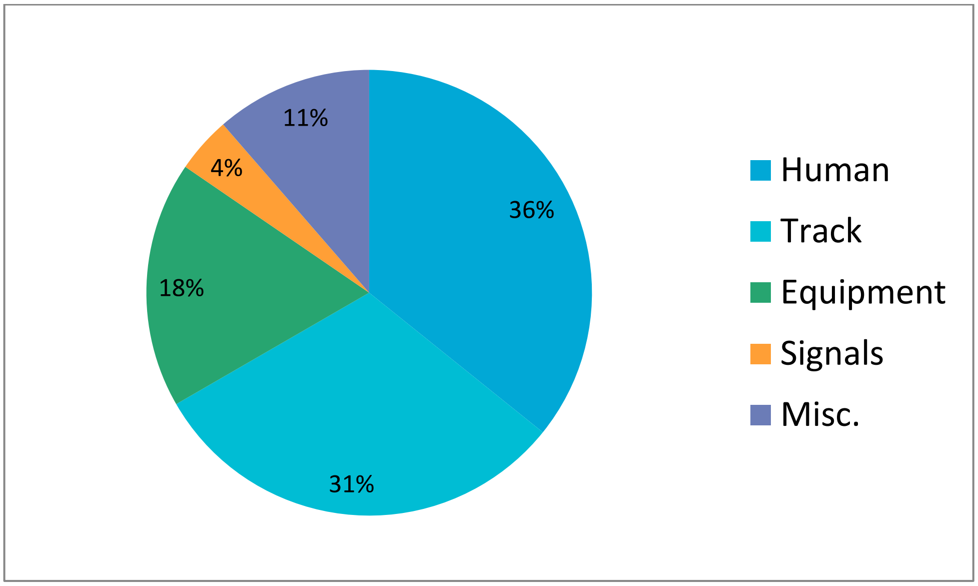
Source: FRA Office of Safety Analysis

Figure 3.12 North Carolina Train Accidents, by Location (2006-2015)



Source: FRA Office of Safety Analysis

Figure 3.13 North Carolina Train Accidents, by Cause (2006-2015)



Source: FRA Office of Safety Analysis

Other Rail Accidents or Incidents in North Carolina

Other rail accidents or incidents include events other than train accidents or crossing incidents that caused a death or injury to any person. Most fatalities in this category are rail trespassers. Other events that generally lead to injuries in this category include activities such as getting on or off equipment, doing maintenance work, throwing switches, setting handbrakes, falling, etc. Rail passenger-related casualties can include getting on or off standing trains or platforms. Statistics for this category of rail incidents are shown in Table 3.9.

Table 3.9 Other Rail Accidents or Incidents in North Carolina

Other Accidents/ Incidents	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Total
Total Accidents	109	94	110	87	103	100	96	138	120	104	**1,061**
Fatalities	21	21	19	15	18	11	14	18	19	14	**170**
Injuries	90	77	92	77	89	91	84	120	101	92	**913**

Source: FRA Office of Safety Analysis

In general, rail-related fatalities in the state, excluding highway/rail incidents, result primarily from trespassers on railroad property who are struck by trains or other equipment. Trespass-related fatalities accounted for 167 of the total 170 fatalities over the decade. Other persons injured as a result of rail accidents or incidents not at highway /rail crossings are primarily railroad employees, contractors, or volunteers performing rail-related activities on railroad property.

At-grade Roadway/Rail Crossing Incidents in North Carolina

Table 3.10 shows the number of highway-rail grade crossing incidents, fatalities, and injuries occurring at all at-grade crossings over the past decade. These figures show a slight decrease in number of total incidents and deaths comparing the first five years of the decade to the last five years. Eighty-four percent of highway-rail incidents occur at public crossings.

Table 3.10 Highway-Rail Incidents in North Carolina

Highway-Rail Incidents	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Total
Total Accidents	75	68	69	55	49	45	45	56	52	67	**581**
Fatalities	8	6	8	8	1	3	2	7	5	8	**56**
Injuries	23	19	31	34	38	22	42	29	28	99	**365**

Source: FRA Office of Safety Analysis

Rail Incidents involving Hazardous Materials in North Carolina

Table 3.11 below shows the history of incidents involving rail cars carrying hazardous material in North Carolina over the past decade. The total rail incidents involving hazardous materials in the state has generally been trending downward over the past decade. The last five years has seen a significant improvement in the reduction of incidents involving hazardous materials. There has been no incident caused by the release of hazardous materials in North Carolina since 2009.

Table 3.11 Rail Incidents Involving Hazardous Materials in North Carolina

Rail HazMat Incidents	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Total
Incidents Involving HazMat Releases	0	1	1	2	0	0	0	0	0	0	**4**
Cars Carrying HazMat	139	119	99	97	95	74	5	70	51	33	**782**
HazMat Cars Damaged or Derailed	1	5	6	24	9	2	0	11	5	1	**64**
Cars Releasing HazMat	0	1	1	3	0	0	0	0	0	0	**5**

Source: FRA Office of Safety Analysis

4.0 Future Performance/Long-Term Trends

4.1 Future Activity/Demand

Overall, rail freight flows are expected to increase in North Carolina from 85.1 million tons in 2014 to 111.6 million tons in 2045 (Table 4.1) or on average 0.9 percent per year with the dollar value increasing at a faster rate of 1.9 percent per year (Table 4.2). Intermodal rail flows are expected to grow from 8.9 million tons in 2014 to 15.4 million tons in 2044 (Table 4.3) – an average rate of 1.8 percent per year which matches the forecasted growth in value per year (Table 4.4).

Table 4.1 North Carolina Rail Flow Forecast, by Weight (thousand tons)

Direction	2014	2015	2020	2025	2030	2035	2040	2045
Local	2,737	2,756	2,855	2,958	3,064	3,174	3,288	3,406
Through	28,909	29,244	30,975	32,809	34,752	36,810	38,990	41,298
Inbound	43,160	43,375	44,465	45,583	46,729	47,903	49,107	50,341
Outbound	10,276	10,434	11,264	12,159	13,126	14,169	15,296	16,511
Total	**85,082**	**85,809**	**89,560**	**93,509**	**97,670**	**102,056**	**106,680**	**111,557**

Source: 2014 Confidential Carload Waybill Sample for North Carolina; Freight Analysis Framework version 4 (FAF4) Database; and analysis by Cambridge Systematics.

Table 4.2 North Carolina Rail Flow Compound Annual Growth Rate Forecast

CAGR 2011-2040	By Weight	By Value
Local	0.7%	2.0%
Through	1.2%	1.6%
Inbound	0.5%	2.1%
Outbound	1.5%	2.1%
Total	**0.9%**	**1.9%**

Source: 2014 Confidential Carload Waybill Sample for North Carolina; Freight Analysis Framework version 4 (FAF4) Database; and analysis by Cambridge Systematics.

Table 4.3 North Carolina Intermodal Forecast, by Weight (thousand tons)

Direction	2014	2015	2020	2025	2030	2035	2040	2045
Local	4,920	4,994	5,381	5,797	6,247	6,730	7,252	7,813
Inbound	1,773	1,809	2,005	2,223	2,463	2,730	3,026	3,354
Outbound	2,197	2,245	2,498	2,780	3,094	3,443	3,832	4,264
Total	**8,890**	**9,048**	**9,884**	**10,800**	**11,804**	**12,903**	**14,109**	**15,431**

Source: 2014 Confidential Carload Waybill Sample for North Carolina; Freight Analysis Framework version 4 (FAF4) Database; and analysis by Cambridge Systematics.

Table 4.4 North Carolina Intermodal Compound Annual Growth Rate Forecast

CAGR 2011-2040	By Weight	By Value
Through	1.5%	1.5%
Inbound	2.1%	2.0%
Outbound	2.2%	2.1%
Total	**1.8%**	**1.8%**

Source: 2014 Confidential Carload Waybill Sample for North Carolina; Freight Analysis Framework version 4 (FAF4) Database; and analysis by Cambridge Systematics.

Inbound traffic makes up the largest share of rail freight movement within North Carolina, accounting for half of total rail tonnage (Table 4.1). However, outbound traffic is expected to grow much faster than inbound non-container traffic, and only slightly faster than container inbound traffic over the next thirty years. Outbound tonnage will grow by 1.5 percent per year between 2014 and 2045 (total value will grow by 2.1 percent); while inbound tonnage is expected to grow moderately at 0.5 percent (but the value climbs at approximately 2.1 percent annually). This is due to significant amounts of heavy-weight coal moved in 2014 to North Carolina, which is forecasted to decline significantly by 2045. In response to the expected decline of coal traffic, the rail operators are moving to capture more intermodal business. Reduction in coal shipments passing through and terminating in North Carolina provides network capacity to accommodate growth in other commodities.

Through-traffic will grow at about 1.2 percent and 1.6 percent in terms of tons and value respectively. As NS and CSXT invest more money into the Crescent Corridor and National Gateway Corridor, respectively, with rehabilitation of rail tracks to achieve faster delivery times, improve capacity, and run more efficient trains, North Carolina will experience growth in intermodal traffic. Currently intermodal traffic is forecasted to grow at approximately 1.8 percent compound annual growth rate from 2014 to 2045.

4.2 Trends and Implications of Growth

4.2.1 Trends

Demographic, Economic, and Land Use Pattern Trends

With much of North Carolina's future population growth anticipated for urban areas, infill development and redevelopment of this kind will play an important role in shaping future land use patterns.

Projections of future land use from the US Forest Service indicate that between 2010 and 2040 urbanized area in North Carolina will increase by approximately 50 percent from about four million acres to about six million acres, with corresponding decreases in the acreages of cropland, pasture land, and forested land.[34] The Piedmont will experience the greatest transition to urbanized area, with nearly ten percent of the region's acreage being converted to urban uses.

[34] Wear, David N. Forecasts of County-Level Land Uses Under Three Future Scenarios: A Technical Document Supporting the Forest Service 2010 RPA Assessment. Gen. Tech. Rep. SRS-141. Asheville, NC: US Department of Agriculture Forest Service, Southern Research Station. Available at: http://www.srs.fs.usda.gov/pubs/gtr/gtr_srs141.pdf

Despite years of manufacturing job losses, North Carolina is beginning to see modest manufacturing growth. More than 40 new manufacturing facilities were announced during 2013. Many of the announcements were for western North Carolina. Manufacturing still employs 18.4 percent of all workers in this region despite losses to furniture and textiles in recent years. While the high-skill and capital-intensive jobs are not a substitute for jobs lost, they are still important for maintaining the region's manufacturing economic base. North Carolina's future manufacturing growth will likely continue to be in high-skill, capital-intensive industries such as chemicals and polymers, pharmaceuticals, aviation equipment, computers and electronics, and industrial machinery.[35]

Other potential rail-dependent industries are seeing recoveries as well. Currently, there are efforts to do more food processing in North Carolina to add value. The State's Food Manufacturing Task Force identified that short line railroads will be critical for companies where rail access is important in their relocation decision. They can take advantage of fresher products and more supply chain security by locating the processing closer to where crops and animals are being grown. Construction employment is beginning to rise due to increased commercial and residential building activities. The majority of new construction is concentrated in Charlotte and the Triangle where there has been recent growth in multi-family housing and to a lesser extent, single-family homes. The Greensboro and Winston-Salem regions are challenged with past manufacturing losses and have not returned to post recession employment levels. As the overall economic climate continues to recover in North Carolina, growth will continue to spill over to residents' discretionary income and boost employment in the trade, transportation, and utilities, and the leisure and hospitality sectors.

Manufacturing is expected to experience a slight decline whereas construction and related aggregate industries are expected to increase over the next 25 years. Fuel costs and other variables will also factor into the future of freight-oriented land uses across the state. Stakeholders participating in the development of this plan have noted the importance of preserving sites along existing rail corridors for freight rail-oriented industries. It has been noted that a program to work with regional and local land use regulators to optimize use of increasingly scarce rail-served sites is needed.

Freight Trends

Over the course of the next 25 or more years, there are spatially-related and commodity-related trends emerging for North Carolina. Spatially, changes in rail flows are presented in Figure 4.1, Figure 4.2, and Figure 4.3. Outbound rail flows are expected to grow on rail lines across the state with significantly more tonnage traversing the Greensboro to Charlotte corridor as well as most major corridors in the western part of the state (Figure 4.1). Outbound intermodal flows are high and continue to increase along the two primary north-south routes in North Carolina (Figure 4.1). Inbound flows increase mainly from the Virginia border to Greensboro and between Greensboro and Raleigh; whereas inbound intermodal flows are expected to increase on the Greensboro to Charlotte corridor (Figure 4.2). Through-rail traffic is not expected to change significantly in terms of routes; however, there is growth in flow between Asheville and Salisbury (Figure 4.3). Overall there is an expected increase in freight volumes originating in North Carolina destined for locations outside of the state.

[35] Wells Fargo Securities. North Carolina Economic Outlook: April 2014. April 3, 2014. Accessed April 9, 2014.

Figure 4.1 North Carolina Outbound Rail Flows, Carload and Intermodal (top, bottom), 2011 and 2035

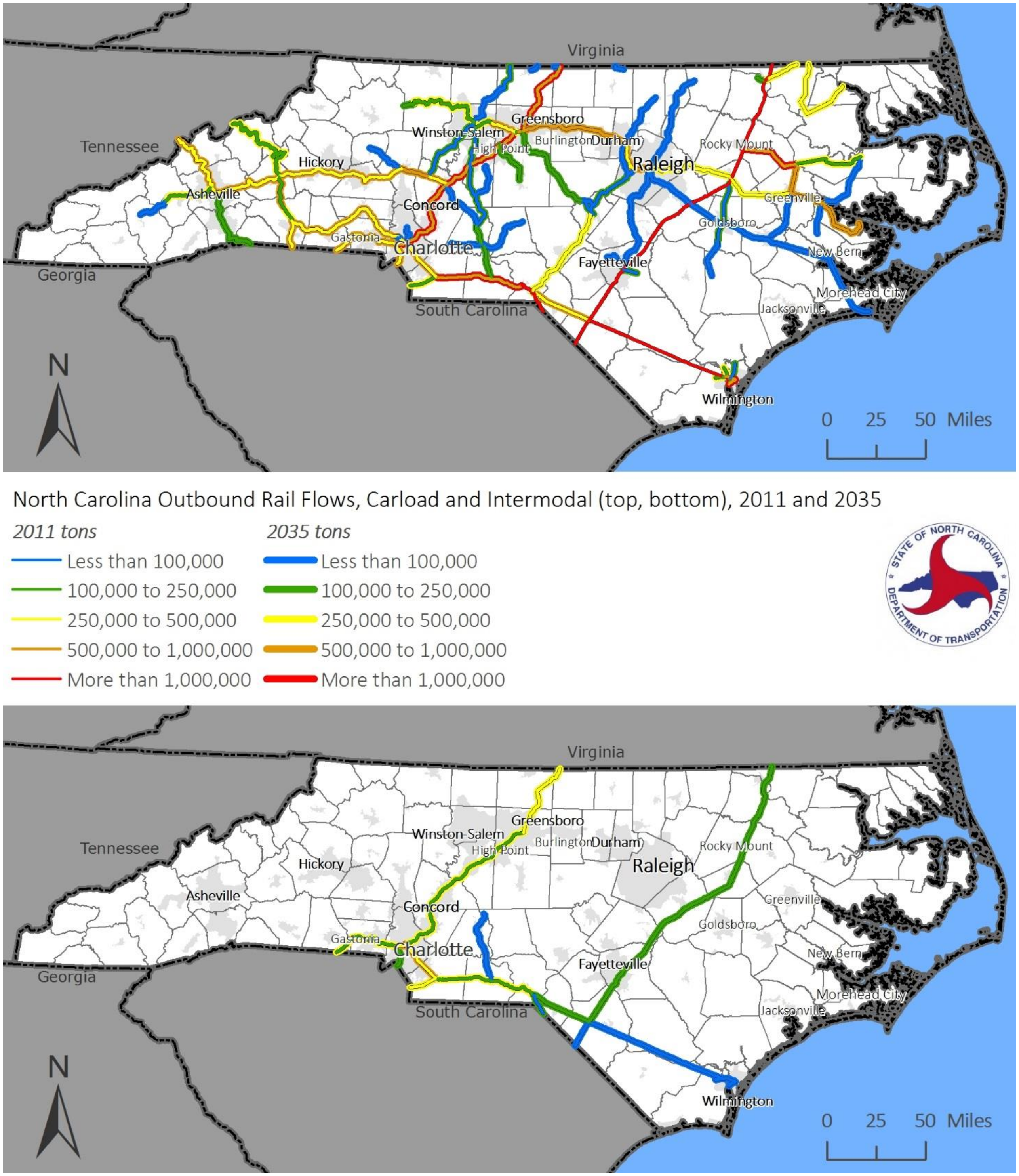


Figure 4.2 North Carolina Inbound Rail Flows, Carload and Intermodal (top, bottom), 2011 and 2035

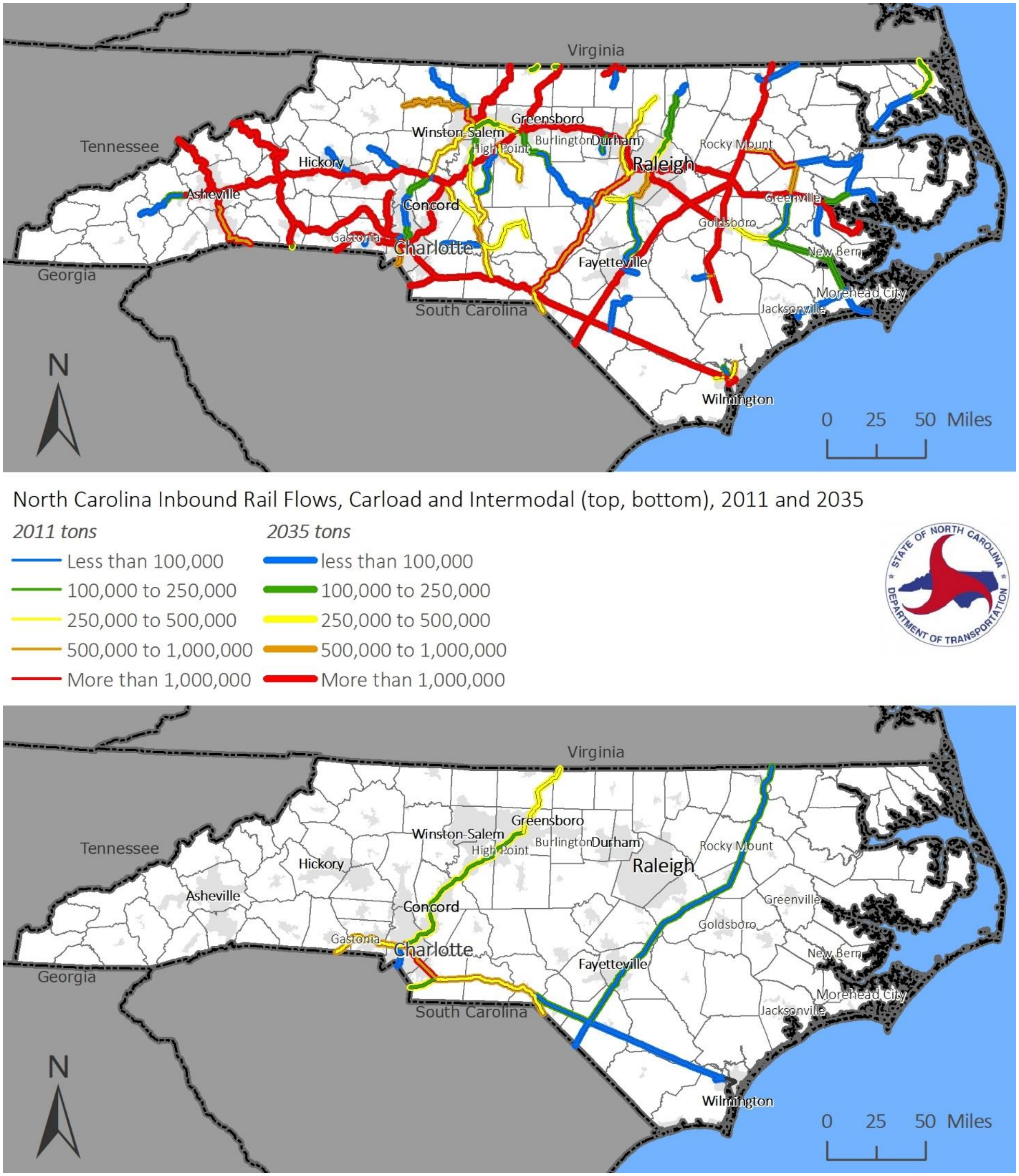
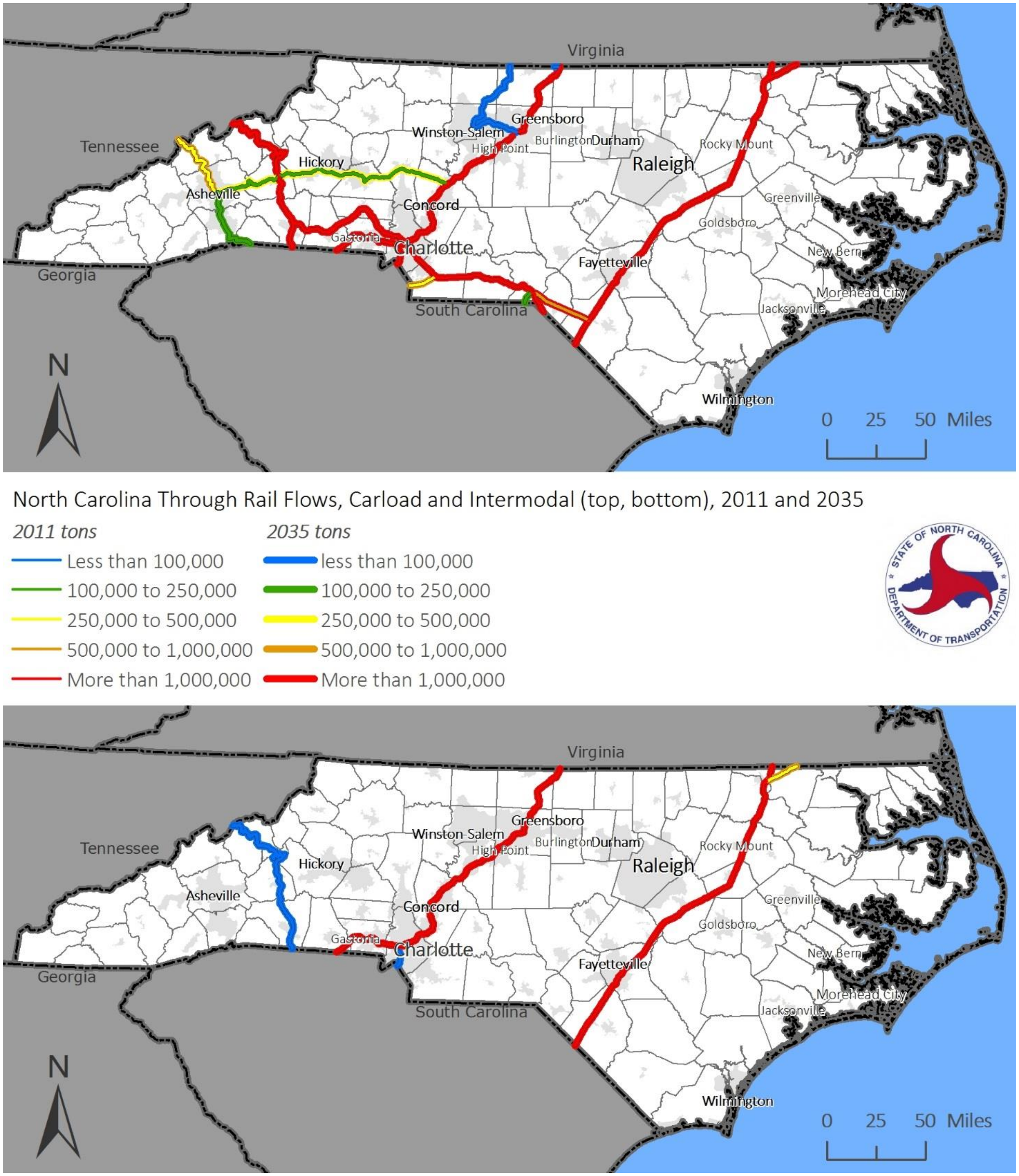


Figure 4.3 North Carolina Through Rail Flows, Carload and Intermodal (top, bottom), 2011 and 2035



In terms of commodity flows, Illinois, Louisiana, and Canada increase in importance for plastics and chemical products shipped to support a growing plastics and packaging industry.

With the exception of coal, most other inbound non-container traffic originates from nearby states in the Northeast and Southern states, while non-container outbound cargo follows a different pattern. More proximate states are still among the most important destinations, especially South Carolina, Georgia, and Virginia, but other large international trade centers such as ports in Virginia and Midwest states receive substantial flows originating in North Carolina. The top outbound goods, respectively to these destinations, are metal scrap, plastics, chemicals, dyes, and wood products. And increase of rail flows to South Carolina and Georgia are expected from plastics, dyes, metal scrap, and broken stone due to increased production of those items in North Carolina.

One of the near-term examples of commodity trends taking place is seen for natural gas and crude oil fracking in areas previously ignored by the industry due to lack of information available on geologic formations, as well as technological and economic limitations. Shale formations are most likely present in several North Carolina formations, including the Deep River Basin, a 150-mile long fault in central North Carolina. Legislation was passed in North Carolina in 2012 and 2014 to allow hydraulic fracturing. The potential exists for further investments in rail and pipelines to move North Carolina and Marcellus/Utica gas to markets in the Southeast. Significant investments are underway now and in the near future centered on upgrading/extending/reversing interstate gas pipelines to allow north-to-south flows. Several extensions are targeting North Carolina in particular. The fracking development techniques utilized for these formations often bring a significant change to the existing land use, transportation, and economic base for the development zones.

Chemicals constitute an important share of non-container freight, especially when measured by value (accounting for approximately 10 percent of the total value). North Carolina plays an important role in chemical supply chains as a consumer of chemical feedstocks as manufacturing inputs (e.g., plastics, packaging, and fertilizer).

Many of the recent investments in wood pellet capacity in the US have occurred along the Atlantic coast, with Enviva and Fram Renewables expanding production in North Carolina, Georgia, and Virginia. Wood pellet industry expansion is primarily driven by demand for biomass in Europe, as a means to find alternatives to coal. In 2013, Europe imported about 3 million tons of wood pellets, and by 2020 that number is expected to grow rapidly to 20 million tons. Wood pellet production levels are, however, subject to uncertainties such as raw material supply. Wood pellets for energy use are closely interlinked with other industries whose outputs comes from sawmill and forestry production. For example, US wood pellet production is strongly led by the country's demand for timber to generate wood residuals and biomass, which is subject to construction industry activity. Enviva and International Wood Fuel are expanding wood pellet production terminal capacity at the ports of Wilmington and Morehead City. Wood pellet rail flows in North Carolina are expected to grow at 2.1 percent compound annual growth rate (CAGR) from 2011 to 2040.

Auto manufacturing is currently growing in South Carolina, Georgia, Alabama, Tennessee, and other southern states. According to the North Carolina Department of Commerce, North Carolina continues to actively pursue opportunities with the automotive industry and related products. An increasing percentage of motor vehicles (by total value) are expected to be shipped into North Carolina between now and 2025 after which the percentage drops sharply off through year 2040.

The role for intermodal terminals continues to grow as more products are shipped via container, including agricultural products and other materials previously shipped in bulk. Bulk products may be loaded and unloaded at customer facilities or with dedicated purpose built connections for transloading. Coal, petroleum, chemicals, plastics and paper, pulp, and paper products each fall into this category of freight products. Minerals and project cargoes, such as military equipment and machinery, will be transported as well. Intermodal commodities can be difficult to tease apart; FAK, or Freight All Kinds is by far the largest category. FAK is a mix of commodities being shipped together. Often FAK shipments are intended for a particular retailer (e.g., Lowe's or Wal-Mart). Beyond this general intermodal category, pharmaceuticals are the major outbound commodity by value, now and through 2040. Growth for inbound freight flows includes such commodities as necessary textile goods, missile or space vehicle parts, and liquor.

4.2.2 Implications of Growth

There are a number of factors that drive freight movement and will shape the changes in rail volumes over time. Changes in port capacities, from draft of vessels served to the mix of intermodal and bulk traffic, will have implications for the rail service to and from North Carolina and across the east and Gulf coasts. One emerging factor is the shift for Asian freight movements to use the Suez Canal and Atlantic routes to the US and Canada rather than trans-Pacific routes. Two additional rail congestion trends are anticipated. The overall congestion on railroad networks may affect North Carolina. Both of the Class I railroads continually examine their respective networks to adapt and improve capacity as freight movements grow and change in response to market conditions and trade flows, as demonstrated by the Crescent Corridor and National Gateway initiatives. Responding to these changes takes time, and may be further complicated by cost and complexity. The second source of potential congestion is a result of shared use with passenger services that require freight and passenger movements to be coordinated and separated temporally. As demand continues to grow for intercity and commuter rail services, there is the potential for more congestion along the freight rail network. The congestion may be complicated by the fact that many industrial customers served by railroads are located in cities and counties that also house their workforce, thus shaping competing land use demands in the future.

Highway Congestion and Freight Rail

Congested highway corridors may create conditions for commodities to be more effectively shipped by freight rail in cases where the commodity, rail capacity, and rail travel times permit. Figure 4.4 and Figure 4.5 show interstate freight truck volumes in 2007 and projected for 2040, respectively. Truck volumes are heaviest along I-40/I-85 in the Piedmont Crescent, I-40 in western North Carolina, I-77 and I-95. The projected truck volume increases for 2040 are in the same corridors. There are long range plans to expand the highway capacity of all of these corridors.[36] Several states have undertaken studies to examine how truck to rail diversion might accommodate existing and future freight growth. The Virginia Department of Transportation conducted this type of analysis for the I-81 Corridor Improvement Analysis – Freight Diversion and Forecast Report. I-81 is the heavily trafficked truck route located northwest of North Carolina in Figure 4.4 and Figure 4.5.[37] Figure 4.6 presents 2040 volume-to-capacity ratios on major highway corridors. Future congestion on highways could serve to incent more movement of goods on rail; however, it should be

[36] North Carolina Department of Transportation. Strategic Transportation Imitative Results Map. https://connect.ncdot.gov/projects/planning/Pages/STI-Results.aspx

[37] Virginia Department of Transportation. I-81 Corridor Improvement Study – Freight Diversion and Forecast Report. http://www.virginiadot.org/projects/resources/freight.pdf

noted that highway congestion can also negatively affect truck movements associated with intermodal systems. As all three intermodal facilities in North Carolina are located in Charlotte and Greensboro, the state must consider the impact of future congestion on I-40 and I-95 on the Triangle's and Eastern North Carolina's access to the intermodal system.

Figure 4.4 Average Daily Long Haul Interstate Freight Truck Traffic (2007)

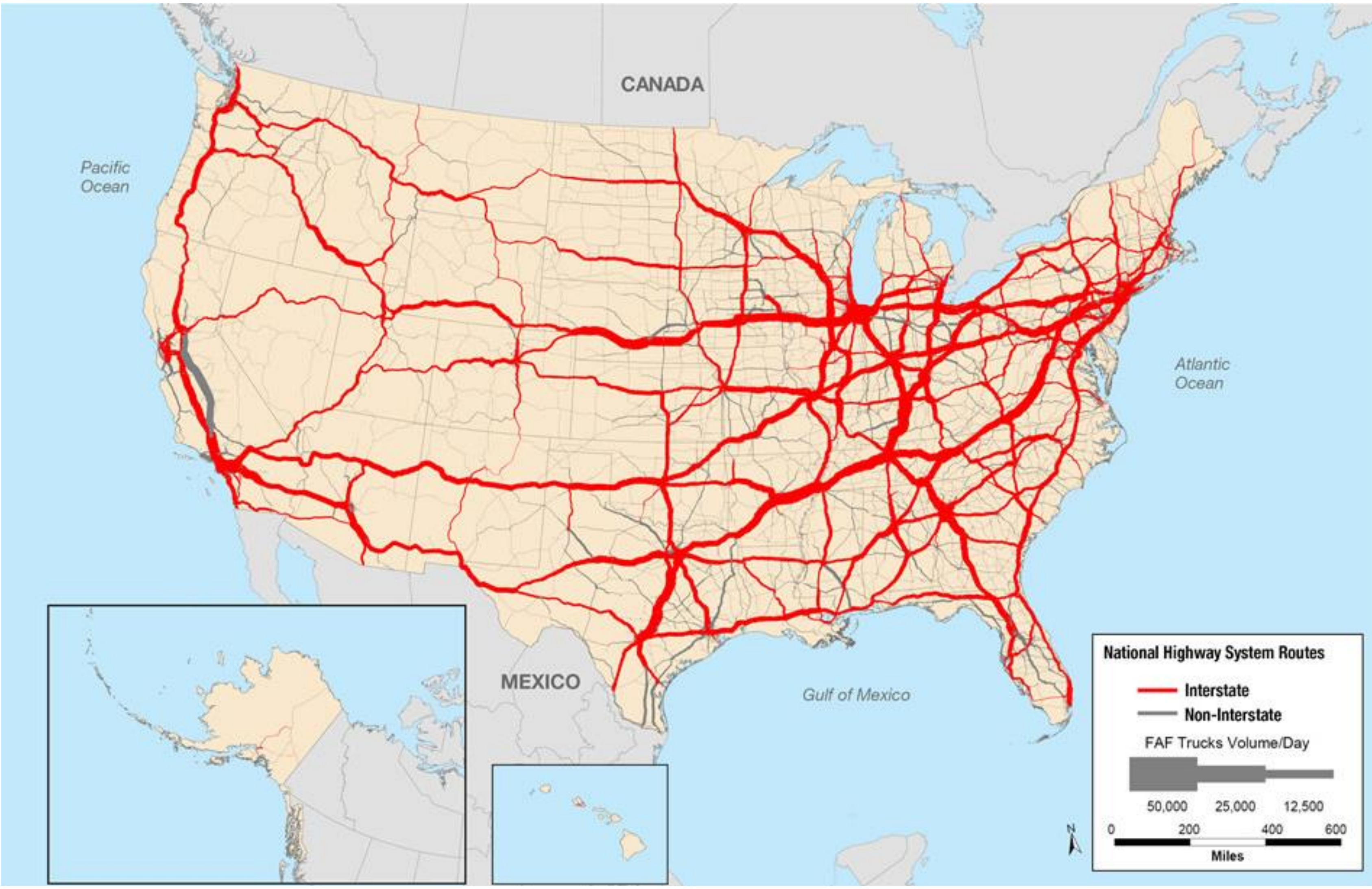


Figure 4.5 Projected Average Daily Long Haul Interstate Freight Truck Traffic (2040)

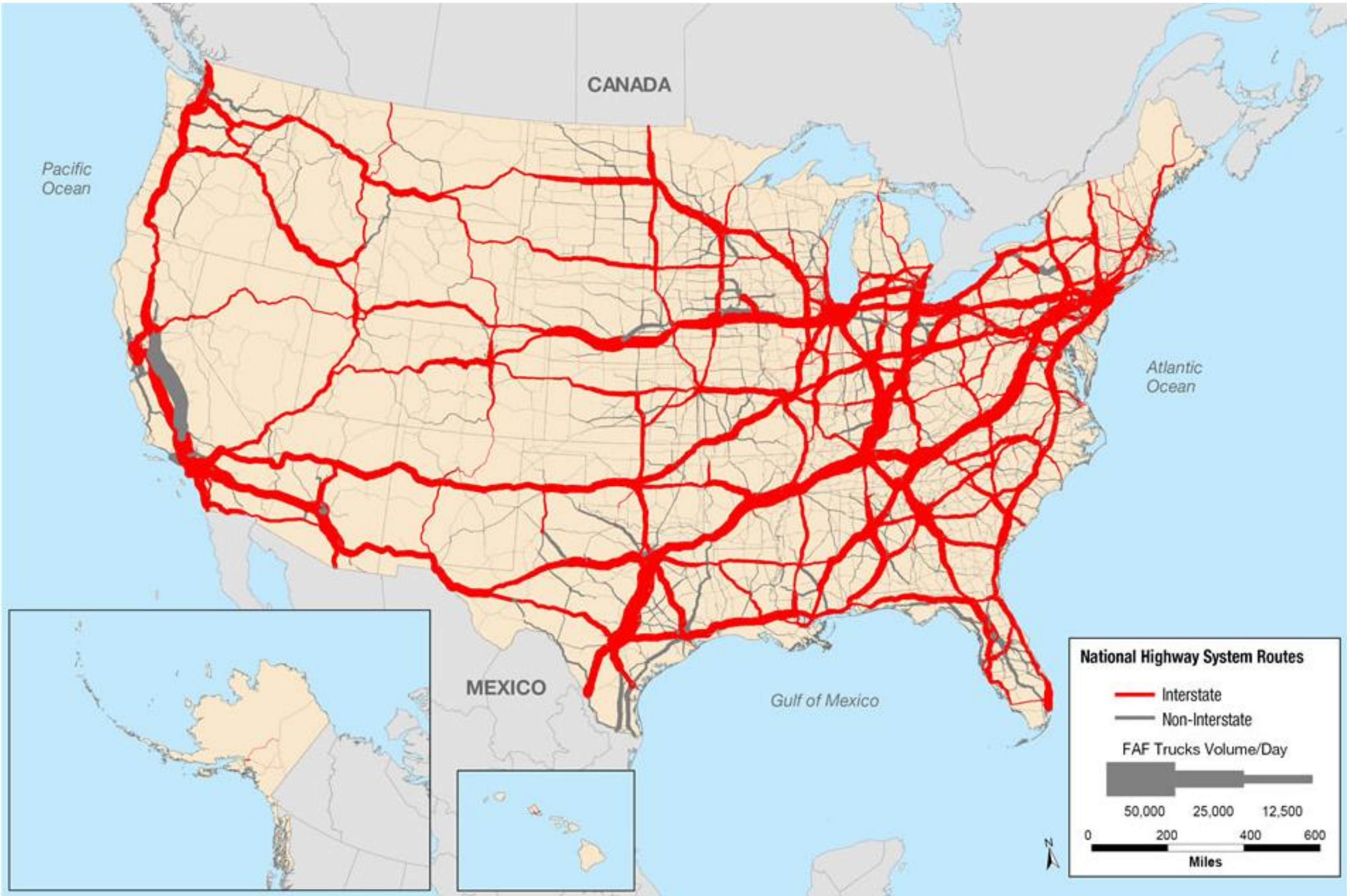
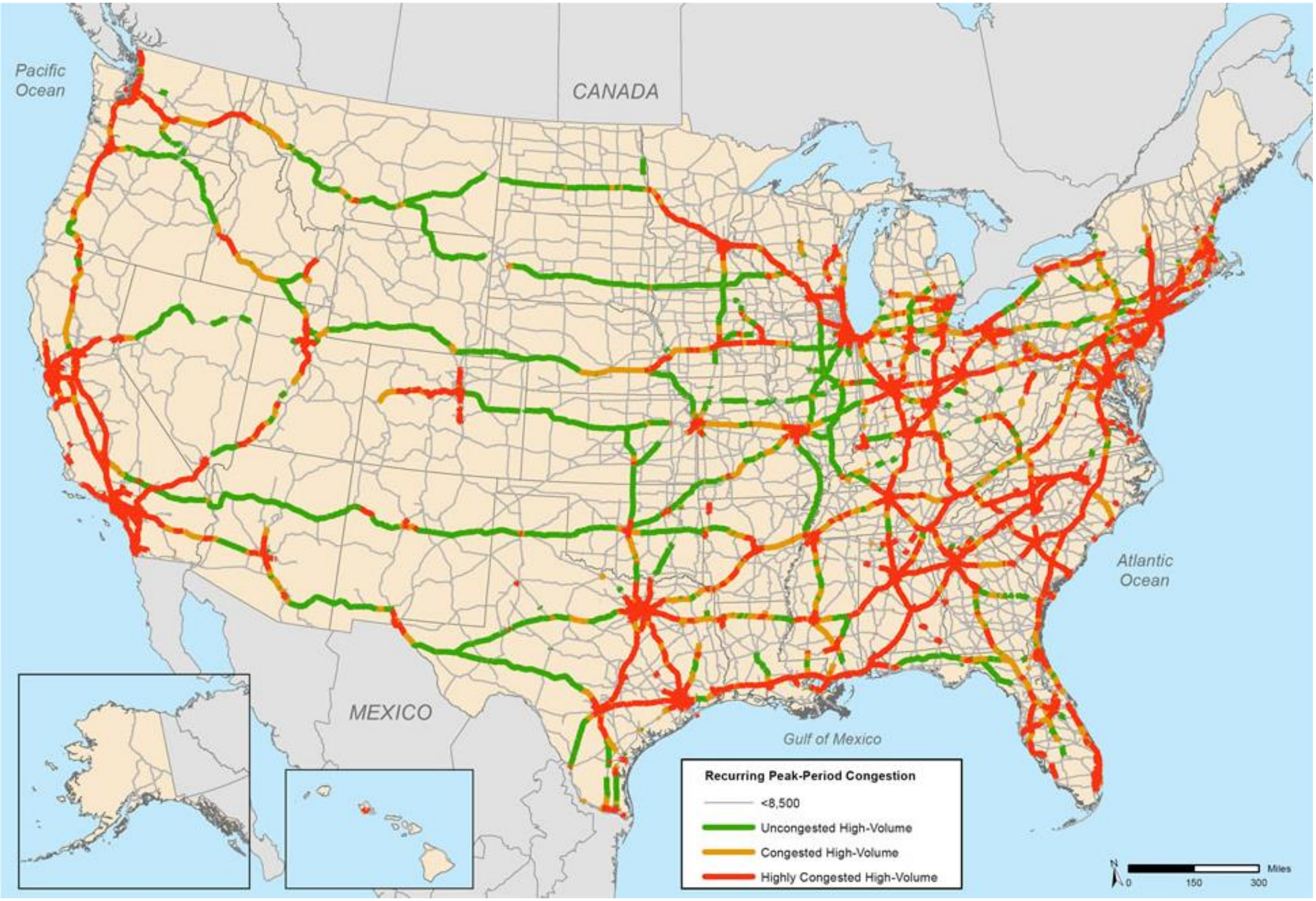


Figure 4.6 Peak Period Congestion on High-Volume Truck Portions of the National Highway System (2040)



Utilizing rail is a cost-effective way to gain travel capacity in high-use corridors and helps diminish the depreciation of highway assets by removing trucks from the highway network. The option of transferring goods from truck to rail for transporting within North Carolina and among its neighboring states provides a means to reduce truck VMT and the associated costs of congestion, maintenance, fuel, and emissions. By removing some trucks from the roads, highway capacity increases without spending state funds for the construction of additional lane-miles, which is often not feasible or desirable, and also saves money on highway maintenance because trucks cause more damage than automobiles.

Passenger Train Delays

North Carolina is served by six intercity passenger routes (14 daily trains) with stops in 16 communities. Five of the routes are interstate services and the other route provides two daily roundtrips along the Raleigh to Charlotte Piedmont corridor.

The *Carolinian* travels along the CSXT A Line and then along the NCRR corridor between Selma, Raleigh, Greensboro, and Charlotte, a portion of which is part of NS's Crescent Corridor (Greensboro to Charlotte). The *Piedmont* travels exclusively on the corridor that connects Raleigh, Greensboro, and Charlotte. On-time performance (OTP) data is gathered by Amtrak for passenger services, it can be used to help identify areas where conflicts between passenger and freight trains occur and result in delay. Though not exclusively a capacity issue, the conflicts can indicate potential congestion issues. Table 4.5 summarizes the causes of host railroad delays encountered by state-supported passenger services.

Table 4.5 Summary of Top Two Host Railroad-Responsible Delays for Passenger Services by Quarter (Q4 FY 2010 through Q2 FY 2016)

Delay Type		Carolinian (CSXT)	Carolinian (NS)	Piedmont (NS)
Commuter Train Interference (CTI)	Average Delay (minutes)	0	0	0
	Count^	0	0	0
Signal Delays (DCS)	Average Delay	343	120	138
	Count	2	5	10
Slow Order Delays (DSR)	Average Delay	299	185	215
	Count	4	20	22
Debris (DBS)	Average Delay	0	0	0
	Count	0	0	0
Freight Train Interference (FTI)	Average Delay	522	250	223
	Count	20	5	14
Passenger Train Interference (PTI)	Average Delay	367	153	0
	Count	20	16	0

Source: Amtrak Rail Service Metrics and Performance Reports.

Note: ^Count means the total number of occurrences between Q4 FY 2010 and up through Q2 FY 2016.

On-time performance for both the Carolinian and Piedmont is below the industry standard of 80 percent. The other long distance trains serving the state have also seen decreases in end-point OTP over the past four years. These decreases in end-point OTP may be due to recent increases in freight traffic, which is creating additional scheduling conflicts between the passenger and freight trains in the CSXT and NS corridors.

The data for the Carolinian indicates that most of the delays for this train occur between Richmond and Selma on the CSXT A Line, rather than along the portion of the route between Selma and Charlotte. Table 4.5 shows that conflict with freight traffic is the most frequent cause and creates the longest delay for the Carolinian between Selma and Washington, DC. There are three additional ARRA-funded projects to install double cross-overs on the double-tracked portions of CSXT's A Line in Halifax, which will help to alleviate some freight-passenger conflicts along that corridor. However, more detailed study of capacity needs along the A Line should be conducted.

5.0 Needs Assessment

The needs and opportunities in freight rail arise from the supply chain focus associated with goods movement. The infrastructure conditions affect how much and how fast. The freight supply chain necessitates the state monitor the effectiveness of origin - destination pairs, both railroad and industry perspectives, by velocity, timeliness and efficiency. Outbound rail freight movements are important to distinguish whether the move is ultimately to ports or industrial sites. The distinction helps to develop closer ties for the attraction and retention of industrial companies in the state.

Rail offers a mix of volume, speed and value for transporting goods long distances across networks with a well-defined operational history. Many of the raw materials required to produce energy, supply food, and construction rely on rail for at least one step of the resource to consumption production cycle. North Carolina is in a position to verify potential changes in freight flows with the Class I, regional, and short line railroads, as well as potential adaptive strategies for handling the volumes.

Chemicals constitute an important share of non-container freight, especially when measured by value (accounting for approximately 10 percent of the total value). North Carolina plays an important role in chemical supply chains as a consumer of chemical feedstocks for manufacturing inputs (e.g., plastics, packaging, and fertilizer).

North Carolina can also explore opportunities for expanding high-value chemicals manufacturing. The overall energy market contributes significantly to the shifts in petrochemical and petroleum resource / production / processing. Crude oil by rail has received substantial attention but is only one dimension.

5.1 Rail Service Needs – Freight

From the freight traffic perspective for the railroad industry, the rail service needs are most often shaped by specific customer and location requirements. For example, the 2013 North Carolina Rail Forum identified an estimated 25 percent of the Class I railroad traffic begins and ends on short line railroads. In North Carolina, the agricultural and restored manufacturing markets are where regional railroads can add fluidity to the Class I railroad network. The short line railroads are able to preserve and upgrade their respective state-of-good-repair conditions with sufficient traffic volumes. However, when volumes decline, often train speed and car weight are reduced while preserving safety in operations. Hence, it remains important to aid industry locations along existing short lines to preserve and maintain traffic where commercial and logistics decisions align. The impact is equally important for Class I and Class III railroads. The 286,000 pound loaded railcar is the industry standard, though the industry is shifting to the 315,000 pound loaded railcar. It is important for industry to have shipments delivered the full trip reinforcing the importance of the “first and last mile” of freight movement. With the average Class III line length of ±45 miles, the service track speed is far less important than the ability to schedule frequent service for a fully loaded railcar. The Railway Association of North Carolina estimated the cost to bring their collective system up to industry standards was approximately $120 million for track and bridges.

Moreover, there are some instances where adjacent state(s), particularly for the supplier/customer linked to a North Carolina industry, and nationwide factors, come into effect. With these broader factors considered, specific freight rail needs in North Carolina are as follows:

- Maintain and improve track capacities, especially on Class II and III systems, for existing and future high flow corridors. The available maximum allowable gross weight for 286,000 pound loaded cars (the industry is considering 315,000 pounds) is becoming more important for industries as they manage productivity and transportation costs. Limitations may arise with the track or with structures along the route. Individual industries served by Class II or III railroads may only have one route to their respective facilities and may become stranded if capacities fail to keep pace with market demands or conditions deteriorate.

- Improve safety and strive to minimize delays. The increases in roadway and rail traffic will continue to lead to greater congestion and delay at at-grade crossings. As freight trains become longer and movements of unit trains increase, the delay hours at crossings will continue to grow. In addition, the movement of hazardous materials creates additional concerns at rail-highway crossings. Therefore, the second rail service area centers on roadway and rail at-grade crossings, including separations and closures. The selective evaluation of activity patterns for roadway transportation in connection with railroad freight traffic may present candidate sites for improvement.

- Expand freight rail infrastructure and/or add redundancy in select locations across the state to support economic development aligned with rail-based markets as well as supply chain reliability. This third area arises from the continued development of the Class I railroad networks. As the NS and CSXT volumes grow and shift across the respective origin and destination pairs they will move traffic across their networks in the most effective manner. The new intermodal facilities built by CSXT in North Baltimore, Ohio and by NS in Rossville, Tennessee and Charlotte are examples that demonstrate the continual growth of their respective networks. The changes on other segments of their networks affect how supply chains function for North Carolina industries.

5.2 Freight Rail Needs and Opportunities

Trends affecting freight rail were discussed in detail in section 4.0. Of particular note, nationwide shifts in coal volumes and the emergence of natural gas development and other energy industries are two trends anticipated to change traffic volumes and shape railroad project needs. The trend in energy supply may also drive growth in certain types of manufacturing, including plastics and chemicals. The state's growing population, as a part of the Piedmont Atlantic Megaregion, will continue to increase demands on the existing infrastructure system. At a regional level, east coast ports are facing a dual competitive threat from increases in container vessel size and the improved Panama Canal at the same time that shifts in industrial capacity move to new areas of the globe.

Specific to North Carolina, freight issues and opportunities include the following:

- Congestion on lines that carry both passenger and freight traffic that lead to interoperability and performance issues for both passenger and freight service providers

- Increased need for investment in transload facilities

- Need for investment in the intermodal network to continue to efficiently serve industries and also provide consumable goods to the growing population

- Improved access and service to North Carolina's ports is needed to better serve North Carolina industries and consumers

Investments are needed on both the Class I and short line networks. As noted in Section 2, a corridor prioritization method was developed to help identify the levels of importance of Class I corridors to the state's economy. Short line railroads often provide last mile connectivity to the Class I network and also provide public benefits.

After evaluating economic, freight, and population data and trends, reviewing related studies, and conducting stakeholder outreach efforts, the following freight rail service needs and opportunities were identified.

As recommended in the Eastern Infrastructure Improvement Study (prepared in accordance with Senate Bill 402 Section 34.23 (2013 General Assembly)), the State of North Carolina should establish the Secretary of Transportation's Freight Intermodal Advisory Council to help leverage strategic infrastructure investment to foster economic growth and create jobs. The Freight Intermodal Advisory Council should include, but not be limited to, representatives from the North Carolina Board of Transportation and the boards of the North Carolina Department of Agriculture and Consumer Services, Department of Commerce, the Global TransPark, and North Carolina State Ports Authority. Private entities with state interest will be invited to join the Council, such as representative trucking companies or associations, the North Carolina Railroad Company, and shippers.

The Secretary's Intermodal Advisory Council can lead efforts as follows:

- Cultivate ongoing partnerships between metropolitan planning organizations/rural planning organizations and railroad companies serving each region to build understanding and improve economic development through coordinated transportation and land-use planning.

- Develop a program to restore and add customers to existing lines where volumes have declined, yet some customers remain.

- Increase transload opportunities on congested corridors to potentially divert more truck traffic to railroads by developing a state-level grant program for transload facility development, operation, and maintenance to optimize siting based on evolving market needs and transport network congestion.

Additional freight rail needs and opportunities are described below.

- Prepare for the emergence of the energy industry in North Carolina that will add freight traffic.

- Continue leading and investing in our nationally-recognized best practice safety program that improves at-grade highway-rail crossings and builds new grade-separated crossings. The program has helped reduce the number of train-car crashes from 244 in 1988 to 51 in 2014.

- Implement the short-term solutions and plan for the long-term recommendations presented in the Eastern Infrastructure Study for GTP, the Port of Morehead City, and the Port of Wilmington. These solutions include the following:

Port of Wilmington and Wallace to Castle Hayne: Continue to preserve the right-of-way for and seek DoD funding to restore the Wallace to Castle Hayne corridor.

Port of Wilmington

- Continue efforts to work with CSXT to identify actions that will lead to regular rail intermodal service to the Port of Wilmington.
- Pursue implementation of recommendations from the ongoing Wilmington Traffic Separation Study of rail crossing consolidation and safety upgrades to improve safety and efficiency of rail and vehicular flow into the Port of Wilmington.
- Pursue environmental, planning and conceptual design studies for the construction of a highway-railroad grade separated access at the North Gate of the Port of Wilmington. Separated access would improve safety, reduce vehicular congestion, and significantly increase rail capacity.
- As future traffic volumes grow at the Port of Wilmington, investigate the feasibility of a new rail bridge across the Cape Fear River from the port area connecting to the rail network in Brunswick County. This would remove port rail traffic from Wilmington.

Global TransPark (GTP)

- Lease the GTP spur (owned by NCDOT) to a private rail operator.
- Examine GTP's authority to optimize its competitiveness for state and federal grant funds for capital improvement projects.
- Investigate retaining state ownership of the North Carolina Railroad Company's water access property in New Bern as a potential barge transload facility for oversized cargo loads.
- To prepare for the long term, conduct the environmental analysis for a CSXT spur from the GTP to railroad point "Elmer" in Kinston and obtain the advance right-of-way.

Port of Morehead City

- In the short term, pursue a super-street style advanced and coordinated traffic plan to reduce rail and truck Port traffic conflicts with vehicle and pedestrian traffic on US 70 Arendell Street.
- Implement an on-port loop track to build/break unit trains.
- Establish the GTP to Morehead City Highway and Rail Mobility Corridor and continue to evaluate a potential Northern Carteret Rail and Highway Bypass as market conditions evolve

Additional Freight Rail Needs and Opportunities:

- Maintain short line support programs such as the Rail Industrial Access Program and Short Line Industrial Access Program via FRRCSI funds to aid North Carolina industries in accessing Class I rail networks.
- Continue efforts to partner with railroads to evaluate placing an intermodal facility in eastern North Carolina or eastern Piedmont to help mitigate future highway congestion's impacts on the Triangle region's access to intermodal service(s) that are currently located in Charlotte and Greensboro. A facility

may also support agriculture and related industries in eastern North Carolina and enhance the ability of goods to reach domestic and international markets through North Carolina and/or regional ports. Also, support the expansion of existing CSXT and NS intermodal facilities in Charlotte and Greensboro.

- Leverage private sector rail capacity investments and augment them to foster truck–to-rail mode shifts. For example, mobilize collateral efforts as appropriate, such as rail training programs to offset the declining numbers of truck drivers.

- Support the Secretary of Transportation’s initiative to identify rail industry workforce education and training needs and meet them through the community college system.

Appendix A. Rail Capacity Analysis

Rail connects local businesses to global markets and provides competitive access to suppliers and customers. Freight rail systems are particularly efficient for long travel distances and large volumes, due to low costs, high capacity, and low environment impacts, when compared to trucking. Hence, rail is important to North Carolina's economy. In this analysis, North Carolina's rail system capacity was examined, both under current and projected future levels of freight activity, to identify rail capacity related investment needs in North Carolina's Statewide Multimodal Freight Plan.

Rail networks are complex, with many physical and operational factors affecting capacity. From an infrastructure perspective, terminal capacity determines the volume of traffic that can enter and leave the rail network or be processed en-route, while line capacity determines the volume of traffic that can traverse the network. The diversity of train operations affects capacity greatly, with lines hosting homogenous operations – such as only hosting unit coal trains – maximizing capacity.

Since a highly detailed capacity analysis is not feasible with only publicly available data, a parametric capacity analysis was performed using methods that were initially developed for the Association of American Railroads' (AAR) National Rail Freight Infrastructure Capacity and Investment Study. Since then, this methodology has been refined and applied in several rail-planning studies, including Minnesota and Washington. Using as its basis information on traffic (origin-destination commodity flows) and operating parameters (train length by type of train service), the daily current and projected train volumes can be estimated. These train volumes are in turn compared to the physical capacity of each main line segment, of which the primary capacity determinants consist of the number of tracks and signal system type.

This analysis examined current (base year of 2014) and projected (future year of 2045) daily train volumes for the existing mainline rail network in North Carolina, which is operated by the Class I railroads Norfolk Southern Railway (NS) and CSX Transportation (CSX).

Rail flows handled by few of the short line railroads including Atlantic & Western Railway (ATW), North Carolina & Virginia Railroad (NCVA) and Aberdeen & Rockfish Railroad (AR), that were reported in the 2014 Carload Waybill Sample, were also included in the analysis. However, short line capacity was not extensively examined. In general, traffic on most short lines is at levels where existing infrastructure is adequate to handle current and projected traffic growth[38].

Although the capacity analysis identifies known constraints on networks within North Carolina, bottlenecks in adjacent states that affect rail service performance in the state were not analyzed. This draft version is expected to be reviewed with the Class I railroads operating in the state. Subsequently, stakeholder feedback will be incorporated and a final version of this analysis produced.

The rest of this Appendix is organized as follows:

1. Data Sources
2. Methodology and Results
3. Conclusions

[38] Depending on physical configuration, single-track rail lines lacking signals have a sustainable capacity of up to 16 trains per day. It is rare for short lines to see this level of traffic – most typically, it is in the range of 1 to 6 trains per day

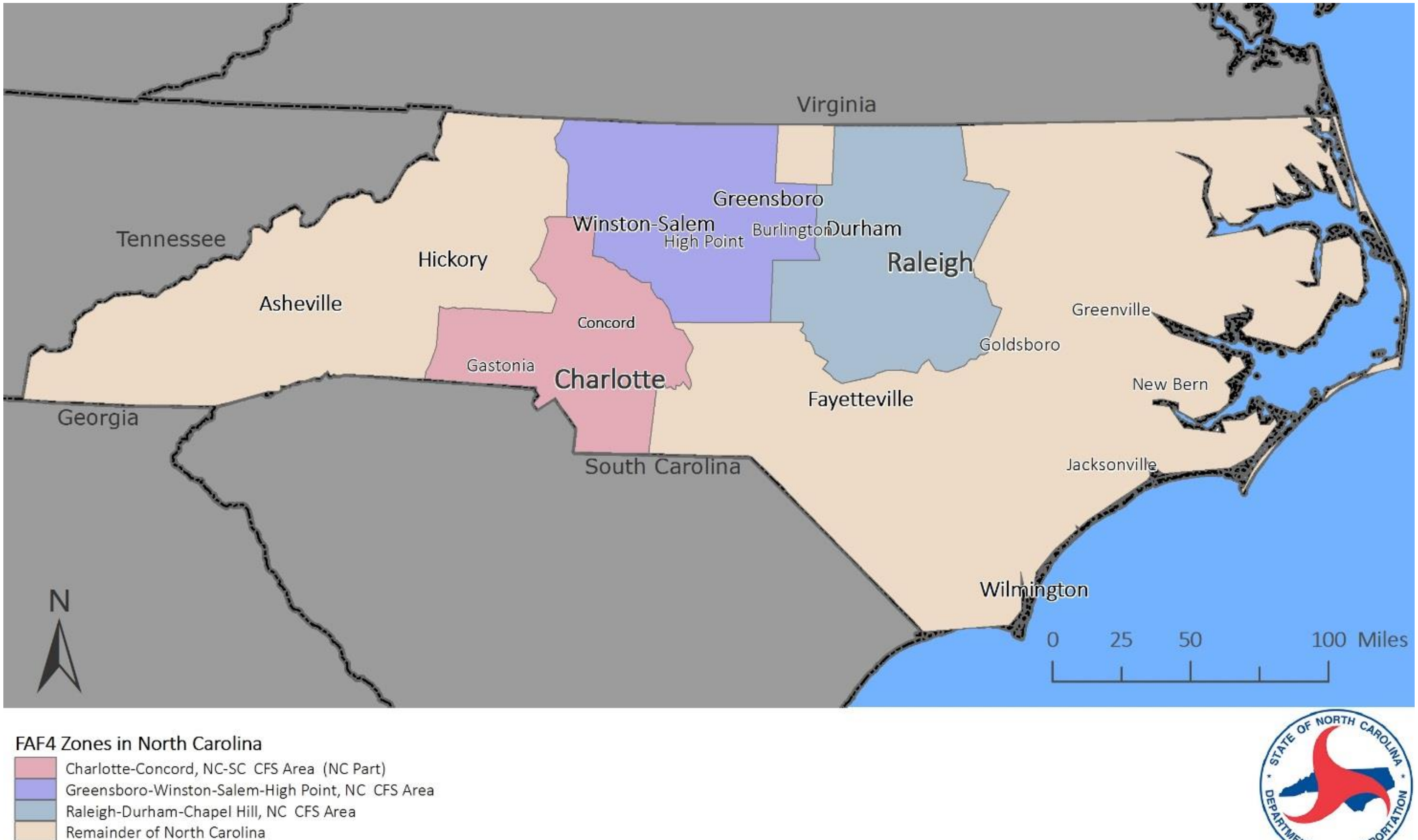
A.1 Data Sources

Several data sources were used in the capacity analysis as follows:

1. **2014 Carload Waybill Sample for North Carolina**. The Association of American Railroads (AAR) collects a stratified sample of carload waybills annually for the Surface Transportation Board (STB) from railroads that terminated at least 4,500 carloads each year for each of the previous three years, or which move five percent or more of any state's total rail traffic. NCDOT obtained and provided to the consultant the confidential version of the Waybill Sample, which includes detailed shipment data including origin county, destination county, 7-digit level standard transportation commodity code (STCC) commodity type, equipment type, and tonnage. This data formed the basis for the base year (2014) freight rail traffic. Cambridge Systematics had developed a proprietary lookup table between a 7-digit STCC commodity type and a 2-digit Standard Classification of Transported Goods (SCTG) commodity types. In this analysis, the rail traffic flows in the 2014 Carload Waybill Sample data were converted to a 2-digit SCTG-equivalent commodity flows database using this lookup table.

2. **Freight Analysis Framework version 4 (FAF4) Database**. The Freight Analysis Framework (FAF), produced through a partnership between Bureau of Transportation Statistics (BTS) and Federal FHWA, integrates data from a variety of sources to create a comprehensive picture of freight movement among states and major metropolitan areas by all modes of transportation. Starting with data from the 2012 Commodity Flow Survey (CFS) and international trade data from the Census Bureau, FAF incorporates data from agriculture, extraction, utility, construction, service, and other sectors. FAF version 4 (FAF4) provides estimates for tonnage and value by regions (multi-county or state FAF zones) of origin and destination, a 2-digit Standard Classification of Transported Goods (SCTG) commodity type, and mode. Data are available for the base year of 2012, the recent years of 2013 - 2015, and forecasts from 2020 through 2045 in 5-year intervals. Growth factors estimated from FAF4 for rail only (carload equivalent) mode and multiple modes and mail mode (which includes rail intermodal) were used to forecast the future year (2045) freight rail traffic. Figure A.1 shows the FAF4 zones in North Carolina.

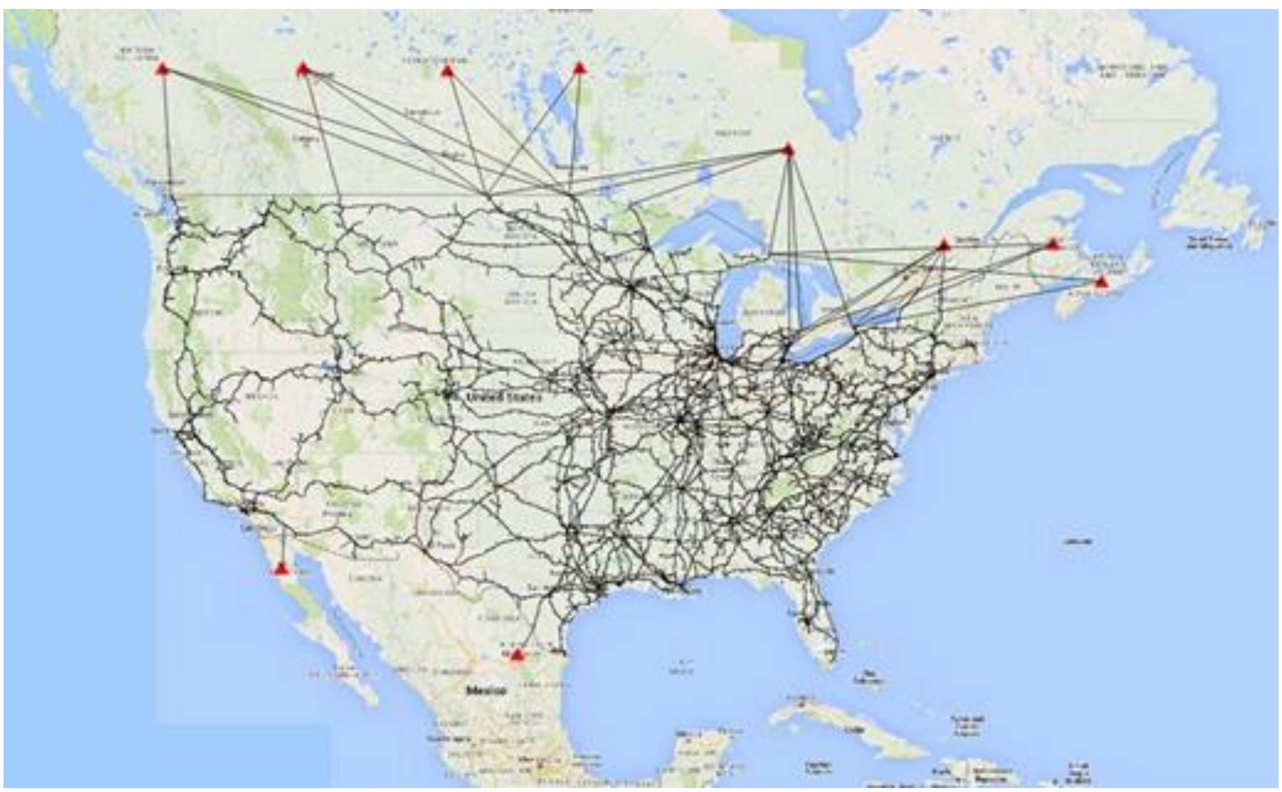
Figure A.1 FAF4 Zones in North Carolina



Source: Freight Analysis Framework version 4 (FAF4) Database; Cambridge Systematics' Analysis.

3. **Oak Ridge National Laboratory's (ORNL) Rail Network based TRANSCAD Model**. Cambridge Systematics had developed a proprietary TRANSCAD model for assignment using Oak Ridge National Laboratory's (ORNL) rail network data. This model is used for rail traffic assignment and was applied in several rail-planning studies, including Minnesota and Washington. The TRANSCAD Model uses a rail network based upon a rail network developed and maintained by the Oak Ridge National Laboratory (ORNL) Center for Transportation Analysis' (CTA). The TRANSCAD Model has 2,295 centroid zones, 2,285 of which represent counties in the US including 88 counties in North Carolina, 8 external centroid zones that represent Canada's provinces and 2 external centroid zones that represent States of Baja California and Baja California Sur and rest of Mexico (see Figure A.2). A set of dummy links, also called centroid connectors, are used in the TRANSCAD Model to connect centroid zones to the rail network. External centroid zones in Mexico and Canada are linked to border crossing rail links using arbitrary centroid connectors. The TRANSCAD Model uses an "All or Nothing" traffic assignment method, ignoring the fact that link travel times are flow dependent (that is, they are a function of link volumes) when there is congestion. The assignment procedure finds the shortest path from origins to destinations based on the link length. In this analysis, the TRANSCAD Model is used to perform rail tonnage assignment. Several updates were made to the TRANSCAD Model during the rail capacity analysis as described in Section A.2.3.

Figure A.2 Zones and Connectors in ORNL Rail Network based TRANSCAD Model



Source: Cambridge Systematics.

4. **2014 Uniform Rail Costing System (URCS) Data**. The Uniform Rail Costing System (URCS), is the STB's general purpose costing methodology used to estimate variable and total unit costs for US Class I railroads. The STB annually publishes URCS eastern- and western-United States regional costs based on a compilation of Class I data. URCS contained data on empty-return ratios by

railroad and car type, these were used to estimate 2014 average empty-return ratios for carload and intermodal rail traffic as shown in Table A.1. The data pertains to the full or national level operational network of the railroads. The average empty-return ratio for intermodal rail traffic was estimated by dividing aggregated total (loaded plus empty) cars by aggregated loaded cars, for all intermodal rail equipment types. The average empty-return ratio for carload traffic was estimated similarly by using all other rail equipment types, including box, gondola, hopper and tank car types.

Table A.1 National Average Empty Return Ratios by Railroad and Rail Service Type, 2014

	Average Empty Return Ratio	
Railroad	Carload	Intermodal
NS	1.89	1.30
CSX	1.90	1.32
Other Eastern Railroads	1.90	1.32

Source: STB Uniform Rail Costing System (URCS), 2014 Worktables.

5. **2007 National Rail Freight Infrastructure Capacity and Investment Study**. The AAR conducted a study in the year 2007 to assess the long-term capacity expansion needs of the continental US freight railroads. The study was used to collect a key operational assumption of carload and intermodal rail traffic, namely, the number of cars or intermodal units per train (Table A.2). In this analysis, the train volumes in North Carolina were estimated applying the assumptions for eastern railroads as provided by the 2007 AAR Study. The productivity in terms of cars per train was updated to 2014 and 2045 conditions as described in Section A.2.8 of this Appendix.

Table A.2 Typical Number of Cars or Intermodal Units by Train Service Type for all Class I Railroads, 2007

Type of Train Service	Eastern Railroads
Auto (Car Count)	57.0
Bulk (Car Count)	86.0
General Merchandise (Car Count)	82.0
Non-Intermodal Average (Car Count)*	**75.0**
Intermodal (TOFC/COFC Count)	**110.7**

Source: Association of American Railroads' (AAR) 2007 National Rail Freight Infrastructure Capacity and Investment Study.

Note: *Used as a surrogate value for carload type rail traffic

Table A.3 shows the average daily train capacity reported in the AAR study based on number of tracks and signal type. In this analysis, the lower capacity (trains per day) estimate (that is practical maximum if multiple train types use corridor) for rail segments was used. The greyed highlighted rows in **Table 2.3** are track and signal type characteristics that are not present in the existing rail mainline system in North Carolina. The same practical capacity assumptions by number of tracks and signal type are used in 2014 and 2045 conditions.

Table A.3 Average Capacities of Typical Rail Segments by Number of Tracks and Signal Type for the North American Rail Network

Number of Tracks	Signal Type	Trains per Day - Practical Maximum If Multiple Train Types Use Corridor	Trains per Day - Practical Maximum If Single Train Type Uses Corridor
1	N/S or TWC	16	20
1	ABS	18	25
1	CTC	30	48
2	N/S or TWC	28	35
2	ABS	53	80
2	CTC	75	100
3	CTC	133	163
4	CTC	173	230
5	CTC	248	340
6	CTC	360	415

Source: Association of American Railroads' (AAR) 2007 National Rail Freight Infrastructure Capacity and Investment Study.

Notes: The lower among the two capacity values by number of tracks and signal type was used in this analysis.

Definitions for signal type are as follows:

- N/S or TWC = No Signal or Track Warrant Control. These are basic train control systems that require the train crew to obtain permission or warrants before entering a section of track. Crews receive track warrants by radio, phone, or electronic transmission from dispatcher. TWC is used on low volume track.
- ABS = Automatic Block Signaling. It is a signal system that controls when a train can advance into the next track block. A block is a section of track with traffic control signals at each end. The length of the block is based on the length of a typical train and the distance needed to stop the train in a safe manner. Automatic block signaling is governed by block occupancy and cannot be controlled by a railroad dispatcher from a remote location.
- CTC = Centralized Traffic Control. It is a signal system that uses electrical circuits in the tracks to monitor the location of trains, allowing railroad dispatchers to control train movements from a remote location, typically a central dispatching office. It allows dispatchers to safely decrease the spacing between trains.

6. **2013 North Carolina Comprehensive State Rail Plan.** In compliance with the federal Passenger Rail Investment and Improvement Act, the North Carolina Department of Transportation (NCDOT) Rail Division developed this Comprehensive State Rail Plan (State Rail Plan) to help identify needs and guide investments in the state's freight and passenger rail network for the next 25 years. The plan identified active rail network and provided train volume estimates at at-grade crossing locations. Over a phone meeting on September 23, 2016, a NCDOT Rail Division staff also provided a few updates on the statewide rail operations and planned projects since the publication of the State Rail Plan.

A.2 Methodology and Results

There are several steps to the sketch-level capacity analysis methodology as follows:

1. Prepare 2014 rail traffic Origin-Destination (OD) matrix for assignment using the 2014 Carload Waybill data.

2. Forecast 2045 rail flows using national FAF4 database and prepare 2045 rail traffic OD matrix for assignment.
3. Update rail network information in the TRANSCAD Model using available information.
4. Perform 2014 and 2045 rail tonnage assignment using the TRANSCAD Model.
5. Convert rail mainline annual tonnage flows to average daily carload and intermodal train volumes.
6. Collect rail mainline passenger train service frequency information and assign to rail mainline segments.
7. Adjust rail mainline freight train volumes and daily train capacity using available information.
8. Develop tonnage and train volume maps, estimate volume-to-capacity ratios and analyze level of service by rail mainline segment.

The details of the methodology and the results for each step are discussed as follows.

A.2.1 Prepare 2014 rail traffic Origin-Destination (OD) matrix for assignment using the 2014 Carload Waybill data

In order to use the ORNL rail network based TRANSCAD Model for assignment and to produce 2-digit SCTG commodity level information, the original rail traffic origin-destination (OD) matrix in the 2014 Carload Waybill data was transformed to an “assignment-friendly” format.

The transformation was carried out in three sub-steps: (a) associate zones in the 2014 Carload Waybill data to zones in the TRANSCAD Model; (b) associate 7-digit STCC commodity level information to 2-digit SCTG equivalent commodity level information; (c) associate default rail service types in the 2014 Carload Waybill data to two rail service types, namely, intermodal and carload, (c) aggregate the 2014 Carload Waybill data in terms of origin and destination zones in the TRANSCAD model, two rail service types, 2-digit SCTG equivalent commodity types, originating railroad and terminating railroad.

For sub-step (a), the association was one-to-one for most zones including counties in the US and provinces in Canada, while it was many-to-one for states in Mexico. The TRANSCAD Model uses only two external centroid zones for Mexico, while Mexico consists of thirty-one states and one federal district. The States of Baja California and Baja California Sur were associated with the western external centroid zone, while the rest of Mexico was associated with the eastern external centroid zone.

For sub-step (b), Cambridge Systematics had developed a proprietary lookup table between a 7-digit STCC commodity type and a 2-digit Standard Classification of Transported Goods (SCTG) commodity types. The rail traffic flows in the 2014 Carload Waybill Sample data were converted to a 2-digit SCTG-equivalent commodity flows database using this lookup table.

For sub-step (c), the default rail service types used in the Carload Waybill Sample were categorized into two rail service types, namely, intermodal and carload, as shown in Table A.4.

Table A.4 Default Rail Service Types in 2014 Carload Waybill Sample and Categorized Rail Service Type

Default Rail Service Type Code	Default Rail Service Type Description	Categorized Rail Service Type
1	All other traffic not included in service types 2, 3 or 4.	Carload
2	Intermodal and finished automobiles, where the TOFC plan is non-zero or the AAR equipment type begins with P, Q, S, or Z.	Intermodal
3	Coal, coke, iron ore and bulk grain, where service type is not 2, and the 2-digit STCC is 11, or the 5-digit STCC is 29913-29914, or the 3-digit STCC is 101, or the 5-digit STCC is 01130-01139 and the AAR equipment type begins with C (designating a covered hopper).	Carload
4	Auto Racks/Finished Automobiles where AAR equipment type is V	Carload

Source: 2014 Confidential Carload Waybill Sample Reference Guide.

At the end of sub-step (d), the "assignment-friendly" format of the 2014 OD matrix consisted of 4,275 rail traffic records. Table A.5 shows a summary of rail flows by 2-digit SCTG commodity type and rail service type. This includes rail tonnage from, to, within and through North Carolina. In 2014, intermodal rail traffic formed just over 10 percent share of total rail tonnage. Coal formed a majority share of the commodities, which is moved as only carload traffic. Mixed freight was the largest commodity in tons for intermodal traffic. Cereal grains (including seed), gravel and crushed stone and basic chemicals were other major commodities in terms of tonnage.

Table A.5 North Carolina's 2014 Rail Flows by 2-Digit SCTG Commodity Type and Rail Service Type (in Thousand Tons)

2-Digit SCTG Commodity Type	2014 Carload Rail Tons (in 1,000s)	2014 Intermodal Rail Tons (in 1,000s)	2014 Total Rail Tons (in 1,000s)	% Share of Total
02: Cereal Grains (including seed)	5,599	0.2	5,599	6.6%
03: Other Agricultural Products, except for Animal Feed	1,309	22	1,331	1.6%
04: Animal Feed and Products of Animal Origin, n.e.c.	2,183	53	2,236	2.6%
05: Meat, Fish, and Seafood, and Their Preparations	15	3	18	0.0%
06: Milled Grain Products and Preparations, and Bakery Products	724	23	747	0.9%
07: Other Prepared Foodstuffs, and Fats and Oils	2,296	245	2,540	3.0%
08: Alcoholic Beverages and Denatured Alcohol	1,596	143	1,739	2.0%
10: Monumental or Building Stone	20	0	20	0.0%
11: Natural Sands	491	0	491	0.6%
12: Gravel and Crushed Stone	5,002	0	5,002	5.9%
13: Non-Metallic Minerals, n.e.c.	1,944	23	1,967	2.3%
14: Metallic Ores and Concentrates	107	0.4	108	0.1%
15: Coal	27,813	0	27,813	32.7%

2-Digit SCTG Commodity Type	2014 Carload Rail Tons (in 1,000s)	2014 Intermodal Rail Tons (in 1,000s)	2014 Total Rail Tons (in 1,000s)	% Share of Total
17: Gasoline and Aviation Turbine Fuel	80	1	80	0.1%
18: Fuel Oils	34	0	34	0.0%
19: Coal and Petroleum Products, n.e.c.	944	2	946	1.1%
20: Basic Chemicals	4,642	48	4,690	5.5%
21: Pharmaceutical Products	0	55	55	0.1%
22: Fertilizers	2,426	0	2,426	2.9%
23: Chemical Products and Preparations, n.e.c.	741	134	874	1.0%
24: Plastics and Rubber	2,707	242	2,949	3.5%
25: Logs and Other Wood in the Rough	117	2	118	0.1%
26: Wood Products	3,985	112	4,097	4.8%
27: Pulp, Newsprint, Paper, and Paperboard	3,690	78	3,768	4.4%
28: Paper or Paperboard Articles	5	307	312	0.4%
29: Printed Products	0	8	8	0.0%
30: Textiles, Leather, and Articles of Textiles or Leather	0	170	170	0.2%
31: Non-Metallic Mineral Products	2,655	23	2,679	3.1%
32: Base Metal in Primary or Semi-Finished Forms and in Finished Basic Shapes	2,317	31	2,348	2.8%
33: Articles of Base Metal	36	70	106	0.1%
34: Machinery	54	42	96	0.1%
35: Electronic and Other Electrical Equipment and Components, and Office Equipment	63	11	74	0.1%
36: Motorized and Other Vehicles (including parts)	308	52	360	0.4%
37: Transportation Equipment, n.e.c.	103	5	109	0.1%
38: Precision Instruments and Apparatus	0	12	12	0.0%
39: Furniture, Mattresses and Mattress Supports, Lamps, Lighting Fittings, and Illuminated Signs	0	107	107	0.1%
40: Miscellaneous Manufactured Products	11	90	101	0.1%
41: Waste and Scrap	2,149	76	2,225	2.6%
43: Mixed Freight	26	6,701	6,727	7.9%
All Commodities	**76,193**	**8,890**	**85,082**	**100.0%**

Source: 2014 Confidential Carload Waybill Sample for North Carolina; and analysis by Cambridge Systematics.
Note: This includes rail flows from, to, within and through North Carolina.

A.2.2 Forecast 2045 rail flows using national FAF4 database and prepare 2045 rail traffic OD matrix for assignment

Forecasting Methodology

The FAF4 database contains flows for rail only as well as multiple modes and mail. While rail only mode flows were considered to represent carload rail service type goods movements, multiple modes and mail mode flows were considered to represent intermodal rail service type goods movements, although it can also include other modal combinations. Hence, growth factors in FAF4 for these modes were applied on the 2014

Carload Waybill data to forecast carload and intermodal rail commodity flow tonnages. Growth factors were developed by origin, destination, 2-digit SCTG commodity type and rail service type. The FAF4 database has a lower geographical resolution (or larger zones) than Carload Waybill data, hence a lookup table for geography[39] was used. The growth factors were applied to the base year (2014) rail traffic OD matrix to prepare a forecast year (2045) rail traffic OD matrix.

Adjustments to FAF4 based Forecasts

The compounded annualized growth rates (CAGRs) between 2014 and 2045 provided by the FAF4 database for a few commodities were overridden by Cambridge Systematics. The following set of adjustments were made:

1. Growth was adjusted to national commodity type and rail service type only based CAGR for 100% of tons of Motorized and Other Vehicles (including parts) and Paper or Paperboard Articles by carload rail service, and 100% of tons of Alcoholic Beverages and Denatured Alcohol and Waste and Scrap by intermodal rail service. As a result, the overall CAGR for Motorized and Other Vehicles (including parts), Paper or Paperboard Articles and Waste and Scrap remained almost unchanged, and the overall CAGR for Alcoholic Beverages and Denatured Alcohol changed from 3.6% to 3.5%.
2. Growth is adjusted to origin, destination, commodity type and rail service type based CAGR for 100% of tons of Pharmaceutical Products and Animal Feed and Products of Animal Origin, n.e.c. by intermodal rail service. As a result, the overall CAGR for Pharmaceutical Products changed from 3.7% to 3.0%, and the overall CAGR for Animal Feed and Products of Animal Origin, n.e.c. remained almost unchanged.
3. Growth is flatlined or CAGR is assumed as zero for 100% of tons of Non-Metallic Minerals, n.e.c., Coal and Petroleum Products, n.e.c. and Transportation Equipment, n.e.c. by carload rail service, and 100% of tons of Coal and Petroleum Products, n.e.c. and Transportation Equipment, n.e.c. by intermodal rail service. The overall CAGRs for Non-Metallic Minerals, n.e.c., Coal and Petroleum Products, n.e.c. and Transportation Equipment, n.e.c. prior to this adjustment were 1.3%, 1.5% and 2.9%.

Also, as a result, the overall CAGR for all commodities changed from 0.93% to 0.88%. The CAGR for carload rail service changed from 0.81% to 0.75%, while the CAGR for intermodal rail service changed from 1.84% to 1.79%.

Forecasting Results and Preparation of 2045 OD Matrix

The CAGRs between 2014 and 2045 by commodity type and rail service type after adjustment of the FAF4 based forecasts are summarized in Table A.6. Among carload rail service type commodities, coal is expected to decline by 35 percent, while basic chemicals are expected to make the largest contribution to tonnage growth. Among intermodal rail service type commodities, mixed freight are expected to be the highest contributors to rail tonnage growth.

The growth factors were applied to the base year (2014) rail traffic OD matrix to prepare a forecast year (2045) rail traffic OD matrix.

[39] Derived from FAF4 zone shape files, Available at: http://faf.ornl.gov/fafweb/ (last accessed on October 20, 2016)

Table A.6 North Carolina's 2045 Rail Flows and 2014-2045 Growth Factors by 2-Digit SCTG Commodity Type and Rail Service Type

2-Digit SCTG Commodity Type	2045 Carload Rail Tons (in 1,000s)	Carload Rail Tons CAGR, 2014-2045	2045 Intermodal Rail Tons (in 1,000s)	Intermodal Rail Tons CAGR, 2014-2045	2045 Total Rail Tons (in 1,000s)	Total Rail Tons CAGR, 2014-2045
02: Cereal Grains (including seed)	6,609	0.5%	0.3	1.4%	6,609	0.5%
03: Other Agricultural Products, except for Animal Feed	2,239	1.7%	47	2.5%	2,286	1.8%
04: Animal Feed and Products of Animal Origin, n.e.c.	4,366	2.3%	75	1.1%	4,441	2.2%
05: Meat, Fish, and Seafood, and Their Preparations	28	2.0%	7	2.9%	36	2.2%
06: Milled Grain Products and Preparations, and Bakery Products	1,244	1.8%	43	2.0%	1,287	1.8%
07: Other Prepared Foodstuffs, and Fats and Oils	4,409	2.1%	453	2.0%	4,862	2.1%
08: Alcoholic Beverages and Denatured Alcohol	4,752	3.6%	269	2.0%	5,020	3.5%
10: Monumental or Building Stone	49	2.9%	0	N/A	49	2.9%
11: Natural Sands	699	1.1%	0	N/A	699	1.1%
12: Gravel and Crushed Stone	5,643	0.4%	0	N/A	5,643	0.4%
13: Non-Metallic Minerals, n.e.c.	1,944	0.0%	32	1.1%	1,976	0.0%
14: Metallic Ores and Concentrates	119	0.3%	0.4	-0.3%	120	0.3%
15: Coal	18,062	-1.4%	0	N/A	18,062	-1.4%
17: Gasoline and Aviation Turbine Fuel	157	2.2%	1	2.0%	158	2.2%
18: Fuel Oils	30	-0.5%	0	N/A	30	-0.5%
19: Coal and Petroleum Products, n.e.c.	944	0.0%	2	0.0%	946	0.0%
20: Basic Chemicals	8,338	1.9%	125	3.2%	8,464	1.9%
21: Pharmaceutical Products	0	N/A	137	3.0%	137	3.0%
22: Fertilizers	3,342	1.0%	0	N/A	3,342	1.0%
23: Chemical Products and Preparations, n.e.c.	1,641	2.6%	336	3.0%	1,976	2.7%
24: Plastics and Rubber	6,072	2.6%	463	2.1%	6,535	2.6%
25: Logs and Other Wood in the Rough	250	2.5%	4	3.0%	254	2.5%
26: Wood Products	7,134	1.9%	148	0.9%	7,282	1.9%
27: Pulp, Newsprint, Paper, and Paperboard	5,468	1.3%	102	0.9%	5,570	1.3%
28: Paper or Paperboard Articles	7	1.3%	498	1.6%	505	1.6%
29: Printed Products	0	N/A	7	-0.3%	7	-0.3%
30: Textiles, Leather, and Articles of Textiles or Leather	0	N/A	323	2.1%	323	2.1%
31: Non-Metallic Mineral Products	4,208	1.5%	48	2.3%	4,255	1.5%
32: Base Metal in Primary or Semi-Finished Forms and in Finished Basic Shapes	3,605	1.4%	44	1.2%	3,649	1.4%
33: Articles of Base Metal	66	2.0%	134	2.1%	200	2.1%

2-Digit SCTG Commodity Type	2045 Carload Rail Tons (in 1,000s)	Carload Rail Tons CAGR, 2014-2045	2045 Intermodal Rail Tons (in 1,000s)	Intermodal Rail Tons CAGR, 2014-2045	2045 Total Rail Tons (in 1,000s)	Total Rail Tons CAGR, 2014-2045
34: Machinery	182	4.0%	125	3.6%	307	3.8%
35: Electronic and Other Electrical Equipment and Components, and Office Equipment	242	4.4%	37	4.1%	279	4.4%
36: Motorized and Other Vehicles (including parts)	604	2.2%	83	1.5%	687	2.1%
37: Transportation Equipment, n.e.c.	103	0.0%	5	0.0%	109	0.0%
38: Precision Instruments and Apparatus	0	N/A	69	5.7%	69	5.7%
39: Furniture, Mattresses and Mattress Supports, Lamps, Lighting Fittings, and Illuminated Signs	0	N/A	336	3.7%	336	3.7%
40: Miscellaneous Manufactured Products	19	1.8%	170	2.1%	189	2.0%
41: Waste and Scrap	3,515	1.6%	154	2.3%	3,670	1.6%
43: Mixed Freight	37	1.2%	11,152	1.7%	11,189	1.7%
All Commodities	**96,126**	**0.8%**	**15,431**	**1.8%**	**111,557**	**0.9%**

Source: 2014 Confidential Carload Waybill Sample for North Carolina; Freight Analysis Framework version 4 (FAF4) Database; and analysis by Cambridge Systematics.

A.2.3 Update rail network information in the TRANSCAD Model using available information

Although the railroads are anticipated to undertake infrastructure investments as needed, or in some cases required (such as positive train control [PTC]), for the purpose of this analysis no capacity improvements were assumed. This means that the rail network configuration and signal systems in 2045 are identical to that of 2014. Also, no changes in freight flows and network routing were assumed. In summary, a no-build and no operational change alternative is analyzed for 2045.

The network editing was primarily focused on updating the TRANSCAD Model's rail network within North Carolina, which uses a decade or less old ORNL rail network with an updated ORNL rail network[40] along with the latest track information and signal types. The extents of the new ORNL rail network for North Carolina was also compared with the rail network in the 2013 State Rail Plan, and network editing was done to ensure that all active rail mainline segments are included and all counties with active rail service are connected to the rail network through the help of centroid connectors.

In addition, network editing was performed on the TRANSCAD Model's rail network outside North Carolina to ensure end-to-end connectivity for all origin-destination pairs. This was done by adding centroid connectors, for all origin and destination zones outside North Carolina and included in the Carload Waybill Sample, when found missing.

[40] Oak Ridge National Laboratory's (ORNL) Center for Transportation Analysis (CTA) – Rail Network (current operational network QC48), Last Updated on September 2014, Available at: http://cta.ornl.gov/transnet/RailRoads.html (last accessed on October 20, 2016)

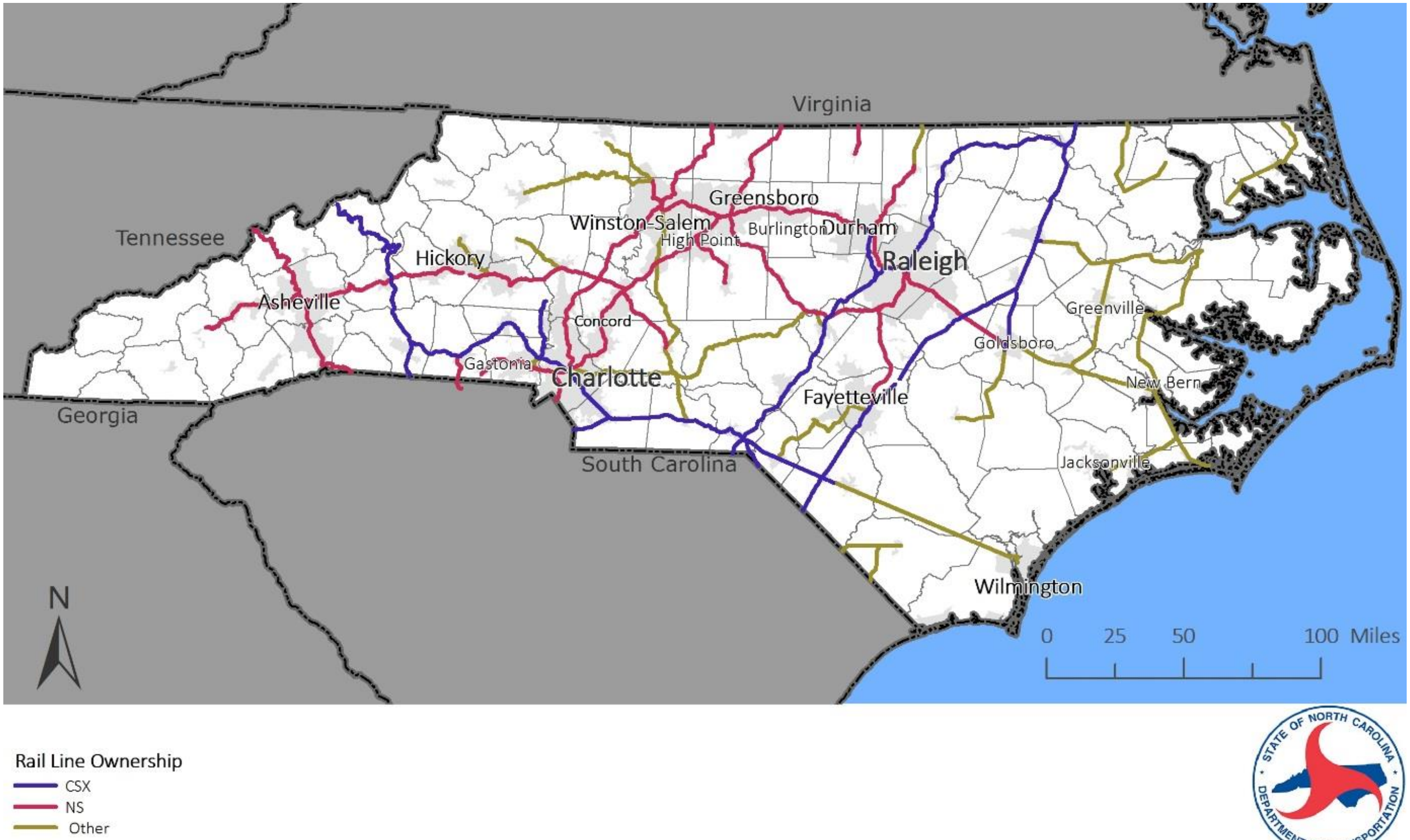
A.2.4 Perform 2014 and 2045 rail tonnage assignment using the TRANSCAD Model

The TRANSCAD Model uses an "All or Nothing" traffic assignment method, ignoring the fact that link travel times are flow dependent (i.e., that they are a function of link volumes) when there is congestion. The assignment procedure finds the shortest path from origins to destinations based on the link length.

In North Carolina, there are two dominant rail carriers that operate the state's mainline network: Norfolk Southern Railway (NS) and CSX Transportation (CSX) (see Figure A.3). To avoid assigning NS tonnages on CSX owned tracks, although a path using CSX tracks is physically the shortest path, Cambridge Systematics introduced "Penalty" in the assignment procedure. "Penalty" is a big number added to the CSX links in the TRANSCAD model during NS tonnage assignment, NS tonnages would reroute to a longer NS path if there was a connection available. "Penalty" was applied only within the rail network in Northern California, and it was not applied to NS tonnages when NS has trackage rights on CSX tracks. This mechanism was applied also under the vice versa situation, that is CSX tonnages on NS owned tracks, and so on.

It was possible to identify the railroad operating and handling the tonnages as NS or CSX and apply "Penalty" only when the rail tonnage flowed from, to or within North Carolina. So, for the purposes of the tonnage assignment, the full rail tonnage OD matrix was broken into three parts, namely, NS originating or terminating in North Carolina rail tonnage OD matrix, CSX originating or terminating in North Carolina rail tonnage OD matrix, and other rail tonnage OD matrix. The other rail tonnage OD matrix includes mostly rail flows through North Carolina, and a very small amount of short line rail tonnage. These datasets were sub-divided into two based on rail service types, namely, carload and intermodal, for modeling convenience. In total, there were six OD data sets based on combinations of service types and railroad operators, namely, CL-CSX, IM-CSX, CL-NS, IM-NS, CL-OTH and IM-OTH. Each of the OD data set contained annual tonnage by commodity type and total annual tonnage. A routing impedance was built for each of the OD data sets using the link lengths and "Penalty".

Figure A.3 Existing Rail Mainline Ownership in North Carolina



Source: Oak Ridge National Laboratory's (ORNL) Center for Transportation Analysis (CTA) – Rail Network, Last Updated on September 2014.

An assignment script was built to loop over the six OD data sets to generate tonnage assignment outputs by commodity. A summarizing procedure was also built to aggregate all six assignment outputs and report the total tonnages by link in the TRANSCAD model by commodity type and service type. The assignment procedure was applied twice, with the 2014 rail traffic OD matrix and the 2045 rail traffic OD matrix. No validation of 2014 tonnage assignment outputs was performed in this study.

A.2.5 Convert rail mainline annual tonnage flows to average daily carload and intermodal train volumes

Using four basic assumptions, the rail mainline annual tonnage flows were converted to average daily train volumes. These are:

- Average tons per car or intermodal unit or in other words, payload factor, by commodity type and rail service type, derived from the 2014 Carload Waybill data[41];
- Empty return ratio by railroad operator and rail service type, derived from the 2014 URCS data;
- Cars or units per train by railroad operator and rail service type, derived from the 2007 AAR study data for eastern railroads; and,
- Annual rail traffic to daily rail traffic conversion factor, assumed as 300 days per year.

Table A.7 shows the payload factors by commodity type and rail service type based on the 2014 Carload Waybill data for North Carolina. Coal is the heaviest commodity among carload rail service type, while agriculture is the heaviest commodity among intermodal rail service type.

Productivity gains were assumed in average tons per car at an annualized rate of 0.3 percent per year, and in train length (same as cars or units per train) at an annualized rate of 0.8 percent per year based on historical (1980-2006) trends in railroad operations, studied in the past by Cambridge Systematics.[42] These productivity gain assumptions may result in lower or even negative growth in train volumes in spite of a higher or positive growth in tonnage. In addition, an adjustment was made for cars per train for coal commodity type rail traffic, to an average of 115 cars in 2014. This is higher than the assumed average for the other carload rail service type.

[41] Containers or trailers on flat cars (COFC/TOFC).

[42] Expected productivity gains reflect historical trends and expectations for continued improvements in the future, based on analysis conducted by CS. The primary drivers for productivity gains are expected to be: (1) completion of the migration to 286,000 pound load limit for all car types and commodities where feasible; (2) continued refinement of car designs to optimally use the available clearance envelope, resulting in shorter, wider and/or higher cars; and, (3) lengthening of trains.

Table A.7 2014 and 2045 Payload Factors by Commodity Type and Rail Service Type in North Carolina

2-Digit SCTG Commodity Type	2014 Carload Payload Factor (Tons per Car)	2014 Intermodal Payload Factor (Tons per COFC/TOFC)	2045 Carload Payload Factor (Tons per Car)	2045 Intermodal Payload Factor (Tons per COFC/TOFC)
02: Cereal Grains (including seed)	106	5	116	5
03: Other Agricultural Products, except for Animal Feed	103	16	113	18
04: Animal Feed and Products of Animal Origin, n.e.c.	100	14	110	16
05: Meat, Fish, and Seafood, and Their Preparations	63	19	69	21
06: Milled Grain Products and Preparations, and Bakery Products	93	15	102	17
07: Other Prepared Foodstuffs, and Fats and Oils	87	16	95	17
08: Alcoholic Beverages and Denatured Alcohol	93	17	102	19
10: Monumental or Building Stone	98	N/A	107	N/A
11: Natural Sands	94	N/A	104	N/A
12: Gravel and Crushed Stone	104	N/A	114	N/A
13: Non-Metallic Minerals, n.e.c.	97	18	107	20
14: Metallic Ores and Concentrates	96	10	106	11
15: Coal	114	N/A	125	N/A
17: Gasoline and Aviation Turbine Fuel	49	20	54	22
18: Fuel Oils	85	N/A	94	N/A
19: Coal and Petroleum Products, n.e.c.	83	13	91	14
20: Basic Chemicals	95	15	104	16
21: Pharmaceutical Products	N/A	19	N/A	21
22: Fertilizers	95	N/A	104	N/A
23: Chemical Products and Preparations, n.e.c.	89	15	98	17
24: Plastics and Rubber	95	14	105	15
25: Logs and Other Wood in the Rough	82	20	89	22
26: Wood Products	90	13	99	15
27: Pulp, Newsprint, Paper, and Paperboard	72	13	79	15
28: Paper or Paperboard Articles	59	13	64	14
29: Printed Products	N/A	13	N/A	14
30: Textiles, Leather, and Articles of Textiles or Leather	N/A	11	N/A	12
31: Non-Metallic Mineral Products	101	16	111	18
32: Base Metal in Primary or Semi-Finished Forms and in Finished Basic Shapes	88	10	96	11
33: Articles of Base Metal	75	10	82	11
34: Machinery	41	11	45	12
35: Electronic and Other Electrical Equipment and Components, and Office Equipment	123	12	135	13

2-Digit SCTG Commodity Type	2014 Carload Payload Factor (Tons per Car)	2014 Intermodal Payload Factor (Tons per COFC/TOFC)	2045 Carload Payload Factor (Tons per Car)	2045 Intermodal Payload Factor (Tons per COFC/TOFC)
36: Motorized and Other Vehicles (including parts)	19	14	21	15
37: Transportation Equipment, n.e.c.	28	8	30	9
38: Precision Instruments and Apparatus	N/A	14	N/A	16
39: Furniture, Mattresses and Mattress Supports, Lamps, Lighting Fittings, and Illuminated Signs	N/A	10	N/A	11
40: Miscellaneous Manufactured Products	135	11	148	12
41: Waste and Scrap	87	18	95	19
43: Mixed Freight	81	12	89	14

Source: 2014 Confidential Carload Waybill Sample for North Carolina; and analysis by Cambridge Systematics.

A.2.6 Collect Rail Mainline Passenger Train Service Frequency Information and Assign to Rail Mainline Segments

Six long-distance and one short-distance intercity passenger rail service operate over North Carolina's main lines (See Figure A.4), namely,

(a) Silver Meteor between New York, New York (NY) and Miami, Florida (FL) via Fayetteville, NC - 1 round trip per day;

(b) Silver Star between New York, NY and Tampa/Miami, FL via Raleigh and Hamlet, NC – 1 round trip per day;

(c) Palmetto between New York, New York and Savannah, Georgia (GA) via Fayetteville, NC – 1 daily round trip;

(d) Carolinian between New York, NY and Charlotte, NC via Raleigh and Greensboro, NC – 1 round trip per day;

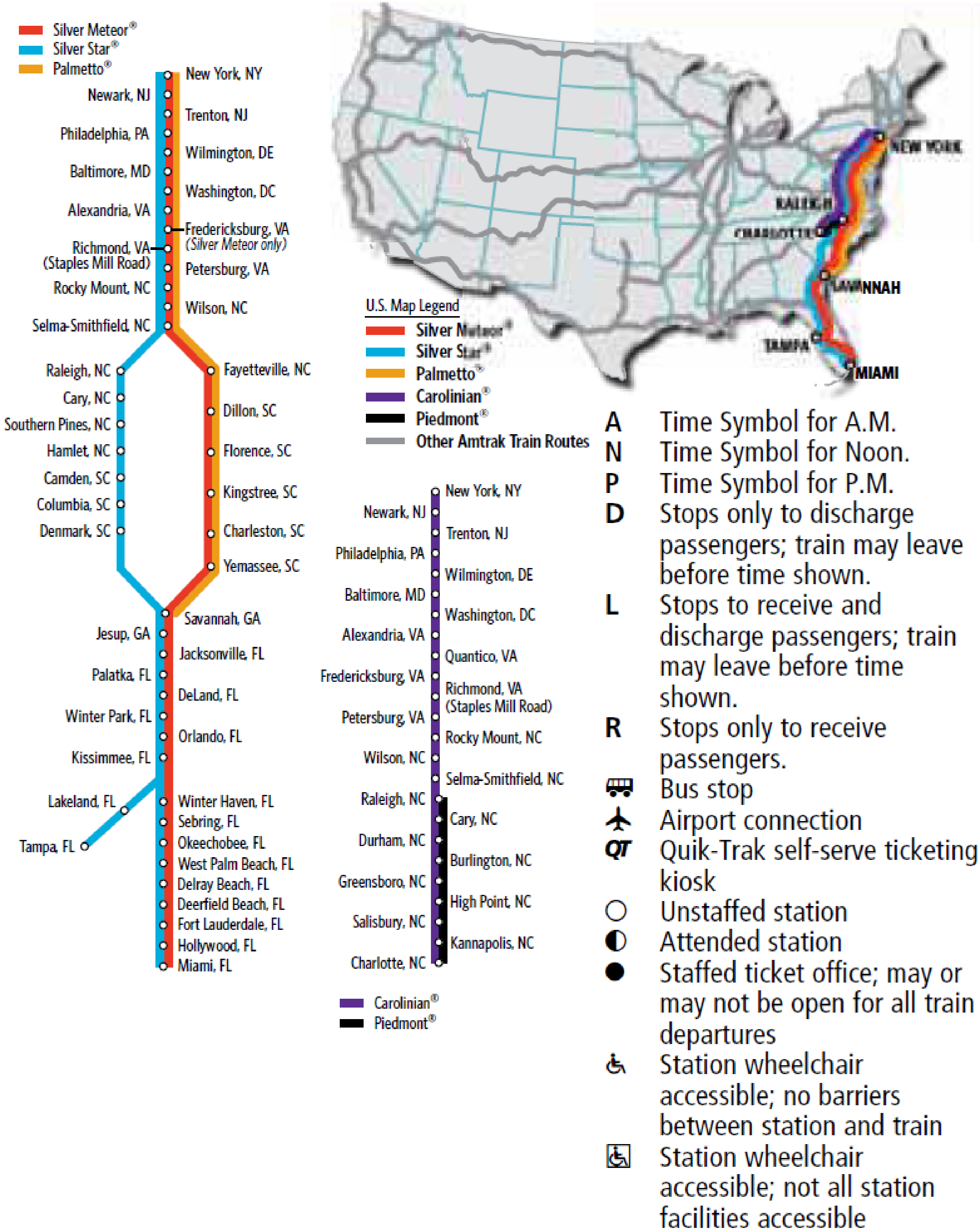
(e) Piedmont between Raleigh and Charlotte, NC via Greensboro, NC – 2 round trips per day;

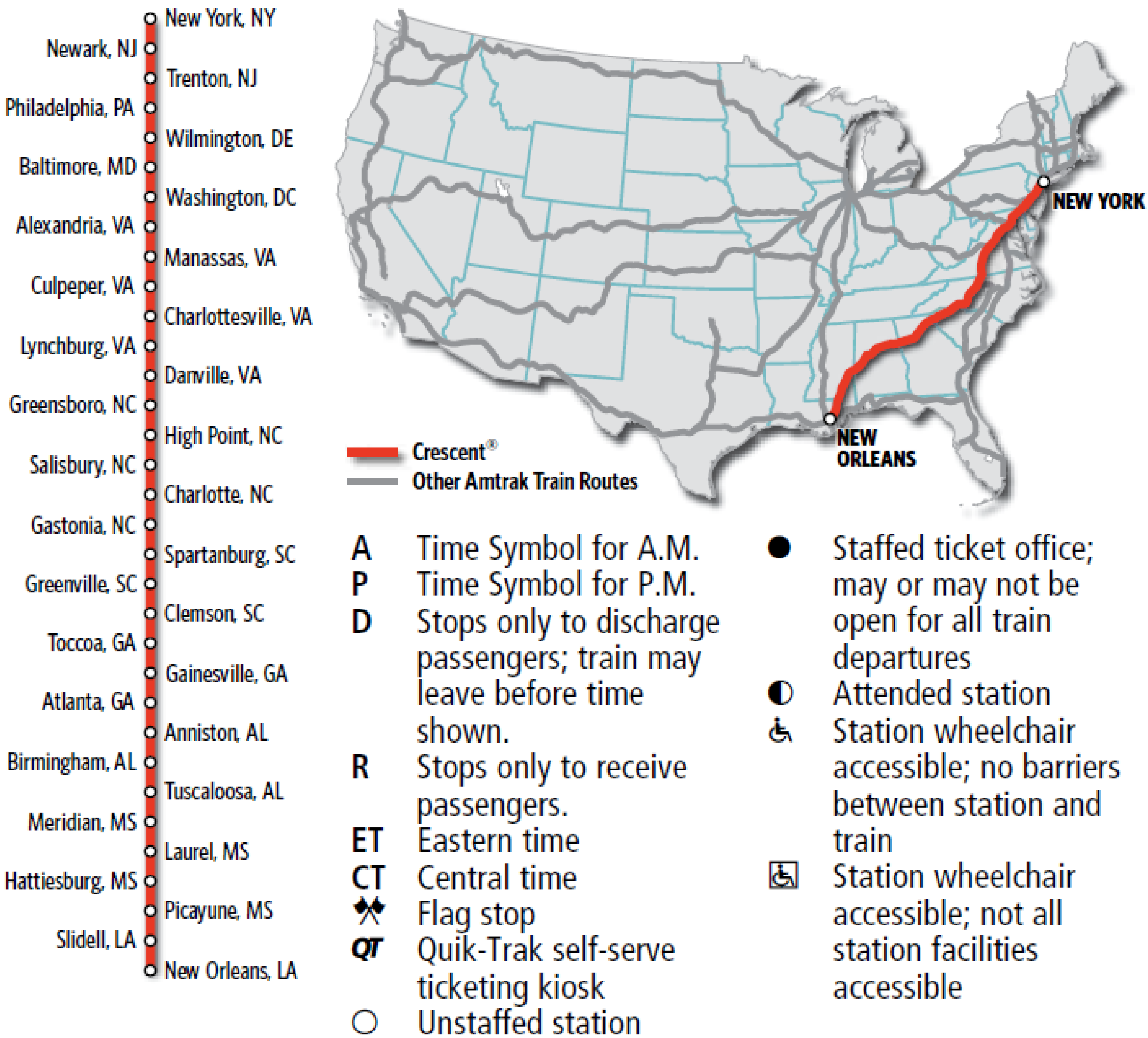
(f) Crescent between New York, NY and New Orleans, Louisiana (LA) via Danville, VA and Charlotte, NC– 1 round trip per day; and,

(g) The Auto Train, between Lorton, VA and Stanford, FL via Fayetteville, NC– 1 round trip per day.

These services were added to the appropriate Class I railroad mainlines.

Figure A.4 Amtrak Passenger Rail Services in North Carolina





Source: Amtrak Website, https://www.amtrak.com/home (last accessed on October 20, 2016).

A.2.7 Adjust Mainline Freight Train Volumes and Daily Train Capacity Using Available Information

Information on current rail operations was collected from NCDOT staff and other sources, and used as follows:

1. There is no double-stacking on NS's line west of Asheville, NC. The cars per train assumption for eastern railroad intermodal train was checked to ensure this restriction.
2. The CSX track through Erwin, NC has stopped handling long-distance through trains after the closure of yard at Erwin, NC. The track is primarily used as an access route for industries located at Kingsport, TN and Johnson City, TN. In this analysis, the origins and destinations for flows through this CSX track were identified using a select link analysis. The OD matrix corresponding to the selected link were broken into two parts, regional rail traffic to and from Tennessee and Kentucky

and western counties of North Carolina and the remaining long-distance rail traffic. “Penalty” was applied to the selected link for OD matrix corresponding to the long-distance rail traffic to route these flows through a longer path, when possible.

Some total checks were performed for train volume estimates in this analysis against the train volumes at grade crossings estimated by the State Rail Plan. For most routes, the modeled daily train volume estimates were found to be lower than the available trains per day data. Due to lack of knowledge on the basis for the grade crossings data such as types of trains included and their train lengths, no adjustments were made to the train volume estimates in this analysis. However, it is recommended that 2014 or recent (as available) train counts data should be collected from the Class I railroads of NS and CSX to validate the train volume estimates.

The rail capacity on links in the TRANSCAD Model in terms of trains per day was estimated based on the 2007 AAR methodology, which uses number of tracks and signal types information. This information was collected from the latest ORNL network and the 2013 State Rail Plan. In this analysis, the lower capacity (trains per day) estimate (that is practical maximum if multiple train types use corridor) for rail segments was used (See Table A.3). Although, CSX operates parallel routes between Selma, NC and Savannah, GA; no directional routing was reported on North Carolina’s rail system. So, no adjustments were made to the estimated link level rail capacity.

A.2.8 Develop Tonnage and Train Volume Maps, Estimate Volume-to-capacity Ratios and Analyze Level of Service by Rail Mainline Segment

Figures A.5 to A.7 show assignment results in terms of annual tonnages in 2014 and 2045, and the annualized rate of growth between 2014 and 2045 by rail mainline segment.

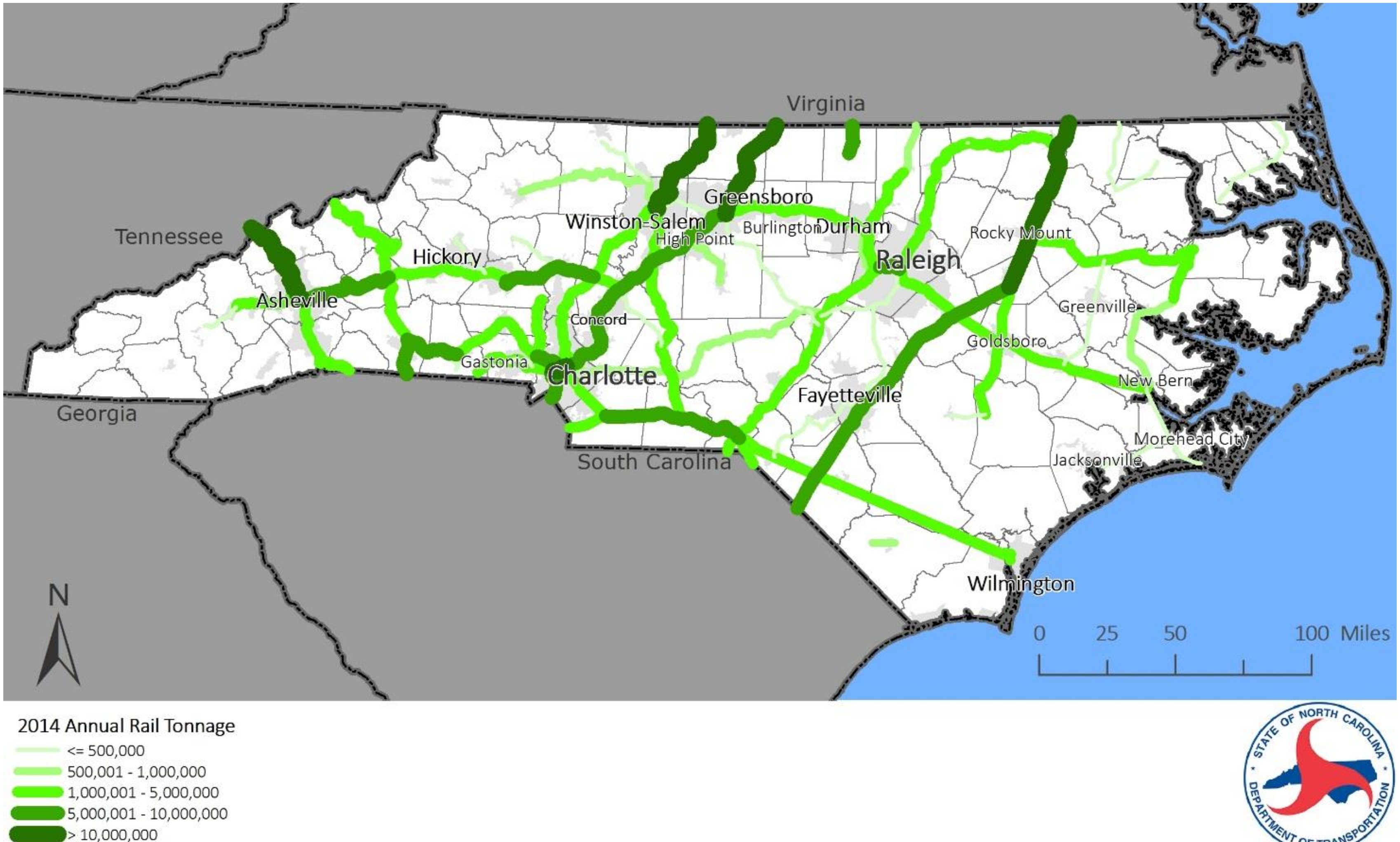
The north-south rail corridors carry a larger share of ton-miles compared to the east-west rail corridors. NS’ Crescent Corridor via Danville, VA, Greensboro and Charlotte, NC and CSX’ I-95 corridor via Selma, NC and Fayetteville, NC are major north-south corridors. Other lines handle mostly local rail traffic.

CSX’s primary classification yard in the region is located at Hamlet, in the south central part of the state. NS’ Charlotte and Spencer classification yards are located in the west central part of the state. Major traffic generators are located at Wilson; the Port at Wilmington; the Ridgeway wood chip mill north of Raleigh; , thermal power stations at Belews Creek, Marshall, NC, and Belmont, NC; and, the Auto Yard at Walkertown, NC. The line to Morehead City, along with industrial sidings located throughout the state adds more traffic. The coal-fired thermal power station at Riverbend, NC was retired in 2013.

The decline in coal traffic is visible in the from of negative CAGRs on the links next to the thermal power stations at Belews Creek, NC – Roanoke, Virginia (VA) rail segment and Belmont, NC – Riverbend, NC rail segment. Most of North Carolina’s mainline segments are projected to experience a growth in rail tonnage between 1% and 2.5% compounded annually.

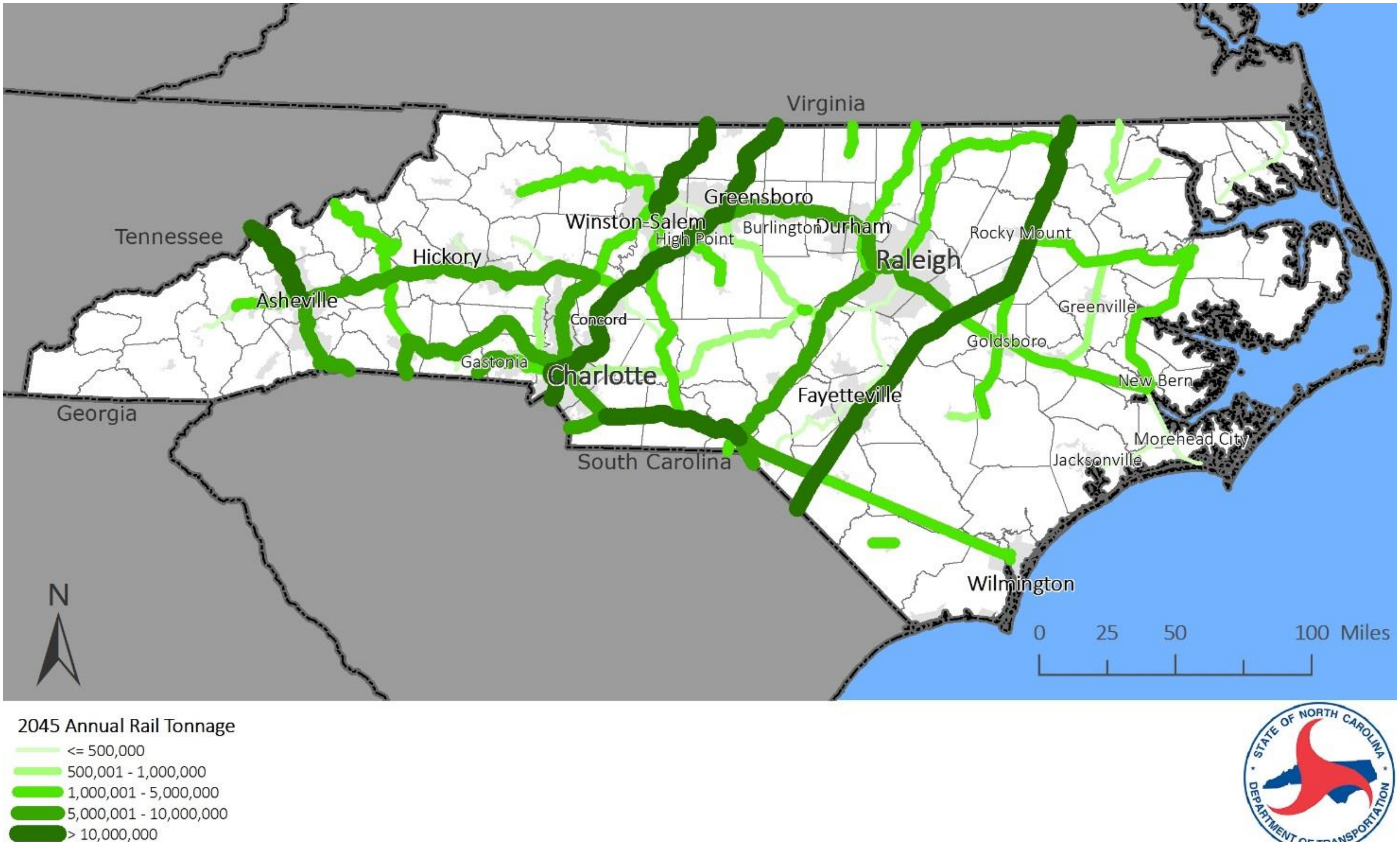
Figures A.8 and A.9 show assignment results in terms of daily trains in 2014 and 2045, and annualized rate of growth between 2014 and 2045 by rail mainline segment in North Carolina.

Figure A.5 Estimated Annual Freight Tonnage Flow on Rail Mainlines in North Carolina, 2014



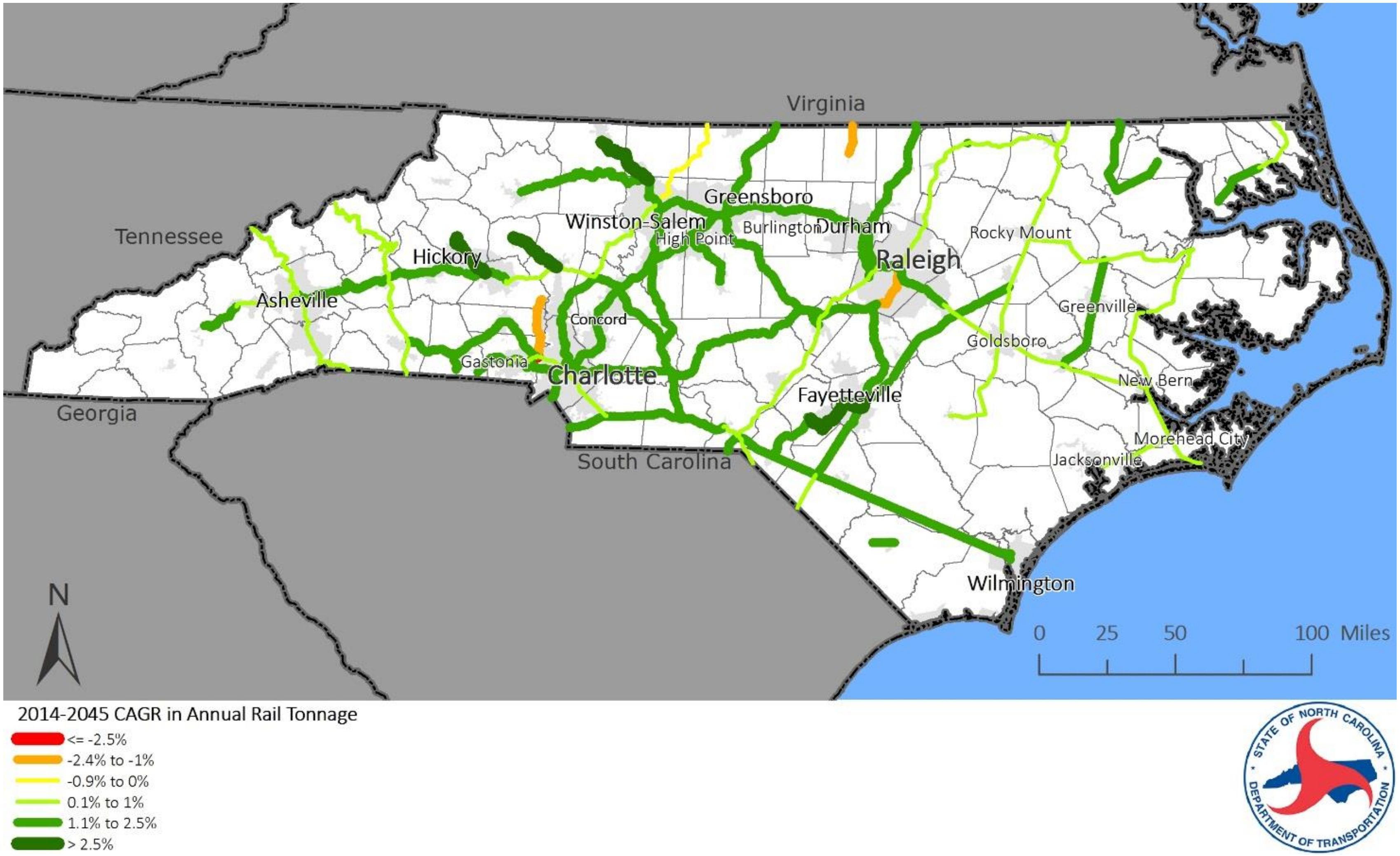
Source: 2014 Confidential Carload Waybill Sample for North Carolina; Freight Analysis Framework version 4 (FAF4) Database; Oak Ridge National Laboratory's Rail Network based TRANSCAD Model for Assignment; Amtrak website; analysis by Cambridge Systematics

Figure A.6 Estimated Annual Freight Tonnage Flow on Rail Mainlines in North Carolina, 2045



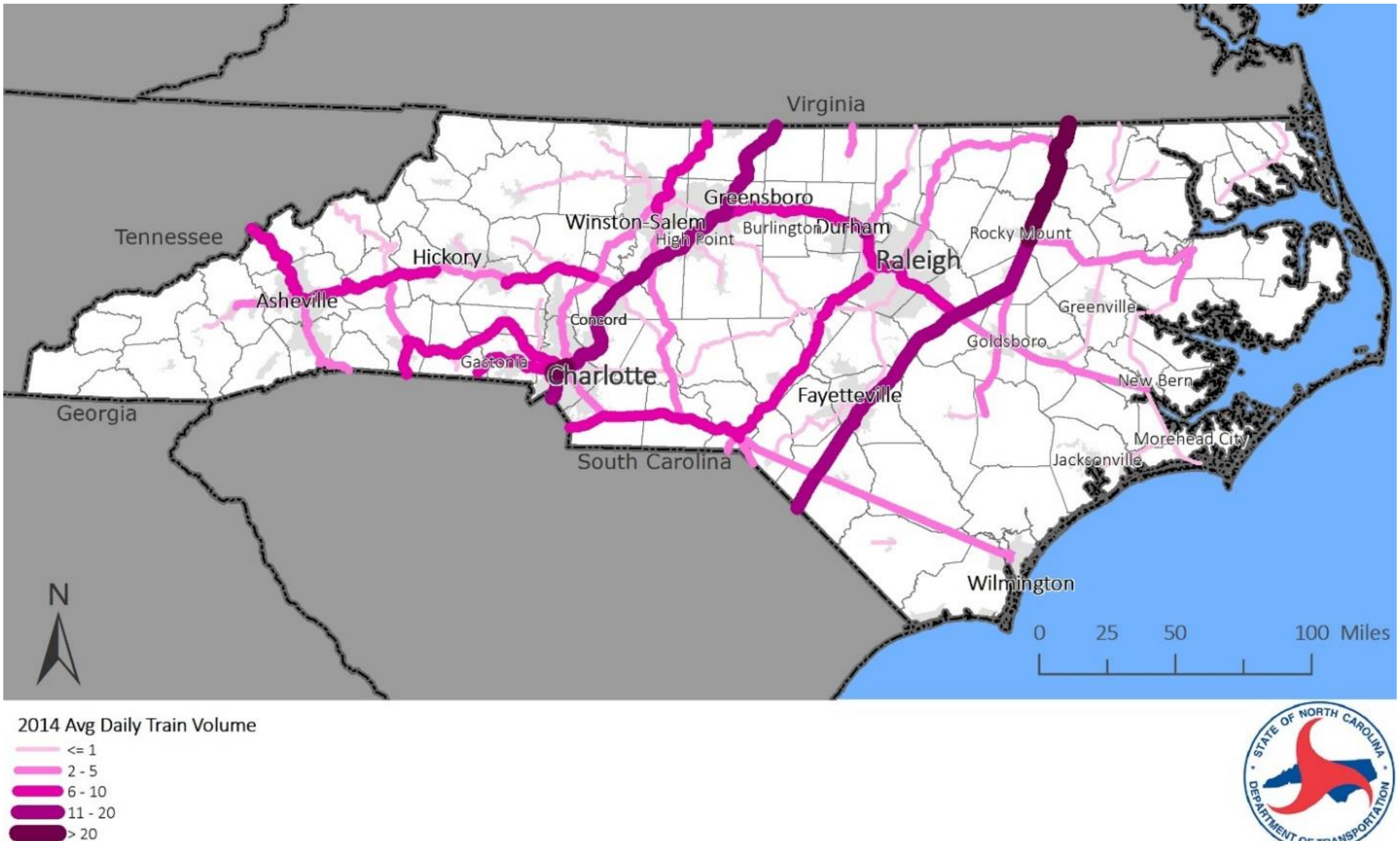
Source: 2014 Confidential Carload Waybill Sample for North Carolina; Freight Analysis Framework version 4 (FAF4) Database; Oak Ridge National Laboratory's Rail Network based TRANSCAD Model for Assignment; Amtrak website; analysis by Cambridge Systematics

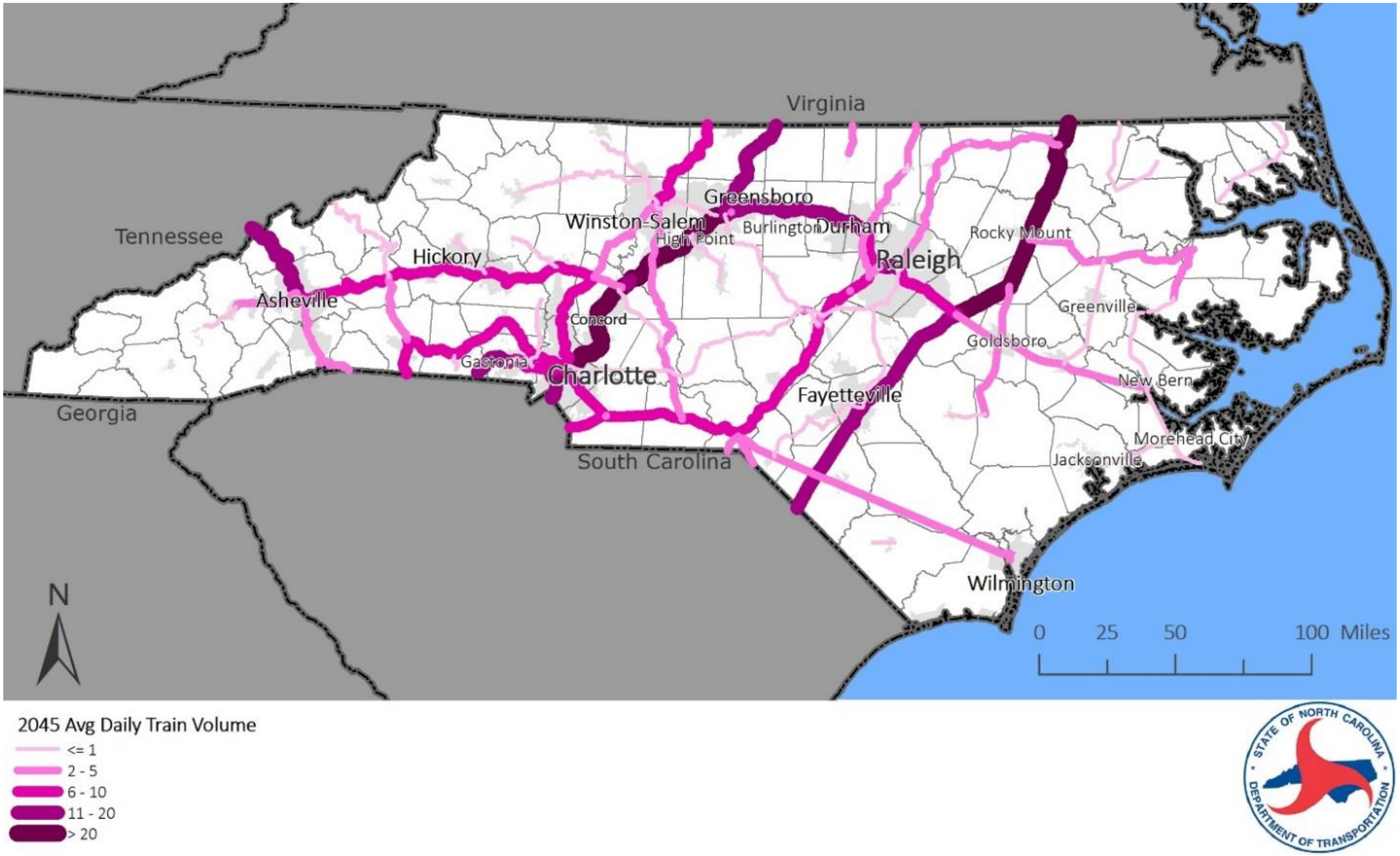
Figure A.7 Estimated Annualized Growth Rate in Freight Tonnage Flow on Rail Mainlines in North Carolina, 2014-2045



Source: 2014 Confidential Carload Waybill Sample for North Carolina; Freight Analysis Framework version 4 (FAF4) Database; Oak Ridge National Laboratory's Rail Network based TRANSCAD Model for Assignment; Amtrak website; analysis by Cambridge Systematics

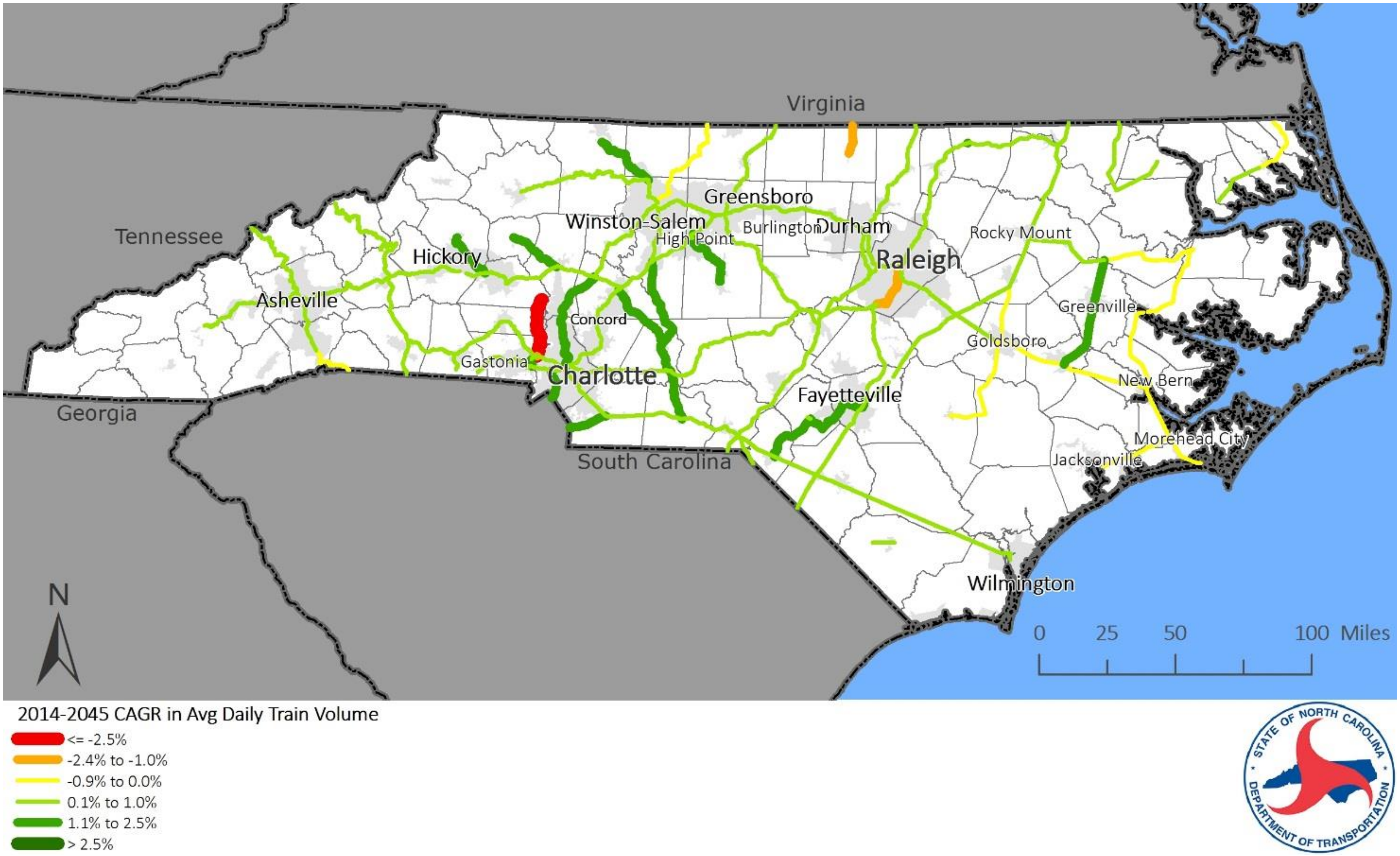
Figure A.8 Estimated Average Daily Total Train Volume on Rail Mainlines in North Carolina, 2014 and 2045





Source: 2014 Confidential Carload Waybill Sample for North Carolina; Freight Analysis Framework version 4 (FAF4) Database; Oak Ridge National Laboratory's Rail Network based TRANSCAD Model for Assignment; Amtrak website; analysis by Cambridge Systematics

Figure A.9 Estimated Annualized Growth Rate in Average Daily Total Train Volume on Rail Mainlines in North Carolina, 2014-2045



Source: 2014 Confidential Carload Waybill Sample for North Carolina; Freight Analysis Framework version 4 (FAF4) Database; Oak Ridge National Laboratory's Rail Network based TRANSCAD Model for Assignment; Amtrak website; analysis by Cambridge Systematics.

The commodity mix in tonnage and rail service type mix in trains in 2014 and their growth rates are shown in Table A.8. The tonnages on NS and CSX lines are comparable. Coal is the top commodity on CSX's through route, while it does not appear as one of the top commodities on NS' through route. Mixed freight and Pulp, Newsprint, Paper, and Paperboard are among the top commodities on both corridors, the other top commodities are unique to these corridors. There is a slightly higher number of average daily intermodal and passenger rail service type trains on NS' through route than CS' through route.

Table A.8 Commodities and Rail Service Type Mix and CAGRs for North Carolina's Major Through Corridors

Category	Unit	2014 Value	% of 2014 Total	CAGR 2014-2045
Norfolk Southern Railway Major Through Corridor Segment between Greensboro, NC and Charlotte, NC				
43: Mixed Freight	Annual Tons	1,477	17%	1.4%
20: Basic Chemicals	Annual Tons	1,091	12%	1.7%
27: Pulp, Newsprint, Paper, and Paperboard	Annual Tons	908	10%	1.1%
24: Plastics and Rubber	Annual Tons	696	8%	2.3%
26: Wood Products	Annual Tons	627	7%	1.9%
Rest of the commodities	Annual Tons	4,100	46%	1.2%
All Commodities	**Annual Tons**	**8,900**	**100%**	**1.4%**
Carload Rail Service Type	Avg. Daily Trains	6.0	31%	0.7%
Intermodal Rail Service Type	Avg. Daily Trains	5.6	29%	0.7%
Passenger Rail Service Type	Avg. Daily Trains	8	40%	0.0%
All Rail Service Types	**Avg. Daily Trains**	**19.7**	**100%**	**0.4%**
CSX Transportation Major Through Corridor Segment between Selma, NC and Fayetteville, NC				
15: Coal	Annual Tons	2,660	29%	-1.7%
07: Other Prepared Foodstuffs, and Fats and Oils	Annual Tons	953	10%	2.1%
43: Mixed Freight	Annual Tons	889	10%	1.5%
27: Pulp, Newsprint, Paper, and Paperboard	Annual Tons	666	7%	1.6%
41: Waste and Scrap	Annual Tons	512	6%	1.6%
Rest of the commodities	Annual Tons	3,542	38%	1.7%
All Commodities	**Annual Tons**	**9,222**	**100%**	**1.0%**
Carload Rail Service Type	Avg. Daily Trains	6.0	44%	0.4%
Intermodal Rail Service Type	Avg. Daily Trains	3.8	28%	0.8%
Passenger Rail Service Type	Avg. Daily Trains	4	28%	0.0%
All Rail Service Types	**Avg. Daily Trains**	**13.9**	**100%**	**0.4%**

Source: 2014 Confidential Carload Waybill Sample for North Carolina; and Cambridge Systematics' Analysis.

Rail network segment daily train volumes were compared to rail capacity in daily trains to calculate volume-to-capacity ratios (V/C). These were expressed as level-of-service (LOS) grades, the results of which are shown in Figure A.10 and Figure A.11. The V/C ratios and the corresponding LOS grades are listed in Table A.9.

Table A.9 Volume-to-Capacity Ratios and Level of Service Grades

LOS Grade		Description	Volume/Capacity Ratios
A	Below Capacity	Low to moderate train flows with capacity to accommodate maintenance and recover from incidents	0.0 to 0.2
B			0.2 to 0.4
C			0.4 to 0.7
D	Near Capacity	Heavy train flow with moderate capacity to accommodate maintenance and recover from incidents	0.7 to 0.8
E	At Capacity	Very heavy train flow with limited capacity to accommodate maintenance and recover from incidents	0.8 to 1.0
F	Above Capacity	Unstable flows; service breakdown conditions	> 1.00

Source: Association of American Railroads, National Rail Freight Infrastructure Capacity and Investment Study, prepared by Cambridge Systematics, Inc., September 2007.

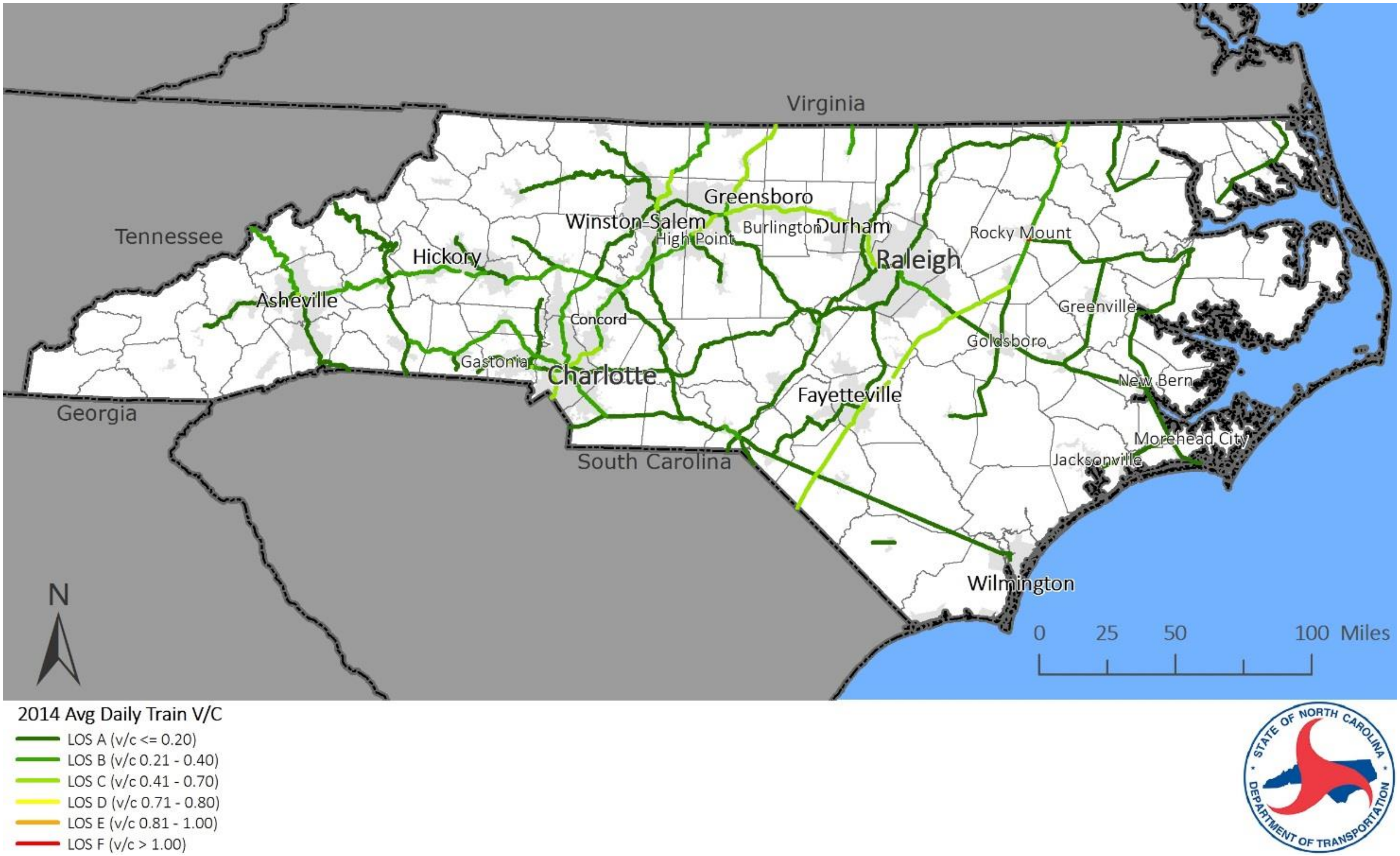
Note: LOS Grade F was further divided into F1 and F2 in this study, where F1 represents volume/capacity ratio ranging between 1 and 1.50, and F2 represents volume/capacity ratio greater than even 1.50. This was done to improve interpretation of the mapped volume/capacity data.

Rail corridors operating at LOS A, B, or C are operating below capacity; they carry train flows with sufficient unused capacity to accommodate maintenance work and recover quickly from incidents such as weather delays, equipment failures, and minor accidents. Corridors operating at LOS D are operating near capacity; they carry heavy train flows with only moderate capacity to accommodate maintenance and recover from incidents. Corridors operating at LOS E are operating at capacity; they carry very heavy train flows and have limited capacity to accommodate maintenance and recover from incidents without substantial service delays. Corridors operating at LOS F are operating above capacity; train flows are unstable, and congestion and service delays are persistent and substantial. The LOS grades and descriptions correspond generally to the LOS grades used in highway system capacity and investment requirements studies.

There is limited double tracking currently in North Carolina. However, only 1.5 percent of rail line miles, and nearly 5% of the ton-miles and train-miles are expected to operate at LOS grade of D or E or F by 2045.

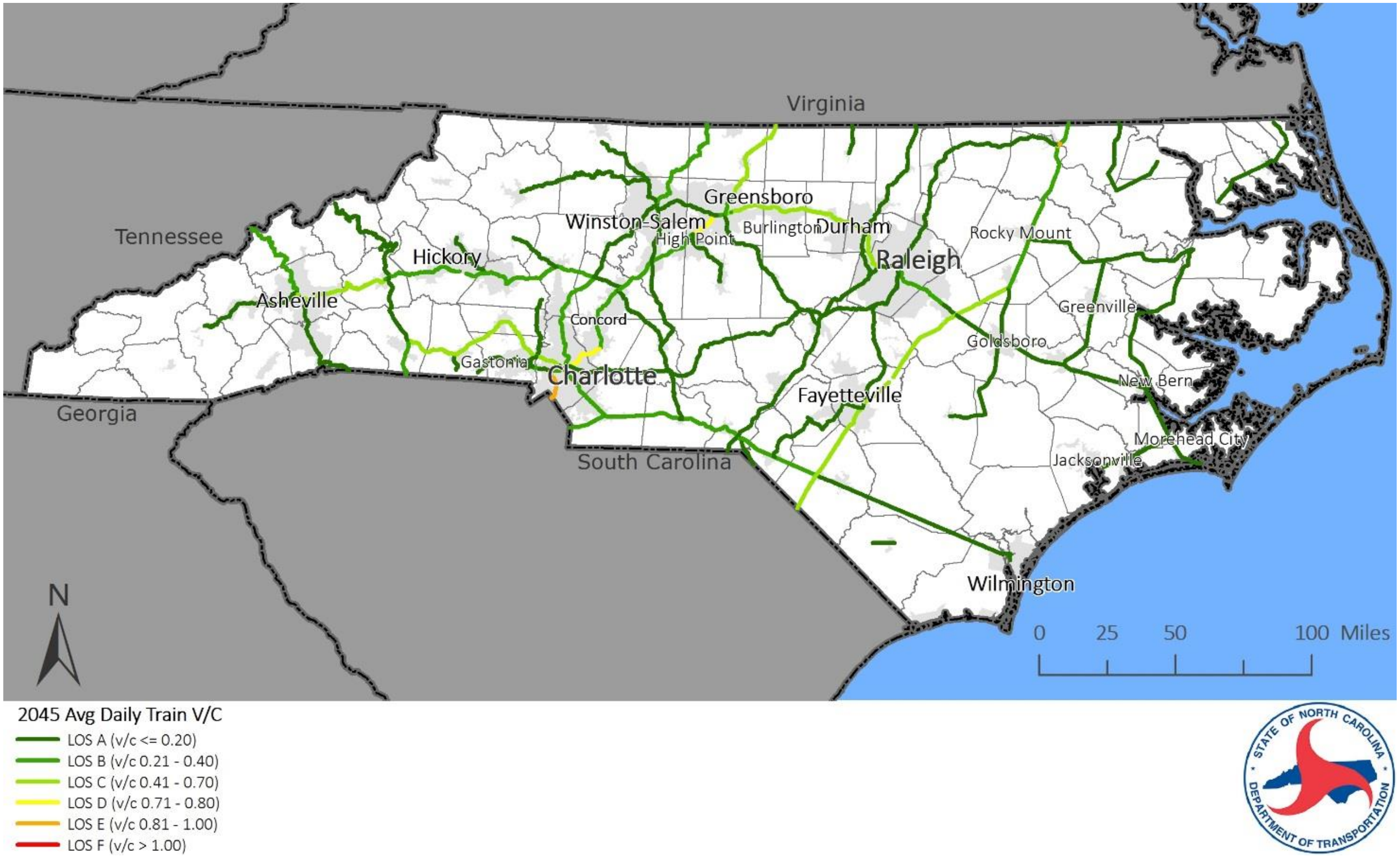
Particular rail mainline segments with LOS grade of D or E or F by 2045 are: Greensboro, North Carolina (NC) – High Point, NC, Kannapolis, NC – Charlotte, NC, and Charlotte, NC – Rock Hill, NC; all of these are on Norfolk Southern's (NS) line. With the double-tracking of the line between Greensboro and Charlotte currently underway, the capacity issues north of Charlotte are likely to be eliminated. In addition, particular rail mainline segments with LOS grade C need to be monitored over time. These include CSX's line between Selma, NC and Pembroke, NC, and NS' lines between Raleigh, NC and Greensboro, NC and between Greensboro, NC and Danville, Virginia. These segments will also be affected by increases in Amtrak (passenger rail) services.

Figure A.10 Estimated Average Daily Volume-to-Capacity Ratio on Rail Mainlines in North Carolina, 2014



Source: 2014 Confidential Carload Waybill Sample for North Carolina; Freight Analysis Framework version 4 (FAF4) Database; Oak Ridge National Laboratory's Rail Network based TRANSCAD Model for Assignment; Amtrak website; analysis by Cambridge Systematics.

Figure A.11 Estimated Average Daily Volume-to-Capacity Ratio on Rail Mainlines in North Carolina, 2045



Source: 2014 Confidential Carload Waybill Sample for North Carolina; Freight Analysis Framework version 4 (FAF4) Database; Oak Ridge National Laboratory's Rail Network based TRANSCAD Model for Assignment; Amtrak website; analysis by Cambridge Systematics.

A.3 Conclusions

The advantages of this capacity analysis are:

- The parametric approach has been successfully used in many studies, including the AAR's 2007 National Rail Freight Infrastructure Capacity and Investment Study;
- It is a rigorous and data based approach;
- It can be developed using data from public sources, which includes the STB Confidential Carload Waybill Sample; and
- It generates information that can be used beyond the current study.

The limitations of this capacity analysis are:

- It uses generalized assumptions for train building, which in reality can vary by customer/market, terminal infrastructure and day-to-day decision-making by railroad managers.
- The sparse availability of information on actual rail traffic (tonnages and train volumes) makes validation difficult;
- Railroads with traffic volumes under the reporting thresholds for the STB Waybill Sample are likely to be underreported or omitted.
- It does not examine the impact of carload and intermodal terminals and yards on capacity.
- It does not examine the impact on capacity of existing bottlenecks that may exist in adjacent states.
- It does not examine potential increases in passenger rail service frequencies, which were kept constant with those present in 2014.

Of particular note is the need for yard and terminal capacity to adapt to demand, impacts that have not been examined here. The nature of these needs depend heavily on the type of traffic – carload, unit train, or intermodal, as well as a carrier's specific operating strategies, which makes estimation of terminal capacity needs far more difficult than for main lines.

Using available data and an eight-step methodology, the study estimated annual tonnage and average daily trains by rail segment, and the resulting volume-to-capacity ratios and level of service (LOS) grade of rail mainline segments mainly owned and operated by NS and CSX.

Table A.10 and Table A.11 summarizes the overall results of the capacity analysis for North Carolina's mainline rail system in terms of miles, annual ton-miles, and daily train-miles by LOS grade in 2014 and 2045. In both years, the distributions over LOS grade are similar although the tonnage of rail flows is increasing, primarily due to anticipated productivity gains from higher train capacity. It is important to recognize that these productivity gains will in part be dependent on continued investment by the railroads to carry heavier cars and longer trains. This includes capacity expansions at terminals, lengthening of main line sidings, and continued improvements in weight handling capacity.

The analysis shows that besides the investments for continued productivity gains, the scale of investments to address volume-to-capacity issues in North Carolina as they relate to expectations for freight traffic are likely to be limited and mostly local.

Table A.10 Miles, Ton-miles and Train-miles by LOS Category, 2014 Rail Mainline System in North Carolina

LOS Grade	Rail Line miles	% of Total	2014 Freight Rail Annual Ton Miles (in billions)	% of Total	2014 Freight Rail Avg. Daily Train Miles (in thousands)	% of Total
A (v/c <= 0.20)	1,881	70.7%	3,300	35.8%	3,032	26.4%
B (v/c 0.21-0.40)	509	19.1%	3,723	40.4%	4,903	42.7%
C (v/c 0.41-0.70)	269	10.1%	2,177	23.6%	3,517	30.7%
D (v/c 0.71-0.80)	1	0.0%	13	0.1%	19	0.2%
E (v/c 0.81-1.00)	0	0.0%	0	0.0%	0	0.0%
F (v/c > 1.00)	0	0.0%	1	0.0%	2	0.0%
TOTAL	2,660	100.0%	9,214	100.0%	11,473	100.0%

Source: 2014 Confidential Carload Waybill Sample for North Carolina; Freight Analysis Framework version 4 (FAF4) Database; Oak Ridge National Laboratory's Rail Network based TRANSCAD Model for Assignment; Amtrak Website, https://www.amtrak.com/home (last accessed on October 20, 2016); and Cambridge Systematics' Analysis.

Table A.11 Miles, Ton-miles and Train-miles by LOS Category, 2045 Rail Mainline System in North Carolina

LOS Grade	Rail Line miles	% of Total	2045 Freight Rail Annual Ton Miles (in billions)	% of Total	2045 Freight Rail Avg. Daily Train Miles (in thousands)	% of Total
A (v/c <= 0.20)	1,770	66.6%	3,526	27.8%	2,682	20.5%
B (v/c 0.21-0.40)	529	19.9%	5,365	42.2%	5,687	43.5%
C (v/c 0.41-0.70)	321	12.1%	3,284	25.8%	3,922	30.0%
D (v/c 0.71-0.80)	27	1.0%	337	2.7%	573	4.4%
E (v/c 0.81-1.00)	13	0.5%	191	1.5%	193	1.5%
F (v/c > 1.00)	0	0.0%	2	0.0%	2	0.0%
TOTAL	2,660	100.0%	12,706	100.0%	13,060	100.0%

Source: 2014 Confidential Carload Waybill Sample for North Carolina; Freight Analysis Framework version 4 (FAF4) Database; Oak Ridge National Laboratory's Rail Network based TRANSCAD Model for Assignment; Amtrak Website, https://www.amtrak.com/home (last accessed on October 20, 2016); and Cambridge Systematics' Analysis.

In addition to the projected demand in this analysis, some new or expanding intermodal terminals and carload industries are likely to induce rail traffic beyond what is projected by FAF4. CSX' new Carolina Connector Intermodal Rail Terminal intermodal yard near Rocky Mount brings a high capacity facility to the I-95 corridor in the eastern part of the state, and will be able to support local shippers as well as the Port of Wilmington. This yard is expected to handle 260,000 container lifts by the 5^{th} year of operation. Active plans to increase passenger service will also impact freight capacity. This includes the Piedmont Corridor service expansion presently underway, as well as the Southeast High Speed Rail initiative that envisions vastly increased service between Washington DC, Richmond, and North Carolina, on a combination of dedicated and joint use rail lines.