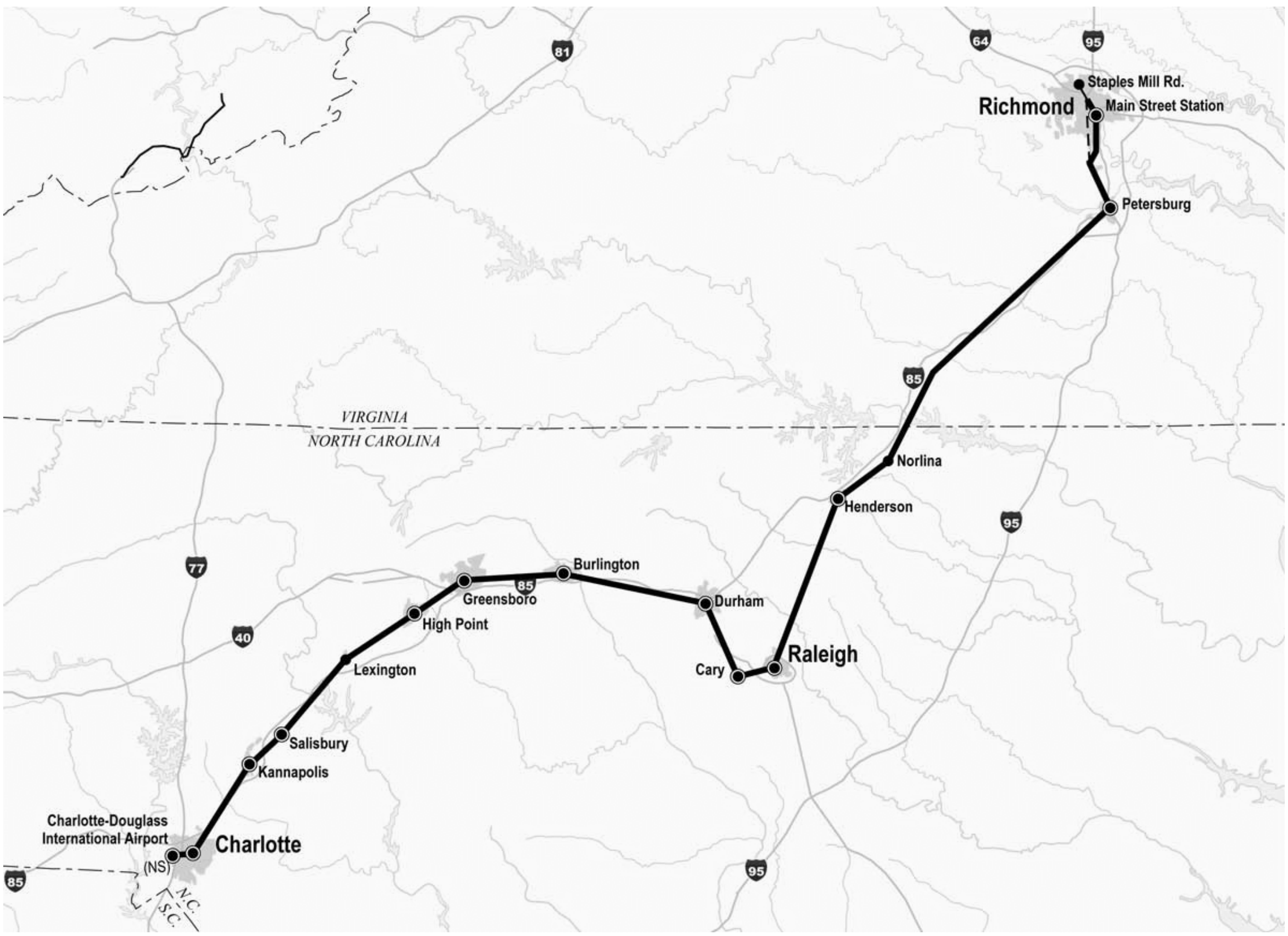
VOLUME I
Executive Summary and Main Report

Technical Monograph: Transportation Planning for the Richmond–Charlotte Railroad Corridor



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16. Abstract

Should the States of North Carolina and Virginia desire to upgrade the railroad corridor between Richmond and Charlotte for improved passenger service that meets a specific travel time goal, a number of infrastructure improvements would be needed. This monograph enumerates, describes, and costs a set of improvements that could, in combination, support a trip time goal of 4 hours, 25 minutes between Richmond and Charlotte. The operational implications of such a service are discussed. As the corridor contains a variety of operating conditions, this monograph may be of technical assistance to other States that are contemplating similar rail passenger service projects.

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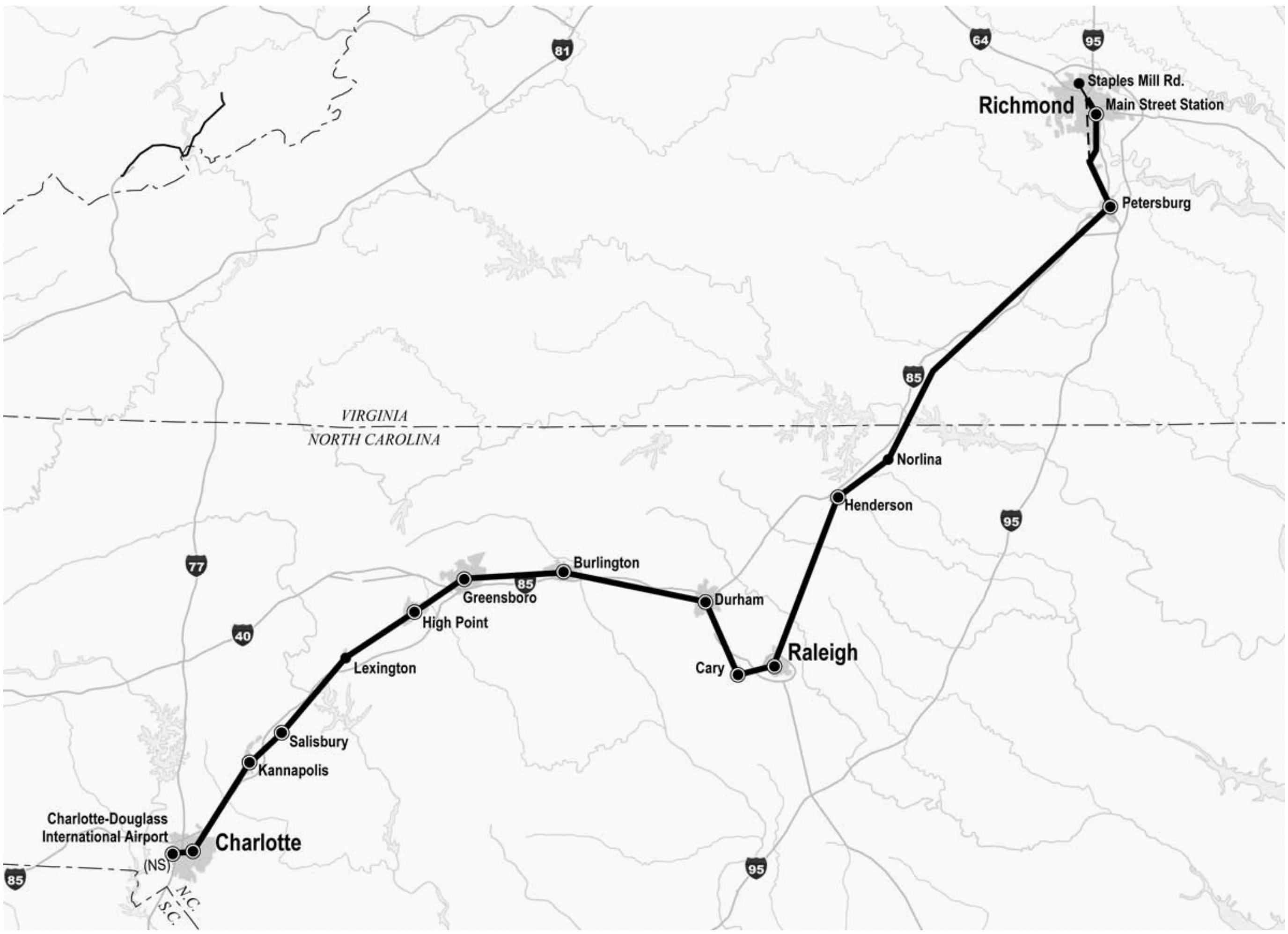
Technical Monograph: Transportation Planning for the Richmond–Charlotte Railroad Corridor

Executive Summary



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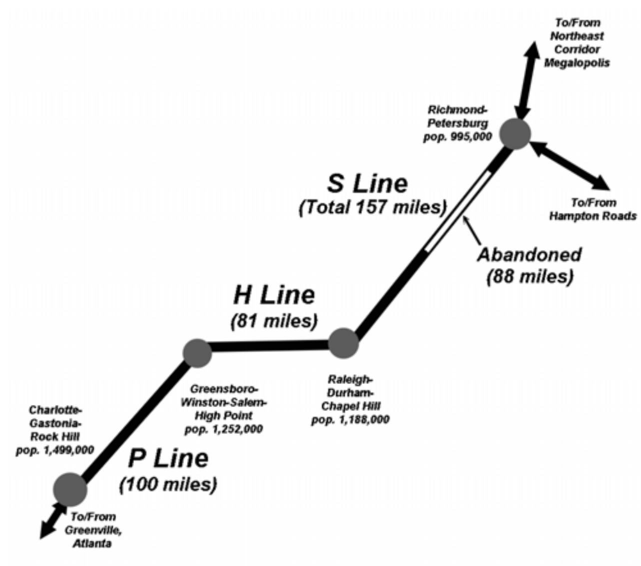
EXECUTIVE SUMMARY

This technical monograph investigates whether, and how, the Commonwealth of Virginia and the State of North Carolina could upgrade the railroad corridor between Richmond and Charlotte to achieve those States' passenger train travel time goals, with consistent on-time performance for all freight and passenger operations.

The Corridor Today (Chapter 2)[1]

As a critical link in a longer rail route linking the Northeastern States with Virginia, the Carolinas, Georgia, and Florida,[2] the Richmond–Charlotte Corridor consists of three distinct components, as shown in Figure ES-1:

Figure ES-1:
Schematic of Richmond–Charlotte Corridor



- The "S Line," a route of the CSXT Corporation (CSXT) between Richmond and Raleigh (North Carolina), more than half of which was abandoned in the 1980s, and most of the rest of which CSXT operates in light-density freight service[3];
- The Raleigh–Greensboro (North Carolina) "H Line," owned by the North Carolina Railroad and operated under moderate traffic density by the Norfolk Southern (NS) Railroad; and
- The Piedmont Main Line ("P Line"), also owned by the North Carolina Railroad[4] and operated by the NS as a heavy density freight route.

The S Line accounts for almost half the mileage. If it is subdivided into its active and abandoned portions, then the Richmond–Charlotte Corridor may be viewed as consisting of four parts, roughly equal in length, but each with its own distinct physical

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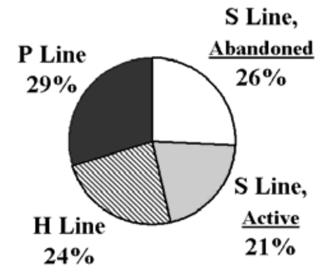
[1] Chapter references are to the Main Report.
[2] This longer route has been Federally designated as the "Southeast Corridor" for possible future improved rail passenger service.
[3] See the section "Important Note on the Environmental Process" in Chapter 1 of the Main Report.
[4] Except for the segment between central Charlotte and the Charlotte Airport.

and operating characteristics (see Figure ES-2). At the time the research for this monograph occurred, the study team regarded the H and P Lines as being in a "state of good repair," meaning that the track was of a quality that met or exceeded the requirements of the Federal Railroad Administration's (FRA's) railroad safety regulations for the speeds and traffic types that it supported.

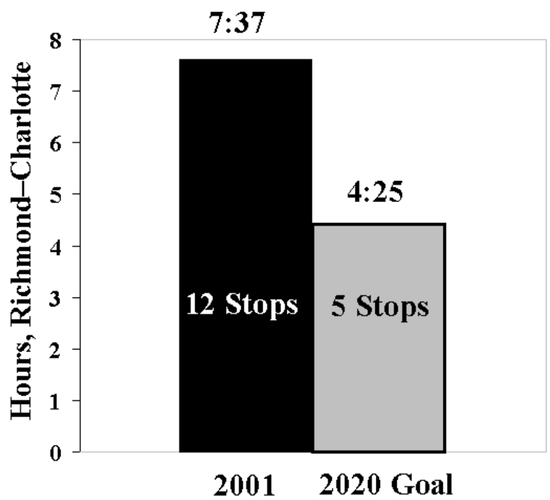
Figure ES-2: Mileages as Percent of Corridor Total



State Goals for the Corridor (Chapter 3)

For improved corridor passenger service between Richmond and Charlotte, the States (Virginia and North Carolina) have set a travel time goal of four hours, 25 minutes with five stops—a 42 percent reduction from existing travel times (Figure ES-3).

Figure ES-3: State Travel Time Goals for Improved Corridor Passenger Service[5]



The States have also set service frequency goals for improved corridor passenger trains: four daily round trips between Northeast Corridor points, Richmond, and Charlotte; plus an additional five daily round trips between Raleigh and Charlotte. These intended frequencies, as well as projected frequencies for freight, conventional passenger,[6] and commuter services, are summarized in Table ES-1.

Approximately one-third of Amtrak's *Carolinian* and *Piedmont* trains currently arrive late at their final destination, largely due to conflicts between freight and passenger movements on the single-track H Line and the partially single-track P line. Since both

[5] The actual time for 2001 is the average of southbound and northbound timings for the *Carolinian.*
[6] I.e., long-distance trains in the traffic lanes between the Northeast Corridor and Florida, and between the Northeast Corridor, Atlanta, and New Orleans.

freight and passenger trains are important to the economies of North Carolina and Virginia, the need to relieve current, and avoid new, bottlenecks for all services has fundamentally influenced the analysis underlying this monograph. This emphasis on reliability is all the more important because the future could see a doubling or tripling of train movements on the H and P Lines.

Table ES-1: Projected Daily Train Movements by Service Type and Segment

NOTE: "Daily train movements" are the sum of one-way operations in the two opposing directions—i.e., double the number of daily round trips.[7]	**S Line (Active Portion, Norlina–Raleigh Only)**		**H Line (Raleigh–Greensboro)**		**P Line (Greensboro–Charlotte)**	
	2001 Existing	**2020 Projection**	**2001 Existing**	**2020 Projection**	**2001 Existing**	**2020 Projection**
Intercity Passenger Trains:						
Corridor (improved by 2020)	0	8	4	18	4	18
Long-Distance	0	2	0	0	2	4
Total, Intercity Passenger Trains	0	10	4	18	6	22
Commuter Trains (Charlotte region)	0	0	0	0	0	22
Freight Trains	4	14	8	8	25	33
Total Daily Movements for All Services	4	24	12	26	31	77
As Percent of Existing Movements	100%	**600%**	100%	**217%**	100%	**248%**

Operations Analysis (Chapter 4)

The analysis took place under the direction of the corridor planning staff of the FRA, with full participation by the Commonwealth of Virginia, the State of North Carolina, Amtrak, the North Carolina Railroad, and CSX Transportation. The Norfolk Southern Corporation chose not to participate. In an iterative process, the study team combined its knowledge of existing conditions on the lines in question, with conceptual plans for a number of fixed facility improvements that would raise train speeds, improve capacity, and meet safety, operational, or marketing prerequisites. Simulations of train performance in the planning year (2020) were conducted over various hypothetical fixed facility configurations, and with various equipment performance specifications assumed. These simulations were of two types:

- Calculations of pure train performance in the absence of interference from other trains; and
- Seven-day simulations of the performance of, and interference among, all the freight, intercity passenger, and commuter train movements envisioned in Table ES-1 above. For this purpose, hypothetical schedules of all these movements were developed; the simulation technique modeled the effects

[7] Train movements for the P Line are the average of the train movements for its two constituent segments, Greensboro–Spencer Yard and Spencer Yard–Charlotte. For details, see Tables 2-5 and 3-1 in the Main Report.

of randomness, for example in the arrival of long-distance freight trains at entry points to the corridor.

The results of this analysis of operations were as follows:

- The States' trip time goals, while challenging, are achievable.
- Train equipment exists that could reliably travel between Richmond and Charlotte in four hours, 25 minutes with five intermediate stops, subject to the completion of the improvements contemplated in this study.
- The system configuration that would allow the trip time goals to be met would include:
  - Maximum authorized speeds of 110 mph;
  - Non-electric trainsets with two locomotives and six cars;
  - Tilting capability in the cars;
  - Unbalanced superelevation of up to seven inches[8]; and
  - The recommended alignment, as described in Chapters 5 and 6.
- To the extent that the States were to substitute other system configurations and improvements for those contemplated in this report, the alterations would need to have the same net effect on speed, capacity, safety, and marketability as those described in this monograph, for the goals to be reliably met.

The Contemplated Improvements (Chapters 5 and 6)

The monograph classifies corridor betterments into two main categories:

- **Systemic** upgrades of corridor-wide railroad components (for example, the signaling system). These[9] form the subject matter of Chapter 5; and
- **Site-specific** projects (for example, track reconfigurations). These are examined in Chapter 6.

The following sections summarize the major elements of the contemplated improvement program, for both systemic and site-specific projects. [10]

[8] See the Glossary (at the end of Volume 1) for an explanation of terms. This specification would be among those subject to the review and approval of the FRA's Office of Safety.

[9] Chapter 5 also describes corridor-wide engineering standards that were applied to site-specific projects, as well as certain program elements which are site-specific in essence, but for which corridor-wide cost estimates are presented.

[10] While this listing should assist the States in considering, and possibly implementing, further development of this corridor, the precise nature, scope, and cost of the systemic and site-specific improvements are, of course, subject to more detailed planning and engineering work.

Restoration of the Abandoned S Line

Worthy of special note is the contemplated restoration of the now-abandoned portion of the S Line between Centralia (Virginia) and Norlina (North Carolina). This 88-mile segment would be rebuilt to modern standards with new wooden ties, continuous welded rail, premium fasteners for track stability, and turnouts allowing for diverging passenger moves at 45 mph. On curves to be operated at high speeds, concrete ties would be installed. The route would benefit from numerous curve realignments and relocations, which would be relatively easy and economical to accomplish on an inactive right-of-way. Of some 63 public highway-railroad grade crossings formerly on this abandoned segment, eight would be eliminated and 55 would be restored with gates and flashers.[11]

Saving some 34 miles, or one-fifth, of the distance of today's circuitous route between Petersburg and Raleigh, restoration of the S Line would bring other components of railway technology up to the standards to be applied elsewhere on the Corridor, and is treated in this monograph as a single site-specific project.[12]

Improvements on the Active S, H, and P Lines

Track Structure

The currently-active portions of the S Line (Richmond–Centralia, Norlina–Raleigh) and the Raleigh–Fetner (North Carolina) segment of the H Line would undergo a significant upgrade, with replacement of rails and other track components to assure safe, expeditious passenger and freight service. In order to make the track structure stable for tilting trains where they operate at between five and seven inches of unbalanced superelevation, approximately 100 track-miles of curves would receive concrete ties and premium fasteners.[13] All other currently-active trackage in the Corridor is assumed to continue in the state of good repair that was perceived during the research for this study, although some surfacing would be required to support the proposed maximum authorized speeds on the H and P Lines.

Curve Realignments

Intended to lengthen the stretches of track available for high-speed running, alignment improvements would cover a broad spectrum from adjustments (sometimes measured in inches) within the existing right-of-way, to major relocations outside the right-of-way. The adjustments would affect the banking of curves ("superelevation"), the transition sections ("spirals") from straight to curved trackage, and in some cases the

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[11] Three new public crossings would be added, also with gate and flasher protection. Also, of the 20 private crossings identified in limited field work as potentially active on the restored line, ten would be closed and ten would be provided with gates and flashers.

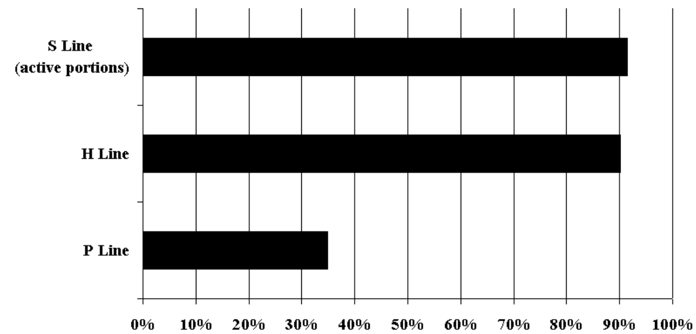
[12] See the section "Important Note on the Environmental Process" in Chapter 1 of the Main Report.

[13] Solely to minimize initial capital costs, wooden ties are assumed for the remainder of the trackage. Suitable transitions would be provided between the concrete and wooden tie sections. If sufficient funds prove to be available, installation of concrete ties throughout the corridor would be beneficial.

degree of curvature itself. Over all the active portions of the Corridor, [14] a total of 39 identifiable curve adjustment projects would occur, spaced on average at six- to seven-mile intervals. By contrast, only ten relocations are envisioned, with seven on the H Line, two on the active S Line, and one on the P Line. A single relocation project on the S Line would eliminate or ease 17 curves south of Wake Forest for a near-doubling of the speed limit[15] and a travel time reduction of 2.6 minutes.

Track Layout Reconfigurations

Figure ES-4:
Percentage of Single Track Territory by Line, 2001



Both the S and H Lines are essentially single-track railroads, as displayed in Figure ES-4, and about one-third of the P Line is single-track territory. The projected 2020 train volumes will not fit into such a constrained physical plant reliably, if at all. Therefore, many track layout reconfigurations are contemplated in this monograph. They can be characterized generally as follows:

- In single-track territory, sidings would be added or expanded to be 3.5 to four miles long, with 11 miles of single track between sidings.[16] The turnouts giving access to and from sidings would allow for 45 mph passenger speeds (40 mph for freight) for trains entering or leaving the siding.
- The P Line would be restored to its former double-track status throughout, with appropriately placed interlockings (where trains can move between tracks). Approximately one-fifth of the P Line would be triple-tracked, mainly through the addition of long center sidings that would maximize operating flexibility in both directions.
- Reconfigurations at major stations, and in the vicinity of important yards, would enhance fluidity by allowing all types of trains to do their work or reach their destinations more quickly, thus freeing up the main tracks for following movements. Chapter 6 details the rationales for, and intricacies of, these site-specific reconfigurations, particularly at Raleigh, Durham, Greensboro, Spencer Yard/Salisbury, and Charlotte.

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[14] Curve realignments, like all other improvements within the abandoned segments of the S Line, are considered part of the S Line Restoration project.
[15] From the former 60 mph for passenger trains, to 100 or 110 mph.
[16] Siding spacings and lengths would vary due to local conditions, the presence of grade crossings, and other limiting factors.

Signaling and Train Control

A modern system of automatic train control, cab signals, and reverse signaling would be installed throughout the Corridor. This system would meet the FRA's safety requirements for train operations over 79 mph by automatically enforcing restrictive signals through the electronics of each locomotive. It would also promote operational flexibility by allowing trains to operate on any track in either direction.

Stations

Properly sited, designed, and accessed stations are prerequisite to the marketability of improved rail service corridors. Table ES-2 summarizes the station program contemplated in this monograph. Stations are assumed to have low-level platforms,[17] fulfill applicable Americans with Disability Act requirements, and provide adequate passenger accommodation, parking, and access/egress to assure marketability of the Corridor's passenger transportation product. However, only selected operational aspects of stations were included in the conceptual planning in this study and the related cost estimates (see "Program Summary," below).

Table ES-2: Contemplated Station Program

Mile-post[18]	Location[19]	Metro Area Population[20]	Disposition		
			Existing, Restored, and/or Reopened	Assumed Relocation	Assumed New Stop
S0	Richmond - Main Street Station	997,000	•		
S22.0	Petersburg		•[21]		
S113.8	Henderson	16,095	•		
H80.4	Raleigh	1,188,000		•	
H72.7	Cary		•		
H54.7	Durham			•	
H21.5	Burlington	1,252,000	•		
H0.1	Greensboro			•	
299.2	High Point		•		
P333.3	Salisbury	1,499,000	•		
P348.9	Kannapolis		•		
P367.1	I-485				•
P377.8	Charlotte			•	
P383.2	Charlotte Airport				•
Total population, Richmond–Charlotte Corridor only[22]		4,952,095			

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[17] High-level platforms would be desirable in a number of locations if funds are available.
[18] Relocated stations will show different milepost numbers than are reflected in Table 2-4 of the Main Report..
[19] Chapter 7 of the Main Report specifies what costs categories are included for each station.
[20] Populations are for Metropolitan Statistical Areas or for the city or town—whichever is the largest applicable to the station. The catchment area for smaller stations will be larger than the city or town population shown. U.S, Census, Year 2000 data from *Statistical Abstract of the United States,* http://www.census.gov/prod/2002pubs/01statab/app2.pdf; town populations from http://factfinder.census.gov/servlet/BasicFactsServlet.
[21] Alternative routes through Petersburg are presently under evaluation as part of a study to extend high-speed rail service to Norfolk. Thus a relocated station is a distinct possibility.

Grade Crossing Improvements

North Carolina's Sealed Corridor Project—an effort to systematically improve safety at the highway-rail grade crossings on the North Carolina Railroad[23]—has established the principle that improved rail passenger service can and should be accompanied by reduced risk of motor vehicle/train collisions. Accordingly, this study has developed a preliminary program to deal with the 370 public and private crossings on the active S, H, and P Lines. Contemplated treatments for these crossings appear in Figure ES-5 and Figure ES-6.

Figure ES-5: Contemplated Disposition of Public Highway-Rail Grade Crossings

Total Crossing Sites[24]: 298

(Active S, H, and P Lines)

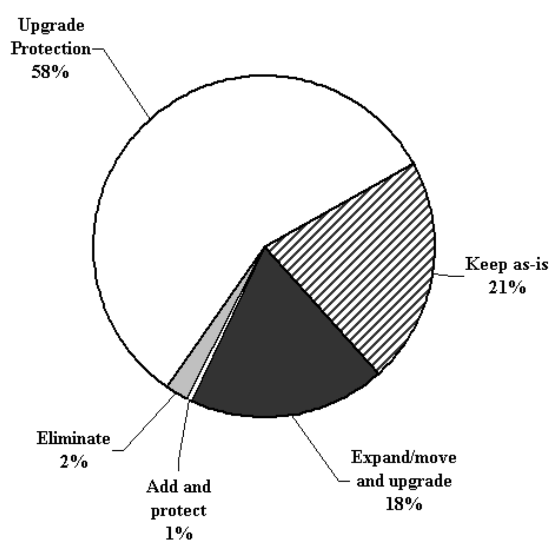
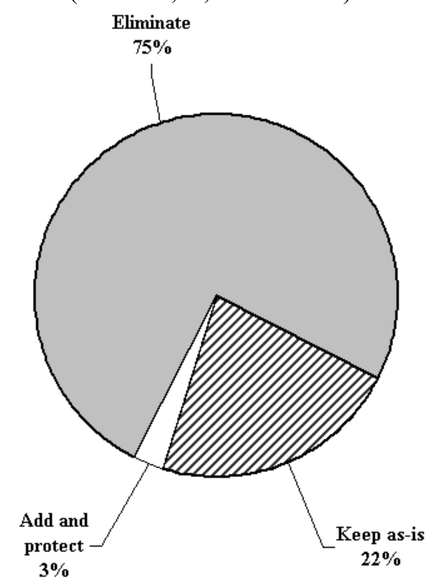


Figure ES-6: Contemplated Disposition of Private Highway-Rail Grade Crossings

Total Crossing Sites: 72

(Active S, H, and P Lines)



Fencing

This study assumes that approximately ten percent of the corridor might require fencing of both sides of the right-of-way to improve safety and minimize the potential for trespassing.

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[22] The important points served by through services, such as Washington, Baltimore, and other Northeast Corridor population centers, are not included in this total.

[23] For details on this trailblazing effort, see Federal Railroad Administration, *North Carolina Phase I U.S.DOT Assessment Report, Report to Congress,* May 2002, available as this monograph goes to press at http://www.fra.dot.gov/downloads/Research/rdv_rep2congress.pdf . This State/railroad partnership has shown that driver run-around violations at crossings can be reduced by up to 98 percent through the installation of four-quadrant gates, median roadway barriers, and other innovations. Further information on the Sealed Corridor Program may be obtained from the North Carolina Department of Transportation's Rail Division at http://www.bytrain.org/safety/ .

[24] "Total Crossing Sites" equals the total number of existing crossings plus likely sites for additional crossings. The latter, amounting to two public and two private sites, are generally introduced to substitute for crossings slated for elimination.

Equipment and Support Facilities

Equipment

Although this monograph emphasizes fixed facility improvements, the study team is mindful that the success of improved rail passenger service depends heavily on the acquisition of locomotives and cars (or complete "trainsets") that can—

- Meet or exceed the travel time goals safely and reliably;
- Comply with the engineering specifications of all rail facilities over which they may be called to operate—for example, the Northeast Corridor;
- Provide levels of passenger comfort, convenience, and amenities that would compete with those of other modes while enhancing the transport economics of the rail service;
- Provide consistent availability over the units' economic life, and hopefully beyond, with industry-standard maintenance; and
- Incur operating and maintenance cost levels that would support the service on a long-term, economic basis.

Should the States elect to pursue development of this corridor, the equipment acquisition project should be accorded at least the same urgency, and given at least the same lead-times, as the fixed facility projects contained in this monograph. In this manner, adequate time and thought would be available for the specification, design, source selection, prototype testing, production, and acceptance testing of an equipment fleet[25] that would exceed all the criteria listed above. This methodical approach is all the more necessary because equipment, which typically costs but a fraction of the fixed facility expenditure,[26] is nevertheless critical to the success of any rail corridor investment effort.

Support Facilities

The study identified a need for equipment storage trackage, as well as servicing and inspection facilities, at Raleigh and Charlotte. The storage yards would provide sufficient capacity for midday and overnight layovers of trains. The Raleigh facility would accommodate Raleigh–Charlotte passenger trains, while the Charlotte facility

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[25] Depending on the timing of corridor development, activities in other corridors, and the state of the rail passenger equipment industry at the time the Richmond–Charlotte Corridor is ready for service, —and subject to the approval of FRA's Office of Safety, —some of these steps could potentially be combined or omitted.

[26] See, for example, Federal Railroad Administration, *High-Speed Ground Transportation for America,* 1997 ("FRA 1997"), Chapter 7 and the Statistical Supplement, for comparative infrastructure and equipment costs in a number of hypothetical corridors. As this monograph goes to press, the FRA 1997 report is available at http://www.fra.dot.gov/Content3.asp?P=515 . For the Southeast Corridor, FRA 1997 projected that vehicles would account for 22 percent of the total initial investment; infrastructure, 77 percent; and ancillary items, one percent.

would deal with both Raleigh–Charlotte and Northeast Corridor–Charlotte equipment. Servicing and storage facilities for this equipment at Northeast Corridor points, as well as facilities for heavy repairs and overhauls, are outside the scope of this monograph.

Cost Estimates and Study Conclusions (Chapter 7)

The total cost[27] of the improvements contemplated in this study, **exclusive of items to be determined,** stands at about one billion dollars (see Table ES-3). The following sections point out noteworthy inclusions in, and exclusions from, this estimate.

Restoration of Abandoned S Line

The S Line restoration is treated as a single project that includes all requisite components of railway infrastructure. It also includes $6.9 million for Petersburg Station platforms and pedestrian access, for reasons explained in Chapter 7.

Real estate acquisition costs are uniformly omitted in this and all other line items.

Track Structure

The only separately-identified track structure improvement costs pertain to the active portions of the S Line, and to the H Line between Raleigh and Fetner. Otherwise, the track on the H and P Lines is assumed to remain in a state of good repair that was detected while this study was prepared. Track surfacing in preparation for high-speed operations is not included in the cost estimates for the H and P Lines.

Curve Realignments

Curve realignment costs include the provision of concrete ties and premium fasteners in curves over which trains will operate with unbalanced superelevations of between five and seven inches.

Track Layout Reconfigurations

The reconfiguration costs include associated signal and control system changes.

Stations

The costs shown are primarily for platforms and pedestrian access structures. Buildings are included only at two smaller sites (Henderson and Kannapolis), and at two completely new locations in the Charlotte area (I-485 and Charlotte Airport Station). The costs for all other buildings, and for all parking, motor vehicle, and transit access to the Corridor, are to be determined and are excluded from the totals.

[27] Costs are expressed in Year 2000 dollars.

Table ES-3: Summary of Cost Estimates for Projects Contemplated for the Richmond–Charlotte Corridor

Railway System Components	Cost Estimates (Millions of Dollars). Blanks mean: "Does not apply." "tbd" means: "Applies, but is to be determined." All totals are exclusive of items to be determined.										
	System-Wide Estimates		Site-Specific Estimates								
	Systemic	Site-Specific Estimated as a Group	S Line - Northerly Active Portion	S Line Abandoned Portion	S Line Southerly Active Portion	Raleigh	H Line	Greensboro	P Line	Charlotte	Corridor Total
RESTORATION OF ABANDONED S LINE				$317.6							$317.6
TRACK STRUCTURE			$10.0		$4.4		$4.7				$19.1
CURVE REALIGNMENTS:											
Curve Relocation Program		$33.7									$33.7
Curve Adjustment Program		$59.3									$59.3
Total CURVE REALIGNMENTS		$93.0									$93.0
TRACK LAYOUT RECONFIGURATIONS			$15.1		$54.7		$96.8		$136.5	$46.4	$349.5
SIGNALING AND TRAIN CONTROL	$58.9										$58.9
STATIONS:											
Operational portions (mainly platforms, pedestrian access)			$1.7		$2.9	$12.8	$5.3	$10.3	$13.0	$12.7	58.6
Buildings (See NOTE below.)			tbd	tbd	$0.6	tbd	tbd	tbd	$2.2	$6.1	$9.0
Parking and access improvements			tbd	tbd	tbd	tbd	tbd	tbd	tbd	tbd	tbd
Total STATIONS (See NOTE below.)			$1.7	tbd	$3.5	$12.8	$5.3	$10.3	$15.2	$18.8	$67.6
GRADE CROSSING IMPROVEMENTS		$37.8									$37.8
FENCING		$16.5									$16.5
EQUIPMENT (Locomotives, Cars, and/or Trainsets)	tbd										tbd
SUPPORT FACILITIES						$4.8				$6.1	$10.9
SYSTEM TOTALS (exclude items "to be determined")	$58.9	$147.3	$26.8	$317.6	$62.6	$17.6	$106.8	$10.3	$151.7	$71.3	$970.9

NOTE: Dollar estimates for station buildings cover only a small fraction of the locations in each corridor segment. Thus, **all** station totals are **partial** with the balance to be determined.

Study Conclusions

This study yields the following conclusions:

- Between Richmond and Charlotte, reliable intercity rail passenger service with a four-hour, twenty-five-minute travel time is feasible, should the Commonwealth of Virginia and the State of North Carolina choose to effect it;
- The cost for items included in the scope of the study amounts to about one billion dollars;
- Freight traffic in this corridor is very important; its free flow is vital to the regional and national economy. Commuter service could become substantial, as well, in limited segments of the Corridor. Thus, extensive capacity expansions would be required if an expedited intercity passenger service is to coexist reliably with other forms of rail transport;
- The Corridor—with its distinct S, H, and P Lines—exemplifies light, medium, and heavy-density railroad facilities and operations. As a result, this transportation planning monograph has applicability to a broad range of rail improvement projects across the country.

  The extensive investments necessary in the P Line as a prerequisite to high-speed corridor passenger service would, for instance, provide valuable information to planners who would likewise superimpose high-speed rail on other heavy-density freight routes. In such cases, where parallel route alternatives exist and lightly-used or abandoned rights-of-way are available, the total cost to upgrade the capacity of the heavy-duty freight line must be compared with the total cost to convert the lightly-used right-of-way for high-speed rail use. Until the site-specific conditions are evaluated, planners cannot know which of the alternatives offers the soundest value under the economic theory of railway location.

  In this case, however, there is no practical alternative to the P Line between Greensboro and Charlotte.

Acknowledgement

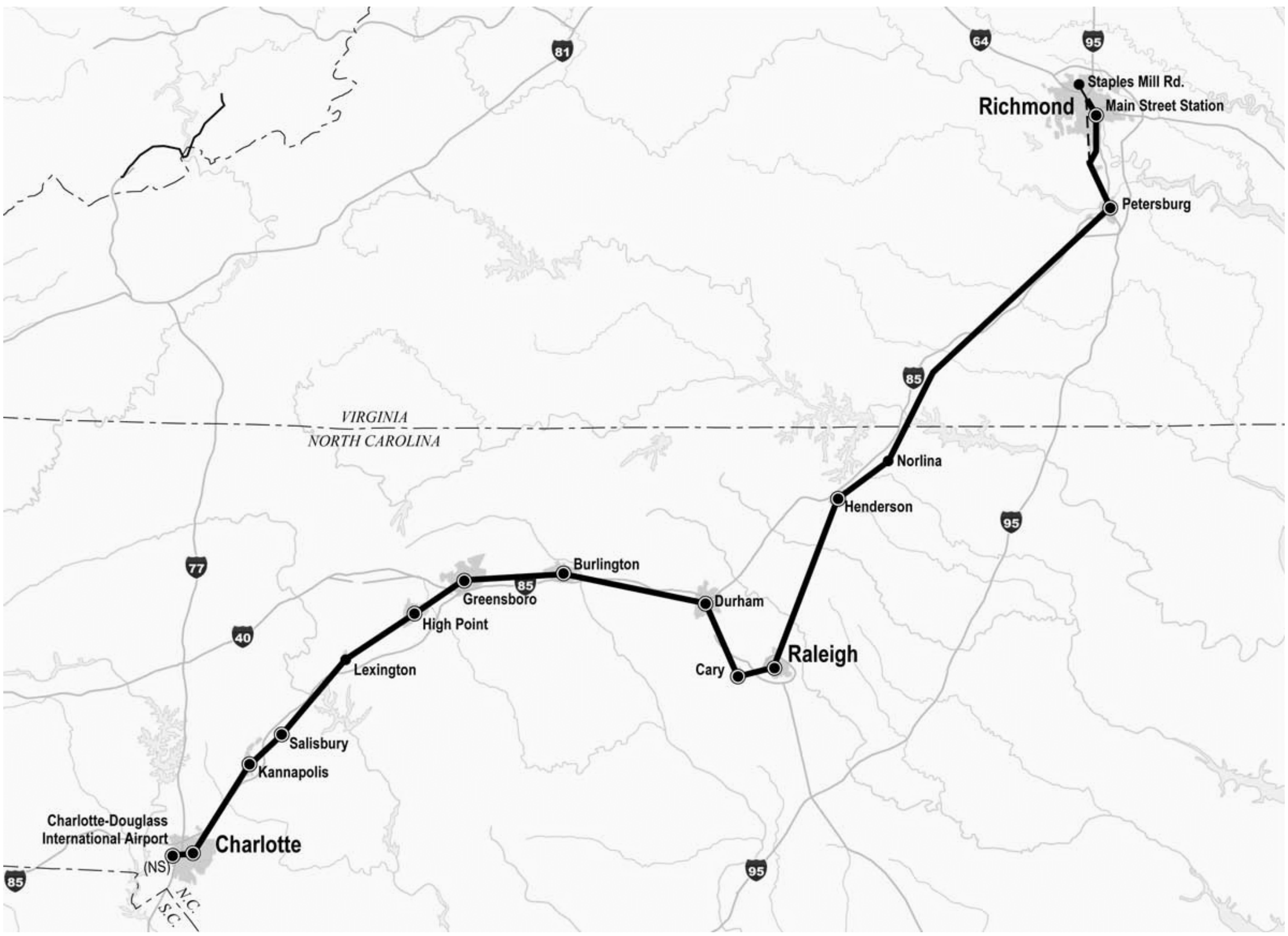
The transportation planning staff in the FRA's Office of Railroad Development acknowledges and values the work of its engineering contractor, the Parsons Transportation Group, in performing complex analyses underlying this study. Also appreciated is the participation of Amtrak, the North Carolina Department of Transportation, the Virginia Department of Rail and Public Transportation, the North Carolina Railroad, CSX Transportation, and local officials in the important communities served by the Richmond–Charlotte Corridor.

Figures in Executive Summary

Tables in Executive Summary

Technical Monograph: Transportation Planning for the Richmond–Charlotte Railroad Corridor

Main Report



Federal Railroad Administration

United States Department of Transportation

January 2004

Chapter 1
INTRODUCTION

Background

This technical monograph describes a set of potential long-term improvements to the designated[1] Richmond–Charlotte high-speed railroad passenger corridor, a 338-mile rail line extending from Main Street Station in Richmond, Virginia to Charlotte, North Carolina, and forming part of the designated Southeast Corridor.[2]

Expressing no opinion whatsoever on the desirability, prudence, or merit of the projects it describes, this technical monograph is not a policy document and simply imparts, to the States and the public, the results of engineering and operational analysis undertaken at public expense by the United States Government. Should the States choose to effect their rail travel time goals for this corridor, they will need to undertake a set of projects having similar effects on train performance capabilities as those enumerated here.

The monograph discusses the origin and purpose of the underlying studies; the corridor's current condition and usage; its intended transportation role in the 21st Century; the methodology for analyzing the corridor's investment requirements; and a set of improvements—both corridor-wide and site-specific—that would allow the Richmond–Charlotte Corridor to provide enhanced intercity passenger, freight, and, ultimately, commuter train services. The monograph analyzes the Richmond–Charlotte corridor in the context of the evolving needs of the freight railroad industry, Amtrak, the States of North Carolina and Virginia, and regional entities where appropriate.

The commercial feasibility report issued in 1997 by the Federal Railroad Administration (FRA), *High-Speed Ground Transportation for America,* identified the Southeast Corridor (of which the Richmond–Charlotte Corridor forms a part) as showing marked potential for the development of high-speed rail service through private/public partnerships. This pronounced "partnership potential" largely resulted from the assumption that net revenue increases on Amtrak's Northeast Corridor resulting from through high-speed rail traffic to and from Southeast Corridor points, would be creditable to the Southeast Corridor.[3] While leaving the details of any such partnership arrangements to the States, Amtrak, and other concerned parties, the 1997 FRA report heightened public awareness of the opportunities presented by rail passenger service south of Washington.

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[1] For an explanation of the term "designated," see the Supplement: Background Materials at the back of this volume under "Rail Corridor Designations ."

[2] Subsequent to the initial designation of Washington–Richmond–Charlotte as a high-speed rail corridor, the Southeast Corridor was extended to include South Carolina, Georgia, and Florida.

[3] See Chapter 8 of FRA, *High-Speed Ground Transportation for America,* Main Report, September 1997; referred to later in this monograph as "FRA 1997." The report is available on the World Wide Web at http://www.fra.dot.gov/Content3.asp?P=515 (Web site references are current as of October 2003.)

Meanwhile, as the logical continuation of a series of Congressionally-mandated transportation plans covering the Northeast Corridor and its extensions,[4] Amtrak and the North Carolina Department of Transportation (NCDOT) —supported by the FRA, and with the participation of the Virginia Department of Rail and Public Transportation (VDRPT)—began an evaluation of the requirements to create a rail passenger route connecting Richmond, Virginia and Raleigh, Greensboro, and Charlotte, North Carolina, while allowing for possible future extension of the corridor southward to Georgia. Such a Richmond–Charlotte route could require initiation of rail service on a path that has never provided continuous, Amtrak intercity passenger service. In fact, one potential route segment of the corridor—between Richmond and Raleigh, via Centralia and Petersburg, Virginia and Norlina and Henderson, North Carolina—has not had rail passenger service since the mid-1980s, and the Centralia–Norlina portion has had its railroad track and signal system removed since the late 1980s.

North Carolina and Virginia envision train service reliably linking Richmond (Main Street Station) and Charlotte, North Carolina (at a new station to be constructed in the vicinity of West 4th Street) in less than four hours and twenty-five minutes by 2020, with five intermediate stops.[5]

The 2020 service would include nine daily trains in each direction, as follows:

- New York–Washington–Richmond–Charlotte trains (four round trips); and
- Raleigh–Charlotte trains (five round trips).

On the assumption that a trip time of less than two hours is attained for the Richmond-Washington route, travel times between New York and Charlotte would be about 9.5 hours, while travel times between Washington and Charlotte would be slightly more than 6.5 hours.

Virtually all the intercity service between Washington and points south would operate over the Northeast Corridor to or from New York City or points north. In view of the projected levels of Northeast Corridor high-speed, conventional, and commuter trains, the intercity trains to and from the South must fit in certain operating windows at a number of "choke points" between New York and Washington, which would basically

[4] These Transportation Plans include those covering the New York–Boston and New York–Washington portions of the Northeast Corridor main line; the Washington–Richmond portion of the Southeast Corridor (see footnote 5 below); and the portion of the Keystone Corridor between Philadelphia and Harrisburg, Pennsylvania. The most recent Congressional mandates for Transportation Plans of this nature appeared in the 1996 Appropriations Act for the Department of Transportation and Related Agencies, and the Omnibus Consolidated Emergency Supplemental Appropriations Act for Fiscal Year 1999.

[5] Service between the restored Main Street Station in Richmond and Washington Union Station is projected to take less than two hours with three intermediate station stops. For further information, readers may consult the Washington–Richmond study report which will be available on the FRA web site, http://www.fra.dot.gov (Web site references are current as of October 2003.)

dictate their arrival and departure times at Washington. There would, therefore, be a need for integrated planning of the Northeast Corridor and service south of Washington.

The planning for the Richmond–Charlotte Corridor also identified several issues related to the feasibility of operating the projected number of—

- Norfolk Southern (NS) freight trains between Raleigh and Charlotte;
- CSX Transportation (CSXT) freight trains between Richmond and Cary, North Carolina;
- Regionally proposed commuter trains using Charlotte as a hub;
- Increased levels of intercity passenger service in Virginia serving Newport News and Bristol[6] through Main Street Station; and
- Amtrak service to Florida and Atlanta/New Orleans, which currently makes use of portions of the Richmond–Charlotte Corridor.

The ongoing studies also identified the need to coordinate use of the corridor between Raleigh and Durham with proposed Triangle Transit Authority (TTA) light-rail service that would construct its tracks within and alongside the right-of-way owned by the North Carolina Railroad (NCRR).

The study scope was confined to fixed facility improvements that would safely support intended train schedules, frequencies, and service reliability through the year 2020. "Service reliability"—that is, on-time performance for passenger and scheduled freight services, and the consistent, expeditious, and economic movement of other freight trains—is of utmost importance because without it, higher passenger train speeds and frequencies and restructured, modernized freight operations will not realize their potential for enhancing the marketability of rail services.

Other types of improvements, including some which would be prerequisite to the desired service and safety levels, did not undergo analysis for this monograph: for example, provision of locomotives and cars, grade crossing hazard reduction, and development of station parking and amenities. These categories of improvement would require careful attention in the more detailed planning and design that must precede any significant investment in the Corridor. With respect to grade crossings, the States have already made significant progress under existing programs.[7]

Purpose in Brief

This monograph aims at specifying, on a preliminary basis, the infrastructure improvements that would enable the Richmond–Charlotte Corridor to accommodate reliably the mix and volume of intercity passenger, commuter, and freight services that the line's operators and public partners foresee for the year 2020.

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[6] The Bristol service does not now exist, but is proposed.

[7] For particulars, see the respective web sites: for North Carolina, http://www.bytrain.org ; for Virginia, http://www.drpt.state.va.us/rail ; and for the Southeast Corridor, http://www.sehsr.org . (Web site references are current as of October 2003.)

Approach

The Richmond–Charlotte Corridor today experiences capacity shortfalls, particularly between Greensboro and Charlotte on the NS Piedmont Main Line between Washington and Atlanta.[8] Thus, a dependability challenge already affects the freight services and the few passenger trains that use the corridor. To establish the investment needs for **reliable** services, this study has adopted a 20-year planning horizon, which would allow sufficient time for high-speed and other improvements to be constructed and implemented in a logical sequence.

In view of the multiple uses of the Richmond–Charlotte Corridor, proper performance of the study necessitated a team effort, in which Amtrak, FRA, the Commonwealth of Virginia, the State of North Carolina, and some freight railroad right-of-way owners and operators (the North Carolina Railroad and CSXT) participated. Although invited to join the study effort, NS did not participate, with the result that all NS schedules and traffic projections had to be derived from other sources.

The study is based on the following comprehensive analytical approach:

- Assess current facilities, services and operating conditions on the route;
- Characterize service needs for the planning year 2020;
- Conduct operational analyses simulating the performance of future (year 2020) services over various configurations of infrastructure; and
- Identify the infrastructure investments that would allow the Corridor's operators to achieve their intended 2020 service quality and train volumes with satisfactory reliability.

The chapters that follow address each of these tasks in turn.

Important Note on the Environmental Process

Description and Status of the Process

All projects that use public funds must first examine potential environmental impacts as part of the public decision-making process. North Carolina and Virginia, with participation from the FRA and the Federal Highway Administration (FHWA), are working together on a two-part environmental study of the Southeast Corridor that evaluates all the potential impacts along possible routes. The first study phase—referred to as the Tier I Environmental Impact Statement (EIS)—takes a broad look at potential impacts along nine possible routes. The second study phase—Tier II—will include more specific analyses along one or more routes.

[8] Between Alexandria, Virginia, and Greensboro, North Carolina, the NS Washington–Atlanta main line follows a route lying to the west of the designated Southeast Corridor which is the subject of this monograph. Between Greensboro and Charlotte (and on to Atlanta), the designated Southeast Corridor and the NS main line are one and the same.

The Southeast Corridor High-Speed Rail project has recently completed the Tier I study phase. The Final EIS was made available on July 26, 2002, and the joint FRA/FHWA Record of Decision (ROD) was issued on October 18, 2002.[9]

In brief, the ROD selects the direct "S" line between Richmond and Raleigh, and the North Carolina Railroad ("H" and "P" lines[10]) between Raleigh, Durham, Greensboro, and Charlotte—modified with passenger connectivity to Winston-Salem—as the alternative that best meets the project's purpose and need while minimizing environmental impacts. The ROD also recommends that the route via the S, H, and P Lines be developed first and that the portion providing connectivity to Winston-Salem be developed in conjunction with the efforts of the Piedmont Authority for Regional Transportation, as appropriate. The Piedmont Authority for Regional Transportation is responsible for coordinating the regional transportation system in the counties around the Winston-Salem connection.

Following the ROD, Tier II environmental studies would evaluate details of track location, station arrangement and final design. The Tier II studies may take anywhere from a few months to several years to complete. Once completed, these documents would be used to acquire the permits needed for construction.

Relationship Between This Monograph and the Environmental Process

This study proceeded independently of, and simultaneously with, the preparation of the FEIS so that this monograph could achieve its purpose of describing the infrastructure improvements necessary to provide high-speed intercity passenger rail service between Richmond and Charlotte. To enhance the understanding of the potential costs and benefits of the project, the study was undertaken at the risk that all or portions of the route studied might not be selected in the environmental process. Certain assumptions had to be made regarding the location of the fixed plant to accomplish the study. The assumed location for this monograph largely coincides with that contained in the FEIS and ROD (the direct S Line between Richmond and Raleigh, and the North Carolina Railroad between Raleigh, Durham, Greensboro, and Charlotte), because this route has been the subject of numerous studies by the States of North Carolina and Virginia over recent years and because it presents favorable engineering and economic qualities. Unlike the environmental process, the provision of connectivity to Winston Salem, as specified in the FEIS and ROD, was not assumed for the present monograph and no facilities or costs for a Winston-Salem service were included. Adding connectivity to Winston-Salem may require alterations in the conceptual designs and costs of certain facilities[11] described in this monograph, over and above the investments required for a Winston-Salem connection *per se.*

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[9] The ROD is available on the Internet at: http://www.fra.dot.gov/Content3.asp?P=1197 (Web site references are correct as of October 2003.)

[10] See the Chapter 2 and following Chapters for a description of the lines in question.

[11] For example, the Greensboro station described in Chapter 6.

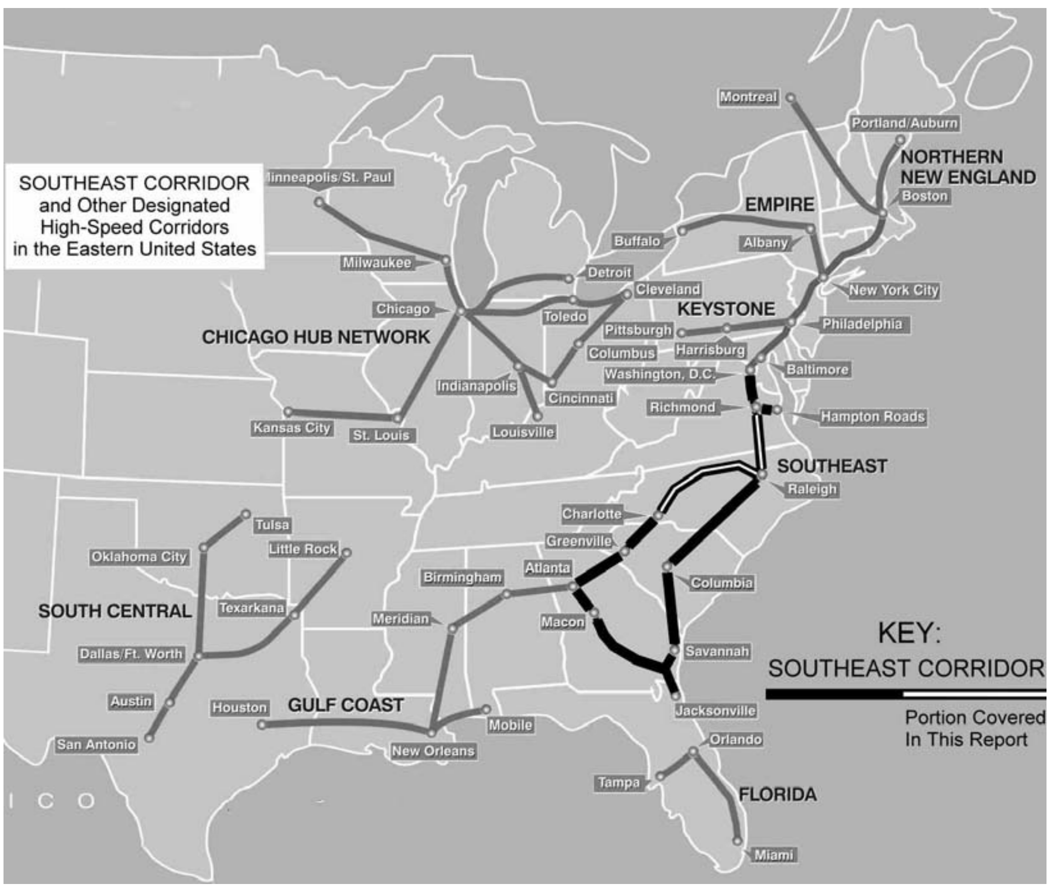
Chapter 2
THE CORRIDOR TODAY

Corridor Location, Population, and Marketing Factors

General Location

The designated Southeast Corridor[1] would link the Northeast Corridor, Washington, D.C., Richmond, Virginia, and Raleigh, North Carolina with Savannah, Georgia and Jacksonville, Florida, via two routes between Raleigh and Savannah: westerly, via Charlotte, North Carolina and Atlanta, Georgia; and easterly, via Columbia, South Carolina. (See Figure 2-1.) Further, the Gulf Coast Corridor is designated as linking Atlanta with Birmingham and points southwest.

Figure 2-1: The Southeast Corridor in Context



The portion of the Southeast Corridor under consideration in this monograph extends only between Richmond and Charlotte (Figure 2-2).

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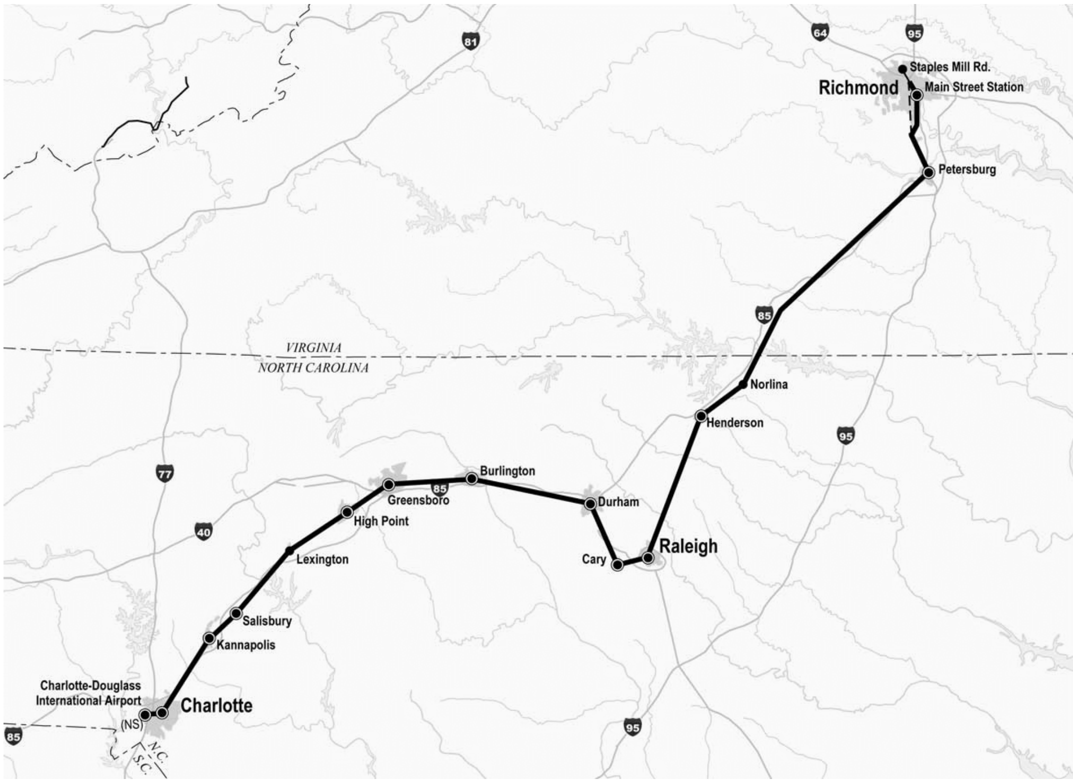
[1] FRA's definitions of corridors do not correspond to Amtrak's operating divisions. Amtrak includes the line from Washington to Richmond and Newport News within its Northeast Corridor operation. FRA includes them in the Southeast Corridor.

Figure 2-2: Southeast Corridor Portion Addressed in This Study (Assumed "S Line" Route is Shown)



Population and Marketing Factors

The Richmond–Charlotte Corridor proper houses some five million people, exclusive of the many millions in the neighboring Northeast Corridor and the 1.6 million in the nearby Hampton Roads area.[2] The Corridor, moreover, contains six major city-pairs, each with endpoints between one and 1.5 million in population, and all falling within or near the preferable distance bracket for high-speed rail—100 to 500 miles.[3] This population distribution (Figure 2-3) drives the projections of substantial travel demand in this corridor.

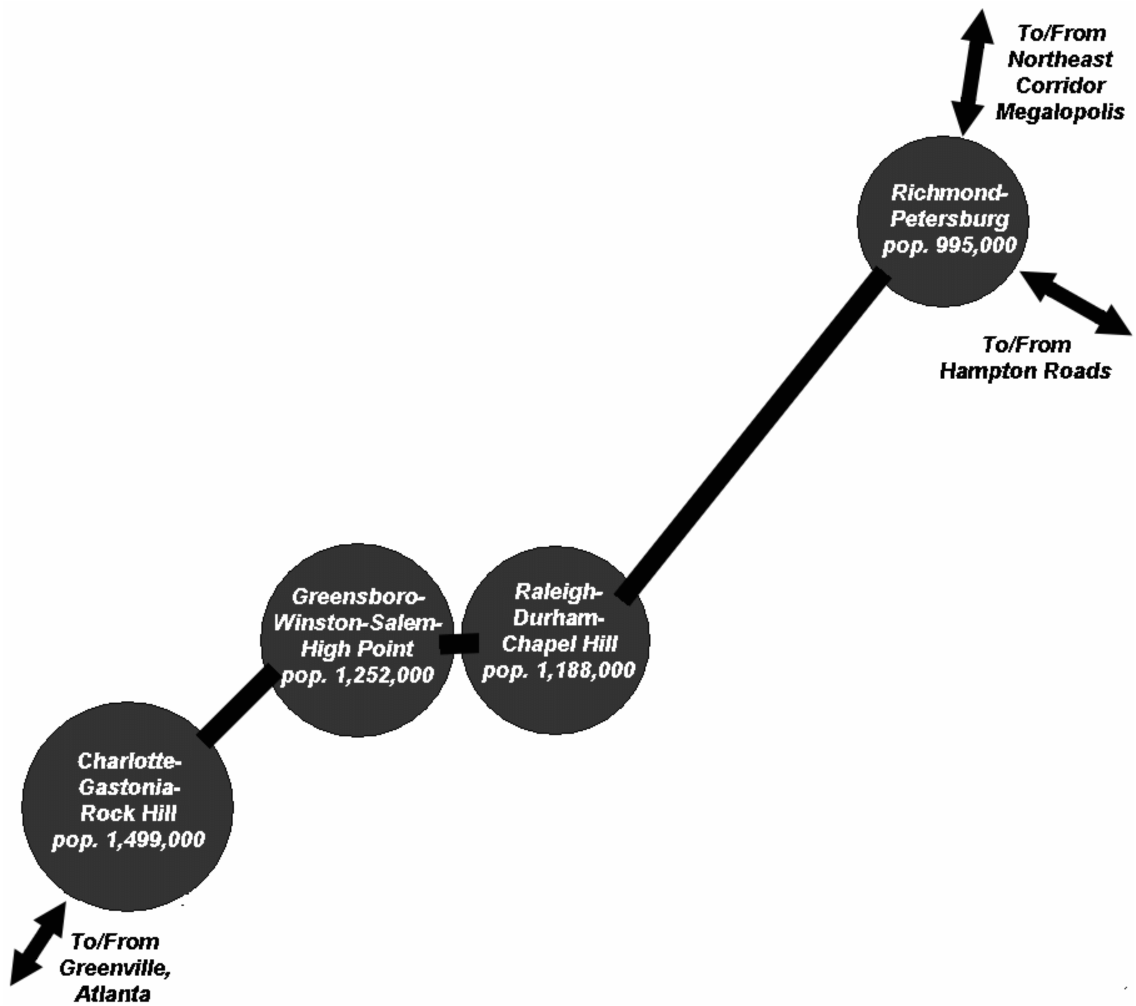
Table 2-1: City-Pair Markets and Mileages Within the Richmond–Charlotte Corridor

—AND / BETWEEN—	Raleigh–Durham–Chapel Hill, NC	Greensboro—Winston-Salem—High Point, NC	Charlotte–Gastonia– Rock Hill, NC-SC
Richmond-Petersburg, VA	158	238	332
Raleigh–Durham–Chapel Hill, NC		80	174
Greensboro—Winston-Salem—High Point, NC			94

[2] All population figures are for Metropolitan Statistical Areas and are from the *Statistical Abstract of the United States,* 2001.

[3] FRA 1997, page 2-1. Three of the six city-pairs are in the distance range of 150-250 miles, which is particularly favorable to incremental high-speed rail.

Figure 2-3: Spatial Distribution of Population in the Richmond–Charlotte Corridor



Fixed Plant

Assumed Route—Richmond and Raleigh

Figure 2-2 includes a number of working assumptions regarding the routing of the Richmond–Charlotte Corridor, both for the Centralia–Petersburg–Raleigh segment as detailed below,[4] and for other areas. For the status of the environmental process, which pertains to route selection among other topics, see the section in Chapter 1 of this monograph entitled "Important Note on the Environmental Process." Additional information, including current documents on the environmental process, can be obtained directly from the concerned States at http://www.sehsr.org .

Three major options exist for providing direct service between Richmond and Raleigh:

[4] For a detailed map of the Centralia–Petersburg–Raleigh segment, see Figure 6-3 on page 6-6.

- **Via "S Line":** The former Seaboard Air Line[5] (SAL) "S Line" via Centralia and Petersburg, Virginia, and Norlina and Henderson, North Carolina;
- **Via "A Line":** The former Atlantic Coast Line (ACL) "A Line" via Centralia and Petersburg, Virginia and Rocky Mount, Wilson, and Selma, North Carolina; and
- **Hybrid:** The A Line via Centralia and Petersburg; the former Burgess Cutoff from south of Collier Yard to Burgess, Virginia on the S Line; and the S Line via Norlina, and Henderson, North Carolina. Other "hybrid" routes are possible.

The S Line is assumed, for analytical purposes, to be the route between Richmond and Raleigh because—

- It is 35 miles shorter than the A Line;
- It would provide a significantly shorter trip time;
- It would optimize operating flexibility;
- Based on environmental studies to date, it would appear to require minimal environmental mitigation; and
- It would maximize the reliability and capacity of the intercity passenger and freight services proposed for the year 2020.

The A Line route option has the further disadvantages of:

- An alignment on the connecting link between Selma and Raleigh that has numerous sharp curves and steep grades; and
- Since it is the primary north-south CSXT freight corridor paralleling I-95:
  - Significant segments of double and triple-track would be required to accommodate the projected freight train, high-speed train service, and Amtrak Florida service[6];
  - A second A Line bridge over the Appomattox River would have to be constructed. Any such second A Line bridge would require a complex alignment modification at both ends of the structure and would have to be constructed sufficiently west of the existing bridge not to disturb its substructure. Instead, a single-track bridge for the S Line would be constructed approximately 1800 feet west of the existing A Line Bridge; and
  - Locations, such as Collier, south of Petersburg, would have numerous trains stopping to set off and pick up freight cars at major yards.

The former Burgess Cutoff "hybrid" route has the following disadvantages:

[5] In the 19th Century, the term "Air Line" was used in the name of a number of railroads to imply that their route was more direct than that of their competitors. The SAL was the last surviving major railroad to use this term in its corporate title; in the case of the Richmond–Raleigh route, the term "Air Line" was properly applied.

[6] Chapter 6, in its discussion of the Greensboro–Charlotte segment of the Corridor, describes the extensive investments (including double- and triple-tracking) required to reliably accommodate high-speed rail service on an existing heavily-trafficked freight line. Unlike the Richmond–Raleigh situation, no practical alternative route is available in the case of Greensboro–Charlotte.

- It is 5.9 miles longer than the S Line route;
- A second A Line bridge over the Appomattox River would have to be constructed; and
- Collier Yard, south of Petersburg, would have trains stopping to set off and pick up freight cars.

The S Line's operating advantages would be particularly apparent in the presence of the other improvements contemplated in this monograph.

Background

Two of the earliest rail lines in North Carolina and Virginia form the nucleus of the Richmond–Charlotte Corridor. The segment from Raleigh to Norlina was part of the Raleigh & Gaston, chartered in 1835 and completed in 1840, to gain access to Portsmouth, Virginia by connecting to another line near Roanoke Rapids, North Carolina. The North Carolina Railroad (NCRR) was incorporated in 1849 and construction began westward from Goldsboro. Together with the Atlantic & East Carolina, it formed a continuous route from the Atlantic Ocean, at Morehead City, to Charlotte, via Raleigh and Greensboro.

The Raleigh & Gaston Railroad became part of the SAL, which was a predecessor of today's CSXT rail system. The Richmond, Petersburg & Carolina Railroad was chartered in 1882 to connect Richmond and Petersburg with the Raleigh & Gaston at Ridgeway Junction, North Carolina, now known as Norlina. Construction did not begin until 1897, and reached completion in May 1900. Together, these two railroads formed the route from Richmond to Raleigh (the S Line).

The NCRR, which is still owned by the State, was leased in 1896 to the Southern Railway, a predecessor of today's Norfolk Southern, and was incorporated into the Southern's operations. Over the years it evolved differently east and west of Greensboro. To the west, it became part of the Southern's main line between Washington, DC and New Orleans, via Atlanta, Georgia, a relatively high-density freight route that once carried a significant number of intercity passenger trains. Owing to these heavy densities, the line south of Greensboro benefited over the years from a number of improvements, including line relocations and capacity expansions. Although double-tracked throughout by the mid-20th Century, the Greensboro-Charlotte route reverted in part to single-track status during that century's final decades as the operating freight railroad sought to maximize asset utilization and reduce maintenance expenses.

East of Greensboro, the NCRR remained a secondary main line under Southern Railway (now NS) operation. It received no automatic signal system or any significant improvements to the alignment. The single track still follows the landscape, much as it did when originally built.

Length and Ownership

The Richmond–Charlotte Corridor extends for 332 miles between Main Street Station, Richmond, and a relocated Charlotte Station. In addition, this study assumes a seven-mile extension from Charlotte south to the Charlotte Airport, for a total of 338 miles. The primary owners of the Corridor are CSXT and NCRR.

As a result of the divergent ownership and control, the study corridor is divided at Raleigh, currently and historically, into two separate segments, one operated by CSXT (the S Line), the other operated by NS.[7] In character and physical development, the NCRR is further divided at Greensboro between the main line route south to Charlotte (the P Line), and the secondary route east to Raleigh (the H Line). At Norlina, the CSXT portion is divided into a light-density local line south to Raleigh, and an abandoned right of way north to Centralia.

The current ownership and use of the abandoned portion of the S Line between Centralia and Norlina would influence the cost and timing of the contemplated improvements. As indicated in Appendix E, the line is not intact: anecdotal reports suggest that scattered segments of the S Line have been conveyed to various public and private entities. Determining precisely the status of the abandoned portion of the S Line would require intensive field work and title searches and, accordingly, was beyond the scope of this study.[8]

A summary of current track ownership by corridor segment is presented in Table 2-2.

Trackage and Track Conditions

Richmond (Main Street)–Centralia

The line, known as the Bellwood Subdivision of the S Line, has two tracks except for a single-track bridge over the James River, and a short singe-track segment in advance of Centralia Interlocking. CSXT, the owner/operator, has maintained the segment in a condition satisfactory for the current designated operating speed class. Passenger trains presently do not operate over the line.

[7] See below, at page 2-8 and footnote 12, for a discussion of the parallel NS and CSXT operation from Raleigh west to Fetner.

[8] This analysis did not attempt to include real estate acquisitions in the cost of the identified improvements; see Chapter 7.

Table 2-2: Track Ownership and Operating Control

Milepost[9]	Route-Miles	Locations	Owner and (Operator) if different	Dispatched From
S0.0 – S10.7	10.7	Main Street Station – Centralia	CSXT	Jacksonville, FL
S10.7 – S98.2	87.5	Centralia – Norlina	Abandoned. See discussion above.	Abandoned.
S98.2 – S157.4	59.2	Norlina – Raleigh	CSXT	Jacksonville, FL
H80.6 – H73.0	7.6	Raleigh – Fetner	NCRR (NS/CSXT)	Jacksonville, FL
H73.0 – H0.0	73.0	Fetner – Greensboro	NCRR (NS)	Greenville, SC
P283.9 – P375.4	91.5	Greensboro – Charlotte (A.T. & O. Jct.)	NCRR (NS)	Greenville, SC
P375.4 – P377.9	2.5	Charlotte (A.T. & O. Jct.) – Charlotte (W. 4th St.)	NS	Greenville, SC
P377.9 – P384.3	6.4	Charlotte (W. 4th St.) – Charlotte Airport	NS	Greenville, SC
Total Mileage	338.4			

Centralia–Norlina

This 88-mile single-track segment of the S Line has been abandoned and the tracks have been removed.[10] Most bridges remain. In the 1950s, when the line was active, short[11] passing sidings were located four to five miles apart at Lynch, Ryan, Burgess, Dinwiddie, De Witt, McKenney, Rawlings, Warfield, Alberta, Grandy, Skelton, La Crosse, Hagood, Bracey, Paschall, and Norlina.

Alternative routes from Centralia through Petersburg to Burgess have been devised using combinations of the old ACL and new passenger mains through downtown Petersburg with connections to the A and S lines west of Petersburg. The VDRPT's Richmond to South Hampton Roads High-Speed Rail Feasibility Study presently is evaluating these alternative routes because they could provide connections between Richmond, Petersburg, and Norfolk. Chapter 6 of this report describes these Petersburg options as they pertain to the Richmond–Charlotte Corridor.

Norlina–Raleigh

The remainder of the S Line between Norlina and Raleigh has been downgraded to a freight-only branch. The line is single-track with short sidings (at Greystone, Henderson, and Youngsville) to enable trains to pass each other and serve local industries. Previously,

[9] Three milepost numbering systems are in use on the assumed route of the Richmond–Charlotte corridor; these reflect the patchwork history and disparate ownership of the line:

Milepost numbers prefixed by—	—Refer to:
S	S Line, Main Street Station to Raleigh
H	North Carolina Railroad between Raleigh and Greensboro
P	North Carolina Railroad (operated as an NS main line), Greensboro–Charlotte

[10] As Chapter 4 states, this characterization of today's S Line reflects the limited on-site inspections that were possible within this study's scope. Fuller information on the S Line's current status would emerge as the engineering work becomes more detailed.

[11] The sidings generally were one to two miles in length.

the line was double-tracked between Neuse (S147.4) and Crabtree (S153.8), and additional sidings were located at Middleburg, Gill, Kittrell, Franklinton, Wake Forest, and Raleigh.

Raleigh–Greensboro

The NCRR owns the 81-mile line segment, termed the "H Line," between Raleigh and Greensboro. The eight-mile portion of the line between Raleigh and Cary (Fetner Interlocking) consists of two adjacent single-track lines used by NS and CSXT and dispatched by CSXT. [12] The CSXT-operated track crosses the NS-maintained track at Fetner Interlocking to access CSXT's Aberdeen Subdivision to Hamlet. The remainder of the line to Greensboro is single-track territory with passing sidings; its sole freight operator is NS.

The alignment has numerous sharp curves, steep grades, and grade crossings. The controlling grade is 1.16 percent, between mileposts H38 and H39. Train performance calculator (TPC) simulations suggest that freight trains ascending this grade could slow to as low as 11 mph. The line passes through numerous cities and small towns, Durham being the principal intermediate city.

Existing sidings are located at Durham, Funston, Efland, Mebane, and McLeansville. The sidings are short, normally less than two miles, and are accessed through hand-thrown switches, operated with permission from the dispatcher.

Lack of a signal system limits the existing maximum authorized speeds (MAS's) for Amtrak passenger trains to 59 mph and 49 mph for freight trains. There are numerous slow-speed areas as the result of curvature and grade crossings.

Greensboro–Charlotte

The Greensboro–Charlotte portion of the Southeast Corridor is the most critical section of the entire Corridor, from the viewpoint of traffic density and bottlenecks. Capacity improvements would be needed here if the States' goals—particularly the reliability goals—of intercity passenger trains and NS freight trains are to be effected.

The NCRR owns the NS's important Washington–Atlanta "Piedmont Main Line" from MP 283.9 in Greensboro to MP 375.4, at the north end of the present Charlotte Station. NS leases this portion of the line, and owns the line from MP 375.4 southward. The alignment is relatively straight; the curvature and gradient are not as sharp and steep as those of the H Line. Grade crossings are numerous. The line originally was double-tracked[13]; however, over one-third of the P Line has been single-tracked. The existing single-track segments, totaling 35 miles, are located between:

- Cox and Hoskins - 8.7 miles,
- Bowers and Lake – 4.2 miles,

[12] In September 2000, CSXT filed a Declaratory Judgment against the NCRR regarding a portion of the right-of-way between Raleigh and Cary, in which CSXT claimed to have a property ownership interest. In December 2001, the NCRR and CSXT resolved that dispute so as to acknowledge the NCRR's ownership of, and CSXT's right to use, the segment in question. Pertinent details appear in the NCRR's press release, in the Supplement at the end of this volume. (Source: http://www.ncrr.com/news/121001news.htm.)

[13] Segments of additional track and sidings were provided in the vicinity of yards and critical locations.

- Reed and North Kannapolis – 10.0 miles, and
- Haydock and Junker – 12.1 miles.

The single-track segments are accessed through power-operated switches controlled by the dispatcher.

Currently, the MAS for passenger trains is 79 mph (50 to 60 mph for freight trains, depending on type). There are numerous slow-speed areas as the result of curvature and grade crossings.

Signaling

The condition of the pole line on the CSXT Bellwood Subdivision between Centralia and Richmond is poor, and the entire 60-year old signal system needs upgrading. The signal system between Centralia and Edgeton, a crossing with NS in north Raleigh, was removed prior to the cessation of service north of Norlina. From Edgeton to Fetner, the CSXT Aberdeen Subdivision is signaled. The parallel NCRR between Boylan Ave and Fetner is controlled by CSXT signals. From Fetner up to and not including Greensboro, the H Line has no signals[14] except for grade crossing warning devices. The NCRR between Greensboro and Charlotte is signaled. The average age of the NS signal system between Greensboro and Charlotte is less than 30 years.[15] Cab signaling is not installed on any portion of the line.

Highway-Railroad Grade Crossings

Like most other corridors, the Richmond–Charlotte route houses a large number of public and private highway-rail grade crossings. Fortunately, the States involved have already begun to take noteworthy action overcome the attendant safety hazards.

Crossing Inventory

In total, there are 448 public and private crossings between Richmond and Charlotte; this count includes some 78 former public and private grade crossing sites on the currently-abandoned portion of the S Line.[16] The incidence of crossings by segment is summarized in Table 2-3.

At a minimum, all the public crossings are protected by crossbucks. Various combinations of flashing lights, gates, and ringing bells are installed at these crossings.

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[14] As this monograph went to press, the State of North Carolina and the NS were cooperatively upgrading the NCRR between Greensboro and Fetner with wayside signaling, Centralized Traffic Control, and siding improvements.

[15] Study of Signal and Train Control System Improvements, Washington, D.C. to Charlotte, N.C. High-Speed Corridor, DRPT #98-02, Thomas K. Dyer, Inc.

[16] If these former S line crossing sites are ignored, there are 296 public and 74 private crossings in service, for a total of 370.

Ongoing Crossing Safety Initiatives

Both North Carolina and Virginia are in the forefront of States actively addressing safety issues at highway-rail grade crossings.

The VDRPT has an ongoing program to identify crossings that can either be:

- Eliminated, through closure;
- Separated, through construction of a bridge or underpass; or
- Improved, through the installation of more extensive and more highly visible protection devices.

Table 2-3: Existing Highway-Rail Grade Crossings in Richmond–Charlotte Corridor

[**NOTE:** "Existing" includes former crossings on abandoned S Line, Centralia–Petersburg–Norlina]

Segment	Line	Miles	Number of Public Crossings	Public Crossings per Mile	Number of Private Crossings	Private Crossings per Mile	Total Crossings	Total Crossings per Mile
Richmond–Centralia	Active S	10.7	10	0.9	1	0.1	11	1.0
Centralia–Petersburg–Norlina[17]	Aban-doned S	87.5	58	0.7	20	0.2	78	0.9
Norlina–Raleigh	Active S	59.2	69	1.2	31	0.5	100	1.7
Raleigh– Greensboro	H	80.6	110	1.4	21	0.3	131	1.6
Greensboro–Charlotte[18]	P	100.4	107	1.1	21	0.2	128	1.3
Totals, Richmond–Charlotte Corridor[19]		338.4	354	1.0	94	0.3	448	1.3

Virginia has received about $4 million under Section 1010 of ISTEA for high-speed rail grade crossing improvements, and is eligible for additional funding under TEA 21 section 1103(c). Completed and planned grade crossing improvements north of Richmond to date include construction of a pedestrian bridge and new roadway bridge at Featherstone in Prince William County, and the provision of Constant Warning Time systems at crossings.

In a nationally-recognized program, the NCDOT Rail Division and NS began working together in 1994 to "seal"—or separate the vehicular and rail traffic on—the NCRR corridor between Raleigh, Greensboro and Charlotte. Aided by Federal funding under the ISTEA and TEA-21 specialized high-speed rail grade crossing programs and the Next Generation High-Speed Rail Program, this Sealed Corridor Initiative aims at improving or

[17] All inventories and projections for the now-abandoned portion of the S Line are based on limited field investigations of crossings that existed when the line was in service. With regard to private crossings: In total, 32 sites exist where private crossings once carried vehicular traffic; of these, the limited field investigations suggest that some three-fifths, or 20 sites, would be active today had the railroad remained in operation. All crossing conditions and needs would require detailed investigation, verification, and analysis should the States proceed with corridor development.

[18] Figures for "Greensboro-Charlotte" include Charlotte Airport.

[19] Includes crossings that formerly existed on the now-abandoned S Line

closing every crossing along the North Carolina portion of the Southeast Corridor, thus helping to ensure safe high speed operation along the line. NCDOT has developed a comprehensive strategy for treating the different types of crossings across the route, with creative solutions including four-quadrant gates, longer gate arms, inexpensive median barriers, and video enforcement. Video surveillance at specific unimproved and improved crossings has proven that advanced highway-rail crossing protection systems, such as four-quadrant gates and median barriers, reduce driver "run-around" violations by as much as 98 percent and thus significantly reduce the risk of train/auto collisions.[20] CSXT also is involved in a segment of the corridor between Raleigh and Cary.

The Sealed Corridor Initiative serves as a model for grade crossing hazard elimination. With its program of technology installation, testing, and assessment, the Initiative is a prime example of a cost-effective, comprehensive, corridor-wide grade crossing treatment. This experiment has provided useful information to the FRA, the FHWA, and the other States as they work to enhance grade crossing safety on other emerging corridors.

The Section 1103(c) program under the Transportation Efficiency Act for the 21st Century contains provisions for special Federal assistance for upgrading safety on highway-railroad crossings in designated high-speed rail corridors like the Southeast Corridor. Subject to the availability of funds, it is anticipated that the two States will continue their past use of that program (as well as other Federal-aid highway grade crossing funding programs and State, local, and other funding sources) to address crossing issues on this Corridor.

Stations

Amtrak, as the existing passenger service provider in the Corridor, and the States are normally responsible for the condition and level of service of the Corridor's stations. As passenger rail traffic declined after World War II, stations lost their perceived importance as links to the transportation system and by the 1960s many stations in North Carolina and Virginia were run down, closed, or had been demolished. In the 1990s, the North Carolina Department of Transportation and Amtrak began the *Carolinian* (Charlotte–Raleigh–Richmond–Washington–New York) and *Piedmont* (Charlotte–Raleigh) trains, dramatically boosting rail travel in the state. As passenger train travel grows in popularity, historic stations are being rehabilitated or new stations are being planned to provide better transportation and economic growth for communities.

Station siting, parking, intermodal connections, highway access, adequate station waiting and ticketing facilities, platform length and width, signage, and Americans With Disabilities Act (ADA) requirements are among the many considerations that require attention as part of the initiation of upgraded intercity passenger service. In particular, given the dispersion of the population within cities, suburbs, and rural areas, adequate access from

[20] For further details on this successful program, see http://www.bytrain.org/safety/sealed.html .

interstate and main highways and sufficient parking to support projected demands would be essential to encouraging increased use of the intercity rail network, should the States wish to do so.

Marketing considerations and evident local preferences dictated this study's assumptions regarding the provision of certain new and relocated station facilities. In most cases, as described in Chapters 5 and 6, this study did not deal with station buildings and parking needs, but focused on track rearrangements and accompanying passenger platforms and access. Consequently, programs to upgrade building facilities and parking to meet 2020 needs are generally omitted from this monograph.

Typical of railway station redevelopment programs around the country is the ongoing effort to re-institute rail passenger service into Main Street Station, Richmond. As part of this program, the station will become part of the Richmond Multi-modal Transportation Center (RMTC). Similar intermodal efforts to revitalize or relocate stations at other major points could become an integral part of development of the Richmond–Charlotte Corridor.

An inventory of station ownership appears in Table 2-3.

Table 2-4: Station Ownership and Use

[For existing stations, status is as of February 2001.]

Milepost[21]	Location	User	Owner		
			Land	**Station**	**Parking**
Existing Stations					
S0	Richmond - Main Street Station	Amtrak	City of Richmond		
S22.0	Petersburg (Ettrick)	Amtrak	CSXT (leased to Amtrak)		
H81.2	Raleigh	Amtrak	NCRR		
H72.7	Cary	Amtrak	City of Cary		City and NCRR
H54.8	Durham	Amtrak	NCRR	NCDOT	NCRR
H21.5	Burlington	Amtrak	NCRR	NCDOT	NCRR
P286.8	Greensboro	Amtrak	NCRR	NS	NCRR
P299.2	High Point	Amtrak	NCRR		
P333.3	Salisbury	Amtrak	Historic Salisbury Foundation, Inc.		
P348.9	Kannapolis	Amtrak	NCRR	Disputed	NCRR
P376.0	Charlotte	Amtrak	NS		

[21] Stations to be relocated will show different milepost numbers in Table 5-3.

Users and Services

The Richmond–Charlotte Corridor currently carries a variety of intercity passenger and freight services. No commuter services operate at present between Richmond and Charlotte (see Chapter 3 for possible future commuter operations). Current service levels for all rail traffic types appear in Table 2-5.

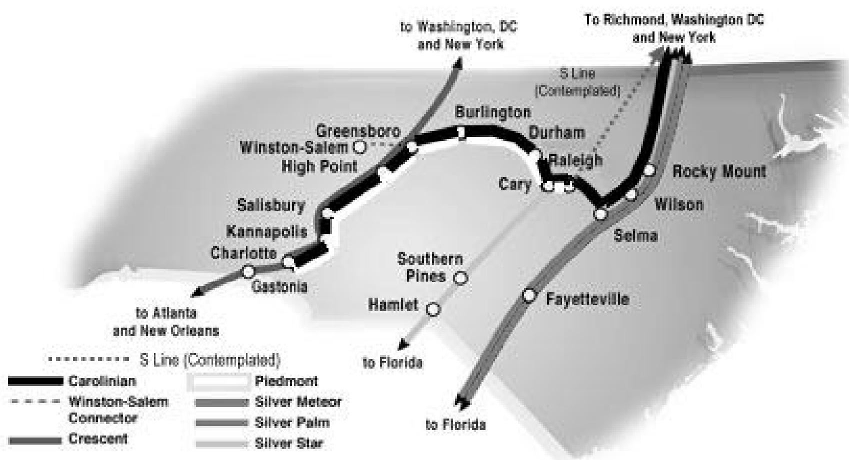
Intercity Rail Passenger Service

All intercity passenger trains in the Richmond–Charlotte Corridor are currently operated by Amtrak, either on its own account or through a contractual relationship with other sponsors. The relationships of the operator and sponsors to the track owners are established in operating agreements. The pertinent agreements are summarized in Appendix E.

Corridor Services

The State of North Carolina sponsors and financially supports two Amtrak-operated passenger trains serving the State:

Figure 2-4: Intercity Rail Passenger Service Through North Carolina[22]



- the *Piedmont* (shown as a white line in Figure 2-4), which operates a daily round trip between Raleigh and Charlotte; and
- the *Carolinian* (shown in black in Figure 2-4), which operates a daily round trip between New York and Charlotte.

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[22] Adopted from map provided by NCDOT Rail Division at its site Hhttp://www.bytrain.org/highspeed/H .

Table 2-5: Existing Railroad Services on the Richmond–Charlotte Corridor

Type of Service	**Number of Daily Train Movements Year 2001, by Segment** (Round Trips Count as Two Movements.) (Movements Under 10 Miles in Length are Omitted.)											
	Washington–Richmond (Note A)	Note	Richmond –Centralia (Note O)	Note	Centralia–Raleigh (Note M)	Note	Raleigh - Greensboro	Note	Greensboro - Spencer Yard	Note	Spencer Yard–Charlotte	Note
Intercity Passenger												
Corridor-type services												
Northeast Corridor–Charlotte	2		2		0		2		2		2	
Raleigh–Charlotte	0		0		0		2		2		2	
Other Virginia services	8	B	0	N	0		0		0		0	
Total, Corridor-type services	10		2		0		4		4		4	
Long-distance services												
Northeast Corridor–Florida (Note J)	6		6		0		0	J	0		0	
Northeast Corridor–Atlanta (Note D)	0	D	0		0		0		2	C	2	C
Lorton, Virginia–Florida AutoTrain	2		2		0		0		0		0	
Total, Long-distance services	8		8		0		0		2		2	
Total Intercity Passenger	**18**		**10**	O	**0**		**4**		**6**		**6**	
Commuter												
Virginia Railway Express	14	E	0		0		0		0		0	
Concord - Charlotte	0		0		0		0		0		0	F
Total, Commuter	**14**		**0**		**0**		**0**		**0**		**0**	
Freight												
Total freight services, CSXT and NS (Note G)	**24**	H	24	O	**4**	I	**8**	K	**26**		**24**	L
Total, Charlotte-Richmond Corridor	**56**		**34**		**4**		**12**	J, K	**32**		**30**	

Note A	Statistics for the Washington–Richmond segment are provided for information only, as that segment is not part of the focus of this monograph. Only trains that travel between Alexandria and Richmond are counted; trains that cover just the distance between Washington and Alexandria are omitted. For full particulars on all numbers in this column, see National Railroad Passenger Corporation, *Potential Improvements to the Washington–Richmond Railroad Corridor*, May 1999, page 15 and elsewhere.
Note B	These services include Northeast Corridor–Richmond and Northeast Corridor–Richmond–Newport News. They do not operate over the segments focused on in this monograph. The count excludes a proposed Bristol–Washington service, which would operate on the Southeast Corridor only between Washington and Alexandria.
Note C	The Atlanta–Washington–New York service operates via Lynchburg and Charlottesville, and makes use of Southeast Corridor only in the Washington–Alexandria and Greensboro–Charlotte–Atlanta segments.
Note D	Within the Washington–Richmond segment, these trains operate only between Washington and Alexandria and are therefore omitted from the count.
Note E	Number shown is for Alexandria–Richmond only. About double the volume makes use of the Washington–Alexandria segment. (See the source listed in Note A.)
Note F	Operates between Charlotte and Concord only.
Note G	Includes through freight trains, locals, and coal trains.
Note H	Number shown is for Alexandria–Richmond only. Slightly more freight volume occurs between Washington and Alexandria due to NS traffic. (See the source listed in Note A.)
Note I	These are local freight trains that operate between Norlina or Wake Forest and Raleigh
Note J	In addition, the *Silver Star* (Train 91/92) operates 8.4 miles between Raleigh and Fetner in the Raleigh–Greensboro segment. Because of the short distance involved, the *Silver Star* is omitted from the count for that segment.
Note K	In addition, 4 CSX freight trains operate between Raleigh and Fetner; these are omitted from the count due to the short distance involved (8.4 miles). Eight NS freight trains operate between Fetner and Greensboro.
Note L	An additional ten Asheville Line trains per day enter or leave the corridor at Salisbury
Note M	This route is currently abandoned between Centralia and Norlina.
Note N	These services either terminate at Staples Mill Road, or pass through the Main Street Station site on their way southeast to Newport News. None of these services makes use of the A Line from Staples Mill Road to Centralia.
Note O	Includes only those passenger services that operate between Staples Mill Road and Centralia on the A Line. Includes all freight services, via both the A and S Lines. Because of the assumed future change in routing, these figures are not comparable with the analogous figures in Table 3-1.

The *Carolinian* currently makes use of the A Line from Richmond to Selma, then diverts west to Raleigh, where it follows the assumed Southeast Corridor route to Greensboro and Charlotte. The Piedmont follows the same path between Raleigh and points west and south. Schedules for these two services appear in Figure 2-5.

Long-Distance Services

Also making use of a segment of the study corridor (between Greensboro and Charlotte) is the *Crescent.* Operating a daily round trip between New York and New Orleans, the *Crescent* cannot provide a corridor-type service in North Carolina as it crosses the State in the middle of the night in both directions.

Figure 2-5: Typical Amtrak Schedules in the Richmond–Charlotte Corridor[23]

NOTE: <u>For illustrative purposes only</u>. For current schedules, readers should contact Amtrak.

CAROLINIAN/PIEDMONT

New York • Washington • Raleigh • Greensboro • Charlotte

Piedmont	Carolinian	◄ Train Name ►					Carolinian	Piedmont
73	79	◄ Train Number ►					80	74
Daily	Daily	◄ Days of Operation ►					Daily	Daily
		◄ On Board Service ►						
Read Down		Mile	▼		Symbol	▲	Read Up	
	6 05A	0	Dp	New York, NY (ET) –Penn Sta.		Ar	9 55P	
	R 6 24A	10		Newark, NJ–Penn			D 9 30P	
	6 38A	25		Metropark, NJ			D 9 13P	
	7 03A	58		Trenton, NJ			8 52P	
	7 31A 7 43A	91	Ar Dp	Philadelphia, PA –30th St. Sta.		Dp Ar	8 22P 8 19P	
	8 06A	116		Wilmington, DE			7 58P	
	9 03A	185		Baltimore, MD–Penn			7 10P	
	9 17A	196		BWI Airport, MD			6 53P	
	9 33A	216		New Carrollton, MD			6 37P	
	9 50A 10 20A	225	Ar Dp	Washington, DC		Dp Ar	6 25P 5 55P	
	10 37A	234		Alexandria, VA			5 25P	
	11 09A	260		Quantico, VA	●		4 55P	
	11 27A	280		Fredericksburg, VA	●		4 35P	
	12 27P 12 37P	334	Ar Dp	Richmond, VA		Dp Ar	3 41P 3 31P	
	1 08P	362	Ar	Petersburg, VA		Dp	2 55P	
	2 39P	460	Dp	Rocky Mount, NC		Ar	1 30P	
	2 57P	476		Wilson, NC			1 11P	
	3 26P	502		Selma-Smithfield, NC	●		12 42P	
7 05A	4 12P 4 22P	531	Ar Dp	Raleigh, NC (see below)		Dp Ar	11 57A 11 49A	9 23P
7 18A	4 36P	540		Cary, NC	●		11 33A	8 55P
7 39A	5 03P	557		Durham, NC			11 08A	8 32P
8 23A	5 48P	591		Burlington, NC	●		10 20A	7 52P
8 58A	6 34P	615		Greensboro, NC Winston-Salem—see below			9 44A	7 18P
9 12A	6 48P	628		High Point, NC	●		9 24A	7 02P
9 49A	7 29P	662		Salisbury, NC	●		8 45A	6 26P
10 06A	7 46P	677		Kannapolis, NC	●		8 27A	6 08P
10 48A	8 21P	704	Ar	Charlotte, NC (ET)		Dp	8 00A	5 40P

Two daily Amtrak Florida round trip services—the *Silver Meteor* and the *Silver Palm*—serve Richmond (Staples Mill Road) and Petersburg, Virginia, and Rocky Mount, Wilson, Selma, and Fayetteville, North Carolina, all via the A Line. This is the easternmost north/south route in Figure 2-4.[24]

A third Amtrak Florida round trip, the *Silver Star*, currently takes the same A Line Route between Richmond (Staples Mill Road), Petersburg, Rocky Mount, Wilson, and Selma, then diverts westward over the H Line to Raleigh and Cary, thence southward via CSXT's active S Line to Hamlet, North Carolina, and Columbia, South Carolina.[25]

The Auto Train, a specialized service carrying passengers and their motor vehicles from northern Virginia to and from Florida, operates a daily round trip via the A Line through Richmond (Staples Mill Road) and Petersburg, but does not stop within the Corridor.[26]

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[23] From Amtrak's Spring/Summer 2001 Timetable, page 38.

[24] As described in Chapter 3, these A Line trains are assumed to continue their present routing into the future, except that in the Richmond/Petersburg area they would operate from Staples Mill Road through Main Street, thence via the S Line to Centralia, where they would resume their current A Line routing.

[25] See Chapter 3: in the future, the Silver Star is projected to operate via Main Street Station, Richmond, thence the S Line via Centralia, Norlina, Raleigh, Hamlet, and Columbia.

[26] See Chapter 3: in the future, the Auto Train is assumed to continue to operate, without passenger stops, on its present A Line routing due to clearance limitations at Main Street Station.

Freight

The level of freight service—including through freight trains, locals, and coal trains—varies by segment.[27] Over the Corridor taken as a whole, most freight trains provide general merchandise and intermodal service.

Richmond is a principal CSXT freight hub. On average, twenty-four daily CSXT freight movements operate on all routes between Richmond and Centralia.[28] The total represents a combination of:

- Freight trains that operate through Main Street Station to and from Centralia on the S Line (most of these are en route between the former Chesapeake & Ohio line via Charlottesville, and points on the former SAL and ACL south of Richmond);
- Local freight trains that provide service to industries adjacent to the S Line; and
- CSXT freight trains that operate between Acca Yard, north of Richmond, through Centralia, to Petersburg on the A Line, CSXT's main north-south freight route paralleling I-95.

On the surviving S Line segment between Norlina and Raleigh, CSXT operates four local freight train movements a day. Four CSXT freight movements also traverse the 8.4-mile NCRR segment between Raleigh and Fetner, where CSXT's Aberdeen subdivision diverges to the southwest, toward Hamlet, North Carolina and Columbia, South Carolina.

NS and CSXT maintain separate yard operations in Raleigh.[29] On the P Line, NS has yards at Greensboro ("Pomona"), north of Salisbury (Spencer Yard in Linwood), and Charlotte. NS, the primary user of the H Line, operates eight daily freight trains between Raleigh and either Pomona or Spencer Yard. NS also serves local shippers on the H Line and Piedmont Main Line.

Presently, approximately 31 NS freight movements per day operate on the busiest freight segment—the Piedmont Main Line between Greensboro and Charlotte.

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[27] Throughout this section, the count of freight trains is the average daily total number of runs operated regardless of direction. The number of nortbound movements plus the number of southbound movements yields the count. This is a realistic way of depicting freight activity, since it recognizes that directional imbalances are typical of freight movements. For comparability among services, the same counting method is applied across-the-board to all rail operations in the summary Table 2-5.

[28] The high level of traffic on the A Line through Centralia and Petersburg has, in part, driven the assumption that the S Line between Centralia, Petersburg, and Norlina would be restored for passenger service.

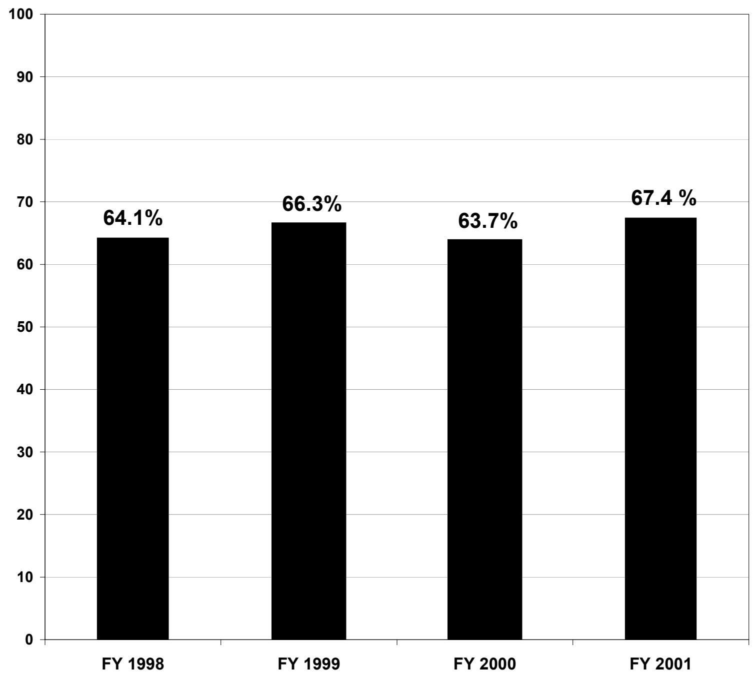
[29] NS's facility is called Glenwood Yard.

Existing Service Quality

At the time this analysis was completed, the maximum authorized speed for passenger trains in the corridor varied by location, as specified in the CSX and NS Employee Timetables, and peaked at 79 mph.[30]

Intercity passenger services in North Carolina, as well as NS freight operations between Greensboro and Charlotte, are incurring substantial delays on a regular basis. In particular, NCDOT intercity passenger train delays are substantial, with on-time performance over the past four years ranging between 60 and 70 percent (Figure 2-6).

Figure 2-6: On-Time Performance of *Carolinian* and *Piedmont*, 1998-2001[31]



These delays indicate that even now, with passenger traffic not fully developed, the Richmond–Charlotte Corridor presents some inherent challenges to reliable operations. Typical challenges include the following:

- The H Line between Cary and Greensboro lacks automatic block signals; their absence restricts passenger train speeds to 59 mph, by Federal law.

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[30] The State of North Carolina, in collaboration with the North Carolina Railroad and the NS, in mid-2002 announced service improvements resulting from its systematic program of investments in the North Carolina portions of the Corridor. These improvements, involving higher train speed limits, are described in an article, "Train speeds to increase between Durham and Charlotte," reproduced in the "Supplement: Background Materials" at the end of this volume.

[31] These are Amtrak's fiscal years, ending on September 30 of the year named. Source: Amtrak on-time records.

Also, the train dispatcher utilizes a track warrant control system[32] to authorize train operations. The lack of any kind of traffic control system requires train service employees to stop trains and manually throw switches to enter and exit sidings, and results in a minimum of a 15-minute delay for each meet with another train.

- The Piedmont Main Line between Greensboro and Charlotte is double-tracked, except for four segments of single track.[33] The route is equipped with automatic block signals and has an MAS of 79 mph, which is the ceiling on MAS established by Federal law for territory without cab signaling. Freight trains currently use the main tracks at Pomona Yard (Greensboro) and Charlotte Yard to set off and pick up cars. These operations consume track capacity and result in conflicts with other trains. Northbound freights that are unable to leave the main line and enter the Pomona Yard facility are held on the single-track segment south of Cox Interlocking, further consuming capacity.

As a practical result of these challenges, conflicts between freight and intercity passenger operations are occurring every day, as expressed in Figure 2-6. As a result, the NCDOT (in cooperation with NCRR and NS) is implementing a short-term program to address some of the capacity and operating issues on this State-owned facility—for example, by installing some signaling and train control. The immediate result of this program is intended to be more reliable passenger operations with no degradation in freight service.[34]

For the long term, these freight and passenger capacity and service issues reinforce the need for a careful scrutiny of the line's capabilities, needs, and future traffic potentials, in light of evolving plans for high-speed passenger service. The balance of this report treats these issues at length.

Areas of Special Complexity

This study has identified five areas of special complexity in the Richmond–Charlotte Corridor:

- Richmond/Petersburg;
- Raleigh;
- Greensboro/Pomona Yard;

[32] A track warrant, issued by the train dispatcher, authorizes a train or engine to occupy the main track within designated limits.
[33] Details are on page 2-8.
[34] Further information on this short-term program appears in the Supplement: Background Materials at the end of this volume, under the heading "Service Improvements on North Carolina Portions of SEC."

- Salisbury/Spencer Yard; and
- Charlotte.

The physical and operational complexity of these regions stems largely from their status as junctions among important freight routes, some of which would also serve a heavy passenger traffic under this monograph's assumptions. Nor are "freight" and "passenger" movements, respectively, homogeneous: heavy coal trains, trains of empty cars returning to mining districts, merchandise trains, local pick-up and delivery runs, and intermodal freights have diverse track capacity requirements, performance capabilities, routings, and predictability characteristics, just as do the overnight, corridor, and commuter movements lumped together as "passenger" trains. Table 2-6 illustrates the variety of rail operations in the areas of special complexity. Particulars appear in Chapter 6, which explains the operating rationale for the various improvement projects contemplated in this monograph.

Table 2-6: Inventory of Operations in "Areas of Special Complexity"[35]

Area of Special Complexity	NS Freight			CSXT Freight			Intercity Passenger		Commuter[36]
	Main Line Freight	Additional Converging Lines	Yard Operations	Main Line Freight	Additional Converging Lines	Yard Operations	Corridor	Overnight	
Richmond	•	•		•	•	•	•	•	
Raleigh	•	•	•	•		•	•	•	
Greensboro	•	•	•				•	•	
Salisbury	•	•	•				•	•	•
Charlotte	•	•	•	•		•	•	•	•

[35] Only substantial yard operations are indicated.
[36] Projected service on the general system of railroads.

Figures in Chapter 2

Tables in Chapter 2

Chapter 3
SERVICE GOALS

All operators and sponsors—intercity passenger, commuter, and freight—intend the services on the Richmond–Charlotte Corridor in the planning year, 2020, to be more reliable than those operating on the Corridor at present; this study has adopted 90 percent on-time performance as a planning goal.[1] North Carolina and Virginia envision train service reliably linking Richmond (Main Street Station) and Charlotte (at a new station to be constructed in the vicinity of West 4th Street) in four hours and twenty-five minutes by 2020, with five intermediate stops.[2] The projected 2020 freight, passenger, and commuter schedules are contained in Appendix F, summarized in Table 3-1, and described below.

The simple number of daily trains envisioned in Table 3-1 for a typical 24-hour period does not adequately depict the potential congestion on the Corridor. Intercity passenger trains are concentrated into an 18- rather than a 24-hour day, since operations between midnight and 6:00 a.m. are minimal; commuter trains have even more pronounced peaks. Thus, to assess the potential for congestion requires analysis of the complex interactions of through freight, local freight, and passenger trains in single and double-track portions of the corridor over a typical day—indeed, over an entire typical week. Such an analysis was essential to this study and is described in Chapter 4.

Intercity Passenger

Corridor-Type Services

Studies prepared for the State of North Carolina project a significant demand for intercity rail travel on the Richmond–Charlotte Corridor by the year 2020 if high-speed rail service were to be implemented. FRA's Commercial Feasibility Study, *High-Speed Ground Transportation for America*, also projected a marked growth in intercity rail travel demand for the Richmond–Charlotte Corridor as part of a Washington–Richmond–Charlotte Southeast Corridor.[3] Both studies assumed through service between Charlotte, Richmond, Washington, and New York.

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[1] This would mean 90 percent of trains would arrive on or before their scheduled time, precisely. See Chapter 4.
[2] Service between the restored Main Street Station and Washington Union Station is projected to take less than two hours with three intermediate stations.
[3] FRA 1997, chapter 8. When that report was prepared, the Southeast Corridor had not been extended to Atlanta and other points south.

Table 3-1: Railroad Services Envisioned for 2020 in the Richmond–Charlotte Corridor

Type of Service	Number of Projected Daily Train Movements, Year 2020, by Segment (Round Trips Count as Two Movements.) (Movements Under 10 Miles in Length are Omitted.)											
	Washington–Richmond (Note A)	Note	Richmond (Main Street) – Centralia (Note M)	Note	Centralia–Raleigh	Note	Raleigh–Greensboro	Note	Greensboro –Spencer Yard	Note	Spencer Yard –Charlotte	Note
Intercity Passenger												
Corridor-type services												
Northeast Corridor–Charlotte	8		8		8		8		8		8	
Raleigh–Charlotte	0		0		0		10		10		10	
Other Virginia services	12	B	0		0		0		0		0	
Total, Corridor-type services	20		8		8		18		18		18	
Long-distance services												
Northeast Corridor–Florida (Note J)	8		8		2		0	J	0		0	
Northeast Corridor–Atlanta (Note D)	0	D	0		0		0		4	C	4	C
Lorton, Virginia–Florida AutoTrain	2		0	M	0		0		0		0	
Total, Long-distance services	10		8		2		0		4		4	
Total Intercity Passenger	**30**		**16**	M	**10**		**18**		**22**		**22**	
Commuter												
Virginia Railway Express	44	E	0		0		0		0		0	
Concord – Charlotte	0		0		0		0		0		22	F
Total, Commuter	**44**		**0**		**0**		**0**		**0**		**22**	
Freight												
Total freight services, CSXT and NS (Note G)	**32**	H	**10**	M, N	**14**	I	**8**	K	**34**		**32**	L
Grand Total, Charlotte-Richmond Corridor	**106**		**26**		**24**		**26**	J, K	**56**		**76**	C, F.

Note A Projections for the Washington–Richmond segment are provided for information only, as that segment is not part of the focus of this monograph. Only trains that travel between Alexandria and Richmond are counted; trains that cover just the distance between Washington and Alexandria are omitted. For full particulars on all numbers in this column, see National Railroad Passenger Corporation, *Potential Improvements to the Washington–Richmond Railroad Corridor*, May 1999, page 24 and elsewhere.

Note B These services include Northeast Corridor–Richmond and Northeast Corridor–Richmond–Newport News. They do not operate over the segments focused on in this monograph. The count excludes the proposed Bristol–Washington service, which would operate on the Southeast Corridor only between Washington and Alexandria.

Note C It is assumed that the Atlanta–Washington–New York service will continue to operate via Lynchburg and Charlottesville, and make use of Southeast Corridor only between Atlanta–Charlotte–Greensboro and Alexandria–Washington.

Note D Within the Washington–Richmond segment, these trains operate only between Alexandria and Washington and are thus omitted from the count.

Note E Number shown is for Alexandria–Richmond only. About double the volume is projected for Washington–Alexandria. (See the source listed in Note A.)

Note F Operates between Charlotte and Concord only.

Note G Includes through freight trains, locals, coal trains, and future growth projections

Note H Number shown is for Alexandria–Richmond only. Slightly more freight volume is projected between Washington and Alexandria due to NS traffic. (See the source listed in Note A.)

Note I Four of these are local freight trains that operate between Norlina and Raleigh

Note J In addition, the *Silver Star* (Train 91/92) is assumed to operate 8.4 miles between Raleigh and Fetner in the Raleigh–Greensboro segment. Because of the short distance involved, the *Silver Star* is omitted from the count for that segment.

Note K In addition, 14 CSX freight trains are projected to operate between Raleigh and Fetner; these are omitted from the count due to the short distance involved (8.4 miles). Only eight NS freight trains are projected to operate between Fetner and Greensboro.

Note L An additional ten Asheville Line trains per day enter or leave the corridor at Salisbury

Note M Includes only those passenger and freight services operating between Main Street Station and Centralia on the S Line. Because of the assumed change in routing, these figures are not comparable with the analogous figures in Table 2-5.

Note N These trains would operate only between the Main Street Station area and Centralia, en route between the CSXT Charlottesville–Gordonsville– Doswell–Richmond line and the A Line south of Centralia.

To satisfy this potential demand, most of which would relieve overburdened highways of intercity travelers, the 2020 service would include nine daily round trips,[4] as follows:

- New York–Richmond–Washington–Charlotte trains (four round trips); and
- Raleigh–Charlotte trains (five round trips).

If a trip time of less than two hours is attained for the Richmond-Washington route, travel time between New York and Charlotte would be about 9.5 hours, while travel times between Washington and Charlotte would be slightly more than 6.5 hours.

Southeast Corridor high-speed passenger train service[5] may someday continue on from Charlotte to Atlanta and beyond, should the States ultimately elect to pursue such an extension. The planning for improved Charlotte–Atlanta service remains in its formative stages[6]; therefore, no such service south of Charlotte was assumed or modeled in the present study. Because of the market potential of the various city-pairs involved, the distances and travel times attached to potential train operations, and the need to cycle equipment and crews for optimal utilization, Charlotte would likely serve as the terminus for a considerable share of corridor trains—in the directions of both Raleigh/Richmond/Washington and Atlanta—if the Atlanta extension comes to fruition.

Long-Distance Trains

At the time this analysis was completed,[7] Amtrak envisioned four daily Florida overnight trains in each direction by 2020, an increase of one over current schedules. For this study it was envisioned that three of the trains (the *Silver Meteor*, the *Silver Palm*, and the one new train) would operate between Richmond's Main Street Station and Centralia on the upgraded S Line, then use the CSXT A Line southward to Florida. The fourth train (the *Silver Star*) would operate via the S Line and Raleigh. However, the simulated schedules are subject to further refinement as work on the Southeast Corridor progresses, and as national policies toward intercity passenger rail service evolve; thus, train routings and timetables could ultimately vary from those assumed. The proposed alignment between Richmond and Raleigh, consisting of segments of single-track with relatively evenly spaced sidings, has been formulated to easily accommodate these potential modifications.

As this analysis was underway, Amtrak was also considering the addition of a second daily long distance train between Washington and Atlanta, in addition to the current Washington–New Orleans *Crescent* trains. This study assumed that any such additional

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[4] Note that the operations are expressed in Table 3-1 as "train movements," i.e., a daily round trip counts as two movements. This method of expression reflects the inherent directional imbalance in freight traffic, which cannot be accurately projected in terms of "round trips."

[5] As distinguished from conventional Amtrak long-distance trains, which already link Charlotte with points south and west, and are discussed below.

[6] Such a possible extension is part of the SEC designation, but is just now entering the feasibility study stage. For an update on that study, see the "Supplement: Background Materials" at the end of this volume, under "Funding for Planning an Extension of the SEC to Atlanta and Macon, Georgia."

[7] May 2001.

Washington–Atlanta trains would operate only between Greensboro and Charlotte on the Southeast Corridor, and that the prime advantage of Richmond–Charlotte Corridor development to long-distance passenger trains would be reliability enhancement in the portions of the corridor between Richmond and Centralia, and between Greensboro and Charlotte.[8]

Commuter Services

Within the Richmond–Charlotte Corridor, the most active planning for future commuter rail services has taken place in Raleigh and Charlotte. Some of these plans are incorporated in the operational simulations underlying this monograph.

Raleigh

As a result of several years of planning, the Triangle Transit Authority (TTA) and the Triangle Region's two Metropolitan Planning Organizations have adopted the Regional Transit Plan, which includes Regional Rail service and expanded bus service, shuttles, park and ride facilities, and enhanced pedestrian and bicycle access to transit. The plan[9] is divided into several phases. The Regional Rail system, proposed to be operational by 2007, would use self-propelled, bi-directional, diesel rail cars using new, dedicated trackage within the existing railroad rights-of-way to connect Durham, Research Triangle Park, Morrisville, Cary, Raleigh and North Raleigh. This service is expected to carry about 44,000 daily riders by 2025. Connections to the RDU Airport and Chapel Hill are considered Phase II of the Plan. Because there are no existing rail corridors that directly link these areas to the Phase I line, the planning, design, and ultimate construction are more complex.

Since the Regional Rail system is presently envisioned by the local authorities as using its own tracks, and thus not normally interacting with the intercity passenger and freight railroad traffic, its operations are not included in the train schedules, operating simulations, or traffic summaries prepared for this monograph. Proper planning is required to assure the optimal coexistence of the proposed transit and high-speed rail systems. If the commuter rail plans for the Raleigh region should ever change so as to include shared usage of the same tracks by commuter, freight, and intercity passenger trains, then the schedules and facility configurations developed in this study for the Raleigh vicinity would require substantial modification.

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[8] With the Richmond–Charlotte improvements in place, there would be no physical impediment to operating a second Washington–Atlanta round trip via Richmond and Raleigh instead of Charlottesville and Lynchburg, should the intercity passenger operator elect to do so. Also, the *Silver Star* between Richmond and Raleigh on the S Line would enjoy improved reliability within that segment, and—potentially—a better overall timetable subject to the capabilities of its equipment consist and the ability of the intercity passenger rail operator and the CSXT to implement schedule improvements over the route as a whole.

[9] The description of the Raleigh transit plan in this monograph is provided for information only. Obviously, the Regional Rail proposal is subject to all requisite environmental and other public processes, including, for example, applicable reviews and approvals by FRA's Office of Safety.

Charlotte

The City of Charlotte projects that increasing commuter travel demand by 2020 will necessitate the initiation of commuter rail service between Concord and Charlotte on the Piedmont Main Line (approximately 25 miles). Additional new commuter services are also possible by 2020.[10] A study of the potential for commuter rail operations in the Charlotte-Concord corridor is underway. For analytical purposes, this monograph has assumed that by 2020 half-hourly peak service in morning southward between Concord and Charlotte (8 trains) and in the afternoon northward between Charlotte and Concord (8 trains) will be operated. Three morning and three evening reverse-direction nonrevenue trains also were assumed, to lessen equipment needs. This schedule, then, would include 22 daily commuter train movements.

Although the possibility of turning trains at the Charlotte Airport instead of in downtown Charlotte was recognized, it was not implemented in the working timetables in Appendix F. Layover facilities in Charlotte for day storage of commuter trains were not identified in this study; overnight storage facilities in the vicinity of Adams Interlocking, just north of Concord, were assumed but not incorporated in the design. All these matters will require careful analysis and resolution prior to the implementation of commuter service in this sector.

Freight

Characteristics of Freight Service

Freight operations are much more variable than passenger services, in terms of arrival and departure times, train size, train performance, and frequency in a given period of time. Freight trains vary significantly in their performance capabilities and their compatibility with passenger trains: for example, unit trains of coal and grain generally have a lower horsepower-to-tonnage ratio than more time-sensitive operations. Thus, a general merchandise or intermodal train ordinarily takes less time to clear a given route segment than a unit coal train. Most freight trains operated on the Richmond–Charlotte route are general merchandise and intermodal trains.

Because almost all intercity passenger trains on the Richmond–Charlotte Corridor operate during daylight hours, the line would, in theory, offer more flexibility to freight operations late at night. In practice, however, the for-profit freight carriers have far-flung operations of which the Richmond–Charlotte Corridor constitutes but one segment. Customer demands, scheduling requirements, and operating constraints elsewhere on their extremely large and complex networks have led the freight railroads to operate their trains in the Richmond–Charlotte traffic lanes throughout the day. **Therefore, the need to provide service reliability for intercity passenger and freight trains alike, throughout the day, has governed the design and evaluation of the improvements contemplated in this monograph.**

[10] For example, as described in Chapter 6, the concept for the Charlotte Station allows for possible future commuter service between Charlotte and Monroe on the CSXT, and between Charlotte and the NS's Statesville line.

As explained below, the need to efficiently manage peak traffic would become even more critical in the future: not only would rail passenger ridership grow, but CSXT and NS levels of freight traffic also are projected to increase. In fact, the I-95 and I-81 freight corridors, which parallel the Northeast Corridor and Southeast Corridor, have been identified as key growth lanes for the two freight companies.

Projected Service Levels

This study used existing levels of freight service, augmented by changes projected by CSXT and forecast by FRA for NS. The Operating Plan contained in the joint application to the STB, in June 1997, for the Conrail Acquisition served as an additional source of information to validate the freight service assumptions. In addition, CSX provided information on planned operations between Raleigh and Richmond as the result of the restoration of the S Line.

On the segment with the highest level of train movements, the P Line between Greensboro and Charlotte, approximately 33 daily freight train movements (total of both directions) were simulated—a one-third increase over today's levels, as depicted in Table 2-4. Increases in intermodal trains, which have higher horsepower-per-ton locomotive assignments and achieve higher operating speeds than other freight operations, are expected to account for much of the expansion in freight traffic.

Tables in Chapter 3

Chapter 4: METHODOLOGY AND ANALYSIS OF OPERATIONS

This chapter presents the overall methodology of the study and describes in detail the underlying operations analysis. Unlike previous transportation plans in this series,[1] the present study envisions high-speed rail primarily on a single-track railroad, of which the operating characteristics will differ markedly from those of multiple-track routes. Since transportation planners in other regions of the United States may wish to consider analogous single-track alternatives for high-speed rail, this discussion could be of value well beyond the Richmond–Charlotte Corridor.

Methodology

Sources for this study included reports prepared by and for NCDOT and VDRPT, track diagrams, maps, equipment specifications, filings before the Surface Transportation Board (STB), and other engineering and ownership documentation. Limited field investigations took place to verify existing conditions. Also, the study team consulted with appropriate State, local, Amtrak, and freight railroad officials to assess the status of their respective plans, and to assemble a consensus list of possible projects that would assist all operators to meet their service goals. Extensive inputs, review, and comments were solicited from these agencies and railroads, and numerous meetings took place to discuss the effort and resolve differences. The work process is described in this chapter.

Work Performed by the States and Amtrak

Prior to the present study, the Rail Division of the NCDOT received funding from the FRA under Section 1036 of ISTEA to conduct master planning for high-speed rail passenger service from Raleigh to Charlotte and Raleigh to Richmond. NCDOT subsequently contracted with Amtrak to coordinate and complete an assessment of the corridor. That study includes an assessment of the existing conditions, capacities, and improvements needed. Technical Reports and a Final Report[2] were prepared and were extensively used in the performance of the analyses documented in this monograph.

VDRPT recently completed a study of signal and train control improvements for this corridor. The study identified short-term upgrades for the existing signal system and long-term recommendations as to the type of signal system that should ultimately be in place when plans for fast, frequent passenger rail service are fully implemented.

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[1] The transportation plans prepared for the Northeast, Keystone (Philadelphia–Harrisburg), and Washington–Richmond corridors all involve lines with two or more tracks.
[2] TranSystems Corporation for NCDOT and Amtrak.

Amtrak, on a continuing basis, has reviewed service options for the SEC as an extension of its service between New York and Washington. Amtrak personnel have actively participated in the studies performed by each of the States and have provided input and comments to this study.

Finally, NCDOT has prepared a Tier 1 Environmental Impact Statement (EIS) for the Southeast Corridor, which encompasses the Richmond–Charlotte segment described in this document.[3]

Data Collection And Organization

Development of this Richmond–Charlotte study included a limited review of the current[4] condition of the Corridor and its ability to safely and efficiently handle the existing levels of rail services operated by Amtrak, CSXT, and NS. The review included, but was not limited to, track conditions and configurations, roadbed and under-grade bridge conditions, signal and traffic control systems, passenger stations, and maintenance facilities.

Consultations took place with staff members of Amtrak, CSXT, NCRR, the City of Charlotte, NCDOT, and VDRPT who were involved with rail operations in the Corridor.[5] The objective was to obtain data on existing and projected 2020 train operations, to obtain information on presently planned improvements to the Corridor, and to review preliminary findings with railroad owners, operators, and public officials so as to resolve their concerns and needs prior to the preparation of this monograph.

Fixed plant location, design, and condition information came from recent railroad-supplied track charts, curve data, and track maintenance program descriptions; from maps and other available documents; from limited on-site-inspections; and from outputs of the FRA track geometry car.[6] From those sources a brief description of the condition of the existing Raleigh–Charlotte rail plant was developed (Chapter 2). Summaries of current and projected 2020 service levels for commuter, intercity passenger, and freight operations appear in Chapters 2 and 3.

A summary of track and station ownership, leases, operating and occupancy rights to the land, equipment, and fixtures was prepared.[7] It included an outline of the various operating agreements that pertain to both freight and passenger rail service between Charlotte and Richmond (Appendix E). This information resulted from contacts with entities having possible ownership or operating interest in Corridor right-of-way, stations, and air rights. Pertinent maps, drawings, agreements (e.g., trackage rights, maintenance,

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[3] For the current status of the EIS, see the section in Chapter 1 entitled "Important Note on the Environmental Process."
[4] As of 1999.
[5] The NS did not participate in the study, as mentioned in Chapter 1, and other sources were tapped to describe and project NS's operations.
[6] This car operates over portions of the Corridor in support of Amtrak intercity operations.
[7] North Carolina and Virginia are separately evaluating ownership of the abandoned portion of the "S" Line between Norlina, NC and Centralia, VA.

and operating), franchises, government permits, title documents, and other data relating to ownership and use of the right-of-way (inclusive of all fixed and moveable-span bridges), and stations were reviewed.

Initial Development Of Improvements

Draft documentation detailing a program of improvements in the Charlotte–Richmond Corridor was prepared and submitted to participating entities for review and comment. The proposed improvements aimed at upgrading the railroad facilities to handle the projected levels of intercity, commuter, and freight service safely and efficiently in 2020.

The study team compiled a list of potential Corridor improvement projects on the basis of prior reports, documents, and improvement programs; consultation with the owners and operators of the railroads, and with Federal, state, and local government agencies; and field investigations to verify existing conditions. Projected operating schedules for Corridor users over the next 20 years also were obtained and reviewed, so that a determination could be made whether the planned improvements would suffice to handle the projected traffic levels.

Specific projects that needed further analysis or conceptual development were identified, and additional information was gathered to enable recommendations to be developed. Projects that were reviewed primarily included proposals to:

- Upgrade and restore the track structure;
- Install new signaling and traffic control systems;
- Realign selected curves to increase operating speeds and reduce trip time[8];
- Reconfigure, eliminate, or install interlockings to improve operating flexibility;
- Install trackage to accommodate increased traffic levels; and
- Initiate station improvements.

Reports, plans, drawings, schematics, schedules, results of operational analyses, and budgets were reviewed to identify areas requiring follow-on investigations. Photographs and video also were used in the analytical process.

As each project that might affect rail operations was identified, a project data sheet was initiated. The data sheet information included, wherever possible: a description, location on the Corridor, and the rationale for the improvement.

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[8]Studies recently performed for NCDOT proposed maximum speeds for individual curves, as follows:

— Between Main Street Station, Richmond, and Centralia: 79 mph; and
— Between Centralia and Charlotte: 110 mph.

These speeds were used as initial speed goals, but were modified as necessary to reflect the iterative analysis process subsequently defined. The curve analysis was based on data taken from a variety of track chart sources between Main Street Station and Raleigh and data obtained from a recent FRA track geometry car run between Raleigh and Charlotte.

After the proposed projects were identified, evaluated and documented, before-and-after diagrams (track charts) were developed. These are included in Appendix D.

The preparation of the preliminary list of projects to meet program goals was a limited iterative process. The process resulted in a list of projects that would—

- meet intercity passenger rail service goals based on reduced running times and higher frequency of service;
- enable other services to coexist at their proposed levels without degradation; and
- accommodate projected or future growth or changing conditions, such as increased commuter and freight operations in the Corridor.

Scenarios to achieve the best integration of intercity, commuter, and freight rail services were prepared, based on operational constraints identified from analyses of the projected 2020 intercity, commuter, and freight volumes.

As necessary, alternative projects, beyond those initially proposed, that would enable attainment of the stated goals were developed, analyzed, and included.

Project Categories

Each proposed improvement was assigned to one of three major categories defining the basic purpose of the work: trip time-related projects, capacity-related projects, and "prerequisite and other" projects. While this categorization is useful analytically, the categories can overlap: some trip time-related projects would help to improve capacity, and some capacity-related projects would help to reduce trip times.

Trip Time-Related Projects

Projects generally contributing directly to lower trip times or permitting higher operating speeds, were included in this category:

- Curve realignments and construction of new line segments replacing existing track;
- Curve and spiral[9] modifications;
- Interlocking reconfigurations;
- Signal modifications for higher speeds; and
- Use of high performance trains.

Capacity-Related Projects

Projects providing additional railroad capacity to preserve attainment of the trip time goals while accommodating higher train frequencies were included in this category:

- Installation of additional tracks;
- Installation of higher-speed turnouts and crossovers;

[9] A spiral is a transition with gradually increasing curvature and superelevation between straight and curved track, designed to ease the dynamic forces of track/train interaction and to assure acceptable ride quality.

- Adding or reconfiguring interlockings; and
- Installation of additional signal speed commands.

Prerequisite and Other Projects

This category—consisting of projects without which a safe, reliable, accessible, and marketable passenger service could not function—would include such items as highway/railroad grade crossing improvements, right-of-way fencing, equipment support facilities, and stations. Many of these projects' benefits would extend to commuter and freight operations as well.

Preliminary Project Phasing

A detailed project schedule for constructing these projects was not developed. Instead, a preliminary phasing analysis was performed to identify project priorities and the relative interface of projects. The phasing of projects was determined once an agreed priority for projects and individual construction work items was established. This approach included an analysis of constraints associated with projects that would depend on track availability for construction. Phasing generally took into consideration logistics and procurement of materials and equipment, availability of resources, environmental approvals, real estate acquisitions, track availability, and funding availability.

Assessment of Projects

The trip-time and capacity benefits associated with individual projects were identified based on the operational analyses. Detailed environmental analysis was not performed; however, experience gained from studies of this nature was reviewed to ensure that recommended projects could reasonably be assumed to be implemented with a minimum of environmental disruption. These tentative findings are without prejudice to ongoing and subsequent environmental processes pertaining to the proposed operation.

Work to identify the potential changes in intercity ridership, revenues, and costs as the result of implementing the contemplated projects, and the proposed 2020 intercity rail service schedules, was not performed; much of the economic analysis has already taken place under the purview of the States and as part of the FRA's Commercial Feasibility Study of High-Speed Ground Transportation.[10]

Equipment Assumption

Both tilting and non-tilting equipment types were evaluated in the TPC model. The results indicated that the use of tilting equipment would optimize trip time while minimizing the number of curve relocations necessary to achieve trip time goals; the curve realignments were designed so as to enable the achievement of the trip-time goals with tilting equipment. Likewise, some of the simulations assumed the use of tilting equipment.

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[10] See FRA 1997, chapter 8.

Cost Estimates

The final steps in the planning process included the development of conceptual cost estimates and the categorization of the projects according to purpose and need.

Conceptual, order-of-magnitude estimates for each project identified and addressed in this study were developed in 2000 dollars.[11] Appropriate levels of contingency, reflecting the level of project development, were included.

Certain categories of investment were neither addressed in detail nor included in the cost estimates, but will inevitably form part of the total implementation package. They will thus require careful attention by the States, localities, the intercity rail passenger operator, and other project partners. These categories include but are not limited to:

- High-speed rail equipment acquisition (locomotives and cars, likely purchased together as "trainsets");
- Real estate, including right-of-way, acquisition where necessary (e.g., the S Line); and
- Station buildings,[12] parking, and access improvements.

Analysis Of Operations

This section summarizes the analysis and provides essential details.

Overview of the Analysis

The analysis compared the services as presently envisioned by the operators for 2020, with the fixed plant as configured today and as upgraded with various carefully ordered combinations of improvements. The analysis focused on two questions:

- Can individual trains meet their trip-time goals, irrespective of other traffic? and
- Can all the services operate in combination at intended speeds and schedules over the Corridor, while still meeting their reliability imperatives?

To answer the first question, the study team used a computer model known as a train performance calculator (TPC) to model the operation of a single train, with defined performance characteristics, over a traffic-free railroad with profile, alignment, and maximum speeds as specified for each segment. The TPC was applied to prototypical freight, intercity passenger, and commuter trains, to assess their optimal performance over the Corridor under different sets of conditions. The TPC runs were used to assess the

[11] These are presented in Table 7-1.
[12] Except in limited instances described in Chapters 5 and 7.

effectiveness of the proposed projects—taken together[13]—in enabling the various types of service to achieve their trip time goals.

However, the mere physical possibility of operating a given train over a given right-of-way at a given trip time offers no assurance that a combination of services can reliably operate on the Corridor.

Thus, to answer the second question above, the study team evaluated the capacity of the recommended system by performing a detailed manual and computerized operations simulations analysis, which assessed the reliability of the projected intercity, commuter, and freight services operating on the trackage between Richmond and Charlotte. The modeling technique utilized was the same sophisticated Monte Carlo™ model used on previous studies of the Northeast Corridor and the Washington–Richmond segment of the Southeast Corridor.[14] The model incorporated random variations in operating conditions and train performance to simulate the full spectrum of freight, intercity passenger, and commuter services projected for 2020 in the Richmond–Charlotte Corridor. These simulations assessed the impacts of changes in both schedules and fixed plant capabilities on all services operating simultaneously over a hypothetical seven-day test period. The operations simulation methodology and results are discussed in Appendix C.

The TPC's "minimum running time" represents the optimal physical performance of the equipment and its operator, with the train running unencumbered by other trains over a route. These conditions will not occur in day-to-day operation; therefore in creating schedules, upward adjustments must be made to the minimum TPC running time to reflect the factors that will inevitably reduce performance. In this context, "delay" may be defined as the difference between the minimum running time—as calculated by the TPC—and the "actual" running time—in this case, as simulated. The difference between the minimum running time and the scheduled trip time is known as "pad."

"Pad" is added to a TPC minimum running time to produce a schedule that can be operated reliably, repetitively, and with a high degree of confidence. The reliable schedule, containing schedule recovery time, will satisfy the expectations of:

- The passengers, who need to know when they will arrive at a given station, and
- The train operator, who needs to plan equipment cycles and service frequency.

Thus, in a given operation, if the delay incurred is less than or equal to the pad provided in the schedule, the train is on time; if the delay exceeds the pad, the train is late.[15]

[13] Each project was not separately evaluated.
[14] See Chapter 1 for more information on the Washington–Richmond study.
[15] Throughout this monograph, the terms "on time" and "late" are used in their exact sense, without allowances or thresholds of any kind; i.e., "on time" means on or before the "published" arrival time.

Since the assumed Richmond–Charlotte Corridor would be a new route for fast passenger trains, there is no historical performance data for rail service planners to draw upon for the contemplated high-speed service. Therefore, schedule design standards and the results of train operations simulations performed for the study were used to estimate how much "pad," recovery time, must be added to the minimum, optimal TPC running times to produce a reliable train schedule.

Taken together, the TPC runs and the detailed operating simulations permitted the study team to compare intended schedules, optimal running times, and expected performance for all services. The effects of alternative schedules and fixed plant capabilities were evaluated through numerous model runs. By these means the study team developed a preliminary list of potential projects and priorities that would meet the trip time and reliability goals of the study. Synthesizing the results of investigations to date, this monograph provides a resource on which the States can draw in their further planning, design, and partnership/financial development of the Richmond–Charlotte Corridor, in cooperation with all interested parties including the freight railroads.

Analysis of Train Interactions

Background: Signaling and Train Control

The Richmond–Charlotte Corridor makes use of a wide variety of signaling and train control systems. These systems are important because they largely determine the operational capabilities of the various line segments and constitute an important part of the contemplated improvement program. The following sections provide general background on the important topic of signaling and train control.

Non-Signaled Operation

In the early days of railroad operation in North America, trains were operated strictly by printed schedules in a "timetable" that established meeting points for opposing trains, or passing points for trains operating in the same direction. The operation was inflexible, and was supplemented by a system that utilized the telegraph, and later the telephone, to provide train crews with written instructions, known as train orders, instructing them to proceed or wait. The train orders enabled trains without timetable schedules to operate and train dispatchers to change meeting or passing points if trains were late, or delayed. In the late 20th Century train orders were replaced by a Track Warrant Control system, which utilized direct radio communications ("Direct Train Control") between dispatcher and train crew to provide authorization for a train to occupy a specified track segment to the next expected meeting point. Direct Train Control eliminated intermediate local "operators" at interlockings, thus reducing costs.

For a meet to occur, the crew of the train designated to take the siding stops, and manually aligns the switch for the siding. The train then proceeds to clear the main line and the crew manually closes the switch. The train remains in the siding until the opposing train passes[16] and the crew is authorized to re-enter the main track and proceed to the next planned meeting point. The Track Warrant Control system simplified and improved the efficiency of train dispatching, but did not increase the capacity of the single-track system. The H Line, between Fetner and Greensboro, was operated utilizing Track Warrants while this monograph was in preparation.

Block Signaling

Late in the 19th Century, a system of train control based on breaking the railroad into a series of "blocks" and "interlockings" was implemented. The train control system consisted of two types of signals, both of which were controlled manually by a block operator working under the instructions of the train dispatcher:

- Manual block signals, which indicated the presence of trains to other trains and thereby served to space trains; and
- Interlocking signals, which controlled the movement of trains through complex trackwork (turnouts, passing sidings, crossings, crossovers, junctions, or drawbridges).

The signals allowed only one train in a block at a time, to prevent rear-end (by a following train), side-on (by a merging train), and head-on (by a train in the opposite direction) collisions, and minimize the potential for human failures. The manual block signal systems increased the efficiency, speed, and capacity of a line to handle trains safely.

Over time, "manual block signals" in which a human operator sets signals were replaced by "automatic block signals" (ABS), which employ a series of consecutive blocks of track with signals actuated by the movement of the trains themselves. The presence of a train (which is detected by a "fail safe" electric track circuit in the rails) sets signals to instruct a following train not to enter the same block and creates a safe spacing of trains by slowing down closely following trains. Automatic block signals maintain a safe separation of trains running in the same direction and also keep trains running in opposite directions from entering the same block of track. They do this "automatically," based on the simple logic of the track circuits, without dispatcher or block operator intervention. Capacity is increased when signals are spaced so that a following train, or a train to be met at a siding, does not have to slow down to maintain a safe separation between trains or avoid a conflict with an opposing train.

Interlockings

Interlockings are locations where tracks branch away, cross over each other, or permit trains to change tracks. They are controlled by a local operator or by the train dispatcher and are programmed to "lock out" the occurrence of conflicting routes within the interlocking. Access to or from a siding in single-track ABS territory is controlled by interlockings at each end, that enable a train to diverge to an available side track, while

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[16] Or the opposing trains pass; there can be more than one.

ensuring that a following or opposing train has a clear route to proceed. All signals at interlockings are set to "Stop" unless they are cleared for a specific movement.

Centralized Traffic Control

Control of an interlocking, or series of interlockings, is "centralized" when the interlockings at a series of locations are controlled from a machine in the dispatcher's office, rather than by a block operator at each interlocking. The Centralized Traffic Control (CTC) system improves the efficiency of train operations on heavily traveled routes by eliminating the dispatcher's need to communicate with local operators to control train movements. CTC ensures the safety of operation and provides a level of flexibility that maximizes the capacity of a track network. Direct control over all the interlockings on a CTC line allows the dispatcher to control the movement of trains by changing their track assignments, using sidings, and applying priorities to trains' movements to minimize delays. Experience has shown that a single-track main line, with frequent sidings controlled by CTC, has about 70 percent of the traffic-handling capacity of a double-track line with ABS signals under normal operating conditions. However, the capacity of a single-track rail line can decline dramatically when a train failure occurs or the track must be shut down to enable track maintenance to be performed.

In the early 1940s, the then-heavily-trafficked S Line between Richmond and Raleigh was one of the first rail lines to have a CTC system installed. CTC enabled the dispatcher to plan moves based on lights on a large board indicating the location of all trains. The CTC and ABS systems were removed prior to the abandonment of the line between Centralia and Norlina. Train movements between Norlina and Raleigh reverted to being controlled by Direct Train Control.

Automatic Train Control and Continuous Cab Signals

While CTC remotely controls the signals and turnout settings, it relies on train operator alertness and compliance to ensure that the train's movement is in accordance with the signals. More sophisticated systems—currently in place on only a few lines in the country, such as the Northeast Corridor—are necessary to provide for improved control over train movements, to still further reduce the possibility of collisions. Such systems, mandatory for any operations over 79 mph, [17] provide for automatic enforcement of signal aspects if the operator should fail to do so for any reason. Accordingly, as described in Chapter 5, this study included continuous cab signaling[18]

[17] 49 CFR Part 236 states "Where any train is operated at a speed of 80 or more miles per hour, an automatic cab signal, automatic train stop or automatic train control system complying with the provisions of [the Railroad Safety Regulations] shall be installed."

[18] Cab signaling is "continuous" if it constantly displays the ruling signals in real time. (An older type of system, "intermittent" cab signals, only displays the ruling signals at specific locations—e.g., near the wayside signals—and, while representing a safety enhancement over wayside signals alone, offers only limited operational advantages.)

and automatic train control[19] in the contemplated program for the Richmond–Charlotte Corridor.

Operations in Single-Track Territory (Richmond–Greensboro)

Among high-speed corridors for which transportation plans of this type have been prepared, the Richmond–Charlotte railway is unique—not only in its innovative assumed routing, but in its use of some single-track segments that have never been upgraded for fast passenger service, and that are, in part, abandoned. This corridor, however, may establish a precedent for similar situations elsewhere in the Nation, where an existing freight and passenger corridor is either too indirect—or too burdened with traffic—to provide an economic solution for high-speed rail, while a parallel route—possibly abandoned or downgraded—may offer plenty of capacity. Therefore, the operating implications of the Richmond–Charlotte Corridor's special configuration merit exploration at some length in this monograph.

Single-Track Operations

The S Line between Petersburg, Virginia and Raleigh, North Carolina, and the H Line between Fetner and Greensboro, North Carolina, were constructed as single-track rail lines. Relatively evenly spaced, short sidings were provided to enable trains to meet or overtake other trains. The primary challenge of dispatching trains on a single-track line is to set up, at the appropriate sidings, "meets," in which trains moving in opposite directions can pass each other with minimal delay, and "overtakes," in which a train can be passed by a faster train moving in the same direction.

Facility Planning and Operational Analyses Considerations

Several critical issue regarding siding spacing and length, track capacity, and train dispatching require attention during the planning process, to assure sufficient operating flexibility and capacity to support reliable, efficient, and timely mixed freight and passenger operations. Issues related to single- and multi-track operations are discussed in this section. The constraints presented by operations in the vicinity of major yards and terminal facilities are discussed elsewhere in this document.

Length and Spacing of Sidings

The spacing of the sidings on a single-track system determines the capacity of the system and also the length of the delays when meets do occur.

Facility and operational analyses of the proposed Richmond–Charlotte high-speed passenger operations concluded that sidings necessary to support reliable freight and passenger operations should be 3.5 to 4 miles long and spaced approximately every 15 miles, center-to-center, i.e., the length of single-track between sidings should not exceed

[19] A system that automatically stops a train if a restrictive signal indication is ignored. It is not a system of automated train operation.

11 miles. Number 20 (45-mph) turnouts should be installed at the ends of each siding.[20] The size and spacing of the sidings would minimize delay to the train entering the siding[21] and increase the probability of meets that would allow it to continue out the other end, without stopping.

Types of Contemplated Meets and Overtakes

The simulations encompassed all types of interactions among intercity passenger, freight, and commuter trains. It was assumed that intercity passenger trains would have operational priority over all other service types, and that commuter trains would have precedence over freight trains; physical improvements were provided to assure that commuter and freight services would retain acceptable levels of reliability. Given the importance and high priority of the intercity passenger operations over the entire length of the corridor, interactions among such trains are a critical operational and design concern.

Meets Between Intercity Passenger Trains

The single-track S Line would be restored, and the mostly-single-track H Line would be upgraded, to facilitate high-speed passenger service. Thus, minimizing delays is a necessary and prominent consideration in planning the project. Simulations performed for this study, and modeling a full week's operations, indicated that each passenger train on the 157-mile segment between Richmond and Raleigh and on the busier 73-mile segment between Fetner and Greensboro[22] will participate in an average of 1.2 meets per segment per day.[23] Each time such a meet occurs, one passenger train would be required to slow down, enter a siding, and wait for the opposing passenger train to go past at full speed on the main track. The full-week simulation further indicated that, as a result of participation in these meets within the combined Richmond–Raleigh and Fetner–Greensboro single-track territories, a typical passenger train between Richmond

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[20] The installation of Number 32, 80-mph turnouts to increase capacity and minimize delays at a few locations is discussed on page 4-14. The higher the switch number, the smaller the diverging angle of the switch, and the faster a train may operate safely over the diverging route. Speed limits for diverging moves through various types of turnouts are shown in the following table:

Maximum Speed for Diverging Moves	Turnout/ Crossover Designation
15 mph	No. 10
30 mph	No. 15

Maximum Speed for Diverging Moves	Turnout/ Crossover Designation
45 mph (passenger)/ 40 mph (freight)	No. 20
80 mph	No. 32

Normally, speed limits for straight moves through crossovers and turnouts are the same as those for the adjoining track.

[21] See at page 4-14 for an explanation of the effects of siding length on main line fluidity.

[22] 9 pairs of high-speed trains would operate between Fetner and Greensboro, versus 4 pairs on the S Line north of Raleigh.

[23] I.e., a given train will be involved in 1.2 meets between Richmond and Raleigh, and 1.2 meets between Raleigh and Greensboro.

and Greensboro would incur an average of 9.5 minutes of total delay time in either direction.

To ensure the reliability of the passenger train operations, a maximum delay of ten minutes[24] to the diverting train in a meet between two passenger trains was posited as the worst-case scenario that would be tolerated. Accordingly, the design criterion for siding spacing was expressed in time rather than miles.[25] The spacing of sidings in terms of time serves to minimize delays, thereby optimizing utilization of the passenger train fleet, achieving a balance in facility and fleet investment requirements, and enhancing the marketability of the service.

Although the maximum speed on the S Line is proposed to be 110 mph, the numerous sharp curves and steep grades will reduce the average speed between station stops to approximately 90 mph. At 90 mph a train travels a mile in about two-thirds of a minute and will therefore—within the posited limit of ten minutes—travel 15 miles. Therefore, the maximum acceptable center-to-center siding spacing on the S Line is 15 miles. If the sidings are four miles long, the length of single track between siding switches should not exceed 11 miles.

Minimizing Delay Within the Four-Mile Siding

Placing an intermediate signal at the mid-point of the four-mile siding would enhance train operations into and through the siding. The signal displayed at the entrance to the siding would allow the train entering the siding to proceed at the maximum speed the interlocking turnout permitted. By arranging the signals in this way a long freight train would enter the siding at a maximum of 40 mph, and thereby clear the single track in the least possible time. The signal displayed at the middle of the siding would depend upon the status of the signal at the end of the siding.

The signal at the end of the siding would either:

- Display "stop" and the intermediate signal would require the train in the siding to begin braking and be prepared to stop at the signal at the leaving end of the siding[26] if the train in the opposing direction, the one being met, had not passed the turnout at the end of the siding and cleared the interlocking, or
- If the train being met had passed by and cleared the turnout at the end of the siding, a signal would be displayed permitting the train in the siding to

[24] This ten-minute duration is not comparable to the 9.5 minutes mentioned in the previous paragraph: The ten minutes is the maximum allowable delay (for siding spacing purposes) to the diverting train for any one meet, while the 9.5 minutes is the average total simulated delay due to meets for a typical passenger train running from Raleigh to Greensboro or vice-versa. For some meets, such a train will divert and lose time up to the maximum; for other meets, the same train will have priority and will keep to the main track with no loss of speed.
[25] In an operation where the train speeds are uniform, miles would be acceptable criteria.
[26] The distance between the intermediate signal and the stop signal must be sufficient to enable a freight train to stop.

proceed and exit the siding at 40 mph, the maximum speed[27] permitted through the turnout.[28]

When a train must take a siding it is best to move it off the main track as quickly as possible. Providing a sufficiently long siding with an intermediate signal would facilitate this. Without the intermediate signal, the train would enter the siding with an indication that it must prepare to stop at the next signal. This would cause the train to enter the siding at a significantly reduced speed, and take much longer to clear the main track. A short passenger train may actually accelerate before reaching the intermediate signal if the allowable siding speed is greater than 40 mph.

If the siding were too short, the intermediate signal could not be provided because there would be insufficient braking distance for a train to stop. The signal at the entering end of the siding would have to provide the safe braking distance and would display an "approach" signal, which would require the train to be prepared to stop at the next signal, until the other end is cleared for it to continue. The engineer of a long freight train may enter the siding at 40 mph but would immediately begin to brake so that the train would be stopped by the time it reached the leaving end of the siding. Therefore, the rear of the train could be crawling into the siding at a very slow speed, depending upon the siding length, and would continue to occupy the single main track for a longer-than-desired period of time. Thus, providing long sidings increases line capacity.

Realistically Locating and Spacing Sidings

Spacing every siding 15 miles center-to-center is often not possible. Major bridges, or clusters of road crossings, and curves may make it too expensive or operationally infeasible to place sidings at the ideal locations. When this occurs, a location should be sought that is free of curves and grade crossings, especially primary road crossings necessary for emergency vehicles.[29,30] Even then, such a location may not be found. This is another reason for having long sidings.

Siding With Number 20 vs. Number 32 Turnout

The following analysis explains the decision to plan for Number 20 instead of Number 32 turnouts at both ends of the passing sidings in single-track territory on the Richmond–Charlotte line.

Number 20 Turnouts (45 mph): A passenger train traveling at 100 mph entering a siding to meet another train would be delayed a **minimum** of five minutes due to:

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[27] See footnote 20 above for speed limits; this section pertains to freight trains and assumes No. 20 turnouts.

[28] The train would then proceed at 40 mph until the rear of the train clears the siding, at which time it could accelerate to the maximum authorized speed for the segment of main track.

[29] Major highway at-grade crossings that would be located on a passing track on which freight trains would be expected to remain for more than a few minutes should be grade separated. This will assure access by emergency vehicles.

[30] To avoid adversely delaying highway traffic, the engineer of a train traveling through sidings with crossings should maintain constant communication with the dispatcher so that the train's arrival and passage through the siding can be made with minimal impact on highway traffic.

- Decelerating to 45 mph upon receiving a signal in advance of the turnout;
- Moving through the siding at 45 mph (without stopping), and
- Accelerating back to 100 mph.

For passenger train "A" to be delayed only the minimal five minutes entering the siding, the opposing passenger train "B" can be no farther than three minutes (4 miles) from the end of the siding at the moment that train "A" receives its initial signal to slow down. Constituting a "nonstop meet," these maneuvers would require train movements so flawless in their timing and choreography as to be only infrequently attainable.

Number 32 Turnouts (80 mph): A passenger train traveling at 100 mph entering a siding to meet another train would be delayed a **minimum** of 1.5 minutes due to:

- Decelerating to 80 mph upon receiving a signal in advance of the turnout;
- Moving through the siding at 80 mph (without stopping), and
- Accelerating back to 100 mph.

For passenger train "A" to be delayed only the minimal 1.5 minutes as a result of taking the siding, the opposing passenger train "B" can be no farther than one minute (1.3 miles) from the end of the siding at the moment that train "A" receives its initial signal to slow down. These maneuvers would likewise constitute a nonstop meet.

Based on historical performance data it is highly likely that few, if any, trains would achieve a nonstop meet with Number 32 turnouts. If the siding spacing is fifteen miles, the opposing train "B" may be a fraction of a minute to as much as nine minutes away from the end of the siding being entered, at the time train "A" receives its signal to slow down. To the extent that train "B" is farther than 1.3 miles from the siding when train "A" starts decelerating, the installation of Number 32 rather than Number 20 turnouts will merely have resulted in Train A's coming to a stop more quickly at the end of the passing track and waiting longer for Train B, thus yielding minimal benefit in return for the additional cost.[31]

The most delay time that might be saved by installing a Number 32 turnout in place of a Number 20 turnout at the end of the four-mile sidings would range from zero (same as at 45 mph) to 3.5 minutes (5 minutes less 1.5 minutes). However, approximately three minutes is about the best that reasonably could be achieved. Therefore, the added cost for Number 32 turnouts would be difficult to justify if only one or two running meets occur at a siding each day. However, when the number of passenger meets is five or more per day at a siding the potential reduction in the amount of train delays might justify the cost.

[31] For trackwork alone, each No. 32 turnout would cost about 50 percent more than a No. 20 turnout (capital costs of $228,000 versus $152,000, respectively). Signaling costs would also be higher for No. 32 than for No. 20 turnouts due to extra machinery and longer interlockings.

Coordinating Siding Locations and Curve Relocations

If the ideal location of a siding coincides with the location of a curve relocation, either the curve relocation should be constructed first, or the siding and the curve relocation should be constructed at the same time. Constructing and then relocating the siding would be an unwarranted expense. Therefore, if adequate siding spacing can be maintained, sidings should be constructed, whenever possible, where no line change is likely.

Locations will be discussed in Chapter 6 where the installation of a siding could not be changed to avoid possible future relocations. In those instances, a choice was made between:

- Building a new main track and retaining the current main track in its existing location as the siding; or
- building a new siding concurrently with relocating the main track.

Freight Trains Meeting Freight Trains

A maximum delay criterion for a meet between two freight trains was not established. The decision as to which opposing freight train would enter a siding would be made while the trains are approaching[32] one of the two sidings that are separated by a segment of single track.

While the maximum speed on the S Line is expected to be 50 mph for general merchandise freight trains, the average speed may be approximately 40 mph because of the many curves and grades. At 40 mph it would take a freight train 25 minutes to travel 15 miles and clear the end of the siding that the opposing freight train is approaching. Twenty-five minutes would be the minimum delay. The average delay would be dependent upon the train consist, the condition of the locomotives, and the actual location of the freight trains when the determination to take the siding is made.

Local Freight Trains

Local freight trains must work the various industrial spurs between through-running trains. A non-signaled siding long enough to hold a local freight train alongside the main track, accessed from hand-operated switches, must be provided if sufficient time cannot be provided to enable local freight trains to switch industries by occupying the main track between through trains. Scheduling local freight trains to work in off-peak times when no or few through trains are operating could be unacceptable to the industries being served and was not assumed to be a viable option.

Freight Trains Overtaking Freight Trains

Typically, main line railroads handle a hierarchy of freight trains, listed below in descending order of precedence:

1. Intermodal freights (containers and trailers on flat cars);

[32] Or one train is located on the main track adjacent to one of the sidings.

2. Manifest freights (merchandise traffic of relatively high value, handled in boxcars and other non-intermodal equipment);
3. Mineral and grain unit trains (coal and other commodities); and
4. Local freights.

Because this hierarchy exists, railroads typically provide for maneuvers in which a lower-priority freight waits at a siding for a higher-priority freight to pass it. Thus, freight trains very often overtake other freight trains.

Simultaneous Meets and Overtakes

Depending on the capabilities of the facility and the length and priority of the trains, dispatchers can choreograph still more complex maneuvers than simple meets and overtakes involving just two trains at a time. By way of illustration (see Figure 4-1): where circumstances bring three trains together in opposing directions, and where the siding is long and has an intermediate crossover—

- Two northbound freight trains—(1) local, (2) intermodal—can be held in the siding;
- (3) A southbound passenger train can operate past the held freights;
- (4) The second—higher priority—freight can then overtake the local freight; and
- (5) the local can then proceed on its way north.

These maneuvers would constitute but one example of the simultaneous meets and overtakes—involving three or more trains of any type(s)—that traffic patterns, dispatching expertise, and track capabilities would make necessary and feasible. Appendix C contains an extensive discussion of procedures for dispatching single-track lines, as well as examples of complex maneuvers that would occur on an upgraded Richmond–Charlotte Corridor.

Operations in Double-Track Territory (Greensboro–Charlotte)

The largely double-track[33] Piedmont Main Line between Greensboro and Charlotte today carries a heavy freight volume, on which a marked increase in passenger traffic would be superimposed. On such a railway, a very large number of trains can be operated on two tracks when the speed of the trains is uniform: for example, commuter agencies can operate well over 100 trains per day on two tracks. However, when the speed of trains is not uniform, the transit time differentials, not the number of trains, create the need for "overtakes"—maneuvers in which a faster train passes a slower train.

Reverse signaling— allowing both tracks to carry traffic at maximum authorized speeds in both directions— certainly facilitates use of the second track, when necessary, to run around slower trains, maintenance work, local freight trains, or disabled trains. Nevertheless, where heavy and disparate traffic exists, reverse signaling may not suffice

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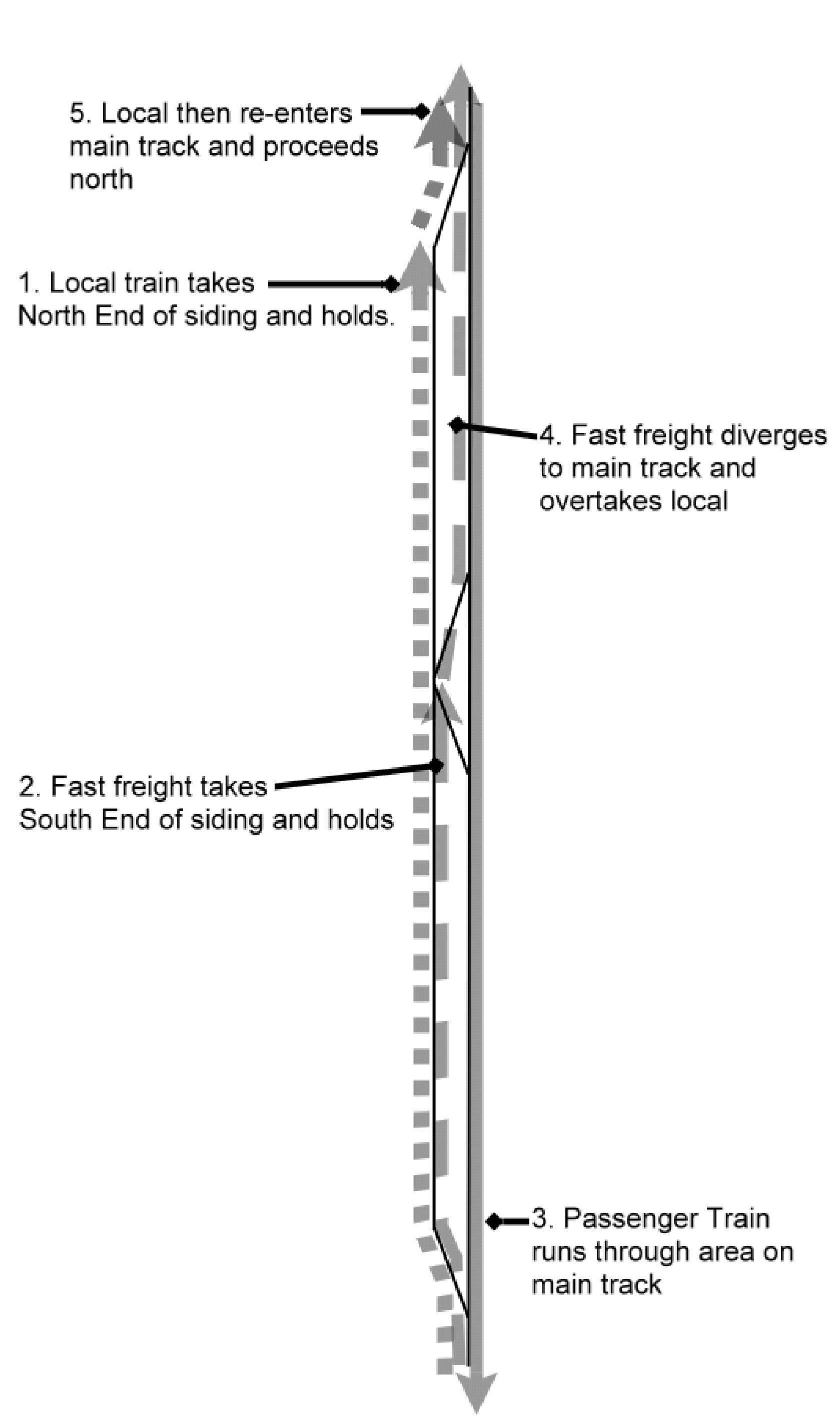
[33] As pointed out in Chapter 2, some two-fifths of the route-mileage in the Greensboro–Charlotte segment has been reduced from double to single track in recent decades.

Figure 4-1: Example of Three-Train Maneuver (Long Siding With Intermediate Crossover)



to prevent the great speed differentials among various types of trains from slowing the traffic flow, in some cases appreciably. This occurs when "windows" (gaps between trains on the other track) in the opposing traffic are too short to allow the faster train to run around the slower train between crossovers without stopping opposing traffic. The simulations between Greensboro and Charlotte project just such a situation.

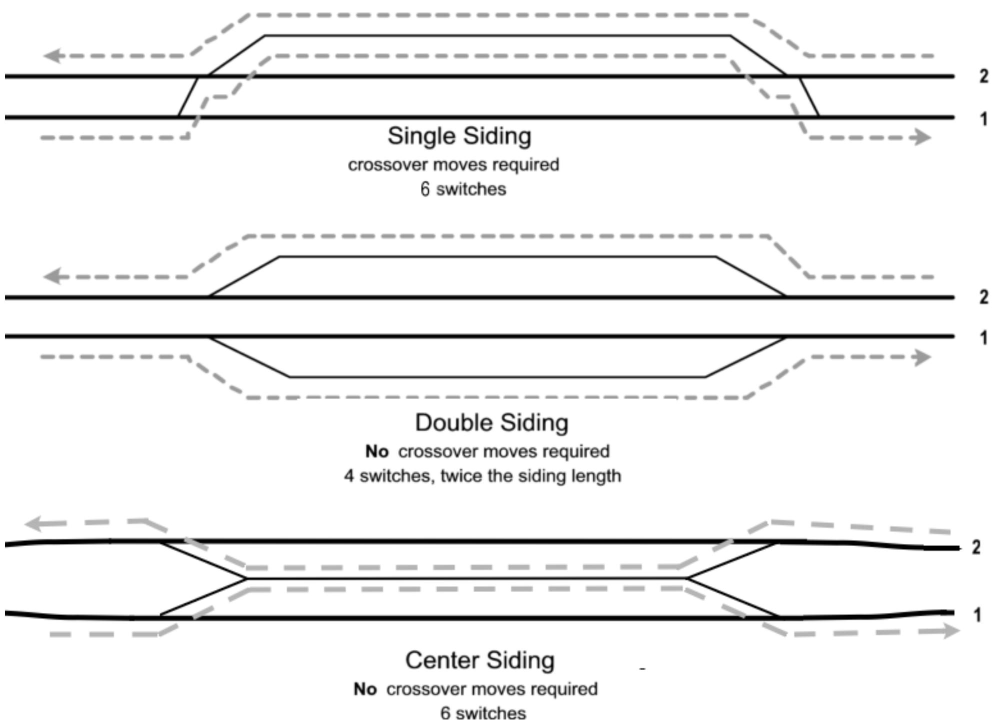
Consequently, the installation of additional tracks in certain areas will be essential. A continuous four-track, or even a three-track system, cannot be justified in this corridor, but in limited instances, a third track is justified.

Passing lanes are added to two-lane highways when traffic becomes heavy enough that faster vehicles can no longer use the opposing lane to overtake the slower vehicles. Similarly, railroads must add sidings or additional tracks at locations where traffic is heavy.

However, instead of directional sidings along each main track (see “single siding” and “double siding” in Figure 4-2), bi-directional center sidings (“center siding” in accompanying figure) between the two main tracks are recommended. Two sidings at a location, the double siding, intended to handle simultaneous overtakes, would be used infrequently. Therefore, four-mile center-sidings located between the two main tracks are proposed between Greensboro and Charlotte.

Figure 4-2: Siding Options in Double-Track Territory

(Dashed lines represent paths of trains diverting to siding.)



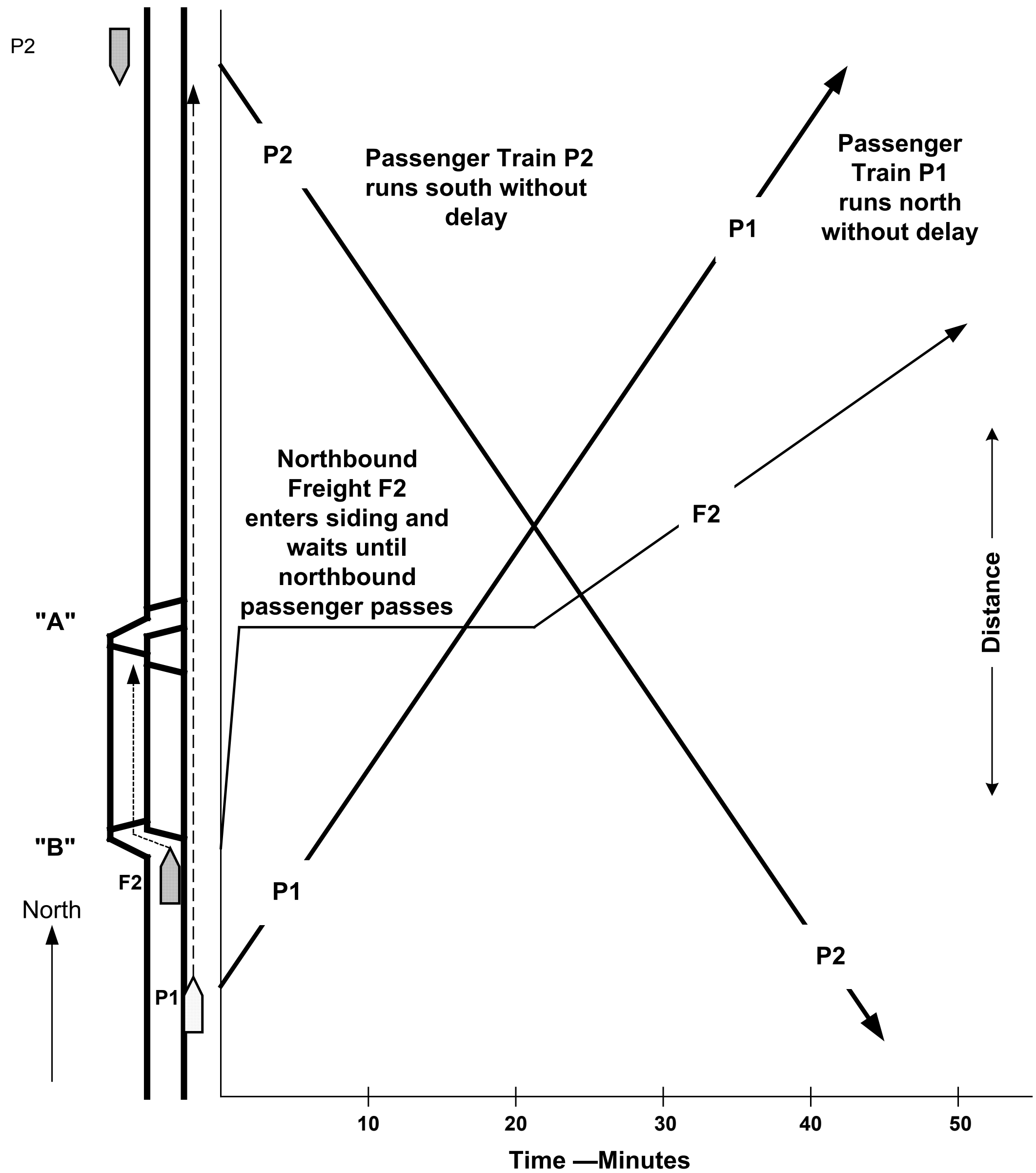
The center sidings would enable freight trains to be passed by passenger trains when clear windows are not available on the other track. Figure 4-3 demonstrates the degree to which a center siding enhances operating flexibility with an example consisting of three trains (a northbound passenger train overtaking a northbound freight train, and a southbound passenger train).

Normally, only one train would be slowed or stopped when the overtaking maneuver occurred. However, the center sidings do not eliminate the possibility that, under certain infrequent circumstances—

- Passenger trains may have to divert to the opposite track to overtake freight trains, or

- Freight trains may be unable to use a center siding because another train is occupying the siding, or;
- Maintenance activities may require unscheduled diversions of passenger tracks.[34]

Figure 4-3: Time Sequence of Moves – Northbound Passenger Train Overtaking Northbound Freight in Center Siding "B to A," Southbound Passenger Train on Opposing Track



[34] None of the illustrative dispatching situations broached in this monograph should be regarded as interpreting, contravening, or otherwise affecting present and future operating agreements between a State and other railroad users.

Each time a center siding is used by a freight train, a passenger train would not have to divert, thereby saving a minimum of about three minutes for a passenger train each time a diversion is avoided.

Thus, although center sidings cannot cure all possible operating problems on a busy double-track railroad with diverse traffic, they can—if properly designed and sited—significantly contribute to the fluidity and reliability of the line under projected Year 2020 traffic conditions.

Additional Background on Train Dispatching

Appendix C provides additional information on the complex decision rules for train dispatching under single- and double-track conditions, with a variety of traffic types. Reflecting the variety of situations that may arise on a railroad in which random freight movements are superimposed on scheduled freight, intercity passenger, and commuter trains, these rules are of interest because they influenced the simulations and have implications for the design of the contemplated improvements.

Results of the Operating Analysis

Appendixes B and C present the detailed results of the train performance calculator and train interaction analyses, respectively. This section excerpts the salient results of those investigations.

To provide for four-hour, twenty-five minute Richmond–Charlotte service with five intermediate stops and 90 percent on-time performance would require a pad of about one-half hour, broken down as follows:

Table 4-1: Pad Requirement for Reliable Richmond–Charlotte Service

Component of Pad	Minutes
Typical seven percent pad used in analyses of double- or multi-track routes	16.4
Single track conflicts (average total delay time per train of 9.5 minutes, plus an allowance of 20 percent to cover excessive delay situations; see page 4-12)	11.4
Congestion on the heavily-trafficked P Line	3.9
Total pad required	**31.7**

Table 4-2, summarizing the results of selected TPC runs, clearly indicates that the only system configuration that would meet the States' trip time goals for the Richmond–Charlotte Corridor—**while providing adequate pad for reliable service**—would entail:

- Maximum authorized speeds of 110 mph;
- Trainsets with two locomotives and six cars. Adding a second locomotive can save up to 16.5 minutes between Richmond and Charlotte;
- Tilting capability in the cars;

- Unbalanced superelevation of up to seven inches[35]; and
- The recommended alignment, as described in Chapters 5 and 6.

Table 4-2: Simulated Run Times and Available Pad for Selected TPC Model Runs

NOTE: Simulated times are compared to trip time goals of four hours, twenty minutes (260 minutes) with four stops, and four hours, twenty-five minutes (265 minutes) with five stops. All trains have six cars with tilt capability, and one or two up-to-date Diesel locomotive(s)

MAS (mph)	No. of Loco-motives	Max. Unbalance	Alignment[36]	No. of Stops	Trip Time Goal (min.)	Simulated Run Time (min.)	Pad (min.)	Pad (as percent of TPC Time)
existing[37]	1	3”	existing	4	260	343.5	n/a[38]	n/a
90	1	7”	existing optimized[39]	4	260	260.1	n/a	n/a
90	2	7”	existing optimized	4	260	251.5	8.5	3.4%
110	1	7”	existing optimized	4	260	253.7	6.3	2.5%
110	2	7”	existing optimized	4	260	238.0	22.0	9.2%
110	2	7”	recommended	4	260	230.9	29.1	12.6%
110	2	7”	recommended	5	265	233.3	31.7	13.0%

Appendix B contains numerous additional cases involving other variables than those summarized above. As that Appendix makes clear, there is some downside risk in the assumptions and calculations underlying Table 4-2:

- Pending detailed engineering work, some uncertainty will attach to the feasibility of the curve modifications that are assumed in the TPC runs;
- If a 110 mile-per-hour MAS cannot be achieved, there is a significant increase in TPC running time; and
- If an unbalanced superelevation lower than 7 inches must be used, the trip time suffers.

As a result, operational analyses would continue to require refinement as part of any future planning and engineering that the States may elect to perform for the SEC.

[35] Subject to the review and approval of the FRA’s Office of Safety.
[36] All alignments assume restoration of the S Line.
[37] As in 1999; or, for the S Line, as in 1975.
[38] “n/a” = “not applicable,” the simulated run time exceeds the trip time goal.
[39] I.e., with spiral and superelevation adjustments but without realignment projects included in the “recommended” alignment.

Figures in Chapter 4

Tables in Chapter 4

Chapter 5
CORRIDOR-WIDE INVESTMENTS AND DESIGN STANDARDS

Chapters 5 and 6 describe a comprehensive set of infrastructure and operating modifications that would support reliable high-speed passenger rail service between Richmond and Charlotte, while protecting freight and proposed commuter services. The present chapter summarizes the entire investment program and then focuses on the improvements and design standards that would apply consistently through the corridor to such railway subsystems as track, signaling, highway-rail grade crossings, and stations. The next chapter focuses on projected site-specific investments, like sidings and other track reconfigurations.

The Contemplated Improvements in Brief

The goal of the contemplated improvements would be to provide five-stop intercity rail passenger service in less than four hours and 25 minutes between the city centers of Richmond and Charlotte. Achieving the goal requires the removal of about three hours from the current schedule of Amtrak's *Carolinian* between Richmond and Charlotte,[1] for a travel time reduction of about two-fifths. A performance improvement of this magnitude would require coordinated betterments in all infrastructure departments—especially track structure and alignment, signaling, grade crossings, stations, and equipment storage and servicing facilities—with implementation of both system-wide and site-specific projects. Of course, a carefully designed program to acquire a suitable fleet of vehicles would necessarily complement the fixed facility investments.

Contributing to achievement of the trip time goals would be the re-establishment of rail passenger service to Raleigh through Richmond's Main Street Station, and the assumed restoration of service on the abandoned, 88-mile S Line between Centralia, Virginia and Norlina.[2] The tracks would have to be restored, new passing sidings provided, and bridges replaced or rebuilt. The existing, operational rail segments between Main Street Station and Centralia, and between Norlina and Raleigh, would be upgraded to support the requisite passenger train speeds. If included in the project, restoration of the S Line would save some 34 miles, or one-fifth, of the existing distance between Petersburg and Raleigh, with a concomitant travel time improvement. Other time savings would rely on a host of smaller projects, such as curve realignments.

Satisfying the trip time goal for passenger rail service on a consistent basis— while preserving and enhancing the dependability of the important and growing freight traffic

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[1] The *Carolinian* currently operates between New York's Pennsylvania Station, Washington, D.C., Richmond, and Charlotte. The Richmond–Charlotte travel time is 7 hours, 39 minutes southbound and 7 hours, 26 minutes northbound; these timings are based on the Staples Mill Road station location in Richmond.

[2] See the section in Chapter 1 entitled, "Important Note on the Environmental Process."

and the potential for commuter services to share the line—would require improvements that would increase rail capacity at strategic locations. Reduced trip times and increased capacity would enable the high-speed service to operate reliably without adversely affecting or being delayed by the large number of long freight trains or by frequently-stopping commuter trains, where the latter service is implemented.

Improvements to station platforms, buildings, parking, or access facilities can enhance the passenger interface with the rail system, reduce door-to-door trip times, increase rail line capacity, and reduce line-haul schedules. This study focused on station improvements that would yield as many of these benefits as possible, and envisioned some relocation of station facilities to improve access and better serve potential markets. In such instances as Raleigh, Greensboro, and Charlotte, the contemplated station improvements would require track configuration modifications. While sometimes complex and costly to build, these station investments are prerequisite to the establishment of a competent service. Indeed, without proper arrangements for passenger access and train throughput, the other contemplated betterments (except for those adding to safety) lose their reason for being, since upgraded mobility for the traveling public would be the underlying justification for considering the entire effort. Other prerequisites to the project include more effective highway-rail grade crossing treatments, selective right-of-way fencing, and the vehicle acquisition and support programs mentioned above.

Corridor-Wide Improvements and Standards

This section describes investments that would affect major railway components and occur on a corridor-wide basis. Also included is a description of corridor-wide design standards for certain components that would be implemented on a site-specific basis.

Track Structure

Current Status of H and P Lines

The line segments between Raleigh, Greensboro, and Charlotte—owned by the North Carolina Railroad, operated by the NS, and already carrying passenger trains—serve as important freight routes in both north–south and east–west traffic lanes, and have been maintained to facilitate safe and expeditious freight and passenger movements. In those segments, this study assumes that the freight railroads, as owners and/or operators of the fixed plant, will continue to maintain it in the state of good repair that exists today.[3,4] Accordingly, between Raleigh, Greensboro, and Charlotte, except as noted below, the investment requirements contained in this monograph do not include replacement in kind of such existing track components as ties and rail—in railroad parlance, "program

[3] The assertion that the H and P Lines are in a "state of good repair" reflects the limited field investigations undertaken for this study. More detailed inspection, analysis, and design work will be needed to precisely establish the modifications necessary to qualify these lines for the types of service contemplated in this monograph.
[4] The sharing of incremental maintenance costs to support the higher speeds contemplated in this study, is outside the scope of this monograph.

maintenance." In addition, the study did not include the incremental costs, primarily surfacing, to enable the existing track structure to comply with the geometric standards for safety and ride quality at 110 mph top speeds.

Locations in Which Upgrading Is Assumed

On the other hand, in the Richmond–Centralia, Norlina–Raleigh, and Raleigh–Fetner segments, this monograph provides for a significant upgrade, with replacement of rails and other track components to assure safe, expeditious passenger and freight service.

Installation of Premium Ties and Fasteners

This study has concluded, based on the simulations described in Chapter 4 and Appendix B, that fulfillment of the trip time goals would require the use of tilt trains capable of operating at seven inches of unbalanced superelevation and an MAS of 110 mph. To assure stability, ride quality, and complete safety when these added forces are applied to the track structure, such an operating regime would necessitate the installation of concrete ties and premium fasteners on curves in which the trains would operate at greater than five inches of unbalanced superelevation.[5] Preliminary analysis indicates that tilt trains would operate at between five and seven inches of unbalanced superelevation on approximately 160 curves or approximately 90 track-miles of curves. Allowing ten percent for the approaches to curves or for short stretches connecting adjacent curves, 100 miles of concrete ties and premium fasteners would be required to safely and efficiently operate tilt trains in the Richmond–Charlotte Corridor. The costs for these upgraded ties and fasteners have been included in the cost estimates for the "curve adjustment program" in Table 5-1 and in Table 7-1.

Specifications for Continuous Welded Rail Installation

Continuous welded rail, as commonly installed in the United States, has demonstrated a tendency toward buckling at times of intense heat, due to the tremendous forces that can build up within the track structure. Current practice on the Northeast Corridor is to reduce passenger train speeds in extremely hot weather (i.e., over 95 degrees), in part as a safety precaution against such tendencies.[6] Such practices, while prudent, also detract from the schedule reliability and marketability of high-speed rail in the summertime, thereby potentially undermining the inherent advantages of the service. In the detailed design of all-new track construction contemplated for the Richmond–Charlotte Corridor, most particularly in the rebuilding of the S Line, it is recommended that state-of-the-art techniques for designing continuous welded rail track —including the best practices in Japan,[7] France, and other countries—receive careful scrutiny and

[5] Solely to minimize initial capital costs, wooden ties are assumed for the remainder of the trackage. Suitable transitions would be provided between the concrete and wooden tie sections. If sufficient funds prove to be available, installation of concrete ties throughout the corridor would be beneficial.

[6] Protection of older portions of the electrical catenary can also enter into these summertime speed restrictions.

[7] For example, the Japanese Shinkansen lines employ expansion joints that relieve stress in the continuous welded rails and assure no degradation in service year-round.

comparison with standard American practices, so as to assure complete safety and uninterrupted high-speed capabilities throughout the year.

Curve Realignments

The recommended alignment improvements—discussed in detail in Chapter 6 and Appendix A—would allow higher train speeds to be sustained over longer distances.

Background

The rail lines comprising the corridor were built between the mid-19th and the early 20th century. Although a few line relocations have been constructed, the corridor still has a significant number of curves. At many locations, adjacent communities have developed in a manner that precludes reducing the track curvature through relocation and other modifications. Also, environmental concerns may make other potential track alignment improvements challenging.

Despite these challenges, and even if tilting equipment is used, the operational simulations revealed that a trip time goal of less than four hours and twenty-five minutes between Richmond and Charlotte would necessitate changing the degree of curvature and other features of selected existing curves, and relocating selected sections of the line. These modifications can be applied individually or in combination:

- Increase superelevation to the maximum allowable for a particular track alignment;
- Increase the amount of unbalanced superelevation used to calculate speeds through curves to minimize the need for physically shifting the track;
- Modify spirals (the length of track that provides a smooth transition from tangent track to curved track) to provide a smoother ride;
- Reduce the degree of curvature either within the existing right-of-way or by acquiring a limited amount of land outside the right-of-way, to ease speed restrictions that adversely affect trip time; and
- Relocate limited sections of the rail line in a cost-effective and environmentally sensitive manner to eliminate sharp curves. Sometimes, multiple curves can be ameliorated or eliminated in a single relocation project.

The work required to modify the curves can be categorized into four levels of shift:

- **Less than six inches**: these changes can normally occur during planned surfacing and line maintenance activities.
- **Between six and 36 inches**: most of the realignment tasks fall in this category. Although shifts greater than six inches are assumed to require specific scheduled work outside of the normal maintenance

requirements, those under 36 inches can usually be accommodated within the existing rail alignment;

- **Between 36 inches and ten feet**. Shifts in this category can fall somewhat outside the existing rail alignment, but in most cases would not require construction of significant new roadbed; and
- **Over ten feet.** In a limited number of instances the curves must be relocated in excess of 10 feet to obtain the desired spiral or superelevation modifications. In those instances it is assumed that significant levels of new roadbed will be constructed.

Of these four levels of realignment, the "curve adjustment program" comprises levels (1), (2), and a portion of (3); the "curve relocation program" incorporates major excursions outside the right-of-way that would include a portion of level (3) and all of level (4).

A comparison of the curve adjustment and curve relocation programs (as summarized in Table 5-1 and Table 5-2, respectively) shows that the relocations are relatively few, and that the total cost of the many contemplated adjustments is almost double that of the relocations. Chapter 6 provides further details about the individual projects of both types.

Criteria for Realignments

To maximize performance while fully adhering to safety requirements and the dictates of passenger comfort, all the altered curves would have geometric characteristics meeting the following criteria:

- Maximum actual superelevation[8] should not exceed six inches.
- Actual superelevation was chosen in increments commensurate with the speed assumed to be authorized for each curve, and with the runoff rates specified by CSXT for the segments between Main Street Station and Raleigh, and by NS for the segments between Raleigh and Charlotte, respectively.
- Maximum unbalanced superelevation should not exceed seven inches, which assumes the use of tilting equipment. As demonstrated in Chapter 4, this system design standard is essential to fulfilling the trip time goals.[9]
- Maximum lateral acceleration parallel to the floorboards should not exceed 0.15 g.

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[8] For definitions of engineering terms used in this section, see the Glossary toward the end of Volume I of this monograph.

[9] Of course, the actual (as opposed to the simulated) use of tilting equipment at unbalanced superelevations greater than five inches would require the express approval of FRA's Office of Safety.

- For conventional coach equipment at a theoretical six inches of unbalanced superelevation, the roll angle should be 2.87 degrees.

Table 5-1: Curve Adjustment Program
(with Cost Estimates. Excludes Abandoned S Line.)

Active Portions of S Line	
DEEPWATER JCT to DALE	$89,433
DALE to FALLING CREEK	$279,516
S NORLINA to N GREYSTONE	$551,638
N GREYSTONE to S GREYSTONE	$1,767,347
S GREYSTONE to N KITTRELL	$1,216,261
S KITTRELL to N YOUNGSVILLE	$1,920,179
N YOUNGSVILLE to S YOUNGSVILLE	$1,797,939
S YOUNGSVILLE to N NEUSE	$837,669
N NEUSE to CRABTREE	$3,541,813
EDGETON to SOUTHERN JCT	$2,346,047
Total, Active Portions of S Line	**$14,347,842**
H Line:	
ASHE to FETNER	$1,922,403
CARY to S CARY	$1,462,878
S CARY to BRASSFIELD	$3,741,759
W DURHAM to FUNSTON	$3,104,346
S GLENN to EFLAND	$995,406
EFLAND to MEBANE	$664,866
MEBANE to S MEBANE	$321,292
S MEBANE to HAW RIVER	$2,204,423
HAW RIVER to S BURLINGTON	$795,457
S BURLINGTON to N McLEANSVILLE	$2,703,664
N McLEANSVILLE to s McLEANSVILLE	$1,413,063
S McLEANSVILLE to N ENGLE	$550,919
Total, H Line	**$19,880,475**
P Line:	
ELM to POMONA	$156,076
POMONA to COX	$653,561
COX to HOSKINS	$3,345,125
VARNER to THOMAS-307	$139,515
THOMAS-307 to BOWERS (new)	$4,074,339
BOWERS (new) to MAYBELLE	$1,687,618
MAYBELLE to LEE	$657,220
SHARP to DUKE	$687,161
DUKE to YAD	$313,722
YAD to SALISBURY JCT	$717,244
SALJCT to N SALISBURY	$282,427
S SALISBURY to REID	$1,015,725
SUMNER to NORKANN	$3,669,609
NORKANN to KANN	$559,079
KANN to ADAMS	$614,168
ADAMS to SHAMROCK	$4,077,151
SHAMROCK to JUNKER	$2,456,433
Total, P Line	**$25,106,173**
Total, Curve Adjustment Program	**$59,334,490**

- All actual superelevation should be introduced and removed over the entire length of the spiral—not within the curve itself or on the tangents adjacent to the spirals.
- Maximum jerk rate through the spiral should be 0.04 g per second.
- Track twist rates for alignments at proposed speeds are as specified by CSXT and NS in their internal engineering standards.

Table 5-2: Curve Relocation Program

(with Cost Estimates. Excludes Abandoned S Line.)

Active Portions of S Line	
Manson Curve (S103)	$5,310,942
Curves south of Wake Forest	$13,782,949
Total, Active Portions of S Line	**$19,093,891**
H Line:	
Curve H64	$595,780
MP H62.7 to H54.6	$1,713,444
E DURHAM to W DURHAM	$1,204,128
W DURHAM to FUNSTON	$549,614
MP H42.9 to H41.8	$1,548,236
MP H 29.2 to H26.3	$5,563,299
MP H6.2 to H5.1	$2,064,495
Total, H Line	**$13,238,994**
P Line (one curve only):	
Curve 296	$1,325,178
Total, P Line	**$1,325,178**
Total, Curve Relocation Program	**$33,658,063**

Track Layout Reconfigurations

Chapter 4 described the many pressing capacity considerations affecting the configuration of the tracks in the Richmond-Charlotte Corridor. [10] Reliably operating passenger service at an average commercial speed of 76 mph,[11] while not negatively affecting the movement of slower freight and commuter trains,[12] clearly requires additional track capacity and siding configurations. Responding to these capacity considerations, the additional and reconfigured trackage contemplated in this study would provide a degree of reliability to match the speed capabilities of the upgraded and reconstructed line.

The types of capacity improvements contemplated for implementation are site-specific, and are discussed further below, and in Appendix G. In general, they include:

- The assumed restoration of the previously abandoned S Line between Centralia and Norlina (a capacity addition because it would parallel and augment the existing heavily-trafficked A Line);
- Construction of second or third tracks and siding tracks at strategic locations;
- Reconfiguration of switching stations (interlockings) to optimize operating flexibility; and
- Accompanying modifications to signaling and train control systems.

These capacity-related capital improvement projects would enable the rail system to accommodate the projected intercity and commuter passenger service and speed increases, and would maintain the quality of freight service on the line. Nevertheless, even with the improvements, proper management of this busy, largely single-track railroad would require all the concerned operators to coordinate their scheduling and dispatching procedures in a straightforward, consistent, and collegial manner.

Equipment

High-speed locomotives and coaches have yet to be selected for the Richmond–Charlotte Corridor. It is, of course, essential that planning for vehicle investments be carefully coordinated with planning for infrastructure improvements, and that the Richmond–Charlotte rolling stock be fully compatible with that providing intercity passenger train service in the Northeast Corridor, between Richmond and Washington, and between the Richmond/Petersburg metropolitan region and Hampton Roads. This compatibility would not only provide flexibility to the intercity passenger rail operator but also assure direct through services—without change of trains—between the Northeast and

[10] Cf. the section in Chapter 4 entitled "Operations in Single-Track Territory"
[11] Assuming the performance equivalent of two Diesel locomotives per train, and including five intermediate stops.
[12] Intermodal freights averaged 40 to 42 mph average and conventional freight trains 35 to 38 mph in the simulation. Commuter trains, if they operate between Concord and Charlotte, would average 35 to 37 mph.

Southeast Corridors. These through services would, in turn, add to passenger convenience and leverage the revenues and profits (or minimize any deficits) attached to the various passenger rail operations. [13]

Signaling and Train Control

As indicated in Chapter 2, most of the route-mileage east and north of Greensboro on the H and S lines lacks signals entirely, and the P line's signaling system does not allow for speeds over 79 mph. Thus, major signal system upgrades would be necessary to efficiently handle increased train traffic on the Corridor and to permit improved intercity passenger service with greater safety. These improvements also would enable freight service, and any potential commuter service, to safely and efficiently operate on the same tracks. In anticipation of increased train speed, a revised block layout and new signal aspects would support operations up to 110 miles per hour. [14] The signal system would use microprocessor-based track circuits and control/indication equipment. Except in the lower-speed territory between Richmond and Centralia (10.7 miles), continuous cab signals would be installed and all locomotives operating on the line would be equipped with Automatic Train Control.[15] Reverse signaling would be installed throughout the corridor. Interlockings would be remotely controlled from Jacksonville, Florida on the S Line and from Greenville, South Carolina for the H and P Lines.

The new signal system would improve the safety and reliability of all train services, help to control maintenance-related operating costs, and enable higher speed train operations. All freight, commuter, and intercity rail locomotives operating over the P, H, or S Lines would be required to have working electronic devices to implement these important safety features. [16]

Station Improvement Projects

Rationale

Representing the beginning and end of each passenger's experience with the railroad, stations can serve as the focus for local participation and investment, as image-builders for train service, and as enhancements to passenger comfort and convenience.

Station betterments—including totally new stations as well as tracks, platforms, buildings, parking, and access facilities at existing locations—serve multiple purposes. By

[13] For an explanation of how through Southeast Corridor services benefit the rail mode, see chapter 8 of the FRA 1997 report.
[14] The braking distance for a 110 mph passenger train is essentially equal to that of a 60 mph freight train.
[15] These would be legally required for operations over 79 mph; see in Chapter 4, the section "Background: Signaling and Train Control."
[16] Both the CSXT and the NS have significant locomotive fleets already equipped for compatibility with cab signals, and are including cab signal equipment on new locomotive purchases. Since the Richmond-Centralia segment would not become cab-signal territory, the CSXT coal trains using that segment only would not need to be so equipped under this study's assumptions.

easing passengers' interface with the rail system, such improvements can reduce the access/egress portion of door-to-door trip times. Station location and platform

improvements, combined with track and interlocking improvements, also contribute to increased rail line capacity (hence on-time performance) and can materially reduce line-haul schedule timings. In some circumstances, station facilities, parking, and amenities can directly generate net revenue for a rail system or its sponsors. For all these reasons, thoughtful station design and development efforts are essential—rather than ancillary—to the operational and economic success of a corridor like that between Richmond and Charlotte.

The nature of the improvements that would be appropriate at each location will vary on a site-specific basis, as detailed in Chapter 6. In developing concepts and costs, this study has focused on tracks, platforms, and pedestrian bridges and tunnels; station architecture, amenities, parking, and site design were generally outside the scope of this effort, as were the institutional partnerships that have proven so important in station revitalizations elsewhere. The corridor partners would, however, need to devote significant resources to these important topics.

List of Projected Stations

Table 5-3 lists the stations projected for an upgraded Richmond–Charlotte corridor. Final decisions on station locations, and the frequency of service at each station, will rest with the States, the localities, and the rail service operator. Descriptions of these stations appear sequentially in Chapter 6.

Types of Station Improvements

The improvements at each station would be site-specific. Because stations are integral to any rail passenger system, however, this study assumed the adoption of certain principles of station design that would apply regardless of the particularities of each site. These principles include:

Station Platforms

Stations were assumed to have low-level platforms. Where usable low-level platforms already exist and no alignment or track configuration changes are foreseen, existing platforms would remain in place, without rehabilitation. In all other cases, new platforms would be built or existing ones upgraded.

Where justified by ridership, the incremental costs of high (versus low) platforms at each of the more heavily patronized stations—including the costs to protect the flow of freight traffic—should be carefully assessed against high platforms' undeniable service

Table 5-3: Contemplated Stations on the Richmond–Charlotte Corridor

Mile-post[17]	Location[18]	Metro Area Population[19]	Status: Existing, Restored, and/or Reopened	Status: Assumed Relocation	Status: Assumed New Stop	Assumed User	Assumed Owner: Land	Assumed Owner: Station	Assumed Owner: Parking
S0	Richmond–Main St. Sta.	997,000	•			SEC operator[20]	City of Richmond		
S22.0	Petersburg		•[21]			SEC operator	CSXT – Leased to Amtrak		
S113.8	Henderson	16,095	•			SEC operator	Currently - Private/Proposed - City		
H80.4	Raleigh	1,188,000		•		SEC operator	NCRR/ TTA[22]	City of Raleigh	NCRR/ TTA
H72.7	Cary		•			SEC operator	City of Cary		City and NCRR
H54.7	Durham			•		SEC operator	NCDOT/City of Durham		
H21.5	Burlington	1,252,000	•			SEC operator	NCRR	NCDOT	NCRR
H0.1	Greensboro			•		SEC operator	City of Greensboro		
299.2	High Point		•			SEC operator	NCRR		
P333.3	Salisbury	1,499,000	•			SEC operator	Historic Salisbury Foundation, Inc.		
P348.9	Kannapolis		•			SEC operator	NCRR	Disputed	NCRR
P367.1	I-485				•	SEC operator, Commuter	New Station – institutional arrangement to be determined		
P377.8	Charlotte			•		SEC operator, Commuter	Charlotte/NCDOT		
P383.2	Charlotte Airport				•	SEC operator	New Station – institutional arrangement to be determined		
Total population, Richmond–Charlotte Corridor only[23]		4,952,095							

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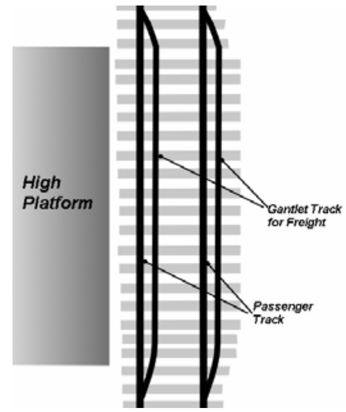
[17] Relocated stations will show different milepost numbers than are reflected in Table 2-4.
[18] Chapter 7 specifies what costs categories are included for each station.
[19] Populations are for Metropolitan Statistical Areas or for the city or town—whichever is the largest applicable to the station. The catchment area for smaller stations will be larger than the city or town population shown. U.S, Census, Year 2000 data from *Statistical Abstract of the United States,* http://www.census.gov/prod/2002pubs/01statab/app2.pdf; town populations from http://factfinder.census.gov/servlet/BasicFactsServlet.
[20] I.e., the Southeast Corridor intercity rail passenger operator, which is currently Amtrak.
[21] Alternative routes through Petersburg are presently under evaluation as part of a study to extend high-speed rail service to Norfolk. Thus a relocated station is a distinct possibility.
[22] Triangle Transit Authority—the regional transit agency in the three-county Triangle region in which Raleigh is the largest city (Wake, Durham and Orange Counties).

benefits.[24] If the incremental costs are reasonable, high platforms would ordinarily be preferable from the passenger service standpoint.

Figure 5-1:
Schematic of Gantlet Track



The installation of audio and visual warnings of approaching trains is also recommended at locations where non-stopping train speeds would exceed 45 mph.

Americans with Disabilities Act (ADA) Issues

The ADA requires reasonable accommodation of the needs of the disabled. To implement the transportation provisions of ADA, the U.S. Department of Transportation has issued rules that require all intercity rail stations to meet ADA standards by 2010, with the exception of flag stops. These standards include: accessible routes, signage to include Braille, full accessibility to both north- and southbound platforms, new platforms with tactile edging and striping, modified ticket counters, updated public address and telephone systems, and accessible restrooms.

To meet these standards, various improvements were assumed to be implemented at Corridor stations, including but not limited to: new platforms, new lighting and canopies, and improved public address systems. These actions would make the stations fully accessible to disabled passengers.

While assuming that the intercity rail passenger operator, NCDOT, and VDRPT will accomplish the ADA modifications, this study has not identified the related costs.

Parking and Access/Egress

Since today's inventory of parking spaces most likely would not accommodate the projected passenger volumes, enhanced train service would necessitate expanded parking facilities at existing intercity stations along the Corridor. New stations serving intercity traffic (for instance, Charlotte I-485) would, of course, need parking facilities as well.

Beyond the obvious requirements for parking, all facets of passenger access/egress—including automobile, taxi, and bus traffic patterns in the station vicinities, as well as rail transit and pedestrian facilities where applicable—will require careful scrutiny. Thus, proper integration of the new service into each community served will necessitate planning and design work of some consequence. Since this type of planning

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[23] The important points served by through services, such as Washington, Baltimore, and other Northeast Corridor population centers, are not included in this total.

[24] Where freight trains would use of a track adjacent to a high platform, clearance needs may mandate a "gantlet track" —a pair of rails sharing the same ties as, but offset between 12 and 24 inches from, the rails of the platform track. Any freight trains with high and wide loads would then divert to the gantlet track, thus making the high platform feasible. Depending on site-specific conditions, such as the frequency of high and wide freight loads, such a gantlet track can cost on the order of one-half to one million dollars for track work and signaling the turnouts at either end. See Figure 5-1.

fell outside the scope of this study, the costs associated with parking and other modes of passenger access/egress are not included in the estimates in Table 7-1.

Equipment Support Facilities

In the Richmond–Charlotte Corridor as in any other passenger rail operation, adequate provisions for equipment servicing and storage are prerequisite to a successful operation. This study therefore projected two maintenance and layover facilities, at Raleigh and Charlotte.[25]

NCDOT Raleigh Storage Yard and Servicing Facility

The existing facilities, located adjacent to the S Line between Southern Junction and Edgeton, would be expanded and upgraded to accommodate the increased level of daily passenger service—five Raleigh–Charlotte round trips, instead of the one presently operated.[26] Access to the main line would also be expedited, as described in Chapter 6.

Charlotte Storage Yard and Servicing Facility

An efficient storage yard and maintenance facility would be built in the vicinity of Charlotte Airport Station to store trains, both during the day and overnight, to enable various equipment cleaning functions to be performed, and to accomplish assigned maintenance functions. The storage yard would provide sufficient yard storage capacity to handle overnight layovers for three trains scheduled to depart Charlotte the next day, and to store equipment awaiting maintenance. Since the designated Southeast Corridor extends beyond Charlotte to Atlanta and beyond, additional space should be preserved for the storage of trainsets that might protect a future Charlotte–Atlanta service.[27]

Grade Crossing Improvements

Chapter 2 presents some basic information on highway-railroad grade crossings in the Richmond–Charlotte Corridor. With respect to future grade crossing safety activities, this section presents some engineering considerations and describes a set of actions that would complement the other corridor betterments contemplated in the monograph.

Planning Principles

Implementation of high-speed rail on the Richmond–Charlotte Corridor would result in higher train speeds and frequencies over existing rail lines, and could involve restoration of train service on the now-abandoned S Line. For these reasons, highway-rail crossing safety would require concerted attention as the planning and design process

[25] In addition, a servicing and storage facility is being planned for downtown Richmond near Main Street Station, primarily for the use of trains between Richmond and points north. This Richmond facility could also be used for an early morning train originating at Richmond for Raleigh and Charlotte, or a late evening arrival in Richmond from North Carolina points.

[26] These Raleigh–Charlotte round trips, utilizing Raleigh as their northerly turnaround point, are in addition to the through services to and from points north of Raleigh. See Tables 2-5 and 3-1.

[27] For the status of potential Charlotte–Atlanta intercity rail passenger improvements, see Chapter 3 (under "Corridor-Type Services"); and the "Supplement: Background Materials" at the end of this volume, under "Funding for Planning an Extension of the SEC to Atlanta and Macon, Georgia."

continues. In particular, each crossing would require study, both individually and in combination with neighboring crossings, to assess the degree of risk that it poses, the opportunities for mitigating that risk, and the cost-effectiveness of the various treatment options. “Risk” depends on a host of factors, including the geometry of the crossing, the type, speed, and volume of motor vehicle and rail traffic, and the protective devices in place or available. Community needs, such as access to nearby properties, obviously demand careful attention.

Any comprehensive grade crossing plan needs to address the full range of improvement options. These include consolidating groups of crossings; grade-separating heavily-used crossings; closing selected crossings; and applying known techniques for reducing hazards at the remaining crossings. In addition, proper treatments must be applied to private crossings, where fatalities can and do occur despite the infrequency of use by motor vehicles.

Specific Considerations

Many engineering and operational considerations would affect the details of a comprehensive grade crossing plan. The following are just a few examples:

Train Speeds

All other things being equal, the highest level of protection would be provided at those remaining crossings though which passenger trains would operate at speeds greater than 90 mph.

Constant Warning Times

Higher train speeds would require the timing in the track circuits (which actuate grade crossing gates and flashing lights) to be lengthened to initiate warnings sufficiently in advance of the arrival of the faster trains. Faster trains take less time to traverse the length of the circuit, and reach the crossing sooner than slower trains. At crossings with fixed circuits, warning time must be set for the fastest possible train. This creates a potential problem: when a slow train approaches the crossing, the gates are held down for an inordinate amount of time. Some motorists lose patience with the situation, and drive around the gate at the risk of a collision.

Constant Warning Time circuits can offset this problem by automatically adjusting the length of the warning to a time appropriate to the speed of each individual oncoming train. The system has the ability to determine the speed of an approaching train, and initiate the crossing warning cycle so that a predetermined period of warning will have transpired when the train reaches the crossing, regardless of the train speed.

Four-Quadrant Gates; Median Barriers

Another innovation with application to many crossings is a system of four-quadrant gates, wherein four gates, instead of two, are lowered across the traffic lanes, blocking both directions on both sides, and median barriers are placed down the center of the roadway.

As North Carolina's Sealed Corridor Initiative has graphically proven,[28] four-quadrant gates and median barriers effectively prevent motor vehicle operators from driving around the gates after they are lowered.

Effect on Train Speed of Crossings Located on Curves

Raising the MAS on a curve containing a grade crossing creates serious concerns. In numerous instances, an increase in superelevation would be necessary to attain the projected increase in train speed planned over the crossings and to reduce the lateral acceleration forces felt by rail passengers.

With superelevation, the outside rail on each track on the curve is raised as much as six inches above the level of the inside rail. With a multiple-track crossing, which many crossings are and would be after the improvements, a series of inclines would need to be crossed, one between the rails of each track, and a dip from the slope of one track to the next. There is also likely to be a slope upward to the tracks on each side, the one on the outside of the curve being significantly greater than the one on the inside of the curve. This is not practical on a heavily-traveled street or highway, and may require that these crossings be closed, or grade-separated. Analysis will be required to develop a recommendation for each crossing.

Sidings and Crossings

Sidings, either to be constructed new or extended, should be placed to minimize the number of grade crossings that would be blocked by freight or passenger trains stopped waiting to meet or be overtaken by another train. Conversely, planning for crossing improvements needs to take the location of sidings into consideration. This is more than a matter of convenience to motor vehicle flow: community needs for access by emergency motor vehicles demand careful attention in the siting, treatment, or elimination of highway-rail grade crossings.

Contemplated Grade Crossing Program

Based on all the considerations described above, the study team developed a list of grade crossing actions that would support the trip-time goals and safety prerequisites of high-speed rail development in the Corridor. These grade crossing actions appear in Table 5-4 (for public crossings) and Table 5-5 (for private crossings). In these tables, the contemplated dispositions are expressed as percentages of the universe of crossings addressed by the study. These possible dispositions include:

- **Elimination,** which can be effected by—
  - Closing the crossing to vehicular traffic;
  - Providing a grade separation; or
  - Relocating the railroad;

[28] The Sealed Corridor Initiative is described in Chapter 2.

- **Upgrading** of protection devices, for example from crossbucks to gates and flashing lights, or from gates that cover only half the road in each direction, to four-quadrant gates that cover the entire road, thereby blocking drivers from "running around" the crossing.
- **Keeping the crossing as-is,** where the level of protection is already appropriate for the contemplated train speeds and road traffic levels;
- **Restoring** an abandoned crossing, with upgraded protection from historic levels;
- **Expanding or moving a crossing** to accord with the engineering improvements described in other sections of this monograph—for example, new sidings or changes to curves; or
- **Adding well-protected crossings** where they do not exist today— normally owing to the other engineering improvements. As shown in Table 5-4, the ratio of crossing eliminations (closures, separations, and relocations) to crossing additions for the Corridor as a whole is projected as four to one.

Table 5-4: Contemplated Disposition of Public Grade Crossings
(Expressed as Percentages of Total Crossings Studied by Segment)

Segment	Eliminate			Retain Existing		Restore and upgrade	Expand or move, with upgrade	Add and protect	Totals by Segment
	Close	Separate	Relocate Railroad	Upgrade Protection	Keep as-is				
Richmond–Centralia (Active S Line)	10%	0%	0%	0%	80%	0%	10%	0%	100%
Centralia–Petersburg–Norlina (Restored S Line)(See footnote 29.)	3%	3%	6%	0%	0%	83%	0%	5%	100%
Norlina–Raleigh (Active S Line)	1%	1%	0%	49%	11%	0%	38%	0%	100%
Raleigh– Greensboro (H Line)	1%	3%	0%	55%	26%	0%	14%	2%	100%
Greensboro–Charlotte (P Line)	0%	0%	0%	70%	19%	0%	11%	0%	100%
Corridor Totals	1%	2%	1%	47%	18%	15%	15%	1%	100%

Table 5-5: Contemplated Disposition of Private Grade Crossings
(Expressed as Percentages of Total Crossings Studied by Segment)

Segment	Eliminate			Retain Existing		Restore and upgrade	Expand or move, with upgrade	Add and protect	Totals by Segment
	Close	Separate	Relocate Railroad	Upgrade Protection	Keep as-is				
Richmond–Centralia (Active S Line)	0%	0%	0%	0%	100%	0%	0%	0%	100%
Centralia–Petersburg–Norlina (Restored S Line) (See footnote 29.)	50%	0%	0%	50%	0%	0%	0%	0%	100%
Norlina–Raleigh (Active S Line)	76%	0%	0%	0%	24%	0%	0%	0%	100%
Raleigh– Greensboro (H Line)	67%	0%	0%	0%	33%	0%	0%	0%	100%
Greensboro–Charlotte (P Line)	86%	0%	0%	0%	5%	0%	0%	10%	100%
Corridor Totals	70%	0%	0%	11%	17%	0%	0%	2%	100%

Upon completion of the program posited in Table 5-4 and Table 5-5, the inventory of highway-rail crossings between Richmond and Charlotte would be as shown in Table 5-6.

Table 5-6: Inventory of Highway-Rail Grade Crossings in Richmond–Charlotte Corridor Upon Completion of the Contemplated Improvements

Segment	Line	Miles	Number of Public Crossings	Public Crossings per Mile	Number of Private Crossings	Private Crossings per Mile	Total Crossings	Total Crossings per Mile
Richmond–Centralia	Now-Active S	10.7	9	0.8	1	0.1	10	0.9
Centralia–Petersburg–Norlina[29]	Now-Abandoned S	87.5	57	0.7	10	0.1	67	0.8
Norlina–Raleigh	Now-Active S	59.2	69	1.2	8	0.1	77	1.3
Raleigh– Greensboro	H	80.6	106	1.3	7	0.1	113	1.4
Greensboro–Charlotte	P	100.4	107	1.1	3	0.0	110	1.1
Corridor Totals		338.4	348	1.0	29	0.1	377	1.1

Site-specific grade crossing analyses were outside the scope of this study; they would be addressed in more detailed engineering work prior to construction.

[29] All inventories and projections for the now-abandoned portion of the S Line are based on limited field investigations of crossings that existed when the line was in service. [Private crossings:] In total, 32 sites exist where private crossings once carried vehicular traffic; of these, the limited field investigations suggest that some three-fifths, or 20 sites, would be active today had the railroad remained in operation. Of the 20 sites, approximately half would be closed and the other half provided with active warning devices (gates and flashers); hence the ten remaining private crossings shown in Table 5-6. All crossing conditions and needs would require detailed investigation, verification, and analysis should the States proceed with corridor development.

Fencing

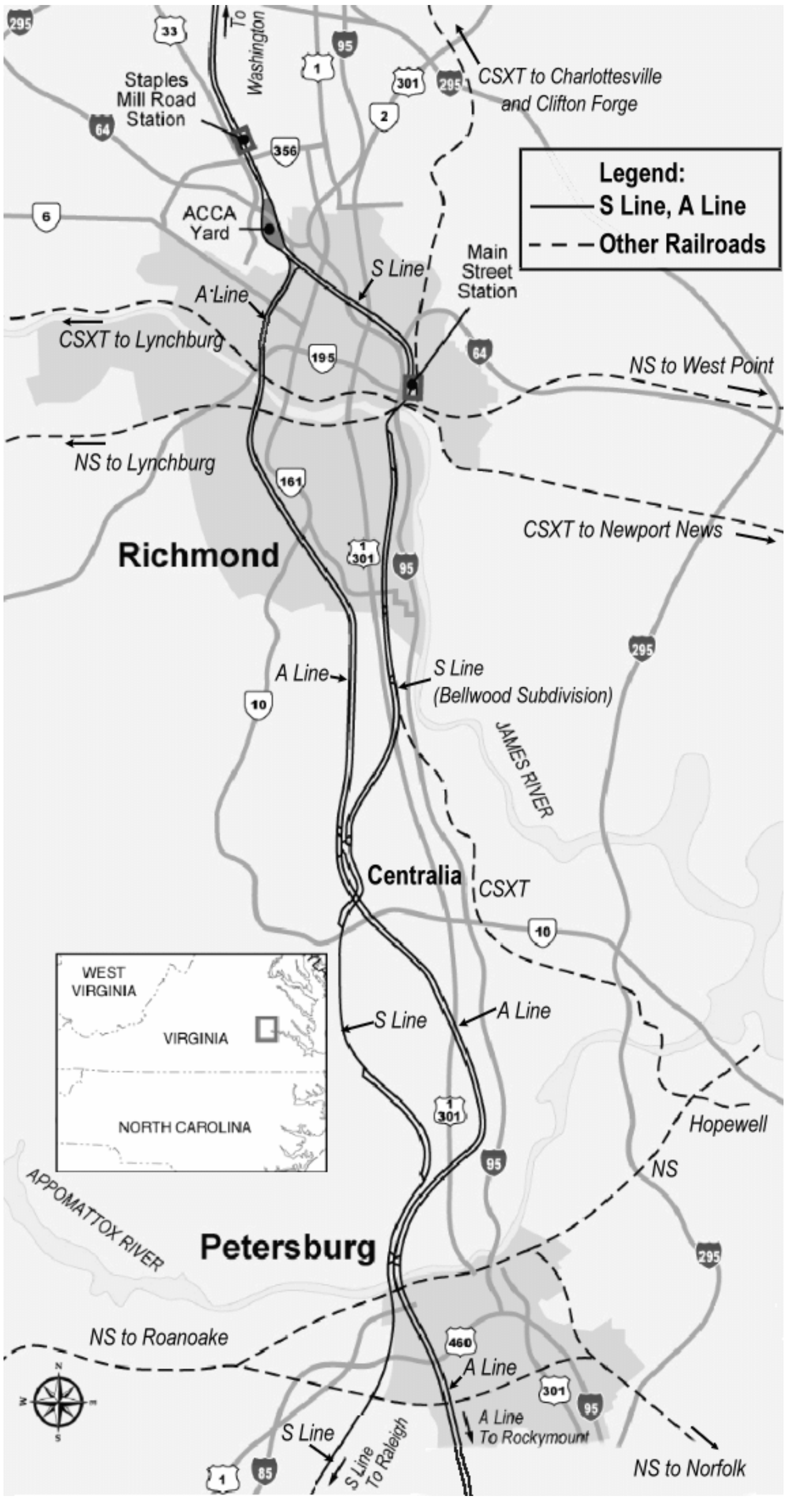
Installation of right-of-way fencing at selected security-related locations, parklands, schools, service facilities, stations, and other locations would be evaluated as part of the final design, project implementation phase. For this document it was assumed that approximately ten percent of the corridor might require fencing of both sides of the right-of-way to improve safety and minimize the potential for trespassing.

Figures in Chapter 5

Tables in Chapter 5

Chapter 6
SITE-SPECIFIC IMPROVEMENTS

Figure 6-1: The Richmond Area



This chapter describes the site-specific improvements, with their operating rationale, that would support the States' travel time and reliability goals for the Richmond–Charlotte Corridor. The improvements appear in their natural geographic sequence, from Richmond south to Charlotte. With respect to direction, the S Line (Richmond–Raleigh) and the P Line (Greensboro–Charlotte) are treated as running from north to south; the H Line (Raleigh–Greensboro) is considered as running east to west.

Richmond–Raleigh (S Line—Runs North and South)

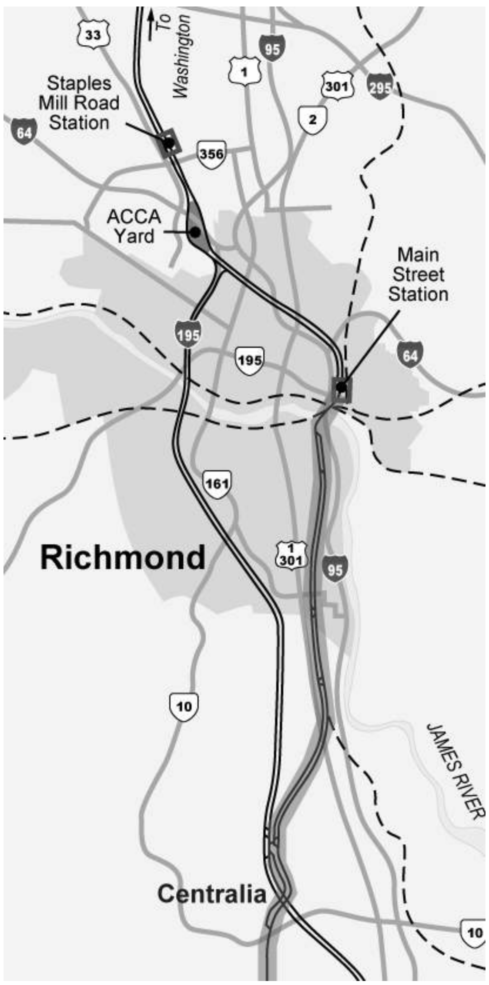
The use of the S Line is a planning assumption subject to the environmental process, the current status of which is described in Chapter 1.

Overview of Train Operations through Richmond

Passenger trains en route to or from south of Richmond currently use the former Atlantic Coast Line Railroad (now the CSXT A Line) from Staples Mill Road Station, through Acca Yard, crossing the James River to the west of downtown Richmond (see Figure 6-1).

The Bellwood Subdivision (part of the S line) currently extends from Acca Yard to Centralia, nine miles south of Main Street Station, where it rejoins the CSXT A Line. Restoration of passenger service on the S Line would require its rehabilitation since it has not been a core system freight or passenger route for several decades. The S line is, however, assuming an increased role in CSXT freight operations in the Richmond area, as a route for the westward movement of empty coal trains from electric utilities in the Carolinas to the Piedmont Subdivision connection,[1] about one mile north of Main Street Station.

VDRPT has initiated a study of the potential for re-instituting rail passenger service between Richmond and Norfolk. The passenger trains would utilize the Bellwood Subdivision to access Main Street Station, potentially adding to the complexity of rail operations between Richmond and Petersburg.



Richmond–Centralia

(MP S "Zero"–S10.3; Track Charts 1 and 2)[3]

The simulations described in Chapter 4 show that restoration of passenger train operations from Staples Mill Road Station through Main Street Station to Centralia would require construction of—

- Numerous improvements between Staples Mill Road Station and Main Street Station, as identified in the Washington to Richmond report;
- Equipment storage and turning facilities in close proximity to Main Street Station; and
- Track, signal, and interlocking improvements between Main Street Station and Centralia, so as to provide improved operating flexibility and capacity for reliable passenger and freight operations.

Richmond: Main Street Station

High-speed rail services proposed by the states of Virginia and North Carolina would utilize Main Street Station, which the City of Richmond is in the process of upgrading as a multi-modal transportation center. The station,

[1] The CSXT, former C&O, line between Richmond and Clifton Forge via Charlottesville.
[2] The segment north from Main Street Station through Staples Mill Road Station to Washington is described in the companion report in this series, *Potential Improvements to the Washington–Richmond Corridor,* Volume I, Washington: National Railroad Passenger Corporation, May 1999.
[3] Track chart numbers refer to Appendix D, contained in Volume II of this monograph.

when completed, would enable rail passenger service to be restored through downtown Richmond. The Richmond Multi-modal Transportation Center would play a key role in the regional rail operation. The interface of passenger and freight operations at the station, and in the vicinity of the station, was previously analyzed.[4]

Historically, Main Street Station was configured to serve the S Line of the SAL (running north-south) on the west side, and the C&O (running east-west to and from Newport News) on the east side.[5] However, a single track and platform on the west side of Main Street Station would be insufficient to reliably operate the volume of freight trains, through passenger trains, and terminating/originating passenger trains projected for 2015. Two tracks and two platforms would, therefore, be constructed on the west side of Main Street Station. Thus, northward freight trains can be passing through the station on Track 2 while southward passenger trains and/or northward originating trains are loading/unloading in the station on Track 1. Similarly, northward and southward passenger trains may load/unload simultaneously.

Richmond–Centralia

The simulations demonstrated that the existing track configuration between Richmond and Centralia would be inadequate to support the projected level of 2020 train operations.

Improvements

Improvements in this segment would therefore include the following.

- Reconfiguration of Rocketts Interlocking to accommodate a proposed Richmond–Bristol rail passenger service;
- Relocation of the existing crossovers in the vicinity of MP S1.5 to Deepwater Junction (MP S1.8) to enable a progressive move, from north to south, to be made from the siding (Sixth Street lead) to Deepwater. The relocation would facilitate the movement of the Acca-Deepwater turn from South Yard (located west of the railroad) to Deepwater (located east of the railroad), Additional facilities would not be needed to permit moves made by the local trains operating between Collier Yard (south of Petersburg) and the S Line.
- Replacement of the existing interlocking at Marlboro (S4.5) with a universal interlocking (with two No. 20 crossovers to enable 45 mph passenger moves[6]) at Dale (S4.8); and
- Relocation of the existing Falling Creek interlocking (S7.3), which is on a two-degree curve. The interlocking would be removed and a universal interlocking (with two No. 20 crossovers) constructed north of MP S7 to replace it. The new interlocking would be located on the tangent track

[4] *Potential Improvements to the Washington – Richmond Railroad Corridor*, Volume II, Appendix C.
[5] Ibid., Volume I, Main Report, p. 50.
[6] For a table of turnout/crossover numbers and their allowable speeds for diverging moves, see Chapter 4.

between the north end of the 2-degree curve, at MP S7.0, and the Falling Creek Bridge.

- Extension of the double track south of Rocketts from MP S8.9 to Centralia (approximately S10.7);

Full reverse signaling would be installed as part of the overall signal system upgrade.

Rationale

The single-track James River Bridge would be the most significant constraint between Brown Street (a proposed interlocking located north of Main Street Station) and Centralia. The universal interlockings at Dale and Falling Creek are essential to provide the operating flexibility and capacity to enable the train dispatcher to manipulate freight trains through the available windows between Rocketts and Main Street, over the James River Bridge

It is assumed that passenger trains would have preference over freight trains for the use of the bridge. Also, the numerous highway crossings between Dale and Rocketts cause a de facto single-track operation for freight trains between Brown Street and Dale, even though two tracks actually exist on both sides of the James River Bridge. Any train that must be held, must be stopped clear of these crossings. Therefore:

- Northward freight trains would require sequencing to enable them to follow a northward passenger train at Rocketts (located at the south end of the James River bridge). Northward freight trains would be held at Dale Avenue, just south of Dale Interlocking, to avoid blocking highway crossings. Freight trains would not be released from Dale Avenue unless they could clear Main Street station before a southward passenger train was scheduled to depart Main Street Station.[7] A northward freight train released from Dale Avenue must be assured non-stop access to the James River Bridge.
- A southward freight train would not be released to enter Main Street Station if a northward freight train has been released from Dale Avenue. Stopping a freight train between Dale and Rocketts would result in crossings being blocked, thereby delaying cross-street traffic.

Northward freight trains would be assumed to have absolute priority on the extended Track 2 at Centralia, except in the following situation:

- A northward freight train passes Centralia less than 10 minutes before a northward passenger train; and
- A southward train (either freight or passenger) is occupying Track 1 between Dale and Centralia.

If a passenger train proceeds northward from Centralia on Track 2, it could stop behind a preceding northward freight train at Dale. This freight would be in a hold situation at Dale Avenue because it could not clear the James River Bridge ahead of the passenger train. To

[7] Main St Interlocking, at the south end of the Station, is the north end of the single track on the bridge.

eliminate this possibility, the existing Falling Creek interlocking (S-7.3) would be removed and a universal interlocking (with two No. 20 crossovers) constructed north of MP S7 to replace it. The new interlocking would enable the passenger train to divert from Track 2 to Track 1 after the southward train has passed the relocated Falling Creek Interlocking. Once diverted to Track 1, the northward passenger train could pass the preceding freight train being held on Track 2, at Dale Interlocking. The passenger train would continue northward to Rocketts on Track 2 without stopping or diverting, if a northward freight train were not ahead of it between Centralia and Dale.

Northward passenger trains on Track 1 would proceed directly to Main Street Station when Track 2 between Centralia and Dale is occupied by freight trains. They would cross over to Track 2 at Dale only when necessary to overtake (pass) or meet a train between Rocketts and Dale on Track 1.

Centralia–Petersburg—Burgess

(MP S10.3–S30; Figure 6-3; Track Charts 2 and 3)

Southward from Richmond, today's active S Line ends at Centralia. At least three options exist for routing the Richmond–Charlotte Corridor through the Petersburg area: the route "as simulated" for this study, the Dunlop option, and the Battersea option. The route "as simulated" and the Battersea option would locate the S Line parallel to the A Line just north of Petersburg[8] and would continue to use the current Petersburg station at Ettrick; under the Dunlop option, trains would stop in downtown Petersburg. All three alternatives appear in Figure 6-3. Although each option receives treatment below, more details are now available for the option "as simulated" than for the others. As indicated in Chapter 2, the alternative routes through the Petersburg area (including additional routing options[9]) are under study by Virginia as part of the Richmond to South Hampton Roads High-Speed Rail Feasibility Study.

Option "As Simulated"

(Track Charts 2 and 3[10])

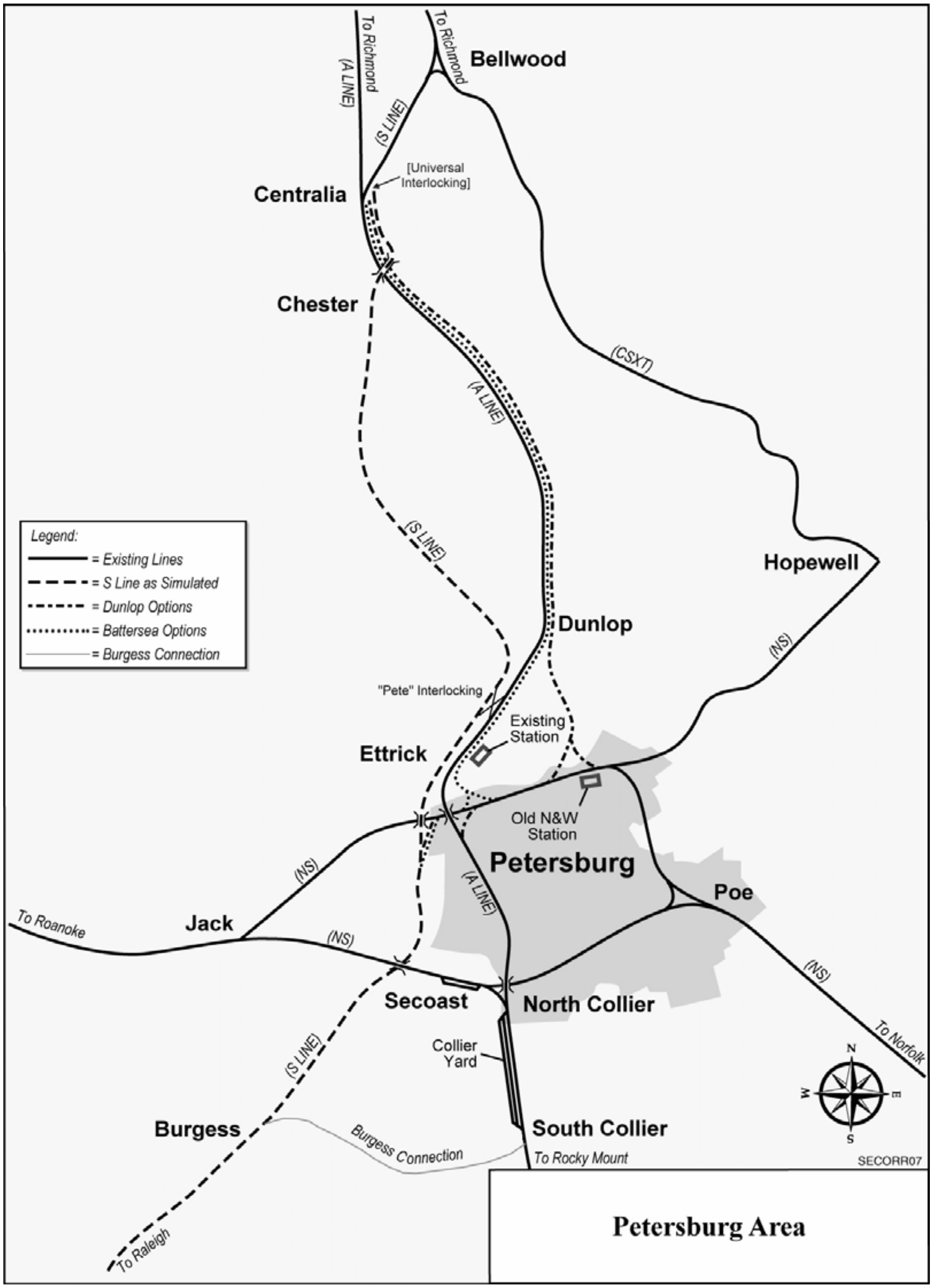
Over the 20 miles between Centralia and Burgess, the option simulated in this study would follow the former S Line routing for portions totaling 16 miles, but would diverge to parallel the A Line for some four miles in the vicinity of the Ettrick station.

The restoration of the S Line to Norlina (S98.2) would begin at Centralia (S10.6). A universal interlocking would provide full connectivity between the A Line and the S Line, in both directions. About ten north/south CSXT freight trains and three passenger round trips to and from Florida (via the A Line and Charleston, South Carolina) would use the Centralia interlocking to switch between the S and A Lines. One Florida passenger train (via Columbia, South Carolina) and the four Richmond–Charlotte high-speed trains would operate between Richmond and Raleigh on the restored S Line. Because of a clearance limitation just south of

[8] The S Line formerly had an alignment through downtown Petersburg, east of the A Line; see the discussion below.
[9] For example, one alternative would route all Richmond–Raleigh passenger trains from Centralia to Collier Yard via the A Line, and then from Collier to Burgess via the Burgess Connection.
[10] The track charts do not depict either of the other options.

Main Street, the Auto Train would continue to operate on the A Line between Centralia and Acca Yard in Richmond.[11]

Figure 6-3: Routing Options, Centralia–Petersburg–Burgess Area
[Track Charts 2 and 3]



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[11] This would make no difference to the passenger service in the Richmond area, as the Auto Train makes no revenue stops between Lorton (Northern Virginia) and Sanford, Florida.

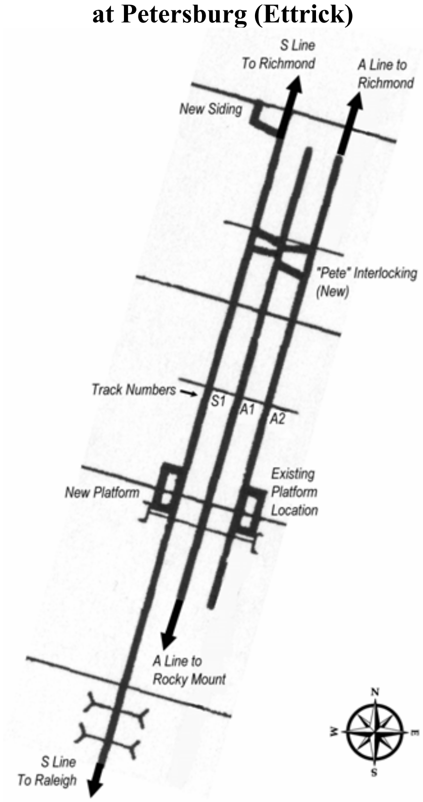
The restored S Line would parallel the A Line south of Centralia for about two miles. Between mileposts S11 and S13, "Chester" Siding would be provided to enable northbound freight trains—diverging at Centralia from the restored S Line to the A Line, and vice-versa—to wait clear of both lines, if access to the A Line is not immediately available.

The S Line would bridge over the A Line at MP S12.5[12]. South of MP S12.5 the restored S Line would be on the roadbed of the abandoned S Line to about MP S20. Between mileposts S16.4 and S20.2 a new "Lynch" siding, much longer than the former siding at that location, would be constructed.

Starting at MP S20, rather than passing under the A Line as was the case with the abandoned S Line, the restored S Line would run parallel to the A Line through Petersburg. [13] The parallel lines would serve a single passenger station in the Petersburg area—at Ettrick, the present location. A universal interlocking ("Pete," MP S20.7) would interconnect the A Line and the S Line one mile north of the passenger station. Pete Interlocking would—

- Enable passenger trains to operate on either the A Line or the S Line between Centralia and Pete;
- Enable freight trains that operate on the S line to enter or leave the A Line at Pete; and
- Make the CSXT a triple-track rail line between Centralia and Pete, thus adding significant capacity for both freight and passenger services.

Figure 2-1: Assumed Station at Petersburg (Ettrick)



The present Petersburg station has one platform, on the northbound A Line track. The construction of a new S Line track on the west side of the existing tracks through the station would necessitate a second platform, adjacent to the S Line track.

At about MP S23, the A Line and the restored S Line would separate. The A Line curves onto its 60-foot high 1300-foot long single-track bridge over the Appomattox River. A new bridge, about one-half mile upstream from the A Line Bridge, would enable the restored S Line to cross the Appomattox and rejoin the former line on the south side of

[12] The S Line previously had crossed over the A Line at this location.
[13] The S Line crossed the Appomattox River on a major bridge that has been removed, and then passed under the A Line again just south of the present A Line Appomattox River Bridge.

the river, at new MP S23.5. Since the milepost of the former line at that spot was MP S24.05,[14] paralleling the A Line through Petersburg would produce an alignment about one-half mile shorter than that of the former SAL.

A road accessing the Chaparral Steel plant at Secoast (MP S26.5), where the NS Belt Line[15] passes over the former S Line, has been constructed on the alignment of the former S Line for a short distance. Restoration of the S Line requires either that the road be relocated or that a new S Line alignment be constructed west of the former line; the former solution was assumed. No changes to the existing NS Belt Line bridge are contemplated.

The alignment continues southward through Burgess (MP S30), where a connection to Collier Yard, on the A Line, formerly diverged but was removed when the S Line was abandoned. The connection was not needed for passenger or freight train operations under the Petersburg routing assumed for this analysis. If the high-speed trains ultimately use other routes through Petersburg, however (as described below), the Burgess Connection might be considered for restoration.

Dunlop Option (Via A Line, Norfolk Southern, Downtown Petersburg)

A third main track would be constructed on the east side of the A Line between Centralia and "Dunlop," continuing through Colonial Heights on the original ACL main line to downtown Petersburg, at the former Norfolk &Western station. There the track would split to connect to the NS Norfolk District main line in both directions. The eastward connection would be for trains operating between Richmond and Norfolk, and the westward connection would be for trains operating between Richmond and both Raleigh, NC and Rocky Mount, NC. West of downtown Petersburg there would first be a connection to the A Line, for trains to Rocky Mount, then a connection to the S Line, for trains to Raleigh.

Concurrent with either the Dunlop or the Battersea option, and depending on the projected CSXT freight traffic flows through Petersburg, the Burgess Connection might be restored between Collier Yard on the A Line, and Burgess on the S Line. This would permit freight trains running to and from Raleigh to avoid the more pronounced grades and curves necessary in the Dunlop and Battersea options. It would also allow them to work at Collier, if desired, and be held there, if necessary.

Battersea Option (Via A Line and Existing Station)

A third main track would be constructed on the east side of the A Line, between Centralia and a point south of the existing Petersburg Station, at Ettrick. There the third track would diverge from the A Line, cross the Appomattox River on a new bridge, and split into connections to the east and west on the NS Norfolk District main line. Trains running between Richmond and Norfolk would pass by the former N&W station, and could stop there, if desired. Trains running to Raleigh would turn westward, operate over the NS for a short distance, pass

[14] References to the S Line mileposts south of Petersburg will conform to the original mileposts.

[15] A portion of the NS route to/from Norfolk that bypasses Petersburg. The track chart (No. 3) shows that a connection between the S Line and the NS Belt Line to and from Norfolk could potentially be located in the vicinity of MP S26. The whole issue of alternatives for direct rail passenger access to Norfolk is the subject of a separate study by the VDRPT.

under the A Line, and then diverge over a new connection[16] to the S Line. Trains running to Rocky Mount would continue southward from Ettrick on the A Line, in the same manner as they do today. As in the Dunlop option, the Battersea option might require the Burgess Connection to be restored for freight purposes.

Burgess–Norlina

(MP S30–S98.3; Track Charts 3-8)

This portion of the S Line once supported top speeds of 79 mph for passenger trains and 50 mph for freight trains but has numerous three and four-degree curves, which would (unless modified) greatly constrain future train speeds. The *Silver Meteor*, the SAL's fastest train between the Northeast and Florida, was scheduled in 1958 at one hour, 32 minutes between Main Street Station, Richmond, and Norlina; between those same points, the travel time for the Richmond–Charlotte high-speed trains is projected to be one hour, 15 minutes. This one-fifth reduction in travel time would be achieved by increasing the top speed to 110 mph and by relocating the line in several places where the current alignment would be unduly restrictive. In addition, to assure capacity for reliable operations, five sidings would be provided.

Table 6-1 describes the contemplated track additions and relocations between Burgess and Norlina:

Table 6-1: Sidings and Relocations Contemplated Between Burgess and Norlina

Location MP	Contemplated Track Additions	Location MP	Contemplated Relocations
S29.6-S34.5	**Burgess Siding**. There was a 1.8-mile signaled siding within this location (MP S30.9–S32.7). Therefore a significant portion of the new siding can be built on the former siding roadbed.		
		S37.1-S39	**Dinwiddie Relocation.** A 1.4-mile realignment, requiring a large fill, would eliminate two four-degree curves and reduce a three-degree curve to one-degree. Simulations of this improvement indicate that top speed on the relocated track would increase from 65 mph to 110 mph. The relocated alignment would reduce running time almost one-half minute and shorten the route by approximately 0.18 miles.
S41–S44.5	**DeWitt Siding**. There was a short (1.4-mile) signaled siding within this location (MP S41.2–S42.6). Therefore a portion of the new siding can be built on the former siding roadbed, albeit at the cost of spacing the De Witt siding about 7 miles from the Burgess Siding, or 3 miles less than the ideal 10 miles.		

[16] That is, the same connection that the Dunlop Option would employ for the same purpose.

Location MP	Contemplated Track Additions	Location MP	Contemplated Relocations
S55.4–S61	**Alberta Siding.** A signaled siding at Warfield began at MP S55.8 and extended to MP S57.3; a second non-signaled siding at Alberta began at MP S59.5 and extended to MP S61. The two former sidings would be connected into the 5.6 mile long Alberta siding, which would have crossovers near its midpoint (at Warfield), thus providing operating flexibility.	S58.5-S60.1	**Relocation.** Realignment of two curves in this 1.6-mile segment, within the limits of the contemplated Alberta Siding, would increase speed to 90 mph and help to eliminate the 80 mph speed restriction that would exist along the track segment between MP S45 and S61, if curve relocations and adjustments are not made. Travel time savings would approach 0.3 minute.
		S62.6–S65.9	**Relocation.** A 2.4-mile relocation would eliminate or reduce the curvature of six of the seven existing curves in the segment. The seventh curve would be reduced from three to two degrees by shifting the curve less than 25 feet inward. The realignment would cross two ridges, separated by a deep ravine. The former S-Line crossed the ravine and Great Creek on a 411-foot long, approximately 50 feet high deck plate girder bridge. It is assumed, for study purposes, that the ravine would be filled to eliminate the need for the Great Creek Bridge. Speed on the relocated track would increase to 90 mph, from the 65-75 mph that would be possible if the curves are merely adjusted. Travel time savings would approach 0.75 minute.
		S68.5-S75.3	**Relocation**. The 7.1-mile curve realignment and right-of-way relocation would incorporate the 3.7-mile Skelton Siding. Contemplated improvements would: • Reduce the curvature of four curves north of the Meherrin River Bridge; • Replace three curves south of the Meherrin River Bridge (MP S70.2) with one 1.6-degree right hand curve supporting speeds up to 100 mph; • Construct a 7,900-foot line change south of MP S71 to replace four curves with a pair of reverse 1.75-degree curves to shorten the existing alignment by approximately 400 feet; • Construct a 2900-foot relocation to replace two curves at the south end of the siding

Location MP	Contemplated Track Additions	Location MP	Contemplated Relocations
S71.2-S74.9	**Skelton Siding** (MP S71.2–S74.9). A mile-long non-signaled passing siding at Skelton was located between MP S73 and MP S74. Since this is difficult terrain, lengthening the siding to four miles would be difficult. However, in the absence of a better location, a new siding would be constructed from approximately MP S71.2 to the north end of the 271-foot, deck plate girder, Taylor Creek Bridge, at MP S74.9. The contemplated 7.1-mile curve realignment and right-of-way relocation would incorporate the siding.		with a single 1.5-degree curve; the relocation would provide sufficient room to place the turnout to the south end of the siding on a tangent north of the Taylor Creek Bridge; and • Reduce the curvature of Curve 75 from two degrees 20 minutes to one-degree 30 minutes by shifting the curve inward. These changes would cut travel times by 1.4 minutes.
		S77-S77.8	**Relocation**. A 4,600-foot realignment would replace three short three-degree reverse curves (75 mph) with one left-hand one-degree curve (110 mph) and eliminate a reduced speed zone in an otherwise high-speed stretch. The alignment avoids encroaching upon a cemetery adjacent to the right-of-way. The revised alignment would reduce transit time almost 0.5 minutes.
S83-S87.2	**Bracey Siding.** The north end of the Bracey Siding would be located less than the desirable 10-11 miles south of Skelton Siding. Rather than eliminate the siding or have spacing greater than 10 miles, the study team retained the capacity that the siding would provide. The roadbed of the northern end of the former Hagood signaled siding, which extended from MP S83 to MP S84.5, would be reused. The siding would extend to MP S87.2, and would subsume a 4,200-foot contemplated relocation.		
		S86.1-S87	**Relocation**. A 4,200-foot relocation would replace three curves (a left-hand 4.5-degree curve (60 mph), a right-hand 4-degree curve (65 mph), and a left-hand 4-degree curve (65 mph)) with one two-degree curve (90 mph, with five inches' superelevation). The relocation would enable Bracey Siding to extend from MP S83 to S87.2. The revised alignment would reduce transit time almost 0.3 minutes.

Location MP	Contemplated Track Additions	Location MP	Contemplated Relocations
		S89.4 –91.4	**Relocation**. One 2.5-degree, and two 3-degree, curves south of the Roanoke River Bridge would be realigned to reduce curvature to 1.5 degrees (110 mph). These realignments would extend a stretch where trains can operate at a constant 110 mph, three miles further north and create the longest continuous high-speed stretch (20 miles, Bracey (MP S88.0) and MP S108.2) between Richmond and Raleigh. The revised alignment would reduce transit time almost 0.2 minutes.

Norlina

(Track Chart 8)

The route from Portsmouth, Virginia to Raleigh, North Carolina —constructed before the route from Richmond to Norlina—was the direct route through Norlina. The S Line from Richmond connected to the original line with a 5 plus-degree curve at Norlina Station. A 3-degree curve was located one and a half miles north of Norlina at MP S96.5.

To make the S Line the optimal route through Norlina, a 1.6-mile relocation (MP S96.5–S98.7) would create a 7,000-foot long one-degree curve (110 mph) connecting the S Line and the Portsmouth Line. The new alignment would necessitate a grade separation and would make use of a reconstructed portion (3500 feet long) of the former line to Portsmouth. By eliminating the highly restrictive (60 mph) five- and three-degree curves at Norlina, the revised alignment would reduce transit time almost 0.9 minutes and would form part of the longest (20-mile) continuous high-speed segment between Richmond and Raleigh

The north end of the Norlina Siding would be at the south end of the one-degree curve.

Norlina–Raleigh

(MP S98.3–S157.4; Track Charts 8–12)

Between Norlina and Raleigh, CSXT has maintained the S line for light-density freight service. When this 58-mile section functioned as a main line, its top speeds were 79 mph for passenger trains and 50 mph for freight trains. The contemplated improvements include sidings, curve realignments, and a station at Henderson, North Carolina.

Norlina–Henderson

Table 6-2 shows the contemplated changes between Norlina and Henderson:

Table 6-2: Track Additions and Relocations Contemplated Between Norlina and Henderson

Location MP	Contemplated Track Additions	Location MP	Contemplated Relocations
S98.2–S102.0	**Norlina Siding.** The S Line previously was double tracked through Norlina, beginning at S97.8 and ending at MP S103.6. A new Norlina Siding would be constructed: its northerly portion would form part of the Norlina relocation, while the balance would reuse the former second track roadbed.		
		S102.5–S104.8	**Manson Curve Relocation.** Between MP S102.5 and S104.8 currently lie three curves, of which the central "Manson" curve exceeds three degrees and would restrict speeds to 75 mph. This relocation would ease the outer curves in this cluster, eliminate Manson Curve entirely, shorten the route by 1,000 feet, allow 110 mph speeds over the full 20 miles between MP S88.0 and S108.2, and save at least one-half minute in travel time.
S108.9–S111.3	**Greystone Siding.** From a spacing standpoint, the next siding south of Norlina should begin at MP S112.5, where a signaled siding previously was located. However, that location would place a new siding in Henderson, which has numerous highway crossings that would be blocked by a standing train. Instead, the existing non-signaled Greystone Siding (at MP S109.5–S110.5) would be extended to become a 2.4-mile siding between MP S108.9 and S111.3. Within the limits of the siding would be a crossing at Greystone Road and a private crossing.		

Henderson Station

Passenger service to Henderson ceased when Amtrak discontinued limited service on the S Line in the late 1980s. Restoration of passenger service would require construction of station and platform facilities. A single platform, planned for the east side of the right-of-way, would suffice at this location. The existing siding at Henderson, now used by the local freight train to serve the many industries there, would continue to be used for freight purposes; any necessary meets could occur at the nearby Greystone or Kittrell sidings.

Henderson–Raleigh

Table 6-3 lists the sidings contemplated between Henderson and Raleigh. The numerous curves south of Wake Forest[17] present particular operational and engineering difficulties and are evaluated below as a group.

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[17] Note that the community of Wake Forest that is situated on the S Line is **not** the site of Wake Forest University, which is in Winston-Salem.

Table 6-3: Track Additions Contemplated Between Henderson and Raleigh

Location MP	Track Addition
S120–S123.7	**Kittrell Siding.** Now abandoned, the formerly-signaled siding at Kittrell (MP S121.9– S123.5) would be reinstalled and extended in both directions. The siding would enable CSXT local freight train F735 to work clear of the main track at Gill.
S133.7–S138.0	**Youngville Siding.** The abandoned, once-signaled siding at Franklinton (MP S129–S130.5) is only 5.3 miles south of Kittrell and would not be reinstalled. Instead, an active, non-signaled siding at Youngsville (MP S135.3 to MP 136.6) would be upgraded as the next siding location south of Kittrell.
S147.6–S153.9	**Neuse Siding.** The north end of a former double-track segment, now removed, was at Neuse (MP S147.6). The double track extended for over six miles to MP S153.9 at Crabtree. It is contemplated that this double track would be rebuilt.
S155.2–S157.1	**Edgeton to Southern Junction.** The single track between Crabtree and Edgeton on the S Line north of Raleigh Yard would remain because a major bridge over Crabtree Creek can accommodate only a single-track. However, approximately two miles of double track would be restored, between a point south of the Edgeton curve (at MP S155.2)) and Southern Junction (MP S157.1). The restoration of this double-track would be essential to provide for efficient train movements throughout Raleigh.

Seventeen curves, of as much as 3.25 degrees, currently complicate the segment from Wake Forest southward, between mileposts 140 and 147.5. So close together as to obviate the installation of proper spirals, these curves restricted former passenger trains to 60 mph. Two options for dealing with the curves south of Wake Forest were evaluated:

- Modify individual curves; this option would raise top speeds to 75 mph and save 1.2 minutes in travel time from the current alignment's capabilities; or
- Treat these curves as a group, thus raising top speeds to 100 or 110 mph. and saving 2.6 minutes over the current alignment's capabilities.

This study assumed the latter option, which would include the following main work items:

- Closing Dunn Street crossing in Wake Forest to enable Curve 140.1 to be superelevated to increase passenger train speeds to 110-mph from 70 mph;
- Extending and relocating Curve 141 approximately 39 feet northward, to reduce the curve to 1.5-degrees;
- Grade-separating or relocating the Forestville Road crossing[18];
- Eliminating curves 142, 142.1, and 142.2, and constructing new tangent track extending to Curve 143;
- Reducing Curve 143 to 1.5 degrees, by moving it about 100 feet inward;
- Providing fill along a hillside to reduce Curve 143.1 to 1.5 degrees, and increase speed from 60 mph to 110 mph;

[18] As this monograph goes to press, NCDOT reports that this crossing has, in fact, been relocated.

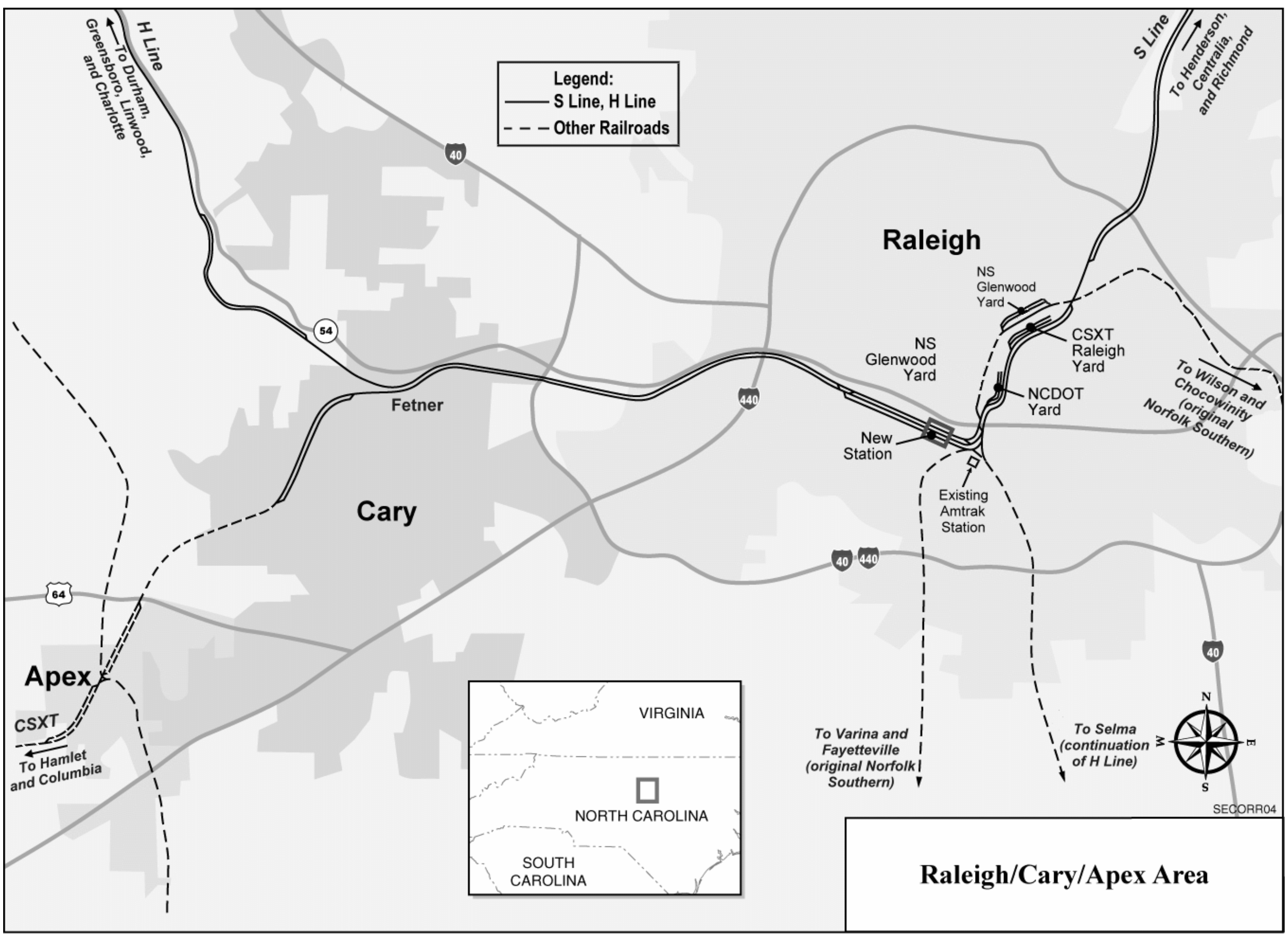
- Realigning Curves 144 and 144.1 to reduce radius from 2-degrees to 1.5 degrees, and achieve a 110 mph operating speed. The alignment of Curve 144.1 passes through the existing Route US 1 overpass;
- Altering the tangent direction between Curves 144.1 and 145 and realigning Curve S145 to 1.8-degrees, to achieve 100 mph; and
- Relocating tangent track between Curve 146.2 (1950 feet long) and Curve 146.3 (1750 feet long), south of Neuse River, to reduce curvature from 3.25 degrees each to 1.8 degrees. This would achieve a 100-mph operating speed. A 200-foot tangent would separate the curves.

Raleigh

(MP S54.6–H79; Track Charts 12-13)

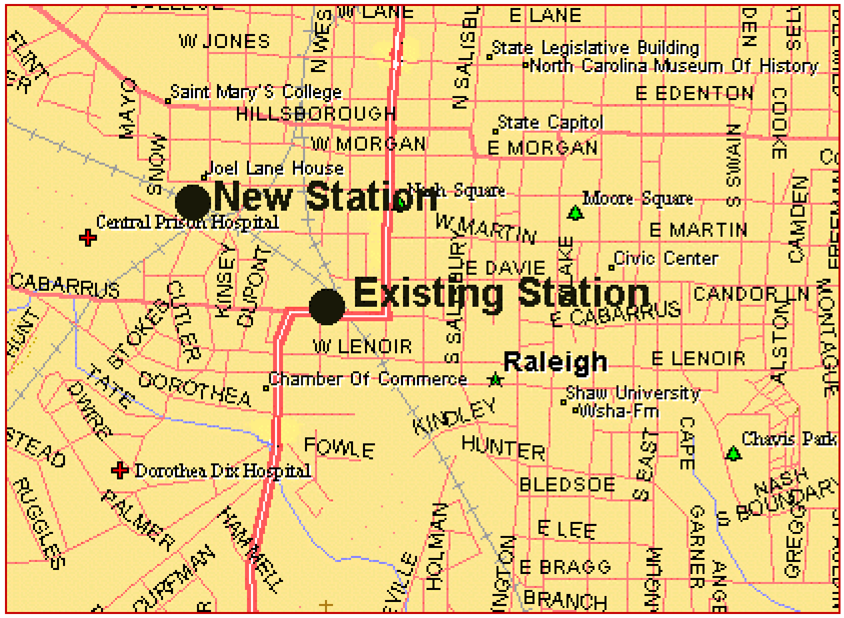
Raleigh (set in its regional context in Figure 6-4) would be one of the most complex dispatching locations in the route between Richmond and Charlotte. A revised configuration to support the contemplated operation was developed.

Figure 6-4: Overview of Rail Lines in Raleigh Vicinity



Raleigh Station

Figure 6-5: Existing and New Raleigh Station Locations



Source: NCDOT, http://www.bytrain.org/passenger/maps/raleighmap.html

Amtrak currently uses the Raleigh station of the former Southern Railway Company (SR), built in 1950. It is located on the H Line to Selma, just east of Boylan Interlocking. The SR discontinued passenger service to Raleigh in 1964. Passenger train service to the SR station resumed in 1984 when Amtrak moved from the old Raleigh SAL station upon the abandonment of the S Line and the substitution of a route via Rocky Mount, Selma, the eastern portion of the H Line, and Raleigh. The station currently accommodates three passenger train round trips daily: the *Carolinian*, *Piedmont* and *Silver Star*.

As the current station is not on the Richmond–Charlotte Corridor under the S Line routing assumption, it would require relocation. In any event, the NCDOT has stated that a new station is needed to accommodate current passengers and prepare for improved and expanded train service in the years to come. In 1995, a report identified, as a suitable location for a new and larger multimodal center, a site west of Boylan Interlocking on the H Line that would allow all existing and projected intercity and commuter trains to use a single facility. Recent studies completed by NCDOT have determined that a new station could accommodate over 500,000 passengers annually by 2015. Conceptual planning for the multi-modal center is underway; the planning phase is being funded jointly and equally by NCDOT, the City of Raleigh and the Triangle Transit Authority.[19]

The present study envisions that a low-level, 24-foot wide center-island platform would be located between Tracks 2 and 4,[20] with a side platform to adjoin Track 1. Normally, passenger trains would make use of Tracks 1 and 2, but the new Track 4 (destined mainly for

[19] This background information on the existing and proposed Raleigh stations comes from NCDOT at http://www.bytrain.org/passenger/stationimp/iraleigh.html.

[20] Track numbers are based on the track charts in Appendix D, and are also used in the relevant figures. These numbers are often hypothetical: in many cases the tracks referred to neither exist nor have ever existed, so that the railroad has never had occasion to number them.

freight trains) would afford additional flexibility. The simulation revealed that the platform configuration and the adjacent interlocking (south of the station—see page 6-22) would have important capacity benefits.

The station would be a multi-modal terminal serving local bus, TTA, long-distance bus, taxi, and auto, in addition to intercity trains.

Overview of Operation

The complexity of railway traffic in Raleigh stems from the multiplicity of flows and types of operations to be served, as illustrated in Table 6-4

Table 6-4: Train Movements Through Raleigh

To and From the North and East	To and From the South and West
1. NS freight trains to and from Glenwood Yard;	1. NS freight trains to and from Linwood Yard and the P Line;
2. CSXT freight trains to and from Raleigh Yard;	2. CSXT freight trains to and from Cary, Apex, Columbia;
3. NS freight trains to and from the H Line toward Selma[21];	3. NS freight trains to and from Varina;
4. CSXT freight trains to and from north of Raleigh on the S Line;	4. Intercity passenger trains to and from Greensboro and Charlotte; and
5. Intercity passenger trains to and from Richmond on the S Line; and	5. Intercity passenger trains to and from Cary, Apex, Columbia
6. Intercity passenger trains to and from the NCDOT Yard adjacent to the CSXT Yard at Raleigh.	

Contemplated CSXT Operations Through Raleigh[22]

Local Freight Trains

CSXT would operate two local freight trains per day north of Raleigh, on the S Line, originating at Raleigh Yard. The exact operating limits of the trains would vary somewhat from day to day, depending upon the workload. The first train would operate north of Wake Forest to Norlina, while the second train would turn at about Wake Forest and continue south of Raleigh, working through Fetner to Apex on the CSXT Line, before returning to Raleigh Yard. As initially simulated for this study, the second local freight train received a large number of significant delays because of conflicts with daylight passenger and freight trains. Therefore, it was rescheduled to leave Raleigh at 1:00 a.m., when passenger trains would not be operating.

[21] Also any residual intercity passenger trains making use of the route via Selma; none of these are assumed to remain in this analysis.

[22] Details of the assumed 2020 NS and CSXT freight trains are presented in Appendix F.

Through Freight Trains

A freight train would depart Raleigh Yard southbound for Hamlet, North Carolina with cars from the two local trains, and would return northbound to Raleigh Yard from Hamlet with cars for that day's local trains. This train would also provide local service between Cary and Hamlet.

CSXT has proposed that four northbound and four southbound intermodal trains would operate between Fetner and Centralia. In the simulations, these trains were assumed to operate uniformly during the day. The trains would randomly enter the corridor between the time scheduled and two hours later. These trains would not work at Raleigh.

A northbound and a southbound merchandise train[23] with traffic to and from Richmond and points north would operate between Fetner and Centralia; these trains would work at Raleigh.

Contemplated NS Operations at Raleigh

Local Freight Trains

A local freight train (LCL6) works between Raleigh and Pomona Yard in Greensboro. The train serves industries on the branch between Glenn (on the H Line at MP H46.8) and Chapel Hill. In the initial simulations for this study, this train was scheduled to work during daylight; with the large number of passenger trains, however, the local freight train could not reach Greensboro in less than twelve hours. [24] Therefore, its schedule was changed to a late evening start. Since nearly all the industrial sidings between Raleigh and Greensboro are trailing going west,[25] an eastward counterpart local freight has not been scheduled. A Spencer Yard[26]-to-Raleigh through train was assumed to handle local service to the few trailing-switch sidings going east.

Through Freight Trains

Three westbound[27] and three eastbound NS through trains would operate daily between Raleigh and Greensboro, via the H Line. Over the 7-day period of the simulation, all these trains randomly entered the system between the time scheduled and two hours later.

- Westbound and eastbound trains (NSLI/LINS[28]) would operate through Raleigh between Spencer Yard and Chocowinity (located to the east of Raleigh and Wilson, on the original Norfolk Southern Railway[29] line).

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[23] Designated "HAAC" and "ACHA"—Hamlet/Acca Yard (Richmond) and vice versa

[24] Twelve hours is the maximum length of time that a single crew can work under the hours of service regulations.

[25] I.e., each siding joins the main line at the siding's western end. Since the locomotive is at the front of the train, this arrangement makes a westbound train more efficient for local switching than an eastbound train.

[26] As described in Chapter 2, Spencer Yard is located in Linwood, North Carolina, approximately eight miles north of the Salisbury station.

[27] The westbound-only local freight brings the total number of southbound NS trains to four.

[28] These codes refer to the Proposed 2020 Schedules in Appendix F.

[29] The original Norfolk Southern Railway was a regional railroad serving eastern Southside Virginia and North Carolina. Its main line extended from Hampton Roads to Raleigh, and thence via its own route (different from the H Line) to Charlotte. At Varina (south and west of Raleigh), a branch line left the main for Fayetteville, to the south. The original Norfolk Southern Railway was purchased by the Southern Railway System on January 1,

- Westbound and eastbound trains (RAWS/WSRA) would operate between Raleigh (Glenwood Yard) and Roanoke, via Winton-Salem.
- Westbound and eastbound freight trains (RALI/LIRA) would operate between Raleigh (Glenwood Yard) and Linwood (Spencer Yard).

Additional trains may enter or leave Glenwood Yard, but only daily southbound and northbound freight trains (RAFA/FARA) that operate between Raleigh and Varina/Fayetteville over the original Norfolk Southern Railway were simulated. Each of these trains must cross the Richmond–Charlotte Corridor at grade, without a significant impact on SEC train operations.

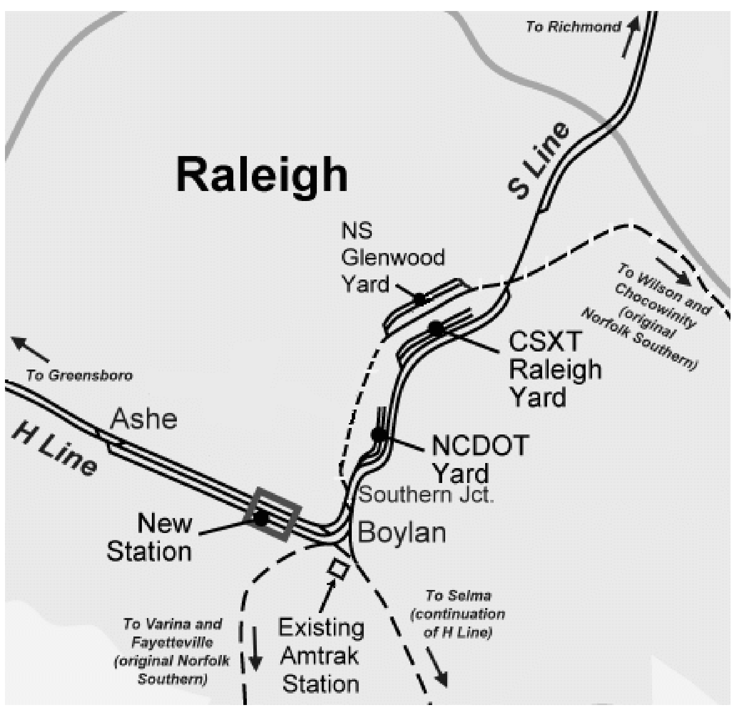
Also considered in the analysis, but not simulated, were occasional NS freight trains over the H line between Raleigh (Glenwood Yard) and Selma.

Operating Challenges and Contemplated Solutions

The challenge in Raleigh is not the frequency of trains, but the diversity of their origins and destinations, the potential for conflicting paths, and the need to anticipate conflicts and provide adequate trackage to alleviate those conflicts' effects. In particular, trains need efficient, accessible space where they can be held for higher-priority trains. The following sections briefly identify the most serious operating challenges in Raleigh and illustrate the contemplated resolutions. Figure 6-6, a close-up map of Raleigh proper, and Figure 6-7 (a condensed track chart showing the existing configuration and the contemplated improvements in Raleigh) provide background to this discussion.

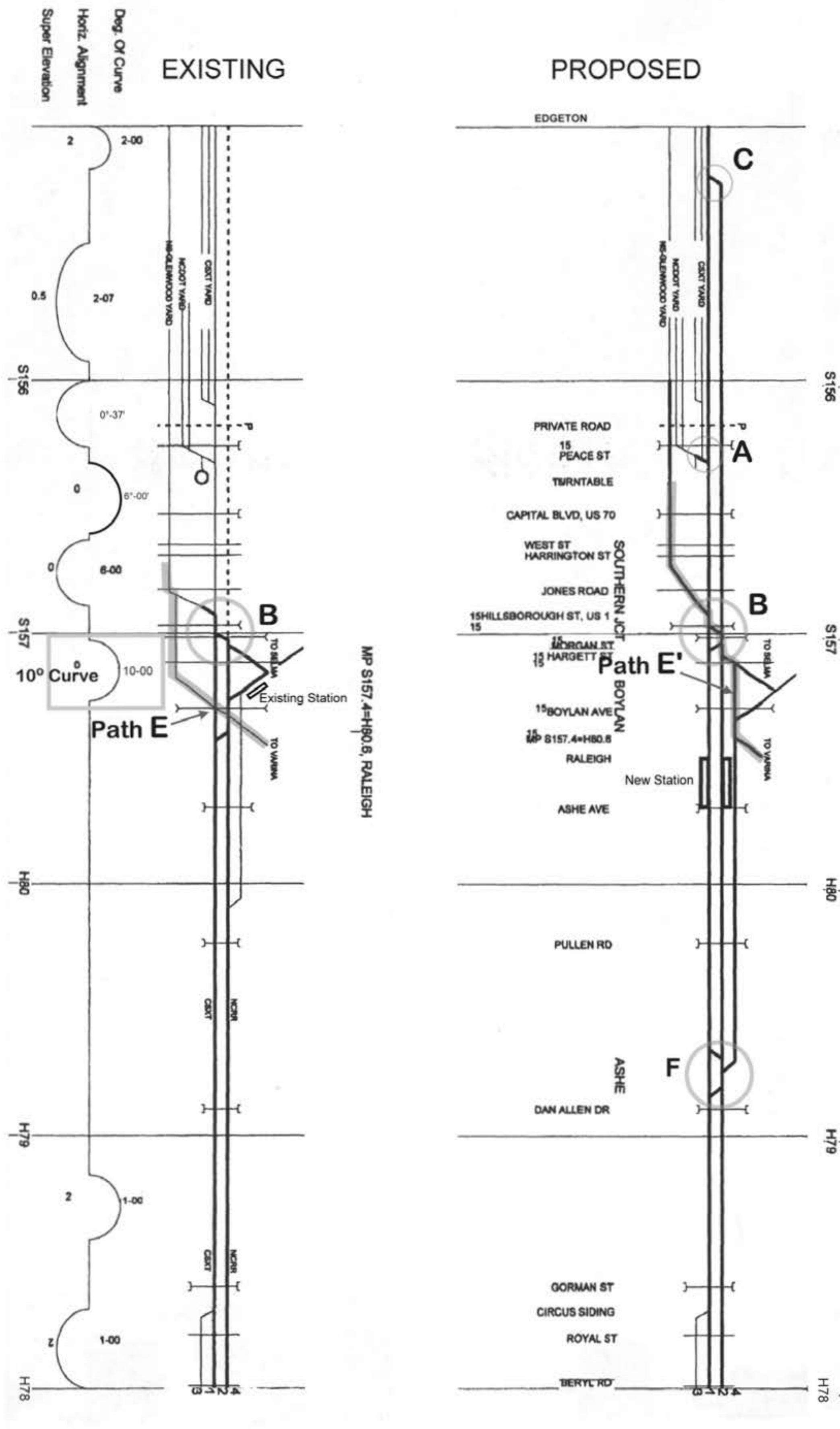
Figure 6-6: Close-Up of Raleigh

[Track Layout Reflects "Contemplated" Configuration in Figure 6-7]



1974. Subsequently, the Southern merged with the Norfolk & Western to form the current NS. Source: http://www.trains.com/Content/Dynamic/Articles/000/000/000/385hxunm.asp.

Figure 6-7: Schematic of Raleigh



Challenge: Provide Efficient Access To and From CSXT and NCDOT Yards

Improvements are needed to speed up the moves between the yards and the main line, thus freeing up main line capacity.

Contemplated Resolution

A single turnout— electronically interlocked and remote-controlled—would link both the NCDOT and CSXT yards with S Line Track 1 at Peace Street (see reference point A[30] in Figure 6-7). In turn, the turnout branching off to the CSXT yard from the joint lead track would also be power-operated. The substitution of electronic for manual operation would expedite Raleigh–Charlotte passenger train movements—five originations and five terminations per day—as well as the CSXT yard moves.

Challenge: Single-Track Bottleneck at Boylan/Southern Junction Interlocking

At present, any train occupying the single-track section at reference point B essentially blocks all traffic in all directions in Raleigh.

Contemplated Resolution

Boylan/Southern Junction would be reconstructed as a multiple-track, universal interlocking with the following features and benefits:

- Double track would extend northward to reference point C (near Edgeton), allowing additional flexibility for trains to be held and to pass each other;
- Access between the NS Glenwood Yard and the former Norfolk Southern Railway south to Varina would be changed from a crossing at Boylan (Path E) to a progressive move across new crossovers and trackage (Path E′). Removal of the crossing at Path E would allow the rigid crossing frogs at Boylan Interlocking to be removed, thus enabling adequate spirals and superelevation to be installed in the ten-degree curve between Boylan and Hargett Street. As a result, speed over this ten-degree curve would increase from 10 to 30 mph on Tracks 1 and 2.
- Also, NS freight moves to and from the Glenwood Yard would see a rise in MAS to 30 mph, since the track leading to the yard is signaled, and the No. 15 turnouts would allow freight train speeds up to 30 mph.

Challenge: Additional Train Holding/Passing Space Needed South of Boylan

Even with the Boylan/Southern Junction interlocking expanded, there would still be a need to for trains to hold, or pass each other when feasible, south of reference point B in the event that—

- One or two passenger trains are stopping at the new Raleigh Station (see below);
- A freight train is ready to depart the CSXT Yard or NS Glenwood Yard;

[30] All reference points in the Raleigh discussion refer to Figure 6-7.

- Two southbound trains, of whatever type, are competing for a slot to leave Raleigh; and/or
- Southbound trains are occupying the single-track stretch north of Raleigh.

These are just examples; with so many potential paths involved, many eventualities will call for additional flexibility and capacity in the Raleigh area.

Contemplated Resolution

Track capacity south from Boylan/Southern Junction would be expanded as follows:

- A new or rehabilitated third track would extend all the way from reference point B to reference point F.
- A new, three-track Raleigh Station—with platforms serving all three tracks—would be built on the straight segment between Boylan and MP H80. This site has the added advantage of lacking highway-railroad grade crossings.
- A new universal interlocking, "Ashe," would be constructed at reference point F. This interlocking would position and sequence northbound trains for access to the station, the three yards, and the S Line toward Richmond. In effect, Ashe Interlocking would convert the two parallel single-track operations of the CSXT and the NS between Fetner and Raleigh[31] into a more flexible, double-track operation—to all carriers' benefit.

Additional Flexibility Proximate to Raleigh

Also immediately assisting the operation in Raleigh would be the provision of long passing sidings at three nearby locations:

- Between Neuse and Crabtree, north of Raleigh on the S Line (see page 6-14)—approximately 6½ miles long;
- Between Cary and South Cary, west of Raleigh on the H Line (less than three miles long); and
- On the connecting CSXT line south to Hamlet and Columbia, a 3½-mile siding beginning some 2½ miles south of the junction with the H line at Fetner (see Track Chart 14a and the description on page 6-24).

Provided on each of the more important routes converging at Raleigh, these sidings would greatly enhance the flexibility of train operations by allowing dispatchers to hold and sequence trains just outside the terminal zone.

[31] At present, there is no interlocking between Fetner and Boylan—a distinct handicap in this area of special complexity.

Raleigh–Greensboro (H Line—Runs East and West)

(MP H80.6–H "Zero"; Track Charts 13–19)

The H Line between Raleigh and Greensboro would be upgraded to top speeds up to 110 mph. Although passenger trains speeds would be increased throughout the line, numerous restricted speed locations would remain.

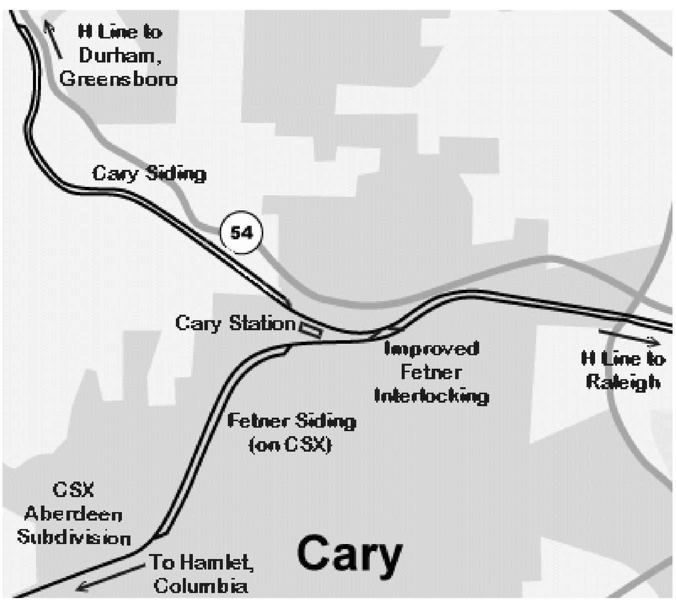
The projected increase in intercity rail service, at increased operating speeds, would require additional track capacity between Raleigh and Greensboro for overtaking freight trains and meeting freight trains or other passenger trains. Almost 31 miles of siding-track (38 percent of the 81 route-miles), with appropriate interlocking modifications, would be constructed. The changes in track configuration would ease congestion, ensure dependability of the train schedules, offset capacity constraints, and accommodate the increased level of intercity passenger and freight movements.

Raleigh–Fetner/Cary

(MP H80-6–H64.0, also CSXT Aberdeen Subdivision; Track Charts 13, 14, 14a)

The conversion of the eight-mile segment between Raleigh and Fetner from what are effectively two single-track lines operated by CSXT and NS,[32] to a double-track, high-capacity railroad (see page 6-22) would also entail the upgrading of both tracks for uniformly higher speeds. Figure 6-8 depicts additional site-specific projects contemplated for the vicinity of this segment; they are as follows:

Figure 6-8: Fetner/Cary Vicinity



Fetner Interlocking

Fetner Interlocking (MP H73) would be reconfigured for more flexible and faster operation. Located on a curve at the junction of the H Line and the CSXT Aberdeen Subdivision, the interlocking enables CSXT trains on the CSXT-owned track between Raleigh and Fetner to access the Aberdeen Subdivision and NS trains on the H Line track to access the H Line west of Fetner.

To facilitate these train movements, the interlocking would be moved to a 1000-foot tangent between the two curves at Fetner, and turnout sizes would be increased to Number 20. Accordingly, maximum train speeds for diverging moves at this interlocking would rise from today's 25 mph to 45 mph (passenger), and from 15 mph to 40 mph (freight). The interlocking can be reconfigured independent of the work on the Fetner or Cary Sidings.

[32] This segment is, however, dispatched by CSXT from Jacksonville for both the CSXT and NS tracks.

Fetner Siding on CSXT Aberdeen Subdivision

(Track Chart 14a)

To keep operations fluid on the H Line and through Raleigh, a siding would be installed just south of Fetner on the CSXT Aberdeen Subdivision. The siding would allow trains to and from the Aberdeen Subdivision to meet or pass. If, for example, an eastbound freight train is to meet a westbound freight train at Fetner, the eastbound train can be held on the siding allowing the westbound train to easily access the CSXT line, minimizing delays on the H Line. The siding would be located so that a freight train occupying the siding would not block any of the grade crossings located just south of Cary Station.

Cary Station

Presently served by two Amtrak round trips daily, Cary is assumed to receive intercity passenger service from "local" Charlotte–Raleigh high-speed trains, as detailed in Appendix F. A single-track, single-platform station is envisioned at the present location—between Henderson and Academy Streets at MP H72.6.

Cary Siding (on H Line West of Cary Station)

Operations west of Raleigh are complicated by a long 0.85 percent grade at Ashe Interlocking. This grade would prevent southbound freight trains, originating in the Raleigh vicinity, from attaining their maximum allowable speed on the H Line for many miles. Indeed, train performance calculator simulations indicate that heavy freight trains, close to their maximum tonnage, would accelerate to only 14 to 15 mph (i.e., four minutes per mile) for the first four miles south of the yard track at Southern Junction. Because of this poor performance, —in the absence of a siding just south of Raleigh, —freight trains would have to be held in the Raleigh yards for as much as an hour in anticipation of a passenger train's arrival from Richmond, if delays to the passenger train are to be prevented.

To avoid this need and to expedite freight traffic, a new, 3.6-mile passing siding would be located on the H Line west of Fetner Interlocking and the Cary station, and would extend between MP H72.6 and Crabtree Creek at MP H69. To be used primarily by freight trains, the Cary siding would provide a location for a slow-moving westward freight to be overtaken by a passenger train. The siding also would provide capacity to store an eastward freight train if the route between Fetner and Raleigh becomes congested with CSXT and NS freight trains. Two highway crossings, one public and one private, would be located within the limits of the siding. The public crossing, Morrisville Boulevard, would have to be grade-separated because of superelevation in both the main track and the siding.[33]

Curve Realignment between Cary and Brassfield

Between MP H65.1 and MP H64.4, an existing three-degree curve would be reduced to 2.15 degrees, with the maximum allowable speed increasing from 70 mph to 90 mph.

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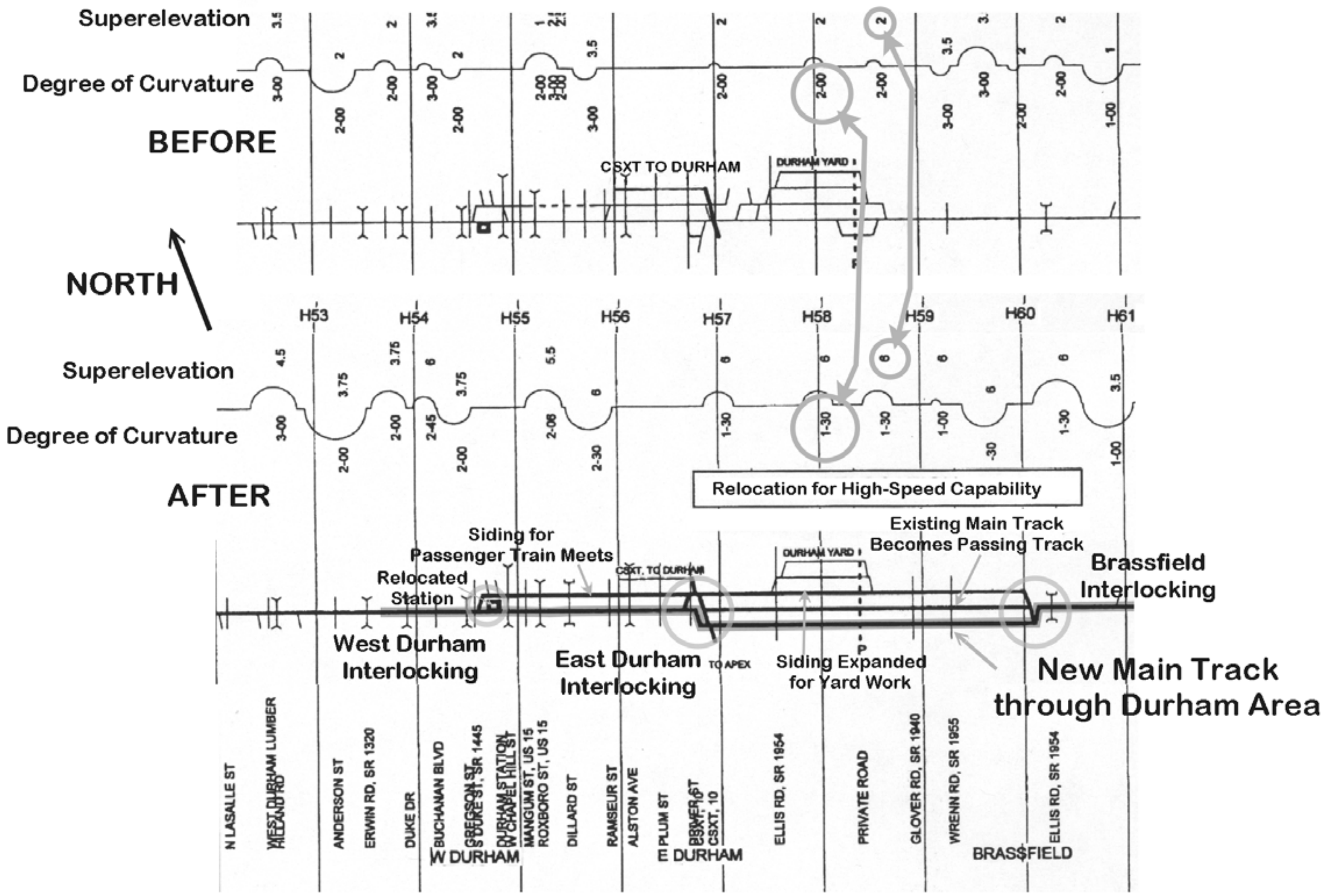
[33] That is,—as described in Chapter 5,—with banking in both the main and passing track, the highway surface would have a "double hump" at the crossing—not a recommended condition.

Projects in the Durham Vicinity

(MP H64-H52)

Figure 6-9: Durham



The route through Durham currently suffers from a difficult alignment, with numerous curves of two degrees and more, as well as a lack of sufficient main line capacity parallel to a busy yard. In fact, a siding does not now exist to enable a freight train to set off or pick up at Durham Yard without blocking the main track of the H Line. This capability is needed to protect reliable freight and passenger service. Thus, a coordinated program of improvements in the Durham area is contemplated (see the schematic, Figure 6-9):

- A relocated, new main track would be provided on the southerly side of the existing right-of-way, from a new Brassfield Interlocking (MP H60.3) through a reconstructed East Durham Interlocking (MP 54.6), and effectively continuing through to West Durham Interlocking. In total, 3.7 miles of new track would be reconstructed and eight curves relocated to create a 6.8 mile section of 110-mph operation between Mileposts H62.8 and H56.[34,35]

- The new main track would be built with curves not exceeding 1.5 degrees, with superelevation and spirals designed for 110 mph operation. These improved features are clearly shown in Figure 6-9 (note highlighted examples of lower curvature and higher superelevation).
- The existing main track would be converted to a passing siding between Brassfield and East Durham;
- The existing siding at Durham Yard would be expanded to provide needed capacity for freight trains to stand or work independently of passenger trains;
- The station would be relocated and redesigned. In July 1996 the City of Durham and the NCDOT opened a new interim station downtown. The station replaced a small bus-type shelter that served the City for six years. A new multi-modal center is planned for Durham in the vicinity of the old Liggett & Myers Tobacco Company, near West Durham Interlocking. The site is located alongside the longest section of track unbroken by city streets in downtown. The multi-modal center will be adjacent to several other historic buildings that are being refurbished for residential, entertainment and office use. A center-island platform will be provided to serve intercity passengers at MP H54.8; and
- Existing sidings would be expanded and joined between East and West Durham Interlockings, to enable passenger trains to meet at Durham. Although this siding would have numerous highway crossings, it would be suitable for passenger purposes and would enhance the flexibility of the line.

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[34] The contemplated Triangle Transit Authority (TTA) rail commuter facility through this location is proposed to cross over from the west side to the east side of the NCRR right-of-way on an elevated structure. The final design of the high-speed rail improvements would need to be coordinated with the proposed TTA alignment to ensure that a mutually beneficial set of improvements is achieved.

[35] Contemplated improvements for this 110-mph section also would include: lengthening the spirals of Curve H60.1 and relocating a left-hand industrial switch located on the low side of the curve; reconstructing Curve H60 as a 1.5-degree curve and grade-separating the Route 1654 crossing; reconstructing Curves H59.1 and H59 from 3 degrees to 1- and 1.5 degrees, and eliminating Curve H59.2; and reconstructing Curves H58, H57, and H56, reducing these short 2-2-degree curves to 1.5 degrees. The remaining four curves in the section would be realigned for 85-mph train operation. Recommended improvements include: Reducing Curve H55.3, a 3-degree curve, to 2.5-degrees by shifting the track inward approximately 32 feet, onto the roadbed of former CSXT tracks; the potential for closing, or grade separating the Fayetteville Street crossing, located in the west spiral of this curve should be evaluated; extending the new east H55.3 spiral through Ramseur Street crossing; realigning Curves H55.2, H55.1, and H55 to a uniform 2.1 degrees; and closing Dillard Street, in the east portion of the curve, by constructing a grade separation to avoid a highway crossing on a curve with six inches of superelevation. Alternatively, if the crossing were not grade separated, traffic could be channeled to the Roxboro Street underpass. The curves are located within the limits of the proposed siding between East and West Durham Interlockings, but could be constructed independent of the siding.

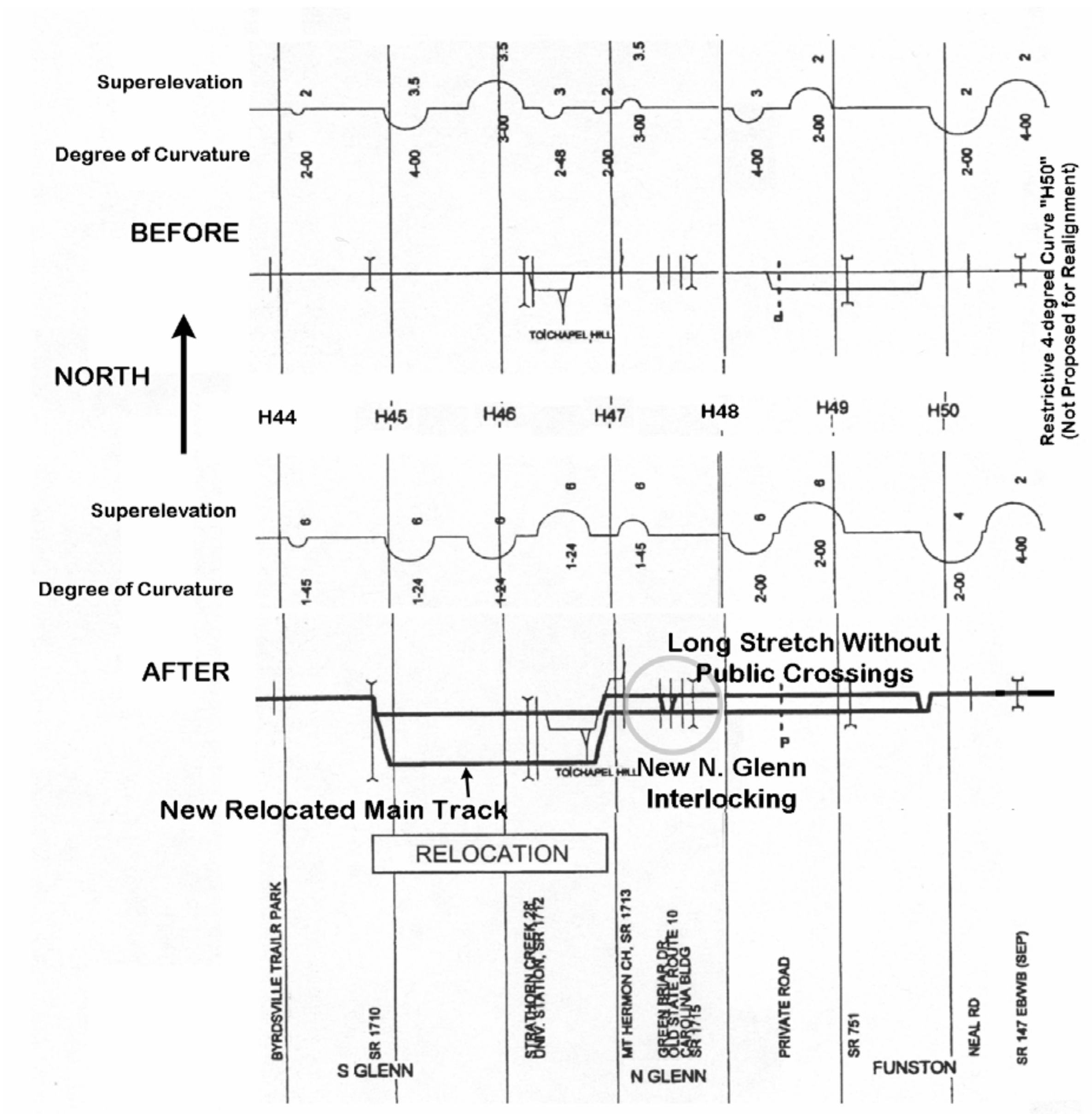
Durham–Greensboro

(MP H52–H02; Track Charts 15-19)

Funston–Glenn Siding and Relocation

An important track doubling and curve realignment project is envisioned in the area between MP H 49.0 and H 43.1. In this area, a second track would be built on a relocated alignment to serve as the new main track (see Figure 6-10); the old main track would serve as a passing siding.

Figure 6-10: Funston–Glenn Siding and Relocation



Combining the existing, shorter, Funston and Glenn sidings, a new 5.0-mile second track would be constructed with a mid-point interlocking—North Glenn. Toward Funston there would be a two-mile section that is free of highway crossings, hence able to hold long freight trains without adversely affecting highway traffic.

With the existing main track to be converted to a siding, 11,000 feet of new main track would be constructed to eliminate several restrictive curves. The new track would bridge over the branch to Chapel Hill[36] and would cut directly across Stony Creek valley on a 50-foot fill. University Station Road would continue to cross the existing track (i.e. the contemplated passing siding) at grade, but would grade separated over the new main track. The relocation would end near the Highway 10 underpass, west of the current west end of Curve H44.1. Approximately 800 feet in distance would be saved.

Due to this project, the route would be straighter as well as shorter: a series of curves, ranging between two and four degrees, would be adjusted to eliminate restrictive speeds.[37] Upon completion of these adjustments, Curve H50—a 2,935-foot, four-degree, 60-mph curve spanning four-lane SR 147—would be the most restrictive curve between Hillsborough (MP H40) and Raleigh (MP H80).

The changes between MP H43.1 and MP H49.0 would create a 4.9-mile long segment that can be operated at 100-110 mph. The reduction in distance traveled would reduce travel time about 0.1 minutes. The increased speed on the remaining trackage would save an additional 1.1 minutes. Thus, a travel time reduction of 1.2 minutes would be achieved.

Other Capacity and Curve Changes

The sidings and curve realignments contemplated for the segment between MP H43.1 (South Glenn) and Greensboro appear in Table 6-5.

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[36] There would be no connection between the new main track and the Chapel Hill branch.

[37] The curve adjustments would include:

- Slightly modifying Curve H49, which reverses into Curve H50—a long four-degree curve. With less than 100 feet between the spirals of Curves H49 and H50, and with Curve H50 not planned for major straightening, the TPC runs indicate that the maximum speed achievable through Curve H49 would be less than 80 mph. Therefore, Curve H49 therefore, the curve would be merely adjusted, not relocated;
- Realigning Curve H48.1, a 2-degree curve, to support 95 mph operations;
- Shifting Curve H48, a 4-degree curve, inward 200 feet, to reduce curvature to two degrees and also remove a 65 mph restriction;
- Shifting Curve H47, a 3.3-degree curve, less than 35 feet, to achieve 1.75 degrees and 100 mph operation;
- Moving the industrial switch leading to Carolina Builders (MP H47.1) westward from the body of the curve to locate it on tangent track;
- Constructing a 2.1-mile (11,000-foot) segment of second-track (including Curves H46.1, H46, H45, and H44.1 to increase speed, facilitate lengthening of the Funston Siding, and provide access to Chapel Hill on the Glenn-Carrboro Branch; and
- Realigning Curve H44, a short 2-degree curve to 1.75 degrees for 100 mph operation.

Table 6-5 : Track Additions and Relocations Contemplated Between South Glenn and Greensboro

Location MP	Contemplated Track Additions	Location MP	Contemplated Relocations
		H42.9–H41.8	Curve H42.1, a 3-degree curve, Curve H42, a 4-degree curve, and Curve H41.1, a 3.5-degree curve, would be realigned to increase speed to 75 mph. This would eliminate a restrictive 60 mph segment. The realignment would include: • Constructing a new bridge for Cates Run (currently 47 feet long) to adjust Curve H42.1; • Adjusting the tangent between Curves H42 and H41.1 enabling the curvature of Curve H41.1 to be reduced from 3.5 degrees to 3.15 degrees, and Curve H42 to be reduced from four degrees to three degrees; and • Relocating an industrial switch to Georgia Pacific, located in the spiral of Curve H42, to the new tangent to improve ride quality and reduce maintenance costs.
H37.5–H31.6	**Efland–Mebane Siding.** The existing Efland siding should be extended southward to include the existing siding at Mebane. A curve realignment at Efland (see columns to the right) would allow the existing main track to become the new siding at that location. The extension would result in a 5.9-mile long siding between MP H37.5 and MP H31.6. The long siding would enable a passenger train to meet one freight train and overtake another freight train (see Chapter 4). A mid-siding pair of crossovers would be provided to enable two opposing freight trains to occupy the siding at the same time. The north portion of the siding has a section of more than two miles without a highway crossing.	H38.9–H36.4	A 1.5-mile relocation would reduce two 3-degree curves; Curves H37 and H38.2, each limited to 70 mph, to 1.75-degree curves. In addition, Curves H38 and H38.1 would be eliminated. To be constructed in conjunction with the Efland–Mebane Siding, the relocation would increase operating speeds to 100 mph. The main track would be constructed on the 100-mph alignment. Southward trains would likely save less time because of the grade between Eno River and Efland.
		H29.2–H26.3	The numerous curves in this section would be grouped together and relocated. The compound curves H28.4, H28.3, and H28.2 would be realigned to a maximum of 1.56 degrees, to achieve a 105 mph operation. Curves H28.2 and H26.2 would be relocated and connected, to eliminate restrictions on the five intervening curves, thereby raising the speed limit from the current 60/70 mph to 105 mph. A new bridge spanning Back Creek (MP H27.6) would be constructed. Curve H26.1 is a 3-degree curve located immediately south of Curve H26.2, a 4-degree curve. These curves must be considered together to achieve a 75-mph alignment. Curve H26.2 would be realigned; Curve H26.1 would be shifted 34 feet to achieve 75 mph. The track would continue to pass under the State Route 1928 overhead bridge. Curve H26, a 579-foot, 4-degree curve, would be shifted inward five feet to create a 3-degree, 75-mph curve.

Location MP	Contemplated Track Additions	Location MP	Contemplated Relocations
H25.5–H21.5	**Haw River Siding.** Haw River, a totally new siding, would be located between MP H25.5 and MP H21.5. The siding would be west of the bridge over the Haw River and east of the Burlington Station. Approximately a 2-mile section in the north portion of the siding and a 1.5-mile section at the south end of the siding would be free of crossings. As is the case with several other project proposals on this single-track line, the current main track would become the siding in this section. This would enable an industrial switch to remain on the former main track.[38] This siding and its westerly approaches would be designed in conjunction with the curve relocations between MPs H22.3 and 20.5, most of which is single-track.		
		H22.3–H20.5	In Burlington, Curves H21.2 and H21.1, and reverse Curves H21 and H20.2, appear to be the result of cuts and throws when adjacent tracks were removed. Lengthening both reverse curves would increase operating speed to 100 mph or greater. A 2700-foot section of new track would be constructed parallel to the current main track and the current main track would be retired to eliminate Curves H21.1 and H21.2. (The new track would extend southbound from Mebane Street to the north end of Curve H20.1.) The curve relocations would be constructed in conjunction with the South Burlington end of the Haw River Siding.
H11.8–H7.8	**McLeansville Siding.** An existing siding at McLeansville should be extended northward to MP H11.8 and southward to MP H 7.8 to create a four-mile long siding. This siding would have an interval of about 1.6 miles where a freight train can stand without blocking any highway crossings.		
		H6.3–H5.6	Curve H6, a right-hand 1-degree curve, presently is only 44 feet from Curve H5.3, a right-hand 2.5-degree curve. The curves would be realigned into one continuous 1.58-degree curve to achieve 100 mph operation. A new bridge over Buffalo Creek would be required as part of this realignment. . Curves H5.2 and H5.1 form a compound curve of 2.1 degrees on the east end and 1.8 degrees on the west-end.[39] They would be realigned to achieve a continuous 2-degree curve capable of 95 mph operation.

[38] The turnout to Cannon Mills, an active industry, comes off the high side of Curve H23. Designating the existing main track as a siding would enable the industrial switch to come off the siding with less superelevation than the main track. (Superelevation, while assisting high-speed through traffic, complicates freight switching operations.) The need to facilitate rail freight access to active industries is an important consideration throughout the conceptual design of this corridor, which has much more on-line industry than other corridors addressed in this series of transportation plans.

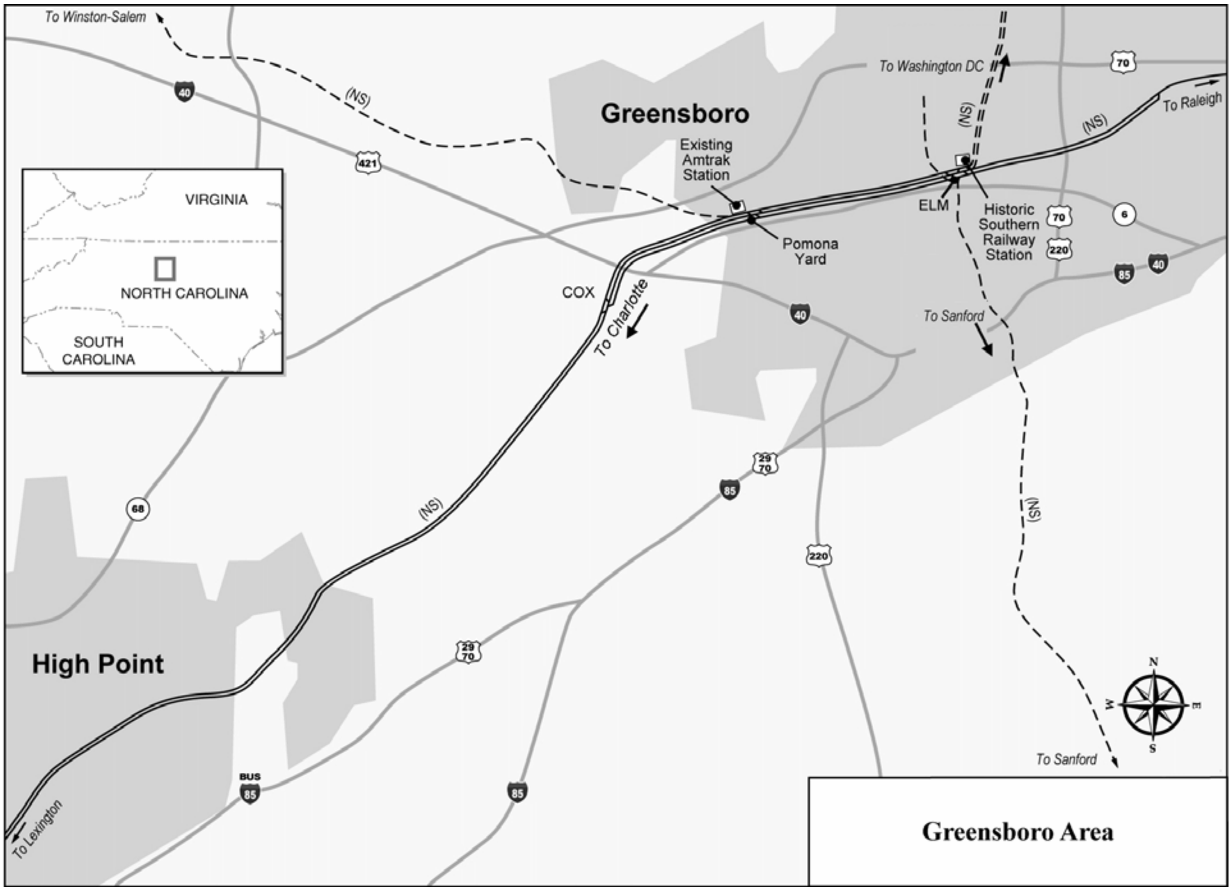
[39] On Track Chart 18, these are shown as a single 1.8-degree curve. The division into Curves 5.2 and 5.1, described in the table, results from analysis of recent track geometry car data.

Greensboro

(Track Charts 19-20)

Greensboro—the site of an important yard (Pomona) and a major junction on the NS system—is an area of special complexity, as depicted in Figure 6-11.

Figure 6-11: Overview of Greensboro



Introduction to Greensboro

Routes converging at Greensboro, all operated and/or owned by NS, comprise:

- The P Line;
- The H Line;
- The line from Pomona to Winston Salem and Rural Hall, and
- The line from Pomona to Sanford, North Carolina.

Elm Interlocking, at the north end of Greensboro, is located at the intersection of the P Line with the H Line to Raleigh; the historic Southern Railway station site is at Elm. Cox Interlocking is located some two miles south of Pomona Yard.

Pomona Yard and an intermodal yard are located on the east[40] side of the Main Line, south[40] of central Greensboro. At present, all Amtrak trains stop at the station/yard tower adjacent to Pomona Yard.

Freight cars for local delivery on the lines radiating from Greensboro are handled at Pomona Yard. NS trains originating at or bound for Spencer Yard at Linwood, near Salisbury (the primary classification yard on the Piedmont Main Line, some 40 miles south of Pomona) use the main tracks at Pomona to set off and pick up cars pertaining to the Greensboro area. These yard-related operations impact main line movements and have implications for the future of this line.

Greensboro Station Relocation

Figure 6-12: Existing Greensboro Station

Integral to the development of the Richmond–Charlotte Corridor would be the relocation of the existing Greensboro Station to the former Southern Railway's downtown station.

The existing station is the first floor of the Pomona Yard tower building located three miles south of the historic downtown Greensboro station. At the existing station, Track 1 is the northward track and Track 2 is the southward track. The existing passenger station/platform is located adjacent to Track 2, on the west side of the right-of-way, which requires trains in both directions to use the same track—thus creating a bottleneck.

Figure 6-13: Historic and Future Greensboro Station

Plans call for remodeling the former station (the Greensboro Southern Railway Depot, Figure 6-13) into a new intermodal passenger terminal, serving intercity rail, intercity buses, and City transit buses. Built in 1927, the building—one of North Carolina's most impressive passenger stations—was donated to the City of Greensboro in 1978, when Amtrak moved to the current location. Designed by a New York architectural firm, Fellheimer and Wagner, the building has a main waiting room with an impressive mural of the Southern Railway network during the 1920's.

Rehabilitation of the historic station would include (among other features) completion of the Amtrak spaces, reconstruction of the pedestrian track subway, two low-level island platforms, and a new baggage tunnel. The first platform would be located between the NS Piedmont Main Line tracks to Washington, D.C., and the second between the two projected H Line tracks. This arrangement, coupled with the contemplated track layout improvements in Greensboro, would provide valuable operating flexibility. The Piedmont Authority for Regional Transportation is considering a possible commuter service between Greensboro and Winston Salem, as well as options for linking Winston-Salem with the Richmond–Charlotte intercity rail

[40] All directions are railroad directions rather than compass directions. On the Piedmont Main Line, "south" means "toward Atlanta and New Orleans," and "north" means "toward Washington."

passenger corridor; either initiative could materially affect the design concept for Greensboro's station and its trackage.[41]

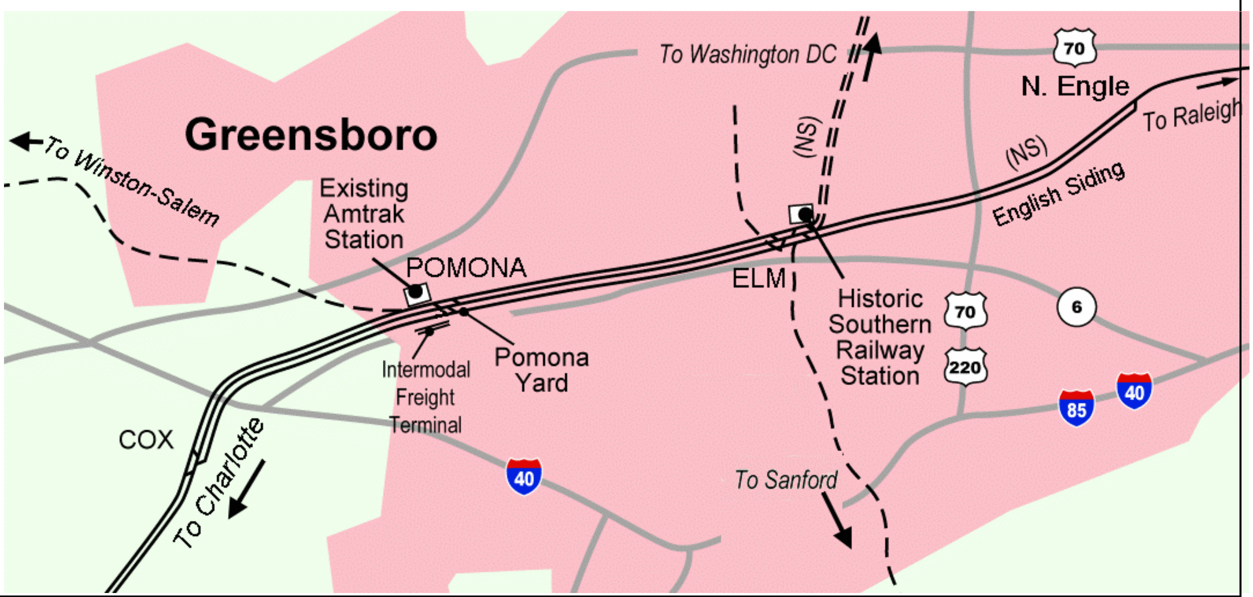
The passenger train stop at Pomona would be eliminated with the reopening of the historic station for intercity passenger rail use.[42]

Improved Track Configuration in Greensboro

(Track Charts 19 and 20)

To assure reliable train operations of all types through Greensboro's complex rail traffic patterns, several track configuration upgrades are contemplated. Figure 6-14 provides a focused view of these improvements.

Figure 6-14: Close-up of Greensboro



English Siding

English, a new passing siding, would be added to the H Line east of its junction with the P line at the historic Greensboro station. English Siding would provide a location where[43]:

- A westward freight train on the H Line to Pomona or Spencer Yards may be held without blocking passenger trains;
- A freight train from the P Line, entering the single-track H Line in the eastbound direction, can be held until an oncoming (opposing) westward freight or passenger train passes;

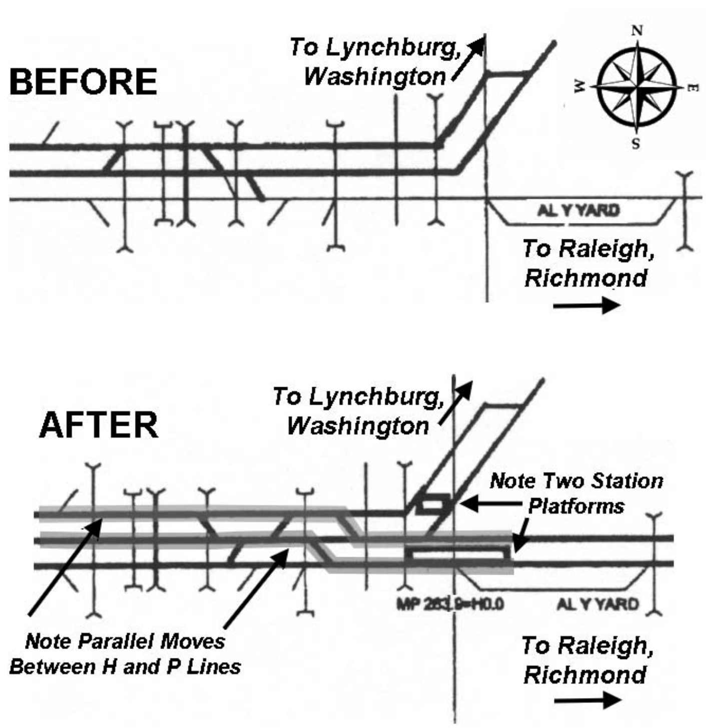
[41] For a discussion of the concept of access between Winston Salem and the Richmond–Charlotte Corridor, see the "Important Note on the Environmental Process" in Chapter 1.

[42] Further information on this important project appears in NCDOT's comprehensive rail web site (http://www.bytrain.org/passenger/ stationimp/igreensboro.html), from which Figure 6-12 and Figure 6-13 and the description of the station were obtained.

[43] In the following discussion, the reader is reminded that the H Line—including the proposed English Siding—runs east and west.

- An eastbound freight train entering the H Line but unable to reach and enter the next siding (at McCleansville) without delaying other traffic, can be held until an eastbound passenger train passes. In the absence of the English Siding, the freight train would have to occupy a busy P Line track; and
- Opposing H Line passenger trains may stop simultaneously at Greensboro station (English Siding would constitute a second H Line station track at Greensboro).

Figure 6-15: Schematic—Greensboro/ Elm Interlocking Before and After Improvement
(Directions are Approximate)



Elm Interlocking
(Track Chart 19)

Elm Interlocking, just south of the junction of the H and P Lines, would be reconfigured with Number 20 crossovers (45 mph). Parallel routes would enable trains to and from the H Line to make simultaneous moves, as shown in Figure 6-15.

At Pomona Yard
(Track Chart 20; Figure 6-16)

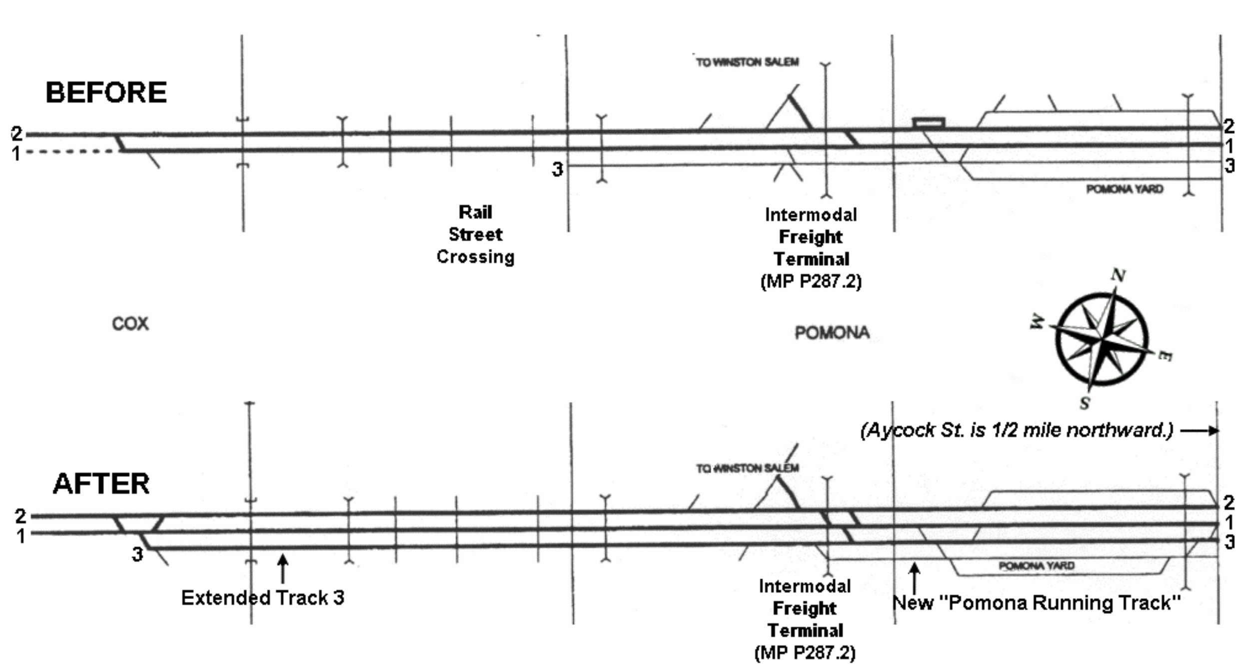
To assure reliability where a busy freight yard coexists with high-speed passenger routes requires ample track capacity and connectivity parallel to the yard. Only in this manner can often time-consuming freight yard operations be kept off the main through tracks, thus protecting reliability in both the freight and passenger services. Such is the need at Pomona Yard, where major track additions would be necessary.

A new "Pomona Running Track" would be constructed between the Intermodal Terminal and Aycock Street to prevent long working freight trains from blocking other working freight trains. Northward working freight trains would enter Track 3 at the relocated Cox Interlocking and proceed to the Intermodal Terminal, where they would enter the new running track at yard speed, without stopping. The running track would enable intermodal trains to make set-offs directly into the Intermodal Terminal and/or pick-ups from the track east of the Pomona Running Track, or the Intermodal Terminal. Other working freight trains would be able to pull north, to approximately Aycock Street, to ensure that the rear of the intermodal train would have cleared the Intermodal Terminal. The Pomona Running Track also would enable southward freight trains of any length to work clear of both main tracks and enable northward and southward freight trains to work independently and in parallel without conflict. Accessing the Running Track would require that southward freight trains cross Track 1 at both Cox and Elm Interlockings.

These improvements are designed to enable freight trains in either direction to work off the running track, unless the running track is in use by another working freight train. If this situation arises, the second freight train would work from Track 1.[44] In this manner, at least one main track will always be open—a distinct improvement from today's situation in which both main tracks are blocked when two trains are working simultaneously at Pomona Yard.

The simulation indicated that the recommended configuration and operations achieved the desired objective of enabling northward and southward freight trains to work at Pomona Yard without interfering with passenger train and through-freight train operations.

Figure 6-16: Schematic of Pomona and Cox
(Directions are Approximate)



Cox Interlocking

As shown in Figure 6-16, Cox Interlocking would be relocated and reconfigured. A right-hand Number 20 (45 mph) turnout would provide access to Track 3, which would be extended southward from the Rail Street grade crossing, where it now dead-ends. As Track 3 formerly extended further south than it does today, the extended track would be constructed where a track once existed. An 80 mph left hand Number 32 crossover, between Track 1 and Track 2, is contemplated to accommodate the large numbers of trains that divert at Cox interlocking.

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[44] If the second freight train is short enough, i.e. under 5,000 feet long, it may be able to work from Track 3, thus completely freeing up the main line tracks.

Signaling on Track 3 would extend from Cox northward to the Intermodal Terminal at MP P287.2. From that point northward to Aycock Street, MP P285.5, Track 3 would not be signaled; it would be operated under yard rules under control of a yardmaster.

Greensboro–Charlotte (P Line—Runs North and South)

A portion of NS's Piedmont Main Line between Washington and Atlanta, the Greensboro–Charlotte segment of the SEC holds the key to the on-time performance of the entire Corridor. Capacity improvements must occur here if the goals—particularly the reliability goals—of intercity passenger trains and NS freight trains are to be met. The line would also be upgraded for increased passenger train speeds up to 110 mph, although numerous restricted speed locations would remain. Fortunately, the P Line—reflecting its long-term status as a prominent and continuously upgraded main line—is not as sharply curved as the remainder of the Richmond to Charlotte corridor. Thus, with one exception, increasing superelevation and shifting the tracks to increase spiral lengths will suffice to significantly increase the speeds.

The projected increase in intercity rail service, with markedly improved travel times, would require additional track capacity between Greensboro and Charlotte for high-speed trains to overtake freight and other passenger trains. The P Line—at one time double-tracked all the way from Washington to Atlanta—was reduced, in part, to single-track status during the last decades of the 20th Century. Generally, a single track railroad—however well signaled and dispatched—cannot match the capacity of an analogous double-track configuration. For this reason, all previously-removed segments of double track between Greensboro and Charlotte would need to be restored as a prerequisite to high-speed service. Beyond that, over one-fifth of the route between Greensboro and Charlotte would need to be triple-tracked.[45,46] Appropriate interlocking modifications would be constructed. The changes in track configuration would ease congestion, ensure schedule adherence, offset capacity constraints, and accommodate the increased level of freight and intercity passenger trains.

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[45] Major segments of triple track contemplated between Greensboro and Charlotte are as follows:

Between—		**—And**		**New triple track installed**		**Total triple track installed and/or upgraded**	
Location	Approximate MP	Location	Approximate MP	feet	miles	feet	miles
Pomona	284	Cox	289	7,000	1.33	28,502	5.40
Thomasville	307	Bowers	311	25,430	4.82	25,430	4.82
Yadkin	329	Salisbury Junction	333	31,056	5.88	31,056	5.88
Kannapolis	350	Adams	353	13,379	2.53	13,379	2.53
Junker	372	A.T. & O. Junction	375	13,499	2.56	13,499	2.56
Total length of triple-track				90,364	17.11	111,866	21.19
Total mileage, P Line portion of Richmond–Charlotte Corridor (including Charlotte Airport)							100.7
Percentage to be converted to triple track, by addition or upgrading							**21%**

[46] Similar massive capacity additions are likely to be required in some other corridors around the country, should very-high-density freight traffic routes be selected for upgrading. In the case of the SEC, there is no alternative to the P Line.

As the major component of a partial triple-tracking, three center sidings on the P Line would enable passenger trains to overtake freight trains:

- Thomasville (near MP 307) to Bowers (near MP 311)
- Yadkin (near MP 329) to Salisbury Junction (near MP 333)
- Kannapolis (near MP 350) to Adams (near MP 353)

Additional capacity in the vicinity of freight yards in Greensboro (as discussed above), Spencer, Salisbury, and Charlotte would be achieved by upgrading yard and other non-main tracks to third main tracks.

The sidings would not eliminate the possibility that passenger trains may have to divert to the opposite track to overtake freight trains.[47] A diverted passenger train would lose a minimum of three minutes per crossover move, for a total of six minutes per diversion.[48] However, as previously described, the lost time could be significantly greater if it needs to follow a freight train for a number of miles before the second track becomes available.

Analyses performed for this study indicated that local freight trains would cause the most diversions between Greensboro and Charlotte. For example, in a seven-day simulation, northward Train NC02 leaving Charlotte at 0600 was the most frequently delayed passenger train. On a typical day NC02 might diverge three times (i.e., change tracks six times) between Charlotte and Greensboro to meet or overtake through freight trains, local freight trains, and commuter trains operating between Charlotte and Concord. These congestion effects delayed the departure of Train NC02 from Greensboro by as much as 12 minutes during the 7 simulated days of operation[49]—a result that would have been far worse had the contemplated improvements not augmented the assumed capacity of the P Line. This example graphically demonstrates how active the P Line is, and how requisite the capacity additions would be to reliable high-speed passenger service upon it. When service is actually ready to begin, the process of timetable construction would need to take these simulation results into account by inserting "pad" into the schedule for the trains most likely to be so affected.

Greensboro–Salisbury

(MPs P289.4–P322.8; Track Charts 20–23)

Table 6-6 lists the track additions and the single curve realignment contemplated in the region between Greensboro and Salisbury.

Table 6-6: Improvements in the Region Between Greensboro and Salisbury

Location MP	Contemplated Track Additions	Location MP	Contemplated Relocations
P289.3–P298	**Cox to Hoskins.** Presently Cox (MP 289.3) is the north end of a single-track segment		

[47] Freight trains most likely would not divert to another track to be overtaken by passenger trains. If a freight train were diverted, it would occupy the opposite track longer than a passenger train, thereby reducing capacity.

[48] There would be two crossover moves per diversion: one to reach the opposite track, the other to return to the normative track.

[49] That is, the train's departure was up to 12 minutes later than it would have been had the diversions not been necessary.

		P296.6-P297.2	Curve 296 would be realigned to reduce curvature from 2.5 degrees to 2-degrees; this would eliminate an 80-mph restrictive curve in a 25-mile section of otherwise high-speed running.
P307–P314 (Track Chart 22)	**Thomas to Lake.** The Piedmont Main Line is currently double tracked from Hoskins to Bowers (now at MP 309.8). A center siding would be installed between MP 306.9, south of Thomasville, and Bowers, which would be relocated to MP 311.4, north of a 2-degree curve. Bowers would be configured to provide universal move capabilities with Number 20 (45 mph) crossovers. Lake, now located at MP P314, would be eliminated as superfluous. The five-mile segment between Bowers and Lake—now single-tracked—would be converted to double track.		

Spencer Yard and Salisbury

(MP P322.8–P334; Track Charts 23 and 24)

The twelve-mile segment between Spencer Yard and Salisbury (inclusive) contains one of the principal freight car classification facilities in the NS system as well as an important junction between the P Line and the route to Asheville, North Carolina. This segment is depicted in Figure 6-17.

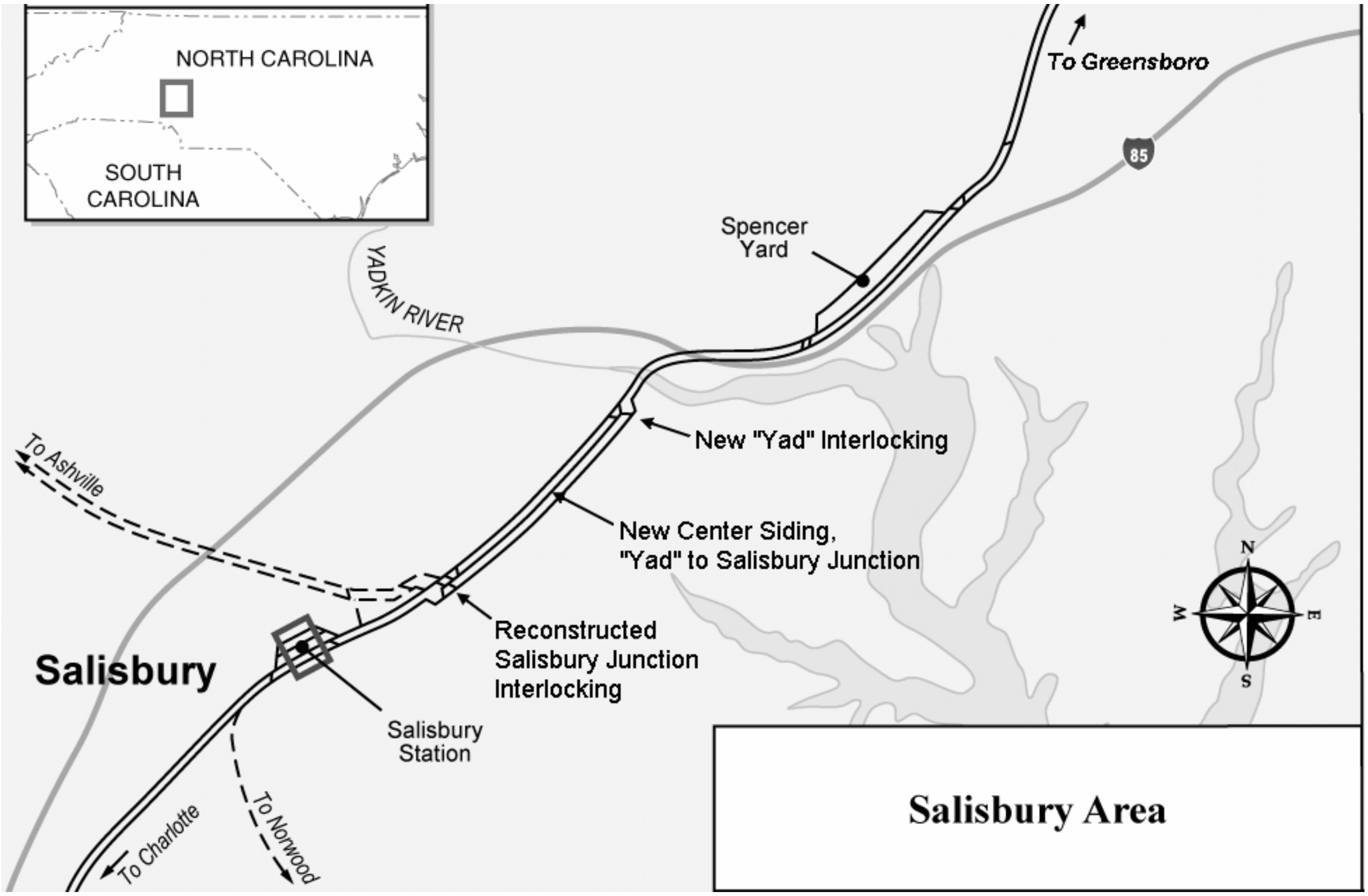
Spencer Yard

Built in the 1970s, Spencer Yard at Linwood, North Carolina is NS's largest yard in the State.

Located approximately eight miles north of Salisbury Station, Spencer Yard functions as a hub for NS operations. Trains from distant points arrive at Spencer; they set off cars, which are classified, or pick up cars, which have been classified. About twelve inbound trains daily arrive from the north or south to have their cars classified to about the same number of outbound trains. Spencer also serves as a distribution point for local freight trains that switch industries along the P Line.

In comparison with other yards in the Richmond–Charlotte corridor, Spencer Yard is carefully designed and modern. In general, it has the capacity, in terms of receiving and departure tracks, to process incoming and outgoing freight trains without creating a bottleneck on the adjacent P Line. Still, the layout at the south end of the yard (at Duke Interlocking)—sited on a short piece of straight track between curves—does not provide sufficient space for desirable improvements in the traffic flow between Spencer Yard, Salisbury, and the Asheville line. As a result, several improvements are contemplated in the area between Yad and Salisbury Junction, and in the connection between Salisbury Junction and the Asheville branch.

Figure 6-17: Spencer Yard and Salisbury



Operating Challenges Between Spencer and Salisbury Junction

Trains to or from Asheville (about ten movements[50] per day) leave or enter the P Line towards Spencer on the double-tracked North Wye at Salisbury Junction. The interlocking is arranged so that northward trains from the Asheville Line can cross Track 2 to access Track 1 while a southward train is also entering the Asheville Line from Track 2. However, the existing P Line crossovers providing access to the North Wye are sandwiched between curves. The speed of trains on the North Wye is restricted to 15 mph, and this may cause long freight trains to occupy the interlocking at Salisbury for five to eight minutes, depending upon whether the train is stopped or not.[51]

Because of these existing constraints at Salisbury Junction, the initial operating analysis indicated that trains coming from the Asheville Line in the future might not be able to cross the

[50] Total of both directions.
[51] Additional information pertinent to the junction of the P and Asheville lines:

- The Asheville Line is double-tracked for 2.1 miles to Majolica, where the line becomes single-tracked.
- A South Wye provides a connection for Asheville Line trains to the P Line south of Salisbury.

flow of southward trains on Track 2 to access Track 1, travel 6 miles to Duke Interlocking, and return to Track 2 to enter the Spencer Yard.

New "Yad" Interlocking; Center Siding to Salisbury; Salisbury Junction Revision

To lessen the operating constraints in the Spencer–Salisbury area, a coordinated set of improvements is contemplated.

South of the Yadkin River Bridge at MP 328.6, a new interlocking ("Yad") would be constructed. From that point, a new center siding would extend as far south as Salisbury Junction, which would be rebuilt.

The center siding would eliminate:

- Any conflict of northbound Asheville Line freight trains with northward through running trains on Track 1; and
- The need for the simultaneous windows on Tracks 1 and 2 to access Track 1 from the Wye at Salisbury Junction.

A portion of Salisbury Junction would be relocated northward about 1500 feet to ensure that turnouts and crossovers are on tangent track. As part of this reconfiguration, the Asheville Line tracks would be extended northward parallel to the P Line. These improvements would assure parallel routes for continued simultaneous operation of northbound and southbound Asheville Line freight trains—but at a top speed of 30 mph, double the present maximum for Asheville moves. The benefits of this shift become apparent in Figure 6-18.

Crossings in Salisbury

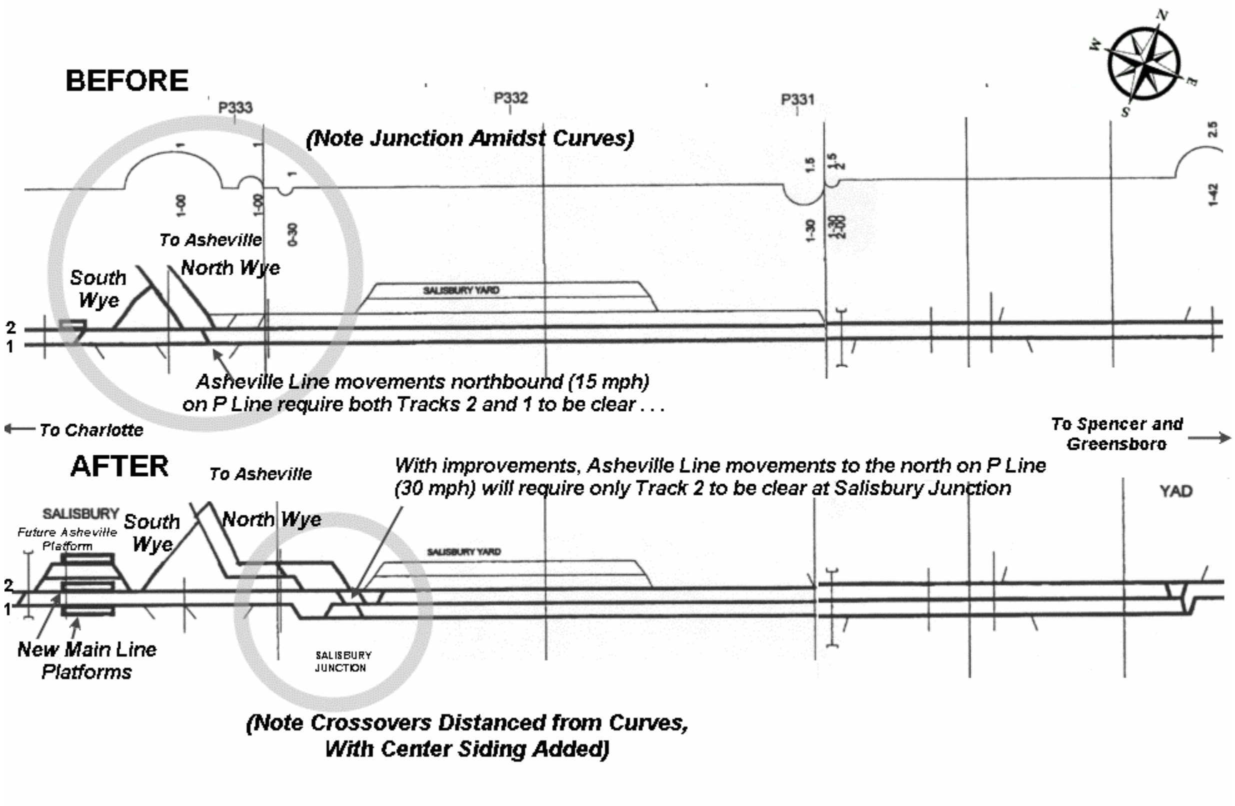
Numerous highway crossings are located on curves in Salisbury. The crossings would be difficult to eliminate and therefore it is envisioned to maintain their current superelevation and alignment and restrict passenger train speeds to 70 mph through the City of Salisbury.[52]

Salisbury Station

The Richmond–Charlotte Corridor will intensify the use of the existing Salisbury Station building. Constructed in 1908 by the Southern Railway, the building is an excellent example of mission style architecture and represents the importance of Salisbury's location on the railroad, lying halfway between Washington and Atlanta and at the eastern terminus of the

[52] Chapter 5 contains a discussion of the effect on train speed of crossings located on curves.

Figure 6-18: Schematic, Yad to Salisbury



Western North Carolina Railroad to Asheville and Tennessee. The building is part of Salisbury's Historic District. (See Figure 6-19.) In 1984, the Historic Salisbury Foundation, Inc. acquired the station, saving it from demolition. They raised over $3 million in private donations and beautifully restored the main waiting room and other parts of the station. The North Carolina Department of Transportation contributed an additional $1 million in enhancement funds to finish the restoration of the main building for civic purposes. NCDOT also has contributed funds for the creation of a transitional park to the east of the station, linking the downtown to the station. The NCDOT completed an enlarged temporary waiting room in December 1999. Platform, canopy and track rehabilitation will be carried out in a future phase.[53]

Figure 6-19: Salisbury Station

Currently, one passenger platform exists along Track 2 between Kerr Street and Council Street. Consequently, all northward passenger trains stopping at Salisbury have to operate left-handed on Track 2 between Reid (MP P337.3) and at least Salisbury Junction (MP 333). That practice would be unsatisfactory for future operations as it constrains both freight and

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[53] The source for the picture and description of Salisbury Station is the NCDOT web site, http://www.bytrain.org/passenger/stationimp/isalisbury.html.

passenger flows on this busy railroad. Therefore, platforms would be located adjacent to both Tracks 1 and 2.

Provisions would also made to add a platform and new tracks on the west side of the station area to accommodate future passenger trains to Asheville, but these tracks would not be built until such service is implemented.

Yadkin Junction

Yadkin Junction at MP 334.5, which is about one mile south of Salisbury Station, consists of a run-around track adjacent to Track 1 and a hand-operated turnout to the former Yadkin Railroad (now the NS line to Albemarle). One train per day has been assumed to operate to and from the branch. No change is proposed for this location.

Salisbury–Charlotte

(MP 337.3–375.3; Track Charts 24 Through 28)

This section of the busy P Line will also require substantial restoration and expansion of track capacity to accommodate projected traffic volumes. These additions are detailed in Table 6-7.

Table 6-7: Improvements in the Region Between Salisbury and Charlotte

Location MP	Contemplated Track Additions	Location MP	Other Improvements
P337.3–P347.3	**Reid to North Kannapolis.** Double track currently remains in place between Salisbury and Reid (MP P337.3). However, the segment between Reid and North Kannapolis (MP 347.3) has only a single track, on which active industries are located. To minimize conflicts with local freight service when passenger traffic increases, the double track between Reid and North Kannapolis would be restored. This segment of double track reconstruction should have a high priority. For improved spacing of crossovers, Reid Interlocking would be eliminated and a new universal interlocking, "Sumner," installed at a point about midway between Salisbury Junction and North Kannapolis, at approximately MP 339.5.		
P349.5–P354.1	**Kannapolis–Adams.** North Kannapolis (MP P347.4) to Haydock (MP P360.1) is double tracked. Kannapolis and Concord are located in this segment. Interlocked crossovers at Adams (MP P354) are located approximately midway between North Kannapolis and Haydock. The third of the three center sidings between Charlotte and Greensboro would begin at Kann (MP P349.5), at the north end of the long 1-degree curve (East C Street), and end at Winecoff School Road, at a relocated Adams Interlocking (MP P352.9). The	P352.7	**Adams Overnight Commuter Equipment Storage.** Depending on the design of a Charlotte–Concord commuter service, an overnight equipment storage facility may need to be provided near Adams Interlocking, north of Concord. Such a facility is not included in the schematics prepared for this monograph.

Location MP	Contemplated Track Additions	Location MP	Other Improvements
	siding is much shorter than desired, but the 317-foot bridge over I-85 prevents the end of the siding from being extended farther south, to Adams, at a reasonable cost. Despite the short length of the siding, a clear space of nearly two miles would exist so that a freight train can be held without blocking any highway crossings.		
P360.1–P371.2	**Haydock –Junker.** Haydock (MP P360.1) to Junker (MP 371.2), a distance of about twelve miles, currently is single-tracked. It is contemplated to restore double track between Haydock and Junker. The segment between Adams and Junker is about eighteen miles. It is recommended that a new universal interlocking, Shamrock, be located about halfway between those locations, at about MP P363, just north of Shamrock Road. When double track is restored, Haydock Interlocking would be removed, and Junker would be relocated to MP P372.2 and reconfigured as the gateway to an expanded rail infrastructure in Charlotte. The new I-485 Station would be located in this segment, as described in the next column.	P367	**I-485 Station.** Although located some ten miles north of Charlotte, this new station is discussed in the section on that city, below. It is envisioned as a basic facility, with low side platforms adjacent to each of the two main tracks.

Charlotte

(Track Charts 28 Through 30)

Figure 6-20 provides an overview of the Charlotte vicinity; it shows not only Charlotte proper with the contemplated center-city station location, but also the new stations at I-485 and the Charlotte airport.

Stations in the Charlotte Region

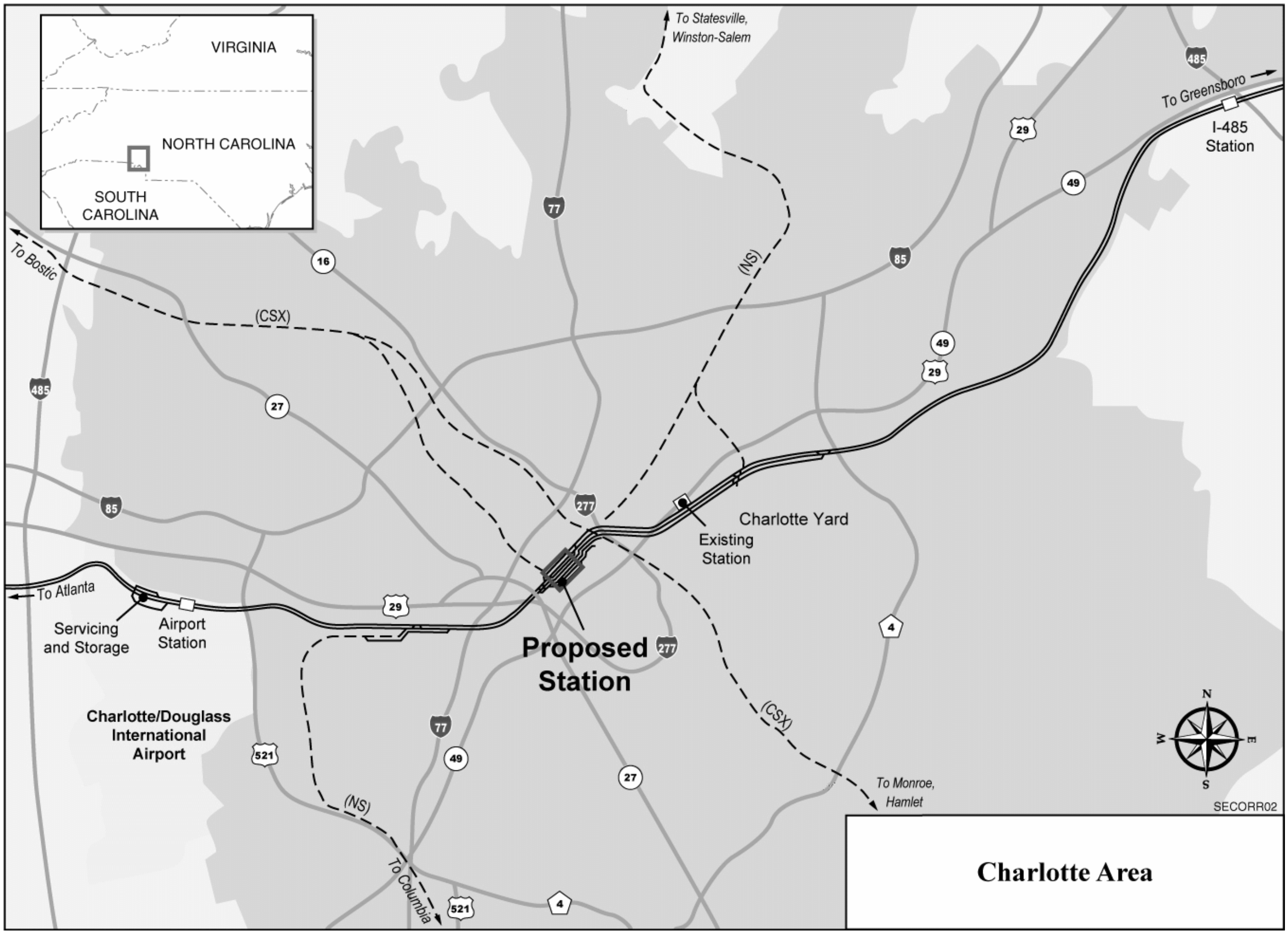
In this metropolitan area of 1.5 million people, the excellent distribution and access provided by three well-located stations would contribute to the demand for high-speed rail corridor service.

I-485 Station

Prior analysis identified the need for a "beltway"-type station to be located north of Charlotte in the vicinity of MP P367, where I-485 passes over the rail line.[54] University City Boulevard parallels the rail line at this location. The station would serve the rapidly developingsuburban area north and east of Charlotte. All intercity passenger trains are assumed to stop at the station, as well as proposed Concord–Charlotte commuter trains.

[54] Such "beltway" stations have proven to be successful in Boston (Route 128), New York (Metropark), and Washington (Capital Beltway); the latter two trace their origins to the Metroliner demonstration program of the 1960s and 70s, catalyzed by the FRA's Office of High-Speed Ground Transportation.

Figure 6-20: Overview of Charlotte Showing I-485 and Airport Stations



Charlotte Station Relocation

Charlotte's existing Amtrak station (Figure 6-21) is located two miles from of the center of the city. The current station was built in 1968 after Southern Railway tore down its old uptown station and consolidated passenger operations to its Charlotte freight yard on Tryon Street. With increased passenger rail services and rail travel demand, the station's small size and suboptimal location no longer fit the requirements of passengers traveling to and from Charlotte. Furthermore, the passenger operations must be relocated to accommodate increasing Norfolk Southern freight operations.

Figure 6-21:
Existing Charlotte Station

To better meet current needs, NCDOT and Amtrak have already expanded the existing station's waiting room and added a second ticket window. These, however, are short-term measures only; a new, better-located station would be a more viable option for the future.

In April 2002 the NCDOT completed a feasibility study that identifies a site in uptown Charlotte for an intermodal passenger terminal (designated as "Proposed Station" near the center of Figure 6-21). The NCDOT study includes conceptual plans for the station and associated track improvements. The new facility would handle upwards of 500,000 rail passengers annually by 2015. Envisioned to have a useful life of 50 years or more, this large and significant project would incorporate all modes of land-based passenger transportation including conventional and high-speed intercity passenger rail, local and regional bus and rail, intercity bus, rental cars, bicycles and pedestrians.

As contemplated in the present study, the intercity passenger rail portion of the station—situated at MP P377.9—would consist of three tracks and two platforms. Details on the envisioned track layout through Charlotte appear further below.

NCDOT is currently purchasing the property for the new facility, which a public/private partnership would fund and construct. [55]

Charlotte Airport Station

Constructed in the early 1980s, the Baltimore-Washington International (BWI) Airport Rail Station has demonstrated the potential value of rail/air intermodal facilities, which can also attract significant rail traffic from nearby suburban communities. The success of the BWI connection has resulted in plans for a similar connection at Greene Airport in Providence, Rhode Island and has led to the concept of constructing an intermodal rail-air station adjacent to Charlotte Airport, near the Airport Freeway. The airport is located approximately six miles west of downtown Charlotte, adjacent to the P Line. A rail passenger servicing and storage yard would be constructed south of the Airport Station.

Rail Operations in Charlotte

The following operational challenges in the Charlotte area drive the facility concept developed in this study:

- An important **at-grade rail/rail crossing at** Graham Interlocking, in which the single-track CSXT crosses the double-track P Line of the NS. Over this crossing, some 25 daily CSXT moves (including yard moves) must pass. Furthermore, the crossing is located on a curve, which restricts train speeds on the NS at Graham.
- An **active freight yard on the east side of the right-of-way.** Charlotte Yard, like Pomona Yard, is located east of the Piedmont Main Line. It is projected that of the approximately 30 daily P Line freight train movements

[55] More detailed information on this important project is available on the NCDOT's rail web site at http://www.bytrain.org/passenger/stationimp/charlottemm/legisupdate.html. That site is the source for the picture and general description of the Charlotte intermodal terminal. The track layout as described in this monograph was developed for the present study.

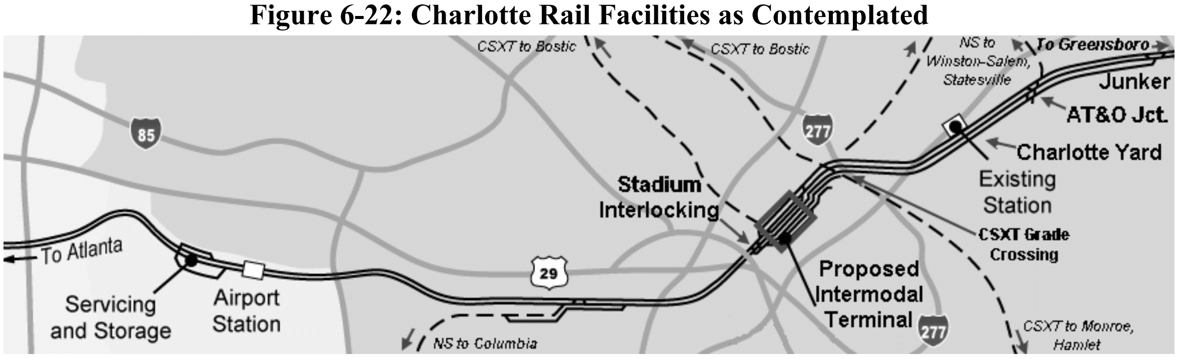
envisioned to pass through the Charlotte Station area in 2020, approximately 10 movements in each direction would call at the Charlotte Yard—several merely to change crews (a ten-minute stop), the majority to pick up or set off cars at the yard (for periods of 45 to 60 minutes). Southbound freight trains calling at the yard must cross the northbound main track upon entering and upon exiting the yard. Crossovers at A.T.& O. Junction and south of the yard are used to move between the yard and the P Line. These crossovers are less than a mile apart. By tying up the crossovers for extended periods,[56] long trains can prevent trains traveling in the opposite direction from working at the yard, and sometimes from moving at all. Therefore, the potential for conflicts among trains exists, just as at Pomona.

- **An interlocking** (A.T. & O. Junction) **with particularly difficult geometry.** A.T. & O Junction is partially located on a 1.8-degree curve with two inches of superelevation. All turnouts and crossovers are Number 10s, which limit train speeds into or out of the yard or to the NS route to Statesville and Winston Salem to 15 mph. For all practical purposes, freight trains in this yard area cannot exceed 5 mph because they need to be able to come to a stop within very short distances. Thus, freight operations tie up the interlocking at A.T. & O. Junction for significant periods of time.
- Twenty-two projected **commuter moves** per day into and out of Charlotte (including nonrevenue runs);
- Twenty-two projected **intercity passenger moves** through Charlotte each day; and
- The need to provide necessary and sufficient **support facilities** for servicing, turning, or storing all the commuter, and most of the intercity, passenger trains.[57]

Facility Needs and Their Rationale

Figure 6-22 presents a set of facilities that would respond to these challenges.

Figure 6-22: Charlotte Rail Facilities as Contemplated



[56] With the existing configuration, a single 8,000-foot freight train entering the yard at 5 mph can block main line traffic for up to 18 minutes.

The train paths described below and in Figure 6-23 are those intended for normal operations; the contemplated track layout incorporates sufficient flexibility for dispatchers to accommodate unusual situations by setting up alternate paths.

Improved Path for Southbound Working Freights

[Figure 6-23(B)]

A third track, new Track 3, would be installed between the relocated Junker Interlocking (MP 372.2; see Table 6-7) and A. T. & O. Junction (MP 375.3). Junker, with its Number 20 turnouts, would enable southward freight trains working at Charlotte Yard to enter Track 3 at 40 mph—a speed boost that is essential to free flow on the busy main line. Track 3 also would provide a holding location for a southward freight train to wait short of the Charlotte Yard without blocking Track 2.

A new connecting track (designated in this monograph as "Track 4") leading southward out of AT&O Jct. would parallel, and be isolated from, the switching ladder at the north end of the yard so that standing or arriving working freight trains would not block switching operations. Track 4 would tie into the existing easternmost track in the yard, which is adjacent to the Intermodal Terminal, and would be upgraded to become a new running track between A.T. & O. Junction and Tryon Street.

From Tryon Street to a new "Stadium" Interlocking,[58] just south of the Charlotte Intermodal Terminal, Track 4 would be signaled. After working in the yard, southward freights would cross northbound Track 1 at Stadium and would merge with other southbound traffic on Track 2. Stadium would have Number 20 (40 mph) turnouts as well, thus expediting the crossover move.

Improved Path for Northbound Working Freights

Figure 6-23(C)

At Stadium, northbound working freights would divert from Track 1 to an upgraded Track 3, and would then proceed to their working location near MP 375.5 without affecting other NS freight trains or passenger trains. However, northbound working freights would have to cross the CSXT tracks at grade, at Graham Interlocking. Since the northward freight train working location is about 7,500 feet from the CSXT at-grade crossing, nearly all P Line freight trains should be able to work with the rear of the train clear of the CSXT crossing. However, Lidell Street may be blocked; that street crossing should be evaluated for possible closure or separation. Relatively short northward working freight trains that arrive before the previous working train departs would wait south of the CSXT crossing, leaving the crossing clear for CSXT trains.

A.T. & O. Junction would be reconfigured to enable freight trains to access Track 1 at 30 mph (over Number 15 turnouts) upon completing work. A new interlocked crossover from Track 3 to Track 1 would replace an existing hand-operated crossover between the yard and Track 1.

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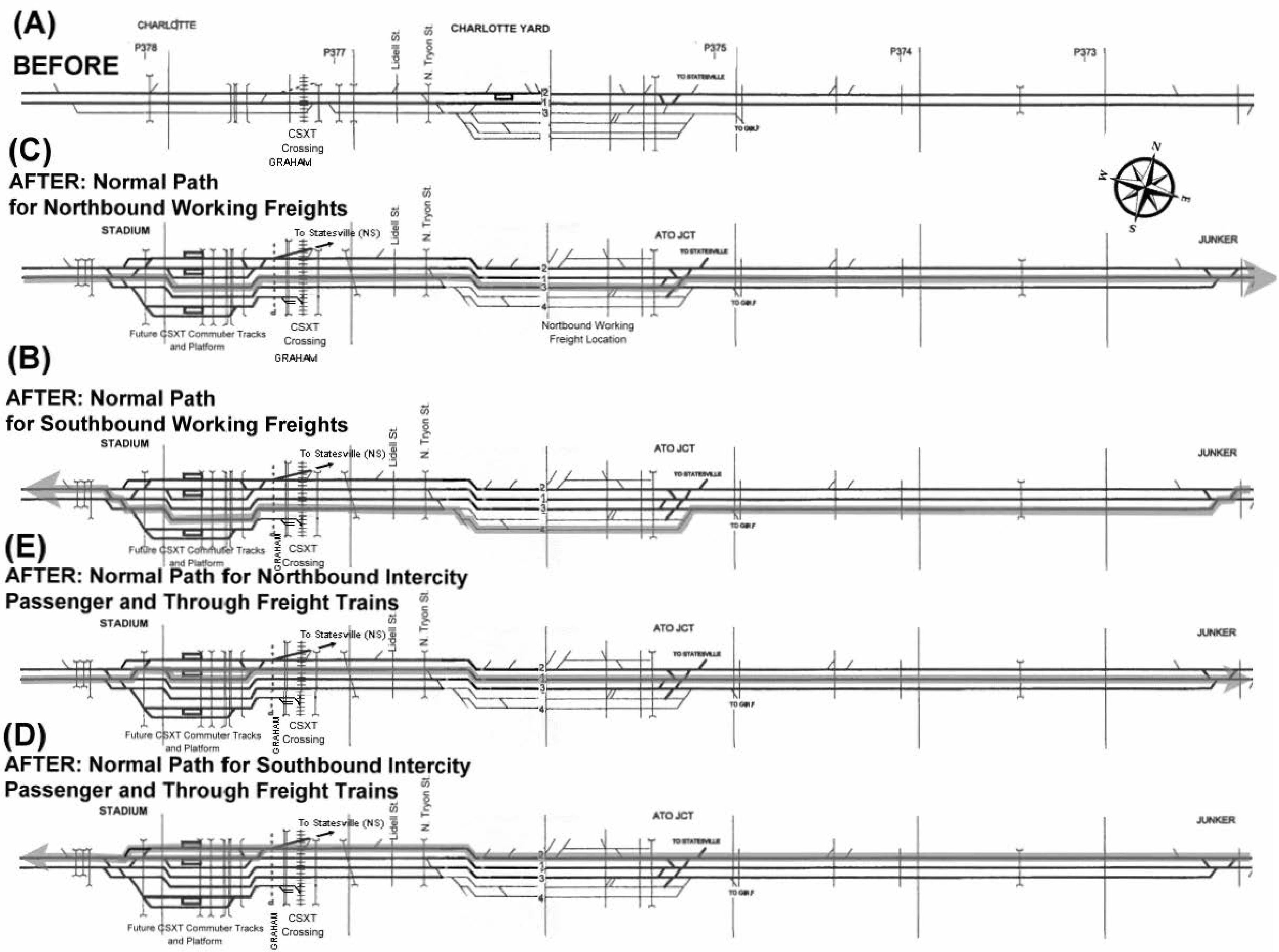
[57] For Charlotte's likely enduring role as a terminus, see Chapter 3

[58] So named because of its proposed location next to Erickson Stadium.

Figure 6-23: Train Pathways Underlying Charlotte Reconfiguration



Track 3 would have a 40 mph maximum speed between Stadium and A.T. & O. Junction. This increase over yard speed would occur because (1) Track 3 would be signaled between Stadium and Tryon Street; (2) the hand-operated crossovers south of Tryon Street would be electrically locked; and (3) all switches on Track 3, between Tryon Street and A.T. &O, Junction, would have switch locks installed. As a result, long freight trains that have finished their work would be able to accelerate to 30 mph prior to accessing the main P Line tracks, thus contributing to the capacity and fluidity of the P Line.

In this manner, both north- and southbound freight trains would be able to work at the Charlotte Yard, without conflicting with each other. The goal of enabling passenger trains and non-working freight trains to have their own tracks in the congested Charlotte area —separate from those used by working freight trains— would be achieved.

Paths for Through Trains; Charlotte Intermodal Passenger Terminal

Tracks 1 and 2 between A.T. & O. Junction and Stadium would be the passenger tracks through Charlotte, and would also accommodate through freight trains that need not stop at Charlotte Yard.

The new Charlotte Intermodal Terminal, located at MP 377.9, would have the following arrangement:

- Track 2, normally southbound, with a side platform to its west;
- Track 1, normally northbound; and
- A third station track, sharing a center platform with Track 1.

The normal paths for through passenger and freight trains at Charlotte appear in Figure 6-23(D) and (E).

Depending on the design of future Charlotte–Concord and other commuter services, there may be a need for daytime train storage facilities near the Charlotte Intermodal Terminal. Such facilities are not included in the schematics prepared for this monograph.

NS Freight Trains to and From Columbia

It is assumed that most southward freight trains to Columbia would operate left handed—that is, on Track 1—for about 1½ miles between Stadium and North Advance/Charlotte Junction, where the NS route due south to Columbia diverges from the P Line to Atlanta. To expedite movements to and from the Columbia line and enhance P Line capacity, a left hand Number 15 (30 mph) turnout at North Advance would be upgraded to a Number 20 (40 mph for freight) turnout.

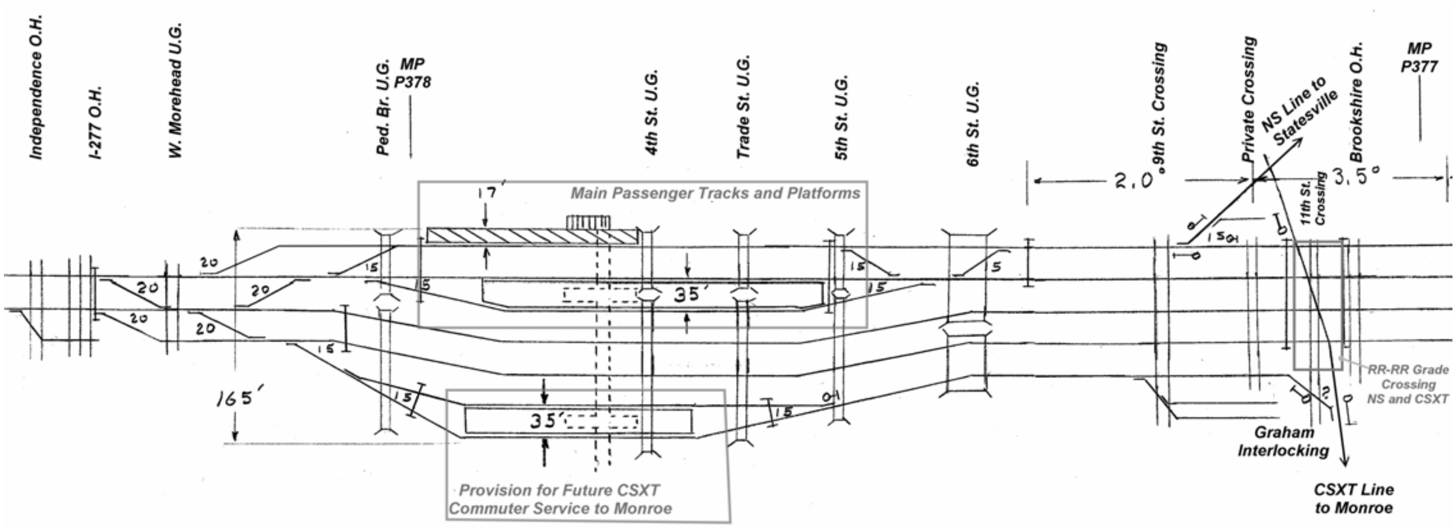
Provisions for Additional Future Commuter Services

In all hypothetical schedules, simulations, and related cost estimates, this study made specific provision for a commuter service as envisioned by the City of Charlotte between Charlotte and Concord. Other rail commuter services are ultimately possible in this large metropolitan region. In the conceptual design of the Charlotte Station, allowances were made for the following two possible commuter operations:

- **Possible service: Charlotte–Monroe (CSXT).** The concept in Figure 6-23 allows for construction, east of the station, of two tracks and a center platform expressly for a possible future commuter service to Monroe via a former SAL, now CSXT, line.[59] Such a service would require a connection between the station tracks and the CSXT at Graham.
- **Charlotte–Statesville (NS).** A former Southern Railway, now NS, line diverges from the P Line at Charlotte in the direction of Mooresville, where it bifurcates northwest to Statesville and northeast to Winston-Salem. A freight-only connection between the P Line and the Statesville line exists today at A.T. & O. Junction, as shown in Figure 6-23; the station concept allows for future reconstruction of a track leading from the Charlotte Station area to the Statesville line. Such a reconstruction would require reinstallation of the diamond crossing of the NS Statesville line and the CSXT. All main platforms and passenger tracks would have direct access to such a Statesville connection.

The schematic in Figure 6-24 shows additional detail regarding the provisions for possible future commuter services.

Figure 6-24: Schematic of Charlotte Station



Airport Extension and Service Facilities

Extending the Richmond–Charlotte Corridor to the Charlotte Airport would respond to both marketing and operational dictates. It would bring high-speed rail directly to the airport,—where important intermodal transfers can occur, —and to the population centers west and south of Charlotte proper; and it would create a fitting southern terminus for the Richmond–

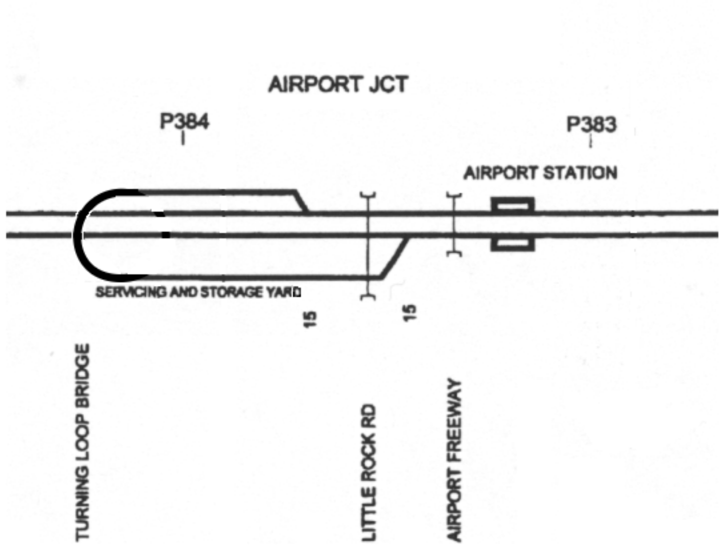
[59] This platform and its tracks would not accommodate the main P Line services, as Figure 6-23 shows.

Charlotte portion of the Southeast Corridor, where trains to and from Raleigh, Washington, New York, and Boston can be turned and serviced efficiently and effectively.

Design of the Airport Station/Richmond–Charlotte Southern Terminus

All intercity passenger trains to and through Charlotte, including any overnight and other long-distance trains,[60] were assumed to stop at the Airport station. Consisting of low-level side platforms adjacent to Tracks 1 and 2, the station would be located adjacent to the Airport Freeway. Just south of Little Rock Road, a loop track for turning trains terminating at Charlotte would diverge westward from Track 2, the southbound main track, passing over both main tracks and rejoining Track 1, the northbound main track (see schematic in Figure 6-25). A storage yard and equipment servicing and inspection facility (S&I) would be sited to the east of Track 1. Passenger trains not terminating in Charlotte, including any future trains on a possible extension of the SEC to Atlanta, Macon, or beyond,[61] would make use of the main line tracks passing under the turning loop.

Figure 6-25 :
Schematic of Contemplated Facilities at Charlotte Airport



This design would have many advantages over and above market penetration in the large Charlotte region. Turning trains south of central Charlotte would simplify operations and consume less track capacity in the congested uptown area. Using a loop track and integral S&I would minimize operating costs, turnaround times, and equipment downtime: an arriving trainset would change direction, undergo cleaning and inspection, and prepare for departure in one virtually continuous movement. This concept, therefore, would benefit the economics and marketability of the SEC as a whole.

Commuter Considerations at the Airport Station

The service plan for the proposed Concord–Charlotte commuter operation will influence the design of the facilities at the Charlotte Airport.

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[60] The simulation included one New York–Atlanta–New Orleans daily round trip, the Crescent, and an additional daily long-distance round trip between Washington and Atlanta via Lynchburg; see Chapter 3.

[61] A proposed Charlotte–Atlanta extension is part of the SEC designation, but is just now entering the feasibility study stage. Chapter 3 contains more information on that proposal, and the "Supplement: Background Materials" at the end of this volume contains information on "Funding for Planning an Extension of the SEC to Atlanta and Macon, Georgia." The effects of any such extension have not been incorporated in this monograph, beyond the discussions in Chapter 3 and the Supplement.

The simulations for this study assumed that the southerly terminus of Concord–Charlotte commuter service would be the Charlotte Intermodal Terminal. Thirty-minute headways from Concord for this service were projected. Layover facilities in Charlotte for day storage of commuter trains—necessary for efficient operation in the assumed service scheme—have not yet been identified. It was assumed that overnight equipment storage facilities would be provided somewhere near Adams Interlocking, as described in Chapter 3.

If, on the other hand, local authorities decide to terminate commuter trains at the Charlotte Airport instead of the main Charlotte station—

- Day storage of commuter trains will not be necessary in uptown Charlotte, but could be provided by means of additional trackage at the Airport—not included in this study's proposals;
- As simulated, three of the eight commuter trains each morning from Concord to Charlotte turned back to Concord for a second trip. If these trains were to operate to and from the Airport, they would not be able to return to Concord for a second trip and additional equipment sets would be required; but
- Public service considerations may, in the judgment of local officials, be better met by providing through commuter service to the Airport, an important employment center.

Clearly, subsequent design work for many Charlotte area facilities will reflect public choices in the realm of commuter service as well as intercity operations.

Figures in Chapter 6

Tables in Chapter 6

Chapter 7
COST ESTIMATES
AND CONCLUSIONS

This chapter recapitulates the nature and cost of the potential improvements to the Richmond–Charlotte Corridor, and summarizes major conclusions of the study.

Recapitulation of Potential Improvements

Table 7-1 lists the corridor-wide and site-specific improvements identified in Chapters 5 and 6 as addressing the Year 2020 goals and requirements underlying the study. The table identifies the objectives and estimated cost of each line item. The projected total cost of all the identified potential improvements (exclusive of rolling stock requirements and other items not estimated in the study) currently stands at from \$0.9 to \$1.0 billion (2000 dollars).

Table 7-1 includes cost estimates only for those infrastructure items covered in the study scope. Items omitted from the study scope are labeled "to be determined (tbd)" and excluded from the totals shown. Some of the items "to be determined" (e.g., grade crossing hazard reduction) may be essential prerequisites to upgraded service on the line and would need to enter into any further studies or implementation plans. Similarly, the identified "station" costs address such operational components as train platforms and pedestrian tunnels and bridges, and in most instances omit new or renovated station buildings.[1] This technical monograph does not include real estate acquisition costs, nor does it address the financing or institutional options which may enter into project implementation.

[1] Station buildings are, however, included in station costs at two relatively low-density locations (Henderson and Kannapolis), and at two completely new locations in the Charlotte area (I-485 and the Charlotte Airport).

Table 7-1: Potential Improvements in the Richmond–Charlotte Corridor

Project	Comment	Estimated Cost[2] (millions of dollars)	Primary Purpose(s)[3]		
			Trip Time	Capacity	Prerequisite and other
Systemic Projects	Exclude costs pertaining to S Line restoration.				
Track Structure					
Surfacing of track—currently in a "state of good repair"—to permit up to 110 mph top speeds	Not estimated as part of this study.	tbd[4]	•		
Installation of premium ties and fasteners on 100 track-miles of curves to maximize time payoff of tilting trains	Included with curve realignment projects.		•		
Signaling and Train Control: Signal System Upgrade	Essentially cost of improvements between site-specific track reconfiguration/ interlocking projects. Those site-specific projects include their associated signal costs.[5]	$58.9	•	•	•
Stations:	See also the stations included in site-specific projects.				
ADA compliance	Beyond the scope of this study.	tbd			•
Parking; vehicular and transit access		tbd			•
Vehicles: Trainsets for high-speed rail service.	Beyond the scope of this study.	tbd	•		•
Total Systemic Projects	Exclusive of S Line restoration and items to be determined.	**$58.9**			
Site-Specific Projects Grouped Together for Cost Estimation	Exclude costs pertaining to S Line restoration.				
Curve Relocation Program	Includes installation of concrete ties on curves with unbalance of 5 to 7 inches.	$33.7	•		
Curve Adjustment Program		$59.3	•		
Grade Crossings: Upgrades and Hazard Reduction	Costs for grade crossing work necessitated by site-specific projects of other types, e.g. relocations, are included with those projects.	$37.8			•
Fencing: Selective Installation of Right-of-Way Fencing		$16.5			•
Total Site-Specific Projects Grouped Together for Cost Estimation	Exclusive of S Line restoration costs.	**$147.3**			

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[2] Fully loaded 2000 dollars in millions - includes design, construction management and contingency.
[3] Most improvements serve multiple ends.
[4] "tbd" designates projects or components that are not addressed in this analysis and are, therefore, "to be determined."
[5] Total signal cost for all projects is $163.1 million.

Project	Comment	Estimated Cost[2] (millions of dollars)	Primary Purpose(s)[3]: Trip Time	Capacity	Prerequisite and other
Site-Specific Projects—All Other					
S Line, Richmond–Raleigh:					
Richmond (Main Street Station) to Centralia (northerly active portion of S Line)	These improvements and their costs are also included in a previous report, *Potential Improvements to the Washington–Richmond Railroad Corridor*, issued by Amtrak in 1999. Thus, there is an overlap of $26.8 million in the total estimates presented in the Washington–Richmond and in the present monograph.[6]				
Welded Rail Installation		$10.0			•
Main Street Station—trackage additions and reconfigurations		$1.7		•	
Richmond to Falling Creek—trackage additions and reconfigurations		$15.1		•	
Total, Richmond (Main Street Station) to Centralia (northerly active portion of S Line)		$26.8			
S Line Restoration—Centralia to Norlina (includes all cost components on abandoned portion)	Includes $6.9 million for a Petersburg area station.[7] Excludes real estate acquisition.	$317.6	•	•	
Norlina to Raleigh (southerly active portion of S Line)					
Welded Rail Installation		$4.4			•
Norlina Siding		$7.1		•	
Greystone Siding		$5.5		•	
Henderson Station	See footnote 1. Includes a station building at $0.6 million.	$3.5			•
Kittrell Siding		$7.6		•	
Youngsville Siding		$8.7		•	
Neuse Siding		$10.9		•	

[6] See in the Washington– Richmond report at p. 52, Table 5-1, the line items "Rehabilitate Main Street to Centralia . . ." and "Reconfigure and Upgrade Track, Staples Mill Road . . . Centralia" (the latter includes additional items north of Main Street Station).

[7] Included in the "S Line Restoration" is $6.9 million for platforms and pedestrian access at the Petersburg station, which is assumed to continue at its current Ettrick location. In the vicinity of Ettrick, the reactivated S Line would be diverted from its former route to parallel the A Line, upon which the Ettrick station location today serves all Amtrak trains between Richmond and points south. (See Chapter 6.) Under this study's assumption, the improved station would greatly expand its service focus to include the relocated S Line as well as the existing A Line; hence its costs are included in the S Line restoration, even though the Ettrick facility never served the S Line when the latter was active for passenger service.

Project	Comment	Estimated Cost[2] (millions of dollars)	Primary Purpose(s)[3]		
			Trip Time	Capacity	Prerequisite and other
Edgeton to Southern Junction—track additions, reconfigurations		$14.9		•	
Total, Norlina to Raleigh (southerly active portion of S Line)		$62.6			
Total S Line		$407.0			
Raleigh Station and Support Facilities:					
Station—track additions, reconfigurations, platforms	See footnote 1. At Raleigh, some $1.5 million for grading is included in the station costs.	$12.8		•	•
NCDOT Raleigh Storage Yard and Servicing Facility[8]		$4.8			•
Total Raleigh Station and Support Facilities		$17.6			
H Line, Raleigh to Greensboro –					
Welded Rail Installation (Raleigh to Fetner)		$4.7			•
Fetner Siding		$6.0		•	
Cary Station	See footnote 1.	$0.9			•
Cary Siding		$8.9		•	
Brassfield Siding		$15.5		•	
Durham Siding		$3.5		•	
Durham Station	See footnote 1.	$4.4			•
Funston – Glenn Siding		$20.9		•	
Efland – Mebane Siding		$18.4		•	
Haw River Siding		$10.1		•	
Burlington Station	See footnote 1.	$0.9			•
McLeansville Siding		$8.9		•	
English Siding		$3.7		•	
Total, H Line		$106.8			
Greensboro Station	See footnote 1.	$10.3		•	•

[8] Although this facility is tabulated as "site specific," it is obviously of corridor-wide significance as it stores and maintains equipment to protect the entire service.

Project	Comment	Estimated Cost[2] (millions of dollars)	Primary Purpose(s)[3]		
			Trip Time	Capacity	Prerequisite and other
P Line, Greensboro to Charlotte: All projects are track additions and reconfigurations unless noted otherwise.	Exclusive of Charlotte terminal area.				
Elm Interlocking to Cox		$18.4		•	
Cox to Hoskins		$14.6		•	
High Point Station	See footnote 1.	$1.4			•
Thomas to Lake		$17.7		•	
Yad to Salisbury		$17.5		•	
South Salisbury and Salisbury Station—trackage additions and reconfigurations		$5.0		•	
Salisbury Station	See footnote 1.	$7.8			•
Reid to North Kannapolis		$20.0		•	
Kannapolis Station	See footnote 1. Includes a station building at $0.6 million.	$5.5			•
Kannapolis to Adams		$10.2		•	
Haydock to Junker		$19.9		•	
I-485 Station	See footnote 1. Includes a station building at $1.5 million.	$6.0			•
Junker to A.T.& O. Jct.		$7.7		•	
Total P Line, Greensboro to Charlotte	Exclusive of Charlotte terminal area.	$151.7			
Charlotte Terminal Area:					
A.T.& O. Jct. to 6th Street (North End Charlotte Station)		$10.7		•	
Charlotte Station Track Reconfiguration (6th Street to Stadium)	See	$26.9		•	
Charlotte Station	See footnote 1.	$10.8		•	•
Charlotte Station to Charlotte Airport Station		$8.8		•	
Charlotte Airport Station	See footnote 1. Includes a station building at $6.1 million.	$8.0			•
Charlotte Storage Yard and Servicing Facility[8]	See footnote 8.	$6.1			•
Total, CharlotteTerminal Area		$71.3			
Total, Site-Specific Projects-All Other		**$764.7**			
Total Investment Requirement (exclusive of real estate acquisition and items to be determined)		**$970.9**			

Further engineering work would necessarily support a detailed segmentation, prioritization, and sequencing of these projects. As an example of segmentation, a major effort like the relocation of Raleigh Station and the track reconfiguration between Southern Junction and Ashe, which this monograph describes in broad outlines, would lend itself to subdivision into a number of interrelated projects. The engineers would then evaluate these separate projects in terms of their cost-effectiveness in fulfilling trip-time, capacity, and re-capitalization needs. Experience on the Northeast Corridor Improvement Project has shown that a disproportionately large share of the trip time benefits could result from a relatively small portion of the total costs, thus emphasizing the benefits of prioritization. Capacity and re-capitalization projects can likewise be evaluated for their urgency and return on investment. Finally, the study's 20-year planning horizon allows for a phased implementation[9] of the contemplated program to match the rail operators' staged introduction of service improvements. Thus, closer scrutiny would assist high-speed rail partners in fashioning a detailed program that is affordable, timely, and efficacious.

Major Study Conclusions

This study of the 338-mile Richmond–Charlotte Corridor represents the first application of the transportation planning concepts that evolved in the Northeast Corridor Improvement Project—America's most intensive high-speed rail development effort—to a predominantly single-track railroad with heavy through and local freight traffic.

Capacity Requirements

The importance of freight traffic, coupled with the bottlenecks inherent in single-track operation, makes protecting the reliability of all services a paramount concern in planning—secondary only to safety. As a result, for this corridor to meet the States' goals for travel time and reliability:

- Significant additional capacity would need to be provided.
- This capacity may take the obvious form of additional tracks, mainly passing sidings but in some instances center sidings, and new interlockings.
- More subtle—but of equal importance—are the detailed improvements that would allow freight trains to enter and exit the main line more quickly, and that would lessen the delays occasioned by interference among all rail services. These include upgrading turnouts for higher operating speeds and providing improved paths for all types of trains through complex yard areas.

[9] However, phased implementation must always be weighed against obvious one-time opportunities to do projects "right the first time," as for example when an abandoned route like the S Line is rebuilt free of traffic.

- Combined with the need for careful attention to engineering detail is the requirement for collegial operations planning, over the long term, among all the operators and service sponsors in the corridor.

With the betterments identified in this study, it would be feasible to upgrade intercity passenger service to achieve reliable travel times of 4.5 hours between Richmond and Charlotte, 6.5 hours between Washington and Charlotte, and 9.5 hours between New York and Charlotte. These timings would approach those incorporated in the FRA's 1997 report on the commercial feasibility of high-speed ground transportation, which emphasized the relatively favorable transportation economics of the Southeast Corridor due to its traffic synergy with the Northeast Corridor north of Washington.

These intercity passenger rail service improvements could occur without adverse impacts to freight operations in this very busy territory, or to the commuter services envisioned by the City of Charlotte. Indeed, all services may stand to benefit from the improved traffic flows made possible by the initiatives described in this monograph.

Three Corridors In One

To make full use of this study's findings, transportation planners and public officials need to be aware that this 338-mile corridor consists of three distinct parts, each of which demands a distinct engineering treatment, even while meriting unified consideration from the marketing and operational viewpoints:

- The **S Line between Richmond and Raleigh** (157 miles) consists mainly of very-light-density freight trackage and an 88-mile stretch of abandoned railroad that would need to be rebuilt. Because of the light freight traffic levels, the existence of a right-of-way, the ability to reconstruct free of traffic on the abandoned portion, and the facility's status as the "air line" or shortest route between Richmond and Raleigh, the S line constitutes an opportunity for the States to establish high-speed rail relatively quickly and at a reasonable cost. Noteworthy is the ability to rebuild the S Line "right the first time"—with time-saving realignments that could, in the absence of daily traffic loads, be built at a very low incremental expenditure.
- The **H Line between Raleigh and Greensboro** (81 miles) carries a moderate freight traffic over a single-track route with an often difficult alignment, through freight yards and a number of junctions with other lines. To obtain speed and reliability over the H Line will require a judicious combination of passing tracks, realignments, and other detailed local improvements.
- The **P Line between Greensboro and Charlotte Airport** (100 miles)—as the main line of the former Southern Railway, and a key link in today's NS network—has benefited from continuous improvements and carries a heavy freight traffic. Moreover, the North

Carolina points that it serves are themselves important traffic generators. Therefore, while only one track realignment is deemed necessary, capacity and reliability concerns would mandate the restoration of all the double track that was removed in the last half of the 20th Century, and the addition of three center passing tracks and other stretches of third track. In addition, major investments are needed at such points as Greensboro and Charlotte to protect the reliability of all the future services.

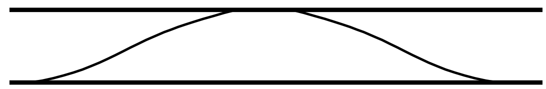
Implications for Other Corridor Studies

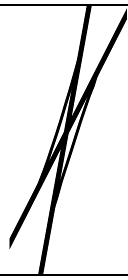
Because the Richmond–Charlotte Corridor consists of three distinctive segments, the present study contains information that will be useful to corridor planners in many other regions of the country where analogous situations prevail. Abandoned segments, light-to-medium density single-track freight lines, and heavy freight routes with limited capacity exist in other designated corridors, and the techniques employed to overcome the varied challenges in the Richmond–Charlotte route will apply elsewhere as well. In particular, planners and decision-makers need to keep in mind the special characteristics of single-track routes—and of high-density freight lines—and the careful attention to operational planning and engineering detail that is prerequisite to their successful adaptation for high-speed rail service.

Tables in Chapter 7

Glossary

Acronym or Term	Meaning
ABS	Automatic Block Signals
ACL	The former Atlantic Coast Line Railroad, a predecessor company of CSXT.
ADA	Americans With Disabilities Act
A Line	The former Atlantic Coast Line main line between Acca Yard, Richmond, Petersburg, Charleston, Savannah, and Florida, via Rocky Mount, Wilson, and Selma, North Carolina.
C&O	The former Chesapeake & Ohio Railway, a predecessor company of CSXT.
CP	Control point—a term designating an interlocking, where trains can switch tracks. For example, CP-Virginia is the current designation for the former "Virginia Interlocking."
Corridor	When used by itself and capitalized, refers exclusively to the Richmond–Charlotte portion of the Southeast Corridor.
CSXT	CSX Transportation, Inc.
CTC	Centralized Traffic Control—a method of railway operation in which train movements are planned, and the turnouts that establish train paths are remotely aligned, from a single point. CTC is only partially automated in that it constantly requires the train operator to observe and actively obey signals and all applicable operating rules and orders.
CTP	Corridor Transportation Plan
DTC	Direct Train Control—a method of railway operation in which train movements are authorized in a territory with predetermined geographic limits, i.e. from Point "A" to Point "B". DTC may be used with or without signal systems. DTC is <u>not</u> CTC.
FHWA	Federal Highway Administration
FRA	Federal Railroad Administration
FRA 1997	Federal Railroad Administration, *High-Speed Ground Transportation for America,* September 1997; As this monograph goes to press, the report is available at: http://www.fra.dot.gov/Content3.asp?P=515
H Line	The portion of the North Carolina Railroad between Greensboro and Raleigh.
HP	High-level platform (at passenger stations)
HSR	high-speed rail

interlocking	 Schematic of a universal, two-track interlocking (each track is represented by a single line). A location where carefully laid-out turnouts (“switches”) allow trains to move from one track to another. The trackwork and accompanying signals are all controlled by a mechanical apparatus and/or electric circuitry that is “interlocked” to prevent conflicting paths from being established for simultaneously passing trains. A **universal interlocking** on a multiple-track railroad allows trains to move from any track to any other track.
jerk rate	The rate of change in lateral acceleration as a train transitions from tangent track through a spiral and enters a curve, and vice versa.
LP	Low-level platform (at passenger stations)
MP	Milepost
MARC	Maryland Rail Commuter service, sponsored by the State of Maryland in the greater Washington and Baltimore metropolitan areas.
MAS	Maximum Authorized Speed
NCDOT	North Carolina Department of Transportation
NCRR	North Carolina Railroad
NEC	Northeast Corridor
NS	Norfolk Southern Corporation
P Line (Piedmont Main Line)	NS’s major route from northern Virginia and the NEC region to Charlotte, Atlanta, and points south and west. Between Charlotte and Greensboro, the Piedmont Main Line is owned by the North Carolina Railroad, operated by NS, and referred to as the “P Line” in this report.
ROD	Record of Decision (part of the environmental process; see Chapter 1, “Important Note on the Environmental Process”).
RF&P	Richmond, Fredericksburg & Potomac Railroad Company, former owner/operator of most of the Washington–Richmond Corridor; a predecessor company of CSXT.
RMTC	Richmond Multi-modal Transportation Center (at Main Street Station)
roll angle	The degree of divergence from the vertical as a train goes through a curve.
runoff rate	The rate at which superelevation is introduced on a spiral, as the curvc is approached. (Note: some railroads have, in the past, occasionally introduced runoff on tangent (straight) track; this is an expedient that does not accord with modern engineering practice.)
SAL	The former Seaboard Air Line Railroad; a predecessor company of CSXT.
SEC	Southeast Corridor

S Line	The former Seaboard Air Line main line between Richmond, Petersburg, Raleigh, Columbia, Savannah., and Florida.
slip switch	 Where two tracks cross at grade at an acute angle, a special piece of trackwork that allows for trains to either go straight or diverge to the other track. A very simple schematic of a slip switch appears to the left. Because slip switches are complex and labor-intensive to maintain, modern railway engineering practice is to avoid them where possible.
spiral	A transition with gradually increasing curvature and superelevation between straight ("tangent") and curved track (and vice versa), designed to ease the dynamic forces of track/train interaction and to assure acceptable ride quality. Spirals first came into use in the late 19th century, so that many original American railways lacked them.
STB	Surface Transportation Board, successor to the Interstate Commerce Commission
superelevation	The difference in height between the two rails, intended as "banking" on curves.
tangent track	A stretch of straight track, i.e., "tangent" to a curve.
TPC	Train Performance Calculator
track twist rate	The rate of change in cross level, i.e. the relative heights of the two rails.
TTA	Triangle Transit Authority
TWC	Track Warrant Control system—a method of railway operation in which the geographic limits covered by train movement authorizations can vary based on decisions by the dispatcher. TWC may be used with or without signal systems. TWC is not CTC.
unbalanced superelevation	The amount of additional superelevation (beyond that physically provided in the track) that would be necessary to assure that the plane of train's floor is perfectly parallel to the horizontal as it traverses the curve, at the curve's maximum authorized speed.
VDRPT	Virginia Department of Rail and Public Transportation
VRE	Virginia Railway Express

Supplement:
BACKGROUND MATERIALS

Rail Corridor Designations

The following is the legislative basis for the program under which the Southeast Corridor was "designated." Source: GPO Access, United States Code, Title 23 (codified in 2000).

TITLE **23**--HIGHWAYS

CHAPTER 1--FEDERAL-AID HIGHWAYS

SUBCHAPTER I--GENERAL PROVISIONS

Sec. **104**. Apportionment

* * *

(d) Operation Lifesaver and High Speed Rail Corridors.--

(1) Operation lifesaver.--Before making an apportionment under subsection (b)(3) of this section for a fiscal year, the Secretary shall set aside $500,000 for such fiscal year for carrying out a public information and education program to help prevent and reduce motor vehicle accidents, injuries, and fatalities and to improve driver performance at railway-highway crossings.

(2) Railway-highway crossing hazard elimination in high speed rail corridors.--

(A) In general.--Before making an apportionment of funds under subsection (b)(3) for a fiscal year, the Secretary shall set aside $5,250,000 of the funds made available for the surface transportation program for the fiscal year for elimination of hazards of railway-highway crossings.

(B) Eligible corridors.--Subject to subparagraph (E), funds made available under subparagraph (A) shall be expended for projects in--

(i) 5 railway corridors selected by the Secretary in accordance with this subsection (as in effect on the day before the date of enactment of this clause);

(ii) 3 railway corridors selected by the Secretary in accordance with subparagraphs (C) and (D);

(iii) a Gulf Coast high speed railway corridor (as designated by the Secretary);

(iv) a Keystone high speed railway corridor from Philadelphia to Harrisburg, Pennsylvania; and

(v) an Empire State railway corridor from New York City to Albany to Buffalo, New York.

(C) Required inclusion of high speed rail lines.--A corridor selected by the Secretary under subparagraph (B) shall include rail lines where railroad speeds of 90 miles or more per hour are occurring or can reasonably be expected to occur in the future.

(D) Considerations in corridor selection.--In selecting corridors under subparagraph (B), the Secretary shall consider--

(i) projected rail ridership volume in each corridor;

(ii) the percentage of each corridor over which a train will be capable of operating at its maximum cruise speed taking into account such factors as topography and other traffic on the line;

(iii) projected benefits to nonriders such as congestion relief on other modes of transportation serving each corridor (including congestion in heavily traveled air passenger corridors);

(iv) the amount of State and local financial support that can reasonably be anticipated for the improvement of the line and related facilities; and

(v) the cooperation of the owner of the right-of-way that can reasonably be expected in the operation of high speed rail passenger service in each corridor.

(E) Certain improvements.--Not less than $250,000 of such set-aside shall be available per fiscal year for eligible improvements to the Minneapolis/St. Paul-Chicago segment of the Midwest High Speed Rail Corridor.

(F) Authorization of appropriations.--There is authorized to be appropriated $15,000,000 for each of fiscal years 1999 through 2003 to carry out this subsection.

The most recent *Federal Register* notices implementing the program are at 65 FR 43826 (July 14, 2000)(available at http://frwebgate5.access.gpo.gov/cgi-bin/waisgate.cgi?WAISdocID=03495623183+1+0+0&WAISaction=retrieve) and 63 FR 68499 (December 11, 1999)(available at http://frwebgate3.access.gpo.gov/cgi-bin/waisgate.cgi?WAISdocID=03630015259+1+0+0&WAISaction=retrieve). Further information on the current status of the designated corridors, including a map, is available on the FRA web site at: http://www.fra.dot.gov/rdv/hsgt/states/index.htm. Availabilities are as of September 2002.

Settlement of NCRR–CSX Dispute on Ownership

News Release from North Carolina Railroad:
http://www.ncrr.com/news/121001news.htm

December 10, 2001

NORTH CAROLINA RAILROAD COMPANY AND CSX TRANSPORTATION RESOLVE PROPERTY DISPUTE; AGREEMENT ENHANCES FREIGHT AND PASSENGER RAIL SERVICE

North Carolina Railroad Company (NCRR) and CSX Transportation Inc. (CSXT) have settled a 140-year ownership dispute over a portion of track near Raleigh, NC. The agreement opens the door for increased rail transit and economic development in the Triangle and eastern portions of North Carolina.

In September 2000, CSXT filed a property lawsuit disputing ownership of a 200-foot portion of the NCRR corridor between Raleigh and Cary that is used by CSXT freight trains and Amtrak passenger trains. The corridor also is proposed for use by the Triangle Transit Authority for its planned regional rail service.

Under the settlement, NCRR, which owns the 317-mile rail corridor between Morehead City and Charlotte, will be acknowledged by CSXT as owner of the corridor in question. In exchange, NCRR grants CSXT the right to continue its use of the corridor.

Both companies agree to continue to accommodate Amtrak. CSXT also may add up to two miles of double track to meet future capacity needs. The settlement also allows the Triangle Transit Authority to use the right-of-way north of the existing CSXT and Amtrak operations area between Raleigh and Cary to build TTA's regional rail transit tracks.

"The resolution of this conflict ensures CSXT freight service to the northeastern part of the state," says NCRR Chairman Sam Hunt. "High quality freight service is an important component for sustained economic growth and development. It is an asset for the businesses already located northeast of Raleigh and can attract new industries considering locating in the region. This will also allow TTA to go forward to finalize their regional rail plans."

CSX Corporation Chairman John Snow said, "From the inception of the Seaboard Air Line Railway in the 1890s, this line has been a key part of our railroad and our company's success. North Carolina and its industries are important to CSX and we look forward to a close working relationship with the North Carolina Railroad Company."

The NCRR's mission is to manage, improve and protect North Carolina's rail properties and corridors in a manner that will enhance passenger and freight service and promote economic development. CSXT and its 35,000 employees provide rail transportation and distribution services over a 23,000 route-mile network in 23 states, the District of Columbia and two Canadian provinces. CSXT is a business unit of CSX Corporation, headquartered in Richmond, Va. Photo available upon request.

Funding for Planning an Extension of the Southeast Corridor to Atlanta and Macon, Georgia

In accordance with the Conference Report 106-940, [1] $200,000 was appropriated for planning of a "Southeast corridor extension from Charlotte, NC to Macon, GA" under Public Law 106-346 (H.R. 4475), "Department Of Transportation and Related Agencies Appropriations, 2001."[2] The result of this earmark was a $199,560 corridor planning grant under the Next-Generation High-Speed Rail Program, provided in March 2002 through the Federal Railroad Administration to the States of Georgia, North Carolina, and South Carolina. Under the 50-50 matching provisions of the authorizing legislation, the States were required to obligate an equal amount in support of this effort, in which Georgia is serving as the lead state.

Further information on the study, which covers the three-State region between Charlotte, Atlanta, and Macon in accordance with the designation of the Southeast Corridor, may be obtained from the Transportation Planning, Data, and Intermodal Development Division of the Georgia Department of Transportation; their Internet address and contact list is at http://www.dot.state.ga.us/specialsubjects/contacts/index.shtml.

Status of Environmental Work on Southeast Corridor, 2002[3]

News Release from Rail Division, NCDOT:
http://www.bytrain.org/redbarinfo/news/2002releases/feis731.html

Date: July 31, 2002

Southeast High-Speed Rail
Tier I Final Environmental Impact Statement Completed

The North Carolina Department of Transportation and the Virginia Department of Rail and Public Transportation have completed the Southeast High-Speed Rail Tier I Final Environmental Impact Statement (FEIS).

The Southeast High-Speed Rail project will develop and operate high-speed passenger rail service in the 500-mile corridor from Washington, D.C. through Richmond, Va. and Raleigh, N.C. to Charlotte, N.C. In March, the transportation secretaries of North Carolina and Virginia announced the preferred route would extend from Washington, D.C. through Richmond, South Hill, Henderson, Raleigh and Greensboro to Charlotte. The route will also include a rail connection to Winston-Salem.

The FEIS document contains the analysis for selecting the preferred high-speed rail route, as well as public and agency comments – and responses to those comments- on the Draft Environmental Impact Statement. The public can review the Final Environmental Impact Statement at 19 locations throughout the corridor. All comments must be submitted to the NCDOT Rail Division by August 30.

After the public, state, local and federal agencies review the FEIS, the U.S. Department of Transportation will issue a Record of Decision, allowing the second study phase on the selected route to begin. In the

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[1] Available at http://thomas.loc.gov/cgi-bin/t2gpo/http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=106_cong_reports&docid=f:hr940.106.pdf

[2] Available at http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=106_cong_public_laws&docid=f:publ346.106

[3] For more recent developments, see Chapter 1, "Important Note on the Environmental Process."

second study phase, the state transportation departments will more closely analyze the impacts of track location and incremental improvements. As these studies are completed, they will be used to acquire the permits needed for construction.

During the past few years, the North Carolina Department of Transportation and Virginia Department of Rail and Public Transportation held dozens of information workshops, formal public hearings and small group meetings to discuss the project and solicit public input. The agencies also conducted numerous interviews with community leaders in both states. More than 80 percent of the feedback from both states indicated support for high-speed rail. Mayors, Chambers of Commerce and other business groups echoed that support and worked together to tout the economic and quality-of-life benefits of a high-speed rail system.

Almost three years of environmental study and public involvement yielded information and analysis of potential environmental impacts, engineering feasibility, revenue, ridership, and costs. This analysis indicates the preferred route would have the best potential for high-speed rail service while having the fewest environmental impacts.

However, completion of the Southeast High-Speed Rail Corridor is dependent on securing federal funds to help develop the route. Congress currently is considering several pieces of legislation that would provide dedicated funding for development of high-speed rail corridors. If funding is approved, the Washington to Charlotte corridor could be completed as early as 2010. The route would later be extended to Atlanta and Macon, Georgia, Columbia, South Carolina and Jacksonville, Florida.

For specific document review locations, click here.

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Service Improvements on North Carolina Portions of Southeast Corridor

News Release from Rail Division, NCDOT:
http://www.bytrain.org/redbarinfo/news/2002releases/trspeeddncclt.html

Date: July 1, 2002

Train speeds to increase between Durham and Charlotte

Raleigh - Beginning August 1, trains will travel a little faster along portions of the North Carolina Railroad between Durham and Charlotte. Train speeds will increase between five and 44 miles per hour, depending on the stretch of track, and will shave about 10 minutes off the trip between the two cities.

"These speed increases follow years of work to make rail crossings safer and improve efficiency on the railroad between Raleigh and Charlotte," said N.C. Transportation Secretary Lyndo Tippett. "The time savings may seem moderate now but, when combined with other slated improvements, will make the passenger rail service more auto competitive. In addition, these speed increases will be good for commerce because they will improve freight shipment efficiency."

Between Durham and Greensboro passenger train speeds will increase from the current 25-55 mph to a maximum of 59 mph, while freight trains will increase from 15-45 mph up to a top speed of 49 mph. Straighter stretches of track between Greensboro and Charlotte will enable passenger trains along this section to operate at top speeds of 79 mph, while freight trains will operate up to 60 mph. Maximum speeds currently range from 35-79 mph for passenger trains and 50-60 mph for freight trains.

For the past decade, state transportation officials have been working with local communities along the busy rail corridor to reduce the number of crossings and add protective devices to remaining crossings to deter drivers from trying to beat the train. Since 1995, 25 crossings have been closed and 89 more have been upgraded with flashing lights, crossing gates or other such devices between Raleigh and Charlotte.

As the NCDOT was outfitting the rail crossings with flashing lights and gates, it also improved the signal circuitry at each crossing. The crossings now include constant warning time devices, which signal the gates to lower 25-30 seconds before the train arrives regardless of what speed it is traveling.

"The constant warning time devices provide consistent advance notice to motorists, thereby improving safety at these crossings." said Tippett. "Drivers are more likely to heed the warning devices because they know the train is imminent."

The department is partnering with Operation Lifesaver, a national public information and education program designed to prevent and reduce train crashes, to notify businesses nearest the railroad tracks about the speed increases. They also plan to have several safety information blitzes to increase awareness among motorists of the speed change.

"We do all we can to prevent injuries and fatalities at rail crossings," said NCDOT Rail Director Patrick Simmons. "Ultimately, however, it is the driverxs responsibility to stop, look, listen and obey the crossing signals."

The crossing improvements are part of a comprehensive project to improve efficiency, increase capacity and reduce travel time between Cary and Greensboro. The North Carolina Department of Transportation, in partnership with the North Carolina Railroad (NCRR) and Norfolk Southern Railway Company, is making $24 million worth of improvements to the tracks along the busy rail corridor. Enhancements include lengthening passing sidings, improving two railroad junctions, installing new train signals, banking some portions of track and installing a new centralized traffic control system.

Once all the work is completed- scheduled for 2004- travel time between the two cities will be reduced by at least 20 minutes. The NCDOT and Norfolk Southern are providing the engineering and design plans for the projects and the NCDOT is paying for the rail improvements with state and federal funds. Norfolk Southern is performing the construction work on the NCRR corridor.

NCDOT

Contact: Julia Hegele, 919-733-4713, ext. 247