Chapter 3
Maximum Build Scenario

The chapter that follows evaluates a "Maximum Build" Scenario. This scenario could be described in general terms as the highest level of improvement that would allow a commuter rail service to function with optimal service frequency and predictability. It would be the most substantial improvement over the existing infrastructure found in the corridor and would be the most costly to build, operate, and maintain the system.

3.1 Maximum Build Scenario Service

Under the Maximum Build Scenario, the rail route between Springfield and New Haven would be rebuilt as a bi-directional double track line with sufficient crossover tracks to permit single track operation around maintenance activities or emergency situations that could block one of the two tracks. The Maximum Build illustrative schedules have several service objectives:

- Frequent morning and evening peak period service (15 minute frequency) to serve work trips into and from New Haven, Hartford, and Springfield. The frequent service would be provided in each direction.
- A high level of service (hourly departures) in each direction for mid-day travel. The mid-day service expands the travel opportunities by serving trips other than traditional 8-hour daytime work travel.
- Service to Bradley Airport, via a connecting shuttle bus from the Windsor Locks station. Should sufficient demand develop, direct rail service into the airport could be considered.
- Connections at New Haven with Metro North, Shore Line East, and Amtrak Northeast Corridor services. The Maximum Build schedules would replace the current less frequent Amtrak shuttle service on the New Haven – Springfield line. Amtrak's Vermonter would continue to operate as a through train from Vermont, Massachusetts, and central Connecticut stations to New York, Philadelphia, and Washington.

Rail Traffic Controller (RTC) simulation software was used to evaluate the expanded schedules. Under ideal operating conditions, the upgraded railroad would easily provide a high degree of service reliability. If emergency or operating conditions should require closing one of the tracks, trains during the peak periods could experience delays up to 10 to 15 minutes due to single track operation. Delays would be less during off-peak periods when trains operate at greater headways. Passenger operation at 15 minute headways would require adjustment of freight operations on the line during the peak periods.

The illustrative schedules would provide 34 trips in each direction, with service from approximately 4:00 am through midnight. The peak period service would include 15-minute headways between 6:00 and 8:00 am, and between 4:00 and 6:00 pm in both directions. Running time would be about 1 hour 30 minutes[4], depending on the extent of train operating speed increases that would be possible with track improvements and improved grade crossing protection.

Table 3-1 shows the illustrative weekday schedules for Springfield, Hartford, and New Haven. The additional stations that would be served are not shown. Although not illustrated by schedules, the service would also operate at approximately two-hour intervals on Saturdays, Sundays, and Holidays to provide connections to Amtrak and Metro North at New Haven. This service could operate more frequently with sufficient demand.

Three caveats applicable to the earlier development of a Minimum Build Scenario are also applicable to this Maximum Build Scenario. First, detailed operations analyses of station operations in Springfield and New Haven have not been conducted, so the schedules at this point assume that station capacity is sufficient. Further analysis of the schedules with Amtrak and Metro North will be necessary, and some adjustments may be anticipated. Second, the needs of freight operators and customers need to be evaluated to determine how freight train movements can be accommodated around the peak periods. Third, the schedules assume that Amtrak and ConnDOT will reach agreement for upgrading the line and for the commuter operations to replace most or all of the Amtrak shuttle services now operating.

3.2 Stations under a Maximum Build Scenario

The Maximum Build Scenario described includes several additional stations and substantial improvements to the station areas. The stations for this scenario, which include those new stations not found in the minimum build scenario (are *italicized* below) and are shown in Figure 3-1:

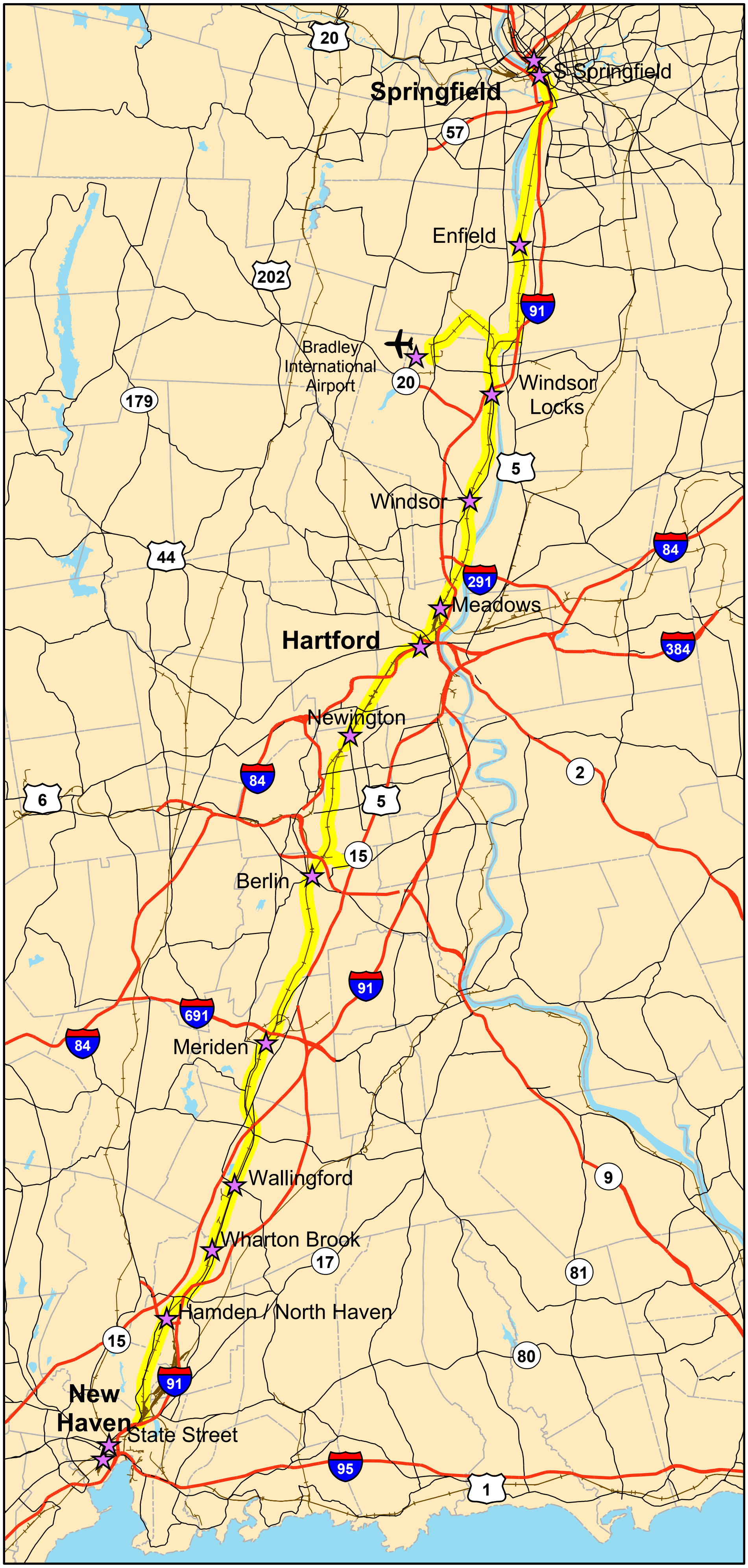
- New Haven Union Station
- State Street Station
- *North Haven / Hamden Station (at Route 40 connector)*
- *Wharton Brook Station (at the Pratt & Whitney site)*
- Wallingford Station

[4] Current rail speed limits, allowing for the additional stations that will be served, would result in 1 hour 32 minutes running times.

Table 3-1
Illustrative Weekday Schedules for Maximum Build Scenario

Southbound				Northbound			
Train	**Leave SPG**	**Arrive HFD**	**Arrive NHV**	**Train**	**Leave NHV**	**Leave HFD**	**Arrive SPG**
1	4:15	4:50	5:45	2	4:20	5:15	5:50
3	5:00	5:35	6:30	4	5:00	5:55	6:30
5	5:45	6:20	7:15	6	5:40	6:35	7:10
7	6:00	6:35	7:30	8	5:55	6:50	7:25
9	6:15	6:50	7:45	10	6:10	7:05	7:40
11	6:30	7:05	8:00	12	6:25	7:20	7:55
13	6:45	7:20	8:15	14	6:40	7:35	8:10
15	7:00	7:35	8:30	16	6:55	7:50	8:25
17	7:15	7:50	8:45	18	7:10	8:05	8:40
19	7:30	8:05	9:00	20	7:25	8:20	8:55
21	7:45	8:20	9:15	22	7:40	8:35	9:10
23	8:15	8:50	9:45	24	8:15	9:10	9:45
25	9:15	9:50	10:45	26	9:00	9:55	10:30
27	10:15	10:50	11:45	28	10:00	10:55	11:30
29	11:15	11:50	12:45	30	11:00	11:55	12:30
31	12:15	12:50	13:45	32	12:00	12:55	13:30
33	13:15	13:50	14:45	34	13:00	13:55	14:30
35	14:15	14:50	15:45	36	14:00	14:55	15:30
37	15:15	15:50	16:45	38	15:00	15:55	16:30
39	15:45	16:20	17:15	40	15:40	16:35	17:10
41	16:05	16:40	17:35	42	16:10	17:05	17:40
43	16:20	16:55	17:50	44	16:25	17:20	17:55
45	16:35	17:10	18:05	46	16:40	17:35	18:10
47	16:50	17:25	18:20	48	16:55	17:50	18:25
49	17:05	17:40	18:35	50	17:10	18:05	18:40
51	17:20	17:55	18:50	52	17:25	18:20	18:55
53	17:35	18:10	19:05	54	17:40	18:35	19:10
55	17:50	18:25	19:20	56	17:55	18:50	19:25
57	18:05	18:40	19:35	58	18:10	19:05	19:40
59	18:35	19:10	20:05	60	18:40	19:35	20:10
61	19:05	19:40	20:35	62	19:40	20:35	21:10
63	20:05	20:40	21:35	64	20:40	21:35	22:10
65	21:35	22:10	23:05	66	22:10	23:05	23:40
67	23:05	23:40	0:35	68	0:15	1:10	1:45

Source: Wilbur Smith Associates



Maximum Build Stations

New Haven - Hartford - Springfield
Commuter Rail Feasibility Study

Legend

- Rail Study Corridor
- Highways
- Major Roads
- Maximum Build Rail Stations

0 5 10 Miles

Figure 3.1

- Meriden Station
- Berlin Station
- *Newington Station (adjacent to New Britain Busway station)*
- Hartford Union Station
- *North Meadows Station (at the Jai Alai facility)*
- Windsor Station
- Windsor Locks Station
- *Enfield Station (at Bigelow Commons in Thompsonville)*
- *Springfield State Street Station (at end of State Street per City of Springfield)*
- Springfield Union Station

Station improvements would include high-level platforms, pedestrian amenities with grade separated crossings, enclosed heated station buildings with restrooms and waiting areas, bicycle storage and racks, and any additional parking required to accommodate projected ridership.

3.3 Construction of a Maximum Build Service

The Maximum Build Scenario includes double tracking the entire New Haven to Springfield line, several additional stations, substantial improvements to the station areas and optimized connecting bus routes. With the Maximum Build Scenario, the connecting bus service was maximized to circulate in each study area town to take full advantage of the rail stations. This called for the elimination of some service that would be redundant with the new commuter rail (such as bus service from Wallingford to New Haven) and inclusion of new routes to circulate rail passengers in each town. These bus service changes are detailed in Chapter 4.

The Maximum Build Scenario will also serve Bradley International Airport from the Windsor Locks Station. Two alternatives for this airport connection are being investigated, a direct rail connection and a shuttle bus using the existing roadway system. Many of the commuter rail systems today have shuttle bus connections to the nearest airport and a few have direct rail connections. The potential connection to the Bradley International Airport is being evaluated to determine which mode would be more cost effective for the horizon year of 2025.

3.4 Ridership Levels under a Maximum Build Service

The Maximum Build service has the ability to attract several different types of riders. For each of these four different types, a different approach to developing ridership forecasts has been developed. These four different types of users are:

1. Commuters accessing employment hubs in New Haven, Hartford and Springfield;
2. Intercity rail ridership to points off the corridor, specifically connections to the Amtrak service in New Haven and Springfield;
3. Users that would have access to Bradley International Airport (BDL); and

4. Off-peak non-commuter and weekend users.

As with the Minimum Build Scenario, the ConnDOT model was used as the primary basis for calculating ridership on the line. The ConnDOT model is, however, primarily a commuter model using population and employment to calculate expected trips. Because the Maximum Build Scenario includes substantial off-peak service (business and recreational trips) and replaces the existing Amtrak trains (intercity trips), additional techniques for developing ridership beyond the ConnDOT model were developed. The following sections highlight the techniques for establishing the total ridership estimates.

3.4.1 Commuter Ridership

The ConnDOT model is a statewide model encompassing the roadway and transit networks in the entire state of Connecticut. Using the ConnDOT year 2025 no-build model, the eleven Connecticut stations from North Haven north were added to the model with service headways of 15 minutes in the peak hours and 60 minutes in the off-peak. Because the adjoining states, Massachusetts, New York and Rhode Island are treated as externals to the model, an off-model calculation of trips from Springfield was added to the model results for the two Springfield stations.

This off-model calculation was based on recently available Census 2000 Journey to Work town to town data, grown to reflect year 2025 population and employment. Expected rail capture rates were applied to the data to determine the number of trips from the Springfield station to the rest of the study area.

The results of the ConnDOT model and the out-of-state ridership evaluation indicate the year 2025 daily commuter ridership for the Maximum Build Scenario is approximately 3,440 as compared to 1,606 for the Minimum Build Scenario. Table 3-13, found later in the report, shows the AM peak commuter boardings (ons) and alightings (offs) for each station.

3.4.2 Intercity Ridership

Intercity ridership reflects the operations of the existing Amtrak service. Since the ConnDOT model does not reflect any rail service in the corridor, the ridership is not reflected in the commuter ridership estimates. In addition, in April 2003, Amtrak reduced their fares and increased service on the corridor to more closely replicate commuter rail service.

In order to get a better understanding of trip origins and destinations, purposes and frequencies for Amtrak users in the New Haven to Springfield corridor, surveys were conducted on board on June 19, 2003. Although there are still substantial differences between Amtrak's current service and the commuter rail service being considered for this study, the Amtrak customer surveys provide information that can be used to estimate the number of people who would likely switch to commuter rail service and those who would remain Amtrak Intercity customers. 599 surveys were distributed and collected on board by members of the consultant team and approximately 85 percent of the riders completed a survey. According to train conductors on board, this was a typical ridership day.

The survey results were coded by the questions asked on the survey, including origin and destination station and city, trip purpose (to or from work, to or from school, business trip made for work, a personal business trip such as to see a doctor, visit a government office, etc or leisure trips), trip frequency, and mode of accessing and leaving the train stations. General survey results follow.

Trip Purpose

Amtrak customers were asked the purpose for their trip, including to get to or from work (i.e., commuter) or to or from school. These two trip purposes are typically made on the most frequent basis. Other trip purposes include a business trip made for work, a personal business trip such as to see a doctor, visit a government office, etc or leisure (fun) trips. Leisure trip purposes were broken into recreational trips, visiting family or relatives or family vacations. Table 3.2 shows the trip purposes stated by the customer for the entire survey and those who could utilize commuter rail. As shown in Table 3-2, the majority were using the train to visit friends or relatives (38 percent) or for work purposes (23 percent). Only 11 percent used the train to get to or from work or school.

Table 3-2
Amtrak Survey Results - Trip Purpose

No answer	1%
To / from work	8%
To / from school	3%
Business for work	23%
Personal business	9%
Recreation	9%
Visit friends / relatives	38%
Family vacation	9%
Other	1%

Source: WSA Amtrak Rider Survey, June 2003

Trip Frequency

On the survey, Amtrak customers were asked the frequency with which their trip was made. They were given a choice of daily, more than once per week, about once per week, more than once per month, about once per month, more than once per year, about once per year, and this is the only time. Table 3-3 shows the trip frequency stated by the customer. As shown in Table 3.3, 10% made the trip at least once per week, with only 3% considering the trip a daily event. Most respondents had made the trip only one time or at most a few times per year.

Table 3-3
Amtrak Survey Results - Trip Frequency

No answer	1%
Daily	3%
More than once per week	4%
About once per week	3%
More than once per month	7%
About once per month	9%
More than once per year	23%
About once per year	15%
This is the only time	35%

Source: WSA Amtrak Rider Survey, June 2003

Mode of Access / Egress

To provide more information about the trip being made, Amtrak customers were also asked their mode of accessing the train and mode of accessing their destination from the train. They were given a choice of dropped off / picked up by car, drove alone, carpooled, Metro North Commuter Rail, Shore Line East Commuter Rail, Amtrak rail, subway, bus transit, walked, bicycle or other. Table 3-4 shows the mode of accessing the train and the mode of egress after the train trip as stated by the customer. The majority of respondents were picked up or dropped off, both when accessing their origin station and leaving their destination station. This is followed by drive alone of accessing the station and subway or taxi for leaving the station.

Table 3-4
Amtrak Survey Results - Mode of Access and Mode of Egress

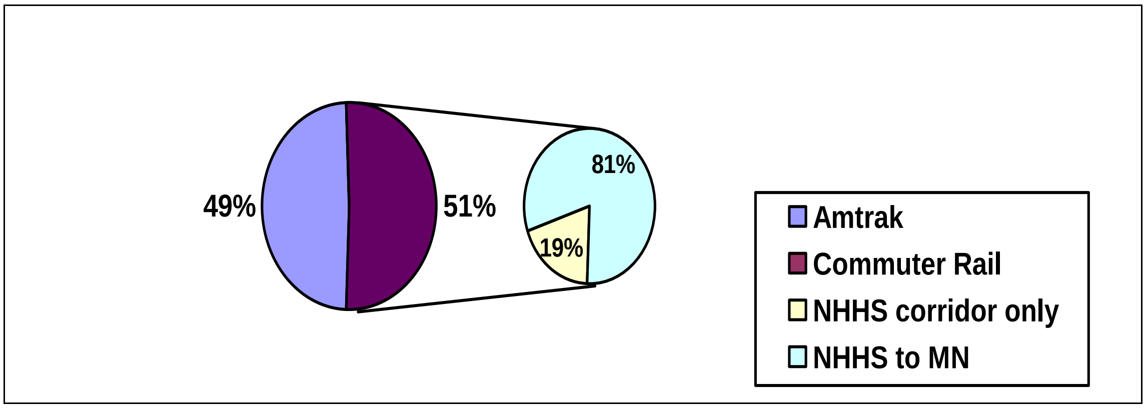
	Mode of Access	Mode of Egress
Other / No answer	3%	11%
Dropped off / picked up by car	52%	46%
Drove / drive alone	16%	7%
Carpool	2%	1%
Metro North Commuter Rail	3%	2%
Shore Line East Rail	0%	0%
Amtrak Rail	7%	6%
Subway	6%	9%
Bus transit	4%	4%
Walked	3%	6%
Bicycle	0%	1%
Taxi	5%	8%

Source: WSA Amtrak Rider Survey, June 2003

Trip Type

In addition to the questions summarized above, Amtrak customers were asked to provide their origin and destination station and origin and destination city/town. Using this data, customers could be sorted into those who would remain on Amtrak and those who would likely switch to commuter rail. As Figure 3-2 illustrates, 51 percent of the Amtrak corridor riders could be users of the New Haven to Springfield commuter rail system. These passengers were originating or destined for somewhere in the corridor and the other end of their trip was either in the corridor or in the Metro North corridor. Of those 51 percent, 19 percent would be using the New Haven to Springfield corridor alone, that is their origin and destination are within the corridor, while 81 percent would be transferring to the Metro North corridor to access intermediate stations or metropolitan New York City. Information about the other survey answers for this group is provided in the following sections.

Figure 3-2
Future Trip Mode



The remaining 49 percent of those surveyed would remain Amtrak customers for at least some portion of their trip, because they are originating or destined for points north of Springfield or south of New York City. The proposed Maximum Build Scenario service would take the place of Amtrak in the corridor except for Vermonter trains. Therefore, non-Vermonter train passengers would begin or end their trip on the commuter rail system and then transfer to Amtrak in Springfield, New Haven or New York.

Potential Commuter Rail Customer Trip Purpose

As mentioned previously, Amtrak customers were asked the purpose for their trip, including trips to get to or from work (i.e., commuter) or to or from school. These two trip purposes are typically made on the most frequent basis. Other trip purposes include a business trip made for work, a personal business trip such as to see a doctor, visit a government office, etc or leisure (fun) trips. Leisure trip purposes were broken into recreational trips, visiting family or relatives or family vacations. Table 3-5 shows the trip purposes stated by the customer for those who would utilize commuter rail, and broken into those on the New Haven to Springfield corridor only and those who would use the corridor and Metro North.

Table 3-5
Potential Commuter Rail Amtrak Customers - Trip Purpose

	All potential commuter rail	NHHS Only	NHHS to Metro North
No answer	1%	0%	1%
To / from work	14%	28%	10%
To / from school	2%	0%	2%
Business for work	28%	17%	31%
Personal business	12%	16%	11%
Recreation	9%	5%	9%
Visit friends / relatives	23%	24%	23%
Family vacation	10%	5%	11%
Other	2%	5%	1%

Source: WSA Amtrak Rider Survey, June 2003

As shown in Table 3-5, for potential commuters on the Springfield line, the majority were using the train for work purposes (28%) or to visit friends or relatives (23%). For those using the New Haven to Springfield corridor alone with no transfer to Metro North, most were using the train to get to or from work (28%) or to visit friends or relatives (24%). These commuter work trips (to / from work) are already accounted for in the modeling process as commuter ridership. Trips for other purposes need to be added to the ridership generated in the modeling process.

Potential Commuter Rail Customer Trip Frequency

Amtrak customers were also asked the frequency with which their trip was made. They were given a choice of daily, more than once per week, about once per week, more than once per month, about once per month, more than once per year, about once per year, and this is the only time. Table 3-6 shows the trip frequency stated by the customer.

Table 3-6
Potential Commuter Rail Amtrak Customers - Trip Frequency

	All potential commuter rail	NHHS Only	NHHS to Metro North
No answer	1%	0%	1%
Daily	6%	19%	3%
More than once per week	7%	12%	6%
About once per week	6%	9%	5%
More than once per month	10%	14%	9%
About once per month	10%	7%	11%
More than once per year	19%	9%	22%
About once per year	11%	5%	12%
This is the only time	30%	26%	31%

Source: WSA Amtrak Rider Survey, June 2003

As shown in Table 3-6, of the riders using the New Haven to Springfield corridor only, 40 percent were traveling at least once per week, including 19 percent making the trip daily. These daily work trips are accounted for in the commuter ridership predicted for the service. Of the riders who would use the NHHS corridor to transfer to Metro North, 14 percent traveled at least once per week, with only three percent considering it a daily trip. It is believed that many of the passengers who would use the service in the future for their daily trip are currently driving to the New Haven station and taking Metro North from there, rather than utilizing the Amtrak service.

Potential Commuter Rail Customer Mode of Access / Egress

Amtrak customers were also asked their mode of accessing the train and mode of accessing their destination from the train. They were given a choice of dropped off / picked up by car, drove alone, carpooled, Metro North Commuter Rail, Shore Line East Commuter Rail, Amtrak rail, subway, bus transit, walked, bicycle or other. Table 3-7 shows the mode of accessing the train and the mode of egress after the train trip as stated by the customer. The majority of respondents were picked up or dropped off, both when accessing their origin station and leaving their destination station. This was also true for the potential commuter rail customers, including NHHS Only and NHHS to Metro North. The second most frequent stated mode for accessing the station was driving alone and the second most frequent stated mode for departing the station was subway for the entire survey and for NHHS to Metro North respondents. For the NHHS corridor only, the second most frequent stated mode was bus transit.

Table 3-7
Potential Commuter Rail Amtrak Customers - Mode of Access and Mode of Egress

	Mode of Access			Mode of Egress		
	All potential commuter rail	NHHS Only	NHHS to Metro North	All potential commuter rail	NHHS Only	NHHS to Metro North
Other / No answer	3%	9%	2%	10%	21%	7%
Dropped off / picked up by car	43%	26%	47%	36%	36%	36%
Drove / drive alone	20%	10%	22%	7%	5%	8%
Carpool	2%	2%	2%	1%	2%	1%
Metro North Commuter Rail	4%	7%	3%	2%	0%	2%
Shore Line East Rail	0%	0%	0%	0%	0%	0%
Amtrak Rail	7%	9%	7%	6%	7%	6%
Subway	7%	2%	9%	16%	3%	19%
Bus transit	6%	22%	2%	5%	14%	3%
Walked	4%	7%	3%	8%	9%	8%
Bicycle	0%	2%	0%	1%	0%	1%
Taxi	4%	5%	4%	8%	3%	9%

Source: WSA Amtrak Rider Survey, June 2003

Modeling results

Using the survey data, the number of current Amtrak riders likely to take the commuter rail for non-commute purposes throughout the day was estimated. This was divided into three groups, those who would likely use the commuter rail because they were destined to points within the corridor or within the Metro North corridor, those who would use the commuter rail for a portion of their trip and then switch to Amtrak because they were traveling beyond New York City or Springfield, and those who would continue to use the Vermonter trains. The first two groups were added to the model ridership as non-commuter trips. Vermonter customers would continue to be served by Amtrak within the corridor.

The estimated ridership added for Intercity trips, that is, trips that would utilize the corridor for a portion and then transfer to Amtrak is 252 daily trips. The estimated ridership added for off-peak ridership, who are currently using Amtrak, but would use New Haven – Springfield or New Haven – Springfield and Metro North is 363 daily trips.

3.4.3 Airport Ridership

While the ConnDOT model will account for trips to the airport associated with the airport employees, business people and leisure travelers using the airport for flights are not accounted for. In order to estimate the airport-related ridership on the proposed commuter rail system, eight other commuter rail systems with airport connections were contacted to obtain data relative to the existing usage of the rail to access the airport. A summary of the characteristics of the eight US commuter rail systems that were chosen for the evaluation are shown in Table 3-8, including their relative size to Bradley Airport (BDL) from the daily local air passengers.

Table 3-8
Notes about Commuter Rail – Airport Connections

Commuter Rail System	Relative size of airport to BDL	Rail Service Frequency	Rail Service Type
Baltimore, Maryland	2.5 times	hourly	shuttle to rail station
Burbank, California	0.7 times	hourly peak, limited off peak	shuttle to rail station
Miami, Florida	2.8 times	hourly	shuttle to rail station
Newark, New Jersey	3.6 times	3 per hour	rail directly to terminal
Philadelphia, Pennsylvania	2.3 times	2 per hour	rail directly to terminal
San Diego, California	2.2 times	hourly	shuttle to rail station
San Francisco, California	3.8 times	hourly	shuttle to rail station
San Jose, California	1.7 times	hourly	shuttle to rail station

Sources: Individual transit agency and airport websites and FAA data

As shown in Table 3-8, most of the airports serve more passengers than Bradley Airport. Information about the service frequency and service type were obtained from the transit agencies. Most of the services were hourly, with Burbank having the least amount of service. Philadelphia and Newark both had service more frequent than hourly in the peak hours. In terms of service type, in six of the cases, a shuttle bus transports riders to and from the nearest commuter rail station, while in the remaining two cases, there is a direct connection to the airport.

In order to calculate the percentage of airport users traveling by commuter rail to access the airport (percent transit users), data on daily ridership, air boardings and origin / destination percentage was obtained. Daily ridership was obtained from the individual transit agencies for the most recent year available, typically 2002. The 2001 annual air boardings (also called enplanements) were obtained from the Federal Aviation Administration and percentage of these boardings that are local origin or destination versus connecting passengers (O&D %) was obtained from the airports. The O&D % was applied to the air boardings to get a number of daily locally originating or destined air passengers. These daily local air passengers were then compared to daily ridership to calculate percent transit users. The data and results are shown in Table 3-9.

Table 3-9
Commuter Rail Transit Airport User Percent Calculations

Commuter Rail System	Daily Ridership[1]	2001 Air Boardings[2]	O&D %[3]	Daily Local Air Passengers	Percent transit users
Baltimore	2300	10,098,665	83%	45,928	5.01%
Burbank	200	2,250,685	98%	12,086	1.65%
Miami	1480	14,941,663	63%	51,579	2.87%
Newark	2950	15,497,560	78%	66,236	4.45%
Philadelphia	1170	11,736,129	66%	42,443	2.76%
San Diego	340	7,506,320	99%	40,719	0.83%
San Francisco	800	16,475,611	77%	69,514	1.15%
San Jose	350	5,981,440	96%	31,464	1.11%
				Average	**2.48%**
				Average taking out highest	**2.12%**
				Average of only hourly services	**2.11%**
Hartford	389	3,416,243	98%	18,345	2.1%

Sources:
[1] Obtained from the individual transit agencies.
[2] Obtained from the FAA.
[3] Obtained from the individual airports.

The daily ridership varies dramatically from 200 daily trips on the Burbank system to almost 3000 daily trips in Newark. The relative size of these airports varies dramatically as well however. As shown in the table, the percent of transit users varies form 0.83 percent in San Diego to 5.01% in Baltimore, with an average of approximately 2.5 percent. In order to be conservative, a second average taking out the highest percentage was calculated at 2.12 percent. In addition, an average using only the services that are hourly and utilize a shuttle rather than a direct rail connection was calculated at 2.11 percent. Therefore, 2.1 percent was applied to the daily local air passengers at Bradley to estimate a daily ridership of 389 passengers to and from the airport.

The travel demand model used to estimate ridership on the commuter rail system does have the ability to estimate airport employees who would use commuter rail. Therefore the model estimated that approximately 36 people would access Bradley Airport using commuter rail. These 36 trips were subtracted from the 389 total airport trips so that they are not double counted. Therefore, approximately 350 daily airport passenger trips were added to the ridership estimates.

In order to apply this total number of trips to the commuter rail system, origin / destination surveys taken at Bradley Airport in July 2000 were consulted to determine which town's residents and visitors to New England who used Bradley Airport were coming from and to. The number of people from the corridor towns was totaled and a percentage of people from each town compared to the others in the corridor were developed. The estimated percentage of airport ridership from each town is shown in Table 3-10. These percentages were adjusted slightly to account for the likelihood that riders from each town would utilize rail to access the airport. These percentages were then applied to the total passenger airport ridership of 350 to determine the number of daily trips at each station.

Table 3-10
Estimated Percentage of Airport Ridership from Each Location

Station	Percentage of ridership	Number of daily trips
New Haven	8%	28
Hamden / North Haven	2%	7
Wharton Brook	3%	10
Wallingford	4%	14
Meriden	3%	11
Berlin	3%	11
Newington	5%	17
Hartford	20%	70
Windsor	4%	14
Windsor Locks	0%	0
Enfield	4%	14
Springfield	16%	56
Metro North	20%	70
Shore Line East	8%	28
Total	100%	350

Source: Bradley International Airport Economic Impact Study, 2000

3.4.4 Airport Connection Alternative Ridership

The two alternatives for connection to Bradley International Airport, direct rail and shuttle bus, were modeled using the ConnDOT model. The difference in ridership on the line between Windsor Locks and the airport was minimal, less than ten trips. In addition, for the commuter rail systems surveyed in the airport ridership section, the difference between an off-line rail connection and a shuttle bus connection had a minimal effect on ridership to the airport. For this system, the travel time via rail or shuttle bus is comparable at approximately ten minutes each. Therefore it is assumed that ridership would be similar for both alternatives at approximately 5,000 weekday trips.

3.4.5 Off-peak and Weekend Ridership

In order to estimate the off-peak and weekend ridership on the commuter rail line, a database of other commuter rail systems was established in the Existing Conditions phase. Included in the data collected was the percentage of peak and off-peak riders. Off-peak riders were separated into weekday off-peak riders and Saturday and Sunday riders. The ridership on these systems during weekday peak, weekday off-peak, and weekend is shown in Table 3-11.

As shown in the table, the average off-peak ridership is 0.32 times the peak ridership. The average weekend ridership is 0.75 times the peak ridership for systems that have weekend service. However, the smaller systems (those with lower ridership), generally have lower off-peak and weekend ridership. Therefore, to be conservative, a factor of 0.27 and 0.57 were used to estimate the off-peak and weekend ridership on the New Haven – Hartford – Springfield commuter rail line.

Table 3-11
Commuter Rail Systems Peak and Off-peak Ridership

Commuter Rail System	Weekday Ridership	Peak Ridership	Off-Peak Ridership	Weekend Ridership	Off-Peak / Peak Factor	Weekend / Peak Factor
Long Island RR, NY	348,000	245,100	102,900	245,000	0.42	1.00
Metra, Chicago	268,000	228,400	39,600	73,400	0.17	0.32
Metro North, NY / CT	252,700	176,700	76,000	167,100	0.43	0.95
New Jersey Transit	210,000	160,300	49,800	197,400	0.31	1.23
SEPTA, Philadelphia	108,600	74,900	33,700	30,700	0.45	0.41
Caltrain, San Jose	39,300	29,800	9,500	No Service	0.32	--
MARC, Baltimore	22,900	19,700	3,200	No Service	0.16	--
MetroLink, Los Angeles	10,400	8,100	2,300	4,600	0.29	0.57
Coaster, San Diego	5,800	4,400	1,400	No Data	0.33	--
Average					0.32	0.75
Average of systems with <50,000 weekday trips					0.27	0.57

Source: Transit agencies, Note: Ridership numbers for most recent year available (2001, 2002 or 2003)

Using an off-peak factor of 0.27 times the commuter ridership yields 936 additional trips. However, 363 trips have already been added due to the Amtrak off-peak ridership, those that currently use Amtrak but would use commuter rail service once implemented. In order to refrain from double-counting these trips, the 363 Amtrak off-peak trips were subtracted from the 936 total off-peak trips. Therefore, 573 trips were added to account for off-peak service in the Maximum Build Scenario. For weekend service, a factor of

0.57 times the commuter ridership yields an estimated 1,964 trips on Saturday and Sunday.

3.4.6 Total Weekday Ridership

Using the adjusted commuter ridership from the ConnDOT model, the additional airport ridership, the additional intercity ridership, and the additional off-peak ridership, a total number of trips was derived for the commuter rail line. The breakdown of total weekday ridership is shown in Table 3-12. The resulting Maximum Build Scenario weekday ridership by station is shown in Table 3-13, along with the boardings (ons) and alightings (offs) for the AM peak commuter trips. It is estimated that this new service scenario would generate 4,978 total weekday trips on the corridor. It is of note that weekend service would bring an estimated additional 1,964 trips.

These ridership totals compare to previous estimates of ridership on the line. A ConnDOT study done in 1994 of the segment between New Haven and Hartford estimated 2000 daily trips to this lower half of the corridor based on capture rates and 1990 census data. A 1992 ConnDOT study of service from Enfield to Hartford estimated approximately 400 trips on that partial segment. The Capital Region Council of Governments Regional Transit Strategy estimated 5,120 trips for the entire New Haven to Springfield segment with the caveat that airport ridership and intercity ridership were not fully captured by the model.

Table 3-12
Components of Total Weekday Ridership

Commuters	3,440
Additional Airport	350
Off-peak	577
Amtrak Off-peak	365
Amtrak Intercity	251
Total	**4,983**

Table 3-13
Maximum Build Scenario Weekday Ridership by Station

	AM Peak Commuter Station Ons	AM Peak Commuter Station Offs	Total Weekday Station Ons
Metro North / Shore Line East	38	260	621
New Haven Union	68	5	119
New Haven State Street	4	138	173
North Haven	77	38	138
Wharton Brook	103	26	156
Wallingford	227	97	389
Meriden	146	44	239
Berlin	120	54	229
Newington	157	50	250
Hartford	115	756	1,212
North Meadows	55	51	124
Windsor	221	53	338
Windsor Locks	78	63	359
Enfield	120	54	210
Springfield State Street	62	6	79
Springfield	129	25	347
Total	1,720	1,720	4,983

Source: Wilbur Smith Associates, Revised ConnDOT Model

3.5 Capital Costs for a Maximum Build Service

Capital costs for the Maximum Build Scenario consist of five components: train set equipment (locomotives and cars), a maintenance facility for the equipment, parking and station costs, cost to double track the line, and bridge costs. Each is described in detail below.

3.5.1 Train Set Equipment

For Maximum Build New Haven-Hartford-Springfield service, there are two types of anticipated train set equipment. One would consist of conventional commuter rail equipment, i.e. a locomotive and three passenger cars. The other would consist of a set of three self-propelled rail cars (Diesel Multiple Units, or DMUs). The service would require 14 train sets, plus a spare equipment ratio equivalent to 2 additional sets. Weekday service would have 5 sets stored overnight at Springfield, and 9 sets at New Haven. The specific equipment required is discussed in this section.

Locomotives

An appropriate locomotive type for the New Haven-Hartford-Springfield service would be a diesel electric locomotive used in commuter rail service today. One locomotive can typically haul five or six commuter cars, but in the Maximum Build Scenario, it would only haul three. The estimated costs of a locomotive come in a range of about $2.8 million for a basic "no frills" passenger locomotive[5] to about $4.5 million for a high-end AC power locomotive[6]. Delivery costs would be a negligible percentage of the purchase price.

Cars

The cars would need to board and alight riders at stations that currently have either low or high platforms. Assuming the traditional train sets, the New Haven-Hartford-Springfield service would use two car types: a cab car and a trailer car or coach. The cab car has an engineer's compartment, which the coach does not. Cab cars are used in a "push pull" configuration. With a cab car on the opposite end of the train from the locomotive, the train set can be operated in either direction, obviating the need to reposition the locomotive from front to back. A cab car typically has 109 seats. A coach car typically has 111 seats with a restroom. An average cost of $1.37 million is assumed for both car types.[7] Delivery costs would be a negligible percentage of the purchase price.

Diesel Multiple Units

An alternative rolling stock assumption is the use of new DMU technology (Figure 3-3). DMUs may be more cost effective on lines with lighter passenger densities than are traditional locomotive-hauled equipment. Colorado Rail Car, whose DMU is seen at right, is the only manufacturer of DMUs that are compliant with safety requirements of the Federal Railroad Administration (FRA) for operation on track shared with freight and conventional passenger rail equipment. The Amtrak Springfield line is such an environment. Accordingly, a DMU operating on the line would have to be an "FRA compliant" DMU.

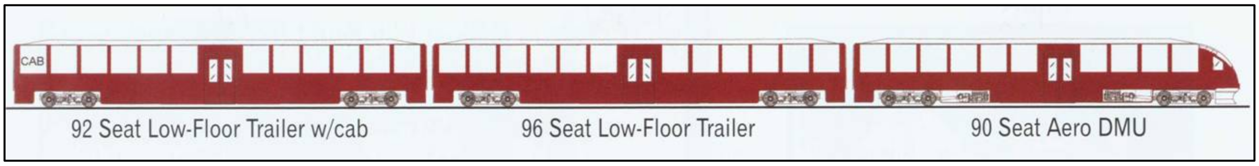
Figure 3-3
Diesel Multiple Unit Commuter Train

Photo by Bill Farquhar

[5] Per conversation with Preston Cook of Engine Systems Inc. (ESI), distributor for EMD.
[6] Per conversation with Peter Richter of the Connecticut Department of Transportation.
[7] Per Connecticut Department of Transportation study entitled *New Haven Line Fleet Configuration Analysis*, Task 5: Lifecycle Cost Analysis, page 102.

Each train set will consist of one motorized unit, a trailing coach, and a cab-coach. This combination will allow the set to operate in a push-pull mode, obviating the need to turn the set for the return trip. Each train set costs $6.8 million, FOB plant (Fort Lupton, Colorado). Delivery costs would be a negligible percentage of the purchase price. A schematic of the three-car train set appears in Figure 3-4.

Figure 3-4
Train Set Schematic



Rolling Stock Summary

Table 3-14 below presents the two rolling stock options and their likely costs. Spares are included. The spare ratio is approximately 20 percent the number of train sets required to operate the Maximum Build Scenario schedules.

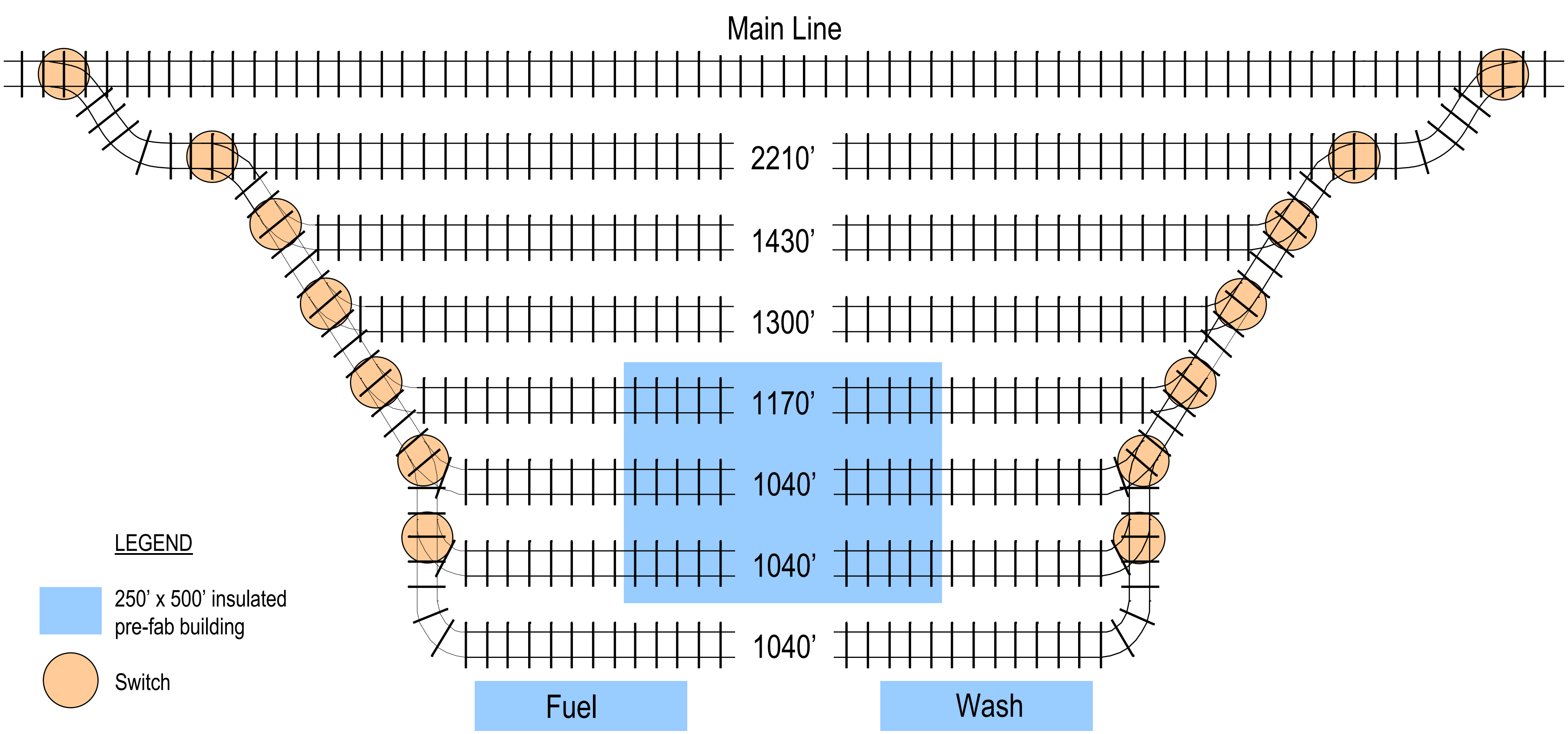
Table 3-14
Rolling Stock Summary

Type	Number	Spares	Total Units	Unit Cost in $ millions	Total Cost in $ millions
Conventional	**14**	**3**	**17**	**8.61**	**146.37**
Locomotives	*14*	*3*	*17*	*4.50*	*76.50*
Cab cars / Coaches	*42*	*9*	*51*	*1.37*	*69.87*
DMUs	**14**	**3**	**17**	**6.8**	**115.6**

Source: Wilbur Smith Associates per sources described in text

3.5.2 Maintenance Facility / Storage

The Maximum Build Scenario assumes a new maintenance facility in the New Haven area to service the train sets. Discussions with Connecticut Department of Transportation and Amtrak officials maintaining the Shore Line East equipment in New Haven pointed to the need for a new facility, as the existing Shore Line East facility shared with Metro North cannot handle several more train sets as currently configured. One potential location for this new facility would be at Cedar Hill Yard, located north along the line from downtown New Haven. Two general areas have been investigated. One is on or near the Amtrak portion of the yard, and the other is on or near the CSXT portion of the yard. A schematic of the facility is shown in Figure 3-5 Conceptually, the facility could include the following:



Notes:

- 3 storage tracks with enough room for 9 train sets
- Fueling and washing on run around track
- 14 switches

MAINTENANCE FACILITY SCHEMATIC FOR MAXIMUM BUILD

ENGINEERS
PLANNERS
ECONOMISTS
Wilbur Smith Associates

FIGURE 3.5

- A 2,210-foot siding off of the main line track where the rail service equipment would be stored overnight. The facility would have two additional storage tracks, 1,430 feet long and 1,300 feet long, adjacent to the siding. Three other tracks would run through the covered maintenance shop. Another track would run around the facility; fueling and washing stations would be on this track. This track arrangement would permit 12 train sets (either conventional or DMU sets) to be stored and three to be serviced at one time. The facility would require a total of 9,230 feet of track and 14 switches.
- The facility would include a 250-foot by 500-foot insulated prefabricated metal shop building with a cast in-place concrete floor, work bench/shop area, small office area and utility / restroom area.
- The area around the building would be paved, including a paved access road to the facility tracks. The areas on each side of and between the rails would also be paved to facilitate all-weather vehicular access to the rail equipment.
- The site improvements around the facility – including the building and surrounding yard area, access roads, and rail equipment tracks – would be illuminated.
- The maintenance facility would be furnished with the appropriate maintenance tools and necessary supplies and equipment for routine servicing and cleaning of the rail equipment including four 100-ton screw jacks, crane or hoist, and welding, grinding, bending and machining equipment and fueling facility. The facility would have its own electrical generator in case of a local power failure.
- The maintenance facility would be furnished with a 4x4 pickup for maintaining the parking areas and maintenance access areas.

The cost for such a facility would be approximately $17.3 million, inclusive of engineering, construction and contingencies, but not including land acquisition or environmental clean-up. Land requirements would be approximately 20 acres, estimated at about $4 million, exclusive of environmental clean-up. Purchase of a site would require assumption of environmental issues on the site, the extent of which would be addresses further in the Environmental Assessment phase of this project. Therefore the total cost would be approximately $21.3 million, exclusive of environmental costs.

3.5.3 Station Costs

For the Maximum Build Scenario, the stations were envisioned to be substantial structures with covered platforms in both directions, bridge walkways over the tracks, parking as required by ridership, and station buildings with restrooms and waiting areas. The following costs include these items broken down into categories for each existing and new station. Where facilities such as a station building already existed, costs were not included. No station costs were included for New Haven Station. At New Haven State Street, a cost for an additional high level platform, elevator and stair tower was included and a cost for conversion to high level platforms was included for Hartford and Springfield stations.

Surface Parking

For a parking lot with 90 degree angle parking, 4-inch bituminous paving, 6-inch granular base, 10-inch subbase, 2-foot excavation, painted lines on pavement, partial drainage system, and continuous curbing, the estimated cost is $5,000 per space. The estimated right-of-way cost for parking is $200,000 per acre with 100 spaces per acre or $2,000 per space. Therefore, surface parking is estimated at $7,000 per space.

Parking Lot Lighting

For fixtures, metal poles and bases, the estimated cost is $2,500 each.

Parking Structure

For a stand alone multistory garage, with 90/45/60 degree angled parking, with precast, prestressed double T's structure, fire stairs and elevators, ramps and floors, the estimated cost is $15,000 per space.

The total parking costs, including surface parking and lighting or parking structure, vary by station and are presented in Table 3-15. The number of spaces required is based on ridership numbers presented previously.

Station Platforms and Canopy

The original estimate for a platform, 400 feet long by 18 feet wide and five feet high on two sides of the tracks was $45.00 per square foot, including stair and handicap ramp access, precast, prestressed double T's structure, and foundations, for an estimated cost of $650,000 per station. The original estimate for a canopy, spanning 200 feet by 15 feet wide on two sides of the tracks was $65.00 per square foot, including steel wide flange structure, lateral support, prefabricated metal panels, roof decking, benches and signage, and lighting, for an estimated cost of $390,000 per station.

Based on Shore Line East station construction bids in Branford, Guilford and Clinton, the platforms and canopy cost have been revised to be $2.5 million for two 200 foot long by 10 foot wide platforms and two 100 foot long by 10 foot canopies.

Station Elevator, Stair Tower and Pedestrian Bridge

The original estimate for two elevators per station, was a lump sum cost of $100,000 each, including fire rated enclosure, elevator cab & shaft, for an estimated cost of $200,000 per station. The original estimate for two stair towers, was a lump sum cost of $50,000 each, including roof enclosures w/glazing, typical stair construction, landings, treads, risers, and safety railings, for an estimated cost of $100,000 per station. The original estimate for a pedestrian overpass between the platforms, with a span of 68 feet by 15 feet wide was $300.00 per square foot, including reinforced concrete slab, steel truss, glass enclosure system w/secondary support, and roof enclosure system, for an estimated cost of $306,000 per station.

Based on Shore Line East station construction bids in Guilford, the elevator, stair tower and pedestrian bridge costs have been revised to be $2.5 million for two elevator, two stair towers and a connecting pedestrian bridge.

Station Building

For a 2,500-3,000 square foot station building at $150 to $175 per square foot, including waiting area and bathrooms, the estimated cost is $500,000 per station. This does not include right-of-way purchases that may be necessary for the station building sites.

The total station costs, including platforms, canopy, elevators, stair towers, pedestrian bridge and station building total $5,500,000 per station.

The total station area costs, including parking and stations are shown in Table 3-15.

Table 3-15
Station Area Costs

Site	Spaces	Lights	Parking	Station	Cost
New Haven State St	--	--	--	$4,000,000	$4,000,000
North Haven	125 (surface)	15	$912,500	$5,500,000	$6,412,500
Wharton Brook	150 (surface)	16	$1,090,000	$5,500,000	$6,590,000
Wallingford	300 (garage)	--	$4,500,000	$5,500,000	$10,000,000
Meriden	250 (garage)	--	$3,750,000	$5,500,000	$9,250,000
Berlin	175 (surface)	16	$1,265,000	$5,500,000	$6,765,000
Newington	225 (surface)	17	$1,617,500	$5,500,000	$7,117,500
Hartford	--	--	--	$2,000,000	$2,000,000
Meadows	100 (surface)	15	$737,500	$5,500,000	$6,237,500
Windsor	300 (garage)	--	$4,500,000	$5,500,000	$10,000,000
Windsor Locks	125 (surface)	15	$912,500	$5,500,000	$6,412,500
Enfield	175 (surface)	16	$1,265,000	$5,500,000	$6,765,000
Springfield State St	--	--	--	$5,500,000	$5,500,000
Springfield	--	--	--	$2,000,000	$2,000,000
Total					**$89,050,000**

Source: URS Corporation, revised by ConnDOT design

3.5.4 Double Track Costs

The Maximum Build Scenario would upgrade the Springfield Line from an existing Single-Track railroad with a bi-directional signaling / train control system and multiple controlled passing sidings to a Double-Track railroad with approximately 38 miles of additional track and ten sets of universal or "double" crossovers for maximum operational flexibility.

This option would essentially restore the Springfield Line to a double-track configuration condition similar to that prior to Amtrak's removal during the 1990s of the same 38 miles of double track. However, Amtrak's recently installed bi-directional cab and wayside signal system must be extended throughout the 38 miles of new track. The Maximum Build Scenario provides the greatest operational throughput to accommodate new passenger and freight service as needed.

The Maximum Build Scenario requires the following significant track changes to existing conditions:

- Addition of second track from approximately MP 7.1 (CEDAR Interlocking) to MP 17.1 (HOLT Interlocking); addition of universal crossovers at CEDAR and HOLT.

- Addition of second track from approximately MP 20.6 (QUARRY Interlocking) to MP 31.1 (NEW Interlocking); addition of universal crossovers at QUARRY and NEW.

- Addition of second track from approximately MP 33.4 (WOOD Interlocking) to MP 37.1 (HART Interlocking); addition of universal crossovers at HART and WOOD; HART Interlocking limits to include Waterbury Switch MP.37 (New Britain Industrial / Griffins Branch).

- Addition of second track from approximately MP 38.9 (FRY Interlocking) to MP 43(WINDSOR Interlocking); addition of universal crossovers at FRY and WINDSOR.

- Addition of second track from approximately MP 46.3 (HAYDEN Interlocking) to MP 54.7 (FIELD Interlocking); addition of universal crossovers at HAYDEN and FIELD.

- Any existing track currently designated as a "Running Track" will be redesignated in the Timetable to allow for a contiguous 62-mile double track railroad with 2 main line tracks.

Track Materials and Construction – $29.4 million

The track materials and construction estimate includes all new track components installed for 36.7 miles of single track. Rail would be minimum 132-lb. with double shoulder tie plates secured to main line ties with standard cut spikes and fully anchored. Grading and drainage remains in place along the line.

Track Switches - $4.0 million

In addition to the materials needed to double track the entire line, locations are needed to switch from one track to the other in the event that a track is taken out of service for repairs. The Maximum Build Scenario requires an additional 10 universal or "double" crossovers. Each crossover requires 4 switches, totaling 40 switches along the line.

Communications Systems – $2.6 million

The communications systems costs to support the Maximum Build Scenario include minimal necessary design and construction changes to the existing communication systems - radio (operations, maintenance-of-way, Police and station services); wayside telephone; fiber optic cable; and Train Dispatcher circuits) along the Springfield Line right-of-way.

Train Dispatcher display boards within Amtrak's Centralized Electrification and Traffic Control (CETC) facility in South Station, Boston, MA, will require modifications to the supervisory display and communication-based non-vital control system for remote supervision of the newly configured Springfield Line. Existing wayside telephone and Amtrak radio system equipment will require minimal changes, such as equipment movement and/or additions at several locations.

Highway Grade Crossings – $3.5 million

Required grade crossing modifications primarily involve moving existing gates and flashing lights in the areas where a second main track will be added. In addition, new approach track circuits will be required wherever a second main track is added within grade crossing approach circuit limits. For cost estimating purposes, 20 of the 36 grade crossings equipped with active warning devices were deemed to require some modifications in areas within the new here a second main line track will be added. For the purposes of the estimate and for consistency, no costs were included for the 10 existing grade crossings without active warning devices.

Train Control (Signal) System – $22 million

The Maximum Build Scenario will require significant equipment additions / changes at 10 existing interlockings on the Springfield Line to accommodate the addition of approximately 38 miles of track and several universal or "double" crossovers. Software and hardware changes to existing vital code-system equipment will be necessary, as well as significant additional equipment (signals, electric switch machines, cabling, etc), and interface with the existing signal system.

New electronic track circuits similar to existing equipment will be added to all new track sections added. Some reengineering and reconfiguration of existing signal block lengths and track circuit limits will be necessary to accommodate new train routing options when the new track is installed. Several Communication & Signal system Central Instrument Houses (CIH) must be relocated to the edge of the railroad right-of-way as they are presently located within the necessary location of the second main line track.

Changes to the supervisory control system must be made at each Interlocking or other "field" locations. In addition, changes are needed to the "office" supervisory control system within the Amtrak CETC facility in Boston. All costs within CETC have been included in the Communications portion of the Maximum Build Scenario cost estimate.

The Maximum Build Scenario will require a review of the existing Springfield Line signal system "block" design from New Haven to Springfield.

Primary Power Distribution (480-volt and 2200-volt) – $500,000
Some relocation and reconfiguring of existing primary power distribution, overhead and underground, will be required to accommodate the Maximum Build Scenario. Amtrak is still in the process of upgrading the remaining 2200-volt power lines mounted on wood poles with a 480-volt buried cable distribution system.

Table 3-16 shows the total costs for double tracking the New Haven to Springfield Line in the Maximum Build Scenario. The cost is estimated at $62 million.

Table 3-16
Total Order-of-Magnitude Estimate for Double Track

Element	Total Cost ($ millions)
Track Materials and Construction	$29.4 M
Track Switches	$4.0 M
Communications Systems	$2.6 M
Highway Grade Crossings	$3.5 M
Train Control (Signal) System	$22.0 M
Primary Power Distribution	$0.5 M
Total	**$62.0 M**

Source: Wilbur Smith Associates, Washington Group Infrastructure

3.5.5 Bridge Costs

As reported in the existing conditions assessment, the condition of the 33 longest span bridges was evaluated based on the Amtrak Bridge Inspection reports. No field investigation of these structures was conducted. Using this information, the need for corrective measures and estimated capital expenditures has been compiled for the 33 bridges identified. Corrective work includes:

- Correction of existing deficiencies as documented in Amtrak's Inspection Reports
- Modifications to provide two tracks on each structure

Based on advisement from Amtrak officials, available bridge loading reports for structures located on the Springfield Line were deemed outdated and to have inconsequential information for the evaluation of each bridge. Therefore, unless an inspection report contained specific information on items which have reduced the load carrying capacity below that required for current trains, we have assumed the structure to have sufficient load carrying capacity.

Rehabilitation quantities were estimated for each bridge based on an educated guess of the extent of the deterioration as documented in Amtrak's inspection report. Since site visits were not included in the scope of work, this estimate was fairly subjective, but based on professional judgment and past experience regarding inspection, design and repair of both railroad and highway bridges. Inspection reports tend to describe the most significant deterioration and document deterioration of lesser degrees as general notes. A portion of the contingency factor is included in the overall cost estimate to help account for these unknowns.

In arriving at the rehabilitation quantity estimates numerous assumptions were made. Among the assumptions were the following:

General Assumptions

- Items rated in excellent or good condition do not require rehabilitation. Items rated in fair condition may or may not require rehabilitation.
- Repair and replacement quantities are based on the number of active tracks noted on the inspection report. Additional spur lines that are present, but not noted as active tracks in the inspection report, are not included in the repair/replacement quantities.
- Underwater inspection reports and scour analysis of the bridges were not available. Given that the bridges have been in-service for some time it is assumed that scour is not an issue.
- Replacement bridges are assumed to be the same length as existing bridges.
- Replacement bridges are assumed to be steel deck girders with ballast decks. Substructure is concrete.

Staging Assumptions

- At least one track must remain in-service at all times.
- For arches, trusses and through girder bridges supporting one or two tracks, it is assumed that neither track is structurally independent. Therefore, in the event of

superstructure or bridge replacement either temporary supports or a temporary span(s) must be installed in order to keep at least one track in-service.

- For all deck girder bridges and through girder bridges with three or more tracks, it is assumed that each track is structurally independent; therefore, portions of the superstructure and substructure can be removed without affecting active tracks.
- For superstructure replacement of only one active track for a deck girder or I-beam bridge, it is assumed that temporary repairs can be made to the inactive track. This will then allow for replacement of the superstructure of the active track while keeping one track in-service.
- It is assumed that sheet piling will be driven to separate the active and in-active tracks when substructure units are removed.

Superstructure Assumptions

- It is assumed that out-of-service tracks require new rails and ties.
- It is assumed that superstructure is in place for two tracks, even if one track is out-of-service.
- With the exception of local areas requiring repair, it is assumed that the existing in-service superstructure has sufficient load carrying capacity.
- For bridges carrying one active track, it is assumed that Amtrak inspected only the superstructure carrying the active track. It is assumed that the superstructure supporting the inactive track is in worse condition, requiring 1.5 times as much repair work as the active track.

Substructure Assumptions

- Substructure units were originally constructed for at least two tracks. It is assumed that the substructure is 18 feet wide for each track.
- For bridges carrying one active track it is assumed that Amtrak generally inspected the entire substructure. A 25 percent increase in substructure repairs is assumed for the case when there is one active track and the repair includes upgrading to two track service. This is primarily to account for repairs near the bearings of out-of-service track.

Cost estimates based on gross order-of-magnitude or “rule of thumb” unit costs for construction work normally associated with bridge rehabilitation and reconstruction were prepared for each of the 33 bridges. These estimates are only appropriate for a planning-level effort. Further study is required before establishing budgets or allocating funds for individual structures.

Table 3-17 itemizes the items that were and were not included in cost estimates.

Table 3-17
Items Included and Not Included in Cost Estimates

Cost estimates were developed for:	1. Rehabilitation of active tracks 2. Rehabilitation of active and inactive tracks 3. Painting of superstructure for active tracks 4. Painting of superstructure for both active and inactive tracks 5. Replacement of superstructure for active tracks 6. Replacement of superstructure for active and inactive tracks 7. Construction of a new bridge
Estimates do not include:	1. Improvements or realignment of roads under the bridge 2. Realignment or other work on the approach track 3. Scour countermeasures 4. Special architectural details 5. Right-of-way acquisition costs 6. Utility relocation 7. Environmental remediation due to hazardous materials 8. Station work or passenger walkways/platforms 9. Engineering or project administration costs 10. Maintenance

The long-term capital expenditure for the rehabilitation option assumes that in addition to the initial rehabilitation and painting, there will be another rehabilitation (but not painting) within the next 50 years. The superstructure and bridge replacement options assume a service life in excess of 50 years; therefore, long-term capital expenditures are assumed to be the same as the initial expenditures.

Table 3-18 lists the recommended corrective measures for providing at least two active tracks. Estimates for short-term, painting and long-term costs are included in the table. These costs do not include maintenance.

Short-term costs are the minimum capital expenditures required to either maintain the existing tracks or provide for at least two active tracks. These costs do not include painting of rehabilitated structures. The total short term costs are $13.5 million to provide at least two active tracks. In addition to the short term costs, rehabilitated steel structures should be painted. Painting costs are $12.4 million to provide at least two track service. For planning purposes the initial cost should include both the short-term costs and painting. These initial costs are $25.9 million to provide at least two active tracks.

Table 3-18
Summary of Recommended Actions and Construction Costs for Bridges

AMTRAK BRIDGE No.	DESCRIPTION	2 Tracks Minimum			
		Short Term	Painting	Additional Long Term	Recommendation
1.48 New Haven	116 ft Concrete Arch over Mill River (4 Tracks)	$227,000	N/A	$227,000	Rehabilitation
1.61 New Haven	154 ft Encased Through Girder over Humphrey St. (4 Tracks)	$102,000	N/A	$102,000	Rehabilitation
1.73 New Haven	79 ft Deck-Thru Girder over James St. (4 Tracks)	$270,000	$543,000	$270,000	Rehabilitation
7.03 North Haven	152 ft Deck Girder over Quinnipiac River (2 Tracks)	$178,000	$496,000	$178,000	Rehabilitation
15.26 Yalesville	58 ft Conc. Box Beam over Falls Brook (1 Track)	$31,000	N/A	$31,000	Rehabilitation
16.78 Meriden	28 ft I-Beam over Gypsy Lane (1 Track)	$2,599,000	$99,000	$2,599,000	Rehabilitation
18.01 Meriden	44 ft Through Girder over S. Colony St. (2 Tracks)	$1,319,000	$ -	$ -	Replace Bridge
18.48 Meriden	51 ft Deck Girder over Harbor Brook (2 Tracks)	$760,000	$ -	$ -	Replace Superstructure
25.52 Berlin	170 ft Stone Arch over Mill River (1 Track)	$44,000	N/A	$44,000	Rehabilitation
25.76 Berlin	35 ft Through Girder over Farmington Ave. (2 Tracks)	$1,150,000	$ -	$ -	Replace Bridge
26.39 Berlin	56 ft Stone Arch over Willow Brook (1 Track)	$84,000	N/A	$84,000	Rehabilitation
30.99 Newington	74 ft Encased I-Beam over Newington River (1 Track)	$86,000	N/A	$86,000	Rehabilitation
32.9 Newington	78 ft Through Girder over New Britain Ave. (2 Tracks)	$ -	$319,000	$ -	Rehabilitation
33.07 Newington	47 ft Conc/Stone Arch over Noyes River (2 Tracks)	$22,000	N/A	$22,000	Rehabilitation
35.15 Hartford	79 ft Through Girder over Park Ave. (1 Track)	$176,000	$386,000	$176,000	Rehabilitation
35.41 Hartford	50 ft Conc/Stone Arch over Park River (1 Track)	$107,000	N/A	$107,000	Rehabilitation
35.51 Hartford	103 ft Through Girder over Capitol Ave. (1 Track)	$288,000	$456,000	$288,000	Rehabilitation

AMTRAK BRIDGE No.	DESCRIPTION	2 Tracks Minimum			
		Short Term	Painting	Additional Long Term	Recommendation
36.38 Hartford	85 ft Through Girder over Roadway B (1 Track)	$29,000	$404,000	$29,000	Rehabilitation
36.53 Hartford	77 ft Through Girder over Asylum St. (1 Track)	$182,000	$381,000	$182,000	Rehabilitation
36.55 Hartford	637 ft Deck Girder over Station Viaduct (1 Track)	$762,000	$2,273,000	$762,000	Rehabilitation
36.66 Hartford	36 ft Deck Girder over Church Street (1 Track)	$1,029,000	$ -	$ -	Replace Bridge
37.35 Hartford	93 ft Conc. Arch and Encased I-Beam over Windsor St. (3 Tracks)	$188,000	N/A	$188,000	Rehabilitation
42.65 Windsor	29 ft Deck Girder over Batchelder Rd. (1 Track)	$123,000	$250,000	$123,000	Rehabilitation
43.08 Windsor	79 ft Through Girder over Palisado Ave. (2 Tracks)	$1,030,000	$ -	$ -	Replace Superstructure
43.3 Windsor	378 ft Stone Arch over Farmington River (2 Tracks)	$59,000	N/A	$59,000	Rehabilitation
49.73 Windsor Locks	1541ft Through Truss & Deck Girder over Connecticut River (1 Track)	$1,844,000	$4,546,000	$1,844,000	Rehabilitation
53.98 Thompsonville	35 ft Encased I-Beam over Main St. (1 Track)	$36,000	N/A	$36,000	Rehabilitation
60.45 Springfield	84 ft Concrete Arch over Mill River (2 Tracks)	$115,000	N/A	$115,000	Rehabilitation
61.71 Springfield	64 ft Through Girder over E. Columbus Ave. (5 Tracks)	$379,000	$631,000	$379,000	Rehabilitation
61.81 Springfield	69 ft Stone Arch over Main St. (3 Tracks)	$12,000	N/A	$12,000	Rehabilitation
61.95 Springfield	30 ft I-Beam over Station Subway (6 Tracks)	$84,000	$427,000	$84,000	Rehabilitation
61.98 Springfield	65 ft Through Girder over Dwight St. (6 Tracks)	$112,000	$733,000	$112,000	Rehabilitation
62.08 Springfield	69 ft Through Girder over Chestnut St. (3 Tracks)	$116,000	$425,000	$116,000	Rehabilitation
Total for 33 Bridges		$13.5 MIL	$12.4 MIL	$8.3 MIL	TOTAL = $34.2 MIL

Source: URS Corporation
NOTES: Short Term = Initial costs assuming no painting of existing superstructure; Painting = Cost to paint existing structure; Additional Long Term = For rehab bridges which WERE painted assume another rehab without painting in 25 years in order to get a 50 year life. For rehab bridges which were NOT painted these additional long term cost will be HIGHER. For superstructure or bridge replacements assume a 50 year life without further capital expenditures. Additional long term costs do not include maintenance.

In addition to these initial costs (short-term and painting), additional long-term costs in order to obtain a 50-year service life will be incurred for rehabilitated structures. It is assumed that another rehabilitation, but not painting, will be required in 25 years. It is further assumed that since only another 25 years of life is required of the structure, painting is not required and some corrosion is acceptable. The cost of this additional rehabilitation is assumed to be the same as the short-term cost. Should the initial rehabilitation not include painting this long-term cost will be higher as corrosion will continue to occur at a much greater rate. For superstructure replacements and new bridges should be designed for a minimum of a 50-year service life; therefore, there are no additional long-term costs. These long-term costs are $8.3 million to provide at least two active tracks.

The general recommendation, based on the available information is to rehabilitate and paint the bridges. Superstructure replacement is recommended for Bridges 18.48 and 43.08. Bridge replacement is recommended for Bridges 18.01, 25.76, and 36.66 in order to increase the under-clearance. State Project 07-168 for replacement of Bridge 25.76 is expected to be bid in the Fall of 2003. The estimated cost for State Project 07-168 is significantly higher than the estimate shown in Table 3-18 due to doubling of span length, providing for a spur track in addition to two mainline tracks, realignment of the road underneath, retaining walls, architectural features and approach track work.

This evaluation is based on limited information and no site visits. It is intended for use at a corridor wide planning level. More detailed studies are required prior to funding work on any individual structure. As shown in Table 3-18, the total cost for bridge work along the commuter rail line to provide a minimum of two tracks is $34.2 million.

3.5.6 Airport Connection Costs

As part of the Maximum Build Scenario, a connection to the airport to serve both employees and travelers was envisioned. This connection can be handled in two possible ways, directly connecting the airport to the main line of the commuter rail via a rail connection or utilizing the airport shuttle service similar to those that pick up in airport parking lots. For the direct rail connection, two possible alignments to the airport were investigated.

The first airport rail connection alternative involves the Suffield Industrial rail spur that travels between the main line just north of Windsor Locks station toward the northwest and then southwest until approximately one mile north of the airport. The line would then be extended to connect to the terminal. For this line, the anticipated cost is $18 million. This cost is anticipated to be higher per unit length than the main line double tracking for several reasons. This cost included the cost for removal of the existing track, ties and rail bed due to poor condition and replacement with new track, ties and rail bed. In addition to the laying of new track, this spur line must also receive new drainage installation and new grading treatments as well as sound barrier construction. Therefore, the estimated cost for this alternative is $18 million for track construction, including track, switches, signal / train control system, grade crossing warning devices, communications, power and a station platform at the airport.

The second airport rail connection alternative involves the median of Route 20, the airport connector. In this alternative, a bridge and a tunnel were investigated to provide a connection between the main line rail south of Windsor Locks station and the median of Route 20 by linking over or under the Route 20 and I-91 interchange. If a tunnel was utilized, the necessary grade to achieve the elevation of Route 20 at Old Colony Road is greater than 2%, which is not feasible with a rail alignment. If a bridge was utilized, although the grades would approach 2%, it is possible to match the elevations where necessary. However, the cost for such a structure alone would be approximately $124 million. In addition, major earthwork, retaining wall construction, and possible modification to the roadway alignment would be required to account for the vertical grade issues further west along Route 20. Therefore, the estimated cost for track construction, signalization, grade crossings and station platform of approximately $15 million would be fairly inconsequential in comparison to the required earthwork and structural work. The structural work and immense amount of earthwork required for this alignment would make the capital cost for this alternative excessive.

For the shuttle bus alternative, no capital construction costs are necessary. The only capital cost is the purchase of an additional airport shuttle bus, estimated at less than $500,000.

3.5.7 Total Capital Costs

A summary of capital costs appears in Table 3-19. The cost estimate includes necessary train sets, spares, the maintenance facility, parking and station costs, double track costs, bridge rehabilitation or replacement costs, and a rail connection to the airport. In addition, a 10% design and inspection fee has been applied. Amtrak flagmen will be required for construction within 25 feet of the rail line, including platforms, overhead structures, and double tracking segments. Many of the right-of-way costs and environmental costs that may be associated with station and maintenance facility construction are not included. However, to be conservative, a contingency of 40% has been used to reflect these unforeseen costs. The total capital cost for the Maximum Build Scenario is $558 million.

Table 3-19
Maximum Build Scenario Capital Costs

Element		Cost
Maintenance facility		21,300,000
Stations		89,050,000
Double Track		62,000,000
Bridges		34,200,000
Airport Rail Connection		18,000,000
Subtotal		**$224,550,000**
Design and Inspection	10%	$22,455,000
Train Equipment		$146,370,000
Amtrak Flagmen		$5,000,000
Subtotal		**$398,375,000**
Contingency	40%	159,350,000
Total		**$557,725,000**

Note: This estimate does not include items excluded from estimates listed in Table 3-17 and potential environmental costs.
Source: Wilbur Smith Associates, URS Corporation, Washington Infrastructure Group

3.6 Operating Costs for a Maximum Build Service

This analysis calculates operating costs by multiplying the New Haven-Hartford-Springfield service's projected annual train miles for its Maximum Build Scenario times a representative cost per train mile.

3.6.1 Train Miles

A train mile measures the distance a train travels. That is, a train set traveling one mile equals one train mile. The Maximum Build Scenario schedule has 34 round trips per day or 68 one-way trips each weekday. A run between New Haven and Springfield is 62 miles; 34 round trips or 68 one way trips would generate 4,216 revenue train miles per weekday. Fifty-two weeks at 5 days per week totals to 260 days of operation, less some holidays on which New Haven-Hartford-Springfield service would not run. (Note that Shore Line East and most commuter rail systems in the US have approximately 254 operating weekdays per year). Annual train miles are thus calculated: 4,216 train miles multiplied by 254 days produces 1,070,864 annual train miles, exclusive of any shop moves or deadheading for maintenance purposes. Saturday, Sunday and holiday trains would contribute another 137,640 annual train miles. Total annual train miles would be 1,208,504.

3.6.2 Cost per Train Mile

As with the minimum build scenario, the Maximum Build Scenario assumes an operating cost for conventional rail equipment of $40 per train mile, which is similar to what Shore Line East (SLE) experiences today. Accordingly, an annual operating cost for the Maximum Build Scenario utilizing conventional rolling stock would be derived as follows: 1,208,504 annual train miles at $40 per train mile totals to $48,340,160.

According to a Colorado Rail Car analysis, operating costs for DMUs can be as much as 20 percent lower on variable operating costs when compared to Bombardier bi-level commuter rail equipment used on various systems throughout the U.S. If so, the 20 percent savings should serve as a conservative estimate of what could be saved relative to single-level equipment used by Shore Line East, as single-level equipment predictably is less expensive to maintain than bi-bevel equipment. The relevant variable operating costs (mechanical, transportation, and fuel) are about 82 percent of SLE total operating costs[8], or about $33 per train mile of the assumed $40 per train mile total cost. Fixed and non-relevant variable costs would be another $7 per train mile.

Assuming a 20 percent savings on the relevant SLE variable operating costs, DMU variable operating costs would be about $26 per train mile, and DMU total operating costs would be about $33 per train mile. Accordingly, an annual operating cost for the Maximum Build Scenario utilizing DMUs would be derived as follows: 1,208,504 annual train miles at $33 per train mile totals to $39,880,632. These costs are given as comparison, DMU technology has not yet been demonstrated in continuous commuter service and further research about train set purchases will be undertaken in the Operating Plan.

3.7 Revenue for a Maximum Build Service

To calculate farebox revenue for the Maximum Build Scenario service, a similar fare structure to that used for Shore Line East and Metro North was developed by ConnDOT. Table 3-20 shows the suggested one-way fare matrix for service on the line using the formula $2.293 + $.138 per mile greater than 10 miles, rounded to the nearest quarter dollar. Monthly fares are 50% of the one-way fares and the per trip cost is based on 42 trips per month. It was assumed that commuter ridership would be using a monthly pass and non-commuter would pay a one-way fare. Weekend ridership was assumed to be one-way fares.

[8] Per Shore Line East FY 04 Budget.

Table 3-20
Maximum Build Scenario One-Way Fare Matrix

Station Pair	New Haven	State Street	North Haven	Wharton Brook	Wallingford	Meriden	Berlin	Newington	Hartford	Meadows	Windsor	Windsor Locks	Enfield	Spring State	Springfield
New Haven	-														
State Street	$2.25	-													
North Haven	$2.25	$2.25	-												
Wharton Brook	$2.25	$2.25	$2.25	-											
Wallingford	$2.75	$2.50	$2.25	$2.25	-										
Meriden	$3.50	$3.50	$2.50	$2.25	$2.25	-									
Berlin	$4.50	$4.50	$3.50	$3.25	$2.75	$2.25	-								
Newington	$5.25	$5.25	$4.25	$4.00	$3.50	$2.75	$2.25	-							
Hartford	$6.00	$6.00	$5.00	$4.75	$4.25	$3.50	$2.25	$2.25	-						
Meadows	$6.25	$6.25	$5.25	$5.00	$4.50	$3.75	$2.75	$2.25	$2.25	-					
Windsor	$6.75	$6.75	$6.00	$5.50	$5.00	$4.25	$3.25	$2.50	$2.25	$2.25	-				
Windsor Locks	$7.50	$7.25	$6.50	$6.00	$5.75	$4.75	$3.75	$3.00	$2.25	$2.25	$2.25	-			
Enfield	$8.25	$8.25	$7.50	$7.00	$6.75	$5.75	$4.75	$4.00	$3.25	$3.00	$2.50	$2.25	-		
Springfield State St	$9.25	$9.25	$8.50	$8.00	$7.50	$6.75	$5.75	$5.00	$4.25	$4.00	$3.50	$2.75	$2.25	-	
Springfield	$9.50	$9.50	$8.50	$8.25	$7.75	$7.00	$6.00	$5.00	$4.50	$4.25	$3.50	$3.00	$2.25	$2.25	-

Source: ConnDOT
Note: Fare calculated at $2.293 + $.138 per mile greater than 10 miles, then rounded to nearest quarter dollar.

Based on the fare structure and weekday ridership presented, revenue would be $12,977 per day. Using 254 days of weekday service per year, the annual revenue would be $3,296,158. Based on the fare structure and weekend ridership presented, revenue would be $2,936 per weekend day or holiday. Using 111 service weekend days and holidays per year, the annual revenue would be $325,896. The total revenue would then be $3,622,054. This equates to a farebox recovery rate of 7.5%. Therefore, given the Maximum Build Scenario is projected to cost $48.34 million to operate using conventional rolling stock with revenues at $3.62 million, the annual operating deficit would be at $44.72 million annually and the subsidy per passenger would be $32.56. This is in addition the to the capital costs of $558 million.

3.8 Summary of Maximum Build Service Findings

The Maximum Build Scenario described in this white paper includes double tracking the entire New Haven to Springfield line, several additional stations, substantial improvements to the station areas and optimized connecting bus routes. There are fifteen stations in this scenario including six stations not in the Minimum Build Scenario. Station improvements would include high-level platforms, pedestrian amenities with grade separated crossings, enclosed heated station buildings with restrooms and waiting areas, bicycle storage and racks, and any additional parking required to accommodate projected ridership. In addition, the Maximum Build Scenario would serve Bradley International Airport from the Windsor Locks Station.

Using the adjusted commuter ridership from the ConnDOT model, the additional airport ridership, the additional intercity ridership, and the additional off-peak ridership, a total number of riders was derived for the commuter rail line. It is estimated that the Maximum Build Scenario would generate 4,978 total weekday trips on the corridor. Weekend service would bring an estimated additional 1,964 trips.

The capital cost for the Maximum Build Scenario includes necessary train sets, spares, the maintenance facility, parking and station costs, double track costs, bridge rehabilitation or replacement costs, a rail connection to the airport, design and construction administration fees, Amtrak flagmen, and a contingency of 40%. The total capital cost for the Maximum Build Scenario is $558 million. An annual operating cost for the Maximum Build Scenario would be $48.34 million. The total annual revenue would be $3.62 million for the Maximum Build Scenario. This equates to a farebox recovery rate of 7.5%. The annual operating deficit would be at $44.72 million annually and the subsidy per passenger would be $32.56. This is in addition the to the capital costs of $558 million.

The capital and operating costs for the Maximum Build Scenario are high for multiple reasons. First, several additional stations have been included in this scenario. Some of these additional stations may not be deemed cost-effective due to the limited ridership they produce. In addition, costs for a rail connector to the airport ($18 million) have been included although this connection is expected to produce a similar number of riders as shuttle bus service using existing roadways. Finally, a frequent level of service with a train every 15 minutes in the peak period was provided in this scenario. This affects not only the operating costs, but also the capital costs because of the number of train sets that must be purchased. A lesser level of service of every 30 minutes in the peak period or every 20 minutes for a shorter peak period would significantly reduce these costs and may only slightly reduce the expected ridership.