New Bedford/Fall River

Commuter Rail Extension Project

South Station

Operational Analysis Report

DRAFT

Prepared for:
Massachusetts Bay Transportation Authority

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SOUTH STATION OPERATIONS ANALYSIS REPORT

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CONTENTS

FIGURES

EXECUTIVE SUMMARY

The MBTA is evaluating a proposed extension of commuter rail service to southeastern Massachusetts with separate terminals in the cities of New Bedford and Fall River. As part of the evaluation, a network RAILSIM® rail operations model was developed by SYSTRA Consulting, Inc. to simulate train operations in 2003, the planned commencement date for New Bedford/Fall River service. The simulation model encompasses all planned services operating from Boston's South Station in 2003, with related planned infrastructure improvements. Planned services include all MBTA South Side commuter rail and Amtrak Inland Route/Northeast Corridor trains.

The simulation model focused solely on the South Station Terminal Area, which is defined for this report to be the rail infrastructure from Back Bay Station to South Station, including the thirteen platform tracks at the station. Also included is the Fort Point Channel Bridge, part of the Dorchester Branch and the MBTA Southampton Service & Inspection (S&I) facility.

A new operating model was developed using time slots that were available after projected Amtrak services had been assigned. Amtrak services were input based on a 1995 proforma operating plan, furnished by Amtrak. In order to have a working simulation model, schedules to some existing MBTA service required extensive modification from existing schedules due to the expansion of Amtrak operating time on the Northeast Corridor (NEC). Amtrak's increase in NEC operating time is a result of their new high-speed service, planned to begin operation in late 1999 or early 2000. In addition to existing MBTA services and planned Amtrak services, the model included the proposed extension of the Stoughton Branch service to New Bedford and Fall River, and operating slots for the proposed Greenbush service. The simulation was run, using the new operating model, to demonstrate Terminal Area operations on a typical weekday. The simulation specifically focused on movements of MBTA and Amtrak train consists between revenue service and layover at the respective yards and movements within the Terminal Area.

Results of the operations simulation of the South Station Terminal Area does not indicate that the introduction of New Bedford/Fall River commuter rail service will present any additional operating difficulties to the MBTA. The model revealed that South Station, itself, can even accept additional expansion of rail services. However, what was revealed through the simulation, is that problems do exist with South Station operations not related to expanded MBTA service, but due to the expansion of Amtrak services.

South Station Operations

The total number of trains in operation in the entire South Station Terminal Area during the morning and evening hour peak periods is nearing capacity. The efficiency of yard movements between Southampton S&I and Readville Yard become critical with the arrival of Amtrak's high-speed train. In the past, for non-revenue trains, the train crews and the dispatcher were not

required to adhere to a strict schedule. In the future, it will become increasingly important to adhere to a strict schedule in order to utilize the shorter windows of opportunity for a crossover from the low side of the station (Tracks 1-6) across the Fort Point Channel Bridge en route to the Southampton S&I and Readville Yard. These crossover moves shut off access to most of the platforms at South Station, halting incoming movements along the NEC from Back Bay. Therefore, schedule adherence to deadhead moves will become critical.

Dorchester Branch

Although the Dorchester Branch was placed back into service to support construction activities along the NEC, its use has evolved from temporary mainline operations to long yard lead. Trains that are headed for the Readville layover facility traverse the Dorchester Branch. This branch becomes critical to the success or failure of the NEC and South Station Terminal Area operations. If deadhead moves from South Station are not made quickly and efficiently, the available number of platforms for trains entering South Station is greatly limited.

Southampton S&I Facility

Because of the unique design, Kawasaki's coaches that are operated by the MBTA, require a pit track for checking the brakes and legal standards require the Kawasaki coaches to be checked every 72-hours. However, the only pit track at the Southampton facility is located on the south side. Considering the number of vehicles and their availability during the off-peak hours, scheduling inspection and maintenance will become extremely difficult.

Readville Yard

At the present time the MBTA stores up to nine trainsets in Readville Yard during the off-peak hours and overnight with the remainder (about 20) stored at the Southampton Yard. The simulation was run with a maximum of 16 trainsets stored at Readville Yard with only four stored at the Southampton S&I as expected with the commencement of Amtrak high-speed service. With the loss of full use of the Southampton Yard, mid-day storage of trainsets will become a problem, regardless of any expansion of services.

Although the main objective of the simulation project was to model operations and analyze capacity at South Station for the New Bedford/Fall River service, important additional information was discovered. It was revealed that operations at South Station will experience difficulties which need to be addressed well before the addition of New Bedford/Fall River service, and that this new service will not add to these difficulties.

OVERVIEW

BACKGROUND

The MBTA is evaluating a proposed extension of commuter rail service to southeastern Massachusetts with separate terminals in the cities of New Bedford and Fall River. The route for the proposed service runs north from each city along existing Conrail branches. These branches join at Myricks Junction, Taunton, and continue north for five miles to Weir Junction, Taunton. At this point the route diverges from the Conrail system and follows an abandoned railroad right-of-way to a connection with the present end of the MBTA Stoughton Branch. The new service would then follow the existing MBTA Stoughton service's route to South Station via the current connection at Canton Junction with the Northeast Corridor (NEC).

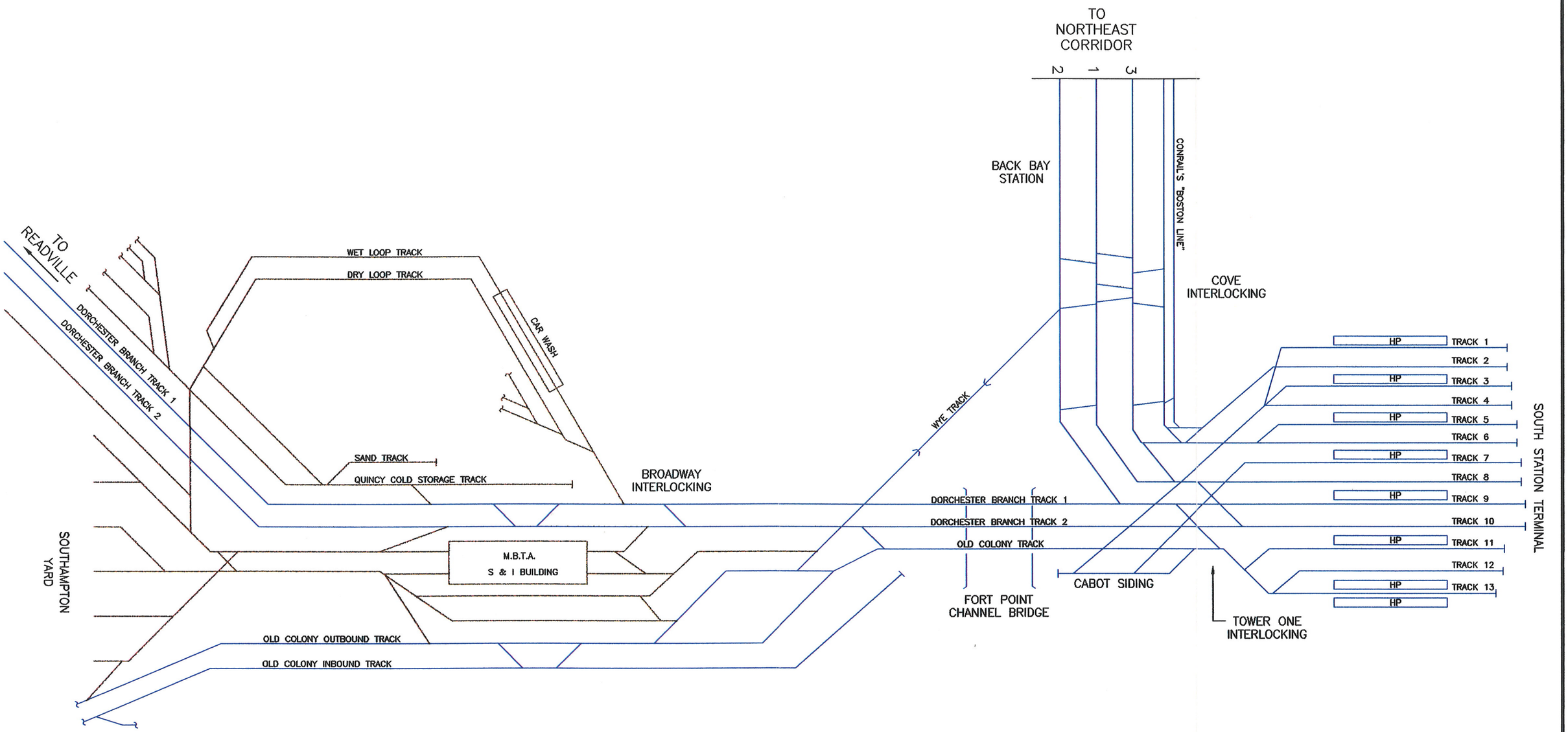
As part of the evaluation, a network RAILSIM® rail operations model was developed by SYSTRA Consulting, Inc. to simulate train operations in 2003, the planned commencement date for New Bedford/Fall River service. The simulation model encompasses all planned services operating from Boston's South Station in 2003, with related planned infrastructure improvements. Planned services include all MBTA South Side commuter rail and Amtrak Inland Route/Northeast Corridor trains. This report discusses observations and findings, and presents data concerning train movements in the South Station Terminal Area (also called the Terminal Area.)

SIMULATION ELEMENTS

A simulation model of the projected Terminal Area infrastructure and signal system configuration in 2003 was developed using RAILSIM. The starting point for this effort was an existing RAILSIM database developed for the MBTA as part of a previous simulation to analyze alternative routes for the proposed New Bedford/Fall River service. The limits of the original simulation model included the following:

- The NEC from Providence, RI to Back Bay Station, Boston, MA
- The Stoughton Branch
- The Franklin Branch
- The Dorchester Branch
- The Needham Branch
- A small portion of the Worcester Line from Beacon Park Yard (in Allston) to the junction with the NEC at Back Bay Station.
- The extension of the Stoughton Branch south to Fall River and New Bedford was added to the model with the decision to implement that alternative.

The new simulation model focuses on the South Station Terminal Area, which is defined for this report to be the rail infrastructure eastward from Back Bay Station through Cove Interlocking to South Station, including the thirteen platform tracks at the station. Also included is the entire



SOUTH STATION TERMINAL AREA

MASSACHUSETTS BAY TRANSPORTATION AUTHORITY

NEW BEDFORD/FALL RIVER
OPERATIONS SIMULATION

SOUTH STATION
TERMINAL AREA

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SCALE: NTS
DATE: 5/19/99
FIGURE: 1

Tower One interlocking plant, the Fort Point Channel Bridge and the Dorchester Branch as far west as Broadway Interlocking. The MBTA Service & Inspection (S&I) facility, layover yards and other servicing facilities located at Southampton Yard are included, as well as the Wye Track and the two lead tracks connecting with the Old Colony Lines.

A new operating model was developed using time slots that were available after projected Amtrak services had been assigned. Amtrak services were based on a 1995 proforma operating plan, furnished by Amtrak. Schedules to some existing MBTA service required extensive modification from existing schedules due to the expansion of Amtrak operating time on the NEC. Amtrak's increase in NEC operating time is a result of their new high-speed service, planned to begin operation in late 1999 or early 2000. In addition to existing MBTA services and planned Amtrak services, the model included the proposed extension of the Stoughton Branch service to New Bedford and Fall River, and operating slots for the proposed Greenbush service. The simulation was run, using the new operating model, to demonstrate Terminal Area operations on a typical weekday. The simulation specifically focused on movements of MBTA and Amtrak train consists between revenue service and layover at the respective yards and movements within the Terminal Area.

ASSUMPTIONS

Development of complex simulation models, which include train operations and/or infrastructure elements that do not yet exist, require key assumptions to be made. Assumptions specifically concerned with the Terminal Area are detailed in this report. Assumptions concerning operations and infrastructure for the proposed New Bedford/Fall River service are further explained in the main body of the April 1999 New Bedford/Fall River Commuter Rail Operations Simulation Report.

INFRASTRUCTURE

South Station is the principal rail terminal in downtown Boston, presently serving all Amtrak intercity operations and MBTA commuter services to suburbs west, southwest, and south of the city. Figure 1 represents the South Station Terminal Area track configuration assumed in the development of the simulation model. The model focused on station, main and running tracks. Tracks that did not contribute to the accuracy or value of the results, such as the Loop tracks and the Southampton Yard were not included in the simulation. Trains operating from these storage yards or shops were entered into simulation at the yard lead tracks.

In recent years, improvements to the Terminal Area have been occurring in conjunction with other transportation capital projects. One such project is the recently opened MBTA Old Colony Lines. This project included the construction of two additional platform tracks at South Station to make a total of 13 platforms. Additional improvements to the Terminal Area were made in connection with the Amtrak High-Speed Rail project. Included in this project was an inside ladder track extending partially across the terminal plant that enables greater parallel move capability. New crossovers in Cove Interlocking near Back Bay Station were also installed, which allow for universal crossover capability and greater flexibility in that area. Each of these improvements has been included in the simulation.

Another Terminal Area improvement project is a result of transit mitigation required for the Central Artery Project. The project includes a new railroad bridge over the Fort Point Channel able to accommodate four tracks, although currently and in the simulation only three are present. Upon completion of the bridge reconstruction, Cabot Siding will be extended across the bridge as the fourth track. This addition will have little effect on the MBTA South Station operations that were simulated.

The following are additional infrastructure improvements or assumptions that have been included in the model:

1. All existing slip switches located within the Tower One Interlocking (as of January 1999) including the ladder track connecting Tracks 1 through 13 and the partial parallel ladder track connecting Tracks 7 through 13 were included.

2. All of the proposed new crossovers at Cove Interlocking have been installed and were included in the model.

3. Maximum Authorized Speed within the South Station Tower One plant was assumed to be 15 miles-per-hour.

4. Maximum Authorized Speed within Cove Interlocking was assumed to 30 miles-per-hour.

5. Signal system control lines through Cove Interlocking were modeled.

6. All of the signal system logic and all wayside dwarf signals at South Station were assumed to be fully functional.

7. The signal clearing time was assumed to be eight (8) seconds. Signal clearing time is the delay experienced for a command to be sent from a dispatcher's console to the field and for the checking signal to return indicating route establishment.

8. Operating Rules in Amtrak NEC Timetable, effective April 5, 1998 were assumed to be in effect.

SERVICING AND INSPECTION

Until 1998, both MBTA and Amtrak trainsets were stored and serviced at Southampton Yard. This facility is now used primarily by Amtrak, which has caused MBTA to send more trains to Readville Yard for layovers. Although MBTA trains are no longer stored and regularly serviced at Southampton Yard, the Service and Inspection (S&I) Building (located at the north end of the yard) is still used for locomotive fueling and railcar underbody inspection and maintenance. It was assumed in the model that two MBTA trainsets can be accommodated inside the building, while two others can be held outside, waiting for inspection and services.

In the model it was assumed that each trainset would be scheduled every third day at the Southampton S&I facility for undercarriage inspection of truck hardware, to assure FRA required inspections could occur. Inspection for MBTA's Kawasaki bi-level coaches requires the use of a pit track, such as at Southhampton Street, since the truck hardware on this type of coach is not is not visible from ground level. In the model it was assumed that *all* MBTA consists would include a Kawasaki bi-level coach and thus would require inspection every three (3) operating days.

As previously stated the MBTA has layover facilities at Readville Yard. This yard is nine miles south of South Station, along the Dorchester Branch. The constraints of this yard were the principal challenge of the simulation exercise. These constraints include the considerable distance from South Station, the fact that the yard is accessed from a double-track main line with revenue operations, and the assumption that the yard could store a maximum of 16 trainsets.

The MBTA stated that only limited servicing would take place at outlying terminals and that all formal rolling stock inspections would take place in Boston. The Boston Engine Terminal (BET) located in Somerville, the MBTA's sole backshop, was assumed to be where significant repairs and most FRA-mandated locomotive inspections will take place. The rotation of equipment through BET was not included in the simulation model. Equipment is operated to and from BET

via the Grand Junction branch through Cambridge. These movements take place as revenue traffic permits and are not scheduled. It was assumed that the MBTA would have adequate spare locomotives and coaches to support repairs and mandatory equipment inspections.

OPERATIONS AND EQUIPMENT

Planning rail operations in the Terminal Area had to first take into account the different uses of South Station platform tracks. The tracks were divided into four operational sections:

I. Tracks 1-7 referred to as the "MBTA Low Side," used for MBTA departures on routes passing through Back Bay Station

II. Track 8 referred to as the "Neutral Track," used as overflow relief for the operations of both carriers

III. Tracks 9 & 10 referred to as the "Amtrak Side," used for Amtrak operations

IV. Tracks 11-13, referred to as the "MBTA High Side," used for MBTA departures on routes passing over the Fort Point Channel Bridge

Each track was assigned a use that best utilizes its specific characteristics. The Amtrak Side is nearest the ticket area and minimizes large-scale movement of baggage-toting passengers and forklifts pulling gurney bins of U.S. Mail across pedestrian flows of commuters. Assigning track areas to specific routes enables commuters to locate their departing train in the same general vicinity each day. Additionally, the high and low scheme for MBTA equipment turns minimizes the number of consists crossing between the two MBTA sides, and thus, moving across the terminal plant.

Since South Station is not a through station but a terminal facility, a credible simulation *must* carefully address equipment dependencies between arriving and departing trains. Every train arriving at South Station in simulation is dynamically linked to a counterpart outbound movement. This may be either a non-revenue move (deadhead) or a revenue move.

Deadheading equipment is routed in simulation to either the S&I facility at Southampton Yard or to the MBTA layover yard at Readville. The only operational element not included in the simulation model is direct shuttling of Deadhead equipment between the S&I facility and Readville for servicing. These operations are carried out as traffic permits and would be timed so as not to interfere with revenue train operations.

Guidelines have been established by the MBTA to govern platform occupancies. These include consists that turn between revenue runs, scheduled revenue trains that return to the yard, and those that come from the yard to become revenue trains. Ten minutes was established as the minimum turn-around time for MBTA trains on platform tracks. However, due to schedules, virtually all trains in the simulation occupied platforms for longer periods. Amtrak trains had longer such time periods (20-25 minutes), with trains carrying storage mail cars having the longest platform time (over 30 minutes).

Old Colony trainsets were assigned only to Old Colony Line services due to the presence of trainlined door systems on those trainsets. Old Colony operations were modeled as of the October 26, 1998 timetable change. In addition, potential future Greenbush service was simulated with three morning peak (arbitrarily numbered 082, 084 and 086) and three evening peak trains. All of them arrive on Track 13 and unlike all other trains in simulation, they have no outbound

counterpart. This was done since planning for that service is not developed enough to provide information regarding potential off-peak service or what other schedules may be supported by this equipment.

The tabulation below displays the estimated number of physical trainsets needed to support the 2003 MBTA operations mimicked by the simulation. The locations indicate the planned site of overnight storage.

Predicted Number of MBTA Trainsets, South Side, 2003

Worcester:	5
Needham:	3
Forge Park:	1 [1]
Pawtucket:	5
Middleboro:	4
Kingston:	4
Freetown:	4
New Bedford:	5
Boston:	11
TOTAL:	42

The above tabulation intentionally does not include equipment requirements for the proposed Greenbush Line, which could not be estimated.

[1] The October 26, 1998 MBTA Public Timetable indicates one trainset is at Forge Park overnight; a total of six trainsets are needed, however, to support morning peak Forge Park service. If the remaining five trainsets deadhead from Boston to Forge Park, the Boston layover total is 11 trains.

OBSERVATIONS

SOUTH STATION OPERATING PLAN DEVELOPMENT METHODOLOGY

Smooth operations within the South Station Terminal Area will increasingly depend upon a documented operating plan. Other busy railroad stations in the country, such as Penn Station New York (PSNY), Grand Central Terminal (GCT) and Chicago's Union Station, either work to an operating plan or are in the process of developing one. The high price of urban real estate in the country's major cities, coupled with the high cost of construction projects, demands the optimum utilization of existing infrastructure. Ideal utilization of resources and infrastructure typically occurs when a well devised plan is implemented rather than operating through past experience.

The simulation required that an operating model be developed. For the simulation, a master spreadsheet (Attachment 2) was developed that indicates a scheduled platform occupancy assignment of each train, both MBTA and Amtrak. It was from this information that train movements within the Terminal Area, both revenue and non-revenue, were simulated.

Non-revenue equipment moves were scheduled with almost the same precision as revenue trains, except that substantial recovery time was built into the schedules of non-revenue trains. This is in recognition of the fact that non-revenue trains will yield to conflicting revenue train movements. Operation of many non-revenue movements across the two South Station ladder tracks is unavoidable because the only reliable access to inspection and layover facilities will be via the Fort Point Channel Bridge. Even though train movements between the low side of the station and the Fort Point Channel have the potential to conflict with high side movements, careful assignment of platform berths and scheduling of non-revenue train movements can minimize this problem. *The South Station rail plant, as redeveloped in the 1980s, is not optimally configured to support a large number of train movements from the low side of the Terminal via the Fort Point Channel Bridge.* However, no capital improvement projects are on the horizon to mitigate this situation, so the operating plan is constrained by the existing infrastructure.

The accompanying Platform Occupancy Charts (Attachment 3) illustrate that platform time will be at a premium on the high side of the station (Tracks 7 through 13) during the morning peak period, except for Tracks 9 or 10 which are reserved for Amtrak services. Similarly, in the evening peak period, platform capacity is again at a premium.

Throughout midday hours, large numbers of train consists sitting idle in the South Station platform tracks made finding a platform track for off-peak revenue movements difficult. When trainsets are returned to service, their departure from the yard must be coordinated with a simultaneous departure of a consist from the Station en route to the yard. Still, some trains from

the yard were held for several minutes on the Fort Point Channel Bridge while off-peak revenue trains used the limited number of available tracks.

The following subsections summarize the operational methodology concerning traffic from each approach to South Station.

Northeast Corridor and Conrail's Boston Line

The rail infrastructure in the Terminal Area includes a portion of the NEC, which the MBTA shares with Amtrak, from Back Bay Station to South Station. The NEC is a triple-track railroad approaching Back Bay Station from the southwest. The two easterly tracks (numbered one and two) are operated with one inbound and one outbound. The third main track, west of the other two, is used as a reversible track, generally with inbound trains during A.M. hours and outbound trains during P.M. hours. All three tracks are equipped with reverse signaling.

In addition, Conrail's Boston Line (MBTA Worcester Line) operates alongside the Corridor for 1.1 miles from Back Bay Station to South Station. The Worcester Line is double-track with reverse signaling, approaching Back Bay Station from the west. Both Worcester Line main tracks are used for train movements in both directions throughout the day. Generally, the Conrail dispatcher directs the South Station Train Director to the track assignment that fits into the operation west of Beacon Park Yard.

Given the configuration of the South Station throat trackage, trains operating to/from either the NEC or the Worcester Line experience fewest conflicts when they are assigned to low side platforms. Amtrak's expected use of Track 10, on the high side, requires an additional crossover move that potentially conflicts with operations to/from the Dorchester Branch.

MBTA trains operating to/from the NEC, Conrail's Boston Line (Worcester Line), the Franklin Line (via Back Bay), the Needham Branch and the proposed New Bedford/Fall River Line were assigned to Tracks 1 through 7 at South Station. The schedule required limited use for these services of Track 8, which is shared with Amtrak. When equipment located on the low side of the station operates outbound to either Readville Yard or to Southampton Yard, the traffic crosses over or intersects with all five main tracks that connect South Station with Cove Interlocking and Back Bay, thereby potentially creating conflicts.

Amtrak

Tracks 9 and 10 in South Station are reserved for Amtrak's exclusive use, so MBTA trains were never assigned to those tracks. The two tracks appear to be adequate to support Amtrak's planned 2003 services. If one of the tracks is needed for an extended layover, such as loading and unloading of mail and express, Track 8 may be used by both the MBTA and Amtrak.

All Amtrak locomotives and rolling stock will be serviced at Southampton Yard. The move from Tracks 8, 9 or 10 to Southampton Yard will not cause any undue interference to other traffic. It was partly for this reason that these tracks were selected for Amtrak operations.

MBTA Dorchester and Old Colony Lines

The bridge over the Fort Point Channel carries the MBTA's Dorchester Line and Old Colony Middleboro and Kingston Branches. This bridge would also provide access for the proposed Old Colony branch to Greenbush. In addition, all train movements to and from the respective yards pass over the Fort Point Channel Bridge. There are currently only three tracks in service until full replacement of the bridge is completed. With final completion of the bridge reconstruction, there will be four tracks operating over the Fort Point Channel.

South of the Fort Point Channel Bridge the Old Colony Railroad is a single-track main line with passing sidings. The Main Line and sidings are equipped with reverse signaling which allow train's to operate efficiently in both directions. Generally, prevailing current of traffic for meet/passes is for inbound trains before noon and outbound trains after noon to take the sidings.

The Dorchester Line is double-track approaching the Fort Point Channel Bridge. Although equipped with reverse signaling, the Dorchester Line is rarely operated with reverse traffic, except within the bridge area, due to the operation and infrastructure of the South Station Terminal Area.

Old Colony and Dorchester Branch trains experience a minimum of interference when they use the extreme high side of the Terminal. With Amtrak being assigned exclusive use of Track 9 and Track 10, the ideal platform tracks for these trains are 11 and 12. These tracks were used in the model whenever possible. Track 13 is a very short track for train storage and, when a train exceeding six cars uses the track, would foul Track 12. Depending on the train's length on Track 13, it could also foul Track 11. This is not desirable as a planned operation. Since the existing schedule leaves little platform availability on Tracks 11, 12 or 13 during desirable peak period time slots, scheduling slots for proposed Greenbush Line trains was difficult. At times, Track 5 had to be used, which is not an optimal situation due to decreased operational flexibility and potential conflicts resulting from the Old Colony main tracks connection from the low side of the station via a single ladder track.

STORAGE AND LAYOVER YARD REQUIREMENTS

South Station, long perceived to be constrained and unable to accommodate even near-term growth in rail operations, actually can handle considerably more trains than at present. The expanded Amtrak service of 2000, the proposed Fall River/New Bedford extension, and the proposed Greenbush Branch all can fit into the Station. The station, itself, can even accept further long-range increases, such as the Amtrak 2010 scenario, and expansion of existing MBTA routes.

South Station Occupancy Chart (Attachment 3), Sheet 1, best demonstrates the fact that the station can handle an increased number of trains. This demonstrates how the station functions during times when yard support is able to accommodate the large flow of train consists for storage and servicing. Sheet 1 displays the morning peak (6-9 AM), demonstrating that South Station can make room for a continuous flow of inbound trains as long as capacity exists at Readville Yard.

However, an evaluation of the 2003 operations simulated indicates that 42 trainsets will be needed in order to support South Side MBTA commuter rail operations. A preliminary analysis of equipment manipulations within the Terminal Area plus the Readville Yard indicates that the expected combined capacity of Readville Yard and the Southampton S&I shop (20 trainsets total) will be exceeded by six trainsets during mid-day when Boston area layover space requirements peak. In addition, the S&I shop is not a storage site as equipment must be constantly rotated through the shop to maintain the necessary servicing and inspection schedules.

Although during preliminary analysis operations were optimized to minimize the number of trainsets required, indications are that as many as seven consists may make a single round-trip each weekday. This could raise concerns regarding the costs and utilization of added trainsets purchased to provide enhanced peak period service.

Due to the lack of storage space at or near the South Station, the station itself must be used as a short-term layover yard during the late morning and early afternoon. This primarily is a result of the inability of Readville Yard and Southampton S&I to accept additional trainsets, and secondarily due to the capacity limitations and conflicts of the Dorchester Branch. This study indicates that by 10 AM on a typical weekday, Readville Yard is full with mid-day layovers, which results in the lack of storage space. For each additional trainset accepted into the yard, another trainset must be cycled back into service. The same situation exists at Southampton S&I. (The simulation model took no account of the possibility of moving trainsets to the new Boston Engine Terminal, and even if it had, this would accommodate only a few trains as the move to BET is time-consuming.)

As the accompanying South Station Track Occupancy Chart illustrates (Attachment 3, Sheet 2), many of the terminal tracks must be occupied by empty trainsets for, in some cases, up to two hours. This indicates a potential need to either perform certain light support services in the station, such as interior car cleaning, or identify additional layover yard capacity that is relatively close-by.

The shortage of platform track space in midday, a result of a lack of storage space, contributes to a potential collapse of the operation in the evening peak. The MBTA will not be able to quickly fill the station platform tracks in advance of the rush with as many outbound consists as is done at present. At the very beginning of the peak, the station still has platform tracks occupied by trainsets waiting to be sent to the yard for servicing. This situation, coupled with Amtrak's need for three tracks at a critical point early in the evening peak and the need for the station to keep handling inbound revenue trains, combine to create the possibility of late departure of revenue trains from South Station during the last half of the 5:00 PM hour, even when operations are normal.

As mentioned previously, the principal challenge of the simulation was to successfully move consists from revenue operation at South Station to layover at Readville Yard. This was difficult primarily due to constraints at Readville Yard, which include the yard's remote location, single directional track for access, inability to fully use key track elements and it's restricted capacity. These are all serious short and long-term concerns that have repercussions on the viability of operations in the entire South Station Terminal Area.

Beginning at 4:20 PM, trainsets begin departing Readville Yard at three minute intervals in the simulation, creating a fleet of deadhead trains that can only be fed into platform tracks one at a time. Frequent delays on the Fort Point Channel Bridge for revenue trains upsets the flow of the parade. A High-Speed trainset that must be sent to the yard in the afternoon due to insufficient platform space also interferes with this continuous line of trains as it returns to the station at the peak of the peak.

Additionally, there is a severe speed restriction along the Dorchester Branch at the Columbia Road Undergrade Bridge, which adds to the problem. This restriction coupled with signal facilities shortcomings and the relatively long distance separating Readville from South Station conspire to create an operating problem which will get worse in the near future unless it is addressed with effective solutions. Since the Dorchester Branch needs to support a dense volume of traffic, steps should be taken to mitigate the speed restriction at Columbia Road. Additionally

an upgrade of the signal system should be considered. A review of Safe Braking distances in order to tune the signal system for shorter headways would help in alleviating some of the problems. Construction of a third main Dorchester Branch track between South Bay and Readville would also be highly desirable if embankment limitations could be overcome.

CONCLUSION

Simulation of operations in the South Station Terminal Area does not indicate that the introduction of New Bedford/Fall River commuter rail service will present any additional operating difficulties to the MBTA. The model revealed that South Station, itself, can even accept additional expansion of rail services. However, what was revealed through the simulation, is that problems do exist with South Station operations, not related to expanded MBTA service but due to the expansion of Amtrak services.

South Station Operations

The number of trains in operation in the South Station Terminal Area during the morning and evening hour peak periods are nearing the limit. The efficiency of yard movements between Southampton S&I and Readville Yard become critical with the arrival of Amtrak's high-speed train. In the past, for non-revenue trains, the train crews and the dispatcher were not required to adhere to a strict schedule. In the future, it will become increasingly important to adhere to a strict schedule to utilize the shorter windows of opportunity for a crossover from the low side of the station (Tracks 1-6) across the Fort Point Channel Bridge en route to the Southampton S&I and Readville Yard. These crossover moves shut off access to most of the platforms at South Station, halting incoming movements along the NEC from Back Bay. Therefore, schedule adherence to deadhead moves will become critical.

Expansion of tracks and platforms at South Station would help to alleviate this problem. With the right layout, incoming trains that turn to yard movements could be scheduled to platform on the high side (Tracks 7-13) to minimize crossover movements that sever the operations from Back Bay. Expansion of the station would not only benefit current operations but would be beneficial to future expansion of the Old Colony Line or Dorchester Branch. In any case, it is imperative that, with the onset of Amtrak high-speed service, a full-detailed South Side operation's plan and train platform assignment schedule be developed.

Dorchester Branch

Although the Dorchester Branch was placed back into service to support construction activities along the NEC, its use has evolved from temporary mainline operations to long yard lead. Trains that are headed for the Readville layover facility traverse the Dorchester Branch. The branch becomes critical to the success or failure of the NEC and South Station Terminal Area operations. If deadhead moves from South Station are not made quickly and efficiently, the available number platforms for trains entering South Station is greatly limited.

The Dorchester Branch signal system was not designed with the current operations in mind. It was designed for trains operating at higher speeds requiring longer signal blocks, since it was used as a temporary corridor. Since it is now being used as the main access to Readville Yard, South Station operations would benefit from a reconfiguration of the signal blocks in order to support a higher capacity of trains at lower speeds. Reconfiguration would allow for more efficient movements out of the station for trains heading to Readville Yard and the Southampton S&I. Since the Dorchester Branch, and the Old Colony Lines also compete with non-reveue trains crossing over the Fort Point Channel Bridge, operations for those routes would benefit as well.

Southampton S&I Facility

Because of the unique design, Kawasaki's coaches that are operated by the MBTA, require a pit track for checking the brakes and legal standards require the Kawasaki coaches to be checked every 72-hours. However, the Southampton facility has the only pit track on the south side. Considering the number of vehicles and their availability during the off-peak hours, scheduling inspection and maintenance will become extremely difficult.

Expansion of the MBTA S&I facility has been considered but with the high-speed Amtrak service starting at the end of this year and the need for space to service those trainsets, it would be difficult for Amtrak to build a facility for their trainsets elsewhere. The MBTA should consider that Amtrak's long-range plan may be to remove the MBTA operation from this yard in order to build an electric locomotive shop for the high-speed trainset.

Readville Yard (Storage)

At the present time the MBTA stores up to nine trainsets in Readville Yard during the off-peak hours and overnight, with the remainder (about 20) stored at the Southampton Yard. The simulation was run with a maximum of 16 trainsets stored at Readville Yard with only four stored at the Southampton S&I as expected with the commencement of Amtrak high-speed service. With the loss of full use of the Southampton Yard, mid-day storage of trainsets will become a problem, regardless of any expansion of services.

Various remedial actions to address the issue of layover yard capacity could include:

- Careful review of proposed service level increases on existing South Side lines to determine whether the anticipated ridership justifies the application of additional rolling stock and locomotives;

- Maximizing the use of available space at Readville Yard;

- Investigating the feasibility of conducting limited servicing and car cleaning functions on one or more platform tracks at South Station, especially Track 1 which is the most lightly used platform track;

- Implementing a rolling storage approach whereby additional mid-day service would be operated (subject to track capacity/schedule slots) if the equipment can be serviced and maintained overnight in Boston or at an outlying point. There is ample main line capacity to operate additional non-revenue trains during late-night hours and this is also the time when demand for equipment servicing in Boston is at its lowest.

- Exploring the possibility of servicing at least one or two trainsets daily at Conrail's Beacon Park engine terminal during the mid-day layover;

- Investigating the potential use of part of the former New Haven South Boston freight yard property for mid-day layover. (This property is being extensively used by Central Artery/Tunnel construction forces at the present time.)

Although the main objective of the simulation project was to model operations and analyze capacity at South Station for the New Bedford/Fall River service, important additional information was discovered. It was revealed that operations at South Station will experience difficulties which need to be addressed well before the addition of New Bedford/Fall River service, and that this new service will not add to these difficulties. It is expected that many of the issues that created the problems encountered during this simulation will be resolved well before the commencement of the planned service.

ATTACHMENTS

ATTACHMENT 1

SIGNAL DELAY

Signal Delay is the time during which trains are forced to operate under signal indications that are less favorable than the best possible indication. Signal Delay measures traffic congestion independently of scheduled arrival and departure times. Signal Delay time is not lateness. For example, if a train operates at 30 miles-per-hour for 90 seconds because of an Approach indication, 90 seconds of Signal Delay is experienced, but this does *not* mean that the train is 90 seconds late. In fact, the train might still be on time, depending on the amount of recovery time built into its schedule.

Signal Delay statistics were generated for the South Station terminal area for Amtrak and MBTA revenue trains. The peak periods of 6:00 to 9:00 AM and 4:00 to 7:00 PM were broken out, because average train delay over a full 24-hour period that includes the late-night hours when few trains operate is not particularly meaningful.

The table below displays the subset of the aggregate accrued network signal delay previously presented in the main body of the April 1999 Operations Simulation Report that occurred within the Terminal Area. Also presented, is the percentage of total network signal delay attributable to Terminal Area signal delays (train conflicts). The total system signal delay figures presented in the body of the Report do *not* include the Old Colony lines and do *not* include delays that were encountered by non-revenue trains. This was done intentionally as not to obscure the findings.

Summary of Signal Delay (h:mm:ss) at South Station				
	MBTA Revenue Trains	% of Network Total	Amtrak Revenue Trains	% of Network Total
AM Peak (6-9 AM)	0:27:29	36%	0:01:58	14%
PM Peak (4-7 PM)	0:28:42	19%	0:00:58	4%
24 Hours	1:00:08	18%	0:04:07	4%

Morning peak-period signal delays accruing to MBTA revenue trains within the Terminal Area represented 36% of total network signal delays. Evening peak period MBTA signal delays within the Terminal Area were only 19% of total network signal delays because the network total was higher. The aggregate signal delay figure for MBTA Terminal Area operations was almost static at 27 to 29 minutes for both the morning and evening peak periods, with a similar number of MBTA revenue trains operating during each peak.

Amtrak revenue trains operating within the Terminal Area experienced an extremely minor signal delay of only 4 minutes 7 seconds over the entire 24 hour period! Allocated among the 38 revenue Amtrak trains in simulation (20 High Speed and 18 Conventional), the average signal delay per Amtrak train is only 6-1/2 seconds.

ATTACHMENT 2

SOUTH STATION OPERATING MODEL

South Station Operating Model

DH	Train ID	Arrivals	Departures	Track	Turns From	Track 1	Track 2	Track 3	Track 4	Track 5	Track 6	Track 7	Track 8	Amtrak Track 9	Amtrak Track 10	Track 11	Track 12	Track 13	Time	Interval	Storage Tracks Occupied
																					3
DH	X501	5:00 AM		1		X501													5:00 AM		2
	501		5:20 AM	1	X501														5:20 AM	0:20	2
	2	6:19 AM		12													2		6:19 AM	0:59	2
	790	6:20 AM		2			790										2		6:20 AM	0:01	2
	32	6:31 AM		13			790										2	32	6:31 AM	0:11	2
	503		6:35 AM	2	790												2	32	6:35 AM	0:04	2
	800	6:40 AM		6							800						2	32	6:40 AM	0:05	2
	3		6:45 AM	12	2						800							32	6:45 AM	0:05	2
	744	6:48 AM		11							800					744		32	6:48 AM	0:03	2
	702	6:48 AM		3				702			800					744		32	6:48 AM	0:00	2
	803		6:50 AM	6	800			702								744		32	6:50 AM	0:02	2
	600	6:50 AM		1		600		702								744		32	6:50 AM	0:00	2
	793		7:00 AM	11	744	600		702										32	7:00 AM	0:10	2
	500	7:02 AM		2		600	500	702										32	7:02 AM	0:02	2
	605		7:05 AM	3	702	600	500											32	7:05 AM	0:03	2
	505		7:05 AM	1	600		500											32	7:05 AM	0:00	2
	33		7:05 AM	13	32		500												7:05 AM	0:00	2
	4	7:05 AM		12			500										4		7:05 AM	0:00	2
	902	7:06 AM		7			500					902					4		7:06 AM	0:01	2
	746	7:15 AM		11			500					902				746	4		7:15 AM	0:09	2
	704	7:15 AM		5			500			704		902				746	4		7:15 AM	0:00	2
DH	X004		7:20 AM	12	4		500			704		902				746			7:20 AM	0:05	3
	552	7:20 AM		1		552	500			704		902				746			7:20 AM	0:00	3
DH	X902		7:21 AM	7	902	552	500			704						746			7:21 AM	0:01	4
	802	7:22 AM		6		552	500			704	802					746			7:22 AM	0:01	4
	34	7:24 AM		12		552	500			704	802					746	34		7:24 AM	0:02	4
	607		7:25 AM	2	500	552				704	802					746	34		7:25 AM	0:01	4
	749		7:30 AM	11	746	552				704	802						34		7:30 AM	0:05	4
	602	7:30 AM		7		552				704	802	602					34		7:30 AM	0:00	4
	904	7:32 AM		4		552			904	704	802	602					34		7:32 AM	0:02	4
	507		7:35 AM	1	552				904	704	802	602					34		7:35 AM	0:03	4
	907		7:35 AM	5	704				904		802	602					34		7:35 AM	0:00	4
DH	X802		7:37 AM	6	802				904			602					34		7:37 AM	0:02	5
DH	X034		7:39 AM	12	34				904			602							7:39 AM	0:02	6
	504	7:40 AM		5					904	504		602							7:40 AM	0:01	6
	9022	7:42 AM		8					904	504		602	9022						7:42 AM	0:02	6
DH	X602		7:45 AM	7	602				904	504			9022						7:45 AM	0:03	7
	831		7:50 AM	4	904					504			9022						7:50 AM	0:05	7
	554	7:50 AM		6						504	554		9022						7:50 AM	0:00	7
	748	7:50 AM		12						504	554		9022				748		7:50 AM	0:00	7
	708	7:50 AM		7						504	554	708	9022				748		7:50 AM	0:00	7
	804	7:52 AM		3				804		504	554	708	9022				748		7:52 AM	0:02	7

DH	Train ID	Arrivals	Departures	Track	Turns From	Track 1	Track 2	Track 3	Track 4	Track 5	Track 6	Track 7	Track 8	Amtrak Track 9	Amtrak Track 10	Track 11	Track 12	Track 13	Time	Interval	Storage Tracks Occupied
	6	7:52 AM		11				804		504	554	708	9022			6	748		7:52 AM	0:00	7
DH	X504		7:55 AM	5	504			804			554	708	9022			6	748		7:55 AM	0:03	8
	9904	8:00 AM		4				804	9904		554	708	9022			6	748		8:00 AM	0:05	8
	735		8:02 AM	8	9022			804	9904		554	708				6	748		8:02 AM	0:02	8
DH	X554		8:05 AM	6	554			804	9904			708				6	748		8:05 AM	0:03	9
DH	X708		8:05 AM	7	708			804	9904							6	748		8:05 AM	0:00	10
	556	8:05 AM		5				804	9904	556						6	748		8:05 AM	0:00	10
	36	8:06 AM		13				804	9904	556						6	748	36	8:06 AM	0:01	10
DH	X006		8:07 AM	11	6			804	9904	556							748	36	8:07 AM	0:01	11
	9906	8:08 AM		7				804	9904	556		9906					748	36	8:08 AM	0:01	11
DH	X804		8:10 AM	3	804				9904	556		9906					748	36	8:10 AM	0:02	12
	8	8:14 AM		11					9904	556		9906				8	748	36	8:14 AM	0:04	12
	799		8:15 AM	12	748				9904	556		9906				8		36	8:15 AM	0:01	12
DH	X9904		8:15 AM	4	9904					556		9906				8		36	8:15 AM	0:00	13
	604	8:16 AM		2			604			556		9906				8		36	8:16 AM	0:01	13
	806	8:16 AM		6			604			556	806	9906				8		36	8:16 AM	0:00	13
DH	X008		8:19 AM	11	8		604			556	806	9906						36	8:19 AM	0:03	14
	558	8:20 AM		4			604		558	556	806	9906						36	8:20 AM	0:01	14
DH	X556		8:20 AM	5	556		604		558		806	9906						36	8:20 AM	0:00	15
	5		8:22 AM	13	36		604		558		806	9906							8:22 AM	0:02	15
	750	8:23 AM		12			604		558		806	9906					750		8:23 AM	0:01	15
	738	8:23 AM		3			604	738	558		806	9906					750		8:23 AM	0:00	15
DH	X9906		8:23 AM	7	9906		604	738	558		806						750		8:23 AM	0:00	16
	906	8:26 AM		8			604	738	558		806		906				750		8:26 AM	0:03	16
	509		8:30 AM	2	604			738	558		806		906				750		8:30 AM	0:04	16
	38	8:30 AM		13				738	558		806		906				750	38	8:30 AM	0:00	16
DH	X806		8:31 AM	6	806			738	558				906				750	38	8:31 AM	0:01	17
	909		8:35 AM	4	558			738					906				750	38	8:35 AM	0:04	17
	9044	8:36 AM		5				738		9044			906				750	38	8:36 AM	0:01	17
DH	X750		8:38 AM	12	750			738		9044			906					38	8:38 AM	0:02	18
	609		8:40 AM	3	738					9044			906					38	8:40 AM	0:02	18
	606	8:40 AM		7						9044		606	906					38	8:40 AM	0:00	18
DH	X906		8:41 AM	8	906					9044		606						38	8:41 AM	0:01	19
	510	8:44 AM		4					510	9044		606						38	8:44 AM	0:03	19
	808	8:46 AM		2			808		510	9044		606						38	8:46 AM	0:02	19
	805		8:50 AM	5	9044		808		510			606						38	8:50 AM	0:04	19
	61		8:50 AM	13	38		808		510			606							8:50 AM	0:00	19
	752	8:52 AM		11			808		510			606				752			8:52 AM	0:02	19
	710	8:52 AM		1		710	808		510			606				752			8:52 AM	0:00	19
DH	X606		8:55 AM	7	606	710	808		510							752			8:55 AM	0:03	20
DH	X510		8:59 AM	4	510	710	808									752			8:59 AM	0:04	21
	10	9:00 AM		12		710	808									752	10		9:00 AM	0:01	21
DH	X808		9:01 AM	2	808	710										752	10		9:01 AM	0:01	22
	9908	9:01 AM		7		710						9908				752	10		9:01 AM	0:00	22
DH	X752		9:07 AM	11	752	710						9908					10		9:07 AM	0:06	23

DH	Train ID	Arrivals	Departures	Track	Turns From	Track 1	Track 2	Track 3	Track 4	Track 5	Track 6	Track 7	Track 8	Amtrak Track 9	Amtrak Track 10	Track 11	Track 12	Track 13	Time	Interval	Storage Tracks Occupied
	608	9:11 AM		8		710						9908	608				10		9:11 AM	0:04	23
	810	9:16 AM		6		710					810	9908	608				10		9:16 AM	0:05	23
	707		9:20 AM	7	9908	710					810		608				10		9:20 AM	0:04	23
DH	X608		9:26 AM	8	608	710					810						10		9:26 AM	0:06	24
	562	9:27 AM		3		710		562			810						10		9:27 AM	0:01	24
	792	9:27 AM		11		710		562			810					792	10		9:27 AM	0:00	24
	40	9:28 AM		13		710		562			810					792	10	40	9:28 AM	0:01	24
	911		9:35 AM	6	810	710		562								792	10	40	9:35 AM	0:07	24
	35		9:35 AM	12	10	710		562								792		40	9:35 AM	0:00	24
	908	9:43 AM		4		710		562	908							792		40	9:43 AM	0:08	24
	7		9:57 AM	13	40	710		562	908							792			9:57 AM	0:14	24
DH	X908		9:58 AM	4	908	710		562								792			9:58 AM	0:01	25
	832	10:02 AM		5		710		562		832						792			10:02 AM	0:04	25
	611		10:05 AM	3	562	710				832						792			10:05 AM	0:03	25
	610	10:16 AM		6		710				832	610					792			10:16 AM	0:11	25
	712	10:22 AM		7		710				832	610	712				792			10:22 AM	0:06	25
	755		10:25 AM	11	792	710				832	610	712							10:25 AM	0:03	25
	511		10:30 AM	5	832	710					610	712							10:30 AM	0:05	25
	12	10:34 AM		11		710					610	712				12			10:34 AM	0:04	25
	9099		10:35 AM	6	610	710						712				12			10:35 AM	0:01	25
	910	10:43 AM		12		710						712				12	910		10:43 AM	0:08	25
	807		10:50 AM	7	712	710										12	910		10:50 AM	0:07	25
	63		10:50 AM	11	12	710											910		10:50 AM	0:00	25
	514	10:50 AM		3		710		514									910		10:50 AM	0:00	25
	60	11:00 AM		13		710		514									910	60	11:00 AM	0:10	25
	812	11:04 AM		4		710		514	812								910	60	11:04 AM	0:04	25
DH	X514		11:05 AM	3	514	710			812								910	60	11:05 AM	0:01	26
	714	11:28 AM		7		710			812			714					910	60	11:28 AM	0:23	26
	612	11:33 AM		5		710			812	612		714					910	60	11:33 AM	0:05	26
	709		11:34 AM	12	910	710			812	612		714						60	11:34 AM	0:01	26
	9119		11:35 AM	4	812	710				612		714						60	11:35 AM	0:01	26
	912	11:43 AM		6		710				612	912	714						60	11:43 AM	0:08	26
	42	11:43 AM		12		710				612	912	714					42	60	11:43 AM	0:00	26
	9		11:50 AM	13	60	710				612	912	714					42		11:50 AM	0:07	26
	516	11:50 AM		2		710	516			612	912	714					42		11:50 AM	0:00	26
	14	12:04 PM		8		710	516			612	912	714	14				42		12:04 PM	0:14	26
	613		12:05 PM	2	516	710				612	912	714	14				42		12:05 PM	0:01	26
	39		12:10 PM	12	42	710				612	912	714	14						12:10 PM	0:05	26
	565		12:30 PM	5	612	710					912	714	14						12:30 PM	0:20	26
DH	X809	12:33 PM		2	809	710	X809				912	714	14						12:33 PM	0:03	25
	9199		12:35 PM	6	912	710	X809					714	14						12:35 PM	0:02	25
	758	12:38 PM		12		710	X809					714	14				758		12:38 PM	0:03	25
	914	12:43 PM		6		710	X809				914	714	14				758		12:43 PM	0:05	25
	759		12:45 PM	7	714	710	X809				914		14				758		12:45 PM	0:02	25
	809		12:50 PM	2	X809	710					914		14				758		12:50 PM	0:05	25

DH	Train ID	Arrivals	Departures	Track	Turns From	Track 1	Track 2	Track 3	Track 4	Track 5	Track 6	Track 7	Track 8	Amtrak Track 9	Amtrak Track 10	Track 11	Track 12	Track 13	Time	Interval	Storage Tracks Occupied
	814	1:04 PM		3		710		814			914		14				758		1:04 PM	0:14	25
	62	1:05 PM		11		710		814			914		14			62	758		1:05 PM	0:01	25
	65		1:20 PM	8	14	710		814			914					62	758		1:20 PM	0:15	25
DH	X758		1:20 PM	12	758	710		814			914					62			1:20 PM	0:00	26
	614	1:33 PM		5		710		814		614	914					62			1:33 PM	0:13	26
	913		1:35 PM	6	914	710		814		614						62			1:35 PM	0:02	26
	916	1:43 PM		6		710		814		614	916					62			1:43 PM	0:08	26
	716	1:46 PM		7		710		814		614	916	716				62			1:46 PM	0:03	26
	518	1:50 PM		4		710		814	518	614	916	716				62			1:50 PM	0:04	26
	711		1:55 PM	5	614	710		814	518		916	716				62			1:55 PM	0:05	26
	16	1:55 PM		12		710		814	518		916	716				62	16		1:55 PM	0:00	26
	615		2:05 PM	7	716	710		814	518		916					62	16		2:05 PM	0:10	26
	11		2:15 PM	12	16	710		814	518		916					62			2:15 PM	0:10	26
	44	2:15 PM		12		710		814	518		916					62	44		2:15 PM	0:00	26
	41		2:25 PM	12	44	710		814	518		916					62			2:25 PM	0:10	26
	515		2:30 PM	4	518	710		814			916					62			2:30 PM	0:05	26
	915		2:35 PM	6	916	710		814								62			2:35 PM	0:05	26
	918	2:43 PM		2		710	918	814								62			2:43 PM	0:08	26
	811		2:50 PM	3	814	710	918									62			2:50 PM	0:07	26
	762	2:56 PM		12		710	918									62	762		2:56 PM	0:06	26
	67		3:00 PM	11	62	710	918										762		3:00 PM	0:04	26
	816	3:04 PM		5		710	918			816							762		3:04 PM	0:04	26
	617		3:05 PM	1	710		918			816							762		3:05 PM	0:01	26
	763		3:06 PM	12	762		918			816									3:06 PM	0:01	26
	64	3:20 PM		12			918			816							64		3:20 PM	0:14	26
	566	3:25 PM		7			918			816		566					64		3:25 PM	0:05	26
	513		3:30 PM	5	816		918					566					64		3:30 PM	0:05	26
	616	3:30 PM		1		616	918					566					64		3:30 PM	0:00	26
	875		3:35 PM	2	918	616						566					64		3:35 PM	0:05	26
	920	3:38 PM		3		616		920				566					64		3:38 PM	0:03	26
DH	X767	3:43 PM		5		616		920		X767		566					64		3:43 PM	0:05	25
	13		3:45 PM	12	64	616		920		X767		566							3:45 PM	0:02	25
	813		3:50 PM	7	566	616		920		X767									3:50 PM	0:05	25
DH	X879	3:57 PM		6		616		920		X767	X879								3:57 PM	0:07	24
DH	X043	4:00 PM		11		616		920		X767	X879					X043			4:00 PM	0:03	23
	767		4:03 PM	5	X767	616		920			X879					X043			4:03 PM	0:03	23
	715		4:03 PM	3	920	616					X879					X043			4:03 PM	0:00	23
	619		4:05 PM	1	616						X879					X043			4:05 PM	0:02	23
	879		4:12 PM	6	X879											X043			4:12 PM	0:07	23
	718	4:12 PM		1		718										X043			4:12 PM	0:00	23
	43		4:15 PM	11	X043	718													4:15 PM	0:03	23
	18	4:21 PM		13		718												18	4:21 PM	0:06	23
DH	X815	4:22 PM		8		718							X815					18	4:22 PM	0:01	22
	766	4:23 PM		12		718							X815				766	18	4:23 PM	0:01	22
DH	X717	4:25 PM		4		718			X717				X815				766	18	4:25 PM	0:02	21

DH	Train ID	Arrivals	Departures	Track	Turns From	Track 1	Track 2	Track 3	Track 4	Track 5	Track 6	Track 7	Track 8	Amtrak Track 9	Amtrak Track 10	Track 11	Track 12	Track 13	Time	Interval	Storage Tracks Occupied
	519		4:30 PM	1	718				X717				X815				766	18	4:30 PM	0:05	21
	618	4:32 PM		5					X717	618			X815				766	18	4:32 PM	0:02	21
	48	4:32 PM		11					X717	618			X815			48	766	18	4:32 PM	0:00	21
DH	X621	4:35 PM		3				X621	X717	618			X815			48	766	18	4:35 PM	0:03	20
	815		4:37 PM	8	X815			X621	X717	618						48	766	18	4:37 PM	0:02	20
DH	X9917	4:39 PM		6				X621	X717	618	X9917					48	766	18	4:39 PM	0:02	19
	737		4:40 PM	12	766			X621	X717	618	X9917					48		18	4:40 PM	0:01	19
	717		4:40 PM	4	X717			X621		618	X9917					48		18	4:40 PM	0:00	19
DH	X571	4:40 PM		2			X571	X621		618	X9917					48		18	4:40 PM	0:00	18
	922	4:43 PM		1		922	X571	X621		618	X9917					48		18	4:43 PM	0:03	18
	9917		4:44 PM	6	X9917	922	X571	X621		618						48		18	4:44 PM	0:01	18
	15		4:45 PM	13	18	922	X571	X621		618						48			4:45 PM	0:01	18
DH	X817	4:46 PM		7		922	X571	X621		618		X817				48			4:46 PM	0:01	17
	917		4:48 PM	5	618	922	X571	X621				X817				48			4:48 PM	0:02	17
DH	X769	4:48 PM		12		922	X571	X621				X817				48	X769		4:48 PM	0:00	16
DH	X719	4:50 PM		4		922	X571	X621	X719			X817				48	X769		4:50 PM	0:02	15
	621		4:55 PM	3	X621	922	X571		X719			X817				48	X769		4:55 PM	0:05	15
	571		4:55 PM	2	X571	922			X719			X817				48	X769		4:55 PM	0:00	15
	45		4:55 PM	11	48	922			X719			X817					X769		4:55 PM	0:00	15
DH	X889	4:55 PM		8		922			X719			X817	X889				X769		4:55 PM	0:00	14
DH	X017	4:59 PM		13		922			X719			X817	X889				X769	X017	4:59 PM	0:04	13
	818	5:04 PM		5		922			X719	818		X817	X889				X769	X017	5:04 PM	0:05	13
	523		5:05 PM	1	922				X719	818		X817	X889				X769	X017	5:05 PM	0:01	13
	817		5:05 PM	7	X817				X719	818			X889				X769	X017	5:05 PM	0:00	13
	769		5:06 PM	12	X769				X719	818			X889					X017	5:06 PM	0:01	13
	719		5:06 PM	4	X719					818			X889					X017	5:06 PM	0:00	13
DH	X623	5:08 PM		3				X623		818			X889					X017	5:08 PM	0:02	12
DH	X575	5:10 PM		2			X575	X623		818			X889					X017	5:10 PM	0:02	11
	889		5:12 PM	8	X889		X575	X623		818								X017	5:12 PM	0:02	11
	17		5:14 PM	13	X017		X575	X623		818									5:14 PM	0:02	11
DH	X047	5:15 PM		11			X575	X623		818						X047			5:15 PM	0:01	10
DH	X595	5:16 PM		1		X595	X575	X623		818						X047			5:16 PM	0:01	9
	919		5:18 PM	5	818	X595	X575	X623								X047			5:18 PM	0:02	9
DH	X771	5:18 PM		12		X595	X575	X623								X047	X771		5:18 PM	0:00	8
DH	X721	5:20 PM		4		X595	X575	X623	X721							X047	X771		5:20 PM	0:02	7
DH	X819	5:22 PM		8		X595	X575	X623	X721				X819			X047	X771		5:22 PM	0:02	6
	623		5:25 PM	3	X623	X595	X575		X721				X819			X047	X771		5:25 PM	0:03	6
	575		5:25 PM	2	X575	X595			X721				X819			X047	X771		5:25 PM	0:00	6
	522	5:25 PM		5		X595			X721	522			X819			X047	X771		5:25 PM	0:00	6
	47		5:30 PM	11	X047	X595			X721	522			X819				X771		5:30 PM	0:05	6
	768	5:30 PM		7		X595			X721	522		768	X819				X771		5:30 PM	0:00	6
	66	5:30 PM		13		X595			X721	522		768	X819				X771	66	5:30 PM	0:00	6
	595		5:35 PM	1	X595				X721	522		768	X819				X771	66	5:35 PM	0:05	6
	771		5:36 PM	12	X771				X721	522		768	X819					66	5:36 PM	0:01	6
	721		5:36 PM	4	X721					522		768	X819					66	5:36 PM	0:00	6

DH	Train ID	Arrivals	Departures	Track	Turns From	Track 1	Track 2	Track 3	Track 4	Track 5	Track 6	Track 7	Track 8	Amtrak Track 9	Amtrak Track 10	Track 11	Track 12	Track 13	Time	Interval	Storage Tracks Occupied
	819		5:37 PM	8	X819					522		768						66	5:37 PM	0:01	6
	924	5:38 PM		3				924		522		768						66	5:38 PM	0:01	6
	9919		5:44 PM	5	522			924				768						66	5:44 PM	0:06	6
	921		5:48 PM	7	768			924										66	5:48 PM	0:04	6
	620	5:50 PM		6				924			620							66	5:50 PM	0:02	6
	20	5:50 PM		11				924			620					20		66	5:50 PM	0:00	6
DH	**X577**	5:50 PM		5				924		X577	620					20		66	5:50 PM	0:00	5
	19		5:53 PM	13	66			924		X577	620					20			5:53 PM	0:03	5
	625		5:55 PM	3	924					X577	620					20			5:55 PM	0:02	5
DH	**X723**	5:55 PM		4					X723	X577	620					20			5:55 PM	0:00	4
	770	5:58 PM		12					X723	X577	620					20	770		5:58 PM	0:03	4
DH	**X529**	6:00 PM		2			X529		X723	X577	620					20	770		6:00 PM	0:02	3
	577		6:05 PM	1	X577		X529		X723		620					20	770		6:05 PM	0:05	3
DH	**X923**	6:05 PM		7			X529		X723		620	X923				20	770		6:05 PM	0:00	2
	821		6:10 PM	6	620		X529		X723			X923				20	770		6:10 PM	0:05	2
DH	**X627**	6:10 PM		3			X529	X627	X723			X923				20	770		6:10 PM	0:00	1
	773		6:11 PM	12	770		X529	X627	X723			X923				20			6:11 PM	0:01	1
	723		6:11 PM	4	X723		X529	X627				X923				20			6:11 PM	0:00	1
	529		6:15 PM	2	X529			X627				X923				20			6:15 PM	0:04	1
	49		6:15 PM	11	20			X627				X923							6:15 PM	0:00	1
	923		6:20 PM	7	X923			X627											6:20 PM	0:05	1
	622	6:24 PM		6				X627			622								6:24 PM	0:04	1
	627		6:25 PM	3	X627						622								6:25 PM	0:01	1
	524	6:25 PM		2			524				622								6:25 PM	0:00	1
	772	6:26 PM		12			524				622						772		6:26 PM	0:01	1
DH	**X021**	6:30 PM		13			524				622						772	X021	6:30 PM	0:04	0
	820	6:33 PM		1		820	524				622						772	X021	6:33 PM	0:03	0
	21		6:45 PM	13	X021	820	524				622						772		6:45 PM	0:12	0
	835		6:50 PM	6	622	820	524										772		6:50 PM	0:05	0
	774	6:56 PM		7		820	524					774					772		6:56 PM	0:06	0
	22	7:01 PM		11		820	524					774				22	772		7:01 PM	0:05	0
	775		7:05 PM	12	772	820	524					774				22			7:05 PM	0:04	0
	629		7:10 PM	2	524	820						774				22			7:10 PM	0:05	0
	579		7:15 PM	1	820							774				22			7:15 PM	0:05	0
	925		7:20 PM	7	774											22			7:20 PM	0:05	0
	528	7:20 PM		8									528			22			7:20 PM	0:00	0
	52	7:25 PM		12									528			22	52		7:25 PM	0:05	0
	51		7:30 PM	11	22								528				52		7:30 PM	0:05	0
	776	7:31 PM		6							776		528				52		7:31 PM	0:01	0
	822	7:33 PM		3				822			776		528				52		7:33 PM	0:02	0
	928	7:43 PM		7				822			776	928	528				52		7:43 PM	0:10	0
DH	**X776**		7:46 PM	6	776			822				928	528				52		7:46 PM	0:03	1
	823		7:50 PM	8	528			822				928					52		7:50 PM	0:04	1
	626	7:58 PM		2			626	822				928					52		7:58 PM	0:08	1
	530	8:05 PM		4			626	822	530			928					52		8:05 PM	0:07	1

DH	Train ID	Arrivals	Departures	Track	Turns From	Track 1	Track 2	Track 3	Track 4	Track 5	Track 6	Track 7	Track 8	Amtrak Track 9	Amtrak Track 10	Track 11	Track 12	Track 13	Time	Interval	Storage Tracks Occupied
	631		8:10 PM	3	822		626		530			928					52		8:10 PM	0:05	1
	23		8:10 PM	12	52		626		530			928							8:10 PM	0:00	1
	720	8:13 PM		8			626		530			928	720						8:13 PM	0:03	1
	533		8:15 PM	2	626				530			928	720						8:15 PM	0:02	1
	725		8:20 PM	4	530							928	720						8:20 PM	0:05	1
DH	X720		8:28 PM	8	720							928							8:28 PM	0:08	2
	836	8:33 PM		5						836		928							8:33 PM	0:05	2
	628	8:36 PM		3				628		836		928							8:36 PM	0:03	2
	930	8:43 PM		11				628		836		928				930			8:43 PM	0:07	2
DH	X836		8:48 PM	5	836			628				928				930			8:48 PM	0:05	3
	927		8:50 PM	7	928			628								930			8:50 PM	0:02	3
	54	8:55 PM		12				628								930	54		8:55 PM	0:05	3
	532	9:05 PM		2			532	628								930	54		9:05 PM	0:10	3
	633		9:15 PM	3	628		532									930	54		9:15 PM	0:10	3
	535		9:15 PM	2	532											930	54		9:15 PM	0:00	3
	722	9:22 PM		7								722				930	54		9:22 PM	0:07	3
	781		9:25 PM	11	930							722					54		9:25 PM	0:03	3
	55		9:30 PM	12	54							722							9:30 PM	0:05	3
	630	9:38 PM		5						630		722							9:38 PM	0:08	3
	932	9:38 PM		6						630	932	722							9:38 PM	0:00	3
	56	9:45 PM		12						630	932	722					56		9:45 PM	0:07	3
	825		9:50 PM	7	722					630	932						56		9:50 PM	0:05	3
DH	X630		9:53 PM	5	630						932						56		9:53 PM	0:03	4
DH	X932		9:55 PM	6	932												56		9:55 PM	0:02	5
	594	10:05 PM		3				594									56		10:05 PM	0:10	5
	24	10:05 PM		11				594								24	56		10:05 PM	0:00	5
	635		10:30 PM	3	594											24	56		10:30 PM	0:25	5
	25		10:30 PM	12	56											24			10:30 PM	0:00	5
	724	10:32 PM		4					724							24			10:32 PM	0:02	5
	824	10:38 PM		7					724			824				24			10:38 PM	0:06	5
	57		10:40 PM	11	24				724			824							10:40 PM	0:02	5
	729		10:45 PM	4	724							824							10:45 PM	0:05	5
	632	10:47 PM		2			632					824							10:47 PM	0:02	5
	929		10:50 PM	7	824		632												10:50 PM	0:03	5
	534	11:05 PM		4			632		534										11:05 PM	0:15	5
	537		11:15 PM	2	632				534										11:15 PM	0:10	5
	726	11:38 PM		6					534		726								11:38 PM	0:23	5
	731		11:40 PM	4	534						726								11:40 PM	0:00	5
	827		11:50 PM	6	726														11:50 PM	0:02	5

Explanation of data columns, left to right:

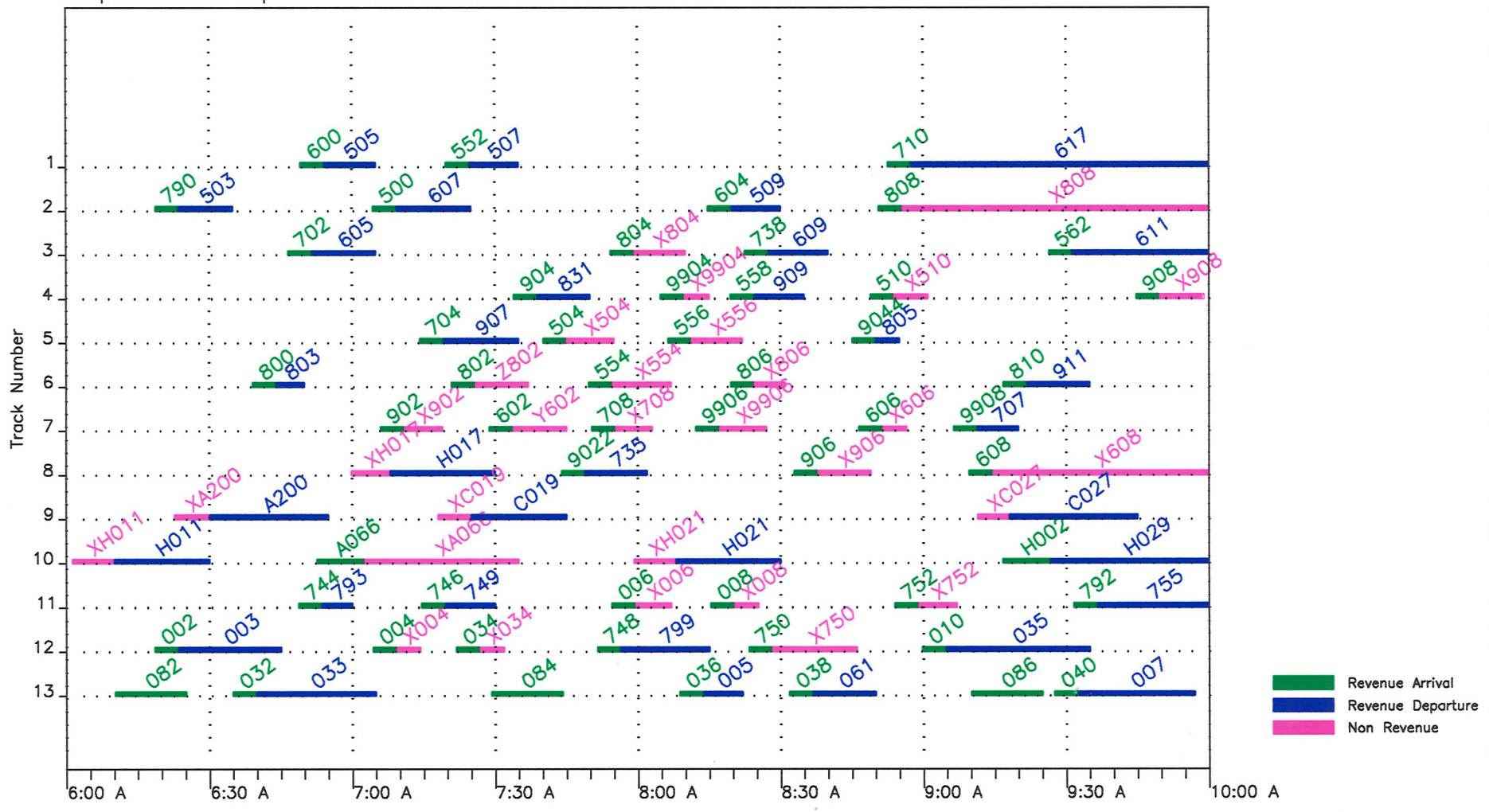
Column 1) If train is non-revenue, "DH" (Deadhead) is emplaced; 2) Train number or "X" prefix if equipment train; 3) Arrival Time; 4) Departure Time;
5) Track assignment; 6) Incoming train supplying equipment; 7 thru 19) Track occupancy, showing the Train Number of the incoming train;
20) Repeats the event time from Column 2 or 3; 21) The time interval since last movement - "0:00" indicates simultaneous movements;
22) "Storage Tracks Occupied" indicates the population of trains in a hypothetical layover yard or yards. Each time a Deadhead train is operated, the population is adjusted by one.

ATTACHMENT 3

SOUTH STATION TRACK OCCUPANCY CHARTS

South Station Operations Simulation – 2002

Graphic Station Report – SOUTH STATION



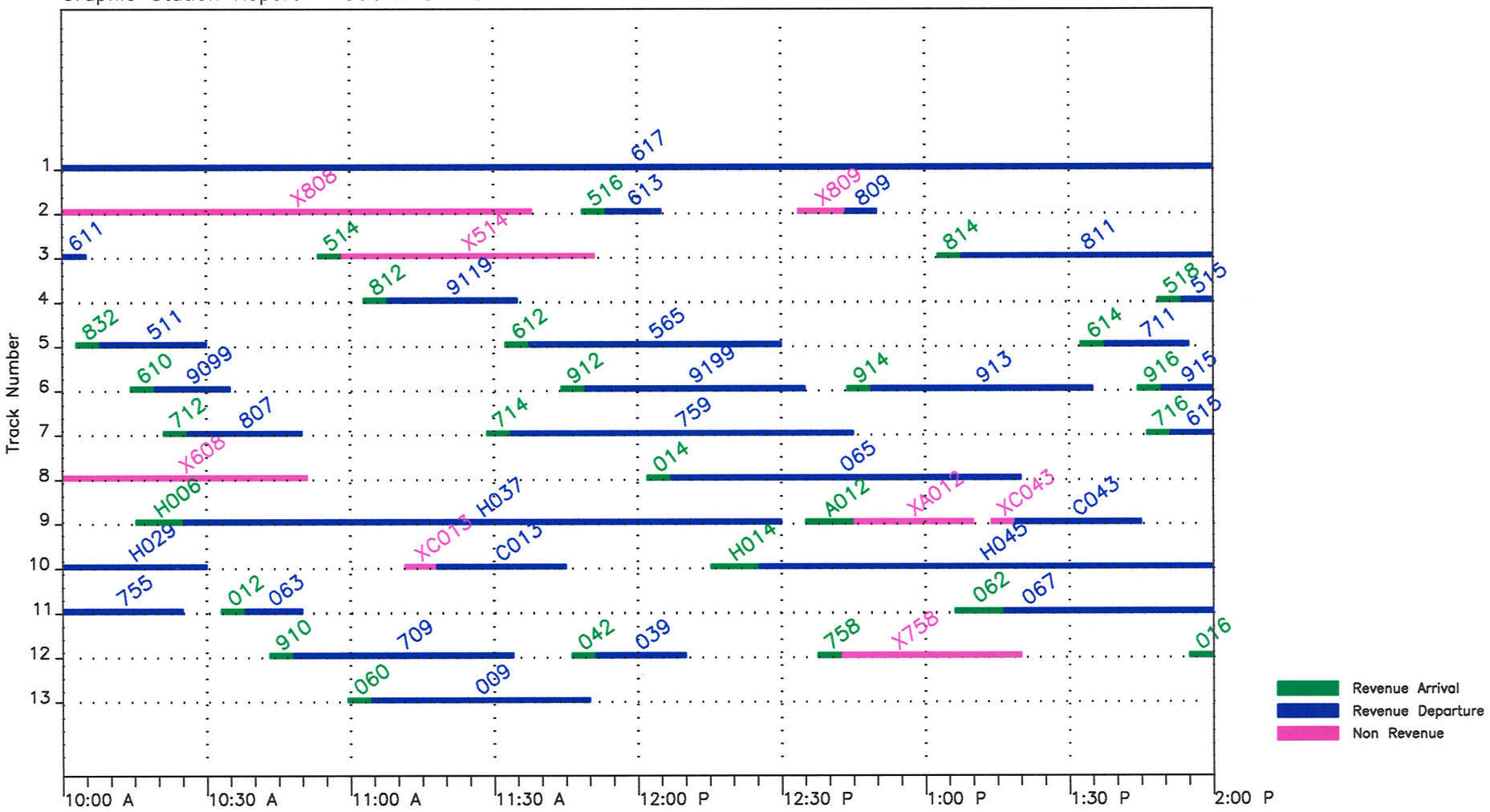
New Bedford/Fall River Operations Simulation South Station Track Occupancy 6:00AM to 10:00AM

SYSTRA CONSULTING, INC.
38 Chauncy Street Boston, Ma. 02111

Sheet	1 of 5
SCALE	NTS
DATE	April 7, 1999
DRAWN BY	JN
CHECKED BY	GN

South Station Operations Simulation – 2002

Graphic Station Report – SOUTH STATION



New Bedford/Fall River Operations Simulation South Station Track Occupancy 10:00AM to 2:00PM

SYSTRA CONSULTING, INC.
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Sheet 2 of 5

SCALE NTS

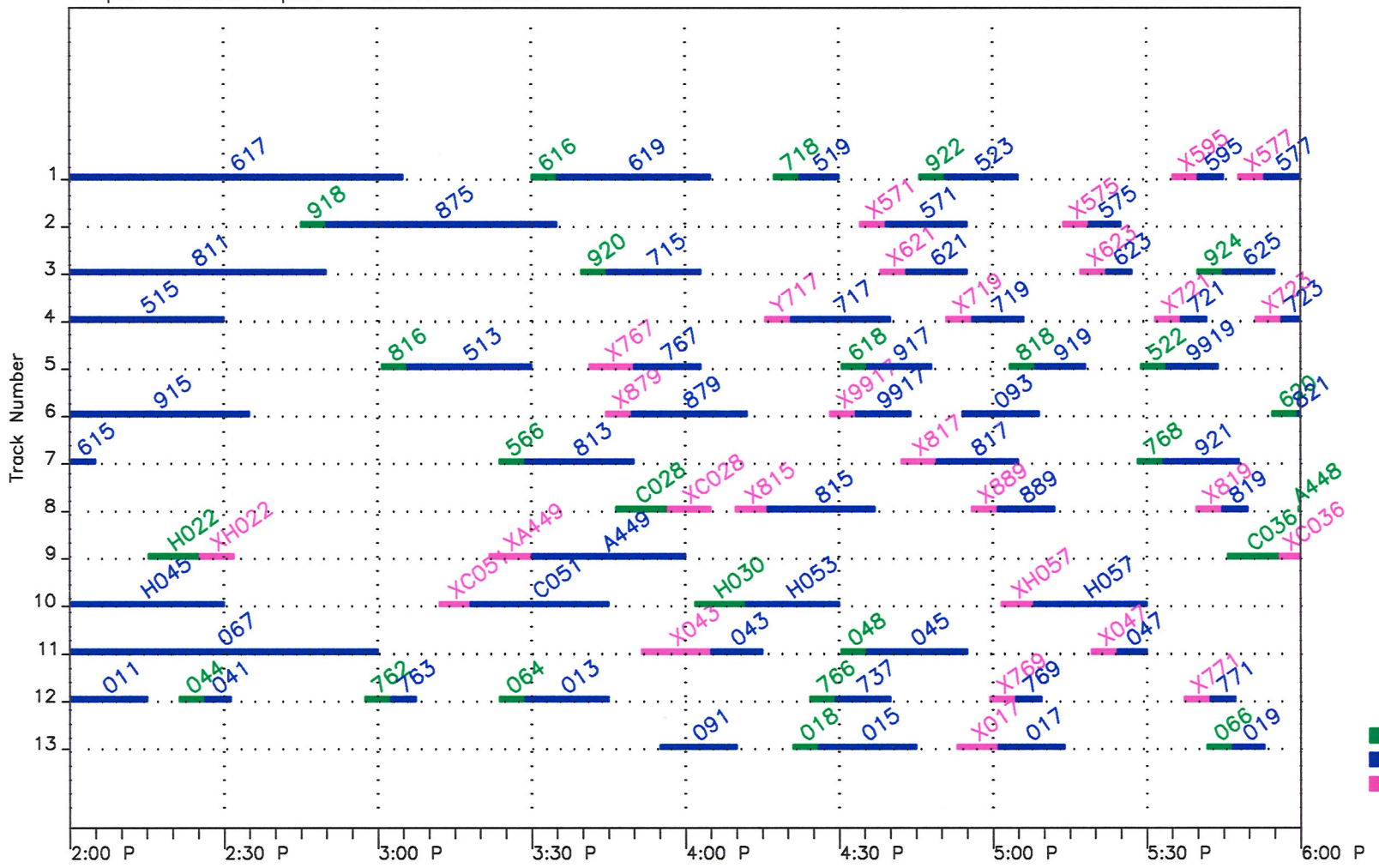
DATE April 7, 1999

DRAWN BY JN

CHECKED BY GN

South Station Operations Simulation – 2002

Graphic Station Report – SOUTH STATION



New Bedford/Fall River Operations Simulation South Station Track Occupancy 2:00PM to 6:00PM

SYSTRA CONSULTING, INC.
38 Chauncy Street Boston, Ma. 02111

Sheet 3 of 5

SCALE	NTS
DATE	April 7, 1999
DRAWN BY	JN
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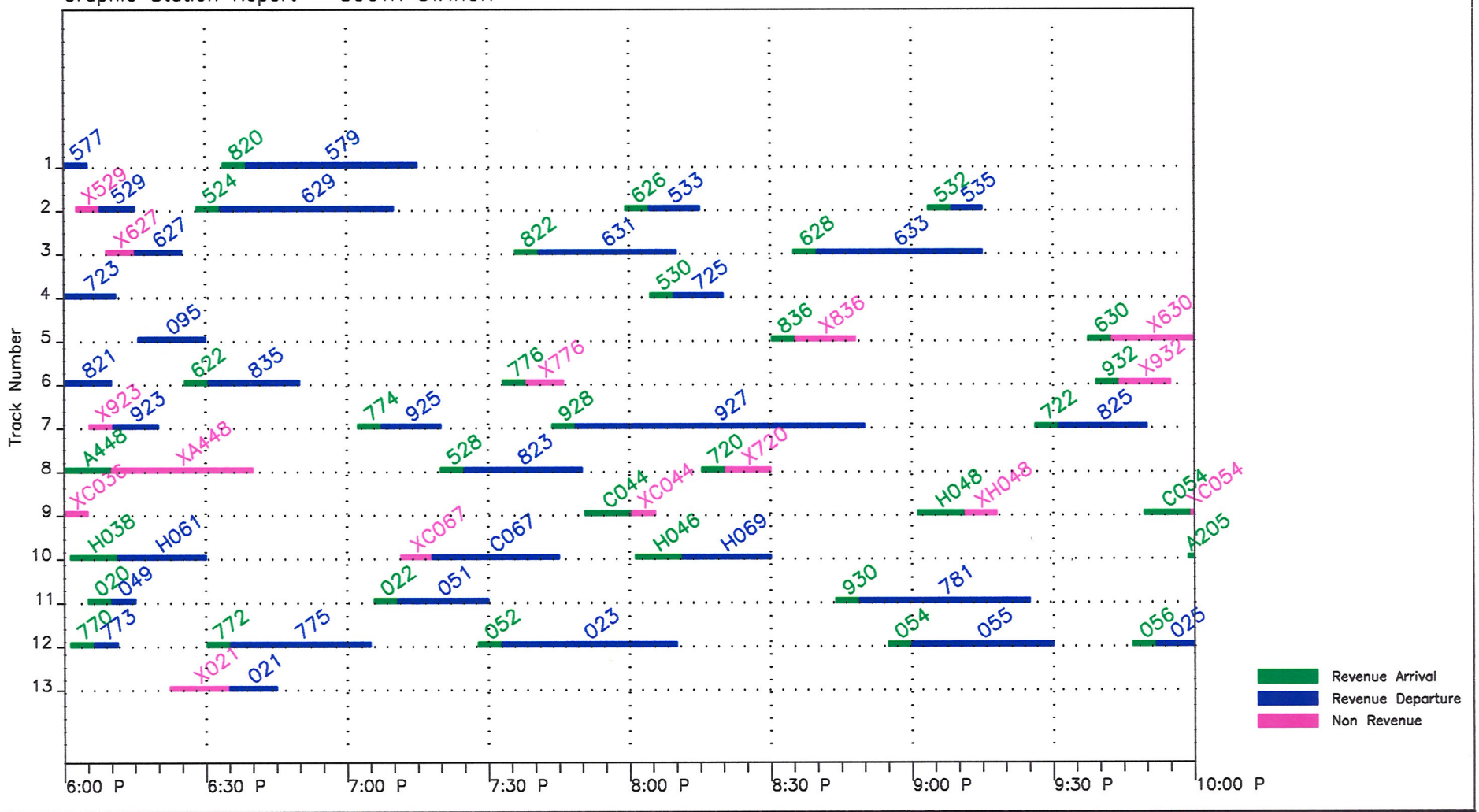
South Station Operations Simulation – 2002

Graphic Station Report – SOUTH STATION



New Bedford/Fall River Operations Simulation South Station Track Occupancy 6:00PM to 10:00PM

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Sheet 4 of 5

SCALE	NTS
DATE	April 7, 1999
DRAWN BY	JN
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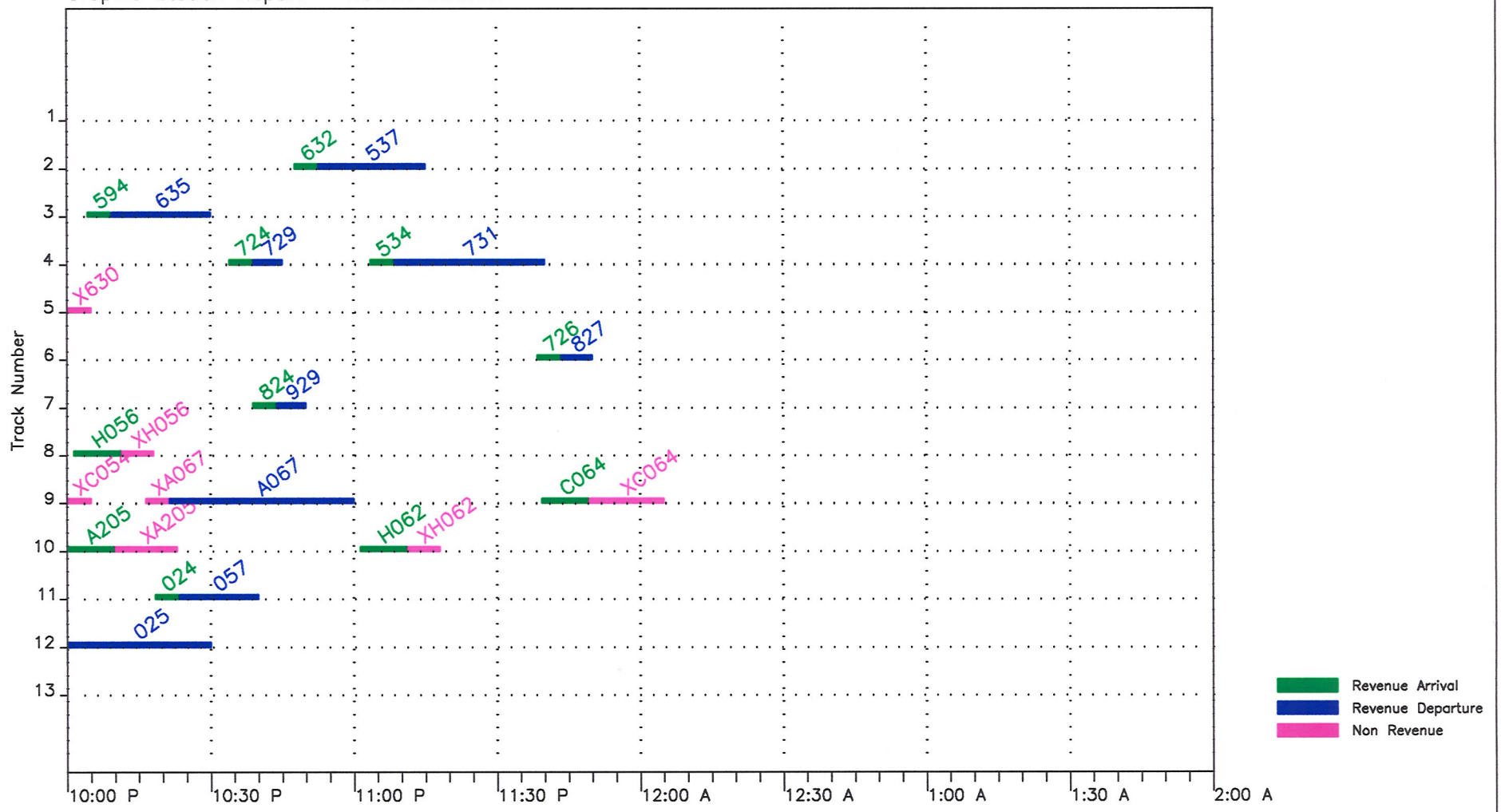
South Station Operations Simulation – 2002

Graphic Station Report – SOUTH STATION



New Bedford/Fall River Operations Simulation South Station Track Occupancy 10:00PM to 2:00AM

SYSTRA CONSULTING, INC.
38 Chauncy Street Boston, Ma. 02111

Sheet	5 of 5
SCALE	NTS
DATE	April 7, 1999
DRAWN BY	JN
CHECKED BY	GN