6. Freight Capacity Methodology and Results

6.1 Introduction

The development of the Midwest Regional Rail System (MWRRS) as a 3,000-mile, high-frequency passenger service throughout the Midwest raises important questions concerning track capacity for the states within the Midwest region and for the freight railroads, which own the tracks and right-of-way. The MWRRS uses freight rail lines that range from lightly used to very heavily used, high-volume lines. It is critical to the development of the project to understand the impact that additional passenger trains will have on existing and future railroad capacity.

Three lines, Chicago-Twin Cities, Toledo-Cleveland and St. Louis-Kansas City, are heavily used railroad corridors and the introduction of MWRRS passenger trains would place significant strain on existing infrastructure resources. The MWRRS capital costs include considerable investments to augment railroad capacity on these lines. Even on corridors with light or moderate traffic, passenger operations could still require additional improvements at critical locations.

The need for infrastructure improvements must be carefully assessed in order to develop a plan that will not compromise freight operations. At a minimum, freight railroads must be able to operate their trains as effectively as they could if the MWRRS did not exist. Beyond this, it is desirable to actually create benefits for freight railroads while developing the infrastructure necessary to support passenger services. Freight railroads must retain their ability to expand their own franchises for future traffic growth.

The Midwest Regional Rail Initiative (MWRRI) Steering Committee asked Transportation Economics & Management Systems, Inc. (TEMS) to carry out a comprehensive capacity analysis for the three most heavily used freight rail lines on the MWRRS. The goal of the analysis was to confirm the feasibility of planned MWRRS operations, and to verify the required capacity improvements and capital costs for these corridors.

The two primary objectives of the capacity analysis were to assess the feasibility of the proposed improvements :

- To measure the delay impact of running passenger trains along with freight trains on the corridors; and
- To estimate the operational and infrastructure improvements needed to achieve an acceptable level of freight and passenger service

The process for evaluating rail infrastructure investment needs involved:

- The development of an accurate and reliable operations and track infrastructure database. This required a cooperative partnership with the railroads that protected the confidentiality of proprietary business information. Freight tonnage data and growth rates were derived from state, federal and freight railroad data sources at the time the analysis was prepared. Updated line tonnage and traffic density information received later was used for development of track maintenance costs, but the line capacity results are reported here are based on the simulation results at the time the analysis was prepared.

- Ideal Day simulations represented peak day traffic, not average day traffic and used growth rates of 2 to 3 percent, well above the national average growth rate, in order to be conservative.
- Typical Day simulations, because they incorporate variability, used average day traffic but in some cases even higher growth rates that were furnished by the freight railroads.
- An assessment of the need for future freight railroad capacity. This included the future level of freight train operations, requirements for regular and programmed capital maintenance, and the ability to deal with extraordinary events such as “hot” and “cold” orders, emergency conditions due to train breakdowns (*e.g.*, due to hot boxes), and signal outages.
- A comprehensive assessment of the impact passenger train operations have on the freight railroad. This provided the input needed to support future discussions and negotiations between the freight railroad, passenger train operator and sponsoring states. The finished assessment should be able to be used to evaluate both freight and passenger rail concerns, and to provide objective input to the negotiating process, thus helping to consummate the business and commercial arrangements needed to implement the system.

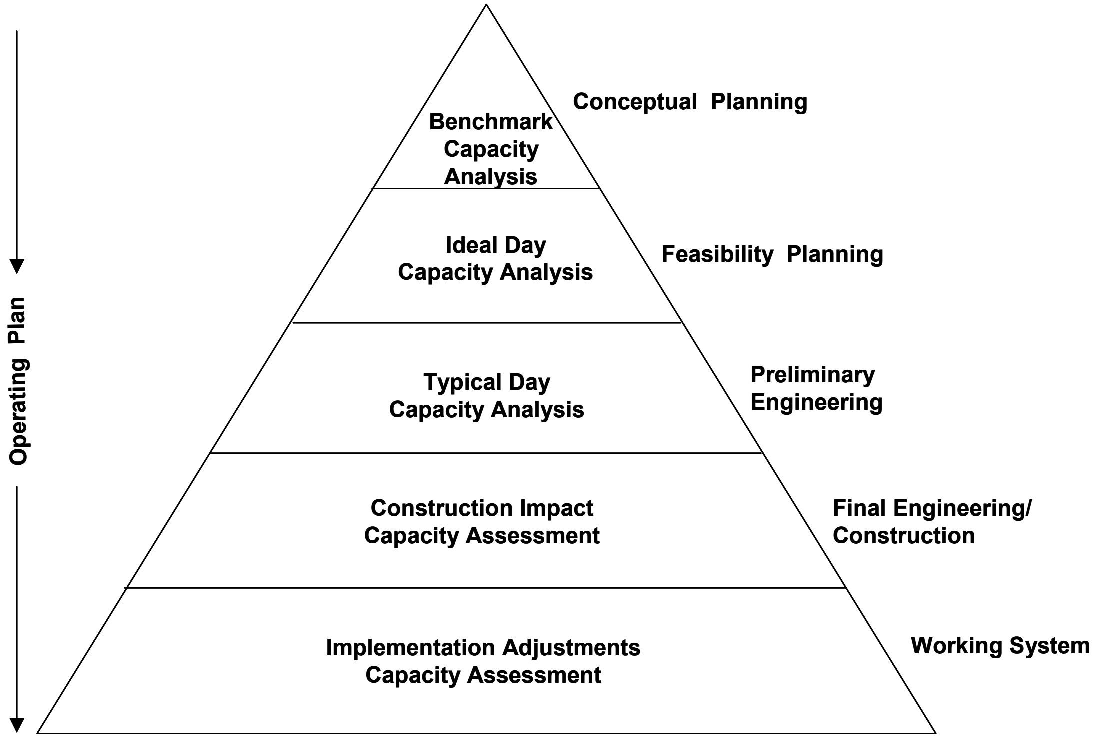
The analysis focused on mainline corridor capacity issues. For both the freight and passenger operations, separate off-line terminal issues will exist, such as the ability of the freight railroad to effectively manage its yard operations, or the ability of the passenger operator to service the passenger trains in the Chicago Union Station. These issues are outside the scope of the analysis except and unless they impact line capacity itself. For example the need to store freight trains on the mainline would be in scope, whereas yard switching operations were out of scope.

Future capacity analysis and engineering assessments will require more discussion to ensure railroad concurrence. Final design concepts and recommended capital plans will depend on detailed operations analysis, design coordination, and in-depth discussions with the freight railroads. As the MWRRS project moves beyond the feasibility phase, railroad involvement and coordination will become increasingly important.

6.1.1 Capacity Analysis Theory and Methodology

Capacity analysis provides an important interface between the engineering design of a railroad and the operations planning process. It is designed to ensure the effective integration of passenger and freight train operations with sufficient physical plant capacity. As the planning work for a project moves from conceptual to feasibility planning, and then into the preliminary and final engineering stages, the requirements for capacity analysis also change. At each step, capacity analysis becomes more detailed and reflects operating practice in an increasingly realistic manner. Exhibit 6-1 provides a diagram of this process.

Exhibit 6-1
Levels of Capacity Analysis Required in the Planning and Engineering Process



In conceptual planning, analysis consists of a manual review of potential conflicts and train "meets" and preliminary recommendations for additional infrastructure. This preliminary estimate requires further refinement as the project planning process continues. At the feasibility analysis level, an *Ideal Day Capacity Analysis* is performed. This type of analysis considers the meets and conflicts on the system and provides recommendations for additional infrastructure requirements based on train-meets, as well as providing estimates of the level of delay to freight operations that must be mitigated in order to ensure the continued effective operation of freight trains on the route.

This Ideal Day Analysis uses existing information about departure and arrival times and replicates travel times by using each train's acceleration and deceleration rates and stopping patterns, along with detailed information about the track infrastructure along the corridor, incorporating any recovery time necessary to accommodate unexpected delays. The Ideal Day Analysis is a "static" process in that it assumes that the conditions under which the trains operate are identical from day to day, producing identical travel times each day. Because there is no variation in travel times, these trains are assumed to operate under "ideal" conditions. The Ideal Day Analysis is particularly effective for inexpensively developing the preliminary estimates of the cost of implementation before more detailed cost estimates can be developed.

In the preliminary engineering phase, a *Typical Day Analysis* is required for heavily trafficked segments and for those approaching full capacity. The Typical Day Analysis produces a more detailed evaluation of train operations than the Ideal Day Analysis. It considers all forms of variation in train performance, particularly actual departure times. Instead of an "ideal" picture of train travel times, the Typical Day Analysis simulates a variation in departure times for trains in order to more realistically replicate day-to-day departure and arrival patterns. This dynamic element provides more "typical" travel time estimates for trains passing through a corridor and thus a more accurate measure of delay and conflict.

In the implementation phase, final operating plans are produced to show how the construction phasing and implementation process will affect operating plans. The Typical Day Analysis allows for the evaluation of the impact of the full range of operating, track and signaling issues. The Typical Day Analysis can be used during construction to measure constraints on freight operations and to plan the construction process in order to minimize the impact on freight service during the construction period. The analysis can also be used to show how the phasing of passenger train operations affects existing freight operations and what might be done to mitigate concerns and issues for the operating freight railroads.

Each of these levels of capacity planning can be completed using TEMS' software systems, including the Major Interlocking Signaling System Interactive Train Planner (*MISS-IT*©) program. The decision concerning which level of analysis is required depends on the quality of the estimate required, budget available and the level of traffic on any given route or corridor. As such, it may be appropriate to carry out a Typical Day Analysis for a feasibility study, if it is felt that the track is heavily used and that an Ideal Day Analysis could underestimate infrastructure needs.

6.1.2 MISS-IT© *Capacity Analysis Evaluation Framework*

The evaluation structure for any capacity analysis study is critical as it provides the framework for assessing mitigation measures and determining investment needs. The *MISS-IT*© Evaluation Framework establishes a *base case* and sets a standard against which to measure the impact of additional trains and the effectiveness of proposed infrastructure improvements. *MISS-IT*© consists of a series of evaluations to ensure that existing railroad performance standards are maintained following the introduction or expansion of passenger service. This analysis is particularly important when freight operations are nearing full capacity, in order to target infrastructure improvements to enable successful coexistence of passenger and freight operations, as well as to provide expandability for growth.

The *MISS-IT*© capacity analysis consists of a series of cases:

Case I – Base Case: This case estimates the corridor's freight and passenger traffic so that the existing delay for freight trains can be measured. These estimates are part of the basic dispatch model calibration of the capacity analysis system and are used to judge and adjust the performance of the model.

Case II – Do Nothing: This case measures the delay for freight traffic in selected forecast years (*e.g.*, 2010 and 2020) without the addition of new MWRRS passenger trains. It is this level of freight and passenger traffic delay that sets the standard for train delay, which must be maintained for the freight railroad to be mitigated.

Case III – Do Something: MWRRS trains are introduced, and the increased train delay associated with freight and passenger trains is measured. In heavily congested corridors, the introduction of MWRRS trains has a significant impact on freight train operations, and thus requires mitigation.

Cases IV– X – Mitigation: In these cases, various mitigation strategies (infrastructure, signaling, and operations) are tested for their ability to alleviate the increase in freight and passenger train delay measured in Case III, and to reduce it to the level previously identified in Case II. The number of mitigation cases developed depends on the number of infrastructure and operating strategies that can be devised to reduce freight and passenger delays. If a large number of infrastructure strategies exist, multiple cases must be assessed.

In carrying out a *MISS-IT©* capacity analysis, the average travel times, standard error, and associated train delay will be calculated for each train and reported. The results can be given by individual train, type of train (*e.g.*, intermodal freight trains) or category of train (passenger intercity, passenger commuter). Exhibit 6-2 is a matrix that shows how trains are disaggregated by type and how the delay for each train type (*e.g.*, bulk, intermodal, commuter, passenger, local, and freight) changes (increases) from the Base Case, to the Do Nothing and Do Something cases. In developing the Mitigation Analysis, results are typically classified by train priority group. High-priority trains include passenger and intermodal trains, while bulk and local freight trains are typically low-priority trains.

Exhibit 6-2
Mitigation Analysis Evaluation Framework

	Case I Base Case	Case II Do Nothing	Case III Do Something	Cases IV-X Mitigation	Result
Priority Group	**Existing Freight Delay**	**Forecasted Freight 2010 Delay**	**Additional Delay Caused by MWRRS Trains**	**Resolved by Operations Infrastructure Signaling**	**Net Forecasted Delay**
1					
2					
3					
4					
5					
6					

Mitigation by train group is achieved in Cases IV through X using a variety of mitigating strategies that increase and improve capacity. The results of the remaining net delay after mitigation will be shown in the last column of the above Exhibit. Ideally, mitigation is achieved when the net delay in the last column is the same or less than the delay in the Do Nothing case, Case II. With this result, a railroad can be said to be "mitigated" because its trains will experience only the delay that would have occurred had the MWRRS trains not been added.

One point worth noting is that a freight railroad may be less concerned about delay in certain types of trains, such as locals and bulks, and may be prepared during the mitigation process to trade off additional improvements for high-priority trains (*e.g.,* intermodal trains), against additional delays for local or bulk trains. The process therefore depends on the objectives and needs of the freight railroad and its preference for different types of mitigation measures under different circumstances.

Mitigation

The mitigation process considers:

- Infrastructure analysis mitigation – This includes the addition of extra crossovers, track (double, triple, quadruple), expansion of station and yard capacities, track speed improvements, elimination of crossings and scheduling drawbridge openings.
- Signaling analysis mitigation – This includes the upgrading of signaling systems to include Automatic Block Signaling (ABS), Centralized Train Control (CTC) or Positive Train Control (PTC), depending on the speed of trains proposed.
- Operations analysis mitigation – This includes the development of an integrated passenger and freight operating plan through the resolution of conflicting start and end times, etc., as well as assessments of train stops, yards, diamonds, drawbridges, and maintenance plans.

In practice, this process is disaggregated by train type, *i.e.*, freight intermodal, bulk, passenger intercity, commuter, or by specific train, so that the direct effect of mitigation can be measured on an individual train and train-type basis. This may lead to additional mitigation needs if some trains have unacceptable delay times within overall (average) satisfactory results.

6.1.3 Capacity Analysis Planning Process

The *MISS-IT*© capacity analysis planning process begins with the development of two databases that are initial inputs of the evaluation of capacity for a rail corridor. These two databases are the corridor track infrastructure for which the capacity is being measured, and the train schedule stringlines that reflect the train operations in the corridor.

TEMS develops the corridor track infrastructure database using its *TRACKMAN*© program. The *TRACKMAN*© program is designed to build an infrastructure inventory database and provide graphic review capabilities for a given railroad route. Using railroad condensed profiles, engineering information, railroad track inspection and survey data, TEMS builds a milepost-by-milepost inventory database within *TRACKMAN*© that contains the physical infrastructure of the route including gradients, sidings, crossovers, curves, bridges, tunnels, yards, and signaling systems. This data is displayed along with the maximum permissible train speed to provide the engineer with a clear definition of the track conditions and capability.

The *TRACKMAN©* database shows which track sections will limit train performance, and the program's upgrade facilities make it possible to develop a list of track improvements that will raise maximum permissible speeds and train capacity on a given route. Using either specific engineering cost data or default unit costs, the proposed list of improvements can be costed and a cost-per-minute-saved priority ranking can be generated for each of the potential track improvements. In this way, *TRACKMAN©* provides a mechanism for identifying the base track condition as well as possible strategies for alternative capacity and speed options. These strategies can then be tested in the *MISS-IT©* capacity analysis evaluation.

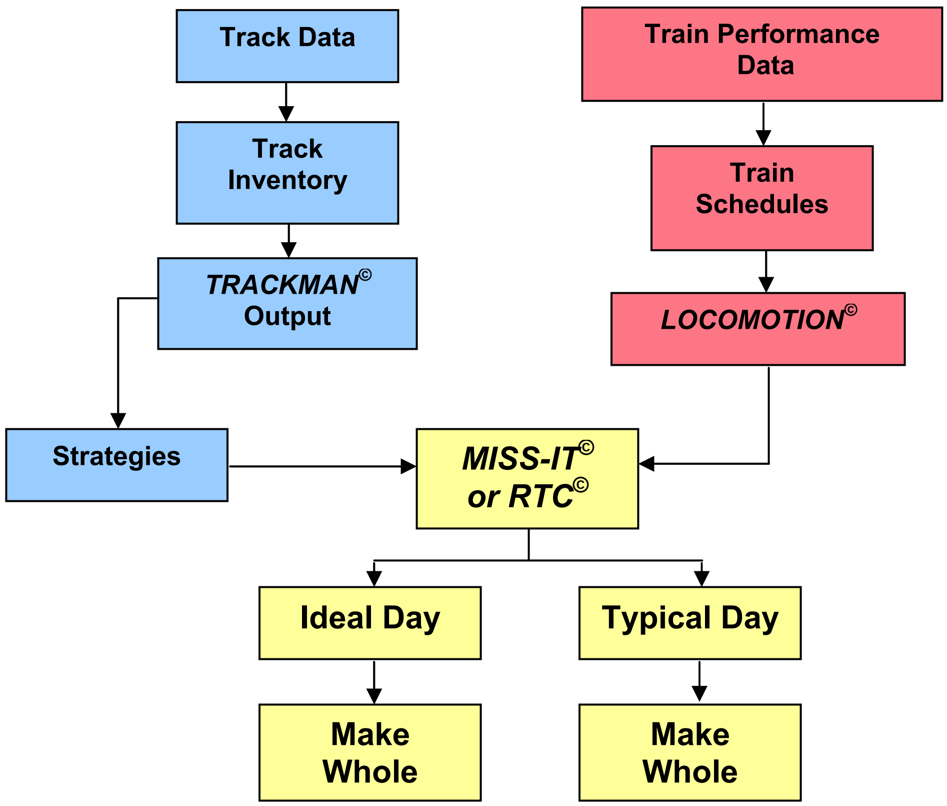
The second key input is the *LOCOMOTION©* program, which estimates train schedules for different passenger and freight train technologies using train performance, engineering track geometry, and train control input data. *LOCOMOTION©* also provides both tabular and graphic output of train performance milepost-by-milepost, based on the characteristics of both the train technology and the track. The system identifies train interaction, provides stringline output for new and existing freight and passenger services and identifies the location of train "meets." The *LOCOMOTION©* program also provides a full understanding of train schedules for any base or forecast year by including the growth of freight or passenger trains over time.

The outputs of the *TRACKMAN©* and *LOCOMOTION©* software systems are combined in the *MISS-IT©* program to perform capacity analysis and to assess the risks of train delay for any given route. In using the *MISS-IT©* program, a decision can be made either to carry out Ideal Day or Typical Day Analysis. As noted above, the Ideal Day Analysis is usually suitable for feasibility studies, while a Typical Day Analysis is required for preliminary and final engineering on heavily used rail routes. A Typical Day Analysis is sometimes needed in a feasibility study, if the corridor has heavy freight traffic and an Ideal Day Analysis would underestimate infrastructure needs.

In both cases, a Mitigation Analysis is used to evaluate the appropriate track, signaling and operating improvements necessary to mitigate delays to acceptable levels and to ensure that the freight railroad is mitigated. Exhibit 6-3 provides a diagram of the capacity analysis process using the planning methodology that was approved by the MWRRS Steering Committee.

It should be noted that the Mitigation Analysis framework is designed to identify the minimum infrastructure requirement that is needed to make a freight railroad "whole" for the cost of added freight train delays. Practically, since capacity comes in increments or step functions, it is seldom possible to satisfy the mitigation criteria exactly. To reduce freight train delays below their target level, it is usually necessary to "overshoot" the mark, so the resulting investment strategy actually does produce a net operating benefit to the freight railroad.

Exhibit 6-3
Capacity Analysis Planning Process



6.1.4 Delay Measurement

A key issue in measuring delay is its cause. Only with a full understanding of the cause of delay can effective corrective action be taken. To meet this need, a train delay management system has been developed in the *MISS-IT*© model. This feature provides comprehensive documentation of the causes of delay.

The *MISS-IT*© Action Log Report reveals the most common types of delay and how they might be mitigated. Specific action log outputs include:

- Tailgating delays
- Meet-point delays
- Signal delays (i.e., time train spends waiting for signal to change)
- Interlocking delays
- Train performance delays (acceleration/deceleration)

6.1.5 Summary

TEMS' *MISS-IT*© capacity analysis system provides a powerful approach to evaluating capacity needs when passenger train operations are imposed on existing freight operations. The system provides a mechanism for assessing all the critical issues of capacity including:

- The level of delay that exists in an existing freight operation
- The effect of increased freight train operations on train delay
- The levels of delay imposed by the introduction of new passenger train service
- The character and level of delay in train operations and how it can be most effectively reduced or managed to maximize train capacity
- The impact of different operating, engineering and signaling mitigation measures. This can be measured at the train type, group or specific train level and ensures effective mitigation of new passenger operations.

6.2 Inputs to the Capacity Analysis Process

The capacity analysis process requires the development of a definitive and detailed data set for infrastructure and train operations, and includes track infrastructure and train data specific to each specific corridor to be analyzed. These data are typically assembled by TEMS with input, assistance and oversight by railroads, state departments of transportation (DOTs) and the study engineers. For both the Ideal Day and Typical Day analyses, the databases will contain the following information on track infrastructure and train data.

6.2.1 Track Infrastructure

A key database for the capacity analysis is the available track infrastructure that trains can use in moving along the corridor. The TEMS *TRACKMAN*© program records on a milepost basis the number and location of:

- Tracks
- Curves
- Super elevations
- Sidings
- Civil speed restrictions
- Stations
- Gradients
- Crossovers
- Bridges
- Tunnels
- Turnouts
- Yards
- Junctions
- Interlockings
- Towers
- Signals
- Interconnections
- Subdivision names and lengths
- Federal Railroad Administration (FRA) track classes
- Diamonds
- Road crossings

In addition to the physical track data, the *TRACKMAN*© data set includes information on types of signal systems and signal placements.

6.2.2 Train Data

Data on existing and future freight and passenger operations for each route must be gathered from the freight and passenger carriers involved, as well as from the MWRRI study team. The train database consists of four data sets:

- Train schedules
- Train types
- Train priority
- Train departure and arrival statistics

Train Schedules

The number of trains, their scheduled departure and arrival times, and their stopping patterns form the basis of traffic analysis on the corridor. Information on the locations and duration of scheduled stops are gathered from the freight railroads, Amtrak and commuter operators, which was then entered into TEMS' *LOCOMOTION*© model.

Train Types

Each passenger and freight train operates with a different performance profile that reflects the train's performance capabilities. These include acceleration and deceleration curves, as well as tilt capability and allowable cant deficiency. The model uses information on how quickly trains can reach maximum attainable speed and the distances and speeds throughout the acceleration. Braking information is used to estimate train deceleration and thus stopping distance.

Train Priority

In order to accurately resolve conflicts between trains, the relative importance of each train, as ranked by the railroad, is input to TEMS' *MISS-IT*© model. In *MISS-IT*©, all trains are prioritized individually, as well as by technology grouping.

Departure and Arrival Statistics

The Typical Day Analysis includes not only estimated departure time but also potential variations in that time. Actual departure and arrival times for freight trains often deviate from scheduled times. In order to model this variation, a distribution of the estimated variance in departure time is input to the model to indicate whether individual trains will depart or arrive early or late and to what extent.

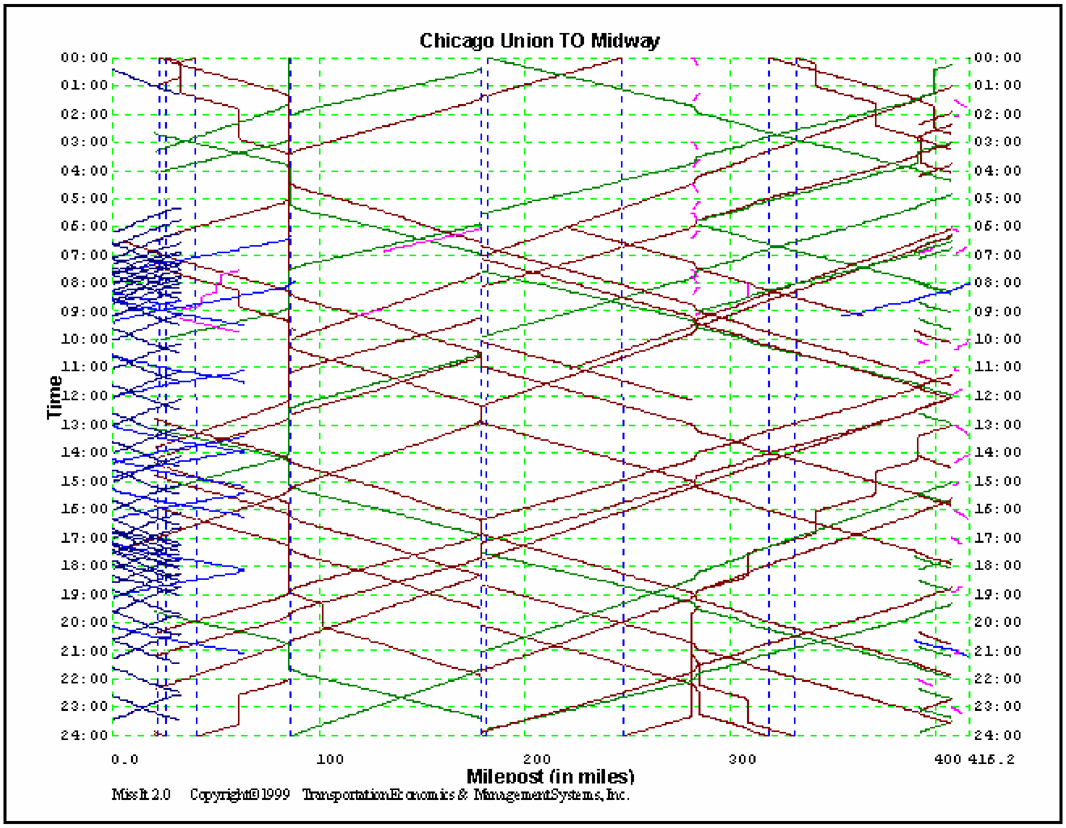
Traffic Growth Rates

Capacity analysis requires a full understanding of both freight and passenger traffic growth so that the impact of increasing traffic over time can be estimated. Any long-term traffic forecasts (or range of forecasts) developed by the railroads can be adopted and tested in the analysis. Annual growth rates are developed for each type of train and forecasts are made for the study years. A set of forecast timetables will be constructed for each train type.

Pre-Dispatch Stringlines

A base travel time for each train is produced. Each train's base travel time is the fastest achievable time given its speed capabilities, the track infrastructure but excluding any delays from meets with other trains along the track. Exhibit 6-4 presents the resulting 'ideal' stringline diagram as a visual representation of the travel times and illustrates the path of the train. It also shows the locations or meets where two trains could potentially converge or conflict.

Exhibit 6-4
Corridor Stringlines for Future Freight and Passenger Traffic Levels



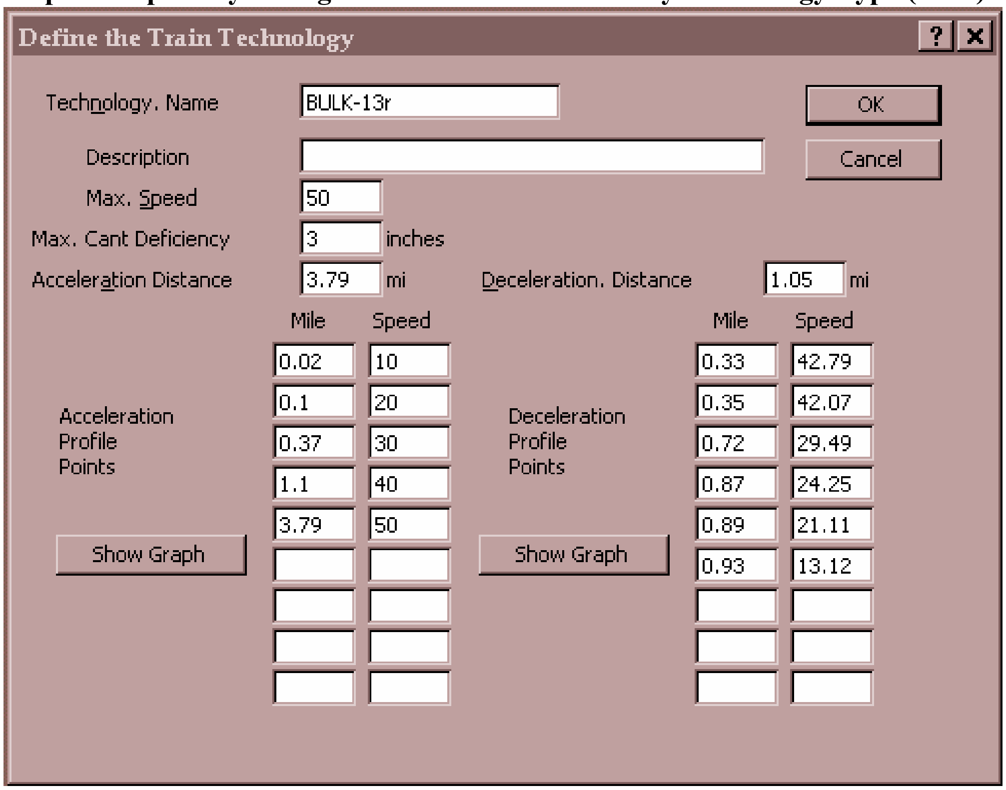
6.3 *Base Case Calibration*

The first step in the analysis of any rail corridor is the creation of the database for the base year, which is generated by TEMS and reviewed, as appropriate, by the freight railroads, Amtrak and the study engineers.

The second step in the analysis is to document the characteristics of the trains traveling along the corridor. In all cases, the name, scheduled departure time, ranking, probability statistics, and speed capability of each train must be provided by the railroads.

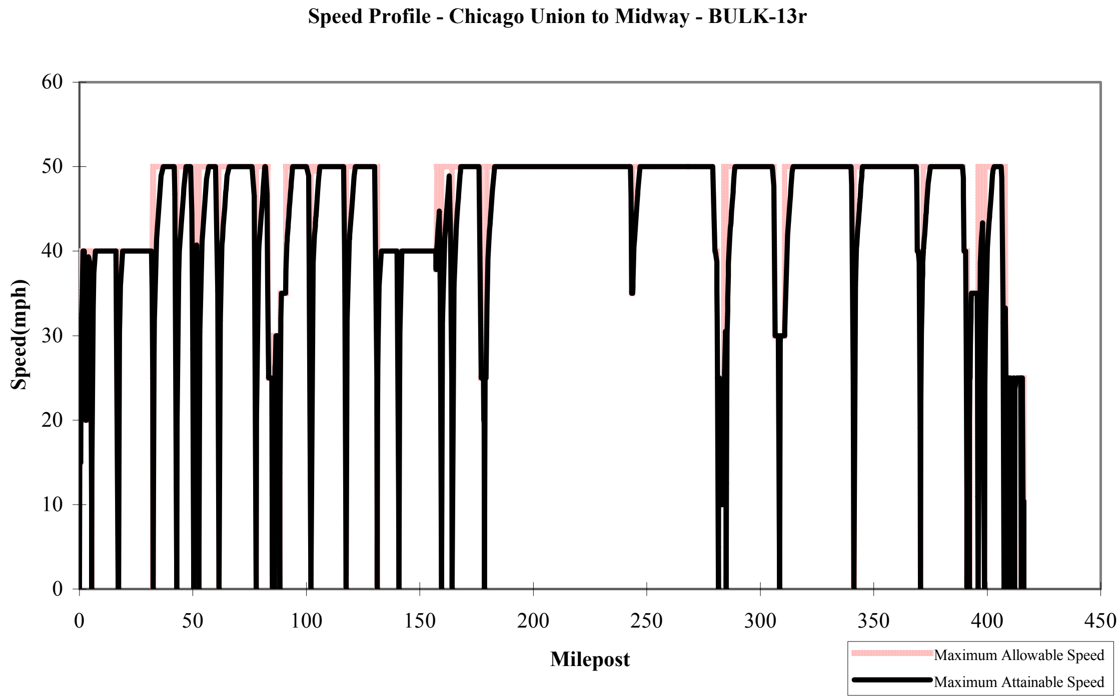
The speed capability of each train type is determined by its horsepower-to-tonnage ratio. As this ratio changes, so does the speed capability of the train, *i.e.*, train performance changes when pulling 100 tons versus 1,000 tons. To effectively describe the speed capabilities of each train, different speed capability profiles are constructed for both bulk and intermodal freight trains. Exhibit 6-5 is an example of the *LOCOMOTION*© program dialog box where the speed capability information is stored.

Exhibit 6-5
Speed Capability Dialog Box in *LOCOMOTION*© by Technology Type (Bulk)



After all of the individual train information and the track infrastructure information are collected, *LOCOMOTION*© model runs are performed to establish the base travel time. The travel times computed by *LOCOMOTION*© assume that there is no congestion along the corridor and no need for any additional time to accommodate unexpected delays. The maximum attainable speed, given the capability of the train and the speed restrictions, is illustrated in the train's speed profile (Exhibit 6-6). This ideal travel time and the train's scheduled departure time are used to replicate an operating schedule without any delays. Operating schedules are then used to calculate each train's stringline. These stringlines are imported into the *MISS-IT*© system, where train delays are calculated, and either Ideal Day or Typical Day Analysis is conducted.

Exhibit 6-6
Speed Profile Typical Bulk Train



6.4 *Introduction: Ideal Day Analysis*

The Ideal Day Analysis uses existing information to replicate a train's movement along a particular corridor. Travel times are modeled using detailed information about track infrastructure, train acceleration and deceleration rates, stopping patterns and built-in recovery time to accommodate unexpected delays. The Ideal Day is a valuable starting point in the planning process, even though it does not always reflect actual practice.

In an ideal situation, all trains will perform as planned. They will:

- Depart at their scheduled times
- Travel at pre-determined speeds
- Adhere to required restrictions
- Make required stops
- Be subject to expected delays
- Arrive at their destinations at scheduled times

A knowledgeable rail operator will not assume that all trains can travel without delay through a corridor; but rather will build sufficient slack time into the schedules of those trains that can accept the extra travel time without severely disrupting the rest of the system. Using this approach, what we call the Ideal Day is not *idealistic*, but is a fairly realistic assessment of train operations where traffic levels are light to moderate. As a result, the operating plan will reasonably balance a complex set of competing requirements for limited available resources, *e.g.*, track infrastructure and train technology. This balance is achieved in such a manner that maximum schedule stability, with acceptable levels of delay and variation, is achieved. For modest deviation in scheduled departures (5 to 10 minutes), the integrity of the overall schedule should remain largely intact.

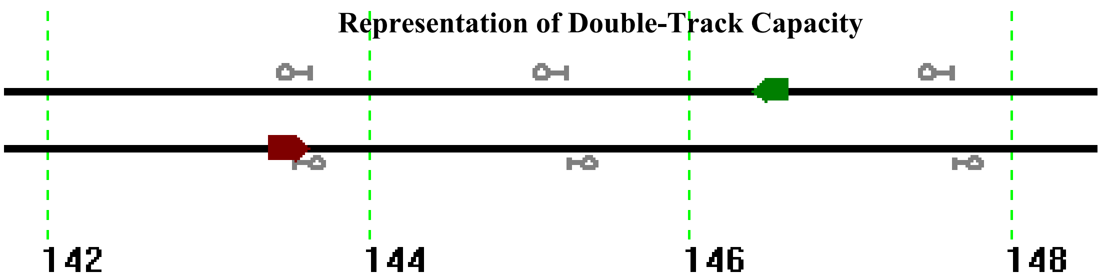
The extent to which such a plan can be constructed depends on how reliably trains can be scheduled. For passenger trains, published timetables provide sufficient guarantee that the scheduled times are realistic. Bulk trains, on the other hand, are not as time sensitive as are passenger trains. Thus, a scheduled departure time may be replaced with a scheduled departure *window*. For corridors running at or near capacity, due to the inherent unpredictability of unscheduled or semi-scheduled trains, planning becomes much more complex, and more detailed Typical Day Analysis is needed.

6.4.1 Calculating Train Travel Time and Delay

For the purposes of the Ideal Day Analysis, regardless of whether or not a train has a published departure time, a specific (most likely) departure time is assigned to each train. These departure times serve as starting points for the construction of a complete operating diagram. Three types of delay may be added to the stringline so that a more realistic replication can be achieved. These are: scheduled stops, slack and recovery time and unplanned delays due to conflict resolution.

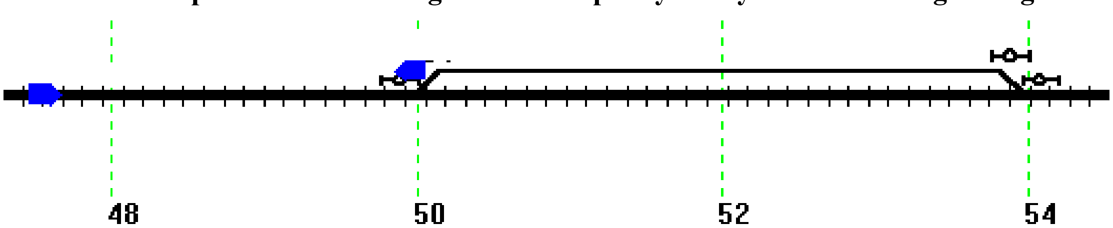
Trains that meet with sufficient infrastructure can pass with no delay to either train (e.g., two trains meeting on double track), as shown in Exhibit 6-7.

Exhibit 6-7
Representation of Double-Track Capacity



However, when there is insufficient infrastructure to accommodate all traffic in both directions, one or more trains must incur some delay to allow another train to pass, as shown in Exhibit 6-8.

Exhibit 6-8
Representation of Single-Track Capacity Analysis with Passing Sidings



Thus, the overall travel time for a train is dependent on the number of delays it encounters on the path to its destination. Whenever a train meets another train, for which there is insufficient infrastructure to allow both trains to pass freely, the lower-priority train is subject to a delay. The sum total of all delays determines the total travel time, according to the following formula.

By measuring each of the components of delay for a given set of trains, train travel time and level of delay can be estimated.

Time Penalties

Once the travel times for all of the trains operating along a given corridor are reproduced in the model, a review of the track infrastructure is conducted to determine if there is sufficient track capacity to accommodate the traffic. If the review determines that sufficient capacity does not exist, time penalties are assessed to trains with lower-priority ranking. Time penalties are based on the actions that dispatchers would likely take to avoid conflicts with other trains. If, for example, a passenger and freight train meet on a segment of single-track, and there is a siding nearby, the model assesses a time penalty on the freight train to approximate the length of time needed for the freight train to pull into the siding and wait for the passenger train to pass, thus avoiding the conflict. The time penalty in the Ideal Day Analysis is a technology-based assessment that depends upon the train type (local, bulk, or intermodal freight; commuter or intercity passenger), and is used in all cases where the review has determined that insufficient track capacity exists to accommodate trains as they meet each other along the corridor.

6.4.2 Ideal Day Outputs

In the Ideal Day Analysis, a travel profile for each train is produced. This profile is based on the fastest achievable trip time, given its technology, speed capabilities, and the constraints unique to the particular corridor. Some additional time is built into each train's base travel time to accommodate unexpected delays so that the train can still arrive at its destination by its scheduled arrival time.

6.4.3 Conclusion

Using this Ideal Day Analysis data, a feasibility estimate of train delay by train, train group and train type can be derived. The output is then used in the Mitigation Analysis to identify the infrastructure, signaling and operations changes needed to effect capacity mitigation.

6.5 Introduction: Typical Day Analysis

As previously noted, the Typical Day Analysis is designed to provide a more comprehensive and detailed evaluation of train operations than the Ideal Day Analysis. Further realism is added to the operations analysis, and the level of complexity in the analytical calculations is raised by an order of magnitude. In the *Ideal Day Analysis*, train departure times are assumed fixed. The Typical Day Analysis allows these times to vary in order to replicate realistic day-to-day departure patterns. To simulate this variation in departure times, the analysis uses a Monte Carlo statistical technique. This technique uses random numbers and probability statistics to estimate multiple randomized dispatch variations that are in turn applied to the scheduled departure times. As departure times are varied, a dynamic element is introduced into the analysis that was not available in the Ideal Day Analysis. Instead of a "snapshot" of a single point in time as shown on the Ideal Day, the Typical Day Analysis is able to take multiple snapshots and to capture how traffic in a varied, real-world environment affects train times and thus provides more "typical" estimates and more accurate measurement of delay.

6.5.1 Dispatch Logic

The Typical Day Analysis provides a detailed analysis of train delay, focused on the individual train and its performance across the route. The analysis, which uses the TEMS *MISS-IT*© capacity analysis system, is a dynamic analysis of train movements and the potential variation in those movements. It uses calibrated, railroad-specific, dispatch logic to model train performance. The analysis begins with the development of "perfect" stringline diagrams that reflect the geometry and engineering of a route and omit limitations due to train-meets and inadequate track capacity. The process then simulates the dispatching of trains according to the selected dispatch logic and calculates new stringlines that include delay times associated with train-meets, signal delays, tailgating, scheduled stops, and a variety of factors that affect dispatch decisions.

The train-meet dispatch logic uses train priority data to determine which trains proceed at each meet, which trains wait, and where they wait, and how much trains are delayed. This priority-based dispatching and conflict resolution process is an event-based logic that determines the interaction of trains as they move down the track. The dispatch logic typically resolves 99.9 percent of all conflicts. When the dispatch model cannot resolve conflicts, a manual override is available to finalize the dispatch decisions.

The advantage of event-based dispatch logic is that it measures the train delays at every train-meet throughout each schedule. Each decision is recorded and can be reviewed. If for any reason a decision needs to be changed, *e.g.*, because of a need for an "illogical" decision such as dispatching a local train ahead of an intermodal train, this can also be done using the manual override.

In carrying out the Typical Day Analysis, a risk analysis can be conducted to determine how train delay will vary as train departure times change. The analysis of risk is performed using a Monte Carlo simulation of train departure times. This model provides a dynamic assessment of train movements and changes in train delay based on empirical factors such as crew work practice, train priority, and special events, etc. The output of the analysis is not only the train delay for the entire train trip, as well as delays at any particular point in the journey, but also the distribution of delay (standard deviation) for the trip on any typical day.

To ensure that the Typical Day Analysis effectively models a "peak" traffic day for the railroad and meets the capacity needs of both freight and passenger traffic on a peak day, the analysis is iterated through a 2- to 30-day cycle. This process ensures that overnight trains are properly modeled and are not excluded from the analysis, which could give a false impression of capacity needs and that weekly and monthly peaks are properly represented. The model runs until all traffic has completed *at least* one trip on a fully loaded corridor.

6.5.2 *Typical Day Analysis Issues*

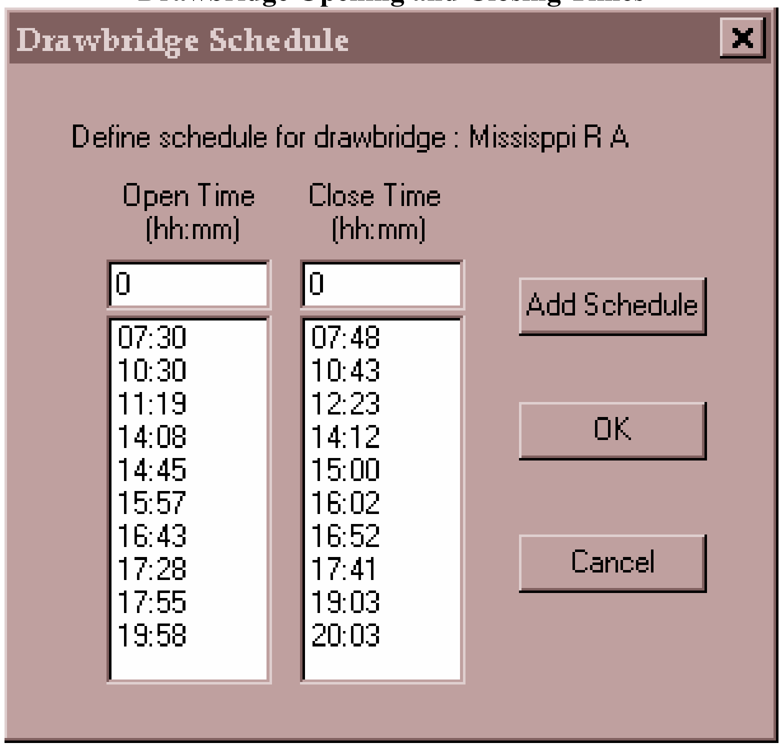
In addition to allowing departure times to vary from their set scheduled times the Typical Day Analysis provides better estimates of train travel times than the Ideal Day Analysis. The reason estimates are improved is that the *MISS-IT*© model uses an event-based conflict resolution process to estimate travel times and the resulting delays. The estimates reflect the speeds of the trains and how quickly they can progress to a point where the conflict can be resolved. In effect, as the model simulates the trains traveling through the system, it also identifies trains traveling in the opposite direction. If the train traveling in the opposite direction is on the same line, the model recognizes the conflict and determines the best way to handle it. If the train is of lower rank, the model will select a place to sidetrack the train to let the other train pass and estimate the wait-time needed for the other train to pass. Since these estimates are determined on a case-by-case basis and are reflective of the attainable train speed and the distance traveled to avoid the conflict, these estimates are more precise than the feasibility delay estimates used in the Ideal Day Analysis.

In order to conduct the Typical Day Analysis, a variety of information is collected from the railroad. The information required includes:

- Scheduled departure times for all trains operating within the corridor
- Statistical information on the probability and degree of variation in the departure and arrival times
- Information on the capabilities of various types of trains
- Detailed information on the track infrastructure
- Expected infrastructure upgrades

Another important component of the Typical Day Analysis is the development and integration of schedules for the diamond crossings and drawbridge openings. Working with the railroads, a database of diamond crossing and drawbridge occupancy and availability is generated for the Typical Day Analysis. CP Rail furnished a dataset of drawbridge opening and closing times, shown in Exhibit 6-9, based on observation of current operations of the drawbridges. The model determines when a train can and cannot pass through a diamond crossing and when a train would be expected to be traveling through the diamond from the crossing corridor. In the same manner, the model identifies scheduled drawbridge openings and when trains can occupy that space. In each case, the Typical Day Analysis considers the effect of the track availability and verifies that the trains operated within the bounds of these schedules.

Exhibit 6-9
Drawbridge Opening and Closing Times



6.5.3 Model Calibration

Comparing known travel times for "scheduled" trains with the post dispatch stringlines generated by the model validates the performance of the dispatch model. This can be completed for Metra commuter trains, Amtrak long distance trains and intermodal and bulk trains. The results of the comparison are used to adjust the dispatch logic and ensure effective representation of trains. In adjusting the dispatch logic, the results of any particular movement can be followed using the Action Log. This shows at what locations interactions occur, what happens to each train in the interaction, which train is delayed, and by how much it is delayed. The Action Log allows the totality of movements of each train to be identified as it moves along its stringline from origin to destination. Exhibit 6-10 shows comparative data for each train category. The results show that the calibrated model's post-dispatch stringlines effectively represent train performance on the corridor. It can be seen that the differences between the freight railroad and *MISS-IT*© train times are well within the allowable variance for each type of train.

Exhibit 6-10
Average Travel Times for Amtrak, Metra, and Freight Trains

Train Classification	Average Travel Times					
	TEMS *MISS-IT*©	Freight Railroad Estimates	Difference		Allowable Variance
			Faster	Slower	
Freight Bulk	12:58	12:30	+0:27		
Amtrak *Hiawatha*	1:26	1:17	-0:09		
Freight Intermodal	8:12	8:34		0:22	
Freight Local	5:30	4:35	0:54		3:00
Metra	0:48	0:50		0:02	0:04

6.5.4 Performance Upgrades/Mitigation Measures

Depending on the elements of the corridor under analysis, various improvements to the infrastructure can reduce travel times. If the railroad has an objective to mitigate or reduce travel times, the following upgrades or a mixture thereof can be added as an input to the analysis to meet these objectives. These include improvements to the signaling system, infrastructure and operations.

Signaling

In highly congested areas, upgrades to the signaling system can provide great time savings to traffic in a corridor because they increase the density of trains and permit higher speeds at signal blocks. Investment in Positive Train Control (PTC) can be especially beneficial when mixing together trains having different speeds and stopping distance profiles. In all areas where passenger train speeds are planned to exceed 79-mph, the MWRRS capital cost already includes an allowance for equipping the line with PTC technology. The amount of delay reduction depends on the exact capabilities of the PTC system that is ultimately deployed, and whether all trains are ultimately equipped with PTC capability. Our proposed remediation for the Chicago-Cleveland and St. Louis-Kansas City lines did not rely on any PTC savings. Rather the remediation consisted of enough infrastructure additions to reduce freight delay to the level they would be without passenger trains. Any PTC savings would be in addition to this.

Infrastructure

By adding segments of track along the corridor, trains are given additional choices to resolve conflicts that they did not have previously. The train can advance further down the track, clearing the way for other trains. The result is a smoother flow of traffic through the corridor and less incurred delay.

Another enhancement that results in performance improvements along the corridor is upgrades to the track to support higher speeds. These improvements help the traffic to move through the system more quickly, preventing potential conflicts with other trains later in the day.

Operations

Another measure that improves the performance of the trains along the corridor is to make changes to the operating schedules. If the analysis indicates that several trains are conflicting, changing their schedules to provide some additional spacing between the trains will smooth the flow of the trains along their journeys with the agreement of the railroads, even minor modifications to the schedules of local and lower priority bulk trains can produce significant operational improvements. This will in turn reduce the delays that these trains were incurring because they were traveling too close together.

6.5.5 Risk Analysis

For a Typical Day Analysis, a risk analysis is performed. This involves running the dispatch model to obtain randomized departure times, which vary from the scheduled departure times for each train. The risk analysis replicates the delay for each train under a series of changes in departure times. In effect, the model attempts to determine the range of delay for each train under several different conditions.

6.5.6 Typical Day Outputs

MISS-IT© is an event-based conflict-resolution model. This means that, once a train is dispatched, the model makes decisions based on oncoming traffic and the track available to avoid conflicts with the oncoming traffic.

Action Log

The action log reports any delays that a train incurs over its pre-dispatch travel time. The action log identifies the dock-to-dock trip times of the different train types and helps in providing origin-to-destination travel plans for the systems trains. It provides a key assessment of effective train movement planning, helping to ensure that the "right car is on the right train on the right day."

The summary format of the action logs reports the total journey time, percent of allowable delay, the amount of delay over the normal operation of the train, and the delays that occur when the train is moving down the track. The percent of allowable delay reported in the action log for each train is determined by the expectations of the railroad. If the railroad determines that it is acceptable for a train's delay to be 10 percent of its journey time for each train type, the percentage of allowable delay recorded in the action log is the accumulated delay time in relation to the allowable delay.

Initially the percentage of allowable delay was designed to indicate if a train was delayed within an allowable range. This meant that if a train incurred a delay, it would rise in rank relative to other trains so that it would still operate within this range of delay. In some cases, this resulted in some of the freight trains taking precedence over passenger trains. Since this was occurring, trains were restricted in rank so that they were allowed to "float" only within their own super-group, *e.g.,* bulk trains.

The delays that result from a train's movements along the track are recorded in the action log. These delays include: acceleration/deceleration, tailgating, non-signal and track switch delays. All of these delays are specific to train type and the type of infrastructure, signaling system, and dispatch policy of the railroad.

The acceleration/deceleration delays are incurred if a train needs to accelerate or decelerate to get out of the way or slow down for another train. Tailgating penalties occur in the model if a train approaches another and cannot immediately pass. The train must then wait until the other train is far enough ahead before it can proceed.

If a train enters an area where there are no signals or if the signals face the opposite direction, a train sustains a non-signal time penalty. In some cases, a railroad may determine that a penalty is not warranted in a non-signaled section, in which case this penalty is set to zero in the model.

A track switch penalty occurs when a train goes through a point where it must change tracks. This penalty is designed to replicate the amount of time a train needs to slow down to travel through a track connection. If the track is straight at this point, the train may not need to slow down. If a train diverges through a crossover or to a side track, the train may have to slow down substantially.

The detailed format of the action log reports the same information as the summary action log, but includes more information about location and time of the delay. In addition, if a train has reacted to another, the detailed action log reports the name of the causing train and its rank. In order to check if a lower-ranked train is waiting for a higher-ranked train, the rank of the current train is reported.

Comparison of Pre-Dispatch and Post-Dispatch Travel Times

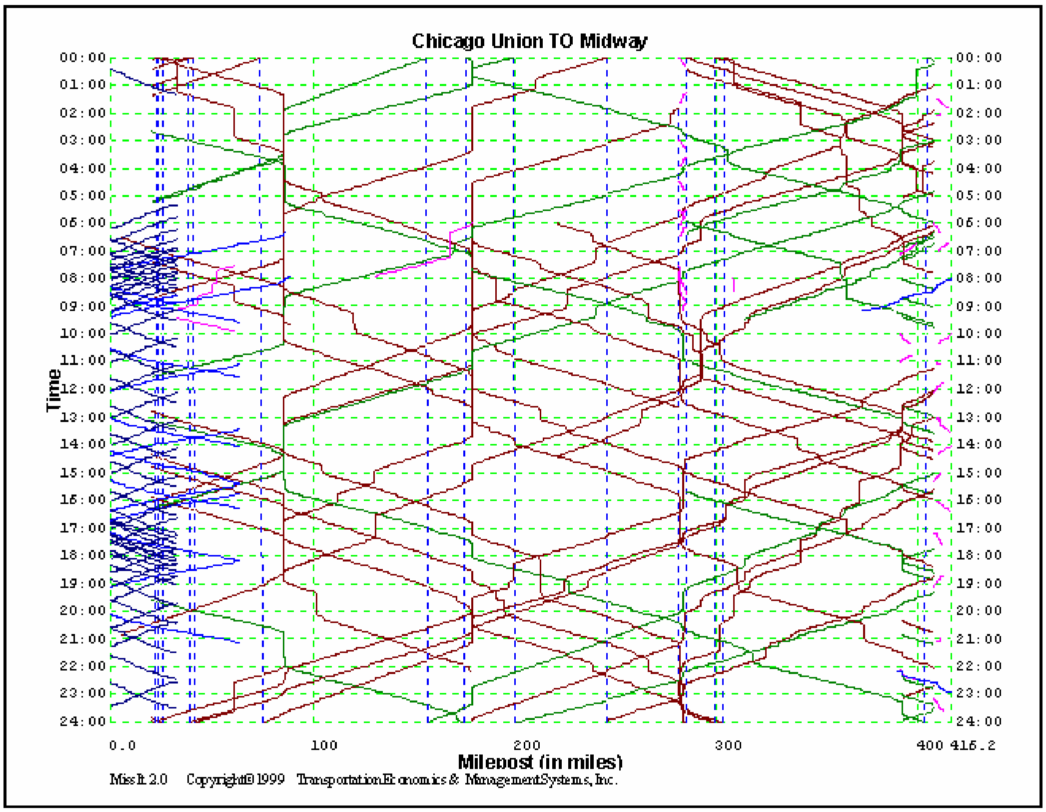
To complete this analysis, a comparison of pre- and post-dispatch travel times is generated. The term "pre-dispatch" refers to travel times or stringlines that exclude any delay associated with passenger and/or freight interaction. "Post-dispatch" refers to times/stringlines that include delay times associated with passenger and/or freight interactions. These results can be used to calculate average delay per train and the standard deviation of the trip duration.

In order to evaluate the comparison of pre- and post-dispatch times, the results can be considered on a sample train or on a train-group basis. If trains are grouped together by similar characteristics, it is easier to see how changes in track infrastructure will impact a particular group.

Post-Dispatch Stringlines

A useful instrument employed during the analysis is the post-dispatch stringline diagram. This diagram illustrates the path of each train as it travels through the system. Comparison of the post-dispatch and pre-dispatch stringline diagrams shows the delays that have been added during the conflict-resolution process as ‘kinks” in the lines. This diagram can be useful in identifying potential problem areas along the corridor. This information is extremely useful in determining the necessary infrastructure to be added during the mitigation process. This is shown in Exhibit 6-11.

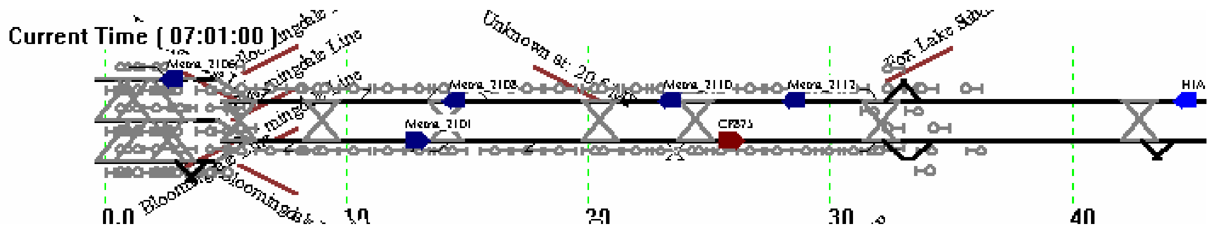
Exhibit 6-11
Post-Dispatch Stringline Diagram



Animation

The animation feature of *MISS-IT*© augments and complements the post-dispatch stringline diagram by introducing a temporal dimension to the software. It takes all the information from the stringline diagram (Exhibit 6-12) and puts it into motion, showing trains’ movements over the track infrastructure. Each train is labeled for easy identification and color-coded to match the group to which it is assigned. These colors are also the same as in the stringline diagram. This animation feature is helpful in understanding the interaction between trains as well as how the trains utilize the track. Another element that the animation brings to light is the departure and arrival patterns of the trains. It also shows trains entering and departing from the track at yards, junctions and stations.

Exhibit 6-12
Example of *MISS-IT*© Animation Graphics



Risk Analysis Outputs

Exhibits 6-13, 14 and 15 provide samples of the reports that are generated in the risk analysis. In this example, the model was run three times, changing the departure times for every train each time, to determine how the trains interacted on three different days. The first part of the report details the probability statistics for each train type operating along the corridor. The second part details the departure, arrival, duration and percentage of allowable delay for each train. Three lines of information are reported for each train because the model was run three times.

The times reported in the summary report for the risk analysis are averages for the journey time, standard deviation, percentage of allowable delay and the standard deviation in the percentage of allowable delay. This Exhibit shows the average result for three runs completed in the risk analysis.

Exhibit 6-13
Risk Analysis Output (Detailed)

Train Risk Analysis Report (Journey Time)					
Model Run Name:					
Dispatch Type: MULTIPLE					
Num of Variations: 3					
Technology Statistics:		**Probability**		**Standard Deviation (min)**	
		Early	**Late**	**Early**	**Late**
BULK-Type 1	:	0.25	0.75	15	30
INT-Type 1	:	0.50	0.50	15	15
BULK-Type 2	:	0.25	0.75	15	30
BULK-Type 3	:	0.25	0.75	15	30
BULK-Type 4	:	0.50	0.50	15	15
BULK-Type 5	:	0.25	0.75	15	30
BULK-Type 6	:	0.25	0.75	15	30
BULK-Type 7	:	0.25	0.75	15	30
BULK-Type 8	:	0.25	0.75	30	60
BULK-Type 9	:	0.25	0.75	30	60
INT-Type 2	:	0.50	0.50	15	15
INT-Type 3	:	0.50	0.50	15	15
INT-Type 4	:	0.50	0.50	15	15
INT-Type 5	:	0.50	0.50	15	15
Copyright 1999-2001, Transportation Economics & Management Systems, Inc.					

Exhibit 6-14
Risk Analysis Output (Detailed) (continued)

Train Number	Departure	Arrival	Duration	Arrival	Status	Percent of Allowable Delay
1 (Bulk)	0:15	12:12	11:57			45
	0:34	12:50	12:16			18
	0:30	10:50	10:20			31
Train Number	**Departure**	**Arrival**	**Duration**	**Arrival**	**Status**	**Percent of Allowable Delay**
4 (Commuter)	0:25	1:16	0:51			0
	1:09	2:00	0:51			0
	1:36	2:27	0:51			0
Train Number	**Departure**	**Arrival**	**Duration**	**Arrival**	**Status**	**Percent of Allowable Delay**
3 (Intermodal)	1:00	14:27	13:27			60
	1:18	14:45	13:27			112
	2:08	15:58	13:50			23

Exhibit 6-15
Risk Analysis Output (Summary)

Train Number	Mean Journey Time	Standard Deviation	Mean Percent of Allowable Delay	Standard Deviation
9 (Local)	0:18	0:00	193	273
1 (Bulk)	11:31	0:50	31	11
4 (Commuter)	0:51	0:00	0	0
3 (Intermodal)	13:35	0:10	65	36
73	0:21	0:00	0	0
74	0:20	0:00	0	0
75	0:29	0:00	0	0
76	0:08	0:00	0	0
77	0:29	0:00	0	0
78	10:51	0:16	83	41
79	0:27	0:00	44	62
80	12:42	0:16	48	24
81	0:18	0:00	0	0
82	3:09	0:01	32	1
83	0:21	0:00	0	0

6.5.7 Ideal Day vs. Typical Day Analysis

The Ideal Day Analysis provides a good estimate of delay under the assumption of a stable timetable and high or moderate traffic levels. The reality of unpredictable timetables on a corridor that is heavily used requires the broader analytic framework offered by the Typical Day Analysis. Exhibit 6-16 shows the difference between these two complementary approaches.

Exhibit 6-16
Comparison of Ideal Day Analysis and Typical Day Analysis

Ideal Day	Typical Day
Preliminary estimates	Final estimate
Static	Dynamic
Fixed schedule	Variable departure times

6.6 Berkeley Simulation Software RTC©

Berkeley Simulation Software's Rail Traffic Controller (RTC©) is a modeling package designed to realistically simulate freight and passenger rail operations in either a planning environment or an online control situation. The study team uses RTC© as a freestanding analysis tool in addition to TEMS' *MISS-IT*© software.

RTC© defines data as "nodes" on the rail infrastructure, including switches, signals, detectors and speed change points. Track between locations is defined as directional "links" and include characteristics such as speed limits, grade, curvature and operating rules. Rolling stock is customized for locomotive types to evaluate locomotive suitability for a particular territory.

Train lengths and costs, types of trains and train schedules are depicted providing a high level of detail needed to make planning decisions for each rail line in the network. RTC©'s logic considers shared-use corridors where decisions must be made regarding train meets, passes, overtaking and routing issues. The RTC© model allows the study team to investigate the shared use of existing facilities and infrastructure, the effect on train delay by the addition of new trains to the current network, the effect of capital improvement to existing levels of infrastructure, the need for and efficient usage of passing sidings, diagnose bottlenecks and simulate recommended schedule or routing changes.

For the MWRRS analysis, the RTC© model was used only for the St. Louis-Kansas City line, at Union Pacific's request. TEMS' *MISS-IT*© software was used to evaluate all the other line segments.

6.7 *MWRRI Ideal Day Analysis Application*

By definition, a corridor at capacity requires additional infrastructure in order to add trains. A corridor operating below capacity should theoretically have the ability to take on additional trains without needing additional infrastructure. However, additional trains may increase delays and overall transit times to all trains now operating on the route, particularly when there is a large difference in the operating speeds of the trains on the corridor. When adding new trains, it is important to understand how the additions affect existing operations, as well as how corridor improvements can mitigate these effects.

In March 2002, an *Ideal Day Analysis* was completed of eight corridors under consideration for the MWRRS. The aim of the analysis was to assess the impact of adding MWRRS passenger trains on these corridors, and to provide an initial estimate of the infrastructure improvements necessary to maintain the current level of performance with the addition of MWRRS trains. The map in Exhibit 6-17 shows the corridors that were included in the 2002 study.

This section summarizes key findings of the *Ideal Day Analysis* report, which was delivered to the MWRRI Steering Committee in March 2002 plus an analysis of the Milwaukee to Green Bay corridor that was originally incorporated into the Green Bay route alternative study. Additional detail is available in the *Ideal Day Report* that is not presented here. Freight tonnage data and growth rates used in Ideal Day Analysis were derived from state, federal, and freight railroad data sources at the time the analysis was prepared. The data represents peak day traffic and used conservative growth rates significantly higher than national average growth rates. The Ideal Day Analysis performed for the Chicago-Carbondale line did not include the recent impacts of the CN purchase of the Illinois Central Railroad.

This analysis is strictly a planning-level study that will review potential conflicts and train meet-points on each corridor. A meet-point location is the point at which two trains will *ideally* pass each other, assuming that both are operating on or close to schedule. Examining these meet-points and the level of delay experienced by all trains moving through the corridor provides a basis for determining the infrastructure improvements required once MWRRS passenger trains are added to the system.

The nine corridors that were examined are:

- Milwaukee to Green Bay, Wisconsin
- Chicago, Illinois, to Quincy, Illinois
- The Omaha Branch from the Quincy main at Wyanet, Illinois, to Omaha, Nebraska
- Chicago to Carbondale, Illinois
- Chicago to Cincinnati, Ohio
- Chicago to Pontiac, Michigan, via Detroit, Michigan
- The Holland Branch from Kalamazoo, Michigan, to Holland, Michigan
- The Port Huron Branch from Battle Creek, Michigan, to Port Huron, Michigan
- Chicago to St. Louis, Missouri

Exhibit 6-17
Ideal Day/Typical Day Corridors

These corridors were chosen based upon the key assumption that each is operating below capacity. With the possible exception of parts of the Chicago-Quincy and Carbondale corridors, traffic levels were generally low enough and existing infrastructure levels were high enough to justify this assumption, except in the urban approaches to large terminal cities. Therefore, the analysis of each route focused on the potential for bottlenecks on the corridor itself and did not address the potential congestion and delays in the terminal areas. Improvements in the Chicago region (defined as the region within the lines of the Elgin, Joliet and Eastern Railroad, but extending east to Porter, Indiana) were specifically *not addressed* due to a highly complex, local operating environment and the existing congestion on many of the routes within the region. The unique complexity of this area made it unsuitable for this type of analysis. The CREATE project, described in Chapter 5, has established an effective model for a process that could be used for identifying and resolving these complex Chicago terminal-area issues.

6.8 Methodology

The first step in the Ideal Day analysis was to model the corridor. Detailed track files were assembled in *MISS-IT*© to replicate the current track configurations over the eight corridors in question. The track configuration of many of the corridors has changed over the past few years, so it was imperative to update these files to reflect current conditions. Next, existing train operations were modeled as discussed below. This allows for the examination of existing delays on the corridor. The existing traffic was then forecast to a future year (2010), and the delays associated with that forecast year level were identified. In this report, this is referred to as the *forecast base*. MWRRS passenger trains were then added to this system without any infrastructure additions to determine the level of additional delay. In the final step, the increase in delay was mitigated as infrastructure improvements were identified that potentially reduced corridor delay times to the forecast base level. The corridor was re-analyzed with these improvements in place to determine the adequacy of the additional infrastructure. If the delay had not been reduced to an acceptable level, additional mitigation options were examined, including additional infrastructure upgrades.

6.9 Current Train Operations Analysis

The goal of this initial analysis was not to eliminate train delays, but rather to ensure the effective calibration of the Ideal Day model. In many cases, delays were unavoidable, particularly on single-track railroads. These were already indirectly recognized in that they were built into existing train schedules and operating plans.

The train movements on the corridor or on a segment of the corridor were modeled based on train counts, operations and schedules. The origins and destinations, schedules and stopping patterns, and speed limits were established first. Actual train performance, including acceleration and deceleration rates, was modeled based on train types. The trains included in this analysis were the local and through freight trains that operated on the corridor and on each corridor segment, and the intercity or non state-supported Amtrak passenger trains *outside of the Chicago region*. While Chicago-area line segments (e.g. Chicago to Joliet) were included in the model, those segments were not modeled in detail since many train operations, including Metra commuter operations (both current and planned or proposed) and Chicago local and transfer freight service, were not included in the *Ideal Day* simulation scope[1].

In addition, yard jobs that might have entered onto the main tracks in and around yards and traffic moving through very short stretches of the corridor (as on the CN lines in Battle Creek, MI) were not included in the stringline diagrams. Proposed commuter operations in Cleveland, Minneapolis, Cincinnati and Detroit and additional passenger train service (like the 3C in Ohio) were also not included in this analysis based on the assumption that these services will begin operation with additional infrastructure for their own requirements. Additional train operations stemming from new freight terminals such as Joliet Arsenal were considered only if traffic patterns and train routings are already established. Proposed or planned terminals, like the

[1] Chicago-area operations including METRA commuter trains were, however included in the scope of the Chicago-Twin Cities study that was conducted using the more detailed *Typical Day* analysis approach.

Detroit Intermodal Freight Terminal, were not considered because the traffic patterns and routings are underdetermined to date.

The performance characteristics of these trains were used in conjunction with the track files to create individual train stringlines. The stringlines shown are simply a graphical representation of each train's movement over the corridor from the time and location where it arrives until its trip is complete. The slope and shape of the stringline was dependent on the train's performance characteristics, including its maximum operating speed and its schedule.

This analysis was a *static* process in that it assumes that the conditions under which each train operates were the same from day to day, creating identical travel times each day. Because there were no variations in travel times, the trains were assumed to be operating under *ideal* conditions. In this ideal situation, all trains will operate as planned in that they will:

- Depart on schedule
- Maintain the maximum speed permitted on each segment of track after allowing for acceleration and deceleration
- Make all required stops with consistent dwell times
- Be subject only to expected delays
- Arrive at their destinations on schedule

Individual idealized stringlines were then applied based on the current corridor operations to model the train operations and develop the daily operating plan. This plan was the schedule for a single day of operation on the corridor. The extent to which an operating plan can be constructed depends a great deal on how reliably trains can be scheduled. For intercity Amtrak passenger trains, published timetables provided the arrival times onto the corridor. High priority intermodal freight trains had similar departure schedules, defined both by the cutoff time when the inbound highway equipment has to be processed through the terminal gate and by the actual train departure time. Lower priority freight trains, on the other hand, were not as time sensitive and subsequently could operate more irregularly with a scheduled departure *window* rather than a fixed departure *time*.

Given that this analysis was applied to corridors that generally have *excess* capacity, normal day-to-day variations in departure times and operations can be absorbed. As a result, the operating plan will reasonably balance the competition for the available capacity. This balance is achieved with some tolerance for schedule deviations (typically 5 to 10 minutes). For corridors running at or near capacity, planning becomes much more complex due to this uncertainty and thus requires, as noted above, a more detailed level of analysis, including a risk assessment.

6.10 Calculating Train Travel Time and Planned Delays

A train's idealized stringline shows the fastest possible travel times from origin to destination. Such idealized stringlines will not reflect train delays where meets take place. These delays were accounted for in the analysis with three types of delay – scheduled stops, slack and recovery time, and unplanned delays due to conflict resolution – added as necessary to achieve a more realistic model of the corridor's operations.

6.11 Calculating Unplanned Train Delays

Trains that meet with sufficient infrastructure can pass with no delay to either train (*e.g.*, two trains meeting on double track). However, when there is insufficient infrastructure to accommodate the traffic in both directions, one or more trains must incur some delay to allow another train to pass. Thus, the overall travel time for a train is dependent on the number of delays it encounters on the path to its destination. Whenever a train meets another train for which there is insufficient infrastructure to allow both trains to pass freely, the lower-priority train is subject to a delay. By measuring each of the components of delay for a given set of trains, train travel time and level of delay can be estimated.

Once the travel times for all of the trains operating along a given corridor were reproduced in the model, track infrastructure was reviewed to determine if there was sufficient track capacity to accommodate the traffic. This was done by analyzing train movements along the corridor and assessing time penalties when the review determined that sufficient capacity did not exist for train meets or overtakes. The time penalties were based on the delays that a train would incur in the event of a meet. For example, if a passenger and a low priority freight train meet on a segment of single track, and there is a siding nearby, the model assesses a time penalty on the freight train to approximate the length of time needed for the freight train to pull into the siding, wait for the passenger train to pass and then accelerate to track speed. The time penalty was used in all cases where the review determined that insufficient track capacity existed to accommodate trains as they met each other along the corridor.

These unplanned delays were the key measurements used for comparing train operations with and without the addition of MWRRS traffic on the corridor and the effects of the suggested infrastructure improvements.

6.12 Forecast and MWWRS Traffic

Traffic levels were forecast to the year 2010 using an annual growth rate of up to two percent per year for through freight traffic[2]. The base traffic year is 2000. Traffic growth was largely focused on through freight traffic with zero growth for intercity Amtrak passenger trains. The through freight traffic in many of the corridors in this analysis has multiple origins and destinations with trains on the same corridor running on different line segments. In these cases, the traffic growth was assumed constant for all groups of trains. In other words, the growth rate was applied equally to trains operating between Chicago and Kankakee and between Chicago and Champaign. Current state-supported Amtrak trains were not included in this analysis on the assumption that MWRRS trains will replace them.

[2] In the *Ideal Day* analyses, traffic was estimated based on a "peak" rather than average day assumption. *Typical Day* corridors and Chicago's CREATE rail plan generally assumed higher growth rates, for example 5% per year on UP's St. Louis to Kansas City line. In spite of this, it is not clear that the *Ideal Day* analysis understates traffic due to its use of a peak day as the starting point. 2% is the traffic growth rate assumption that was approved by the MWRRI Steering Committee at the time when the *Ideal Day* analysis was performed and represents a growth rate well above national freight traffic growth.

6.13 *Infrastructure Improvements*

In developing the types of infrastructure improvements to analyze, the best course of action is to keep trains moving wherever possible by avoiding situations where trains slow or stop for meets. By keeping trains moving during meets, fewer delays are incurred.

6.13.1 Types of Infrastructure Improvements

Improvements in alignments and local track geometry were not considered. The levels of infrastructure improvement considered in this analysis are listed below.

- Adding *passenger* sidings located primarily for passenger-to-passenger train meets. These sidings are ideally six miles long for a 79-mph area and 10 miles long for a 110-mph area. The length of the sidings allows for passenger train meets without stopping either train, with a total tolerance in the actual running time of about 5 minutes. In all cases, the sidings were assumed to have 60-mph premium turnouts on each end. Some sidings also have a pair of 30-mph crossovers in the middle to allow for 3-way train meets and overtakes. In many cases, these types of improvements can be achieved by simply extending existing sidings. While these sidings are primarily located for passenger train meets, their use is by no means limited or restricted to passenger train operations. The addition of crossovers in the middle of some of these sidings specifically adds additional flexibility for freight train operations.
- The addition of *freight* sidings for holding freight trains for meets. Typically, these sidings are 10,000 feet or 2 miles in length. On corridors such as Chicago to Quincy, these were used to stage trains into or out of potential choke points such as regions affected by commuter windows or outside major classification yards. On lower density routes such as the Omaha branch, these sidings provided room for freight traffic to clear the main for oncoming traffic or for overtaking priority traffic. The reasoning was that the additional cost of a longer siding is not justified on a low-density freight route.
- Extending sections of multiple tracks for increased capacity, particularly on both sides of single-track bottlenecks. These extensions not only create, in effect, longer sidings, but with the addition of 60-mph premium turnouts, they also allow all trains, including freight traffic, to accelerate and maintain that speed prior to hitting the bottleneck section. This helps minimize the time spent on the bottleneck by each train, increasing the capacity or number of trains that can use the line.
- Adding crossovers in bi-directional multiple-track territory. Additional crossovers allow for much greater flexibility in handling traffic on multiple-track territories. With the improvement of only one track to full MWRRS speed in multiple-track territory, the addition of crossovers was necessary to keep traffic fluid while minimizing delay. Unless otherwise noted, the speed limit on the additional crossovers is 45-mph.

6.13.2 Infrastructure Improvement Assumptions

Several assumptions were made with regard to the infrastructure improvements used in this analysis. First and foremost, no field inspections were conducted and it was assumed that all proposed improvements were feasible in the field. Important track and environmental constraints such as track curvature and the location of fixed structures such as bridges were considered in locating sidings. Because there were no field inspections, all the milepost locations given for various improvements must be considered approximate.

The second key assumption was that a train control system was in place on all of the corridors. This is a critical assumption because a train control system can significantly improve rail capacity by allowing trains to safely operate with reduced headways. However, it must be noted that several different train control products are being developed by several Class I railroads. The interoperability of these systems has not been developed or even contemplated. However, for purposes of this study it is assumed that the MWRRI system is equipped with a completely interoperable and seamless train control system. The train control system to be deployed is assumed to be RF communications based.[3]

The speed limit through turnouts was assumed to be a minimum specific speed. The reason speed limits were used rather than specifying turnout type or geometry was because the local conditions can play a significant role in determining what will and will not work at a particular location. As noted above, it was assumed that where a 60-mph turnout was specified, it would be feasible to install at this particular location. Turnouts with speed limits in excess of 60-mph would likely further improve operations and enhance capacity, but given their considerable space requirements, they were not considered based on the assumption that they may not be practical to install in all locations.

The remaining assumption was that all stations have two platforms in multiple track territories with no need to route the MWRRS passenger trains onto a specific track into the station.

Note that the speed limits used for MWRRS passenger trains were either 79-mph or 110-mph, as noted in the description of each corridor in their respective chapters below. These speed limits were all based on the business plan, as it existed in late 2001 and early 2002. Subsequent to completion of this analysis, some speed limits were reduced from 110-mph to 90-mph or even 79-mph. This change in planning assumptions has not been reflected in the results presented here, which summarize the findings as of early 2002, when the Ideal Day Analysis was completed.

6.14 Calculating Train Travel Time and Delay with Infrastructure Improvements

The meet-points and delays were re-analyzed after infrastructure upgrades were added on each corridor. In areas where new *passenger* sidings were installed, the new siding was found to eliminate all the delays associated with opposing train meets (including freight train meets), with the exception of three-train meets and overtaking situations. In the case of three-train meets, the delays on the second and third trains were maintained. Likewise, delays were kept in place in overtaking situations for the train being overtaken. Delays were also eliminated for train meets on multiple track unless there were meets with three trains or there were overtake situations, in which case the delays were handled as described above. In some cases, delays were reduced but not eliminated for freight train and passenger train meets on single track with siding and turnout improvements due to faster entry or exit speeds into and out of the sidings. Finally, minor

[3] Under FRA regulations, either a conventional cab-signaling system or a train control system deployment will be required to support passenger train speeds exceeding 79 MPH. While the NAJPTC territory in Illinois supports the implementation of moving block as an overlay to the existing signal system, development efforts are underway, but deployment in revenue service is several years in the future.

schedule adjustments were made to eliminate meets just outside of sidings or end terminals. The resulting reductions in delays were then applied to the total delay time to determine if the improvements were sufficient. Exhibit 6-18 summarizes the results of the analysis presented.

Exhibit 6-18
Ideal Day Delay Summary by Corridor

Corridor Analysis Summary - Year 2010				
Total Delays (in minutes)	***Base Forecast***	***MWRRS***	***MWRRS w/ improvements***	***% Change vs. Base***
Quincy	3,100	5,700	3,200	3.2%
Omaha	160	820	190	18.8%
Carbondale	3,260	4,580	3,340	2.5%
Cincinnati	660	1,360	620	-6.1%
Detroit	980	3,500	1,010	3.1%
Holland	60	240	80	33.3%
Port Huron	980	1,580	960	-2.0%
St. Louis	560	2,440	590	5.4%
Totals	**9,760**	**20,220**	**9,990**	**2.4%**

6.15 Milwaukee-Green Bay Corridor Assessment

In July 1999, WisDOT asked Transportation Economics & Management Systems, Inc. (TEMS) to assess the feasibility of providing 110-mph rather than 79-mph passenger train service on the Milwaukee-to-Green Bay route and to determine whether there will be sufficient capacity to accommodate the addition of passenger rail service as well as the anticipated growth in freight service. The initially proposed alignment connected Milwaukee and Green Bay via Duplainville through Brookfield, Allenton, Fond du Lac, Oshkosh and Appleton, and was referred to as the *Duplainville Route Option.*

The preliminary results of that analysis led to a second study request by WisDOT in January 2000 to evaluate an alternative alignment from Milwaukee to Green Bay via West Bend. Canadian Pacific Railway (CPR) had asked WisDOT to consider an alternative alignment that would redirect passenger trains away from CPR's mainline route. The second possible alignment connects Milwaukee and Green Bay via West Bend to Fond du Lac and is referred to as the *West Bend Route Option*. The route rejoins the WCL mainline at Fond du Lac and continues on the WCL's mainline to Neenah. From Neenah to Green Bay, the route uses the alignment of the FVWR. From Fond du Lac to Green Bay, the *Duplainville* and *West Bend* route options are identical.

TEMS conducted an *Ideal Day* analysis for the *Duplainville Route Option*. Because of the low volume of freight operations on the *West Bend Route Option,* a track capacity analysis of that segment of the route was not required. In the event the *West Bend Route Option* is selected, the improvements proposed between Duplainville and Fond du Lac would not be needed. Those funds would be invested in the parallel *West Bend* corridor instead.

As a first step in the track capacity analysis, TEMS staff conducted an operations inspection of the *Duplainville Route Option*. The operations inspection identified both the high volume of freight trains on the route and the number of industrial sidings at key locations along the route. The inspection revealed that Neenah is a critical crossroads for WCL's freight train movements from northern and western Wisconsin to Chicago and for the movement of CN freight trains from Canada through Superior and to Chicago.

The track capacity analysis conducted for this study identified train delays based on the number of train-meets derived from combining the assumed operating schedules of both passenger and freight trains. The location and amount of additional infrastructure that would be required to eliminate conflicts between passenger and freight trains were then estimated. The three types of train meets that would occur on a rail corridor that has both freight and passenger trains operating over it are *passenger-to-passenger, passenger-to-freight* and *freight-to-freight.*

As part of the track capacity analysis, TEMS considered mitigation results from both infrastructure and operating improvements. In terms of mitigation through operating changes, passenger train departure times were adjusted to minimize the impact on freight operations. For both the 79-mph and 110-mph passenger train options, operating schedules were adjusted so that *passenger-to-passenger* and *passenger-to-freight* train-meets occurred at a limited number of specific locations. This reduced the number of additional sidings required and limited the number of passenger-to-freight meets.

The analysis methodology used the operating schedules for both 79-mph and 110-mph passenger rail service and identified the number of *passenger-to-passenger* meets in each case. From this information, TEMS determined the total number and lengths of sidings needed to eliminate these meets and subsequent delays.

To estimate the *passenger-to-freight* meets, the analysis used the projected WCL freight schedules for 2020, which were then combined with the proposed passenger train schedules. The conflict analysis identified the additional infrastructure required to eliminate *passenger-to-freight* meets.

The analysis also identified that even without passenger train operations, additional infrastructure would be needed just to meet the needs of the route's growing freight traffic.

A basic assumption embedded in the MWRRI and therefore carried forward in this study is that the track and signaling system will be upgraded to FRA Class 4 track for 79-mph passenger rail operations and to FRA Class 6 for 110-mph operations. The 79-mph operations can use various forms of wayside signaling, but 110-mph operations must use an in-cab signaling system. For both cases, it was assumed that *passenger-to-passenger* meets will require 10-mile passing sidings to allow passenger trains to pass at speed. For both cases, it was also assumed that *passenger-to-freight* meets and *freight-to-freight* meets can be resolved by using 5-mile passing sidings and that the freight train taking the siding will stop to allow the other passenger or freight train to pass.

The results of the capacity analysis described above are presented in Exhibits 6-19 and 6-20. The results are shown as additional miles of sidings required to resolve the three types of train meets that can occur on a rail corridor that has both freight and passenger trains operating over it.

Exhibit 6-19
Total Miles of Sidings Required to Mitigate Train Conflicts for Duplainville Route Option

Types of Train Conflicts Mitigated	Passenger Train Operating Scenario	
	79-mph 5 Round-trips Daily	110-mph 7 Round-trips Daily
Passenger-to-passenger	20	40
Passenger-to-freight	26	21
Total	**46**	**61**

Exhibit 6-20
Freight-to-Freight Capacity Needs

Type of Passenger Rail Service	Miles of Siding Needed
None	26
79-mph	15
110-mph	10

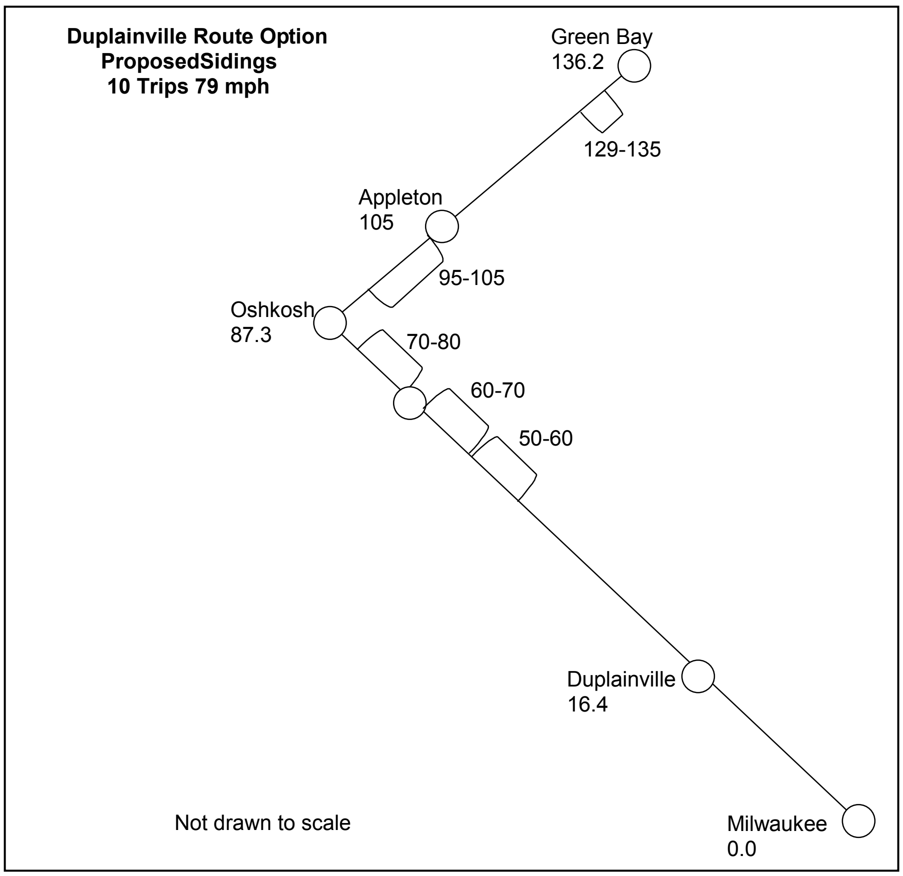
As shown in Exhibit 6-20, in the absence of the implementation of passenger rail service in the Duplainville corridor, WCL would need to build 26 miles of sidings in order to accommodate the projected growth of its own freight train traffic. However, implementing passenger rail service would add infrastructure that would reduce these *freight-to-freight* siding requirements. The 26 miles of siding that the WCL is projected to need would be reduced to 15 miles under the 79-mph passenger rail option and to 10 miles under the 110-mph option because of the mitigation of *passenger-to-passenger* and *passenger-to-freight* train conflicts. The addition of these extra sidings would increase the amount of track capacity available for freight train traffic at the times when passenger rail does not operate, providing the WCL with increased operational flexibility. Thus, the infrastructure improvements required for passenger rail service would provide additional capacity that the WCL could use for its freight train operations and thereby reduce the amount of additional track capacity required by the WCL to meet its projected growth in freight train operations.

As also shown in Exhibit 6-19, the addition of 79-mph passenger train service on the Duplainville Route would require the construction of 46 miles of new sidings to eliminate the train meets caused by the passenger rail service. Exhibit 6-21 shows the location and length of each siding. Exhibit 6-22 provides a schematic representation of the proposed siding locations.

Exhibit 6-21
Location of Proposed Sidings to Mitigate Train Conflicts for Duplainville Route Option for 79-mph Passenger Train Speed Option

Type of Train Meet	Begin @ Milepost	End @ Milepost	Length of Siding (Miles)
Passenger-to-passenger	50	60	10
Passenger-to-passenger	95	105	10
Passenger-to-freight	60	70	10
Passenger-to-freight	70	80	10
Passenger-to-freight	129	135	6
Total Miles of Sidings			**46**

Exhibit 6-22
Schematic Representation of Proposed Sidings to Mitigate Train Meets on the Duplainville Route Caused by 79-mph Passenger Train Service



As shown in Exhibit 6-19, the addition of 110-mph passenger train service on the Duplainville Route would require the construction of 61 miles of new sidings to eliminate the train meets caused by the passenger rail service. The location and length of each siding is presented in Exhibit 6-23.

Exhibit 6-23
Location and Length of Proposed Sidings to Mitigate Train Meets on the Duplainville Route Caused by 110-mph Passenger Train Service

Type of Train Meet	Begin @ Milepost	End @ Milepost	Length of Siding (Miles)
Passenger-to-passenger	25	35	10
Passenger-to-passenger	45	55	10
Passenger-to-passenger	60	70	10
Passenger-to-passenger	90	100	10
Passenger-to-freight	16	21	5
Passenger-to freight	37	42	5
Passenger-to-passenger	75	80	5
Passenger-to-freight	129	135	6
Total Miles of Sidings			**61**

Exhibit 6-24 shows that seven new passing sidings are proposed between Duplainville and Appleton. Because these proposed sidings are so numerous and close to each other, the construction of a dedicated[4] passenger track from Duplainville to Appleton was assumed for purposes of this feasibility study. The dedicated passenger track would begin approximately at WCL's Chicago Subdivision Milepost 102.3 and end at Fox River Subdivision 213, a subdivision distance of 90 miles. The proposed dedicated passenger track allows the WCL to maintain its current freight train communications and control system between Duplainville and Appleton.

Exhibit 6-25 schematically depicts the location of the dedicated passenger track recommended for passenger trains operating at speeds up to 110-mph on the Duplainville Route between Duplainville and Green Bay. A dedicated passenger track was not proposed for the Appleton to Green Bay segment of this route. In this segment, passenger train speeds would be limited to 79-mph. However, a 6-mile passing siding would be required to accommodate passenger-to-freight train meets.

The capacity analysis for the Duplainville Route Option shows that significant additional track capacity is required for both the 79-mph and the 110-mph passenger train speed alternatives. In the case of the 79-mph option, 46 miles of new siding will be required to mitigate forecast train-meets caused by the introduction of passenger rail service. For the 110-mph option, 61 miles of new passing sidings would be required to mitigate forecast train meets caused by the introduction of passenger rail service. Because the proposed passing sidings are so numerous and close

[4]It was assumed that freight trains would be able to make use of this track for passing purposes.

together between Duplainville and Appleton, the construction of a new 90-mile track dedicated to passenger rail is a more effective solution.

For the section of track between Appleton and Green Bay, both the 79-mph and 110-mph passenger train speed options will require a 6-mile siding immediately south of Green Bay to accommodate freight train movements on the industrial spurs in the area.

Finally, with respect to freight operations on the Duplainville route option, WCL will need to build additional sidings to accommodate projected growth in freight train traffic. By accommodating passenger rail service, WCL's need for additional sidings is reduced from 26 miles to 15 miles, if the passenger trains operate at speeds up to 79-mph and to only 10 miles if the passenger trains operate at speeds up to 110-mph.

Exhibit 6-24
Schematic Representation of Proposed Sidings to Mitigate Train Meets on the Duplainville Route Caused by 110-mph Passenger Train Service

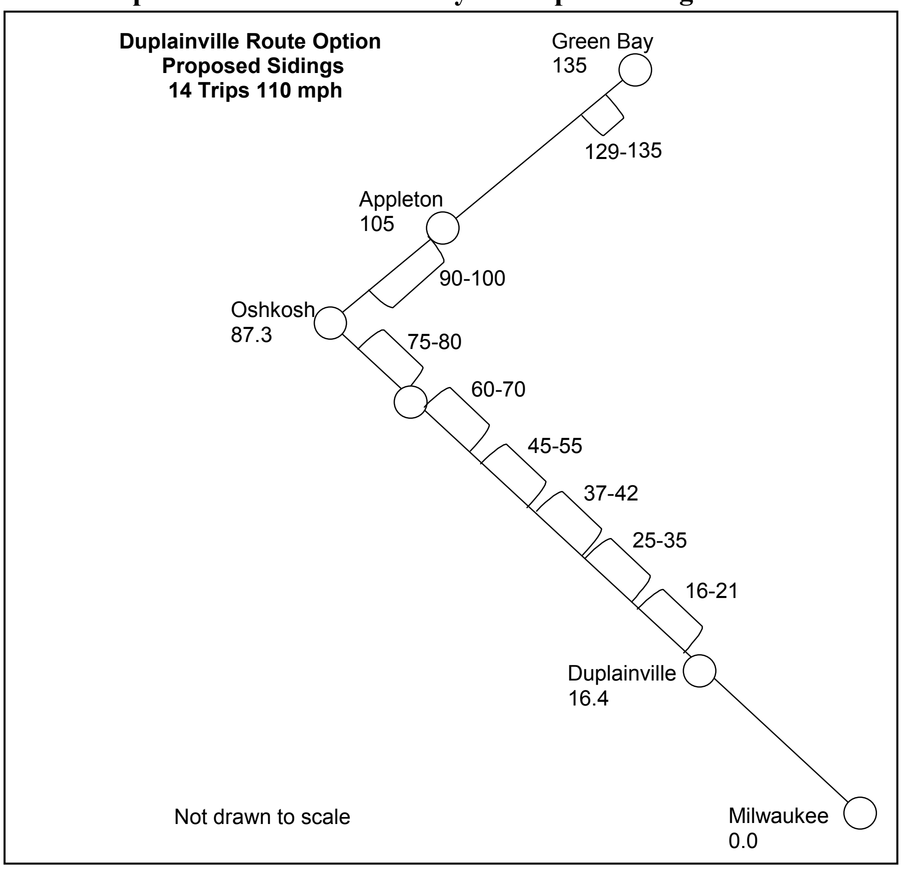
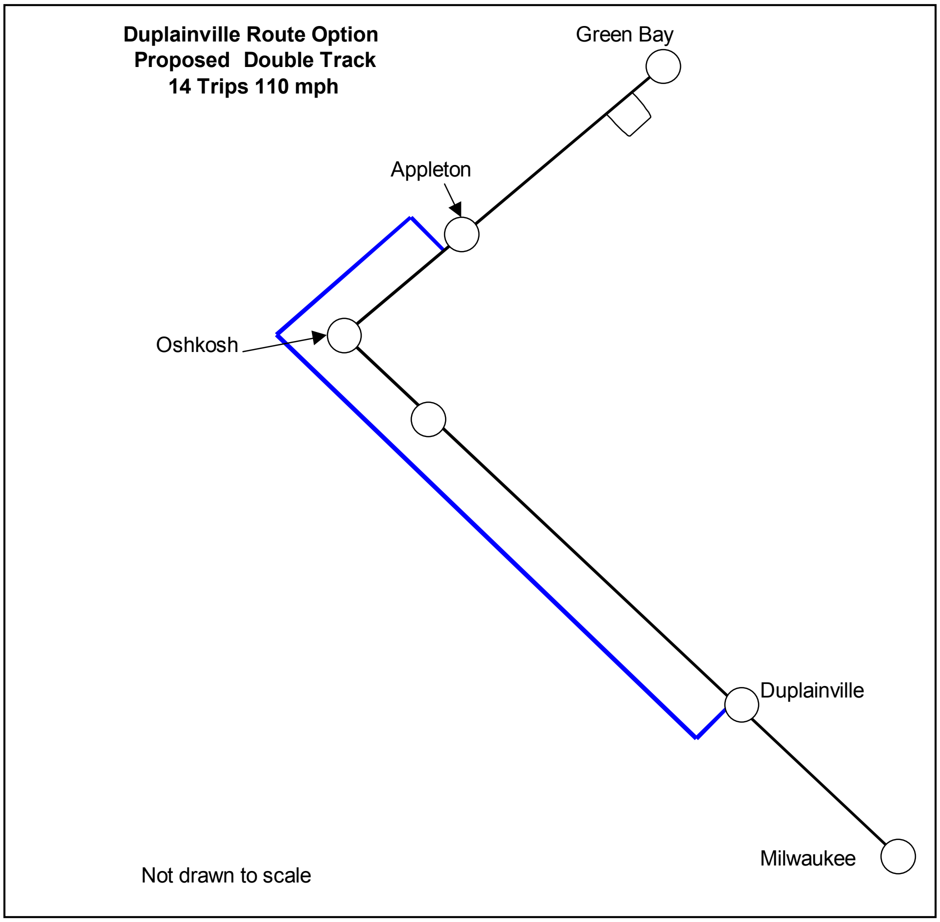


Exhibit 6-25
Schematic Representation of Proposed Double Track for the Duplainville Route to Accommodate 110-mph Passenger Train Service



6.16 Chicago-Quincy Corridor Assessment

From Chicago Union Station, this route traverses three BNSF Subdivisions. From east to west, they are the Chicago, Mendota and Brookfield Subdivisions. The Chicago Subdivision has two to four tracks, with multiple crossovers typically every two to four miles, and two major terminals: Cicero Intermodal yard and Eola classification yard. Mendota Subdivision is double-track with crossovers typically every 11 to 12 miles; the Galesburg classification yard is at its west end. Brookfield is single-track with nine passing sidings that are longer on the east end to allow for holding trains awaiting access to Galesburg yard. Siding spacing is from six to 12 miles, averaging nine miles apart.

The current traffic control system in use on all three of these Subdivisions is Centralized Traffic Control (CTC) and current freight speed limits are 50-mph between Chicago and Aurora and then 60-mph between Aurora and Quincy, except for loaded coal trains, which are limited to 50-mph and empty coal trains that are limited to 55-mph.

Chicago region traffic currently originates in Eola and Cicero and will originate in Joliet Arsenal, possibly joining this route in either Eola (off the EJ&E) or Galesburg (off the Chillicothe Subdivision). Traffic density is highest in the Chicago region, with 150 train movements a day up to Aurora. Aurora is both the terminus of Metra commuter trains and where Twin Cities and Pacific Northwest traffic split off, including most of the intermodal traffic from Cicero. The line from Aurora to Galesburg has 20 trains per day, including Powder River Basin coal traffic, Amtrak's *Illinois Zephyr* and two long distance trains – the *California Zephyr* and *Southwest Chief* – which split off at Galesburg. Between Galesburg and Quincy, 12 trains per day operate, including the *Illinois Zephyr* to Galesburg. This corridor was modeled with 27 freight trains (total includes both eastbound and westbound trains) per day between Eola and Galesburg and 21 freights between Quincy and Galesburg.

The Chicago-Quincy Ideal Day analysis assumed that MWRRS traffic operates at 110-mph, with four roundtrips daily between Chicago Union Station and Quincy and five daily round trips on the Omaha branch that splits off this line at Wyanet, IL. MWRRS trains operate intermixed with freight traffic along the full length of the corridor. In multiple-track territory, only one track will be upgraded to 110-mph. *Subsequent to completion of this study, the planning speed was reduced from 110-mph to 90-mph from Chicago to Quincy.* However since the capacity needs were based on a passenger design-speed of 110-mph, they are conservative from a freight perspective.

Chicago-Quincy is, in general, a high capacity, well-engineered route with a long and ongoing history of handling passenger and other priority traffic. There is also a long history of moving trains on a multiple bi-directional railroad. In addition, this route is operated by a single railroad, which significantly increases the likelihood of smooth operations. As noted, commuter windows are a concern for some trains, but in general, the proposed MWRRS schedule has many trains operating outside the windows and avoiding the resulting delays. Cicero Yard is a very important terminal on this route. Since it has been redeveloped recently, it will continue to play a major role in years to come even as new terminals such as Joliet Arsenal develop. The intermodal train departures typically create local fleeting problems, especially in the early evening with multiple westbound trains having similar cutoff and departure times. While this is a concern in the Chicago region, the majority of this traffic moves off the corridor at Aurora bound for Pacific Northwest and Twin Cities destinations.

Base level (2010) delays were calculated at 3,100 minutes for the corridor. The addition of the MWRRS brought the total delay to 5,700 minutes, an 84 percent increase over the forecast base.

The increase in delays with the addition of the MWRRS passenger traffic was attributable to the following:

- Passenger Traffic: Heavy commuter traffic from Aurora to Chicago Union Station (CUS), including express trains operating on the middle main.
- Freight Traffic: the limited hours of freight operation in the commuter district (commuter windows) and the resulting congestion west of Eola. The commuter windows typically created situations where the freight trains bunch up as these trains attempt to make it through the window. Eastbound passenger trains that operated when the window was closed can overtake significant traffic, especially eastbound freight trains waiting just

west of Eola for the window to open. The MWRRS passenger trains typically encountered these trains east of Galesburg, particularly around Mendota.

- Galesburg Yard: The yard leads at the north end of Galesburg yard are short, forcing yard jobs to pull out onto the main when switching the leads.
- Brookfield Subdivision: The sidings west of Galesburg on the Brookfield Subdivision are restrictive. The sidings near Galesburg were lengthened to hold trains awaiting room in Galesburg yard while the sidings to the west are generally short, some far too short, for long coal trains.

Potential Mitigation Options (all mileposts are from CUS and are the same as local railroad mileposts):

- Passenger Traffic: the Chicago area was included in this study
- Freight Traffic: Fleeting trains will have a particular impact on the Mendota Subdivision between Aurora and Galesburg. To accommodate this, add a 10-mile passenger siding plus two pairs of 45-mph crossovers between the original two mains between milepost (mp) 82 and 92 for multiple meets and overtakes between passengers and freights. For additional flexibility on this section of double track, add 45-mph double crossovers at mp 66 and mp 105 and a second set of 30-mph crossovers at mp 80 and mp 129. In addition, add a two-mile long freight siding around mp 62-63 mainly for holding eastbound traffic waiting to get into Eola.
- Galesburg Yard: To keep Galesburg yard jobs off the main, extend the yard lead east past the station for approximately ½ to 1 mile.
- Brookfield Subdivision: Extend the Abingdon siding (mp 173) west by about 2.4 miles and add a pair of 30-mph crossovers in the middle (near current west turnout). This would allow for westbound freights to depart and hold clear of Galesburg while simultaneously allowing eastbound trains to wait for clearance into Galesburg with room for a passenger train to pass both. Extend the Colchester siding (mp 210) to 10 miles long, east to mp 207 and west to mp 217, for passenger-to-passenger meets. Include a pair of 45-mph crossovers in the middle at the current west turnout for additional flexibility.

The total level of infrastructure improvement is as follows (not including Chicago Union Station to Eola):

- Capacity improvements addressing passenger needs: 18 miles of new trackage, plus four premium turnouts (60-mph) for new *passenger* sidings and sixteen 45-mph turnouts for higher-speed crossovers
- Capacity improvements addressing freight needs: three miles of new trackage, plus 12 turnouts (30-mph) for use in *freight* sidings and lower-speed crossovers

The results of this analysis show that these improvements should be sufficient to accommodate the MWRRS trains operating over some or all of this route (including the Omaha branch trains). Overall, delays with improvements were 3.2 percent above the total delays experienced in the forecast base case scenario.

Freight train delays were virtually unchanged from the pre-MWRRS conditions, with a one percent increase over existing delays, well within the margin of error in this analysis.

All passenger trains, including the 18 MWRRS trains, using this corridor ended with, on average, about three additional minutes in delay with all of the improvements in place, well within the planned recovery time. Average delays for freight trains increased by less than a minute.

Exhibit 6-26 shows that all passenger trains, including the 18 MWRRS trains, using this corridor ended with, on average, about three additional minutes in delay with all of the improvements in place, well within the planned recovery time. Average delays for freight trains increased by less than a minute.

Exhibit 6-26
Additional Average Delays per Train, Chicago-Quincy Corridor
(With Infrastructure Improvements)

	# Trains Modeled	***Additional Delays***
Passenger	22	3.2 Minutes
Freight	48	0.6 Minutes
Total	70	1.4 Minutes

6.17 Wyanet-Omaha Corridor Assessment

The Omaha branch diverges from the Chicago-Quincy line at Wyanet, IL. From there to Omaha, NE, trains operate over the Iowa Interstate Railroad. On-line yards exist in Des Moines, Iowa City and the Quad Cities area, mainly for local traffic. The entire route is single-track, with 25 passing sidings. The sidings tend to be relatively short, typically 4,000 to 6,000 feet in length. Siding spacing is in the order of eight to 18 miles on the eastern two-thirds of the route and higher (up to 28 miles apart) on the west end. The current traffic control system on the entire route is Track Warrant Control (TWC). Current freight speed limits are 40-mph.

Current freight traffic is light with a mix of local, mainly agricultural carload freight and through traffic, including intermodal. Omaha freight traffic generally terminates offline in the Union Pacific yard in Council Bluffs. No passenger service currently exists on this route. This corridor was modeled with three through freights each way per day along the full length of the route.

MWRRS traffic operates at 79-mph on this corridor co-mingled with freight traffic along the full length of the corridor. There are four roundtrips daily between Chicago Union Station and Omaha and one daily round trip between Chicago and Des Moines.

Two other factors to consider on this route are that this corridor is a relatively low volume freight route, and operation over the entire route is on one railroad, simplifying traffic control and dispatching.

Base level delays for the corridor were calculated at 160 minutes in the year 2010. The addition of the MWRRS brought the total delay to 820 minutes, a 412 percent increase over the forecast base.

The increase in delays with the addition of the MWRRS passenger traffic was attributable to the following:

- Passenger Sidings: The line is long (365 miles) without infrastructure necessary for train meets. There is currently no way for passenger trains to meet without incurring significant delays.
- Freight Sidings: Many of the sidings are short with only hand-thrown turnouts.
- Omaha Terminal: Potential congestion problems exist in the Omaha terminal area, particularly if freight traffic volumes increase subsequent to MWRRS track upgrades.

Potential Mitigation Options (Iowa Interstate Railroad mileposts/corridor mileposts from CUS):

- Passenger Sidings: Passenger-to-passenger sidings need to be built by extending existing freight sidings to 6 miles in length (5 for Durant) at Atkinson (mp 151/135), Durant (mp 203/188), Marengo (mp 267/251), Ascalon (mp 297/281) and Earlham (mp 387/372). In all cases, add 60-mph turnouts and switch machines. In addition, extend the siding at Rock Island (mp 181/165) through the station area and add 45-mph powered turnouts.
- Freight Sidings: Add switch machines and upgrade turnouts and sidings for freights at Atlantic (mp 440/424). Extend Colfax (mp 334/319) and Casey (mp 410/394) sidings to 2 miles in length for freight meets.
- Omaha Terminal: The Omaha terminal issues are not addressed in this study but need to be further addressed. A preliminary analysis shows that the addition of a 1-mile long freight siding around mp 484/464 will provide the ability to stage traffic into and out of Council Bluffs.

The total level of infrastructure improvement is as follows:

- Capacity improvements addressing passenger needs: 28 miles of new trackage, ten 60-mph premium turnouts and two 45-mph turnouts for new sidings.
- Capacity improvements addressing freight needs: 3 miles of new trackage, plus eight turnouts (30-mph) for use in *freight* sidings and lower-speed crossovers. The results of the analysis show that the improvements will cut delays from an unimproved MWRRS by almost 96 percent, but they were not reduced completely to within the margin of error of the forecast base level. This is due to the long length of the corridor and the insufficient number of sidings.

The freight trains that are projected to be in operation on this corridor actually see a reduction in total delays of around 30 percent on the corridor with infrastructure improvements (see Exhibit 6-27).

Exhibit 6-27
Omaha Branch Additional Average Delays per Train
(With Infrastructure Improvements)

	# Trains Modeled	*Additional Delays*
Passenger	10	8.0 Minutes
Freight	6	-8.3 Minutes
Total	16	1.9 Minutes

The 10 MWRRS passenger trains on this corridor ended with, on average, eight additional minutes in delay with all of the improvements in place. This total was in addition to the three minutes of average delay gained on the Wyanet to Chicago segment of the line. On average, the six modeled freight trains lost over eight minutes in delays.

6.18 Chicago-Carbondale Corridor Assessment

This study assessed the planned future MWRRI route, not the current Amtrak route that uses the St. Charles Air Line. From Chicago Union Station, this route first operates over Amtrak trackage to 21st Street, interlocking then on the Norfolk Southern Chicago Line to *Grand Crossing*, where the line crosses over Canadian National track on the south side of Chicago. There are two major intermodal terminals on the NS – 55th Street and Park Manor.

The connection to the CN line at Grand Crossing would be new. From this new connection, the route follows the CN all the way to Carbondale, operating over three districts. From the north, the route is on the Chicago, Champaign and Centralia districts. The Chicago District is four tracks on the first 14 miles on the north end, narrowing to three tracks for 3.5 miles, double-track for the next five miles and then single-track with seven passing sidings (including six miles of double track in Gilman, IL). The sidings are typically about two miles in length and spaced eight to 10 miles apart.

There are major freight and intermodal yards in the Homewood/Harvey area. The Champaign District is mainly single-track with nine passing sidings that are typically two to three miles long and spaced every nine to 12 miles (spacing increases to 14 and 19 miles for the last two sidings north of Centralia). There are six miles of double-track through Centralia. The only terminal of any significance on this district is a freight yard in Champaign. The Centralia District is single track south of Centralia, with three passing sidings going into Carbondale. The sidings range in length from 4,000 feet to 4-½ miles and are spaced from six to 15 miles apart. The last five miles into Carbondale are double-tracked. The current traffic control system throughout this route is CTC, with the exception of some diamonds that are locally controlled. Current freight train speed limit is 60-mph.

Much of the current freight traffic on this route originates in the Chicago area, though recently there has been a significant change to more through traffic from Canada with the acquisition of Wisconsin Central by Canadian National. A fair amount of traffic enters the line at crossings in central Illinois. Traffic also leaves the route at various local yards or at junctions. Consequently, traffic density varies along the route. Each day there are 35 freight trains from the Chicago area to Kankakee, 30 trains between Kankakee and Gillman, 24 freights between Gillman and Champaign, 18 freights between Champaign and Effingham, and 26 freights between Effingham and Carbondale. Freight train traffic includes intermodal trains originating in Harvey. In addition, Amtrak currently operates two trains per day on this route, the *Illini* to Carbondale and the long distance *City of New Orleans* running the length of this corridor on its way to New Orleans.

Freight traffic was modeled as follows: 39 freights between Chicago and Kankakee, 33 between Kankakee and Gilman, 28 between Gillman and Champaign, 20 between Champaign and Effingham and 30 from Effingham to Carbondale.

In this analysis, MWRRS traffic was assumed to operate at 110-mph, with two roundtrips daily between Chicago Union Station and Carbondale, plus three round trips per day between Chicago and Champaign. MWRRS trains operate intermixed with freight traffic. In multiple track territory, only one track will be upgraded to 110-mph. *Subsequent to completion of this study, the planning speed was reduced from 110-mph to 90-mph from Chicago to Carbondale.* However since the capacity needs were based on a passenger design-speed of 110-mph, they are conservative from a freight perspective.

The Chicago-Carbondale route is, in general, a highly efficient corridor with current passenger service on the route. Outside of Chicago, this route is also on a single railroad that already has scheduled freight operations (unlike most other freight operations), which significantly increases the likelihood of smooth operations. As noted below, commuter congestion in the Chicago area is a concern, but in general, the Metra and South Shore commuter trains operate on dedicated trackage from University Park to Chicago (the South Shore trains operate only as far as Kensington).

At-grade railroad crossings are a definite concern. This route has multiple at-grade mainline railroad crossings (at Kensington, Kankakee, Tolono, Tuscola, Effingham, Odin, Ashley and Tamaroa). Cross traffic can be heavy in places, placing restrictions and even operating windows for traffic on the CN. Kensington Junction in particular sees a significant number of train movements with crossing South Shore commuter traffic. The management of crossing slots where used will be key for consistent operation. Contingency slots will need to be built into critical junctions as necessary.

Base level delays were calculated at 3,260 minutes for the corridor. The addition of the MWRRS brought the total delay to 4,580 minutes, a 40 percent increase over the forecast base.

The increase in delays with the addition of the MWRRS passenger traffic was attributable to the following:

- Sidings: The route was single-tracked south of the commuter district when Illinois Central (IC) operated it. Siding lengths were designed primarily with freight traffic in mind, and as a result, siding lengths are typically inadequate for unobstructed MWRRS passenger service.
- CN Operations: After Canadian National merged with IC, this line became a key route in the new, integrated system. Recent projects have seen intermodal terminal upgrades at Harvey and improved connections with CN lines into Michigan and Canada. These improvements have resulted in a growth in freight traffic with more likely to follow.

Potential Mitigation Options (all mileposts are from CUS and are the same as local railroad mileposts):

- Sidings: The majority of passenger meets occur in multiple track territory. Consequently, only a few freight sidings need to be upgraded. For passenger-to-passenger meets, extend the Kankakee siding (mp 54) south into the station area connecting to Otto siding (two miles total). In addition, install a pair of crossovers north of the NS Streator line crossing. This will enable meets and overtakes during station stops. Extend Ashkum siding (mp 72) eight miles south to the Gillman double-track. Add a pair of crossovers around mp 75, primarily for passenger-to-passenger passing. In addition, extend the Paxton siding (mp 100) by three miles and add premium turnouts.
- CN Operations: The additional sidings noted above should allow for the expected freight traffic growth. The intermodal trains departing Chicago are fleeted to a degree, but not to the extent of other corridors, as travel times to certain cities (like New Orleans) generally allow for later cutoff times.

The total level of infrastructure improvement is as follows:

- Capacity improvements addressing passenger needs: 13 miles of new trackage, plus six premium turnouts (60-mph) for new sidings and four 45-mph turnouts for higher-speed crossovers.
- Capacity improvements addressing freight needs: four 30-mph turnouts for lower-speed crossovers.

In addition to the above changes to the infrastructure, MWRRS train number 400 from Carbondale-Chicago was moved back by 10 minutes for improved meets. The departure time from Carbondale changed to 6:38 a.m. with arrival at 10:50 a.m. at CUS.

The results of this analysis show that these improvements should be sufficient to accommodate the MWRRS trains operating over this route. Overall, delays with improvements were 2.5 percent above total delays experienced in the forecast base case scenario. Freight train delays were virtually unchanged from the pre-MWRRS conditions, coming in at less than 1 percent of existing delays, lower than the margin of error in this analysis.

As indicated by Exhibit 6-28, all passenger trains using this corridor, including the 10 MWRRS trains, ended with, on average, five additional minutes in delay with all of the improvements in place, which was within the planned recovery time. Freight train delays were essentially unchanged from the base forecast level.

Exhibit 6-28
Additional Average Delays per Train, Chicago-Carbondale Corridor
(With Infrastructure Improvements)

	# Trains Modeled	***Additional Delays***
Passenger	12	5.0 Minutes
Freight	150	0.1 Minutes
Total	162	0.5 Minutes

6.19 *Chicago-Cincinnati Corridor Assessment*

This route is one of the most complicated of the eight routes examined in this report. Initially, it was proposed that MWRRS trains would operate on Amtrak trackage to 21st Street, followed by the NS Chicago Line, the *South-of-the-Lake* improvement, CSX Garrett Subdivision, the Alida connection, CSX Medaryville Spur, CSX Monon Subdivision, CSX Lafayette Subdivision, CSX Crawfordsville Branch, CSX St. Louis Line, CSX Shelbyville Secondary and the Central Railroad of Indiana (CIND) for the final run from Shelbyville, IN, to Cincinnati, OH.

Subsequent to completion of this analysis, the routing from Chicago was changed. Instead of using the busy CSX Garrett Subdivision from Gary, IN to Alida, IN a distance of about 25 miles, the former PRR Fort Wayne line to Wanatah was proposed. In this option trains would turn south at Wanatah, which is just 6 miles south of Alida, onto their originally planned route towards Medaryville and Indianapolis. The advantage of using the Fort Wayne line is that it not only avoids the busy CSX Garrett Subdivision, but is also the route for the Chicago-Fort Wayne-Toledo-Cleveland MWRRI trains, so some capital and maintenance costs can be shared.

While this analysis of the northernmost part of the route from Chicago to Alida no longer reflects current planning assumptions, the vast majority of the analysis is still relevant to the MWRRS capital plan south of Wanatah. Funding limitations have not permitted the previous study to be updated. This section summarizes capacity planning work as it was originally completed in 2002, however to reduce possible confusion, references to the CSX Garrett Subdivision (that will no longer be used) and Alida improvements have been removed to footnotes.

The Chicago Line and the St. Louis Line are all double-track with multiple crossovers and CTC traffic control. The South of the Lake improvement is assumed double-track throughout. The remaining lines are single-track in general, with relatively few passing sidings.

There are no passing sidings on the Medaryville Spur. The CSX Monon, Lafayette and Crawfordsville lines combined have five passing sidings plus a stretch of double-track through Lafayette yard, which is used primarily as a yard lead. There are intermodal yards at 55th Street and Park Manor on the NS Chicago Line, and there is a freight yard on the CSX in Lafayette. The Medaryville spur is unsignaled and operates as a single block for its entire length.

Direct Traffic Control (DTC) is used on the Monon and Lafayette subs, while Form D Control System (DCS) traffic control is used on the Crawfordsville branch and Shelbyville secondary. Current freight train speed limits are 70-mph for the Garrett Subdivision; 60-mph for the Monon and Lafayette Subdivisions, the Crawfordsville branch and the St. Louis Line; 40-mph on the Shelbyville Secondary; and 25-mph on the Central Railroad of Indiana extending from Shelbyville to Cincinnati.

Traffic on this line is almost as varied as the route. The line from Wanatah south to Monon sees at most one local train a day between Monon and Medaryville. Between Monon and Crawfordsville, CSX operates up to 10 trains per day. There are also three to four freight trains a day operating between Lafayette and Indianapolis. South of Indianapolis, traffic thins to four freight trains per day to Shelbyville and approximately two per day between Shelbyville and Cincinnati on the CIND. Amtrak's *Cardinal*, operates between Monon and Indianapolis.

Train operations on this corridor were modeled as follows: 12 freight trains per day between Monon and Crawfordsville, five freight trains per day between Lafayette and Indianapolis, seven trains per day between Indianapolis and Shelbyville and five trains between Shelbyville and Cincinnati[5]. Traffic on the St. Louis Line was not modeled due to the very short length in which MWRRS trains will operate on this route.

MWRRS traffic operates at 110-mph, with five round trips daily between Chicago Union Station and Indianapolis, plus one round trip per day between Chicago and Indianapolis and one round trip per day between Indianapolis and Cincinnati. Both tracks on the *South-of-the-Lake* improvement were assumed to be 110-mph. MWRRS trains are co-mingled with freight traffic along most of this route except on the South of the Lake line and from Wanatah to Medaryville.

This is a complicated route operating over multiple railroads and divisions, making centralized passenger train control a key to success on this corridor. Ensuring that every railroad and division know when to expect MWRRS trains will be critical to minimizing the delays when transitioning from one line to another. The main strength of this corridor is that the majority of the route is on low freight volume or dedicated passenger trackage, which should help to minimize delays.

The base level delays were calculated at 660 minutes for the corridor. The addition of the MWRRS brought the total delay to 1,360 minutes, a 106 percent increase over the forecast base.

The increase in delays with the addition of the MWRRS passenger traffic was attributable to the following[6]:

- Northern Sidings: Going south from Alida, there are only 2 short sidings until Lafayette, and those are between Monon and Lafayette. The lack of passing points on the north end of this route can seriously hamper consistent operations.
- Lafayette: Once in the Lafayette area, there can be significant freight train congestion around the yard and station. CSX often fleets freight trains, especially northbound trains, which results in trains blocking the main while waiting for access to the yard.
- Central Sidings: There are no sidings between Crawfordsville (Ames) and Indianapolis (33 miles).
- Indianapolis: The CSX St. Louis Line is another high volume route with potential congestion in Indianapolis.
- Southern Sidings: There are no sidings from Indianapolis to Shelbyville and only a few short sidings known to exist on the line south to Cincinnati.

[5] 57 trains per day were modeled on the Garrett Subdivision

[6] CSX Traffic: The CSX Garrett Subdivision was double-tracked subsequent to the Conrail acquisition to handle expected major traffic increases. Traffic has increased significantly on the line, resulting in a greater potential for delays, especially because the passenger routes on both sides are single-track lines without passing sidings.

Potential Mitigation Options[7] (local railroad mileposts/corridor mileposts from CUS):

- Northern Sidings: Extend the Brookston siding (mp 105/114) north through Chalmers and into Reynolds (mp 97/104), creating 10-mile long siding primarily for passenger-to-passenger meets. Include 60-mph turnouts on each end plus two sets of single 45-mph crossovers at Brookston and Reynolds for local freights and multiple meets. Add a two-mile long freight siding roughly halfway between Monon and Alida, as both extra insurance for passenger meets and for local freight traffic meets.
- Lafayette: Extend the double track north of Lafayette yard (mp 117/125) by approximately 2 miles to just south of the Wabash River Bridge to provide for additional freight staging room clear of the mainline. Upgrade the siding south of Lafayette at mp 122/130, adding 45-mph turnouts and switch machines to provide both staging room south of Lafayette yard and the ability to pass passenger trains if necessary. Extend the Linden siding (mp 137/146) to five miles long, with a pair of crossovers in the middle to allow for both passenger-to-passenger meets, freight train meets and overtakes.
- Central Sidings: Add a four-mile long siding at Jamestown at mp 31/173.
- Indianapolis: No change is needed on this line as well due to the minimal distance running on the St. Louis line (including station stop at Indianapolis). The line already has multiple crossovers for flexibility.
- Southern Sidings: Extend the Shelbyville siding (mp 82/232) to about 9.5 miles in length (three miles north and two miles south) to allow for passenger-to-passenger meets. Include a pair of freight crossovers in the middle to turn CSX and Central of Indiana freight trains. In addition, improve the existing siding at mp 64/250 with new powered turnouts (45-mph). Add a two-mile freight siding around mp 30/285 to provide the ability to stage traffic into and out of Cincinnati.

The total level of infrastructure improvement is as follows:

- Capacity improvements addressing passenger needs: 21 miles of new trackage, plus eight premium turnouts (60-mph) for new sidings and 16 higher speed turnouts (45-mph) for crossovers and one passing siding
- Capacity improvements addressing freight needs: seven miles of new trackage, plus seven turnouts (30-mph) for use in *freight* sidings and lower-speed crossovers

The results of the analysis show that these improvements should be sufficient to accommodate the 14 daily MWRRS trains operating over this route with additional room for even more growth. Overall, delays with improvements were 6.1 percent less than the total delays experienced in the forecast base case scenario. Freight train delays were nine percent less than the pre-MWRRS conditions.

Exhibit 6-29 shows that all of the passenger trains on this corridor, including the 14 MWRRS passenger trains using this corridor, ended with, on average, less than two additional minutes of delay with all the improvements in place, well within the planned recovery time. Freight train delays were, on average, slightly less than the base forecast.

[7] CSX Traffic: To increase flexibility on the Garrett Subdivision, 45-mph crossovers were also added at Alida mp 221/52.3 to allow for passenger trains to operate on either track.

Exhibit 6-29
Additional Average Delays per Train, Chicago-Cincinnati Corridor
(With Infrastructure Improvements)

	# Trains Modeled	***Additional Delays***
Passenger	12	1.7 Minutes
Freight	86	-0.7 Minutes
Total	98	-0.4 Minutes

6.20 Chicago-Pontiac via Detroit

While not quite as complicated as the Chicago-Cincinnati route, the Chicago-Detroit corridor comes close. Leaving Chicago Union Station, the route follows Amtrak to 21st Street, the NS Chicago Line to Porter, Amtrak's Michigan Line to Kalamazoo, the NS Michigan Line to just outside Detroit (with a short stretch in Battle Creek on the CN South Bend Subdivision), followed by a trip on the Conrail Shared Assets Michigan Line and then their North Yard Branch, with the final leg into Pontiac on the CN Holly Subdivision.

The NS Chicago Line, the CN line in Battle Creek and the Conrail and NS lines in the Detroit region are all double-track with crossovers. Crossovers are situated every two to three miles near Chicago to every four to seven miles near Porter on the Chicago Line. Furthermore, the Detroit region has multiple crossovers. The remaining route is single-track with passing sidings.

The Amtrak line has eight sidings roughly 10 to 12 miles apart. While the line between Battle Creek and Kalamazoo is double-track on both ends, there are no sidings on the 16 miles of single track in between. East of Battle Creek has five sidings between three to 17 miles apart. There are intermodal yards on the NS Chicago Line at 55th Street and Park Manor and Livernois freight yard in Detroit. Traffic control is CTC throughout with Incremental Positive Train Control currently in revenue service as part of an FRA demonstration project on the Amtrak Michigan line.

Outside of the Chicago and Detroit regions, the traffic on this route is largely passenger. Even before ConRail was formed in the late 1970's, the Penn Central hds shifted most of its freight south between Detroit and Chicago via Toledo. Since ConRail didn't want to include this line segment in their network, Amtrak acquired ownership of the Porter to Kalamazoo line. Amtrak currently operates four round trips per day on this route, including the *Blue Water*[8] between Chicago and Battle Creek. Amtrak service changes however, have no effect on the line capacity simulation that was performed since future MWRRS schedules and not current Amtrak schedules are what was simulated.

Freight train operations on this corridor were modeled as follows: five total trains per day between Porter and Kalamazoo, 15 per day between Kalamazoo and West Detroit, 32 per day between West Detroit and Milwaukee Junction and 16 per day between Milwaukee Junction and Pontiac. This is intended to reflect a peak day freight operation. The only Amtrak train modeled

[8] The *Blue Water* replaced a longer-distance international train to Toronto, the *International*.

was the *International*. CN traffic in Battle Creek was not modeled due to the short length of the route shared with the MWRRS.

MWRRS traffic operates at 110-mph, with four roundtrips daily between Chicago Union Station and Pontiac, plus 5 round trips per day between Chicago and Detroit and 1 daily round trip between Chicago and Battle Creek. Mainline trains were assumed either to operate between Kalamazoo and Chicago with the branch line trains coupled. This operating scenario is currently under evaluation. MWRRS trains operate intermixed with freight traffic. In multiple track territory, only one track will be upgraded to 110-mph.

Another factor to consider here is that the entire route is the same as the current Amtrak route to Detroit and Pontiac. This has led to well-established procedures for operating passenger trains despite the multiple railroads involved. The Amtrak ownership of the Porter-Kalamazoo line and height restrictions help to keep freight traffic relatively low, with the exception of the areas around Chicago, Battle Creek and Detroit. The Detroit area has several improvements already in the planning stages, including the New Center Station and the addition of a new connecting track between Conrail and the CN at West Detroit.

Base level delays were calculated at 980 minutes for the corridor. The addition of the MWRRS brought the total delay to 3,500 minutes, a 350 percent increase over the forecast base.

The increase in delays with the addition of the MWRRS passenger traffic was attributable to the following:

- Chicago: Congestion on the Chicago line and in the Chicago terminal area. Intermodal trains are particularly important on this route and tend to operate in fleets both eastbound and westbound to meet tight cutoff and departure times.
- Passenger Meets: Relatively short sidings between Kalamazoo and Porter for passenger-to-passenger train meets create the potential for delays in waiting for opposing traffic.
- Kalamazoo: There are no sidings between Battle Creek and Kalamazoo. With Port Huron branch line trains operating between Battle Creek and Kalamazoo, the result is 28 passenger trains per day (plus the Amtrak International) on this line. In addition, splitting the trains results in a 20-minute gap on eastbound trains, creating a significant potential bottleneck, particularly for any freight traffic operating during the day. The limited windows available for freight operations, except for the hours between 1 and 5 a.m., result in little time for on-line local switching. The lack of slots will lead to fleeting of the few freight trains operating on the line, which may compound delays.
- Battle Creek: Potential freight and passenger train congestion through Battle Creek.
- Sidings: East of Battle Creek towards Detroit, there are relatively long distances between sidings.
- Detroit: Though perhaps not as severe as Chicago, the Detroit area also faces congestion delays, especially at major interlockings.

Potential Mitigation Options (local railroad mileposts/corridor mileposts from CUS):

- Chicago: Chicago west of Porter is not included in detail in this study due to the complexity of the operations. Additional trackage is likely needed in this area, and fleeting concerns will likely have to be addressed through the development and management of detailed freight and passenger train operating schedules.

- Passenger Meets: Extend Three Oaks siding (mp 214/68) to connect with Dayton siding (10 miles) to create 13.5 miles of double track for unobstructed passenger-to-passenger train meets. Include a pair of 45-mph crossovers in the middle of the siding and extend the Dowagiac siding (mp180/102) east five miles to the siding at mp 173/109.
- Kalamazoo and Battle Creek: Extend the double track west from Battle Creek by about 1 mile and upgrade turnouts to 60-mph on both the Battle Creek and the Kalamazoo end. This provides about 22,000 feet (vs. 16,600 ft.) of unrestricted double track at Battle Creek to enable eastbound freights to accelerate up to 60-mph and keep this speed through the turnout and onto the single-track section. Even with these changes, freight trains will have to be carefully slotted on this line to avoid major delays.
- Sidings: Extend the Chelsea siding (mp 56/226) two miles west to mp 58/224 and add a pair of crossovers in the middle of the siding. Add a single set of crossovers in the Jackson siding (mp 78/203). Both of these upgrades would allow for three-way meets. Add a freight siding at mp 34/247 (about 10,000 feet long), mainly for staging local traffic.
- Detroit: The Detroit terminal was not analyzed in detail for this study due to its complexity.

The total level of infrastructure improvement is as follows:

- Capacity improvements addressing passenger needs: 18 miles of new trackage, plus eight premium turnouts (60-mph) for new sidings and four 45-mph turnouts for higher-speed crossovers.
- Capacity improvements addressing freight needs: two miles of new trackage and eight turnouts (30-mph) for use in *freight* sidings and lower-speed crossovers.

The results of this analysis show that these improvements should be sufficient to accommodate the MWRRS trains operating over this route. Overall, delays with improvements were 3.1 percent above the total delays in the forecast base case scenario. As noted above, freight trains will still need to be carefully slotted between Battle Creek and Kalamazoo, as will passenger trains coming into and out of Chicago.

Freight train delays were about 2 percent more than the pre-MWRRS conditions without any significant schedule adjustments. This value is well within the margin of error for this analysis.

The 28 MWRRS passenger train movements on this corridor ended with, on average, less than one additional minute in delay with all of the improvements in place (Exhibit 6-30), well within the planned recovery time. Freight traffic likewise saw an increase in average delay of less than one minute per train.

Exhibit 6-30
Additional Average Delays per Train, Chicago-Pontiac Corridor
(With Infrastructure Improvements)

	# Trains Modeled	***Additional Delays***
Passenger	28	0.4 Minutes
Freight	68	0.3 Minutes
Total	96	0.3 Minutes

6.21 Holland-Kalamazoo

From Holland going east, this route follows the CSX Grand Rapids Subdivision, followed by the CSX Grand Rapids Terminal Subdivision and then the NS BO Secondary from Grand Rapids to Kalamazoo. With the exception of double track in Grand Rapids and Holland, this entire route is single track with passing sidings. There is one passing siding between Holland and Grand Rapids and 4 short passing sidings south to Kalamazoo. There is a local freight yard on line in Grand Rapids. The traffic control systems currently in use are: CTC on the CSX Grand Rapids Subdivision, Automatic Block Signals (with tracks signaled for one direction) on the CSX Grand Rapids Terminal Subdivision, and DCS on the NS BO Secondary. Current freight train speeds are 25-mph on the Grand Rapids Terminal Subdivision and 40-mph on the NS BO Secondary.

This line has light freight traffic throughout, particularly on the NS BO Secondary. Amtrak currently operates an established service between Holland and Grand Rapids. Freight traffic was estimated for this analysis at four trains per day each way between Holland and Kalamazoo, plus 6 total trains per day between Holland and Grand Rapids.

MWRRS traffic operates at 79-mph, with four roundtrips daily between Holland and Kalamazoo. MWRRS trains operate intermixed with freight traffic.

Base level delays were calculated at 60 minutes for the corridor. The addition of the MWRRS brought the total delay to 240 minutes, 300 percent over the forecast base.

Due to the very light level of traffic, there are essentially no concerns on this route, with the exception of the lack of sidings between Grand Rapids and Kalamazoo. This poses a problem with two passenger-to-passenger train meets on this line segment with the current schedule. These two meets are responsible for the increase in delays with the addition of the MWRRS passenger traffic:

- Sidings: there are few sidings for meets between two passenger trains and between a passenger train and a local freight switching industries between Kalamazoo and Grand Rapids.

Potential Mitigation Options (local railroad mileposts/corridor mileposts from Holland):

- Sidings: add a 1-mile siding between mileposts 90/38 and 91/37 for local freights for both passenger-to-passenger and freight meets. A siding of this length will impose a delay on one of the passenger trains in a two-train meet, but a short siding is justified in this case given the low volume on this route. In addition, upgrade the existing passing siding at Plainwell (mp 66/62) with powered 45-mph turnouts for passenger train meets.

The total level of infrastructure improvement is as follows:

- Capacity improvements addressing passenger needs: one mile of new trackage and four turnouts (45-mph) for passing sidings.
- Capacity improvements addressing freight needs: none.

The results of this analysis show that these improvements should be sufficient to accommodate the MWRRS trains operating over this route

While overall delays with improvements were 33 percent above the total delays experienced in the forecast base case scenario, and freight train delays were about 17 percent over the pre-MWRRS conditions, delays per train were actually only slightly higher than the base forecast case.

The eight MWRRS passenger train movements on this corridor ended with, on average, just over one additional minute in delay with the one improvement in place, well within the planned recovery time. Freight traffic delays saw an increase of, on average, less than one minute per train, as shown in Exhibit 6-31.

Exhibit 6-31
Additional Average Delays per Train, Holland Branch
(With Infrastructure Improvements)

	# Trains Modeled	*Additional Delays*
Passenger	8	1.3 Minutes
Freight	20	0.5 Minutes
Total	28	0.7 Minutes

6.22 Battle Creek-Port Huron Corridor Assessment

Splitting off the Detroit-Pontiac line in Battle Creek, this route is on Canadian National's Flint Subdivision to Port Huron. The route has been reconfigured very recently with the single tracking of sections of what was once a double-track line. Double track sections remain in place in Port Huron (five miles), Flint (13 miles), Durand (six miles), Lansing (19 miles) and Battle Creek (20 miles). The remaining route is now single track, with four passing sidings. The single-track sections, between double-track segments and between sidings, are typically 10-12 miles in length; sidings are 2- to 2-½ miles long. In addition, service tracks at the Flint and Lansing yards are often used as sidings. There are numerous local freight yards along the route plus a major classification yard in Battle Creek. CTC is the traffic control system on the entire route. The maximum freight train speed limit is 60-mph.

This route is CN's primary route between Chicago and Canada, with heavy overhead traffic, both carload and intermodal. In addition, considerable traffic originates or terminates on line. Current traffic levels are as follows: 22 trains per day between Battle Creek and Durand, 19 between

Durand and Flint and 16 per day between Flint and Port Huron, which are typically through trains between Canada and Chicago. In addition, Amtrak's *International* operates on this route between Battle Creek and Port Huron.

Freight train operations on this corridor were modeled as follows: 26 total freight trains per day between Battle Creek and Durand, 22 per day between Durand and Flint and 20 per day between Flint and Port Huron. The only Amtrak train modeled was the *International*.

MWRRS traffic operates at 79-mph, with four roundtrips daily between Chicago Union Station and Port Huron. MWRRS trains operate intermixed with freight traffic.

As with the Chicago-Quincy route, this corridor runs along the same railroad, but in this case, operations are all on the same division, greatly simplifying train operations. Amtrak currently operates on this route with their train the *International*, helping to establish procedures for handling passenger trains. The recent track reconfiguration program has been relatively sophisticated with long sidings, extensive use of 45-mph turnouts on sidings and crossovers and several crossovers on double track sections.

Base level delays were calculated at 980 minutes for the corridor. The addition of the MWRRS brought the total delay to 1,580 minutes, a 65 percent increase over the forecast base.

The increase in delays with the addition of the MWRRS passenger traffic was attributable to the following:

- Track Reconfiguration: Despite the relatively advanced track redesign, the line was reconfigured predominantly to handle the expected local and through freight traffic, not passenger traffic. The east end of the line in particular has the potential for creating delays for passenger traffic as it consists of a series of 10-12 mile long single track sections separated by two-mile long sidings.
- Freight Traffic: This line serves as CN's primary bridge route between Canada and Chicago via the Sarnia tunnel. Consequently, there is heavy freight traffic all along the length of the line, including a number of priority intermodal trains. The track design also lends itself to fleeting, creating fewer opportunities for passenger trains to overtake freights.
- Local Congestion: There are potential congestion problems through many of the major cities due to local freight trains running on and working off the mainline.

Potential Mitigation Options (local railroad corridor/corridor mileposts from Port Huron):

- Track Reconfiguration: With the current MWRRS schedule, many of the passenger-to-passenger meets are scheduled at stations, but there is a need to create 6-mile long passenger sidings by extending the existing sidings at Emmett (mp 318/16) and Lapeer (mp 289/45). In addition, extend the Shaftsburg (mp 236/98) and Charlotte sidings (mp 203/131) by two miles each to bring them to eight miles and three miles long, respectively. These longer sidings will provide for more efficient meets for both freight and passenger traffic.

- Freight Traffic: Add pairs of 45-mph crossovers in Flint at mp 266/68 and at Battle Creek mp 184/150. These will provide more options for passing and overtake situations on congested double track sections.
- Local Congestion: Add crossovers in Flint mp 269/65 (one set), two single sets at Lansing at mp 217/117 and mp 221/113, and two single sets in Battle Creek at mp 177/157 and mp 181/153. These upgrades allow for greater flexibility for through trains to pass as locals enter or exit the yards.

The total level of infrastructure improvement is as follows:

- Capacity improvements addressing passenger needs: 12 miles of new trackage, plus eight premium turnouts (60-mph) for new sidings and eight 45-mph turnouts for higher-speed crossovers.
- Capacity improvements addressing freight needs: 10 turnouts (30-mph) for lower-speed crossovers.

The results of this analysis show that these improvements should be sufficient to accommodate the MWRRS trains operating over this route. Overall, delays with improvements were lower than the forecast base case scenario by 2 percent. Freight train delays were 2 percent less than the pre-MWRRS conditions. Passenger trains using this corridor, including the eight MWRRS passenger trains, ended with no additional delays with the improvements in place; freight trains saw a slight decrease in average delays per train (Exhibit 6-32).

Exhibit 6-32
Additional Average Delays per Train, Port Huron Branch
(with Infrastructure Improvements)

	# Trains Modeled	*Additional Delays*
Passenger	10	0.0 Minutes
Freight	68	-0.3 Minutes
Total	78	-0.3 Minutes

6.23 Chicago-St. Louis

The St. Louis route begins on Amtrak trackage from Chicago Union Station to 21st Street. From there, the Canadian National Bridgeport and then Joliet Districts are used to reach Joliet. At Joliet, trains switch to the Union Pacific's Joliet and Springfield Subdivisions that are used all the way to just outside St. Louis. The last few miles from East St. Louis to the terminal are on the trackage of the Terminal Railroad Association of St. Louis (TRRA). The trackage from Chicago to Mazonia (about 5 miles south of Braidwood, IL) is double track with few crossovers. From Joliet to Mazonia there are two paired single tracked lines that together act as double track. The CN Joliet District has a number of manual crossovers used primarily for locally switching while the paired single track lines from Joliet south are widely separated, and thus have no crossovers.

South of Mazonia, the line is single track with 15 passing sidings. The passing sidings are typically 1¾ to 2 miles long, spaced about 10 to 12 miles apart. In addition, there are two sections of double track in Bloomington/Normal and Granite City. The final few miles into St.

Louis on the TRRA are double track. The only freight yards of significance on this route are the CN Glenn Yard in Chicago and the UP yard in Springfield. The route is currently controlled with CTC traffic control, with local sections of ABS and TWC traffic control in the Chicago area. The on going Chicago-St. Louis High-Speed Rail project will alter this route, bringing PTC (through the North American Joint PTC project) and capacity improvements, as noted below. A maximum freight train speed limit is 60-mph throughout (with many local exceptions particularly at crossings in the Chicago area).

The traffic on this route, representing a peak day, was modeled with 10 freight trains per day between Joliet and Bloomington, 12 per day between Springfield and Bloomington and 15 per day between Bloomington and St. Louis. The only Amtrak train modeled in this analysis is the *Texas Eagle* since MWRRS replaces existing Amtrak corridor service.

MWRRS traffic would operate at 110-mph, with nine roundtrips daily between Chicago Union Station and St. Louis. MWRRS trains operate intermixed with freight traffic.

This route has several additional factors to consider. Despite the fact that this route connects two major Midwestern cities, freight traffic is relatively light. However, several major at-grade crossings on this route in the Chicago area create the potential for delays. The key crossings are in Brighton Park, Corwith, Argo and Joliet. The management of crossing slots, where used, will be a key to consistent operation. Contingency slots need to be built into critical junctions as necessary. The archaic non-interlocked crossing at Brighton Park will need to be upgraded to minimize delays currently experienced at this location.

Base level delays were calculated at 560 minutes for the corridor. The addition of the MWRRS brought the total delay to 2,440 minutes, a 335 percent increase over the forecast base. The increase in delays with the addition of the MWRRS passenger traffic was attributable to the following:

- Chicago Congestion: Chicago area congestion, including commuter and local freight traffic into Joliet. This section of the corridor operates through a highly industrialized region with numerous freight shippers located on line.
- Joliet: The Joliet area itself presently offers key challenges with several projects under study or development, including the Joliet Arsenal terminal.
- Passenger Meets: While there are numerous meet-points on this corridor, few are sufficient for unobstructed passenger-to-passenger train meets.
- St. Louis Congestion: Freight train congestion is also a concern in the St. Louis area, particularly on the approaches to the McArthur Bridge across the Mississippi River.

Potential Mitigation Options (all mileposts are from CUS and are the same as local railroad mileposts):

- Chicago Congestion: Metra commuter operations consist of three roundtrips per day only at peak hours. The current MWRRS schedule calls for minimal conflict with the commuter operations, as there is only one early evening, westbound MWRRS train that potentially could overtake westbound commuter trains. Three MWRRS trains will potentially meet opposing commuter trains en route but with double track operation, there should be no delays. Additional upgrades to eliminate or improve rail grade crossings northeast of Joliet were not within the scope of this analysis.

- Joliet: Add a pair of 45-mph crossovers at mp 39 just south of Joliet to increase flexibility in the station area. As noted above, increased traffic through this crossing may require the creation and management of crossing slots to minimize delays.
- Passenger Meets: Create passenger-to-passenger sidings at Dwight – mp 72 (extend north by five miles), Odell – mp 82 (extend south 6.5 miles), Bloomington/Normal – mp 122 (extend double track north two miles), Ballard – mp 107 (extend north two miles and south one mile), McLean – mp 139 (extend north 1.5 miles and south 2.5 miles), Elkhart Siding – mp 169 (extend north by four miles), Girard – mp 211 (extend north 3.5 miles) and Carlinville – mp 224 (extend north 7 miles). On the Odell, McLean, Elkhart and Carlinville sidings, add a set of 30-mph crossovers in the middle. Add 30-mph double crossovers on the Granite City double track at mp 269. All other passenger train meets take place at stations or on existing double track sections.
- St. Louis Congestion: While the St. Louis area is not addressed in detail in this report, the creation and management of train slots is key to keeping passenger service consistent through this point. In addition, a second connecting track with additional crossovers from the bridge to the UP line may need to be considered, depending on the constraints of the current junction area.

The total level of infrastructure improvement is as follows:

- Capacity improvements addressing passenger needs: 35 miles of new trackage, plus 16 premium turnouts (60-mph) for new sidings and four 45-mph turnouts for higher speed crossovers.
- Capacity improvements addressing freight needs: 20 turnouts (30-mph) for use in *freight* sidings and lower-speed crossovers.

As noted, this corridor has improvements planned as part of the Chicago-St. Louis High-Speed Rail project. Phase 2 of this project will see the addition of double track on the south end between mileposts 204 and 218 and an improved freight siding at Elkhart at mp 169. The Phase 2 improvements were not considered to be in place when proposing potential infrastructure improvements. If added, the new double track will eliminate the need to upgrade the Carlinville siding. The siding at Elkhart will still need to be extended, but by only two miles in place of the four miles noted.

The results of this analysis indicate that these improvements should be sufficient to accommodate the 18 daily MWRRS trains operating over this route. Overall, delays with improvements were 5.4 percent above the total delays experienced in the forecast base case scenario, but freight train delays were about 10 percent less than the pre-MWRRS conditions.

All of the passenger trains, including the 18 MWRRS passenger train movements on this corridor ended with, on average, about four additional minutes in delay (Exhibit 6-33), well within the planned recovery time. Freight traffic lost, on average, over one minute in delay time.

Exhibit 6-33
Additional Average Delays per Train, Chicago–St. Louis Corridor
(With Infrastructure Improvements)

	# Trains Modeled	***Additional Delays***
Passenger	20	4.5 Minutes
Freight	37	-1.6 Minutes
Total	57	0.5 Minutes

6.24 Chicago-Twin Cities Corridor Assessment

The MWRRS sets out a 10-year implementation program that will provide daily passenger rail service from Chicago to Milwaukee, Madison, Green Bay, and Twin Cities. The first step in this process, Phase I, is to extend service from Milwaukee to Madison and increase frequencies between Chicago and Milwaukee

A key requirement of the MWRRS is the use of right-of-way that is currently owned by the freight railroads. In order to facilitate that use, the MWRRS states will need to develop a cooperative agreement with the freight railroads that includes additional capacity to ensure that the freight railroads can maintain their own train service. As part of the *Milwaukee-Madison Passenger Rail Corridor Study – Environmental Assessment,* WisDOT and Canadian Pacific Railway (CPR) agreed to carry out a track capacity analysis study. The goal of the study is to identify the short- and long-term capacity needs of the Chicago-Milwaukee-Twin Cities corridor in terms of both freight and passenger train operations. However, this simulation contains preliminary data that is subject to review, verification and approval by Canadian Pacific Railway. As of the date of this report, this review process has not taken place. Findings are not to be construed as a commitment on the part of Canadian Pacific to operate additional service.

The *MISS-IT*© capacity analysis system was used to conduct the analysis. *MISS-IT*© creates a Mitigation Analysis evaluation framework using existing databases of both the track infrastructure and the current train operations in order to measure existing train delay and establish a benchmark against which future freight and passenger train delay can be compared. These data files are developed using railroad, state, and survey data collected explicitly for the purpose and stored in *TRACKMAN*© (infrastructure) and *LOCOMOTION*© (train profiles) systems.

For this study, the capacity analysis process was designed to:

- Measure the impact of running MWRRS passenger trains on the Chicago-Milwaukee-Twin Cities corridor. It should be noted that this corridor is not identical to the study corridor of Chicago-Milwaukee-Madison as the rail line between Watertown and Madison diverges from the CPR right-of-way, and will use a revitalized track to access Madison. Since the purpose of this analysis was to mitigate freight train delays, the direct freight line from Watertown to Portage via Columbus is the route that was simulated. In the future after leaving Madison, MWRRS trains will rejoin the CPR line at Portage and then use the CPR line to Twin Cities.
- Identify the potential operational and infrastructure mitigation measures (track and signals) needed to achieve an acceptable level of service in terms of train delay and travel time and to ensure effective mitigation of the impact of adding MWRRS trains.
- Evaluate the necessary Mitigation Analysis measures needed for both the short term (2003) and the long term (2020).

6.24.1 Typical Day Mitigation Analysis

As part of the Mitigation Analysis, the *MISS-IT*© model evaluates a range of strategies for mitigating capacity delays and maintaining train delay at the appropriate level or benchmark in a given base or forecast-year. In the case of the Chicago-Milwaukee-Twin Cities corridor, the evaluation years selected for analysis were:

- 2000: base year
- 2003: first year of MWRRS implementation
- 2020: a year near the end of the MWRRS life cycle and investment period

For the forecast-years 2003 and 2020, a benchmark file was constructed that incorporated the proposed infrastructure improvements for that year, as well as the growth in freight and passenger (Metra, Amtrak) train traffic. Once this file was constructed, a second file that incorporated the MWRRS trains proposed for that year was also developed. The travel times generated by these two files were then evaluated in the *MISS-IT*© model to determine the impact of the MWRRS trains had on overall train delay.

The goal of the Mitigation Analysis was to identify where bottlenecks occurred with the addition of MWRRS trains and to add infrastructure to bring travel times back to previous levels (prior to the addition of the MWRRS trains). Canadian Pacific Railroad (CPR), Amtrak, WisDOT and study team engineers held a workshop to identify appropriate mitigation strategies. Mitigation measures included: changes in train operations to accommodate higher-ranked trains, upgrades to the signaling system to improve train throughput, and the addition of track to add capacity at bottleneck locations. The group then structured mitigation strategies in a unit form to allow for incremental application of any single strategy or combination of strategies.

Mitigation Measures

- Infrastructure: By adding segments of track (sidings, double or triple track) along the corridor, trains are given additional choices to resolve conflicts. Additional track provides for a smoother flow of traffic through the corridor and less incurred delay because trains can advance more quickly down the track and clear the way for following trains.
    - Increasing track capacity at targeted locations can ease bottlenecks and increase the free-flow of traffic in heavily traveled areas. Increasing capacity in these sections can be accomplished with the addition of new track, or when possible, utilizing existing infrastructure such as sidings and converting switches to crossovers.
    - Track upgrades that support higher speeds provide another enhancement that results in performance improvements along the corridor. Track upgrades help the traffic to exit the system more quickly, preventing potential conflicts with other trains later in the day. If overall train speeds are increased on a network, capacity is increased. However, greater disparities in speeds between passenger trains and bulk freight trains can also reduce capacity because of the degree of overtaking.

- Signaling: In highly congested areas, upgrades to the signaling system can provide significant time savings to traffic along a corridor, through the ability to increase traffic density and maintain higher speeds at signal blocks. The choices of signaling systems currently available include: Dark Territory or Non-Signaled (NS), ABS, Color Aspect Signaling (CAS), CTC, and PTC. Advancing to a PTC environment offers the advantage of reduced “block lengths” and even “moving blocks.” By reducing block space, the railroad has effectively increased the capacity of the same track.

  - The real differences become apparent when evaluating existing signaling systems such as ABS and more recent systems such as PTC. The older systems permit trains to enter a block only when cleared by the dispatcher after the previous train has exited the block. While highly effective for lightly used lines, fixed block systems impede heavily used systems as trains must slow and even stop when following slower or inadequately spaced trains. With moving block systems, a train is not slowed until following a preceding train at a minimally safe distance. As a result, a moving block system obtains the maximum length capacity.
  - It is proposed that with PTC moving block, trains carry their own block (safety zone) with them and therefore on heavily used lines will both maximize the available capacity and minimize the delays waiting or stopping for slower trains. The *MISS-IT*© model evaluates these options by measuring delays due to tailgating and stopping when distances and capacity become inadequate. This means that the trains can be concentrated as much as possible within safety constraints. In fixed block signaling, there can only be a less dense flow of trains with much greater delays, as trains must respond to fixed block limitations and controls.
- Operations: Changes to operating schedules provide another measure that improves the performance of the trains along the corridor. The preliminary operating plans for 2003 and 2020 are the result of a range of hypothetical decisions and plans developed independently by rail organizations and other authorities. Therefore, an “integration” analysis is needed to make the best use of the track, bearing in mind market and operating requirements. If the analysis indicates that there is overlap in dispatch times of passenger and freight trains, so that several trains are traveling too closely together, changing their schedules to provide some additional spacing between the trains will smooth the flow of the trains along their journeys. This will reduce the delays incurred by these trains.

For this analysis, restrictions were developed as to the degree of flexibility possible for each train type as it was recognized that any changes in real working schedules would need to be negotiated between all the railroads involved.

Growth Rates

The growth rates of train frequencies for each year in the analysis were necessary to determine the volumes at each stage of the analysis. Based on these growth rates, trains were added to replicate the appropriate level of traffic during the analysis year. A growth rate of 1.5 percent per year was assumed for Metra commuter trains and bulk freight trains. Intermodal grew at a faster rate of 4.0 percent per year. No growth was assumed in Amtrak or local trains.

Freight tonnage data and growth rates used in this analysis were derived from state, federal, and freight railroad data sources at the time the analysis was prepared. Since that time, more refined freight tonnage and growth forecast information has been made available from freight railroads and has been incorporated into subsequent analyses.

6.24.2 Capacity Analysis Results

The capacity analysis was used to assess the need for mitigation for CPR, Metra, Amtrak and BNSF train operations in both the short and long term. The year 2003 was selected to represent the short term, and the year 2020 was selected to represent the long term.

Year 2003 Analysis Results

For the year 2003, the volume of freight and passenger trains that was projected to use the Chicago-Milwaukee-Twin Cities corridor is shown in Exhibit 6-34. The first 32.5 miles from Chicago Union Station are the busiest, with 116 trains (62 Metra trains and 20 MWRRS trains). There are 17 CPR bulk trains and nine CPR intermodal trains. Amtrak has six trains including the *Empire Builder*, planned new *Fond du Lac*, and planned *Janesville* trains (Fond du Lac service was never started, and the Janesville train has since been discontinued.) The next busiest section is between mileposts 370.6-415, which has 78 trains, including 23 BNSF trains. Elsewhere, train volumes are in the 30-50 range.

As multiple commuter lines merge together on the final approaches to Chicago Union Station and St. Paul Union Depot, a detailed simulation of these terminals was not included in the scope of the line capacity simulation analysis. It is assumed that these highly localized commuter issues will be resolved by the respective metropolitan authorities. North of milepost 415, the analysis does not include all the trains that are operating in the section because this area is beyond the Twin Cities (St. Paul Union Depot) station to which MWRRS trains will operate.

Exhibit 6-34
2003 Train Volume by Track Segment*

Train	*Milepost*										
	0-32.5	*32.5-85.9*	*85.9-131.6*	*131.6-178.5*	*178.5-240*	*240-285.01*	*285.01-295*	*295-310.1*	*310.1-370.6*	*370.6-415*	*415-416.19*
Amtrak	6	4	4	2	2	2	2	2	2	2	2
BNSF	0	0	0	0	0	0	0	0	0	23	0
Bulk	17	17	17	15	19	21	21	21	19	19	0
Intermodal	9	9	9	9	9	9	14	14	14	14	0
Local	2	2	2	2	0	20	0	0	2	2	0
Merriam Park	0	0	0	0	0	0	0	6	0	18	6
Metra	**62	0	0	0	0	0	0	0	0	0	0
MWRRS	20	20	12	0	0	0	0	0	0	0	0
Total	**116**	**52**	**44**	**28**	**30**	**52**	**37**	**43**	**37**	**78**	**8**

* *This includes all trains in 2003 without any routing mitigation.*
***This excludes Metra trains between Union Station and Healy Station (mp 6.3).*
**** Amtrak's current Hiawatha service of 14 trains per day is included in the Midwest Regional Rail train volume numbers*

Base track data for 2003 shows the route to be largely a double-track railroad between mileposts 0.0 and 104.2, and then a largely single-track railroad with some double-track sections totaling 70 miles north to the Twin Cities, a distance of just over 300 miles. The line is largely CTC with some short stretches of ABS (*e.g.*, from milepost 85.7 to 95.1 and 246 to 255.5).

For the year 2003, the provision of a Muskego Yard northern lead, and 11.4 miles of double track between mileposts 119.6 and 131.0, would permit the operation of the MWRRS, including the addition of four extra trains, for a total of 10, operating on the Chicago-Milwaukee-Watertown-Madison route. If PTC signaling is provided and appropriate track changes are made, the train operation could be increased to 110-mph from the 79-mph operation that is possible with CTC/ABS.

Chicago-Milwaukee-Madison Analysis

For 2003, two basic sets of infrastructure improvements were tested in the Milwaukee-Watertown segment:

- 2003A – Allows 79-mph train operations and reflects existing CTC/ABS signaling system
- 2003B – Allows 110-mph train operations and requires PTC signaling system

To each of these basic strategies a series of infrastructure options was added. In both 2003A and 2003B, an additional lead was provided to Muskego Yard. This was done because it was recognized that even at today's level of traffic, this is a bottleneck that should be eliminated and clearly with MWRRS trains on the track, this one basic improvement is necessary to permit effective train operations. As such, it was made a basic component of each strategy.

The focus of the 2003 strategies was the Milwaukee-Watertown segment (mileposts 85.6–131.6), which would need upgrading to allow for new MWRRS Phase 1 train operations on the Chicago-Milwaukee-Madison corridor. The 2003 strategy only extends service only to Madison, not beyond. It is only in later phases of the MWRRS that MWRRS trains connect to Portage (milepost 178.0) and Twin Cities (milepost 407.4). The connection to Madison uses the CPR right of way leased to WSOR. This connects with the mainline at milepost 176.75. Exhibit 6-35 summarizes the infrastructure strategies adopted. In each case the following additional infrastructure was added to the previous strategy:

- Strategy 1 – Double track for an additional 11.4 miles between Milwaukee and Watertown (mp 119.6–131.0)
- Strategy 2 – Double track for an additional 15.4 miles (mp 104.2–119.6)
- Strategy 3 – Add a Muskego Yard bypass (mp 83.5–87.2)

Exhibit 6-35
2003A Infrastructure: Overview

Infrastructure	*2003A*	*Strategy 1*	*Strategy 2*	*Strategy 3*
CPR signal improvements, 79-mph, Muskego Yard lead upgrade	✓	✓	✓	✓
Double-track from mp 119.6 to 131		✓	✓	✓
Double-track from mp 104.2 to 119.6			✓	✓
Muskego Yard freight bypass				✓

The effect of adding Strategy 2, or double tracking from mp 104.2 to 131.0, is to effectively provide a double-track rail line from Chicago (mp 0.0) to beyond Watertown to as far as milepost 157.1, given the fact that double track already exists between mileposts 131.0 and milepost 157.1.

Exhibits 6-36 through 6-39 provide the results of the capacity analysis. In the case of 2003A (Exhibit 6-37) Strategy 1 easily mitigates the CPR, BNSF, Amtrak, and Metra trains; Strategies 2 and 3 would provide huge benefits as well. In fact, the improvements are such that there would be no degradation from the amount of delay that currently exists on the line, a level well below the Base Case year 2003. For the 2003B strategy, Strategy 1 achieved a similar result with mitigation. The effect of introducing the PTC signaling system between Milwaukee and Watertown can be seen by comparing the results of Strategy 1 in Exhibits 6-38 and 6-39. Its introduction to the 46-mile stretch reduces travel time on average by 3 to 4 minutes for every train, and the CPR intermodals would get a 7-minute benefit.

Exhibit 6-36
2003A Average Delay

	Freight	***Freight + Growth (no lead)***	***Freight + Growth + MWRRS (no lead)***	***+ Capacity Improvements (with lead)***		
	2000	***2003A (with CTC)***	***2003A (with CTC)***	***Strategy 1***	***Strategy 2***	***Strategy 3 (with freight bypass)***
Metra	0:00	0:03	0:03	0:03	0:03	0:02
Intermodal	1:15	1:37	2:16	1:26	1:14	1:10
BNSF	0:02	0:03	0:02	0:02	0:02	0:02
Bulk	2:15	2:41	3:35	2:27	2:11	2:08
Local	0:15	0:16	0:23	0:21	0:18	0:16
Amtrak*	1:15	1:30	1:44	1:14	1:19	1:17
MWRRS	—	—	0:28	0:17	0:14	0:11
Average Delay Time	**0:50**	**1:01**	**1:13**	**0:50**	**0:45**	**0:43**

Shaded area used for comparison.
*Delay time for Amtrak increases under Strategies 2 & 3, whereas all others decrease.

Mitigation

Average delay time is calculated by averaging the delay time for each train group for a particular infrastructure condition (*e.g.*, Freight 2000, Freight + Growth, etc.). These times show that as infrastructure improvements are made, the overall system is benefiting, even when some group times improve while others worsen.

Exhibit 6-37
2003A Standard Deviation of Duration

	Freight	*Freight + Growth (no lead)*	*Freight + Growth + MWRRS (no lead)*	*+ Capacity Improvements (with lead)*		
	2000	***2003A (with CTC)***	***2003A (with CTC)***	***Strategy 1***	***Strategy 2***	***Strategy 3 (with freight bypass)***
Metra	0:04	0:08	0:08	0:08	0:08	0:07
Intermodal	4:01	3:51	4:26	3:46	3:55	3:53
BNSF	0:04	0:07	0:03	0:05	0:04	0:04
Bulk	4:10	4:18	5:09	4:02	3:49	3:47
Local	0:29	0:30	0:41	0:40	0:34	0:31
Amtrak	3:45	3:50	3:44	3:42	4:16	4:16
MWRRS	—	—	0:35	0:33	0:24	0:23
Average Delay Time	**2:05**	**2:07**	**2:06**	**1:50**	**1:52**	**1:51**
Shaded area used for comparison.				Mitigation		

Exhibit 6-38
2003B Average Delay

	Freight	*Freight + Growth (no lead)*	*Freight + Growth + MWRRS (no lead)*	*+ Capacity Improvements (with lead)*		
	2000	***2003B (with PTC)***	***2003B (with PTC)***	***Strategy 1***	***Strategy 2***	***Strategy 3 (with freight bypass)***
Metra	0:00	0:02	0:03	0:03	0:02	0:02
Intermodal	1:15	1:35	1:46	1:19	1:11	1:09
BNSF	0:02	0:03	0:02	0:03	0:02	0:02
Bulk	2:15	2:38	3:07	2:15	2:15	2:08
Local	0:15	0:16	0:20	0:19	0:16	0:10
Amtrak*	1:15	1:26	1:34	0:55	0:51	0:59
MWRRS	—	—	0:20	0:13	0:10	0:09
Average Delay Time	**0:50**	**1:00**	**1:01**	**0:43**	**0:41**	**0:39**
Shaded area used for comparison. *Amtrak's delay time increases between Strategies 1 & 3.				Mitigation		

Exhibit 6-39
2003B Standard Deviation of Duration

	Freight	*Freight + Growth (no lead)*	*Freight + Growth + MWRRS (no lead)*	*+ Capacity Improvements (with lead)*		
	2000	***2003B (with PTC)***	***2003B (with PTC)***	***Strategy 1***	***Strategy 2***	***Strategy 3 (with freight bypass)***
Metra	0:04	0:08	0:08	0:08	0:08	0:07
Intermodal	4:01	3:57	4:09	3:50	3:51	3:49
BNSF	0:04	0:07	0:05	0:07	0:05	0:04
Bulk	4:10	4:27	4:47	3:55	4:01	3:59
Local	0:29	0:32	0:39	0:39	0:33	0:32
Amtrak	3:45	3:36	3:26	3:21	3:17	3:17
MWRRS	—	—	0:26	0:31	0:21	0:20
Average Delay Time	**2:05**	**2:07**	**1:57**	**1:47**	**1:45**	**1:44**
Shaded area used for comparison.					Mitigation	

Chicago-Milwaukee-Twin Cities Analysis (2020)

As shown in Exhibit 6-40, the volume of trains in the corridor by 2020 grows significantly due to the high growth rate of CPR intermodal and BNSF freight trains, and the moderate growth in CP bulk and freight trains, and Metra commuter rail trains. For the first 32.5 miles from Chicago Union Station to Rondout Station, the number of trains increases from 116 in 2003 to 156 trains in 2020. Between mileposts 370.6 and 410.5, the increase is from 78 trains to 122, of which 35 are BNSF trains. Over the rest of the corridor, train volumes approach the capacity limit of 65 to 80 trains, except between mileposts 131.6 and 240, in which they range from 40 to 55 trains. A first assessment of train volumes suggests that triple track may well be required on the first 32.5 miles of the route north of Chicago Union Station, since there are more than 120 trains in this section, and also between mileposts 370.6 and 410.5 because there are more than 40 trains on that segment. Double track may also be required from milepost 104.2 to milepost 131.6 and between mileposts 240.0 and 370.6.

For the year 2020, despite very significant forecasts of freight growth, it was found that mitigation could be achieved for the full MWRRS rail service from Chicago via Madison to Twin Cities. The mitigation proposed for 2003 in terms of track (11.4 miles) and yard capacity (lead) was enhanced by the following:

- Providing a PTC System for the Chicago-Milwaukee-Twin Cities Corridor
- Adding 20 miles of double track to complete the double-tracking of the route between Milwaukee and Watertown
- Adding a Muskego Yard Bypass
- Adding the infrastructure proposed in the *Chicago/Milwaukee Rail Corridor Study* of 1997
- Adding 121 miles of extra double track between mileposts 245.0 and 410.0

- Completing an Integration Analysis of all the 2020 train services and making modest changes to CPR local train operations at La Crosse and to the scheduled times of MWRRS trains.

Strategies

In developing strategies for 2020, a number of basic infrastructure upgrades were adopted for the route. The first upgrade is a requirement for triple track on the first 32.5 miles of the route. This requirement was set forth in by the *Chicago-Milwaukee Rail Corridor Study* of 1997, which proposed three specific mitigation measures between Chicago and Milwaukee. The results of that study were accepted without prejudice for this analysis.

The three measures were:

- Triple track from Chicago Union Station to Rondout mp 32.5
- The separating of CPR operations at Truesdell and providing a separate line for these trains to Techny, where today the CPR trains turn off for Bensenville
- Providing three 2-mile freight sidings at 10-mile intervals north of Truesdell

It was determined that joint operations of freight and passenger trains north of Truesdell would be modeled. In modeling the route south of Truesdell, since CPR trains would not be operating on the right-of-way, there was no need to consider their trains beyond the impact on the junction at Techny.

Exhibit 6-40
2020 Train Volume by Track Segment*

Train	*Milepost*										
	0-32.5	*32.5-85.9*	*85.9-131.6*	*131.6-178.5*	*178.5-240*	*240-285.01*	*285.01-295*	*295-310.1*	*310.1-370.6*	*370.6-410.5*	*410.5-416.19*
Amtrak	6	4	4	2	2	2	2	2	2	2	2
BNSF	0	0	0	0	0	0	0	0	0	35	0
Bulk	21	21	21	21	24	26	26	26	24	24	0
Intermodal	17	17	17	17	17	17	25	25	25	25	0
Local	2	4	2	2	0	20	0	7	2	4	0
Merriam Park	0	0	0	0	0	0	0	0	0	20	6
Metra**	78	0	0	0	0	0	0	0	0	0	0
MWRRS	32	32	30	0	12	12	12	12	12	12	0
Total	**156**	**78**	**74**	**42**	**55**	**77**	**65**	**72**	**65**	**122**	**8**

* This includes all trains in 2020 without any routing mitigation.
** This excludes Metra trains between Union Station and Healy Station (MP 6.3)
*** Amtrak volumes were based on the Empire Builder plus the then-planned *Fond du Lac* and *Janesville* trains.

Although it was found that 2003A Strategy 1 and 2003B Strategy 1 mitigated train delays in year 2003, given the growth in train traffic, the 2003B Strategy 3 was used as a base for the 2020 analysis as instructed by the Wisconsin Department of Transportation. This strategy, as previously described, assumes an additional lead is provided to Muskego Yard and that 26.8 miles of double track are provided between mileposts 104.2 and 131.0, that PTC is installed, and that a bypass for the Muskego Yard is developed. This incorporates the already proposed improvements for 2003 into the basic 2020 track infrastructure.

Once the basic elements of the 2020 infrastructure were established (2020-Base, see Exhibit 6-41), a set of additional possible strategies was developed. In Strategy 1, the basic elements are included to ease freight movements through Milwaukee and the five 10-mile passenger sidings located strategically along the route to allow for passing of passenger trains.

Exhibit 6-41
2020 Strategies Overview

Infrastructure	*2020-Base*	*Strategy 1*	*Strategy 2*	*Strategy 3*	*Strategy 4*
2003B – Strategy 2 *Double-Track:* *MP 104.2-MP131*	✓	✓	✓	✓	✓
Freight bypass at Muskego Yard *MP 83.5-MP 87.2*	✓	✓	✓	✓	✓
Chicago / Milwaukee Rail Corridor Study *Diverting Freight Traffic to UP Line: Techny (MP 20.45) to Truesdell (MP 52.6)* *Three freight sidings:* *MP 59-61* *MP 70-MP 72,* *MP 81.5-83.5*	✓	✓	✓	✓	✓
Ideal Day Analysis: Five 10-mile sidings *MP 236-MP 246,* *MP 269-MP 277,* *MP 320-MP330,* *MP 348-MP 363,* *MP 398-MP 408 (416)*		✓	✓	✓	✓
Southern Relief: Two sections of improvements *MP 157-MP 174,* *MP 288-MP 294*			✓		
River Junction Relief: Two sections of double-track *MP 260-MP 282,* *MP 288-MP320*				✓	
Northern End Relief: Six sections of double-track *MP 236-MP 246,* *MP 260-MP 282,* *MP 288-MP 340,* *MP 348-MP 385,* *MP 411-MP 416*					✓

6.24.3 Infrastructure Definitions for 2020

Strategy 1: Ideal Day Analysis-Five Sidings

In Strategy 1, five 10-mile sidings identified as part of the Ideal Day Analysis for the route conducted as part of the MWRRI Phase 3B. The locations of these Ideal Day sidings are as follows:

- Mileposts 236 to 246
- Mileposts 269 to 277
- Mileposts 320 to 330
- Mileposts 348 to 363
- Mileposts 398 to 408 (416)

In order to increase train performance, the lengths of sidings 4 and 5 were increased as it considerably increased train performance. In addition, the fifth siding was further extended to milepost 416 to accommodate future commuter rail operations in the Twin Cities.

Strategy 2: Southern Relief Option

In Strategy 2, the option, the effect of double tracking an additional 90 miles of track on the southern end of the route (between mileposts 157 and 174 and 288 and 294), was evaluated. Including existing sidings, this effectively extends double track from Chicago to milepost 180, a segment of the route with extensive passenger train operations.

Strategy 3: River Junction Relief Option

In Strategy 3, the option, 121 miles of double track are added to minimize the impact of the La Crosse Mississippi River crossing at milepost 283. The route is effectively double tracked on either side of this bridge from mileposts 260 to 330, with the exception of the Mississippi River Bridge itself.

Strategy 4: Northern End Relief Option

In Strategy 4, the Northern End Relief option, 163 miles of double track were assessed between mileposts 236 and 416 with only three short breaks. Two of the breaks are for the two Mississippi crossings at mileposts 283 and 385, while the third break is between mileposts 340 and 348. The aim of this strategy was to minimize the impact of the Mississippi bridges on the performance of the long-distance corridor trains.

6.24.4 Mitigation Results

The evaluation of these strategies is shown in Exhibits 6-42 and 6-43. Mitigation of train delay is achieved by the Strategy 3 infrastructure. The average delay for all trains is 45 minutes, while average delay for the benchmark is 1 hour and 3 minutes. The time-critical trains, as well as the passenger and intermodal freight trains, all have delays less than the benchmark delay times.

Exhibit 6-42
2020 Average Delay by Train Type

	Freight	*Freight + Growth*	*Freight + Growth + MWRRS*	*+ Capacity Improvements*			
	2000	***2020***	***2020-Base***	***Strategy 1***	***Strategy 2***	***Strategy 3***	***Strategy 4***
Metra	0:00	0:01	0:05	0:02	0:03	0:03	0:08
Intermodal	1:15	1:37	2:22	2:05	2:05	1:25	1:23
BNSF	0:02	0:04	0:01	0:00	0:00	0:00	0:00
Bulk	2:15	3:18	3:42	4:10	3:18	2:02	1:55
Local	0:15	0:17	0:21	0:24	0:21	0:16	0:09
Amtrak	1:15	1:40	1:45	1:50	1:41	1:31	1:27
MWRRS	—	—	1:21	1:06	0:57	0:28	0:27
Average Delay Time	**0:50**	**1:09**	**1:22**	**1:22**	**1:12**	**0:49**	**0:47**
Shaded area used for comparison.							Mitigation

Exhibit 6-43
2020 Standard Deviation of Duration by Train Type

	Freight	*Freight + Growth*	*Freight + Growth + MWRRS*	*+ Capacity Improvements*			
	2000	***2020***	***2020-Base***	***Strategy 1***	***Strategy 2***	***Strategy 3***	***Strategy 4***
Metra	0:04	0:04	0:01	0:05	0:05	0:07	0:10
Intermodal	4:01	3:34	3:57	3:33	3:42	3:30	3:56
BNSF	0:04	0:12	0:12	0:04	0:05	0:06	0:06
Bulk	4:10	4:33	4:41	4:54	4:29	4:11	4:05
Local	0:29	0:30	0:25	0:44	0:37	0:38	0:30
Amtrak	3:45	3:47	3:50	3:55	3:50	3:44	3:45
MWRRS	—	—	1:24	1:22	1:20	1:11	1:09
Average Delay Time	**2:05**	**2:06**	**2:04**	**2:05**	**2:01**	**1:55**	**1:57**
Shaded area used for comparison.							Mitigation

Operations Integration

While the investment in track and signaling meets the overall delay requirements, further adjustment is required to meet the needs of passenger trains – and specifically MWRRS trains – to improve the flexibility and effectiveness of the overall operating plans of all trains using the corridor.

In evaluating the capacity analysis strategies for the Chicago-Milwaukee-Twin Cities corridor, considerable delay was identified at the following five locations, which have been prioritized in terms of severity of delay:

- River Junction (mileposts 282-283.7): The Mississippi River Bridge is itself a major bottleneck, but this problem is exacerbated by the local La Crosse trains that operate all day, including peak operating hours, across the bridge.
- Muskego Yard (mileposts 83.5-87): This is potentially the most difficult area of the route given the importance of the yard for freight operations and the level of passenger train operations in the section. However, the extra lead and the bypass infrastructure for the yard effectively resolve the problems.
- Hastings River Crossing (mileposts 391.2-392): This bridge is a problem given the volume of freight traffic and the projected level of MWRRS operations. However, the capacity issue can be resolved by measures of effective train scheduling and the scheduling of bridge operations. In the future (beyond 2020), the potential increases in both passenger and intermodal operations is likely to encourage further consideration of the potential doubling of bridge track.
- Union Station (milepost 32.5): The growth of Metra, MWRRS, Amtrak and CPR trains on this section of track could present some of the most complex capacity problems if proposed changes in CPR train routing are not achieved. Considerable attention should be paid to developing a full understanding of infrastructure and train plans for the principal rail operations in the segment.
- Mileposts 240 to 410: The level of train operations on this segment needs to be carefully monitored to ensure that capacity is sufficient. Capacity is being approached, and although the Risk Analysis currently shows no major problems, as few as 10 additional trains could dramatically affect delays. Full double track may be needed between mileposts 240 and 410. Beyond that, the two Mississippi single-track bridges form a critical bottleneck.

Following the review of capacity-constrained areas, the train schedules were reviewed for efficiency. No changes or adjustments to the schedules of CPR intermodal trains or bulk trains were included in the analysis (local train schedules, on the other hand, were adjusted within a reasonable range). As a result, the integration analysis proposed the following adjustments:

- Metra trains – no change
- MWRRS trains – departure time adjustments less than 1 hour from original schedule
- Amtrak – no change
- CPR intermodal – no change
- CPR bulk – no change
- BNSF – no change
- CPR locals – significant change to River Junction operation. Trains were moved up to 3-4 hours.

Exhibit 6-44 shows the adjustments to the operating schedules of MWRRS and CPR local trains.

Exhibit 6-44
Adjustments to Operating Schedules of MWRRS and CPR Local Trains

Train Name	***Old Departure Time***	***New Departure Time***	***Difference***
	2020-3	***2020-3A***	
***MWRRS*:**			
MWTCPTL-1	7:52	7:02	0:50
MWMDCHL-1	11:47	11:25	0:22
MWTCPTE-2	8:21	8:06	0:15
MWMDCHE-4	12:00	12:14	0:14
MWMDCHL-2	17:31	18:21	0:50
MWTCPTE-3	16:20	15:50	0:30
MWMDCHE-5	19:59	19:29	0:30
MWMDE-3	13:00	12:30	0:30
MWPTTCL-1	10:42	11:22	0:40
MWMDE-2	10:40	10:10	0:30
MWPTTCE-2	13:30	13:00	0:30
MWTCPTE-1	6:47	6:13	0:34
MWMDE-1	5:50	5:30	0:20
MWPTTCE-1	8:13	7:53	0:20
MWTCPTE-1	6:47	5:47	1:00
La Crosse (locals):			
CPLacW1	3:00	2:00	1:00
CPLacW2	4:30	0:30	4:00
CPLacW3	5:30	2:30	3:00
CPLacW6	12:30	11:30	1:00
CPLacW7	14:30	11:45	2:45
CPLacE2	3:49	2:49	1:00
CPLacE3	5:06	1:06	4:00
CPLacE4	6:07	3:07	3:00
CPLacE7	13:29	12:29	1:00
CPLacE8	15:34	12:49	2:45

6.24.5 Chicago-Twin Cities Infrastructure Needs

The capacity analysis for the Chicago-Milwaukee-Twin Cities corridor has identified the critical infrastructure and operating strategies for mitigating the freight railroad. In developing the Capacity Analysis model for the study, the results of the 1997 *Chicago/Milwaukee Rail Corridor Study*, a base-year comparison was made of the study's results and those of the *MISS-IT*© model. It was found that the *MISS-IT*© model assessment of train performance closely matched the study's estimates in terms of the average travel times for base-year trains.

This study accepted without prejudice the 1997 *Chicago/Milwaukee Rail Corridor Study* such that the evaluation of capacity needs of the Chicago-Milwaukee-Twin Cities corridor were based on specific assumptions that need to be reviewed and verified. The assumptions included:

- A triple-track rail system from Chicago to mp 32.5 as proposed in the 1997 study. The validity of this assumption has been questioned and needs to be reevaluated.
- The adoption of the assumption that CPR will use the UP line from Truesdell to Bensenville. This assumption needs to be agreed to by CPR and UP railroads, given the land use development at Truesdell.
- The assumption that the CPR and UP connection can be made at Truesdell needs to be assessed, given recent land use developments that may have impacted the availability of the proposed right-of-way for the connection between the existing UP right-of-way and the CPR right-of-way.
- The acceptability of PTC to CPR. This assumption appears very reasonable for 2020, but PTC may not be reasonable in the near future.
- The adoption of drawbridge schedules by the Coast Guard. This assumption needs to be validated by detailed discussions with the relevant authorities.
- The study findings need to be reviewed with CPR to ensure that maintenance needs can be effectively completed in forecast years.

For the year 2020, despite forecasts of very significant freight growth, it was found that mitigation could be achieved for the full MWRRI rail service from Chicago via Madison to Twin Cities. The mitigation proposed for 2020 is the following:

- Add a PTC System to the Chicago-Milwaukee-Twin Cities Corridor
- Add 20 miles of double track to complete the double-tracking of the route between Milwaukee and Watertown. The Wisconsin rail plan has advanced the full double tracking of Watertown-Milwaukee to occur when the Madison passenger service is implemented.
- Add a Muskego Yard Bypass
- Add the infrastructure proposed in the *Chicago/Milwaukee Rail Corridor Study* of 1997
- If capacity constraints at the Mississippi River bridges cannot be directly addressed, then add 121 miles of extra double track between mileposts 245.0 and 410.0
- Complete an Integration Analysis of all the 2020 train services and make modest changes to CPR local train operations at La Crosse and to the scheduled times of Midwest trains to avoid passenger conflicts with scheduled freight operations.

6.25 St. Louis-Kansas City Corridor Assessment

Joining Union Pacific's (UP's) transcontinental routes to eastern rail connections at the St. Louis gateway, UP's St. Louis-Kansas City line is literally at the heart of the U.S. rail network. As shown in Exhibit 6-45, in 2002 the line handled over 100 million gross tons, making it one of UP's highest-density lanes. It carries high volume Powder River coal mixed with intermodal and merchandise freight trains. As Powder River coal continues to penetrate farther east, Union Pacific projects nearly a doubling of freight traffic by 2020. Additional traffic will come from UP's newly-acquired Golden State route to El Paso, TX which forms part of a southern transcontinental route to Los Angeles, CA.

Exhibit 6-45
UP Tonnage Density Map[9]

[9] UP 2002 Analyst Factbook: Railroad Overview, .pdf document downloaded from UP web site.

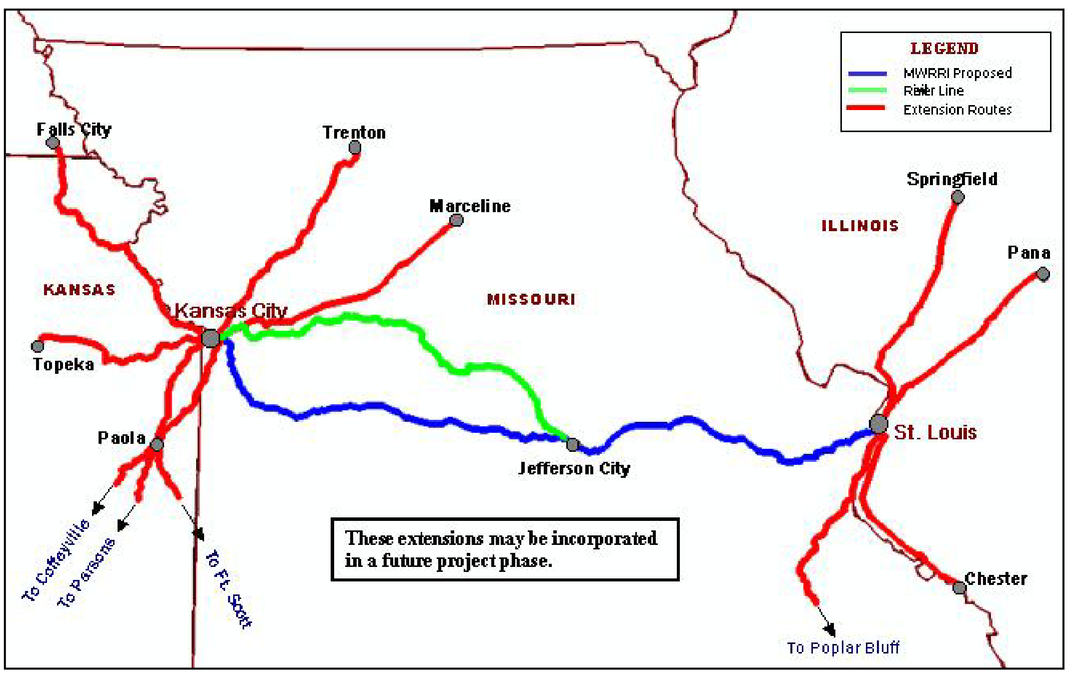
NOTICE:
This simulation contains preliminary data which is subject to review, verification and approval by Union Pacific Railroad. As of the date of this report, this review process has not taken place. Findings are not to be construed as a commitment on the part of Union Pacific to operate additional service.

In addition to all this freight traffic, Amtrak operates two round-trip passenger trains between St. Louis and Kansas City on a daily 5:40 schedule. The Midwest Regional Rail Initiative (MWRRI) proposes to introduce tilting train technology to increase speeds to 90-mph by 2013. The number of trains is slated to grow to four round-trips by 2011 and to 6 round-trips with a 4:42 running time by 2013. This service would extend Illinois'110-mph Chicago-St. Louis corridor all the way to Kansas City.

To nearly double freight volume and triple passenger traffic on this congested corridor will require significant investment. An important part of this investment is the capacity of freight yards in St. Louis and Kansas City, as well as that of rail lines radiating in all directions from both terminals. Exhibit 6-46 shows the St. Louis to Kansas City line in blue and green; route extensions used by UP around both endpoints are shown in red. This exhibit does not show *all* rail lines – it only shows lines operated by Union Pacific.

A study of the St. Louis and Kansas City terminals and their feeder lines is essential to understanding the long-term needs for rail infrastructure in the region. The simulation effort is still incomplete since it does not include an analysis of the impact on St. Louis and Kansas City terminals. It is anticipated that funding to complete the scope of the simulation effort will be sought in a future project phase.

Exhibit 6-46
UP Route Extensions around the Endpoint Terminals



Note: This exhibit shows only those rail lines operated by Union Pacific.

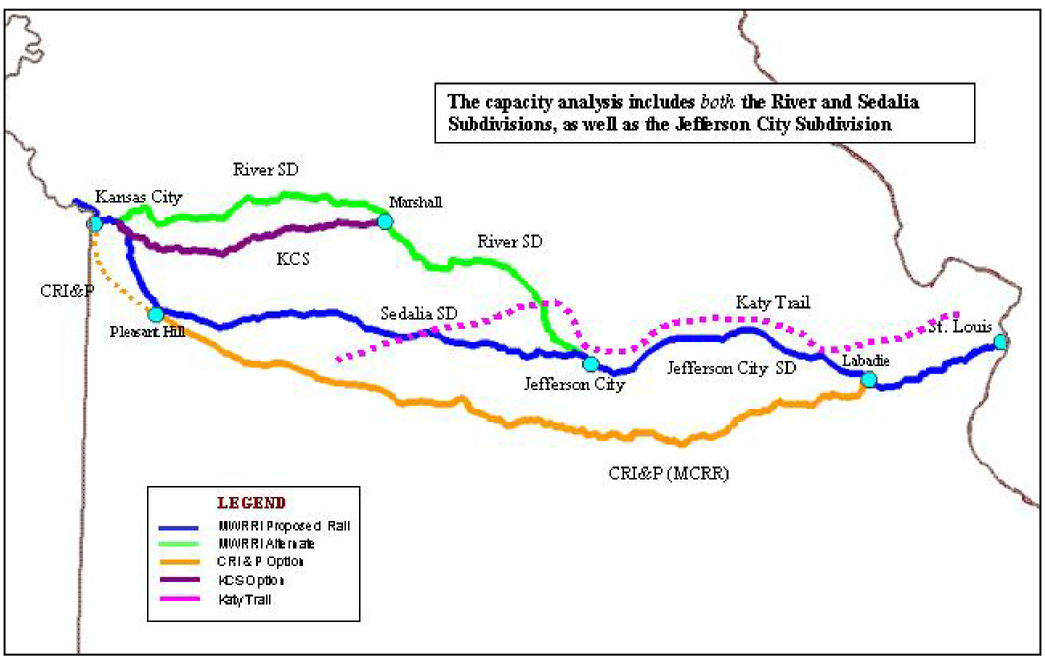
NOTICE:
This simulation contains preliminary data which is subject to review, verification and approval by Union Pacific Railroad. As of the date of this report, this review process has not taken place. Findings are not to be construed as a commitment on the part of Union Pacific to operate additional service.

This reports the results of a simulation of the St. Louis-Kansas City line, not including the endpoint terminals, that was undertaken by the study team during the summer of 2003. TEMS and Missouri Department of Transportation sincerely appreciate the excellent cooperation received from Union Pacific who supplied data needed for the analysis. When the simulation work is accomplished, (including Kansas City and St. Louis terminals and radiating lines out 75 miles) it will be subject to review, verification and approval by Union Pacific Railroad. As of the date of this report, this simulation work has not been accomplished and consequently the review process has not taken place. Findings are not to be construed as a commitment on the part of Union Pacific to operate additional service.

6.25.1 Route Alternatives within the Corridor

As previously discussed, Union Pacific and the Missouri Department of Transportation required that Berkeley Simulations Software's RTC model be used for the capacity analysis of the St. Louis-Kansas City corridor (Exhibit 6-47). As such, it was not possible to simulate the use of a Positive Train Control (PTC) system. On other MWRRS corridors, PTC use typically resulted in more than a 10 percent savings in train delays. In addition, because of other limitations of the RTC model, scenario development was performed with MWRRS trains at current 2002 freight levels instead of projected 2020 freight levels.

Exhibit 6-47
St. Louis to Kansas City Route Alternatives



NOTICE:
This simulation contains preliminary data which is subject to review, verification and approval by Union Pacific Railroad. As of the date of this report, this review process has not taken place. Findings are not to be construed as a commitment on the part of Union Pacific to operate additional service.

Katy Alternative

As shown above, the Missouri-Kansas-Texas railroad formerly operated a parallel route on the north side of the Missouri River, from St. Louis to Sedalia via Jefferson City. After the rail line was abandoned in 1986, the right-of-way was converted as part of the *Rails to Trails* project into the highly popular, recreational use *Katy Trail.* In spite of the obvious cost advantage for reusing an existing right of way, that corridor is no longer available for rail operations between St. Louis and Sedalia.

Rock Island Alternative

Another possibility is to reactivate the former Rock Island line across Missouri. Except for the eastern 107 miles from St. Louis to Belle, MO, this track has remained unused since 1980. From Union to Belle, however, the track is in poor shape and impassible. West of Belle, the right-of-way is completely overgrown. Trees are growing between the rails and ties have rotted completely away. Washouts, landslides and urbanization have compromised the right-of-way. Bridges have been demolished for highway and road expansion, and some farmers along the line have even pulled up rails and sold them for scrap.

For freight service, directional use of the Rock Island for westbound trains between Labadie and Pleasant Hill may be a possibility. However, to traverse the large rivers and rugged hills of the northern Ozarks mountain country, many tunnels and high trestles would need to be restored. The line was known as Rock Island's *mountain railroad* because of its grades and curves. All these factors make the line unattractive for through freight service.

The Rock Island alignment is better known for its grand scenery than for its on-line traffic base. It bypasses Missouri's state capitol of Jefferson City and so is not an attractive route for providing MWRRS passenger service.

Union Pacific has examined, however, the possibility of reactivating the west end of the Rock Island line between Pleasant Hill and Kansas City, for reducing delays on the Sedalia line. However, diverting freight trains from the Sedalia to the River line, as proposed here, would minimize the need for adding freight capacity between Pleasant Hill and Kansas City.

UP River Line Alternative

Union Pacific's River subdivision is currently used for eastbound freight trains from Kansas City to Jefferson City, MO. It is eight miles longer and a little slower than the Sedalia subdivision, but offers easier grades and lower fuel consumption. Subject to completion of a detailed line simulation analysis incorporating the terminal areas (which has not been completed) double-tracking the River line should be investigated as a possible means for separating freight from MWRRS passenger operations west of Jefferson City.

One disadvantage of relying on the River line is its tendency to flood. Most flooding problems have occurred west of Jefferson City. During floods, Union Pacific runs trains bi-directionally over the Sedalia subdivision. After the MWRRS start-up, UP could still use the Sedalia line for emergency rerouting. Capacity upgrades to support MWRRS passenger service would in fact facilitate this. Several computer simulation runs will be presented to evaluate use of the Sedalia line for freight under emergency conditions.

KCS Variant of the River Line Alternative

Kansas City Southern (KCS), Norfolk Southern (NS) and Burlington Northern Santa Fe (BNSF) all have active lines between St. Louis and Kansas City. All three railroads run north of UP's alignment through Jefferson City, so UP trains could not use any of those routes without significantly disrupting UP crew and terminal operations. Both BNSF and NS have line capacity problems of their own. However, the KCS line, formerly part of Illinois Central, remains underutilized.

A portion of the KCS route – from Kansas City to Marshall, MO – could be used without affecting operations at either UP endpoint terminal. At Kansas City, the KCS line joins the Sedalia line just east of Rock Creek Junction. At Marshall, a new connection track would probably need to be built where the two lines cross. Between Marshall and Jefferson City, both east and westbound trains would operate over the River line, which would be double-tracked between those points.

The main benefit of using the KCS line is that it avoids the need for double-tracking 82 miles of the River line. With the KCS variant, only 74 miles of River Line would have to be double-tracked, rather than 156 miles. It appears that the KCS variant is operationally equivalent to double-tracking the River line. Further study is recommended of this cost savings opportunity, but an engineering analysis is needed first to confirm the feasibility of incorporating this route segment into Union Pacific's River line.

6.25.2 Needed Improvements on UP Infrastructure

A *partial* estimate of improvement costs was developed. The $314 million for improvements to the St. Louis-Kansas City line does not include costs for the capacity upgrades or River line improvements recommended here. The estimate includes:

- $170.7 million for track condition upgrades – timber and surface with 66 percent tie replacement, new switches and curve improvements on the Jefferson City and Sedalia lines
- $64.4 million for installing a Positive Train Control (PTC) system and other signaling upgrades
- $58.6 million for grade crossing improvements

An engineering cost estimate for needed capacity improvements has not yet been completed. An additional $578 million[10] Placeholder Cost for St. Louis-Kansas City capacity improvements has been included in the MWRRS business plan.

[10] This $578 million placeholder was estimated based on unit costs from other passenger rail corridor studies. It assumes infrastructure improvements recommended in this report east of Jefferson City and a full double tracking of

A capacity improvement plan has been developed for each subdivision. In the RTC model simulations, each subdivision's improvements were treated as a group. Improvements to all three subdivisions are needed to satisfy the delay mitigation criteria for the MWRRS.

6.25.3 Sedalia Subdivision - Capacity and Speed Improvements

The Sedalia subdivision extends from Jefferson City, MO to Kansas City, MO (Rock Creek Junction) via Sedalia. Long passing sidings on the Sedalia line would allow "running meets" between MWRRS passenger trains but would also significantly boost capacity of the Sedalia line for emergency freight use. Assuming westbound freights are diverted to the River line, the MWRRS guideline of a 10-mile siding every 50-miles, or 20 percent double-track, was used for developing an initial plan to upgrade the Sedalia line for passenger use. Since the total length of the Sedalia line is 150 miles, 20 percent double-track would allow 30 miles of new construction. These miles were distributed as follows:

- MP 248 to 260 - Connect Pleasant Hill to Lee's Summit siding
- MP 217 to 224 - Extend Centerview siding east, past Warrensburg
- MP 189 to 197 - Extend Dresden siding east to Sedalia
- MP 150 to 160 - Extend California siding west to MP 160

While these four sidings total 37 miles long, this total includes existing sidetrack mileage incorporated into new extended *passenger* sidings. Four sidings are spaced at 25-30 mile intervals. The proposed siding placement takes into account local conditions, including gradients for restarting freight trains, grade crossings and local industrial service.

The proposed layout of the Sedalia line represents a compromise between conflicting passenger and freight requirements. Such a compromise adds four long sidings instead of just two. By lengthening existing sidings, two sidings can be 10-miles long, while the other two sidings would be only slightly shorter. This distributes more sidings at uniform spacing along the length of the line. It provides much more freight capacity than would a two-siding solution and eliminates conflict with local industry switching at Sedalia

An alternative to double-tracking the River line would be to double-track the Sedalia line instead. This alternative has double-track with universal crossovers every 8-12 miles. The advantages of double-tracking the Sedalia subdivision instead of the River line include:

- Double-tracking the Sedalia avoids problem areas for flooding on the River line
- The Sedalia line is eight miles shorter and is faster than the River line

However, double-tracking the Sedalia line would keep freight and passenger operations mixed. The advantages of double-tracking the River line instead of the Sedalia are:

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the Sedalia subdivision. This placeholder has been estimated in advance of field inspections or detailed discussions with Union Pacific Railroad.

- Double-tracking the River line would provide a completely separate, low-grade route for freight trains west of Jefferson City
- Separating freight and passenger lines would offer reliability gains, particularly for MWRRS passenger service
- The current plan is to operate MWRRS trains at 90-mph with tilting equipment. Curves on the Sedalia line are not as severe as those on the River or Jefferson City subdivisions. If the line were dedicated to passenger trains, super-elevations (the amount of banking in the curves) could be raised to permit higher speeds. The design standard for MWRRS-dedicated tracks is a curve balancing speed of 60-mph, up to a maximum super-elevation of 6 inches.

Increasing super-elevations on the Sedalia line for 110-mph passenger trains would also allow speed limits of 70-mph for intermodal trains. However, increasing Sedalia super-elevations may also limit UP's ability to utilize the line for heavy bulk trains should the Missouri River flood. Any decision to upgrade the Sedalia line above a 90-mph standard would have to be undertaken based on the mutual consent of both UP and the MWRRI.

Jefferson City Subdivision – Capacity Improvements

The Jefferson City subdivision, between Jefferson City and St. Louis, handles UP freight in both directions, as well as two Amtrak trains each way. The line operates today with top freight train speeds of 60-mph. A *LOCOMOTION*® analysis determined this is the maximum freight speed possible for existing curve super-elevations. Curves on the Jefferson City line allow 90-mph with tilting equipment, but are too sharp for 110-mph operation. Since curvature restricts passenger train speed to 90-mph and this speed can be accommodated in mixed freight and passenger operations, the study assumed that there is no need to separate freight and passenger tracks over this line segment.

This segment needs to be upgraded to handle a doubling of freight volume and a tripling of passenger volume by 2020. Although there is currently no design standard for upgrading double-track lines for the MWRRS, a 20 percent target was used for determining the mileage of new passing siding capacity to be added. This mileage was distributed as follows:

- Double-track across Osage River Bridge and eliminate single-track bottleneck
- Double-track across Gasconade River Bridge and eliminate single-track bottleneck
- Center Siding at Dozier MP 28 to 37
- Center Siding at Berger MP 71 to 79.5

By 2020, triple-track will also be needed from Osage River (MP 117.4) to River Junction (MP 129.4.) This additional 12 miles of triple-track would be installed as part of the proposed support yard project at Jefferson City.

Subsequent to completion of this phase of the simulation effort, Union Pacific indicated they were planning to double-track the Osage and Gasconade River bridges, as well as to address yard capacity needs for crew changing at Jefferson City. The timing of this investment would be based on UP's own traffic growth and need for added capacity. Adding these bridge improvements into the base infrastructure would lower the amount of freight train delay in the base. While the MWRRS would avoid the cost of the bridge improvements, additional triple-track may be required to mitigate the impact of passenger delays on freight operations.

River Subdivision - Capacity and Speed Improvements

The River line would be upgraded by double-tracking its entire length from River Junction to Rock Creek Junction. Universal crossovers should be provided every 8-12 miles mainly to provide flexibility during track maintenance, although this was not explicitly simulated. A third track should be added along the shared BNSF section.

The distance from River Junction to Marshall, MO is 74 miles. Beyond Marshall, it is another 82 miles to Kansas City. If the parallel KCS line could be used between Marshall and Kansas City, the cost of double-tracking 82 miles of the River line can be avoided. If KCS cannot be used, double-tracking the Sedalia line might be less expensive. We recommend that the possibility of using the KCS alignment for westbound directional freight trains be formally evaluated in a future study.

The possibility of raising the River line speed limits to 60-mph was studied on stretches over 10 miles in length totaling 60.6 miles in length. Eastbound trains that are able to exceed 50-mph[11] would save 10 minutes. For westbound trains, the Sedalia line is still a little faster, but this improvement could reduce the time difference. Overall, since River line speeds would be improved in both directions, freight trains diverted to the River line may experience little adverse effect on total running times. The exact time savings or cost cannot be determined until the infrastructure upgrade plan is determined in more detail.

6.25.4 Yard and Terminal Issues

The line capacity simulation revealed problem areas at Jefferson City and at Sedalia. At Jefferson City, there is a need for additional yard tracks for crew changes and train staging. This is needed to keep the main tracks clear for passenger operations. In Sedalia, where a local train serves industries on the single-track main, this switching conflicts with both MWRRS passenger trains and with through freight trains.

Locating the End-of-Double-Track at Sedalia

At Sedalia, local industries are generally located west of the Amtrak station. Double-tracking MP 189-197 would allow through trains to pass around switching activities, but if the siding ends at MP 189, eastbound trains would have to restart against an ascending 1.35 percent gradient. If double-track were extended farther east through the Sedalia yard to MP 186.5, the starting gradient would be reduced to 0.15 percent ascending. However, unless new double-track could be added on the south side, the Sedalia yard lead would have to be replaced. The details of the infrastructure required to serve local industry at Sedalia have not yet been finalized.

[11] Coal loads are today limited to 50-mph, as are many manifest freight trains.

Jefferson City Support Yard

By 2020, additional yard capacity will be needed at Jefferson City for changing crews on freight trains, while keeping both main tracks clear. While some crew changes can take place on the main tracks at the Amtrak station, MWRRS passenger trains limit how much those tracks can be used. Some MWRRS trains are scheduled to meet at Jefferson City. When this occurs, MWRRS requires the use of both main tracks.

Use of yard tracks for crew changing would displace yard capacity at Jefferson City that is now used for switching purposes. There appear to be a few acres of land between the yard and the Missouri River where short half-mile mile tracks could be squeezed in to expand the existing switching yard.

A better option may be to construct an entirely new support yard west of town, at the mouth of Grays Creek. Trains headed to or from the Sedalia line would be limited to about 1½ miles in length. Even though westbound trains would normally use the River line, access to the Sedalia line is still needed for emergency use and during maintenance on the River line. If the yard needs to be longer than this, a 100-foot cut through a bluff or a tunnel would be needed to provide a head-on movement to the Sedalia line farther west.

An alternative plan would be to site the yard entirely west of River Junction, where tracks could be as long as desired. By installing a connecting Wye track at River Junction, westbound trains could reach the Sedalia line by reversing direction, or crews could change on the main line at Jefferson City when MWRRS trains do not need it. Since the Sedalia line would see only occasional use, this site may prove satisfactory. An engineering field survey and further discussion are needed before definitive plans are made.

An aerial survey suggests that the land needed for yard expansion might be available alongside the Missouri River west of Jefferson City; however the area is in a flood plain. Constructing a yard there may require moving existing levees. A detailed engineering assessment is needed to determine the feasibility and optimal site(s) for yard expansion near Jefferson City.

By 2020, a full-fledged, six-track support yard will be needed to provide for changing crews on freight trains. This yard must have direct access from the River Route to prevent conflicts with MWRRS passenger trains. Triple-track should also be provided on the east end of the yard to the Osage River, so freight trains can arrive and depart the yard simultaneously even if a MWRRS passenger train is coming.

Given the high cost of land in St. Louis and Kansas City, coal-staging yards might be built *outside* these major metropolitan areas at a lower cost. The goal for coal trains should be to get them *through* St. Louis and Kansas City as quickly as possible, not to hold or store them there. It would be more cost-effective to build new support yards at Jefferson City and Marysville, rather than trying to squeeze more yard capacity into the already-congested St. Louis and Kansas City terminals.

Kansas City Terminal

The Kansas City Terminal (KCT) between Rock Creek Junction and Kansas City Union Station was included in the RTC simulation. However, freight train data was not received from either KCT or BNSF. Currently KCT handles well over one hundred freight trains per day on a double-tracked railroad, with some triple-track. Amtrak operates four trains a day, projected to grow to 12 with implementation of MWRRS. MWRRS would represent a very small percentage of the total train movements over KCT track. Line congestion remains an issue, but KCT capacity issues will be driven more by projected increases in freight traffic than by MWRRS needs.

The most serious operational problem between Rock Creek Junction and Union Station is a level crossing at Sheffield with both KCS and the UP Coffeyville rail line. The Sheffield flyover recently bridged that crossing. A new connection track at Rock Creek Junction is needed to allow MWRRS passenger trains to access the flyover and avoid conflicts with freight trains crossing at Sheffield.

6.25.5 St. Louis-Kansas City Simulation Analysis

This study develops an infrastructure plan to accommodate MWRRS passenger trains at forecast 2020 freight traffic levels. The evaluation was conducted following the mitigation framework described earlier in this report. The MWRRS mitigation determines the investment needed to reduce freight delays to the level they would be without the addition of MWRRS passenger trains, on current infrastructure in 2020. Current infrastructure was assumed as the base line. Subsequent to completion of the simulation modeling, Union Pacific indicated they were planning to double track the Osage and Gasconade River bridges. This changed assumption is not reflected in this report, but will be addressed in a future project phase.

The proposed rerouting of westbound freight trains from the Sedalia to the River line raises a question whether *train delay* or *transit time* should be equalized. Since the River line is slightly longer and slower than the Sedalia, Union Pacific suggested that transit time mitigation be used. Anticipated locomotive and fuel savings associated with the use of the River route should at least partially compensate Union Pacific for any added free-running time. Nonetheless, Union Pacific's requested criterion of transit time equalization was used in this analysis.

Union Pacific also requested that a *freight-only* base case be developed. This request was also accommodated. If freight traffic doubles without adding infrastructure, the performance of the system by 2020 will be very weak. Without investment, it will not even be possible to continue operating Amtrak trains on any acceptable schedule. The RTC simulation locked up when a 2020 *Do Nothing* simulation was attempted, keeping the Amtrak trains on the tracks. Accordingly, the Amtrak trains were removed from the simulation and a 2020 *Do Nothing* scenario was developed without Amtrak trains, which allowed the RTC simulation to run successfully.

The cost estimate prepared includes $64.4 million for a Positive Train Control (PTC) or Communications-Based Train Control (CBTC) system and other signaling improvements between St. Louis and Kansas City. However, Berkeley's RTC model is not able to simulate a PTC-overlay signal system with moving block. We had to assume conventional TCS signaling. Presumably, a PTC system could reduce delays – in addition to the delay savings generated by the proposed infrastructure improvements. It was not possible to quantify the magnitude of the savings here since, at the request of Union Pacific, the RTC model was used for the simulation runs. Accordingly, the mitigation option of using PTC on the routes was not studied.

Of the three mitigation options discussed earlier in this report, only the option of adding infrastructure could be pursued here; signaling improvement could not be simulated by the RTC model and there were no obvious opportunities for any operations-based mitigation.

6.25.6 Scenario Development

Even with new infrastructure added, the RTC model took four days to complete one 30-day simulation at 2020 volumes. The size and complexity of this analysis creates a challenge for the timely completion of computer simulation runs. At 2020 traffic volumes, the simulation performs adequately only if the full package of proposed infrastructure investments are included. With any fewer investments, the simulation bogs down and often terminates short of completion. This reflects the physical reality of conducting complex, high-volume rail operations. However, to obtain comparative delay statistics, there is often still a desire to obtain a completed simulation of a hypothetical "Do Nothing" alternative. Because of this difficulty in getting the RTC model to run with less than full infrastructure at 2020 traffic levels, scenario development was performed with MWRRS passenger trains at current 2002 freight traffic levels.

Exhibit 6-48 shows the complete set of scenario development simulations. All were performed at 2002 freight levels. Of particular interest was determining whether mitigation could be attained *without* making all the improvements proposed on each subdivision. *If the mitigation criteria could not be satisfied even at 2002 traffic levels, the plan clearly would not work for 2020.* The Sedalia, Jefferson City and River lines were *individually* reverted – one subdivision at a time – back to their unimproved condition. This produced a measure of the incremental benefit of investment on each subdivision without overloading the RTC model. Scenario development runs included:

- A 2002 Base Case both with and without Amtrak trains, over current infrastructure
- A Future Railroad scenario including the complete set of improvements proposed for MWRRS
- In the Jefferson Base scenario, the Jefferson City subdivision was not improved. This measures the benefit of improvements east of Jefferson City.
- In the River Base scenario, the River line remains single-tracked and empty trains return via the Sedalia line, with improved passing sidings. This measures the incremental benefit of double-tracking the River line.
- In the Sedalia Base scenario, the Sedalia Subdivision was not improved. This run measures the incremental benefit of improvements to the Sedalia Subdivision.
- A Sedalia Double scenario explores the possibility of double-tracking the Sedalia instead of the River line. Sedalia double-track would replace both River line double-track and long Sedalia passenger passing sidings.
- Two special simulations explored reroute options using the Sedalia line during flood conditions on the River line.

Exhibit 6-48
St. Louis to Kansas City Scenario Development

Investments Included	***Base Case***	***Future RR***	***Jefferson Base***	***River Base***	***Sedalia Base***	***Sedalia Double***	***River Flooded w/Single***	***River Flooded w/Double***
Years Run	**2002**	**2002**	**2002**	**2002**	**2002**	**2002**	**2002**	**2002**
Jefferson City Sub Improvements	Freight Only and with Amtrak	✓		✓	✓	✓	✓	✓
River Sub Double-track		✓	✓		✓		Out of Service	Out of Service
Sedalia Sub Passenger Sidings		✓	✓	✓			✓	
Sedalia Sub Double-track						✓		✓

Freight train running time was longer in both the Jefferson Base and River Base simulations than it was in the current Base Case with Amtrak. *Therefore, the freight mitigation criteria for the MWRRS cannot be satisfied without the full set of improvements to both the Jefferson City and River lines*. This establishes the need for both the Jefferson City and River line investment packages even at 2002 freight traffic levels, so further analysis of these partial investment packages in 2020 is not needed.

The Sedalia Base alternative shows that freight mitigation can be achieved without extending the passing sidings on the Sedalia line. Due to freight trains being diverted off the Sedalia onto the River line, the ability to do so without Sedalia siding improvements is not unexpected. However, long passing sidings on the Sedalia line are still needed for passenger use and they would provide significant added capacity for overflow freight or for emergency reroutes.

Clearly, there is a need to maintain at least some operations during flood conditions on the River line. The most severe flooding tends to occur west of Jefferson City, on the portion of the River line proposed to be double-tracked. During flooding, freight trains can operate bi-directionally via the Sedalia line. Extra locomotive power is required on eastbound coal trains to do this.

The existing Sedalia line does not offer enough capacity to handle even today's traffic in both directions, so operations have to be restricted. However, the improvements advocated for the MWRRS would extend or connect several Sedalia passing sidings to provide about 20 percent double-track. Another strategy would completely double-track the were examined for emergency freight operations on the Sedalia line:

- First, as shown in the River Base simulation, an improved Sedalia line can accommodate a *directional* (westbound) freight operation, along with MWRRS passenger trains. It was expected that this would routinely occur anytime maintenance on the River line takes a track out of service.
- The Sedalia line, even with planned improvements, does not have enough capacity to handle freight in both directions along with MWRRS passenger trains. However, bi-directional freight (at 2002 levels) could be accommodated on an improved single-track Sedalia by temporarily suspending MWRRS passenger service. The River Flooded w/ Single scenario simulates this.
- The Sedalia Double scenario double-tracks the Sedalia line instead of the River line. It continues directional operation, routing westbound freight trains over the Sedalia while loaded coal trains continue to use the River line.

While the Sedalia Double scenario shows satisfactory performance at 2002 traffic levels, it continues to mix freight and passenger operations rather than separating them. In the long term, this may lead to a cost and reliability penalty for both freight and passenger services. It may be better to take advantage now of the opportunity to completely separate freight from passenger operations west of Jefferson City.

The Sedalia Double option does offer one significant advantage: it provides enough capacity to support bi-directional freight along with full MWRRS passenger schedules, if the River line is flooded. However, this benefit would only accrue perhaps one week a year. To obtain it, passenger and freight operations would have to remain mixed for the remaining 51 weeks a year, even when the river is not flooded. Improved flood protection for the River line may be a better option than double-tracking the Sedalia line.

Base Case Calibration

Two variants of the 2002 Base Case were created: *freight only* and *with Amtrak trains*. These Base Case simulations identified three significant sources of delay:

- Eastbound Amtrak trains oppose westbound freight trains on the Sedalia line
- Delays occur around Jefferson City as freight trains wait for crew changes
- LSJ69 serves industry along the Sedalia line. If LSJ69 is released to serve industries along the single-track portion, through trains catch up taking significant delay, or else LSJ69 must be held in a siding waiting for a work window. In the post-MWRRS scenario, it actually becomes easier to avoid interference, since through freights would be diverted to the River line and the locals could operate at night when passenger trains are not running.

In data supplied by UP, average freight train speed from Kansas City to St. Louis was 18.6-mph and 24.1-mph in the westbound direction. This includes all delays and crew changing time. Faster westbound speeds result from the improved weight-to-power ratio of empty trains and from higher speed limits on the Sedalia line.

Union Pacific also furnished data on temporary slow orders and track outages. Although slow orders are a normal part of any rail operation, planned track condition upgrades and raising the FRA Track Class will reduce the frequency of slow orders that affect freight operations. For example instead of having a slow order that reduces speed from 50-mph down to 25-mph, a “slow” order in Class 5 territory may instead reduce speed from 90-mph down to 60-mph. Such a restriction would affect passenger trains but would have minimal effect on freight. On upgraded infrastructure, slow orders of such severity that they affect freight operations should be rare.

By including slow orders in the base case simulation, simulated running times could have been brought closer to real-world results. However, since the MWRRS plan allocates $170.7 million for track condition upgrades, slow orders were not simulated in the base case. Any train delay savings from elimination of slow orders would be *in addition to* savings from MWRRS line capacity improvements. This omission of slow orders from the base case tends to *understate* the delay mitigation benefit of the proposed MWRRS investment, which would clearly benefit freight as well as passenger trains.

MWRRS Mitigation Simulations

For establishing mitigation, RTC model simulations were developed at 2002, 2012 and 2020 traffic levels.

- 2002 Base Case and 2012 Do Nothing scenarios were developed with and without current Amtrak trains. These were compared to a Future Railroad simulation for each forecast year.
- For 2020 volume, a freight-only Do Nothing simulation of the existing infrastructure was simulated. The RTC model aborted immediately when Amtrak trains were turned on. This freight-only Do Nothing result was compared to a 2020 Future Railroad simulation.

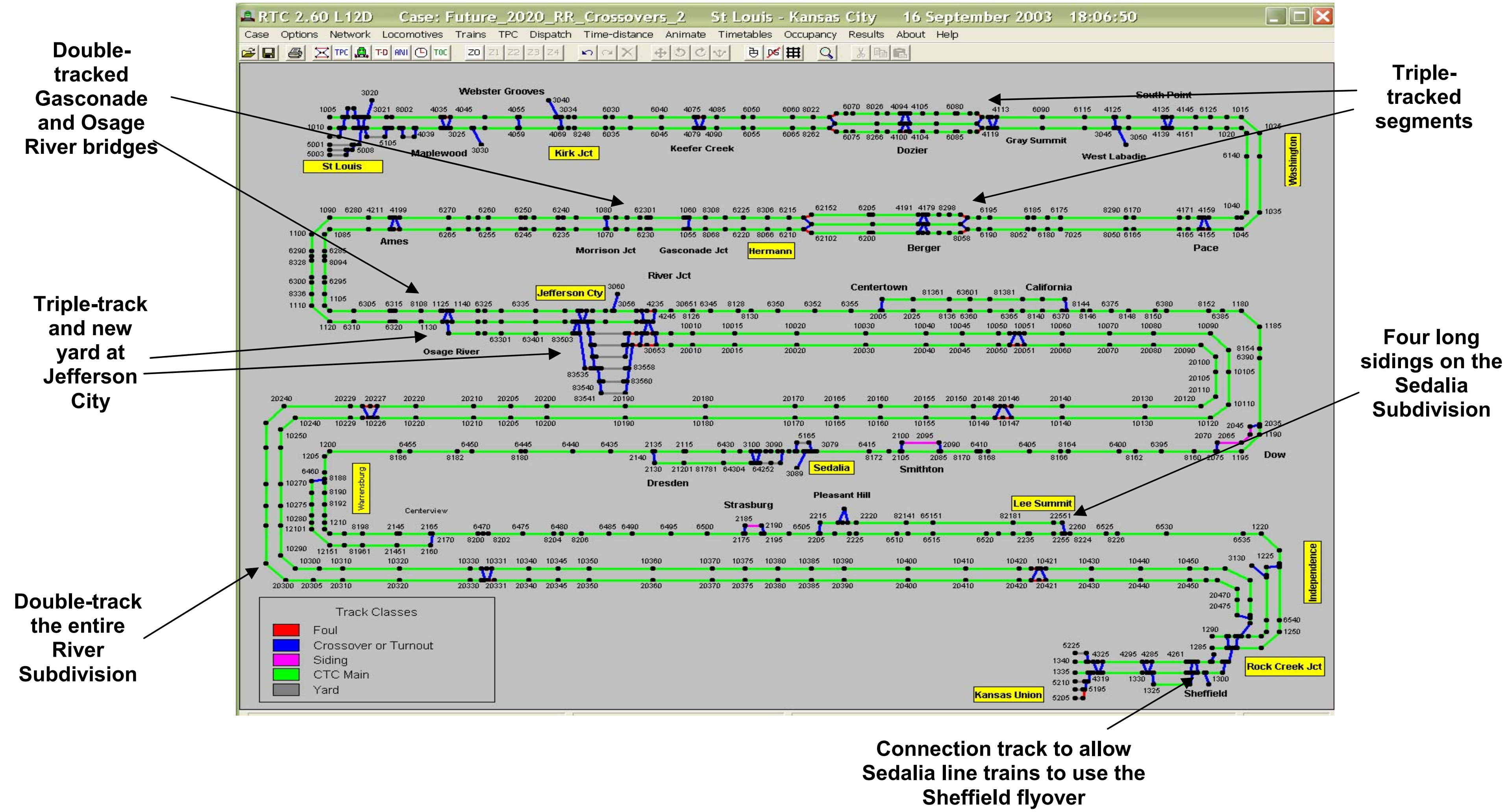
Proposed Future Railroad capacity enhancements are shown in Exhibit 6-49. At first, even with all improvements, freight train delays were too high. Further simulation was used to help finetune interlocking configurations, crossover locations and the configuration of the crew-changing yard at Jefferson City – until 2020 freight delays were reduced below the level that would have occurred if the MWRRS did not exist.

Diverting through freights onto the River line would give passenger trains their own dedicated track west of Jefferson City to Kansas City. Long sidings on the Sedalia line would facilitate running meets between MWRRS passenger trains, and would increase freight capacity for emergency use. In the future case simulation, two single-track bottlenecks on the Jefferson City line were eliminated and three sections of triple-track were added along with a new support yard at Jefferson City. This complete set of upgrades was introduced at the same time as MWRRS passenger service.

Exhibit 6-50 shows forecasted total elapsed time in each of three simulated years – 2002, 2012 and 2020. Three curves are shown – the current railroad with and without Amtrak, and the proposed MWRRS mitigation solution. In 2002, adding the proposed MWRRS infrastructure would reduce train-running time substantially below its current value. *As traffic levels increase in the future, proposed MWRRS infrastructure additions become even more valuable.* By 2012, the MWRRS mitigation outperforms the current railroad even *without* Amtrak. Because the RTC model was unable to operate at 2020 traffic levels on the current railroad with Amtrak trains, a value for the result of that run was estimated.

The 2002 Base Case generates 11 days of freight train delay; by 2020, without double-tracking the Osage and Gasconade River bridges, this would rise to 121 days in the Do Nothing scenario even if Amtrak trains were discontinued. Freight delays grow by a factor of 12 when volume less than doubles. This disproportionate increase in train delays clearly shows that the system will be reaching its capacity limit by 2020. If Union Pacific proceeds with double-tracking the two river bridges, then additional triple-tracking between Jefferson City and St. Louis (beyond what is included in the current infrastructure plan for the MWRRS) will be needed to reduce 2020 freight delays below the level that would have occurred, if MWRRS did not exist. Development of such a strategy will require an engineering field assessment to determine the areas where triple-tracking may be feasible, along with additional simulation modeling effort to ensure the delay mitigation criteria for the MWRRS are fully satisfied. A likely scenario is full triple tracking except for the tunnels at Gray's Summit and the Osage and Gasconade River bridges, which may remain only double tracked. It is anticipated this expanded modeling effort will be funded in a future project phase.

Exhibit 6-49
Proposed Future Railroad Capacity Additions



NOTICE:

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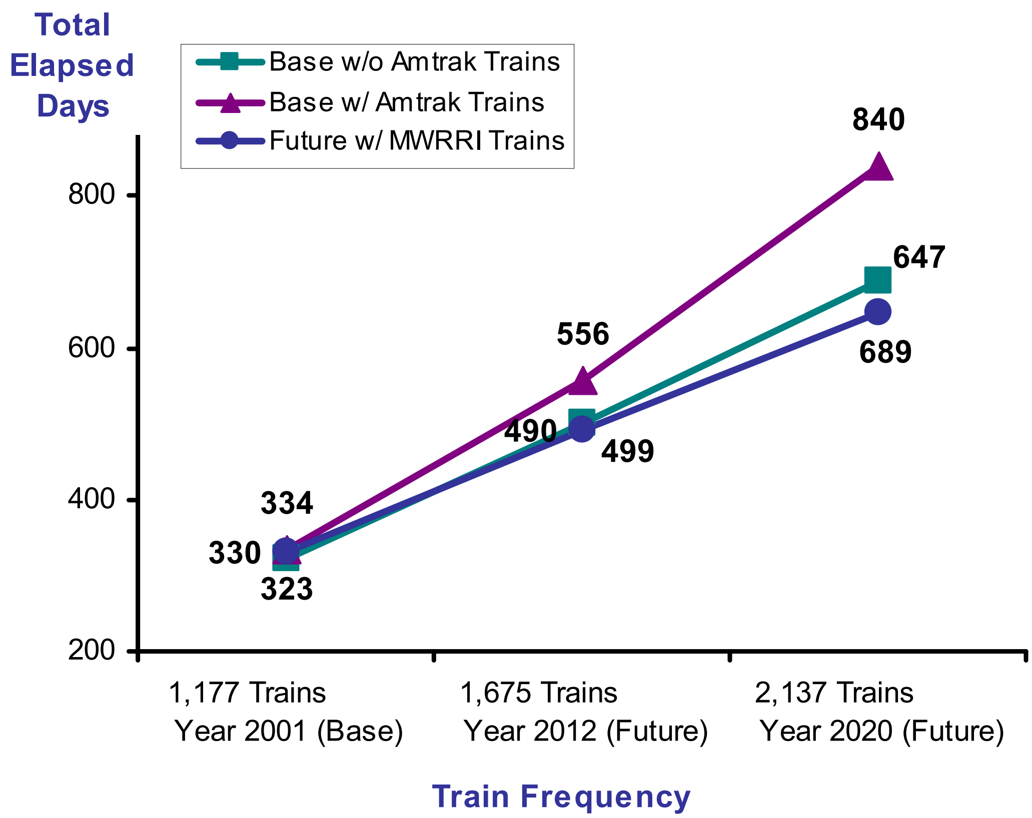
Exhibit 6-50
St. Louis-Kansas City Mitigation Statistics
30-day Simulation – Summary Statistics for Freight Trains Only
Total Running + Delay Time of All Freight Trains



6.25.7 Conclusions and Recommendations

The St. Louis to Kansas City line is one of Union Pacific's highest density freight corridors. Already carrying more than 100 million gross tons per year, freight traffic is forecast to almost double by 2020. In addition, the line carries two round trip Amtrak trains each day. The goal of the MWRRI is to increase passenger service to six round trips by 2013 and to shorten the schedule by one hour by introducing new tilting trains (that can go faster around curves) and a Positive Train Control (PTC) signaling system.

Increase in freight train delays occur because of projected freight traffic growth and would happen even without the addition of MWRRS passenger trains. To partially offset these delays, Union Pacific has indicated it is planning to double-track the Osage and Gasconade River bridges, and to make whatever yard investments are needed at Jefferson City to support its own operations. This report develops an infrastructure plan for returning 2020 freight delays to a level *lower* than they would be without any passenger trains on existing infrastructure. Specifically:

- Capacity needs west of Jefferson City would be fully addressed by double-tracking the River line and by upgrading the Sedalia line to serve as a dedicated high-speed passenger and freight route and as a relief route for high-speed freight or emergencies. Since westbound traffic consists mostly of empty trains, these could be diverted as needed to the Sedalia line without damaging MWRRS passenger tracks.
- Infrastructure improvements for the MWRRS would eliminate the two remaining single-track bottlenecks and install three sections of triple-track to allow MWRRS and intermodal trains to overtake slower coal trains. Since this line segment is already double-tracked, infrastructure improvements for the MWRRS would be selectively targeted to address the most urgent capacity needs. These include major construction to double-track bridges across the Osage and Gasconade Rivers, and providing triple track at critical meet points.

The proposed infrastructure improvements for the MWRRS would provide enough capacity west of Jefferson City not only for day-to-day operations but also to meet emergency and maintenance needs. By making an upgraded Sedalia line available during flood conditions or to relieve freight congestion on the River line, the need for building more than two tracks on the River line can be avoided.

Some benefits to Union Pacific of the infrastructure improvements for the MWRRS would include:

- An investment of $64.4 million to install a Positive Train Control system and other signaling upgrades. The RTC model simulation does not reflect the benefits of this PTC investment, which has reduced train delays in other MWRRS corridors by more than 10 percent.
- An investment of $170.7 million for general track condition upgrades, *over and above* the cost of line capacity additions and River line improvements. This would dramatically reduce freight train delays due to slow orders. These train delay savings have been neither quantified nor included in the RTC model mitigation.
- An investment of $58.6 million for grade crossing improvements. In addition to saving lives and reducing property damage, this investment would reduce the frequency of severe operational disruptions caused by grade crossing accidents.
- The capacity enhancements suggested here would offer significant *benefits* to yard and terminal operations. With directional running, if either line is shut down it is difficult to divert trains to the other track. With a double-tracked River line, one track could be closed for maintenance while full operations continue using the other track. With the added line capacity west of Jefferson City provided by MWRRS, the need for holding or staging trains in Kansas City and St. Louis yards for track maintenance curfews should be dramatically reduced.

A projected increase in freight delays on current infrastructure by 2020 remains a serious concern. To maintain freight delays near their current level along with MWRRS operations, it will be necessary to fully triple-track the Jefferson City line except perhaps for a few short stretches at tunnels and bridges. To reduce costs, MWRRS trains should possibly switch to the BNSF alignment east of Pacific (MP 35). Some other joint-running or capacity-sharing arrangement with BNSF from Pacific into St. Louis might also be possible. For perspective, Union Pacific today operates an average of 45 trains-per-day (including passenger trains) on its double-tracked line between St. Louis and Kansas City. This is forecast to grow to 88 trains-per-day by 2020, an average of 44 trains-per-track per-day on a double-tracked line.

By comparison, between O'Fallons and North Platte, NE, Union Pacific operates 125-150 freight trains per day on a triple-tracked rail line or, 42-50 trains per track per day. This volume was formerly handled on a double-track line, but not without significant problems. Union Pacific's own operating experience, therefore, confirms the possibility of operating as many as 88 trains-per-day over a double-tracked Jefferson City line, although that would clearly be reaching the upper limits of line capacity. The three sections of triple track provided in the current simulation would be intensively used to allow overtaking not only by passenger trains, but also by higher-priority automotive and intermodal freight trains.

While the simulation suggests this partial triple-tracking solution may be adequate for handling MWRRS trains along with today's freight traffic volume, without full triple tracking by 2020, the proposed MWRRS service could be expected to suffer reliability problems. Union Pacific's St. Louis to Kansas City corridor is one of the densest bulk and manifest freight routes in the United States. The challenge of overlaying a high-speed passenger network on this route is further complicated by the curvature and gradient profile of the line. At projected 2020 traffic levels, assuming Union Pacific funds the cost of double-tracking the Osage and Gasconade River bridges, the capacity needed to support proposed MWRRS service would be equivalent to providing one additional track all the way from St. Louis to Kansas City. However in the context of the MWRRS project, this is no greater investment than has been proposed for other corridors, such as from Cleveland to Toledo where a dedicated third track would be constructed alongside nearly the entire length of the Norfolk Southern line.

With its own dedicated track from St. Louis to Kansas City, the proposed MWRRS service could operate with minimal interaction with existing freight service. However to optimize the freight benefit of making the investment, this plan instead envisions adding a third *shared* track from St. Louis to Jefferson City rather than a dedicated passenger line. West of Jefferson City, using the River route for freight would completely separate freight from passenger operations. Given a nearly $1 billion investment that would effectively separate freight from passenger trains all the way from St. Louis to Kansas City, TEMS believes these two kinds of services should be able to coexist without difficulty.

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6.26 Chicago–Toledo-Cleveland Rail Corridor

The aim of this analysis was to:

1) Assess the impact of MWRRS high-speed 110-mph passenger train operations on the Toledo-Cleveland railroad corridor, and
2) Confirm the initial estimate of the infrastructure improvements needed to maintain freight operations at current levels of performance. This study is strictly a feasibility-level analysis that identifies line capacity issues and evaluates potential operational conflicts on the corridor.

Norfolk Southern owns the Toledo-Cleveland line. This analysis has been advanced prior to the initiation of detailed operational discussions or negotiations with the railroads, or the identification of specific project funding sources. Future engineering assessments will require considerably more discussion to ensure railroad concurrence. Final design concepts and recommended capital plans will depend on detailed operations analysis, design coordination, and in-depth discussions with the freight railroads. As the MWRRS project moves beyond the feasibility phase, railroad involvement and coordination will become increasingly important.

Chicago-Toledo Route Alternatives

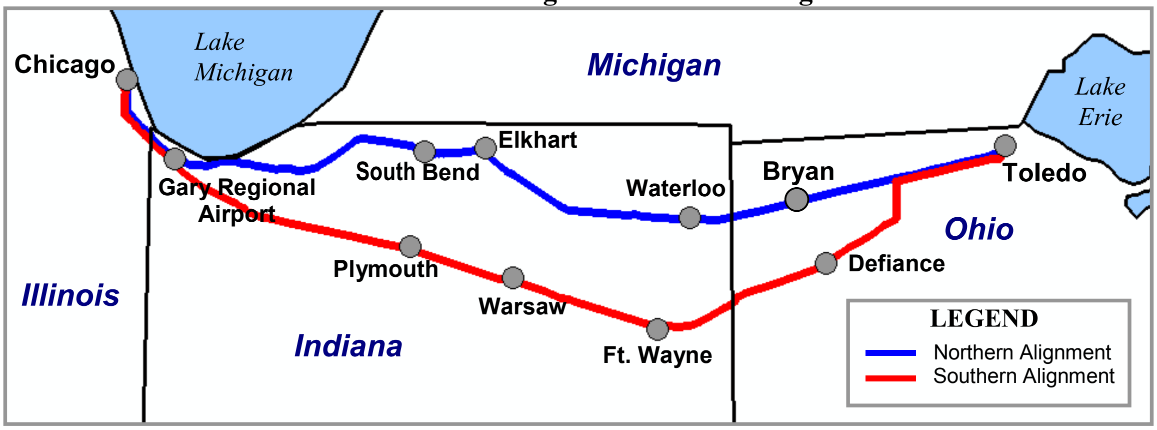
Originally, the MWRRS had considered only Norfolk Southern's Chicago Line, also called the "Northern Alignment" as the route between Chicago, Toledo and Cleveland. However, in 2002, the Indiana Department of Transportation requested a comparative analysis of an alternative "Southern Alignment"[12] from Buffington Harbor, near the Gary Airport in northwest Indiana, to Delta, Ohio, west of Toledo. This alternative route, which passes through Gary, Plymouth, Warsaw, Ft. Wayne and Defiance, has relatively light freight traffic.

As shown in Exhibit 6-51, the MWRRS alternative routes between Chicago and Toledo consist of several route segments, each of which has distinct ownership and operational characteristics. Amtrak currently operates the daily *Capitol Limited* (Washington-Pittsburgh-Chicago) and the daily *Lake Shore Limited* (New York-Albany-Chicago) over Norfolk Southern's "Chicago Line" (the northern alignment) with stops in Hammond, South Bend, Elkhart, Waterloo, Bryan, and Toledo.

Despite being approximately 13 miles longer, because of the lower density of traffic and upgraded track, the Southern route is up to nine minutes faster than the Northern route. In financial and economic terms, the Southern Alignment was shown to be more beneficial than the Northern route. This is because the Southern Alignment serves Fort Wayne, and allows higher train speeds at a lower cost by redeveloping a light-density freight rail line for passenger use.

[12] See the *Northern Indiana/Northwestern Ohio Routing Study*, TEMS, Inc., November 2002.

Exhibit 6-51
Northern and Southern Alignments from Chicago to Toledo



Several factors led to this finding. Higher infrastructure capital costs were found for the northern route. Because freight traffic levels on the existing northern corridor are particularly high, a new dedicated track would be required along the entire length of the corridor. In areas where there is not enough room to construct the adjacent passenger track at the required minimum distance from the freight line, speeds would be reduced to 90 mph. This slower speed on portions of the northern route increased the overall travel time and subsequently lowered the projected ridership for the corridor. Competitive commuter rail service between South Bend and Chicago had a further negative impact on the overall projections for the northern route. Given the selection of the southern route, Indiana DOT proposed to enhance the NICTD system by providing additional express train service between South Bend and Chicago. This provides an effective connection with the MWRRS at Gary.

The substantially lower freight density on the southern corridor reduced the cost of that route since it allowed for plans to rebuild the existing tracks without a need to build an entirely new set of adjacent tracks. Because of the lighter freight density on the Ft. Wayne line, it is anticipated that opportunities will exist for cooperative freight and passenger shared use of the line.

By 2012, MWRRS plans to introduce new high-speed (110-mph) train operations and a Positive Train Control (PTC) signaling system. Nine daytime MWRRS round-trips would operate between Cleveland and Toledo (eight of which would continue to Chicago), in addition to the two Amtrak long-distance trains that operate today[13]. By raising Chicago-Toledo-Cleveland train speeds from 79 to 110-mph, running times would be shortened from the current 7:15 to 4:48 (HH:MM). New trains would use tilting technology to allow faster speeds through curves, while maintaining passenger comfort and ride quality.

[13] In addition, Ohio's proposed high speed "Cleveland Hub" service would use the Cleveland-Toledo portion of the corridor. Cleveland Hub would operate an additional eight round-trips from Cleveland to Detroit on a 2:47 (HH:MM) schedule. We assume that the single MWRRS Toledo-Cleveland round trip will eventually be replaced by Cleveland Hub service, reducing the number of daily MWRRS round-trips from nine to eight.

On the Southern Alignment between Buffington Harbor (Gary Airport) and Delta, Ohio, long high-speed sidings for passenger train meets would be added according to the MWRRS standard of 20% double track. Sidings would be located at Valparaiso, Hanna, Plymouth, Warsaw, Van Dale, Fort Wayne, Antwerp and Defiance. Freight train interference on the Fort Wayne line should not be an issue since Conrail downgraded its Fort Wayne line to secondary status in 1990 only local freight service remains. Track configuration details for local industry switching remain to be defined during the preliminary engineering phase of this project.

At Delta, the passenger alignment would use the Indiana & Ohio railroad bridge, crossing over the NS Chicago Line and would then turn right to parallel the NS freight tracks.

In Toledo, representatives from Norfolk Southern, Amtrak and the State of Ohio conducted a joint field investigation of the Toledo terminal operations. Engineering plans for running the passenger alignment around Airline Yard remain to be finalized, but a $40 million capital placeholder has been designated for that purpose.

Toledo-Cleveland

From Toledo to Cleveland, the MWRRS passenger alignment would follow the Norfolk Southern right-of-way on the north side of the existing Chicago Line. Amtrak operates the *Capitol Limited* and the *Lake Shore Limited* over this route with stops in Sandusky, Elyria, and Cleveland.

As requested by both CSX and NS, wherever 110-mph FRA Class 6 operations are planned, a new high-speed track would be added with 28-foot centerline offset from the existing freight tracks. MWRRS train speeds would be restricted to 90-mph or less whenever a 28-foot separation cannot be maintained.

The MWRRS capital plan assumes that the Toledo-Cleveland passenger rail alignment would be mostly separated from the freight mainline operation. However, the MWRRS proposes to share the existing NS double track in several places where it would not be economically feasible to widen the right-of-way. The shared track segments, where freight and passenger trains would co-mingle include locations in Toledo, the Sandusky Bay Causeway and the bridge crossings over the Huron and Vermilion Rivers. Because of these short co-mingled track segments and the need for passenger trains to meet each other, MWRRS passenger trains *would not be completely separated* from freight between Toledo and Cleveland.

6.26.1 Toledo-Cleveland: Past and Present Freight Flows

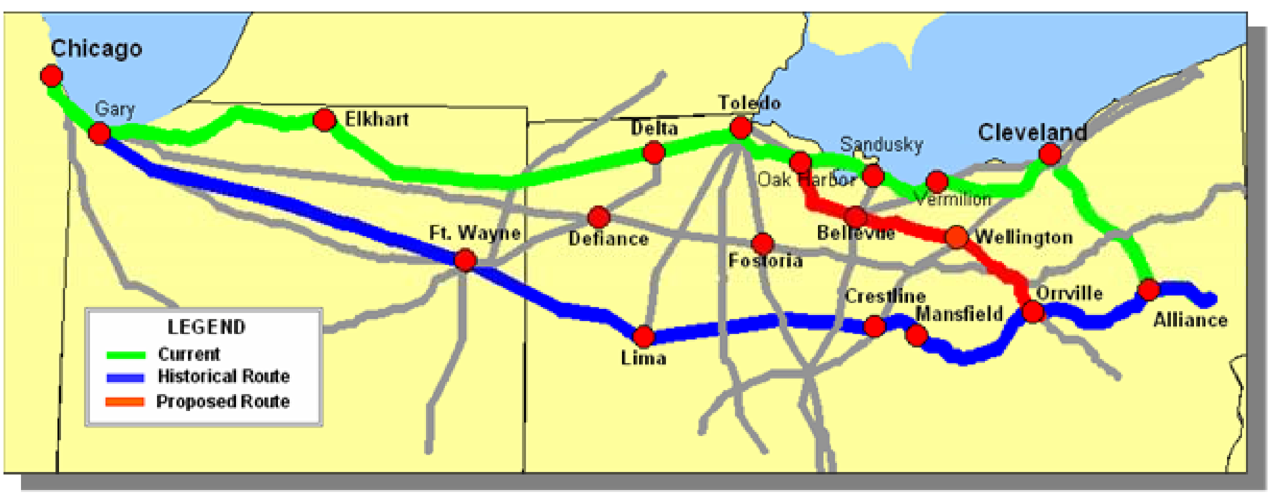
In examining railroad capacity on the Toledo-Cleveland freight corridor, it is helpful to highlight recent changes in freight railroad traffic flows. Freight railroad operations in the Toledo–Cleveland corridor changed dramatically in 1999 with the acquisition of Conrail by NS and CSX. As a result of the acquisition, the major flow of rail traffic has changed considerably.

Prior to 1999, the traffic was accommodated over two railroad corridors running through Fort Wayne. Today, the major flows of freight traffic use the NS Toledo–Cleveland line along with a parallel CSX route.

- As shown in Exhibit 6-52[14], NS Chicago traffic from Pennsylvania and Maryland, which before 1999 used Conrail's direct line west through Crestline and Fort Wayne (blue route), is now routed from Alliance to Cleveland instead (green route). A possible future routing for this traffic via Orrville and Bellevue is shown in red. This route alternative will be discussed in more detail in section 6.26.6.
- As shown in Exhibit 6-53, prior to 1999, NS Chicago traffic originating on the former Nickel Plate (NKP) east of Cleveland was handled on the line via Bellevue and Fort Wayne (blue route). Rerouting this former NS traffic on the new route via Toledo alleviated capacity constraints on NS' Chicago–Fort Wayne line. However, the old NS line from Cleveland via Toledo still remains an alternative for this traffic, or a new routing via Wellington and Bellevue (red route) may also be a possibility for it. This route alternative will also be discussed in more detail in section 6.26.6.

Currently, the east and west ends of the NS Cleveland-Toledo line have heavier volumes of freight traffic than the middle portion of the route. This is due to the NS Bellevue Yard which collects merchandise carload traffic and operates as a major classification point for north-south shipments heading into traditional NS territory in the south. To allow trains to reach Bellevue from the acquired Conrail (NYC) line, NS installed connection tracks shown in 6-54, 6-55 and 6-56, at Vermilion and Oak Harbor.

Exhibit 6-52
Pennsylvania and Maryland to Chicago (Former Conrail Traffic)



[14] In Exhibits 6-50 and 6-51, a "proposed route" option is also shown in red. See section 6.33.

Most NS bulk and intermodal trains continue to operate over the direct Cleveland-Toledo line through Sandusky. However, freight trains often use the connection tracks at Oak Harbor and Vermilion to stop at Bellevue yard. This freight diversion via Bellevue reduces the number of trains crossing the Sandusky Bay causeway, which is a critical capacity bottleneck on the line. So, the east and west ends of the Cleveland-Toledo line have heavier freight traffic than the middle portion.

Exhibit 6-53
Buffalo to Chicago (Former NS Traffic)

Exhibit 6-54
Norfolk Southern Toledo–Cleveland: Two Routes

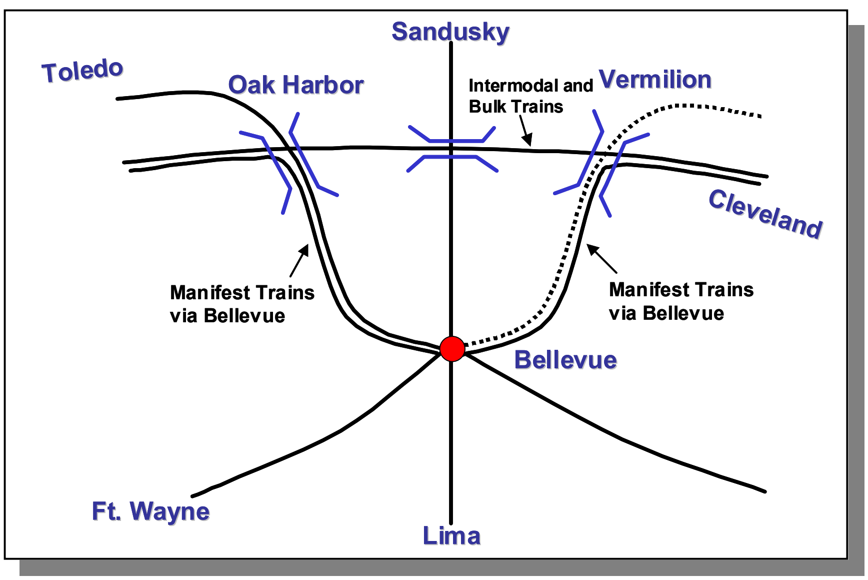


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Exhibit 6-55
NS Oak Harbor Connector

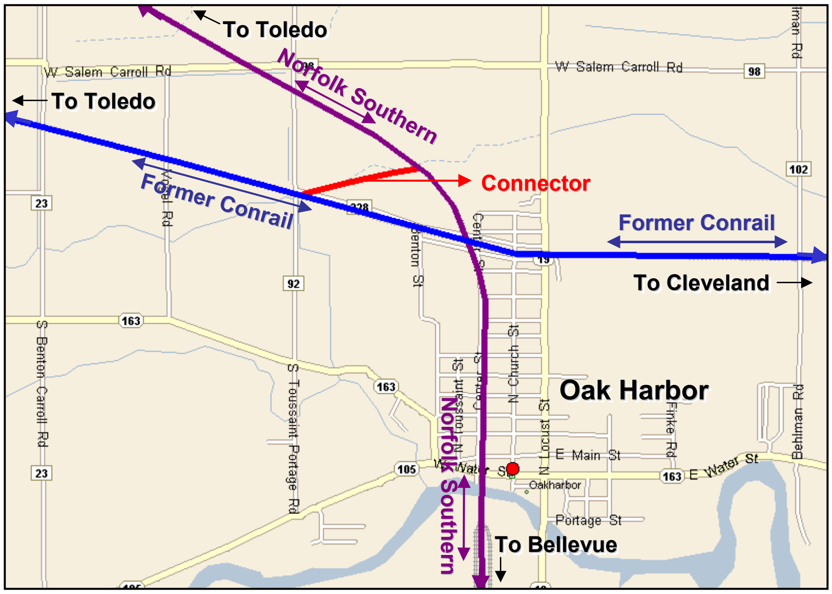
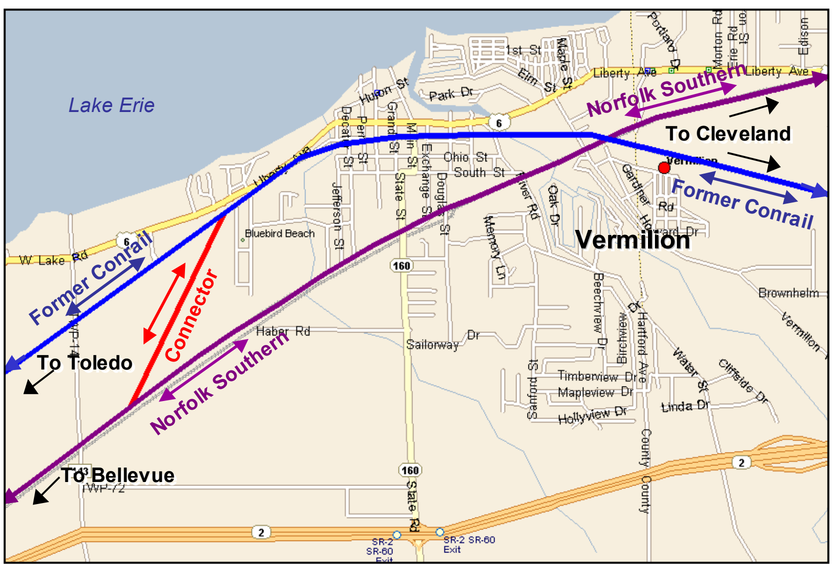


Exhibit 6-56
NS Vermilion Connector



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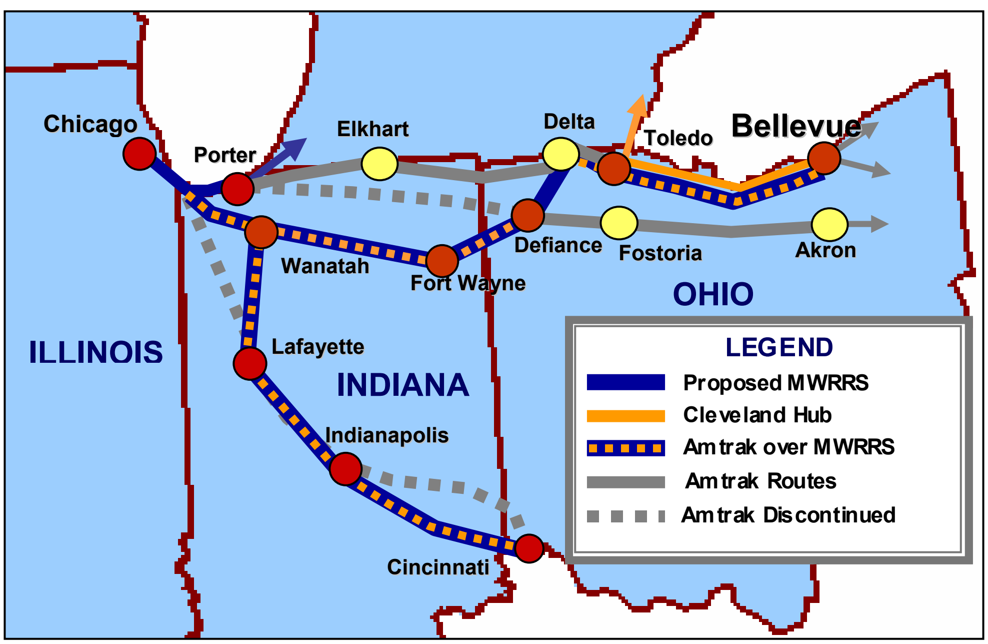
6.26.2 Possible Benefits to Amtrak Long-Distance Trains

Assuming existing Amtrak long-distance trains remain in operation, Exhibit 6-57 illustrates the potential rerouting of Amtrak's trains in northern Indiana and Ohio. By removing two daily Amtrak passenger trains in each direction from CSX's Chicago-Defiance line segment, and by taking advantage of the MWRRS high-speed track between Delta and Cleveland, MWRRS investments should positively impact both Amtrak service and freight railroad capacity. For example:

- Only two trains serve the Chicago–Cleveland passenger market today: Amtrak's Chicago–New York *Lake Shore Limited* and Chicago–Washington *Capitol Limited*. Both trains can take advantage of capacity improvements made by MWRRS between Delta and Cleveland.
- Amtrak's *Three Rivers* operates today on a CSX routing through Akron and Fostoria, OH. With restoration of the Fort Wayne line for high-speed passenger service, the *Three Rivers* could be rerouted into Fort Wayne by adding a connection track at Defiance, OH.
- Amtrak's *Cardinal* operates today on a daily basis to Indianapolis and tri-weekly through to Cincinnati and Washington, D.C. While daily Amtrak service to Indianapolis will be replaced by MWRRS, tri-weekly long-distance service through to Washington may continue. Presently, the *Cardinal* is routed over congested freight tracks through the Chicago terminal, but MWRRS would offer an even better option. The *Cardinal* could operate over the MWRRS corridor from Chicago to Wanatah, then turn south on MWRRS' Cincinnati line.

Exhibit 6-57
Proposed Passenger Service in Northern Indiana and Ohio



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6.26.3 *Simulation of the Chicago–Toledo-Cleveland Corridor*

NS freight train volumes shown in Exhibit 58 were estimated based on a peak-day extracted from NS defect detector data. An annual growth rate of 2% was assumed for carload and bulk freight, and 5% for intermodal. No growth was assumed for local trains. The same growth rates were applied to every line segment.

Exhibit 6-58
NS Cleveland-Toledo Projected Train Counts

Train Group	2002			2010			2020		
	Toledo-Oak Hbr	Oak Hbr-Vermilion	Vermilion-Cleveland	Toledo-Oak Hbr	Oak Hbr-Vermilion	Vermilion-Cleveland	Toledo-Oak Hbr	Oak Hbr-Vermilion	Vermilion-Cleveland
Amtrak	4	4	4	4	4	4	4	4	4
Freight	36	36	36	41	41	41	47	47	47
Short Frt	8	0	12	9	0	14	11	0	17
Intermodal	12	12	12	18	18	18	31	31	31
Local	3	3	3	3	3	3	3	3	3
MWRRS	N/A	N/A	N/A	18	18	18	18	18	18
Total	**63**	**55**	**67**	**93**	**84**	**98**	**114**	**103**	**120**

When MWRRS passenger service was introduced in the simulation, investments were simultaneously added to restore freight delays to the level they would be without the addition of passenger trains to the line(s). Several simulations were run to evaluate the impact of different combinations of improvements at projected traffic levels for 2010 and 2020. Nine 30-day scenarios were run as a *Typical Day* analysis. The simulations showed four main freight benefits:

- **Installation of a Positive Train Control system by MWRRS** can improve performance by allowing closer train spacing and raising line capacity.
- **Planned Track Condition Upgrades** from FRA Class 4 to Class 5 and signal upgrades would allow raising freight speed from 50- to 60-mph and increasing intermodal speed from 60- to 70-mph, should NS choose to take advantage of this capability[15]. The engineering costs provide for upgrading 83 miles of existing track, with 33% tie replacement plus surfacing.
- **Additional line capacity provided by MWRRS** would add more than 20 miles of new Class 5 "passenger sidings" – fully accessible to freight trains. In the simulation, the Class 6

[15] Although FRA Class 5 track allows freight operation at up to 80-mph, most freight equipment is unable to operate at that speed without special modifications to stabilize the suspension system. If only a single car on a train is speed restricted, the entire train must be speed restricted. In addition, the design of signal systems must permit adequate stopping distance within the braking capabilities of the train. For this reason, U.S. freight train speeds are likely to remain in the 60- to 70-mph range for the foreseeable future – although higher speeds might be possible for specially equipped trains.

dedicated passenger track was also made accessible for occasional freight use with a 30-mph speed limit. Track capacity added by MWRRS would allow NS to expedite premium intermodal and automotive trains, whereas today it may not be feasible to do so.

- Amtrak long-distance trains would be accommodated on new MWRRS infrastructure which would mitigate any Amtrak-caused delays that exist in the Base Case.

6.26.4 Current Cleveland-Toledo Capital Plan

- Although NS freight would be completely separated from MWRRS passenger operations west of Delta, OH, the current MWRRS plan calls for sharing the NS right-of-way between Delta and Cleveland. The study team, Amtrak and, to some extent, Norfolk Southern developed the concept for improving the railroad infrastructure for shared freight and passenger operations over this route segment: The plan would add 94 miles of dedicated Class 6 110-mph track between Delta and Berea, with 28' off-set from the existing freight tracks. This is required by the freight railroads to allow 110-mph passenger train operations.
- The engineering cost estimate *also* provides for upgrading 83 miles of existing track with 33% tie replacement, along with 20 miles of discretionary "passenger siding" but does not specify exactly where this additional mileage will be located. This track can be placed where it can do the most good, and would be constructed to Class 5 90-mph standards.

The current plan does *not* completely separate passenger trains from freight operations. Had it been possible to construct new track along the *entire* length of the Toledo–Cleveland corridor, complete separation of passenger from freight operations might have been achieved. Then freight interference would not have been a concern. With shared line segments however, the problem is how best to add infrastructure to mitigate freight delays. This led to development of two different strategies for deploying discretionary mileage: a "uniform-spacing" and "freight-optimized" configuration:

- **A configuration based on uniform spacing of passing sidings** locates high-speed passenger sidings primarily to facilitate meets between passenger trains. This design was developed as if the Toledo-Cleveland route were a single-tracked line built for exclusive use of MWRRS passenger trains. It assumes MWRRS trains will meet or pass each other using only the passenger sidings provided, and not use freight tracks at all except on the shared segments. A basic design principle for single-tracked lines is to space passing sidings equally. This has been shown to minimize train delay[16].

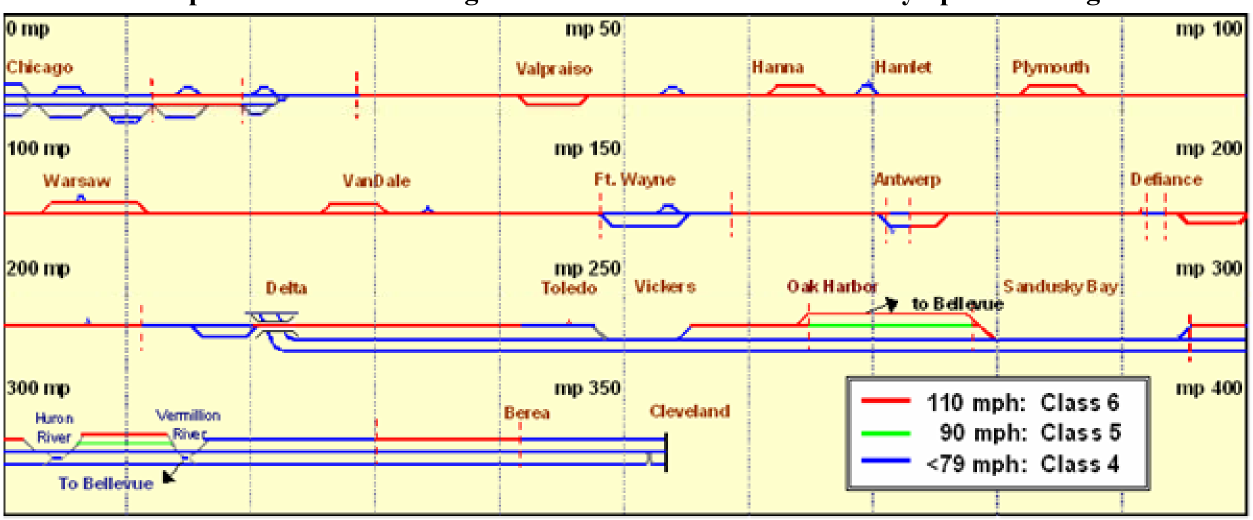
[16] Kraft, E. R. (1988) Analytical Models for Rail Line Capacity Analysis, *Journal of the Transportation Research Forum* **29** (1) 153-162.

- **A freight-optimized configuration** places added capacity where freight trains need it most: east of Vermillion, or west of Oak Harbor. This plan assumes MWRRS passenger trains use any available track to meet and pass one another. Therefore, passing siding location imposes no practical constraints on scheduling of passenger trains. Conversely, placement of the siding mileage can be improved to produce greater benefit to freight operations. The uniform-spacing design adds capacity *between* Vermilion and Oak Harbor, where freight volumes are lower. A freight-optimized design corrects this by shifting more capacity west of Oak Harbor, and by shortening the length of the critical bottleneck at the Sandusky Bay Causeway.

Design of the Uniform-Spacing Configuration

Although the ideal placement for passing sidings is to space them equally, it may be necessary to adjust locations to account for local engineering constraints. In this case, the Sandusky Bay crossing, and Huron and Vermilion River bridges constrain where passenger sidings may be located. The assumption that passenger train meets and passes can be limited only to "passenger sidings" is not very practical. Current MWRRS train schedules were built around customer-preferred departure times and for efficient equipment utilization, not to optimize meet/pass performance. Secondly, even if schedules were built around a need to avoid using freight tracks, small delays -- inevitable in daily operations -- would still require freight tracks to be occasionally used to avoid further compounding those delays. See Exhibit 6-59 for a graphic depiction.

Exhibit 6-59
Proposed MWRRS Chicago–Cleveland Line: With Uniformly Spaced Sidings



110-mph passenger tracks are shown in red; 90-mph "passenger siding" miles are shown in green. Crossovers or interlocking details are not shown in these schematics.

Design of the Freight-Optimized Configuration

An option to reduce freight train delays would be to allow freight trains to use the new MWRRS infrastructure. However, high-speed track is difficult to maintain under heavy tonnage. Without any restrictions on axle loads or freight train speeds using high-speed tracks, this could prove to be a very expensive solution. A compromise, therefore, would allow shared use of 90-mph MWRRS "passenger sidings" [17] but restrict the speed of freight trains on the 110-mph passenger tracks to perhaps 30-mph. To adjust the uniform-spacing proposal to better meet freight needs, the location of the passenger siding mileage was changed as follows:

- Construct a single dedicated passenger track at FRA Class 6 standards to support 110-mph passenger operations. In our *MISS-IT*© simulation, freight trains were allowed to use these high-speed tracks, but a 30-mph speed limit was imposed.
- Construct additional "passenger siding" mileage at FRA Class 5 standards so freight trains may use these tracks without speed restriction. Class 5 tracks allow up to 90-mph passenger speeds and are the standard for high-speed freight track in the US.[18]
- For further running time improvements, existing freight tracks between Cleveland and Toledo may be upgraded from FRA Class 4 to Class 5 standards[19]. Upgrading the freight tracks would allow flexible use of any track for meeting and passing passenger trains, improve ride quality, reduce fuel consumption of freight trains, and raise the speed limit for intermodal service.

The freight-optimized configuration deploys the two passenger sidings farther west than they are if sidings are uniformly spaced, as shown in Exhibit 6-60:

- The proposed siding in the uniform spacing configuration from Vermilion to Huron is located west of the Vermilion connection track – therefore it cannot be used by many freight trains. However, the MWRRS plan provides another section of third track just east of the Vermilion river bridge that can be used for holding NS freight trains awaiting clearance to move onto the connection.

  Therefore, this siding mileage was moved farther west to create a seven-mile passenger siding from MP 233.0 to MP 240.6, Huron to Sandusky. This appears as four-track territory in Exhibit 6-60. The passenger siding should be constructed as a third freight track immediately adjacent to the existing line, with 28' separation between the passenger siding and the proposed Class 6 high-speed main line.

[17] Restricting the speed of freight trains reduces the dynamic loading on the infrastructure and therefore reduces the track damage they cause.

[18] Class 5 track allows up to 80 mph freight speeds, but most freight equipment cannot go that fast. Practically, Class 5 allows 70-mph intermodal trains. For a more complete description of the FRA Track Classification system, see: http://www.trains.com/Content/Dynamic/Articles/000/000/003/010pwhmw.asp

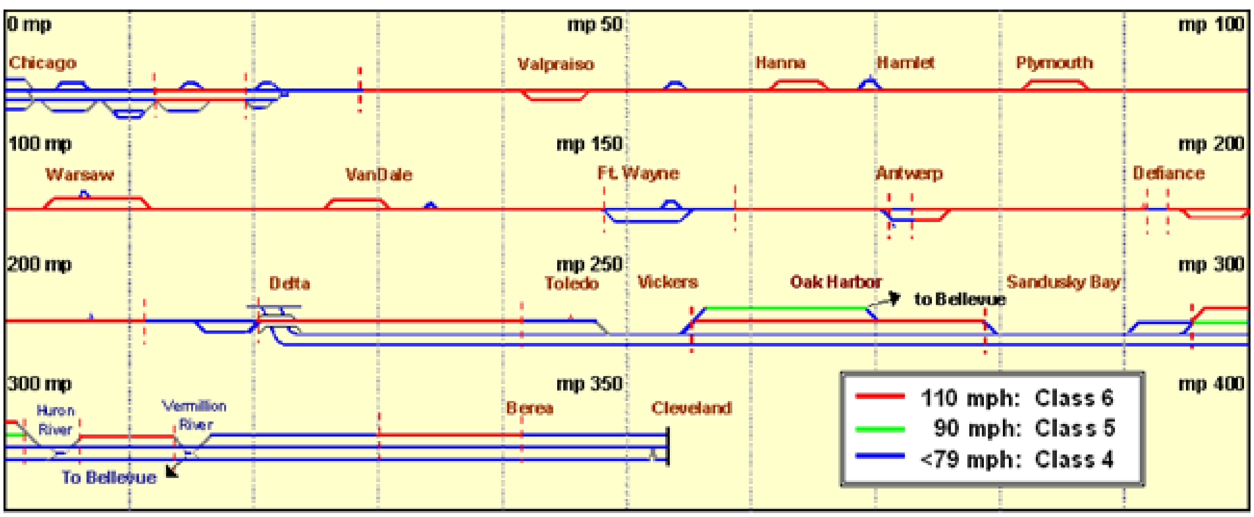
[19] Subject to negotiation of an appropriate cost-sharing agreement with the freight railroad for the added cost of maintaining higher-quality Class 5 track.

Even though 110-mph territory ends at MP 240.6, it appears there is room to extend a third-track at conventional speed further west another four miles to MP 244.8. The third track at Sandusky should be extended as far west as possible, to minimize the length of the Sandusky Bay causeway double-track section. This extension is shown as a blue track in Exhibit 6-60.

- The NKP connection track at Oak Harbor enters the NS mainline on the north side. Entering and exiting freight trains at Oak Harbor would conflict with high-speed passenger operations planned for the north side. To deal with the awkward freight connection at Oak Harbor, the freight-optimized configuration proposes to construct a freight track on the *north* side of the proposed MWRRS track to eliminate freight interference at Oak Harbor. This track would extend from the Oak Harbor connection at MP 265.7 all the way to the west end of the 110-mph section at Millbury, MP 280.7. With this design, the proposed 110-mph track must be placed in the *middle* of the right-of-way between two freight tracks or else a flyover bridge must be constructed to move passenger trains back to the outside track. MWRRS might ask NS to waive the usual 28' separation requirement in this area.

Another solution for addressing the Oak Harbor connection problem may be to restore the abandoned rail line from Fremont direct to Millbury. Freight trains would enter Millbury on the south side, eliminating conflicts with MWRRS passenger trains. Some portions of this right-of-way have been converted to trail use as the North Coast Inland Trail[20], so restoration of rail service over this alignment may no longer be feasible.

Exhibit 6-60
Proposed MWRRS Chicago–Cleveland Line: With Siding Mileage Optimized for Freight Needs



110-mph passenger tracks are shown in red; 90-mph "passenger siding" miles are shown in green. Crossovers or interlocking details are not shown in these schematics.

[20] See: http://home.earthlink.net/~bikeohio/elmore.html

6.26.5 *Simulation Results*

- A 2002 Base Case simulated current operations at traffic levels, *with* Amtrak but *without* MWRRS passenger trains. The 2002 Base Case assumed a conventional signaling system. The 2010 and 2020 "Base + Growth" scenarios were simulated *twice*: once with conventional signaling and again with a PTC signaling system. Addition of the PTC system reduced freight delays even as additional freight traffic was added.
- A "Do Something" scenario that would operate MWRRI trains over existing freight tracks was not simulated, since it would have contradicted Norfolk Southern's requirement that new tracks be built alongside their existing line to support passenger operations at 110-mph. Neither 90-mph or 79-mph operation were part of the current project scope. Neither engineering costs nor a demand forecast had been developed for them, so these reduced-speed scenarios over the existing NS trackage were not evaluated.
- MWRRS trains were added to expanded infrastructure with dedicated 110-mph tracks to develop three scenarios. These were:
  - "Uniform spacing"
  - Freight-optimized" and
  - "Freight-optimized" with freight tracks upgraded to FRA Class 5.

The simulations show an improved ability to expedite intermodal and other time-sensitive freight trains over the expanded infrastructure. While bulk train delays increase slightly, these delays are more than offset by the improvement to intermodal trains so the overall level of freight delay is reduced. The simulations show that freight operations would significantly benefit from the proposed line capacity improvements, higher track speeds and installation of a PTC signaling system, all funded by MWRRS. Beyond this, freight transit times could be substantially reduced should NS choose to take advantage of the ability to run its intermodal trains at a higher speed on upgraded Class V tracks.

All three scenarios improve freight train performance over the Base Case, however the freight-optimized configuration performs best. Compared to 2010 and 2020 "Base + Growth with PTC" runs that *include PTC in the Base*, it can be seen that the proposed mitigation does *not* rely on either PTC benefits or on freight speed improvements. Exhibit 6-61 details the results of a 30-day simulation of freight trains on the NS Cleveland-Toledo line.

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Exhibit 6-61
NS Cleveland-Toledo 30-day Simulation -- Summary Statistics for Freight Trains Only*
Times in DDD:HH:MM format

Statistic	2002	2010 Frequencies					2020 Frequencies				
	Base	Base + Growth	Base + Growth w / PTC	Freight Optim	Fast Freight Uniform Spacing	Fast Freight Freight Optim	Base + Growth	Base + Growth w / PTC	Freight Optim	Fast Freight Uniform Spacing	Fast Freight Freight Optim
For All Freight Trains:											
# of Run Time Trains	71	85	85	85	85	85	109	109	109	109	109
Elapsed Time	07:05:04	08:18:10	08:00:29	07:22:04	07:10:32	07:09:59	11:15:04	10:13:07	10:04:07	09:13:04	09:09:49
True Delay	01:01:58	01:12:17	00:18:36	00:16:38	00:08:35	00:08:03	02:10:22	01:08:26	00:23:48	00:14:16	00:11:06
Delay per Train (minutes)	21.9	25.6	13.1	11.7	6.1	5.7	32.1	17.9	13.1	7.9	6.1
Delay as % of Elapsed Time	15%	17%	10%	9%	5%	5%	21%	13%	10%	6%	5%
For Expedited Freight Trains: (Intermodal)											
# of Run Time Trains	12	18	18	18	18	18	31	31	31	31	31
Elapsed Time	01:05:24	01:21:23	01:16:39	01:12:57	01:11:26	01:11:46	03:08:58	03:00:28	02:17:02	02:14:10	02:13:51
True Delay	5:13	9:03	4:19	0:46	1:26	1:48	18:20	9:49	2:13	3:37	3:18
Delay per Train (minutes)	26.1	30.2	14.4	2.6	4.8	6.0	35.5	19.0	4.3	7.0	6.4
Delay As % of Elapsed Time	18%	20%	11%	2%	4%	5%	23%	14%	3%	6%	5%
Average Speed Including Dwell	43.6	42.4	47.3	51.9	54.1	53.6	41.0	45.7	53.4	53.1	53.4
For Regular Freight Trains:											
# of Run Time Trains	59	67	67	67	67	67	78	78	78	78	78
Elapsed Time	05:23:39	06:20:46	06:07:50	06:09:06	05:23:06	05:22:12	08:06:05	07:12:39	07:11:04	06:22:54	06:19:57
True Delay	20:44	01:03:14	14:17	15:51	7:08	6:15	01:16:02	22:37	21:34	10:39	7:48
Delay per Train (minutes)	21.1	24.4	12.8	14.2	6.4	5.6	30.8	17.4	16.6	8.2	6.0
Delay As % of Elapsed Time	14%	18%	9%	10%	5%	4%	20%	13%	12%	6%	5%
Average Speed Including Dwell	31.3	31.2	33.8	33.6	35.9	36.2	29.6	32.5	36.0	35.2	36.0

2010 Base — *MITIGATION* — *2020 Base* — *MITIGATION*

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6.26.6 *Alternative Corridor Concepts*

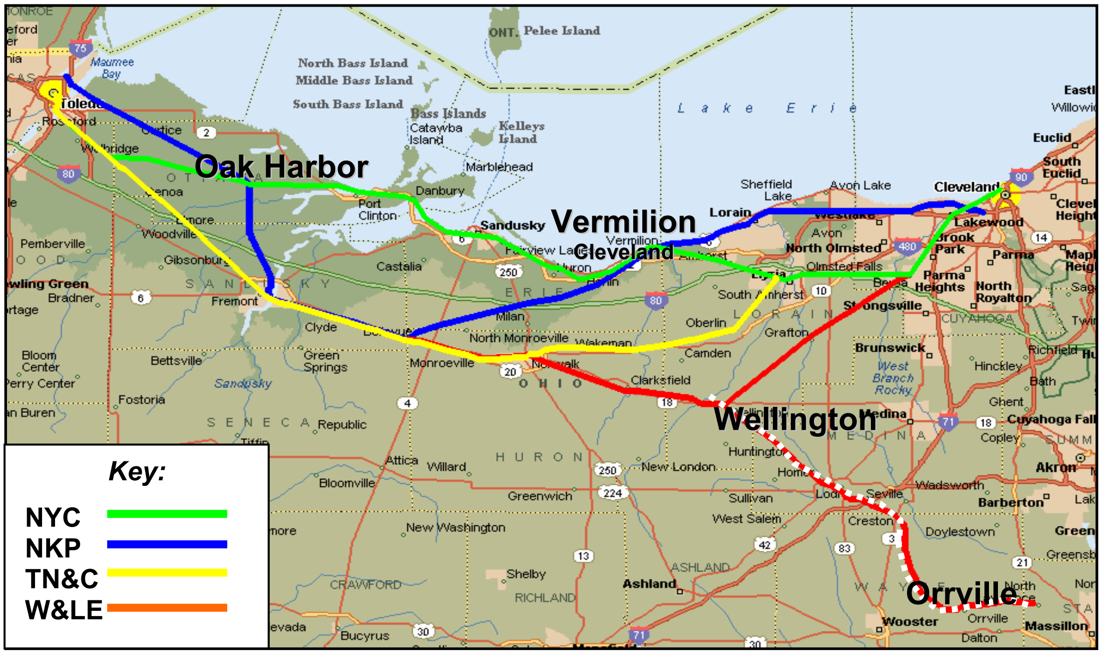
The current MWRRS infrastructure plans do not result in a complete separation of high-density freight from passenger operations between Cleveland and Toledo. Additional study is warranted to identify a dedicated alignment for MWRRS that accomplishes this separation. This would likely identify lower cost solutions that have a greater public benefit than the current MWRRS proposal.

Currently, Norfolk Southern maintains two parallel lines between Cleveland and Toledo. Perhaps one of these routes could be dedicated to MWRRS and high-speed intermodal freight service, allowing bulk traffic to be concentrated on the other line. Concentrating its traffic on only one line would free Norfolk Southern from the expense of maintaining two parallel lines, while the other route would still remain available to NS for intermodal trains, emergency use or during track maintenance. Completely separating freight from passenger operations may also facilitate the eventual introduction of passenger trains even faster than the 110-mph trains currently under consideration.

Exhibit 6-62 on the following page shows some of the route alternatives that could be considered between Cleveland and Toledo. These are further discussed in the following subsections:

- The proposed MWRRS alignment now serves as the Norfolk Southern main freight line, utilizing the former Conrail (NYC) route shown in green.
- The abandoned Toledo, Norwalk and Cleveland line is shown in yellow. Portions of this route have been converted to trail use (the North Coast Inland Trail.)
- NS' traditional NKP line between Cleveland and Toledo, shown in blue parallels the NYC route. This line serves a major freight yard at Bellevue, OH.
- Reactivating the Bellevue to Orrville route for NS Pittsburgh–Chicago freight could implement a *Cleveland Bypass* for NS traffic originating in former Conrail territory in Pennsylvania and Maryland.

Exhibit 6-62
Cleveland to Toledo Rail Options



Passenger Re-route Concepts

Any of the corridors in Exhibit 6-62 could be considered as a possible MWRRS passenger route. However, the location of Bellevue yard favors selection of the former NKP line as the primary freight route. By process of elimination, this leaves the former NYC route as the most practical alternative for MWRRS passenger service. Upgrading the existing double track mainline to FRA Class 6, could probably accommodate the proposed passenger service if heavy bulk freight trains were diverted to another route. New investments in the significant expansion of freight capacity could be focused on upgrading the parallel freight routes instead. With the exception of local trains and high-speed intermodal service, the freight traffic could be diverted to the parallel lines. This reroute concept is presented as a point of discussion to be studied in additional detail as the project develops.

However, one option that should be considered for passenger service is to utilize the parallel NKP Lakeshore line instead of the NYC route between Vermilion and Cleveland. NS has already diverted nearly all its freight traffic off this segment. Although the Lakeshore line bypasses Cleveland Hopkins Airport, it does pass through a more heavily populated area than does the NS Chicago Line via Elyria. Directly serving added population along the lake shore could generate additional traffic for the MWRRS.

Freight Re-route Concepts

The Conrail split in 1999 enhanced the possibility for establishment of a dedicated MWRRS passenger route between Cleveland and Toledo. This transaction left NS with two parallel lines, and diverted a major portion of the traffic that historically operated this way to a parallel CSX route. The exhibits on the next page show historical, current and possible new routings for freight traffic to establish a corridor that can be dedicated to MWRRS passenger service (though not exclusively) from Toledo to Cleveland:

- Before 1990, Conrail's Pittsburgh–Chicago traffic (in green) was routed directly west through Fort Wayne, while traffic from upstate New York (in blue) moved via Cleveland and Toledo. NS Buffalo–Chicago traffic (in red) was routed through Bellevue and Fort Wayne. This historical traffic pattern is shown in Exhibit 6-63.
- After NS and CSX absorbed Conrail in 1999, routings changed. Conrail's Pittsburgh–Chicago traffic (in green) was allocated to NS and continued moving via Cleveland, a routing that Conrail had established in 1990 when the Fort Wayne line was downgraded. Traffic from upstate New York (in blue) was allocated to CSX and diverted to a B&O routing via Willard. NS Buffalo–Chicago traffic (in red) was diverted to the NYC line through Toledo and Elkhart. This traffic pattern, which remains in effect today, is shown in Exhibit 6-64.
- A potential new freight routing uses Wheeling and Lake Erie's line from Bellevue to Orrville, shown in red in Exhibit 6-65. At Orrville, OH, the W&LE line connects to the former PRR Fort Wayne route to Alliance. NS freight would move directly from Pittsburgh to Bellevue instead of being routed through Cleveland. Toledo to Cleveland freight could also benefit from the W&LE alternative. Freight trains could either follow their historical NKP routing to Bellevue, or use the CSX mainline south from Berea to Wellington, OH, then head west to Bellevue over the W&LE line.

A Cleveland freight bypass via Orrville could give NS a shorter route for Pittsburgh to Chicago freight; reduce the number of freight trains competing with passenger trains for line capacity between Cleveland and Toledo; and would reduce the number of freight trains and hazardous materials shipments passing through the highly populated Cleveland area. This would also remove many freight trains from the Cleveland to Alliance line segment, possibly allowing reconsideration of that route for implementing high-speed passenger service between Cleveland and Pittsburgh. Clearly broadening the scope of the planning study to consider more alternatives offers a possibility for reducing the cost, as well as improving the public benefits of the investment in MWRRS infrastructure. Again, this reroute concept is presented as a point of further discussion, to be studied in additional detail as the project develops.

Exhibit 6-63
Rail Freight Traffic Patterns before 1990

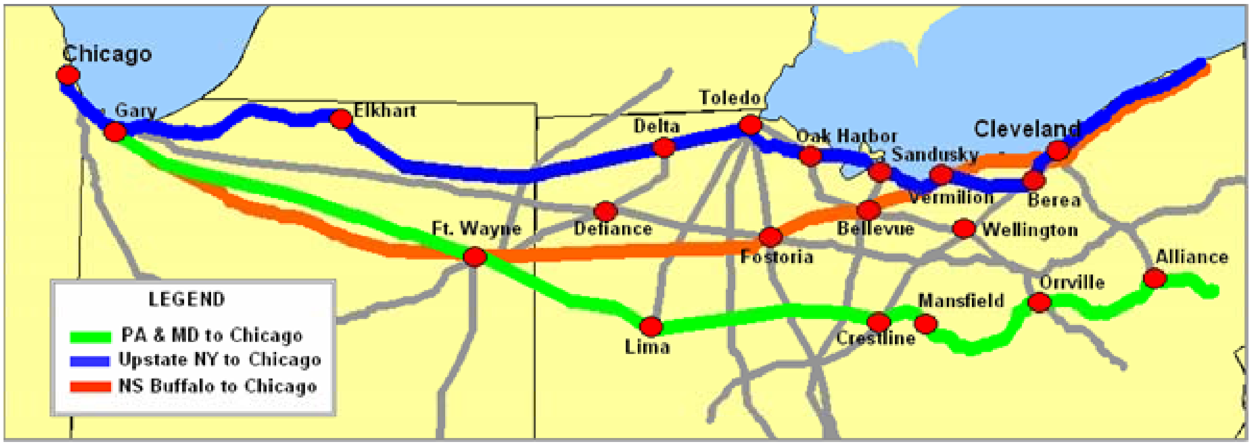
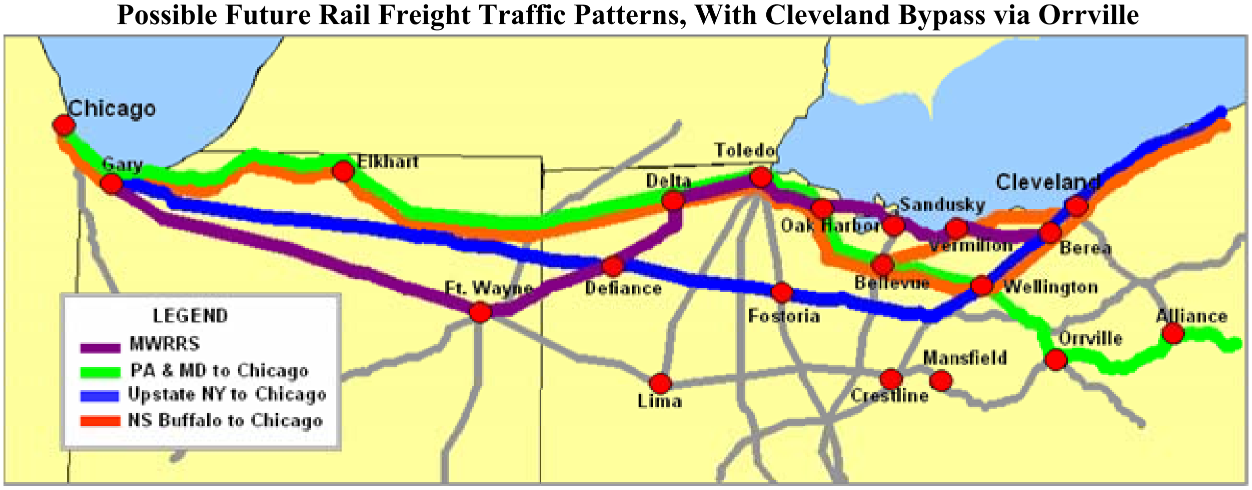


Exhibit 6-64
2003 Rail Freight Traffic Patterns

Exhibit 6-65
Possible Future Rail Freight Traffic Patterns, With Cleveland Bypass via Orrville



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6.26.7 Conclusions and Recommendations

The capacity analysis confirmed the feasibility of shared passenger and freight operations on the NS Cleveland to Toledo line. Our results suggest that the proposed MWRRS line capacity, track condition and signaling system upgrades will mitigate passenger-caused delays to freight. By allowing NS to better expedite its own high-priority intermodal and automotive freight trains, the proposed improvements may in addition offer substantial improvement to freight train operations.

All three future-case scenarios considered:

- "Uniform spacing"
- "Freight-optimized" and
- "Freight-optimized" with freight tracks upgraded to FRA Class 5.

are consistent with current Engineering cost estimates, provided that the 33% tie replacement with resurfacing would be sufficient to upgrade the track condition to FRA Class 5.

Higher freight train speeds allowable with Class V track – particularly the ability to increase intermodal train speeds to 70 mph – would amplify the improvement to freight operations resulting from this investment, but are not required to satisfy the MWRRS delay mitigation criteria. This evaluation therefore confirms, at least for planning purposes, the sufficiency of the infrastructure now proposed to be added to the Toledo-Cleveland line segment.

While this analysis does suggest the feasibility of the current plan for adding MWRRS trains to Norfolk Southern's Cleveland-Toledo line, it is possible that the cost might be reduced and benefits increased through the consideration of additional alternatives. Therefore, TEMS recommends that the scope of the current planning process be broadened, to comprehensively assess freight as well as passenger route needs, with the goal of separating freight from passenger operations on separate line from Toledo to Cleveland. We also recommend expanding the scope of the MWRRS simulation also to consider the requirements of Ohio's own rail initiative, the Cleveland Hub system, as well as the capacity needs of any potential commuter rail operation in the Cleveland area.