CONNECTICUT DEPARTMENT OF TRANSPORTATION
Bureau of Policy and Planning
Intermodal Planning

WATERBURY AND NEW CANAAN BRANCH LINES NEEDS AND FEASIBILITY STUDY Project 170-2562

Phases I and II

Waterbury and New Canaan Branches Innovative Technologies Report

Date: April 2010

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1.0 PROJECT DESCRIPTION

The Connecticut Department of Transportation (CTDOT) in cooperation with the South West Regional Planning Agency (SWRPA), Greater Bridgeport Regional Planning Agency (GBRPA), Council of Governments of the Central Naugatuck Valley (COGCNV), and the Valley Council of Governments (VCOG), is preparing this needs and feasibility study for improvements to transit service along the New Canaan and Waterbury Branch corridors of the New Haven Line. The results of this study will identify potential service and infrastructure improvements for the 27-mile rail corridor between Milford and Waterbury, and the 7.9-mile rail corridor between Stamford and New Canaan. It will also provide decision-makers with the information necessary to determine how the CTDOT-owned New Canaan and Waterbury Branches fit into an overall statewide transportation strategy that balances needs and funding ability.

Metro-North Railroad operates service between New Haven and Grand Central Terminal (GCT) on the New Haven Line, Connecticut's busiest commuter rail line. Three branch lines feed into the New Haven Line: the New Canaan Branch, the Danbury Branch, and the Waterbury Branch (Figure 1-1). While this study is focused on the Waterbury and New Canaan Branches, a separate feasibility study of the Danbury Branch is also underway.

The Waterbury Branch is the longest of the three branch lines, operating passenger service between Waterbury and Bridgeport with stops at Naugatuck, Beacon Falls, Seymour, Ansonia, and Derby-Shelton (Figure 1-2). The branch consists of an unsignalized single track with no passing sidings, making it impossible for northbound and southbound trains to pass one another along the branch and limiting the amount of service that can be provided. Freight trains also operate on the line.

The Waterbury Branch runs parallel to Connecticut Route 8, which is frequently congested during rush hour periods, especially in the vicinity of the Route 8/Interstate 95 (I-95) interchange. Improved transit service in the corridor could attract new ridership, which in turn might reduce vehicle trips and congestion on local roadways.

The New Canaan Branch is the shortest of the three branches and the only one that is electrified. Metro-North provides frequent peak-period passenger service from New Canaan to Stamford and GCT, with stops at Talmadge Hill, Springdale, and Glenbrook (Figure 1-3). Like the Waterbury Branch, the New Canaan line consists of a single track without any passing sidings. The signalization on the branch ends just before New Canaan Station, which limits the operations of trains on the northern end of the branch. Greater frequency of service and faster running times could potentially make the branch more attractive to commuters. Freight trains are also allowed, though they do not currently operate on the line.

This report will investigate the availability, cost and applicability of innovative technologies that could enhance service and improve the customer experience on the Waterbury and New

Canaan Branches. After a review of potentially applicable technologies, this report will recommend those improvements that merit further study.

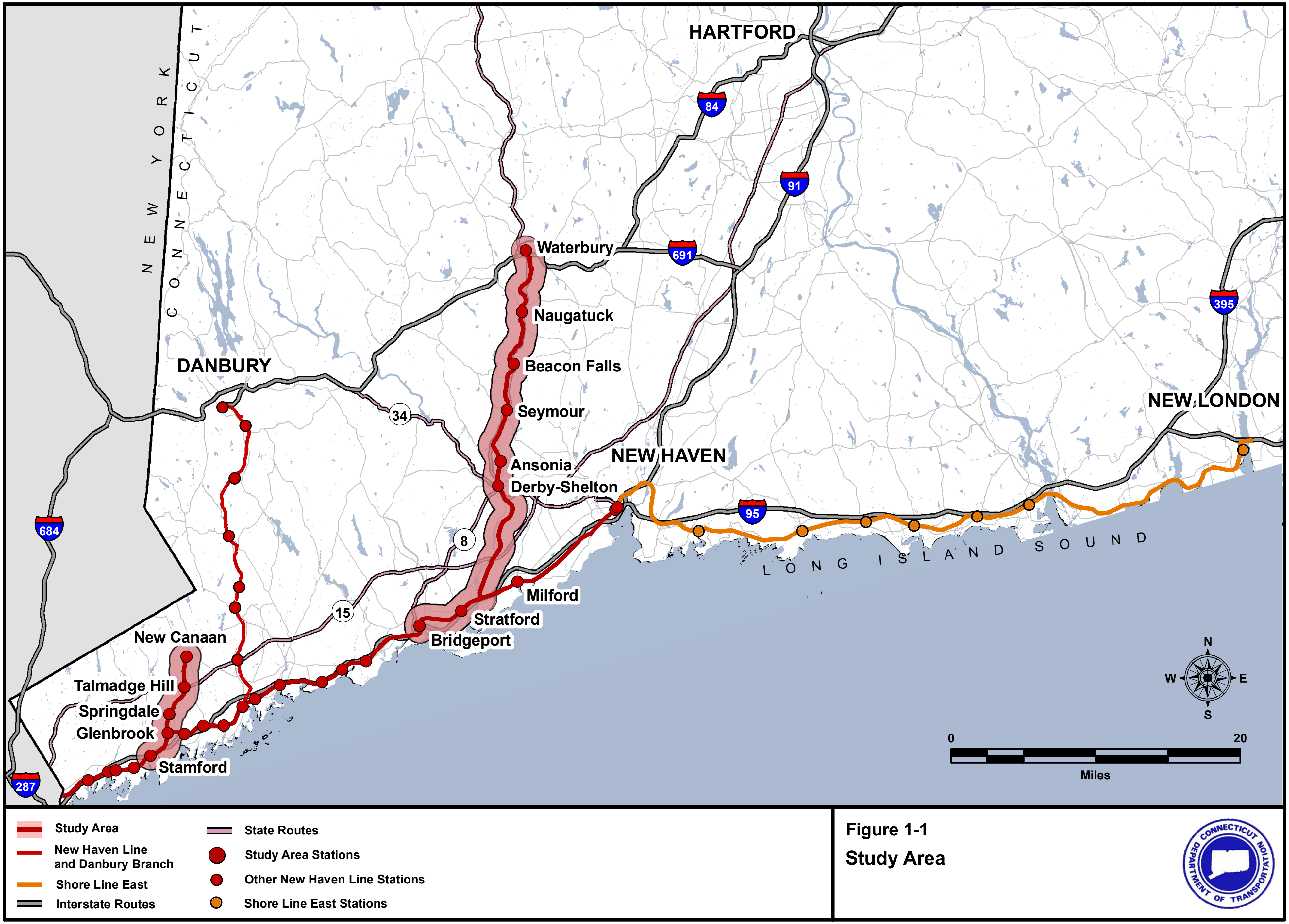


Figure 1-1
Study Area

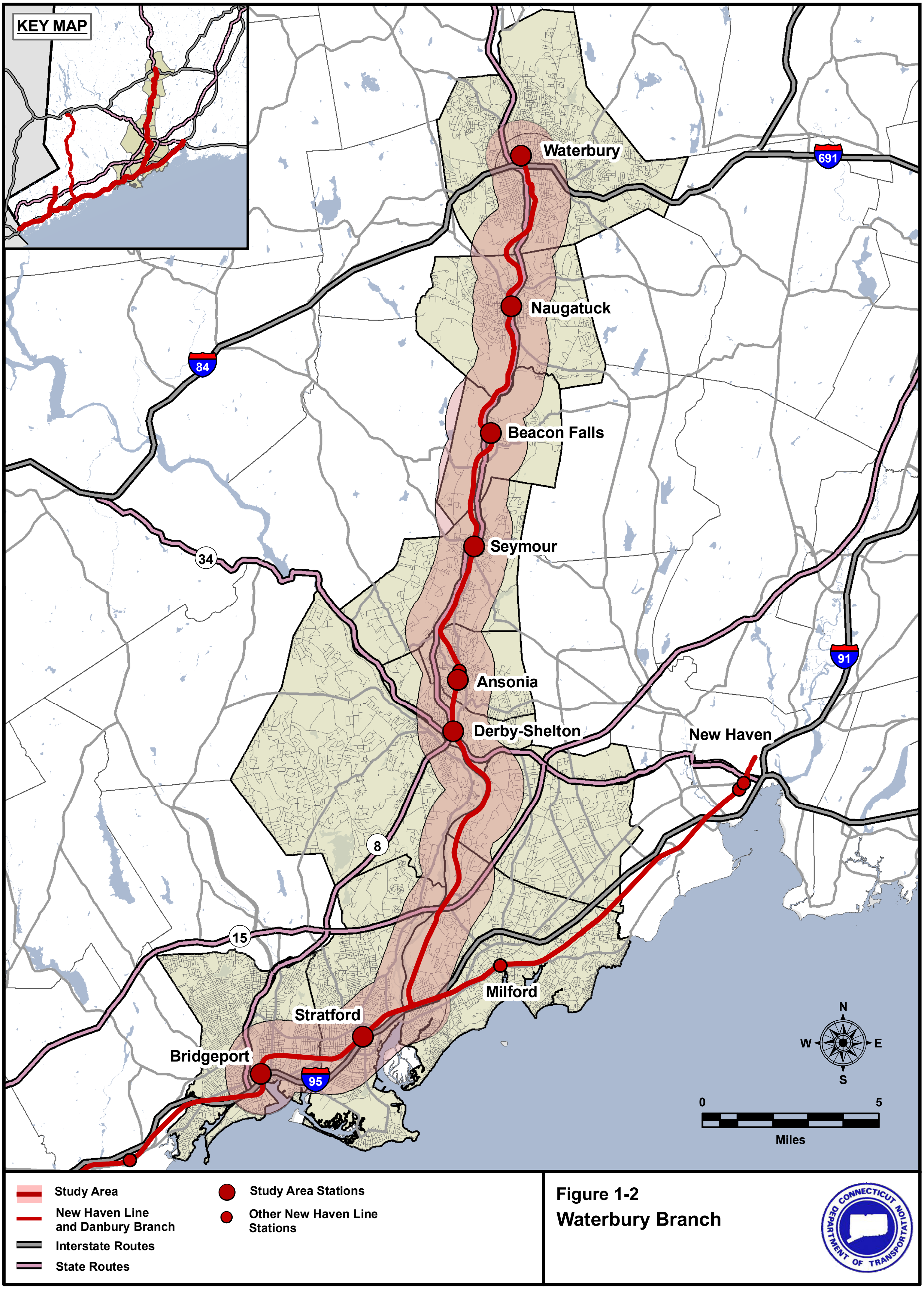
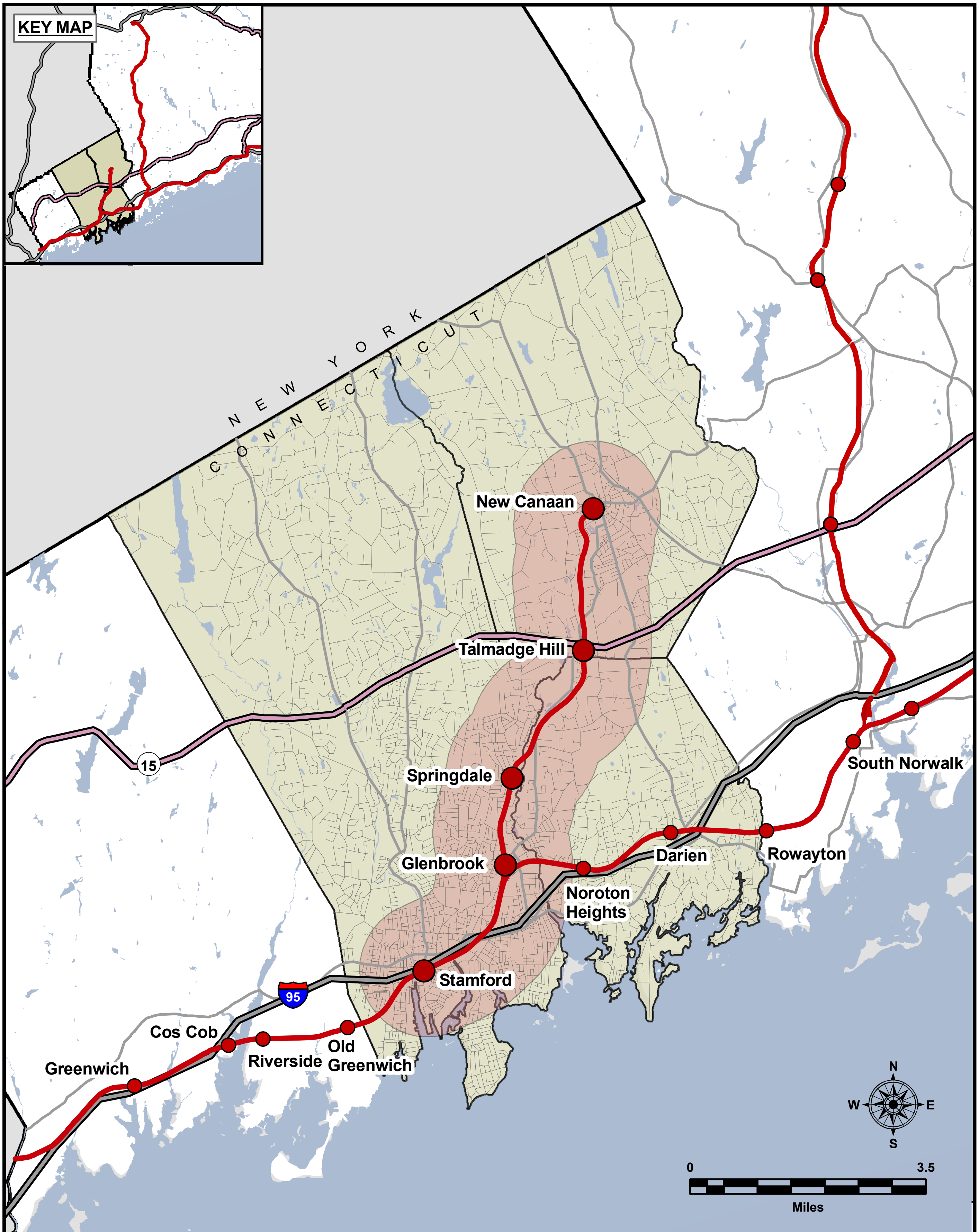


Figure 1-2
Waterbury Branch



Study Area
New Haven Line and Danbury Branch
Interstate Routes
State Routes
Study Area Stations
Other New Haven Line Stations

Figure 1-3
New Canaan Branch

2.0 INNOVATIVE TECHNOLOGIES

Innovative technologies are new ideas or methods in transit technology that have the potential to improve service, provide greater efficiencies, and potentially increase customer satisfaction. Technologies proven through use by other transportation providers are categorized and discussed below. In addition, several advanced rail technologies currently under research are presented at the end of the chapter. Chapter 3 will outline those improvements that merit further study for the Waterbury and/or New Canaan Branches.

2.1 RAIL VEHICLES

The following section describes how the Waterbury and New Canaan Branches might benefit from advances in rail vehicle design.

2.1.1 Waterbury Branch

Waterbury Branch service currently uses diesel push-pull trains (i.e., diesel locomotives push or pull non-powered passenger cars). Locomotives can be propelled by several different methods, each with its own set of benefits and drawbacks. The major advantage of diesel powered trains on the Waterbury Branch is that there is no need for wayside propulsion infrastructure. The type of infrastructure that supports electric propulsion (i.e., substations and catenary) is already in place along the New Haven mainline and the New Canaan Branch. A significant investment in wayside infrastructure would be required to bring the benefits of electric propulsion (e.g., lower emissions, lower noise, faster acceleration) to the Waterbury Branch.

However, there are two other propulsion technologies that could benefit the Waterbury Branch without additional wayside infrastructure.

Dual-mode locomotives use both diesel and electricity as sources of energy. Metro-North currently uses such locomotives on the Danbury Branch. The major advantage for providing dual-mode service on the Waterbury Branch would be the possibility of a one-seat ride from Waterbury to Grand Central Terminal. Diesel-only locomotives are not able to travel south of 125th Street Station in Harlem because the tunnel that leads to GCT cannot handle the diesel emissions. The current dual-mode locomotives used on the Danbury Branch, General Electric (GE) Genesis P32AC-DM, use a diesel engine to power the train along the branch and mainline, and an electric motor in the tunnel leading to GCT.

In a certain sense, the new electric M8 trains that will be used on the New Haven Line have more than one operating mode because they operate under two conditions – collecting alternating current electric power from overhead catenary and collecting direct current electric power from a third rail – because both propulsion technologies are used within the Metro-North system. While the propulsion infrastructure along the New Haven mainline consists of overhead catenary, the propulsion infrastructure along the Harlem and Hudson Lines consists of third rail.

The tunnels leading into Grand Central Terminal have both catenary and third rail. The new M8 cars will be able to operate on any Metro North electrified branch.

The dual-mode locomotives used on the Danbury Branch – which, like the Waterbury Branch, in not electrified – are designed to receive electric power from the third rail in lieu of the catenary. This configuration allows a one-seat ride to GCT for customers accessing the Danbury Branch. While other agencies (**New Jersey Transit, Agence Métropolitaine de Transport Montreal**) use dual-mode locomotives that combine diesel engines with catenary-powered electric motors, no current locomotives combine all three capabilities.

Hybrid locomotives use both a rechargeable battery and a secondary energy source, typically a diesel engine, to propel trains. The secondary source simultaneously powers the locomotive and recharges the battery, which in turn boosts train performance. In addition, some trains are designed to capture the energy released by the train during braking. This type of system is called regenerative braking. Energy derived from regenerative braking can be used to feed back into the locomotive or stored for following trains in an electrified system.

Currently, **Union Pacific Railroad** uses a hybrid switching locomotive at the ports of Los Angeles and Long Beach built by RailPower Technologies of Vancouver, British Columbia. Though these locomotives do not provide service benefits, they have significantly reduced noise and environmental impacts, and reduced overall operating costs. Even without regenerative braking, they emit 80 to 90 percent less nitrous oxide and decrease diesel fuel consumption by between 40 to 60 percent (Thermos and Schoch, 2005). GE is developing a hybrid locomotive for long haul runs that would include regenerative braking (General Electric, 2010). Though currently being marketed to freight railroads, hybrid locomotive technology might eventually be able to help passenger railroads cut costs and reduce impact.

2.1.2 New Canaan Branch

The New Canaan Branch is fundamentally different because it already shares the catenary propulsion technology with the New Haven mainline. Likewise, the corridors share rolling stock, M2, M4 and M6 EMUs that collect energy from overhead catenary, as described in Section 2.1.1, and have regenerative braking capability. The M2s date back to the 1970s, the M4s to the late 1980s, and the M6s to the early 1990s.

However, in the near future, most of these cars will be replaced by M8 cars manufactured by Kawasaki Rail Cars Inc. The exterior of the new M8 vehicles will be similar to that of the earlier vehicles (and especially similar to the M7 vehicles used on the Harlem and Hudson Lines), but the interior will offer passengers additional convenience and comfort. The doors will be single leaf with overhead LED displays, and the trains will have an automated public address system. The crew will be able to communicate via a dedicated intercom, instead of over the public address system. Additional amenities will include power plugs in every row, bicycle racks, and the potential for onboard WiFi at some future date. These new customer amenities could be considered for future Waterbury Branch passenger cars as well.

One issue along the New Canaan Branch that the design of the new M8 vehicles will not address is passenger overcrowding, due to the short train lengths. The mainline trains are longer (i.e., have more cars) than those on the New Canaan branch, because the station platforms are longer. To effectively increase passenger loading in short platform environments, the **Long Island Rail Road (LIRR)** and **New Jersey Transit** utilize bi-level coaches on their most popular lines to increase capacity without increasing the number of cars, which can involve costly platform upgrades and extensions. Bi-level coaches have clearance issues with tunnels that must be addressed. Although trains traveling to GCT could not use traditional bi-level coaches due to tunnel clearance issues, bi-level rolling stock could be used for shuttle trips to and from Stamford, or on trains traveling to New York Penn Station, should the concept to provide MNR service to Penn Station be advanced.

2.2 TRACK AND GRADE CROSSINGS

The design of track and grade crossings can impact travel time, safety, and long-term maintenance costs. The potential applicability of new technologies in this area for the Waterbury and New Canaan Branches is described below.

2.2.1 Track Design

Track design has evolved both through the use of superior materials and through structural changes.

Railroad ties, also known as crossties, are the lateral beams that support rails. They anchor the track, providing a sound base upon which trains can pass. The majority of ties in the United States, including those along the Waterbury and New Canaan Branches are wood. However, new ties are frequently made of concrete or composite materials, including along some portions of the New Haven Line. They are made of pre-stressed concrete containing reinforced steel, and weigh about three times more than wood ties (AREMA, 2003).

Due to their longer service life and lower life cycle cost, concrete ties are replacing wood ties as the standard in some high density corridors. They can also be critical in supporting high speed trains.

Switches, also known as turnouts, are required to move trains from one track to another. The physical discontinuity in the tracks and the lateral force generated by a train negotiating a turnout can require speed restrictions. High-speed turnouts and crossovers based on specific geometric standards can handle higher speed moves or decrease track wear and tear. One way to increase speed through a switch is to reduce the angle of the turnout by increasing its physical length. Experiments on **New Jersey Transit** also show how agencies can increase speed or reduce lateral force through switch redesigns that don't increase overall length, thereby reducing installation cost (FRA, 2006). Such installations might be applicable along the Waterbury or New Canaan Branches where sidings are recommended since new switches would be required and timetable reliability and train speed are concerns.

2.2.2 Grade Crossings

Grade crossings are intersections where roads and railroad tracks intersect at the same grade instead of separated by an overpass/underpass. There are 17 grade crossings along the Waterbury Branch between Waterbury Station and the Devon Wye. There are 11 grade crossings along the New Canaan Branch.

Grade crossing protection is a mechanism used at a crossing to prevent train-vehicle and train-pedestrian collisions. Grade crossing protection devices may include warning signs, crossbucks, pavement markings, bells, flashing lights, or one- to four-quadrant gates. For speeds above 79 mph, FRA recommends certain grade crossing protection devices. For speeds between 110 and 125 mph, FRA requires “impenetrable barriers” for street vehicles if grade crossings are to be permitted. For speeds above 125 mph, FRA requires elimination of grade crossings or grade separation. FRA also encourages the use of advanced train control systems that provide warning time to motorists and assure crossings are clear of obstacles after gates or barriers are in place (FRA, 2010).

Traffic signal preemption systems near railroad grade crossings can provide additional safety benefits while also decreasing automobile congestion caused by passing trains. In conjunction with active grade crossing protection such as flashing lights and/or gates, traffic signal preemption systems reduce the likelihood of a motor vehicle getting stuck in the middle of a grade crossing while queuing at the adjacent intersection. Preemption systems operate by disrupting the normal phasing of a traffic signal when a train approaches an adjacent grade crossing. The signal is reprogrammed with two phases that do not cycle. The first phase permits only roadway movements that clear the crossing, starting early enough so that all vehicles are clear once the train arrives. The second phase allows non-conflicting roadway traffic to flow while the train is occupying the crossing (i.e., not allowing vehicle movements onto the roadway leading to the grade crossing that might queue to the point of clogging the intersection). Once the train has cleared the crossing, the traffic signal returns to its normal phasing program. The Manual on Uniform Traffic Control Devices (MUTCD) suggests installing preemption at signalized intersections within 200 feet of a railroad grade crossing (Marshall and Berg, 1997).

Quiet zones are grade crossings where trains are prohibited from sounding their horns in order to decrease the noise level for nearby residential communities. The feasibility of a quiet zone is based on the level of protection provided at a grade crossing. Congress directed FRA to issue a rule requiring the use of locomotive horns at all public at-grade highway-rail crossings. However, some communities have complained that the horns pose an excessive burden on quality of life. To remediate this situation, FRA created quite zone rules (U.S. Department of Transportation, Federal Railroad Administration, 2003). Protections that enable a quiet zone include channelized vehicular approaches to gated crossings or four-quadrant gates.

2.3 TRAIN CONTROL

The primary function of a train control system is to ensure safe movement of trains. The simplest form of train control consists of track-switch-position indicators combined with track-side “stop” or “proceed” signals. Advanced systems include fully automated train control to prevent human error from causing collisions. Currently, the Waterbury Branch is dark territory, a term that refers to a lack of signaling. Most of the New Canaan Branch is controlled by the Metro-North operations control center in Grand Central Terminal using its automatic train control (ATC) system, except for the switch immediately south of the New Canaan Station, which must be operated manually. Forms of train control that might benefit the Waterbury or, in some cases, the New Canaan Branch include block signaling, automatic cab signaling, ATC, station stopping subsystem, and communications-based train control (CBTC).

2.3.1 Block Signaling

Block signaling significantly improves the safety of railroad operations over dark territory by sectionalizing the track into single occupancy blocks. Signals detect the presence of a train within a block when its wheels complete an electrical circuit between the two tracks. Depending on the occupancy of proceeding blocks, wayside signals inform operators to stop, run slowly, or proceed at posted speeds.

2.3.2 Automatic Cab Signaling

Automatic cab signaling systems use transmitters along a rail and sensors on a train to direct information to an onboard display monitored by the train operator. This system reduces or eliminates the need for wayside signals and improves the all-weather safety of train movements. Simple applications include displays of the color-coded instructions standard on wayside signals. More sophisticated applications can include allowable speed, location of nearby trains and information about the track ahead.

2.3.3 Automatic Train Control

ATC is an onboard system that monitors the operating speed of a train. If it senses the speed of a train is greater than allowed, it applies the brake. ATC is often used in conjunction with automatic cab signaling to create a dynamic control system.

2.3.4 Station Stop System

Station stop systems are programmed to accurately position the car doors at a station platform and let the trains smoothly decelerate at relatively high rates for the comfort of the passengers and efficiency of operation.

2.3.5 Communications-Based Train Control

CBTC is a system where trains report their location to a dispatch center that monitors and controls train movements systemwide. The dispatch center sets train routes, controls switches, and enforces speed limits to maintain safe and efficient operations. Software allows dispatchers to anticipate conflicts and create alternative routings that minimize system disruption. CBTC can enable a moving block signal program, where safe braking distance is maintained with a dynamic buffer around a train, instead of with a set of fixed blocks. Benefits include increased safety, reliability, and more frequent service.

2.3.6 Positive Train Control (PTC)

PTC is a communications-based system that prevents a train from making unsafe movements by remotely halting any train that ignores a signal. Unlike traditional signaling, however, PTC does not necessarily include the use of electrical circuits to identify train locations. Instead, PTC can use information from Global Positioning System (GPS) devices, augmented by odometer readings to identify location, which is communicated to a dispatch center. The Rail Safety Improvement Act (RSIA) of 2008 mandated the installation of PTC systems on all commuter, intercity passenger, and Class I railroads by December 2015.

Of particular relevance to the Waterbury and New Canaan Branches is Amtrak's PTC program along the Northeast Corridor (NEC), the Advanced Civil Speed Enforcement System (ACSES). ACSES supplemented an existing ATC and cab signaling program on the NEC trains, adding the ability to bring a train to a full stop should it, for any reason, make an unauthorized or unsafe movement. Location monitoring on the NEC utilizes both wayside transponders and radio communications. However, the same ACSES functionality could be applied to dark territory through the use of radio communications and virtual blocks.

2.4 CUSTOMER INFORMATION AND CONVENIENCE

Transit customers, just like general consumers, continue to increase their demand for more useful and up-to-date information. In addition, passengers are looking to stay connected while they travel, especially during their commutes to and from work. This section will examine opportunities to increase convenience and the overall customer experience for passengers along the Waterbury and New Canaan Branches through the use of other innovative technologies.

2.4.1 Real-Time Information

Real-time information refers to continually updated communication with passengers through a variety of potential media concerning a variety of topics. Such information might include the next estimated departure, an estimated delay, or details about a special weather or emergency event. Real-time information may be made available by means of a website, a telephone call center, a text message, mobile devise application, and/or an e-mail. Information may also be provided at a station location, including visual and/or audio components, as part of a public address customer information system (PACIS). A distinguishing characteristic that separates real-time information from schedule information is that it includes data on both current vehicle location and general travel conditions.

New York City Transit (NYCT) is currently installing PACIS service in stations throughout its subway system. **New Jersey Transit** recently launched a program called “DepartureVision” that allows commuters to view train departure screens showing track assignments, departure and arrival times, and status reports via a website or mobile device. In Great Britain, **TrainTracker** provides real-time rail travel information for the entire United Kingdom over a website or a mobile phone using speech recognition technology.

2.4.2 WiFi

WiFi connections on trains and/or in station areas allow passengers to browse the internet, making trip time more productive and transit more attractive. WiFi can have benefits for both the customer and the operator. Public access allows passengers to browse the web and access e-mails. Agencies can also use WiFi infrastructure to privately and securely transmit operations information. **VIA Rail Canada** has added WiFi service to 160 train cars, 22 key stations, and 7 lounges.

2.4.3 Fare Payment Technologies

Advances in technology have expanded options for fare collection. Metro-North has added ticket vending machines (TVMs) that accept credit and debit cards, as well as cash, at many of its stations. TVMs have been installed at a few stations along the New Canaan Branch but not at any Waterbury Branch stations. Future advances might also include provisions for the use of contactless fare cards, similar to EZPass, but for transit patrons. The **Southeastern Pennsylvania Transportation Authority (SEPTA)** recently solicited proposals for an integrated electronic fare collection system that would be accepted on all services (bus, light rail, subway, and regional rail) and would utilize a contactless fare card system.

2.5 ADVANCED RAIL TECHNOLOGIES

Under a Five-Year Strategic Plan for Railroad Research, Development, and Demonstrations, FRA has identified various areas for Intelligent Railroad System research and development. These include national differential global positioning system (NDGPS), electronically controlled pneumatic (ECP) brakes, knowledge display information, crew registration and time-keeping, crew alertness monitoring systems, task forces terminals (TFTs), automatic equipment identification, wayside equipment sensors, wayside track sensors, locomotive health monitoring systems, energy management systems, vehicle-borne track monitoring systems, on-board component systems, on-board commodity sensors, intelligent grade crossings, intelligent weather systems, tactical traffic planners (TTP), strategic traffic planners, yard management systems, work order reporting systems, locomotive scheduling systems, car reservation and scheduling systems, crew scheduling systems, yield management systems, emergency notification systems, travelers advisory systems, and security systems.

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3.0 SUMMARY AND RECOMMENDATIONS

The innovative technologies presented in Chapter 2 are recognized approaches in the transportation industry for increasing operational efficiency and improving the customer experience. This chapter will discuss which technologies seem most applicable at this time for further study for the Waterbury and/or New Canaan Branches.

3.1 RAIL VEHICLES

CTDOT and Metro-North are already making technological progress through their procurement of the new M8 EMUs. The features of these cars that improve the customer experience (more legroom, LED displays, automated public address system, etc.) will more greatly benefit riders of the New Canaan Branch since that corridor has infrastructure to allow EMU operation, although Waterbury Branch riders who transfer to mainline trains will also enjoy these new benefits. CTDOT might consider retrofitting existing push-pull passenger cars with similar amenities. A secondary benefit of the new vehicles for Waterbury Branch riders will be the increase in the size of Connecticut's passenger rail fleet, freeing up diesel rolling stock currently under use along the Shore Line East corridor for use on the Waterbury Branch. This, along with signal improvements, will allow an increase in service frequency along the branch.

As it is unlikely that CTDOT or Metro-North will invest in new diesel locomotives for the Waterbury Branch in the near future, exploration of hybrid technology is not advisable at this time. It may be worthwhile to revisit that technology or to consider additional dual-mode locomotives at an appropriate future date. Also looking to the future, CTDOT might consider the possibility of adding bi-level EMUs to their fleet to reduce overcrowding on Stamford shuttles or in the event that is made feasible through the initiation of Penn Station service from the New Haven Line.

3.2 TRACK AND GRADE CROSSINGS

Since track along the Waterbury and New Canaan Branches is currently in operating condition, it would not be cost-effective to remove the existing ties and install concrete ones. At such a time when they do have to be replaced, however, it would be worth revisiting the possibility of concrete. Concrete ties might also be considered in the event that new sidings are added to either branch. They are more expensive than wood ties, but have lower life cycle costs because they have to be replaced less frequently.

The only current turnouts used by passenger trains along the branches are at New Canaan Station where trains can transfer to storage tracks. There is no benefit in raising the allowable speed through these turnouts since they are in a station area near the terminus of the branch. Turnouts would be added where new sidings are installed. Given that the anticipated allowable speed on the sidings would be only 30 mph, high-speed turnouts would not provide much benefit here either.

There is good reason to consider the implementation of improved grade crossing protection along both branches. Such projects improve safety and let communities establish quite zones. The Town of New Canaan has explored the use of four-quadrant gates, though it does not currently have funding available to cover the approximately $500,000 per crossing cost.

3.3 TRAIN CONTROL

Certain PTC upgrades must be incorporated into future plans for the Waterbury and New Canaan Branches. These federally mandated improvements will increase safety. The New Canaan Branch would be well served to add the switch at New Canaan Station to the signalization system that monitors and controls the rest of the branch. The Waterbury Branch, which is currently dark territory, would need signals installed to support the ultimate desired increase in service frequency. The appropriate technology for that project would require further review, although it is likely that the same cab signaling technology utilized on MNR's other lines would be used on the Waterbury Branch.

3.4 CUSTOMER INFORMATION AND CONVENIENCE

All technologies described in Section 2.4 are potentially applicable to the Waterbury and New Canaan Branches. Providing real-time travel information at stations and through web or mobile applications would enhance the passenger experience. WiFi connections at stations and on trains would increase the attractiveness of transit as a travel option. New electronic fare collection technologies could decrease crew workload and increase customer convenience.

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