# Engineering and Architectural Design Guidelines – Phase 1 Rev. A

*Prepared for:*

*MassDot*

*10 Park Plaza*

*Boston, Massachusetts*

*Prepared by:*

*The VHB/HNTB Team – a Joint Venture*

*99 High Street, 10th Floor*

*Boston, Massachusetts*

*September 2017*

*This page intentionally left blank.*

# REVISIONS

Revisions to the Engineering and Architectural Guidelines will be made on a per page basis as required and appropriate to reflect updates and/or modifications on the South Coast Rail project. Each page that has been revised carries a revision number and date in the lower right corner of the page. An asterisk (*) on this sheet indicates a new page has been issued for that revision. Only pages with revisions are listed on this page.

| Date | Page | Revision |
|---|---|---|

This Page Intentionally Left Blank

# Table of Contents

# Figures

| Figure No. | Description | Page |
|---|---|---|

# Tables

# 1 Introduction

## 1.1 Purpose

The SCR project is an initiative of the Massachusetts Department of Transportation (MassDOT), implemented through the Massachusetts Bay Transportation Authority (MBTA). The purpose of the project is "to more fully meet the existing and future demand for public transportation between Fall River/New Bedford and Boston, Massachusetts, and to enhance regional mobility while supporting smart growth planning and development strategies in the affected communities." Phase 1 of the SCR project will extend the existing Old Colony Line commuter rail service south to Fall River and New Bedford using the existing Middleboro Line from Pilgrim Junction to Cotley Junction, the New Bedford Main Line from Taunton to New Bedford, and the Fall River Secondary from Myricks Junction (Berkley) to Fall River. The Middleboro, New Bedford and Fall River lines are active freight railroads.

Phase 1 of the project will provide diesel operated commuter rail service, with stops at a new station in Pilgrim Junction as well as five new stations (East Taunton, Freetown, Fall River Depot, Kings Highway and Whale's Tooth) in the Southern Triangle. Two new overnight layover facilities will be constructed (Weaver's Cove in Fall River and Wamsutta in New Bedford). Phase 1 will provide service from New Bedford, Fall River, and Taunton to Boston using 35.1 miles of the existing of the Middleborough/Lakeville Commuter Rail Line from Boston to Pilgrim Junction in Middleborough; upgrade 7.5 miles of existing Middleborough Secondary track from Cotley Junction in Taunton to Pilgrim Junction in Middleborough; reconstruct 20 miles of the New Bedford Main Line from Taunton to New Bedford; and reconstruct 12.3 miles of the Fall River Secondary between Berkley and Fall River. The project will add a second track where needed to support Phase 1 commuter and freight operations in the Southern Triangle and a siding will be added on the Middleborough Secondary for emergency situations and staging maintenance of way equipment. The project will also reconstruct or replace railroad bridges over roads and waterways, and will need to reconstruct one highway bridge that crosses over the railroad. The project will also upgrade equipment and signals at all at-grade crossings to meet modern standards.

The SCR project was reviewed under the Massachusetts Environmental Policy Act (MEPA) in 2002 and 2013, with a Final Certificate issued in January 2014, completing the MEPA process. It has also been reviewed under the National Environmental Policy Act (NEPA) with the U.S. Army Corps of Engineers (USACE) as the lead federal agency. The Final Environmental Impact Statement was released in late 2013. The USACE has not yet issued its Record of Decision to complete the NEPA process. Following the completion of the MEPA process, the MBTA retained the partnership of VHB and HNTB as its Program Manager-Construction Manager (PM-CM) for the project. The project is currently in the preliminary design and permitting phase.

The purpose of this Engineering and Architectural Design Guidelines manual is to provide standards for the design aspects of the SCR project. These guidelines establish a clear baseline where a coordinated effort among the multi-disciplinary design team will result in an accurate and consistent design package. This will lead to the ultimate goal of a safe, efficient, and reliable commuter rail service for southeastern Massachusetts.

These guidelines are not intended to address all design issues encountered during a typical design development. They will, however, provide the criteria and guidance necessary to resolve these issues. Where it is either impossible, extremely expensive or impractical to adhere to the guidelines of this manual, alternatives may be presented to the MBTA and other authorities for approval on a case-by-case basis using an established design criteria exception waiver process. This process is described further in section 2.2.3.

## 1.2 Design References

These design criteria have been developed in accordance with the following documents in the priority listed for the applicable technical subject. All work will conform to the codes and standards listed below, including any interim codes and standards. Where code version is not specifically stated below, or is not specified by reference from a higher ranking code, the basis will be the version currently in effect as of the Notice to Proceed (NTP) date of the portion of the project under consideration. Where different code versions are specified by different superior code references, the project will follow the more restrictive requirement or proceed as directed by the AHJ.:

- MBTA Railroad Operations “Book of Standard Plans - Track and Roadway” April 29, 1996;
- MBTA Railroad Operations “Commuter Rail Design Standards Manual” Revision No. 1 April 19, 1996;
- MBTA “Track Material Specifications”;
- MBTA “Standard Specifications”;
- Americans with Disabilities Act, 2010 ADA Standards for Accessible Design
- Boston Center for Independent Living (BCIL) Agreement (April 2006)
- Code of Federal Regulations (CFR) 49 Parts 200 to 399;
- United States Department of Transportation, Federal Highway Administration, Railroad-Highway Grade Crossing Handbook, Second Edition FHWA-SA-07-010, August 2007;
- The American Railway Engineering and Maintenance of Way Association (AREMA), 2014 Manual for Railway Engineering and “Portfolio of Trackwork Plans”;
- The American Railway Engineering and Maintenance of Way Association (AREMA), Communication and Signals Manual of Recommended Practices, 2012;
- Hickerson, “Route Location and Design”, Fifth Edition, McGraw-Hill Book Company, 1964;

- CSX Transportation Standard Specifications for Track Construction, Office of Chief Engineer – Design and Construction, Jacksonville, Florida. August 8, 1988, Revised May 27, 1997;
- Massachusetts State Building Code (780 CMR), Ninth Edition (2015 International Building Code with amendments)
- Massachusetts Comprehensive Fire Safety Code (527 CMR 1.00 – 2012 NFPA 1: Fire Code, with amendments)
- Massachusetts Electrical Code (527 CMR 12.00 – 2014 NFPA 70: National Electrical Code with amendments)
- Massachusetts Architectural Access Board Regulations (521 CMR)
- 2014 NFPA 130: Standard for Fixed Guideway Transit and Passenger Rail Systems
- Other applicable federal, state, and local statutes.

## 1.3 Design Updates

The PM/CM Team received preliminary direction from the MBTA in July 2017 that the Maximum Authorized Speed (MAS) the MBTA will operate at when the project is first built is 79 mph. This is consistent with the MBTA RR Operations current MAS and design standards.

The applicability of the FRA – Rail Grade Crossing Guidelines for High Speed Passenger Rail will be considered and further addressed in a future “Phase 2” version of the project design criteria.

# 2

# Safety and Security

## 2.1 Introduction

The modern commuter rail design will address system elements according to the requirements of the applicable standards listed. Should any standard or requirement conflict, the most stringent standard will apply. The purpose of this chapter is to establish the safety and security standards for the design of all elements of the SCR project. To ensure the safety and security of the system and to resolve hazards and mitigate vulnerabilities on the project, the designer and contractors shall comply with the current version of the SCR project's Safety and Security Management Plan (SSMP), Safety and Security Certification Plan (SSCP), and after they are developed, with the State Oversight Agency (SOA)-approved System Safety Program Plan (SSPP) and System Security & Emergency Preparedness Plan (SSEPP). These documents describe the process for approving the Design Criteria, and for making changes to, or approving deviations from, the approved Design Criteria.

Once these Design Criteria are approved, all changes and/or deviations must go through a formal review process, as described in the SSMP and detailed in the SSCP or MBTA Administrative Procedures or Standard Operating Procedures. This formal review process is needed to assure that all potential safety or security impacts of the suggested criteria change, or deviation, have been adequately assessed and found acceptable before it is approved. The Project Manager, Project Management Consultant, or Design Engineer will formally present recommended changes in, or deviations from, the manner described in the SCR SSCP and Procedures manuals.

Some general requirements for the development and use of the safety and security design criteria are as follows:

1. Standards, specifications, regulations, design handbooks, safety design checklists and other sources of design guidance will be reviewed for pertinent safety and security design requirements applicable to the system. The design will establish criteria derived from all applicable information. Some general system safety and security design requirements are:

    - Identified hazards and vulnerabilities will be eliminated or associated risk will be reduced through design, including material selection or substitution. When potentially hazardous materials must be used, such materials selected will pose the least risk throughout the life cycle of the system.

    - Hazardous substances, components and operations will be isolated from other activities, areas, personnel and incompatible materials.

    - Equipment will be located so that access during operations, servicing, maintenance, repair or adjustment minimizes personnel exposure to hazards (e.g. hazardous chemicals, high voltage, electromagnetic radiation, cutting edges or sharp points) and threats.

    - Risk resulting from excessive environmental conditions (e.g. temperature, pressure, noise, toxicity, acceleration and vibration) will be minimized.

    - Risk resulting from human error in system operation and support will be minimized as part of the design effort.

    - Risk resulting from excessive vulnerability to threats (e.g. theft, vandalism, sabotage, assault) will be minimized as part of the design effort

    - In the case of risk from hazards and vulnerabilities that cannot be eliminated, alternatives that will minimize such risk will be considered. (e.g. interlocks, redundancy, fail safe design, system protection, fire suppression and other protective measures, such as clothing, equipment, devices and procedures, fencing, lighting, CCTV surveillance, alarm systems, and access control)

    - Power sources, controls and critical components of redundant subsystems will be protected by physical separation or shielding, or by other suitable methods mutually agreeable to the design and the project team.

    - When alternate design approaches cannot eliminate the hazard, safety and warning devices and warning and cautionary notes shall be provided in assembly, operations, maintenance and repair instructions, and distinctive markings will be provided on hazardous components, equipment and facilities to ensure personnel and equipment protection. These will be standardized in accordance with commonly accepted commercial practice or, if none exists, normal procedures. Where no such common practice exists, the design will propose the method or methods to be used for review and approval. The design will provide all warnings, cautions and distinctive markings proposed for review and comment.

2. Qualitative and quantitative analyses will be performed, documented and furnished as part of the design process to ensure adequate consideration of safety and security. At a minimum, a Preliminary Hazard Analysis (PHA) and initial Threat and Vulnerability Assessment (TVA) will be conducted for the project, and additional analyses may be conducted as the need arises. If the recommended hazard resolution or vulnerability mitigation conflicts with the approved design criteria, it will be evaluated through the same process as any other deviation from the approved Design Criteria.

3. The Safety and Security Certifiable Items List (CIL) will be used as the basis to develop design modifications and operating and maintenance procedures to eliminate or control the hazards and vulnerabilities. Approved resolutions of hazards or mitigations of vulnerabilities will be included on the CIL and/or other documentation as described in the SSCP.

4. Safety and Security information and procedures will be developed for inclusion in instructions and other publications. These will include, but not be limited to, testing plans and procedures, operational training, the book of operating rules, maintenance procedures, and SOPs for both normal and emergency operations.

### 2.1.1 Project Safety and Security Organization

The Project's safety and security organization is described in the SCR SSMP and will be detailed in support plans such as the SSCP. Refer to those plans for information on the Project safety and security organization and individual and committee responsibilities.

## 2.2 System Safety and Security Criteria

The SCR design will address system elements according to the requirements of the applicable standards listed. Should any standard or requirement conflict, the most stringent standard will apply. Standards, specifications, regulations, design handbooks, safety and security design checklists, and other sources of guidance will be reviewed for pertinent safety or security design requirements applicable to the system. The design will establish criteria derived from all applicable information. General safety criteria that will be adopted are described in Section 12.2.1 and general security criteria are described in Section 12.2.2. Project- specific safety and security criteria are described in Section 12.2.3. A listing of applicable codes and standards, as well as reference documents, is found in Section 12.2.4.

### 2.2.1 General Safety Criteria

These criteria for systems, fixed facilities, structural designs, and subsequent operational procedures will ensure that the system safety goals are implemented and documented through all aspects of design development, construction, implementation, testing, operations, and maintenance. General system safety criteria include:

1. Minimize exposure of personnel operating, maintaining, or repairing equipment to hazards such as entrapment, chemical burns, electrical shock, cutting edges, sharp points, electromagnetic radiation, or toxic atmospheres.

2. Emergency equipment/devices for public use will be clearly identified and accessible. Interlocks, cutouts, fittings, etc., will be accessible through access panels, which will be secured to prevent tampering and vandalism.

3. Where failures could result in personal injury, major system damage, or inadvertent operation of safety critical equipment, redundancy or fail-safe principles will be incorporated into the design.

4. Physical and functional interfaces between subsystems will be analyzed. Those hazards associated with interfaces will be specifically identified as system integration hazards and tracked for effective resolution.

5. There will be no single-point failures in the system that can result in an unacceptable or undesirable hazard condition.

6. If an unacceptable or undesirable hazard condition can be caused by combining multiple incident failures, then the first failure shall be detected, and the system will achieve a known safe state before subsequent failures occur.

7. All safety critical elements in a vital system will be designed and implemented with fail-safe principles. Fail-safe principles will be realized by designing the system to have intrinsically safe failure characteristics or by designing the system with verifiable techniques that detect potentially unsafe failures and ensure that the system reverts to a known safe state.

   - The following criteria will be used, as a minimum, for implementing fail-safe functions and vital circuits:

     - Component failures or loss of input signals will not cause unsafe consequences and will not, when added to other failures, cause unsafe consequences.

     - All systems must be designed Failsafe to prevent an unsafe condition from occurring. No latent failure will result when combined with any other failure.

- The following criteria will apply to electrical/electronic circuits:
  - Broken wires, damaged or dirty contacts, relays failing to respond when energized, or loss of power will not result in an unsafe condition.
  - The relays used in vital circuits will conform to all applicable parts of the AREMA Communications and Signals Manual of Recommended Practice, Section 6, Relays.
  - Circuitry components will be considered able to fail in either the open or shorted condition. It will be assumed that multi-terminal devices can fail with any combination of opens, shorts, or partial shorts between terminals. Protection will be provided in the event that any amplifier is subject to spurious oscillations at any frequency.

8. Where redundancy is used in a safety critical area, there will be no single point of failure that would result in the loss of safety protection. Redundant paths will not contain a common predominant failure mode.

9. Design will include component interlocks wherever an out-of-sequence operation can cause a hazard.

10. Suitable warning and caution notes in operating, assembly, maintenance and repair instructions, and distinctive markings on hazardous components, equipment, or facilities for personal protection, will be provided.

11. Color-coding used for equipment and facilities will be uniform.

12. Each design will be evaluated for hazards to identify basic deficiencies, inherent hazards of operation, safety critical malfunctions, maintenance hazards, human factors deficiencies, environmental hazards procedural deficiencies, and for compliance with codes, standards, and regulations. Written documentation of this evaluation will be provided at the time final design is accepted.

13. The system safety analysis will include review of fixed facilities and structures for employee access and maintenance safety.

14. Maintenance activities required to preserve or achieve risk levels will be prescribed to the Director of Commuter Rail Operations during the design phase. These maintenance activities will be minimized in both frequency and in complexity of their implementation. The personnel qualifications required to adequately implement these activities will also be identified.

15. Software faults will not cause an unacceptable or undesirable hazard condition.

16. Unacceptable hazards will be eliminated by design.

17. Hazardous substances, components and operations will be isolated from other activities, areas, personnel and incompatible materials.

18. Risk resulting from excessive environmental conditions (e.g. temperature, pressure, noise, toxicity, acceleration, and vibration) will be minimized.

### 2.2.2 General Security Criteria

System security will be provided by a combination of procedures, subsystems and devices to assure security of passengers, employees, equipment, and facilities. Operating procedures will be developed to maintain the fullest use of the security systems provided.

The System Security goal is to provide commuter rail system facilities and operations that minimize threats to the employees, patrons, contractors, first responders, and the general public that operate, maintain, construct, use or are in the vicinity of transit operations. To accommodate this goal, engineering designs will be reviewed to determine if threats and vulnerabilities have been identified and eliminated, and minimized or controlled to an appropriate level throughout the intended service life. Engineering designs must satisfy security design requirements applicable to the individual systems and elements.

More detailed goals of the System Security Program include:

- Design security into the SCR project by using such concepts as Crime Prevention through Environmental Design (CPTED) and security technology.
- Incorporate security features into the designs to reduce threats and vulnerabilities, such as: fencing, lighting, guard shacks, security office, gates, sensors or motion detectors, burglar/intrusion alarm systems, Closed Circuit TV (CCTV), public address systems, emergency telephones, silent alarm, card or controlled access.
- Employ a continuing Threat and Vulnerability Assessment (TVA) Process.
- Implement identified security countermeasures throughout the design.
- Implement the recommendations included in the FTA's Transit Security Design Considerations, FTA-TRI-MA-26-7085-05, November 2004.
- Comply with any U.S. Department of Homeland Security, Office for Domestic Preparedness directives.
- Use the Transportation Research Board Report Deterrence, Protection, and Preparation as guidance throughout the design.

The security design will incorporate the following mitigation strategies as an integral part of the design process of new facilities:

- Defensive Layering: Defensive layering provides multiple levels of security in order to slow or prevent an adversary's access to a site.

- Crime Prevention through Environmental Design (CPTED) principles: One of the primary aims of CPTED is to reduce the opportunity for specific crimes by creating an environment that does not tolerate crime. It focuses on design techniques and use of a particular space to deter crime with four basic elements: natural surveillance, natural access control, territorial reinforcement, and maintenance. CPTED strategies include: maximizing visibility of people, patron flow areas and building/structure areas; providing adequate lighting and minimizing shadows; graffiti guards, mylar shatter guard protection for glass windows; landscape plantings that maximize visibility; gateway treatments; perimeter control; elimination of structural hiding places; and open lines of sight.

- Target Hardening: Target hardening employs structural techniques to increase the ability of a building to withstand an explosion while minimizing the loss of life and property damage.

- Situational Crime Prevention (SCP) principles: SCP is closely related to CPTED. Its premise is that the physical environment can be managed to produce desired behaviors in those who enter a facility by such factors as assuring cleanliness, the type and amount of staffing, and various operational and physical measures.

- Physical Security System Elements: Physical security elements are intended to: 1) delay an intruder to allow time to detect them; and 2) inform responders of a penetration of a facility or protected area.

- Passenger Security: Train-borne intercom will be provided for passengers to notify the operator of any urgent incidents on board the vehicle.

- Public Security: In addition to application of CPTED design principles, public street areas where the vehicles will pick up and discharge passengers should be designed to enable them to be maintained clean and secure. Stop areas should be marked and illuminated for maximum assurance of safety and security, and shelters designed to minimize vandalism and graffiti.

- Facility Security: CCTV cameras will be provided at various facilities to-be-determined. A Fire and intrusion alarm systems will be provided to monitor critical facilities and equipment such as traction power substations and communications equipment. Alarms and CCTV will be monitored at the Operations Control Center.

- Information and Information System Security: Sensitive data such as personal identification information, procurement documents, security information and designs of information storage systems will be fortified against unauthorized access. Additionally, contract specifications will require contractors to establish a formal information protection program and plan that at least meets the following SSI requirements.

- Compliance with the Code of Federal Regulations regarding the release of transit-related Homeland Security Information.

- Protected security related information may not be subject to subpoena or discovery and not subject to inspection by the general public, and will include:

  - Assessments, plans or records that reveal MBTA susceptibility to terrorism.
  - Drawings, maps, or plans showing location and vulnerabilities of infrastructure.
  - Records or other information that detail specific emergency response plans.
  - Written information detailing response agency plans to a terrorist attack.
  - Identification of equipment used for covert, emergency, or tactical operations.
  - Response agency radio frequencies, codes, passwords, or programs.

- Personal, Financial, and Medical Information will be protected in accordance with federal regulations (e.g. Freedom of Information Act, Privacy Act, Health Insurance Portability and Accountability Act [HIPAA], and Health and Human Services Standards for Privacy of Individually Identifiable Health Information).

- Information Technology Systems used to store and process security and personal information will be protected, as the stored data would warrant.

- Individuals who require access to sensitive, personal, or proprietary information in order to accomplish their duties will sign and comply with a non-disclosure agreement. This agreement prohibits an employee from disclosing designated information, even after their employment ceases.

### 2.2.3 Project Specific Safety and Security Criteria

Safety and security criteria are interspersed in respective sections of the Design Criteria Manual. Detailed safety and security-related criteria for the various subsystems of the SCR project is forthcoming.

Additional information relating to safety and security criteria and the processes with which they were developed can be found in the following documents, separate from the Design Criteria:

- Safety and Security Management Plan (SSMP)
- Safety and Security Certification Plan (SSCP)
- Preliminary Hazard Analyses (PHA)
- Threat and Vulnerability Assessment (TVA)
- Rail Activation Plan (RAP)

- System Integration Test Plan (SITP)
- Start-Up and Pre-Revenue Operations Plan (PROP)

The Design Engineer will identify those system elements and design standards to comply with the major steps in the safety and security certification process. These steps are implemented beginning with system design and continue through the start of revenue operation.

- Define and identify those safety-critical system elements to be certified.
- Define and identify those security-related elements to be certified
- Define and develop a Certifiable Elements List (CEL) and Certifiable Items List (CIL).
- Identify safety and security requirements for each certifiable element
- Verify and document design compliance with the safety and security requirements

Each design certifiable item will have an associated verification form. The SSCP details the process for completing criteria conformance review and construction verification checklists. Waivers for design exceptions will be reviewed through a design exception request process. This process begins with a Design Exception Request, submitted in the format shown in Figure 2-1. This is then reviewed in coordination with the appropriate MBTA departments and will require a final sign-off from an MBTA safety review.

### 2.2.4 Codes and Standards

Detailed safety-related and security-related criteria for various systems and subsystems of the project are covered in the applicable section of this design criteria document. References to these items are provided below to assist the designer.

- AREMA Manual for Railway Engineering
- TCRP Report 57
- NESC sections 25, 26, rule 261H, Article 225
- MUTCD (part 10)
- Policy on Geometric Design of Highways and Streets
- Roadway Design Guide (AASHTO)
- 49 CFR192; ASME Guide for Gas Transmission and Distribution Piping Systems
- Occupational Safety and Health Administration (OSHA)
- IEC-1287, EN12663-2000, EN15227, EN1993-1-9
- ANSI/UL 1995, Section 33
- ANSI/ASHRAE Standard 15
- ANSI Z26.1
- NFPA 70, 72, 101, 130
- ISO 2204, 3381, 3095
- AREA manual Chapter 33 part 2

- International Building Code (IBC)
- Applicable Federal, state, and local codes and standards

The following documents were used as guidance or reference for the design criteria and will be used as such for all phases of the design process:

- MIL-STD 882D, System Safety Program Requirements, U.S. Department of Defense, January 19, 1993.

In addition to the documents listed above, the design will be in accordance with the following standards. If the standards requirements conflict, the most stringent requirement shall apply.

- National Fire Protection Association (NFPA) – 1, 2, 10, 13, 14, 70, 72, 90A, 101, 130
- Federal Occupational Safety and Health Administration (OSHA) Standards
  - (General Industry), 29 CFR 1910
  - (Construction Industry), 29 CFR 1926
- Massachusetts State Building Code, Uniform Fire Code (UFC) and/or International Fire Code (IFC), supplemented by local municipal code amendments.

The following regulations and guidelines will be considered in the design of the SCR project, where applicable:

- Federal Railroad Administration - 49CFR 51, 201, 202, 205, 207, 209, 211, 213, and 241.

**Figure 2-1.** *Design Exception Request form*

The VHB/HNTB Team
a Joint Venture
99 High Street, 10th Floor
Boston, MA

SCR SOUTH COAST RAIL

Massachusetts Bay Transportation Authority
massDOT Massachusetts Department of Transportation

# DESIGN EXCEPTION REQUEST (DER)

| | | | |
|---|---|---|---|
| **Section 1: Request Information** | | | |
| **Proj. DER No.:** | 001 | **Date:** | November xx, 2015 |
| **Exception Location:** | Track xx at STA xxx+xx to STA xxx+xx | | |
| **Requester** | William Sullivan | **Agency/ Firm:** | HNTB |
| **Section 2: Design Exception Description (Provide brief concise statements)** | | | |
| **Excepted Design Standard and Section No.** | Xxx<br>Xxx<br>xxx | | |
| | **Attach Design Standard, unless it is either a Project Specific or MBTA Standard** | | |
| **Description of Exception:** | Xxxxxx<br>Xxx<br>Xxxx<br>xxx | | |
| **Reason for Request:** | Xxxxx<br>xxxxx | | |
| **Section 3: MBTA Review Comments** | | | |
| **Comments and Recommendation** | Xxxxx<br>Xxx<br>Xx<br>Xxxx<br>Xxxx | | |
| **Reviewer Name** | XXXXXXXX | **Title** | XXXXXX |
| **Section 4: MBTA Approval/Denial Status** | | | |
| **Approve or Deny** | **Signature** | | |
| | **Name** | | |
| | **Title** | | |
| | **Date** | | |

# 3

# Track and Roadway Design

## 3.1 Design References

All work will conform to the latest codes and standards listed below, including interims, as of the NTP date of the portion of the project under consideration.

- MBTA Railroad Operations *Book of Standard Plans - Track and Roadway* January 5, 1996;
- MBTA Railroad Operations *Track Maintenance Standards* January 2, 2001;
- MBTA Railroad Operations *Commuter Rail Design Standards Manual* Revision No. 1 April 19, 1996;
- MBTA Railroad Operations *MW-1, Specifications for Construction and Maintenance of Track*, November 1, 2004;
- Current MBTA *Construction Specifications*;
- The American Railway Engineering and Maintenance of Way Association (AREMA), 2014 *Manual for Railway Engineering and Portfolio of Trackwork Plans* and;
- Applicable federal, state, and local statutes.

# 3.2 Geometric design

## 3.2.1 General

Roadway design will conform to the geometric design criteria as found in Chapter 3 of the MBTA Commuter Rail Design Standards Manual, except as noted herein.

## 3.2.2 Design Speeds

**Table 3.1.** *Maximum Design and Authorized Speeds*

| | |
|---|---|
| **Main Tracks (Passenger/Freight)** | Diesel locomotive: 79 mph MAS - Passenger; 40 mph - Max. Freight |
| **Minimum speed** | Maximum speed allowed by local conditions |
| **Terminals, Servicing Areas, Layover Facilities, Other than Main Tracks** | 20 mph desired<br>15 mph minimum |
| **Station by-pass speed** | Maximum authorized speed |

The maximum speed of freight trains will be governed by the optimal geometry for passenger operations. Maximum authorized passenger speed (MAS) is 79 mph and maximum freight speed is 40 mph. In no case, on shared tracks, shall the freight speed be less than one half the maximum passenger speed.

## 3.2.3 Alignment - Horizontal

### 3.2.3.1 Track Layout

Wherever practicable, single main line track locations will be held in an attempt to minimize earthwork, bridge modifications, or relocation of the initial track. Station platforms will be high-level and located on tangents wherever possible. Where placement on a tangent is not possible, platforms may be placed on curves per section 3.2.3.2 of this document.

Passing siding locations will be determined by string-line analysis of Phase 1 operations.

Universal crossovers on double track main lines will be located at branch line junctions.

Freight runaround, wyes, yards, and set-off tracks will be located as required to facilitate efficient freight operation and minimize freight interference with passenger trains. No. 10 crossovers will be provided in double track main line as required to facilitate efficient freight switching operations.

The minimum allowable turnout to be used on main line track is No.10. Turnouts beyond the main line turnout for industry tracks, layover facilities, and yard tracks will meet MBTA Design Criteria.

#### 3.2.3.2 Curvature

At station platforms, the maximum degree of curvature will be limited to as flat a curve as possible. Platforms on the outside of curves will not exceed 2°-00’ of curvature. Platforms on the inside of curves will not exceed 4°-00’ of curvature.

#### 3.2.3.3 Superelevation

Freight trains are assumed to operate on all sections of existing track; on all existing track the maximum actual superelevation (Ea) will be 4 inches. In areas where track is not in use by freight trains, MBTA maximum Ea is 6 inches.

Within stations it is desirable to limit Ea to 3 inches and use 2.75 inches Eu to allow express operation at MAS.

Where curvature is in excess of 2°-00’ and/or superlevation is over 1”, horizontal clearance to be reviewed by Chief Engineer Railroad Operations, per MBTA Drawing No. 1019.

Minimum Ea is ½ inch in areas of freight operation only. Minimum Ea is 1 inch in areas of passenger operation and shared use.

Pending choice of passenger equipment, maximum Eu for passenger trains is 3 inches.

#### 3.2.3.4 Spirals

Spirals will be designed in accordance with the geometric design criteria as found in Chapter 3 of the MBTA Commuter Rail Design Standards Manual. Spiral calculations not covered by MBTA criteria will use equations published by AREMA.

#### 3.2.3.5 Compound Spirals

Compound spirals will be used between compound curves, except where Ea does not change and the difference in Eu is less than ½ inch.

Spiral lengths will equal or exceed the values found in The American Railway Engineering and Maintenance of Way Association (AREMA), 2015 Manual for Railway Engineering:

- Ls (compound) $\geq$ 1.63 ($\Delta$ Eu) V
- Ls (compound) $\geq$ 80 ($\Delta$ Ea)
- Ls (compound) $\geq$ 62 ($\Delta$ Ea) [where V $\leq$ 50 mph]

If combining spirals are used, additional definitions and equations can be found in the current AREMA Manual for Railway Engineering.

### 3.2.4 Alignment – Vertical

#### 3.2.4.1 Vertical Curves

The vertical alignment will be designed using the MBTA Commuter Rail Design Standards Manual, except as noted below.

The minimum length of vertical curves will be designed based on AREMA Chapter 5 Section 3.6 Vertical Curves (2002).

## 3.3 Trackwork Design

### 3.3.1 General

Ballasted track construction will be used at all locations. It is the MBTA's preference that open deck bridges be replaced with ballast deck; open deck bridges are therefore subject to MBTA approval. Track materials will conform to the trackwork criteria as found in Chapter 4 of the MBTA Commuter Rail Design Standards Manual, except as noted herein.

### 3.3.2 Track Material

#### 3.3.2.1 Rail

All new rail will be 136 RE section, continuous welded (CWR). Rail will be shop welded into 1400' strings so as to minimize the number of field welds. Electric flash butt welding will be used wherever possible for field welds, except within 400' of special trackwork. CWR strings will be field cut for insertion of special trackwork and insulated joints. Insulated rail joints will be shop-manufactured per MBTA Drawing No. 1340.

Suitable relay rail may be used on freight sidings and yards, maintenance of way tracks, and layover facilities.

#### 3.3.2.2 Ties

Wood crossties will be used on all main tracks, open deck bridges, and special trackwork.

Rail will be fastened to the ties using a resilient fastener system to be specified by the MBTA. Vibration dampening tie plates and fasteners will be used on all open deck bridges and on any direct fixation trackwork. They may also be used in noise sensitive areas.

Wood crossties will be used on freight sidings and yards, maintenance of way tracks, and layover facilities. Wood ties will use a resilient fastening system.

#### 3.3.2.3 Rail Lubricators

Rail lubricators will be provided for all curves of 2 degrees or greater. Lubricators will be located prior to the start of curve in the predominant direction of travel.

#### 3.3.2.4 Railroad Signs

Mileposts, crossing signs, no trespassing signs, utility markers, clearance signs, flanger signs whistle posts, and speed restriction signs will be as specified in the MBTA Railroad Operations Book of Standard Plans. Speed restriction signs will be placed one-half mile prior to the start of the restriction. Railroad warning signs will be placed at all public grade crossings.

## 3.4 Roadway Design

### 3.4.1 General

Roadway design will conform to the roadway criteria as found in Chapter 5 of the MBTA Commuter Rail Design Standards Manual, except as noted herein.

### 3.4.2 Track Roadbed

#### 3.4.2.1 Typical Standard Track Roadbed Section

Track roadbed will generally conform to Figures 3-1 and 3-2. These figures are modified versions of MBTA Standard Drawing Nos. 1000 and 1002.

#### 3.4.2.1 Modified Track Roadbed Section

A design exception request (dated July 27, 2017) was prepared, submitted and approved by the MBTA and MassDOT, detailing the applicability of a modified track roadbed section to certain areas of the SCR Phase 1 project limits. The proposed modified track sections were developed based on geotechnical analysis with the use of Ground Penetrating Radar (GPR), borings and open test pit investigations throughout the Phase 1 project limits. A summary of the modified track roadbed sections is as follows:

1. Perform a 9” track raise along the New Bedford Mainline and Fall River Secondary with new ballast material.
2. Perform a 6” track raise along the Middleboro Secondary with new ballast material.
3. Retain existing ballast/subballast in lieu of replacement with new subballast material.

The proposed modified track roadbed sections will meet Class 4 standards with a MAS of 79 mph.

### 3.4.3 Slopes and Walls

Side slopes will generally be 2H:1V. Stabilized 1.5H:1V slopes will be considered where steeper slopes are required to avoid wetlands, right-of-way lines, or excessive earthwork, and where existing slopes in the vicinity demonstrate that 1.5H:1V slopes are stable.

Retaining walls or reinforced slopes may be used to avoid land acquisition or wetlands impacts associated with normal side slopes. A reinforced slope will be specified where a 1.5H:1V slope can be placed within the site constraints provided rip rap stone protection is utilized; otherwise, a retaining wall will be used. See Section 8 for Retaining Wall design criteria.

### 3.4.4 Drainage

#### 3.4.4.1 General

All track construction within areas subject to jurisdiction under the Massachusetts Wetlands Protection Act (MGL ch.131 §40) must have drainage and stormwater management facilities designed in accordance with the Massachusetts Stormwater Standards (310 CMR 10.05(6)(k)) as further defined and specified in the Massachusetts Stormwater Handbook. In areas of existing active rail, the project will qualify as “redevelopment” and will be required to meet the Standards to the extent practicable.

Track requires a decentralized approach to stormwater management because the track is a linear feature with nearly negligible width, as compared to its length, and no centralized location where stormwater BMPs can be constructed. The existing track infrastructure generally includes ditches along one or both sides of the track for drainage. In many places, these ditches have been filled or blocked and are no longer capable of providing adequate drainage for the track bed. As part of the track reconstruction project in all segments of the SCR rail lines, these ditches will be reconstructed to conform to the proposed typical track section in order to maintain proper drainage.

Under both existing and proposed conditions, stormwater will be conveyed via overland flow or through a drainage system consisting of drainage ditches alongside the tracks or underdrains installed in the rail ballast. In areas where no ditches or underdrains will be required to keep the track bed dry, such as areas where the rail will be elevated above the surrounding land, stormwater is assumed to leave the rail corridor by overland flow, resulting in no point discharges of stormwater. In areas where the rail will run through a cut section, ditches and underdrains will be required to direct stormwater to safe discharge locations and to keep the ballast dry and stable.

To support the wetland permit applications, track design engineers for each segment will provide a drainage report, as required by each community, containing a completed DEP Stormwater Checklist, supporting narrative, and calculations.

#### 3.4.4.2 Drainage Criteria

Drainage design shall comply with MBTA Railroad Operations Commuter Rail Design Standards Manual, Section I, Chapter 5, and the MassDEP Massachusetts Stormwater Policy, including these following key requirements:

- Existing drainage patterns shall be maintained wherever possible.
- To the maximum extent possible, drainage of the roadbed shall be handled by a gravity system.
- Do not drain areas from beyond the track bed through the track structure. Typically, a ditch or subdrain will lie between the track and the adjacent ground area to intercept fines from an adjacent slope which would foul the ballast.
- Track drainage system, including underdrains (subdrains), shall be designed to accommodate peak flows produced by the 50-year design storm without surcharge and maintain a maximum water level 18 inches below top of tie during the 100-year design storm. Water levels in side ditches for the 50-year design storm shall be at least 3 feet below top of rail.
- Cross culverts below tracks shall meet the following:
    - Reinforced Concrete Pipe (RCP) or Reinforced Concrete Box are the preferred materials for culverts, however other materials suitable for use below track will be considered.
    - Pipes and box culverts under railroad tracks shall be designed for Cooper E80 loading and shall have a minimum cover of 2 feet from bottom of tie to the top of pipe.
    - Minimum pipe size under track shall be 18” RCP, Class V, Wall C.
    - Culverts shall be designed for a 50-year storm event with a maximum allowable Headwater/Depth ratio (HW/D) of 1.5 or less. The headwater for the 50-year design event shall be no higher than 3 feet below top of rail and shall also be kept no higher than 6 inches below the top of railroad subgrade. Flow velocities shall be limited to between 3 to 10 feet/second.
    - Culverts shall be checked for a 100-year event and the headwater elevation shall be no higher than 1.5 feet below top of tie.
- The track underdrain invert shall maintain a minimum depth of 4′-0″ from the top of rail and its centerline shall be at least 6′-6″ from the track centerline.
- The minimum pipe size for storm drains and underdrains is 12 inch HDPE.

- Drain pipes and underdrains under railroad tracks shall be designed for Cooper E80 loading and shall have a minimum cover of 2 feet from bottom of tie to the top of pipe. Segments of underdrain crossing below track shall be solid wall pipe, no perforations.

- Underdrains shall be bedded in a trench filled with ¾-inch crushed stone wrapped in filter fabric. Cleanouts shall be spaced no more than 300 feet apart.

#### 3.4.4.3 Discharge Standards

Discharges from track drainage will be directed away from stormwater critical areas such as Outstanding Resource Waters (ORWs) and into adjacent upland areas to the maximum extent practicable. ORWs in the vicinity of the track include vernal pools, wetlands and waterways within the Hockomock Swamp ACEC, and tributaries to surface drinking water supplies. Selection of appropriate treatments for each location will occur during final design as part of the detailed grading plans and drainage analysis. Any treatments proposed will be constructed in a manner consistent with other measures intended to avoid, minimize, and mitigate wildlife habitat impacts.

Stormwater Best Management Practices (BMPs) must be incorporated wherever feasible. Drainage runoff collected by underdrains is anticipated to contain minimal pollutants, as most suspended solids and other contaminants will be caught in the ballast above the underdrains and/or the geotextile filter fabric encapsulating the crushed stone underdrain trenches. The use of surface ditches will allow stormwater infiltration as well as settling of suspended solids, reducing stormwater volumes and contaminant loads prior to discharge to any waterbodies or wetlands. Sediment forebays and check dams will be installed upstream of discharge points to provide additional sediment removal. Outfalls will be protected using crushed stone or concrete structures, as appropriate, to prevent erosion in the receiving waters or wetlands. Because the surface of the rail corridor consists of pervious stone ballast and does not include new impervious surfaces, there will be no change in the peak discharge rate from the rail corridor and therefore, BMPs that provide rate control are not required.

#### 3.4.4.4 Track Drainage Elements

Track drainage elements include vegetated drainage swales, sediment forebays with check dams, perforated pipe underdrains, stone swales with high density polyethylene (HDPE) liners, outlet protection stone, and infiltration trenches. These BMPs and the criteria used to determine where particular treatments will be used are described below.

##### Vegetated Drainage Swales

Track side drainage ditches will be constructed vegetated drainage swales to provide positive drainage for the track ballast, maintain open space, and allow runoff to infiltrate to the extent practicable. Side slopes of the swale may be no steeper than 2:1, and the floor of the swale must be at least 2 feet wide. The longitudinal slope of the swale must be less than 5 percent, and maximum velocities will be less than 1 foot per second during the water quality event. Swales will end at sediment forebays with check dams or outlet protection stone. A typical detail and plan view of a vegetated drainage swale is shown on Figure 3-7.

### Sediment Forebays

Sediment forebays with stone check dams must be used at locations where swales discharge runoff to wetland resource areas. A typical detail and plan view of a sediment forebay and stone check dam is shown on Figure 3-6.

### Perforated Pipe Underdrains

Perforated pipe underdrains will be used in locations where the track corridor is constrained or where the adjacent grading does not allow open channel flow. Per MBTA design guidelines, a minimum pipe size of 12 inches is required. Underdrains will be bedded in a trench filled with ¾-inch crushed stone wrapped in filter fabric. Cleanouts will be spaced no more than 300 feet apart. A typical detail and plan view of a perforated pipe sub-drain is shown on Figures 3-1, 3-2, and 3-7.

### HDPE-Lined Swales

Stone-lined swales with HDPE liners will be used in locations where the track is less than 200 feet from the Zone 1 of a drinking water supply well. This occurs in the vicinity of the Easton GP Well #1 on Gary Lane in Easton. In accordance with MassDEP regulations, drainage in this area will be directed away from the Zone 1. A typical detail and plan view of a stone-lined swale with an HDPE liner is shown on Figure 3-10.

Stone-lined swales with HDPE liners will also be used in locations where vernal pools are located immediately adjacent to the track to prevent the track drainage from dewatering the pool. These locations will use the same detail as shown on Figure 3-9.

### Outlet Protection

Stone-lined scour protection pads are required at each end of swale and pipe segments to protect adjacent soils from erosion and to trap coarse debris. Scour protection stone and energy dissipation bowls must be sized for the discharge rates anticipated at each outlet. Details of a flared end section with stone scour protection and a headwall with stone scour protection are shown on Figure 3-8.

## 3.4.5 Bridges Over Water and Culverts

Drainage structures will conform to the roadway criteria found in Chapter 5 of the MBTA Commuter Rail Design Standards Manual where possible, except as noted herein.

Where applicable, feasible and practicable, culverts and bridges will conform to the Massachusetts River and Stream Crossing Standards, dated March 1, 2006, developed by the River and Stream Continuity Partnership.

These standards will be applied to new and replacement stream crossings, river crossings, and other culverts that have high potential for wildlife use. These culverts are identified in other project environmental documents.

The above Stream Crossing Standards include both General Standards and Optimum Standards. A general project goal is to meet the General Standards for the identified culverts to the extent practical. The more stringent Optimum Standards are applicable to areas critical to wildlife habitat and areas of special environmental concern. The requirement to meet Optimum Standards on the project is limited to the Hockomock Swamp ACEC. Within that area, which will be spanned by a low trestle, the roof of existing culverts will be removed to provide increased headroom for wildlife passage.

Some of the key goals of the General Standards include:

- Culverts will be embedded over their entire length as described below. Embedment is defined as the vertical distance between the bottom of the culvert structure and the natural channel invert at the face of the culvert at both the inlet and outlet. The embedment material within the culvert shall be the natural bottom substrate of the stream channel approaching and exiting the culvert. The intent is to mimic existing stream conditions through the culvert to promote passage of small wildlife.
    - A minimum of 2 feet embedment for all culverts that must meet Stream Crossing Standards.
    - A minimum of 2 feet and at least 25 percent for round pipe culverts.
- Culvert spans channel width a minimum of 1.2 times the bankfull width.
- Openness Ratio (culvert cross-sectional area / culvert length) is at least 0.82 feet.

Some of the additional requirements when Optimum Standards must be met:

- Maintain a minimum culvert height of 8 feet and an Openness Ratio of 2.46 feet if conditions are present that significantly inhibit wildlife passage (high traffic volumes, steep embankments, fencing, Jersey barriers or other physical obstructions).
- If conditions that significantly inhibit wildlife passage are not present, maintain a minimum culvert height of 6 feet and an Openness Ratio of 1.64 feet.

In sensitive environmental areas, consideration will be given to maintaining existing hydrology. Overflow culverts or berms may be considered to protect track structure from intense storm events while maintaining existing hydrology.

# 3.5 Clearances

## 3.5.1 General

Track centers and clearances to horizontal and vertical obstructions will conform to the clearance criteria found in Chapter 6 of the MBTA Commuter Rail Design Standards Manual and the MBTA Railroad Operations Book of Standard Plans, except as noted herein.

## 3.5.2 Track Centers

Track centers in tangent sections of track are to maintain the minimum horizontal distance between railroad track centerlines as shown in Figure 3-1.

Track centers in curved sections of track are to maintain the minimum horizontal distance between track centers plus track center widening as necessary for the degree of curve as shown in Figure 3-2.

Freight passing sidings track centers are to maintain the minimum distance between freight sidings parallel to a main track of 14 feet plus compensation from the centerline of any main track. Freight passing sidings are assumed to be used for temporary storage of railcars; no loading or unloading of railcars will occur on freight passing sidings.

Yard tracks and industry sidings track centers are to maintain the minimum distance between yard tracks and industry sidings parallel to a main track of 17’-0” from the centerline of any main track. See MBTA Drawing. No. 1020 for more information on industry sidings.

## 3.5.3 Horizontal/Vertical Clearances

Standard clearances at stations will be as shown in Figure 3-3.

Standard side clearances from the centerline of track, including compensation for curvature and superelevation, will be as shown in Figure 3-5.

Track with existing freight service will provide minimum clearances and allow for Plate F clearance.

Bridges passing over the railroad will be required to meet minimum vertical clearances.  Vertical clearance below the limits will be increased by one of the following means:

1. Increase the existing vertical clearance to meet the requirement by lowering the trackbed and/or by a limited raising of the bridge superstructure.

2. Total bridge replacement.

Vertical clearances are measured from the top of rail to bottom of structure. The proposed minimum vertical clearance requirements for bridges and other overhead structures are as follows:

- Diesel Locomotive Trains: The minimum vertical clearance is 18 feet, 0 inches

Clearances for new overhead bridges will be as shown in Figure 3-4.

The above clearances are based on the following assumptions:

- Provision for future track raising is not included; and
- Provision for double stack freight clearances is not provided.

Standard clearances for signal equipment and utility crossings along tangent track will be as shown in attached MBTA Drawing No. 1014.

Dwarf signals through plate girders will be as shown in attached MBTA Drawing. No. 1014.

Continuous obstructions (i.e. sound barriers, walls, etc.) are allowed to encroach within standard clearance where safety niches are provided. See the MBTA Commuter Rail Design Standards Manual for more information.  Any horizontal clearance below standard track clearance requires written project approval.

# 4 Signals

## 4.1 Automatic Highway Crossing Warning System

### 4.1.1 General

Within the project right-of-way there are 28 existing public grade crossings currently scheduled for Automatic Highway Crossing Warning (AHCW) installations and/or upgrades. These crossings have a crucial effect on Commuter Rail operations and are an important parameter to be considered in calculating the headway and the number of trains in the project section. At each grade crossing there is a potential for conflict between the highway traffic and the Commuter Rail traffic. To achieve a smooth and safe flow of both traffic modes, it is important that the traffic pattern is studied in detail and coordinated with the railroad design to achieve a safe and efficient transition. A grade crossing diagnostic team review will be conducted for each grade crossing to determine if any specific warning devices or traffic signal pre-emption is required. FRA safety regulations and development in and around the crossing area will be addressed as part of the diagnostic team review and included in the conceptual grade crossing designs.

### 4.1.2 Design Criteria

The Automatic Highway Crossing Warning (AHCW) systems will be designed to meet the applicable recommended practices of the American Railway Engineering and Maintenance-of-Way Association (AREMA) Signal and Communications Manual, the Manual of Uniform Traffic Control Devices (MUTCD) part VIII, and the Code of Federal Regulations CFR49 Part 234. All work will conform to the latest codes and standards listed above, including interims, as of the Notice to Proceed (NTP) date of the portion of the project under consideration.

Crossing “H” plans showing tracks and roadway intersection along with all appropriate warning devices will be developed for each crossing based on the diagnostic team findings. These conceptual plans will be submitted for concurrence to the Department of Public Utilities (DPU) of the Commonwealth of Massachusetts. The final approval and design of the grade crossings will address the DPU comments received.

The AHCW systems will consider all technology commercially available suitable for operation with mixed mode passenger and freight service. This review is ongoing and will be further defined in the conceptual design report. The crossing approach start distances will be set in accordance with the Maximum Authorized Speed (MAS) as shown on the track charts. MBTA Commuter Rail standards will be applied, physical characteristics of the crossing considered and specific requirements of the system utilized, in determining the amount of warning time required.

The AHCW will be tailored to promote safety and efficiency so as not to endanger the public or delay roadway traffic. The selected system will handle all the logic and report any critical failures that occur within the AHCW system to the Commuter Rail Operations Control Center (CROCC). The systems will be redundant with automatic transfer capability. Event recorders shall be included with storage capacity of 30 days of railroad operations at the crossing, capable of being accessed remotely from CROCC over the fiber optic network to be installed as part of this project.

As a minimum each grade crossing will be provided with a standard arrangement of automatic gates, flashers and electronic bells. Gate mechanisms shall meet MBTA standards in place on NTP date. Where required this standard arrangement may be supplemented with additional warning devices as determined in the diagnostic review process.

All automatic gates will be positioned in accordance with the MUTCD and will not exceed thirty-eight feet in length as defined by AREMA. Roadways exceeding this distance will be supplemented with additional gates so that each highway traffic lane approaching the crossing will be clearly obstructed during a train event. All flasher signals will be 12” diameter LED’s on 20” backgrounds in accordance with the AREMA and MUTCD standards.

Each crossing will have a conduit duct bank on both sides of the railroad. The duct bank will consist of six 4” conduits and four 4” conduits on opposite sides with locations to be determined by survey and coordination with utilities. There will be two track crossing conduit duct banks approximately 15’ from the edge of roadway, on each side of the roadway. These duct banks will consist of four 4”conduits for AHCW system components such as gates, flashers and electronic bells. Two 4” conduits will be placed under each track placed 55’ from roadway, on both side of roadway to support track circuits. The under track duct banks will be buried a minimum of 30” cover depth below the bottom of tie. Roadway conduits shall have a minimum 30” cover depth below finish roadway grade. Roadway conduits and duct bank installation shall be coordinated with track panel construction.

Each crossing will require a power utility feed from the nearest commercial source. This utility will consist of 240 VAC, 100 Amp service with the sole intent to support the AHCW system at the crossing. It should be noted that additional or supplemental devices may require additional utility infrastructure to support a particular application such as traffic preemption or advance active warning signs.

Each crossing will follow Commuter rail standards and have a 10’ X 10’ steel signal instrument house (SIH) that will house the AHCW systems. The houses will be placed at the most advantageous quadrant so as not to limit the sight distance of pedestrians, motorists or train engineers. Where possible these SIH’s will be set back twenty-five feet off the centerline of the nearest track and fifty feet from roadway edge in accordance with MBTA Commuter Rail standards.

Each AHCW system will be supported by storage batteries during times of power outages. The batteries will be sized to Commuter Rail standards of 472 amp hour (AH) to provide for twenty-four hours of continued schedule operations. This will afford maintenance personnel sufficient time to install portable generators alongside the SIH should a power outage occur.

### 4.1.3 Summary of Existing Conditions

Although some of the crossings currently have AHCW systems in place, the systems are an older generation technology in some cases beyond their expected lifecycle and not consistent with current MBTA Commuter Rail standards. This combined with the need to add or re-align track infrastructure will require a complete replacement of the existing AHCW systems.

## 4.2 Signal System Criteria

### 4.2.1 General

The target Maximum Authorized Speed (MAS) for the South Coast Rail (SCR) routes will be 79 MPH.

The design of the SCR signal system will include Positive Train Control (PTC) based on the ACSES II system consistent with the MBTA's submitted PTCIP and PTCDP. This system utilizes transponders that communication via fiber optic cable and/or radio frequencies that distribute messages to the train from the wayside and back office systems. All MBTA trains that currently operate on the NEC including the existing Stoughton service are required to have the ACSES system installed and working prior to operating over the NEC.

Do to the limited number of trains operated by Mass Costal Railroad (MCR), they will be exempt from operating under the PTC regulation in accordance to CFR 236.1029 PTC system use and failures.

In addition to PTC, an Automatic Train Control (ATC) system will be installed along the wayside. This ATC system will be based upon a dual power frequency, coded specifically to transmit block ahead information to the engineer or operator of the train. These speed codes are interpreted by the carborne ATC system and displayed to the engineer inside of the operating cab. SCR will utilize the current four frequency code system that is in use today on all MBTA Commuter Rail line equipped with an ATC system. MCR locomotives will need to be equipped with ATC equipment to interpret ATC frequencies.

Signal system design criteria presented herein was developed for safe, efficient handling of projected (final service) traffic at an optimal value/cost, incorporating state-of-the-art technology consistent with systems in current use on contiguous sections of MBTA Commuter Rail System.

The signal system for SCR will be design in accordance with the CFR 49 Parts 234 and 236 and in conformance with industry standards set forth in the AREMA signal manual and MBTA Commuter Rail standards. This approach will cut down research and cycle time required for approval of the detailed design. In addition, this method will ensure that final installation will fully meet the performance expectations of the MBTA's Maintenance Department.

The vital signal system will be controlled and monitored 24x7 from CROCC. This function is currently done under an operations and maintenance contract between Keolis and the MBTA. While it is recognized that this function may be transferred to another operating contractor prior to the commissioning of the SCR operations, for the purpose of this report's writing clarity, Keolis will be used as the "operator" of the proposed SCR service.

## 4.2.2 Specific Design Requirements

### 4.2.2.1 Block Layout

Block layout will be determined using finalized track gradient and profile plans developed for the project's track design (track charts). The track charts will be the basis for determining safe braking distance calculations that will be used in the route and aspect charts. The route and aspect charts will support the levels of service deemed possible by the operations simulation performed during the preliminary design phase.

Braking calculations for passenger trains will utilize the MBTA Commuter Rail braking criteria in effect at the time of NTP.  Freight braking shall be based on criteria provided by Mass Coastal Railroad and/or CSX, whichever is more restrictive.

Code change points will be incorporated into the design based on the needs of the block layout and to ensure a safe and comfortable braking curve exists. Where feasible, grade crossing, cut section, and electric lock locations shall be located in the same SIH to reduce cost.

### 4.2.2.2 Signal System

The Signal system will  consistent with MBTA Commuter Rail standards. Conventional (physical) signals will only be installed at interlocking's. Code change points will be defined by insulated rail joints. The basis for the vital signal system will be "cab signals" known as Automatic Train Control (ATC).  The ATC will monitor the track conditions ahead through inductors mounted on the lead control unit of the train.  They will receive power frequency codes through this inductor, decode them through the carborne train control system and display them to the engineer inside of their control cab.

### 4.2.2.3 Track Circuits

#### Interlocking

The track circuits within interlocking limits will be direct current (DC) utilizing electronic track chargers (TC'S).   This vital interlocking circuit will be used to provide switch locking, signal clearing cab enable, and support the vital train detection while the train is within interlocking limits.

### Automatic Block Territory

The track circuits utilized between interlockings shall be coded DC. This digital track circuit will transmit DC coded information via the rails to signal instrument houses as well as to the carborne vital train control system. The actual length of the track circuits will be site specific and based on the block layout. These track circuits will not exceed one mile (5,280 feet) without MBTA approval.

### Speed Commands

The following speed commands shall be utilized:

| Code Rate | Indication | Speed Command |
|---|---|---|
| 0/0 | Positive Stop | 0 MPH (ACSES II System) |
| 0/0 | Restricting | 20 MPH |
| 75/0 | Approach | 30 MPH |
| 120/0 | Limited | 45 MPH |
| 180/0 | Clear | MAS |

## 4.2.2.4 Signal Test Loops

Two cab signal test loops will be installed one each at Fall River, and New Bedford layover facilities. Trains will be cycled through these loops once per day, prior to beginning service.

## 4.2.2.5 Cut Sections

Cut sections will be responsible for code generation on the rails for the purposes of sending and receiving vital train control codes defined above. Cut sections will exist along the ROW at specific points as defined by the limits of the track circuits in accordance with the signal block design. These locations will consist of a 6’ X 6’, steel SIH. Inside the 6’ X 6’ structure it is anticipated to include, but not limited to, the following devices :

- Vital signal microprocessors
- Electro-mechanical relays (plug-in type);
- Signal Power transformers

- Circuit breaker box
- Fire resistant plywood terminal boards to secure vital cable terminations.
- Vital fiber optic modems
- Battery bank and battery chargers
- Heating and cooling units

### 4.2.2.6 Interlockings

At points along the ROW as defined by the track and signal layouts, interlockings will be required. Predominately there will be three types of interlocking's on the SCR. These include:

- Universal interlocking. (These will allow movement between tracks in double track territory)
- Two to One track (end of sidings) interlockings. These are required where double track transitions to single track.
- Yard interlockings. These are required to move equipment out of the two planned layover facilities onto the main line to either begin or end their revenue service.

Interlocking's will be controlled by dispatchers at CROCC. Dispatchers will have the capability of controlling the movement of trains through the computer based control system. This system allows the dispatchers to place any "home signal" (the physical wayside signal located at the entrance to an interlocking) in either the permissive (clear, continue) or restrictive (stop, do not continue) position. The dispatchers can also remotely change the positions of track switches to allow for the movement of trains between signaled track.

End of siding interlockings will consist of (1) 10' x 28' SIH. Universal Interlockings will consist of a 10' X 20' main and a 10' x 10' satellite SIH. A third SIH will be added if design determines the need in accordance with MBTA Commuter Rail standards..

Inside the SIH's it is anticipated to include, but not limited to, the following devices:

- Vital signal microprocessors
- Solid state DC based track circuits
- Electro-mechanical relays;
- Signal Power transformers
- Circuit breaker box
- Fire resistant plywood terminal boards to secure vital cable terminations.
- Vital fiber optic modems
- PTC equipment
- Local control and maintenance panels
- Battery bank and battery chargers
- Heating and cooling units

The basis for the interlocking system will be a vital microprocessor. The vital processor will receive information from the wayside equipment and transmit the information over a dedicated fiber line to CROCC. Interlocking's may also be locally operated in an emergency or for maintenance from a Computer Based Local Panel.

Track circuit equipment for sections contiguous to the interlockings will be installed in a rack at the Signal Instrument House (SIH) for ease of maintenance and testing.

#### 4.2.2.7 Signal Units

Interlocking signals will be 12V DC color light LED units, Siemens type V-20 or engineer approved equal. All main line signals will be either ground mount high signals or cantilever signals depending on curve/preview, set at the entrance points to the interlocking. Signals will be set to the left and the right of the track at a minimum 12 feet from the centerline of the nearest track. Any location encompassing three or more tracks a signal bridge that spans the tracks shall be utilized.

#### 4.2.2.8 Relays

Vital electro-mechanical relays will be a plug-in type unless a specific application calls for a special type.

#### 4.2.2.9 Switch Machines & Layouts

New interlockings will use turnouts with pipe connected rotary helper rods, and fixed (vertical) P10 front rods. High Voltage DC dual control switch machines, using the standard MBTA commuter rail switch layout, will be used. Battery back-up for switch machine operation will be provided. This battery bank will also provide inverter backup to operate the local panel, and telecommunications circuitry during power failures.

#### 4.2.2.10 Electric Locks

Outlying siding tracks, used to clear the main line, located within the signaled territory, will be equipped with an Alstom model 9B or approved equal electric lock that will be tied into the vital train control system to prevent unauthorized use. Movements from the main line into the siding will be controlled by a series shunt "overlay" track circuit. Trains stopping within fifty feet of the switch point will be allowed to enter the siding after a crew member unlocks and changes the position of the switch. Movements from the side track to the main line will require running the approach time for the block before the lock releases.

Interface of electric locks to adjacent cut sections or interlocking will be accomplished via express signal cables buried along the side of the railroad ROW. Directly adjacent to the switch points a small signal case will be installed to house the vital signal components needed for the electric lock. Derails and split point derails will be determined on a site-specific base and will interface with the lock circuitry.

#### 4.2.2.11 Cables

In order to facilitate minimum system cable inventory for maintenance and replacements, cables to be used will be standard, "off-the-shelf" direct burial (UG) composite cables. It should be noted that special applications may require different cable structure; however, these applications will be limited to the greatest extent possible. The following vital signal cabling is anticipated:

- Track circuits – 2 Conductor #6 Twisted Pair
- Express Cables - 27 Conductor #14AWG
- Color Light Signals - 7 Conductor #9AWG
- Switch Machines – Two separate cables 6 Conductor #6 and 9 Conductor #14AWG
- Gate Mechanism- Two separate cables 7 Conductor #6 and 10 Conductor #9AWG
- Electric Locks - 12 Conductor #14AWG
- Derail-5 Conductor #14AWG
- Communication - 96 strand single-mode fiber optic cable between locations; 12 strand single-mode fiber optic cable between SIH's within interlockings.
- Power Cables - Based on final design load requirements
- Vital Fiber Optics - Based on final engineering

The splicing of cables will not be allowed unless special permission is granted. If splicing is approved then it must be done in accordance with the manufacturer's instructions so as not to negate the warranty.

#### 4.2.2.12 Signal Transformers

Dry type transformers of sufficient capacity based upon engineering submittals will be used. Rating of each transformer will include 25% future capacity.

#### 4.2.2.13 Batteries

Storage batteries of sufficient capacity shall be used to support all vital functions of the signal system. MBTA Commuter Rail standard battery bank of 472 AH for the 12 volt banks and 3CA5 for the 100V switch bank shall be utilized unless the equipment utilized requires further capacity to provide 24 hour backup. Maintenance free type batteries shall be utilized.

#### 4.2.2.14 Foundations

All foundations required to support the signal equipment will be pre-cast concrete unless specific applications are warranted. SIH's will be supplied by PTMW Inc. in accordance with MBTA commuter rail standards, equipped with self-contained foundations.

#### 4.2.2.15 Power Supplies

Signal power supplies will be ungrounded, floating type, sized in accordance with the specific application. Commuter Rail standard AR75 battery chargers for 12 volt banks and NRS120/25R for 120 volt switch banks shall be utilized.

#### 4.2.2.16 Aspects

The signal aspects will be in conformance with NORAC and MBTA Commuter Rail operating rules. Two headed signals will be utilized at interlockings unless a three headed signal is necessary to provide a site specific aspect requirement. There will be no other wayside signals installed between interlocking's. Dwarf signals will only be used where clearance requirements provide no other option.

Cab aspects will conform to NORAC Rule 279. Block clear aspects will be utilized to facilitate train movement in the event of a carborne equipment failure.

# 4.3 Signal Power System

## 4.3.1 General

The major signal power requirements are for grade crossings, interlockings (including switch heaters), and cut sections. The service areas at New Bedford and Fall River may require higher power requirements due to the additional turnouts and associated switch heaters than those locations along the ROW.

Signal power will be provided via local utility drops coordinated with utility companies. Power cables will either need to be buried or hung on poles along the ROW from utility drops to specific locations . Step down 480-240/120v transformers will supply the power to the SIH's. Numerous power transformers provided by the local utility company shall provide the 480V feeds. Cut section locations along the ROW that do not have direct access to a utility power service may be powered from the nearest grade crossing or interlocking service. The signal power supply, due to its vital nature will require shielded isolation transformers. Actual power requirement shall be calculated based upon the final design equipment requirements.

## 4.3.2 Power for Grade Crossings

To operate the grade crossing equipment and system logic, power will be required at each grade crossing location. Initial surveys indicate all of the crossing locations have utility power supply in the vicinity. A 220V, 3 wire metered service will be run from the nearest utility pole to the Branch circuit panel board in the SIH where it will be utilized to develop the 110V required for the signal system. In cases where grade crossings are located within close proximity to one another, one metered service may be provided and distributed to the adjacent grade crossing(s).

## 4.3.3 Signal Power

### 4.3.3.1 Interlockings

Interlockings shall normally be fed from the switch heater distribution case. Voltage shall be stepped down to develop a 240/120V AC single phase 3-wire (ungrounded) power system. Shielded isolation transformers will be needed to build the ungrounded system.

### 4.3.3.2 Wayside Locations

Cut sections, electric locks, and other locations along the ROW shall be fed from either a local utility service or in cases where no utility is available within close proximity, fed from the nearest grade crossing or interlocking.

#### 4.3.3.3 Switch Heaters

Switch heaters are to be critical layouts consistent with MBTA commuter rail standards which provide two single ended rail heaters on each switch point and crib. Heaters shall be 480 volt, 275w/ft. rail heaters and 200w/ft. crib heaters. Service requirements are typically 480V, 3 phase, 400 or 800 amp depending on the number of switches.

Switch heaters are fed by utility power. For each interlocking a utility transformer will be adequately designed to carry the load of switch heaters located in the interlocking area. To meet these requirements a 480V, AC, 3-phase, 4-wire system will be developed from the available commercial supply. Switch heater panel and control system will be designed to operate locally and remotely. Interface to the CROCC dispatch system will be used for remote interface.

Switch heater cables from transformers to heater elements shall be buried in PVC conduit. For crossing tracks GRS conduit will be used.

#### 4.3.3.4 Electromagnetic Interference (EMI)

Electromagnetic Interference (EMI) from high voltage power transmission lines is a serious problem especially where signal circuits and safety equipment are involved. Some of the railroad facilities that will be affected due to induction are track circuits, signal control line circuits, communication circuits, cab signals, and crossing protection. The economics of large scale integrated circuits has produced a proliferation of computer controlled and digital electronic systems, which are susceptible to EMI. Modern rail signaling and communication systems depend on digital electronics and computer controls. Further, the increase in integrated circuit density has motivated reductions in operating levels. The lower operation levels lead to increased sensitivity to interference. Transients can also cause problems with electronic equipment.

As power transmission line voltages and currents increase, possible problems associated with electrostatic and electromagnetic coupling between overhead alternating current transmission lines and conductive objects increases. Electro statically induced voltages are possible when a conductive object insulated from ground is in the vicinity of overhead lines. Similarly, electromagnetic inductions effects are possible when transmission line phase conductors carrying fault currents cause induced voltages at the open ends of an insufficiently grounded conductive object. Inadequately grounded conductive objects provide avenues for the current flow through other alternative paths, which could be the instrument case ground.

Generally Electrostatic and Electromagnetic field effects must be considered and minimized. The voltage induction effects of overhead transmission lines or insulated or inadequately grounded conductive objects are governed by the amount of capacitive coupling, inductive coupling and resistive coupling from the line to the object.

The measurement of EMI at all paralleling high voltage electric lines shall be performed to determine possible shielding requirements. In-house computer programmers and test methodology will be used to study the EMI effects, especially in the proposed track bypass area, where high tension transmission lines are close to the tracks. This will be done during the Preliminary Design Phase.

#### 4.3.3.5 Grounding

Grounding is an essential part to reduce noise and stray current. Furthermore, proper grounding of equipment is essential to maintain personal safety. A local grounding system with ground grid will be provided at all instrument housings.

#### 4.3.3.6 Utility Coordination

To obtain power to various sources, it is essential that the utility be informed about the power requirements at various locations. At some locations, utility may need to extend their power lines to accommodate power to crossings or interlockings. Further, utility may have particular metering requirements depending on the load. Close co-ordination will be maintained throughout the project with the various utility companies to avoid construction delays to the project.

# 5
# Communications

## 5.1 Communication Systems

### 5.1.1 General

A 53-mile fiber optic communications network will be installed as part of the SCR project and will serve as the communications backbone for SCR service operated by the MBTA.

In general, the fiber optic communications network design will provide connectivity to the field devices. The fiber optic communications network will connect the various field devices, such as station equipment, signal control points and grade crossings, and radio, to the fiber optic backbone to take full advantage of the fiber optic network's speed and reliability. This project will design the best path to connect the fiber optic network edge equipment to the station communications cabinet devices and signal houses. The new grade crossing system will be compatible with an electrified railroad and increase safety for passengers, motorists, and pedestrians. Various field device connectivity will be investigated to implement the communications needs for the new grade crossing system and design the connectivity to the fiber optic network. The goal of the fiber optic network design is to provide secure and reliable communications to field devices or equipment.

Communications devices or interfaces included in this preliminary design are as follows:

1. Passenger station devices (CCTV, public address and public information signs, passenger emergency intercoms) and communications huts/bungalows;
2. Signaling control points;
3. Dispatch and PTC Radio equipment;
4. Grade crossing houses;
5. Pedestrian crossing houses;
6. Control center facility;
7. Traction power substation facilities; and
8. Communications network for PTC system

Preliminary design for the communications element that includes a fiber optics communications network will support vital communications for signal, communication, and remote control and monitoring of electrification devices such as circuit breakers, disconnects and current/voltage sensors, PTC signaling, CCTV, public address, message boards, and other devices.

#### 5.1.1.1 Fiber Cable

The communication system will use a dedicated fiber-optic backbone trenched along the inbound and outbound right-of-way (diverse routed). A 6-inch cable plow chute with four 1½-inch high density polyethylene (HDPE) innerduct will be installed. Two 96-strand direct buried fiber optic cables will be installed in each 1½-inch HDPE. The remaining two 1½-inch HDPE innerducts will be spare. The core system will consist of two 96-strand fiber optic cables, one will be installed on the inbound right-of-way and one will be installed on the outbound right-of-way. Crossings under existing track will be accomplished using three 8-inch steel casing Auger Bores with three 1¾-inch HDPE. The 96-strand fiber optic cable along the outbound track will be utilized for signal system support of the Central Traffic Control (CTC) system; vital communications between interlocking and master locations along the right-of-way; station communications such as passenger warning signs, station announcement (audio and video), and security cameras; functions in and around station locations, signal housings and other security cameras at key locations; and fare collection if needed. A redundant 96-strand fiber optic cable will be installed along the inbound track.

The fiber optic cables will be terminated at all control points and station locations. Individual copper cable may be used depending upon the application in order to breakout from the fiber cable to specific functions involving the fire alarm systems, police call back phones, and passenger information systems. The use of copper cable will be kept to a minimum to the greatest extent possible.

### 5.1.2 Fiber Optic Backbone Transmission System

The design will deploy leading edge communications technology in the form of fiber optic cables equipped with 10 gigabyte hardened Managed PoE Ethernet switch equipment fed from both AC power and battery rectifier systems. In addition to having almost limitless circuit capacity, fiber optics have the added advantage of complete immunity to electromagnetic interference (EMI) produced by traction/signal power feeders along the right-of-way.

A basic fiber optic communication system consisting of a fiber optic cable will start at the NEC (under the Attleboro and Stoughton Alternatives) or at the Middleborough Junction on the Old Colony Railroad and run to New Bedford and Fall River throughout the length of the rail line. The MBTA commuter rail has existing manholes between Canton Junction and Back Bay with available 1½-inch HDPE between manholes. New fiber will be required within these manholes to complete the route to Back Bay where MBTA fiber is available for routing back to South Station. The fiber optic cable(s) is to be buried in a 6-inch cable plow chute within one of four 1½-inch HDPE innerducts and conduit that will also house vital signal and power cable. The cable plow chute will be 36 inches below the bottom of tie. Crossings below the track will be accomplished using three 8-inch steel casing Auger Bores with three 1¾-inch HDPE. Crossings below roadways will be done in FRE conduit duct banks with suitable handholds to provide future access.

The fiber optic cable will consist of two 96-strand fiber cables that will be capable of handling long-term requirements for the vital signal system, voice, data, and CCTV circuits.

At certain locations along the length of the fiber optic cable, such as stations, communication huts, and central instrument houses, ethernet manged PoE switch equipment nodes will be established where the fiber optic light wave on the voice/data dedicated fibers would be converted into ethernet TCP/IP protocol. Virtual Local Area Network (VLANs) will be established for VoIP circuits that will then be connected to telephones, talk-back equipment, and publicaddress systems. VLANs will also connect to supervisory/control remote terminal units via short metallic distribution cables (19-AWG shielded Cat6 cable).

### 5.1.3 Cable

The 96-strand fiber optic cable will have the following major optical specifications and properties:

- Single-mode fibers (9-um nominal core) with 125-um cladding and 250-um coating per diameter;
- Dual window operation at 1300 and 1550 nm;
- Direct buried type, double jacketed with steel tape armor and dielectric central strength member or suitable cable to be used in duct;
- Optical wavelength: 1300 nm and 1550 nm;
- Optical attenuation: 1300 nm: 0.5 dB/km at 20 C; and
- Optical dispersion: 1300 nm: 3.5 to 4.5 PSEC/nm-km 1550nm: $\leq$ 20 PSEC/nm-km.

### 5.1.4 Ancillary Devices

The ancillary devices and equipment to be installed with the fiber optic cable will include fiber slack enclosures, fiber distribution panels, patch cords, pigtails, inner duct, and attenuators as required.

Fiber slack enclosures (FSEs) will house and protect fiber optic cable slack. The fiber distribution panels (FDPs) will house the splice shelf and connector sleeve.

### 5.1.5 Optical Patch Cords and Pigtails

The optical patch cords will consist of a section of single fiber, jacketed cable equipped with optical connectors at both ends. Patch cords for connections between FDP sleeves will be equipped with SC connectors on both ends of the patch cord. Patch cords for connections from FDP to optical modem will be equipped with an SC connector on one end only. The optical pigtails will consist of a section of single fiber, jacketed cable equipped with an SC connector at one end; the other end will be stripped and prepared for fusion splicing. The SC connectors for the optical patch cords and pigtails will be compatible with connector sleeves on the FDP.

### 5.1.6 Fiber Optic Inner Duct

Fiber optic corrugated inner duct will be installed at locations where fiber optic cable is exterior to fiber slack enclosures or any dedicated conduit.

The inner duct is normally made from poly vinyl chloride (PVC) and has a minimum tensile strength of 500 lbs and a crush resistance of 900 lbs.

## 5.2 Americans with Disabilities Act

The Americans with Disabilities Act (ADA) of 1990 specifies the guidelines for services to be provided to the disabled. Under Section III of the ADA, both new and existing facilities must be made accessible to the physically and mentally impaired and must also address the concerns of the elderly and disabled in the communities within each authority's service area.

The following are some of the factors that will be considered for the overall communication criteria system for compatibility with ADA provisions:

- Provision of passenger-assisted telephones at a lower wheelchair height with provision for volume control. This applies to all telephones located next to the elevators.
- Strategic placement of passenger-assisted telephones at entry and exit ramps, parking lots, etc.
- Access signage with audio-visual aid and equipment designed to blend with the existing signage and to maintain any historic ambience of structures.
- General improvements to each station's public address system through installation of fiber optic communication cable. This will enhance the audibility and quality of the system.
- In case of emergency, provision of activation of an alarm system with audible signals for the sight-impaired and flashing lights for the hearing-impaired.

## 5.3 Public Information Systems

Stations on transit systems currently have public address capability to provide information to passengers. In most cases, the announcements originate at a control center and are transmitted to the stations via transit-owned lines or lines leased from a public telephone company. New and improved technologies for public address systems, such as high-quality digital recording and transmission, automatic remote test equipment, and noise-operated automatic level control devices, will be evaluated and proposed as needed for the proposed new passenger stations.

Electronic signage conforming to ADA requirements will also be evaluated for deployment at the passenger stations. Signage messages will be coordinated with the public address audio messages to meet the needs of both the hearing and visually impaired.

The design in these areas will be based on the following criteria:

- Standalone systems to be implemented originally;
- Expandability to MBTA system-wide operations; and
- Possible present or future implementation of voice synthesized announcements, visual information displays, and slows scan/full motion wide surveillance.

### 5.3.1 Public Address System

The public address (PA) system will receive, amplify, and distribute voice announcements originating both from a remote PA control system and from a local control panel.

The equipment cabinet located at each station will contain the following devices:

- A control cabinet microphone for local "real time" announcements, "pre-recorded" announcements, and a station control unit (SCU);
- Multi-channel mixer/power amplifier; and
- Prioritization circuits to prevent simultaneous announcements from different sources.

The loudspeaker cable will be one pair, 16 AGW, and copper stranded of nominal O.D. 0.255 inch. The microphone/control cable will be six pair 22 AGW, copper stranded, with each pair having aluminum Polysier foil shield and drain wire, and an overall PVC jacket and nominal O.D. of 0.355 inch.

The AC power supply will be obtained from the station power system. All electrical wires will be single conductor, suitably rated meeting all standard requirements.

The PA equipment will also have a thermostatically controlled heater and vent fan, besides status indication light for power ON and OFF.

The Station PA equipment will integrate to the existing headend for both audio and visual ADA announcements.

### 5.3.2 Signage System

The signage system will be electronic based and display information via light emitting diode (LED). The scrolling signs will be located appropriately underneath station platform canopies.

Control of the signage will be from the central PA control system. Control data will be transmitted through the new network system. Electronic signs will display text corresponding to PA announcements and will be simultaneous with them. The electronic signs will have the following characteristics:

- Microprocessor controlled non-volatile EPROM with battery protected memory;
- Software addressable interface;
- The character display matrix will be 5 x 7 dot for normal font and 7 x 7 dot for wide font, with each dot or pixel consisting of four LEDS; and
- The power utilized will be an input voltage of 120 volts AC at 60 HZ.

### 5.3.3 Telephone Systems

The function of an internal telephone system for a transit is normally limited to operational activities. Public telephone company services and equipment are utilized for the systems' external telephone needs. Substations, central instruments rooms, single bungalows, and wayside facilities will be provided with an internal MBTA telephone. Typically, two telephone sets are provided: one two-line set to access the MBTA's PBX (IP and Analog) systems or ring down lines, and another single-line set to access the Public Telephone System.

The telephone network design will include a study of phone usage to determine which of the following telephone services should be used:

- Plain telephone service – Verizon;
- CENTREX;
- MBTA-PBX; and
- Key System Units.

The telephone system on this project will include a telephone communication Manager System Gateway to feed dispatcher's telephone line and a maintainer's telephone line. In addition, media modules will support:

- Power over Ethernet (PoE) IP telephones;
- DCP digital telephones;
- DCP Module that will support 24 digital telephones;
- Analog telephones and trunks;
- E1/T1 trunks;
- ISDN PRI trunks;
- ISDN BRI trunks;
- E1/T1 and USP WAN data lines;
- On-board ports; and
- USB ports.

Communications will be carried via a new VoIP network communication system. The dispatcher's telephone line will provide open-line direct communications between wayside telephones, signal instrument house telephones, communication shelter telephones, and the dispatcher.

The maintainer's telephone line will provide switched communications from signal instrument houses and adjacent communication shelters. From each phone on the maintenance line, personnel will be able to dial any other telephone. The telephones in the signal instrument house and communication shelters will be two-line, DTMF push button wall telephones.

### 5.3.4 Radio System

In general, there are radio communications to all train operators and all maintenance personnel from a control center. Normally, radio equipment is not dedicated to specific lines but is shared among them. However, there are separate frequencies for the various "operations" and "maintenance" uses. Additionally, transit police, local police, and fire departments each have separate frequencies. The present day state-of-the-art equipment utilizes digital transmission to achieve improved voice quality, broadened system coverage, and more efficient spectrum utilization.

Latest technology portable and mobile radio units have LED displays for caller identification, field upgradeable software, automatic identification transmittal, and automatic transmitter power control, as well as many other innovative features.

The radio system design will address the following issues:

- Adequate coverage throughout the operating area;
- Efficient locations for base stations and consoles;
- Reliable audio network between consoles and base stations;
- Ease of maintenance, trouble shooting and fault detection; and
- Communication with other railroad operators including AMTRAK, CSX, Mass Coastal and Fore River Railroad.

On this project, radio frequency coverage will be provided by base stations located at suitable locations. The radio system will be equipped for the following channel requirements:

- MBTA maintenance and Engineering;
- AMTRAK Road; and
- MBTA Dispatch.

Specific frequencies will be determined later.

The radio system will be controlled from:

- CETC South Station, Boston;
- Local Control; and
- Other required areas.

The base station transmitter final power amplifier will be rated for continuous operation under full rated output power. Frequency generation will be performed via frequency synthesis. The station identification will be in international Morse Code.

The antennas will be 6-db gain-folded dipole arrays. The antenna will be oriented so as to maximize coverage to the required area. Low profile antennas will be used to reduce interference where required.

Propagation study reflects the area that can be covered, but a more detailed analysis will be required for reduction of interference and antenna heights.

### 5.3.5 CCTV System

A CCTV system will be provided as a means of visually monitoring and verifying reported incidents from the MBTA control center. Cameras will be located to provide coverage of the public segments of the station areas and selected areas in and around the stations. Additionally, CCTV cameras will be provided to allow coverage of the power substations, grade crossings, and MBTA facility areas including the perimeter of the facility and the tracks. The CCTV system design will utilize IP camera types and all system components, which will interface with the current MBTA Video Management System (VMS).

Camera locations and views design will be guided by the Secure Stations Initiative (SSI) and by MBTA security section personnel. Some camera locations will include:

- Fare vending machine (FVM) locations;
- Customer emergency and information telephone kiosks;
- Elevator doors and interiors;
- Escalator and stairs facing the direction of passenger flows;
- Platforms including platform ends;
- All pedestrian track crossings and train crossings; and
- Other locations indicated by industry best practices and MBTA Security and Operations.

The CCTV system will be a real-time IP video system working in conjunction with the Hub Center Digital Video System. The system will utilize new IP cameras within the stations and transmit live and recorded video via IP to various monitoring locations.

Station design will consider the location of CCTV camera monitors at the head end of each platform so that dispatchers and operators will have camera views of the platforms at stations.

The CCTV system will use a separate MBTA security virtual WAN assigned on the new fiber optic communication network as a means of transmitting IP video to locations as required for recording and viewing. The system will incorporate the expansion of the MBTA storage network for Networked Video Recorders (NVRs) to accommodate storage for the new cameras and will include all hardware and software that may be required to transmit/receive video over an IP network for a complete and functional system.

Each station will include an uninterruptible power supply that meets or exceeds the following specification:

- 750VA Rack Mount UPS;
- Input 120V-208V/ Output 120V; and
- Battery runtime at full load: 7 minutes.

Sufficient numbers of Ethernet switches providing Power over Ethernet (PoE) ports of adequate wattage to provide IP cameras with power will be provided, installed and configured as part of the design. Communications closets will be implemented to house PoE switches in order not to exceed Cat-6 cable distance limitations. The station CCTV LAN will meet the requirements of the Station Security Network. The design team will confirm with MBTA the total number of PoE ports to be installed and provisioned, including ports set aside for maintenance and future capacity

#### 5.3.5.1 Camera Types

Camera types used in the CCTV system design at each station will utilize Pan, Tilt, and Zoom (PTZ), as well as fixed view IP cameras, to meet the required views.

The CCTV system is governed by the MBTA Secure Stations Initiative specifications.

Cameras will support dual streaming output and will utilize IP Ethernet connectivity.

Cameras utilized at stations will be equipped to automatically clear their lenses and protective covers from the elements under all types of weather conditions.

Fixed cameras will utilize arifocal lenses to enable camera views to be tuned on site. Cameras will also include optical image stabilization to cancel the effects of shake and vibration.

A rigid mounting of the cameras is essential to provide vibration-free images on the monitors in the control room. Where cameras must be mounted on poles, the poles and enclosures must be designed to withstand a 100 mph wind load and still maintain a usable image.

The exact location of each camera and default PTZ orientation will be determined through the above criteria tempered by the presence of objects, which may obstruct view.

Cameras will be installed at any vehicle or pedestrian crossing of commuter rail tracks and in the station facility vicinity to observe activities. IP Cameras requiring PoE connectivity, which are more than 300 cable feet from a PoE switch, will be connected using fiber optic cable with a media converter and a PoE injector near the camera or camera cluster. Fiber to Ethernet cable media converters will be managed and have Simple Network Management Protocol (SNMP) status reporting capability.

Many of the cameras will be mounted in locations that will require protection from natural elements. Locations that require special blowers or heaters to keep camera or enclosure lenses clear will require additional power. Other locations and camera view requirements will require PTZ enclosures, which also may require additional power in addition to that wattage from a PoE switch. These additional power sources will be provided by the SCR project and will have emergency power such as Uninterruptible Power Supply (UPS) to ensure continuous service during station emergencies. Conduit requirements for these separate power sources will be determined by the level of voltage and wattage delivered and by EMI protection requirements.

Cameras will generally have heavy duty PTZ capability. NEMA 4X rated dome type color cameras will be used throughout the project. Cameras will have the following additional attributes:

- Solid state design;
- Vandal resistant dome enclosure;
- Automatic focus lenses with auto-iris;
- PTZ controllable from the control rooms;
- Low light black and white mode; and
- Digital “flipping” function.

#### 5.3.5.2 Camera Operation

The output signal of the camera will be compatible with the existing video management system. The design will utilize standard Cat-6 cable from the camera to the communications rooms and will support PoE Plus when required by the camera design.

Video will be saved to a storage area network utilizing a RAID 5 + 1 disk storage configuration at the MBTA Control Centers as defined by MBTA SSI specifications.

### 5.3.6 Positive Train Control

The Rail Safety Improvement Act of 2008 as enacted by Congress requires all Class I railroads and passenger rail operators to implement a mandatory PTC collision avoidance system by December 31, 2015. The technology must be installed on all main line tracks where intercity passenger railroads and commuter railroads operate, as well as on lines carrying toxic-by-inhalation hazardous materials. Existing safety systems use spaced, trackside equipment to determine train location within a block of track, and a relatively simplistic colored-light notification system for drivers. PTC introduces continuous location and speed tracking, with more sophisticated on-board wireless technology for enforcing movement authority from a centralized control center, wherever the vehicle may be. PTC will be inherently more reliable and offer greater real-time functionality than conventional systems. The new radio system will be designed to meet and support the new federal requirements by utilizing PTC and Amtrak's planned use of the 220 MHz radio for train-to-wayside communication. Wayside control points will be designed to allow constant wayside-to-train communication throughout the line, including at-grade crossing locations.

# 6

# Noise and Vibration

## 6.1 Noise

The Federal Transit Administration (FTA) Transit Noise and Vibration Impact Assessment guidelines were used to determine if noise impacts would occur. These guidelines specify transit noise impact criteria and define procedures to project transit noise exposure.

The FTA noise impact criteria were developed specifically for transit noise sources operating on fixed guideways or at fixed facilities. They are related to the existing sound levels, the future change in sound levels, and the land use category. These criteria are based on a curve relating the percentage of people highly annoyed to the noise exposure in their residential environment. The criteria for assessing residential impacts are based on the day-night average sound levels (Ldn). The criteria for assessing impacts to non-residential areas are based on the daytime, peak-hour equivalent sound level (Leq) for the noisiest hour of transit related activity during which human use occurs at the sensitive location. The daytime Leq is used for determining noise impacts at locations where nighttime noise sensitivity is not a factor.

The FTA guidelines establish three land use categories which correlate land use with sensitivity to noise intrusions and reflect the various noise sensitive land uses that could be present along the proposed rail corridor. The three noise-sensitive land use categories are defined in Table 5-1.

The impact criteria are based on the relationship between existing noise exposure and project noise exposure. The criteria are divided into three categories (no impact, impact, and severe impact) based on the predicted project noise exposure level. Impact determinations are made by comparing the predicted project noise exposure with the existing sound level determined for each particular noise-sensitive location. The relationship between impact assessment and the three impact categories is as follows:

**No Impact**: If the project noise exposure is less than the *No Impact* criteria, no commuter rail impacts are predicted. For existing noise exposures between 50 and 65 Ldn, *No Impact* occurs where the noise exposure increase ranges from 5 dBA or less at 50 Ldn to no more than 1 dBA at 65 Ldn.

**Impact**: If the project noise exposure is stated as *Impact*, moderate noise impacts are predicted. *Impact* rating (moderate noise impacts) means that commuter rail service is predicted to increase noise exposures at sensitive land uses adjacent to the track. For existing noise exposures between 50 and 65 Ldn, *Impact* occurs when the noise exposure increases between 5 and 10 dBA at 50 Ldn and between 1 and 4 dBA at 65 Ldn.

**Table 6-1.** ***Land Use Categories and Metrics for Transit Noise Impact Criteria***

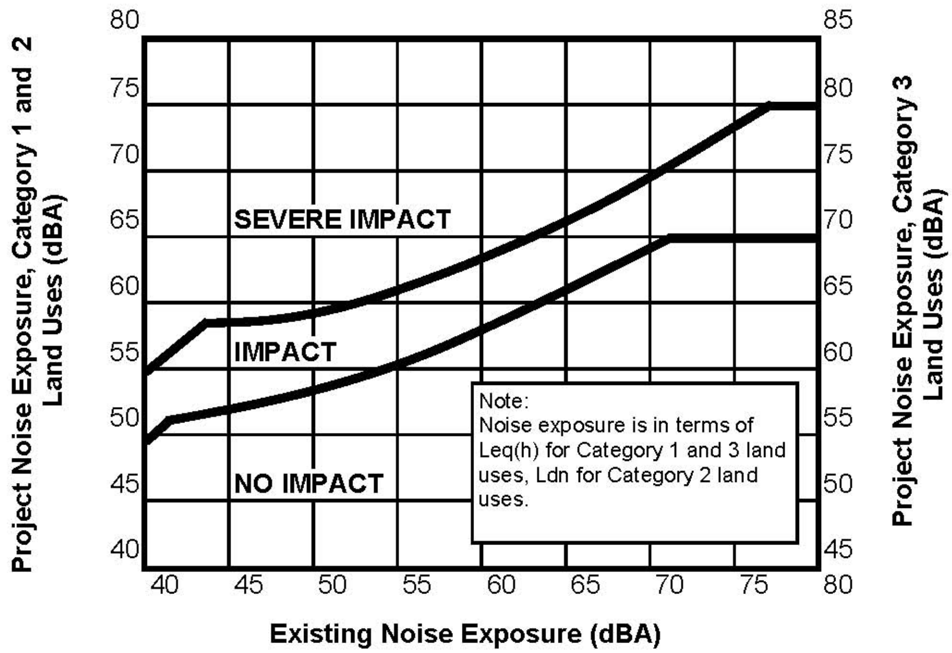
| Land Use Category | Noise Metric (dBA) | Description of Land Use Category |
|---|---|---|
| 1 | Outdoor Leq(h)[1] | Tracts of land where quiet is an essential element in their intended purpose. This category includes lands set aside for serenity and quiet, and land uses such as outdoor amphitheaters and concert pavilions, as well as National Historic Landmarks with significant outdoor use. |
| 2 | Outdoor Ldn | Residences and buildings where people normally sleep. This category includes homes, hospitals, and hotels, where a nighttime sensitivity to noise is assumed to be of utmost importance. |
| 3 | Outdoor Leq(h)[1] | Institutional land uses with primarily daytime and evening use. This category includes schools, libraries, and churches where it is important to avoid interference with such activities as speech, meditation, and concentration on reading material. Buildings with interior spaces where quiet is important, such as medical offices, conference rooms, recording studios, and concert halls, fall into this category. Places for meditation or study associated with cemeteries, monuments, museums, certain historical sites, parks, and recreational facilities are also included. |

1 Leq for the noisiest hour of transit-related activity during hours of noise sensitivity.

**Severe Impact**: If the project noise exposure is within the *Severe Impact* criteria, severe noise impacts are predicted. The *Severe Impact* criteria means that commuter rail service is predicted to substantially increase noise exposures at sensitive land uses adjacent to the track. For existing noise exposures between 50 and 65 Ldn, S*evere Impact* occurs when noise exposure increase ranges from more than 10 dBA at 50 Ldn to more than 4dBA at 65 Ldn.

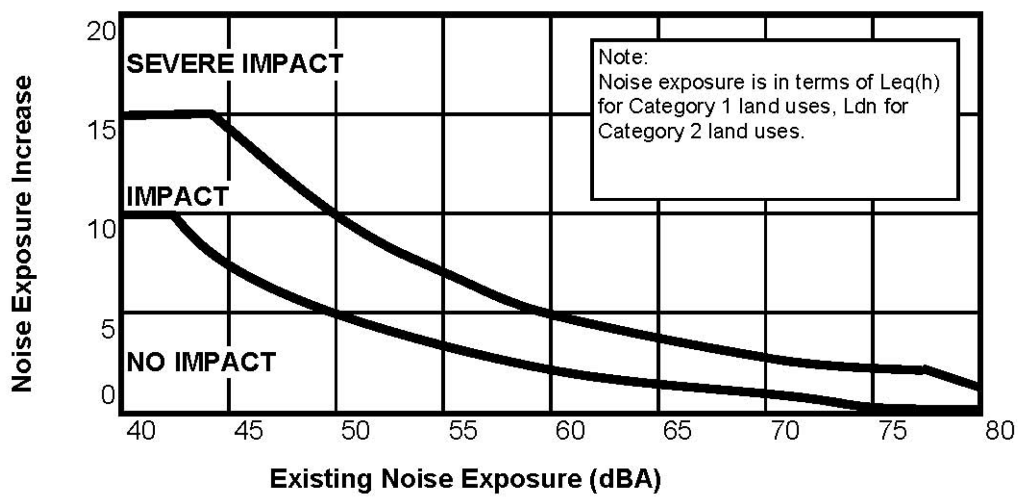
The noise impact criteria are presented in Figures 6-1 and 6-2.

**Figure 6-1.** *Noise Impact Criteria for Transit Projects*




Source: FTA's Transit Noise and Vibration Impact Assessment, May 2006

**Figure 6-2.** *Increases in Cumulative Noise Levels*




Source: FTA's Transit Noise and Vibration Impact Assessment, May 2006

## 6.2 Vibration

### 6.2.1 Groundborne Vibration

The following table gives the criteria for the maximum allowable groundborne vibration that can be generated by commuter trains. These criteria apply to the vertical vibration of floor surfaces within the affected building. The design standards do not include any limits for building damage from train vibration since the threshold for structural damage is much higher than the threshold for human annoyance. Achieving the vibration levels within the allowable limits will provide a considerable margin of safety against potential building damage.

**Table 6-2.** ***Vibration Limits (Maximum Rms Levels of Groundborne Vibration) For The New Bedford/Fall River Commuter Rail Trains***

| Sensitive Locations | Groundborne Vibration Limits[3] | |
|---|---|---|
| | Decibels (VdB)[1] | Peak Particle Velocity (PPV) |
| Sensitive Manufacturing, Vibration Sensitive Research, Concert Halls, TV Studios, Recording Studios[2] | 65-80 VdB | 0.0018 to 0.01 in./sec |
| Hospital Operating Room | 65 VdB | 0.0018 in./sec |
| Residential Buildings, Schools, Churches, Hospitals, Museums, Theaters, Libraries | 80 VdB | 0.01 in./sec |
| Office Buildings | 83 VdB | 0.014 in./sec |
| Commercial/Retail Building | 83 VdB | 0.014 in./sec |

1 Vertical vibration velocity in VdB relative to 10-6 in./sec
2 These represent special cases of activities that are unusually vibration sensitive. The appropriate limits must be determined on a case-by-case basis.
3 Limits from “Transit Noise and Vibration Impact Assessment” Federal Transit Administration, FTA-VA-90-1003-06, May 2006

# 7
# Utilities

## 7.1 General

This section provides the design criteria for proposed relocation of existing utility lines within the railroad corridor, station footprints, areas attached to and/or crossing at bridges, roadway intersections, for new utility services for the proposed stations, and work on any other utilities as part of South Coast Rail Project.

### 7.1.1 Codes, Standards, References, and Guidelines

The following standards, codes and guidelines shall be used in the relocation/extension of utility lines (e.g., water, sewer, gas, fire alarm, electric, telecom, etc.) as part of construction for the South Coast Rail project for the rail corridor, proposed station footprints, bridges and roadway elements, as appropriate, unless noted, or directed otherwise. The design criteria will be set forth by the latest edition, including revisions, amendments and supplements, of the publications presented below and in the subsequent sections of this document. In the event there is a design criteria conflict between any of the design documents the more stringent conditions shall apply, unless otherwise directed by the MBTA.

Utilities located within the Corridor, the following documents shall govern.

- AREMA Part 5 Pipelines, which includes specifications for pipelines conveying flammable and non-flammable substances, uncased gas pipelines within the Right-of-Way, overhead pipelines crossings, and fiber optic construction on railroad Right-of-Way.

Massachusetts Bay Transportation Authority (MBTA) standards and guidelines -

- MBTA Railroad Operations Commuter Rail Design Standards Manual for Track and Roadway
- MBTA Commuter Rail Track and Roadway Book of Standard Plan
- MBTA Railroad Operations Commuter Rail Design Standards Manual for Bridges.

- MBTA Railroad Operations Directorate MBTA Manual of Guidelines and Standards
- MBTA Guidelines for Designing Barrier-Free Transportation Facilities
- MBTA Commuter Rail Station Access Guidelines

For utilities owned by municipalities (including fire alarm), the following documents shall govern: **(To be determined once the latest design documents for each community has been obtained and compared versus state and federal design documents):**

- Town of Raynham
  - o Refer to section(s)
- City of Taunton
  - o Refer to section(s)
- Town of Berkley
  - o Refer to section(s)
- Town of Lakeville
  - o Refer to section(s)
- Town of Freetown
  - o Refer to section(s)
- City of New Bedford
  - o Refer to section(s)
- City of Fall River
  - o Refer to section(s)

For utilities owned by private utility companies, the following documents shall govern: **(To be determined once the latest design documents for each private utility has been obtained and compared versus state and federal design documents):**

Gas - National Grid (NiSource)

o Blue Book Specifications and Requirements for Gas Installations

Gas – NSTAR (Eversource)

o Information and Requirements for Gas Service
o Operating and Maintenance Procedures for NSTAR Gas Distribution

Gas - Algonquin Gas

o Latest design document needs to be obtained and reviewed.

Electric – NSTAR (Eversource)

o NSTAR Electric's D3820 "Construction, Material, and Work Specifications for New 15/25 kV

Primary Underground Distribution Systems up to 200 Amps" (issued August 2009)

o NSTAR Electric's "Information and Requirements for Electric Service" (revised 2009).

Telecom - AT&T (Siena Engineering)

o AT&T Specifications for Trenching, Conduit, Boxes and Manholes, Aerial Entrance Mast, Service Cabinets, Bonding and Grounding.

o AT&T's Guidelines for Access to AT&T Inc. and Operating Companies Structure (Issue 1, Oct. 2000)

o AT&T's Interstate (Long Lines) Specifications

Telecom – Verizon

o Verizon's Network Equipment Installation Standards (Information Publication IP7220, December 2009, Issue 4)

Telecom – NSTAR (Eversource)

o Shall be in accordance with the same design criteria and standards set forth by NSTAR Electric, per NSTAR Telecom

Telecom – Comcast (Xfinity)

o 2004 Specifications and Installation Guide for Underground Service to Residential Developments

Telecom, RCN

o Latest design document needs to be obtained and reviewed.

### 7.1.2 Permits and Regulatory Requirements

Proposed relocation of utility lines and new utility services for the proposed stations, crossings, and corridor as part of the South Coast Rail Project shall be in accordance with the requirements of each affected utility company as described in the following sub-sections. Proposed lines that cross or otherwise impact an existing Massachusetts Water Resource Authority (MWRA) easement or property will require an 8(m) permit prior to construction.

### 7.1.3 Design Criteria

This section discusses the design criteria for the relocation of several types of utility lines that belong to either municipalities or private utility companies:
**(To be determined once the design documents for each community has been obtained and compared versus state and federal design documents).**

#### 7.1.3.1 By City and Town

- Town of Raynham
  - Refer to section(s)

- City of Taunton
  - Refer to section(s)
- Town of Berkley
  - Refer to section(s)
- Town of Lakeville
  - Refer to section(s)
- Town of Freetown
  - Refer to section(s)
- City of New Bedford
  - Refer to section(s)
- City of Fall River
  - Refer to section(s)

#### 7.1.3.2 By Utility Company

- Town of Raynham
  - Aquaria Water
  - Columbia Gas of Massachusetts
  - Taunton Municipal Lighting Plant
  - Verizon Communications
  - Comcast Communications

- City of Taunton
  - Veolia Water
  - Aquaria Water
  - Spectra Energy Transmission
  - Taunton Municipal Lighting Plant
  - Verizon Communications
  - Comcast Communications
  - NiSource Gas

- Town of Berkley
  - Columbia Gas of Massachusetts
  - Spectra Energy Transmission
  - Taunton Municipal Lighting Plant
  - Verizon Communications
  - Comcast Communications

- Town of Lakeville
  - Middleborough Wastewater Department
  - Taunton Waste Department
  - Columbia Gas of Massachusetts
  - Taunton Municipal Lighting Plant
  - Verizon Communications
  - Comcast Communications
  - Middleborough Gas and Electric Department

  - Eversource Energy Communications

- Town of Freetown
  - Eversource Energy Electric and Gas
  - Verizon Communications
  - Comcast Communications
  - Spectra Energy Transmission

- City of New Bedford
  - Eversource Energy Electric and Gas
  - Spectra Energy Transmission
  - Verizon Communications
  - Comcast Communications
  - Open Cape

- City of Fall River
  - NiSource Gas
  - Eversource Energy Electric and Gas
  - Verizon Communications
  - Comcast Communications
  - Open Cape
  - Spectra Energy Transmission

## 7.2. Utilities

### 7.2.1 NiSource Gas

The relocation of gas lines owned by NiSource shall be in accordance with the design criteria and specifications outlined in the NiSource Blue Book Specifications and Requirements for Gas Installations. (Note that the criteria listed below have been obtained from the NiSource Blue Book.)

**NiSource Equipment on Private Property:** All NiSource equipment located on the customer's premises, such as the gas service line, meter, regulators, meter piping, etc., remain NiSource property, and may be removed by NiSource in the event such equipment is no longer needed.

**Gas Service Line(s)/Lateral(s) Location Requirements:** NiSource will install gas service piping in areas free of paved driveways or other paved areas. If it becomes necessary to locate a gas service line where it will be under a driveway or walk, the contractor shall not pave the driveway or walk until the gas service line has been installed. Alternately, the customer may opt to install a polyvinyl chloride (PVC) sleeve a minimum of 18" below grade in the area to be paved through which the gas service can be installed after the paving installation. This should first be discussed with NiSource who will advise the correct size sleeve and location, and obtain approval for the installation. NiSource shall designate the exact location of the meter and service riser.

**Clearance Requirements:** NiSource requires 18-24" clearance between the gas main line and the top of wall/footing. The major consideration with constructing a footing beneath the existing gas main would be that the main and surrounding soil would need to be supported during construction. In addition, protective full depth vertical steel sheeting and clearance (24" minimum) between gas line and adjacent work is required. NiSource also requires that a foreign opening inspector be present on-site during work to inspect and monitor excavation and advise with regard to impact on NiSource facilities.

**Customer-owned Gas Piping System:** General Requirements: Before proceeding with the design and installation of gas piping systems, contractors are advised to refer to the International Fuel Gas Code. Review the State requirements to ensure that the proposed installation is in compliance with local codes.

**High-Pressure Gas Pipelines:** Any construction/relocation activity as part of the South Coast Rail project that occurs in the vicinity of NiSource high pressure gas pipelines (above 7 bar gauge) and associated installations shall be in accordance with the NiSource criteria provided in the "Specification for Safe Working in the Vicinity of NiSource High Pressure Gas Pipelines and Associated Installations. Requirements for Third Parties T/SP/SSW/22" published in August 2007. These specifications should also be observed when carrying out work in the vicinity of intermediate pressure mains (pipelines operating between 2 and 7 bar gauge), which may be relaxed but only with the prior agreement of NiSource. This ensures that individuals planning and undertaking work take appropriate measures to prevent damage. It is the responsibility of the contractor to ensure that any work carried out conforms to the requirements of the Construction and Design Management Regulations and all other relevant health and safety legislation. The following are some of the specifications for carrying out work in the vicinity of NiSource high pressure gas pipelines:

**Formal Consent:** No work shall be undertaken in the vicinity of the pipeline without the formal written consent of NiSource. Any documents handed to contractors, or other individuals undertaking work, on site by NiSource, shall be signed for by the site manager. Within an Easement: The promoter of any works (see Section 2 of NiSource's document T/SP/SSW/22) in the Vicinity of NiSource High Pressure Gas Pipelines and Associated Installations) within an easement shall provide NiSource with details of the proposed works including a method statement of how the work is intended to be carried out. On acceptance of NiSource's requirements the promoter of the works shall give NiSource 7 working days' notice, or shorter only if agreed with NiSource, before commencing work on site. Within the Highway: Work shall be notified to NiSource in accordance with the requirements of The New Roads and Street Works Act (NRSWA) and HS(G)47. The promoter of any works within the highway should provide NiSource with details of the proposed works including a method statement of how the work is intended to be carried out. This should be submitted 7 working days before the planned work is to be carried out or shorter, only if agreed with NiSource. If similar works are being carried out at a number of locations in close proximity a single method statement should be adequate.

**Pipeline Locating:** Where formal consent to work has been given, the third party should give 7 workingdays' notice or shorter, only if agreed with NiSource, to ensure that the pipeline is suitably located and marked out by NiSource prior to the work commencing. Previously agreed working practices should be reviewed and revised based on current site conditions. Any changes shall be agreed by the NiSource responsible person. The requirements for trial holes to locate the pipeline or determine levels at crossing points shall be determined on site by the NiSource responsible person. The excavation of all trial holes shall be supervised by the NiSource responsible person.

**Slabbing and Other Protective Measures:** No protective measures including the installation of concrete slab protection shall be installed over or near to the NiSource pipeline without the prior permission of NiSource. NiSource will need to agree to the material, the dimensions and method of installation of the proposed protective measure. The method of installation shall be confirmed through the submission of a formal written method statement from the contractor to NiSource. Where permanent slab protection is to be applied over the pipeline NiSource will normally carry out a survey (Pearson Survey) of the pipeline to check that there is no existing damage to the coating of the pipeline prior to the slab protection being put in place.

**Excavation Requirements:** In Proximity to a Pipeline in an Easement: Third parties may excavate, unsupervised, with powered mechanical plant no closer than 10 feet (3 meters) to the NiSource located pipeline and with hand held power tools no closer than 5 feet (1.5 meters).

### 7.2.2 Spectra Energy Transmission

The relocation and/or protection of gas lines owned by Spectra Energy in the vicinity and within the limits of the South Coast Rail project shall be in accordance with the following documents: "Information and Requirements for Gas Service", "Operating and Maintenance Procedures for Spectra Energy Gas Distribution" Any relocation of underground gas mains owned by NSTAR will be performed by Spectra Energy. The gas main will be installed after the water, sewer or septic, drains, electrical crossovers, and electrical main conduit are in place and prior to paving. Upon completion of the gas main and crossover installations, the main is tested and natural gas will be immediately installed into the new main. All road excavation shall be completed at the time the new main is installed. The relocation of gas main, if any, will be sited by the NSTAR Gas Planning Department. With some exceptions, installation generally adheres to the following: the gas line should run parallel to the water, sewer, and electric services. In addition, the drain, water, and sewer are in the "paved way"; electrical, telephone and cable are on one side of the road, and the natural gas main will be on the opposite side of the road, in the grass strip, or underneath the sidewalk. A typical trench for gas pipe is 36 inches deep and 12 inches wide. Installation of #10, solid core, yellow wrapped, copper wire is placed in the bottom of the trench. Approximately 6 inches of sand is placed over the wire (sand utilized shall be free of any stone and will be of masonry quality). Plastic pipe is then installed and another 6 inches of sand is placed on top of the pipe. A yellow terra tape is placed approximately 1 foot below finished grade to indicate the gas main location. Plastic pipe, wire and tape are considered facilities of Spectra Energy Gas and can only be installed by designated contractors or by qualified Spectra Energy Gas personnel. Spectra Energy Gas must size all gas lines up to the new or existing meter fit from the gas main, but will not size internal piping systems for a plumber or heating contractor. The separation criteria for gas mains from other services or systems should conform to

Spectra Energy's requirements. Underground services shall have a horizontal separation of at least 3 feet from all other services or systems. In case of unavoidable crossing, the gas service shall be kept at least 6 inches away from other services or systems. Some municipalities do not allow crossing of utilities. The request for relocation of any existing Spectra Energy gas meters must be addressed to the relevant Spectra Energy gas representative. The contractor needs to contact Spectra Energy's Technical Services Department at 508-305-6890 or 508-305-6887. A meter relocation request by the contractor will be performed by Spectra Energy at the contractor's expense after a distribution foreman visits the site, and assesses work to be performed. If in the judgment of Spectra Energy any existing gas meter installation may be subject to damage, the contractor may be required to provide suitable protection or enclosures for the meter equipment or relocate the equipment at their expense. The relocation of Spectra Energy gas lines shall be in accordance with the Damage Prevention Criteria as listed in section 4.2.0 of the Operating and Maintenance Procedures Manual. The purpose of these criteria is to establish a program to prevent damage to the pipeline by excavation activities. "Excavation activities" include excavation, blasting, boring, tunneling, backfilling, the removal of above ground structures by either explosive or mechanical means, or other earth moving operations. According to Spectra Energy's Operating and Maintenance Procedures Manual, the contractor is required to notify DIGSAFE whenever digging, trenching, blasting, demolishing, boring, backfilling, grading, pile driving, landscaping, or other earth moving operations are anticipated. DIGSAFE shall not be used for miscellaneous requests to relocate, lower or remove facilities. The contractor needs to refer to Section 4.2.2 of the Operating and Maintenance Procedures Manual for guidance on how DIGSAFE requests from third party should be handled. All excavation, backfilling and safety practices shall be in accordance with Section 4.3.0 of Spectra Energy's Operating and Maintenance Procedures Manual, Department of Transportation, Title 49, Part 192, Massachusetts Department of Labor and Industries, Bulletin 12 and U.S. Department of Labor, OSHA, Title 29, Part 1910 and revisions thereto. Relocation of Spectra Energy transmission lines and pipelines, if any, in the project site or its vicinity shall be in accordance with the criteria listed in Section 4.5 of the Operating and Maintenance Procedures Manual. Relocation of Spectra Energy gas mains, if any, in the project site or its vicinity shall be in accordance with the criteria listed in Section 4.6 of the Operating and Maintenance Procedures Manual. Specific criteria for lowering a Polyethylene (PE) gas main shall be in accordance with section 4.6.10 of the manual.

### 7.2.3 NiSource Electric

The relocation of electric lines owned by NiSource shall be in accordance with the design criteria and specifications outlined in the NiSource 2010 Specifications for Electrical Installations that cover NiSource service areas in MA, NH, NY, and RI. These specifications may be revised or amended from time to time in keeping with developments and progress of the industry. The Contractor should check for the latest official version of this document at NiSource's website: **http://www.nationalgridus.com/electricalspecifications**. The following are some of the specifications and requirements as listed from the NiSource Specifications for Electrical Installations:

**Relocation of Service Laterals Requirements:** When electric service relocation is at the request of the Customer, all costs associated with the relocation of the service lateral on both private and public land shall be borne by the Customer. When the service lateral relocation is the result of an order by a public authority, the Customer shall pay for that portion of the cost associated with the service lateral movement on private property. In some instances, the public authority may compensate the Customer for this expense. When the pole from which a customer-owned underground service lateral originates must be replaced it is the Customer's responsibility to move its service lateral to the new pole location at its sole expense. For a customer-owned electric service lateral needing relocation, it is the Customer's responsibility to arrange with its contractor to move its service lateral. This responsibility includes coordination of this relocation with NiSource and inspection of the newly relocated service lateral by an authorized electrical inspector. NiSource-owned facilities involved with any relocation will be the responsibility of NiSource.

**Right-of-Way Requirements:** Rights-of-way and easements must be cleared of any obstructions at no charge to NiSource. The Contractor shall grade the right-of-way or easement to within six inches (150 mm) of final grade before NiSource commences construction, and must maintain NiSource's clearance and grading requirements.

**Electric Meter Clearances:** Electric meters shall not be located above or below gas regulating vents and must maintain a minimum 36" horizontal distance from a gas regulating vent. In all cases, the Gas Service Provider should be consulted regarding the location of gas meters near electric meters or electrical equipment.

**Temporary Service Requirements:** For temporary service requirements, refer to section 4.1.10 of the 2010 NiSource Specifications for Electrical Installations.

**Overhead Service Line Requirements:** Relocation of NiSource overhead service line as part of the South Coast Rail project shall be in accordance with clearance requirements of the National Electrical Safety Code, NiSource's Overhead Construction Standards, and section 4.2.4.1 for General Overhead Service Clearances set forth in the 2010 NiSource 2010 Specifications for Electrical Installations.

### 7.2.4 Eversource Electric Energy and Gas

The relocation of electric lines, owned by Eversource Energy, as part of the South Coast Rail project shall be in accordance with the design criteria and standards set forth Eversource Energy Electric's D3820 "Construction, Material, and Work Specifications for New 15/25 kV Primary Underground Distribution Systems up to 200 Amps" (issued August 2009) and NSTAR Electric's "Information and Requirements for Electric Service" (revised 2009). The Contractor should check for the latest official version of these documents from NSTAR. Any relocation or construction activities that involve underground NSTAR electric lines shall be contingent on fulfillment of the requirements set forth in "Section III Prerequisites" given in NSTAR Electric's D3820 "Construction, Material, and Work Specifications". Specific clearance requirements during relocation of NSTAR electric lines shall be in accordance with "C3802 Clearance Requirements from Equipment Buildings, Landscaping, or Traveled Way" Relocation, extension or new construction of NSTAR electric lines shall be in accordance with "Section VII Construction Standards and Issues" given in NSTAR Electric's "Construction, Material, and Work Specifications".

### 7.2.5 Spectra Energy Transmission

Spectra Energy requires that for gas lines crossing below railroad tracks is standard practice to encase the line in steel casing. Spectra Energy will execute this work: A typical duration of this type of project including the notification process, permitting, planning, and physical work could take anywhere between 9 and 12 months to complete.

### 7.2.6 AT&T Communications

The relocation of telecom lines, owned by AT&T, as part of the South Coast Rail project shall be in accordance with the design criteria and standards set forth in "AT&T Specifications for Trenching, Conduit, Boxes and Manholes, Aerial Entrance Mast, Service Cabinets, Bonding and Grounding", "AT&T's Guidelines for Access to AT&T Inc. and Operating Companies Structure" (Issue 1, Oct 2000), and AT&T's Interstate (Long Lines) Specifications. According to the AT&T Specifications, the Contractor should verify the location of AT&T utility structures and buried facilities two days prior to excavation. Construction of trench and placing/relocation of substructures shall be in accordance with AT&T plans and specifications. Any new conduit shall be installed and functional prior to the shutdown and disconnect of any existing conduit. PVC pipe buried to a depth of approximately 48" is the AT&T standard for underground conduit. Underground conduits require 18" of clearance horizontally between drainage, and in some cases may allow 12" of clearance. AT&T (Siena Engineering) requires 36" clearance horizontally between power systems (such as OCS), and should not be within the same duct system as OCS. Steel pipe is the AT&T standard for conduit above ground, overhead, and strapped to bridges. No concrete encasement is required for the conduit along the track. The Contractor should plan relocation of AT&T (Siena) utilities such that it may take up to two (2) months to organize a splicing crew in the event that an AT&T conduit has to be permanently relocated.

### 7.2.7 Verizon Communications

Relocation of telecom lines owned by Verizon shall be in accordance with Verizon's Network Equipment Installation Standards, Information Publication IP7220, December 2009, Issue 4. All cable and wire installed should be Verizon-approved, and a three-inch clearance must be maintained under all building constructions. The minimum vertical clearance required for aerial lines owned by Verizon is 18 feet. The typical cover required over underground conduit is approximately 36 inches, which could be up to 5-6 feet at manholes. The standard manhole dimensions for Verizon telecom lines are 12' x 6' x 7' (interior). Verizon prefers to locate their utility within the web of the bridge structure for protection, but would also allow their system to be mounted to the exterior edge if required. For conduits that are buried in sand, the minimum clearance between pipes is 12 inches. If the conduit is encased in concrete, the minimum clearance between pipes is 6 inches. Cable TV lines and telephone lines can be located in the same trench since they are both considered as low voltage lines. Specific issues related to the design and spacing of bridge hangers and extension joints as part of any proposed relocation of Verizon lines will be handled by the American Utel Contracting Company.

### 7.2.8 Comcast Communications

Relocation of telecom lines owned by Comcast shall be in accordance with the "2004 Specifications and Installation Guide for Underground Service to Residential Developments". Typically, Comcast requires approximately two months to perform utility relocations (including proper coordination and notification). Any relocation of a Comcast overhead utility line in the MBTA Right-of-Way (ROW) requires a prior application for an aerial easement. Due to conflict with catenary lines along the corridor, aerial lines crossing the corridor should be relocated. The minimum overhead clearance required for Comcast aerial lines is 28 feet. If a Comcast line is underground in the MBTA ROW, Comcast prefers to leave this underground. The typical sequence of utility relocation is NSTAR, fire alarm, Comcast, and Verizon. Relocation criteria of underground Comcast lines related to layout and grading, trenching, backfilling, inspection, conduit installation, transformer or switch vault, and riser poles shall be in accordance with the "2004 Specifications and Installation Guide for Underground Service to Residential Developments" for Comcast.

### 7.2.9 Lightower Electric

Lightower is a high performance provider of network solutions. Lightower typically leases conduit from other utility companies. In general, relocation of utility lines that belong to Lightower shall be in accordance with the design criteria set forth by their respective parent lessor company, at the respective proposed relocation sites.

# 8

# Structural

## 8.1 Codes

All work will conform to the latest codes and standards listed below, including interims, as of the Notice to Proceed (NTP) date of the portion of the project under consideration. Where more than one code is relevant, the more stringent requirements will govern.

- *AREMA Manual for Railway Engineering* of The American Railway Engineering and Maintenance-of-Way Association, commonly referred to as AREMA;
- *Standard Specifications for Highway Bridges* of the American Association of State Highway and Transportation Officials, commonly referred to as "AASHTO Specifications." Used for Allowable Stress Design Load Combinations and/or for evaluation of existing structures as applicable;
- *AASHTO LRFD Bridge Design Specifications* of the American Association of State Highway and Transportation Officials, commonly referred to as "AASHTO LRFD Specifications";
- *AASHTO Guide Design Specifications for Bridge Temporary Works*;
- *AASHTO Guide Specifications for LRFD Seismic Bridge Design*;
- *MassDOT LRFD Bridge Manual Parts I, II, and III* of the Massachusetts Department of Transportation, commonly referred to as "MassDOT LRFD Bridge Manual";
- *Standard Specifications for Highways and Bridges* of the Massachusetts Department of Transportation, commonly referred to as "MassDOT Specifications";
- *MBTA Guide Specifications for Structural Design of Rapid Transit and Light Rail Structures*, commonly referred to as the "MBTA Guide Specifications";
- *MBTA Railroad Operations Book of Standard Plans – Track and Roadway*;
- *MBTA Railroad Design Construction Standard Specifications*, commonly referred to as the "MBTA specifications"'

- *MBTA Railroad Operations – Commuter Rail Design Standards Manual*, commonly referred to as "MBTA Standards";
- MBTA Standard Line Items.
- 780 CMR Massachusetts State Building Code, of the Commonwealth of Massachusetts, commonly referred to as the "Massachusetts Building Code", which is comprised of the Massachusetts Amendments to the International Building Code 2009;
- *ASCE/SEI Minimum Design Loads for Buildings and Other Structures* of the American Society of Civil Engineers;
- *ASCE/SEI Design Loads on Structures During Construction* of the American Society of Civil Engineers;
- *AISC-ASD/LRFD Steel Construction Manual* of the American Institute of Steel Construction, commonly referred to as the "AISC Steel Manual";
- *ACI 318 Building Code Requirements for Structural Concrete and Commentary* of the American Concrete Institute, commonly referred to as "ACI 318";
- *Standard Specification for Transportation Materials and Methods of Sampling and Testing*, adopted by the American Association of State Highway and Transportation Officials;
- *The Structural Welding Code – Steel, AWS D1.1, (AWS D 1.1)* of the American Welding Society;
- *The Bridge Welding Code – ANSI/AA AWS D1.5 (AWS D 1.5)* of the American Welding Society; and
- *National Design Specification for Wood Construction* of the American Wood Council, commonly referred to as "NDS Specifications."

## 8.2 Loads

### 8.2.1 General

All structures will be designed to resist loads and forces defined as follows:

#### 8.2.1.1 Dead Loads

The dead loads consist of the weights of all permanent construction. The following unit weights will be used:

| | |
|---|---|
| Steel | 490 pcf |
| Concrete (Plain or Reinforced) | 150 pcf |
| Earth Above Water Table (Min.) | 125 pcf |
| Earth Below Water Table (Min.) | 62.6 pcf |
| Ballast | 120 pcf |
| Asphaltic Concrete | 150 pcf |
| Timber (Treated or Untreated) | 60 pcf |
| Concrete Ties (8'-6" long) | 800 lbs |
| Running Rails | 132 lbs/yd |

Other Dead Loads - Mass. State Building Code Section 704.0; also AISC Part 6

#### 8.2.1.2 Live Loads (LL)

Live loads include superimposed loads such as railroad vehicles, roadway vehicles, pedestrians, and mechanical equipment. These live loads will generally be determined from the following:

- Railroad Structures: AREMA (Cooper E80 or Alternate Live Load Vehicle) (See Railroad Loads of this chapter)

- Highway Structures: AASHTO (HL-93 Load) (see Highway Loading and Pedestrian Loading of this chapter)

- Building Structures: Massachusetts State Building Code

#### 8.2.1.3 Impact Loads (I) / Dynamic Load Allowance (IM)

Vehicular live loads will be increased for dynamic, vibratory and impact effects in accordance with the following:

- Impact for Railroad Structures:
  - Steel: AREMA Chapter 15
  - Concrete: AREMA Chapter 8

- Dynamic Load Allowance for Highway Structures: AASHTO Section 3.6.2

#### 8.2.1.4 Centrifugal Forces (CF)

Provisions will be made for centrifugal force in all regions of horizontal curvature in accordance with the following:

- Railroad Structures:
  - Steel: AREMA Chapter 15
  - Concrete: AREMA Chapter 8

- Highway Stuctures: AASHTO Section 3.6.3

#### 8.2.1.5 Lateral Forces and Wind (W)

Provisions will be made for lateral forces from equipment (nosing) and from wind on the structure and on the live load in accordance with the following:

- Railroad Structures:
  - Steel: AREMA Chapter 15
  - Concrete: AREMA Chapter 8

- Highway Structures: AASHTO Section 3.8

- Building Structures: Massachusetts State Building Code

#### 8.2.1.6 Longitudinal Force (LF) / Braking Force (BR)

Provisions will be made for longitudinal force due to acceleration and deceleration in accordance with the following:

- Railroad Structures:
  - Steel: AREMA Chapter 15
  - Concrete: AREMA Chapter 8

- Highway Structures: AASHTO Section 3.6.4

#### 8.2.1.7 Earthquake Forces (EQ)

All structures and portions thereof will be designed to resist lateral forces due to earthquake in accordance with the following:

- Railroad Structures:
  - Steel: AREMA Chapter 9
  - Concrete: AREMA Chapter 9
- Highway and Pedestrian Structures: AASHTO Section 3.10
- Building Structures: Massachusetts State Building Code

#### 8.2.1.8 Thermal Forces (T)

Provisions will be made for stresses and movements resulting from temperature variations, in accordance with the following:

- Railroad and Highway Structures: AASHTO Section 3.12 (Criteria for Cold Climates)
- Building Structures: Massachusetts State Building Code

#### 8.2.1.9 Thermal Forces in Rail (CWR)

Provisions will be made for transverse (radial) and longitudinal forces due to temperature variations in the rails, which are to be controlled as per MBTA-MW-1.

#### 8.2.1.10 Buoyancy (B)

Buoyancy will be considered, as it affects the design of all structures. The factor of safety against uplift will be not less than 1.10 against the high water table. Side friction will not be considered.

#### 8.2.1.11 Friction (FR)

For sliding shoes supporting members, friction applicable to the material will be used, but in no case will it be less than 10 percent of the vertical load.

#### 8.2.1.12 Lateral Earth Pressure (E)

Lateral earth pressure will conform to the type of structure, material, water level, and amount of surcharge, but in no case will it be less than an equivalent fluid pressure of 35 pounds per cubic foot. (See section 8.2.4 of this document.)

#### 8.2.1.13 Ice (IC)

The effects of ice pressure, both static and dynamic, will be accounted for in the design of piers and other portions of the structure where conditions so warrant. Ice loads shall be calculated in accordance with AREMA criteria. If no site-specific data is available, the design pressure will be taken as 200 pounds per square inch at the normal high water elevation (Q1.1) and 100 pounds per square inch at the 50 year flood elevation (Q50), and the ice thickness will be taken as 18 inches.

### 8.2.2 Railroad Loads

All structures supporting railroad loads will be designed for the Cooper E80 or Alternate Live Load Vehicle. See section 3.2.2 of this document for design speeds.

### 8.2.3 Highway Loading and Pedestrian Loading

All structures supporting highway vehicular traffic will be designed for AASHTO HL-93 Load in accordance with AASHTO LRFD bridge design specification.

All pedestrian structures will be designed for a live load of 90 pounds per square foot in accordance with AASHTO.

### 8.2.4 Loads and Forces on Earth Retaining and Underground Structures

The following are in addition to the applicable loads and forces given in previous sections:

#### 8.2.4.1 Dead Loads

Dead load will consist of the weight of the complete structure and all material permanently fastened to and supported by it. The possibility of a heavy deck structure being constructed in the future and its effect on the supporting sub-structure elements will be considered.

Vertical load on underground structures will be computed using the depth of soil cover above groundwater table times a minimum unit weight of 125 pounds per cubic foot, plus the depth of soil cover below the groundwater table times a minimum weight of 62.5 pounds per cubic foot, plus the depth of groundwater affecting the structure times a unit weight of 62.4 pounds per cubic foot. In general, a minimum soil depth of 2 feet will be used. The effect of the loads from adjacent buildings, both live loads and dead loads, carried on foundations within the zone of influence will be considered in the design.

Buildings supported on friction piles will receive special consideration.

For structures constructed under or adjacent to vacant property, consideration will be given to possible future use of the property as directed by the MBTA.

#### 8.2.4.2 Live Loads

Live loads on underground structures will consist of any non-permanent load which must be supported by the structure.

A superimposed live load of 250 pounds per square foot will be used regardless of depth of structure below the surface or AASHTO HL-93 loading will be used, whichever is more critical.

The distribution of concentrated loads will be determined by the designer following AASHTO or AREMA specifications as applicable.

Live load surcharge for retaining walls will be determined in accordance with AASHTO or AREMA Specifications as applicable for the particular structure.

Underground structures will be designed for side pressure due to earth abutting against the side wall, loads resting on abutting earth, and hydrostatic pressure.

In designing for the side pressure, the following will be adhered to:

- Lateral earth pressure will be taken as the vertical pressure at the point considered (including the effect of loads resting on the earth above that point) multiplied by a suitable coefficient "K". The value of K will be selected with consideration for the character of the material and the type and rigidity of the structure. The minimum equivalent liquid pressure shall be 35 pounds per cubic foot.

- Highway or railroad loads where applicable will be considered when computing side pressures on walls.

## 8.3 Design

### 8.3.1 Clearances

#### 8.3.1.1 Vertical/Horizontal

See section 3.5 of this document for standard horizontal clearances and for vertical clearances of bridges over railroad.

#### 8.3.1.2 Hydraulics

Bridges over waterways will have a minimum freeboard clearance of 2 feet over the Q100 water surface elevation where feasible and practical. At a minimum, a waterway opening equivalent to the existing will be provided. Additionally, at a minimum, the existing low structure elevation will be maintained.

#### 8.3.1.3 Environmental

See sections 3.4.5 and 3.4.6 of this document for sensitive environmental area considerations.

## 8.3.2 Loading Combinations

### 8.3.2.1 General

Loading combinations will be in accordance with the following:

- Structures carrying motor vehicles: AASHTO Specifications.
- Buildings, shops, stations, acoustical deck, (other than 1 above) retaining walls supporting 4 feet or more of fill, and miscellaneous structures: Massachusetts State Building Code.
- Structures carrying railroad traffic: AREMA Specifications.

### 8.3.2.2 Underground Structures

The following combinations of loadings will be considered for the design of underground structures (Sections will be proportioned for the most severe case):

Case I: Long-Term Loadings:
- Roof: Full dead load, plus live load, plus earth surcharge loads.
- Sidewalls: Full hydrostatic pressures (H), plus "at-rest" earth pressure (Ko), plus live load, plus surcharge loads.

Case II: Minimum Side Pressure:
- Roof: Full dead load, plus live load, plus earth surcharge loads.
- Sidewalls: Reduced hydrostatic pressure (equivalent to drawdown elevation immediately upon completion of backfill), plus earth pressure.

Case III: Construction Case:
- General: Such other loading configurations as the designer may consider appropriate based on the anticipated soil conditions, construction sequence and methods, backfill procedures, and other pertinent factors. Minimum construction equipment loading of 600 pounds per square foot will be considered in the temporary support of excavation design.

## 8.3.3 Steel Design

### 8.3.3.1 General

This section designates the general design criteria where structural steel is to be used.

#### 8.3.3.2 Material

For normal uses: ASTM A36.

For uses requiring higher strength steels or where economically justifiable: ASTM A242, A709, A572, and A588.

The choice of steel for the particular application is to be determined by the codes governing the use as outlined in the sections that follow.

#### 8.3.3.3 Structural Steel Carrying General Highway Traffic or Buses Only

General design criteria for structural steel carrying general highway traffic or supporting MBTA bus traffic will be in accordance with AASHTO Specifications as modified by the MassDOT Bridge Manual.

#### 8.3.3.4 Structural Steel Carrying Railroad Traffic

Structural steel carrying railroad traffic will be designed in accordance with the AREMA Specifications.

#### 8.3.3.5 Other Structural Steel Design

Design unit stresses and general design criteria for steel structures not subject to moving loads will be in accordance with the latest AISC Specifications for the Design, Fabrication and Erection of Structural Steel for Buildings.

##### Welding

The design of all weldements will be in accordance with the current specifications of the American Welding Society, supplemented by the various codes applicable to the type of structure involved.

##### Composite Design Using Shear Connectors

Composite steel and concrete design may be used with shear connectors, except all dead loads of concrete primary pours will be carried by the structural steel as noncomposite unless otherwise approved by MBTA. The modular ratios of steel to concrete will be in accordance with the provisions of the applicable code for the type of structure involved and the provisions for composite girders of that code.

## 8.3.4 Reinforced Concrete Design

### 8.3.4.1 General

This section designates general design criteria of reinforced concrete structures. It does not include prestressed concrete, which is covered under a separate section.

### 8.3.4.2 Reinforced Concrete—Material Specifications

Reinforced concrete cast-in-place will be designed based upon a concrete strength of f'c = 4,000 psi. Other concrete strengths (e.g. f'c = 3,000 psi or f'c greater than 4,000 psi) may be used if economically justifiable.

Reinforcing steel (other than for prestressed control) will be ASTM A615 - Grade 60. Reinforcing bar details will be in accordance with the latest ACI Code and Manual of Standard Practice for Detailing Reinforced Concrete Structures.

### 8.3.4.3 Concrete for Structures Carrying General Highway Traffic or Buses

Concrete and reinforcing steel design and general design criteria for the concrete portions of structures carrying general highway traffic or buses will conform to the AASHTO Specifications as modified by the MassDOT Bridge Manual.

### 8.3.4.4 Concrete for Structures Carrying Railroad Traffic

Concrete and reinforcing steel design, allowable stresses, and general design criteria for the concrete portion of structures carrying railroad traffic will conform to the AREMA Code subject to modifications that may be imposed by the railroad being carried. Design will be by strength method. For structures carrying rapid transit or highway loads in addition to railroad traffic, design criteria will also conform to AASHTO.

### 8.3.4.5 Concrete for Other Structures

Concrete and reinforcing steel design, allowable stresses, and general design criteria for stations, shops, acoustical deck or other structures both above and below ground shall conform to the ACI Code. Design will be by strength method.

### 8.3.4.6 Special Design Criteria and Modifications to Codes

Distribution or temperature reinforcing will be used in all walls and slabs, regardless of whether it is exposed to temperature changes or not.

The ACI Code will be used to supplement other code based upon the judgment of the designer.

## 8.3.5 Prestressed Concrete Design

### 8.3.5.1 General

This section designates the general design criteria of prestressed concrete structures.

### 8.3.5.2 Material

Prestressed concrete members will be based on a concrete compressive strength of 6,500 psi. This may be increased, however, where availability of suitable materials and the establishment of rigid control of mixing, placing, and curing have been established.

### 8.3.5.3 Prestressed Concrete Members carrying General Highway Traffic of Buses

Prestressed concrete members carrying general highway traffic and buses will be designed in accordance with the AASHTO Specifications as modified by the MassDOT Bridge Manual.

### 8.3.5.4 Prestressed Concrete Members Carrying Railroad Traffic

General design criteria for the prestressed concrete members carrying railroad traffic will conform to the AREMA Code.

### 8.3.5.5 Prestressed Concrete Members for Other Structures

Prestressed concrete members for other structures will be designed in accordance with the ACI Code.

## 8.3.6 Timber and Stress Grade Lumber

### 8.3.6.1 General

This section designates the general design criteria of timber and stress grade lumber and its fastenings. It does not include timber piles for foundations.

### 8.3.6.2 Material

Timber and stress grade lumber will be material that is 2 inches nominal or more in thickness and width for use where working stresses are required. The material will be stress-graded by a recognized inspection bureau for the species of wood involved. Ordinary yard lumber which is intended for general building purposes will not be covered by this standard.

### 8.3.6.3 Timber for Structures Carrying General Highway Traffic or Buses

General design criteria for timber portions of structures carrying general highway or bus traffic will conform to the AASHTO Specifications.

#### 8.3.6.4 Timber for Structures Carrying Railroad Traffic

General design criteria for timber portions of structures carrying railroad traffic will conform to the AREMA Code.

#### 8.3.6.5 Timber for Other Structures

Timber design criteria for stations or other structures will conform to the National Design Specification for Stress Grade Lumber and Its Fastenings as recommended by the National Forest Products Association.

#### 8.3.6.6 Special Design Criteria and Modifications to Codes

An allowance for overstresses in temporary structures will be made in accordance with the applicable code and type of structure involved. However, structures which can be expected to have duration of loading greater than 7 days shall not be designed with the overstresses.

### 8.3.7 Retaining Walls

#### 8.3.7.1 General

Retaining walls will be utilized as required to minimize property impacts and land acquisition; minimize wetlands and flood plain impacts; and to facilitate grading around bridges and other structures. Retaining wall types will be selected on a case by case basis depending on the design constraints at each wall site. Approved retaining wall types include cast-in-place and precast concrete gravity walls; cast-in-place concrete cantilever walls; precast concrete modular wall systems; gabion walls (not approved for supporting elevated track sections); soldier pile and lagging with concrete facing and cap; soldier pile and precast concrete lagging; and sheet pile walls with and without concrete facing. Mechanically stabilized earth walls may also be considered where appropriate. Permanent tie backs and/or soil reinforcement shall not be permitted below existing or proposed tracks.

#### 8.3.7.2 Design

Retaining walls shall be designed in accordance with the relevant sections of the AREMA Manual for Railway Engineering. For evaluation of wall types or elements not covered by the AREMA Manual for Railway Engineering, the AASHTO Bridge Design Specifications and/or other relevant reference manuals shall be utilized as required and appropriate. For retaining walls with an exposed face of over 4 vertical feet, the design shall satisfy the requirements of the Massachusetts State Building Code, including hydrostatic and seismic design criteria, as the walls will require State Building Permits.

# 8.4 Existing Structures

## 8.4.1 Railroad Bridges

### 8.4.1.1 Rating Procedure

Railroad bridges will follow the load rating procedures found in the following sections of AREMA:

- Steel: AREMA Chapter 15, Part 7;
- Concrete: AREMA Chapter 8, Part 19; and
- Timber: AREMA Chapter 7, Part 3.

### 8.4.1.2 Single-bay Structures:

Rate one of each type of structural member in the bay. For example, on a through-girder bridge, rate one stringer, one floor beam, and one girder. Rate the stringer, floor beam, or girder with the "worst case" combination of loading and section loss. Assume these members represent the condition of all other members of that type in the bay. So if the "worst case" floor beam and stringer do not rate, it will be assumed that the entire floor system needs to be replaced. If the "worst case" girder does not rate, it will be assumed that the entire bridge will need to be replaced.

### 8.4.1.3 Multi-bay Structures:

Use the single-bay structure procedure, except rate each bay of a two-bay structure. For three-bay structures, rate all three bays if the current live track is in the middle bay. If the current live track is in the exterior bay of a three-bay structure, rate only the live track bay and the bay immediately adjacent to it.

The following conditions require rating:

- Bending;
- Shear;
- Compression (trestle pile pier members, timber pile piers); and
- Fatigue.

Ratings are not required for bridge timbers and ties, rivets, diaphragms, bearings, and all non-load bearing members.

### 8.4.1.4 Load Distribution and Rating Assumptions

Dead Load

- Rate based on existing open or ballasted deck condition;
- Assume track and timbers dead load in all bays of multi-bay structures, even if only one bay currently has track and timbers in it; and

- Apply a factor of 1.10 to the self-weight of load carrying steel members to account for detailing.

Live Load

- Live loads are to be determined using the AREMA's MVR Table for Cooper E80 Live Load (see attached); and
- Assume only one train at a time will be on structures with multiple bays, unless the structure currently carries more than one live track.

#### 8.4.1.5 Fatigue

Fatigue design of undergrade bridges will be in accordance with AREMA 1.3.13, Chapter 15. The number of stress cycles, N, is computed based on 2 cycles per train and the number of trains is as defined below:

Bays currently carrying live tracks:

- Date bridge built to 1959 - 25 trains per day (50 trains per day for center girders of multi-bay bridges);
- 1959 to 1997 - 5 trains per day;
- 1997 to 2000 - 10 trains per day; and
- 2000 to 2050 - 35 trains per day.

Bays not currently carrying live tracks:

- Date bridge built to 1959 - 25 trains per day (50 trains per day for center girders of multi-bay bridges);
- 1959 to 1997 - no trains on these tracks;
- 1997 to 2000 - 10 trains per day; and
- 2000 to 2050 - 35 trains per day.

Members shall initially be rated for fatigue to the year 2000. The members that rate for fatigue to the year 2000 will be subsequently rated for fatigue to the year 2050.

#### 8.4.1.6 Rehabilitation

All bridges (steel, concrete and timber) will be reviewed to determine the work required to upgrade and improve bridges and to repair or replace deteriorated or substandard bridge elements. Repairs and improvements can include some of the following:

- Cleaning and graffiti removal;
- Painting of members;
- Repair or replacement of rusted and/or deteriorated structural elements;
- Concrete patching;
- Masonry pointing;
- Repairs to damaged or undermined substructure elements;
- Repairs to damaged bearings;
- Consider access restrictive fencing and anti-missile fencing when appropriate;
- Provide approach slabs for all open-deck bridges;
- Add permanent bridge markers; and
- Strengthening of members.

#### 8.4.1.7 Minimum Capacity

Bridges with Cooper E ratings below E72 are to be upgraded. Components of these bridges rated below E72 (including fatigue considerations) will be replaced or rehabilitated to E80 design capacity in accordance with AREMA design criteria including fatigue considerations.

## 8.4.2 Highway Bridges

### 8.4.2.1 General

All work performed on existing highway bridges will be in accordance with the Massachusetts Highway Department Bridge Manual Parts I, II, and III.

## 8.4.3 Culverts

### 8.4.3.1 General

All culverts will be reviewed to determine structural adequacy. Replacement or repairs will be specified where necessary.

## 8.4.3 Other Structures

### 8.4.3.1 General

All structures which are to remain over or adjacent to proposed structures will be investigated to determine the requirements for protection and temporary or permanent support and underpinning.

## 8.4.3 Stability for Bridge Substructures and Retaining Walls

### 8.4.2.4 General

- Substructures of bridges and retaining walls subject to highway or pedestrian traffic will be in accordance with AASHTO LRFD Specifications Section 11.

  The passive resistance of the earth in front of wall will be neglected in determining wall stability, but its weight will be considered in computing soil pressure.

  Allowable bearing pressures and soil properties will be as per geotechnical recommendations.

- Substructures of railroad bridges and retaining wall subjected to railroad traffic or within railroad right-of-way.

  The service loads will be used for the evaluation of the foundation bearing pressure and structure stability in accordance with AREMA Chapter 8, Section 5.4.

The resultant force on the base of the wall or abutment will fall within the middle third if the structure is founded on soil, and within the middle half if founded on rock, masonry or piles. The resultant force on any horizontal section above the base of a solid gravity wall will intersect this section within its middle half. If these requirements are not satisfied, safety against overturning will be investigated.

The factor of safety for overturning will be at least 2.0.

The factor of safety against sliding will be at least 1.5.

The factors of safety against overturning and sliding failure under seismic loading shall be at least 1.2 and 1.1, respectively.

The passive resistance of the earth in front of wall will be neglected in determining wall stability, but its weight will be considered in computing soil pressure.

Allowable bearing pressures and soil properties will be as per geotechnical recommendations.

## 8.5 Temporary Structures

### 8.5.1 General

The construction contractor will be responsible for the design of temporary structures. The engineer will develop and include in the contract documents performance criteria for the design of these structures. Design and use of temporary structures will be subject to approval of the engineer. The following sections will form the basis on which these criteria will be established.

#### 8.5.1.1 Excavation Retaining Structures

##### Loading Conditions

Earth-retaining structures will be analyzed for the various conditions that may occur during the life of the structure, such as the several stages of excavation, construction, installation, and removal and relocation of streets.

##### Unequal Loading

Where the loading conditions on opposite sides of an excavation are not equal, the stability of the temporary retaining structure will be analyzed to take this condition into account.

##### Soldier Pile and Lagging Wall/Sheet Pile Wall

Soldier pile wall with timber lagging or steel sheet pile wall could be considered for temporary support of excavation. Other wall types, including secant pile walls, could also be used for temporary support of excavation. Wall type and final design shall be determined by the contractor.

#### Wales and Struts

The loads in wales and struts or tie backs for flexible or rigid wall systems shall be computed by assuming the wall to be hinged at a support point below the bottom of the excavation and at each strut except the top one. Subject to review by the coordinating consultant, section designers will specify the strut preload or tieback proof load for the proposed system.

#### Connections

All compression member connections, in addition to being designed for their compression loads, will be designed for tension and shear equal to a minimum of 10 percent of the compressive load, unless actual tension and shear loads are greater.

Bracing with tiebacks, if needed, will be designed in accordance with FHWA GEC No. 4 - Ground Anchors and Anchored Systems.

#### Deflections

Suitable criteria will be developed to limit deflection of temporary structures.

#### Stability for Temporary Support of Excavation Structures

The minimum factor of safety (FOS) for the temporary support of excavation wall global stability will be 1.3.

### 8.5.1.2 Design Loading Combinations and Allowable Stresses

#### Deck Structures

Vertical loading will consist of DL + LL + I + E + H at 100% of the allowable stress or DL +L + I + E + H + LF + W at 125 percent of the allowable stress, whichever is greater.

The value of LL is the maximum total live load obtained by considering the various live loads that might exist at one time. Basic Loading (LL): AASHTO HS 20-44. Operating loads from construction equipment (LL) will include not less than 50 percent impact.

Sidewalks and pedestrian islands will be designed for 250 psf or vehicular loads where applicable or likely.

Wind loads (W): 20 psf on exposed area of vehicles and equipment, but not less than 100 psf on deck structure applied normal to the direction in which the length is measured.

Lateral earth (E) and hydrostatic (H) pressures same as defined for retaining structures.

## Excavation Retaining Structures

***Wall systems***. Elements in contact with earth, except lagging, will be designed for all superimposed dead loads and live loads, excluding impact on deck structures.

Lateral loads from earth pressure due to weight of soil and surcharge (E), hydrostatic pressure (H), and axial loads from end bulkheads (E&H) will be considered if critical.

Loadings will consist of: DL + LL + E + H at 100 percent of the allowable stress.

***Bracing Systems***. Main members carrying direct loads, including struts and wales will be designed for simple beam reactions from wall systems for E & H and for axial loads from end walls.

Loadings shall consist of: DL + LL + E + H at 100 percent of the allowable stress.

Secondary bracing carrying an axial load will be designed with a KL/R ratio no greater than 140.

# 9

# Streets and Highways

## 9.1 Design References

All work will conform to the latest codes and standards listed below, including interims, as of the Notice to Proceed (NTP) date of the portion of the project under consideration (Note: in November 2009, MHD became MassDOT Highway Division with many of its design documents still carrying the "MHD" label):

- AASHTO, *A Policy on the Geometric Design of Highways and Streets, 6th Edition,* 2011. ("Green Book");
- AASHTO, *Guide for the Development of Bicycle Facilities*, 4th Edition, 2012;
- AASHTO, *Roadside Design Guide*, 4th Edition, 2011;
- MHD, *Project Design and Development Guide*, January 2006. ("MHD Guide");
- MHD, *Standard Specifications for Highways and Bridges* (as amended), 1988. ("Standard Specifications");
- MHD, *Supplemental Specifications to the 1988 Standard Specifications for Highways and Bridges,* June 2012. ("Supplemental Specifications");
- MassDOT, *Construction Standard Details*, 2014. ("Standard Details");
- *MassDOT Right of Way Manual*, 2012;
- MHD, *Standard Drawings for Traffic Signals and Highway Lighting*, 1968;
- FHA, *Manual on Uniform Traffic Control Devices*, 2009 Edition w/ Rev. 1 & 2 dated 2012. ("MUTCD");
- *MassDOT, Massachusetts Amendments to the 2009 Manual on Uniform Traffic Control Devices and the Standard Municipal Traffic Code*, 2012;

- TRB, *Highway Capacity Manual 2010 Edition*, 2010. ("HCM");
- MBTA Railroad Operations, "Book of Standard Plans – Track and Roadway" April 29, 1996;
- The American Railway Engineering and Maintenance of Way Association (AREMA), 2014 Manual for Railway Engineering and "Portfolio of Trackwork Plans";
- City and town design standards; and
- Applicable federal, state, and local statutes.

## 9.2 General

Standards in this chapter pertain to new street and intersection construction, as well as reconstruction of existing streets and intersections where required. New roadway construction associated with this project will primarily involve station driveway access to local streets. Some reconstruction of streets may be required for other work elements, such as improved grade crossings and new grade separations.

All designs shall conform to AASHTO, MassDOT, and local standards. MHD's *Project Design and Development Guide* ("MHD Guide") shall be the primary reference for the design of highways. Where additional guidance is required beyond that provided by the MHD Guide, AASHTO's *A Policy on the Design of Highways and Streets* ("Green Book") shall be used. If local municipal standards require more conservative design assumptions, for example wider lanes, the municipal standard shall govern.

### 9.2.1 Area Type

The design of highways should be context-sensitive to the type of area the roadway passes through and serves. The MHD Guide provides the definitions of area types to be used in the development of highway designs. The area types are:

- <u>Rural</u>—Generally undeveloped or sparsely settled with development at low densities along a small number of roadways or clustered in small villages.
- <u>Natural</u>—Forests, farm land, and other open space.
- <u>Village</u>—Isolated built-up area with storefronts, civic uses, and residential.
- <u>Developed</u>—Low density residential or occasional commercial uses.
- <u>Suburban</u>—Transitional areas between densely developed cities and rural areas.
- <u>Low Density</u>—Low to moderate density residential development and isolated commercial properties.
- <u>Village/Town Center</u>—Built-up area of commercial and residential uses, usually with a uniform setback.

- High Density—Residential development mixed with intensive commercial development such as commercial strips and malls.
- Urban—The core of a metropolitan area, including the central business district, and high density residential and commercial development.
- Residential—Dense multifamily developments with uniform setback and common scale.
- Central Business District—Dense commercial and mixed-use development at the urban core.

For more detailed descriptions of the area types, see Chapter 3 of the MHD Guide.

## 9.2.2 Classification

The design of highways must respect the function of the roadway. The MHD Guide provides the definitions of roadway types to be used in the development of highway designs. The classifications are:

- Freeways—Limited-access roadways that serve interstate and regional travel.
- Major Arterials—Roadways that service statewide travel as well as major traffic movements within urban areas or between suburban town centers.
- Minor Arterials—Roadways that link cities and towns in rural areas and interconnect major arterials within an urban area.
- Major Collectors—Roadways that link arterials and provide connections between cities and towns.
- Minor Collectors—Roadways that connect local roads to major collectors and arterials.
- Local Roads and Streets—Roadways that serve local circulation and access and are not intended for regional connectivity.

For more detailed descriptions of the roadway types, see Chapter 3 of the MHD Guide.

## 9.2.3 Pavement Design and Materials

### 9.2.3.1 Roadway Pavements

Roadway surfaces will be hot mix asphalt as specified by the Standard Specifications and Supplemental Specifications. The thickness of the pavement section will meet the requirements found in Chapter 9 of the MHD Guide or local standards, whichever is thicker.

Roadway base and sub-base materials, such as gravel borrow, dense grade crushed stone, ordinary borrow, special borrow, and loam borrow, will conform to the Standard Specifications and Supplemental Specifications.

### 9.2.3.2 Curbing

All curbing, edging, and berms will conform to the Standard Specifications, Supplemental Specifications, Standard Details, and Supplemental Drawings:

- Vertical granite curbing will be utilized in parking areas and in areas with sidewalks.
- Sloped granite edging will be utilized along driveways except where sidewalks or fixed structures exist adjacent to the roadway, in which case vertical curbing will be used.
- Hot mix asphalt berm will be utilized in areas with closed drainage systems and in areas without sidewalks.

### 9.2.3.3 Cross Section

The cross section of roadways will be designed as follows:

- Lane width will be based on roadway and area type, governed by Exhibit 5-14 of the MHD Guide.
- Shoulder width will be based on roadway and area type, governed by Exhibit 5-12 of the MHD Guide.
- Travel lane cross slope will be 2 percent, except in areas of superelevation.
- Superelevation will be used where required to achieve the desired horizontal radius. Every effort should be made to avoid superelevation on local streets and in urban areas. Collectors and local streets shall be designed to low-speed roadway design criteria to achieve this goal. Superelevation rate, runoff length, and runout length will be in accordance with Chapter 4 of the MHD Guide. The maximum rate of superelevation shall be 6 percent.
- To provide for better drainage in areas where shoulders are at least 8 feet wide, the cross slope of the shoulder may be increased to maximum 6 percent.
- Sidewalk width will be a minimum of 5 feet, exclusive of curb. If necessary to pass occasional spot obstructions, absolute minimum sidewalk width may be 42", exclusive of curb. In areas of high pedestrian traffic, wider sidewalks will be used; see Chapter 5 of the MHD Guide.Wheelchair ramps provided to conform to the accessibility requirements of the ADA and AAB. Ramps will conform to the Standard Details and Supplemental Drawings.
- Where local standards require wider lanes or sidewalks, the wider width will govern.
- Where existing facilities have a consistent cross section greater than required by the design standards, the proposed section will match the existing cross section for roadway consistency.
- Unless site conditions restrict the design, sidewalks will be provided on both sides. Sidewalks will be provided on at least one side of all roadways.

#### 9.2.3.3 Design Speed

The design speeds will be based on roadway and area type, governed by Exhibit 3-7 of the MHD Guide. In all cases of roadway reconstruction, the design speed will be consistent with the design speed of the abutting roadway segments.

Stopping sight and decision sight distances will be consistent with the Green Book.

#### 9.2.3.4 Horizontal Alignment

The horizontal alignment of roadways will be designed as follows:

- Horizontal curves will be simple circular curves without transition spirals.
- The minimum radius of horizontal curvature will be in accordance with Chapter 4 of the MHD Guide.
- Superelevation transition lengths (runoff and runout) will be in accordance with Chapter 4 of the MHD Guide.

#### 9.2.3.5 Vertical Alignment

The vertical alignment of roadways will be designed as follows:

- The **minimum allowable grade** will be 0.50 percent to provide adequate drainage. The maximum allowable grade will be determined by Exhibit 4-21 of the MHD Guide. Grades will be consistent with abutting roadway sections to the extent possible.
- Vertical curves will be symmetric parabolic vertical curves.
- The lengths of crest and sag curves will be determined by Exhibit 4-26 and Exhibit 4-27, respectively, of the MHD Guide.

#### 9.2.3.6 Vertical Clearances

Minimum vertical clearance will be 15’-6” for automobile and conventional transit buses. On collectors and local streets, vertical clearance of 14’-6” may be used with the consent of MHD and the municipality.

### 9.2.4 Capacity

#### 9.2.4.1 Arterial Streets

New or reconstructed arterial streets shall be designed to permit operation at an acceptable level of service given Design Year (2016) traffic demand projections and area characteristics. This will mean achieving a level-of-service (LOS) C or above where possible but a minimum LOS E where environmental and other constraints prevent attainment of LOS C. Levels of service will be as defined in the HCM and will be estimated using the HCM procedures for arterial streets.

#### 9.2.4.2 Collector and Local Streets

Collector and local street capacity shall be determined based on the capacity of nearby intersections and using the procedures of the HCM.

#### 9.2.4.3 Intersections

Newly created intersections, including station driveway intersections, will be designed to permit operation at an acceptable level of service under Design Year (2016) traffic conditions, i.e., LOS C where feasible, with a minimum LOS E in locations where environmental constraints and/or pre-existing traffic levels preclude attainment of LOS C.

Where new intersection locations meet MUTCD warrants for traffic signals, signalization shall be considered.

#### 9.2.4.4 Curb Cuts/Driveways

Driveways providing station access will be situated as far away from existing intersections as is practicable, but a minimum distance of 100 feet will be used for local streets.

Where feasible, two-way station driveways will be designed with two striped exiting lanes and at least one separate entering lane. One-way station entrance or exit driveways shall have a minimum of two lanes. Exit driveways from stations will be clear of parking bays and circulation aisles. Where feasible, exit driveways will have sufficient length to store the median (50th percentile) vehicle queue during the peak exiting hour, but will, as a minimum, be long enough to store two queued automobiles.

Station driveway grades will be the minimum feasible, depending on site constraints, with a maximum permitted grade of 10 percent for short driveway distances. Immediate driveway approaches to intersecting streets will have grades of 2 percent or less for a minimum distance of 40 feet.

### 9.2.5 Traffic Control Devices

#### 9.2.5.1 Signals

Traffic signals shall be designed and installed in accordance with MUTCD, Standard Specifications, Supplemental Specifications, and Standard Drawings for Traffic Signals and Highway Lighting. Traffic signal actuation shall be determined by traffic demand and local conditions and requirements, but in general, signals located at station entrance/exits shall be at least semi-actuated.

#### 9.2.5.2 Signs

Street name, regulatory, warning, and other signs shall be designed in accordance with MUTCD and MassDOT Highway Division standards. Where local guidelines prevail in preference to MUTCD and/or MassDOT Highway Division standards, the local standard shall be used.

Station identification signs shall be designed and located in conformance with the MBTA Commuter Rail Design Standards Manual for Stations & Parking. (Also refer to Chapter 10, “Stations & Parking,” of this manual.) Station signs at station entrances shall be placed with adequate height and setback from the street so as not to obscure sight distance for vehicles exiting stations.

#### 9.2.5.3 Pavement Markings

Pavement marking layout and design shall be in conformance with the MUTCD and MassDOT Highway Division standards. Where local standards prevail in preference to MUTCD and/or MHD standards, the local standard shall be used.

All crosswalk and lane striping shall be of thermoplastic material. Stop lines, directional arrows, gore markings, and street lettering shall be reflectorized white paint.

### 9.2.6 Pedestrian Crosswalks and Overpasses

The location of pedestrian crosswalks near station entrances will be based on projected pedestrian and traffic volumes; access street speeds; widths and curvature; and neighborhood character. Crosswalks at station entrances will be located close to station driveways. Warning signs will be installed in advance of crosswalk locations; adequate visibility to cross walks will be provided by on-street parking prohibitions close to crosswalks.

Where conditions warrant installation of pedestrian-actuated traffic signals, these will conform in design and location to MUTCD standards for pedestrian signal indications.

Crosswalks will have access from sidewalks. Wheelchair ramps will be designed as described in section 9.2.3.3 of this document.

Grade-separated pedestrian street crossings will only be provided as a final option in areas where pedestrian demand and traffic flow cannot be jointly accommodated by crosswalks. Any such crossings will be pedestrian overpasses rather than underpasses. The width of pedestrian overpasses will be determined on the basis of volume of pedestrian traffic. Minimum width of walkway will be 8 feet.

### 9.2.7 Grade Crossings

All railroad highway grade crossings will be upgraded to conform to federal, state, and local design and safety criteria.

Per the NCDOT Roadway Design Manual Ch. 7: Railroads, all Median Separations at Highway/ Railway At-Grade Crossings will conform with this chapter unless exceptions are approved by MBTA Safety and Railroad Operations. Special attention to be paid to the "Notes" section in this chapter where specifications are made for median length and width, travel lane width, reflective markers, etc. Additionally, planters may be used in lieu of concrete or reflective markers within the median where such substitution is approved by MBTA Safety and Railroad Operations. Any and all conflicts between this manual and the MUTCD or MassDOT Highway standards will be evaluated for the proper applicability, operation, and maximum risk reduction on the MBTA railroad system. The NCDOT Roadway Design Manual Ch. 7: Railroads is available in Appendix A.

Automatic Highway Crossing Warning Systems (AHCW) will be installed at all public grade crossings. The AHCWs will meet the requirements of the AREMA Signal and Communications Manual and the MUTCD.

The highway approaches will conform to AASHTO site distance requirements given highway vehicle design speeds. If it is otherwise impractical to conform to AASHTO sight distance criteria utilizing a post mounted flashing signal and typical advance signing, a cantilever mounted flashing signals and/or additional advance warning signs will be utilized.

Geometric roadway improvements and vegetative clearing will be considered at grade crossings to improve sight distance and provide a safer roadway facility. Geometric improvements will conform to the previously described highway design standards.

Traffic studies will be performed at high volume grade crossings with nearby traffic signals to determine if signal pre-emption is necessary. Where pre-emption is used at or near a crossing, pre-emption sequencing will be consistent with the Institute of Transportation Engineers' Recommended Practice entitled "Pre-emption of Traffic Signals at or Near Railroad Grade Crossings" (2006).

Full-depth rubber crossing surfaces will be used at all arterial public roadway crossings. Asphalt and rubber rail seal type surfaces will be used at collector, local, and private crossings where approved by the MBTA.

Provisions for pedestrian protection will be installed at crossings to upgrade existing features or where there are high pedestrian volumes. Provisions will include sidewalk and pedestrian gates.

# 10

# Stations and Parking

## 10.1 System-wide Aspirations and Guidelines

This chapter contains general architectural, engineering, and urban design criteria for the MBTA SCR project. These criteria govern the design of the platforms and canopies, site circulation, parking layout, landscaping, and connectivity to the neighborhoods adjacent to the stations. Discussion of sustainability, resiliency, accessibility, materials and maintenance, level of service (LOS) determination, and egress are intended to ensure an efficient design of passenger circulation and safety while providing aspirational guidance for the system as a whole. With that in mind, this section is intended to add clarity to the project goals and design intent.

### 10.1.1 General

The SCR project presents opportunities to approach parking and station area development in a holistic manner. The commuter rail stations will both contribute to the context of the neighborhood and its community and promote the identity of the MBTA commuter rail system. Key concepts toward this objective are stations that provide universal accessibility; are forward-thinking in terms of sustainability and resiliency; and seek to achieve maximum efficiency while being durable with low maintenance requirements. To that end, the following criteria have been established to facilitate the anticipated transit-oriented development (TOD), while providing adequate parking and promoting the maximum number of riders at the onset of service.

The design will approach each station site as a unique design opportunity that optimizes development, multimodal access, and parking potential, while promoting the identity of the MBTA across the SCR. Architectural design will aim to be lasting and enduring, as well as enjoyable, pleasant, and functional to all people. The design will provide safe and convenient access to and from the station by all modes of transportation, as well as adequate and equitable parking options that respect community character.

The design will anticipate future economic and housing development in a one-mile radius around stations as described in the South Coast Rail Economic Development and Land Use Corridor Plan[1]. There will be focus on land use and development within a half-mile of stations. Detailed station-area plans will be developed in close collaboration with property owners and the private sector[2]. Sustainability and resiliency criteria that promote a healthier environment in the future will be established.

### 10.1.2 Accessibility

A core facet of the MBTA is the development of a global benchmark for public transportation[3]. A fundamental component of that goal is system-wide equitable access to all people, regardless of abilities. Therefore, stations will be designed to employ the accessible design standards of the project, as referenced in section 10.1.8 of this document, to achieve seamless access from curb to commuter vehicle.

Stairs and ramps must complement each other because ramps alone do not meet everyone's access needs. Therefore, both stairs and ramps will be provided at all stations.[4]

Elevators are to be used at all center island stations.

Each section of this chapter addresses specific requirements as necessary.

### 10.1.3 Safety and Security

When designing for safety and security circulation through the site and onto the platform; location of platform and landscape elements; use of lighting; and maintaining visually connectivity between various areas on station sites will be considered

The principles of Crime Prevention Through Environmental Design (CPTED) will be applied to all furnishings and amenities.

Closed-circuit television cameras (CCTVs) are to be used as a means of maintaining surveillance over station areas from monitors in a central control facility. CCTVs will, at a minimum, cover the platform, stairs and ramps, underpasses, and transition plaza. Camera locations will be coordinated with locations of other station equipment such as lighting, public address system, and signage. The cameras will be visible to the public but not easily accessed. Focal areas of cameras will be well illuminated.

[1] South Coast Rail Economic Development and Land Use Corridor Plan, p.37
[2] South Coast Rail Economic Development and Land Use Corridor Plan, p.99
[3] http://www.mbta.com/riding_the_t/accessible_services/default.asp?id=16901
[4] MBTA Guide to Access, p.166

### 10.1.4 Sustainability and Resiliency

The SCR project presents a unique opportunity to implement many initiatives oriented toward sustainable and resilient development that protects the health of the environment and the assets of the MBTA while also promoting the well-being of citizens. From considering the carbon footprint of the station itself to the connections made with the immediate neighborhood, both current and anticipated, establishing forward-thinking sustainability criteria for SCR will help ensure the resiliency of the system and support a sustainable future for the entire region. Design criteria for the station sites will therefore include considering sustainable design principles and high performance design capabilities from the early conceptual stages of the design process.

Resiliency can be thought of as a system's ability to recover from an acute extreme weather event (i.e. storm surge or flooding event) or to anticipate and respond to future climate condition scenarios (i.e. increasing temperatures, sea level rise, or changing precipitation patterns). Key dimensions of providing a resilient system will be a design that responds to flooding and extreme heat events, shows adaptive capacity, and balances climate concerns with economic realities of the project[5]. There are many opportunities to build resiliency into the commuter rail system and designers should consult the MBTA *Design for the Environment* document for areas of elevated concern and possible mitigation solutions.

The *GreenDOT Implementation Plan, South Coast Rail Economic Development and Land Use Corridor Plan*, and the MBTA *Design for the Environment Guidance Report* should be referenced in development of sustainability strategies from the earliest conceptual phases of the design process. In accordance with these documents, the SCR project is committed to exploring and employing sustainable technologies in order to reduce greenhouse gas emissions, a number of which are addressed in more detail in each section of this document. A few broad considerations are as follows:

- Solar power will be explored at all stations and implemented where possible. There are many options for incorporating solar energy at rail stations, from small to large scale, including: solar-powered trash and recycling compactors, solar lamps, parking canopy solar PV array, rooftop solar PV array, platform solar PV array, and bridge canopy solar PV array.[6]

- Wind power, including microgeneration, will be explored at all stations and implemented where possible.[7]

- Consideration will be given when locating critical infrastructure in areas prone to flooding or that are susceptible to storm surge, with special consideration given to future climate scenarios for elements with long interval replacement cycles.[8]

[5] MBTA Design for the Environment, Chapters 2.7 and 6
[6] MBTA Design for the Environment, Section 2.5.1
[7] MBTA Design for the Environment, Section 2.5.2
[8] MBTA Design for the Environment, Chapter 6

### 10.1.5 Material Sourcing and Maintenance

This sub-section is intended to provide general material guidelines with an emphasis on sourcing and maintenance. These guidelines should be followed for all station buildings, site amenities, signage, curbing, and external paving.

- All materials will be durable, easily maintained, and well-designed.
- Employ life cycle cost analysis to select finish materials (low maintenance, cost of repair/replacement) while permitting competitive bidding.
- Where possible, specify materials that incorporate recycled content. Post-consumer materials are preferable to pre-consumer materials, but may not be available for all materials. Recycling requirements will be included in particular project specifications.
- Where possible, specify materials that are extracted and manufactured within the region, specifically within a 200-mile radius[9].
- Where possible, reduce the use and depletion of finite raw materials and long-cycle renewable materials by replacing them with rapidly renewable materials.
- Where wood is proposed in the construction of the station elements, specify Forest Stewardship Council (FSC) Certified Wood.
- Reduce the heat island effect at each station by utilizing high-reflectance (high-albedo) materials for hardscape. These materials will have a Solar Reflective Index (SRI) of at least 29. SRI is a measure of the constructed surface's ability to reflect solar heat as shown by temperature rise.
- Consider the quality of appearance and the compatibility with other materials on site, as well as durability and resistance to vandalism.
- Select materials considering passenger safety under different weather conditions.
- Reuse or repurpose existing on-site materials whenever feasible.

### 10.1.6 Waste Management and Recycling

During demolition of existing buildings and infrastructure on the proposed station site, divert debris from disposal in landfills and incinerators. Consider materials that can be recycled, reused, or donated, including concrete, stone, brick, metal, plastics, and wood.

[9] GreenDOT, p.46

**Environmental Controls**

An Erosion and Sediment Control Plan will be created for the project, employing strategies such as temporary and permanent seeding, mulching, silt fencing, and sediment traps to reduce pollution from construction activities.

Additional methods will be considered to control air pollution of dust and particulate matter during construction.

### 10.1.7 Preservation of Site Elements

Opportunities to preserve significant site elements will be explored. Wherever possible, these elements should be repurposed to preserve cultural history and natural features.

### 10.1.8 Reference Codes, Standards, and Guidelines

The following codes and standards will be adopted and used for quality assurance as well as conformity to local statutes. The specific contents of these codes and standards will not be addressed in this document; refer to current applicable documents as necessary.

General:

- MBTA Guidelines and Standards;
- MBTA Standard Contract Specifications;
- MBTA Commuter Rail Design Standards (CRDS);
- MBTA Design Lighting Levels and Fixtures Directive, October 1, 2015;
- APTA Guidelines (American Public Transportation Association);
- Transit Capacity and Quality of Service Manual, TCRP Report 100, Transportation Research Board;
- Pedestrian Planning and Design, Dr. John Fruin, Second Edition 1987;
- Association for American Railroads (ARR); and
- AASHTO A Policy on Geometric Design of Highways and Streets 2011, Sixth Edition.

Life Safety:

- Massachusetts State Building Code 780 CMR, Eight Edition;
- Massachusetts State Elevator Code 524 CMR;
- NFPA 101 Life Safety Code; and

- NFPA 130 Standard for Fixed Guideway Transit Systems.

Accessibility:

- Massachusetts Architectural Access Board 521 CMR (MAAB);
- MBTA Guide to Access;
- ADA and ABA Accessibility Guidelines for Buildings and Facilities;
- Boston Center for Independent Living Agreement (BCIL);
- Public Rights-of-Way Access Advisory Committee (PROWAAC); and
- FTA Accessibility Handbook for Transit Facilitates.

Sustainability / Resiliency:

- MassDOT: GreenDOT Implementation Plan; and
- MBTA: South Coast Rail Design for the Environment Guidance Report.

Economic Development:

- South Coast Rail Economic Development and Land Use Corridor Plan; and
- City/Town Master Plans.

### 10.1.8.1 Emergency Exiting

Exit requirements under emergency conditions include evacuation of a train after it arrives in the station, crisis conditions, or other passenger threatening situations on the platform. The station configurations that are susceptible to evacuation calculations are those without at-grade unconstrained connections to a point of safety:

- Center platform stations with dual track sides; and
- Side platform stations which are grade-separated from the curb-side drop off lane/sidewalk with stairs/ramp.

The emergency egress code in effect for the MBTA transit system is NFPA-130.

### 10.1.8.2 Transit Capacity

The Transit Capacity and Quality of Service Manual (published as TCRP-100 by TRB) establishes pedestrian LOS standards for stations. The desirable LOS to be used is related to the acceptable density of passengers either waiting or in motion in the station. By establishing quantitative criteria for this density, the team can arrive at an acceptable station design. A thorough analysis of the LOS concepts involves understanding of how people move in the station between headways.

Maximum demand is set at the peak hour boardings set by the ridership forecast in plan year 2035. By use of scheduled headways and spatial formulas found throughout the TCRP-100 document, the project establishes spatial requirements for the fundamental elements of station circulation (platform width, stairs, and ramps).

In accordance with TCRP-100, transit platforms should be designed at LOS "C" to "D" or better. For the remaining part of the station, it is acceptable for stairs and ramps to operate at LOS "D."

## 10.2 Station Design

### 10.2.1 General

Commuter rail station architecture will contribute to the context of the neighborhood and community, both current and anticipated, while promoting the identity of SCR. The architectural design will aim to be lasting and enduring, as well as enjoyable, pleasant, and functional to all people.

Issues of safety, security, and accessibility that are associated with public circulation elements such as walking surfaces, curbs, ramps, stairs, handrails, and stair treads will be addressed during the design of the stations.

### 10.2.2 Comfort and Convenience

A commuter rail station stands as a link between the neighborhood and the train system and enables citizens to connect with towns, cities, and the broader region. It represents both its function as a connecting part of a larger transit system and its relationship with its environment. It should be clear to passers-by that the structures are part of a larger system which enables them access to the region. The design of the station should be an asset to the community and enhance its environment. Furthermore, the design should provide user comfort, safety, and shelter, and afford access to all, including those persons with disabilities.

The stations along the SCR are assumed to be unmanned. If station specific planning leads to design of manned stations, current MBTA Design Guidelines for light rail should be referenced.

Some design consideration for enhancing customer comfort and convenience are:

- Efficiency and clarity of circulation:
  - Provide vertical and horizontal circulation elements to meet passenger demands;
  - Provide adequate queuing areas at all stairs and ramps;

- Provide an easily comprehendible hierarchy of decision points that promote intuitive circulation routes and enhances clarity of circulation;
- Provide the most direct possible route to the platform; and
- Under all circumstance, however, all circulation must be in conformance with all egress, ADA and SWA requirements and must be rigorously held to applicable dimensions.

- Seating:
  - Benches will meet the latest MBTA standards and be fully accessible to those with disabilities.
  - Benches in station areas will be anchored to paving, protected from the elements, and located no greater than 200 feet apart. This requirement also holds on ramps.
  - Benches will be sloped and slated for drainage with minimal vertical supports to minimize potential for litter collection beneath the seating.
  - At least half the benches will have a high back and armrests to provide aid to those with limited strength and mobility and to provide comfort.
  - Seating material should be durable and vandal-resistant. (Wood seating material will have a minimum nominal thickness of 2 inches to prevent easy breaking by vandals.)
  - Benches along platform will include windscreens with MBTA-approved graphics.
  - Integrate benches with signage and canopy structure where possible to minimize platform area disruption.

- Trash Receptacles:
  - Trash receptacles will meet latest MBTA standards. Blast/explosion-proof criteria to be developed.
  - Trash receptacles will be located outside, but adjacent to, paths of travel, be easily accessible for maintenance, and be vandal proof.
  - Provide a minimum of one trash receptacle per platform; however, additional receptacles should be provided to prevent overflow between trash removals.
  - Where applicable, solar powered trash compactors will be used.

- Recycling receptacles will be provided at an easily accessible area that serves the entire platform and are dedicated to the collection and storage of non-hazardous materials for recycling including paper, corrugated cardboard, glass, plastics, and metals. Blast/explosion-proof criteria to be developed.

- Snow covered pavement can be hazardous in the winter. Some considerations for locations and design of on-site storage of snow and general maintenance equipment and supplies include:
  - Side Platform Stations – Stations must have at least one sand storage bin per platform. Bins should be located in the vicinity of the platform; in an area not used by passengers; and away from entrances and boarding areas.
  - Center Island Platform Stations – A minimum of two bins should be located at Center Island stations, one on the platform and one in the vicinity of the Transition Plaza. Storage bins should be incorporated into the structure where feasible. (i.e. under stairs or benches,

or into a bench design, for instance.) Bins should be located outside of an accessible route, but easily accessed by MBTA maintenance personnel. Size: TBD

- Historic information panels, which can include maps, points of interest, depictions of historically relevant event, or highlights of important ecological features, should be considered for each station. Considerations for the panels include:
  - MBTA graphic design group will be consulted in the selection of images.
  - There will be no obstructions in front of the panels to block the view of persons in wheelchairs, or the visually impaired.
  - Panels will be mounted at a height that is visible from all eye levels.
  - Braille should be incorporated for the blind.
  - Historic information panels are not the same thing as integral art. Refer to Section 10.2.9 for requirements for integral art.

- P.A. System:
  - P.A. systems will be installed at all stations, with announcements coming from either Tower "A" or the South Station Trainmasters office.
  - Wherever there is an auditory announcement system in use at stations, a visual announcement system will be provided for passengers with hearing impairments.[10]

## 10.2.3 Platform Elements

The station geometry will address the dimensional criteria concerning station needs (trains, patrons, entry, etc.) to accommodate all users. Criteria have been established as a basis for defining station physical characteristics:

### 10.2.3.1 High Level Platform Design

The design of the station platforms will support two functions: (a) queuing areas for passengers waiting to board the train and (b) circulation area for departing and arriving passengers. All new stations will be of the high level platform type. Some design considerations for high level platforms are as follows:

- Location:
  - Platforms will be located on an accessible route and as close as possible to accessible parking spaces. When station site conditions prevent accessible parking spaces within 200 feet of an accessible platform entrance, the platforms must be located within 100 feet from the passenger drop-off area.

[10] 521 CMR, Section 18.11

- The track-side edge of the platform will be located 5 feet, 7 inches from the centerline of the track. This dimension is to be measured from the track centerline to the track-side face of the rub rail.

- A minimum of two remote means of egress must be provided at each station platform.[11]
  - Maximum travel distance of 325 feet permitted on the platform to the point at which the egress route leaves the platform.[12]
  - Maximum common path of travel will be 82 feet or the length of one train car.[13]
  - Common path of travel shall not be less than 75 feet, unless an intermediate egress point, establishing 3 or more egress points total is included (except at Easton Village Station – see below).

- Platform length will be 800 feet, except in Easton Village where it will be 750'.

- Platform width will be determined by Equation 1:

  W=P*(7.0SF/p + 0.5 SF/p)/800 + 4.0 FT + 3.5 FT (Equation 1)

  Where:

  P = Boarding passengers in peak AM inbound train ridership
  7.0 SF/p = Platform LOS of "C"
  0.5 SF/p = Equivalent amenity waiting area per waiting passenger
  800 = Platform length in feet
  4.0 feet = Accessible circulation zone for side platforms (increase to 6.0 feet for center island platforms)
  3.5 feet = Tactile strip and warning strip (24 inches and 18 inches respectively)

  - Minimum platform width at center platform stations: 26-feet, 6-inches (including the 3 inch rub rail on each side). Refer to Typical Section Detail ******.
  - Minimum platform width at side platform stations: 12-feet.
  - Platforms must maintain a minimum clear width of 60 inches in all cases, with 6 feet preferred, excluding the tactile warning strip.[14]
  - Platform widths may taper at ends to not less than 22 feet where platforms are located along curved track alignments, or where tapering is required to minimize direct environmental resource area impacts, provided minimum clear widths are maintained.

- Platform height will be 4 feet above top of rail.

[11] NFPA 130, Section 5.5.3
[12] NFPA 130, Section 5.5.6.1.1
[13] NFPA 130, Section 5.5.1.4
[14] 521 CMR 18.5.1

- Material is to be developed.  A slip resistant and glare-free surface will be provided.

- Platform cross slope will not exceed 1.5%, allowing for a 0.5% ± construction tolerance.  At all side platform locations, cross slope shall pitch away from track.  At center-island locations platform shall be crowned along longitudinal centerline, draining to the track.

- A continuous 24-inch detectable warning strip will be provided at the edge of the platform.  The material of the warning strip will contrast visually with adjoining material and be an integral part of the walking surface.

- A continuous 3-inch nominal rubbing strip will be provided at the track edge of platform.

- Platform guardrails will be located on side platform stations on the back face of the platform; under ramps to a height of 80 inches; at drops in elevation of 2 feet; and where freight tracks are located behind the platform freight tracks are located behind the platform freight tracks are located behind the platform.
  - Guardrails will have a height of 3 feet, 6 inches with maximum 4 inch gaps.
  - Railing material is to be developed. Galvanized steel alone will not be used.

### 10.2.3.2 Reconstructed Platforms

There are different accessibility requirements for reconstructed stations than for new stations. However, although Canton Center Station and Stoughton Station are to be reconstructed, the stations will be considered to be new construction and will comply with all accessibility requirements of a new station.

### 10.2.3.3 Grade-Separated Track Crossings for Pedestrian

- Pedestrian Overpass:
  - Pedestrian overpasses are preferred to underpasses.
  - The overpass will be minimum 10 feet wide and minimum 18 feet, 3 inches from top of rail to underside of overpass.
  - The overpass on the platform side will lead directly to a stair and a ramp complying with accessible design project standards.
  - Materials are to be developed. Galvanized steel alone will not be used.
  - The overpass bridge structure will be a steel frame. Finish is to be determined
  - Pedestrian overpasses must be illuminated.

- Pedestrian Underpass

  - Pedestrian underpasses will be preferred when the track is on a raised embankment.
  - Underpasses will be a minimum of 12 feet wide and 9 feet high at the midpoint of the ceiling.

- Underpasses must conform to rules and regulations governing accessibility.
- Underpasses must be as open as possible and well illuminated for security and the appearance of security for users.
- Materials are to be developed. Materials appropriate to the area are important for visual integration with the surrounding community. Materials must be weather and vandal-resistant.
- Refer to Section 10.1.3 for safety and security requirements.

#### 10.2.3.4 Emergency Grade Track Crossings for Pedestrian

At-grade crossings will not be permitted under any circumstances.

#### 10.2.3.5 Ramps

- In all cases, platform stairs ramps conform to all applicable accessibility requirements.
- Where the station design requires level changes, ramps will be designed to meet the accessible design project standards. Ramps will be convenient to passenger drop-off areas and the ends of platforms in center-island stations. Where the site permits, a service ramp with curbs will be provided only for MBTA plows.
- Materials: To be developed
- Minimum ramp width will be 6 feet; 5 feet minimum for service ramps.
- Ramp slope will meet code requirements and the accessible design standards of the project: 8 percent in direction of travel, cross slope will not exceed 1.5%, allowing for a 0.5% ± construction tolerance. Slope for service vehicle ramps is 30 percent maximum.
- The maximum rise for any run shall be 30 inches.
- Benches will be located on ramps at a distance of not more than 200 feet apart and at ramp switchback landings. Benches will be located as to not impede circulation flows.
- Landing lengths will be at least as wide as the ramp
- Landings required at ramp direction change will be 5 feet minimum in length.
- Landings at top and bottom of ramps will be 5 feet minimum with a 2 percent maximum slope.
- Ramps will be slip-resistant and glare-free surface (0.8 minimum static coefficient of friction).
- Minimum run-off to edge of queuing space will be 10 feet.
- Minimum run-off to an obstruction will be 1.7 times the width of the ramp.
- Ramps and landings with drop-offs will have guardrails.
- Handrail materials along ramps will be designed per MBTA Guide to Access and MAAB regulations. Materials will be developed. Galvanized steel alone will not be used.

#### 10.2.3.6 Stairs

Where the station design requires level changes stairs, including treads, risers, handrails, guardrails, and cover, will be designed to meet code requirements and the accessible design project standards. The MBTA Guide to Access requires both stairs and ramps be provided to achieve fair and equitable access.

- In all cases, platform stairs will conform to all applicable accessibility requirements.
- Stairs will be convenient to passenger drop-off areas and as required.
- Materials are to be developed.
- Stairway width will be 5 feet minimum, 6 feet preferred.
- Landings will be every 12 feet of vertical rise. The size of the landing will not reduce the width of the stair in the direction of travel.1
- The rise-tread ratio: 2R + T = 25″ (maximum riser 7 inches and minimum tread 11 inches). Risers and treads will meet all slope and angle requirements.
- Stairs will be slip-resistant and glare-free (minimum static coefficient of friction of 0.6).
- Handrails at stairs will be designed and sized per MBTA Guide to Access and MAAB regulations.
- Railing materials are to be developed. Galvanized steel alone will not be used.
- Railing specification to be per MBTA standards.

#### 10.2.3.7 Elevators

All center island stations (North Easton, Raynham Place, and Taunton Depot) will have a pair of pass-through type elevators at the pedestrian overpass nearest the accessible parking and transit pick-up/drop-off. One will be located at the Transition Plaza, the other on the platform. Design considerations will include:

- Elevators must comply with all applicable codes and standards, including Massachusetts State Building Code, BCIL, ADAAG, and MBTA Elevator Design Standards, among others.
- Maximize transparency into the shaft and cab so passengers are visible from as many directions as possible.
- Locate elevators in prominent, easily visible locations on or adjacent to predominant pedestrian routes and as close as possible to stairs connecting the same levels. Maximize visibility of the entrances and exits when locating elevators.
- Elevators will provide a covered and well-lit area for waiting passengers.
- The cab will be a minimum of 60 inches x80 inches so that the long dimension is perpendicular to the door (BCIL agreement).
- The elevator will be located so that the long dimension is parallel to the platform.
- Queuing of passenger waiting for elevators should not impede flow of passengers.

### 10.2.3.8 Guardrails

Pedestrian guardrails will be designed where required by applicable code and in the following situations:

- A direct vertical drop in excess of 4 feet within 2 feet of walkway, parking area, or roadway;
- Along all open-sided walkways, mezzanines, and landing;
- A vertical drop at the side of a ramp, landing or stair;

Materials are to be developed. Galvanized steel alone will not be used.

Pedestrian guardrail will conform to applicable codes and the following:

- Minimum guardrail height will be 3 feet, 6 inches (vertical from leading edge of tread or top of walking surface).
- Maximum 4-inch diameter opening.
- Railing materials to be developed. Galvanized steel alone will not be used.
- Loading requirements will be per Massachusetts State Building Code.

### 10.2.3.9 Canopies

- Canopy Structure:
  - Vertical canopy supports will be located in the center of the platform on center island platform stations, and toward the back side of the platform on side platform stations. The intent is to minimize the possible obstruction to circulation flows. The canopy structure will be open on its side with a full-height safety screen/mesh attached to the main structure at ramps and stairs.
  - Canopy structures will be located at all ramps and stairs, except those that serve solely as emergency egress, and along the platforms.
  - The length of canopies should be sized to sufficiently accommodate a minimum of 60 percent of the passengers at peak loads. In all cases, however, platform canopy structures will be a minimum of 150 feet plus the length of the ramps and stairs.[15] Where a canopy structure occurs on the platform at the end of a ramp or stars, it will extend a minimum of 50 feet past the ramp or stair. Where a canopy does not occur on the platform, the ramp or stair canopy will extend 5 feet past the end of the ramp or stair.
  - The width of canopies should be sized to sufficiently accommodate 60 percent of passengers at peak loads. Regardless of passenger load, canopies must be a minimum of 5 feet wide.

[15] 521 CMR, 18.5.1 (b)

- Absolute minimum horizontal clearance from vertical canopy supports to track-side edge of the platform is 7 feet, 6 inches per drawing #1013 of the MBTA Commuter Rail Standards. The minimum horizontal clearance from the edge of canopy roof overhang to centerline of track is 7 feet, 6 inches
- Minimum vertical clearance from top of rail to underside of canopy roof is 12 feet, 1 inch.
- Materials are to be developed. Galvanized steel alone will not be used.
- Specifications per MBTA Standards.

- Canopy Roof:
  - Canopy roofs are to be snow, wind, UV, and vandal resistant.
  - Roof materials are to be developed.
  - Gutters will not be used except in locations where the canopy forms a V-shape. (Transition Plaza and center islands stations for example.)
  - Specifications per MBTA Standards.

## 10.2.4 Site Circulation

Site layout should ensure that the station offers safe and convenient pedestrian access to encourage walking and TOD in the nearby vicinity. Moreover, multimodal forms of transportation are to be anticipated and designed for to the maximum extent possible. The parking should not be laid out in a configuration that appears to keep development away from the station, if TOD is pursued on site. The integration of the station functions and the TOD or other mixed use development will evolve through the site's master plan, and is understood to be fundamental to the ultimate success of the SCR project.

### 10.2.4.1 Separation of Circulation

Pedestrian, vehicular, and rail movements will be separately delineated to ensure maximum safety for circulation at the stations. All circulation crossings and interfacing must be well-defined with sight lines maximized.

Provide convenient loop turn-arounds for drop-off/pickup vehicles (buses, taxis, automobiles). The layout should maximize efficiency of movement and minimize conflicts between modes.

### 10.2.4.2 Transition Plaza

The transition plaza is envisioned as a site 'hot spot', where a number of activities and transitions between modes of transportation will occur. It should also act as a visual threshold for the community, signifying the entrance to the platform. Given this importance, the transition plaza should be considered a prime design opportunity to provide a contextually sensitive response to the community.

Locating the transition zone is the primary concern. The first order of consideration is proximity to the passenger loading zones. This inherently also ties into the proximity to both accessible parking spaces and the platform entrance. This relationship must meet the letter of the law and enhance user experience of the station.

**Drop-Off / Pick-Up Areas (Passenger Loading Zones)**

Drop-off/Pick-up areas will be provided at all stations and will be designed to meet all accessibility requirements. Provide a minimum vertical clearance of 9 feet, 6 inches at accessible passenger loading zones and along at least one vehicle access route.[16]

All passenger loading areas will be located as conveniently to the station as possible. When accessible parking spaces cannot be located within 200′ of the accessible entrance, an accessible drop-off must be located within 100′ of the entrance.[17]

To the extent feasible locate a mix of covered and uncovered seating areas in the vicinity of the passenger loading zones and/or Transition Plaza. The intent is that waiting passengers would have a variety of options depending on weather conditions.

- Layout:
  - The preferred organization of passenger loading zones is to provide a continuous flush curb along the station entrance/transition area to accommodate the various modes of arrival to the station.
  - In all cases, a minimum 20 feet x 13 feet parallel type accessible drop-off/pick-up area with curb cuts and tapered ends over its entire length must be provided (see diagrams in the MBTA Commuter Rail Design Standards).
  - Striping will be provided to designate accessible zones of activity.
  - Provide bollards to separate the passenger loading zones from the transition plaza.

### Bike Storage

Bicycle areas should not simply be spaces taken away from cars, as an afterthought, but should be incorporated into the original pedestrian circulation network.

- The preferred location for bicycle storage is adjacent to, but not in, the transition plaza or in close proximity to the termination of bicycle routes.
- Bicycle storage should be readily visible, both for commuters and for observation by MBTA personnel.
- Provisions should be made for expansion of bicycle storage in the future with at least half of the bicycle racks being covered.
- Material is to be developed.

[16] 521 CMR, Section 23.7.5
[17] 521 CMR, Section 23.3.3

#### 10.2.4.3 Arrival and Departure Modes

SCR stations are conceived as points of multimodal transportation convergence, and should therefore be designed to fully integrate each anticipated mode of travel. The design of the commuter rail stations should address the following arrival and departure modes, listed in the order of their importance:

- Paratransit
- Pedestrian
- Bicycle
- Public transportation (including taxis)
- Automobile (Drop-off and pick-up, and Park and Ride)

Pedestrian, public transportation, and drop-off/pick-up modes will be encouraged by minimizing walking distances from site entry points and curbside stops to the platform. Each station will include a transition plaza (area between platform circulation elements and curb side drop-off or main sidewalk). Newspaper racks and parking paying machines, which are not allowed on platforms, as well as bike racks and non-MBTA signage can be placed in the transition plaza,.

#### 10.2.4.4 Paratransit

Paratransit provides door-to-door shared-ride transportation options for those who cannot use fixed-route transportation options all or of some of the time because of either physical or mental impairments. Transportation that accommodates the elderly may also fall under this heading and will be considered when planning stations.

Paratransit is a rapidly growing and evolving form of transportation. Therefore, both existing and planned services should be considered and coordinated when planning stations.

Passengers using this mode of travel may have a range of impairments and may require more space for boarding than other transit riders. When playing layout for paratransit users, space should be allocated for a wheelchair lift.

Loading zones will be designed to reinforce pedestrian safety and located near the platform on an accessible route.

#### 10.2.4.5 Pedestrian

Pathways should be direct, well-defined, and provide a clear indication of where they lead.

An accessible route must be provided at all new, reconstructed, altered, or remodeled stations. The accessible route must connect all terminal buildings, platforms, parking and entrances, per 521 CMR, Section 18.2. Access to MBTA vehicles and facilities will be a fundamental design objective from the curb to the commuter vehicle and will follow universal design principles such as:

- Equitable use to persons with diverse abilities;
- Provision of choice and flexibility;
- Intuitiveness and simplicity of use;
- Employment of low physical effort; and
- Use of various modes of perceptible information.

Accessible routes will be designed to employ the accessible design standards of the project as referenced in the codes/regulations/agreements in the front of this chapter and as is otherwise required.

Pedestrian access from the surrounding community will be encouraged by providing a direct paved walkway from the adjacent public way to the platform that meets all accessibility requirements.

### Walkway Design

- Walkways will be sized according to pedestrian circulation formulas found in TCRP-100 and as required by the egress code in effect.
- Minimum preferred sidewalk width is 5 feet; however wider sidewalks will be considered where a high volume of people are anticipated.
- Multiuse paths that are designed to accommodate both pedestrian and bicycle access. The minimum width for a multiuse path is 10 feet with an additional 2 feet shoulder, and should follow all applicable standards.
- Walkway slopes will meet code requirements and the accessible design standards of the project.
- No level change greater than ½-inch is permitted unless a ramp is provided. Level changes between ¼-inch and ½-inch will be level at a maximum slope of 1:2
- Each station will have durable and environmentally sustainable pedestrian pavement. Concrete walkway surfaces will be a minimum of 4,000 PSI 28-day compressive strength with steel reinforcing.
- Colored or stamped concrete or permeable pavers are not to be used.
- Walkways will be slip-resistant with a minimum static coefficient of friction of 0.6.
- Sidewalks adjacent to parking areas will be avoided. If it is necessary, the parked vehicle overhang must be considered to maintain required sidewalk width.
- When possible, walkways will be separated from vehicular traffic by a landscape buffer.
- Snow removal and storage areas will be considered in the location and design of walkways.

#### Crosswalks

- Crosswalks will be equal to or wider than walkway width (6 feet preferred minimum).
- Striping:
  - 6 inches wide, parallel white edge lines (transverse)
  - 6 inches wide, 45 degree diagonal white stripes with alternating 12-inch space

- Crosswalks will be located to maximize visibility between pedestrians and vehicles.
- Curb cuts (wheelchair ramps) must be provided wherever an accessible route crosses a curb. Curb cuts will have a minimum width of 5 feet and maximum slope of 1:12.

#### At-Grade Track Crossings for Pedestrians

- At-grade track crossings for pedestrians will be prohibited.
- Crossings at existing streets (existing at-grade crossings) are permissible; coordination with appropriate signaling is required.
- All new pedestrian crossings will be grade-separated.
- Under special conditions, new grade track crossings for emergency egress only may be permissible.

### 10.2.4.6 Bicycle

- Bicycle accommodation will be consistent with the project's context while anticipating the future growth from community and development plans.
- Minimum bike lane width will be 5 feet.
- Shared use lanes for vehicles and bicycles shall have a minimum width of 15'.
- Refer to MassDOT standards for bicycle accommodations on arterial and collector roads.

### 10.2.4.7 Public Transportation and Taxis Service

#### Buses

It is assumed that all stations have, or will have, local bus service to the station. Some bus-passenger interface elements to consider are:

- Loading zones will be a linear platform type; located adjacent to or near the station; reinforce pedestrian safety; on an accessible route; and allow for future growth. Sizing of the loading zones will depend on the requirements of the specific buses operated by transit agencies.
- Queuing areas should provide coverage from weather and be inviting and safe. Queuing areas will be sized to accommodate comfortable queuing of expected loads.
- A minimum of one covered bench per passenger loading location is recommended.
- One trash receptacle per loading location should be provided.

- Buses may have their own dedicated lane, but must in all cases be separately delineated to maximize safety of circulation. The location of bus parking will be clearly identified and visible from the platform.

**Taxis**
When feasible, a separate queuing area for taxis should be provide, sized for expected demands. This area should be located reasonable close to the transition zone, but preference will be given to accessible parking.

Vehicle turning radii will conform to the criteria of the AASHTO *A Policy on Geometric Design of Highways and Streets 2011 Sixth Edition*.

### 10.2.4.8 Automobile

The most direct roadway access possible between the site entrance and the drop-off/pick-up area will be provided. Vehicle access and circulation should favor the inbound side, bringing inbound traffic on-site quickly to prevent traffic backups at key entrances.

### 10.2.4.9 Roadway Design

- Minimum two way travel lane width preferred: 12 feet.
- Absolute minimum two way travel lane width: 10 feet.
- Absolute minimum lane width for one-way single lane: 16 feet.
- The minimum lane widths presented above represent the travel widths for vehicles only and do not include the width of bike lanes or passenger pick-up/drop-off areas.
- Cross Slope (preferred): 2 percent.
- Absolute Minimum Cross Slope: 1 percent.
- Absolute Maximum Cross Slope: 3 percent.
- Maximum Roadway Gradient—Automobiles:
  - Ramps, access roadways, driveways: 10 percent.
  - Sustained Grade: 6 percent.
  - Roadways with frequent ice, snow, sleet, fog: 5 percent.
- Maximum Roadway Gradient—Buses:
  - Operating Grade: 10 percent.
  - Design Grade: 6.5 percent.
- Vehicle turning radii will conform to the criteria of the AASHTO *A Policy on Geometric Design of Highways and Streets 2011 Sixth Edition*.

#### 10.2.4.10 Entrances and Exits

- The recommended distance between site entrances/exits and adjacent roadway intersections are as follows:

| Roadway Type | Minimum Distance | Preferred Distance |
|---|---|---|
| Major Arterial | 200 feet | 400 feet |
| Minor Arterial | 150 feet | 300 feet |
| Collector/Local | 100 feet | 200 feet |

- An exit auxiliary lane should be provided where a moderate number of left-hand turns are anticipated (12 feet preferred; 10 feet minimum).

### 10.2.5 Station Parking

#### 10.2.5.1 General

- To the maximum extent possible, the parking layout will be designed to maximize use of the accessible route to the platform.

- In effort to reduce the number of cars on the road, and thus, the amount of carbon emitted, reserved parking for customers that use car sharing should be provided. However, preference will be given to required accessible parking.

- Electrical Vehicle (EV) Charging Stations: Executive Order 484, better known as "lead by example," mandates a 40 percent reduction in greenhouse gas (GHG) emissions from transportation services by 2020. Therefore to encourage and accommodate modes of travel that reduce the emission of greenhouse gases, EV charging stations shall be installed at all stations where feasible.

- Photovoltaic (PV): Typically, surface parking is an underutilized real estate asset. However, surface parking lots offer a prime opportunity to install energy generating "solar canopies" which should be considered wherever feasible. In addition to energy production, solar canopies provide the added benefit of shading vehicles from the sun.

#### 10.2.5.2 Layout

- 90-degree parking stall orientation is preferred to maximize parking capacity.

- 90-degree perimeter parking will be used where feasible to maximize parking capacity.

- Parking arrangements other than 90-degree orientation will be considered when the preferred layout is not feasible.

- Parking lot layout should leave a sufficient landscape buffer around the perimeter of the site.

### 10.2.5.3 Dimensions for Surface Lots (90 degree)

- Standard Cars:
  - Stall: 8′ - 6″ x 17′ 0″
  - Bay: 60′-0″
  - Aisle: 26′ - 0″
  - Circulation Route: 30′-0″

- Compact Cars:
  - Stall: 8′ - 0″ x 15′ - 0″
  - Aisle: 24′ - 0″
  - Bay 54′ - 0″

- Gradients:
  - Maximum grade: 5 percent.
  - Minimum grade preferred: 1 percent.
  - Absolute minimum grade: 0.5 percent.
  - Maximum cross slope for accessible parking: 2 percent.

### 10.2.5.4 Islands

- Curbed islands will be provided only if necessary to direct vehicular traffic and to provide for safe pedestrian circulation and landscaping. Curbed islands generally occur at entrances and exits, and at turnarounds. Islands can also be used to separate circulation paths between different users as described previously in this chapter. The number of islands should be kept to a minimum.

- Curbed islands will be a minimum of 4 feet wide.

- It is preferable to use painted islands at the ends of parking rows.

- Long islands perpendicular to parking stalls will only be used where necessary for grading or circulation

- In general, it is preferable to make islands large enough to store plowed snow.
- Curbed inside corners should be avoided since they make plowing difficult, trap debris, and increase the number of drainage structures needed.

#### 10.2.5.5 Accessible Parking

- Provide minimum 8-foot wide spaces with an adjacent 5-foot wide access aisle for car accessibility. For efficiency, two spaces may share the same 5-foot access aisle. Access aisles will have a level surface with slopes not to exceed 2 percent. Access aisles will be clearly marked with diagonal stripes.[18]
- Provide minimum 8-foot wide space with an adjacent 8-feet wide access aisle for van accessibility to accommodate a wheelchair lift. Vertical clearance at van spaces and at least one vehicle access route will be 9 feet, 6 inches.[19] One of every eight accessible spaces, but always at least one, must be van accessible.[20]
- Accessible parking will be located on the shortest accessible route of travel from the adjacent parking lot to an accessible entrance.[21]
- All accessible parking spaces will be marked with signage as being reserved.
- The number of accessible parking spaces provided will comply with MBTA commuter rail standards and all applicable code requirements.
- At a minimum, a curb ramp must be provided for each striped aisle.[22] Whenever possible, it is preferred to have a flush curb along the entire length of the transition zone including accessible parking spaces and the multiple modes of arrival and drop-off.
- Surface slopes will meet code requirements and the accessible design standards of the project.

#### 10.2.5.6 Barriers

Granite curbing with a 7-inch reveal will be used where curbs are required. Consider sloped granite as an alternative to vertical granite where appropriate. Sloped granite is cheaper than vertical granite, but vertical granite curbing is more durable, less likely to be damaged by snowplows, and better at directing traffic. Do not use sloped granite in areas of pedestrian circulation. Existing on-site granite curbing should be reset where possible. If granite curb is used, it should be precut for uniformity,

[18] 521 CMR, Section 23.4.6
[19] 521 CMR, Section 23.7.5
[20] 521 CMR, Section 23.2.2
[21] 521 CMR, Section 23.3.1
[22] 521 CMR, Section 23.5

durability, and cost savings. If a lot can be easily drained to nearby ditches, curbing may not be desirable.

Vehicular guardrail will be used to confine parking to specific areas. The guardrail should be combined with curbing or bollards. Bollards can be used for the same purpose as guardrail while allowing free flow of pedestrians. Pipe rail may be used for pedestrian guardrails and as a means of channeling movements. Use where vertical drop-offs are greater than 8 inches along the top side of retaining walls, and at stairs and ramps.

Fencing will be used to limit pedestrian access for safety and security and will be set back and protected by curbing or guardrail. Inter-track fencing will be chain link fence installed between tracks to channel pedestrians to designated crossings. Fencing is to be 4 feet high and extends 200 feet beyond the platform ends. Alternative design solutions should be considered where fencing occurs between the track and the transition plaza.

#### 10.2.5.7 Drainage

Storm drainage systems will be provided in all parking lots. The systems will conform to the standards of this manual as well as MassDOT and State Stormwater Management regulations and criteria.

Station design will minimize the amount of impervious cover, increase on-site infiltration, reduce or eliminate pollution from stormwater runoff, and eliminate contaminants. The most effective stormwater management system would be to treat all runoff resulting from the station in an open system on site or to harvest it in an on-site collection system for later use. On-site collection and infiltration can be achieved through the installation of rain gardens or open vegetated swales at each station site. Additionally, the use of pervious paving along sidewalks and other paved areas will also help reduce impervious cover. These features will aid in the removal of contaminants via natural vegetative infiltration and should also be seen as educational opportunities for highlighting the ecological aspect of landscape features.

#### 10.2.5.8 Parking Fee Collection

There are two types of parking lots at SCR stations: those owned by the MBTA and those shared by the MBTA with other entities. Examples of shared parking lots are Whale's Tooth, where the lot is shared with the ferry service, and Kings Highway, where the lot is shared with a private retail center. The shared lots will require discussions with the owners to come to an operational agreement, but each lot type will likely lend itself to different fee collection methods.

Lots owned by the MBTA: In lots owned by the MBTA, fee collection by smartphone apps should be considered. In this scenario, there would be no need for a centralized fee collection board or for numbered parking spaces.

Shared lots: In lots shared by the MBTA, a central coin slot system will likely be used to collect parking fees. Depending on final negotiations with lot owners, these fee collection boards should conform to the following:

- Centralized parking fee depository with numbered coin slots keyed to numbered spaces in the parking lot. Collection box location will be located in the transition plaza or an area that is agreeable to both the owner of the lot and MBTA.
- For a consistent aesthetic, the parking fee depository should use a similar material palette to the station signage and wayfinding structures.
- Parking spaces will be clearly marked and numbered consecutively per MBTA commuter rail design standards.

#### 10.2.5.9 Parking Lot Material

To increase the amount of permeable surfaces and reduce storm water volumes, permeable paving should be considered. In all cases, the use of recycled material in paving and concrete applications should be considered in the design of the stations and surrounding parking.

### 10.2.6 Lighting

The design will provide lighting which is properly selected and located to achieve the desired levels of illumination in each area to promote safe, reliable, and continuous operation of stations. Station and parking lot lighting will be provided utilizing MBTA listed standard lighting fixtures attaining recommended illumination levels for all areas based on IES, APTA, and MBTA guidelines.

To counteract light pollution, dark sky standard will be applied to lighting design. Technologies to reduce pollution include, but are not limited to: full cut-off luminaire, low-reflectance surfaces, and low-angle spotlights.[23]

All lighting will be weatherproof and vandal-resistant.

Refer to MBTA 'Design Lighting Levels and Fixtures Directive' for lighting levels at parking lots, platforms, outdoor plazas, pedestrian walkways, and similar areas. Over lighting should be avoided.

Refer to MBTA 'Design Lighting Levels and Fixtures Directive' for mounting heights for fixtures.

On islands, locate centerline of poles a minimum of 2 feet, 6 inches back from the face-of-curb to allow automobile overhangs. Where a setback is not possible, or no islands exists where a pole is needed, mount poles on concrete bases which extend 24 inches above grade.

[23] Design for the Environment, Section 2.6.2

Lighting should be designed as to minimize shadows in public areas. Photometric plans will be developed to demonstrate compliance with lighting level and uniformity ratio requirements at various surfaces.

Generally, lighting circuits will be group controlled by photoelectric cells to switch on at dusk and a timing circuit which will turn off the majority of lights after service stops. However, some circuits, such as those controlling tunnel lighting or in vandal-prone areas, will operate on photoelectric cells only and will remain on until dawn. A keyed manual switch will be located on the exterior of the electrical control box for lighting at each station.

Reduce visual impacts from lighting within and adjacent to historic districts by minimizing the number of light poles.[24]

Where feasible, solar powered lighting should be considered.[25]

Light emitting diode (LED) should be investigated for use on the SCR project, and is considered to be an approved lighting system.

### 10.2.7 Energy Performance

Typically, lighting is the greatest energy demand at a station. That said, lighting level and design is a critical parameter to achieving security, wayfinding, and general passenger experience goals.

Design station lighting and other systems to maximize energy performance. Strive to achieve a better base minimum energy performance for buildings than ASHRAE Standard 90.1-2004. Use a computer simulation model to assess energy performance and identify the most cost-effective energy efficiency measures.

Assess the station design for non-polluting and renewable energy potential, including solar, wind, geothermal, low-impact hydro, biomass, and bio-gas strategies. When utilizing these opportunities, take advantage of net metering with the local utility.

### 10.2.8 Signage and Wayfinding

There are three objectives to signage and wayfinding. The basic purpose of effective signage and wayfinding is to safely and efficiently guide passengers from one transit mode to another. Passengers will be arriving at the stations via multiple modes of transportation and should be able to move effortlessly from one mode to the next. Second, signage and wayfinding should also help to develop a common look and feel across stations within the system. Passengers should be able to orient themselves at any station, regardless of familiarity with a particular station. Simplicity, clarity, and consistent conventions help to achieve this goal. Finally, effective

[24] Design for the Environment, Section 2.4
[25] Design for the Environment, Section 2.5.1

signage and wayfinding should help to facilitate safe and convenient movement of passenger within the stations themselves. Passengers are often in a rush when entering or leaving stations and should be guided to the platform or connection points in a clear and efficient manner.

At a minimum, the following will be considered:

- Each station will be clearly marked so that passenger can recognize its location regardless of mode of arrival;
- Within stations, signage and wayfinding information should contain directional signage and maps to connecting modes of transit, nearby streets, and local attractions and landmarks.
- Signage should be located at critical decision-making points, but should not impede circulation flows.
- Connecting transit services should be clearly identified.
- Provide real-time information regarding the next arrival of train.
- The system ID sign will be visible from all approaches.
- Signage should be well illuminated.
- Station ID must be visible at a distance but be sympathetic to the scale and character of the station's context.
- Locate signs in a sensitive manner within and adjacent to historic properties.[26]
- In conjunction with trailblazer signs, the commuter should be able to easily identify and arrive at the station. Trailblazers are to be located in the field as necessary to lead pedestrians, bicyclists, and vehicles from points outside the station to the station.
- All signage and wayfinding provisions must meet all accessibility requirements, including braille, and should assist non-readers in the use of the commuter facilities.
- All signage will employ or complement existing national and international conventions.

### 10.2.9 Integral Art

Transportation excellence includes every element in the system, and should enhance the experience of travel. As multiple modes of travel become more integral to how we think about creating spaces for passengers, art and design must be integral to the process and the stations. Integral art will be explored at each station as early in the design process as possible, and coordinated with the surrounding communities. Some of the opportunities for integral art proposals include: pedestrian overpass lighting, fences, guardrails, plazas, benches, and retaining walls.[27]

## 10.3 Station Landscaping

The design of the landscape plays an integral role in the environmental and social goals of SCR. Planting provides shade, defines circulation, directs views, reduces glare from windshields, buffers adjacent residences from automobile headlights and views of parking lots, and in many cases buffers commuters from unsightly

[26] Design for the Environment, Section 2.4
[27] MBTA Integral Art Guidelines

views of industrial areas. The Landscape plays an important role in the comfort and well-being of pedestrians, as well as a central role in creating sustainable and resilient environments.

Landscapes offer many opportunities to promote sustainable development. The design of stations and parking along the SCR should therefore consider strategies that minimize use of chemicals and energy in maintenance and enhance ecological performance.

The following are some design considerations:

- Vegetation
    - Native and low maintenance, drought-resistant vegetation should be used wherever possible.
    - In coastal areas, choose plants from the Massachusetts Coastal Zone Management's Coastal Plant list.[28]
    - Natural landscape should be used beyond sight lines and recovery zones. In areas where manicured grass exists, the option of reverting to a natural state should be considered and encouraged.
    - Noxious or invasive species will not be considered.
    - In areas where invasive species are found to exist, a mitigation plan should be developed as part of the landscape design.
    - Natural vegetation buffers between stations and wetlands will be increased wherever possible.
    - Where planted islands are use, the minimum practical width for a planted island should be considered to be 6 feet.
    - Disturbed vegetation areas will be replanted.[29]

- Grass
    - Decrease amount of grass area from conditions prior to construction. Where grass is used, turf grass should be avoided. The use of broad spectrum blends of grass, including warm season and slow-growing blends, or wildflowers should be used instead. This approach will lower the use of chemical pesticides and fertilizers, reduce maintenance, and minimize water usage.
    - Lawn area should be avoided. Difficult to mow areas, such as planted islands, should be covered with a low maintenance or maintenance-free ground cover.

- Trees
    - Mature, healthy trees should be preserved to the maximum extent possible. Such trees will be saved by the use of curbed islands, tree wells, and/or walls at the discretion of the landscape architect.
    - Generally, trees are to be cleared to within 25 feet from the center line of the track. The intent is to reduce safety hazards and disruptions on the track. Large trees closer to the track might be saved at the discretion of the landscape architect if they are important for neighborhood screening and can be adequately pruned to not interfere with railroad operations.

[28] Design for the Environment, Section 2.2.2
[29] Design for the Environment, Section 2.2.2

- Where trees are removed anywhere on the site, a 2 for 1 replacement schedule should be implemented.
- Urban areas will experience a net overall increase in tree coverage after installation of landscape design is complete.
- Shrubs should be low-growing (not exceeding four feet at maturity), low maintenance, and not requiring any pruning.  The use of shrubs will be minimized, however, and confined to places where they will have the most impact.
- Trees will be low maintenance varieties, 4 inches to 4½ inches DBH at time of planting for shade trees and 3 inches to 3½ inches DBH for flowering trees.
- Tree and shrub varieties will be able to withstand salt from platforms, parking lots, roadways, etc. The depressions created by settling of new transplants should be filled or leveled as soon as new transplants become established, and organic matter should be added to the soil to help filter salt deposits.
- Because of personal safety considerations, planting should not attempt to completely screen parking but should temper the impact of the stations and visually soften and visually reduce the size of the parking lots.  Shelters should not be obscured from view.
- Trees and shrubs will not interfere with driver sight lines or sight distance requirements within the station or at intersections with public streets.
- Trees will be located in such a manner that foliage will obstruct the light distribution.
- Trees will be planted a minimum of 2 feet, 6 inches in from the face of curb to prevent damage from overhanging automobiles.  Additionally, planting trees in line with the parking stall stripes minimizes the likelihood of damage.  Where practical, guardrails can also be used as such protection.
- If pedestrian traffic and therefore paving is to occur in treed areas, use tree grates or cobble tree pits (a less expensive alternative).  If cobbles are used, they will be sized as to discourage vandalism and theft.  A minimum of 5 feet x 5 feet, 3 feet x 6 feet or  6 feet x 6 feet tree pit size is preferable.

- Water
  - In general, the design should aim to eliminate the use of potable water for landscape irrigation at each station site.  Either install landscaping that does not need irrigation beyond the initial establishment period, which can be achieved via watering trucks, or use rainwater collected and stored on site for irrigation at the station.
  - To the maximum extent feasible the landscape layout should increase filtration and reduce storm water runoff.

- Stormwater Management
  - In general, station design should aim to minimize stormwater runoff through permeable pavement and manage stormwater onsite through the use of retention ponds, rain gardens, vegetated filter strips, bioretention swales, biorention basins, and infiltration basins.[30]

[30] Design for the Environment, Section 2.3

- Grading
  - Screening can also be accomplished by grading techniques such as berms and depression of parking. However, the same rules of personal safety should be followed. No berms higher than four feet should be used and cars should only be hidden up to their headlights.
- Wetlands
  - Wetlands should be protected by adequate parking setback, sedimentation, and erosion control during construction and internal site drainage. If drainage to wetlands is required, retention ponds, stone traps, filter berms, sumped and hooded catch basins, oil separators, etc. should be employed.
- Salvaging Existing Site Elements
  - Endeavor to reuse special site elements such as wrought iron bridge railings and fencing and granite walls and curbing.
- Utilities
  - All electrical and communication wires will be installed underground.
- Hardscapes
  - In effort to improve life-cycle impacts of investments and reduce solar heat gain, materials that increase the albedo factor in hardscapes, rooftops, and paving should be considered.

## 10.4 Urban Design

### 10.4.1 General

**South Coast Rail Corridor Plan**

The success of the SCR project, as stated in the South Coast Rail Corridor Plan, will be measured by the economic development of the communities in which stations are located; the enhancement of citizen's quality of life; and the improvement of the environment at both the local and regional scales. Sustainable, resilient, and equitable development at the urban and regional scales should, therefore, be a central focus of the SCR. One of the potential limitations to the project, however, is that the possibility of coordinating with, or directly engaging, anticipated TOD projects is unknown. This limitation poses a challenge of how best to integrate stations into their surrounding communities.

Planning the larger context while still in the land acquisition phase of the SCR project would help to ensure the most comprehensive and compatible solution. Some sites may have owners that can partner with the MBTA, while other parcels around stations may need to be acquired and put out for a Request for Information to willing landowners to solicit development proposals. In all cases deep community involvement is necessary during the planning process.

With that in mind, the planning and design of stations should consider the existing context as well as the Transit Oriented Development (TOD) anticipated for the areas adjacent to the stations, and, to the maximum extent possible, look for opportunities to engage with the anticipated development. At a minimum, SCR station urban design should anticipate engaging property frontage and/or access roads to stations as well as immediately adjacent intersections as zones of design. In addition, each station should be investigated for site-specific conditions that warrant expanding this boundary.

Early planning and coordination with the various stakeholders impacted by the SCR will help to ensure the desired economic development and environmental stewardship goals are met.

**Urban Design**

Urban design has been described as the art and science of shaping a community's public realm. The public realm is not a series of discrete objects. Rather, it is a system of interconnected pathways and places. Therefore, the stations along the SCR should not be seen as autonomous islands, but as important features of a greater network of transportation, environmental stewardship, economic development, and social well-being.

However, not all stations have the same contexts. Some are urban, some are rural, while others are somewhere in-between. Anticipated TOD projects may happen quickly at some stations, and take longer to materialize at others. There should not be a one-size-fits-all approach to the design of community interfaces. The following sections are some considerations to consider when thinking about how station meet their surroundings.

### 10.4.2 Connectivity

Regardless of context, one thing will remain consistent throughout the SCR project, transit riders will generally have one purpose in mind: getting from here to there on transit with the greatest of ease and convenience as possible. Connectivity, therefore, is at its most basic level, the ease with which a passenger can transfer from one mode of transportation to another and is a fundamental component of integration of the SCR into the wider region.

Connectivity is an indicator of a passenger's ability to use more than one mode of transit for a single trip. By making a multi-operator trip nearly as easy as a single-operator trip, good connectivity can help retain users and attracts new ones, while increasing the mobility of all those that use the system. Good connectivity reduces transit times, provides reliable connections, and ensures that the points of connection are attractive and safe.

Some design considerations when thinking about connectivity are as follows:

- Connecting services should be clearly identified.
- Transit connectivity should contain both local and regional scale maps showing transit routes and points of interests or popular destinations.
- Real time information regarding next arrival times should be considered for all public transit arrival modes. Real time and accurate information can prove to be an important component of regional connectivity because it can enhance transit usage and allows for users to review transportation alternatives.
- Where the connecting mode of transportation is bicycles or foot, clearly defined and well-lit routes should be provided from the platform, along access roads and paths, and out to the interface of the station with the community.

## 10.4.3 Urban Design Elements

### 10.4.3.1 Sidewalks:

Sidewalks need to be safe and accessible to all; usable in all weather conditions; and provide a comfortable environment for pedestrians, while, in some cases, be designed as a multimodal path to accommodate bicycles. Moreover, they need to be located to intelligent connect and facilitate pedestrian movement from surrounding communities to stations sites, and on to station platforms.

Sidewalks should be constructed in all locations, even if they do not currently exist. By providing sidewalk capacity to the station frontage; along access roads; and further into the community, if warranted, future development can more easily expand multimodal travel, a key goal of the SCR project.

The proper zoning of sidewalks help to promote a vibrant and safe public realm. An ideal zoning of sidewalks in many locations should contain: a curb; a maximized vegetation zone with street furniture; a pedestrian zone; and a zone to provide a buffer between pedestrians and vehicular traffic. Sidewalks should be sized and programmed appropriately for its context.

In rural contexts the zoning and programming of sidewalks will differ, but they, nonetheless, remain important.

**10.4.3.2 Vegetation:**

Street trees, shrubs, grasses, and flower offer a range of social, environmental, and economic benefits, but may increase maintenance demands and require special consideration when planning and installing in urban settings. However, they are a relatively economical way to achieve successful placemaking; provide shade for people; reduce heat gain, aid in storm water management and ground water qualities; and support native wildlife habitat.

From an urban design perspective, street trees can help to define space by framing views and creating a sense of enclosure; provide comfort from summer sun by shading people and surfaces that can gain and radiate heat back into the environment; and reinforce the character of a place. The species and placement of trees must be thoughtfully composed with the context in mind to ensure both the ecological benefits of vegetation and to create a seamless transition from the community to the station site.

**10.4.3.3 Street Lights:**

Street lighting provides a sense of safety; promotes movement of pedestrians and vehicles; and plays a significant role in the development of the character and sense of a place of the public realm.

Lighting should be chosen and planned to enhance the urban design of the station sites, along access roads, and adjacent context where station sites meet surrounding streets. Lighting must also provide a sense of security and pedestrian scale where appropriate, particularly in areas such as the multiuse path that connects the Kings Highway platform to Tarkiln Hill Road. Finally, lighting should enhance illumination at critical decision making points and gathering places along pedestrian and vehicular routes.

**10.4.3.4 Intersections:**

Intersections are important points of convergance for those accessing the station from different modes of travel, and should enhance the context of the converging streets, surrounding land uses, and the neighborhood identity. Intersections should accommodate multiple modes of travel and must be accessible to all pedestrians.

At a minimum, the SCR project should consider immediately adjacent intersections as within the scope of design. Additional intersections may be deemed necessary to enhance pending site-specific analysis.

In addition to the important transportation function played by intersections, they also present opportunities to create a sense of place that pedestrians can enjoy. Reinforcing station and community identity and character; placement and scale of lighting and vegetation; treatment of paving materials; and inclusion of public art shall all be considered when designing intersections.

**10.4.3.5 Station Elements:**

Adaptive Reuse: Repurposing existing building elements found at the various station stops should be considered wherever feasible and appropriate. An example would be the gantry crane at Taunton that could be repurposed, perhaps as a gateway to the station.

Historic Contexts: There are historically significant contexts along the SCR, such as Easton Village, that should be considered in the design of stations and the adjoining areas. Historic sensitivity does not necessarily mean reproducing historical styles. Rather, it is an opportunity to produce a contemporary structure that respects historic cultural assets while asserting its own claim to history.

Stations and surrounding development that act as gateways to towns or cities, such as Whale's Tooth in New Bedford, bold structures should be considered to enhance the strategic importance of such sites.

**10.4.3.6 Plazas:**

The presence of a plaza adjacent to the station such as 'Gates of the City' at Battleship Cove provides an opportunity to program the stations beyond merely moving passengers in and out of trains, they can become a new sort of gathering spot to promote an active civic space within the city. Designers should search for opportunities to broaden the use of such spaces through dialogue with local cultural groups, civic associations, government agencies, and other community-based groups like farmer's markets.

# 11

# Layover Facilities

## 11.1 Overnight Layover Facility Design

### 11.1.1 General

The overnight layover facility is a location where trains can be parked overnight. One layover facility will be provided along the Fall River Secondary (Weaver's Cove Layover) and another along the New Bedford Main Line (Wamsutta Layover).

At both locations, light cleaning, such as trash removal and light interior cleaning, is anticipated. Heavy maintenance of railcars and locomotives, holding tank service, and other major work is anticipated to be done at other existing MBTA facilities as they are capable and available.

### 11.1.2 Alignment - Horizontal

#### 11.1.2.1 Track Layout

The horizontal alignment will be designed in accordance with Section 3.0 of this document, except as noted below.

The full build-out of each layover yard shall have a minimum of six tracks to accommodate five commuter train consists plus provide one additional track for Maintenance of Way use. Lengths of storage tracks are described in Table 11-1.

**Table 11-1.** ***Desired and Minimum Layover Track Lengths***

| **Desired Layover Track Length** | | | | |
|---|---|---|---|---|
| | Length | | Quantity | Length |
| | Ft | inch | | Ft |
| Coach | 85 | 4 | 9 | 768 |
| Locomotive* | 69 | 7 | 2 | 139.2 |
| Bumping Post | 15 | | 0 | 0 |
| Stopping Allowance | 40 | | 1 | 40 |
| | | | Total | 947.2 |
| Minimum Clear Length of Track | | | | 950 |

| **Minimum Layover Track Length** | | | | |
|---|---|---|---|---|
| | Length | | Quantity | Length |
| | Ft | inch | | Ft |
| Coach | 85 | 4 | 9 | 768 |
| Locomotive* | 69 | 7 | 1 | 69.6 |
| Bumping Post | 15 | | 1 | 15 |
| Stopping Allowance | 25 | | 1 | 25 |
| | | | Total | 877.6 |
| Minimum Clear Length of Track | | | | 880 |

* Based on Amtrak Acela locomotive length

Each layover yard will have a single connection to the main line track. Where feasible, a tail track will be provided with length adequate to accommodate one train consist clear of the mainline and the layover yard. The intent of the tail track is to allow a departing or arriving train to wait prior to entering the main line or yard tracks.

The layover yard, including all layover turnouts, will be completely off of the operating right-of-way. The operating right-of-way is defined as the strip of land required to contain the railway's main tracks, passing tracks, embankments, cut slopes, drainage ditches, culverts and bridges. The preferred minimum distance to clearance point will be 17 feet as per “MBTA Book of Standard Plans,” Drawing No. 1020, with an absolute minimum distance of 13 feet between track centers. The centerline to centerline distance between the main line track and the closest yard track should be 27 feet (minimum).

### 11.1.2.2 Roadway/Yard Layout

Yard track centers will alternate between 15 and 35 feet. The strip between the 35-foot track centers will be paved and used as access to the trains for light maintenance, light repair, and emergency vehicles. An area for snow storage is to be included. Permanent blue flag protection devices will be installed on each track; devices will comply with applicable federal regulations.

Access roadways will have the following characteristics:

- Longitudinally, 24-foot wide paved roadways will be located centered between Yard Tracks 1 and 2, Yard Tracks 3 and 4, and Yard Tracks 5 and 6 to allow vehicles to service trains on both sides of the access roadway.
- Longitudinally, minimum 10-foot wide unpaved roadways will be located parallel to the outermost yard tracks (Yard Tracks 1 and 6) to provide emergency access. Emergency access paths shall be connected to lateral roadways at each end.
- Laterally, each end of the paved 24-foot roadways connects to a minimum 30-foot roadway. On one end, the 30-foot roadway crosses the tracks beyond the oil drip pans. On the other end, the 30-foot road passes behind the bumping posts.
- Roadways between tracks will have inverted crowns (the center of each roadway section is the low point) to which surface runoff will drain towards, where it is collected by catch basins and underdrains.
- The access roadway shall connect to a public road.
- Pavement sections shall be as follows:
  - Paved Access Road
    - Surface Course: 1.5" superpave surface course – 9.5 (SSC-9.5)
    - Intermediate Course: 2.5" superpave intermediate course – 19.0 (SIC-19.0)
    - Subbase: 12" gravel borrow, Type B
      - Subbase shall be separated from ballast by a layer of geotextile filter fabric.
  - Hot Mix Asphalt Driveway and Parking
    - Surface Course: 1.5" superpave surface course – 9.5 (SSC-9.5)
    - Intermediate Course: 2" superpave intermediate course – 12.0 (SIC-12.0)
    - Subbase: 12" gravel borrow, Type B
  - Cement Concrete Sidewalks and Wheelchair Ramps shall be provided between the parking area and the crew building entrance. No sidewalks are to be provided from the adjacent public way to the parking area.

    - Surface Course: 4” cement concrete (air entrained 4000 PSI – ¾” - 610 LB)
    - Subbase: 8” gravel borrow, Type B
  - Unpaved Access Road
    - Surface Course: 12” gravel borrow, Type B over geotextile filter fabric.

Yard lighting will meet the standards of section 10.0 of this document, except as noted herein:

- Yard areas will maintain 1-2 foot-candles.
- Turnouts on the lead track and in the yard will maintain 5-10 foot candles.
- Yard lighting will be suspended from OCS structures, spaced between the tracks and over access roadways.

### 11.1.3 Vertical - Alignment

#### 11.1.3.1 Vertical Grade

The vertical alignment will be designed according to section 3.0 of this document, except as noted below.

The preferred layover yard profile of the tracks for a single-ended facility is sloping down and away from the main line track connection. Alternately, the yard tracks can be flat (zero slope).

Where yard tracks are flat or must slope towards the main line, a crest curve shall be designed between the main line and yard tracks. If such a crest curve is not feasible, the maximum allowable slope towards the main line is 0.50% with a double split switch derail located on the lead track that directs an errant train away from the main line.

### 11.1.4 Support Infrastructure

#### 11.1.4.1 Crew Building

For SCR Layover facilities, a climate-controlled crew building (approximately 50’ x 30') shall be located at each layover facility. The crew building will have typical utility services, including electricity, communications and cable TV, potable water, and sewer. The crew building shall comply with the following:

- Separate men’s and women’s bathrooms, each complete with at least one accessible toilet, sink, and shower.

- Dedicated office spaces.
- Dedicated Common area (at least one).
- Storage/garage area: Not to exceed 50% of building footprint.
- Dedicated utility closets for electrical, data and communications, plumbing and janitorial functions.
- Crew building shall have a separate breaker panel provided within.
- The building shall conform to all requirements of ADA and the MAAB.

Building materials to be determined.

### 11.1.4.2 Employee Parking

An employee parking lot shall be provided, located just outside the train storage area. Parking spaces shall be 9' x 18' (minimum) with a clear space of 24' for backing up. The number of spaces shall be computed as follows:

- 1 engineer per train consist.
- 1 conductor per 1.5 cars (rounded up).
- 7 spaces for supervisors, maintenance staff, and others.
- For every 25 spaces, at least 1 shall be accessible (rounded up).
  - Accessible spaces shall conform to all requirements of ADA and the MAAB.

### 11.1.4.3 Other Amenities and General Facility Operations

- Switch Heaters – Electric track switch heaters shall be provided on any turnouts necessary to move all train consists onto the main line.
- Water Supply/Distribution System:
  - Yard hydrants (2" diameter) for filling locomotive cooling systems, supplying fresh water to on-train lavatory storage tanks, and basic car cleaning shall be provided. They shall be located such that a 100-foot hose can reach all train consists stored in the yard. The hydrants shall be manually controlled without special tools and shall be designed to allow water to automatically drain out of the exposed portions of each hydrant after use (to prevent freezing). Hydrants located along the access roadways shall be protected by bollards with snow flags attached.

    - Fire hydrants must be provided in accordance with local authority requirements. At a minimum, a town-approved hydrant shall be provided at the main entrance of each facility. Fire hydrants shall be protected by bollards with snow flags attached.

    - A meter pit and backflow preventer shall be installed just outside the main entrance to each facility, provided with a water meter, backflow preventer, shutoff valve, and reducers as necessary.

    - The size and location of the new water service supply line shall be coordinated with, and be in compliance with, the requirements of the local water company.

- Sanitary Sewer System:

    - A sanitary sewer is required from the lavatories in the crew building. The sanitary sewer system should be preferably connected to existing municipal facilities, if available. Otherwise, a complete and properly sized septic system shall be provided.

    - Cleaning of train car lavatories shall be done by truck, where waste is removed and disposed of off-site in compliance with all local and regulatory requirements.

- Security Fence and Cameras

    - Security fence shall be installed around the entire perimeter of the layover facility with gated access established at the driveway entrance to the facility. Preferably, security fence between the layover facility and the mainline track will also be installed.

    - Preferably, gates shall be single or double cantilever rolling gates where space allows. Alternatively, swing gates may be allowed where cantilevered rolling systems will not fit. Gates will be installed at the main driveway entrance to the facilities, across the layover facility lead track(s) where minimum clearances can be achieved for both yard tracks and main line track, and at designated locations adjacent to the emergency access roads (coordinated with local emergency response authorities). Pedestrian size gates shall be installed adjacent to each facility building where perimeter fencing ties into to those buildings.

    - Security fence shall be 8' high galvanized chain link fence unless otherwise directed by the Owner.

    - Closed-circuit cameras are to be used as a means of maintaining surveillance over layover facility areas from monitors in a central control facility. At a minimum, they should cover facility and building entrances, storage areas, yard tracks, and lead tracks.

- Camera locations will be coordinated with locations of other facility equipment, such as lighting, OCS, and signage. The cameras should not be easily accessed.
- Focal areas of cameras should be well illuminated.

### 11.1.5 Drainage

#### 11.1.5.1 General

All layover facility construction within areas subject to jurisdiction under the MA Wetlands Protection Act (MGL ch.131 §40) (Buffer Zone, Riverfront Area, Land Subject to Flooding) must have drainage and stormwater management facilities designed in accordance with the Massachusetts Stormwater Standards (310 CMR 10.05(6)(k)) as further defined and specified in the Massachusetts Stormwater Handbook. Where the site is previously developed, the project would qualify as redevelopment and would be required to meet the Standards to the extent practicable. Layover facilities are classified as “industrial uses” and must meet the requirements of the EPA Multi-Sector General Permit for Stormwater Discharges Associated with Industrial Activity (40 CFR Part 42; 33 USC 1251).

To support the wetland permit applications, design engineers for each Layover Facility will provide a Drainage Report containing a completed DEP Stormwater Checklist, supporting narrative, and calculations.

#### 11.1.5.2 Design Standards

Both proposed layover facilities would be located on previously developed sites and qualify as redevelopment under the Stormwater Standards. Railroad layover facilities are considered a land use with higher potential pollutant loading (LUHPPL) as defined in 310 CMR 10.04 and 314 CMR 9.02. As a result, certain BMPs are required to prevent contamination of local wetlands and water resources such as the New Bedford Inner Harbor or the Taunton River.

#### 11.1.5.3 Layover Drainage Elements

Non-structural water quantity and quality control BMPs required at the layover facilities include:

##### Snow Management

The final design must indicate areas designated for proper snow storage. No snow may be placed in or directly adjacent to wetland resource areas. Snow would be allowed to melt on pavement as much as possible, where debris and sand may be deposited and swept up for disposal. Snow melt would enter the stormwater management system, where it would receive proper treatment.

#### Spill Prevention

The final design will include an operational phase Spill Prevention, Control and Countermeasures (SPCC) Plan as required under the Clean Water Act (40 CFR Part 112). Any oil or other hazardous materials storage locations will be provided with secondary containment structures to catch any spills.

Structural water quantity and quality control BMPs to be implemented at each layover facility (not all BMPs are suitable for each site) include:

#### Catch Basins with Sumps and Oil/Debris Traps

Catch basins at layover facilities are to be constructed with sumps (minimum 4 feet) and oil/debris traps to prevent the discharge of sediments and floating contaminants.

#### Drip Pans (Collection Trays)

The storage tracks will be designed with drip pans or collection trays to catch any incidental drips, leaks, or spills of hazardous materials that may occur during storage or maintenance of the trains. While the locomotives are electric-powered and contain no diesel fuel, they do contain potentially hazardous fluids, including coolant, oil, and grease. Runoff and contaminants collected in drip pans will be connected to an oil/grit separator prior to discharge to another BMP or to the municipal storm drain.

#### Oil/Grit Separator

MassDEP requires the use of a pretreatment BMP, such as an oil/grit separator, for layover facilities (sites that constitute LUHPPLs). These structures are underground storage tanks consisting of chambers that are separated by interior baffle walls. The placement of the interior baffles and the outlet from the structure are designed to remove heavy particulates, floating debris and hydrocarbons from stormwater.

#### Vegetated (Grass and Gravel) Filter Strip

Where appropriate, the site design will incorporate vegetated or grass filter strips, which are linear stormwater management measures that are generally oriented parallel to the contributing drainage area and treat sheet flow or small quantities of concentrated flows that can be distributed along the width of the filter strip. A level spreader, consisting of a pea gravel diaphragm or other similar feature, runs the width of the area being treated. The level spread intercepts and dissipates runoff to minimize the risk of erosion due to concentrated flows.

### Vegetated (Grass) Swales

Where appropriate, the site design will incorporate vegetated swales which provide some treatment, reduction, and distribution of stormwater during conveyance. Pollutant removal mechanisms include filtering by the swale vegetation (both on side slopes and on bottom), filtering through a subsoil matrix,[1] and/or infiltration into the underlying soils.

### Infiltration Basins

Where appropriate, the site design will incorporate infiltration basins, which are stormwater runoff impoundments that are constructed in areas with permeable soils. Pretreatment of runoff is critical to prevent the basin from becoming clogged with fine sediment and suffering premature failure. Runoff from the design storm will be stored until it exfiltrates through the soil of the basin floor.

### Operations and Maintenance Plan

The final design will include an Operations and Maintenance (O&M) Plan for the layover facility stormwater collection, conveyance, and treatment systems. The O&M Plan must include a comprehensive source control program to be implemented at each site, which includes regular pavement sweeping, catch basin cleaning, and enclosure and maintenance of all dumpsters, compactors, and loading areas. This plan will address specific maintenance measures that must be performed and the required frequency in order to maintain the stormwater management measures at each station site. The O&M Plan will include a maintenance schedule for inspecting and cleaning catch basins, drip pans, oil/grit separators, filter strips, vegetated swales, bioretention swales, infiltration basins, and any other stormwater features.

[1] The soil matrix is the portion (usually more than 50 percent) of a given soil layer that has the predominant color, http://www.wetlands.com/coe/87manp3b.htm.