DESIGN DIRECTIVE

To: Distribution

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Chief Engineer

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RE: Drainage Design

This design directive is intended to consolidate, reiterate, supplement, and clarify the MBTA's drainage design approach, preferences, and requirements.

OBJECTIVE

Drainage design for all new station construction and station renovation projects shall include a drainage design that is consistent with the MBTA's priorities in order of importance:

1. Protect the MBTA's infrastructure from issues related to stormwater.
2. Protect the environment and downstream resources.
3. Maximize the simplicity of the system and minimize the number of elements that require maintenance.
4. Create a resilient and sustainable design that withstands decades of use and maintenance.
5. Consider the wider context of resource protection and conservation including utilization of the landscape and other materials for stormwater management.

Effective drainage systems are a key component to the functionality and longevity of MBTA systems, including the station platforms, parking areas, and associated infrastructure. As such, drainage designs shall prioritize function and ease of maintenance over time.

REGULATORY CONTEXT

Drainage systems design will conform to the standards of MBTA, MassDOT, Massachusetts Stormwater Management regulations and criteria. The MBTA is not required to comply with local zoning or related requirements under Mass General Law Chapter 161A, Section 3 (i) states "*the (MBTA) board shall determine the character and*

extent of the services and facilities to be furnished, and in these respects their authority shall be exclusive and shall not be subject to the approval, control or direction of any state, municipal or other department, board or commission…."
The designer shall review the local requirements and review with MBTA where appropriate. Projects shall be designed in a way to satisfy the regulatory context of the proposed work, while focusing on the Design Principles and Criteria noted herein.

CODES, STANDARDS, REFERENCES, AND GUIDELINES

The direction provided herein shall be used in coordination with all other documented MBTA Standards and Guidelines as well as all applicable policies and procedures. In the event conflicting guidance is provided, the more stringent direction shall be followed, and be documented by the design professional as such.

The latest edition, including revisions, amendments and supplements, of the following publications:

- Massachusetts Department of Environmental Protection (MassDEP) Stormwater Policy
- Massachusetts Department of Environmental Protection (MassDEP) Stormwater Management Standards
- Massachusetts Department of Environmental Protection (MassDEP) Stormwater Handbook
- Mass Highway Project Development and Design Guide – Chapter 8, Drainage
- Mass Highway Construction Standard Details
- ASCE Design and Construction of sanitary sewers, MOP 37
- ASCE Design and Construction of urban stormwater management systems, MOP 77
- ASCE 24 – Flood resistant Design and Construction
- 521CMR-MA Architectural Access Board Regulations
- 78CMR-MA State Building Code

DESIGN PRINCIPLES

As noted below, the term "site drainage" refers to actions required to manage stormwater in both paved and unpaved areas of a site. Stations shall have storm drainage systems that connect to the municipal system and/or outfall to natural areas on MBTA property, but not consisting of or directly discharging to the track right of way. Plans for upgrading or installing a station drainage system shall be coordinated with the local public works department.

Station improvements, especially parking, create a substantial increase in paved area and may also disrupt natural drainage patterns. The following guidelines establish a preferred approach to dealing with the issues of grade modifications, drainage of paved areas and unpaved areas, and slope control.

Grade Modification Guidelines:

- The grading design should balance the aesthetic, drainage, maintenance, and operational needs of the station site.
- Coordinate proposed grades with plant material to remain (such as larger trees) with other existing site elements.
- The grading design should attempt to balance cut and fill.
- Design slopes within minimum and maximum tolerances to provide drainage, ease of maintenance, and prevention of erosion.

Drainage of paved areas:

- All new or rehabilitated parking lots shall have a storm drainage system connecting to an existing municipal system or discharging to natural areas on property designed to accommodate collected stormwater. Discharge/Infiltration areas shall not saturate the ballasted tracks, or ground below. Designs for natural stormwater discharge and infiltration shall demonstrate that track structures are not impacted by stormwater discharge.
- Minimum and maximum slopes in paved areas will vary with the material and location but should be as prescribed in the Circulation and Parking sections of the Commuter Rail Design Standards Manual, Volume I, Section II:
  (a) Design flows for the system shall be determined by using the Rational Method (or an accepted alternative) and as detailed in Manual No. 37, Design and Construction of Sanitary and Storm Sewers, American Society of Civil Engineers
  (b) The selection of a particular storm frequency and discharge capacity for non-main line track areas such as parking lots and station access-ways, shall be based upon the following chart:

Station Drainage Design	
Preferred Storm Frequency in Years	**Drainage System Element**
10	ditches, gutters, ditch inlets, curb and paved area inlets, and inlet ponding on catch basins
25 (10 minimum)	All pipes and culverts except under major roads and culvert outlets
50	Relocated Stream Channels, major stream structures, transverse pipes
100	**Use only when required by the local agency**

Storm Data: NOAA ATLAS 14 Point Precipitation Frequency Estimates

- The capacity of the storm-drain system that receives flows from the proposed system shall be investigated to determine if there is adequate capacity to handle the flow from the station
- Drainage Design by System Elements:
  - Catch Basins:
    - 4-foot minimum inside diameter
    - 4-foot minimum sump depth
    - Preferred Catch Basin grates have 2-inch square openings, provided they are not located in pedestrian areas.
    - Hoods may be plastic or cast iron. The designer shall justify material selection based on the frequency of catch-basin cleaning.
  - Pipes:
    - All exposed drainage pipes shall be galvanized stainless steel.
    - The recommended minimum pipe size is 12 inches for the parking area collection system. The preferred pipe material for solid buried pipe is reinforced concrete (RCP).
    - Underground pipes collecting area drains, underdrains, or small canopy drains may be PVC, with a minimum pipe size of 8-inches
    - Perforated underdrain pipes may be PVC or HDPE.
  - Outlets:
    - Concrete headwalls or flared end sections are permitted.
    - Outfalls shall be sized to prevent erosion.
  - Subsurface Systems: Subsurface recharge and detention systems may be constructed of HDPE or reinforced concrete.
  - Water Quality and Quantity Best Management Practices (BMPs): The designer shall consider regulatory requirements of a site and its specific constraints and opportunities when developing a stormwater management plan. The selection and design of BMPs for peak rate attenuation, infiltration and/or water quality shall also consider the MBTA priorities related to maintenance and resiliency.

Drainage of Platform and walkway drainage shall be designed as follows:

- Platforms and walkways shall have a cross slope of 1.5%, allowing for a 0.5% ± construction tolerance.
- At all side platform locations, platform cross slope shall pitch away from track
- Side platform drainage shall be directed via sheet flow to adjacent landscape or hardscaped areas, where it can be directed to the station site drainage systems for collection and treatment. Site-specific conditions or regulatory considerations may require a variation of this approach.
- At center platform locations, platforms shall be crowned to direct stormwater to the ballast, with track drainage designed accordingly.
- Slope all surfaces to drain including post bases.

Canopy drainage shall be designed as follows:

- Canopy Drainage is preferred to sheet flow to adjacent landscape areas or collected into municipal system.
  - Use a stone drip-strip to prevent erosion where drainage sheet flows on grade.
  - Use an area drain or underdrain in the stone drip-strip or landscaped area where larger storm flows or frozen ground conditions would create runoff onto a pedestrian area.
  - Direct stormwater from canopies to the site drainage system for collection and treatment.
- Use gutters and downspouts as necessary to prevent shedding of water onto pedestrian areas, including platforms, ramps, stairs, sidewalks and transition plazas.
  - A Y-shaped canopy and a central gutter is preferred for ease and safety of maintenance, rather than an A-shaped canopy.
  - Gutters and downspouts shall be of a robust material such as galvanized steel, stainless steel, or better.
  - All exposed drainage piping shall have a minimum 6-inch diameter.
  - Use metal/cast iron receiving flanges at connection points from downspouts to collection pipes wherever these elements are accessible to the public Provide an air-gapped connection or a cleanout to allow for ease of maintenance. The designer shall be responsible for ensuring compatibility between dis-similar metals in the development of the design details.
  - Drainage piping shall be exposed, surface mounted, and shall not be encased within concrete structures.

Transition Plaza drainage shall be designed to:

- Provide ADA / MAAAB compliant slopes throughout transition plaza and all station pedestrian routes.
- Transition Plazas shall be graded towards the parking lot. If this is not feasible, grade the transition plaza in a manner that avoids the need for catch basins within the transition plaza paved areas.
- Direct transition plaza drainage away from the tracks.
- Gutters and drainage piping for roofs over stairs and ramps shall be sized such that no in-structure drainage is necessary.

Station site and parking areas drainage shall be designed to:

- Minimize the quantity of catch basins by maximizing the efficient placement of the catch basins that are provided.
- Minimize the use of curbing.
- Locate catch basins at low points to maximize efficiency and to minimize ponding/icing.

- Locate catch basins where they will be accessible to plows and maintenance equipment (such as within drive aisles).
- Direct stormwater away from accessible parking areas, crosswalks and accessible routes to the extent practical. Never place drainage grates in crosswalks, in accessible parking areas, or in areas that are likely to cause ponding in accessible routes.
- Grade paths of travel such that catch basins and low points do not coincide with walking paths.
- Where feasible use overland flow to above ground stormwater conveyances along the perimeter of the site.
- Consider "what happens if" there is a failure in the system. To the extent practical, an element of redundancy may be appropriate in the grading or drainage design.
- Avoid locating catch basins at inside corners or with parking stalls (i.e., under parked cars), to maximize access to the asset and to minimize the potential for clogging and ponding beneath parked cars.
- Swales should be avoided where they will interfere with plowing operations
- Avoid locating drainage structures in accessible parking areas or passenger loading zones.
- Avoid curbed parking lot Islands unless necessary for traffic flow, drainage, or safety of pedestrian and vehicular operations.
- Pipes under parking lots and driveways shall be designed for H-20 loading (minimum), with a minimum cover of 12-inches from bottom of pavement to top of pipe.
- Snow storage: Station designs should consider snow removal in the design of the layout, the placement of curbing, and the size of open areas provided for the stockpiling of snow. It is preferred that snow storage areas be designed to hold a minimum of 25% of the average annual snowfall at a compaction rate of 5:1.
- Wet stormwater BMPs that establish a permanent pool require a design waiver.

SITE MAINTENANCE

As part of the design process, the designer shall develop a Maintenance Manual for the drainage system at each site. Manuals shall include expected frequency of maintenance and inspection, maps showing locations of the system components, and logs for easily recording inspection and maintenance activities that are performed.

RAILROAD TRACK DRAINAGE

- Existing drainage patterns shall be maintained wherever possible.
- Drainage shall be gravity driven, flowing longitudinally in ditches that feed into structures, transverse ditches, or streams.

- Use of pumping stations will only be permitted with written authorization by Chief Engineer.
- Low points in ditches shall drain into structures to provide positive drainage.
- Drainage systems that discharge into an existing wetland or are within 100 feet of a wetland shall comply with the rules and regulations of the Wetlands Protection Act and shall consider applicable local bylaws.
- All underground utilities shall be sleeved when crossing the tracks. Underground utility crossings shall comply with the current MBTA requirements for utility crossings and shall be reviewed by the MBTA. The exception is underdrains shall not be cased.
- Each track shall drain into its own ditch or underdrain without draining from one track across or towards an adjacent track.
- Do not drain areas from beyond the track bed through the track structure. A ditch or underdrain shall lie between the adjacent ground and the track to intercept fine materials that would foul the ballast.
- Drainage for a double-track section is from a crown between the tracks to ditches or underdrains on the field side of the tracks.
- When double track is between walls or tight areas that do not offer space to locate field-side drainage ditches or underdrains, a single underdrain may be located between the tracks.
- Drainage for a single-track section is from a crown on the track centerline to ditches or underdrains on each side.
- When single track is between walls or tight areas that do not offer space to locate field-side drainage ditches or underdrains, a ditch or underdrain may be located on one side and the subgrade sloped in one direction towards the ditch or underdrain.
- At station platforms, an underdrain shall be placed between the track and the platform.
- Track drainage system shall be designed to accommodate peak flows produced by the 50-year design storm and maintain a maximum water level 18-inches below top of tie during the 100-year design storm.
- Drainage ditches shall be of a trapezoidal section, with a minimum depth of 18-inches and a minimum bottom width of 2-feet.
- Drainage ditches shall have a minimum gradient of 0.25% and a maximum design velocity of 2 feet per second for unlined channels.
- Water levels in ditches at design flow rates shall be at least 3-feet below the top of rail.
- Underdrain shall be located with pipe centerline a minimum of 6-feet 6-inches from the track centerline, and with an invert elevation no less than 4-feet below the top of rail.
- Drainage structures shall be installed at all pipe junctions and grade or alignment change points.
- Drainage structures shall be installed every 300 feet (maximum interval of 300 feet).
- The minimum diameter for perforated underdrain pipes shall be 12-inches.

- In the case where perforated pipes are used to carry water with groundwater control, a secondary requirement must be met. This condition requires the pipe to be laid with perforations up. By default, pipe shall be laid with perforations down.
- Underdrains shall consist of perforated HDPE pipes.
- Pipes 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. Ductile iron is preferred for underdrain pipes crossing beneath tracks.
- Where underdrains or ditches risk dewatering wetland resources, an impervious barrier should be considered between the underdrain or ditch and the wetland resource to mitigate that impact.

ADDITIONAL CRITERIA AND CONSIDERATIONS

- Slopes shall be self-cleaning at minimal flows (2 feet per second preferred) wherever possible.
    - Where this is not practical to attain, the design shall consider the effects of sedimentation, odors, and operational difficulties at lower velocities.
- Underdrain System:
    - Where underdrain pipe runs in a linear fashion, drainage structures shall be wye cleanouts that.
        - are of the same material and dimensions as the pipe connected to
        - are encased in concrete
        - are capped above grade
    - Where underdrain pipe changes direction, or where multiple pipes connect, drainage structures shall be underdrain portals (small manholes) that
        - have an inner diameter of 36 inches
        - have a maximum sump of 12 inches
        - support a 24-inch manhole frame and cover
        - are made of precast concrete designed to handle Cooper E-80 loads
    - Perforated pipe holes may be designed with ¾-inch diameter holes spaced longitudinally. 12-inches on center, with a minimum of 3-inches between hole centers laterally, and shall be encased in ¾-inch washed stone wrapped with filter fabric.