# Macro Approach Example to Meet Stormwater Standard 4 for MassDOT Highway Projects

# 1

# Introduction

MassDOT roadway and bridge projects are fundamentally linear in nature and, as a result, often face unique design challenges that make it difficult or impossible to meet stormwater management goals and regulatory requirements. These design challenges may include constraints such as proximity of wetlands or waterbodies, steep slopes, presence of bedrock, high groundwater, soils with poor infiltration capacity, limited Right-of-Way (ROW), and/or existing development which can interfere with meeting the Stormwater Standards.

MassDOT employs the Macro Approach on a highway project once it has been determined that it is impracticable to meet the Stormwater Standards at each design point (i.e., location of interest chosen by the designer such as outfall, receiving water body, wetland, downstream culvert, etc.). The Macro Approach was developed to document compliance with the Stormwater Standards on a project-wide scale rather than at each individual design point. MassDOT encourages the Macro Approach for constrained projects that require flexibility in meeting the Stormwater Standards so the design can maximize stormwater improvements on site. The Macro Approach can be used to demonstrate partial or full compliance with the following requirements:

- Standard 2 (Peak Rate Control)
- Standard 3 (Recharge)
- Standard 4 (Water Quality)

## 1.1 Purpose of this Example

This document presents a conceptual project example with the purpose of providing the reader a general understanding of the Macro Approach and how it could be employed to meet MassDEP Standard 4. This example is not meant to be exhaustive or show all

documentation required for the Stormwater Management Report. *Specific instructions or guidance are shown in blue italics.* Section 2.3.4 of the MassDOT Stormwater Design Guide (SDG) provides a description of the Macro Approach and its requirements, and the MassDOT Stormwater Management Report template[1] contains further detail and guidance on how to apply the Macro Approach to Standards 2, 3, 4, and 7. Figures and calculations included in this example are conceptual and were developed for illustrative purposes only.

1 See the template at: https://www.mass.gov/service-details/stormwater-management-massdot-environmental-services

# 2

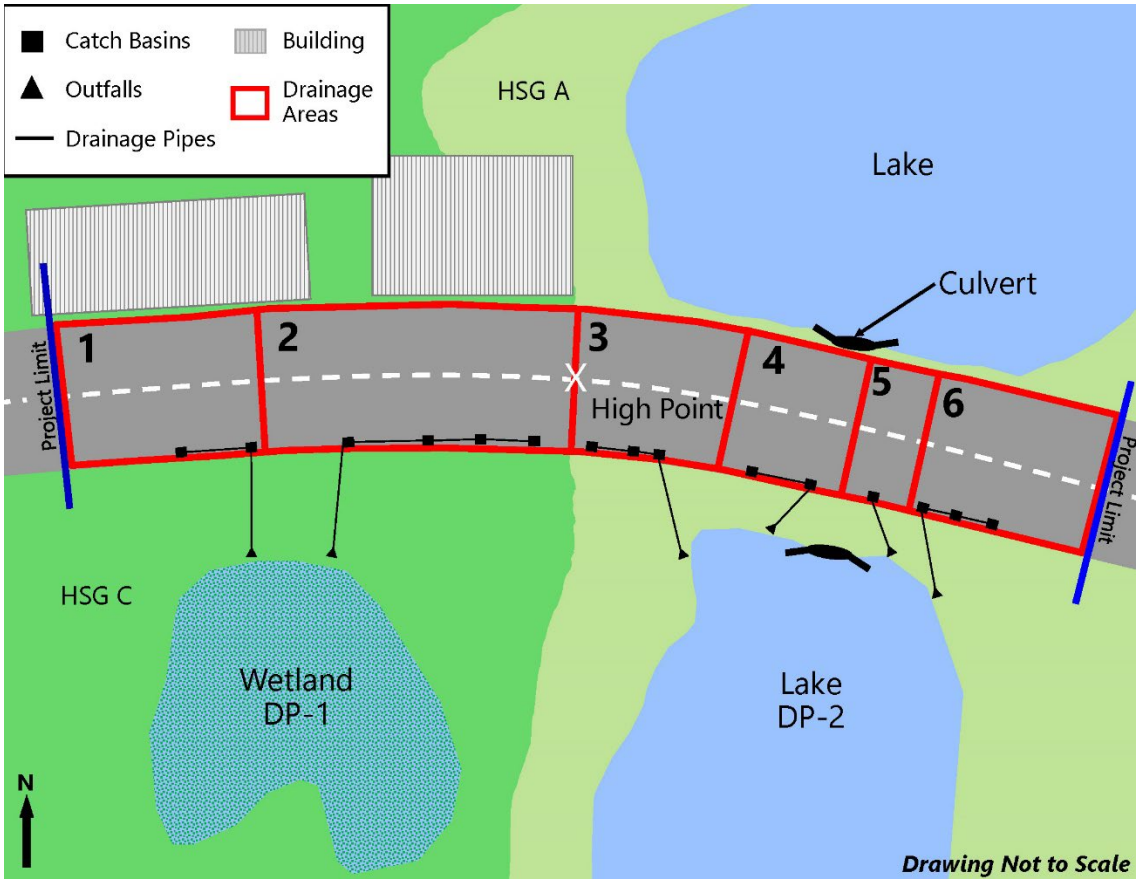
# Conceptual Project Example

## 2.1 Project Background and Approach

The project site consists of an existing two-lane highway with no shoulders. As shown in Figure 1, the highway is constrained by a wetland, lake, and existing buildings located adjacent to the highway. The highway crosses the lake at one location where a culvert provides a hydraulic connection between the two lake segments. Stormwater runoff is collected by catch basins along the edge of road and discharged through outfalls directly to the lake or near the wetland.

- **Location:** This project is located within the 100-foot buffer of a Resource Area and therefore subject to the Wetlands Protection Act. The project does not discharge to a Critical Area or Land Use with Higher Pollutant Loads (LUHPPLs).
- **Soil information:** Information on NRCS mapping of HSGs are provided in Table 1 and in Figures 1 and 2. Test pit results are not yet available.
- **TMDLs:** The lake has a final TMDL for total phosphorus so the WQDF requires SCMs that reduce phosphorus loading.

**Figure 1 Existing Conditions**



Under proposed conditions as shown in Figure 2, the highway will be expanded so that there will be a third lane south of the existing lanes. The stormwater design will consist of one new bioretention basin and two new infiltration basins to treat runoff from the existing highway lanes and new lane to be constructed. The existing drainage infrastructure along the southern edge of the existing lanes will be relocated to the southern edge of the new lane. The bioretention basin (SCM #1) will be located in Hydrologic Soil Group (HSG) C soils and the infiltration basins (SCM #2 and #3) will be located in HSG A soils.

**Figure 2 Proposed Conditions**

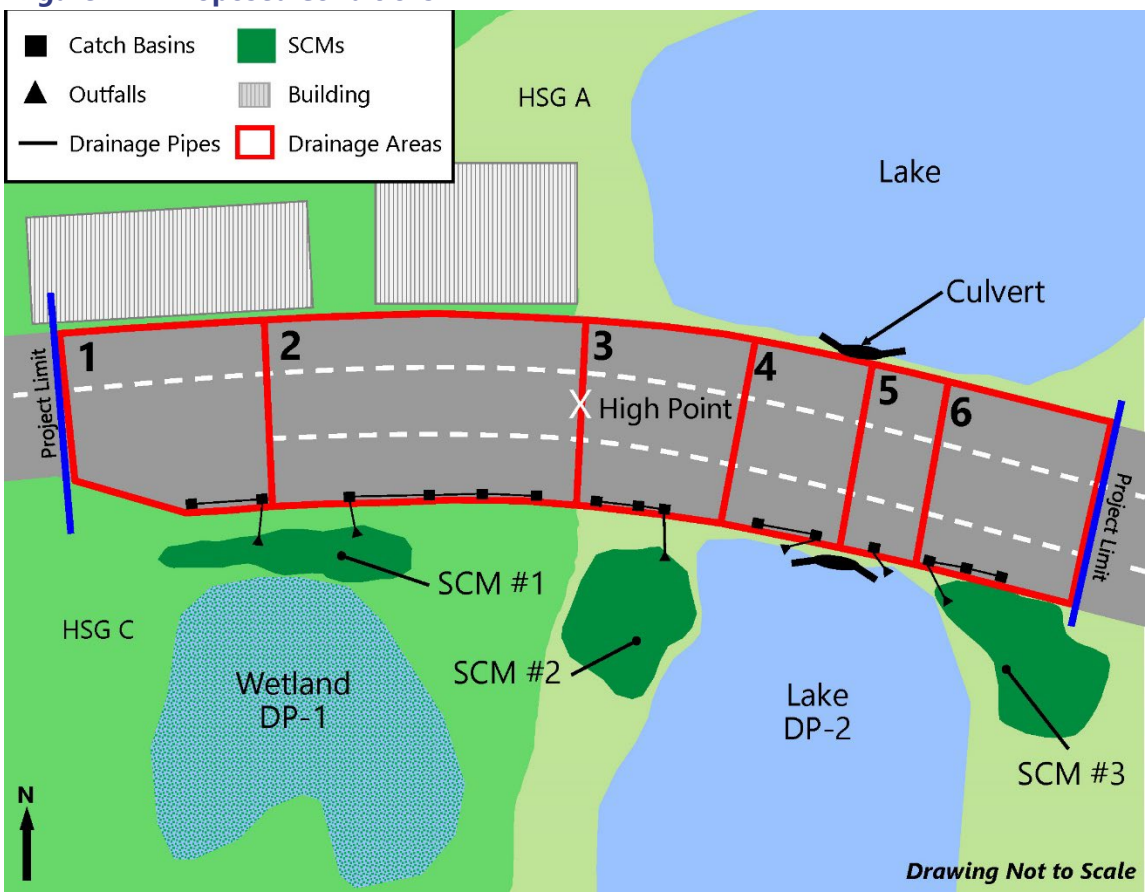



**Table 1 HSG Types and Drainage Areas**

| HSG | Drainage Area | Existing IA (sf) | Proposed Total IA (sf) | Proposed New IA (sf) |
|---|---|---|---|---|
| C | DA-1 | 40,000 | 60,000 | 20,000 |
| | DA-2 | 80,000 | 120,000 | 40,000 |
| A | DA-3 | 40,000 | 60,000 | 20,000 |
| | DA-4 | 30,000 | 45,000 | 15,000 |
| | DA-5 | 10,000 | 15,000 | 5,000 |
| | DA-6 | 40,000 | 60,000 | 20,000 |
| **Total** | | 240,000 | 360,000 | 120,000 |

## 2.2 Application of Macro Approach

***Step 1: Use the guidance in SDG Section 2.2.1 on Standard 4 (Page 2-30) to identify the requirements for water quality treatment***

*This project is considered both new development and redevelopment (the new lane requires full compliance and the existing lanes to the MEP) and is subject to MassDEP WPA regulations. Therefore, the approach to compliance is as follows:*

- ✓ *Follow the Regulatory Requirements guidance (on page 2-30 of the SDG).*

  *To meet MassDEP Standard 4, these requirements should be met:*

  - ✓ *Treatment of WQV (0.5 or 1.0 inch times impervious area) to achieve at least 80% TSS reduction of new IA within the project limits, calculated using Massachusetts Stormwater Handbook (2008)*
  - ✓ *Provide treatment to the MEP for existing IA and improve existing conditions.*
  - ✓ *Develop a Long-Term Pollution Prevention Plan (LTPPP).*

- ✓ *Follow the requirements provided in the WQDF.*

**MassDEP Standard 4 Requirements:**

The project does not discharge to a Critical Area or LUHPPL so a minimum of 0.5 inches (versus 1.0 inches) should be treated over the new impervious area, the existing impervious area should be treated to the MEP, and the design should improve existing conditions. Table 2 below shows the Water Quality Volume (WQV) requirements by design point.

**Table 2 WQV at Each Design Point**

| Design Point | WQV for New IA (cf) | WQV for Existing IA (cf) | Total WQV (cf) |
|---|---|---|---|
| **DP-1** | | | |
| DA-1 | 833[2] | 1,667 | 2,500 |
| DA-2 | 1,667 | 3,333 | 5,000 |
| **Total** | **2,500** | **5,000** | **7,500** |
| **DP-2** | | | |
| DA-3 | 833 | 1,667 | 2,500 |
| DA-4 | 625 | 1,250 | 1,875 |
| DA-5 | 208 | 417 | 625 |
| DA-6 | 833 | 1,667 | 2,500 |
| **Total** | **2,500** | **5,000** | **7,500** |
| **Project Total** | **5,000** | **10,000** | **15,000** |

[2] As an example calculation, 20,000 sf (from Table 1) x 0.5 in = 833 cf

***Step 2: Follow the five major steps of the Macro Approach in SDG Section 2.3.4 (Page 2-49).***

1. *Identify downstream areas of potential impact and design points.*
2. *Demonstrate and document (as explained herein) that the Standard cannot be practicably met at each design point.*
3. *Explore combining design points, located within the same drainage area to receiving water bodies, to reduce the number of discharge points for individual analysis.*
4. *Design the overall highway drainage system to meet stormwater management objectives.*
5. *Document use of the Macro Approach in the Stormwater Management Report.*

Two design points were identified for this project as shown on Figure 2.

- Design Point 1 (DP-1) is a wetland that receives runoff from Drainage Areas 1 and 2.
- Design Point 2 (DP-2) is a lake that receives runoff from Drainage Areas 3, 4, 5, and 6.

As shown in Figure 1, the existing highway is within a constrained corridor.

- Drainage Areas 4 and 5 are completely constrained by the lake on either side so there is no available land to treat runoff.
- Drainage Areas 1 and 2 are constrained by buildings to the north and a wetland to the south. There is a small amount of pervious area between the highway and the wetland but there are poorly draining soils and high groundwater.
- Drainage Areas 3 and 6 have some constraints with the lake nearby but there is space for larger SCMs and the soils have higher infiltration rates.

Low Impact Development practices were reviewed, and the project design was able to incorporate the preservation and enhancement of vegetation and maintenance of pre-development drainage patterns.

SCM types were reviewed and three SCMs were chosen. Due to high groundwater and poorly draining soils, a bioretention basin (SCM #1) is proposed to treat Drainage Areas 1 and 2 which discharge to DP-1. To take advantage of the sandy soils and high infiltration capacity in Drainage Areas 3 and 6, two large infiltration basins (SCMs #2 and #3) are proposed, both of which discharge to DP-2. No SCMs are proposed to treat Drainage Areas 4 and 5 due to site constraints from the lake. *The designer should use the MassDOT Stormwater Management Report template to document that all reasonable efforts were made to meet Standard 4 including explanation of all constraints at the site and consideration of all possible integrated site design practices, LID techniques, and SCM categories.*

The proposed drainage system was reviewed to identify if outfalls could be combined to reduce the amount of discharge points and more treatment could be provided. The discharge points, as shown on Figure 2, were determined based on low points of the road and gutter spread requirements.

Table 3 shows the WQV provided by each SCM at each design point.

**Table 3 WQV Provided by the SCMs at Each Design Point**

| Design Point | Pretreatment | WQV Provided (cf) | Meets Required WQV for New IA | Meets Total WQV |
|---|---|---|---|---|
| **DP-1** | | | | |
| SCM 1 | Yes | 1,000 | **No** | **No, but to MEP** |
| **Total** | | **1,000** | | |
| **DP-2** | | | | |
| SCM 2 | Yes | 2,000 | **Yes** | **No, but to MEP** |
| SCM 3 | Yes | 2,000 | | |
| **Total** | | **4,000** | | |
| **Project Total** | | **5,000** | **Yes** | **No, but to MEP** |

As described earlier, the design needs to treat a WQV equal to 0.5 inches over the new impervious area and 0.5 inches to the MEP over the existing impervious area at each design point to meet Standard 4. The project also needs to improve existing conditions.

In DP-1, the project SCM only provides 1,000 cf treatment due to site constraints (i.e., poorly draining soils, high groundwater). The design does not provide the required WQV for new impervious, nor the total WQV. In DP-2, there is greater potential for treatment since the soils are sandy and there is more space to build larger basins. Within DP-2, the project SCMs provide a total of 4,000 cf of treatment even though only 2,500 cf is required for the new impervious area. The basins provide less than the 7,500 cf for total WQV, but the SCMs are made as large as possible to provide treatment to the maximum extent practicable. The basins are oversized in DP-2 and provide more treatment than required in order to compensate for the treatment deficit in DP-1.

Therefore, as an overall project, the design provides treatment for 5,000 cf, which meets the required WQV for new impervious. It does not meet the total WQV goal of 15,000 cf, but the design provides treatment to the maximum extent practicable due to site constraints. Additionally, the project improves existing conditions since the site currently provides no water quality treatment. This conceptual project example shows how the project uses the Macro Approach to meet the requirements of Standard 4.