SPECIAL FACTORS TO CONSIDER IN APPLYING STORMWATER MANAGEMENT MEASURES AND DEVELOPING A STORMWATER POLLUTION CONTROL PLAN FOR AN EXISTING HIGHWAY ENVIRONMENT

The improvement of existing roadways involves unique constraints associated with the fixed alignment and linear configuration of the roadway facility. Unlike a typical "site development" project, the opportunity to use site planning to configure the various elements of a roadway improvement design is very limited in the "existing roadway" setting. As described in more detail in the following sections, existing transportation facilities are subject to numerous unique constraints that do not usually affect new development on undeveloped, more consolidated sites. The inclusion of post-construction stormwater management measures and objectives detailed in DEP's 2004 Connecticut Stormwater Quality Manual, and LID requirements in particular, are often not well-suited for our highway projects. Some of these limitations and complications with implementing them in the highway environment are listed below and described in detail below:

- Limited Rights of Way
- Engineering compatibility
- High groundwater
- Limited depth to bedrock
- Adjacent land uses
- Utility conflict
- Maintenance and inspection
- Soil stability issues
- Construction feasibility
- Safety considerations
- Steep topography
- Cost
- Contaminated soils

ConnDOT Storm Water Treatment Measures – Limitations & Considerations

	Considerations for Roadway and Drainage Design
Limited Rights of Way	Public right-of-way within existing highway corridors is typically limited. Available right-of-way width can severely limit the choice of storm water management facilities and their locations. Sufficient space must be available within the right-of-way to accommodate the BMP, ancillary structures, grading requirements, safety and clear zone setbacks, and applicable regulatory setbacks. Space also needs to be provided for operation and maintenance access. Acquisition of additional permanent right-of-way for implementation of BMP's may be constrained by available funding, by the short time frames of certain types of highway projects (e.g., for operational or funding reasons), and by landowner opposition. While there are mechanisms that allow the permanent acquisition of privately-owned property, a significant amount of judgment must be exercised to determine to what extent, if any, the taking of property is reasonable at each location. The scope of the property acquisition must be commensurate with the scope of the project in terms of both cost and adverse effects to homes and businesses. Additionally, property acquisitions often require 18 months or more, which may cause unacceptable delays on high profile projects or safety improvements. Designers and Rights-of-Way staff need to consider whether additional right-of-way can be reasonably obtained, given the project scope, location, nature of other adjacent land uses, and project funding. BMP's that cannot fit within available right-of-way (including practicable takings) are not satisfactory candidates for storm water management measures.
Engineering Compatibility	Department highway and drainage design standards must be applied consistently through projects. BMP's must allow for the effective drainage of the highway surface and sub-base, consistent with standard engineering practice for roadway design, and with the objectives of public safety and roadway structural integrity.

	Considerations for Roadway and Drainage Design
High Groundwater	Roadways may require sub-drains to control the effect of groundwater levels on the pavement structure. These methods may be required to control the effect of local groundwater levels on the sub-structure of the road to limit frost action and to prevent premature deterioration. Stormwater treatment methods which infiltrate water into areas below the roadway, conflict with these measures. Also, to the extent these construction methods use up available right-of-way, the choice of BMP's may be limited. Certain BMP's require minimum clearances to groundwater. For example, recharge BMP's must have at least two feet of clearance (and sometimes more) between the infiltration surface and seasonal high groundwater. Where such clearances are not available, recharge BMP's may not be practical. Other BMP's such as a wet pond may utilize groundwater levels to maintain a minimum water elevation. Maximum and typical ground water elevations should be investigated utilizing test wells prior to finalizing a decision to use these BMP's.
Limited Depth to Bedrock	The presence of bedrock close to the surface in a roadway right-of-way can significantly affect the choice of drainage system, BMP type, and location.
Soil Permeability Limited	Certain soils will not offer practicable locations for certain BMP's. For instance, recharge BMP's cannot be located in Hydrologic Group D soils, and may be problematic in other soils as well (e.g., where receiving soils are prone to clogging under anticipated design conditions). See Appendix 2.
Soil Stability Issues	The structural properties of underlying soils, as well as erodibility and frost susceptibility are important considerations in the design of the highway cross section (i.e., embankment, cut slopes, and pavement structure), the choice of type of drainage system, and type of BMP.
Contaminated Soils Contaminated Soils (continued)	The presence of contaminated soils can affect cuts and fills, final proposed roadway elevations, methods of construction, right-of-way decisions, as well as the choice and design of storm water BMP facilities. It is undesirable (and also a potential legal liability) to infiltrate water into contaminated (even low level) soils. This will eliminate stormwater treatment measures which function in this manner. Parcels that may contain contaminated soils are also a concern in the acquisition of property. This must be investigated and considered.
Contaminated Groundwater	When contaminated groundwater is present, the infiltration of additional water should only be done following careful consideration of geology and groundwater hydraulics, since it may cause undesirable movement or accelerate the movement of the contaminated plume. Infiltration BMP's or wet pond systems may not be suitable when contaminated groundwater is present because of possible exchanges between groundwater and surface waters, which may occur in either direction at different times.
Salt Contamination	There is significant concern raised by the public that water-supply wells in the vicinity of Department roadways might become contaminated by salt applied in winter snow operations. This issue needs to be examined based on these concerns and the associated liabilities, prior to infiltration of stormwater containing dissolved salts.
Construction Feasibility and Accessibility	Roadway improvement projects can be difficult to construct. Even though the general site conditions may be favorable for a certain BMP, some types of treatment measures may not be constructible due to requirements to maintain and protect traffic, or due to inaccessibility of the site to construction equipment. Existing traffic must be accommodated during roadway improvement projects. The installation of deep sump catch basins or other underground structures at the edge of pavement of shoulder may be restricted. Treatments proposed at the toe of a tall, steep fill embankment with mature vegetation is a common example of a site that presents a significant challenge to the construction methods and the capabilities of standard construction equipment. Designers need to visualize actual construction conditions and construction personnel need to be consulted in such cases.
Hydraulic Head Limitations	Most BMP's depend on gravity flow for their operation, and many will require minimum operating depths for their effective function. Flat slopes may restrict certain BMP's, if those BMP's need more hydraulic

	Considerations for Roadway and Drainage Design
	head than available given the site topography. The designer must consider the required operating head of a BMP in the screening process, as well as in the design. If multiple BMP's will be used, the combined hydraulic head requirement must be considered, and compared to the available vertical clearance at the site. Furthermore, some BMP's have underground structures, piping, or other components. The depth of cover over these components must be considered in determining whether BMP's can be installed within available vertical clearances.
Steep Topography	Location of a highway and development of the longitudinal highway profile area greatly dependent on topography. Longitudinal profile depends on alignment standards for safety, drive-ability, and drainage. Cross section is dependent on safety standards, slope stability, and available right-of-way. As a result of these factors, existing topography and required finished slope grades can constrain the amount of space available for installation of drainage facilities. Slopes can thus affect the choice of closed drainage over open drainage, the selection of water quality BMP's, and the selection of structural surfaces versus vegetation for stabilization. Slopes can also affect the choice of BMP's because of BMP design considerations; for instance, steep slopes may constrain the site of a detention basin, because a sufficient storage volume would require an excessively high impoundment berm.
Limited Contributing Drainage Area	Certain BMP's have recommended minimum drainage areas considered suitable for the practices. For example, the minimum area recommended for an Extended Detention Basin is 10 acres, unless the extended detention outlet control can be designed to prevent clogging. BMP's that are not sustainable by the contributing area can be eliminated from further consideration. However, the designer should note that the minimum drainage areas recommended from some BMP's (such as ponds and wetlands) should not be considered inflexible limits and may be increased or decreased depending on water availability (base flow or groundwater) or the mechanisms employed to prevent clogging of outlet structures. Certain BMP's have recommended maximum drainage areas considered suitable for the practices. For example, the maximum area recommended for a subsurface recharge system (trench or bed) is 5 acres. The size of the drainage area of a roadway drainage system is in part indicated by the number of drainage inlet structures contained in it. Based on past Department practice, drainage systems which contain a limited number of catch basins have been typically allowed a reduced set of appropriate stormwater treatment measures. This common sense approach should still apply. Extraordinary treatment measures are generally not warranted for small drainage systems with only a small number of catch basin inlets and a limited flow volume.
Safety Considerations	Safety is of paramount concern in the roadway setting. Designers are charged with the responsibility of developing publicly-funded projects that improve safety and meet established design standards for safety. Any stormwater BMP must be compatible with safety requirements. Depending on particular site conditions, this may rule out the use of certain BMP's, or affect their placement and design if they are used. Along heavily used roadways (such as limited access highways and urban arterial roadways), the safety implications posed by a particular BMP that may require frequent inspection or maintenance must be considered. BMP's should be selected and sited so that inspectors and maintenance crews can access and service them, with an absolute minimum of disturbance to traffic flow and possible incident. In addition, other public safety concerns will need to be considered. For example, in residential settings, the provision of BMP's that have open pools of water may be very undesirable because of public safety concerns (e.g., accidental drowning, attractive nuisance concerns, insect/pest considerations.) These may also require extra monitoring, special design requirements and access controls (e.g., protective fencing).

	Considerations for Roadway and Drainage Design
Development Density	Density, land-use type, types of structures, and other man-made features in the landscape, affect the location of highway improvements and the selection and design of drainage system components. For example, the presence of a major building and its foundation in close proximity to the right-of-way can significantly limit the choice of drainage facilities for both conveyance and treatment. Some BMP's which required a large amount of area or open water are not suitable for highly developed areas. Similarly some treatment measures such as underground treatment chambers may be improper to utilize in open rural areas.
Adjacent Land Uses	The need to avoid unreasonable adverse effects on residential, commercial or industrial properties, or other features important to the community or other stakeholder groups may preclude the responsible implementation of some treatment practices. Also, in such cases, designers should discuss the proposed activity during the early design stages with the appropriate regulatory agencies, town staff, abutters, and other stakeholders.
Adjacent Wells/Septic	Property adjacent to a roadway project may contain water supply wells and on-site sewage disposal systems. The presence of these facilities may limit the extent to which the existing roadway drainage system can be modified, and can also constrain the placement of new BMP's. In some cases, these facilities may preclude use of certain BMP's (e.g., recharge BMP's should not be placed within the zone of influence of a water supply well or a septic field).
Utility Conflict	Roadway rights-of-way are frequently shared by other utilities, including above-ground power and communications systems, and below-ground power, communications, gas, water, sanitary, and storm drain conduits. Also, existing utilities may be located outside the right-of-way but in close proximity to the roadway. Aerial or underground utility installations such as these may limit options for retrofit stormwater treatments. The relocation of utilities which utilize gravity flow (such as sanitary sewer) may not be possible in all cases.
Cost	Designers are charged with the responsibility of developing publicly-funded projects that meet all design objectives (including environmental protection) in a cost-effective manner. The combined life-cycle costs of rights-of-way, construction/installation, operation, maintenance and repair of any stormwater treatment measure must be commensurate with the overall scope of the project, available funding, the relative pollutant load of the drainage system, and the relative sensitivity of the receiving area. Stormwater treatments with extraordinary costs relative to these factors may be impractical for a given location. A reasonable guideline may be that the cost of the stormwater treatment should not exceed the estimated total cost of all other drainage work at the site.
Maintenance and Inspection	Maintenance and Inspection requirements of BMP's must be considered in the selection process. Preference should be given to measures that can be easily observed by maintenance staff and accessed without lane closures or elaborate traffic safety measures. Such measures and those that are familiar to maintainers are more likely to receive the attention they require. Preference should be given to treatments that can be maintained routinely with standard equipment available in District maintenance garages. Agreements will be required for BMP's, which are built by one agency and expected to be maintained by others. Typical maintenance concerns to be considered are: • Frequency of routine maintenance • Complexity of maintenance • Chronic maintenance problems such as clogging • Reported failure rates Maintenance staff should be provided an opportunity to comment on proposed treatment systems.
Natural Resources	Designs must also consider other sensitive public resources adjacent to the highway, including wetlands, wildlife habitat, historical features, scenic roads/rivers, and vegetated buffers that can influence the selection or placement of stormwater treatment measures. Environmental planners must provide assistance in determining the appropriate balance between the degree of stormwater treatment and adverse affects on other valuable resources. In some cases, other regulatory requirements, approvals, or protection objectives may apply to these resources.

Soils and Foundations Guidance for Stormwater Pollution Control Plan Submittals

The retention/infiltration of increased volume rather than detention of increased discharge, that is required for project subject to LID regulations, are often not practical for transportation related projects. Areas required for retention/infiltration systems tend to be significant. Most highways/roadways have limited rights-of-way, and much of the geology within those rights-of-way is not suitable for a retention/infiltration system. Examples of this include, but are not limited to; roadways in rock cuts; cut or at-grade roadways constructed within dense/impermeable glacial till/varved clay; cut or at-grade roadways in areas of high groundwater; roadway fills constructed with onsite material*; roadways supported by mechanically stabilized earth walls or steepened slope systems (often required to avoid encroachment into designated tidal or inland wetlands); roadways in areas of environmental concern (e.g. introducing groundwater flow into contaminated soil could result in unintended migration of the contaminants); etc. In general, water is a major cause/contributor to rapid roadway deterioration and embankment/cut slope instability resulting from saturation of the subbase / subgrade and/or embankment/cut soils. We strive to remove groundwater from beneath and alongside the roadway, not introduce more of it into the roadway geology. LID regulations and the use of retention/infiltration systems within highway project should be only applicable to projects that significantly increase impervious areas (as defined elsewhere in this document) and where the site geology allows design/construction of a retention/infiltration system that will not negatively impact the stability and safety of the transportation or abutting private facilities. Per the DEP's *2004 Connecticut Stormwater Quality Manual,* only locations with soils classified as NRCS Hydrologic Soil Group Type A are suitable for a retention/infiltration facility.

For those limit number of project where LID regulations apply, and in regards to Section 5(b)(1)(B)(v), (c), (d) and footnote 1 of the regulations, it is impractical to designate all areas within a project site to be either suitable or unsuitable for infiltration through the use of field permeability tests. Per the *2004 Connecticut Stormwater Quality Manual,* this task is best accomplished with a screening process using NRCS Hydrologic Soil Group maps (i.e. Soil Type A, B, D and D). Areas with unknown infiltration properties (e.g. artificial fills) could default to a conservative value based on the surrounding geology. Field permeability tests may be performed on a limited basis where the Engineer has determined they are warranted and only in specific areas designated for the design of an infiltration system. Design of the infiltration systems and its input should be determined by the design engineer and be subject to review by the permitting agent. Means and method of infiltration system designs/inputs should not be prescribed by the regulatory agency. Design of infiltration systems for Department projects would be in conformance with the DEP's *2004 Connecticut Stormwater Quality Manual* and the Department's *Drainage Manual* (Chapter 10).

*Standard construction methods per the ConnDOT's Form 816 calls for use of on site material for formation of embankments. Given that a large percentage of the state's surficial geology consist of glacial tills, the embankments often contain fine contents that are not suitable for retention systems. Use of a retention systems in a typical roadway embankment would likely lead to slope stability problems and subgrade failures.