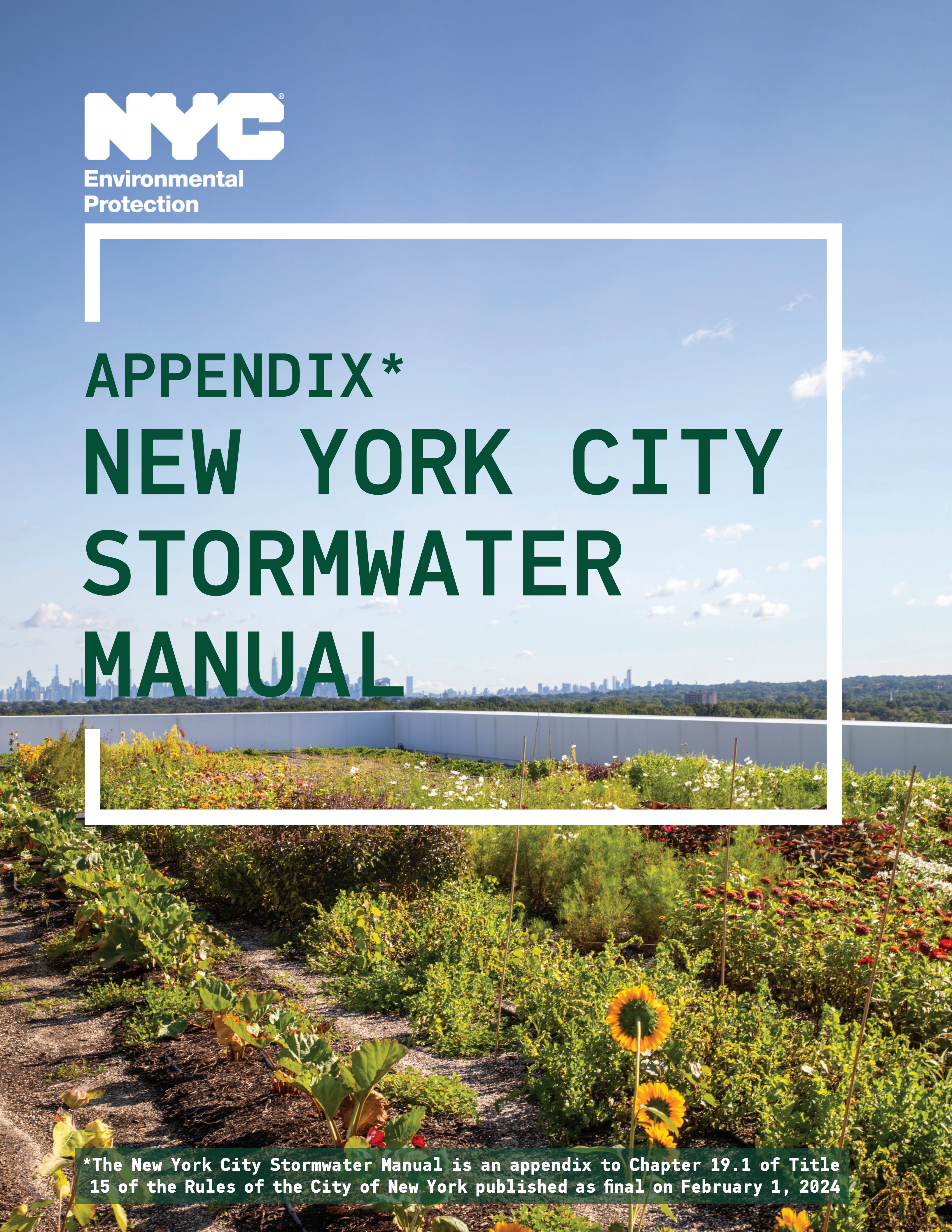
NYC Environmental Protection

APPENDIX*

NEW YORK CITY STORMWATER MANUAL



*The New York City Stormwater Manual is an appendix to Chapter 19.1 of Title 15 of the Rules of the City of New York published as final on February 1, 2024

New York City Stormwater Manual

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ACRONYMS

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ACRONYMS

Aic: Area of new impervious cover

A.S.T.M. The American Standards for the Testing of Materials, latest edition

BEPA: Bureau of Environmental Planning & Analysis or its successor

BMP: Best Management Practice

BWSO: The Bureau of Water & Sewer Operations or its successor

CSO: Combined Sewer Overflow

CSS: Combined Sewer System

DEP: The New York City Department of Environmental Protection or its successor Agency

DO: Dissolved Oxygen

DOB: The New York City Department of Buildings or its successor Agency

DOF: The New York City Department of Finance or its successor Agency

DOT: The New York City Department of Transportation or its successor Agency

ESC: Erosion and Sedimentation Control

HCP: House Connection Proposal

HSG: Hydrologic Soil Group

IC: Impervious Cover

MS4: Municipal Separate Storm Sewer System

NNI: No Net Increase

NOI: Notice of Intent

NOT: Notice of Termination

NYC SWM: New York City Stormwater Manual

NYSDEC: The New York State Department of Environmental Conservation

NYS SWMDM: New York State Stormwater Management Design Manual

O&M: Operations and Maintenance

PC: Post-Construction

POC: Pollutant of Concern

PPGH: Pollution Prevention and Good Housekeeping

ROW: Right of Way

RR: Runoff Reduction

RRv: Runoff Reduction Volume

SCP: Site Connection Proposal

sf: square feet

SMP: Stormwater Management Practice

SWPPP: Stormwater Pollution Prevention Plan

SWPTS: Stormwater Permitting and Tracking System

TN: Total Nitrogen

Vv: Sewer Operations Volume

WQ: Water Quality

WQv: Water Quality Volume

WRRF: Wastewater Resource Recovery Facility

New York City Stormwater Manual

GLOSSARY

NYC Environmental Protection

GLOSSARY

Agency: An agency of the City.

Applicant: The person filing the online application for a stormwater construction permit or a stormwater maintenance permit. This may be the owner, developer, qualified professional, or other person that is a registered user in the online application system.

Building: A structure having a specific Block and Lot (or tax sub-lot). In general, a structure will be considered a Building if it has a separate entrance from an outdoor area.

City: The City of New York.

Cleanout: Structure to allow access to subsurface pipes for cleaning.

Cleanout Pipes: Pipes that provide a connection between the cleanout and internal pipes to allow for regular maintenance.

Code: The Administrative Code of the City of New York.

Combined Sewer: A sewer receiving a combination of sanitary and/or industrial wastewater and stormwater runoff.

Combined Sewer Overflow (CSO): Sometimes, during heavy rain and snowstorms, a combined sewer system receives higher than normal flows. NYC wastewater resource recovery facilities (WRRFs) are unable to handle flows that are more than twice their design capacity and when this occurs, a mix of excess stormwater and untreated wastewater discharges directly into the City's waterways at certain outfalls to prevent upstream flooding. This is called a combined sewer overflow.

Combined Sewer System (CSS): A sewer system used to convey both wastewater and stormwater in a single pipe to WRRFs.

Commissioner: The Commissioner of the New York City Department of Environmental Protection.

Connection permit: A written authorization issued by the DEP to connect to an existing sewer or drain or an approved outlet.

Contractor: An entity retained by the Owner/Applicant to construct a facility.

Contributing (or contributory) drainage area: A drainage area bounded by the ridgelines of the furthest boundaries from which flow reaches a point of discharge.

Controlled-Flow Orifice: Orifice located within the outlet control structure used to reduce the flow rate out of a practice.

Conveyance Pipes: Umbrella term used to describe pipes that convey stormwater, which can include yard drains, as well as SMP specific pipes, such as bypass pipes, overflow pipes, and intake pipes.

Covered development project: Development activity that involves or results in an amount of soil disturbance greater than or equal to 20,000 square feet; or creation of 5,000 square feet or more of impervious surface; or covered roadway maintenance. Such term includes development activity that is part of a larger common plan of development or sale involving or resulting in soil disturbance greater than or equal to 20,000 square feet or creation of 5,000 square feet or more of impervious surface.

Covered Roadway Maintenance: Maintenance work that involves 20,000 sf or more in the municipal right of way (ROW) including milling and filling of existing asphalt pavements ("milling and paving") and replacement of concrete pavement slabs.

CSO Outfall: The physical point where a municipally owned or operated combined sewer discharges to surface waters of the state.

Department: The New York City Department of Environmental Protection (DEP).

Designer: A Qualified Professional.

Detention System: A system designed to slow and temporarily hold an accumulation of stormwater runoff and release it at a controlled rate.

Developer: A person that owns or leases land on which development activity that is part of a covered development project is occurring, or a person that has operational control over the plans and specifications for the development activity or covered roadway maintenance, including the ability to make modifications to the plans and specifications.

Developed Storm Flow: The developed average rate of storm runoff in cubic feet per second (cfs), which is computed using the "Rational Method." The "Rational Method" assumes a uniform block rainfall distribution over the entire tributary area, that the runoff hydrograph has the same shape with respect to time as the rainfall hyetograph, that the use of a weighted runoff coefficient for the tributary area is valid, and that the time of concentration of the tributary area is less than the duration of the rainfall event. It is used primarily for sewer design. For New York City areas of 10 square miles or less these assumptions are considered valid. For areas greater than 10 square miles, other modeling techniques may be more appropriate.

Development Activity: Creation of impervious surface and/or soil disturbance on a site including but not limited to land contour work, clearing, grading, excavation, demolition, construction, reconstruction, stockpiling activities or placement of fill. Clearing activities can include but are not limited to logging equipment operation, the cutting and skidding of trees, stump removal, and/or brush root removal. Such term does not include routine maintenance.

Disturbance Threshold: The minimum area of disturbed soil or created impervious surface as a result of development activities that triggers the need for a Stormwater Construction Permit.

Discharge: The introduction or release of any substance, whether knowing or unknowing, accidental or otherwise, to a public sewer or private sewer connected to a public sewer or to waters of the State and shall include indirect discharges as defined herein.

Drawdown: The process of stormwater emptying a practice storage area (surface or subsurface) through one or more of infiltration, evapotranspiration, reuse, filtration, or an outlet pipe.

Dual Function System: Cases in which one stormwater management practice is configured to support runoff management via two, equally contributing functions.

Erosion and Sediment Controls (ESC): Stormwater management practices designed to minimize the discharge of pollutants during development activities including, but not limited to, structural erosion and sediment control practices, construction sequencing to minimize exposed soils, soil stabilization, dewatering control measures, and other pollution prevention and good housekeeping practices (PPGH) appropriate for construction sites.

Evapotranspiration System: A system designed primarily to capture stormwater for evaporation and/or transpiration back into the atmosphere.

Filtration System: A system designed primarily to remove pollutants from stormwater by trapping and separating particles in stormwater as it passes through a porous media.

Floatables: Manmade materials, such as plastics, papers, or other products which, when improperly disposed of onto streets or into catch basins, can ultimately find their way to waterbodies and may create nuisance conditions with regard to aesthetics, recreation, navigation, and waterbody ecology.

Flow: A continuous movement of storm water or wastewater.

Forebay: A separate segment within a stormwater basin used to trap sediment, chosen to facilitate maintenance and removal of the sediment. Use of a forebay is intended to facilitate sedimentation and thus protect other unit treatment processes.

Fronting: An existing sewer or drain abutting an existing or proposed development.

Green Infrastructure (GI): Also known as and referred to throughout this Manual as stormwater management practices (SMPs), are designed to protect, restore, or mimic the natural water cycle within built environments by retaining, detaining, and/or treating stormwater runoff. Generally includes practices such as rain gardens, green or blue roofs, porous pavements, subsurface stormwater storage systems, and stormwater reuse systems.

GreenHUB: DEP's web-based application with data management capabilities that provides asset management for the green infrastructure practices citywide over their lifecycle, where designers upload the Project Tracking Spreadsheet.

Groundwater: Any existing water in subsoil stratums, including water from springs and natural underground streams, but excluding water from wells used for the delivery of potable or processed water.

Groundwater table: The actual depth of ground water below surface.

Head (Hydraulic Head): Energy represented as a difference in elevation. In slow-flowing open systems, the difference in water surface elevation, e.g., between an inlet and outlet.

House connection proposal (HCP): A plan showing proposed Sewer connection(s) to a City sewer, a Private sewer, a Private drain, or an approved outlet to serve Fee Simple One (1), Two (2) or Three (3) Family Dwelling Units less than 20,000 square feet in total site area, connecting to a sewer that is fronting the site.

Hybrid System: Cases in which two or more stormwater management practices of the same function are integrated as one practice.

Impaired Water: Includes (i) a water body for which NYSDEC has established a total maximum daily load ("TMDL"), (ii) a water body for which NYSDEC expects that existing controls such as permits will resolve the impairment, and (iii) a water body identified by NYSDEC as needing a TMDL. A list of impaired waters is issued by NYSDEC pursuant to section 303(d) of the federal water pollution control act, chapter 26 of title 33 of the United States code.

Impervious Area (Cover): All impermeable surfaces that cannot effectively infiltrate rainfall, including paved, concrete and gravel surfaces (e.g., parking lots, driveways, roads, runways and sidewalks); building rooftops; miscellaneous impermeable structures such as patios, pools, and sheds; and any portion of the site of a covered development project from which impervious cover was removed within five (5) years before SWPPP submission to the Department.

Impervious Surface: Any surface that cannot effectively infiltrate rainfall: generally, rooftops, pavements, sidewalks, and driveways.

Indirect Discharge: The term "indirect discharge" means a discharge from a private sewer to a public sewer, or a discharge to any street, gutter, pipe, channel, pumping station, catch basin drain, waterway, or other conveyance leading to or connecting with a public sewer, including but not limited to the placement or abandonment of any substance which could reasonably enter a public sewer under the force of stormwater or other influence.

Infiltration: Process of water percolating through a porous media, mainly in a downward direction, due to gravity. Infiltration rate (or infiltration capacity) is the maximum rate at which a soil in a given condition will absorb water.

Infiltration System: A system designed primarily to infiltrate stored or detained stormwater into soils below.

Inlet: Any structure that captures water which eventually drains to a practice, usually located at the low points of a site.

Internal Pipes: Perforated pipes inside the practice that can be used to evenly distribute or drain water in the stone base.

Invert: The bottom elevation of a channel, pipe, or manhole.

Larger Common Plan of Development or Sale: A contiguous area where multiple separate and distinct development activities are occurring, or will occur, under one plan. The term "plan" in "larger common plan of development or sale" is broadly defined as any announcement or piece of documentation including a sign, public notice of hearing, sales pitch, advertisement, drawing, permit application, uniform land use review procedure (ULURP) application, state environmental quality review act (SEQRA) or city environmental quality review (CEQR) application, application for a special permit, authorization, variance or certification pursuant to the zoning resolution, subdivision application, computer design, or physical demarcation (including boundary signs, lot stakes, and surveyor markings) indicating that development activities may occur on a specific plot. Such term does not include area-wide rezonings or projects discussed in general planning documents. For discrete development activities that are located within a larger common plan of development or sale that are at least 1/4 mile apart, each activity can be treated as a separate plan of development or sale provided that any interconnecting road, pipeline or utility project that is part of the same "common plan" is not concurrently being disturbed.

Lot: A tax lot as shown on the Tax map of the City.

Maintenance Entity: The entity identified by the owner that will be responsible for the long-term operation and maintenance of each post-construction stormwater management practice.

MS4 Area: Those portions of the city of New York served by separate storm sewers and separate stormwater outfalls owned or operated by the city of New York or areas served by separate storm sewers owned or operated by the city of New York that connect to combined sewer overflow pipes downstream of the regulator owned or operated by the city of New York, and areas in which municipal operations and facilities drain by overland flow to waters of the state, as determined by the department.

MS4 Project: Covered Development Project that is located in the MS4 area and has submitted a SWPPP to the SWPTS.

Multi-sector general permit (MSGP): The NYSDEC SPDES Multi-Sector General Permit for Stormwater Discharges Associated with Industrial Activity, Permit No. GP-0-17-004 or its successor.

Municipal Operations and Facilities: Any operation or facility serving a New York city governmental purpose and over which the City of New York has operational control.

No Net Increase (NNI): A pollutant load analysis included in the SWPPP that demonstrates adequate controls are in place such that the change in pollutant loading will not result in a net increase.

Notice of Intent (NOI): For MS4 projects or industrial stormwater sources in the MS4 area, the document submitted to NYSDEC to obtain coverage under the NYSDEC construction general permit or the multi-sector general permit, respectively.

Notice of Termination (NOT): For MS4 projects or industrial stormwater sources in the MS4 area, the document submitted to NYSDEC to terminate coverage under the NYSDEC construction general permit or the multi-sector general permit, respectively. For non-MS4 area projects, the term "notice of termination" or "NOT" means the document submitted to DEP to terminate coverage under the DEP SW construction permit.

NYC MS4 No Net Increase Calculator for Nitrogen: Interactive spreadsheet tool developed by DEP to help developers calculate post-development nitrogen load increases and select SMPs to manage total nitrogen. The calculator takes pre- and post-development inputs from the user and outputs net runoff volume and nitrogen load changes.

NYC MS4 Permit: The SPDES permit for MS4s of New York city, SPDES No. NY-0287890 or its successor.

NYSDEC Construction General Permit (CGP): The SPDES general permit for stormwater discharges from construction activities, Permit No. GP-0-15-002 or its successor.

Observation Well: Structure located within the footprint of a practice that allows monitoring of subsurface water levels.

Outlet Control Structure: Any structure that houses a controlled-flow device or weir that regulates drainage from a practice.

Outlet Pipe: A pipe that can drain water from a stormwater management practice before it is full, which typically connects the storage zone of the practice with a point of discharge.

Owner (for purposes of Chapter 19.1): A person having legal title to premises, a mortgagee or vendee in possession, a trustee in bankruptcy, a receiver, or any other person having legal ownership or control of premises.

Owner (for purposes of Chapter 31): Any individual, firm, corporation, company, association, society, institution or any other legal entity that owns the property, appurtenances, and easements compromising an existing or a proposed development.

Pathogens: Disease-producing agents such as bacteria, viruses, or other microorganisms. Fecal coliform is a pathogen-related water quality parameter.

Peak Runoff: The maximum stormwater runoff rate (cfs) determined for the design storm, or design rainfall intensity.

Person: Means an individual, corporation, partnership, limited-liability company or other legal entity.

Pollutant: Dredged soil, filter backwash, solid waste, incinerator residue, sewage, garbage, sewage sludge, munitions, chemical wastes, biological materials, radioactive materials, heat, wrecked or discarded equipment, rock, sand and industrial, municipal, and agricultural waste discharged into water; which may cause or might reasonably be expected to cause pollution of the waters of the State in contravention of the standards or guidance values adopted as provided in 6 New York codes, rules and regulations ("NYCRR") section 750-1.2(a).

Pollutant of Concern (POC): Pollutants causing the impairment of an impaired water segment listed in Appendix I of the New York City MS4 permit, including nitrogen, phosphorus, pathogens, and floatables.[1]

Ponding Depth: The depth of surface water within a practice.

Post-Construction Stormwater Management Practice or Post-Construction Practice: A stormwater management practice serving a developed site and consisting of technology or strategies designed to reduce pollutants in stormwater runoff or reduce runoff rate or volume from the developed site through infiltration, retention, detention, direct plant uptake, filtration, or other method or treatment. Such term includes, but is not limited to, detention systems and retention systems.

Post-Development: Relating to the site conditions such as land use, land coverage, topography, zoning, and corresponding hydrologic functions that will exist following proposed development activities.

Pre-Development: Relating to the site conditions such as land use, land coverage, topography, zoning, and corresponding hydrologic functions that exist prior to proposed development activities.

Qualified Inspector: A person who is knowledgeable in the principles and practices of erosion and sediment control, such as a licensed Professional Engineer, a Certified Professional in Erosion and Sediment Control (CPESC), or a Registered Landscape Architect.

This term can also mean someone working under the direct supervision of, and at the same company as, the licensed Professional Engineer or Registered Landscape Architect, provided that person has training in the principles and practices of erosion and sediment control. Training in the principles and practices of erosion and sediment control means that the individual working under the direct supervision of the licensed Professional Engineer or Registered Landscape Architect has received four (4) hours of NYSDEC endorsed

[1] The 2018 NYS 303(d) list and Appendix I (Impaired Water Segments and Pollutants of Concern) of the 2022 MS4 Permit have replaced reference to "pathogens" with "fecal coliform" and reference to "floatables" with "garbage and refuse;" see also Table 2.4 of this Manual.

training in proper erosion and sediment control principles from a Soil and Water Conservation District, or other NYSDEC endorsed entity. After receiving the initial training, the individual working under the direct supervision of the licensed Professional Engineer or Registered Landscape Architect shall receive four (4) hours of training every three (3) years. This term can also mean a person that meets the Qualified Professional qualifications in addition to the Qualified Inspector qualifications.

Note: Inspections of any post-construction stormwater management practices that include structural components, such as a dam for an impoundment, shall be performed by a licensed Professional Engineer.

Qualified Professional: A person who is knowledgeable in the principles and practices of stormwater management and treatment such as a licensed professional engineer or a registered landscape architect or other NYSDEC endorsed individual(s).

Individuals preparing SWPPPs that require the post-construction stormwater management practice component must have an understanding of the principles of hydrology, water quality management practice design, water quantity control design, and, in many cases, the principles of hydraulics. All components of the SWPPP that involve the practice of engineering, as defined by Article 145 of the NYS Education Law, shall be prepared by, or under the direct supervision of, a professional engineer licensed to practice in the State of New York.

Reuse System: A system designed primarily to store or detain stormwater for onsite uses.

Retention: The process of holding or retaining runoff close to the source for infiltration, evapotranspiration, or reuse.

Retention System: A system designed to capture an accumulation of stormwater runoff on site through infiltration, evapotranspiration, storage for reuse, or some combination of these.

Routine Maintenance Activity: A maintenance activity, including, but not limited to:

- Re-grading of gravel roads or parking lots
- Stream bank restoration projects (does not include the placement of spoil material);
- Cleaning and shaping of existing roadside ditches and culverts that maintains the approximate original line and grade, and hydraulic capacity of the ditch;
- Cleaning and shaping of existing roadside ditches that does not maintain the approximate original grade, hydraulic capacity and purpose of the ditch if the changes to the line and grade, hydraulic capacity or purpose of the ditch are installed to improve water quality and quantity controls (e.g. installing grass lined ditch);
- Placement of aggregate shoulder backing that makes the transition between the road shoulder and the ditch or embankment;
- Removal of sediment from the edge of the highway to restore a previously existing sheet-flow drainage connection from the highway surface to the highway ditch or embankment; and
- Replacement of curbs, gutters, sidewalks, and guide rail posts; and
- Repairs made to SMPs to restore them to former condition or to operating order.

Runoff: Overland stormwater flow that is not absorbed into the ground.

Runoff Coefficient: The fraction of total rainfall (volume or rate) that appears as total runoff (volume or rate) for a given type of land cover.

Separate Stormwater Outfall: A point where stormwater from a storm sewer or other source of concentrated stormwater flow, owned or operated by the city of New York, is discharged into a water of the state or to a separate storm sewer system that requires coverage under the NYSDEC MS4 general permit.

Sewer: A pipe or conduit for carrying sewage and/or stormwater. Except where otherwise specified or where the context clearly dictates otherwise, the term "sewer" must refer to a public sewer.

Sewer Certification: A house connection proposal application or site connection proposal application to certify the adequacy of the existing abutting sewer to receive site storm and sanitary discharge from a development.

Sewer Connection: That part of a sanitary, stormwater, or combined sewer disposal pipe, which extends from the property line to an existing City sewer, a Private sewer, a Private drain, or an approved outlet under the jurisdiction of the DEP.

Site: The area that is being developed.

Site Connection Proposal (SCP): A plan showing proposed Sewer connection(s) from existing or proposed developments other than a House Connection Proposal.

Site Connection Proposal (SCP) Certification: The Department's acceptance of a Site Connection Proposal.

Slope: Land gradient described as the vertical rise divided by the horizontal run expressed in percent.

Storm Sewer: A sewer, which conveys only stormwater.

Stormwater or Stormwater Runoff: The excess water running off the surface of a drainage area during, and immediately following, a period of precipitation. For the purposes of the stormwater construction permit, precipitation includes rain events or snowmelt.

Stormwater Construction Permit: A permit issued by the department authorizing development activity on land on which there is a covered development project with an approved SWPPP.

Stormwater Maintenance Permit: A permit issued by the department where maintenance is required of post-construction stormwater management practices by owners of real property benefited by such facilities.

Stormwater Management Practice (SMP): Measure to prevent flood damage or to prevent or reduce point source or nonpoint source pollution inputs to stormwater runoff and water bodies. Such term includes ESC, post-construction SMPs, and practices to manage stormwater runoff from industrial activities.

Stormwater Permitting and Tracking System (SWPTS): The Department's online system for submitting applications for a Stormwater Construction Permit or for checking the status of an existing application.

Stormwater Pollution Prevention Plan (SWPPP): (i) when used in connection with a covered development project, a plan for controlling stormwater runoff and pollutants during construction and, where required by these rules, after construction is completed, or (ii) when used in connection with an industrial stormwater source, a plan, which is required by the MSGP, for controlling stormwater runoff and pollutants.

Stormwater Pollution Prevention Plan (SWPPP) Acceptance Form: The form used to indicate acceptance of a SWPPP by the Department.

Stormwater Pollution Prevention Plan (SWPPP) Approval: The Department's initial approval of the application for a Stormwater Construction Permit

Stormwater Release Rate: The rate at which stormwater is released from a site, calculated in terms of cubic feet per second (cfs)

Subsurface Loaded Practices: Practices designed to have stormwater enter the facility below-grade.

Surface Loaded Practices: Practices designed to have stormwater enter the facility through the surface.

Surface Waters of the State or Waters of the State: Lakes, bays, sounds, ponds, impounding reservoirs, springs, rivers, streams, creeks, estuaries, marshes, inlets, canals, the Atlantic ocean within the territorial seas of the state of New York and all other bodies of surface water, natural or artificial, inland or coastal, fresh or salt, public or private (except those private waters that do not combine or effect a junction with natural surface or underground waters), which are wholly or partially within or bordering the state or within its jurisdiction.

Temporary Shutdown: The suspension of development activity at a site with an approved stormwater construction permit.

Time of Concentration (Tc): The time for runoff to travel from the hydraulically most distant point of the drainage area to the watershed outlet or study point.

Trained Contractor: An employee of a contracting (construction) company, who has received four hours of NYSDEC-endorsed training in proper erosion and sediment control principles from a soil and water conservation district, or other NYSDEC-endorsed entity. After receiving the initial training, the trained contractor must receive four hours of training every three years. The term can also mean an employee of a contracting (construction) company who meets the qualifications required to be a qualified inspector. The trained contractor is responsible for the day-to-day implementation of the SWPPP during development activities.

Tributary Drainage Area: The amount of surface area that drains to a practice or point of study.

Unified Stormwater Rule: Chapters 19.1 and 31 of title 15 of the rules of the city of New York.

Weighted Runoff Coefficient: The fraction of total rainfall (volume or rate) that appears as total runoff (volume or rate) for a drainage area, calculated as an area-based, weighted average of the runoff coefficients for the various types of land cover present in the drainage area.

New York City Stormwater Manual

Chapter 1

INTRODUCTION

01 INTRODUCTION

The New York City Department of Environmental Protection (DEP) is charged with preserving and enriching the environment and safeguarding public health for all New Yorkers. Stormwater management is a critical element of DEP's work, and with the promulgation of a Unified Stormwater Rule and release of this NYC Stormwater Manual (SWM) in 2022, NYC entered a new era of stormwater management. The Unified Stormwater Rule updated and aligned water quantity requirements in the city's combined sewer drainage areas with water quality requirements in separately sewered drainage areas, providing a comprehensive, citywide stormwater management policy for public and private development. This NYC Stormwater Manual (SWM) provides technical guidance for developers, designers, and engineers who work with DEP on stormwater permitting.

The Unified Stormwater Rule and the technical guidance within this Manual emphasize a retention-first, green infrastructure approach to stormwater management practice selection and design, applying lessons learned during more than ten years of implementing the NYC Green Infrastructure Program, through which DEP and partners have constructed over 11,000 distributed green infrastructure practices across the city.

Green infrastructure practices, also known as and referred to throughout this Manual as stormwater management practices (SMPs), are designed to protect, restore, or mimic the natural water cycle within built environments by retaining, detaining, and/or treating stormwater runoff. SMPs generally include practices such as rain gardens, green or blue roofs, porous pavements, subsurface stormwater storage systems, and stormwater reuse systems. These practices are important and demonstrably effective tools for stormwater management in NYC, allowing stormwater to be managed where it falls and reducing, filtering and/or slowing the amount of stormwater entering the City's sewer system.

In NYC, SMPs are reducing Combined Sewer Overflows (CSOs), decreasing the amount of polluted stormwater runoff entering waterbodies, and increasing capacity within City infrastructure. When coupled with vegetation or other siting goals, SMPs provide benefits beyond stormwater management: increased urban greening, reduced urban heat island, minimized urban flooding, and improved habitats for birds and pollinators.

The Unified Stormwater Rule brought together two DEP stormwater regulation programs: Site/House Connection Proposal Certification and Stormwater Construction/Stormwater Maintenance Permitting ("Stormwater Permitting"). This unification has allowed applicants and designers to approach projects with a clear understanding of the individual permit objectives and the technical requirements for compliance. It also created a consolidated technical approach for applicants seeking to implement SMPs to meet both application objectives.

This chapter provides more information on NYC's stormwater management regulatory framework, the purpose and scope of this Manual, and an overview of the other chapters and technical guidance included.

This NYC SWM provides the technical guidance necessary for compliance with the Unified Stormwater Rule, providing the core benefits summarized below:

- **Consistent approach to water quality and sewer operation objectives across combined sewer system (CSS) and Municipal Separate Stormwater Sewer System (MS4) areas;**
- **A retention-first SMP hierarchy that requires a feasibility assessment for implementation of retention-based practices to reduce the amount of stormwater entering City sewers and to maximize SMP benefits;**
- **Increased on-site detention requirements to reduce loading rates on City sewers; and**
- **Prioritization of green, vegetated SMPs to provide co-benefits to NYC residents and to align with the sustainable roofing requirements of the Climate Mobilization Act of 2019.**

1.1. Background

Like other ultra-urban cities, NYC is faced with increasing challenges from managing stormwater runoff from impervious surfaces. Unmanaged stormwater runoff overburdens the City's sewer system and wastewater resource recovery facilities, contributes to CSOs and increases pollutant loads into receiving waterbodies. Development offers an opportunity to improve on-site stormwater management on properties that were developed at a time when stormwater management best practices were not well-understood or widely implemented and current stormwater management regulations were not yet in place.

The NYC Charter gives DEP authority over and responsibility for the city's drainage plan and stormwater management. Through DEP approval of sewer certifications (approval that the city sewer can accept the development's proposed discharge) and subsequent sewer connection permits (authorization to connect to a sewer), DEP limits the flow from developed lots to ensure adequate capacity in the sewer system. NYC's 2012 house/site connection stormwater rule had the goal of reducing the adverse impacts on City sewers from runoff during rainstorms more severe than combined sewers are designed to handle. Sewer overflows, floods, and sewer backups can occur when excessive stormwater from impervious surfaces enters the sewer system too quickly.

The 2012 rule set forth a new performance standard, which applied to development in combined sewer areas of the City, allowing the City to more effectively manage stormwater runoff by prescribing standards for the permitting, construction and inspection of sewer connections to the City's combined sewer system. The revised performance standard provided a mechanism to reduce peak discharges to the city's sewer system during rain events by requiring greater on-site storage of stormwater runoff and slower release to the sewer system.

DEP, pursuant to the MS4 permit the NYS Department of Environmental Conservation (NYSDEC) issued to the City, is also responsible for administering a construction/post-construction program equivalent to the state's NYS SPDES General Permit for Stormwater Discharges from Construction Activity. Through approval of Stormwater Construction and Stormwater Maintenance permits, including approval of Stormwater Pollution Prevention Plans (SWPPPs) for all applicable construction projects, DEP requires owners and developers to implement measures in the MS4 areas of the City to reduce pollution in stormwater runoff from developments with the goal of protecting and improving water quality in the City's waterbodies.

NYC's 2017 stormwater rule required stormwater management controls for construction projects to reduce the flow of stormwater runoff and water borne pollutants into sewers that empty directly into the waters of the state or that overflow into such waters because of rain or snowmelt events that exceed the design capacity of wastewater resource recovery facilities. The revisions to that rule incorporated in the Unified Stormwater Rule extended to the CSS area DEP's permitting, inspection, and enforcement program, including requirements for construction and post-construction stormwater controls and standards for such controls.

Specifically, the Unified Stormwater Rule brought together and updated these existing stormwater management requirements by:

- Increasing on-site stormwater detention requirements and updating release rate requirements for CSS and establishing new release rate requirements for MS4 areas for Sewer Certification and Sewer Connection Permitting;
- Expanding the Stormwater Permitting requirements citywide to include CSS areas; reducing the soil disturbance threshold from 1 acre to 20,000 square feet; and adding the creation of 5,000 square feet of impervious area as an additional trigger;
- Requiring a retention-first approach to SMP design for Stormwater Permitting requirements; and
- Providing a clear technical path for using SMPs constructed under Stormwater Permitting requirements to satisfy requirements for SMPs under Sewer Certification and Sewer Connection Permitting.

Users of this Manual are encouraged to review Chapters 31 and 19.1 of Title 15 of the Rules of the City of New York for the requirements of the Unified Stormwater Rule.

1.2. Manual Purpose and Scope

The NYC SWM provides a comprehensive overview of NYC stormwater management requirements, and design guidance for developers of and design professionals on projects that must comply with the requirements of the DEP Sewer Certification/Sewer Connection Permitting and Stormwater Permitting. The intent of the SWM is to provide a clear and consolidated approach for meeting stormwater management requirements that, when followed, results in successful and streamlined project implementation. However, please note that while the water quality criteria presented in the NYC SWM align with water quality criteria of NYSDEC SWMDM, meeting the NYC SWM criteria does not obviate the need for a full review of and compliance with NYSDEC SWMDM requirements, as applicable.

The SWM replaced the Guidelines for the Design and Construction of Stormwater Management Systems (2012), the Criteria for Detention Facility Design (2012), and the NYC Stormwater Design Manual (2018). In addition, this SWM provides the information needed to complete and submit applications for Stormwater Permits in NYC. Application guidance and materials for Sewer Certification and Sewer Connection Permitting are not a part of this Manual and are available on DEP's website https://www1.nyc.gov/site/dep/about/sewer-connections.page.

Table 1.1. Chapters in this SWM and the purpose of each.

Chapter	Purpose
Chapter 1 Introduction	Provides an overview of the NYC Stormwater Manual and the Sewer Certification/Sewer Connection Permitting and Stormwater Permitting Programs.
Chapter 2 Stormwater Management Requirements	Details NYC stormwater management requirements and how to determine applicability.
Chapter 3 City Development & Review Process	Provides an overview of the review process for projects that trigger either Sewer Certification/Sewer Connection Permitting or Stormwater Permitting or both and step-by-step instructions for submitting projects that trigger Stormwater Permitting Program.
Chapter 4 Stormwater Management Practice Selection & Design	Defines SMP types and functionalities and provides guidance on how to select and design an appropriate SMP.
Chapter 5 Post-Construction Stormwater Management Requirements	Provides SMP operation and maintenance procedures and requirements for Stormwater Maintenance Permits.
Chapter 6 Right-of-Way Stormwater Management Requirements	Provides guidance for right-of-way covered development projects that trigger Stormwater Construction Permits.
Chapter 7 Roadway Maintenance Stormwater Management Requirements	Provides guidance for roadway maintenance, including practices required for both milling and paving operations.
Appendix A Stormwater Management Practice Hierarchy Checklist	Lists SMPs by implementation tier, function type, and practice type and indicates which constraints would impact SMP feasibility. Also indicates which SMPs can be used toward sewer operations criteria.
Appendix B Nitrogen No-Net-Increase Calculator Guide	Provides an example for NYC MS4 No-Net Increase Calculator for Nitrogen.
Appendix C Stormwater Management Practice Siting Criteria	Provides SMP siting criteria for on-site projects.
Appendix D Stormwater Management Practice Sizing Examples	Provides example SMP sizing calculations for each practice function.
Appendix E Site Design Example	Provides an example design for an entire site.
Appendix F Controlled-Flow Pump Workbook	An Excel-based workbook, which includes a template for controlled-flow pump calculations and a design example.
Appendix G Detention in Series Workbook and Examples	An Excel-based workbook available to assist designers with detention in series calculations.
Appendix H Right-of-Way Guidance Materials	Supplemental guidance materials referenced in Chapter 6.

New York City Stormwater Manual

Chapter 2
STORMWATER MANAGEMENT REQUIREMENTS

Environmental Protection

02 STORMWATER MANAGEMENT REQUIREMENTS

2.1. Permit Applicability

Stormwater Construction Permit
In accordance with Chapter 19.1 of Title 15 of the Rules of the City of New York, the Stormwater Construction Permit applies to all covered development projects. A covered development project is any development in New York City, public or private, that meets one or both of the following criteria:

- Disturbs 20,000 sf or more of soil; OR
- Creates 5,000 sf or more new impervious area.

There are several types of activities that are not considered covered development projects per Chapter 19.1 of Title 15 of the Rules of the City of New York. Examples of projects not considered covered development projects are listed below, but readers should refer to the rules noted above for the most up-to-date list of exclusions and definitions:

- Routine maintenance activities
- Emergency activities that are immediately necessary for the protection of life, property, or natural resources

Soil Disturbance
Disturbed area is the area of soil disturbed by development activities, such as building, demolition, renovation, replacement, restoration, rehabilitation, or alteration of any structure or road; or land clearing, land grading, excavation, filling or stockpiling.

Activities that do not disturb soils, such as interior renovations, and surface markings of paved areas, are not considered in the estimation of disturbed areas.

There are two important clarifications to consider when determining the disturbed area. First, all soil disturbances, even those outside the bounds of the developed property, are counted as part of the disturbed area. Second, if an individual project disturbs less than the soil disturbance threshold but is part of a larger common plan of phased development or sale that will exceed the soil disturbance threshold, the individual project is also considered a covered development project.

The Unified Stormwater Rule linked and enhanced two rules: the first rule aims to improve water quality through a Stormwater Construction Permitting program; the second rule aims to manage flow rates in City sewers through a Site/House Connection Proposal Certification program. Between the two rules, there are a total of five stormwater management requirements that may apply to projects in NYC. In addition to bringing these requirements under one umbrella, the Rule updated several requirements to help meet the City's stormwater management goals.

This chapter covers the applicability of each permit (Section 2.1), the applicability of requirements within those permits (Section 2.2), the criteria for meeting each requirement (Section 2.3), and the requirements for geotechnical investigations (Section 2.4).

Impervious Area
An impervious surface is any surface that cannot effectively infiltrate rainfall: generally, impervious hardscapes such as rooftops, pavements, sidewalks, and driveways. Impervious surfaces can also include miscellaneous structures such as patios, pools, and sheds. In addition, pervious hardscapes such as gravel roadways, parking lots, driveways, and sidewalks are also considered impervious surfaces unless a geotechnical investigation indicates that the permeability rate of underlying soils is sufficient for reducing runoff. More specifically, underlying soils must have a permeability rate of at least 0.5 in/hr.

An increase (or decrease) in impervious area is calculated as the difference in total impervious area from pre-to-post development. The pre-development case must represent the least amount of impervious surface for the disturbed area within the last 5 years prior to proposed development. When possible, photos, plans, and/or satellite images should be used to determine the appropriate pre-development impervious area.

House/Site Connection Proposals
In general, house or site connection proposals are required when one or more of the following are true:

- Project proposes a new sewer connection
- DOB requires a house or site connection proposal
- Applicant agency's process requires a house or site connection proposal

Readers are encouraged to refer to Chapter 31 of Title 15 of RCNY for the latest details on when house and site connection proposals are required.

For projects that require a house or site connection proposal, the house connection proposal (HCP) shall be used for 1-3 family (fee simple) residential homes that do not meet the definition of covered development project. All other projects shall use a site connection proposal (SCP).

Before proceeding to the specific requirements of each permit, it is worth noting that the criteria set forth in the Unified Stormwater Rule supersede the 2012 NYC Stormwater Rule and the 2012 NYC BWSO Criteria for Detention Facility Design.

In all other cases, the Unified Stormwater Rule does not obviate the need for compliance with any existing city, state, or federal permit that may be otherwise required for the covered development project. The owner is responsible for identifying and complying with all other rules applicable to that development activity, including, but not limited to, any applicable NYC DOB construction code regulations.

2.2. Permit Requirements

For projects that require a Stormwater Construction Permit, a stormwater pollution prevention plan (SWPPP) must be prepared that meets up to four stormwater management requirements:

Erosion and sediment control (ESC) – aims to minimize the discharge of pollutants during construction activities.

Water quality (WQ) – aims to manage runoff from small, frequent storm events that can significantly impact the quality of receiving waters in both MS4 and CSS areas.

Runoff reduction (RR) – aims to maintain a minimum level of runoff reduction during small storms to preserve natural hydrologic functions.

No net increase (NNI) – aims to reduce pollutants of concern in MS4 areas that discharge to an impaired waterbody.

For projects that require a House/Site Connection Proposal, the proposal must meet the following stormwater management requirement:

- **Sewer operations (Vv) –** aims to manage runoff from larger storm events to maintain optimal flow rates in the City's sewer system and, in turn, improve overall sewer operations.

The applicability of each stormwater management requirement is shown in Table 2.1; such applicability is based on several factors including soil disturbance area, new impervious area, activity type, sewershed type, receiving water body, and whether a house or site connection proposal is required. A brief description of how to determine the applicability of each requirement is provided in the following paragraphs.

Table 2.1. Applicability criteria for each stormwater management requirement.

SMR	Applicable Projects
Erosion & Sediment Control (ESC)	Covered development project
Water Quality (WQ)	Covered development project Except for activities listed in Table 2.2
Runoff Reduction (RR)	Covered development project Except for activities listed in Table 2.2
No-net Increase (NNI)	Project area of 20,000 sf or more AND Project located in MS4 area AND Discharges to an impaired water body AND Increases impervious area
Sewer Operations (Vv)	Project requires a house connection proposal OR Project requires a site connection proposal

The ESC requirement applies to all covered development projects. The WQ and RR requirements apply to all covered development projects that are not listed in Table 2.2. While not exhaustive, a list of typical development projects that require WQ and RR requirements is included in Table 2.3.

In the case of highly complex projects, such as those with irregular site conditions, significant drainage areas, complex drainage systems, or complex SMPs, additional criteria or submittals not described in this Manual may be required at the discretion of DEP.

Table 2.2. Covered development projects that require the preparation of a SWPPP that includes only erosion and sediment control (ESC) requirements.

Covered Development Activity
Installation of underground, linear utilities such as gas lines, fiber-optic cable, cable TV electric, telephone, sewer mains, and water mains
Environmental enhancement projects, such as wetland mitigation projects, stormwater retrofits and stream restoration projects
Pond construction
Linear bike paths running through areas with vegetative cover, including bike paths surfaced with an impervious cover
Cross-country ski trails and walking/hiking trails
Sidewalk, bike path or walking path projects, surfaced with an impervious cover, that are not park of residential, commercial or institutional development
Sidewalk, bike path or walking path projects, surfaced with an impervious cover, that include incidental shoulder or curb work along an existing highway to support construction of the sidewalk, bike path or walking path
Slope stabilization projects
Slope flattening that changes the grade of the site, but does not significantly change the runoff characteristics
Spoil areas that will be covered with vegetation
Vegetated open space projects (i.e. recreational parks, lawns, meadows, fields, downhill ski trails) excluding projects that alter hydrology from pre- to post-development conditions
Athletic fields (natural grass) that do not include the construction or reconstruction of impervious area and do not alter hydrology from pre to post development conditions
Demolition project where vegetation will be established, and no redevelopment is planned
Overhead electric transmission line project that does not include the construction of permanent access roads or parking areas surfaced with impervious cover
Temporary access roads, median crossovers, detour roads, lanes, or other temporary impervious areas that will be restored to pre construction conditions once the construction activity is complete
Road reconstruction projects where the total soil disturbance from all activities is less than 1-acre

Table 2.3. Covered development projects that require the preparation of a SWPPP that includes ESC requirements, as well as WQ and RR requirements.

Covered Development Activity
Single family home directly discharging to one of the impaired segments listed in Appendix 2 of the MS4 Permit
Single family home that disturbs five (5) or more acres of land
Single family residential subdivisions directly discharging to one of the impaired segments listed in Appendix 2 of the MS4 Permit
Single family residential subdivisions Multi-family residential developments; includes duplexes, townhomes, condominiums, senior housing complexes, apartment complexes, and mobile home parks
Airports
Amusement parks
Breweries, cideries, and wineries, including establishments constructed on agricultural land
Cemeteries that include the construction or reconstruction of impervious area (>5% of disturbed area) or alter that hydrology from pre to post development conditions
Commercial developments
Churches and other places of worship
Golf courses
Institutional development; includes hospitals, prisons, schools, and colleges
Industrial facilities; include industrial parks
Landfills
Municipal facilities; includes highway garages, transfer stations, office buildings, POTW's, water treatment plants, and water storage tanks
Office complexes
Playgrounds that include the construction or reconstruction of impervious area
Sports complexes
Racetracks; includes racetracks with earthen (dirt) surface
Road construction, including roads constructed as part of the covered development projects listed in Table 2.2
Road reconstruction, except as indicated in Table 2.2 when the total soil disturbance from all activities is less than 1-acre
Parking lot construction or reconstruction, including parking lots constructed as part of the covered development projects listed in Table 2.2
Athletic fields (natural grass) that include the construction or reconstruction of impervious area (>5% of disturbed area) or alter the hydrology from pre to post development conditions
Athletic fields with artificial turf
Permanent access roads, parking areas, substations, compressor stations and well drilling pads, surface with impervious cover, and constructed as part of an over-head electric transmission line project, wind-power project, call tower project, oil or gas well drilling project, sewer or water main project or other linear utility project
Sidewalk, bike path or walking path projects, surfaced with an impervious cover, that are part of a residential, commercial, or institutional development
Sidewalk, bike path or walking path projects, surfaced with an impervious cover, that are part of a highway construction or reconstruction project
All other covered development projects that include the construction or reconstruction of impervious area or alter the hydrology from pre and post development conditions, and are not listed in Table 2.2

The NNI requirement is applicable only when all four of the following conditions are met:

- Disturbed area is 20,000 sf or more[2]
- Project is located in an MS4 area
- Project discharges to an impaired waterbody, and
- Project results in an increase in impervious area.

A project is located in the MS4 area if stormwater drains from the project to surface waters through a separate storm sewer, high-level storm sewer, or bluebelt owned or operated by the City that is connected to either an MS4 outfall or combined sewer overflow (CSO) outfall downstream of a regulator. Projects involving NYC municipal operations and facilities where stormwater drains from the project directly to surface waters are also considered to be in the NYC MS4 area. Non-municipal projects that drain directly to surface waters follow separate guidance from NYSDEC (see https://www.dec.ny.gov/chemical/43133.html).

The MS4 Interactive Map (www.nyc.gov/dep/ms4map) is available to assist applicants in locating outfalls and drainage areas that are part of the NYC MS4 area. Applicants should recognize that all projects that require house/site connection proposal approval for connection to a DEP storm sewer are likely located in the MS4 area. The interface of the MS4 Interactive Map is shown in Figure 2.1 for illustrative purposes. However, readers should refer to the website for the latest maps and to help determine the sewershed status of their project.

An impaired waterbody is one that does not meet water quality standards for its intended use in accordance with the Clean Water Act. Impairments can be due to several pollutants of concern (POCs), including fecal coliform, garbage and refuse, phosphorus, and nitrogen. Impaired waterbodies in and around NYC are identified in Appendix I of the NYC MS4 Permit, which is provided in Table 2.4 for ease of reference.

The MS4 Interactive Map can also be used to help determine whether a project ultimately discharges to an impaired waterbody. By selecting the MS4 area associated with a project, the map brings up a table of additional details that include the name of the receiving waterbody, as well as a “yes or no” indication about whether the waterbody is impaired by each POC (Figure 2.2).

Increases in impervious area are determined by comparing the total area of impervious surfaces for the project from pre- to post-development. The pre-development case must represent the least amount of impervious surface for the disturbed area within the last 5 years prior to proposed development. Section 2.1 includes definitions of impervious surfaces and suggested resources for selecting the appropriate pre-development case.

The sewer operations requirement is applicable to all projects that require a house or site connection proposal, as described in Section 2.1.

[2] Except in ROW, where threshold is 1 acre or more. See Chapter 6 of this Manual.

Figure 2.1. Interface of the MS4 Interactive Map for NYC.

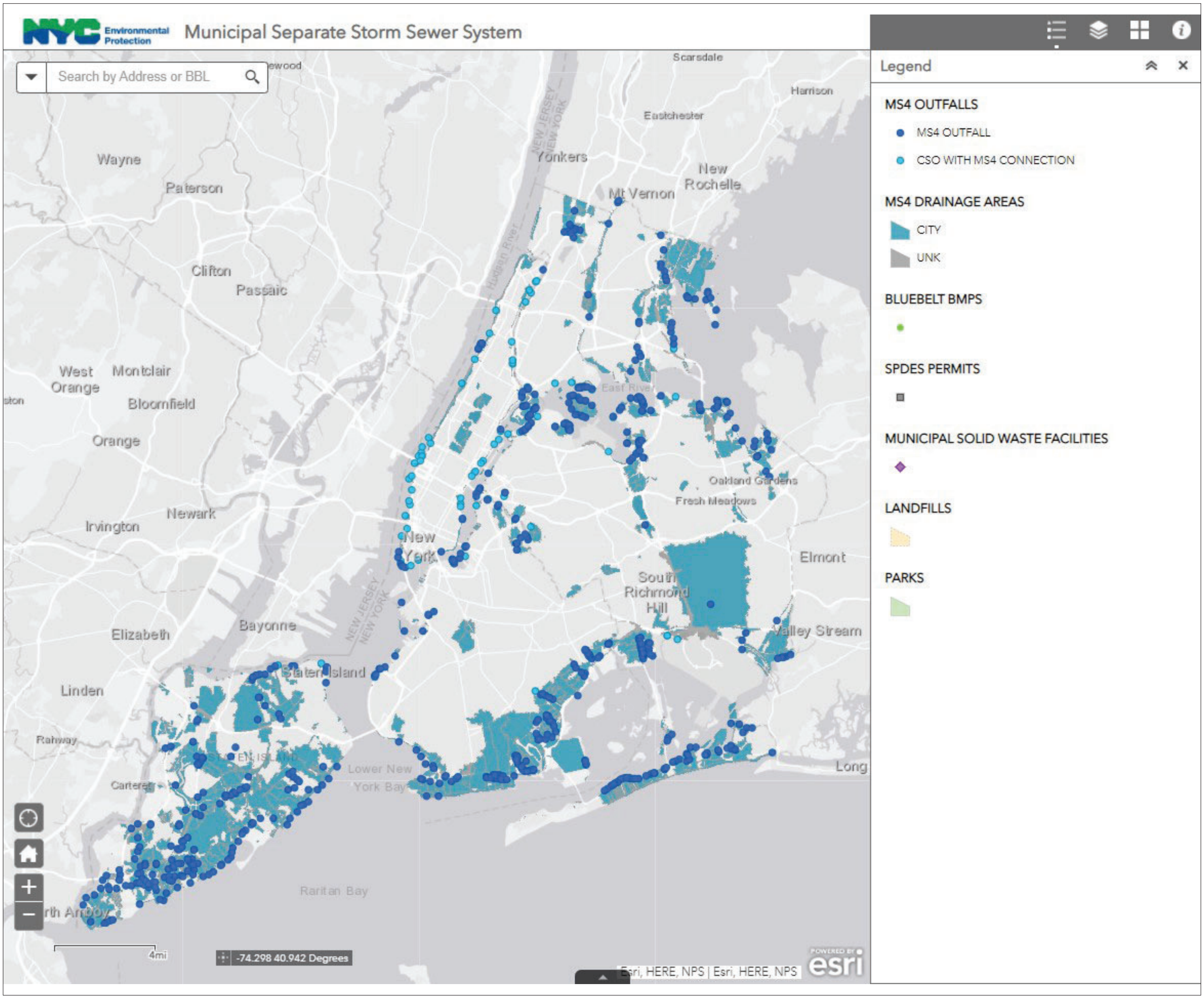


Figure 2.2. Using the MS4 Interactive Map to identify impaired waterbodies in and around NYC.

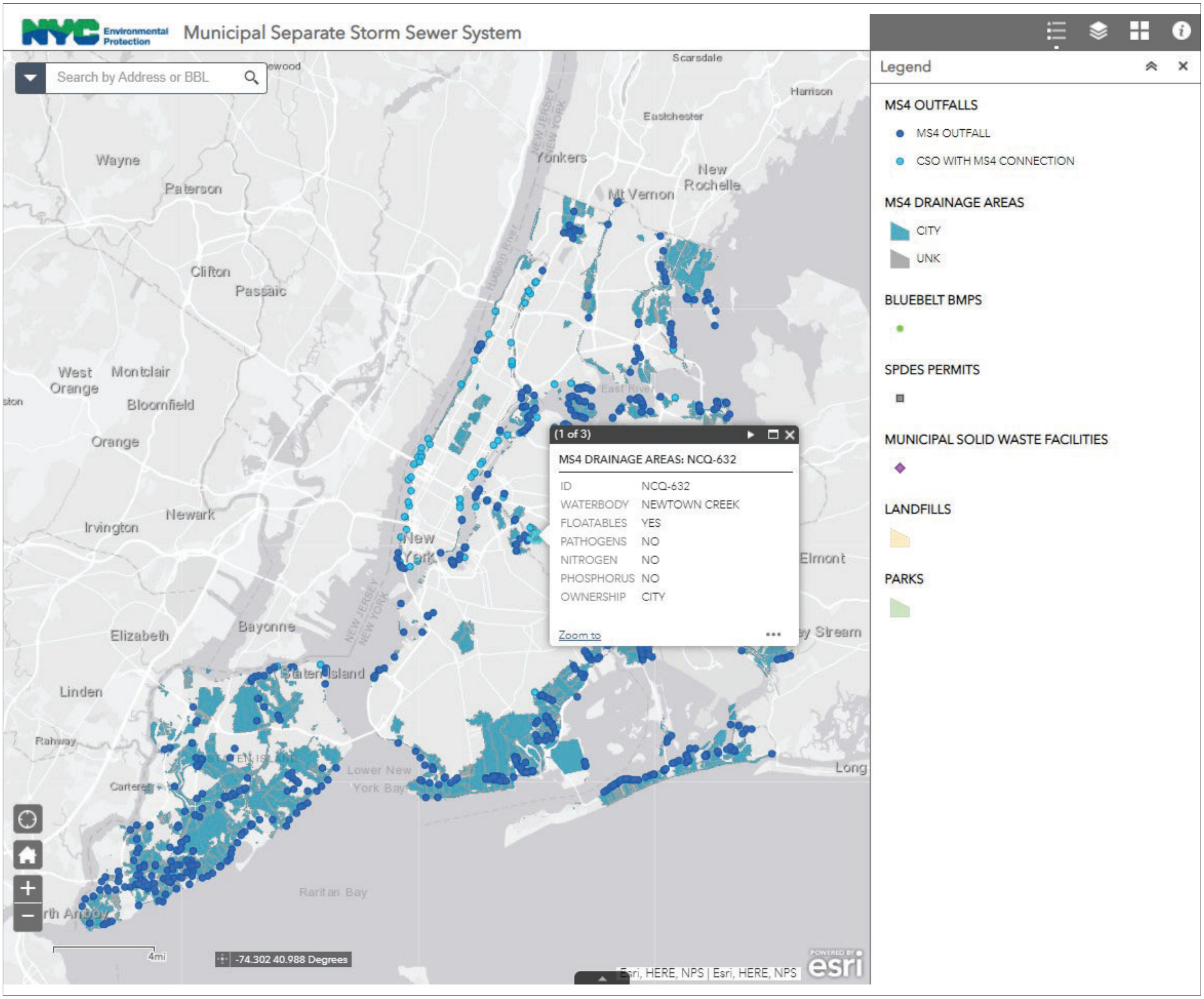


Table 2.4. Impaired Water Segments and Pollutants of Concern in and Around NYC (Source: Final 2018 NYS 303(d list, which is the basis for Appendix I of the 2022 NYC MS4 Permit NY0287890).

Waterbody Name	Water Body Identification Number (WIN)	Pollutant
Alley Creek/Little Neck Bay Trib	(MW2.5) ER/LIS-LNB-19 thru 20	Fecal Coliform
Arthur Kill (Class I) and minor tribs	(MW1.2) SI (portion 1)	Garbage & Refuse
Arthur Kill (Class SD) and minor tribs	(MW1.2) SI (portion 2)	Garbage & Refuse
Atlantic Ocean Coastline	(MWO.O) AO (portion 1)	Fecal Coliform
Bergen Basin	(MW8.5a) JB-247	Fecal Coliform
Bergen Basin	(MW8.5a) JB-247	Nitrogen
Bergen Basin	(MW8.5a) JB-247	Garbage & Refuse
BronxRiver, Lower	(MW2.4) ER-3	Fecal Coliform
BronxRiver, Lower	(MW2.4) ER-3	Garbage & Refuse
BronxRiver, Middle, and tribs	(MW2.4) ER-3	Fecal Coliform
BronxRiver, Middle, and tribs	(MW2.4) ER-3	Garbage & Refuse
Coney Island Creek	(MW1.1) LB/GB-253	Fecal Coliform
Coney Island Creek	(MW1.1) LB/GB-253	Garbage & Refuse
East River, Lower	(MW2.1) ER (portion 1)	Garbage & Refuse
East River, Upper	(MW2.3) ER (portion 2)	Garbage & Refuse
East River, Upper	(MW2.3) ER (portion 3)	Garbage & Refuse
Flushing Creek/Bay	(MW2.5) ER-LI-12	Fecal Coliform
Flushing Creek/Bay	(MW2.5) ER-LI-12	Garbage & Refuse
Gowanus Canal	(MW1.3) UB-EB-1	Garbage & Refuse
Grasmere Lake/Brady's Pond	(MW1.2) SI.P1039, P1051, P1053	Phosphorus
Harlem Meer	(MW2.2) ER.P1036	Phosphorus
Harlem River	(MW2.3) ER-1	Garbage & Refuse
Hendrix Creek	(MW8.6) JB-249a	Fecal Coliform
Hendrix Creek	(MW8.6) JB-249a	Nitrogen
Hendrix Creek	(MW8.6) JB-249a	Garbage & Refuse
Hutchinson River, Lower and tribs	(MW3.2) LIS-2	Garbage & Refuse
Jamaica Bay, Eastern, and tribs (Queens)	(MW8.5b) JB	Fecal Coliform
Jamaica Bay, Eastern, and tribs (Queens)	(MW8.5b) JB	Nitrogen
Jamaica Bay, Eastern, and tribs (Queens)	(MW8.5b) JB	Garbage & Refuse
Kill Van Kull	(MW1.2) SI (portion 4)	Garbage & Refuse
Kissena Lake	(MW2.5) ER-LI-12-P76	Phosphorus
Little Neck Bay	(MW2.5) ER/LIS-LNB	Fecal Coliform
Meadow Lake	(MW2.5) ER-LI-12-100a	Phosphorus
Mill Basin and tidal tribs	(MW8.6a) JB-25 0b	Garbage & Refuse
Newark Bay	(MW1.2) SI (portion 3)	Garbage & Refuse
Newtown Creek and tidal tribs	(MW2.1) ER-LI-4	Fecal Coliform
Newtown Creek and tidal tribs	(MW2.1) ER-LI-4	Garbage & Refuse

Table 2.4. Continued

Waterbody Name	Water Body Identification Number (WIN)	Pollutant
Paerdegat Basin	(MW8.6a) JB-250a	Garbage & Refuse
Prospect Park Lake	(MW8.6a) JB-P0009	Phosphorus
Raritan Bay (Class SA)	(MW1.2) RB (portion 1)	Fecal Coliform
Shellbank Basin	(MW8.5a) JB-248a	Nitrogen
Spring Creek and tribs	(MW8.5a) JB-249	Garbage & Refuse
The Lake in Central Park	(MW2.2) ER-P1029	Phosphorus
Thurston Basin	(MW8.5a) JB-241a	Fecal Coliform
Thurston Basin	(MW8.5a) JB-241a	Garbage & Refuse
Van Cortlandt Lake	(MW2.3) ER-1-5-P1043	Phosphorus
Westchester Creek	(MW2.4) ER-4	Garbage & Refuse
Willow Lake	(MW2.5) ER-LI-12-100f	Phosphorus

A three-step flowchart was created to further assist readers in determining which requirements and procedures are applicable to their projects (Figure 2.3). Each step is described further in the following paragraphs.

Readers are again encouraged to refer to Chapter 31 of Title 15 of RCNY for the latest details on when HCP and SCP are required.

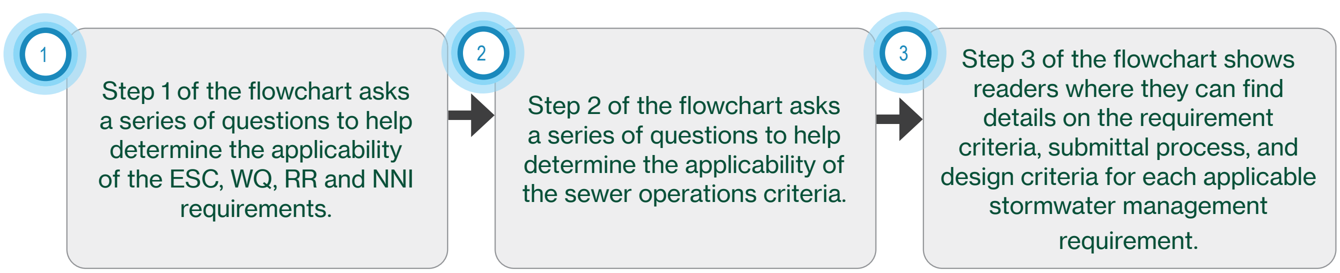


Figure 2.3. Flowchart to help determine applicable stormwater management requirements and procedures.

Step 1. Determine applicability of the ESC, WQ, RR, and NNI requirements.

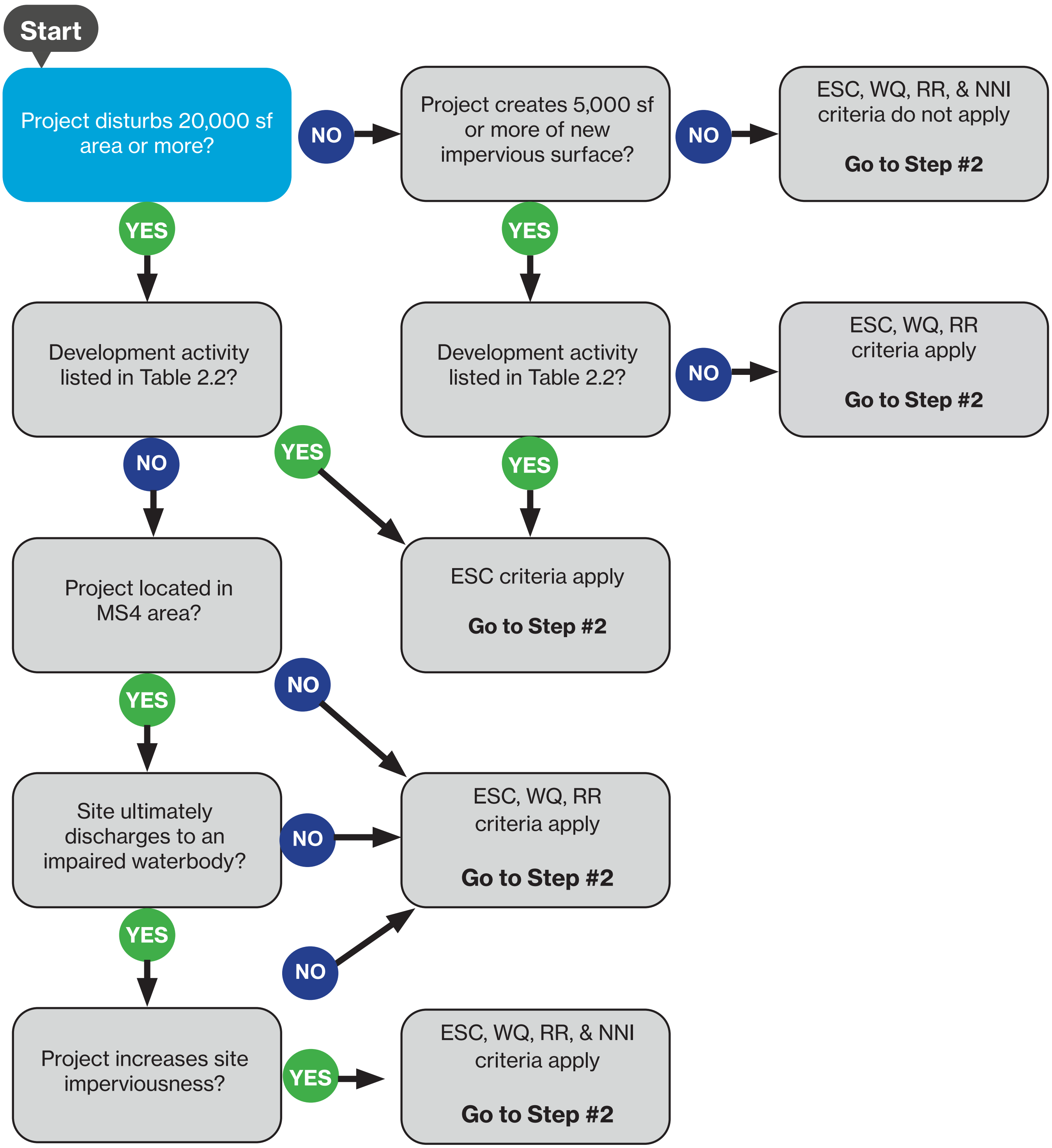


Figure 2.3. Continued

Step 2. Determine applicability of the sewer operations requirement.

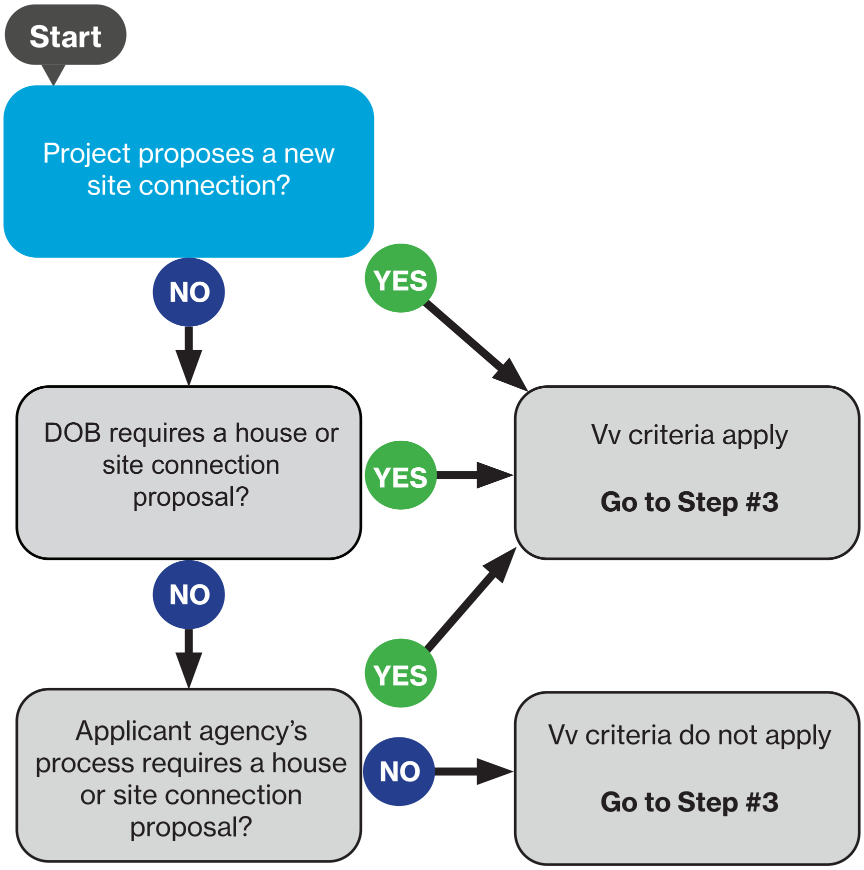
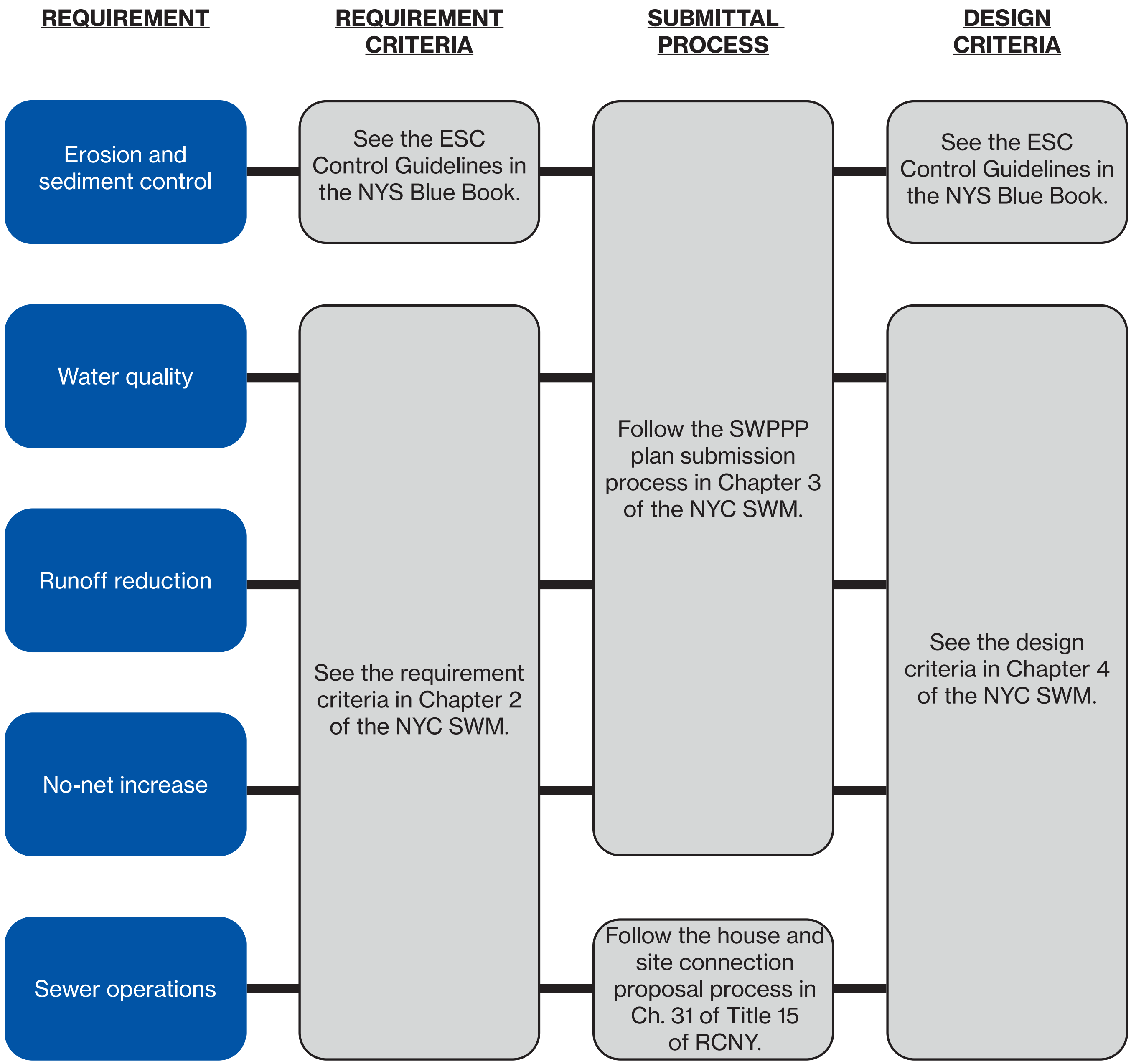


Figure 2.3. Continued

Step 3. Identify procedures for the applicable requirements.



2.3. Requirement Criteria

This subsection outlines the specific criteria that must be met for each stormwater management requirement applicable to a project.

Erosion and sediment criteria

Erosion and sediment control (ESC) refers to stormwater management practices (SMPs) that are designed to minimize the discharge of pollutants during construction activities.

ESC measures can include, but are not limited to, structural controls (e.g., sediment barriers), intentional sequencing of construction to minimize exposed soils, soil stabilization measures, dewatering control measures, and other pollution prevention and good housekeeping (PPGH) measures that are appropriate for construction sites.

All covered development projects must implement ESC measures in accordance with the NYS Standards and Specifications for Erosion and Sediment Control (The Blue Book), dated November 2016 or its successor (https://www.dec.ny.gov/chemical/29066.html).

Water quality criteria

The water quality (WQ) requirement aims to manage runoff from small, frequent storm events that can significantly impact the quality of receiving waters in both MS4 and CSS areas.

In MS4 areas, runoff from these events tends to contain higher pollutant levels. Therefore, retention and treatment of small storm runoff in MS4 areas help to remove those pollutants and, in turn, improve WQ.

In CSS areas, these events trigger the majority of CSO events. Therefore, retention and detention of small storm runoff in CSS areas helps to reduce CSOs and, in turn, improves water quality.

The WQ criterion is met by managing runoff from the applicable small storm design event. NYS DEC defines this design event as the 90th percentile rain event. In New York City, the 90th percentile rain event is 1.5 inches of rainfall (see NYS SWMDM).

The volume of runoff from the 90th percentile rain event, which must be managed by SMPs, is also referred to as the water quality volume (WQ_V). The following equation can be used to calculate the WQ_V:

EQ 2.1

$$WQ_V = \frac{1.5''}{12} * A * R_V$$

where:
WQ_V: water quality volume (cf)
A: contributing area (sf)
R_V: runoff coefficient relating total rainfall and runoff
R_V: 0.05 + 0.009(I),
I: percent impervious cover

The SWPPP must show how the WQv is managed at the practice and site levels. This requirement means that the contributing area, runoff coefficient, and WQv must be determined for each individual practice – and that, in total, the practices must manage the WQv across the entire site. It is also important to note that the contributing area includes all tributary areas, even those which may be outside the covered development project area.

SMPs used to meet WQv must be selected in accordance with the SMP hierarchy (Section 4.2). Refer to Chapter 4 for details on the sizing and design of SMPs.

Runoff reduction criteria

The runoff reduction (RR) requirement aims to maximize the level of RR during small storms in order to preserve natural hydrologic functions. Runoff is considered reduced when it is retained by SMPs for infiltration, evapotranspiration, or reuse. Ideally the entire WQv will be reduced by SMPs when the SMP hierarchy is followed (Section 4.2), however if site constraints are such that reducing the entire WQv is not possible, the application must demonstrate that the minimum RRv has been met.

In no case shall the runoff reduction volume (RRv) of SMPs be less than the minimum RRv resulting from the newly constructed impervious areas, determined by the following equation:

EQ 2.2

$$RR_V = \frac{1.5"}{12} * 0.95 * Aic * S$$

where:
Aic: total area of new impervious cover (sf)
S: specific reduction factor, see Table 2.5

Sites that meet the WQv using only retention practices will, by default, also meet the RR criteria. All other cases must check that the RR criterion is met.

The specific reduction factor used to calculate RRv will depend on the hydrologic soil group (HSG) of soils underlying the project site, as defined in Part 630 of the National Engineering Handbook (NRCS 2007). As indicated in the handbook, there are four HSG categories based on saturated hydraulic conductivity, depth to water impermeable layer, and/or depth to high water table. Designers may classify soils based on results of the geotechnical investigation or refer to the NRCS web soil survey for data on HSGs by location.

Changes in the specific reduction factor for each HSG reflect differences in the underlying soils' ability to infiltrate water. Refer to Table 2.5 for specific reduction factor values by category.

Table 2.5. Specific reduction factors based on hydrologic soil group (HSG).

S	Description
0.55	HSG-A
0.40	HSG-B
0.30	HSG-C
0.20	HSG-D

The total area of new impervious cover (Aic) is determined by comparing the total area of impervious surfaces for the project from pre-to-post development. The pre-development case must represent the least amount of impervious surface for the covered development project within the last 5 years prior to proposed development. Section 2.1 includes definitions of impervious surfaces and suggested resources for selecting the appropriate pre-development case.

In most cases, using the SMP hierarchy (Section 4.2) to meet the WQ requirement, will also result in the project meeting the RR requirement. Refer to Chapter 4 for details on the sizing and design of SMPs.

No net increase criteria

The NNI requirement aims to reduce POCs in MS4 areas that discharge to an impaired waterbody. POCs can include:

- Pathogens[3] – disease-producing agents such as bacteria, viruses, or other microorganisms
- Floatables[4] – manmade materials such as plastics, papers, or other products, which have made their way to a waterbody
- Phosphorus – a nutrient that can lead to algae blooms that deplete oxygen in the water, which can kill aquatic life
- Nitrogen – another nutrient that can lead to algae blooms that deplete oxygen in the water, which can kill aquatic life

Pathogens

Pathogens are disease-producing agents such as bacteria, viruses, or other microorganisms. Most pathogens found in stormwater runoff are from human and animal fecal matter. The presence of fecal indicator bacteria, such as fecal coliform, can provide evidence of fecal contamination and the potential presence of pathogenic organisms.

To meet the NNI requirements for pathogens, BMPs must be implemented as provided in the post-construction O&M manual to mitigate potential sources of pathogens present at the developed site. Table 2.6 lists examples of BMPs that may address pathogen sources per land use. This list is not exhaustive or prescriptive, and applicants may propose additional BMPs to mitigate site-specific pathogen sources.

Floatables

Floatables are manmade materials, such as plastics, papers, or other products that, when improperly disposed of onto streets or into catch basins, can ultimately find their way to local waterbodies.

The NYS SWMDM contains provisions for floatables control in the design of SMPs. These provisions include pretreatment, settling or filtration, outlet controls and maintenance that will effectively capture and remove floatables and settleable trash and debris prior to discharge.

To meet the NNI requirements for floatables, refer to the NYS SWMDM to determine the required garbage and refuse removal features of post-construction SMPs.

Phosphorus

Phosphorus is a nutrient that is a natural part of aquatic ecosystems and supports the growth of algae and aquatic plants. However, excess phosphorus can cause nuisance algae blooms and aquatic weed growth, which reduces water clarity and dissolved oxygen (DO) and can harm aquatic life. Sources of phosphorus include lawn/plant fertilizer, illicit discharges of sanitary waste, pet and wildlife waste, and leaves, branches, and grass clippings.

Part II.B.1.b.ii of the NYC MS4 Permit states, "For phosphorus-limited waterbodies, compliance with Chapter 10 of the NYS SWMDM will satisfy the No Net Increase requirement." To meet the NNI requirements for phosphorus, refer to the NYS SWMDM to design SMPs.

Nitrogen

Nitrogen is a nutrient that occurs naturally in aquatic ecosystems but can be harmful in high concentrations. Sources of nitrogen in stormwater are the same as those described above for phosphorus.

Projects in MS4 areas that discharge to nitrogen-impaired waters must provide calculations to demonstrate NNI in total nitrogen (TN) loading from existing conditions to post-development conditions. If the project will increase the TN load, excess nitrogen must be removed through the implementation of SMPs. Procedures for completing these calculations are detailed in Appendix B.

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[3] The current NYS 303(d) list and Appendix I of the 2022 MS4 Permit NY0287890 have replaced references to "pathogens" with "fecal coliform." Fecal coliform is a pathogen-related water quality parameter; see also Table 2.4 of this Manual.

[4] The current NYS 303(d) list and Appendix I of the 2022 MS4 Permit NY0287890 have replaced reference to "floatables" with "garbage and refuse." The meanings of the terms are analogous; see also Table 2.4 of this Manual.

Table 2.6. BMPs for pathogen removal by land use.

BMP	Source of Pathogen	Applicable Land Use
Install sign, distribute public education and outreach materials, and implement trainings to support pathogen reduction programs.	All	All
Inspect and clean areas where animal waste may be present (e.g., dumpsters, grease storage, waterfowl congregation areas, and dog parks).	Pets and Wildlife	All
Discourage free-range pets. Adopt rules within a development to pick up pet wastes. Offer bags and waste receptacles to make it easy for pet owners to pick up and dispose of waste products. Distribute educational materials and signage to support program.	Pets	Residential, Open Space & Outdoor Recreation, Commercial & Office Buildings (pet store, veterinarian)
Identify areas with high bird populations and evaluate deterrents, habitat modifications, and other measures.	Wildlife	Open Space & Outdoor Recreation, Residential (common areas in a development), Vacant Lots
Reduce food sources accessible to urban wildlife (e.g., manage restaurant dumpsters/grease traps and residential garbage).	Wildlife	Residential, Commercial & Office Buildings (restaurants, groceries), Public Facilities & Institutions, Industrial
Use latched or heavy-lidded trash containers to deter wildlife.	Wildlife	Open Space & Outdoor Recreation, Residential, Commercial & Office Buildings (restaurants, groceries), Public Facilities & Institutions, Industrial
Increase collections and waste disposal for provide haulers.	Wildlife	Commercial & Office Buildings (restaurants, groceries)
Reduce attractive odors that may draw wildlife.	Wildlife	Residential, Commercial & Office Buildings (restaurants, groceries)
Introduce strategies to reduce food, shelter, and habitats for overpopulated urban wildlife.	Wildlife	All
Inhibit access to open water by managing vegetation growth, limit food sources-seeds, and discourage feeding wildlife, especially on impervious surfaces, near open water, or near practices that discharge directly to open waters. Provide educational materials to support program.	Wildlife	Open Space & Outdoor Recreation, Residential (common areas in a development)
Inspect and clean catch basins regularly and distribute educational materials to support program.	Wildlife	Residential, Commercial & Office Buildings, Parking
Monitor for illegal dumping into catch basins.	Human and Pet	All
Monitor illicit connections by tenants to storm sewer. Look for dry weather flows in storm sewer system.	Human	All
Minimize stormwater runoff that is directly connected to the system from impervious areas.	All	All
Clean main sewer line that connects to building, pump septic tank, or leaching pit. Pressure test or inspect sewer main or septic tank for leakage once every five years.	Human	Residential, Commercial & Office Buildings, Industrial, Public Facilities & Institutions
Locate portable toilets away from storm drains or open water.	Human	All (especially during construction and temporary public events)

Sewer operations criteria

The sewer operations volume (Vv) requirement aims to manage runoff from larger storm events in order to maintain optimal flow rates in the City's sewer system and, in turn, improve overall sewer operations. Compliance with this requirement is usually achieved by detention practices, but some retention practices may also be used as part of the Unified Stormwater Rule and as clarified by this Manual (see Chapter 4).

There are two elements to the sewer operations criteria; a volume (V_V) that must be provided to temporarily store water – and a maximum release rate (Q_{DRR}) that must be maintained via flow control systems. This volume (Vv) is consistent with the stormwater management volume in Chapter 31 of Title 15 of RCNY, but will be referred to hereafter as the sewer operations volume for clarity in the context of this Manual. The two elements (Vv and Q_{DRR}) work in tandem to manage peak flow rates from the site. Please note that compliance with the sewer operations criteria does not obviate full review of and compliance with all NYSDEC SWMDM requirements, as applicable.

Consistent with previous Bureau of Water and Sewer Operations (BWSO) rules for the connections to the City's sewer, sites must manage the peak rate of runoff for the 10YR rainfall event. The following equation can be used to determine the sewer operations volume (Vv):

EQ 2.3

$$V_V = \frac{R_D}{12} * A * C_W$$

where:

V_V: sewer operations volume (cf)

R_D: rainfall depth (in)

A: contributing area (sf)

C_W: weighted runoff coefficient relating peak rate of rainfall and runoff

The rainfall depth (R_D) used to calculate V_V will vary based on sewershed type and connection proposal type for the project, as shown in Table 2.7. This variation in applied rainfall depth reflects the different operational goals between CSS and MS4 areas, as well as a reduction in requirements for small, residential lots that apply for HCPs. As before, the contributing area includes all tributary areas, even those which may be outside the disturbed area.

Table 2.7. Applied rainfall depth by sewershed type and connection proposal type.

R_D	Description
1.85	CSS areas with SCP
1.50	CSS areas with HCP
1.50	MS4 areas with SCP
1.10	MS4 areas with HCP

The runoff coefficient is based on surface type, where values for common surfaces are provided in Table 2.8.

Table 2.8. C values for various surface types.

C	Surface Description
0.95	Roof areas
0.85	Paved areas
0.70	Green roof with min. 4 in. growing media
0.70	Porous asphalt/Porous Concrete[a]
0.70	Synthetic turf fields[a]
0.65	Gravel parking lot
0.30	Undeveloped areas
0.20	Grass, bio-swales, or landscaped areas

[a] Using a C value of 0.7 for the indicated surface types typically requires the use of an outlet pipe, with approval at the discretion of DEP.

In cases where the contributing area includes more than one surface type, the area weighted runoff coefficient across all surface types shall be used in the calculation of V_V, which may be calculated as follow:

EQ 2.4

$$C_W = \frac{(C_1 A_1 + C_2 A_2 + \cdots etc.)}{A_t}$$

where:

C_W = weighted runoff coefficient relating peak rate of rainfall and runoff

C_1 = runoff coefficient for surface type 1

A_1 = area of surface type 1 (sf)

C_2 = runoff coefficient for surface type 2

A_2 = area of surface type 2 (sf)

A_t = total area (sf)

While there is no hierarchy for the selection of SMPs to meet the sewer operations criteria, the SMP hierarchy checklist (Appendix A) does include SMPs that can be used toward this goal. Refer to Chapter 4 for details on the sizing and design of SMPs.

In cases where two detention practices are proposed in series, the upstream detention system may reduce the effective C_W value used to determine Vv for the downstream system. Technical notes on the design of detention systems in series are provided in Section 4.11.

The second element of the sewer operations criteria, the maximum release rate, will also vary based on sewershed type. This variation again reflects the different operational goals between MS4 and CSS areas. Values for the maximum release rate per acre (q) are shown in Table 2.9 and defined in Chapter 31 of Title 15 of RCNY.

Table 2.9. Maximum release rate per acre (cfs/acre) by sewershed type.

q (cfs/acre)	Description
1.0	MS4 areas
0.1	CSS areas

The maximum release rate per acre (q) can then be used to calculate the maximum release rate for the contributing area (Q_{DRR}) using the following equation:

EQ 2.5

$$Q_{DRR} = \frac{q\left(\frac{cfs}{acre}\right) * A(sf)}{43560(\frac{sf}{acre})} \text{ or } 0.046 \; [\text{whichever is greater}]$$

Q_{DRR}: maximum release rate, site (cfs)
q: maximum release rate, per acre (cfs/acre)
A: contributing area (sf)

The equation above includes a conversion factor from square feet to acres. All house or site application proposals for the sewer operations criteria must be in units of square feet, not acres.

The maximum release rate must be maintained using flow control systems, such as an orifice or other controlled-flow device, such that the maximum rate is not exceeded when the sewer operations volume is being provided. Technical notes on the design of flow controls can be found in Section 4.10.

When the sewer operations requirement is applicable, projects must meet both the volume (Vv) and maximum release rate (Q_{DRR}) criteria. Specifically, the sewer operations volume (Vv) is applied in circumstances where the developed storm flow exceeds the maximum release rate. The developed flow, or the average rate of storm runoff in cfs is computed using the "Rational Method" by the equation:

$$Q_{Dev} = \frac{C_{WS} A_S}{7{,}320}$$

where:
Q_{Dev} = the developed site average storm runoff rate of flow in cfs, based on a rainfall event with a 5 yr. return period, and a 6 minute (min.) time of concentration
C_{WS} = the weighted runoff coefficient for the site
A_S = the site area in ft^2
7,320 = 43,560 ft^2/ac divided by 5.95 inches per hour (in/hr), the average rainfall intensity for the event with a 5 yr. return period and a 6 min. time of concentration

In addition, the proposal must show how the Vv and Q_{DRR} criteria are met at the practice and site level. Therefore, the contributing area, weighted runoff coefficient, and maximum release rate must be determined for each individual practice and, in total, the practices must meet the criteria across the entire site. It is also important to note that the contributing area includes all tributary areas, even those which may be outside the disturbed area.

In circumstances where design constraints require the system release at a rate lower than 0.046 cfs, DEP may require that additional volume be provided in accordance with accepted hydraulic design principles. In these cases, use the equations outlined in Section 4.11 Special Cases of this Manual to calculate the required volume.

2.4. Geotechnical investigation

An understanding of subsurface conditions is needed to determine the feasibility of using various SMP types.

This is illustrated by the SMP hierarchy in Section 4.2, which indicates the potential for soil and subsurface constraints to impact the selection of SMPs.

Therefore, unless otherwise directed by DEP, a limited geotechnical investigation is required to characterize subsurface conditions of the site. The limited geotechnical investigation shall include soil borings and permeability tests to, at a minimum, determine the following:

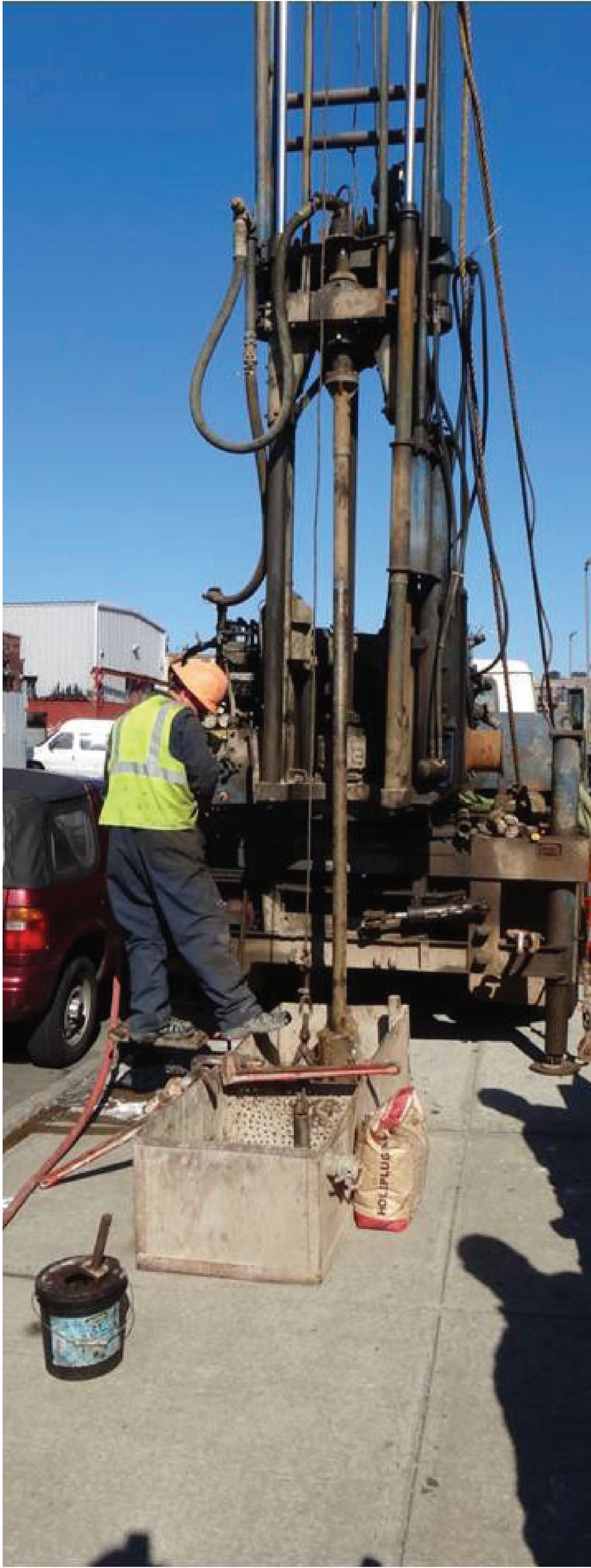
- Soil characteristics and texture
- Depth to groundwater (if encountered)
- Depth to bedrock (if encountered)
- Infiltration rate of soils at specified depths
- Any potential contamination concerns (if encountered)

Procedures
Geotechnical investigations shall be conducted in accordance with the NYS SWMDM procedures. The minimum number of soil boring and permeability tests, collectively referred to as B/PTs, is based on the footprint area of the proposed SMP, as follows:

- SMPs with areas less than 1000sf: at least one B/PT per SMP
- SMPs with areas of 1000sf or more, but less than 5000 sf: at least two B/PT per SMP
- SMPs with areas of 5000sf or more: at least two B/PTs plus an additional B/PT for every 5000 sf of SMP area

Additionally, the designer must make a reasonable determination as to whether additional tests may be needed based on field conditions, such as soil textural classifications and the standard penetration tests. This determination is particularly critical in areas of fill soils where characteristics will vary greatly over small distances.

The owner is responsible for obtaining all applicable permits and approvals related to conducting the geotechnical investigation.



Chapter 3
CITY DEVELOPMENT AND REVIEW PROCESS

NYC Environmental Protection

03 CITY DEVELOPMENT AND REVIEW PROCESS

3.1. Projects that Require Site or House Connection Proposals Only

As noted to the right, this Chapter predominantly provides application guidance for projects that require a Stormwater Construction permit. For Site and House Connection Proposal applications and associated guidelines, see DEP's website: https://www1.nyc.gov/site/dep/about/sewer-connections.page.

Refer to other chapters of this Manual for technical requirements and stormwater management practice (SMP) design guidance for projects that trigger a Site or House Connection Proposal.

Two DEP offices review NYC stormwater management permit applications. Bureau of Water and Sewer Operations (BWSO) reviews Site and House Connection Proposals and Bureau of Environmental Planning & Analysis (BEPA) reviews Stormwater Construction Permits.

This chapter predominantly provides application guidance for projects that require a Stormwater Construction Permit and outlines the process through which applications will be submitted to and reviewed by DEP's BEPA. However, because some projects may trigger both permitting requirements, section 3.2 provides an overview of the joint review process in place for such projects. Prior to using Chapter 3, the applicant must review the stormwater regulations and project applicability requirements described in Chapter 2.

3.2. Projects that Require both Site Connection Proposal and Stormwater Construction Permit

Some projects will require both a Site Connection Proposal and a Stormwater Construction Permit. For projects that trigger both requirements, this section outlines that process through which the applications will be reviewed by the respective bureaus responsible for enforcing the requirements and how the reviews will be coordinated. An applicant may submit the applications in any sequence or simultaneously, as appropriate to the project timeline. Two DEP offices (as noted above, BWSO for the Site Connection Proposal and BEPA for the Stormwater Construction Permit) will review these applications.

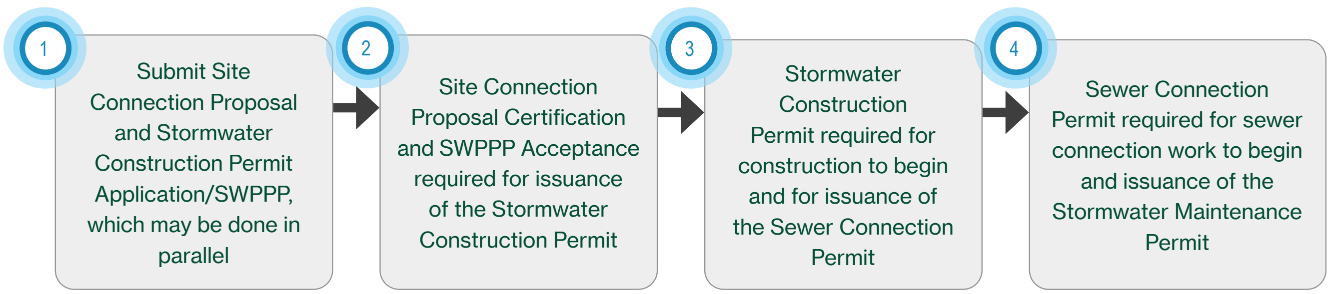
As part of the BWSO review process, the initial application for a sewer connection from the property is the Site Connection Proposal (SCP), and BWSO's acceptance of that proposal is the SCP Certification. The main DEP BWSO office at LeFrak in Queens issues the SCP Certification, though other BWSO offices may review and issue certifications, especially for House Connection Proposals, depending on the circumstances. The SCP Certification is required under all circumstances in which: (1) the applicant proposes a new connection, (2) DOB requires the certification, or (3) the applicant agency's process includes the requirement. Before making the physical site connection, applicants must also obtain a Sewer Connection Permit. BWSO's local offices issue the Sewer Connection Permits.

As part of the BEPA review process, the initial application for stormwater management compliance includes the Stormwater Pollution Prevention Plan (SWPPP), and BEPA's approval of that plan is known as SWPPP Acceptance. In addition to the SWPPP Acceptance, covered development projects must also obtain a Stormwater Construction Permit and a Stormwater Maintenance Permit from BEPA, as further detailed below.

For projects that require both the Site Connection Proposal and Stormwater Construction Permit, the Site Connection Proposal Certification, Sewer Connection Permit, SWPPP Acceptance, and Stormwater Construction Permit are inter-related as follows:

- The Site Connection Proposal Certification and SWPPP Acceptance are required before BEPA issues the Stormwater Construction Permit, which is required before a shovel goes into the ground.
- BWSO does not issue the Sewer Connection Permit until the connection to a City sewer is necessary. The Site Connection Proposal Certification includes a condition that BWSO will not issue the Sewer Connection Permit until the applicant obtains the Stormwater Construction Permit.
- BEPA will not issue a Stormwater Maintenance Permit until BWSO issues the Sewer Connection Permit.

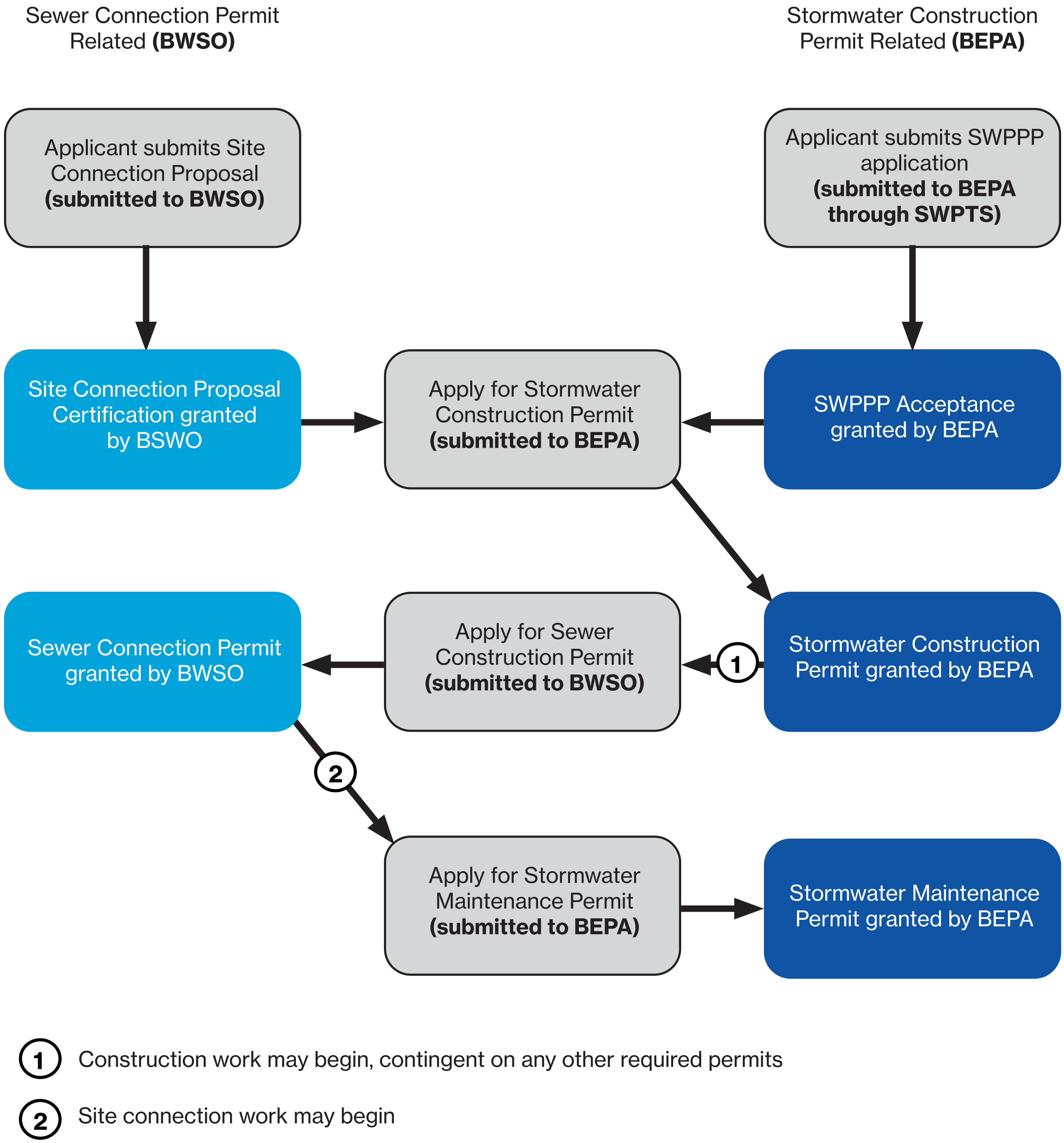
Figure 3.1. illustrates how each submission, approval, and/or permit is inter-related. Overall, the order of the DEP process can be summarized in four steps:



For Site and House Connection Proposal applications and guidelines, see DEP's website https://www1.nyc.gov/site/dep/about/sewer-connections.page.

For projects that require a Stormwater Construction Permit, see section 3.3 for submittal requirements, review processes, and the Stormwater Permitting and Tracking System (SWPTS).

Figure 3.1. Flowchart outlining the inter-relation of BWSO and BEPA submissions, approvals, and permits.



3.3. Projects that Require Stormwater Construction Permit (All)

To simplify the submittal and approval process, DEP has created an online project application system, the Stormwater Permitting and Tracking System (SWPTS), (https://deppermits.microsoftcrmportals.com/), which enables applicants to submit a SWPPP and Stormwater Construction Permit application, as well as to follow the status of DEP's review.

The SWPTS allows DEP to confirm that each permit application meets the requirements for erosion & sediment control, water quality, runoff reduction, and no net increase, as applicable. The review time for the DEP SWPPP approval process is forty-five (45) days. Applicants should note that DEP Stormwater Construction Permits and DEP Stormwater Maintenance Permits issued under the requirements of Title 15, Chapter 19.1, do not obviate the need for obtaining any other existing city, state or federal permit that may be required for the covered development project.

A user-friendly template for SWPPP applications can be found on DEP's website www.nyc.gov/dep/stormwaterpermits. The template is an editable document file where text, tables, and figures can be added or removed as needed. In total, the template includes eight sections and 14 appendices, with instructions on what information is needed for each. For ease of reference, the following sections are included in the SWPPP template:

- Contact Information / Responsibilities
- Site Evaluation, Assessment, and Planning
- Erosion and Sediment Controls
- Construction Inspection
- Post Construction Stormwater Controls
- Certification and Notification
- Retention of Records
- Required Drawings

For projects in MS4 areas, upon receiving DEP SWPPP Acceptance, the applicant may proceed to request coverage under the New York State Department of Environmental Conservation (NYSDEC) State Pollutant Discharge Elimination System (SPDES) General Permit for Stormwater Discharges from Construction Activity (CGP) for the covered development project.

As part of the SWPTS, DEP has identified roles and responsibilities for people involved with the development project, as provided below and in Table 3.1. While in some instances the roles and responsibilities may overlap, the following major roles are identified in the SWPTS and used throughout the following sections of this Manual.

Owner – Owner of the property undergoing development is the individual, corporation, partnership, limited-liability company or other legal entity having legal title to premises, a mortgagee or vendee in possession, a trustee in bankruptcy, a receiver, or any other person having legal ownership or control of premises. Owners must certify that they are aware of the development activity and understand their role under RCNY Title 15 Chapter 19.1. The owner may also be the Developer.

Developer – Primary project contact, is the person who owns or leases land on which development activity that is part of a covered development project is occurring, or a person who has operational control over the development or maintenance activity's plans and specifications, including the ability to make modifications to the plans and specifications. Developers must certify that they have overseen the SWPPP development and that the project has been completed as designed. The Developer may also be the Owner.

Applicant – Fills in applications and uploads reports, plans and other documentation to the SWPTS.

SWPPP Preparer – Must be a qualified professional. Creates the SWPPP for review and submittal to the SWPTS. The SWPPP Preparer, who typically works for the Developer, must certify that the SWPPP was prepared in accordance with RCNY Title 15 Chapter 19.1.

Qualified Professional (Construction) – Responsible for inspection and certification of installed SMPs. Qualified Professional (Construction), who typically works for the Developer, must certify that all SMPs have been constructed in accordance with the SWPPP.

Qualified Inspector – Responsible for inspection and certification that final stabilization has been achieved at the site. Performs weekly inspections of erosion and sediment control (ESC) practices. The Qualified Inspector, who typically works for the developer must certify that all ESC SMPs are constructed and removed in accordance with the SWPPP.

Contractor – Responsible for construction of project and implementation of SWPPP. Contractors must certify that they will agree to comply with the SWPPP as well as all applicable permits, including the NYC Stormwater Construction Permit and/or the CGP. The Contractor reports to the Developer.

Trained Contractor – Responsible for daily inspection, implementation and maintenance of ESC. Reports to Contractor and must be an employee of the Contractor.

Table 3.1. Roles and responsibilities in the SWPTS.

Role	Responsibility	Minimum Professional Registration/ Certification	Signoff/ Certification Required for Plan Approval/ Construction Permitting?	Signoff/ Certification Required for Construction Closeout/ Maintenance Permitting?
Applicant	Fills in application and uploads reports and plans to the SWPTS.	N/A	N/A	N/A
Contractor	Responsible for construction of project and implementation of SWPPP.	NYC DOB	Yes	N/A
Developer	Primary project contact, responsible for payments and project staff. May be the same entity as Owner.	N/A	Yes	Yes
Owner	Must provide permission for work to occur on property. May be liable for all fees and fines.	N/A	Yes	N/A
Owner/Developer	See 'Owner' and 'Developer'	N/A	Yes	Yes
Qualified Inspector	Responsible for weekly (bi-weekly) inspections. Reports to Developer.	NYS PE or RLA or works under direct supervision of same or CPESC.	N/A	Yes
Qualified Professional (Construction)	Responsible for inspection and certification of installed SMPs. Reports to Developer. May also serve as the SWPPP Preparer or Qualified Inspector.	NYS PE or RLA	N/A	Yes
SWPPP Preparer	Responsible for creating the SWPPP for review and approval. Works for Developer. May also serve as the Qualified Professional (Construction) or Qualified Inspector.	NYS PE, RLA or CPESC (E&SC Plan only)	Yes	N/A
Trained Contractor	Responsible for daily inspection, implementation and maintenance of ESC. Reports to Contractor and must be an employee of Contractor.	NYSDEC 4-hour ESC Class	N/A	N/A

3.4. DEP SWPPP Submittal and Review Process

Figure 3.2 details, from start to finish, the complete DEP SWPPP submittal, review, and approval process for a covered development project. The responsible party for each step in the process is designated by color, with decision points for approvals and other actions noted accordingly.

As part of the SWPPP approval and stormwater construction permitting process, all users must register in the SWPTS to use the system. Users include the owner, applicant, developer, contractor, etc. Each responsible party must provide requested information in the SWPTS to be able to submit an application and receive DEP approval.

An in-depth, step-by-step description of the process is provided in Section 3.5. DEP encourages SWPPP preparers, developers, and applicants to read Chapter 3 in its entirety to understand the entire submittal and review process along with the associated requirements and decision points. During development of the SWPPP, SWPPP preparers, developers, and applicants should also review Chapters 2 and 4 and make sure they understand what is required in order to develop a SWPPP that will obtain DEP approval.

Electronic Submissions

The SWPPP and all associated application information must be submitted electronically using the SWPTS. All required information except for the SWPPP document itself must be entered directly into the SWPTS using the online input forms. The complete SWPPP, including all drawings and associated materials, must be uploaded into the SWPTS as a pdf. If issues arise during the upload of the SWPPP document, contact NYCSWPTSAdmin@dep.nyc.gov to request direction on how to submit the application.

Contacting DEP Staff

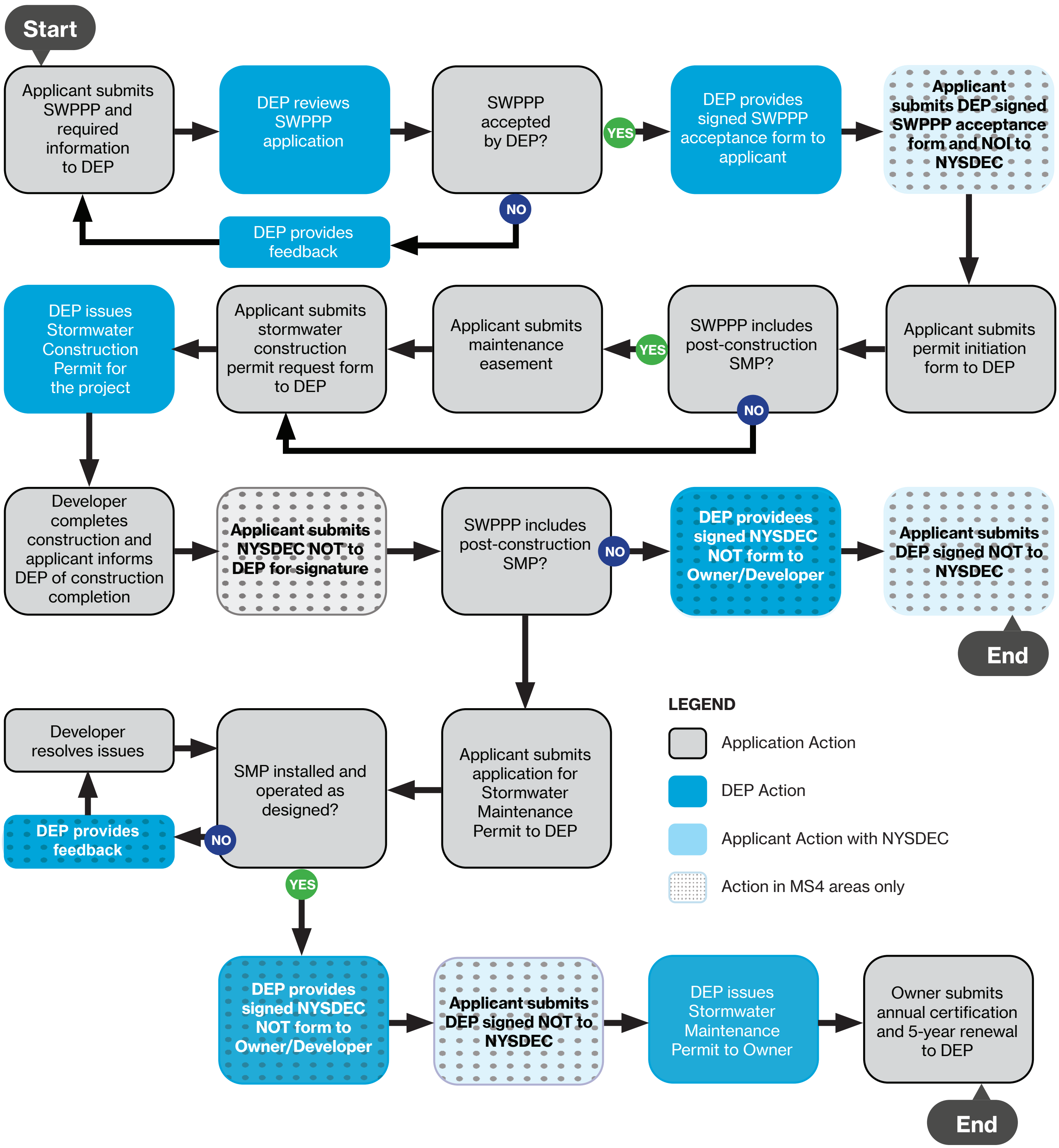
DEP encourages SWPPP preparers and applicants to contact the DEP SWPPP Review and Inspection Team for assistance at any point during development of the SWPPP and/or the submittal and review process. For additional information and answers to frequently asked questions, SWPPP preparers and applicants can:

- Visit the DEP SWPTS website at https://deppermits.microsoftcrmportals.com/
- Email the DEP SWPPP Review and Inspection Staff at stormwaterpermits@dep.nyc.gov

SWPPP preparers and applicants may request discussions with DEP to address site challenges and proposed innovative stormwater management approaches. Each project will be assessed on a case-by-case basis to determine if the concerns require an in-person meeting. All questions or requests for in-person meetings should be emailed to stormwaterpermits@dep.nyc.gov.

Parties requesting an in-person meeting will need to provide a project description, preliminary site plan, a description of the issues/concerns that need to be discussed and three (3) preferred dates and times to meet with DEP within two (2) weeks of the meeting request submittal. DEP staff will determine the final meeting date and time based on availability.

Figure 3.2. Detailed NYC Stormwater Permit Submission, Review, and Approval Process.



3.5. SWPPP Submission, Review and Approval Details

The following sections provide detailed information about the specific phases of the DEP SWPPP submittal and approval process shown in Figure 3.2.

SWPPP Submission Materials

To begin the DEP submittal and approval process, the applicant for the covered development project must:

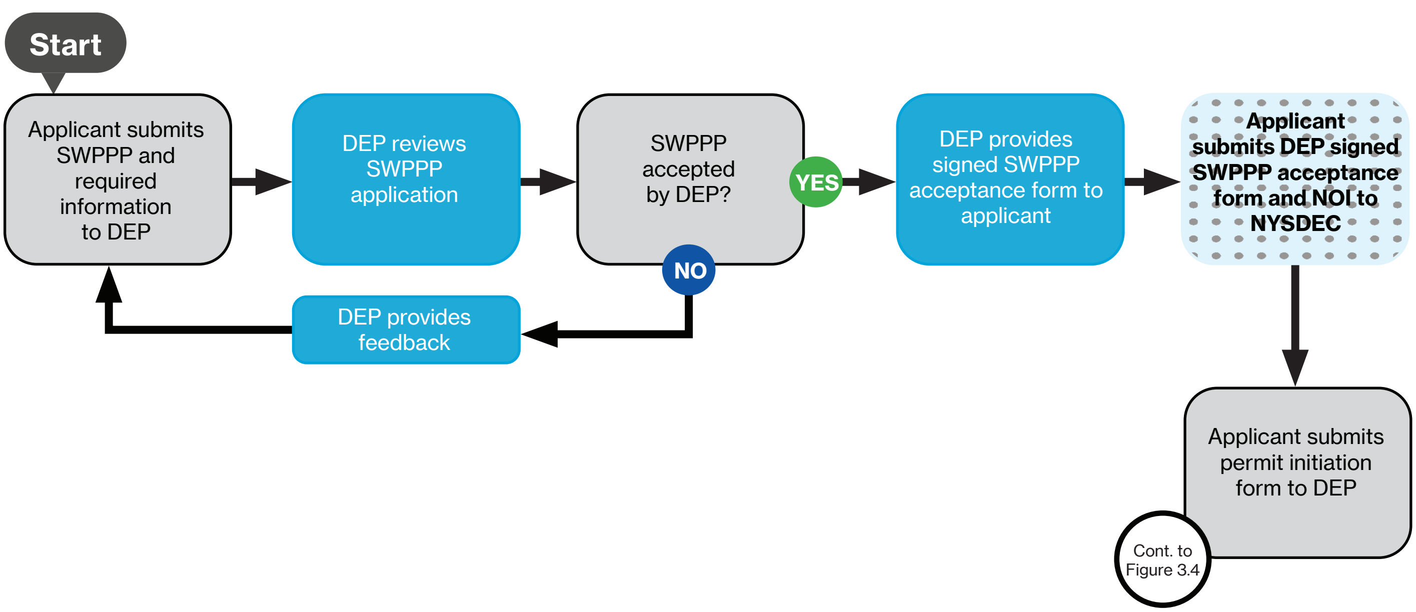
- Complete the online application in the SWPTS;
- Upload a complete SWPPP in the SWPTS; and
- Pay the associated permit fees.

SWPPP Acceptance

If DEP disapproves the submitted SWPPP application, as shown in Figure 3.3, it provides the applicant with a notice identifying the deficiencies within the SWPPP that must be addressed in order to obtain DEP approval. A new application then has to be submitted to DEP for review and approval.

If DEP approves the submitted SWPPP application, DEP provides the applicant with a signed SWPPP Acceptance Form for the project. For projects in MS4 areas, the applicant then includes the signed SWPPP Acceptance Form with the NYSDEC Notice of Intent (NOI) when applying to obtain coverage for the proposed project under the CGP.

Figure 3.3. SWPPP Acceptance Decision Point.



SWPPPs without Post- Construction SMP(s)
If the SWPPP does not require a post-construction SMP, the Permit Initiation Form may be submitted in the SWPTS without a stormwater maintenance easement, as shown in Figure 3.4.

DEP issues a Stormwater Construction Permit for the project once all the required information in the Permit Request Form has been submitted and approved. Once the DEP Stormwater Construction Permit has been issued, construction may begin. DEP may conduct inspections at any time during the construction process.

After the completion of construction, the applicant will inform DEP of construction completion. For projects in MS4 areas, the applicant will submit the NYSDEC Notice of Termination (NOT) to DEP for the MS4 acceptance signature, as shown in Figure 3.5. DEP may inspect the project site and, if satisfied, will provide the signed NOT to the applicant. The applicant will then submit the signed NOT to NYSDEC.

Figure 3.4. Permit Initiation Form and Maintenance Easement Requirements.

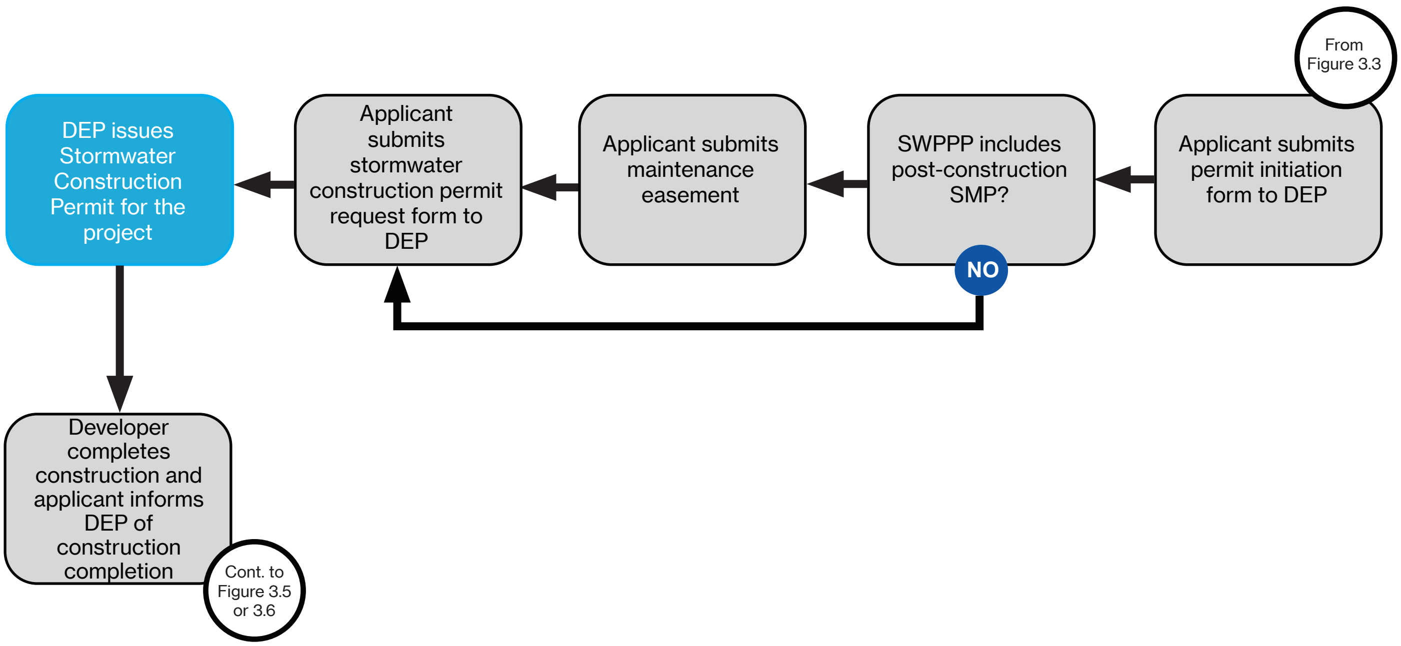
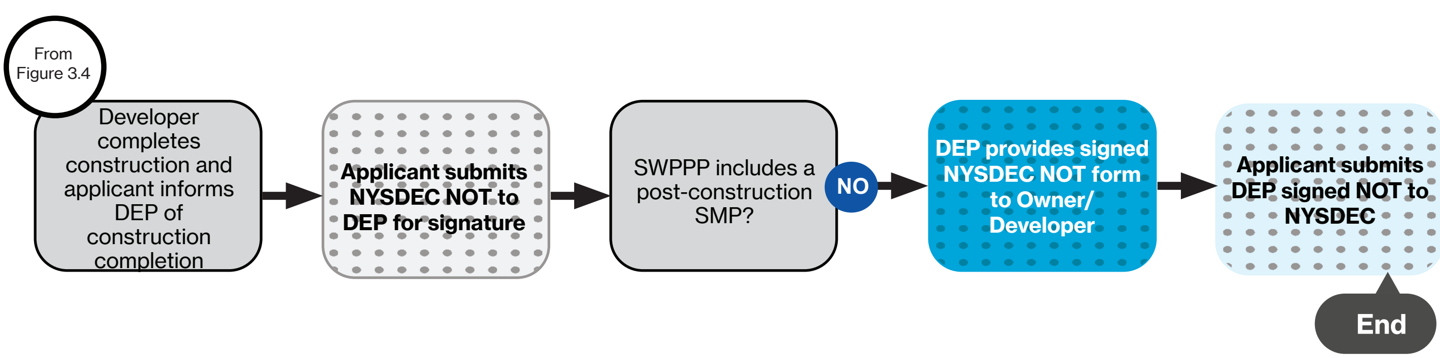


Figure 3.5. SWPPP Does Not Include Post-Construction SMP Decision Point.



SWPPP with Post-Construction SMP(s)

If a SWPPP includes one or more post-construction SMPs, the applicant must obtain a maintenance easement. A copy of the maintenance easement and the information required on the Permit Initiation Form must be submitted via SWPTS as shown in Figure 3.4. DEP issues a Stormwater Construction Permit for the project once all the required information in the Permit Request Form has been submitted and approved. Once the DEP Stormwater Construction Permit has been issued, construction may begin.

Once construction is completed, the applicant must also submit the application for a Stormwater Maintenance Permit to DEP as shown in Figure 3.6. The Stormwater Maintenance Permit application shall consist of the following:

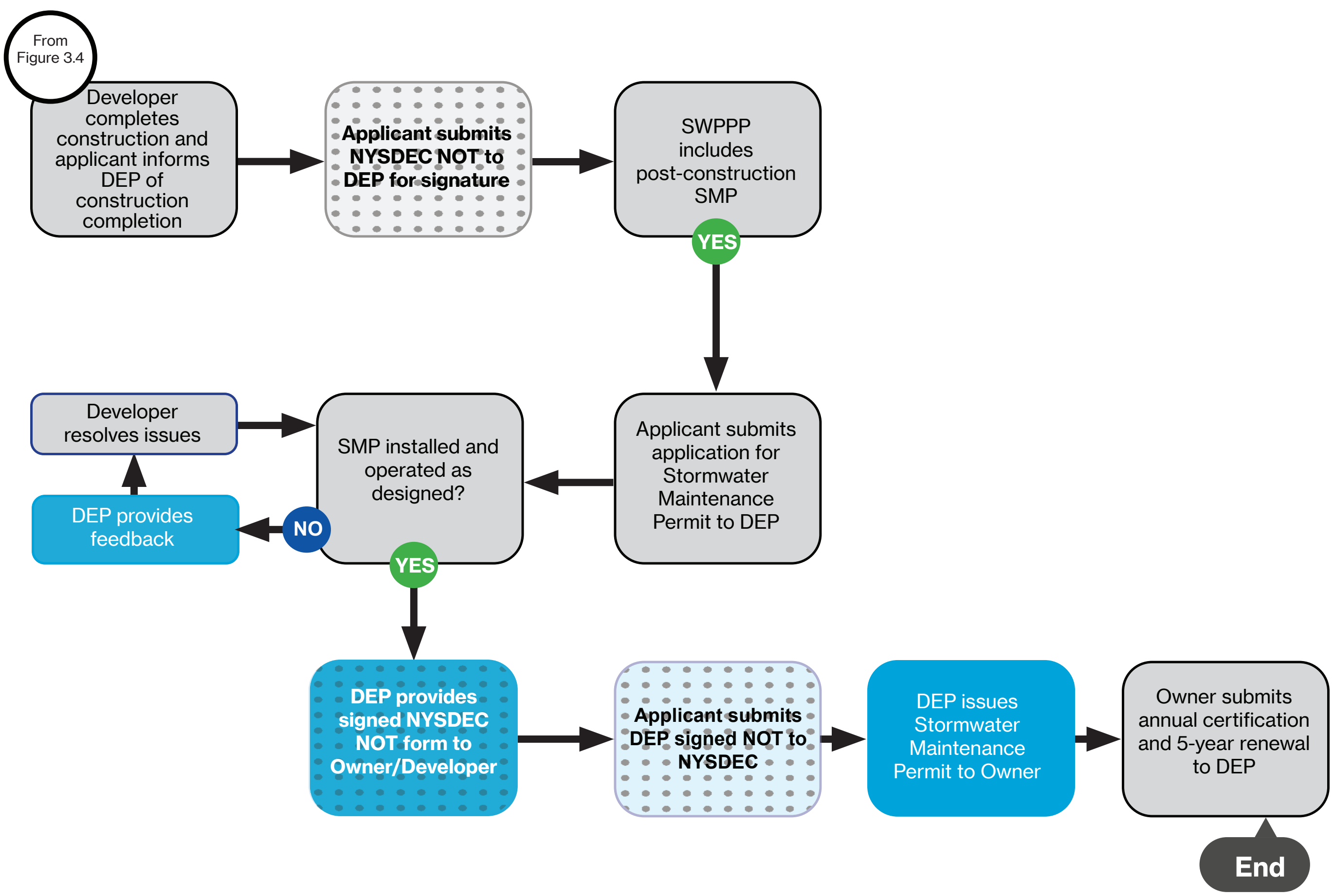
- NOT;
- As-built plan;
- Operation and maintenance manual that designates the entity responsible for the long term maintenance;
- Fee specified in the DEP Stormwater Rule.

An electronic version of the NOT is available on the SWPTS. As-built plans and a final Operation and Maintenance Manual need to be uploaded in a PDF or other acceptable format. The Operation and Maintenance plan should be finalized based on the installed SMP(s), reflecting any changes that were made during the construction period.

DEP may inspect the SMP(s) at any time. If the SMP is not installed or operating as designed, DEP will provide feedback and the applicant must resolve the issue(s). Once the SMP(s) is installed and operating as designed, DEP will provide the acceptance signature for the NOT and issue the Stormwater Maintenance Permit. For projects in MS4 areas, the applicant will then submit a signed NOT to NYSDEC.

The owner must submit an annual certification for the SMP as well as a 5-year permit renewal to DEP via the SWPTS. Requirements for inspection schedules as well as typical SMP operation and maintenance requirements are detailed in Chapter 5.

Figure 3.6. SWPPP Does Include Post-Construction SMP Decision Point.



3.6. Expiration Policy

SWPPP Acceptances expire if a permit is not requested within 2 years of the plan approval date. A Stormwater Construction Permit expires if the commencement of development activities does not take place within one year or is not completed by a date specified in the permit. Furthermore, a Stormwater Construction Permit expires if the permitted work is suspended or abandoned for a continuous period of 12 months unless such permit expires earlier. Expired permits require reapplication as detailed in the permit conditions.

3.7. Partial Shutdowns

If a covered development project requires temporary shutdown for less than 12 months, the developer must notify DEP a minimum of seven days before the shutdown and submit documentation showing that the site is stable and that all SMPs are operational. The developer is responsible for having a qualified inspector visit the site and inspect it at least once every 30 days during the shutdown. In addition, all permits must be kept current during the suspension of development activity.

If a covered development project requires a planned shutdown with partial project completion for 12 months or longer, the owner or developer must submit a completed NOT to DEP for sign-off prior to submitting the NOT to NYSDEC. The department reviews the completed NOT to ensure that the following conditions have been met:

- All soil disturbance has ceased;
- All areas disturbed as of the project shutdown date have achieved final stabilization;
- All temporary structural ESC measures have been removed; and
- Any post-construction SMPs required for the completed portion of the project have been constructed in conformance with the SWPPP and are operational.

New York City Stormwater Manual

Chapter 4
SMP SELECTION AND DESIGN

NYC Environmental Protection

04 SMP SELECTION AND DESIGN

4.1. Practice Types

This chapter covers the following topics:

- Section 4.1 | Overview of SMP functions and surface types used for classification
- Section 4.2 | Selecting SMPs using the SMP hierarchy
- Section 4.3 | Methods for sizing SMPs to meet applicable stormwater management requirements
- Section 4.4-4.8 | General design criteria for SMPs by function
- Section 4.9 | Process for approval of other, innovative systems
- Section 4.10 | Specific design criteria for each SMP component
- Section 4.11 | Calculations for special cases

SMPs are systems that are designed to protect, restore, or mimic the natural water cycle within built environments by retaining, detaining, and/or treating stormwater runoff. In this Manual, SMPs are categorized in two ways: first, by their primary function and second, by their surface type.

SMP Functions

Runoff that enters an SMP is typically managed via one or more of the following physical processes:

- **Infiltration –** water is captured and infiltrated into the underlying soils (sometimes referred to as exfiltration).
- **Evapotranspiration (ET) –** water is captured and evaporated or transpired back into the atmosphere.
- **Reuse –** water is captured and reused for purposes other than SMP irrigation (which can reduce water storage potential of other SMPs).
- **Filtration –** water passes through a filtration medium to remove various pollutants.
- **Detention –** water is temporarily stored and released at a lower flow rate.

SMPs may support more than one process, but there is usually one primary function for which the system was designed. For example, a bioretention system that is constructed on permeable soils is designed to manage runoff primarily by infiltration, since ET accounts for a smaller portion of managed runoff. However, a bioretention system with an outlet pipe is designed to manage runoff primarily by filtration, since most runoff will exit the practice and enter the sewer system once it has been filtered.

While one primary function is most common, some SMPs may be configured to support runoff management via two, equally contributing functions, e.g., detention systems that are also designed with components to filter runoff as it flows through the practice. These types of SMPs are referred to as dual function systems, which are described further in the Innovative Systems section (Section 4.9).

Among the five primary functions, infiltration, ET, and reuse SMPs are considered retention-based practices because they aim to eliminate or reduce the total volume of runoff leaving the site. The other two functions, filtration SMPs and some extended detention SMPs, are considered treatment-based practices because they aim to remove pollutants from runoff before it ultimately leaves the site. The distinction between retention-based practices and treatment-based practices is important when selecting an SMP to meet water quality goals, discussed further in Section 4.2.

In this Manual, the primary SMP function, or dual functions for some systems, will be used to help categorize SMPs. This does not mean that secondary processes are to be neglected during the SMP design but allows for a straightforward means for grouping and crediting SMPs. As indicated in the earlier examples for bioretention systems, SMPs can take on different functions depending on how they are designed, and this framework provides flexibility for a wide range of potential configurations that may be necessary to accommodate various site constraints. An illustration of the physical process for each function type is shown in Figure 4.1, along with a brief description and example SMP.

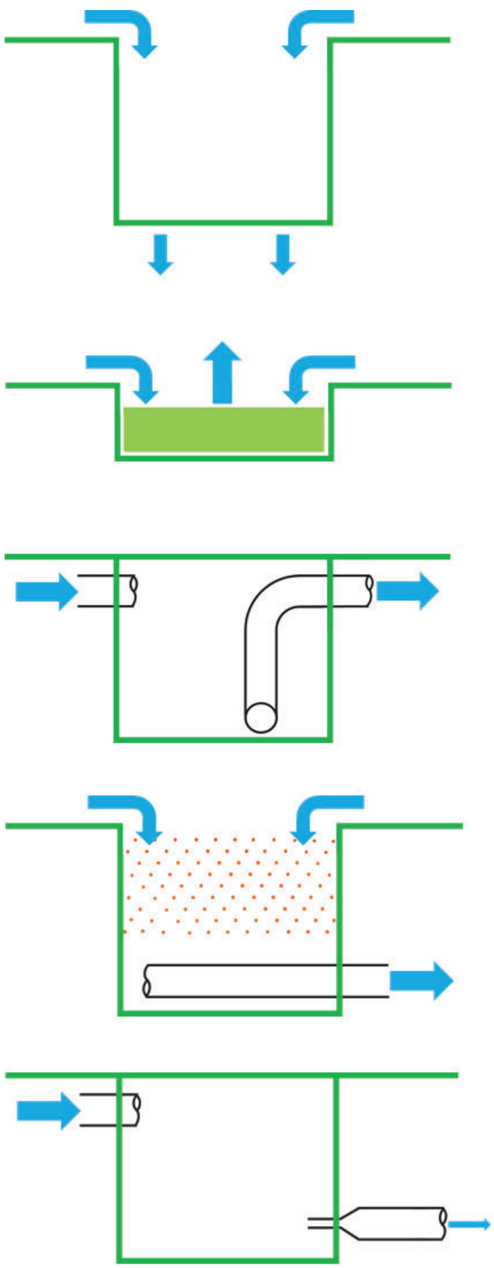
SMP Surface Types

In addition to primary function, SMPs can be further categorized by one of two surface types:

- **Vegetated SMPs –** practices with a planting media that supports vegetation.
- **Non-vegetated SMPs –** practices without vegetation, such as permeable hardscapes, permanent ponds, enclosed systems, or subsurface systems.

Vegetated practices can provide a number of added co-benefits beyond stormwater management, such as air filtration, reduction of heat island effects, ecological benefits, and amenity. Non-vegetated practices often lack most co-benefits but may be necessary for highly constrained sites. A major goal of the Unified Stormwater Rule, and therefore this Manual, is to increase the use of vegetated practices in order to realize additional co-benefits for NYC residents.

Figure 4.1. SMP function diagrams.



Infiltration

Description: Water is captured and infiltrated into the underlying soils, which is sometimes referred to as exfiltration.
Design: Relies on sufficient permeability rates of underlying soils. Practices do not use outline pipes to drain water.
Example: Bioretention system, no outlet pipe

Evapotranspiration

Description: Water is captured and evaporated or transpired back into the atmosphere.
Design: Relies on ET occurring between rainfall events. Practices are usually shallow and have no or limited ability to infiltrate water.
Example: Green roof

Reuse

Description: Water is captured and reused for non-irrigation purposes.
Design: Relies on continuous reuse of water. Practices can be integrated into existing non-potable and non-contact water uses.
Example: Reuse in cooling tower

Filtration

Description: Water passes through a filtration media to remove various pollutants.
Design: Relies on steady flow of water through the filtration media. Practices have an outlet pipe to support filtration.
Example: Sand filter

Detention

Description: Water is temporarily stored and released at a lower flow rate.
Notes: Relies on ability to control release rate. Practices have a controlled-flow device, such as an orifice.
Example: Detention tank

4.2. Selecting an Appropriate System

Designers must select and design practices to meet all applicable stormwater management requirements outlined in Chapter 2. This subsection includes guidance on selecting practices to meet the water quality criterion (WQv), runoff reduction criterion (RRv), and no net increase criterion (NNI). This guidance follows an SMP hierarchy based on several guiding principles.

The ESC criteria should be met using best practices in accordance with the NYS Standards and Specifications for Erosion and Sediment Control (The Blue Book). The sewer operations criterion (Vv) does not require the use of the SMP hierarchy, although DEP encourages the use of vegetated infiltration practices, where feasible, because of their potential co-benefits.

The SMP hierarchy was created with two goals: first, to create a clear and consistent approach for the selection of SMPs throughout the City and second, to guide designers toward practices that are most effective at meeting the City's goals for stormwater management and co-benefits. The SMP hierarchy follows three logical steps:

1. (CSS & MS4) – use vegetated retention practices to meet requirements, or up to the maximum extent practicable.
2. (CSS & MS4) – use non-vegetated retention practices to meet requirements, or up to the maximum extent practicable.
3. (CSS) – meet any remaining requirements using either vegetated or non-vegetated detention practices.

   (MS4) – meet any remaining requirements using either vegetated or non-vegetated treatment practices.

These steps reflect several principles that were discussed in Chapter 2. For example, the principle that improving water quality in CSS areas is largely achieved by limiting CSO volume and occurrence. In this case, retention practices are preferred, while detention practices are a secondary option. Alternatively, improving water quality in MS4 areas is largely achieved by managing pollutants in runoff. In this case, retention practices are preferred, while treatment practices, such as filtration systems and some extended detention systems, are a secondary option. Finally, the SMP hierarchy also reflects that vegetated practices are generally preferred over non-vegetated practices due to the valuable co-benefits the former can provide for NYC residents.

The SMP hierarchies for CSS areas and MS4 areas are shown in Figures 4.2 and 4.3, respectively. Each hierarchy shows five groups of SMPs based on their function and/or surface type, as previously defined in Section 4.1. The CSS hierarchy includes groups for retention systems (vegetated and non-vegetated), detention systems (vegetated and non-vegetated), and reuse systems. The MS4 hierarchy is similar, except detention systems are replaced with treatments systems. Within each group are a list of applicable practices. Since some SMPs can be configured for multiple functions, they may appear in more than one group.

These SMP groups are shown in a grid that is arranged by their order of preference, with more preferred practices at the top-left and least preferred practices at the bottom-right. Reuse systems, which are also recognized as retention systems, appear as a standalone group that is optional, but can be used at any time. This placement reflects that reuse applications are not practical for all sites, but are among the high-priority SMP types, when appropriate.

The priority level of each SMP group is indicated by tiers with different colors, where the darker shades of green (CSS) or blue (MS4) indicate higher tier SMPs. These priority levels reflect the three logic steps of the SMP hierarchy. Designers must assess and implement SMPs in higher tiers to the maximum extent practicable before moving to lower tier systems. In this case, the maximum extent practicable is defined as the greatest extent to which site constraints allow.

Figure 4.2. SMP hierarchy for CSS areas.

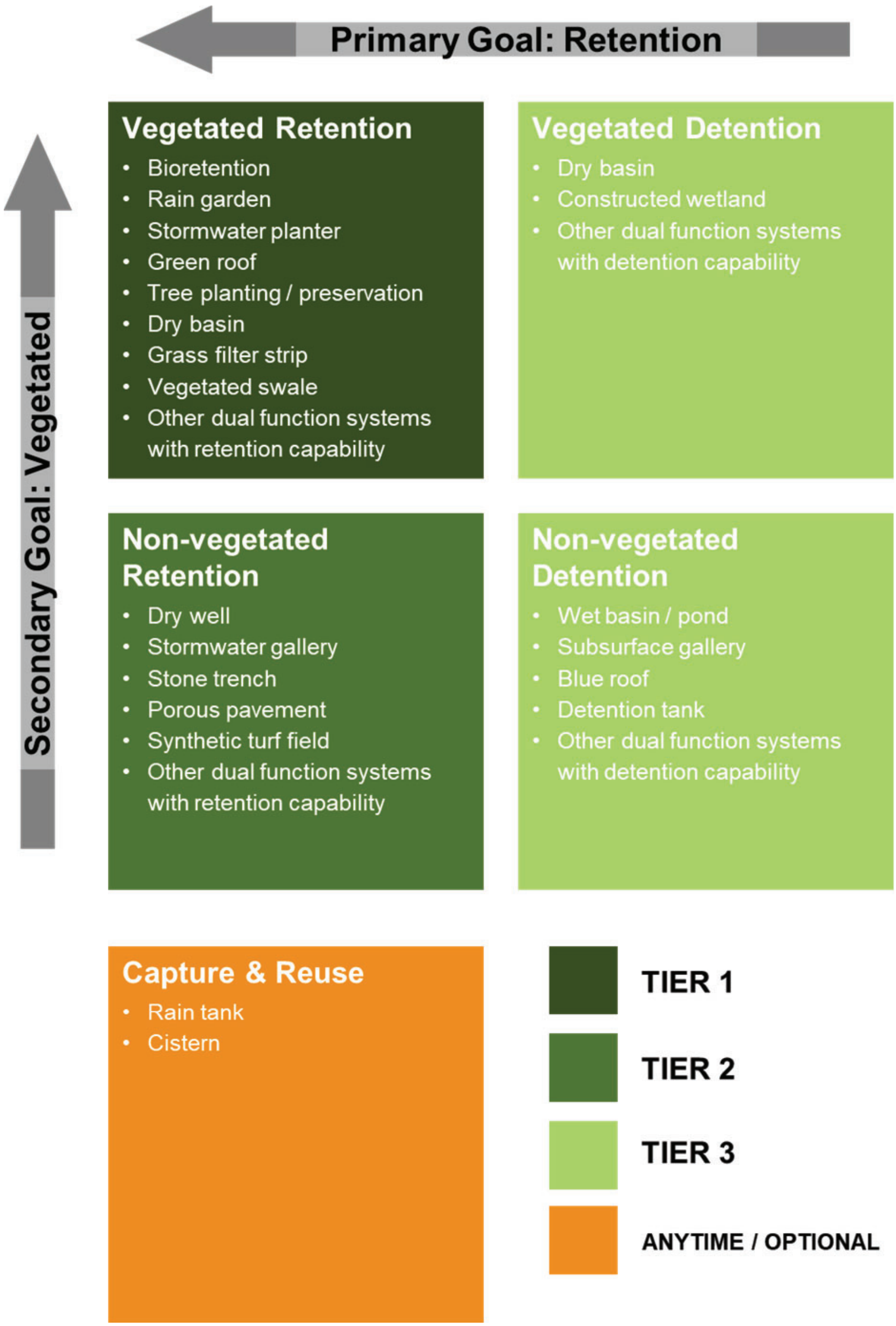
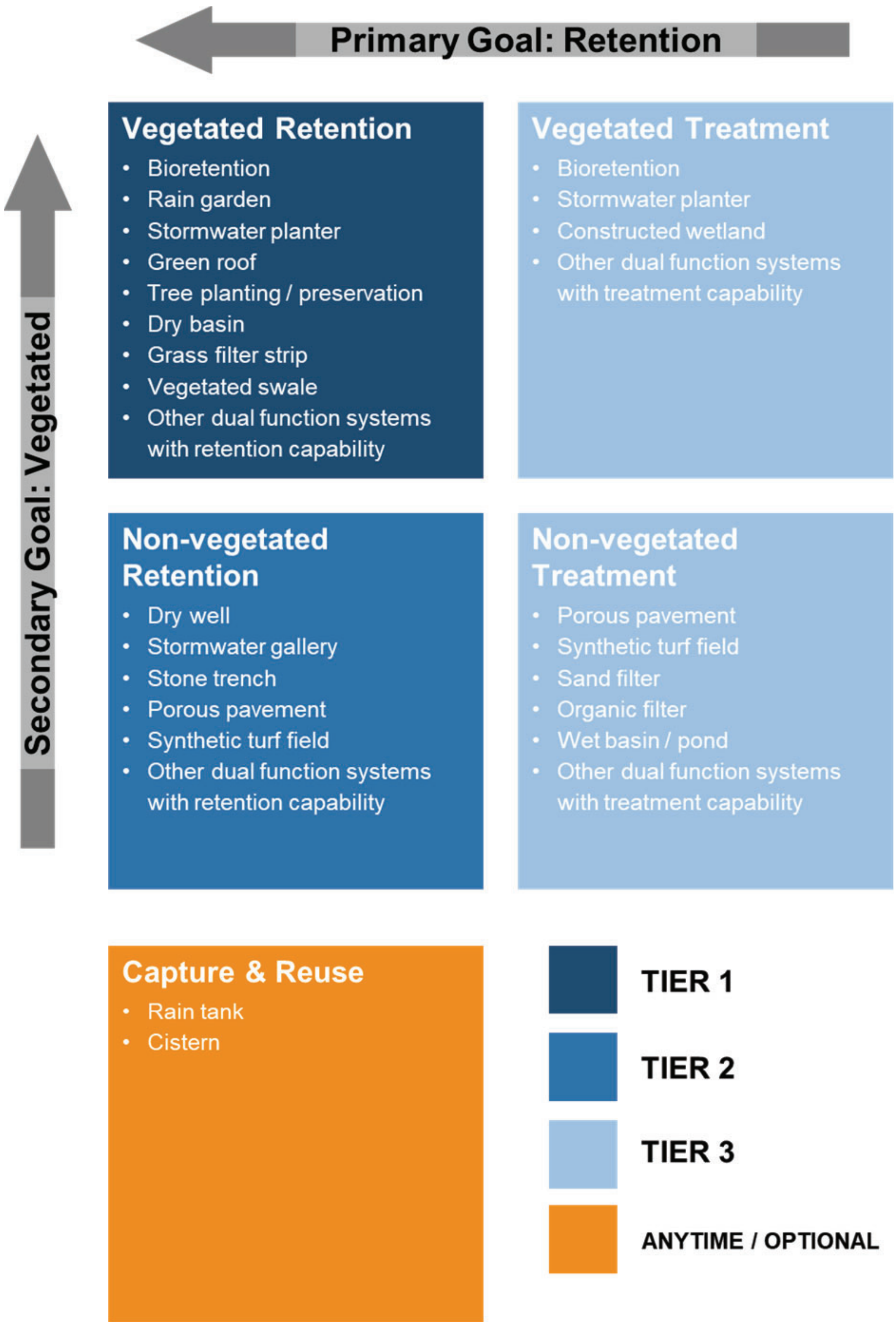


Figure 4.3. SMP hierarchy for MS4 areas.



There are five potential site constraints that may impact the feasibility of SMPs, defined as follows:

- Soil constraints – permeability tests indicate that soil infiltration rates are less than 0.5 in/hr, limiting the use of infiltration practices.
- Subsurface constraints – boring tests indicate that the bottom of practice would be less than three feet from the groundwater table or bedrock, limiting the use of most practices, except those enclosed in concrete with adequate anchoring, as determined by an engineer.
- Hotspot constraints – land use or soil conditions increase the risk of runoff contamination, limiting the use of infiltration practices, or those without liners. (see criteria below).
- Surface constraints – regulations require the use of paved surfaces, limiting the use of vegetated practices. As an example, regulations for parking and/or egress requirements.
- Space constraints – required setbacks from structures, utilities, property lines, existing trees, or other site features limits the use of practices at the ground level. General siting criteria for on-site projects can be found in Appendix C.

Keep in mind, that some constraints may be limited to one portion of the site, rather than impacting the entire site. For this reason, it is important that designers consider how constraints may vary across the site when demonstrating that SMPs are used to the maximum extent practicable. To assist designers in following the SMP hierarchy, an SMP hierarchy checklist was created which shows how each constraint impacts the feasibility of specific SMPs in CSS and MS4 areas (Appendix A).

Hotspot constraints may be caused by either land uses or soil conditions. Land uses that cause stormwater hotspots are referenced in the NYS SWMDM. Soil conditions that cause stormwater hotspots are listed below, which may be demonstrated through environmental assessments or as part of a regulatory program (e.g., NYSDEC Spills and Remediation Programs) documentation:

- Presence of grossly contaminated soil or non-aqueous phase liquid (NAPL) as defined in NYSDEC DER-10
- Soil exceeds the groundwater protection objectives of NYSDEC 6 NYCRR 375
- Soil is characterized as hazardous waste as defined in 6 NYCRR 360 or 40 CRF 261
- Groundwater exceeds standards, guidance values and/or limits described in NYSDEC AWQS in 6 NYCRR 703 or TOGS1.1.1

The checklist includes one row for each SMP type, with fields that indicate the practices: tier, function type, and practice name, along with markers to show which constraints would impact that SMP's feasibility. For example, "X" markers in the checklist are used to indicate the site constraints that would prevent each practice from being used. Designers are required to use the SMP selection checklist to determine which practices should be used on a site-by-site basis. This can be done in three steps:

- Determine what, if any, site constraints are applicable for the site, or portions of a site
- Eliminate practices that are not feasible given the applicable site constraints
- Meet the water quality criterion by exhausting all remaining SMP opportunities from higher tiers, before moving to lower tiers

When SMPs are eliminated due to site constraints, the designer must provide the appropriate documentation that demonstrates each constraint (see Chapter 3). In addition, whenever a tier 2 or tier 3 SMP has been proposed, the designer must provide written justification for how higher tier practices have either been eliminated due to site constraints or used to the maximum extent practicable. All documentation for constraints and justification for use of lower tier practices are subject to review and approval by DEP.

Once selected, SMPs must be designed in accordance with all applicable design criteria outlined in Sections 4.4-4.11.

4.3. SMP Sizing

SMPs shall be sized so that the total volume of water that can be stored in the practice meets or exceeds the volume of runoff that must be managed to meet the stormwater management requirement. Procedures for computing the SMP storage volume are outlined in this subsection, along with how that volume is applied towards meeting the stormwater management requirements.

It is important to note that the following sizing methods are applicable to volume-based stormwater management requirements and SMPs. Designers seeking a deviation from the sizing methods or design criteria in this chapter must submit a stormwater model that demonstrates SMPs will meet the goals of each applicable stormwater criterion, subject to approval by DEP. Models must assess storage, routing, and drawdown for the design event(s) of interest. Acceptable stormwater models include HydroCAD and EPA SWMM.

Volume-based stormwater management requirements include water quality, runoff reduction, sewer operations, and NNI for Nitrogen removal. Other NNI requirements and the ESC requirement are criteria-based and should be met by following all relevant guidelines outlined in Chapter 2.

Volume-based SMPs include all practices except grass filter strips, vegetated swales, and tree preservation, which are criteria-based. As an example, the design criteria for grass filter strips and vegetated swales are intended to promote contact time between surface runoff and the vegetated surface for infiltration, rather than to use a storage element. These practices shall be designed to meet all relevant guidelines outlined in Sections 4.4-4.10.

The storage volume of a practice is the volume of water that can be stored at the surface or within the voids of the system itself. Internal voids can include those of any media (e.g. engineered soil or crushed stone), as well as voids of any internal structures (e.g. chambers or pipes). To be counted, the storage volume must fall within the active storage zone of the practice, which spans the distance from the lowest elevation from which water exits the storage zone up to the elevation of an overflow device that allows water to exit or bypass a practice once full.

For infiltration, the bottom of the active storage zone is simply the bottom of the practice. For ET systems, the bottom of the active storage zone is the bottom of the soil media layer. For reuse systems, the bottom of the active storage zone is the lowest elevation of usable water. For filtration and detention systems, the bottom of the active storage zone corresponds to the invert elevation of the outlet pipe.

The volume of the active storage zone can be calculated by adding up the volume of voids for each storage component. Therefore, a general formula for the calculation of storage volume is as follows:

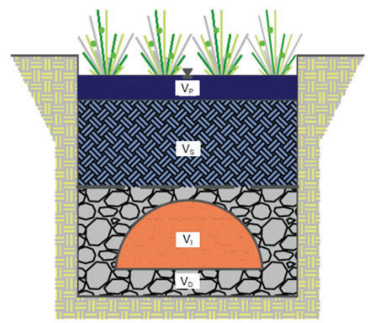
EQ 4.1

$$V_{SMP} = V_P + V_S + V_I + V_D$$

where:
V_{SMP} = storage volume of SMP (cf)
V_P = volume of surface ponding (cf)
V_S = volume of voids in the soil media layer (cf)
V_I = volume of voids created by internal structures such as chambers or pipes (cf)
V_D = volume of voids in the drainage media (cf)

One benefit of this general formula is that it is applicable to all storage based SMPs, regardless of function type or geometry. As an example, Figure 4.4 shows each of the four storage components for a bioretention system that uses a subsurface chamber. Methods for calculating the storage volume of each term in the general formula will be discussed first, followed by a consolidated formula that may be used for common practices with simple geometry.

Figure 4.4. Illustration of storage areas for a bioretention system with surface ponding (V_P), soil media (V_S), internal structure (V_I), and drainage media (V_D).



During the design process, designers should also consider any other factors which may impact the size of the overall practice or specific elements. For example, the elevation of the overflow device will govern the top of the active storage zone, which may impact the depth of drainage media that may be counted towards SMP storage volume.

Surface Ponding

The volume of surface ponding can be calculated using several different methods, depending on the most appropriate method for the geometry of the ponding area. Prior to calculating the volume of surface ponding, designers should refer to the applicable design criteria for each SMP to identify whether a minimum volume of surface ponding is required. This requirement is intended to prevent bypass of the water quality event in cases where water must percolate through a planting or filtration media.

For ponding areas where the surface is relatively flat, the equation for the volume of a rectangular box shall be used:

EQ 4.2

$$V_P = A_{SMP} * D_P$$

where:
V_P = volume of surface ponding (cf)
A_{SMP} = area of the SMP (sf)
D_P = depth of ponding (ft)

For ponding areas where the surface has slopes that are relatively uniform, the equation for the volume of a truncated pyramid shall be used:

EQ 4.3

$$V_P = \frac{1}{3}\left(A_{P1} + \sqrt{A_{P1} * A_{P2}} + A_{P2}\right) * D_P$$

where:
V_P = volume of surface ponding (cf)
A_{P1} = area at the base of surface ponding zone (sf)
A_{P2} = area at the top of surface ponding zone (sf)
D_P = depth of ponding (ft)

For ponding areas with complex geometry, the designer shall create a stage-area curve that relates the depth of ponding to the area of ponding at regular intervals. The volume of each interval may then be calculated using the equation above by inputting the area at the top and bottom of the interval. The volume of surface ponding can then be calculated as the sum of all intervals.

Finally, in cases where there is no surface ponding, or the surface ponding area is above the elevation of an overflow device, the surface ponding volume is zero.

Soil Media

The volume of voids in the soil media layer is calculated as the total volume of soil times the porosity of soil:

EQ 4.4

$$V_S = A_{SMP} * D_S * n_S$$

where:
V_S = volume of voids in the soil media layer (cf)
A_{SMP} = area of the SMP (sf)
D_S = depth of soil media layer (ft)
n_S = available porosity of soil media (cf/cf)

Available porosity is defined as the percent of soil volume that is available for water storage at the onset of a rainfall event, on an average annual basis. The available porosity of soil media shall be set to 0.2 cf/cf. This value is less than the total porosity of a typical engineered soil used for SMPs, which reflects a reduction in storage capacity due to residual soil moisture.

The soil media storage equation assumes the sides of the practice are vertical, which means that the volume of soil may be calculated as the volume of a rectangular box. Where the sides of the practice are sloped, this method should be adjusted to use the equation for the volume of a truncated pyramid.

Internal Structures

The volume of voids created by internal structures is calculated based on the type of structure. For modular structures, such as chambers, tanks, cisterns, crates, or other pre-cast units, the volume is calculated as the interior volume of one modular structure times the number of units:

EQ 4.5

$$V_I = V_M * N_M$$

where:
V_I = volume of voids created by internal structure (cf)
V_M = interior volume of one modular structure (cf)
N_M = number of modular structures (unit less)

For voids created by internal pipes, the volume is calculated as the interior area of the pipe times the total length of pipe:

EQ 4.6

$$V_I = A_P * L_P$$

where:
V_I = volume of voids created by internal structure (cf)
A_P = area of pipe (sf)
L_P = total length of pipe (ft)

Outlet and overflow pipes may not be counted towards the storage volume of a practice. In addition, any portion of structures above the elevation of an overflow device must be excluded from the calculated volume.

In cases where more than one type of modular system or more than one pipe size is used, the volume of voids may be calculated for each system and summed together to determine the total volume of voids.

Drainage Media

The volume of voids in the drainage media is calculated as the total volume of the drainage media, excluding the volume of any internal structures in this layer, multiplied by the porosity of drainage media:

EQ 4.7

$$V_D = (A_{SMP} * D_D - V_{I,d}) * n_D$$

where:
V_D = volume of voids in the drainage media (cf)
A_{SMP} = area of the SMP (sf)
D_D = depth of the drainage media (ft)
$V_{I,d}$ = volume of voids created by internal structures within the drainage media (cf)
n_D = porosity of drainage media (cf/cf)

The porosity of stone base and sand shall be set based on media composition, with a maximum value of 0.4 cf/cf, unless otherwise approved by DEP. If there are internal structures within the drainage media, then the volume of voids for those structures must be subtracted to avoid double counting. Since the active storage zone for ET practices is only the soil media layer, the volume of storage in drainage media is excluded for these systems.

Like the calculation for soil media, this equation assumes the sides of the practice are vertical, allowing us to calculate the volume of the drainage media as the volume of a rectangular box. Where the sides of the practice are sloped, this method should be adjusted to use the equation for the volume of a truncated pyramid.

If more than one type of drainage media is used, the volume of voids may be calculated for each layer and summed together to determine the total volume of voids. DEP may request that the volume occupied by walls of internal structures also be subtracted from total volume of the drainage layer. This would be limited to instances where the volume of walls is significant due to wall thickness or large number of structures, at the discretion of NYCDEP.

Meeting Requirements

As noted earlier, SMPs must be sized so that the total storage volume of the SMP meets or exceeds the volume of runoff that must be managed for the applicable stormwater management requirement. Rather than design separate systems to meet each stormwater management requirement individually, the USWR framework allows designers to apply each SMP towards meeting multiple objectives.

As an example, an infiltration system may be sized to store the water quality volume, but that storage may also help reduce the peak rate of runoff for larger events towards meeting the sewer operations requirement. The percentage of storage volume that may be applied to each stormwater management requirement will depend on the function of the system, as shown in Table 4.1.

Table 4.1. Percent of SMP volume that may be applied to SW management criteria by SMP function.

	Percent of SMP Volume Applied to Requirement (F_A)		
SMP Function	**WQv**	**RRv**	**Vv**
Infiltration	100	100	50
Evapotranspiration	100	100	0
Reuse[A]	100	100	50
Filtration	100[B]	40[C]	0
Detention	100[D]	0	100

[A] Designers must demonstrate continuous and reliable capacity throughout the year (see Section 4.11)
[B] Applies to MS4 areas only
[C] Applies to practices with engineered soils only
[D] Applies to CSS areas and select detention practices with treatment abilities in MS4 areas

In all cases, the entire storage volume can be applied toward WQv because the practice will fully retain, filter, or detain the WQ event by design, as appropriate for CSS and MS4 areas.

The percentage of total volume that can be applied toward RRv reflects the portion of the runoff that may be retained by the practice. This is 100% for infiltration, ET, and reuse practices and 40% for bioretention used as filtration practices, as specified in the NYS SWMDM.

Detention practices that are designed to meet the Vv event will have 100% of their volume applied to meeting the Vv criterion. Any other practices that are designed to infiltrate or reuse the WQv event can apply up to 50% of their volume towards the Vv criterion as well, which accounts for several factors related to differences between the WQv and Vv events. To apply reuse volume towards stormwater management requirements, designers must demonstrate that the system will have continuous and reliable capacity throughout the year, approved at the discretion of BEPA/BWSO (see Section 4.11). The application of volumes for dual function systems are covered in Section 4.9 on Innovative Systems.

Generally, it is recommended that designers size practices to meet the WQv as a first step. Once the WQv requirement is met, designers can compute the volume that may be applied to other requirements to determine whether any additional practices are needed.

Note that when retention practices alone are used to meet the WQ requirement, this will typically result in meeting the RR and NNI for nitrogen requirements as well. Alternatively, in cases where only the sewer operations requirement is applicable to a site, designers may size practices to meet Vv as a first step.

The following equation can be used to compute the SMP volume that may be applied to each stormwater management requirement:

EQ 4.8

$$V_A = V_{SMP} * F_A$$

where:
V_A = storage volume that may be applied to relevant stormwater management requirement (cf)
V_{SMP} = storage volume of SMP (cf)
F_A = percentage of storage volume that may be applied to the stormwater management requirement (%)

Values for the percentage of storage volume that may be applied to the stormwater management requirement (F_A) are provided in Table 4.1. In total, the storage volume that may be applied to each criterion (V_A) must equal or exceed the required storage volume of each criterion.

SMPs must meet all design criteria outlined in the following sections for their volume to be applied towards the applicable stormwater management requirements. In addition, there are Special Cases that do not follow the general percentages listed in Table 4.1, which are marked as "SC" on the SMP selection checklist. An example sizing calculation for each practice function can be found in Appendix D, while an example design for an entire site can be found in Appendix E.

Simple Systems
When the geometry of the SMP is relatively simple, equations to calculate the volume of individual components can be substituted into Equation 4.1 to create a streamlined formula for sizing. In cases where the ponding surface is flat, the sides of the SMP are vertical, and voids created by internal structures are all located in the drainage layer, then the simplified formula becomes:

EQ 4.9

$$V_A = [A_{SMP}(D_P + D_S * n_S + D_D * n_D) + V_I(1 - n_D)] * F_A$$

where:
V_A = storage volume that may be applied to relevant stormwater management requirement (cf)
A_{SMP} = area of the SMP (sf)
D_P = depth of ponding (ft)
D_S = depth of soil media layer (ft)
n_S = porosity of soil media (cf/cf)
D_D = depth of the drainage media (ft)
n_D = porosity of drainage media (cf/cf)
V_I = volume of voids created by internal structures such as chambers or pipes (cf)
F_A = percentage of storage volume that may be applied to the relevant stormwater management requirement (%)

Looking at each parameter of Equation 4.9 in more detail leads to several additional simplifications. For example, the available porosity of soil media (n_S) is set to the specified value of 0.20 cf/cf. Similarly, the porosity of the drainage layer (n_D) shall be set based on media composition, with a maximum value of 0.40 cf/cf. In addition, the percentage of storage volume that may be applied towards the stormwater management requirement (F_A) will be referenced from Table 4.1 based on the SMP function and the applicable stormwater management requirement.

This leaves the area of the SMP (A_{SMP}), depth of ponding (D_P), depth of soil media (D_S), depth of drainage media (D_D), and the volume of internal structures (V_I) as design elements of the system. The area of the practice is bounded by the maximum allowable ratio between the SMP area and the contributing TDA area, as detailed in Sections 4.4-4.8. Similarly, the depths of various media are constrained by the maximum allowable drawdown time, which can be evaluated using the following methods.

Drawdown Time – Surface Ponding
The drawdown time for surface ponding is calculated by dividing the volume of ponding by the average flow rate through the surface media. In this case, the flow rate is calculated based on the principles of Darcy's law. Drawdown time is calculated as:

EQ 4.10

$$dt_P = \frac{V_P}{\left(\frac{K_S}{12}\right) * \left(1 + \frac{0.5D_P}{D_M}\right) * \left(\frac{A_{P1} + A_{P2}}{2}\right)}$$

where:
dt_P = drawdown time of surface ponding (hr)
V_P = volume of surface ponding (cf)
K_S = saturated hydraulic conductivity of media below the surface ponding area (in/hr)
D_P = maximum depth of ponding (ft)
D_M = depth of media below surface ponding area (ft)
A_{P1} = area at the base of surface ponding zone (sf)
A_{P2} = area at the top of surface ponding zone (sf)

Hydraulic conductivity shall be set based on media type, as follows:

- Engineered soil: 0.5 in/hr
- Sand filter media: 1.75 in/hr
- Peat/sand filter media: 1.0 in/hr

The denominator of the surface ponding drawdown time equation uses three terms to estimate the flow through rate which account for, from left to right, the hydraulic conductivity of the surface media, average hydraulic gradient through the surface media, and average area of surface ponding zone (area of percolation).

For infiltration SMPs, designers must confirm that the flow rate of infiltration through the bottom of practice is not more restrictive that the flow rate through surface media. This is done by comparing the denominator of surface ponding drawdown time with the denominator of infiltration drawdown time equation. The lesser of the two values should be used to compute surface drawdown time.

Designers shall confirm that the drawdown time of the surface ponding area does not exceed the maximum allowable for that the proposed practice (see Sections 4.4-4.8), which is commonly 12-hours.

Drawdown Time – Infiltration SMPs

The drawdown time for infiltration SMPs is calculated by dividing the volume of the practice by the average flow rate out of the system via infiltration. In this case, the flow rate via infiltration is field measured, which also relies on the principles of Darcy's law. Drawdown time is calculated as:

EQ 4.11

$$dt_{SMP} = \frac{V_{SMP}}{\left(\frac{i}{12}\right) * A_{INF}}$$

where:
dt_{SMP} = drawdown time of infiltration SMP (hr)
V_{INF} = volume of infiltration SMP (cf)
i = field measured infiltration rate (in/hr)
A_{INF} = area of infiltrating surface at the bottom of SMP (sf)

The denominator uses two terms to estimate the flow rate, which are the field measured infiltration rate and the area of infiltrating surface at the bottom of practice. As a factor of safety, the field measured infiltration rate used to calculate drawdown time shall be capped at 5 in/hr.

Designers shall confirm that the drawdown time of the infiltration SMP does not exceed 48 hours, where applicable.

Drawdown Time – ET SMPs

The soil media of ET systems releases water back to the atmosphere as evaporation and transpiration occur over time. Given the variable nature of ET throughout the year, ET systems are designed to avoid long periods of ponded water by using shallow ponding depths, small loading rations (practice-to-contributing area), and a means to drain excess water. For these reasons, there is no drawdown calculation for ET SMPs.

Drawdown Time – Filtration SMPs

The drawdown time for filtration SMPs is typically calculated by dividing the volume of the practice by the average flow rate through the filtration media. In this case, drawdown time can be calculated similar to surface ponding, which is based on the principles of Darcy's law. Drawdown time is calculated as:

EQ 4.12

$$dt_{SMP} = \frac{V_{SMP}}{\left(\frac{K_S}{12}\right) * \left(1 + \frac{0.5D_{pf}}{D_f}\right) * A_f}$$

where:
dt_{SMP} = drawdown time of filtration SMP (hr)
V_{SMP} = volume of filtration SMP (cf)
K_S = saturated hydraulic conductivity of filtration media (in/hr)
D_{pf} = maximum depth of ponding above filtration media (ft)
D_f = depth of filter media (ft)
A_f = area of filter bed (sf)

Hydraulic conductivity shall be set based on media type, as follows:

- Engineered soil: 0.5 in/hr
- Sand filter media: 1.75 in/hr
- Peat/sand filter media: 1.0 in/hr

The denominator uses three terms to estimate the flow rate which account for, from left to right, the hydraulic conductivity of the filtration media, average hydraulic gradient through the filtration media, and area of the filter bed (area of percolation).

If the flow rate through the filtration media is greater than the flow rate through any outlet pipes or controlled-flow devices, then the drawdown time is not governed by the filtration media and must be determined by the most flow restrictive component. Where a level outlet pipe or controlled-flow device restricts flow, the drawdown time may be calculated using the equation for detention SMPs.

Where sloped outlet pipes restrict flow, the Manning's equation may be used to estimate the outlet flow rate, which replaces the denominator in the drawdown time calculation.

If outlet pipes are connected to an internal pipe or network of pipes, designers must ensure that the perforations in the internal pipes are adequate to not restrict flow.

Designers shall confirm that the drawdown time of the filtration SMP does not exceed 48-hours, where applicable.

Drawdown Time – Reuse SMPs
The drawdown time for reuse SMPs is calculated by dividing the volume of the practice by the average flow rate out of the system via the water reuse application. In this case, drawdown time is simply calculated as:

EQ 4.13

$$dt_{SMP} = \frac{V_{SMP}}{Q_{RU}}$$

where:
dt_{SMP} = drawdown time of filtration SMP (hr)
V_{SMP} = volume of filtration SMP (cf)
Q_{RU} = flow rate of reuse application (cf/hr)

Designers shall confirm that the drawdown time of the reuse SMP does not exceed 48 hours, where applicable. In cases where the reuse application alone does not meet this requirement, controlled-flow devices can be used in tandem to achieve the desired drawdown time.

Drawdown Time – Detention SMPs
The drawdown time for detention SMPs is calculated by dividing the volume of the practice by the average flow rate out of the system via a controlled-flow device. In this case, the system can be treated as a tank with an orifice, where the flow rate is derived from the Bernoulli equation. Drawdown time is calculated as:

EQ 4.14

$$dt_{SMP} = \frac{V_{SMP}}{0.5C_D A_o\sqrt{2gH}} * \frac{1}{3600}$$

where:
dt_{SMP} = drawdown time of filtration SMP (hr)
V_{SMP} = volume of filtration SMP (cf)
C_D = coefficient of discharge; 0.61 (flush), 0.52 (re-entrant), or 0.73 (long re-entrant)
A_o = area of the orifice (ft2)
g = acceleration due to gravity, 32.2 (ft/s2)
H = maximum hydraulic head above the centerline of the orifice (ft)

Designers shall confirm that the drawdown time of the detention SMP does not exceed the maximum permitted, which varies by practice type (Section 4.8).

4.4. Infiltration Systems

Infiltration is the process whereby water passes through a porous media, mainly in a downward direction, due to gravity. SMPs that primarily manage runoff via infiltration of water into underlying soils are classified as infiltration systems. Infiltration systems are also considered retention systems because their primary function reduces runoff.

There are several features that are common to all infiltration systems:

- Underlying soils have adequate hydrologic conductivity for infiltration
- Underlying soils are not constrained by high groundwater, bedrock, or contamination
- Have no liner or other impermeable material at the bottom (i.e. has a permeable bottom)
- Have no outlet pipe or have an outlet pipe that is permanently capped

An outlet pipe is any pipe that can drain water from the practice before it is full. Typically, this would be a pipe that connects the storage zone of the practice with a point of discharge, such as a sewer, site drainage system, or structure with a controlled-flow orifice. For infiltration systems, outlet pipes must be permanently capped, except during maintenance, to prevent water from exiting the system.

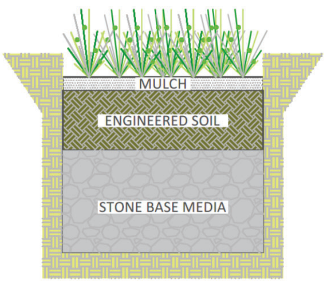
Components used for infiltration systems vary, but may include surfacing mulch for moisture retention, engineered soil used to support vegetation, surface area used for ponding, stone base used to store water, geotextiles, and internal structures or pipes used to help distribute or store water. The total volume of water that can be stored in the practice must meet or exceed the volume of runoff calculated for the stormwater management requirement (Section 2.3). Further details on SMP sizing can be found in Section 4.3.

Infiltration systems provide a range of stormwater management benefits, which include runoff reduction, peak flow mitigation, groundwater recharge, and treatment of pollutants from runoff. Vegetated systems may provide several added co-benefits such as heat island mitigation, ecologic function, community amenity, and removal of airborne pollutants.

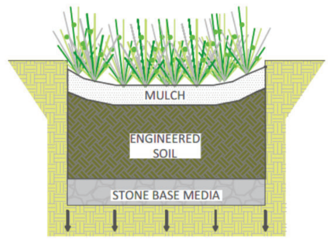
The feasibility of infiltration systems can be limited by soil constraints, subsurface constraints, hotspot constraints, and space constraints. In addition, surface constraints may limit the use of vegetated infiltration practices. A description of each constraint may be found in Section 4.2. Readers should refer to the SMP Selection Hierarchy (Appendix A) for details on how various constraints impact the use of specific SMPs.

Infiltration SMPs

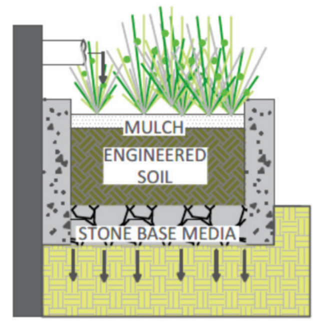
SMPs that can be configured to function as infiltration systems include bioretention, rain gardens, stormwater planters, tree plantings, dry basins, grass filter strips, vegetated swales, dry wells, synthetic turf fields, porous pavements, stone trenches, and stormwater galleries. In addition to these systems, other innovative systems may also qualify as infiltration practices, as described in Section 4.9. A brief description of each infiltration SMP is provided below, along with an example cross section. Please note that the cross sections are for illustrative purposes only and are not meant to show all required components. Further, systems described in this Manual may differ from those used as part of the ROW green infrastructure program.



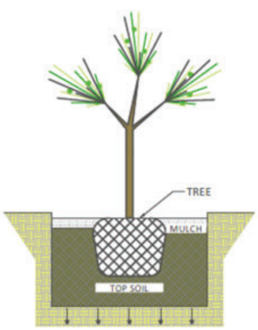
Bioretention
Landscaped shallow depression that captures surface runoff. Typically used in dense urban areas. Similar to rain gardens, but components are designed to manage runoff from large areas. Commonly consists of a surface ponding area, mulch layer, engineered soil with vegetation, and stone base.



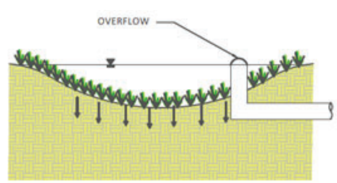
Rain Garden
Landscaped shallow depression that captures surface runoff. Typically used in residential applications. Similar to bioretention, but components are designed to manage runoff from small areas. Commonly consists of a surface ponding area, mulch layer, engineered soil with vegetation, and a shallow stone base to improve infiltration.



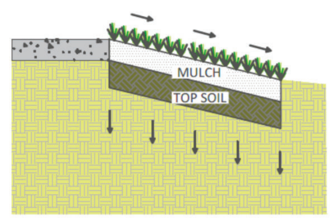
Stormwater Planter
Self-contained planter box with a permeable bottom. Commonly consists of a surface ponding area, mulch layer, engineered soil with vegetation, and stone base.



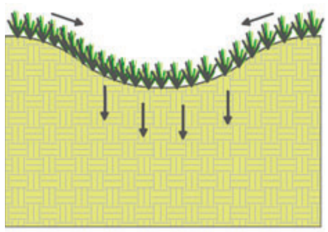
Tree Planting (or preservation)
Standalone trees (planted or preserved) that capture surface runoff. Commonly consists of a shallow surface ponding area and topsoil for tree planting. In the case of plantings, may also include a shallow drainage layer. This practice is counted towards a reduction of impervious area when calculating the runoff coefficient, rather than towards a required storage volume.



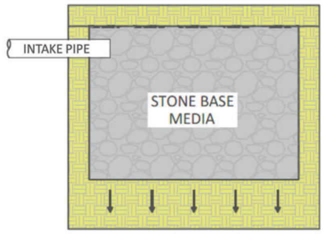
Dry Basin
Earthen depression that is typically planted with grasses and functions as one large surface ponding area. Usually constructed on naturally pervious soils that do not require the layering of engineered materials.



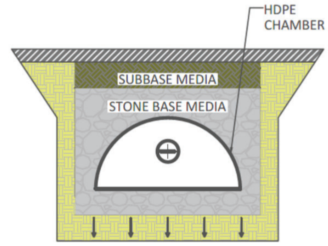
Grass Filter Strip
Strip of grass that infiltrates sheet flow as it passes over its surface. Commonly consists of a shallow topsoil that is planted with short grasses.



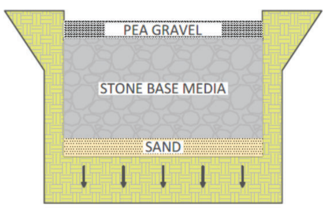
Vegetated swale
Open, shallow channels with short vegetation along bottom and sides that infiltrates water as it is conveyed along swale. Commonly consists of a shallow topsoil that is planted with short grasses and may also have check dams to regulate flow within the channel.



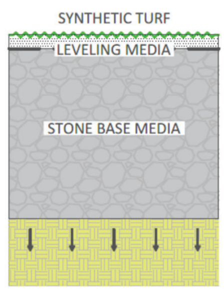
Dry Well
Subsurface shaft (circular) that is typically excavated or augured and then filled with a stone base or a prefabricated structure used to store water. When the depth of a dry well is greater than its diameter, which is common, an EPA injection well permit may be required (visit epa.gov/uic for more details).



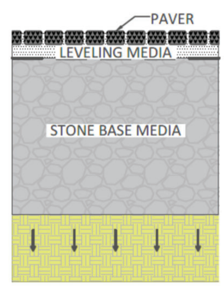
Stormwater Gallery
Subsurface area (typically rectangular) that is excavated and then filled with stone base, prefabricated structures, chambers, or pipes used to store water. Usually larger than a typical dry well system and, as a result, may treat larger drainage areas.



Stone Trench
An excavated trench (typically linear) that is filled with stone base or internal pipes used to store water. Similar to a dry well, except the stone trench length is usually greater than its depth and it receives runoff via an exposed stone surface.



Synthetic Turf Field
Synthetic turf material that allows runoff to percolate into underlying layers. Common underlying layers include a shock absorbing pad, leveling course, and a stone base. Due to their size, many synthetic turf fields also include internal pipes to help spread water evenly across the entire storage area.



Porous Pavement
Pavements that contain voids which allow runoff to percolate into underlying layers. The surface of these systems can either be entirely porous pavement or a grid of pavers and porous materials, such as grass or gravel. Common underlying layers include a leveling course and a stone base.

Design Requirements

A comparison of general design requirements for each infiltration system is shown in Table 4.2. Additional requirements, specific to each SMP component, are provided in Section 4.10. Designers must ensure that requirements for all applicable components are met via their design drawings, notes, and specifications. Example sizing calculations can be found in Appendix D.

Maintenance Requirements

Post-construction maintenance requirements for various systems are detailed in Chapter 5.

Table 4.2. General design requirements for infiltration SMPs.

Design Parameter[a]	Bioretention	Rain garden	Stormwater planter	Tree planting/ preservation	Dry basin
MAX. loading ratio, practice-to-contributing area	1:20	1:5	1:20	1:4	1:40
MAX. contributing area	5 acre	1000 sf	15000 sf	400 sf	5 acre
MIN. infiltration rate of underlying soils	0.5 in/hr	0.5 in/hr	0.5 in/hr	0.5 in/hr	0.5 in/hr
Vertical separation from groundwater / bedrock[b]	3' MIN	3' MIN	3' MIN	-	3' MIN
Surface ponding depth	12" MAX[C]	12" MAX	12" MAX[C]	-	-
Media layers	Mulch Eng. Soil Stone base	Mulch Eng. Soil Stone base	Mulch Eng. Soil Stone base	Mulch Topsoil	Native soils or Topsoil
Surfacing media depth	2-3" TYP	2-3" TYP	2-3" TYP	Varies	-
Leveling media depth	-	-	-	-	-
Planting/filter media depth	2.5' MIN 4' MAX	1' MIN 2' MAX	1.5' MIN	Varies	-
Stone base depth	12" MIN	6" MIN 12" MAX	12" MIN	-	-
Slope of practice surface	1:3 MAX	1:3 MAX	No Slope	-	1:3 MAX
Slope of practice bottom	No Slope	No Slope	No Slope	-	3% MAX
MAX. Drawdown time	Surface = 24hr Total = 48hr	Surface = 24hr Total = 48hr	Surface = 24hr Total = 48hr	-	Surface = 48hr

[a] SMPs in MS4 areas shall follow any additional criteria set forth in the NYS SWMDM for all parameters or components that are not already defined in the NYC SWM

[b] Minimum vertical separation from the top of groundwater table in sole source aquifers is increased to 4 feet.

[c] Storage in surface ponding area above planting media must be 75% of WQv to prevent bypass. This requirement is waived for infiltration practices when a connection is made between the surface ponding area and drainage course to increase rate of storage.

Table 4.2. General design requirements for infiltration SMPs (Continued)

Design Parameter[d]	Grass filter strip	Vegetated swale	Dry well	Stormwater gallery	Stone trench	Porous pavement	Synthetic turf field
MAX. loading ratio, practice-to-contributing area	1:3 (Prv.) 1:1.25 (Imp.)	-	-	-	-	-	-
MAX. contributing area	10,000 sf	5 acre	1 acre	5 acre	5 acre	5 acre	5 acre
MIN. infiltration rate of underlying soils	0.5 in/hr	0.5 in/hr	0.5 in.hr	0.5 in/hr	0.5 in/hr	0.5 in/hr	0.5 in/hr
Vertical separation from groundwater / bedrock[e]	3' MIN	3' MIN	3' MIN	3' MIN	3' MIN	3' MIN	3' MIN
Surface ponding depth	-	4" MAX[f]	-	-	-	-	-
Media layers	Native soils or Topsoil	Native soils or Topsoil	Stone base	Stone base	Pea gravel Stone base Sand filter	Leveling media Subbase[g] Stone base	Leveling media Subbase[g] Stone base
Surfacing media depth	-	-	-	-	6" TYP	-	-
Leveling media depth	-	-	-	-	-	2-4" TYP	2-4" TYP
Planting/filter media depth	-	-	-	-	6" MIN	-	-
Stone base depth	-	-	12" MIN	12" MIN	12" MIN	12" MIN	12" MIN
Slope of practice surface	15% MAX 8% MAX (AVG.)	1:3 MAX[h]	-	-	-	5% MAX	-
Slope practice bottom	-	0.5% MIN 4% MAX	No Slope	No Slope	No Slope	-	No Slope
MAX. Drawdown time	-	-	Total = 48hr	Total = 48hr	Total = 48hr	Total = 48hr	Total = 48hr

[d] SMPs in MS4 areas shall follow any additional criteria set forth in the NYS SWMDM for all parameters or components that are not already defined in the NYC SWM.

[e] Minimum vertical separation from the top of groundwater table in sole source aquifers is increased to 4 feet.

[f] Maximum depth of water in the vegetated channel.

[g] In cases where geosynthetics do not provide adequate separation and stability, subbase may be added between leveling course and stone base in accordance with manufactuer's recommendation.

h Maximum cross slope of the vegetated channel.

4.5. Evapotranspiration (ET) Systems

ET occurs when water moves from the land to the atmosphere via the combination of evaporation from land surfaces and transpiration from plants. SMPs that primarily manage runoff by capturing it and slowly releasing it back into the atmosphere over time via ET are classified as ET systems. ET systems are also considered retention systems because their primary function reduces runoff.

There are several features that are common to all ET systems:

- Limited or no ability to infiltrate water due to the composition of underlying soils or physical barriers.
- Receive only direct rainfall or surface runoff (i.e., surface loading only)
- Shallow depth practice composed of mostly soil media, which promotes the natural wicking of moisture to the surface for ET.
- Means of draining excess runoff through outlet pipes, weep holes, drainage course, or other method

An outlet pipe is any pipe that can drain water from the practice before it is full. Typically, this would be a pipe that connects the storage zone of the practice with a point of discharge, such as a sewer, site drainage system, or structure with a controlled-flow orifice. For ET systems, outlet pipes can be used as a means to drain excess runoff, which is required to prevent ponding over long periods.

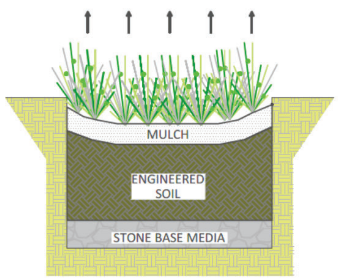
Components used for ET systems vary, but may include surfacing mulch for moisture retention, engineered soil used to support vegetation, surface area used for ponding, drainage media, and geotextiles. The total volume of water that can be stored in the practice must meet or exceed the volume of runoff calculated for the stormwater management requirement. Further details on SMP sizing can be found in Section 4.3.

ET systems provide a range of stormwater management benefits, which include runoff reduction, peak flow mitigation, and treatment of pollutants from runoff. Vegetated systems may provide several added co-benefits such as heat island mitigation, ecologic function, community amenity, and removal of airborne pollutants.

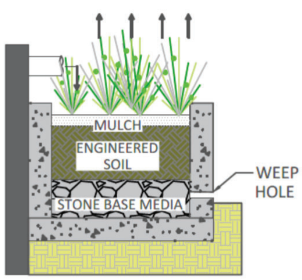
The feasibility of ET systems can be limited by subsurface constraints and space constraints. In addition, surface constraints may limit the use of some vegetated ET practices. A description of each constraint may be found in Section 4.2. Readers should refer to the SMP Hierarchy Checklist (Appendix A) for details on how various constraints impact the use of specific SMPs.

ET SMPs

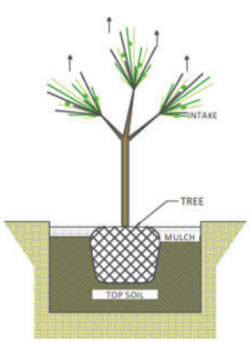
SMPs that can be configured to function as ET systems include rain gardens, stormwater planters, tree plantings, and green roofs. In addition to these systems, other innovative systems may also qualify as ET practices, as described in Section 4.9. A brief description of each ET SMP is provided below, along with an example cross section. Please note that the cross sections are for illustrative purposes only and are not meant to show all required components. Further, systems described in this Manual may differ from those used as part of the ROW green infrastructure program.



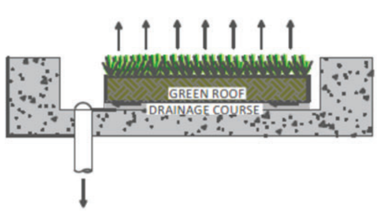
Rain Garden
Landscaped shallow depression that captures surface runoff. Typically used in residential applications. Similar to bioretention, but components are designed to manage runoff from small areas. Commonly consists of a surface ponding area, mulch layer, engineered soil with vegetation, and a shallow stone base for drainage.



Stormwater Planter
Self-contained planter box with a concrete bottom. Commonly consists of a surface ponding area, mulch layer, engineered vegetation, and a stone base drainage layer. May also have weep holes to help drain excess water.



Tree Planting (or preservation)
Standalone trees (planted or preserved) that capture surface runoff. Commonly consists of a shallow surface ponding area and topsoil for tree planting. In the case of plantings, may also include a shallow drainage layer. This practice is counted towards a reduction of impervious area when calculating the runoff coefficient, rather than towards a required storage volume.



Green Roof
Series of built-up layers on a rooftop that supports vegetation. Commonly consists of a green roof media and drainage course. Some systems include other specialized layers for enhanced storage, filtration, or detention capabilities.

Design Requirements

A comparison of general design requirements for each ET system is shown in Table 4.3. Additional requirements, specific to each SMP component, are provided in Section 4.10. Designers must ensure that requirements for all applicable components are met via their design drawings, notes, and specifications. Example sizing calculations can be found in Appendix D.

Maintenance Requirements

Post-construction maintenance requirements for various systems are detailed in Chapter 5.

Table 4.3. General design requirements for ET SMPs.

Design Parameter[a]	Rain garden	Stormwater Planter	Tree planting/ preservation	Green roof
MAX. loading ratio, practice-to-contributing area	1:5	1:5	1:4	1:1
MAX. contributing area	1000 sf	15000 sf	400 sf	-
MIN. infiltration rate of underlying soils	-	-	-	-
Vertical separation from groundwater/ bedrock[b]	3' MIN	3' MIN	-	-
Surface ponding depth	3" MAX	3" MAX	-	-
Media layers	Mulch Eng. Soil Stone base[c]	Mulch Eng. Soil Stone base[c]	Mulch Topsoil	Green roof media Stone base[c]
Surfacing media depth	2-3" TYP	2-3" TYP	Varies	-
Leveling media depth	-	-	-	-
Planting/filter media depth	1' MIN 2' MAX	1.5' MIN	Varies	4" MIN[d]
Stone base depth	Varies	Varies	-	Varies
Slope of surface media	1:3 MAX	No Slope	-	Varies[e]
Slope of bottom of practice	No Slope	No Slope	-	Varies[e]
MAX. Drawdown time	-	-	-	-

[a] SMPs in MS4 areas shall follow any additional criteria set forth in the NYS SWMDM for all parameters or components that are not already defined in the NYC SWM.

[b] Vertical separation requirements are waived for practices enclosed in concrete with adequate anchoring to withstand uplift pressures.

[c] Evapotranspiration practices must allow drainage of excess water via outlet pipe, weep hole, or other equivalent measure. Geosynthetics can be used as a drainage course instead of stone base, where appropriate, in accordance with manufacturer's specifications.

[d] Green roof media depth of 6-inches is preferred.

[e] Configuration of green roof systems varies widely, see manufacturer's specifications.

4.6. Reuse Systems

Reuse is the process of collecting rainfall or runoff and storing it for eventual reuse in other applications. SMPs that primarily manage runoff by capturing it and reusing it over time, in this case for non-potable and non-irrigation purposes, are classified as reuse systems. Reuse systems are also considered retention systems because their primary function reduces runoff.

There are several features that are common to all reuse systems:

- Enclosed containment area to hold runoff
- Connection with (or manual application to) a system that will reuse stormwater for non-potable and non-irrigation purposes
- Dewatering device

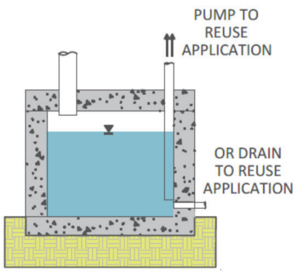
A dewatering device may be needed to empty the container for regular maintenance or cleaning. Common dewatering devices include a valve that releases water or a pump that discharges water. Components of reuse systems commonly include a watertight storage container, secure cover, screen for debris and mosquitoes, access hatch, and the dewatering device. The total volume that can be stored in the structure must meet or exceed the volume of runoff calculated for the stormwater management requirement. Further details on SMP sizing can be found in Section 4.3.

Reuse systems provide runoff reduction and peak flow mitigation through the capture of runoff. In addition, reuse systems help to reduce the demand on potable water.

The feasibility of reuse systems is usually based on the availability of a suitable reuse application, rather than the typical site or space constraints that limit other SMPs. Nonetheless, readers should still refer to the SMP Hierarchy Checklist (Appendix A) when assessing the suitability of various SMPs for the overall project.

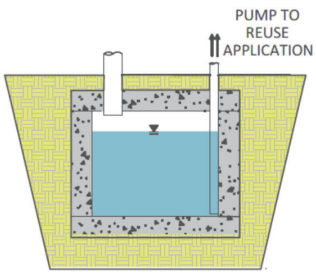
Reuse SMPs

SMPs that can be configured to function as reuse systems include rain tanks and cisterns. In addition to these systems, other innovative systems may also qualify as reuse practices, as described in Section 4.9. A brief description of each reuse SMP is provided below, along with an example cross section. Please note that the cross sections are for illustrative purposes only and are not meant to show all required components. Further, systems described in this Manual may differ from those used as part of the ROW green infrastructure program.



Rain Tank

Container that is used to store runoff at or above grade. Typically connected to a system that will automatically and continuously reuse water over time.



Cistern

Container that is used to store runoff below grade. Typically connected to a system that will automatically and continuously reuse water over time.

Design Requirements

Rain tanks and cisterns are typically manufactured products, available in a wide range of potential materials, sizes, and geometries. As such, designers shall meet all manufacturer recommendations for the installation, use, and maintenance of the system. Additional requirements, specific to each SMP component, are provided in Section 4.10. Designers must ensure that requirements for all applicable components are met via their design drawings, notes, and specifications. Example sizing calculations can be found in Appendix D.

Maintenance Requirements

Post-construction maintenance requirements for various systems are detailed in Chapter 5.

4.7. Filtration Systems

Filtration is the process of passing a liquid through a porous medium to trap and separate solids from the liquid. SMPs that primarily manage runoff by filtering out pollutants are classified as filtration SMPs. Filtration SMPs are not considered retention SMPs because they often provide limited runoff reduction. As indicated in Appendix A, filtration practices may not be used towards meeting the water quality stormwater management requirement in CSS areas.

There are several features that are common to all filtration systems:

- Contains a filtration medium that runoff is passed through, which is deep enough to facilitate pollutant removal
- Have an outlet pipe that promotes the continuous filtration of runoff

An outlet pipe is any pipe that drains water from the practice before it is full. In filtration systems, the outlet pipe is located beneath the filtration medium to continuously remove water from the system after it has been filtered. This outlet pipe would typically be a pipe that connects the drainage media of the practice with a point of discharge, such as a sewer, site drainage system, or structure with a controlled-flow orifice.

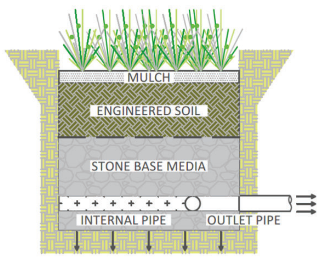
Components used for filtration systems vary but may include a filtration medium (such as engineered soil, sand, or sand/peat blend); temporary storage area above the filtration medium (can be surface or subsurface); stone base to promote drainage; geotextiles; and an outlet pipe. The total volume of water that can be stored in the practice must meet or exceed the volume of runoff calculated for the stormwater management requirement. Further details on SMP sizing can be found in Section 4.3.

Filtration systems, mainly targeting the treatment of pollutants from runoff, are more limited in stormwater management benefits in comparison to other systems. However, some peak flow reduction may occur where temporary storage areas are used, and some runoff reduction may occur where engineered soils are used as filtration media. Vegetated systems may provide several added co-benefits such as heat island mitigation, ecologic function, community amenity, and removal of airborne pollutants.

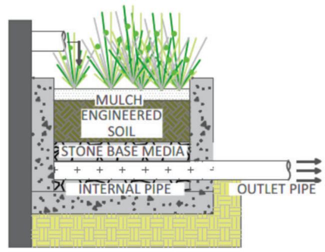
The feasibility of filtration systems can be limited by subsurface constraints and space constraints. In addition, surface constraints may limit the use of vegetated infiltration practices. A description of each constraint may be found in Section 4.2. Readers should refer to the SMP Hierarchy Checklist (Appendix A) for details on how various constraints impact the use of specific SMPs.

Filtration SMPs

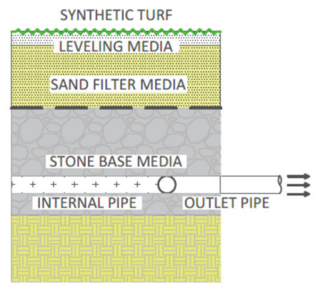
SMPs that can be configured to function as filtration systems include bioretention, stormwater planters, porous pavements, synthetic turf fields, sand filters, and organic filters. In addition to these systems, other innovative systems may also qualify as filtration practices, as described in Section 4.9. A brief description of each filtration SMP is provided below, along with an example cross section. Please note that the cross sections are for illustrative purposes only and are not meant to show all required components. Further, systems described in this Manual may differ from those used as part of the ROW green infrastructure program.



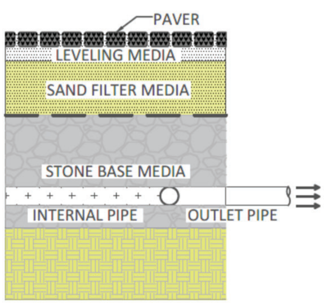
Bioretention
Landscaped shallow depression that captures surface runoff. Typically used in dense urban areas. Similar to rain gardens, but components are designed to manage runoff from large areas. Commonly consists of a surface ponding area, mulch layer, engineered soil with vegetation, and stone base to promote drainage.



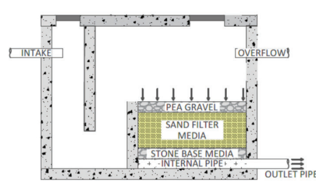
Stormwater Planter
Self-contained planter box with a permeable or lined bottom. Commonly consists of a surface ponding area, mulch layer, engineered soil with vegetation, and stone base.



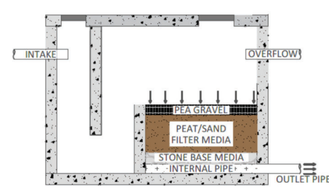
Synthetic Turf Field
Synthetic turf material that allows runoff to percolate into underlying layers. Common underlying layers include a shock absorbing pad, leveling course, sand filter media, and a stone base. Due to their size, many synthetic turf fields also include internal pipes to help spread water evenly across the entire storage area.



Porous Pavement
Pavements that contain voids which allow runoff to percolate into underlying layers. The surface of these systems can either be entirely porous pavement or a grid of pavers and porous materials, such as grass or gravel. Common underlying layers include a leveling course, sand filter media, and a stone base.



Sand Filter
Typically a prefabricated chamber that contains a filter bed of sand. The chamber also facilitates the temporary storage of water above the filer bed as it percolates through the sand filter.



Organic Filter
Typically a prefabricated chamber that contains a filter bed of organic media. The chamber also facilitates the temporary storage of water above the filter bed as it percolates through the organic media filter.

Design Requirements

A comparison of general design requirements for each filtration system is shown in Table 4.4. Additional requirements, specific to each SMP component, are provided in Section 4.10. Designers must ensure that requirements for all applicable components are met via their design drawings, notes, and specifications. Example sizing calculations can be found in Appendix D.

Table 4.4. General design requirements for filtration SMPs.

Design Parameter[a]	Bioretention	Stormwater Planter	Porous pavement	Synthetic turf field	Sand filter	Organic filter
MAX. loading ratio, practice-to-contributing area	1:20	1:20	1:60	1:60	1:60	1:30
MAX. contributing area	5 acre	15000 sf	5 acre	5 acre	10 acre	10 acre
MIN. infiltration rate of underlying soils	-	-	-	-	-	-
Vertical separation from groundwater / bedrock[b]	3' MIN	3' MIN	3' MIN	3' MIN	3' MIN	3' MIN
Surface ponding depth[c]	6" MIN 12" MAX	6" MIN 12" MAX	Varies	Varies	6" MIN	6" MIN
Media layers	Mulch Eng. Soil Stone base	Mulch Eng. Soil Stone base	Leveling media Subbase[d] Sand filter Stone base	Leveling media Subbase[d] Sand filter Stone base	Pea gravel[e] Sand filter Stone base	Pea gravel[e] Peat/sand filter Stone base
Surfacing media depth	2-3" TYP	2-3" TYP	-	-	Varies[e]	Varies[e]
Leveling media depth	-	-	2-4" TYP	2-4" TYP	-	-
Planting/filter media depth	2.5' MIN	1.5' MIN	1.5' MIN	1.5' MIN	1.5' MIN	1.5' MIN
Stone base depth	12" MIN	12" MIN	12" MIN	12" MIN	6" MIN	6" MIN
Slope of surface media	1:3 MAX	No Slope	5% MAX	-	-	-
Slope of bottom of practice	No Slope	No Slope	-	No Slope	-	-
MAX. Drawdown time	Surface = 24hr Total = 48hr	Surface = 24hr Total = 48hr	Total = 48hr	Total = 48hr	Total = 48hr	Total = 48hr

[a] SMPs in MS4 areas shall follow any additional criteria set forth in the NYS SWMDM for all parameters or components that are not already defined in the NYC SWM.

[b] Vertical separation requirements are waived for practices enclosed in concrete with adequate anchoring to withstand uplift pressures.

[c] Storage in ponding area above filtration media must be 75% of WQv to prevent bypass. This requirement cannot be waived for filtration practices.

[d] In cases where geosynthetics do not provide adequate separation and stability, subbase may be added between leveling course and stone base in accordance with manufactuer's recommendation.

[e] Surfacing media type and depth for protection of filtration media varies Other types of surfacing media can include debris screens and topsoil.

4.8. Detention Systems

Detention is the process of temporarily holding back stormwater so that it may be released in a controlled manner at a lower rate. SMPs that primarily manage runoff by detaining runoff to reduce the peak flow rate felt by downstream systems are classified as detention SMPs. Detention SMPs are not considered retention SMPs because they often provide limited runoff reduction.

There are several features that are common to all detention systems:

- Device which controls the flow rate of runoff that exits the practice, such as an orifice
- Temporary storage zone that can fill-up when the inflow rate is greater than the release rate
- Hydraulic connection between the controlled-flow device and temporary storage zone, usually via an outlet pipe

An outlet pipe is any pipe that drains water from the practice before it is full. In detention systems, the outlet pipe typically connects the drainage layer of the practice with a structure that contains a controlled-flow orifice.

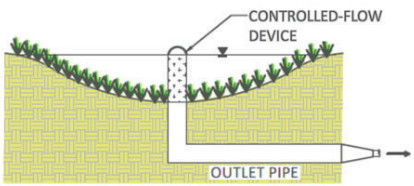
The temporary storage zone of detention systems is usually either a surface area for ponding, enclosed container, or subsurface stone base. Other common components can include engineered soil used to support vegetation, geotextiles, controlled-flow orifice, and internal structures or pipes used to help distribute or store water. The total volume of water that can be stored in the practice must meet or exceed the volume of runoff calculated for the stormwater management requirement. Further details on SMP sizing can be found in Section 4.3.

Detention systems, mainly targeting the reduction of peak flow rates, are more limited in stormwater management benefits compared to other systems. However, some runoff reduction may occur in systems where soil media are used. Vegetated systems may provide several added co-benefits such as heat island mitigation, ecologic function, community amenity, and removal of airborne pollutants.

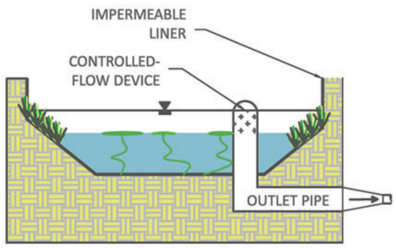
The feasibility of detention systems can be limited by subsurface constraints and space constraints. In addition, surface constraints may limit the use of vegetated detention practices. A description of each constraint may be found in Section 4.2. Readers should refer to the SMP Hierarchy Checklist (Appendix A) for details on how various constraints impact the use of specific SMPs. As indicated in Appendix A, only select detention practices with treatment abilities may be used towards meeting the water quality stormwater management requirement in MS4 areas.

Detention SMPs

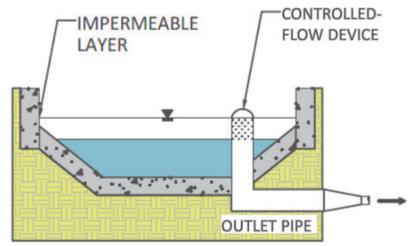
SMPs that can be configured to function as detention systems include dry basins, constructed wetlands, wet basins (or ponds), stormwater galleries, blue roofs, and detention tanks. In addition to these systems, other innovative systems may also qualify as detention practices, as described in Section 4.9. A brief description of each detention SMP is provided below, along with an example cross section. Please note that the cross sections are for illustrative purposes only and do not show all potential components. Further, systems described in this Manual may differ from those used as part of the ROW green infrastructure program.



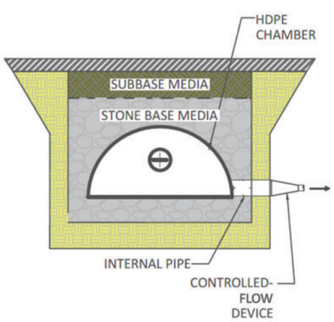
Dry Basin
Earthen depression that is typically planted with grasses and functions as one large surface ponding area. May be constructed on pervious or non-pervious soils when used as a detention system.



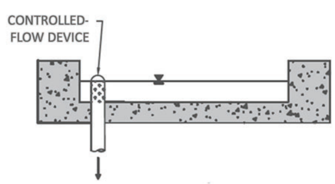
Constructed Wetlands
An artificial wetland that is created using impervious soils or liners, within which vegetation and a permanent pool of water are used to treat stormwater. These systems allow for additional, temporary storage above the permanent pool.



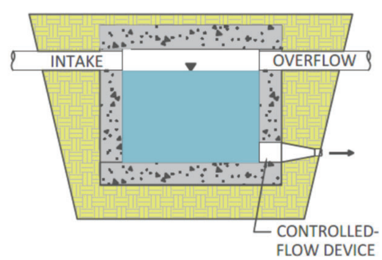
Wet Basins/Ponds
A permanent pool of water used to treat stormwater, usually underlain by impervious soils or a liner. These systems allow for additional, temporary storage above the permanent pool.



Stormwater Gallery
Subsurface area (typically rectangular) that is excavated and then filled with stone base, prefabricated structures, chambers, or pipes used to store water. Usually larger than a typical dry well system and, as a result, may treat larger drainage areas.



Blue Roof
Any rooftop that is outfit with a system that temporarily holds back water on the roof surface. Common systems include check-dams, modular storage units, or roof drain restriction devices.



Detention Tank
Enclosed tank with a device that controls the release rate of water. Common devices include a controlled-flow orifice or pump.

Design Requirements

A comparison of general design requirements for each detention system is shown in Table 4.5. Additional requirements, specific to each SMP component, are provided in Section 4.10. Designers must ensure that requirements for all applicable components are met via their design drawings, notes, and specifications. It is essential that designers configure the detention system to maintain the appropriate maximum release rate for either CSS or MS4 areas, as specified in Equation 2.5. Example sizing calculations can be found in Appendix D.

Table 4.5. Basic design requirements for detention SMPs.

Design Parameter	Dry Basin	Constructed Wetland[a]	Wet Basin/ Pond[a]	Stormwater Gallery	Blue Roof	Detention Tank
MAX. (MIN.) loading ratio, practice-to-contributing area	1:40	(1:100)	(1:100)	-	-	-
MAX. (MIN.) contributing area	5 acre	(25 acre)	(25 acre)	5 acre	-	-
MIN. infiltration rate of underlying soils	-	-	-	-	-	-
Vertical separation from groundwater / bedrock[b]	3' MIN	3' MIN	3' MIN	3' MIN	-	3' MIN
Has a permanent pool?	No	Yes	Yes	No	No	No
Slope of surface media	1:3 MAX	1:3 MAX	1:3 MAX	-	-	-
Slope of bottom of practice	3% MAX	3% MAX	3% MAX	No Slope	-	-
MAX. Drawdown time	Temp. Storage Area = 48hr	Temp. Storage Area = 48hr	Temp. Storage Area = 48hr	Temp. Storage Area = 48hr	Temp. Storage Area =24hr	Temp. Storage Area = 72hr

[a] SMPs in MS4 areas shall follow any additional criteria set forth in the NYS SWMDM for all parameters or components that are not already defined in the NYC SWM.

[b] Vertical separation requirements are waived for practices enclosed in concrete with adequate anchoring to withstand uplift pressures.

4.9. Innovative Systems

SMP technologies are constantly evolving as innovations are made in their components and configurations. As such, new and innovative systems may not conform to the standard practices or common functions outlined in the previous sections. DEP supports the use of innovative practices through several pathways for the approval of proprietary, hybrid, and dual function technologies. This section outlines the approval process for these systems.

Proprietary Systems

Proprietary systems encompass a broad range of manufactured SMPs that are made available by commercial vendors. These systems can vary widely in terms of components and intended function. Some examples of common proprietary systems include:

- Hydrodynamic separators – flow-through structures that use the dynamics of moving water to separate and deposit pollutants such as sediment and floatables. Typically, this system involves creating a centrifugal flow and/or movement through a series of baffles.
- Alternative media filters – systems that filter runoff using an alternative medium, such as fabrics, activated carbon, perlite, zeolite, or other blended media.
- Modular infiltration systems – prefabricated structures with proprietary components that facilitate the storage and infiltration of runoff.
- Enhanced green roofs – green roofs that manage stormwater using proprietary media other than soils, such as retention fabrics, detention meshes, and modular storage components.

This list of common proprietary systems is not meant to be exhaustive and, in fact, new systems will continue to become available over time. In general, the use of proprietary systems must be approved when one or more of the following are true:

- The system does not meet the design criteria of standard practices outlined in this chapter
- The system function does not correspond to the standard functions outlined in this chapter
- The system seeks a variance in the methods used for determining storage capacity

For application in MS4 areas, proprietary systems must be evaluated and approved via one of the processes outlined in the NYS SWMDM. Proprietary systems that are verified or certified by one of the processes outlined in the NYS SWMDM as meeting the treatment criteria detailed in the NYS SWMDM are approved for use in MS4 areas.

Proprietary systems that are approved via the NYS SWMDM processes may also be used in CSS areas. In addition, DEP may also evaluate and approve proprietary systems for application in CSS areas on a case-by-case basis. For approval from DEP, designers must demonstrate that the proprietary system will either achieve the desired level of infiltration, ET, reuse, or detention; or result in an equivalent reduction of CSO volume. Depending on the type of proprietary system, this may involve showing that:

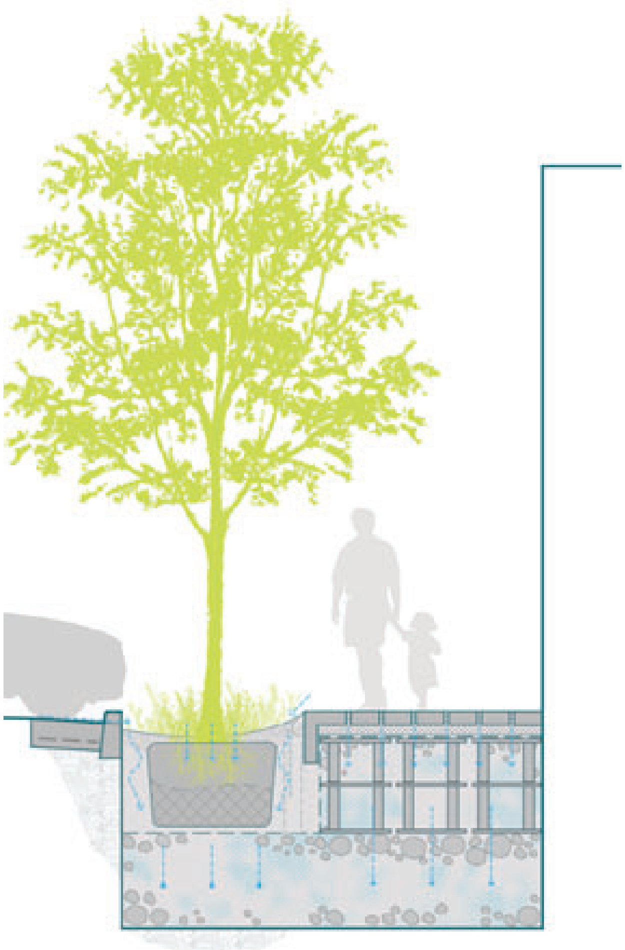
- Infiltration and ET systems have an active storage zone that is sufficient to fully capture the water quality event and recharge that capacity in a timely manner.
- ET systems with alternative storage methods (e.g., non-soil storage) will achieve sufficient ET either by wicking to the green roof media layer or by direct evaporation.
- Reuse systems do not rely on water uses that would impair another systems stormwater management capability.
- Filtration systems and other flow based practices are able to treat the water quality event without bypass. Designers should refer to the NYS SWMDM for flow calculation methods.
- Detention systems are able to maintain a maximum release rate of 0.1 cfs/acre for the sewer operations event.

Approved technologies must be sized to manage runoff from contributing areas for the appropriate design event. Storage-based practices may be sized in accordance with the storage volume methods of Section 4.3. Designers are responsible for meeting all design criteria, guidelines, and recommendations provided by the manufacturer for that system, including, but not limited to, structural integrity, components, configuration, installation, operation, and maintenance. In addition, designers must ensure that any requirements related to setbacks, subsurface conditions, inflow/outflow rates, bypass, overflow, accessibility, maintenance, or safety issues are addressed.

Hybrid Systems

Hybrid systems refer to cases where two or more SMPs of the same function are integrated as one practice. Typically, hybrid systems involve the use of two infiltration systems that share a single storage zone. For example, a bioretention and porous pavement system that are located adjacent to one another and drain into a shared stone base (Figure 4.5).

Figure 4.5. Illustration of a hybrid system that incorporates bioretention and porous pavement features (image courtesy of SCAPE).

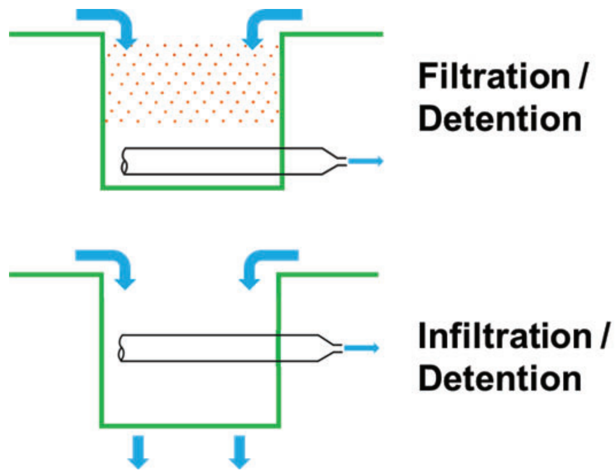


If each SMP of the hybrid system meets all applicable design criteria, then no special approvals are required for their use. When this is not the case, hybrid systems must gain approval through the same processes identified for proprietary systems. While most hybrid systems are anticipated to be infiltration systems, other types may be feasible at the discretion of DEP.

Dual Function Systems

Dual function systems refer to cases where one SMP is configured to support runoff management via two, equally contributing functions. The two most common types of dual function systems are ones with filtration/detention systems and infiltration/detention systems, as illustrated in Figure 4.6.

Figure 4.6. Illustration of the two most common dual function systems.



While these are the most common types, other dual function systems may be possible. A brief description and examples of the two common dual function systems are presented in the following paragraphs.

Filtration/Detention Systems

Dual function systems for filtration/detention are designed to allow water to pass through a filtration media, which then drains to a controlled-flow device for slow release. These systems rely on both the steady flow of water and the ability to control the release rate.

Any of the standard filtration practice may be designed with a controlled-flow device to facilitate detention. No special approvals are required when the SMP meets all of the design criteria for filtration systems and has a controlled-flow device with a maximum release rate of 0.1 cfs/acre in combined areas or 1 cfs/acre in separate areas. In cases where one or both of these conditions are not met, dual function filtration/detention systems must gain approval through the same processes identified for proprietary systems.

If a release rate of 0.1 cfs/acre would require an orifice less than one-inch, a one-inch orifice with a smaller inner diameter may be accepted, at the discretion of DEP. If the flow rate through the controlled-flow device is more restrictive than the filtration media, designers must use the controlled-flow rate to calculate drawdown time.

With regards to storage volume, the active storage zone for both filtration and detention practices are the same. The bottom of the active storage zone is the invert elevation of the outlet pipe, while the top is the elevation at which water may overflow or bypass the system. Therefore, the volume of the practice used for both functions is the same.

Filtration/detention practices may apply 100% of their volume towards the water quality criterion (WQv) and 50% towards the sewer operations criterion (Vv). Finally, if the filtration / detention system uses an engineered soil media filter, 40% of the volume may be applied towards the runoff reduction criterion (RRv).

Infiltration / Detention Systems

Dual function systems for infiltration/detention are designed with an outlet pipe that is raised above the bottom of the practice and drains water to a controlled-flow device. This means that water below the outlet pipe is captured and infiltrated, while water above the invert of the outlet pipe is detained.

Any standard infiltration practice with a stone base may be designed with a controlled-flow device to facilitate detention, except for rain gardens. No special approvals are required when the SMP meets all of the design criteria for infiltration systems and also has a controlled-flow device with a maximum release rate of 0.1 cfs/acre in combined areas or 1 cfs/acre in separate areas. In cases where one or both of these conditions are not met, dual function filtration/detention systems must gain approval through the same processes identified for proprietary systems.

If a release rate of 0.1 cfs/acre would require an orifice less than one-inch, a one-inch orifice with a smaller inner diameter may be accepted, at the discretion of DEP.

The calculation of drawdown time and application of volumes is more complex for infiltration / detention systems since their storage volumes are defined differently. The volume that functions as infiltration is only the volume below the invert elevation of the outlet pipe, whereas the volume that functions as detention is the volume above the invert elevation of the outlet pipe up to the elevation that either overflow or bypass occurs. With that in mind, two drawdown times must be computed. One for the drawdown time of the infiltration volume and another for the drawdown time of the detention volume.

Of the volume that functions as infiltration, 100% may be applied towards the WQv and RRv, while 50% may be applied towards the Vv. Of the volume that functions as detention, 100% may be applied towards the WQv in CSS areas and 50% may be applied to the Vv. However, if the practice does not have any planting or filtration media (e.g., stormwater gallery), then 100% of the volume that functions as detention may be applied toward the Vv. The storage volumes for each function of infiltration/detention systems must be clearly identified in section view as part of permit applications.

4.10. SMP Components

SMPs are designed as systems with several components that work together to ensure the functionality of the practice. This section provides guidance and requirements for the design of each common SMP component. Designers must ensure that requirements for all applicable components are met via their design drawings, notes, and specifications. The designer may propose systems with components that are not mentioned here, subject to approval by DEP.

Pre-treatment

Pre-treatment refers to systems that help remove sediment, floatable debris, hydrocarbons, and/or other contaminants commonly found in stormwater runoff before they enter an SMP.

All inlets that ultimately drain to a subsurface practice must have pre-treatment systems that help to remove sediments and floatables. This requirement helps protect the SMP against the reduction of storage capacity, clogging of internal pipes, and/or loss of infiltration that sedimentation can cause over time. Designers should refer to the inlet component subsection for more details.

Beyond the required pre-treatment systems for inlets, designers shall consider other measures in cases where sedimentation risks are increased due to land uses, topography, or high permeability of underlying soils (greater than 2 in/hr). In these cases, additional pre-treatment measures, such as a forebays, vegetated swales, filter strips or hydrodynamic separators may be required, at the discretion of DEP.

Pretreatment may be of particular importance for industrial maintenance facilities where pollutants of concern include, salt, oils, and grease. In addition to the measures described above, pre-treatment devices such as media filters and sorbents have been shown to be effective at removing oils and grease (CWP 2007, Pitt et al. 1999). Salt, however, is highly soluble and is not readily removed by structural management practices, including media filters. Pollution prevention, such as covering salt storage areas or placing impermeable barriers around salt piles is the most effective method of reducing salt transport via stormwater runoff (WDNR 1994, MPCA 2000).

Ponding Area

Ponding areas are used to temporarily store runoff at the surface of an SMP. Most SMPs with ponding areas allow depths of up to 12-inches, except for ET SMPs which allow up to 3-inches, as well as a few specific practices that temporarily store all their volume at the surface (e.g., dry basins). Ponding areas must drawdown within 24-hours to mitigate the risk of mosquito breeding, except for dry basins which are allowed 48-hours to drawdown. Drawdown time calculations are provided in Section 4.3.

Most practices that filter water through a planting or filtration media must be able to temporarily hold 75% of the WQv above the filter media to avoid bypass of the WQ event (see design criteria). This is typically done in the ponding area but may also be achieved by an equalization structure. For infiltration practices, this requirement is waived when a hydraulic connection is made between the ponding area and stone base, such as a riser pipe or stone gabion. Designers must consider measures to reduce the sedimentation risks of hydraulic connections, such as raising the connection above the lowest ponding elevation, providing screens, or other alternatives.

A minimum 3 inches of freeboard (i.e., depth between maximum surface ponding and adjacent grade) is required for all ponding areas. Overflow devices shall be used to control the maximum surface ponding depth. Typical overflows consist of a riser pipe and domed grate.

In cases where the surface of an SMP is not level, the ponding depths may vary across the practice, but the minimum and maximum allowable values must be followed. When graded slopes are used to create ponding areas, a maximum side slope of 1V:3H shall be used.

Other considerations for the design of the ponding depth may include adjacent land use, site constraints, and the potential need for public safety measures. Specifically, in cases where ponding area design may present public hazards, designers shall consider signage, barriers, and/or other safety measures to mitigate such hazards.

Permanent Pool

Unlike ponding areas, a permanent pool is a surface area where water is permanently held. Typically, permanent pools are underlain by an impermeable soil or liner to prevent them from draining. Wetlands and wet ponds have permanent pools that help to treat runoff through sedimentation and biological processes.

SMPs with permanent pools require a 25-foot buffer area between the point of maximum water surface elevation and any site features. Trees in the buffer area should be preserved during construction. Warning signs must be posted around SMPs with permanent ponds, which prohibit swimming, wading, and skating; warn of possible contamination or pollution of pond water; and indicate the maximum depth of the pond. In addition, designers shall also consider barriers and/or other safety measures to mitigate public hazards.

The perimeter of all permanent pools with depths of 4ft or more must have an aquatic bench and a safety bench. In these cases, the boundary of the permanent pool will have four distinct zones, each with its own slope requirement:

- Aquatic bench – extends from the edge of the normal water level, 15ft inwards towards the basin floor. Maximum slope of 1V:10H.
- Pool slope – extends from the aquatic bench to the basin floor. Maximum slope of 1V:2H.
- Safety bench – extends from the edge of the normal water level, 15ft outwards towards the edge of the practice. Maximum slope of 1V:15H.
- Toe slope – extends from the safety bench to the edge of the practice. Maximum slope of 1V:3H.

Each permanent pool must have an outlet pipe that, when activated, can drain the pond within 24 hours. In addition, the outlet pipe shall have an elbow or protected intake to prevent sediment deposition within the pipe.

Vegetation

Establishing vegetation is essential to the functionality of a vegetated practice. Plants should be chosen based on their hardiness, soil and light conditions, root structure, and ability to adapt to wet and dry conditions. The vegetative cover and root systems should promote infiltration within the engineered soil, provide an aesthetic benefit, and help prevent erosion, particularly on surface side slopes.

In cases where runoff enters a practice via a vegetated surface, the entrance velocity of runoff may not exceed erosive velocities. If the grading of adjacent areas cannot be modified to prevent erosive velocities, or the practice receives surface water from a rooftop drain pipe, energy dissipation measures must be used to limit erosion (see energy dissipation components).

Given that landscaping is critical to the performance of vegetated SMPs, a landscaping plan must be provided for these systems. Guidance on the selection and planting of SMP vegetation can be found in the Native Species Planting Guide for New York City, which is available online at the NYC DPR publications webpage (www.nycgovparks.org/greening/natural-resources-group/publication). In general, considerations for the development of landscaping plans include:

- Vegetation should be selected that are capable of withstanding frequent cycles of inundation and drought.
- Native plant species should be specified over non-native species.
- The prevalence of wet, dry, sunny, or shady zones within the SMP should be considered as part of the landscaping plans.
- Where trees are proposed, an understory of shrubs and herbaceous materials should be provided.
- Woody vegetation should not be specified at inflow locations.
- For on-site facilities, a tree spacing of approximately 10 feet on-center is recommended.
- The recommended spacing for shrubs is 5 feet on-center for large container sizes (5gal or more), 3 feet on center in standard applications, and 1.5 foot on-center for small rain gardens.
- The recommended spacing for herbaceous vegetation is 2 feet on-center for grasses and 1.5 feet for perennials.

Media

Most SMPs consist of a series of built-up media layers that work together to manage stormwater. A wide range of media types have been developed for SMPs, which have an equally wide range of naming conventions and compositions. Table 4.9 includes standard names and compositions for ten media types, which are to be used for SMP design. A general description for each media type is as follows:

- Mulch – used on the surface of soils for moisture retention and nutrients
- Pea gravel – used on the surface of filters or other media to reduce direct contact or scour
- Engineered soil – default soils to be used for planting areas, except for special cases
- Topsoil – specialized soils for standalone tree plantings or soil amendments that have more fine and nutrient content
- Green roof media – specialized soils for green roofs that are lightweight and fast draining
- Sand filter media – sand media that is intended to filter percolating water
- Peat/sand filter media – peat/sand media blend that is intended to filter percolating water
- Stone base media – default media to be used for storage and/or drainage layers
- Leveling media – used under porous pavements and synthetic turf fields to increase contact area and allow leveling
- Subbase media – may be used as a transition between the leveling media and stone base media for added separation and stability

The design criteria tables in Sections 4.4-4.8 indicate which media are appropriate for each practice type, along with their required depths. Guidance on the composition for each media type are provided in Table 4.6. Practices that are not constructed in accordance with these media guidelines may be rejected, at the discretion of DEP.

Wherever trees are used, practices must have at least 2.5 feet depth of soil media, which would be topsoil for standalone tree plantings and engineered soil for other practices. All other vegetation requires at least 1 foot depth of soil media, with a depth of 2 feet being preferred.

The installation of stone base should be done in lifts of 6-8 inches, with care taken not to over-compact the subgrade or stone base layers. Over-compaction can result in lower than anticipated storage potential and a reduction in infiltration rates. Any practice that uses a subsurface stone base must include an observation well or other means of observing the subsurface water level (see the Observation Well component subsection).

Table 4.6. Composition guidance for the ten SMP media types.

Media Name	Composition	Additional Guidance
Mulch (Surfacing Media)	Shredded hardwood	Aged 6-months minimum
Pea gravel (Surfacing Media)	ASTM D 448 No. 6	Clean and free of fines Rounded bank run gravel
Engineered soil, CSS areas	By weight: Gravel (>2.0mm) 0-8% Sand (0.05-2mm) 80-8%, of which: Course Sand (0.5-1mm) 0-5% Medium Sand (0.25-0.5mm) 55-75% Fine Sand (0.1-0.25mm) 20-40% Silt (0.002-0.05mm) 5-10% Clay (<0.002mm) 3-8% Organic Matter 3-6%	pH 5.0-7.0 Kjeldahl N - 0.06 - 0.25% (NO-3 < 20ppm) Phosphorous - 80 - 100 lbs/acre Potasium - 100 - 300 lbs/acre Acid-producing Soil Test pH > 4.5 Free of refuse, hard clods, woody vegetation, stiff clay, construction debris (of any kind), boulders, stones greater than 1-1/2 inch, chemicals, or other deleterious material toxic to any vegetation used on this project.
Engineered soil, MS4 areas	By volume: Sand (0.05-2mm) 35-60% Silt (0.002-0.05mm) 30-55% Clay (<0.002mm) 10-25% Organic Matter 1.5-4%	pH 5.2-7.0 Phosphorous > 75 lbs/acre Potasium > 85 lbs/acre Magnesium > 35 lbs/acre Free of stones, stumps, roots, or other woody materials over 1" in diameter. Brush or seeds from noxious weeks.
Topsoil media	By weight: Gravel (>2.0mm) <20% Sand (0.05-2mm) 65-70% Silt (0.002-0.05mm) 10-30% Clay (<0.002mm) <10% Organic Matter 5-9%	pH 6.0-7.5
Green roof media	By weight: Silt (0.002-0.05mm) ≤ 10% Clay (<0.002mm) ≤ 2% Organic Matter ≤ 8%	pH 6.0-8-5 Maximum water holding capacity 35-65%
Sand filter media	Clean AASHTO M-6 or ASTM C-33 concrete sand	Sand substitutes such as diabase and graystone #10 are not acceptable. No calcium carbonated or dolomitic sand substitutions are acceptable. "Rock dust" cannot be substituted for sand.
Peat/Sand filter media	By volume: 50% Reed-sedge hemic peat 50% Clean AASHTO M-6 or ASTM C-33 concrete sand	Sand guidance: see above Peat guidance: Ash Content < 15% pH 4.9-5.2 Loose bulk density 0.12-0.15 g/cc Shredded, uncompacted, uniform, and clean
Stone base media	ASTM No. 57 Stone	Clean and free of fines Maximum wash loss of 0.5% Maximum abrasion of 10% for 100 revolutions and 50% for 500 revolutions
Leveling media	ASTM No. 89	
Subbase media	ASTM No. 2 Stone	Clean and free of fines

Subgrade (Underlying Soils)

Subgrade refers to the native soils that are underneath the base of an SMP. Prior to the installation of SMPs, the subgrade must be evaluated in accordance with the NYS SWMDM procedures. Only subgrades with an infiltration rate of 0.5 in/hr or more are suitable for infiltration practices. Alternatively, when the permeability rate is 2.0 in/hr or greater, additional pre-treatment measures may be needed to reduce the risk of contaminant transport.

Wherever possible, SMPs should be designed with a permeable bottom between the SMP base and the subgrade to help facilitate infiltration, even in cases where the practice is not considered an infiltration practice (i.e., permeability rates are low). However, SMPs may not have a permeable bottom in the following cases:

- land uses may result in contaminated runoff,
- geotechnical tests indicate that native soils may be contaminated, or
- water table or bedrock are within three feet of the bottom of the practice

After SMP excavation, particular care should be taken not to compact the subgrade prior to placement of the stone base or other components. In cases where compaction could not be avoided, the subgrade shall be restored via tilling or aerating prior to placement of the stone base or other components.

In addition, the subgrade surface should be scarified prior to the placement of any infiltration practices. In cases where erosion of the subgrade has resulted in an accumulation of fine materials at the proposed base of an SMP, remove these materials to a depth of 6 inches and replace with engineered soil.

It is recommended that the stone base and other components are placed immediately after subgrade preparation to prevent the accumulation of debris or sediment.

Internal Structures

Internal structures refer to any interior container that is used to store water, typically located within the drainage layer of the SMP. Internal structures include modular systems, such as chambers, tanks, cisterns, crates, or other pre-cast units, as well as storage pipes.

In the case of modular systems, designers must follow all manufacturer guidelines for their design and installation. This may include, but is not limited to, guidelines for setbacks, spacing, cover, base depth, hydraulic connections, and maintenance access. In the case of storage pipes, refer to the internal pipe component subsection.

Geotextile

Geotextile fabrics should be used along the sides and top of the drainage layer, where the drainage layer interfaces with native soils, engineered soils, and filtration media. Geotextile fabrics should not be used at the base of practices, as the fabric is more likely to become clogged and impede infiltration. In addition, geotextile fabrics should not be used around perforated pipes, when they are within the drainage layer of an SMP, to help reduce the potential for clogging.

Non-woven geotextile fabrics are the most appropriate type for allowing and sustaining infiltration. It is critical that the geotextile fabric does not impede flow rates, and designers shall specify materials accordingly. Heat-bonded nonwoven fabrics are not recommended, because they tend to clog very quickly. Designers should review manufacturer’s recommendations to avoid placement that would void the warranty.

Adjacent strips of geotextile filter fabric shall overlap a minimum of 16 inches and shall be secured at least 4 feet outside of bed until all bare soils contiguous to beds are stabilized and vegetated.

Geomembranes

SMPs must be completely lined with a geomembrane in the following cases:

- land uses may result in contaminated runoff, or
- geotechnical tests indicate that native soils may be contaminated

Geomembranes may also be used along the sides of practices to reduce the risk of water intrusion when SMPs cannot meet setback requirements from structures, at the discretion of DEP. In this case, the impervious liner shall extend from the top of the freeboard to 12 inches beneath the bottom of the practice and shall cover the full width of the excavation.

All geomembranes shall be made of high-density polyethylene. The geomembrane liner shall be sufficiently anchored along the upper edge to prevent slipping and shall not extend to the surface where it would be visible. Specific material requirements for geomembranes include the following:

- ASTM D751 (30 mm thickness)
- ASTM D412 (tensile strength 1,100 lb, elongation 200%)
- ASTM D624 (tear resistance 150 lb/in)

Inlets

An inlet is any structure that captures water which eventually drains to an SMP. They are usually located at the low points of a site. Common types of inlets include yard drains, catch basins, and manholes with a slotted frame. All inlets must include where appropriate:

- A minimum 1-foot sump to allow for sediment collection and removal
- Hood or baffle to allow for containment of floatable debris
- ADA (Americans with Disabilities Act) compliant grates, if placed over pedestrian surfaces
- H-20 loading grates, if placed in locations with vehicular traffic

To prevent flooding, inlets shall include a means of bypassing the practice once it is full. This is often a bypass pipe that connects to a drainage system downstream of the practice. The invert of the bypass shall match or exceed the maximum storage elevation of the SMP. In cases where a bypass pipe is not feasible, designers must show that flow rates to the inlet will not cause surcharge within 6 inches of the inlet surface when the practice is full.

Pre-treatment components, such as the sump and the hood or baffle, are particularly important for reducing the amount of sediment and debris that are conveyed to the SMP. This requirement helps protect the SMP against the reduction of storage capacity, clogging of internal pipes, and loss of infiltration that sediment and debris can cause over time.

Hoods and baffles are typically installed around the pipe that exits the inlet to prevent floatable debris from being conveyed downstream. The hood or baffle must extend at least four inches below the exiting pipe's invert and must project away from the pipe opening enough not to restrict flow. In the case of proprietary hoods and baffles, all manufacturers' guidelines must be followed.

Additional pre-treatment measures, such as filter bags and baskets, can help to further reduce sediment and floatable debris that are conveyed to the SMP. While these measures are typically optional, they may be required in areas where risk of sedimentation and floatable debris is high.

Filter bags and baskets are inserts that are situated under the inlet grate to capture floatable debris and sediments as water enters the inlet. Filter bags are typically made of permeable fabrics, while baskets are usually made of more rigid materials with openings. The level of pre-treatment provided by filter bags and baskets is related to the size of openings in the materials; where smaller openings will capture more sediments but require more frequent maintenance to prevent clogging. The size of openings should be set to capture the most sediment and debris possible without resulting in a flow restriction when the bag or basket is partially full. Designers should also consider the likely frequency of maintenance when setting the size of openings.

Energy Dissipation

Energy dissipation and/or armoring measures are required when the velocity of runoff entering an SMP may result in erosion.

Energy dissipation is often achieved by some form of level spreader which reduces the velocity of runoff by creating sheet flow across a larger surface area. Other, proprietary, energy dissipation methods usually involve sending water through a matrix where eddies and friction work to slow the velocity of water. Common types of armoring, to protect against erosive velocities, include inlet aprons of hard materials and crushed stone ballasts or channels.

Manholes

Manholes are structures that serve as junction points of the drainage system, used where pipes change elevation, change direction, or at each 300 ft interval of pipe to allow access and maintenance. Whenever feasible, manholes should be designed so that they do not require confined space entry but can easily be accessed by a vactor truck attachment. Generally, manholes:

- Shall be a minimum of 4 feet in diameter when there are two or more inlet pipes
- Shall not have more than three pipe connections at the same elevation; additional connections shall be separated by at least 1 foot vertically
- Shall be located at least 3 feet above the groundwater table, or be properly anchored, to prevent potential groundwater infiltration into the system
- Require a minimum concrete leg of 6 inches between the manhole block-outs for adjacent pipes.

Observation Wells

Observation wells must be installed in all practices with a subsurface stone base. As an alternative, inspection ports may be installed in cases where chambers are used. Other suitable alternatives may also be considered that allow observation of the subsurface water level. The observation well or inspection port is key to monitoring the water levels in the practice and determining the need for maintenance. One observation well or other means of observation is required for each 5,000 sf of SMP area.

Observation wells shall consist of a minimum four-inch diameter polyvinyl chloride (PVC) pipe, extending from the surface of the practice to the bottom of the drainage layer, with perforations along the entire drainage layer. The observation well must be anchored in place, which is commonly done using a concrete collar. The top of the observation well must be capped with a lockable top lid. In locations with pedestrian access, the cap of the observation well must be flush with the surface to avoid a tripping hazard.

Pipes

Given the wide range of pipe functions and naming conventions, the Unified Stormwater Rule defines four types of pipes for clarity, as follows:

- Conveyance pipes – umbrella term used to describe yard drains, bypass pipes, overflow pipes, and intake pipes
- Internal pipes – perforated pipes inside the practice that can be used to evenly distribute or drain water in the stone base
- Cleanout pipes – pipes that provide a connection between the surface (vertical) and internal pipes (horizontal) to allow for regular maintenance
- Outlet pipes – any pipe that can drain water from the practice before it is full, which typically connects the active storage zone of the practice with a point of discharge

Specific requirements for each type of pipe are described in the subsections below. It is important to note that a pipe connecting the on-site drainage system to the City sewer is called a site connection. While the Unified Stormwater Rule includes stormwater management requirements for obtaining site/house connection permits, this Manual does not prescribe the design of site connection pipes themselves, which is regulated separately by BWSO.

Any pipes used to convey stormwater inside of buildings must be designed in accordance with the latest NYC DOB Plumbing Codes for Storm Drainage systems. Any pipes used to convey stormwater outside of buildings, except for site connections, must be designed for a minimum 3 in/hr rainfall intensity for the associated drainage area, or as required by the NYC DOB Plumbing Code in special cases where pipes convey both primary and secondary rooftop drains. Designers may also consider larger events, as appropriate, to provide additional drainage capacity.

Conveyance Pipes

A bypass or overflow device shall be provided to safely convey runoff away from all practices once they are full, sized in accordance with the above guidance. In addition, conveyance pipes shall:

- Have 6-inch or greater diameter and use materials that can be joined to existing site infrastructure, consistent with NYC Plumbing Code
- Have a minimum slope of 0.5% and a maximum slope of 10%
- Have a minimum full-flow velocity of 3.5 feet per second

Internal Pipes

Typically, internal pipes have no slope and rely on conveyance pipes and outlet pipes to convey water into and out of the practice, respectively. In larger systems, a grid of connected internal pipes can be used to form an internal pipe network. Internal pipes shall:

- Have 8-inch or greater diameter and be made of high-density polyethylene (HDPE) meeting the requirements of ASTM D3350
- Be perforated with perforations meeting AASHTO Class II specifications
- Have cleanouts that may be used to access every 75 feet of straight pipe runs
- Have endcaps at the ends of all segments that do not connect to a cleanout
- Use 1/8 (45 degree) elbows for bends (does not apply to pipe networks). For example, 90-degree bends should be made using two 1/8 (45 degree) elbows and separated by at least 1 foot of straight pipe
- Have a minimum of 6 inches of stone on all sides

The contractor should follow the engineering design documents and manufacturer's installation instructions when installing perforated pipes. The spacing between parallel pipes should be at least 12 inches for pipes with internal diameters less than 24 inches, and at least equal to half of the internal pipe diameter for pipes larger than 24 inches.

Cleanouts

At least one cleanout must be provided when internal pipes are used. In cases where cleanouts are installed in engineered soils, the top of the cleanout must be anchored in place, which is commonly done using a concrete collar. The top of the cleanout well must be capped with a lockable top lid. In locations with pedestrian access, the cap of the cleanout must be flush with the surface to avoid a tripping hazard. In addition, cleanouts shall:

- Be 8-inch diameter or greater high-density polyethylene (HDPE) meeting the requirements of ASTM D3350
- Use 1/8 (45 degree) elbows for transition from vertical to horizontal
- Have caps placed above the freeboard elevation in areas with surface ponding and permanent pools
- Be placed within 75 feet of and in-line with each outlet pipe
- Be placed at the end of any standalone internal pipe used for distribution
- Be placed at the ends of an internal pipe network along primary pathways
- Be placed outside of any play fields or high traffic areas
- Give consideration to site constraints and maintenance equipment access

Outlet pipes

Outlet pipes shall be installed in all filtration practices, as well as detention practices that are not self-contained, unless directed otherwise by DEP. In cases where outlet pipes are used in infiltration practices for maintenance purposes, the outlet pipe must have a permanent cap that is only removed when maintenance is being performed. ET practices must have a means of draining excess runoff, using either outlet pipes, weep holes, drainage course, or other method. In addition, outlet pipes shall:

- Be 6-inch diameter or greater HDPE meeting the requirements of ASTM D2729
- Have a minimum slope of 0.5% and a maximum slope of 10%
- Use 1/8 (45 degree) elbows for bends. For example, 90-degree bends should be made using two 1/8 (45 degree) elbows and separated by at least one foot of straight pipe. Designers should make every effort to avoid using bends in outlet pipes
- Be accessible on both ends, either by a cleanout or drainage structure (e.g., outlet control structure)
- Avoid having an open connection to surface features when conveyed to a controlled-release device to prevent entry of sedimentation and trash

- Have base and embedding material, as appropriate, to prevent pipe damage

Outlet Control Structures

An outlet control structure (OCS) is any structure that houses a controlled-flow device or weir that regulates drainage from a practice. These structures serve as an access point for maintenance and typically include other measures to manage sediments or allow overflow once the practice is full.

OCSs are required for all detention practices except for blue roofs, where the controlled-flow device is already accessible from the roof surface. Note that detention tanks are themselves an OCS and do not require a separate facility. OCSs may also be used for infiltration practices, as an access point for maintenance, when the outlet pipe is capped or a weir is provided to prevent water from draining the practice before it is full. Several OCS configurations are acceptable if the following requirements are met:

- Connected to the SMP via an outlet pipe (does not apply for detention tanks)
- Provides an overflow for discharge of captured runoff in excess of the design volume
- Provides a controlled-flow device for the slow release of water (applies to detention systems only)
- Provide, for the collection of debris, a 12-inch minimum sump below the invert of the outlet pipe or controlled-flow orifice, whichever is lower
- Allows access to the controlled-flow device and sump for regular maintenance
- Discharge only to an on-site drainage structure, such as a manhole or inlet, rather than directly to a City sewer (does not apply to detention tanks)

Controlled-Flow Orifice

A controlled-flow orifice is a small opening used to regulate drainage from a practice. Detention practices must have a controlled-flow device, which includes controlled-flow orifices. Controlled-flow orifices shall:

- Be sized to drain the practice in accordance with the appropriate maximum release rate for the contributing area (see Chapter 2).
- Be easily accessible and have appropriate protection to prevent clogging
- Drain the practice within the required maximum drawdown time (see design criteria tables in Section 4.4-4.8)
- Be set at or above the invert elevation of connection to the on-site drainage system (minimum 3-inch drop preferred)

Detention practices with controlled-release orifices may be used to manage the water quality volume in CSS areas when higher tier practices have been exhausted and the maximum release rate complies with the sewer operations requirement in Chapter 2 (i.e., 0.1 cfs/acre). The maximum release rate of the controlled-flow orifice should be calculated as follows:

EQ 4.15

$$Q_O = C_D * A_o * \sqrt{2gH}$$

where:
QO = maximum release rate of orifice (cfs)
CD = coefficient of discharge; 0.61 (flush), 0.52 (re-entrant)
AO = area of orifice (ft2)
g = acceleration due to gravity, 32.2 (ft/s2)
H = maximum hydraulic head above the centerline of the orifice (ft)

Controlled-flow orifice size should never be smaller than 1-inch diameter for practices. Practices with orifice sizes less than 2-inches shall include pre-treatment measures to prevent clogging.

Eq. 4.15 may be simplified and converted into the following two equations, Eq. 4.16 and 4.17, which may be used to determine the approximate maximum storage depth for a particular release rate or orifice.

Compute the maximum storage depth in ft. of a detention facility with a Re-entrant orifice tube outlet, S_{DR}, with a C_D of 0.52, by the equation:

EQ 4.16

$$S_{DR} = 1{,}930(Q_{DRR})^2/(d_O)^4 + d_O/24$$

where:
S_{DR} = the maximum storage depth in ft. for a Re-entrant orifice tube outlet
Q_{DRR} = the detention facility maximum release rate in cfs
d_O = the nominal dia. of the orifice tube outlet in in.

Compute the maximum storage depth in ft. of a detention facility with a Flush orifice tube outlet, S_{DF}, with a C_D of 0.61, by the equation:

EQ 4.17

$$S_{DF} = 1{,}400(Q_{DRR})^2/(d_O)^4 + d_O/24$$

where:
S_{DF} = the maximum storage depth in ft. for a Flush orifice tube
Q_{DRR} = the detention facility maximum release rate in cfs
d_O = the nominal dia. of the orifice tube outlet in in.

Controlled-flow orifices within outlet control structures should provide flexibility to modify SMPs in the future with minimal changes to the practice. Adjustments to the system can be made to account for actual performance by either opening or closing the orifice.

Controlled-Flow Pumps

A controlled-flow pump is a small pump used to regulate drainage from a practice, which is reserved for cases where site or utility elevations prevent the use of a controlled-flow orifice that drains by gravity. These circumstances can include, but are not limited to:

- Sites that drain to shallow sewers, where roof detention is insufficient or infeasible
- Sites that require deeper practices due to utility interference or other regulatory conflicts, where the outlet would be too low for gravity drainage

Given these conditions, controlled-flow pump detention systems should only be built below the site grade. Such systems must still maintain the required maximum release rates outlined in Chapter 2 using a controlled-flow pump system. Controlled-flow pump systems require the following components, which must be shown on a section view of the proposed system:

- A detention facility where water may be stored, with dimensions
- At least one pump and one backup pump. If other pumps are to be used as "primary pumps," such as when pumps are to be used in parallel, a backup pump is required for each primary pump
- An intake, outlet (a "force main"), and an overflow, shown on a section view, with dimensions

The dimensions provided on the section view must be to scale and match the proposed configuration specified in the pump analysis calculations.

Design methods for controlled-flow orifices differ from controlled-flow pumps. For example, the design goal of a controlled-flow orifice is to ensure that the release rate does not exceed maximum rate for the facility, at the time when the volume is being provided. However, for controlled-flow pumps, the design goal is to ensure that the average release rate does not exceed the maximum rate for the facility, at the time when the volume is being provided.

The analysis to determine if the controlled-flow pump meets the release rate criterion is substantially more complex than the analysis that must be done for a controlled-flow orifice. For this reason, a controlled-flow pump workbook is available in Appendix F, which includes a template for calculations and a design example. In addition, the following paragraphs include details on the calculation methods and criteria for using controlled-flow pumps.

The average pump rate for the system is determined by taking the maximum and minimum pump rates for the system and averaging these. The maximum and minimum rates are determined by finding the operation point for each rate, respectively. The operation point is defined as the point where the system head curve intersects with the pump curve. There will be two system curves, one corresponding to the maximum rate, and the other corresponding to the minimum rate, and each will have a corresponding amount of head loss.

There are a number of methodologies that are used to generate a system head curve for a particular type of pump system, but the one that DEP uses for analysis is the "equivalent length." So regardless of the methodology that the applicant uses, DEP requires the following inputs to do an analysis of equivalent length:

1. The fittings that are proposed, specified by the number of each type of fitting. Each fitting has an equivalent length and should be shown diagrammatically on the section view. See Appendix F for more information about the types of fittings that can cause head loss.
2. The elevation of water where the pump system is designed to turn on. This must be above the elevation where the pump is designed to turn off.

3. The elevation of water where the pump system is designed to turn off. This is typically near the bottom of the tank.
4. The elevation at which the proposed force main will discharge by gravity only (where it is no longer under pressure). The nature of this elevation requires that it be above the sewer.
5. The required detention volume, in cubic feet (cf) calculated for the system. The required detention volume for singular detention systems can be computed using equations in Chapter 2, while the required detention volume of systems in series can be computed using equations in Section 4.11.
6. The area of the detention tank, in square feet (sf), which in conjunction with item (5), will determine the elevation of the maximum storage volume.
7. The force main pipe diameter, in inches (in).
8. The force main length, in feet (ft), not including any equivalent lengths provided in item (1).
9. The proposed maximum pump rate that the pump will operate at, in gallons per minute (GPM). This should be the operation point for when the pressure head is the lowest.
10. The proposed minimum pump rate at which the pump will operate, in gallons per minute (GPM). This should be the operation point for when the pressure head is the highest.
11. The proposed Hazen-Williams coefficient, typically 130 for new wrought or cast Iron, steel, ductile iron, or vitrified clay pipes.

The above inputs will allow for the following outputs to be calculated:

1. The minimum static lift, in feet (ft)
2. The maximum static lift, in feet (ft)
3. The provided storage depth, in feet (ft)
4. The minimum head loss, in feet (ft)
5. The maximum head loss, in feet (ft)
6. The maximum pump rate, in cubic feet-per-second (cfs)
7. The minimum pump rate, in cubic feet-per-second (cfs)
8. The maximum pump rate, in cubic feet-per-second (cfs), which is the average of item (6) and (7)

The process of finding the actual pump behavior requires testing a proposed maximum and minimum pump rate (items 9 and 10 in the inputs), against the minimum and maximum head losses (items 4 and 5 in the outputs), iterating until each operation point is found. Once each operation point is found, their average is used as the actual release rate of the pump system. If this is lower than the maximum release rate, then the pump system is acceptable.

4.11. Special Cases

There are several special cases (SC) where the methods for sizing and applying SMP volume, as outlined in Section 4.3, do not apply. These cases are marked as "SC" on the SMP Hierarchy Checklist (Appendix A). There are three general types of special cases:

- Criteria-based practices used to meet water quality goals, where storage volume is either not provided or cannot be computed
- Reuse systems used to meet sewer operations goals, where the amount of volume that may be applied varies by system operation
- Detention systems in series, where the upstream detention system modifies the volume to be managed in the downstream system

The following subsections include methods for determining how these special case systems may be applied to meet stormwater management requirements.

Criteria-Based Practices

Criteria-based practices include grass filter strips, vegetated swales, and standalone trees (planted or preserved). These are special cases because either the SMP has no storage volume or, in the case of tree preservation, it often cannot be computed due to unknown conditions. Criteria-based practices must meet all special design criteria to facilitate the desired stormwater management requirement. When all criteria are met, these systems reduce a set percentage of the WQv that falls on the contributing area.

Grass filter strips can manage 100% of the WQv that falls on the contributing area when the following supplementary design criteria are met:

- Minimum width of 50 feet for slopes of 0% to 8%, 75 feet for slopes of 8% to 12% and 100 feet for slopes of 12% to 15%
- Maximum contributing length (i.e., length of flow path to the grass filter strip) shall be 150 feet for pervious

surfaces and 75 feet for impervious surfaces

- For a combination of impervious cover (IC) and pervious cover (PC), use the following to determine the maximum length of each contributing area:
  - 150 – IC = contributing length of PC (maximum IC = 75, maximum PC =150)
- Maximum slope of the first ten feet of filter is less than 2%
- Average contributing slope is 3% maximum unless a flow spreader is used

Vegetated swales can manage 20% of the water quality volume that falls on the contributing area when the following supplementary design criteria are met:

- Receive WQv flow rates from the contributing area that are 3 cfs or less
- Convey the peak discharge for water volume flow (3 cfs or less):
  - at a velocity of < 1.0 fps, and
  - at a flow depth of 4 inches or less
- Provide sufficient length (minimum 100 ft) to retain the computed treatment volume for 10 minutes in a swale that receives runoff as a point discharge at the inlet, or an average of 5 minutes of retention time for a swale receiving sheet drainage or multiple point discharges along its length
- Have a trapezoidal or parabolic shape, with a bottom width minimum of 2' and no greater than 6'
- Provide 4 inches of topsoil
- Apply recommended seed mixes (or sod) per the table from NYS SWMDM below:

NYS SWMDM Table 5.9 Mixtures	Rate per Acre (pounds)	Rate per 1,000 square feet (pounds)
A. Perennial ryegrass	30	0.68
Tall Fescue or smooth bromegrass	20	0.45
Redtop	2	0.05
OR		
B. Kentucky bluegrass[1]	25	0.60
Creeping red fescue	20	0.50
Perennial ryegrass	10	0.20

[1]Use this mixture in areas which are mowed frequently. Common white clover may be added if desired and seeded at 8 pounds/acre (0.2 pound/1,000 square feet).

Calculations for peak runoff rates, design flows, and retention times should be done in accordance with small storm hydrology methods, conventional hydrology methods, or Manning's equations for open channel flow, as appropriate (see NYS SWMDM). For hydraulic calculations, variable n values should be used corresponding to flow depths, from 0.15 down to 0.03.

Tree planting and preservation refers to standalone trees, rather than trees planted as part of larger bioretention practices. A standalone tree (planted or preserved) may be counted as a reduction in impervious area when calculating the runoff coefficient (Rv) in the WQv equation. The amount of impervious reduction that may be applied is based on the size of the tree, which reflects the increased stormwater management benefits of a larger canopy and root system.

Standalone trees may reduce the impervious area used to calculate Rv by half the tree canopy area, up to 100 sf. This means that trees with canopies of 16-foot diameter or less will count half their canopy area, while larger canopies will be capped at 100 sf reduction. In order for standalone trees to apply this reduction, the following supplementary design criteria must be met:

- New trees planted must be planted within 10 feet of ground-level, directly connected impervious areas.
- New deciduous trees must be at least 2-inch caliper and new evergreen trees must be at least 6 feet tall to be eligible for the reduction.
- For new trees, the average slope for the contributing area, including the area under the canopy must not be greater than 5%.

Reuse Systems

Reuse systems may be eligible toward meeting the sewer operations volume requirement, when designers can demonstrate that reuse application will be automated and continuous throughout the year. In this case, designers must submit documents that indicate the intended reuse application, the anticipated reuse for each month of the year, and the systems and logic that will automate the reuse process. Eligible reuse systems will be able to apply 50% of their total volume towards the sewer operations volume requirement, subject to approval by DEP BWSO.

Detention Systems in Series

Common examples of detention systems in series include a blue roof system with a downstream detention tank, or where two detention systems are used on separate floors of a building due to space constraints. These are special cases because the volume and release rates of the detention systems may vary, requiring alternative calculations.

For example, where the downstream system is designed to maintain the 0.1 cfs/acre maximum release rate, the upstream system may be designed with a release rate up to 2 cfs/acre. In this case, the upstream system would require less volume to maintain the release rate compared to the sewer operations volume calculation. In addition, the downstream system may also require less volume, if the upstream system provides meaningful flow reductions.

The volume required for the upstream detention system is a function of its maximum release rate, which can be computed using the following two equations:

EQ 4.18

$$V_U = \left[\frac{0.19 * C_W * A_U}{(t_U + 15)} - 40Q_{DRR}\right] * t_U$$

where:

V_U = required detention volume of the upstream detention system (cf)

C_W: weighted runoff coefficient relating peak rate of rainfall and runoff

A_U = site area tributary to the upstream detention system (ft2)

t_U = duration of sewer operations event where the upstream detention system is filling (min)

Q_{DRR} = maximum release rate of the upstream detention system (cfs)

EQ 4.19

$$t_U = 0.27 * \sqrt{\frac{C_W * A_U}{Q_{DRR}}} - 15$$

where:

t_U = duration of sewer operations event where the upstream detention system is filling (min)

C_W: weighted runoff coefficient relating peak rate of rainfall and runoff

A_U = site area tributary to the upstream detention system (ft2)

Q_{DRR} = maximum release rate of the upstream detention system (cfs)

The actual storage volume of the upstream system, determined using methods of Section 4.3, must be equal to or greater than the required storage volume calculated above. In cases where this is not feasible, the maximum release rate of the upstream system must be increased until the required storage volume is equal to or less than actual storage volume.

The upstream detention system will reduce the peak flow rate for its tributary area which will, in turn, reduce the effective runoff coefficient for that area. The effective runoff coefficient for the tributary area of the upstream system may be calculated as:

EQ 4.20

$$C_{EU} = 311 * Q_{DRR} * \frac{(t_U + 15)}{A_U}$$

where:

C_{EU} = effective runoff coefficient for the area tributary to the upstream detention system

Q_{DRR} = maximum release rate of the upstream detention system (cfs)

t_U = duration of sewer operations event where the upstream detention system is filling (min)

A_U = site area tributary to the upstream detention system (ft2)

The effective runoff coefficient for the area tributary to the upstream detention system (C_{EU}) may then be used to calculate the area weighted runoff coefficient of the downstream detention system. Note, that unless the area tributary to the upstream and downstream systems is the same, designers may not use CEU directly as the weighted runoff coefficient for the downstream system. Instead, designers must consider the runoff coefficients of all other areas that may be tributary to the downstream detention system, weighted by area.

The weighted runoff coefficient of the downstream detention system is then used to calculate the required volume for that system, using the sizing methods in Section 4.3. A detention in series workbook is available in Appendix G, which includes a template for calculations and design examples to assist designers.

New York City Stormwater Manual

Chapter 5
POST CONSTRUCTION STORMWATER MANAGEMENT REQUIREMENTS

NYC Environmental Protection

05 POST-CONSTRUCTION STORMWATER MANAGEMENT REQUIREMENTS

Maintenance of SMPs and BMPs is the responsibility of the property owner and is required per the issued Stormwater Maintenance Permit. The Stormwater Maintenance Permit requires ongoing maintenance and periodic inspections to assess the condition and functionality of each SMP and BMP and to assess any adjustments to maintenance frequencies and tasks that may be needed to maintain performance over time. Furthermore, owners must provide an annual certification that SMPs and BMPs have been inspected and properly maintained. Every fifth year, a certification from a registered qualified professional must be provided with the maintenance permit renewal. Owners are subject to random DEP inspections and must renew their Stormwater Maintenance Permit(s) every five years.

DEP recommends that the maintenance and inspection procedures outlined in this Chapter are also followed for SMPs constructed as part of non-covered development projects.

SMPs that are constructed as part of a covered development project must be regularly maintained and inspected in accordance with this Chapter to ensure continued performance as designed. Non-structural best management practices (BMPs) used to meet NNI requirements in the NYC MS4 area must also be continuously maintained.

This chapter outlines the requirements for:

- **SMP Maintenance Procedures (Section 5.1);**
- **SMP Operation and Maintenance Plan Requirements (Section 5.2); and**
- **SMP Inspection, Reporting, and Re-certification Require requirements (Section 5.3).**

5.1. Maintenance Procedures

Maintenance procedures contained in this section consist of recommended tasks and associated frequencies for routine maintenance activities, as well as general guidance on common problems. While maintenance procedures generally apply to SMPs, the continued implementation of BMPs may also require maintenance practices.

Maintenance comprises those activities that occur on a set frequency or that are otherwise periodically required for SMP upkeep. These activities include tasks such as weeding, watering, sediment, and trash removal for bio-retention SMPs that can often be accomplished during pre-set routine maintenance cycles.

Occasionally, SMPs require non-scheduled maintenance to address performance issues that may arise and cannot be adequately addressed through pre-set maintenance activities. These activities may include replanting, erosion control, and structural repairs and may require specialized equipment and/or skilled expertise to properly implement. The alteration or modification of an approved SMP or of the approved operation and maintenance of SMPs will require prior review and approval of DEP.

Routine Maintenance

Routine maintenance consists of tasks that are performed on a set schedule or undertaken periodically based on the results of the annual inspections. Routine tasks are intended to maintain system performance under normal operating conditions, assuming SMPs have been appropriately sited, designed, and constructed.

Routine maintenance tasks and suggested frequencies are specified by SMP type in Tables 5.2 to 5.14. To help streamline, readers can refer to Table 5.1 for an overview of the applicable maintenance table for each SMP.

Suggested frequencies are guidelines based on normal operating conditions. Generally, frequencies for many tasks will need to increase for high sediment loading and highly exposed SMPs (i.e., SMPs sited adjacent to commercial driveways, parking lots, or other areas with heavy vehicular traffic that receive direct runoff from these surfaces) and may be decreased for lower sediment loading and/or less exposed SMPs (i.e., SMPs sited adjacent to areas of low or no vehicular traffic and receive primarily roof runoff). Frequencies should be adjusted over time based on the results of ongoing and annual SMP inspections.

Table 5.1. Overview of the applicable maintenance table for each SMP type.

Vegetated	
Bioretention	Table 5.2
Rain garden	Table 5.2
Stormwater planter	Table 5.2
Tree planting	Table 5.3
Tree preservation	Table 5.3
Green roof	Table 5.4
Grass filter strip	Table 5.5
Vegetated swale	Table 5.5
Dry basin	Table 5.5
Constructed wetland	Table 5.6

Non-Vegetated	
Rain tank	Table 5.7
Cistern	Table 5.7
Dry well	Table 5.8
Subsurface gallery	Table 5.8
Stone trench	Table 5.9
Synthetic turf field	Table 5.10
Porous pavement	Table 5.11
Sand filter	Table 5.12
Organic filter	Table 5.12
Wet basin / pond	Table 5.13
Blue roof	Table 5.14
Detention tank	Table 5.7

Table 5.2. Routine Maintenance Tasks and Frequencies for Bioretention, Rain Gardens and Stormwater Planters

Task	Description	Frequency
Watering	Watering of new plantings during the first two years of establishment	During extended dry periods of no significant precipitation within 7 days, or as needed based on plant condition
Weeding	Removal of non-native or undesirable vegetation	Quarterly at minimum during the growing season or more frequently based on ongoing inspections
Mulching	Mulching of planting beds	Once annually for the first two growing seasons or until beds have filled in
Vegetation Management	Cutting and trimming of detrital herbaceous vegetation from the previous growing season to four to six inches above the ground	Annually in late winter or early spring prior to break in dormancy
Sediment Removal	Removal of accumulated sediment and debris from practice areas	Twice per year or more frequently if needed based on ongoing inspections (note: leaves and other natural materials can be left in place if they do not impede conveyance)
Pipe Cleaning	Hydraulic cleaning of inflow, outflow and underdrain piping	As warranted based on video pipe inspections conducted every three years
Inlet Filter Cleaning	Emptying of inlet filter bags and/or baskets	Minimum quarterly or more frequently based on ongoing inspections
Inlet Cleaning	Vacuum cleaning of accumulated sediment and debris within inlets sumps and hoods	Minimum annually or more frequently if debris accumulation is rapid based on ongoing and annual inspections
Outlet Cleaning	Removal of accumulated sediment and debris from risers (vacuum cleaning), trash racks, and spillways and clearing sediment from orifices and outlet control structures to prevent clogging	Annually at minimum or more frequently based on ongoing and annual inspections
Erosion Control	Stabilization of eroded soil areas with vegetative or mechanical means	As warranted based on ongoing inspections

Table 5.3. Routine Maintenance Tasks and Frequencies for Trees

Task	Description	Frequency
Watering	Watering of new plantings during the first two years of establishment	During extended dry periods of no significant precipitation within 7 days, or as needed based on plant condition
Weeding	Removal of non-native or undesirable vegetation	Quarterly at minimum during the growing season or more frequently based on ongoing inspections
Mulching	Mulching around root flare to suppress weeds and regulate temperature	Minimum annually or as needed based on ongoing inspections
Pruning (Small)	Removal of dead, damaged or diseased wood under 2” diameter	As observed throughout the year
Pruning (Large)	Removal of dead branches over 2” in diameter or selective removal for proper form	During the dormant season as warranted
Sediment Removal	Removal of accumulated sediment and debris from practice areas	Twice per year or more frequently if needed based on ongoing inspections (note: leaves and other natural materials can be left in place if they do not impede conveyance)

Table 5.4. Routine Maintenance Tasks and Frequencies for Green Roofs

Task	Description	Frequency
Watering	Watering of new plantings during the first two years of establishment	During extended dry periods of no significant precipitation within 7 days, or as needed based on plant condition
Weeding	Removal of non-native or undesirable vegetation	Quarterly at minimum during the growing season or more frequently based on ongoing inspections
Vegetation Management	Removal of detrital herbaceous vegetation from the previous growing season	Annually or as needed depending on the type of green roof vegetation
Fertilization	Use of slow-release fertilization capsules to supply plant nutrients; may only be done in the first year of establishment	As necessary based on visual observation of plant health or soil fertility testing
Outlet Cleaning	Removal of sediment from drain outlets including rooftop drains, gutters, downspouts and secondary overflows	Twice a year or as needed based on ongoing inspections
Erosion Control	Stabilization of eroded soil areas via vegetative or mechanical means	During the growing season for plant materials and as warranted for mechanical methods based on annual and ongoing inspections

Table 5.5. Routine Maintenance Tasks and Frequencies for Grass Filter Strips, Vegetated Swales and Dry Basins

Task	Description	Frequency
Watering	Watering of new plantings during the first two years of establishment	During extended dry periods of no significant precipitation within 7 days, or as needed based on plant condition
Weeding	Removal of non-native or undesirable vegetation	Quarterly at minimum during the growing season or more frequently based on ongoing inspections
Mowing/Trimming	Mowing and/or trimming of detrital herbaceous material to four to six inches above the ground	Annually for non-turf grass type vegetation or more frequently for turf grasses during period of active growth (all clippings should be removed)
Vegetation Management	Dethatching and soil conditioning for turf grasses	Annually or as warranted based on ongoing inspections
Sediment Removal	Removal of accumulated sediment and debris from practice areas	Twice per year or more frequently if needed based on ongoing inspections (note: leaves and other natural materials can be left in place if they do not impede conveyance)
Pipe Cleaning	Hydraulic cleaning of inflow, outflow and underdrain piping	As warranted based on video pipe inspections conducted every three years
Inlet Filter Cleaning	Emptying of inlet filter bags and baskets	Minimum quarterly or more frequently if debris accumulation is rapid based on ongoing inspections
Inlet Cleaning	Vacuum cleaning of accumulated sediment and debris within inlets sumps and hoods	Minimum annually or more frequently if debris accumulation is rapid based on annual and ongoing inspections
Outlet Cleaning	Removal of accumulated sediment and debris from risers (vacuum cleaning), trash racks, and spillways and clearing sediment from orifices and outlet control structures to prevent clogging	Annually at minimum or more frequently based on ongoing and annual inspections
Erosion Control	Stabilization of eroded soil areas with vegetative or mechanical means	During the growing season for plant materials and as warranted based on ongoing inspections

Table 5.6. Routine Maintenance Tasks and Frequencies for Constructed Wetlands

Task	Description	Frequency
Watering	Watering of new plantings during first two years of establishment	During extended dry periods of no significant precipitation within 7 days, or as needed based on plant condition
Weeding	Removal of non-native or undesirable vegetation	Quarterly at minimum during the growing season or more frequently based on ongoing inspections
Woody Vegetation Removal	Removal of woody vegetation from berms and embankments	Annually during the dormant season when present
Sediment Removal	Removal of accumulated sediment and debris from forebay and open water areas	Every 5 years or when 50% of capacity has been lost
Pipe Cleaning	Hydraulic cleaning of inflow and outflow and underdrain piping	As warranted based on video pipe inspections conducted every three years
Inlet Filter Cleaning	Emptying of inlet filter bags and/or baskets	Minimum quarterly or more frequently if debris accumulation is rapid based on ongoing inspections
Inlet Cleaning	Vacuum cleaning of accumulated sediment and debris within inlets sumps and hoods	Minimum annually or more frequently if debris accumulation is rapid based on ongoing and annual inspections
Outlet Cleaning	Removal of accumulated sediment and debris from risers (vacuum cleaning), trash racks, and spillways and clearing sediment from orifices and outlet control structures to prevent clogging	Annually at minimum or more frequently based on ongoing and annual inspections
Erosion Control	Stabilization of eroded soil areas via vegetative or mechanical means	During the growing season for plant materials and as warranted for mechanical methods based on annual and ongoing inspections

Table 5.7. Routine Maintenance Tasks and Frequencies for Rain Barrels, Cisterns and Detention Tanks

Task	Description	Frequency
Sediment Removal	Vacuum cleaning of accumulated sediment from primary storage tank(s)	As warranted based on annual inspections
Intake Cleaning	Cleaning of sediment from intake screen, hose and/or pipe	Quarterly at a minimum or as warranted based on ongoing inspections
Pipe Cleaning	Hydraulic cleaning of inflow and outflow piping	As warranted based on video pipe inspections conducted every three years
Outlet Cleaning	Cleaning of gutters, downspouts and first flush chambers	Twice a year or more frequently based in ongoing and annual inspections
Inlet Cleaning	Vacuum cleaning of accumulated sediment within inlet hoods and sumps	Minimum annually or more frequently if debris accumulation is rapid based on ongoing and annual inspections

Table 5.8. Routine Maintenance Tasks and Frequencies for Dry Wells and Subsurface Galleries

Task	Description	Frequency
Pipe Cleaning	Hydraulic cleaning of inflow, distribution and outflow piping	As warranted based on video pipe inspections conducted every three years
Sediment Removal	Vacuum cleaning of accumulated sediment and debris within internal structures	As warranted based on video inspections of subsurface galleries conducted every three years
Inlet Filter Cleaning	Emptying of inlet filter bags and/or baskets	Minimum quarterly or more frequently if debris accumulation is rapid based on ongoing inspections
Inlet Cleaning	Vacuum cleaning of accumulated sediment and debris within inlets sumps and hoods	Minimum annually or more frequently if debris accumulation is rapid based on ongoing and annual inspections
Outlet Cleaning	Removal of accumulated sediment and debris from risers (vacuum cleaning), trash racks, and spillways and clearing sediment from orifices and outlet control structures to prevent clogging	Annually at minimum or more frequently based on ongoing and annual inspections

Table 5.9. Routine Maintenance Tasks and Frequencies for Stone Trenches

Task	Description	Frequency
Sediment Removal	Removal of accumulated sediment from permeable surface	Twice per year or more frequently for high loading systems based on ongoing and annual inspections
Pipe Cleaning	Hydraulic cleaning of inflow, outflow and underdrain piping	As warranted based on video pipe inspections conducted every three years
Inlet Filter Cleaning	Emptying of inlet filter bags and/or baskets	Minimum quarterly or more frequently if debris accumulation is rapid based on ongoing inspections
Inlet Cleaning	Vacuum cleaning of accumulated sediment and debris within inlets sumps and hoods	Minimum annually or more frequently if debris accumulation is rapid based on ongoing and annual inspections
Outlet Cleaning	Removal of accumulated sediment and debris from risers (vacuum cleaning), trash racks, and spillways and clearing sediment from orifices and outlet control structures to prevent clogging	Annually at minimum or more frequently based on ongoing and annual inspections

Table 5.10. Routine Maintenance Tasks and Frequencies for Synthetic Turf

Task	Description	Frequency
Weeding	Removal of any vegetation from synthetic turf area	Year-round as observed during on ongoing inspections
Raking	Raking of the synthetic turf to keep grass fibers upright and to loosen and evenly distribute the infill layer	As needed based on manufacturer's/ installer's specifications
Sediment Removal	Vacuuming or removal of small, loose debris using a blower	Twice per year or more frequently based on level of use
Pipe Cleaning	Hydraulic cleaning of inflow, outflow and underdrain piping	As warranted based on video pipe inspections conducted every three years
Inlet Filter Cleaning	Emptying of inlet filter bags and/or baskets	Minimum quarterly or more frequently if debris accumulation is rapid based on ongoing inspections
Inlet Cleaning	Vacuum cleaning of accumulated sediment and debris within inlets sumps and hoods	Minimum annually or more frequently if debris accumulation is rapid based on ongoing and annual inspections
Outlet Cleaning	Removal of accumulated sediment and debris from risers (vacuum cleaning), trash racks, and spillways and clearing sediment from orifices and outlet control structures to prevent clogging	Annually at minimum or more frequently based on ongoing and annual inspections

Table 5.11. Routine Maintenance Tasks and Frequencies for Porous Pavements

Task	Description	Frequency
Sediment Removal	Vacuuming of porous asphalt or concrete surfaces with regenerative air sweeper or commercial vacuum sweeper (pavement washing systems and compressed air units are not recommended)	Twice per year or more frequently based on ongoing and annual inspections
Weeding	Removal of non-native or undesirable vegetation from vegetated pavement systems	Quarterly at minimum during the growing season or as warranted based on ongoing inspections
Mowing	Mowing of vegetative material to four to six inches above the ground	As needed based on rate of vegetative growth during the growing season (all clippings should be removed)
Pipe Cleaning	Hydraulic cleaning of inflow, outflow and underdrain piping	As warranted based on video pipe inspections conducted every three years
Inlet Filter Cleaning	Emptying of inlet filter bags and/or baskets	Minimum quarterly or more frequently if debris accumulation is rapid based on ongoing inspections
Inlet Cleaning	Vacuum cleaning of accumulated sediment and debris within inlets sumps and hoods	Minimum annually or more frequently if debris accumulation is rapid based on ongoing and annual inspections

Table 5.12. Routine Maintenance Tasks and Frequencies for Sand and Organic Filters

Task	Description	Frequency
Media Raking	Raking of sand or organic filter media to remove trash and debris from control openings	As warranted based on annual inspections
Surface Media Replacement	Removal, cultivation, and replenishment of sand or organic filter media to sufficient depths to achieve unclogged media	As warranted based on annual inspections
Sediment Removal	Vacuum cleaning of accumulated sediment from filter bed within sedimentation chambers	Annually or when the sediment accumulation within the sedimentation chamber reaches a depth of 6 inches
Pipe Cleaning	Hydraulic cleaning of inflow and outflow piping from subsurface systems	As warranted based on video pipe inspections conducted every three years
Inlet Filter Cleaning	Emptying of inlet filter bags and/or baskets	Minimum quarterly or more frequently if debris accumulation is rapid based on ongoing inspections
Inlet Cleaning	Vacuum cleaning of accumulated sediment and debris within inlets sumps and hoods	Minimum annually or more frequently if debris accumulation is rapid based on ongoing and annual inspections
Outlet Cleaning	Removal of accumulated sediment and debris from risers (vacuum cleaning), trash racks, and spillways and clearing sediment from orifices and outlet control structures to prevent clogging	Annually at minimum or more frequently based on ongoing and annual inspections

Table 5.13. Routine Maintenance Tasks and Frequencies for Wet Basins and Ponds

Task	Description	Frequency
Weeding	Removal of non-native or undesirable vegetation from vegetated pavement systems	Quarterly at minimum during the growing season or as warranted based on ongoing inspections
Mowing/Trimming	Mowing and/or trimming of detrital herbaceous material to four to six inches above the ground	Annually for non-turf grass type vegetation or more frequently for turf grasses during period of active growth (all clippings should be removed)
Woody Vegetation Removal	Removal of woody vegetation from berms and embankments	Annually during the dormant season when present
Sediment Removal	Removal of accumulated sediment and debris from forebay, basin and open water areas	Every five years or when 50% of capacity has been reached
Pipe Cleaning	Hydraulic cleaning of inflow and outflow piping	As warranted based on video pipe inspections conducted every three years
Inlet Filter Cleaning	Emptying of inlet filter bags and/or baskets	Minimum quarterly or more frequently if debris accumulation is rapid based on ongoing inspections
Inlet Cleaning	Vacuum cleaning of accumulated sediment and debris within inlets sumps and hoods	Minimum annually or more frequently if debris accumulation is rapid based on ongoing and annual inspections
Outlet Cleaning	Removal of accumulated sediment and debris from risers (vacuum cleaning), trash racks, and spillways and clearing sediment from orifices and outlet control structures to prevent clogging	Annually at a minimum or more frequently based on ongoing and annual inspections
Signage Maintenance	Damage repair and clearing of visual obstructions to keep posted signage in good and legible conditions	As warranted based on ongoing inspections

Table 5.14. Routine Maintenance Tasks and Frequencies for Blue Roofs

Task	Description	Frequency
Sediment and Debris Removal	Removal of sediment and debris from roof storage area(s), behind check and/or slotted dams; and from drain outlets including roof drains, gutters, downspouts, secondary overflows and drain screens	Monthly during the first year after installation to determine maintenance frequency, and minimum twice per year based on ongoing inspections or as needed
Ice Removal	Break-up and removal of ice formations around outlet and overflow structures	As warranted based on inspections during wintertime
Repair Leaks	Repair of roofing materials for damages and leaks	As warranted based on ongoing inspections

Additional Maintenance Activities

Additional maintenance activities include those activities intended to repair or remediate SMPs that are not functioning properly. Additional maintenance activities are usually identified during the course of an annual inspection or during informal visual assessments. Additional maintenance activities that result in a modification to the stormwater management practice require review and approval of the department.

The need for additional maintenance activities may indicate an underlying performance issue that may require additional investigation and analysis, particularly if the performance issues are recurring. The assistance of a qualified professional will likely be required in order to perform diagnostic activities needed to properly remediate recurrent problems. Examples of some common problems addressed via additional maintenance activities are provided below.

Erosion Problems

Erosion issues are common at the system inflow points for vegetated SMPs such as areas downslope of curb cuts conveying flow into a stormwater planter system. Erosion problems can typically be remedied by either replanting the area with an extended term erosion blanket or turf reinforcement matting or by adding structural measures such as rip-rap or river stone.

Poorly Performing Plantings

Vegetation health is integral to any vegetated SMP, such as bioretention systems and green roofs. Poorly performing plantings may be an indication of one or more underlying problems, particularly if plantings fare poorly in the same location within the SMP on a recurring basis. Poor plant performance commonly results from improper plant selection and can be effectively addressed by replanting with an adjusted plant palette that is more appropriate for the soil and moisture conditions in the area.

Plantings can also be negatively affected by various other external factors including erosion, sedimentation, poor soil conditions, disease, shade, road salt, and foot traffic compaction. A landscape or horticultural qualified professional can help diagnose areas and causes of poor plant performance and recommend a combination of adjusted plantings and/or soil amendments, among other remedies.

Differential Settlement

Differential settlement occurs where portions of the ground surface become depressed relative to surrounding areas. Some minor settlement is common after construction, but more severe settlement could indicate the presence of soft soils or improperly compacted subgrade. Monitoring areas of settlement once they are identified is critical for assessing the need for excavation and repair.

Diagnostic activities to assess the soil and subsurface conditions in areas of settlement include ground penetrating radar scans or other geophysical methods, soil borings, and dye testing. Potential remedial activities could include excavation of poorly compacted underlying soils and replacement with suitable compactable backfill. Major settlement issues often require a qualified professional to perform an evaluation and determine the correct solution.

Sedimentation and Clogging

Routine maintenance activities involve removal of sediment from SMPs, particularly inlet areas and forebays. However, in some cases, rates of sedimentation may be excessive and may lead to performance issues such as clogging and planting failure. In these situations, it is important to assess the contributing drainage area to identify any areas of bare soil, active construction, or other activities that may be the source of high rates of sediment delivery to the SMP. Cessation of these activities or the implementation of temporary or permanent erosion control measures can help to lower rates of sediment delivery and reduce the frequency of sediment removal from the SMP.

Remediation of severe sedimentation and clogging conditions may require a qualified professional to identify where the removal and replacement of some or all storage/filtration media is required. Adequate pre-treatment and routine maintenance can help to extend SMP service life and reduce the frequency of storage/filtration media replacement.

Structural Defects
Structural defects can cause a wide array of performance issues and most commonly include broken or cracked hydraulic control structures and/ or piping and damaged concrete edging or metal edge restraints around structures such as stormwater planters. Areas of surface wear on porous pavement also fall into this category. Depending on the issue, inspection by a qualified structural professional may be warranted to determine if and how a structure can be safety repaired.

5.2. Operations and Maintenance Plan

All permitted SMPs that are constructed as part of a covered development project must have an operations and maintenance (O&M) plan that sets forth a specific plan for operation and maintenance of each permitted SMP. Submission and approval of the O&M plan is a pre-requisite to Stormwater Maintenance Permit issuance.

At minimum, the O&M plan must contain the following:

- List of SMPs to be maintained;
- Copy of the as-built plans showing locations and elevations of SMPs;
- Location map depicting SMPs to be maintained;
- Contact information for responsible party;
- Information regarding whether the maintenance will be performed by the responsible party and/or contracted to an outside party;
- Table of maintenance tasks and frequencies for each SMP type;
- Inspection form with list of maintenance checks and fields for recording observations;
- Schedule of proposed self-inspections; and
- Copy of the Stormwater Maintenance Permit issued by DEP.

In addition, if the permitted project is subject to NNI requirements for pollutants of concern, the O&M plan must contain a list of BMPs to address the applicable pollutant of concern sources. The list should also be included as an inspection form or checklist to be submitted as annual certification that BMPs have been implemented and maintained. See Table 2.6 for an example list of BMPs for pathogen removal by land use.

5.3. Inspection, Reporting, and Recertification Requirements

Property Owner Inspections
Property owners are responsible for conducting periodic inspections of SMPs to ensure that the systems are working properly, to reassess routine maintenance frequency, and to identify additional maintenance work required to address any condition or performance deficits. Routine maintenance and frequency recommendations presented in Tables 5.2 through 5.14 for specific types of practices present general guidelines for when inspections should occur.

Table 5.15 provides types and frequencies of inspections as a guideline for developing an ongoing SMP inspection program. Property owners are also responsible for maintaining BMPs to continue to meet the NNI requirements for pollutants of concern.

In addition to the inspection tasks outlined in Table 5.15, the property owner or maintenance personnel should perform periodic, quick visual assessments of SMP function when performing routine maintenance. For example, observation wells should be checked for standing water during dry periods, which may be an indication that the system is not functioning properly. Similarly, green and blue roof membranes can be checked for leaks and defects.

Some proprietary practices such as green and blue roof may have recommended frequencies for inspections per manufacturer's or installer's specifications that should be followed.

Inspection forms
All inspections must be logged and recorded on an inspection form. The owner must keep and maintain copies of all inspection records and tests for five years after performance of such inspections or tests.

Annual Certification
Property owners are responsible for providing an Annual Certification attesting that any permitted SMPs and BMPs have been properly inspected and maintained. The Annual Certification must be submitted via the SWPTS.

Table 5.15. Routine Inspection Frequency Summary Table

Type of Inspection	Purpose	Applicable Components or SMPs	Suggested Frequency
Video pipe inspection	To identify accumulated sediment and defects in piping systems	Inflow, outflow and underdrain piping	Every three years
Video subsurface internal storage inspection	To identify accumulated sediment and defects in internal storage and detention structures	Subsurface internal structures	Every three years
Annual vegetation inspection	To assess the health and condition of vegetation	Vegetated SMPs	Annually during the growing season
Annual structural inspection	To identify areas of differential settlement or structural concern	Structural components including concrete structures, piping, fencing	Annually
Drawdown test	To assess the drawdown time of the practice	Infiltration practices	As needed, based on changes in permeability of infiltrating surface
Surface infiltration test following ASTM C1701 or other approved method	To assess the infiltrating capabilities	Porous pavement surfaces	Twice per year or more based on changes in permeability of porous pavement surface

DEP Inspections
As the permitting agency, DEP reserves the right to perform periodic inspections of permitted SMPs. DEP inspectors will typically perform a visual assessment of key components to check for issues such as poor plant cover, erosion, sedimentation, clogging, or structural damage. DEP inspectors may also ask to see inspection and maintenance records, which must be kept up-to-date and available on premises. DEP inspections may be more frequent immediately following construction to ensure that property owners are effectively transitioning to an active O&M phase.

Deficiencies
If DEP inspections reveal deficiencies in the SMPs, DEP will issue a deficiency notice and the property owner must initiate a remedial action plan to address any noted deficiencies. Annual certification and permit renewal will depend on the resolution of any outstanding deficiencies.

Deficiencies that are not resolved in a timely manner as determined by DEP may result in Notices of Violation and, ultimately, fines.

Permit Renewal
DEP rules require that Stormwater Maintenance Permits be renewed every 5 years. Permit renewal requires a certification from a qualified professional, depending on the type of professional that signed and sealed the original construction drawings. Permit renewal applications must be filed on the SWPTS.

New York City Stormwater Manual

Chapter 6
RIGHT-OF-WAY STORMWATER MANAGEMENT REQUIREMENTS

NYC Environmental Protection

06 RIGHT-OF-WAY STORMWATER MANAGEMENT REQUIREMENTS

Guidance included in this Chapter is applicable only to Right-of-Way (ROW) projects requiring permitting in either the Combined Sewer (CSS) areas or Municipal Separate Storm Sewer (MS4) areas. All other projects, including new road construction, shall refer to Chapters 2-5 or, for covered roadway maintenance, Chapter 7, for relevant information. This chapter covers the following topics:

- **Section 6.1 | Overview of criteria for applicability of stormwater construction permit**
- **Section 6.2 | Stormwater Pollution Prevention Plan (SWPPP) requirements based on development activity type and other factors**
- **Section 6.3 | Technical requirements for meeting stormwater management objectives**
- **Section 6.4 | Guidance for selecting, siting, and sizing of Post-Construction (PC) Stormwater Management Practices (SMPs)**
- **Section 6.5 | Geotechnical requirements for ROW SMPs**
- **Section 6.6 | Additional resources for SWPPP application development**

6.1. Permit Applicability

A ROW project must apply for a stormwater construction permit, which includes a SWPPP, when the project meets one or both of the following criteria:

- Disturbs 20,000 sf or more of soil; OR
- Creates 5,000 sf or more new impervious area

Disturbed area is the area of soil disturbed by development activities such as building, demolition, renovation, replacement, restoration, rehabilitation, or alteration of any structure or road; or land clearing, land grading, excavation, filling or stockpiling.

All soil disturbances that are part of a common plan development must be considered toward the soil disturbance threshold and the need for a stormwater construction permit.

Activities that do not disturb soils, such as surface markings of paved areas are not considered in the estimation of the extent of the disturbed area.

It is important to note that linear utility work that results in soil disturbance counts toward the overall soil disturbance threshold. In cases where linear utility work, or any other development activity, is carried out in phases, the project may be considered a common plan of development for which the total disturbed area across all phases results in the need for a stormwater construction permit.

An impervious surface is any surface that cannot effectively infiltrate rainfall. Such surfaces generally include rooftops, pavements, sidewalks, and driveways. In addition, pervious hardscapes such as gravel roadways and gravel sidewalks are also considered impervious surfaces unless a geotechnical investigation indicates that the permeability rate of underlying soils is sufficient for reducing runoff. More specifically, underlying soils must have a permeability rate of at least 0.5 in/hr.

The increase (or decrease) in impervious area is calculated as the difference in total impervious area from pre- to post-development. The pre-development case must represent the least amount of impervious surface for the disturbed area within the last 5 years prior to development. When possible, photos, plans, and/or satellite images should be used to determine the appropriate pre-development impervious area.

6.2. SWPPP Requirements

For projects that have been determined to require a stormwater construction permit and a SWPPP, the next step is to determine what stormwater management measures must be included in the SWPPP. The following guidance can be used to make that determination.

ROW projects that require a stormwater construction permit, but disturb less than one acre of soil will require a SWPPP with only erosion and sediment controls (ESC).

ROW projects that require a stormwater construction permit and disturb one acre of soil or more will have varying SWPPP requirements based on the type of development activity. More specifically, covered development projects listed in Table 2.2 (Chapter 2) will require a SWPPP with only ESC, while all other covered development projects will require both ESC and PC SMPs.

For ease of reference, common activities related to ROW work and their associated requirements are included in the table below.

Table 6.1. ROW Project Scenarios and SWPPP Requirements.

Project Scenarios	Type of SWPPP Required
1. Private utility move-outs – coordinated with city agency to support agency work	ESC
2. Water/sewer mains trench work only	ESC
3. Road reconstruction**	ESC and PC SMPs
4. Road reconstruction with water/sewer mains work**	ESC and PC SMPs

**PC SMPs are required only when the project disturbs one acre or more of soil

Project Scenario Definitions:

- **Private Utility Move-out –** Installation of underground utilities, such as gas lines, fiber-optic cable, cable TV, electric, telephone, sewer mains, and water mains.
- **Water/Sewer Mains Trench Work Only –** Installation or rehabilitation of water/sewer mains where soils are disturbed only within the trench width required for utility work.
- **Road Reconstruction –** Full depth roadway replacement from curb to curb that results in exposure of subbase or disturbance of soils.
- **Road Reconstruction with Water/Sewer Mains Work –** Full-depth roadway replacement that occurs in conjunction with the installation or rehabilitation of water/sewer mains, which results in exposure of subbase or disturbance of soils outside of trench width required for utility work.

Projects that include development activities across multiple blocks or locations may use control measures appropriate for each area. For example, using ESC and PC SMPs in areas with roadway reconstruction, while using ESC only in areas with water/sewer main trench work.

For projects that require a SWPPP with ESC, the ESC measures shall be designed in accordance with the NYS Standards and Specifications for Erosion and Sediment Control (The Blue Book), dated November 2016, or its successor (https://www.dec.ny.gov/chemical/29066.html).

For projects that require a SWPPP with PC SMPs, see sections 6.3 and 6.4 for technical requirements and design guidance on PC SMPs, respectively.

In addition to identifying required ESC and PC SMPs, practitioners must determine whether No Net Increase (NNI) criteria are applicable to the project. The NNI requirement is applicable in the ROW when all four of the following conditions are met:

- Disturbed area is 1 acre or more
- Project is located in an MS4 area
- Project discharges to an impaired waterbody, and
- Project results in an increase in impervious area

When NNI is applicable, designers shall refer to Chapter 2 for specific criteria.

The remaining sections in this chapter provide guidance on ROW projects that require PC SMPs.

6.3. Technical Requirements

Projects without new impervious area
ROW projects that do not cause an increase in impervious area have the following options for meeting water quality goals:

- **Option 1 -** Reduce the existing *impervious area* by a minimum of 25% of the total disturbed, *impervious area*. The Soil Restoration criteria in Section 5.1.5 of the NYSDEC SMMDM must be applied to all newly created pervious areas; or
- **Option 2 -** Manage a minimum of 25% of the WQv from the disturbed, *impervious area* by the application of PC SMPs; or
- **Option 3 -** Apply a combination of 1 and 2 above that provides a weighted average of at least two of the above methods.

In addition, if there is an existing PC SMP located on the site that captures and treats runoff from the *impervious area* being disturbed, then the condition and size of the PC SMP shall be evaluated by the designer. If the PC SMP is able to manage the appropriate WQv as-is, then use of that practice may be continued. Otherwise, designers need to consider additional practices or changes to the existing practice to meet the requirements above. Additional details on each option are provided in the following sections.

Option 1 – Reduce impervious area
As a first step, designers must seek to reduce existing impervious area by a minimum of 25% of the total disturbed, impervious area. The designer must demonstrate that impervious area reduction was thoroughly analyzed and implemented to the maximum extent practicable before proceeding to Option 2. Agencies should include this analysis in the planning stage. DEP will review submitted supporting documentation in making its determination about whether an impervious area reduction is infeasible.

Impervious area can be reduced by replacing existing impervious surfaces with pervious surfaces. Some specific examples include:

- **Vegetated medians –** a vegetated area that separates opposing or merging lanes of traffic.
- **Curb strip –** a strip of grass, plants, or trees, located between a roadway curb and a sidewalk.
- **Street trees –** a tree that is growing in the city ROW between the sidewalk and the curb.

Street trees should be designed in accordance with all applicable criteria from the NYC DPR tree planting standards (www.nycgovparks.org/trees/street-tree-planting) and the NYS SWMDM. Note that vegetated medians may be used either as a means to reduce impervious cover, if configured as a simple greenspace, or as a PC SMP, if designed with the standard practices identified in Section 6.4. If reducing impervious area by 25% is not feasible, then PC SMPs are required to meet water quality goals.

Option 2 – Capture and treat the WQv
The water quality requirement aims to manage runoff from small, frequent storm events that can significantly impact the quality of receiving waters.

In MS4 areas, runoff from these events tends to contain higher pollutant levels. Therefore, retention and treatment of small storm runoff in MS4 areas help to remove those pollutants and, in turn, improve water quality.

In CSS areas, these events trigger the majority of CSO events. Therefore, retention and detention of small storm runoff in CSS areas helps to reduce CSOs and, in turn, improves water quality.

The water quality criteria are met by managing runoff from an appropriate small storm design event. NYSDEC defines this design event as the 90th percentile rain event. In New York City, the 90th percentile rain event is 1.5 inches of rainfall (see the NYS SWMDM).

The volume of runoff from the 90th percentile rain event, which is the target to be managed by PC SMPs, is also referred to as the water quality volume (WQ_V). The following equation can be used to calculate 25% of the WQ_V, which needs to be managed by PC SMPs:

EQ 6.1

$$WQ_V = \frac{1.5''}{12} * A * 0.95 * 0.25$$

where:
WQ_V: water quality volume (cf)
A: disturbed, impervious drainage area (sf)

This equation is only applicable to ROW projects. All other projects should refer to guidance in Chapters 2 through 5.

The SWPPP must show how the WQv is managed at the practice and site level, i.e., the disturbed, impervious drainage area, runoff coefficient, and WQv must be determined for each individual practice, and, in total, the practices must manage the WQv across the entire project.

ROW projects have a limited number of PC SMPs that may be used to manage the WQv due to several unique challenges of working in the ROW. For more information on suitable PC SMPs for ROW projects refer to Section 6.4. Guidance on delineating the disturbed, impervious drainage area is also provided in Section 6.4.

Finally, designers must also ensure that runoff from any additional contributing areas, beyond the disturbed, impervious drainage area itself, can safely bypass the PC SMP without adversely impacting the practice or surrounding areas. A note should be included on the SWPPP to indicate that safe bypass of runoff was considered and that any water in excess of WQv will continue along the gutter to catch basins, as intended.

Option 3 – Combination Approach
This option proposes a combination of impervious cover (IC) reduction and PC SMPs that results in an equivalent management of stormwater runoff compared to either method individually. The total combination is calculated using the following equation:

EQ 6.2

$$25\% = \%\,IC\ reduction + \%\,WQv\ managed\ by\ PC\ SMPs$$

Below are examples of how the water quality goals can be met using the combined method in each disturbed drainage area:

- 5% IC reduction, 20% WQv with PC SMPs
- 10% IC reduction, 15% WQv with PC SMPs
- 15% IC reduction, 10% WQv with PC SMPs
- 20% IC reduction, 5% WQv with PC SMPs

Note that areas where impervious surfaces have been changed to pervious can be counted **EITHER** towards the IC reduction to reduce the percent of WQv that needs to be treated, **OR** to reduce the runoff coefficient (Rv) when calculating WQv. New pervious areas cannot be counted twice as both a percent IC reduction and a reduction of Rv.

Projects with new impervious area
ROW projects that cause an increase in impervious area must manage 100% of the WQv from the newly created impervious areas. The remaining disturbed areas may be managed using one of the three options above.

Projects that cannot meet technical requirements
After following the guidance in this Chapter, projects that cannot meet the above technical requirements must schedule a consultation with DEP before proceeding with the SWPPP application. As part of the meeting, DEP and the designers will review opportunities and other potential considerations for meeting water quality objectives.

6.4. ROW SMP Selection, Siting, and Sizing

Designers must ensure that proposed PC SMPs meet the WQv requirements detailed in Section 6.3. This section provides guidance on the selection, siting, and sizing of PC SMPs for ROW projects to meet this objective.

SMP Selection
ROW projects have a limited number of PC SMPs that may be used to manage the WQv due to several unique challenges of working in the ROW.

Table 6.2. Applicable ROW PC SMPs

SMP Function	SMP Types (in order of preferred hierarchy)
Infiltration	ROW Precast Porous Concrete Panels[5] ROW Bioswales with Type D inlet ROW Infiltration Basins ROW Bioswales

All of these practices are considered infiltration practices, because they capture and infiltrate runoff into the underlying soils (sometimes referred to as exfiltration). Infiltration practices may only be used in areas where geotechnical tests indicate that soils are adequate for infiltration.

Designers should refer to the latest DEP Standard Designs and Guidelines for Green Infrastructure Practices for the layout and configuration of each system (https://www1.nyc.gov/site/dep/water/green-infrastructure.page).

In accordance with these standards, porous concrete panel systems should be designed to look continuous across the entire length of the block. In places where valves or other street features prevent the use of pre-cast panels, poured-in-place concrete (non-porous) may be used to achieve a continuous concrete system. Refer to the casting detail in the green infrastructure standard designs for the required dimensions of poured-in-place concrete around valves and other castings to prevent cracking.

Note that the PC SMPs listed in Table 6.2 above are ordered in a preferred practice hierarchy. Designers should evaluate the feasibility of PC SMPs in the order in which they are listed. However, each location must be assessed for its unique siting constraints in order to select the appropriate SMP. When feasible, designers may consider placing these standard practices in the ROW median. Finally, designers should evaluate adjacent publicly owned properties for SMP implementation if necessary.

SMP Siting
There are five site constraints that may limit the feasibility of PC SMPs:

- **Soil constraints –** permeability tests indicate that soil is not suitable for infiltration. See Appendix H for more information on soil permeability.
- **Subsurface constraints –** boring tests indicate that the bottom of the practice would be too close to groundwater table or bedrock for proper function.
- **Hotspot constraints –** land use or soil conditions increase the risk of runoff contamination, limiting the use of infiltration practices (see criteria below).
- **Surface constraints –** regulations require the use of paved surfaces, which limit the use of vegetated practices, e.g., regulations on parking and/or egress requirements.
- **Space constraints –** required setbacks from structures, utilities, property lines, existing trees, or other site features limit the use of practices at the ground level.

Keep in mind, that some constraints may not impact the entire site, but may be limited to one portion of the site. In such cases, it is important that, when demonstrating that SMPs are used to the maximum extent practicable, designers consider how constraints may vary across the site.

[5] As of the release of this version of the guidance NYC DOT is evaluating porous technologies for use in bike lanes. Future versions of this guidance document may include additional porous technologies to facilitate implementation.

Hotspot constraints may be caused by either land uses or soil conditions. Land uses that cause stormwater hotspots are referenced in the NYS SWMDM. Listed below are soil conditions that cause stormwater hotspots, which may be demonstrated through environmental assessments or as part of regulatory program (e.g., NYSDEC Spills and Remediation Programs) documentation:

- Presence of grossly contaminated soil or non-aqueous phase liquid (NAPL) as defined in NYSDEC DER-10
- Soil exceeds the groundwater protection objectives of NYSDEC 6 NYCRR 375
- Soil is characterized as hazardous waste as defined in 6 NYCRR 360 or 40 CRF 261
- Groundwater exceeds standards, guidance values and/or limits described in NYSDEC AWQS in 6 NYCRR 703 or TOGS1.1.1

The latest siting criteria for ROW projects can be found online at the DEP green infrastructure webpage (www1.nyc.gov/site/dep/water/green-infrastructure.page). Note that the siting criteria in Appendix C are meant for on-site projects and do not include all ROW siting criteria. The ROW siting criteria may be used to determine where SMPs cannot be placed within the ROW project area, due to space constraints: for example, the required clearances between PC SMPs and street furnishings such as utility poles, street signs, and parking meters.

SMP Sizing

PC SMPs must be sized to manage the appropriate WQv from the disturbed, impervious drainage area, as described in Section 6.3. The SWPPP must show 1) how the WQv is managed at the practice and project level: the disturbed drainage area, runoff coefficient, and WQv must be determined for each individual practice; and 2) that, in total, the practices manage the WQv across all areas that require PC SMPs.

For ROW projects, designers can determine the disturbed, impervious drainage area and appropriate SMP size in five steps, using the following guidance.

Step 1. Gather Data

The delineation of disturbed, impervious drainage areas will require the following data:

- Surface elevation data for the project area to determine roadway flow directions
- Locations of any existing or proposed catch basins in the project area to determine drainage points
- Locations of property lines around the ROW project area to delineate drainage areas
- Information on existing surface cover types

In cases where a topographic survey has been conducted for the project area, these data should be used to identify runoff flow directions and cover types.

When topographic survey is unavailable, digital elevation maps and property lines may be downloaded from the NYC Open Data online portal (https://opendata.cityofnewyork.us/). In addition, catch basin data can be requested from DEP BWSO using a Request for Records form, which can be found online (https://www1.nyc.gov/site/dep/about/request-records.page).

Please note that practitioners should account for any catch basins that will be added or removed as part of the proposed project.

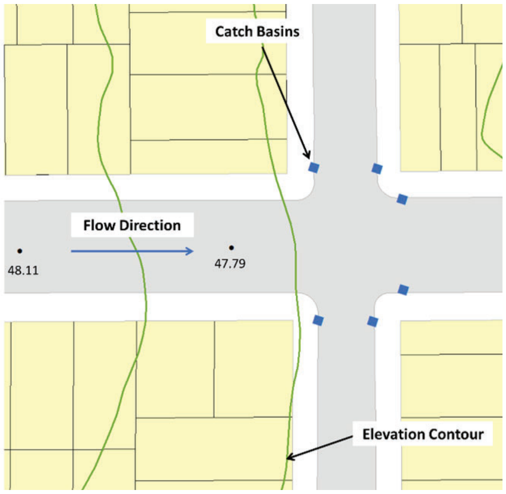


Figure 6.1. Example roadway flow direction analysis.

Step 2. Evaluate Roadway Flow Directions
Using the surface elevation data, practitioners should identify the direction of runoff flow along each roadway within the project area. When using digital elevation maps, it is recommended that contours are generated to assist with this analysis. Spot elevations should be consulted for any flat or difficult to evaluate areas.

In cases where one portion of the roadway flows in a different direction from the other, the location of any high points should be marked and a flow direction for each portion of the roadway should be assigned. An example of the roadway flow direction analysis is shown in Figure 6.1.

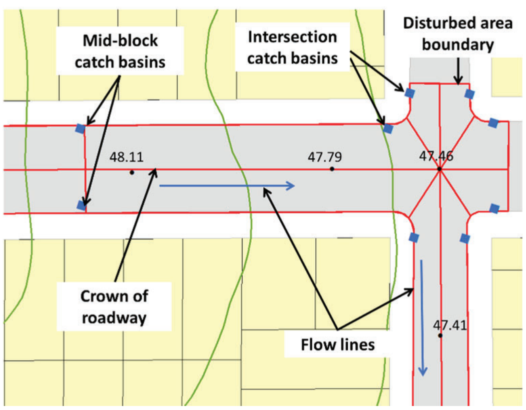


Figure 6.2. Example delineation of disturbed drainage areas with separation lines for the crown of roadway and catch basins.

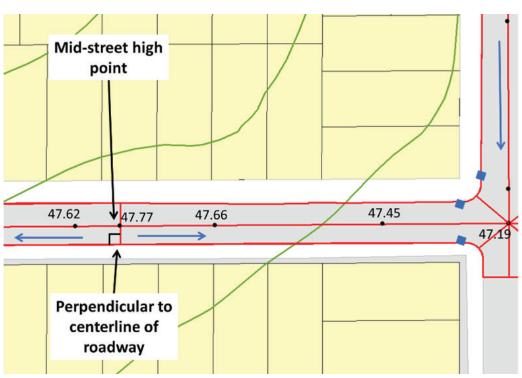


Figure 6.3. Example delineation of disturbed drainage areas with added separation lines at high points.

Step 3: Delineate the disturbed, impervious drainage area of each catch basin
To delineate the disturbed drainage area of each catch basin, first draw the boundary of the disturbed area. Then add lines that reflect the hydraulic boundaries between separate drainage areas. Hydraulic boundaries can include the crown of the roadway, catch basins, and high points. See the following paragraphs for example delineations.

Figure 6.2 shows delineations after drawing the boundary of the disturbed area and adding separation lines for the crown of roadway and catch basins. When catch basins are located at the corner of an intersection, draw a boundary that connects the center of the intersection, with the corner of the disturbed area boundary. When catch basins are located mid-block, draw a boundary perpendicular to the street centerline at the location of the catch basin.

Figure 6.3 shows updated delineations when separation lines are added for high points along the roadway. Similar to mid-block catch basins, the boundary for a high point is drawn perpendicular to the street centerline.

Perform this process until the disturbed drainage areas for each catch basin within the project area have been identified. Once completed, then identify the portion of each disturbed drainage area that is impervious using available information on existing surface types. The resulting disturbed, impervious drainage areas can be used to determine the required WQv within the applicable project area.

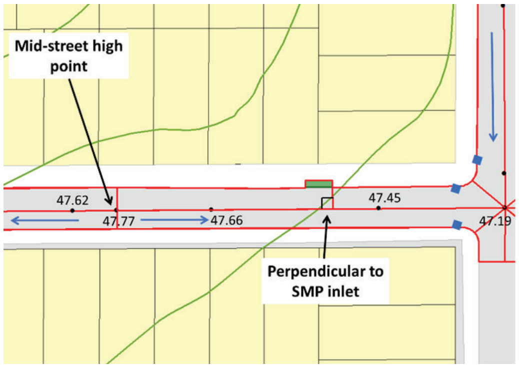


Figure 6.4. Example boundaries at inlets of PC SMPs.

Step 4: Delineate the disturbed, impervious drainage area of each SMP
Once the disturbed, impervious drainage areas of catch basins are known, these areas can be further delineated into drainage areas for each SMP. To do this, designers should draw another boundary perpendicular to the street centerline at the inlet location of each individual practice, as shown in Figure 6.4.

The resulting areas can be used to calculate the WQv that must be managed by each practice.

Step 5: Size PC SMPs to manage the WQv
PC SMPs must be sized to manage the associated WQv from their disturbed, impervious drainage area. In addition, PC SMPs must be sited in a way that manages the total WQv across the entire ROW project.

Note that when two or more PC SMPs are located in the same catch basin drainage area, the downstream PC SMPs may be used to manage any WQv that could not be managed by upstream practices.

Designers should refer to Chapter 4 for guidance on determining the storage volume for each PC SMP and for sizing accordingly to meet the WQv requirement.

6.5. Geotechnical Requirements

Guidance on geotechnical investigations for ROW projects is provided in Appendix H. Note that on-site projects must refer to the NYSDEC SWMDM for geotechnical requirements.

6.6. Additional Resources

For more information on how to submit stormwater construction permit applications, refer to Chapter 3.

A ROW SMP Data Tracking Form is required for SWPPPs that include both ESC and PC SMPs. See Appendix H for this form and associated guidance.

PC SMPs in ROW areas will require an O&M plan as part of the stormwater construction permit; refer to Chapter 5 for individual SMP maintenance requirements.

New York City Stormwater Manual

Chapter 7
ROADWAY MAINTENANCE STORMWATER MANAGEMENT REQUIREMENTS

NYC Environmental Protection

07 ROADWAY MAINTENANCE STORMWATER MANAGEMENT REQUIREMENTS

Guidance included in this Chapter is applicable to covered roadway maintenance. This chapter covers the following topics:

7.1. General Requirements

Measures identified in this chapter are to be implemented during milling and paving operations. Between each operation, all practices must be removed, and the roadway must be opened to traffic for safety and to mitigate street flooding.

Order of Operations

MILLING

1. Identify NYC drainage assets including standard assets such as manholes and catch basins, or green infrastructure assets such as rain gardens/bioswales, infiltration basins, and porous concrete panels in the ROW where work is to commence.
2. Mark all headers and aprons that must be protected during milling by placing white lines perpendicular to the curb.
3. Protect NYC drainage assets during milling operations:
   - **a. Rain Garden:** Block inlets and outlets with filter sock, or equivalent.
   - **b. Infiltration Basin:** Cover infiltration inlet with filter sock, or equivalent.
   - **c. Catch Basin:** Cover all catch basin grates with metal plates, wood panels or equivalent. Curb inlets must be blocked with filter sock or other similar material to prevent materials from entering the catch basin. See section 7.3 for additional requirements.
   - **d. Porous Concrete Panels:**
     - — Place traffic barrels along the panels for visibility
     - — Do not drive dump trucks and other heavy-duty equipment over the panels
     - — Run the milling machine no closer than 2-4 inches from the edge of the concrete header
     - — Use a mechanical ripper to carefully remove asphalt along the concrete header
     - — Clear loose millings off panels using either a handheld blower or broom
4. Avoid storing milling debris or tools (e.g., shovels, brooms, rakes) in or on top of NYC drainage assets.
5. Mill the old pavement. The machine operator should be able to position the milling machine around NYC drainage assets without damaging hardware or concrete. If necessary, use hand picks or other light equipment to remove old pavement from sensitive or hard-to-reach areas.
6. Use mechanical ripper and hand picks to separate any areas between the asphalt pavement and the concrete components such as aprons, headers.
7. Where applicable, use hand sweeping and/or debris blower on any remaining loose material to move it away from NYC drainage assets and into milled roadway.
8. Use machine vacuum sweeper to sweep all milled roadway areas.
9. Remove all protections from NYC drainage assets when milling is completed.
10. Open the roadway to traffic.

PAVING

1. Identify NYC drainage assets such as catch basins, rain gardens/bioswales, infiltration basins, and porous concrete panels in the ROW where work is to commence.
2. Mark all headers and aprons that must be protected during paving by placing white lines perpendicular to the curb.
3. Protect NYC drainage assets during paving operations:
   a. **Rain Garden:** Block inlets and outlets with filter sock, or equivalent
   b. **Infiltration Basin:** Cover infiltration inlet with filter sock, or equivalent.
   c. **Catch Basin:** Cover all catch basin grates with metal plates, wood panels or equivalent. Curb inlets must be blocked with filter sock or other similar material to prevent materials from entering the catch basin. See section 7.3 for additional requirements.
   d. **Porous Concrete Panels:**
      — Place traffic barrels along the panels for visibility
      — Do not drive dump trucks or other heavy-duty equipment over the panels
      — Use a temporary liner to protect panels from foot traffic contamination (i.e., tracking tack and asphalt onto the panel)
      — Shift the temporary liner as crew advances along the panel
      — Clear loose asphalt off panels using either a handheld blower or broom.
4. Avoid storing asphalt or tools (e.g., shovels, brooms, rakes) in or on top of NYC drainage assets.
5. Apply tack coat to milled and swept roadway using a mechanical spraying method with tank truck distribution system (tack coat spraying truck).
6. Using an Asphalt Paving Machine (APM), place new asphalt pavement over milled and coated surface.
   a. The machine operator should be able to position the APM around the NYC drainage assets without causing damage.
7. When necessary, use a hand rake, broom, or a debris blower on any loose material to move it away from NYC drainage assets and into paved roadway.
8. While the asphalt pavement is still hot, use a Mechanical Roller to compact the new pavement.
   a. The machine operator must not position the Roller over green infrastructure but should be able to position the Roller over other NYC drainage assets without causing damage.
9. When necessary, remove excess, loose material away from NYC drainage assets and out of roadway.
10. Remove all protections from NYC drainage assets when paving is completed.
11. Open the roadway to traffic.

7.2. Practices Required for Milling and Paving Operations

Erosion and Sediment Control Requirements

Select, install, implement, and maintain control measures to minimize the discharge of pollutants and prevent a violation of water quality standards during milling and paving. The selection, installation, implementation, and maintenance of these control measures must meet the standards set forth in section 7.3 of this chapter.

Pollution Prevention Measures

Employ the following pollution prevention methods as needed to prevent discharges of pollutants during the milling and paving phases of the work.

1. Use mobile fuel tank trucks, refuel milling and paving equipment away from NYC drainage assets, as operationally feasible.
2. Ensure that spill control materials are available, and measures are in place to address discharges of oils, coolants, solvents or other harmful materials from equipment breakdowns or other accidental discharges.
3. If a spill is released into any NYC drainage asset,

notify NYC DEP HAZMAT at (718)-595-4646. For oil or petroleum spills, notify NYSDEC at (800)-457-7362 unless all the following conditions are met:

The spill

- is less than 5 gallons;
- is contained and under the control of the spiller;
- has not reached/impacted land or water; and
- is cleaned up within two hours of discovery.

4. Appropriately store and dispose of asphalt collected as waste.
5. Install practices during both the milling and paving operations to keep all asphalt out of NYC drainage assets.

7.3. Standards and Specifications for Drainage Infrastructure Protection

Standards for Open Grate Protection

At-grade inlet protection for open grates must meet the following minimum requirements:

1. Cover the entire inlet including curb opening; filter sock may be used to block curb opening.
2. When the curb opening is covered with a filter sock, use a metal plate, wood panel or equivalent to cover entire inlet.
3. Do not remove grate to install.
4. When a) material will be in place for more than 1 working day or during a rain event; and/or b) protection is left in place after work hours for catch basin grates without curb inlets, ensure the covers for open grates meet or exceed the following material specifications:

Table 7.1. Material Specifications for Open Grate Covers

Property	ASTM Test	Value
Mass per unit area (oz./yd^2)	D 3776	5.2
Grab Tensile, MDxCD	D 4632	297x223
Grab Elongation, MDxCD (%)	D 4632	58/59
Trapezoid Tear, MDxCD (lbs)	D 4533	81x75
Puncture (lbs)	D 4833	99
Burst Strength (psi)	D 3786	940
Permittivity (sec^{-1})	D 4491	2.60
A.O.S. (U.S. sieve no. - mm)	D 4751	60
Water Flow Rate (gpm/ft^2)	D 4491	192

Standard for Filter Socks

Filter socks must be placed to block curb inlets to all drainage infrastructure. Filter socks must meet the minimum material specifications.

Table 7.2. Minimum Material Specification for Filter Socks

Recycled Content	Up to 85%
Absorbency	Up to 2.25 US Gallons
Height	Minimum 3"
Width	Minimum 12.5"
Length	As needed for inlet protection
Maximum Flow Rate	10 Gal/Min
Substances filtered	Oil, sediment, debris and trash
UV Resistant	Yes