New York State

Stormwater Management Design Manual

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Prepared by
Center for Watershed Protection
8391 Main Street
Ellicott City, MD 21043

For:
New York State
Department of Environmental Conservation
625 Broadway
Albany, NY 12233

George E. Pataki, Governor Erin M. Crotty, Commissioner

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Acknowledgments

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Bob Alpern, New York City Dept. of Environmental Protection
Pete Bartell
Toni Cioffi, NYS DEC, DOW, Bureau of Water Permits
Doreen Clemens, Saratoga County SWCD
Thom Engel, NYS DEC, DEP
Pat Ferracane, NYS DEC, Region 3
Eugena Flatlow, NYC SWCD
Matt Gillette, NYS DEC, Region 8
Dave Graves, NYS DOT, Environmental Analysis Bureau
Chad Kehoe, NYS DEC, Region 6
Paul Kieda, NYS DOT
Thilliayambur Manickam, NYS DEC, Region 9
Paul Mankiewicz, Ph.D., GAIA Institute
Robin Marx, Natural Resources Defense Council
Tom McMahon, Suffolk County SWCD
Mindy Moore, Westchester County SWCD
Bill Morton, NYS DEC, DOW, Bureau of Watershed Management
Bill Nechamen, NYS DEC, DOW, Bureau of Flood Protection
Michael Patterson, Environment 21
Paula Smith, Monroe County SWCD
Thomas Snow, NYS DEC
Don Stribick, Erie County SWCD
Don Sweezy, NYS DOT, Region 6
William Wegner, the Riverkeeper

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Forward

On November 16, 1990, the initial federal NPDES stormwater regulations were established. These required certain industrial activities to obtain permit authorization in order to discharge site runoff. DEC, as the NPDES permit issuing authority in this State, promulgated two SPDES general permits for stormwater runoff in 1993, GP-93-05 for the more traditional industrial sites and GP-93-06 for construction sites.

GP-93-06 requires that an operator who is covered under the permit implement a stormwater pollution prevention plan (SWPPP) that has been developed for the particular site. The minimum components of the SWPPP include a variety of requirements, including both structural and non-structural practices, inspections, contractor certifications, compliance with narrative water quality standards and other conditions. The attention, concern and efforts being directed at stormwater management practices at construction sites are constantly growing as new technologies emerge and experiences with older ones is gained. Additionally, construction site runoff is gaining wider attention as the federal NPDES stormwater program progresses. There is an ever-growing need to disseminate information concerning practices that are acceptable in New York.

The scope of attention is broadening on a national scale to smaller construction sites as evidenced by the "Phase 2" stormwater regulations. Phase 2 lowers the threshold to one or more acres of disturbance, the runoff from which requires NPDES authorization for discharges to surface waters. Permitting will be required beginning on March 10, 2003. It's becoming more evident as time passes that there is a greater need for stormwater management practices that are technically effective and viable in New York State. "Spreading the word" to engineers, municipal officials, and the general public is crucial to the success of DEC's efforts in implementing the federal NPDES stormwater regulations and reducing incidences of water quality impairments.

Accordingly, permits that are issued in the future for construction site runoff will rely heavily on this new manual and the practices that are described therein. When properly designed and maintained, the implementation of these practices will become an important component of New York's overall stormwater management program. Adherence to the criteria and practices described will better ensure a successful implementation of stormwater controls and compliance with the SPDES general permit(s) issued for construction site runoff and maintaining water quality.

N. G. Kaul, P.E.
Director
Division of Water

Preface

The New York State Stormwater Design Manual is prepared to provide standards for the design of the Stormwater Management Practices (SMPs) to protect the waters of the State of New York from the adverse impacts of urban stormwater runoff. This manual is intended to establish specifications and uniform criteria for the practices that are part of a Stormwater Pollution Prevention Plan (SWPPP).

This manual is intended primarily for engineers and other professionals who are engaged in the design of stormwater treatment facilities for new developments. Users are assumed to have a background in hydrology, hydraulics, and runoff and pollutant load computation. It is not intended to be a primer on any of these subjects. The manual may also be used by reviewing authorities to assess the adequacy of SWPPPs.

The manual is limited to the design of structures. It does not address the temporary control of sedimentation and erosion from construction activities, nor the development of Stormwater Pollution Prevention Plans. The reader is referred to the documents "*Reducing the Impacts of Runoff from New Development*" and "*New York State Guidelines for Urban Erosion and Sediment Control*" for guidance with these subjects.

Recommended Standards, consisting of proven technology, are intended to serve as a guide in the design and preparation of plans and specifications for Stormwater Management Practices, to suggest limiting values for items upon which an evaluation of such plans and specifications may be made by the reviewing authority, and to establish, as far as practicable, uniformity of practice. As statutory requirements and legal authority pertaining to stormwater management are not uniform across the State, and since conditions and administrative procedures and policies also differ, the use of these Standards must be adjusted to these variations.

The terms "shall" and "must" are used where the practice is sufficiently standardized to permit specific delineation of requirements or where safeguarding of the public health justifies such definite action. Other terms, such as "should," "recommend," and "preferred," indicate desirable procedures or methods, with deviations subject to individual consideration.

Chapter 1: Introduction to the Manual

Section 1.1 Purpose of the Manual

The purpose of this manual is threefold:

1. To protect the waters of the State of New York from the adverse impacts of urban stormwater runoff
2. To provide design guidance on the most effective stormwater management practices (SMPs) for new development sites
3. To improve the quality of SMPs constructed in the State, specifically in regard to their performance, longevity, safety, ease of maintenance, community acceptance and environmental benefit

Section 1.2 How to Use the Manual

The *New York State Stormwater Management Design Manual* provides designers a general overview on how to size, design, select and locate SMPs at a development site to comply with State stormwater performance standards. The manual also contains appendices with more detailed information on landscaping, SMP construction specifications, step–by- step SMP design examples and other assorted design tools. The manual is organized as follows:

Chapter 2. Impacts of Stormwater Runoff

This chapter examines the physical, chemical, and biological effects of unmanaged stormwater runoff on the water quality of local streams and waterbodies. This brief overview provides the background for why the stormwater management manual is needed and how the new criteria will help local communities meet water quality standards.

Chapter 3. Permit Requirements

This chapter explains the permitting process for stormwater management facilities, and what permits may be necessary to construct these facilities.

Chapter 4. Sizing Criteria

This chapter explains sizing criteria for water quality, channel protection, overbank flood control, and extreme flood management in the State of New York. The chapter also outlines the basis for design calculations.

Chapter 5. List of Practices

This chapter briefly outlines the five groups of acceptable structural SMPs that can be used to meet water quality sizing criteria. The following are acceptable SMP groups:

- Stormwater Ponds
- Stormwater Wetlands
- Infiltration Practices
- Filtering Systems
- Open-Channel Practices

The chapter also explains the criteria for addition of a new practice to the list of acceptable SMPs, and provides fact sheets for some practices that are not on the list of practices, but can be used to provide supplemental treatment.

Chapter 6. Performance Criteria

This chapter presents specific performance criteria and guidelines for the design of the five groups of structural SMPs. The performance criteria for each group of SMPs are based on six factors:

- Feasibility
- Conveyance
- Pretreatment
- Treatment
- Landscaping
- Maintenance

In addition, the chapter provides guidance on design adjustments that may be required to ensure proper functioning in cold climates.

Chapter 7. Guide to SMP Selection and Location

This chapter presents guidance on how to select the best SMP or group of practices at a development site, as well as environmental and other factors to consider when actually locating each SMP. The chapter contains five comparative matrices that evaluate SMPs based on the following factors:

- Land Use
- Physical Feasibility
- Watershed /Regional Factors
- Stormwater Management Capability
- Community and Environmental Factors

Chapter 7 is designed so that the reader can use the matrices in a step-wise fashion to identify the most appropriate SMP or group of practices to use at a site.

Chapter 8. Design Examples

Design examples are provided to help designers and plan reviewers better understand the new criteria in this manual. The step-by-step design examples demonstrate how the new stormwater sizing criteria are applied, and some of the design procedures and performance criteria that should be considered when planning a new stormwater management practice.

Stormwater Design Appendices

The appendices contain the technical information needed to actually design, landscape and construct an SMP. There are a total of thirteen appendices:

Appendix A. The Simple Method to Calculate Urban Stormwater Loads

This appendix describes a fast and effective way to calculate stormwater runoff pollutant loads. Using impervious cover estimates based on land use, the Simple Method calculates annual runoff volume as a product of annual rainfall, and a runoff coefficient (Rv). Annual runoff can then be combined with readily available stormwater pollutant concentrations to provide a quick estimate of annual pollutant loads. The appendix also discusses the limitations of the Simple Method.

Appendix B. Design Tools

The accurate calculation of stormwater flows may require modifications to some methods to account for small storm hydrology. This appendix provides methodologies to calculate the storage requirements for the channel protection flow event, and a methodology to calculate the peak flow from the small water quality storm.

Appendix C. SMP Construction Specifications

Good designs only work if careful attention is paid to proper construction techniques and materials. Appendix C contains detailed specifications for constructing ponds, infiltration practices, filters, bioretention areas and open channels.

Appendix D. Infiltration Testing

This appendix describes methodologies to test soil infiltration rates, in order to determine if infiltration is an acceptable option on site.

Appendices E-G. Checklists

These three appendices provide example checklists that can be used to assist in the plan review, construction, and operation and maintenance of an SMP.

Appendix H. Landscaping Guidance

Good landscaping can often be an important factor in the performance and community acceptance of stormwater SMPs. Appendix H also includes tips on how to establish more functional landscapes within stormwater SMPs, and contains an extensive list of trees, shrubs, ground covers, and wetland plants that can be used to develop an effective and diverse planting plan.

Appendix I. Cold Climate Sizing Example

This appendix supplies guidance on sizing SMPs to account for cold climate conditions that might hamper performance. Example sizing designs that illustrate how to incorporate cold climate criteria into SMP design are also included.

Appendix J. Geomorphic Assessment

This appendix provides a description of the Distributed Runoff Control (DRC) methodology to size stormwater practices based on downstream geomorphic characteristics.

Appendix K. Miscellaneous Details

The designs of various structures previously discussed in the manual are presented in Appendix K. These structures help enhance the performance of stormwater management practices, especially in cold climates. Schematics of structures such as weirs, trash racks, and observation wells are included.

Appendix L. Critical Erosive Velocities

This appendix provides data on critical erosive velocities for soil and grasses.

Section 1.3 Symbols and Acronyms

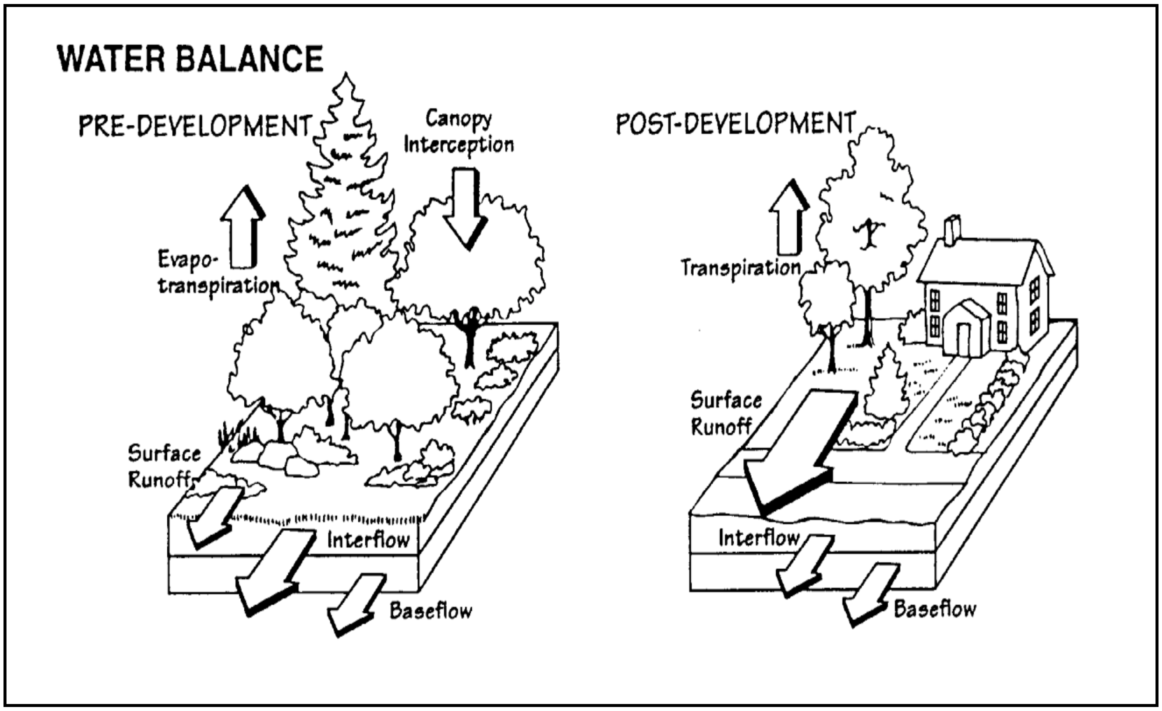
As an aid to the reader, Table 1.1 outlines the symbols and acronyms that are used throughout the text. In addition, a glossary is provided at the end of this volume that defines the terminology used in the text.

Table 1.1 Key Symbols and Acronyms Cited in Manual

Symbol	Definition	Symbol	Definition
A	drainage area	Qf	extreme flood storage volume
A_f	filter bed area	Qi	peak inflow discharge
A_s	surface area, sedimentation basin	Qo	peak outflow discharge
cfs	cubic feet per second	Qp	overbank flood control storage volume
Cp_v	channel protection storage volume	q_p	water quality peak discharge
CMP	corrugated metal pipe	qu	unit peak discharge
CN	curve number	SMP	stormwater management practice
Cp_v-ED	extended detention of the 1 year post-development runoff	R_v	volumetric runoff coefficient
d_f	depth of filter bed	R/W	right of way
du	dwelling units	SD	separation distance
DOT	Department of Transportation	SPDES	State Pollutant Discharge Elimination System
DPW	Department of Public Works	t_c	time of concentration
ED	extended detention	t_t	time to drain filter bed
f_c	soil infiltration rate	TR-20	Technical Release No. 20 Project Formulation-Hydrology, computer program
fps	feet per second	TR-55	Technical Release No. 55 Urban Unit Hydrology for Small Watersheds
h_f	head above filter bed	TSS	total suspended solids
HSG	hydrologic soil group	Vr	volume of runoff
Ia	initial abstraction	Vs	volume of storage
I	percent impervious cover	Vt	total volume
K	coefficient of permeability	Vv	volume of voids
NYSDEC	New York State Department of Environmental Conservation	WQ_v	water quality storage volume
NRCS	Natural Resources Conservation Service	WQ_v-ED	12 or 24 hour extended detention of the water quality volume
P	precipitation depth	WSEL	water surface elevation

Urban development has a profound influence on the quality of New York's waters. To start, development dramatically alters the local hydrologic cycle (see Figure 2.1). The hydrology of a site changes during the initial clearing and grading that occur during construction. Trees that had intercepted rainfall are removed, and natural depressions that had temporarily ponded water are graded to a uniform slope. The spongy humus layer of the forest floor that had absorbed rainfall is scraped off, eroded or severely compacted. Having lost its natural storage capacity, a cleared and graded site can no longer prevent rainfall from being rapidly converted into stormwater runoff.

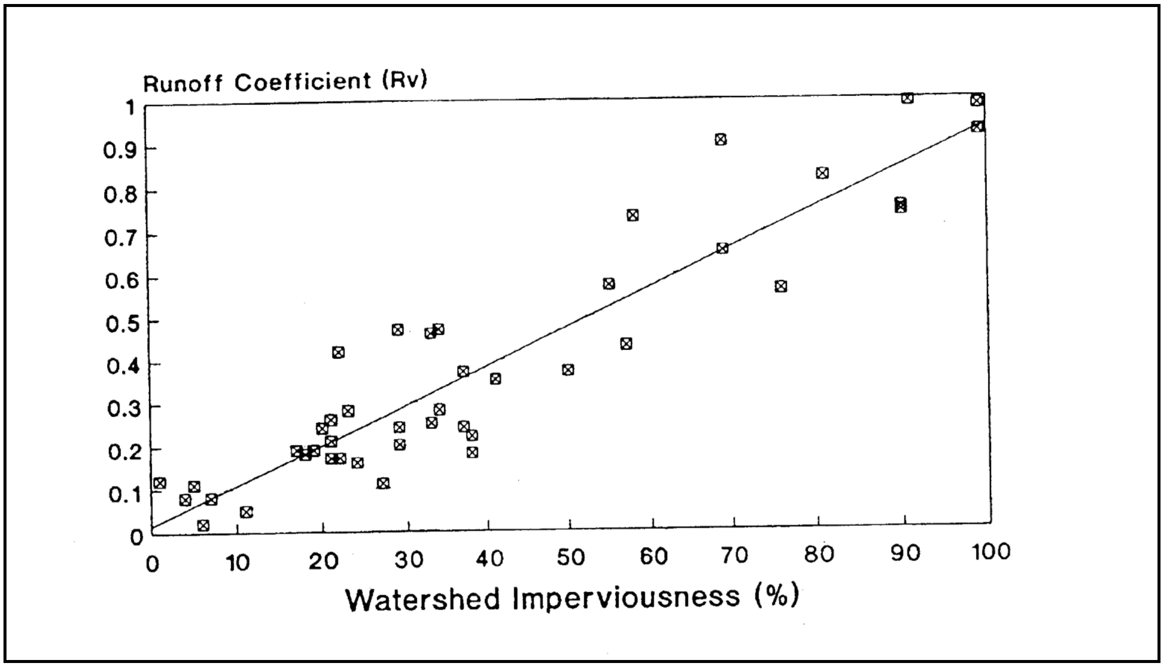
Figure 2.1 Water Balance at a Developed and Undeveloped Site (Schueler, 1987)



The situation worsens after construction. Rooftops, roads, parking lots, driveways and other impervious surfaces no longer allow rainfall to soak into the ground. Consequently, most rainfall is directly converted into stormwater runoff. This phenomenon is illustrated in Figure 2.2, which shows the increase in the volumetric runoff coefficient (R_v) as a function of site imperviousness. The runoff coefficient expresses the fraction of rainfall volume that is converted into stormwater runoff. As can be seen, the volume of stormwater runoff increases sharply with impervious cover. For example, a one-acre parking lot can produce 16 times more stormwater runoff than a one-acre meadow each year (Schueler, 1994).

The increase in stormwater runoff can be too much for the existing drainage system to handle. As a result, the drainage system is often "improved" to rapidly collect runoff and quickly convey it away (using curb and gutter, enclosed storm sewers, and lined channels). The stormwater runoff is subsequently discharged to downstream waters, such as streams, reservoirs, lakes or estuaries.

Figure 2.2 Relationship Between Impervious Cover and Runoff Coefficient (Schueler, 1987)



Section 2.1 Declining Water Quality

Impervious surfaces accumulate pollutants deposited from the atmosphere, leaked from vehicles, or windblown in from adjacent areas. During storm events, these pollutants quickly wash off, and are rapidly delivered to downstream waters. Some common pollutants found in urban stormwater runoff are profiled in Table 2.1.

Table 2.1 National Median Concentrations for Chemical Constituents in Stormwater

Constituent	Units	Concentration
Total Suspended Solids[1]	mg/l	54.5
Total Phosphorus[1]	mg/l	0.26
Soluble Phosphorus[1]	mg/l	0.10
Total Nitrogen[1]	mg/l	2.00
Total Kjeldhal Nitrogen[1]	mg/l	1.47
Nitrite and Nitrate[1]	mg/l	0.53
Copper[1]	ug/l	11.1
Lead[1]	ug/l	50.7
Zinc[1]	ug/l	129
BOD[1]	mg/l	11.5
COD[1]	mg/l	44.7
Organic Carbon[2]	mg/l	11.9
PAH[3]	mg/l	3.5*
Oil and Grease[4]	mg/l	3.0*
Fecal Coliform[5]	col/100 ml	15,000*
Fecal Strep[5]	col/ 100 ml	35,400*
Chloride (snowmelt)[6]	mg/l	116

* Represents a Mean Value
Source:
1: Pooled NURP/USGS (Smullen and Cave, 1998)
2: Derived from the National Pollutant Removal Database (Winer, 2000)
3: Rabanal and Grizzard 1995
4: Crunkilton *et al*. (1996)
5: Schueler (1999)
6: Oberts 1994

Sediment (Suspended Solids)

Sources of sediment include washoff of particles that are deposited on impervious surfaces and erosion from streambanks and construction sites. Streambank erosion is a particularly important source of sediment, and some studies suggest that streambank erosion accounts for up to 70% of the sediment load in urban watersheds (Trimble, 1997).

Both suspended and deposited sediments can have adverse effects on aquatic life in streams, lakes and estuaries. Turbidity resulting from sediment can reduce light penetration for submerged aquatic vegetation critical to estuary health. In addition, the reflected energy from light reflecting off of suspended sediment can increase water temperatures (Kundell and Rasmussen, 1995). Sediment can physically alter habitat by destroying the riffle-pool structure in stream systems, and smothering benthic organisms such as clams and mussels. Finally, sediment transports many other pollutants to the water resource.

Nutrients

Runoff from developed land has elevated concentrations of both phosphorus and nitrogen, which can enrich streams, lakes, reservoirs and estuaries. This process is known as eutrophication. Significant sources of nitrogen and phosphorus include fertilizer, atmospheric deposition, animal waste, organic matter, and stream bank erosion. Another nitrogen source is fossil fuel combustion from automobiles, power plants and industry. Data from the upper Midwest suggest that lawns are a significant contributor, with concentrations as much as four times higher than other land uses, such as streets, rooftops, or driveways (Steuer *et al*., 1997; Waschbusch *et al*., 2000; Bannerman *et al*., 1993).

Nutrients are of particular concern in lakes and estuaries, and are a source of degradation in many of New York's waters. Nitrogen has contributed to hypoxia in the Long Island Sound, and is a key pollutant of concern in the New York Harbor and the Peconic Estuary. Phosphorus in runoff has impacted the quality of a number of New York natural lakes, including the Finger Lakes and Lake Champlain, which are susceptible to eutrophication from phosphorus loading. Phosphorus has been identified as a key parameter in the New York City Reservoir system. The New York City DEP recently developed water quality guidance values for phosphorus for City drinking water reservoirs (NYC DEP, 1999); a source-water phosphorus guidance value of 15 μg/l has been proposed for seven reservoirs (Kensico, Rondout, Ashokan, West Branch, New Croton, Croton Falls, and Cross River) in order to protect them from use-impairment due to eutrophication, with other reservoirs using the State recommended guidance value of 20 μg/l.

Organic Carbon

Organic matter, washed from impervious surfaces during storms, can present a problem in slower moving downstream waters. Some sources include organic material blown onto the street surface, and attached to sediment from stream banks, or from bare soil. In addition, organic carbon is formed indirectly from algal growth within systems with high nutrient loads.

As organic matter decomposes, it can deplete dissolved oxygen in lakes and tidal waters. Declining levels of oxygen in the water can have an adverse impact on aquatic life. An additional concern is the formation of trihalomethane (THM), a carcinogenic disinfection by-product, due to the mixing of chlorine with water high in organic carbon. This is of particular importance in unfiltered water supplies, such as the New York City Reservoir System.

Bacteria

Bacteria levels in stormwater runoff routinely exceed public health standards for water contact recreation. Some stormwater sources include pet waste and urban wildlife. Other sources in developed land include sanitary and combined sewer overflows, wastewater, and illicit connections to the storm drain system. Bacteria is a leading contaminant in many of New York's waters, and has lead to shellfish bed closures in the New York Bight Area, on Long Island, and in the Hudson-Raritan Estuary. In addition, Suffolk, Nassau, and Erie Counties issue periodic bathing-beach advisories each time a significant rainfall event occurs (NRDC, 2000).

Hydrocarbons

Vehicles leak oil and grease that contain a wide array of hydrocarbon compounds, some of which can be toxic to aquatic life at low concentrations. Sources are automotive, and some areas that produce runoff with high runoff concentrations include gas stations, commuter parking lots, convenience stores, residential parking areas, and streets (Schueler, 1994).

Trace Metals

Cadmium, copper, lead and zinc are routinely found in stormwater runoff. Many of the sources are automotive. For example, one study suggests that 50% of the copper in Santa Clara, CA comes from brake pads (Woodward-Clyde, 1992). Other sources of metals include paints, road salts, and galvanized pipes.

These metals can be toxic to aquatic life at certain concentrations, and can also accumulate in the bottom sediments of lakes and estuaries. Specific concerns in aquatic systems include bioaccumulations in fish and macro-invertebrates, and the impact of toxic bottom sediments on bottom-dwelling species.

Pesticides

A modest number of currently used and recently banned insecticides and herbicides have been detected in urban and suburban streamflow at concentrations that approach or exceed toxicity thresholds for aquatic life. Key sources of pesticides include application to urban lawns and highway median and shoulder areas.

Chlorides

Salts that are applied to roads and parking lots in the winter months appear in stormwater runoff and meltwater at much higher concentrations than many freshwater organisms can tolerate. One study of four Adirondack streams found severe impacts to macroinvertebrate species attributed to chlorides (Demers and Sage, 1990). In addition to the direct toxic effects, chlorides can impact lake systems by altering their mixing cycle. In 1986, incomplete mixing in the Irondequoit Bay was attributed to high salt use in the region (MCEMC, 1987). A primary source of chlorides in New York State, particularly in the State's northern regions, is salt applied to road surfaces as a deicer.

Thermal Impacts.

Runoff from impervious surfaces may increase temperature in receiving waters, adversely impacting aquatic organisms that require cold and cool water conditions (e.g., trout). Data suggest that increasing development can increase stream temperatures by between five and twelve degrees Fahrenheit, and that the increase is related to the level of impervious cover in the drainage area (Galli, 1991). Thermal impacts are a serious concern in trout waters, where cold temperatures are critical to species survival.

Trash and Debris

Considerable quantities of trash and debris are washed through the storm drain networks. The trash and debris accumulate in streams and lakes and detract from their natural beauty. Depending on the type of trash, this material may also lead to increased organic matter or toxic contaminants in water bodies.

Snowmelt Concentrations

The snow pack can store hydrocarbons, oil and grease, chlorides, sediment, and nutrients. In cold regions, the pollutant load during snowmelt can be significant, and chemical traits of snowmelt change over the course of the melt event. Oberts (1994) studied this phenomenon, and describes four types of snowmelt runoff (Table 2.2). Oberts and others have reported that 90% of the hydrocarbon load from snowmelt occurs during the last 10% of the event. From a practical standpoint, the high hydrocarbon loads experienced toward the end of the season suggest that stormwater management practices should be designed to capture as much of the snowmelt event as possible.

Table 2.2 Runoff and Pollutant Characteristics of Snowmelt Stages (Oberts, 1994)

Snowmelt Stage	Duration/ Frequency	Runoff Volume	Pollutant Characteristics
Pavement Melt	Short, but many times in winter	Low	Acidic, high concentrations of soluble pollutants, Cl, nitrate, lead. Total load is minimal.
Roadside Melt	Moderate	Moderate	Moderate concentrations of both soluble and particulate pollutants.
Pervious Area Melt	Gradual, often most at end of season	High	Dilute concentrations of soluble pollutants, moderate to high concentrations of particulate pollutants, depending on flow.
Rain-on-Snow Melt	Short	Extreme	High concentrations of particulate pollutants, moderate to high concentrations of soluble pollutants. High total load.

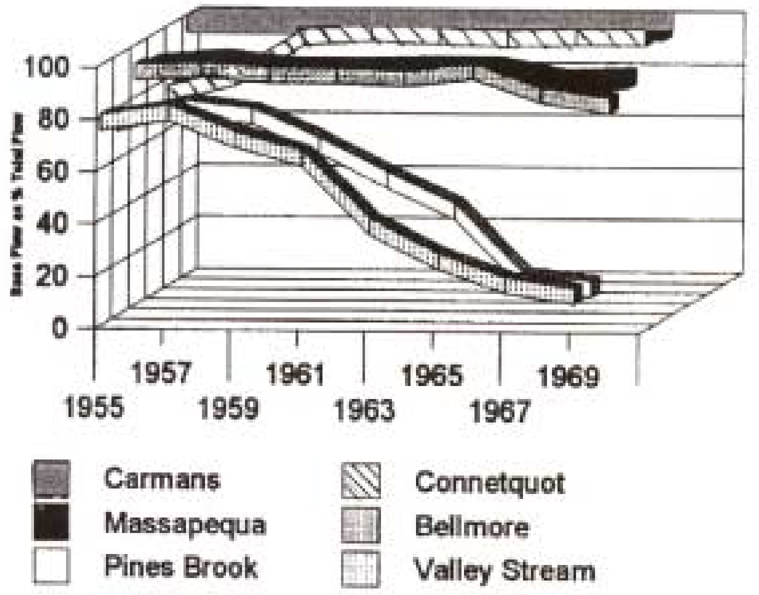
Section 2.2 Diminishing Groundwater Recharge and Quality

The slow infiltration of rainfall through the soil layer is essential for replenishing groundwater. Groundwater is a critical water resource across the State. Not only do many residents depend on groundwater for their drinking water, but the health of many aquatic systems is also dependent on its steady discharge. For example, during periods of dry weather, groundwater sustains flows in streams and helps to maintain the hydrology of non-tidal wetlands.

Because development creates impervious surfaces that prevent natural recharge, a net decrease in groundwater recharge rates can be expected in urban watersheds. Thus, during prolonged periods of dry weather, streamflow sharply diminishes. Another source of diminishing baseflow is well drawdowns as populations increase in the watershed. In smaller headwater streams, the decline in stream flow can cause a perennial stream to become seasonally dry. One study in Long Island suggests that the supply of baseflow decreased in some developing watersheds, particularly where the water supply was sewered (Spinello and Simmons, 1992; Figure 2.3).

Urban land uses and activities can also degrade *groundwater quality,* if stormwater runoff is infiltrated without adequate treatment. Certain land uses and activities are known to produce higher loads of metals and toxic chemicals and are designated as *stormwater hotspots*. Soluble pollutants, such as chloride, nitrate, copper, dissolved solids and some polycyclic aromatic hydrocarbons (PAH's) can migrate into groundwater and potentially contaminate wells. Stormwater runoff from designated hotspots should never be infiltrated, unless the runoff receives full pretreatment with another practice.

Figure 2.3 Declining Baseflow in Response to Development



Notes:

Carmans and Connetquot: Rural/suburban, watersheds are unsewered

Bellmore and Massapequa: Moderately urbanized, not sewered until 1989

Valley Stream and Pine Brook: Urbanized and densely populated watersheds, sewer systems completed in 1960s

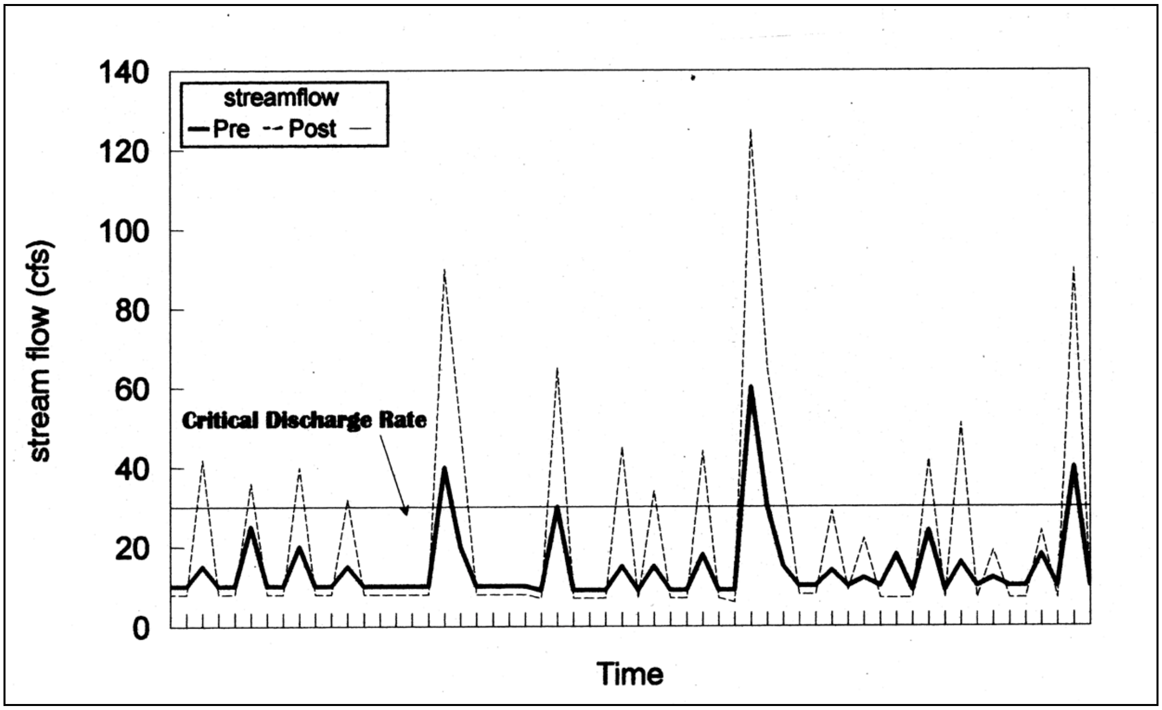
1953-1964: Period of sanitary sewer construction in eastern Nassau County

1962-1966: Drought years

Section 2.3 Impacts to the Stream Channel

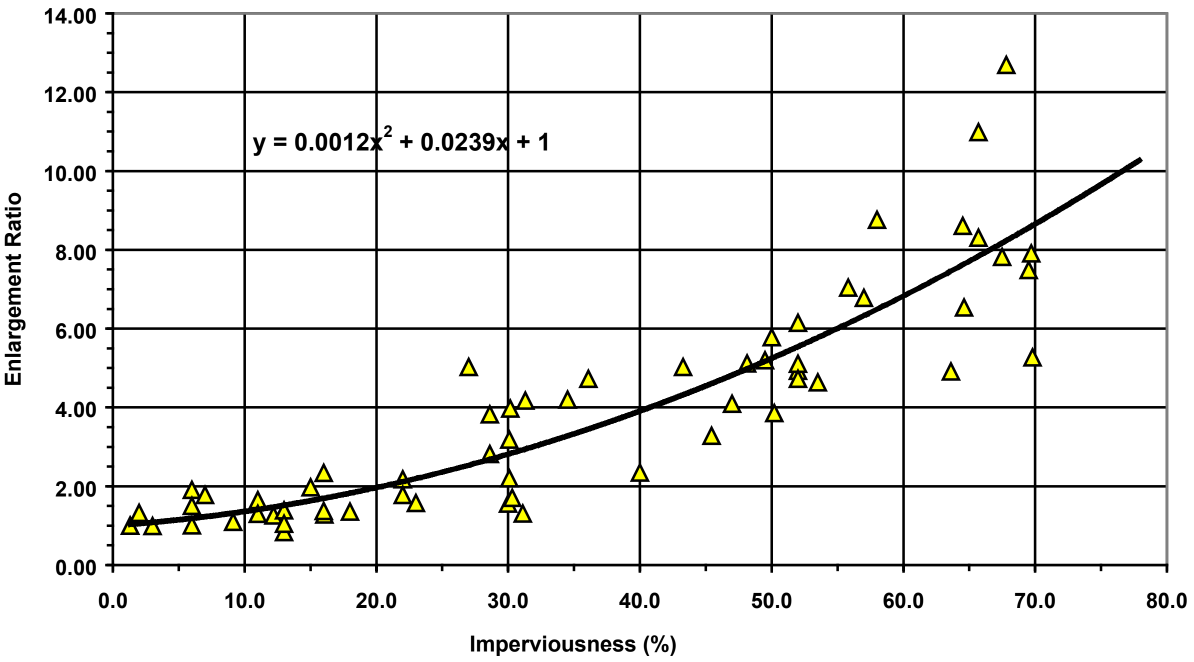
As pervious meadows and forests are converted into less pervious urban soils, or pavement, both the frequency and magnitude of storm flows increase dramatically. As a result, the bankfull event occurs two to seven times more frequently after development occurs (Leopold, 1994). In addition, the discharge associated with the original bankfull storm event can increase by up to five times (Hollis, 1975). As Figure 2.4 demonstrates, the total flow beyond the "critical erosive velocity" increases substantially after development occurs. The increased energy resulting from these more frequent bankfull flow events results in erosion and enlargement of the stream channel, and consequent habitat degradation.

Figure 2.4 Increased Frequency of Erosive Velocities After Development



Channel enlargement in response to watershed development has been observed for decades, with research indicating that the stream channel area expands to between two and five times its original size in response to upland development (Hammer, 1972; Morisawa and LaFlure, 1979; Allen and Narramore, 1985; Booth, 1990). One researcher developed a direct relationship between the level of impervious cover and the "ultimate" channel enlargement, the area a stream will eventually reach over time (MacRae, 1996; Figure 2.5).

Figure 2.5 Relationship Between Impervious Cover and Channel Enlargement



Historically, New York has used two-year control (i.e., reduction of the peak flow from the two-year storm to predeveloped levels) to prevent channel erosion, as required in the 1993 SPDES General Permit (GP-93-06). Research suggests that this measure does not adequately protect stream channels (McCuen and Moglen, 1988, MacRae, 1996). Although the peak flow is lower, it is also extended over a longer period of time, thus increasing the duration of erosive flows. In addition, the bankfull flow event actually becomes more frequent after development occurs. Consequently, capturing the two-year event may not address the channel-forming event.

This stream channel erosion and expansion, combined with direct impacts to the stream system, act to decrease the habitat quality of the stream. The stream will thus experience the following impacts to habitat (Table 2.3):

- Decline in stream substrate quality (through sediment deposition and embedding of the substrate)
- Loss of pool/riffle structure in the stream channel
- Degradation of stream habitat structure
- Creation of fish barriers by culverts and other stream crossings
- Loss of “large woody debris,” which is critical to fish habitat

Table 2.3 Impacts to Stream Habitat

Stream Channel Impact	Key Finding	Reference	Year
Habitat Characteristics			
Embeddedness	Interstitial spaces between substrate fill with increasing watershed imperviousness	Horner *et al.*	1996
Large Woody Debris (LWD)	Important for habitat diversity and anadramous fish.	Spence *et al.*	1996
	Decreased LWD with increases in imperviousness	Booth *et al.*	1996
Changes in Stream Features	Altered pool/riffle sequence with urbanization	Richey	1982
	Loss of habitat diversity	Scott *et al.*	1986
Direct Channel Impacts			
Reduction in 1st Order Streams	Replaced by storm drains and pipes increases erosion rate downstream	Dunne and Leopold	1972
Channelization and hardening of stream channels	Increase instream velocities often leading to increased erosion rates downstream	Sauer *et al.*	1983
Fish Blockages	Fish blockages caused by bridges and culverts	MWCOG	1989

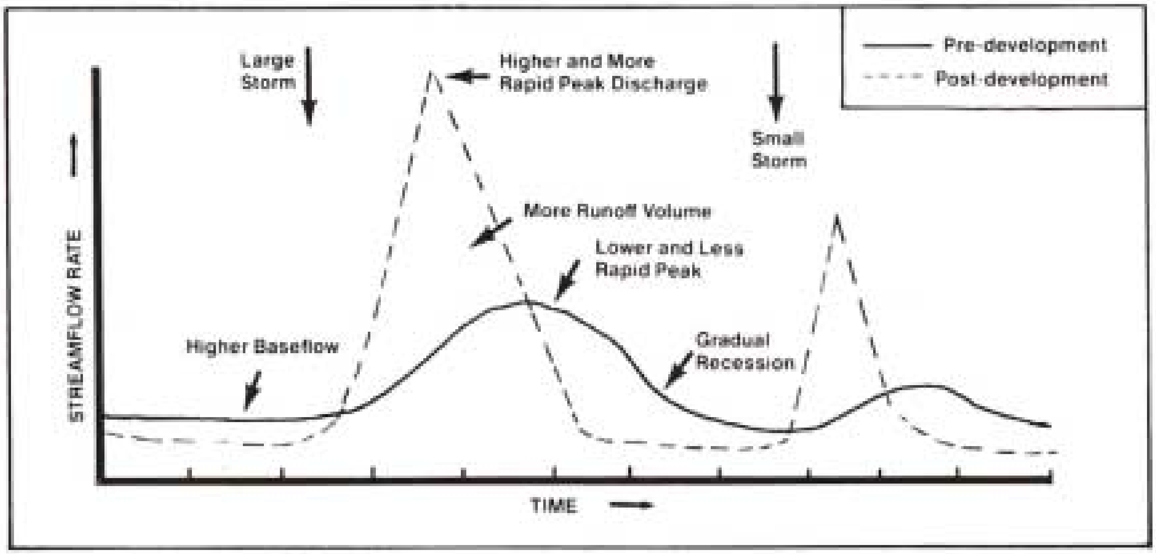
Section 2.4 Increased Overbank Flooding

Flow events that exceed the capacity of the stream channel spill out into the adjacent floodplain. These are termed “overbank” floods, and can damage property and downstream structures. While some overbank flooding is inevitable and sometimes desirable, the historical goal of drainage design in New York has been to maintain pre-development peak discharge rates for both the two- and ten-year frequency storm after development, thus keeping the level of overbank flooding the same over time. This management technique prevents costly damage or maintenance for culverts, drainage structures, and swales.

Overbank floods are ranked in terms of their statistical return frequency. For example, a flood that has a 50% chance of occurring in any given year is termed a “two-year” flood. The two-year event is also known as the “bankfull flood,” as researchers have demonstrated that most natural stream channels in the State have just enough capacity to handle the two-year flood before spilling out into the floodplain. Although many factors, such as soil moisture, topography, and snowmelt, can influence the magnitude of a particular flood event, designers typically design for the “two-year” storm event. In New York State, the two-year design storm ranges between about 2.0 to 4.0 inches of rain in a 24-hour period. Similarly, a flood that has a 10% chance of occurring in any given year is termed a “ten-year flood." A ten-year flood occurs when a storm event produces between 3.2 and 6.0 inches of rain in a 24-hour period. Under traditional engineering practice, most channels and storm drains in New York are designed with enough capacity to safely pass the peak discharge from the ten-year design storm.

Urban development increases the peak discharge rate associated with a given design storm, because impervious surfaces generate greater runoff volumes and drainage systems deliver it more rapidly to a stream. The change in post-development peak discharge rates that accompany development is profiled in Figure 2.6. Note that this change in hydrology increases not only the magnitude of the peak event, but the total volume of runoff produced.

Figure 2.6 Hydrographs Before and After Development

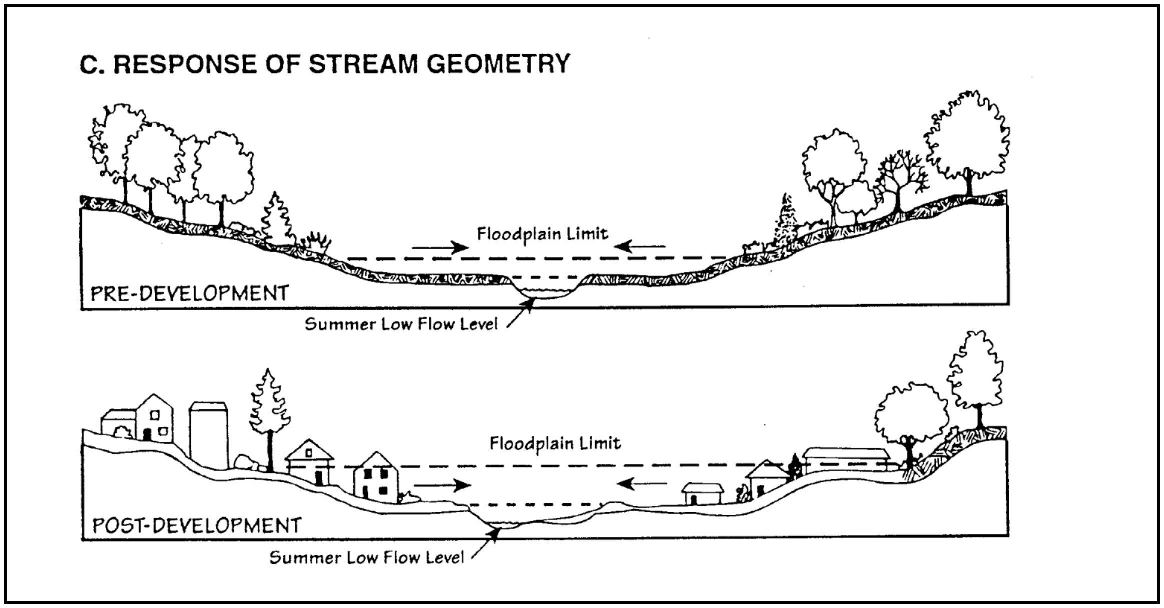


Section 2.5 Floodplain Expansion

The level areas bordering streams and rivers are known as floodplains. Operationally, the floodplain is usually defined as the land area within the limits of the 100-year storm flow water elevation. The 100-year storm has a 1% chance of occurring in any given year. In New York, a 100-year flood occurs after between five and eight inches of rainfall in a 24-hour period (i.e., the 100-year storm). These floods can be very destructive, and can pose a threat to property and human life.

As with overbank floods, development sharply increases the peak discharge rate associated with the 100-year design storm. As a consequence, the elevation of a stream's 100-year floodplain becomes higher and the boundaries of its floodplain expand (see Figure 2.7). In some instances, property and structures that had not previously been subject to flooding are now at risk. Additionally, such a shift in a floodplain's hydrology can degrade wetland and forest habitats.

Figure 2.7 Floodplain Expansion with New Development



Section 2.6 Impacts to Aquatic Organisms

The decline in the physical habitat of the stream, coupled with lower base flows and higher stormwater pollutant loads, has a severe impact on the aquatic community. Research suggests that new development impacts aquatic insects, fish, and amphibians at fairly low levels of imperviousness, usually around 10% impervious cover (Table 2.4). New development appears to cause declining **richness** (the number of different species in an area or community), **diversity** (number and relative frequency of different species in an area or community), and **abundance** (number of individuals in a species).

Table 2.4 Recent Research Examining the Relationship of Urbanization to Aquatic Habitat and Organisms

Watershed Indicator	Key Finding	Reference	Year	Location
Aquatic insects and fish	A comparison of three stream types found urban streams had lowest diversity and richness. Urban streams had substantially lower EPT scores (22% vs 5% as number of all taxa, 65% vs 10% as percent abundance) and IBI scores in the poor range.	Crawford & Lenat	1989	North Carolina
Insects, fish, habitat water quality,	Steepest decline of biological functioning after 6% imperviousness. There was a steady decline, with approx 50% of initial biotic integrity at 45% I.	Horner *et al.*	1996	Puget Sound Washington
Fish, Aquatic insects	A study of five urban streams found that as land use shifted from rural to urban, fish and macroinvertebrate diversity decreased.	Masterson & Bannerman	1994	Wisconsin
Insects, fish, habitat, water quality, riparian zone	Physical and biological stream indicators declined most rapidly during the initial phase of the urbanization process as the percentage of total impervious area exceeded the 5-10% range.	May *et al.*	1997	Washington
Aquatic insects and fish	There was significant decline in the diversity of aquatic insects and fish at 10% impervious cover.	MWCOG	1992	Washington, DC
Aquatic insects and fish	Evaluation of the effects of runoff in urban and non-urban areas found that native fish and insect species dominated the non-urban portion of the watershed, but native fish accounted for only 7% of the number of species found in urban areas.	Pitt	1995	California
Wetland plants, amphibians	Mean annual water fluctuation inversely correlated to plant & amphibian density in urban wetlands. Declines noted beyond 10% impervious area.	Taylor	1993	Seattle

Table 2.4 Recent Research Examining the Relationship of Urbanization to Aquatic Habitat and Organisms

Watershed Indicator	Key Finding	Reference	Year	Location
Aquatic insects & fish	Residential urban land use in Cuyahoga watersheds created a significant drop in IBI scores at around 8%, primarily due to certain stressors that functioned to lower the non-attainment threshold When watersheds smaller than $100mi^2$ were analyzed separately, the level of urban land use for a significant drop in IBI scores occurred at around 15%.	Yoder *et. al.*	1999	Ohio
Aquatic insects & fish	All 40 urban sites sampled had fair to very poor index of biotic integrity (IBI) scores, compared to undeveloped reference sites.	Yoder	1991	Ohio

IBI: Index of Biotic Integrity: A measure of species diversity for fish and macroinvertebrates
EPT: A measure of the richnies of three sensitive macro-invertebrates (may flies, caddis flies, and stone flies), used to indicate the ability of a waterbody to support sensitive organisms.

Chapter 3: Department of Environmental Conservation Permits

This chapter provides a summary of the applications that may need to be filed with the Department of Environmental Conservation (DEC) for new development projects. This section identifies general policies and timelines for filing a State Pollutant Discharge Elimination System (“SPDES”) General Permit for stormwater discharges from construction activities as well as environmental permits under the Uniform Procedures Act (UPA). More detailed information on the permits and up-to-date regional contact information are available from the DEC web site at the following URLs:

www.dec.state.ny.us/website/dcs/permits_level2.html
www.dec.state.ny.us/website/dcs/upa/upa_permits.html

Section 3.1 Filing for a Stormwater Permit

40 CFR Part 122 prohibits point source discharges of stormwater to waters of the United States without a permit issued under the National Pollutant Discharge Elimination System ("NPDES"). New York State is approved by the EPA to administer its SPDES program in lieu of EPA's NPDES program. The operator of a storm water discharge, which qualifies for coverage under the SPDES General Permit for stormwater, must submit a Notice of Intent (NOI) form to obtain permit coverage. Consult the general permit for any possible restrictions on eligibility of coverage. The permit includes a complete set of instructions for filing an NOI and for filing a Notice of Termination (NOT).

3.1.1 Where to File the NOI Form

Completed NOIs should be sent to:

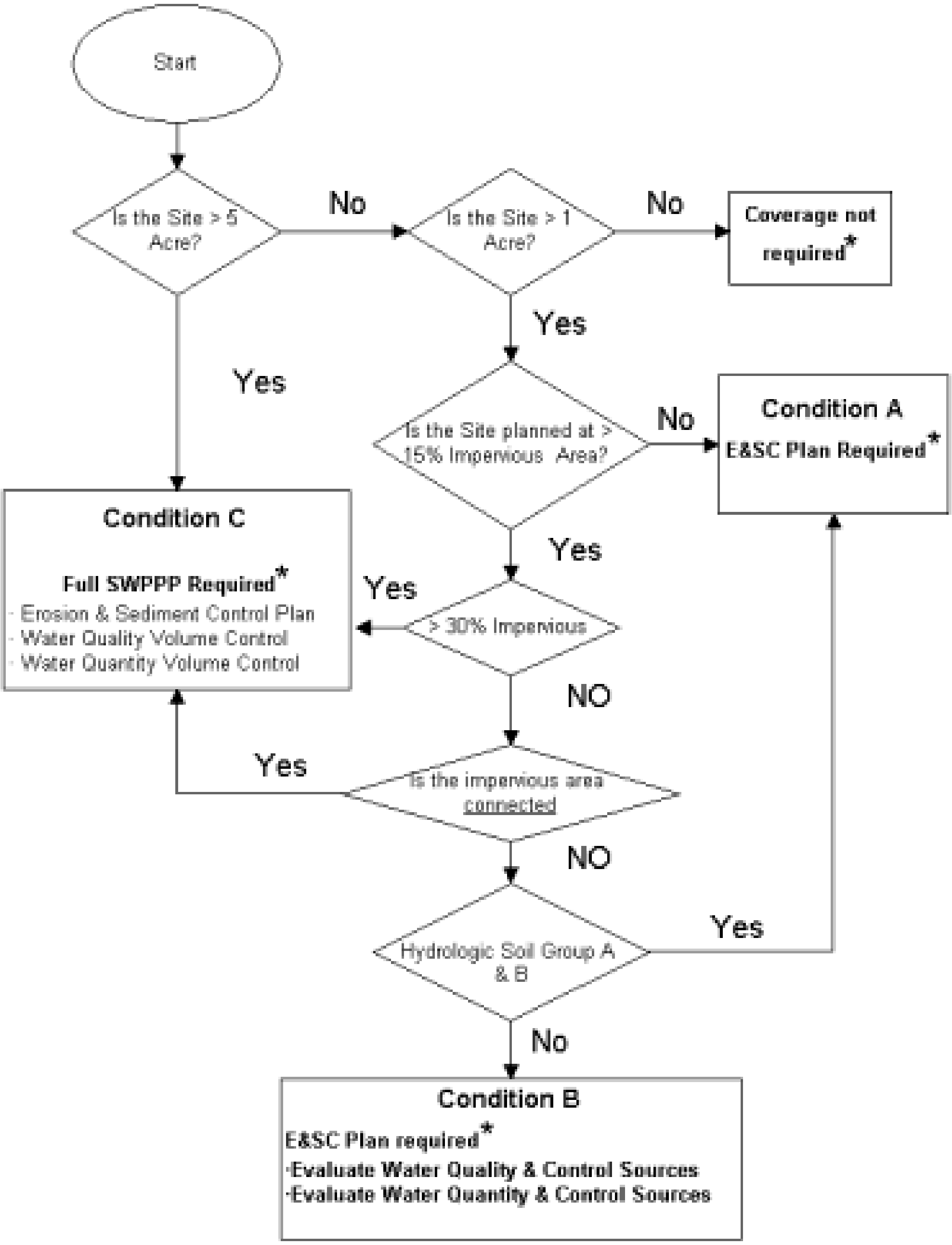
NYS DEC – Notice of Intent
Bureau of Water Permits
625 Broadway
Albany, NY 12233-3505

3.1.2 Stormwater Pollution Prevention Plan

The applicant must check whether the project will be a small or large one and whether the plan conforms to either NYSDEC or local Municipal Separate Storm Sewer System (MS4) requirements. The flow chart in Figure 3.1 identifies what components of the Stormwater Pollution Prevention Plan need to be prepared depending on the size and complexity of the site.

If one wishes to seek some variance from either local or NYSDEC requirements, then the information in Section V of the NOI must be filled out. The purpose of this section is to give NYSDEC some preliminary information. Based on the information provided, DEC will determine if other information is required. Only operators who state that their plan will NOT conform to either NYSDEC or local MS4 requirements need to fill out this section.

Figure 3.1 Stormwater Pollution Prevention Plan Component Requirements



* Under any of the above conditions other permits may be required.

3.1.3 Review and Approval

Once the Notice of Intent (NOI) has been reviewed by DEC, an acknowledgement letter will be returned to the sender. Filing of an NOI does not supercede or negate the necessity to comply with other local laws and other state or federal requirements, which affect stormwater management. It is the responsibility of the operator to comply with any and all such regulations. Operators are encouraged to have their Stormwater Pollution Prevention Plan reviewed by the local Soil and Water Conservation District.

New York City has enacted various land use controls that affect certain construction projects in areas tributary to their drinking water reservoirs. Similarly, the Lake George Park Commission and the Adirondack Park Agency (APA) have enacted regulations which impact construction activity. The APA has jurisdiction over private lands within the Adirondack Park and requires environmental review for most land development projects. It also administers the State's Wild and Scenic Rivers and Freshwater Wetlands programs on these lands. Development within the APA's jurisdiction is not subject to SEQR. For more information, please contact the APA at 518-891-4050.

Other municipalities and agencies of New York State may have adopted similar legislation. It is the responsibility of the operator to comply with any and all such regulations. Table 3.1 provides a summary table describing the permits issued by DEC that may apply to the new development.

Section 3.2 Filing Other Permit Applications

Most other environmental permits are administered under the UPA, which establishes uniform review procedures for the DEC's major regulatory programs and provides time periods for DEC action on applications for environmental protection permits. Generally permits identified under the UPA need to be filed through the DEC Regional Office. (See Figure 3.2 for regional contact information). If more than one permit is required, the applicant should submit all applications at one time. In addition, the applicant must list permits of other agencies that he or she knows to be applicable, together with a statement of the status of approval of the review under the State Environmental Quality Review (SEQR).

3.2.1 What Other Permits Do I Need to File?

Several permits under the UPA may be applicable to a particular development project. Table 3.1 lists many of permits required under the UPA that may apply to new residential, commercial, and industrial development in New York State, and provides a brief description of each. Please note that the table includes only the permits that are directly applicable to the stormwater and site plan development. Thus several UPA permits may be required that are not included on this table, including Long Island Wells, Water Supply, 401 Water Quality Certification, Air Pollution Control, Mined Land Reclamation, Hazardous Waste Management Facilities, and Waste Transporter.

Table 3.1 Summary of Environmental Permits Issued by DEC That May Apply to New Development

3.1 Permit Title	3.2 Implementation Authority	3.2.1 Applicability	3.2.2 Regulated Activities
State Pollutant Discharge Elimination System	ECL Article 17 Division of Water	• Construction sites disturbing one acre or more.	*Regulated:* Stormwater discharge associated with industrial activity, including new construction; point source discharges and disposal systems *Exempted:* Agricultural discharge[1], discharge of sewage effluent to groundwater less than 1,000 gallons a day.
Dam Safety	ECL Article 15-0503 see *Guidelines for Design of Dams*	• Applies to on-stream and off-stream structures having height > 6' and storage capacity > 3MG, or height ≥ 15' and storage capacity ≥ 1 MG.	*Regulated:* Construction, reconstruction, repair or removal of dams or impoundment. *Exempted:* Structures for treatment or storage of wastewater, or materials other than water.
Freshwater Wetlands	ECL Article 24 Division of Fish, Wildlife and Marine Resources	• Freshwater wetlands appearing on New York State freshwater wetland maps • Generally limited to 12.4 acres or greater, but stricter requirements in the Adirondack Park	*Regulated:* Construction of buildings, roadways, septic systems, dams, docks; filling, draining, or excavating; vegetation removal *Exempted:* Ordinary maintenance and repair of existing structures; recreational activities
Tidal Wetlands	ECL Article 25 NY DEC, Tidal Wetlands Regulatory Program	• Official DEC tidal wetlands maps. • Anywhere tidal inundation occurs on a daily, monthly, or intermittent basis, including but not exclusively within the salt wedge (salt marshes, vegetated flats, and shorelines)[2] • Adjacent areas extend up to 300 ft. inland from wetland boundary (NYC 150 ft)	*Regulated:* Residences and condos; accessory structures; commercial and industrial buildings; roadways and parking lots; boat ramps; septic systems; drainage structures; erosion control structures (groins, sea walls); docks, piers, etc. Clearing/clear cutting; beach nourishment; dredging, excavation, and grading.
Protection of Waters	Title 5, ECL Article 15 Division of Fish, Wildlife and Marine Resources	Bed or banks of protected streams	*Regulated*: Modification or disturbance of the bed or banks of protected streams, including removal of sand or gravel; filling dredging in navigable waters; construction/modification/ repair of

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[1] - Eligible for coverage under Concentrated Animal Feeding Operation (CAFO)

[2] Applicable to Rockland and Westchester Counties, NYC and Long Island.

Table 3.1 Summary of Environmental Permits Issued by DEC That May Apply to New Development

			certain dams, docks, and mooring areas. *Exempted:* Ordinary maintenance
Coastal Erosion Hazard Areas	ECL Article 34 Division of Water	• Lands adjacent to Lakes Erie and Ontario; the St. Lawrence, Niagara, Harlem, East, and Hudson Rivers; Kill van Kull; Arthur Kill; Atlantic Ocean; and connective water-bodies. • Natural Protective Features (NPF) nearshore areas; and landward Structural Hazard Areas (SHA)	*Regulated*: Construction/ modification/ restoration of structures, e.g. buildings, docks, piers, walkways; Filling, draining or excavating; Construction/modification/restoration of erosion control structures *Exempted:* Ordinary maintenance and repair of existing structures
Wild, Scenic, & Recreational Rivers	Title 27, ECL Article 15 Division of Fish, Wildlife and Marine Resources	All or portions of DEC-designated waterways: Three levels of classification include recreational rivers, scenic rivers, wild rivers	*Regulated*: Specifics depend on classification, but includes construction of residential, non-residential, accessory structures, and roads; Water quality, wastewater treatment, disposal; Vegetative cutting and agriculture; Recreational uses and development; Commercial and industrial uses. *Exempted*: Continuation of existing land uses; Maintenance and repair--without changes

* UPA permits not included in this table are Long Island Wells, Water Supply, 401 Water Quality Certification, Air Pollution Control; Mined Land Reclamation, Hazardous Waste Management Facilities, Waste Transporter
Source URL:(http://www.dec.state.ny.us/website/dcs/upa/upa_permits.html)

3.2.2 Schedule for DEC Review

The time for permit approval depends on whether a project is determined to be UPA major or UPA minor. Each of the permits included in the UPA process has specific definitions of what constitutes UPA major and UPA minor projects. DEC first determines if an application is complete, and then begins the review process. For most projects, DEC must determine completeness within 15 days and for federally delegated permits within 60 days. For UPA minor projects, DEC must make a decision on the permit within 45 days of determining the application complete.

For UPA major projects, the length of time for review depends on whether a public hearing is required. If no hearing is required, DEC must make a decision within 90 days of determining the project complete. If a hearing is required, DEC notifies the applicant and the public of a hearing within 60 days of the completeness determination. The hearing must commence within 90 days of the completeness determination. Once the hearing ends, DEC must issue a final decision on the application within 60 days after receiving the final hearing record.

- **Dam Safety**

Constructing, reconstructing, repairing, or modifying dams and water impounding structures that permanently or temporarily impound water as a result of a structure placed across a watercourse or overland drainage way or which receive water from an external source such as drainage diversion or pumping of groundwater require a dam safety permit. Some examples of activities requiring this permit are: siting and constructing a new dam or water impounding structure, reconstruction, modification or maintenance which may affect the structural integrity or functional capability of a dam or impounding structure.

- **Freshwater Wetlands/Tidal Wetlands**

A freshwater or tidal wetlands permit may be required for work in or adjacent to wetlands designated by the State. Official tidal wetlands maps showing the locations of New York's regulated tidal wetlands are on file at DEC regional offices in Regions 1, 2, and 3, and in the County Clerks' Offices of Nassau, Suffolk, Bronx, Kings, New York, Queens, Richmond, Rockland, and Westchester Counties. They are also available at local assessing agencies in these areas. Official freshwater wetlands maps showing the locations of New York's wetlands are on file at DEC regional offices, the Adirondack Park Agency, and local government offices.

Wetlands permit applications require analysis of alternatives. Even when a development is adjacent to a regulated wetland, the site plan and stormwater management plan need to be modified to adequately protect these resources.

- **Protection of Waters**

This permit applies to the dredging and filling in navigable waters and dams and work on the banks of protected streams. The permit also regulates the construction of dams in both waterways and overland drainage ways. When a site plan includes dam construction as a part of a quantity or quality control requirement, a permit will be required unless the following conditions are met:

- Maximum height is six feet or less (maximum height is measured as the height from the downstream (outside) toe of the dam at its lowest point to the highest point at the top of the dam).
- Maximum impounding capacity is one million gallons or less (maximum impounding capacity is measured as the volume of water impounded when the water level is at the top of the dam).
- Maximum height is between six feet and 15 feet and the maximum impounding capacity is less than three million gallons.

- **Coastal Erosion Hazard Areas**

This permit is required where coastal erosion is a concern, and applies to Natural Protective Features (NPFs), such as sand dunes, and a Shoreline Hazard Area (SHA) defined based on the annual recession rate of the coast. The permit is required for construction of any structures within the SHA, and the permitee must demonstrate that the proposed project does not contribute to coastal erosion.

- **Wild, Scenic, & Recreational Rivers**

This regulation applies strict regulations, which restrict certain uses for development bordering wild, scenic, or recreational rivers in New York State. Furthermore, the applicant must demonstrate that no reasonable alternative exists, and that the proposed activity will not have an undue adverse environmental impact. Listed waterways include:

Scenic Rivers

Carmans River
Peconic River
East Canada Creek
Grasse River
Oswegatchie River
GenesseeRiver

Recreational Rivers

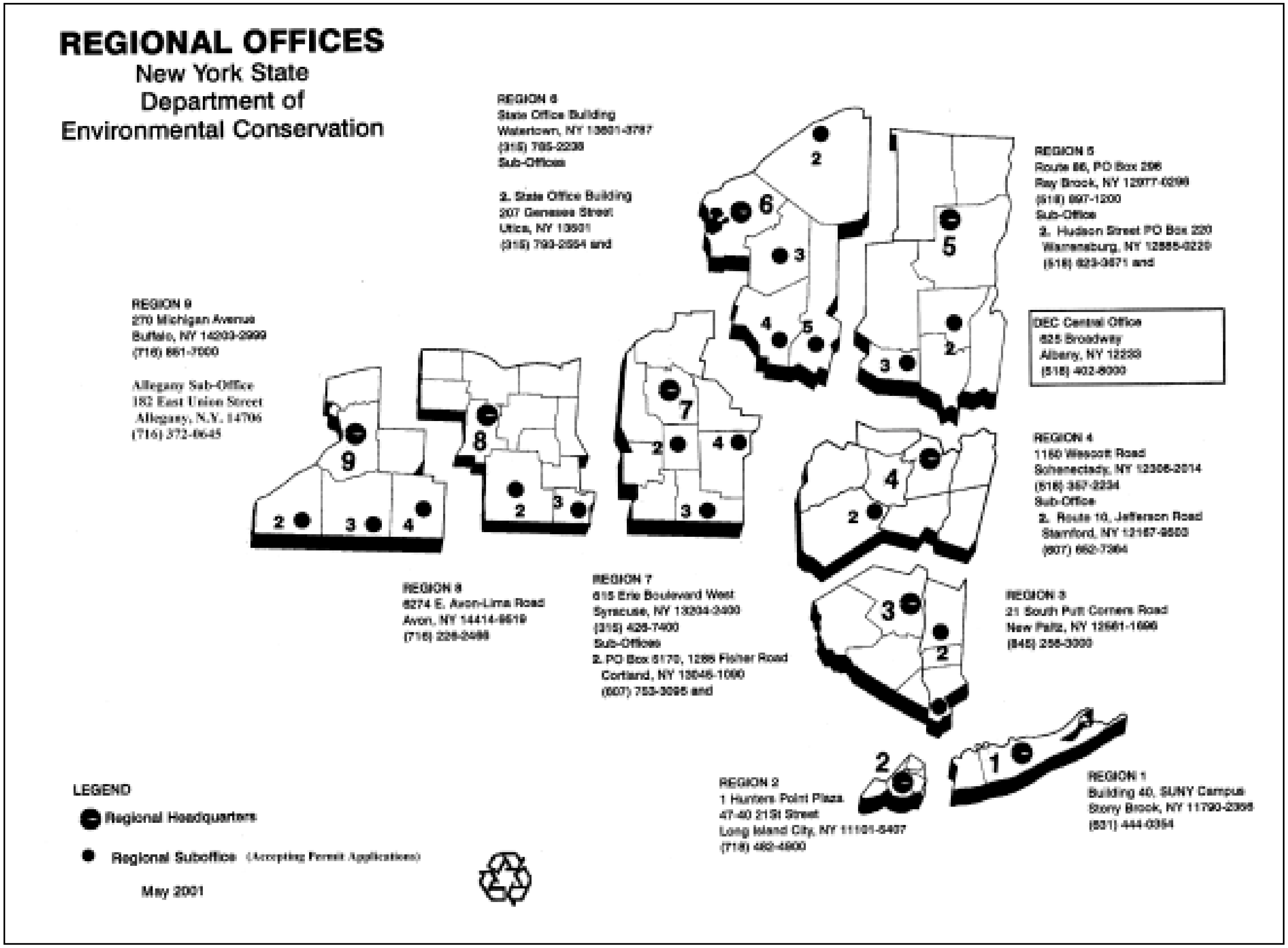
Carmans River
Connetquot River
Nissequogue River
Peconic River
Ramapo River
Shawangunk Kill
Ausable River
Fall Creek

- **State Environmental Quality Review Act (SEQR)**

Many projects are subject to SEQR. It is important that operators inform local governments about their projects and obtain necessary local approvals before starting work. Projects, for which only a general permit is needed, are not subject to SEQR. If any other permits are required, the applicant must submit applications, which are reviewed in accordance with SEQR.

All agencies involved (state and local), must consider the environmental impacts of construction projects before approving, funding, or directly undertaking an action. Development projects subject to SEQR will require an Environmental Assessment Form. If a project may have a significant environmental impact, an Environmental Impact Statement (EIS) will be required. Projects will require public involvement as a part of this process.

Figure 3.2 New York State Regional Contact Information



REGIONAL OFFICES
New York State
Department of
Environmental Conservation

REGION 6
State Office Building
Watertown, NY 13601-3787
(315) 785-2239
Sub-Offices

2. State Office Building
207 Genesee Street
Utica, NY 13501
(315) 793-2554 and

REGION 5
Route 86, PO Box 296
Ray Brook, NY 12977-0296
(518) 897-1200
Sub-Office
2. Hudson Street PO Box 220
Warrensburg, NY 12885-0220
(518) 623-3671 and

DEC Central Office
625 Broadway
Albany, NY 12233
(518) 402-8000

REGION 9
270 Michigan Avenue
Buffalo, NY 14203-2999
(716) 851-7000

Allegany Sub-Office
182 East Union Street
Allegany, N.Y. 14706
(716) 372-0645

REGION 4
1150 Wescott Road
Schenectady, NY 12306-2014
(518) 357-2234
Sub-Office
2. Route 10, Jefferson Road
Stamford, NY 12167-9503
(607) 652-7364

REGION 8
6274 E. Avon-Lima Road
Avon, NY 14414-9519
(716) 226-2466

REGION 7
615 Erie Boulevard West
Syracuse, NY 13204-2400
(315) 426-7400
Sub-Offices
2. PO Box 5170, 1285 Fisher Road
Cortland, NY 13045-1090
(607) 753-3095 and

REGION 3
21 South Putt Corners Road
New Paltz, NY 12561-1696
(845) 256-3000

REGION 2
1 Hunters Point Plaza
47-40 21St Street
Long Island City, NY 11101-5407
(718) 482-4900

REGION 1
Building 40, SUNY Campus
Stony Brook, NY 11790-2356
(631) 444-0354

LEGEND
● Regional Headquarters
● Regional Suboffice (Accepting Permit Applications)

May 2001