City of Cambridge, Massachusetts
Department of Public Works
147 Hampshire Street • Cambridge, MA 02139

Wastewater and Stormwater Management Guidance

Version 1
May 2008

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1. INTRODUCTION

1.1. What is Stormwater Management?

It wasn't long ago that stormwater management meant increasing the size of the stormwater drain to allow stormwater to drain from an area as quickly as possible. This approach often resulted in increased flooding, erosion and water quality problems. Originally, stormwater management was concerned with the quantity of water and the downstream flooding potential. Over the past 15 years there has been a growing concern with the quality of the stormwater runoff and its impacts on the environment. Today stormwater management is also associated with engineering and land management practices that incorporate into the design of a development measures that mitigate or abate soil erosion, pollution from stormwater runoff (nonpoint source pollution), and flood risks. Best Management Practices (BMPs) are stormwater management techniques that store and/or treat stormwater before (source controls) or after (end of pipe controls) they enter the stormwater drainage system.

1.2. Stormwater Management Objectives

The objective of this document is to provide guidance for construction projects and development and redevelopment projects in the City of Cambridge (City) to ensure that measures are taken throughout the project to address erosion, nonpoint source pollution, and flood control. These measures are necessary to protect the City of Cambridge's infrastructure, and natural Water Resources, and to ensure that the City complies with the provisions of the Clean Water Act and the City's permits issued by the U.S. Environmental Protection Agency (EPA) through their National Pollution Discharge Elimination System (NPDES) programs specific to stormwater (Phase II) and Combined Sewer Overflows (CSO). Water conveyed through the City's combined sewer and stormwater drainage systems to the Charles River, Little River, Alewife Brook and other water bodies within the City is regulated by these permits. Water Resources, as referred to throughout this Guidance document, are lakes, ponds, streams, rivers, wetlands, and groundwater.

The Cambridge Department of Public Works (DPW) requires development/redevelopment projects to provide on-site detention storage for the difference between the 2-year 24-hour storm event hydrograph and the 25-year 24-hour storm event hydrograph. The existing public stormwater drainage system can adequately convey a 2-year design storm, but in larger events the City has experienced flooding, backups and ponding in various locations. To this end, there are a number of traditional storage techniques (tanks and pipes) that are useful in achieving the required storage volumes; however these are less effective in terms of improving water quality. Replacing existing paved impervious areas with permeable green and vegetated open space can also create natural storage and lessen the required on-site storage. Such controls can also reduce the concentrations of pollutants in the stormwater and improve water quality. These controls can be broadly classified as Low Impact Development (LID) controls, and are discussed in more detail in Appendix A. LID controls and techniques are identified throughout this Guidance document with a water drop symbol (♦).

Urbanization increases the amount of pollution and runoff directed to local waterways. Redevelopment of property in highly impervious and urbanized areas represents an opportunity to begin to address the stormwater quality and quantity concerns for the City. This Guidance document will complement the City's planning, sewer separation and stormwater management construction efforts, and will provide property owners with strategies to manage stormwater discharged from their properties.

In several areas throughout the City, the jurisdiction of the Cambridge Conservation Commission, specifically as it relates to floodplain protections within the 1-percent-annual-chance flood zone, overlaps with the City's NPDES Phase II stormwater permit requirement. Nothing in this Guidance document should be construed as being in conflict with the provisions of the Wetland Protection Act or to be contrary or obstructive to the authority of the Cambridge Conservation Commission.

Guidance outlining required sanitary sewer improvements for all new redevelopment projects is also provided in this document. Future development cannot exacerbate existing CSO volumes or frequencies. Inflow and infiltration (I/I) and storage strategies are outlined so as to provide appropriate mitigation for new sanitary discharges.

1.3. Cambridge Watersheds

The City of Cambridge is approximately 7.1 square miles in size (6.4 square miles of land area, 0.7 square miles of water area) and is bounded by Boston on the east and south, Watertown and Belmont on the west, and Somerville and Arlington to the north. Land use in Cambridge is a mixture of commercial, residential, and industrial development. The Cambridge topography is relatively flat and drains water to two watersheds: the Mystic River (Boston Harbor) watershed and the Charles River watershed. Approximately 2.5 square miles lie within the Mystic River watershed and 4.6 square miles lie within the Charles River watershed. Important Cambridge water resources in the Mystic River watershed include Fresh Pond (the City's drinking water supply), the Little River, Alewife Brook, Wellington Brook, Blair Pond, and Blacks Nook. Important Cambridge water resources in the Charles River watershed include the Charles River and the Millers River. The Federal Emergency Management Agency (FEMA) defined 1-percent-annual-chance and 0.2-percent-annual-chance floodplains in the areas of these water resources in 1982. Some of these boundaries are currently under re-examination by FEMA and are expected to be expanded and affect more of the City.

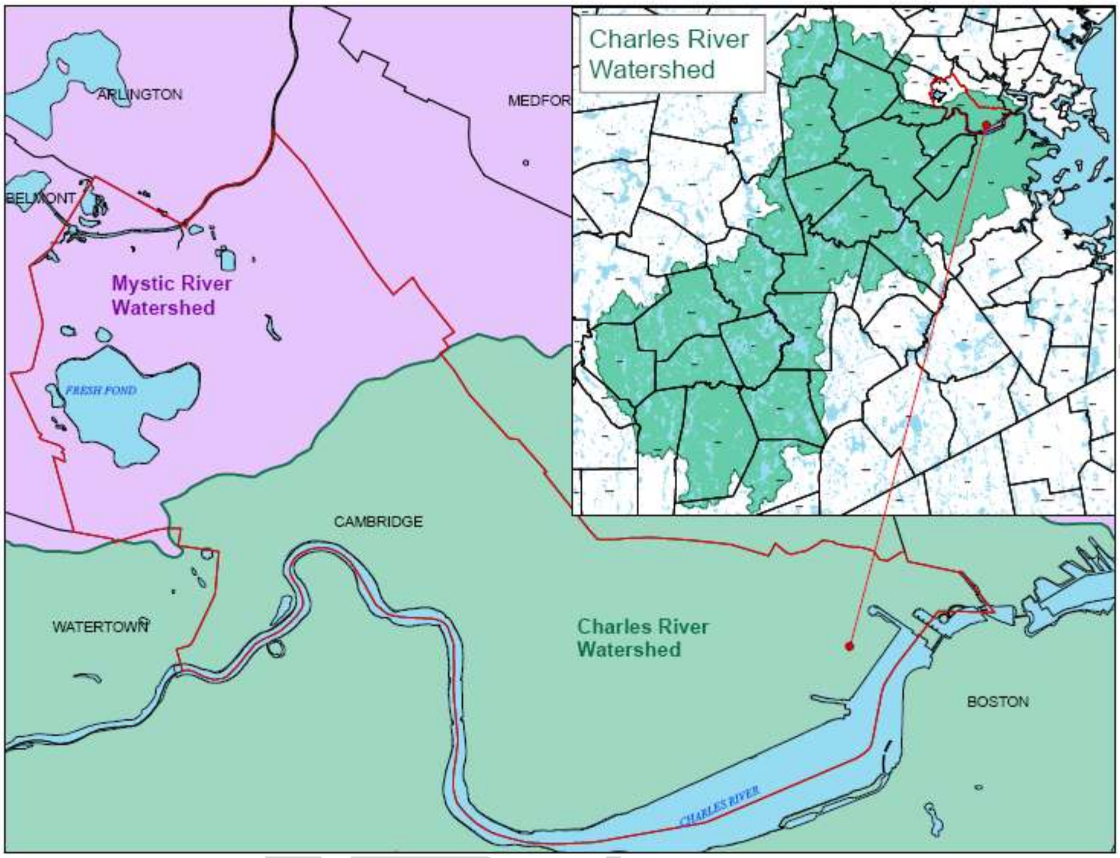
The Massachusetts Department of Environmental Protection (MA DEP) has determined that water quality in the Mystic and Charles River watersheds is degraded due to CSOs, illicit connection of sewage to stormwater drains, failing sewer infrastructure, and stormwater runoff . The City is addressing water quality concerns through its programs to reduce CSO activations and to improve stormwater management. The City, in partnership with the Massachusetts Water Resources Authority (The MWRA), is implementing a program to reduce and control CSO discharges to both the Charles River and Alewife Brook. This is being accomplished through separating combined sewer areas within the City, installing floatables control mechanisms at CSOs and constructing other system relief structures. Since 1996 the City of Cambridge has programmatically removed illicit connections from its separated stormwater systems. The City is presently in the middle of a second generation confirmation survey, implemented in accordance with EPA's recommendations, reassessing stormwater systems to ensure no further illicit connections exist or have been created. Cambridge is also addressing its stormwater quality issues through the construction of stormwater BMPs within its drainage system and through the implementation of a stormwater management plan developed in compliance with the EPA's NPDES Phase II Rule for Municipal Separate Storm Sewer Systems (MS4). The NPDES Phase II program was generated from the Clean Water Act (1972) and was created to improve the quality of local surface waters by reducing the quantity of pollutants in stormwater runoff. Pollution from stormwater runoff is a leading cause of degraded water bodies in Massachusetts. Pollutants parameters of concern and the corresponding watershed locations are provided in Section 1.6.

1.3.1. Charles River Watershed

The Charles River Watershed has an area of approximately 308 square miles, encompassing 35 communities. The Charles River flows 80 miles along a winding path from Echo Lake in Hopkinton to Boston Harbor. The river is fed by 80 brooks and streams and several aquifers including Mill River, Mine Brook, and Muddy River. The watershed also contains some 33 lakes and ponds – most of them are manmade. Industrialization of the river with dams and mills, expansion of the population along the river, and the inevitable development and reduction in pervious surfaces increased pollution and poor water quality in the river. At one time the US EPA rated the Charles River water quality a "D", but with successful efforts by many organizations, by 2005 the river had earned a grade of "B+". As the suburbs of Boston continue to grow, increased demand for drinking water and wastewater and stormwater drainage system operations continue to affect the Charles River and the watershed. The Charles River watershed is the most densely populated watershed in New England, and development throughout the watershed is still a concern. The City of Cambridge is actively seeking ways to ensure that imperviousness is reduced and that stormwater runoff is treated prior to reaching the

Charles River. Currently, approximately 63% of the Cambridge portion of the watershed is impervious.

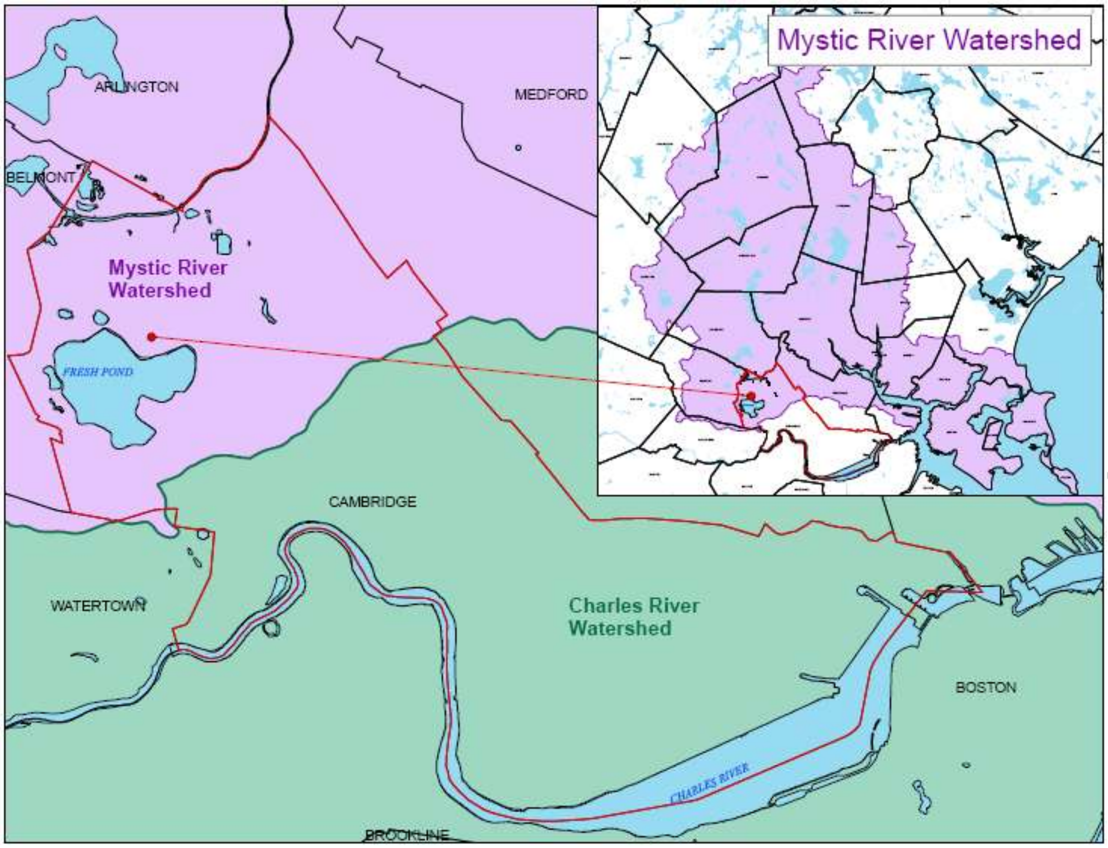
Figure 1-1: Overall Charles River Watershed



1.3.2. Mystic River Watershed

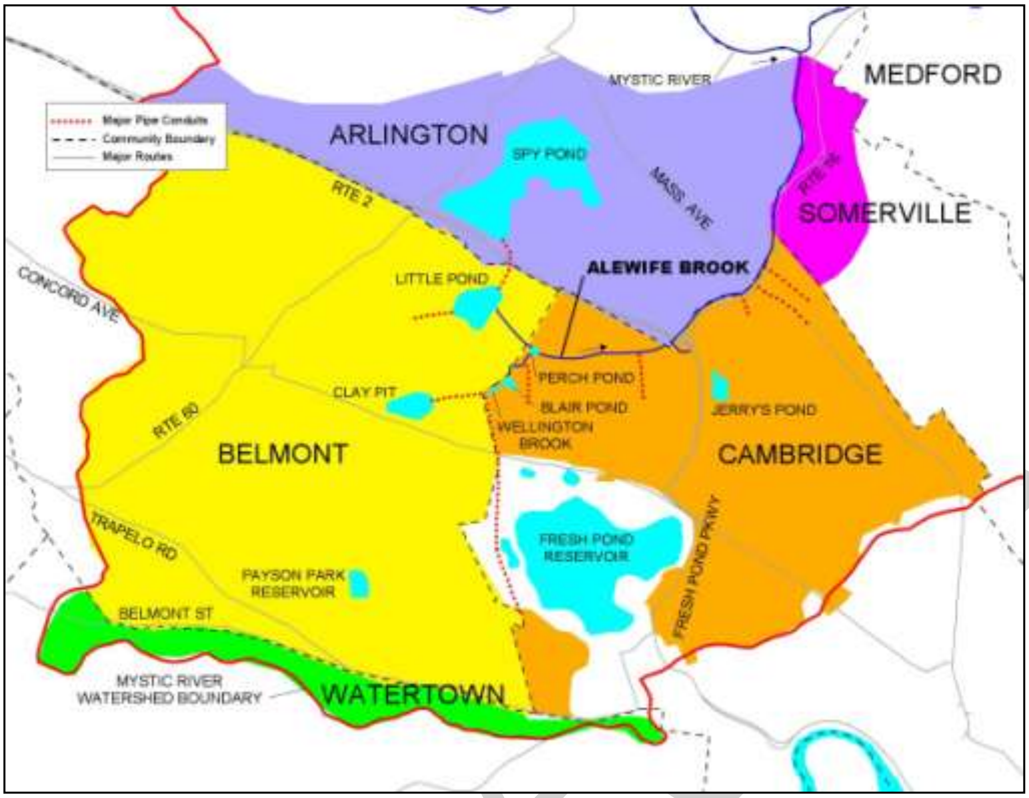
The Mystic River Watershed has an area of approximately 76 square miles, encompassing 21 communities north and west of Boston. The headwater of the system begins in Reading and from the Aberjona River, which flows through several towns before emptying into Boston Harbor. Main tributaries to the Mystic River include Mill Brook, Alewife Brook, Malden River, and Chelsea Creek. The Mystic River watershed is home to approximately 8% of the state's population in less than 1% of its land area; the Mystic is one of the most densely populated and urban watersheds in Massachusetts. Approximately 49% of the Cambridge portion of the Mystic River Watershed is impervious.

Figure 1-2: Overall Mystic River Watershed



The Alewife Brook sub-watershed lies in the southwest portion of the overall Mystic River watershed. The majority of the 8.5 square mile Alewife Brook sub-watershed lies within three communities: Arlington (20%), Belmont (39%) and Cambridge (29%), with the balance of the area falling within portions of Somerville, Watertown, and Medford. Figure 1-3 illustrates the portions of the sub-watershed in each community. The Alewife Brook flows northeasterly to the confluence with the Mystic River, which discharges into Boston Harbor. The area draining to the Alewife Brook is primarily a residential urban area. Some commercial and industrial portions also lie within the basin, mainly near the northern Cambridge border. The shape of the sub-watershed is essentially that of a bowl. The steeper sloped areas of the system characterize the western, eastern and southern fringes, and the central area is predominantly flat. The system has very little topographic relief; the primary relief point being the Alewife Brook. In addition to its topography, the other principal natural hydrologic feature of the watershed is the various ponds: Spy Pond, Little Pond, Blair Pond, and Clay Pit Pond in a culvert. Little Pond in Belmont is at the upstream end of the Little River and is 18 acres (0.3 square miles) in extent. Clay Pit Pond in Belmont flows toward Blair Pond in Cambridge via Wellington Brook. Blair Pond is connected to Little Pond/Little River by the continuation of Wellington Brook.

Figure 1-3: Alewife Brook Sub-watershed



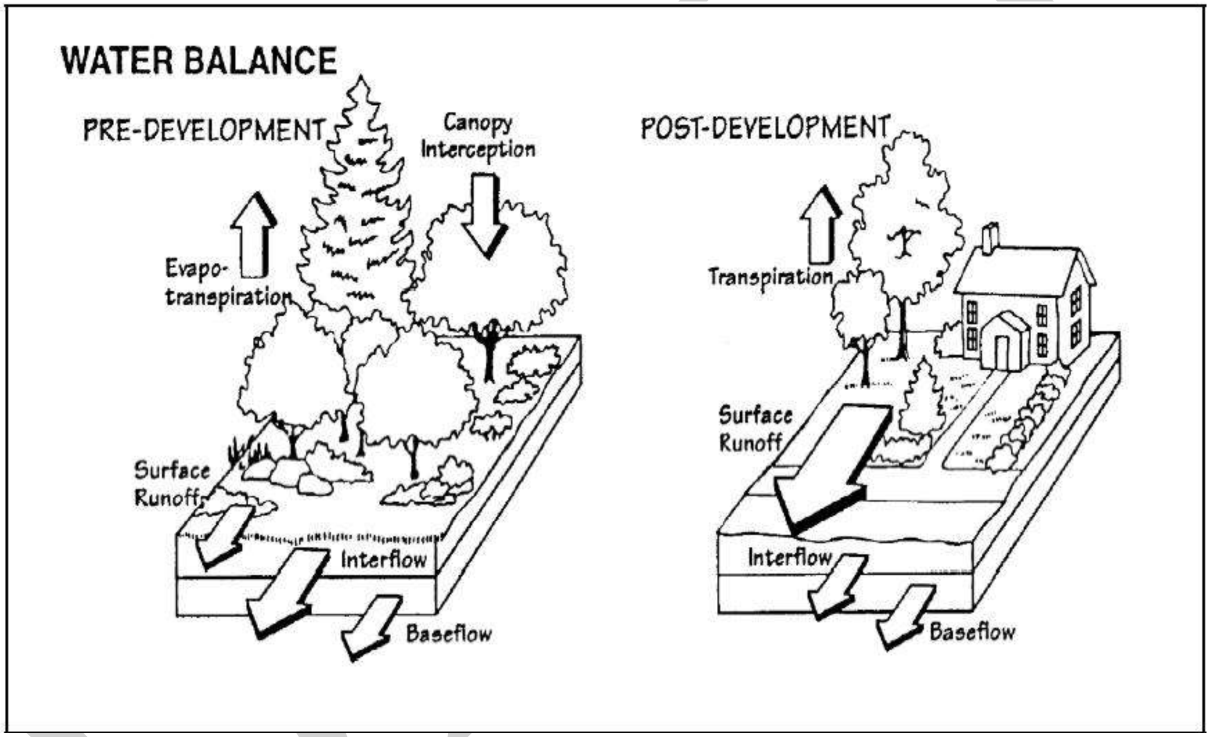
1.3.3. Effects of Development on the Watersheds

Urbanization of the sub-watershed communities has fundamentally changed the natural hydrologic characteristics of the area. Natural detention and storage of stormwater in marshes, wetlands, forests or undeveloped areas has been largely eliminated and replaced by impervious surfaces with constructed drainage systems. Development of impervious surfaces has increased the demand on the constructed drainage system. Movement of peak stormwater discharges through the system is limited by the conveyance rate and capacity of the trunk line pipes. Water that once soaked into the ground or was trapped in marshland now runs off impervious surfaces and into constructed drainage systems. Thus, ponding and flooding problems occur throughout the municipal system as a result of flat topography and limited conveyance capacity. It is important to note that the Alewife Brook has always experienced flooding, even prior to the development of the contributing municipalities, and a large portion of the Charles watershed in Cambridge was reclaimed tidelands created out of land once part of the marsh and mud flats of the former tidal Charles River.

1.4. Hydrologic Impacts of New Development

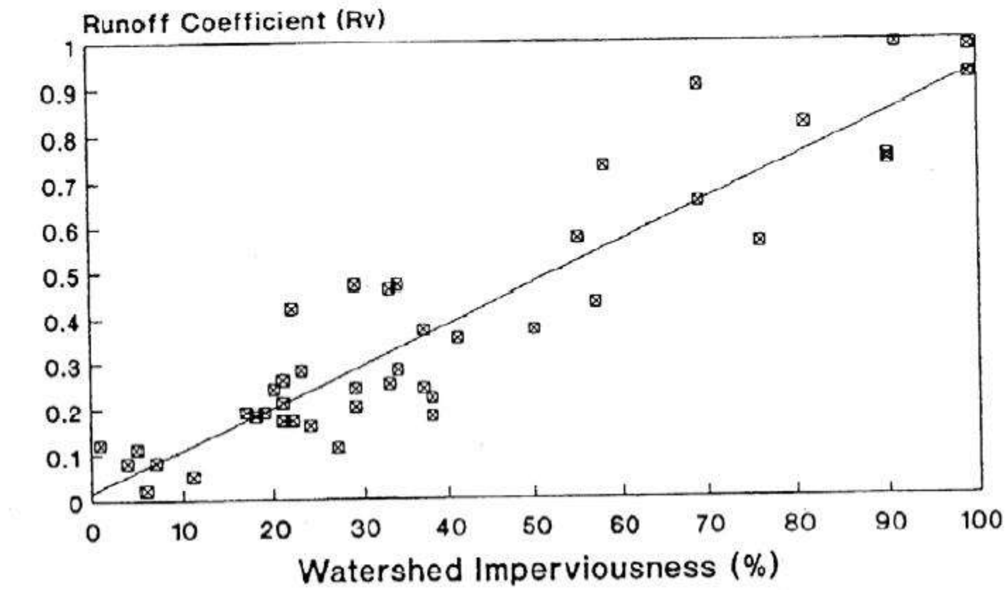
Urban development has a profound influence on the conveyance quantity and quality of receiving waters. Development can dramatically alter the local hydrologic cycle (See Figure 1-4). The hydrology of a site changes during the initial clearing and grading that occurs during construction. Trees that had intercepted and stored rainfall are removed and natural depressions (i.e. wetlands and marsh areas) that had temporarily ponded water are graded to a uniform slope. Having lost its natural storage capacity, a cleared and graded site can no longer prevent rainfall from being rapidly converted into stormwater runoff.

Figure 1-4: Water Balance at a Developed and Undeveloped Site (Schueler, 1987)



The situation can worsen 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. Figure 1-5 shows the increase in the volumetric runoff coefficient as a function of site imperviousness. The runoff coefficient expresses the fraction of rainfall volume that is converted into stormwater runoff. For example, a one-acre parking lot can produce 16 times more stormwater runoff than a one-acre meadow each year (Schueler, 1994).

Figure 1-5: Relationship Between Impervious Cover and Runoff Coefficient (Schueler, 1987)



The increase in stormwater runoff can be too much for the existing local stormwater drainage system to handle. As a result, the stormwater drainage system is often "improved" to rapidly collect runoff and quickly convey it away (using curb and gutter, enclosed stormwater drainage pipes, and lined channels). The stormwater runoff is subsequently discharged to downstream receiving waters, such as the Alewife Brook and the Charles River in Cambridge.

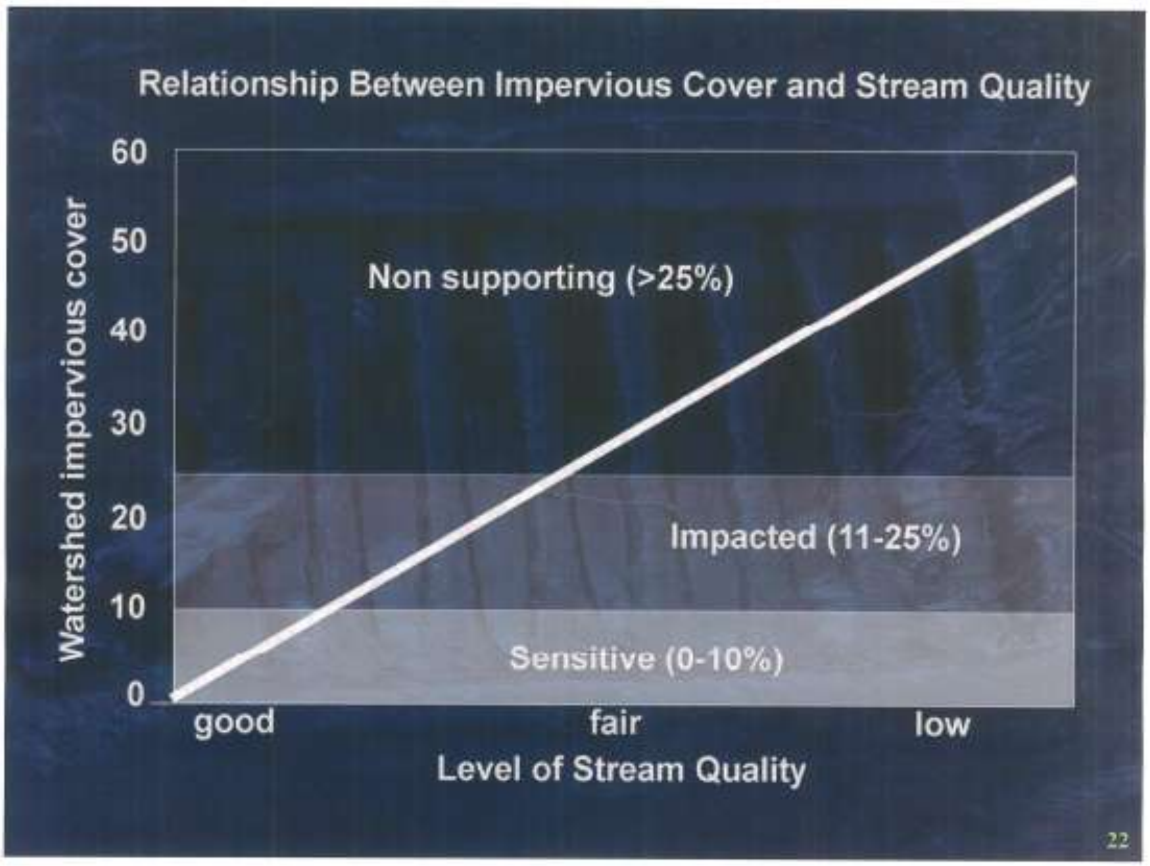
Development within the floodplain of a river can increase flood impacts beyond those previously mentioned. New structures constructed within the floodplain may displace floodwaters such that the elevation of those waters increases, exacerbating flood conditions elsewhere. Conservation Commissions are empowered to require development within the prescribed 1-percent-annual-chance floodplain to provide unrestricted access to compensatory storage volume on a per-foot basis as a flood rises to the 100-year event elevation, as established by FEMA. The City of Cambridge requires a special permit for building in a floodplain.

1.5. Water Quality Concerns from Development

Surfaces accumulate pollutants deposited from the atmosphere, leaked from vehicles, windblown from adjacent areas, or left behind by humans and/or animals. During storm events, these pollutants quickly wash off impervious surfaces, and are rapidly delivered to downstream waters. Pollutants originate from varying sources including industrial and residential parking areas, roadways, automobile service stations, sewer infiltration from leaking pipes, accidents and spills, parks and residential/commercial lawns, construction sites, and active and inactive industrial sites.

Highly developed areas with greater percentages of impervious cover create the potential for high concentrations of pollutants in stormwater runoff and surface waters that are more readily degraded. As seen in Figure 1-6, research indicates that increased imperviousness results in increased impacts on surface water quality.

Figure 1-6: Relationship Between Impervious Cover and Stream Quality



Source: EPA Webcast: "Post-Construction Overview and Introduction to Smart Growth and Low Impact Development," March 16, 2006

Some common pollutants found in urban stormwater runoff are profiled in Table 1-1. Appendix B provides more detail with regard to these pollutants.

Table 1-1.
National Median Concentrations for Chemical Constituents in Stormwater

Constituent (Units)	Source of Data (% detection)	Concentration (Mean)	Concentration (Median)	Number of Events
Total Suspended Solids (mg/l)	Pooled NURP/USGS[1]	78.4	54.5	3047
Total Phosphorus (mg/l)	Pooled NURP/USGS[1]	0.315	0.259	3094
Soluble Phosphorus (mg/l)	Pooled NURP/USGS[1]	0.129	0.103	1091
Total Nitrogen (mg/l)	Pooled NURP/USGS[1]	2.39	2.00	2016
Total Kjeldhal Nitrogen (mg/l)	Pooled NURP/USGS[1]	1.73	1.47	2693
Nitrite and Nitrate (mg/l)	Pooled NURP/USGS[1]	0.658	0.533	2016
Copper (Ug/l)	Pooled NURP/USGS[1]	13.35	11.1	1657
Lead (Ug/l)	Pooled NURP/USGS[1]	67.5	50.7	2713
Zinc (Ug/l)	Pooled NURP/USGS[1]	162	129	2234
BOD (mg/l)	Pooled NURP/USGS[1]	14.1	11.5	1035
COD (mg/l)	Pooled NURP/USGS[1]	52.8	44.7	2639
Organic Carbon (mg/l)	Nationwide Stormwater Inflow[5]		11.9	19
Cadmium (Ug/l)	NURP[4]	0.7		150
Chromium (Ug/l)	Dallas-FW NPDES[2]	4		32
PAH (mg/l)	Four urban catchments[3]	3.5		NA
Oil and Grease (mg/l)	NURP[4]	3.0		NA
Fecal Coliform (col/100 ml)	Nationwide Stormwater Inflow[5]	15,038		34
Fecal Strep (col/100 ml)	Nationwide Stormwater Inflow[5]	35,351		17
Cryptosporidium (organisms)	NY[6]	37.2	3.9	78
Giardia (organisms)	NY[6]	41.0	6.4	78
MTBE (Ug/l)	National Study 16 cities[7]		1.6	592
Chloride (snowmelt) (mg/l)	Minnesota[8]		116	49
Diazonon (Ug/l)	Stormflow[2] (92% - residential only)		0.55	76

Source: Stormwater Best Management Practices Design Guide Volume 1, United States Environmental Protection Agency, September 2004. US EPA cites these sources: (1) Smullen and Cave 1998, (2) Brush et al. 1995, (3) Rabanal and Grizzard 1995, (4) Crunkilton et al. 1996, (5) Schueler 1999, (6) Stern et al. 1996, (7) Delzer 1996, (8) Oberts 1999.

1.6. Pollutants of Concern for Cambridge

In 2004, the MA DEP listed four surface waters in Cambridge as *"Impaired and requiring one or more Total Maximum Daily Loads (TMDL)"*. The following surface waters were listed: the Alewife Brook from the Little River in Belmont to the confluence of the Mystic River in Arlington/Somerville, Blacks Nook in Cambridge, the Charles River from the Watertown Dam in Watertown to the Science Museum in Boston, and the Unnamed Tributary also known as Millers River from the headwaters to the confluence with the Charles River in Cambridge. These listings as impaired waterways were reviewed and approved by the EPA. The "Pollutants of Concern" specific to these Water Resources are listed below. These were developed by MA DEP from visual inspection and water quality sampling survey data. This Guidance document will continue to be updated to reflect evolving Federal and State water quality requirements specific to the TMDL rule.

Table 1-2.
Impaired City Waters and Pollutants Needing a TMDL

Surface Water	Watershed	Pollutants Needing TMDL
Alewife Brook	Mystic River	Metals Nutrients Objectionable sediments (solids) Oil and grease Organic enrichment/Low dissolved oxygen Pathogens Taste, odor and color
Blacks Nook	Mystic River	Noxious aquatic plants Nutrients
Charles River	Charles River	Metals Nutrients Noxious aquatic plants Oil and grease Organic enrichment/Low dissolved oxygen Pathogens Priority organics Taste, odor and color Turbidity Unknown toxicity
Unnamed Tributary/Millers River	Charles River	Metals Oil and grease Priority organics Taste, odor and color

Source: Final Massachusetts Year 2004 Integrated List of Waters, MA DEP.

Once a water body is identified as impaired, MA DEP is required by the Federal Clean Water Act to develop a "pollutant budget" for each of the pollutants of concern. The pollutant budget is designed to restore the health of the impaired body of water. TMDLs are designed to limit the maximum amount of the identified pollutant that can be discharged to a specific water body to meet water quality standards, and assign pollutant load allocations to the sources.

As of the date of this document, two TMDLs have been set for the Charles River Watershed:

- Final Phosphorus TMDL for the Lower Charles River Basin
- Final Pathogen TMDL for the Charles River Watershed

And, a draft TMDL has been developed for the Mystic River Watershed (which is part of the larger watershed area that drains to Boston Harbor):

- Draft Pathogen TMDL for Boston Harbor Watershed

More detailed information about these TMDLs can be found in Appendix C.

Pollutants of concern and TMDLs in Cambridge can begin to be addressed through BMP selection as discussed in more detail in Section 3. Table 1-3 can be used along with Section 3 and Appendix A for BMP selection.

Table 1-3.
Common Pollutants Quick Reference Guide for BMP Selection

Pollutant of Concern	BMP Selection
Metals	1.1 Street and Parking Lot Sweeping 1.2 Snow Removal and Deicing 1.3 Lawn and Grounds Maintenance 1.4 Materials and Waste Management 1.5 ♠Roof Garden 3.5 ♠Vegetated Filter Strip 4.1 ♠Bioretention Area (including Rain Gardens) 4.2 Constructed Stormwater Wetland 4.3 Extended Dry Detention Basin 4.4 ♠Gravel Wetland 4.5 Proprietary Media Filter (varies) 4.6 Sand/Organic Filter 4.8 Wet Basin 5.1 ♠Dry Well 5.2 ♠Infiltration Basin 5.3 ♠Infiltration Trench 5.5 Subsurface Structure 6.2 ♠Grassed Channel/Biofilter Swale 6.3 Water Quality Swale 7.4 Catch Basin Insert (varies)
Noxious Plants	Mechanical Harvesters Beetles

Pollutant of Concern	BMP Selection
Nutrients	1.1 Street and Parking Lot Sweeping 1.2 Snow Removal and Deicing 1.3 Lawn and Grounds Maintenance 1.4 Materials and Waste Management 1.5 ♠Roof Garden 4.1 ♠Bioretention Area (including Rain Gardens) 4.2 Constructed Stormwater Wetland 4.4 ♠Gravel Wetland 4.5 Proprietary Media Filter (varies) 4.8 Wet Basin 5.1 ♠Dry Well 5.2 ♠Infiltration Basin 5.3 ♠Infiltration Trench 5.5 Subsurface Structure 6.3 Water Quality Swale 7.4 Catch Basin Insert (varies)
Objectionable Deposits/Turbidity (TSS)	1.1 Street and Parking Lot Sweeping 1.2 Snow Removal and Deicing 1.3 Lawn and Grounds Maintenance 1.4 Materials and Waste Management 1.5 ♠Roof Garden 3.1 Deep Sump Catch Basin with Hood 3.2 Oil/Grit Separator 3.3 Proprietary Separator 3.4 Sediment Forebay 3.5 ♠Vegetated Filter Strip 4.1 ♠Bioretention Area (including Rain Gardens) 4.2 Constructed Stormwater Wetland 4.3 Extended Dry Detention Basin 4.4 ♠Gravel Wetlands 4.5 Proprietary Media Filter (varies) 4.6 Sand/Organic Filter 4.7 ♠Treebox Filter 4.8 Wet Basin 5.1 ♠Dry Well 5.2 ♠Infiltration Basin 5.3 ♠Infiltration Trench 5.4 Leaching Catch Basin 5.5 Subsurface Structure 6.2 ♠Grassed Channel/Biofilter Swale 6.3 Water Quality Swale 7.2 ♠Porous Pavement 7.4 Catch Basin Insert (varies)

Pollutant of Concern	BMP Selection
Oil and Grease	1.1 Street and Parking Lot Sweeping 1.2 Snow Removal and Deicing 1.3 Lawn and Grounds Maintenance 1.4 Materials and Waste Management 1.5 ♦Roof Garden 3.1 Deep Sump Catch Basin with Hood 3.2 Oil/Grit Separator 3.3 Proprietary Separator 3.5 ♦Vegetated Filter Strip 4.1 ♦Bioretention Area (including Rain Gardens) 4.2 Constructed Stormwater Wetland 4.3 Extended Dry Detention Basin 4.4 ♦Gravel Wetland 4.5 Proprietary Media Filter (varies) 4.6 Sand/Organic Filter 4.8 Wet Basin 5.1 ♦Dry Well 5.2 ♦Infiltration Basin 5.3 ♦Infiltration Trench 6.2 ♦Grassed Channel/Biofilter Swale 6.3 Water Quality Swale 7.4 Catch Basin Insert (varies)
Organic Enrichment/Low Dissolved Oxygen	1.1 Street and Parking Lot Sweeping 1.2 Snow Removal and Deicing 1.3 Lawn and Grounds Maintenance 1.4 Materials and Waste Management 1.5 ♦Roof Garden 4.2 Constructed Stormwater Wetland 4.4 ♦Gravel Wetland 4.5 Proprietary Media Filter (varies) 4.8 Wet Basin 5.1 ♦Dry Well 5.2 ♦Infiltration Basin 5.3 ♦Infiltration Trench 5.5 Subsurface Structure 6.2 ♦Grassed Channel/Biofilter Swale 6.3 Water Quality Swale 7.4 Catch Basin Insert (varies)

Pollutant of Concern	BMP Selection
Pathogens	1.3 Lawn and Grounds Maintenance 1.4 Materials and Waste Management 1.5 ♦Roof Garden 4.2 Constructed Stormwater Wetland 4.3 Extended Dry Detention Basin 4.4 ♦Gravel Wetland 4.5 Proprietary Media Filter (varies) 4.6 Sand/Organic Filter 4.8 Wet Basin 5.1 ♦Dry Well 5.2 ♦Infiltration Basin 5.3 ♦Infiltration Trench 7.4 Catch Basin Insert (varies)
Priority Organics	1.1 Street and Parking Lot Sweeping 1.2 Snow Removal and Deicing 1.3 Lawn and Grounds Maintenance 1.4 Materials and Waste Management 1.5 ♦Roof Garden 3.5 ♦Vegetated Filter Strip 4.1 ♦Bioretention Area (including Rain Gardens) 4.2 Constructed Stormwater Wetland 4.3 Extended Dry Detention Basin 4.4 ♦Gravel Wetland 4.5 Proprietary Media Filter (varies) 4.6 Sand/Organic Filter 4.8 Wet Basin 5.1 ♦Dry Well 5.2 ♦Infiltration Basin 5.3 ♦Infiltration Trench 5.5 Subsurface Structure 6.2 ♦Grassed Channel/Biofilter Swale 6.3 Water Quality Swale 7.4 Catch Basin Insert (varies)
Taste, Odor, and Color	Assumed to be removed when BMPs achieve Removal Standards in Section 3

The water quality standard designates the most sensitive uses for which the surface waters will be enhanced, maintained and protected, prescribes minimum water quality criteria to sustain the designated uses, and includes prohibition of discharges (MA DEP 1996). The Alewife Brook and the Charles River are currently under a variance to the water quality standard until September 1, 2010 and October 1, 2010 respectively. The Alewife Brook and the Charles River are classified as Class B_{CSO} waters. Class B_{CSO} waters are designated as habitat for fish, other aquatic life and wildlife, and for primary and secondary contact recreation, but permit short-term impairment of swimming or other recreational uses due to CSO discharges. Primary and secondary uses are supported through most of their annual period of use. A B_{CSO} classification allows limited CSO discharges until MA DEP has the information necessary to determine the appropriate water quality standard and level of CSO control for the receiving water. Presently there are eight (8) permitted CSOs along the Little River/Alewife Brook, of which six (6) are permitted to the City of Cambridge, one (1) to the City of Somerville and one (1) to The MWRA. There are currently seven (7) permitted CSOs along the Charles River, of which five (5) are permitted to the City of Cambridge and two (2) to The MWRA.

The MWRA has developed a long-term CSO control plan to reduce and eliminate CSOs throughout its sewer system including areas within the Alewife Brook and Charles River. MWRA's long-term control plan was recommended in the Final CSO Facilities Plan and Environmental Impact Report (1997) and has been modified by subsequent Notice of Project Change, Supplemental Environmental Impact Reports and other regulatory filings. The proposed level of CSO control for the Alewife Brook was revised and is detailed in the MWRA's Notice of Project Change for the Long Term CSO Control Plan for Alewife Brook (April 2001) and the Response to Comments on the Notice of Project Change for the Long Term CSO Control Plan for Alewife Brook (May 2003). A Federal District Court Order in the Boston Harbor Case has established a timetable giving the MWRA until the year 2020 to implement and complete the CSO work and monitoring. Cambridge has partnered with the MWRA to implement the long-term CSO control projects within the City of Cambridge. It is anticipated that EPA and MA DEP will extend the water quality variances for the Alewife Brook and the Charles River until 2020.

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2. CAMBRIDGE HYDROLOGY

2.1. Overview

The City of Cambridge is shown in Figure 2-1. The City is approximately 7.1 square miles, and approximately 4.1 square miles of the area is impervious. The average imperviousness of the area is 58%.

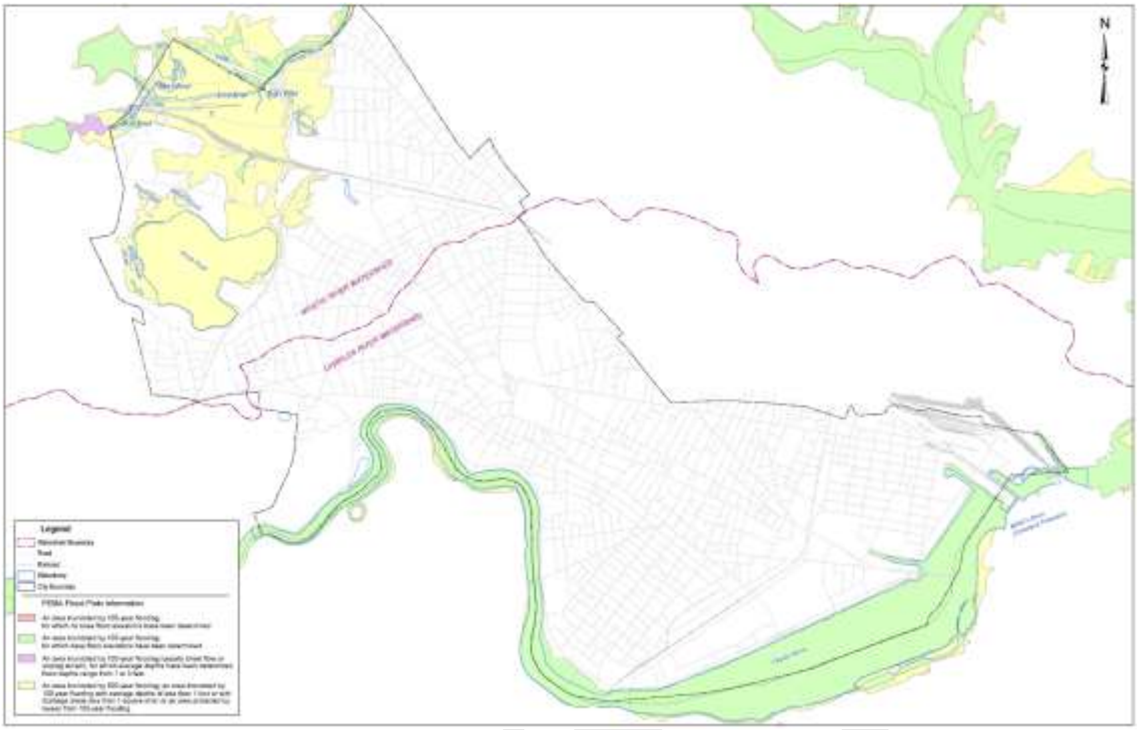
Subcatchments were delineated in the City for the purpose of hydrologic/hydraulic analysis and are shown in Figure 2-1. Figure 2-1 shows the average imperviousness for each subcatchment. Figure 2-2 shows a histogram of the imperviousness of the area, based on the subcatchments. Approximately XX% of the City has imperviousness between XX% and XX%.

Figure 2-1: Impervious Area in Cambridge

Figure 2-2: Histogram of Imperviousness for Cambridge

Most of Cambridge is highly urbanized and contributes significant runoff to the Alewife Brook and Charles River drainage basins. These drainage basins have floodplains associated with them and development within the floodplains is regulated by the City of Cambridge Conservation Commission and by the City of Cambridge Planning Board. The most recent significant flooding in Cambridge occurred in August 1955 during hurricane Diane. Moderate damage was sustained on the Wellington and Alewife Brooks and the Charles River. In 1979, construction of the new Charles River Dam at Warren Ave. in Boston was completed. The dam serves as a protection measure to control the level of the Charles River within Cambridge. It was designed to maintain a basin level of 4.35 feet during the 100-year flood, protecting properties and other infrastructure along the river. Figure 2-3 illustrates the delineation of the current FEMA 1-percent-annual-chance and 0.2-percent-annual-chance floodplains.

Figure 2-3: FEMA Floodplains



2.2. Soils

The soils found within Cambridge will dictate the types of stormwater management controls that can be put in place during development and redevelopment projects. For example, soils categorized as A or B by the National Resources Conservation Service (NRCS) are suitable for infiltration BMPs and will likely accommodate LID stormwater controls more readily than other soils.

The soils in the City of Cambridge consist mainly of urban fill. Historically, the Alewife Brook sub-watershed in Cambridge was mined for clays and as a result of the subsequent development most of the surface soils in the area were highly disturbed by cut and fill activities, leaving a significant quantity of urban fill in the area. Other areas throughout the City were affected by urbanization and development in the same way. Most of the soils now lack characteristics of naturally developed, undisturbed soils, such as defined layers and horizons, and their poor quality may serve as a constraint to restoration. Soil boring logs extracted as part of recent construction activities in the Alewife Brook sub-watershed in Cambridge, as well as onsite visual observations during previous construction projects confirm the nature of the majority of the soils in the area as being poorly draining with low permeability. These borings indicate the presence of 10-12 feet of poorly draining urban fill and peat/organic silt layers mixed together. These conditions will restrict the types of potential stormwater management controls for the area.

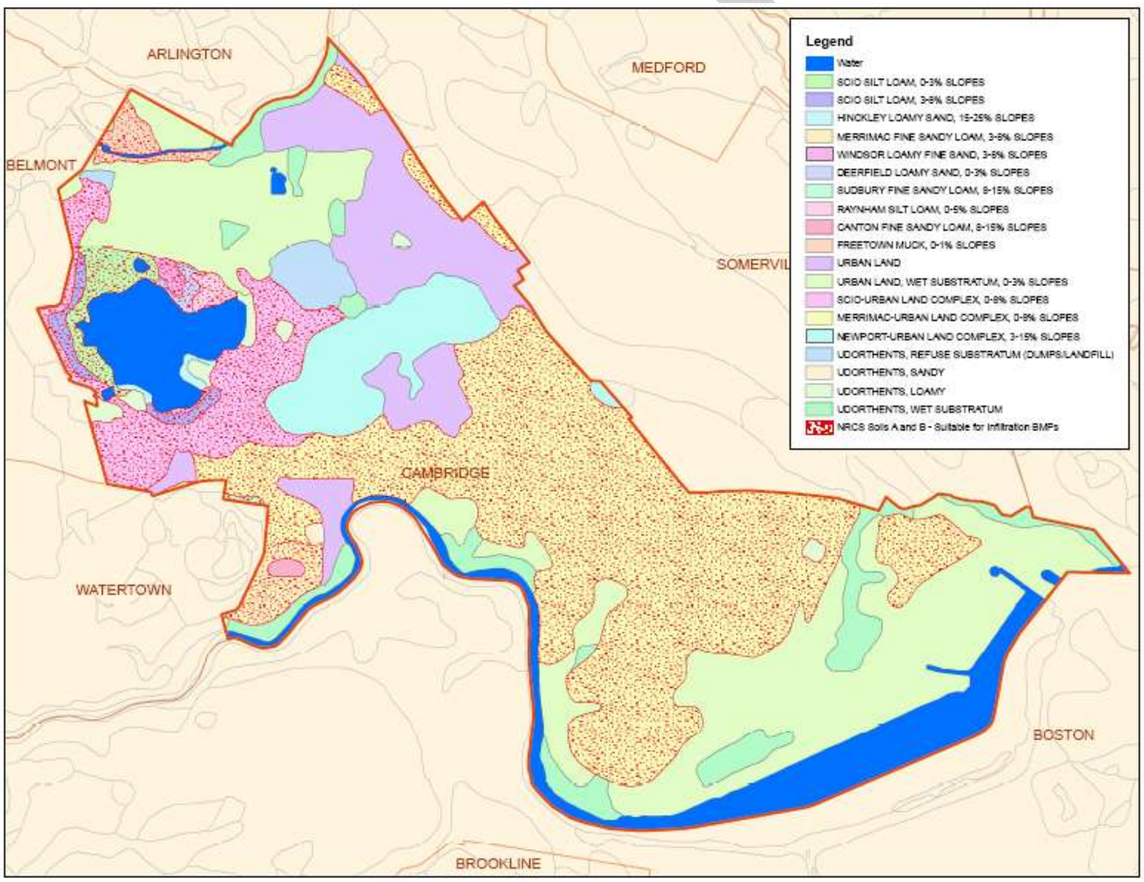
However, the central portions of Cambridge as well as areas surrounding Fresh Pond are made up of Merrimac-Urban Land Complex and sandy soils. These soils are classified as A and B by the NRCS. Table 2-1 shows soil type percentages found within the City and Figure 2-4 displays the different soil classifications found in the City and indicates which areas are appropriate for infiltration BMPs.

Table 2-1.
Soil Type Percentages

Soil Type	Area (mi^2)	Percent of Total Area
Soil Slope A	0.2	3%
Soil Slope B	2.8	45%
Other	3.4	53%
Total Soil Area (Land Area)	**6.4**	**100%**

Source: NRCS soils data layer from MassGIS.

Figure 2-4: Soils Map

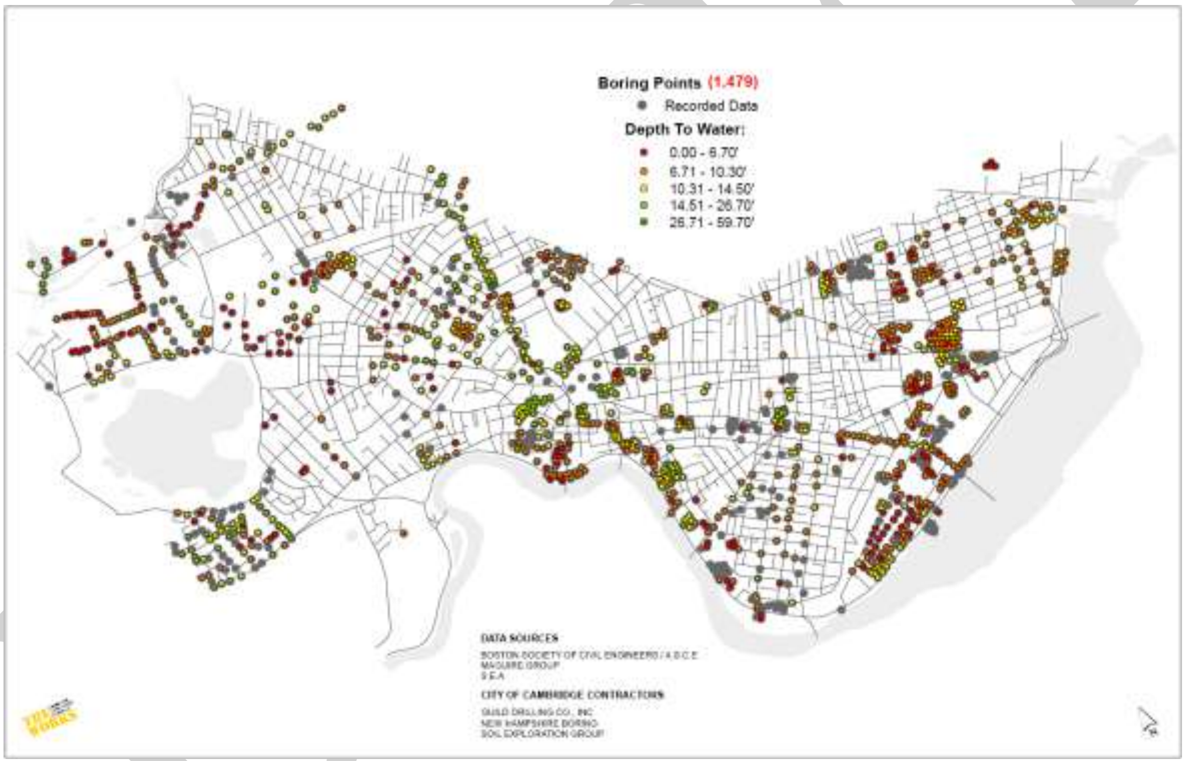


Source: Soils layer data from MassGIS.

2.3. Groundwater

Figure 2-5 depicts depth from ground surface to average groundwater table in the City. Groundwater levels were monitored throughout the Fresh Pond Reservation during the period of 1995-1997 (CDM). The average groundwater elevation observed at the monitoring station near Black's Nook adjacent to Concord Avenue was 4.4 ft NGVD. The range of measurements varied from 3.4 to 6.7 ft NGVD. The standard deviation of the observed levels at Black's Nook based on 17 readings was 1.1 feet. A groundwater elevation of 4.5 ft NGVD was noted at Wheeler Street just north of Concord Avenue during recent soil boring work conducted by the DPW. Long term monitoring wells (2001-2003) placed at the south of the end of Cambridgepark Drive and near Little River indicated an average groundwater elevation of 1.0 ft NGVD.

Figure 2-5: Depth to Groundwater



On the basis of this information average values of groundwater elevations throughout the Alewife Brook sub-watershed were linearly interpolated starting from 4.5 ft NGVD at Concord Avenue, 4.0 ft NGVD at Fawcett Street (south of the B&M railroad), 3.75 ft NGVD on the north side of the railroad tracks, 3.5 ft NGVD at Cambridgepark Drive, 2.0 ft NGVD at the Massachusetts Department of Conservation and Recreation's (DCR) access road, and 1.0 ft NGVD at Little River. It should be noted that this profile represents an average value interpolation with the potential to be higher during wet years.

The median groundwater depth in the Alewife Brook sub-watershed is 3.4 feet. The shallowness of the groundwater table in the Alewife Brook sub-watershed will limit the types of effective stormwater management techniques.

2.4. Water Quality

The degraded condition of wetlands along the Little River and Alewife Brook and continued development within the City means there are less effective means of buffering, treating, and storing stormwater naturally before it reaches the surface waters. The Charles River water quality has improved significantly in recent years (as discussed in Section 1.3), and work in the basins contributing runoff to the river continues. Recent projects by the MWRA, the Army Corps of Engineers, the cities of Somerville and Cambridge, and the towns of Belmont and Arlington have helped to protect the wetlands, increase public awareness in the City, reduce CSOs and eliminate illicit discharges to the City's waterways. These projects have contributed significantly to the improvement in water quality, and continuing projects will yield yet more improvements in the future.

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3. LAND DISTURBANCE REGULATIONS & STORMWATER CONTROL REQUIREMENTS

3.1. Introduction

Development and redevelopment projects in Cambridge are subject to the City's Wastewater and Stormwater Drainage System Ordinance and Land Disturbance Regulations. Land disturbance is any action that causes a change in the position, location, or arrangement of soil, sand, rock, gravel or similar earth material. Land disturbance includes exposing soil due to clearing, grading, or excavation activities. Land disturbance activities can change runoff flow patterns as well as the quantity and quality of stormwater discharging from a site. Stormwater quantity and quality control is required to the maximum extent practicable on all development/redevelopment (projects) in the City of Cambridge. Additionally, a Land Disturbance Permit is required for land disturbances that meet one or more of the following thresholds, unless deemed otherwise by the City Engineer:

1. Where the project disturbs one (1) or more acres of land.
2. Where the project exceeds fifty thousand (50,000) square feet of Gross Floor Area
3. Where the project parcel or parcels equals or exceeds one acre in size.
4. Where the project includes outdoor parking for 10 cars or more.
5. Where a Special Permit is required by the Planning Board.
6. Where, in the opinion of the City Engineer, project may result in adverse impact of the municipal Sewer, Combined Sewer, Stormwater Drainage Systems or Water Resources.[1]

Stormwater quantity and quality controls are not mutually exclusive, and in many instances the solutions specified for water quantity control provide significant water quality benefits as well. Generally, stormwater quality control can be achieved by a variety of stormwater storage and sedimentation techniques. Many of the controls specified in this Section have been adopted from the MA DEP's Stormwater Management Policy most particularly as they relate to water quality.

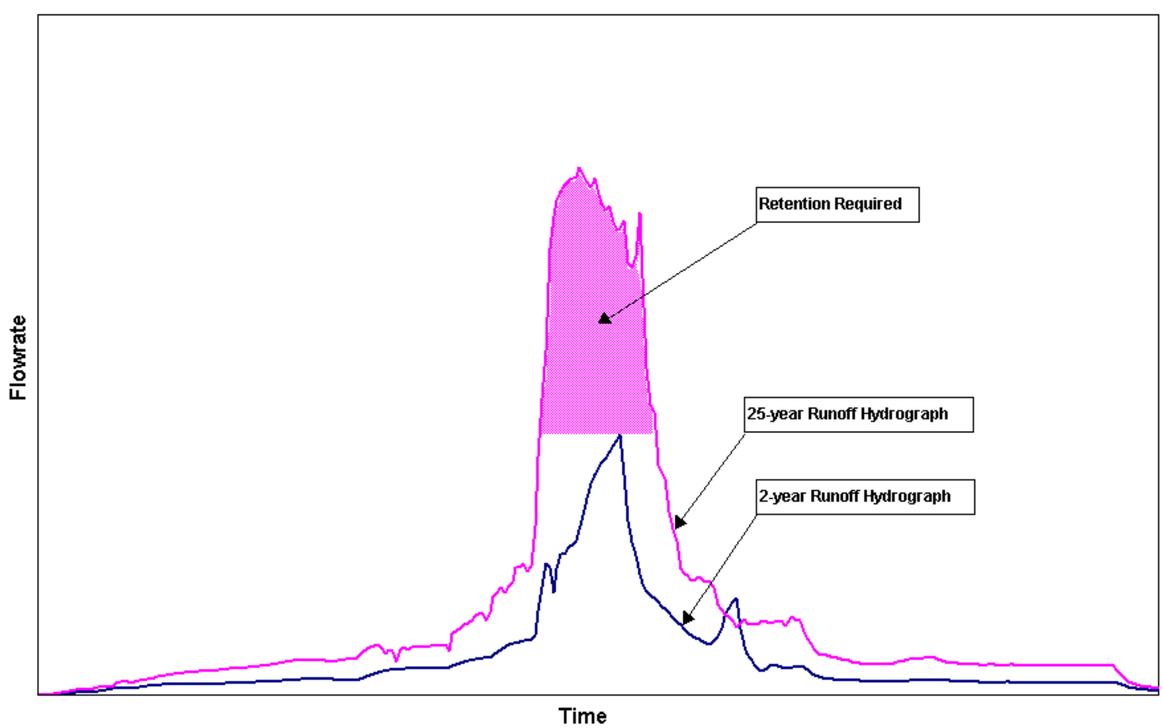
[1] The following scenarios are of most concern to the City: critical area adjacent to a resource area, hot spot runoff, increase in impervious area, sites with history of stormwater issues (high risk sites).

3.1.1. Water Quantity Controls

Acceptable water quantity controls must meet the following criteria:

1. Maximize the extent to which runoff from the project site is infiltrated to groundwater, providing that in so doing, soil and groundwater contamination is not exacerbated in accordance with MA DEP guidelines.
2. Store the difference between the 2-year 24-hour pre-construction runoff hydrograph from the site and the post construction 25-year 24-hour runoff hydrograph from the site, except in the Charles River Buffer Zone (1000 ft. zone). See Section 3.1.4 for detailed information on the Charles River Buffer Zone. As a general rule, for properties discharging in to the City of Cambridge municipal drainage system the City will provide a drainage level of service capacity to accept and transport up to the 2-year storm event. The stormwater runoff detention requirement states that the total volume of runoff generated between the pre-development 2-year 24-hour storm discharge and the post development 25-year 24-hour storm discharge shall be retained. Figure 3-1 illustrates this requirement with hypothetical stormwater runoff plots. The shaded area (the area between the peak 2-year runoff and the 25-year runoff) represents the quantity of stormwater retention required for achieving compliance with the City's stormwater quantity control rule.

Figure 3-1: Onsite Retention Requirements



7. In the Charles River Buffer Zone where flooding is not of concern, infiltrate at minimum the first inch of runoff from the project site to groundwater when soil and groundwater conditions allow.
8. Where soil conditions do not permit infiltration, provide alternative BMPs that ensure 80% removal of TSS from the site. Appropriately address pollutants of concern.
9. Ensure that the post-project peak discharge rates do not exceed the pre-project peak discharge rates (from the project area).
10. Ensure that stormwater runoff, as a result of the project, does not have a negative impact on abutting property.
11. Ensure that there will be no reduction in groundwater recharge as a result of the project.

These control requirements are in addition to those required for properties within the 1-percent-annual-chance floodplain, can be engineered to complement each other, and are discussed in more detail in Section 3.3.

3.1.2. Water Quality Controls

The runoff volume to be treated for water quality is based on the MA DEP Stormwater Management Policy. Acceptable water quality controls must meet the following criteria:

1. Treat the full water quality volume.
2. New development projects: Remove 80% TSS and 98% trash and floatables by following the prescribed stormwater runoff treatment train in accordance with the type of project and site conditions. Refer to Section 3.3 for more details.
3. Redevelopment projects: Be capable of TSS, trash and floatables removal to the maximum extent practicable (MEP).

For the purposes of this Guidance document, "to the maximum extent practicable (MEP)" will be defined as:

- Applicants have illustrated that they have made all reasonable efforts to meet the applicable requirements;
- They have made a complete evaluation of possible stormwater management measures which could be used on site including environmentally sensitive site design that minimizes land disturbance and impervious surfaces, LID techniques, and stormwater BMPs; and,
- If not in full compliance with the applicable requirements, they are implementing the highest practicable level of stormwater management.

The water quality runoff volume can be applied toward the total runoff quantity control volume to be retained onsite, provided the post-development peak discharge rate requirements are met.

With the exception of "stormwater hot spots" noted in Section 3.1.3, all treatment systems capable of satisfying the above requirements are also assumed to satisfy pollutant level criteria for other "pollutants of concern".

These control requirements are discussed in more detail in Section 3.3.

3.1.3. Stormwater Hot Spots

A stormwater hot spot is defined as a land use or activity that generates higher concentrations of hydrocarbons, trace metals or toxicants than are found in typical stormwater runoff. These hot spots are termed "land uses with higher potential pollutant loads" by the MA DEP. The hot spot designation has important implications for how stormwater is managed on site. Stormwater runoff from hot spots requires specific structural BMPs which have been determined to be suitable for treating discharges from such locations. Hot spot runoff can only be allowed to infiltrate into the ground after specific treatment requirements have been met. Planning considerations for hot spot runoff typically involve preparing and implementing a Stormwater Pollution Prevention Plan (SWPPP) that identifies operational practices to be implemented in order to reduce the generation of pollutants from a site and prevent pollutants from coming into contact with rainfall. The SWPPP[2] is a requirement of the General Permit for Storm Water Discharges from Construction Acitivites[3], which must be obtained from the EPA for all projects which disturb an acre or more of land. Specific BMPs which are suitable for treatment of hot spot runoff are discussed in Section 3.3. For both present and future conditions, the following land uses and activities within the City are considered typical stormwater hot spots:

- Areas within an industrial site that are the location of activities subject to the NPDES Multi-Sector General Permit (except where a No Exposure Certification for Exclusion from NPDES Stormwater Permitting has been executed).
- Vehicle salvage yards (auto recycler facilities)
- Vehicle fueling stations
- Exterior vehicle service, maintenance and equipment cleaning areas
- Exterior fleet storage areas (bus, truck, construction equipment yards)
- Commercial parking lots with high intensity use (1000 vehicle trips per day or more). Such areas typically include fast food restaurants, convenience stores, high turnover (chain) restaurants, shopping centers and supermarkets.
- Road salt storage and loading areas (if exposed to rainfall) and snow storage areas.
- Commercial landscape nurseries

[2] EPA's SWPPP guidance http://www.epa.gov/npdes/pubs/sw_swppp_guide.pdf
[3] NPDES General Permit for Storm Water Discharges from Construction Activities: http://www.epa.gov/npdes/pubs/cgp2003_entirepermit.pdf

- Outdoor storage and loading/unloading facilities
- SARA 312 generators (if containers exposed to rainfall). A SARA 312 generator means a facility that is required by the Emergency Planning and Community Right to Know Act (EPCRA), also known as Title III of the Superfund Amendments and Reauthorization Act of 1989 (SARA Title III), to submit an inventory of the location of hazardous chemicals which are located at the site.
- Marinas and boatyards (service, painting and hull maintenance areas).
- Confined disposal facilities, disposal sites, landfills or wastewater residuals landfills if stormwater that may come into contact with these areas may cause or contribute to the discharge of pollutants to wetlands, surface waters or groundwater or otherwise result in a release or threat of release as defined in M.G.L.c.21E.

The following land uses and activities are not normally considered hot spots:

- Public streets
- Residential development
- Institutional development
- Office developments
- Non-industrial rooftops

BMPs should be design to treat 1.0 inch of runoff times the total impervious area at the post-development site for runoff from urban hot spots, should follow the prescribed treatment train for hot spot locations, and must meet the following additional water quality treatment criteria:

1. 98% removal of oil and grease
2. 90% removal of all heavy metals associated with particulate solids in excess of 10 microns
3. The submission of a Spill Prevention Plan.

3.1.4. Critical Areas

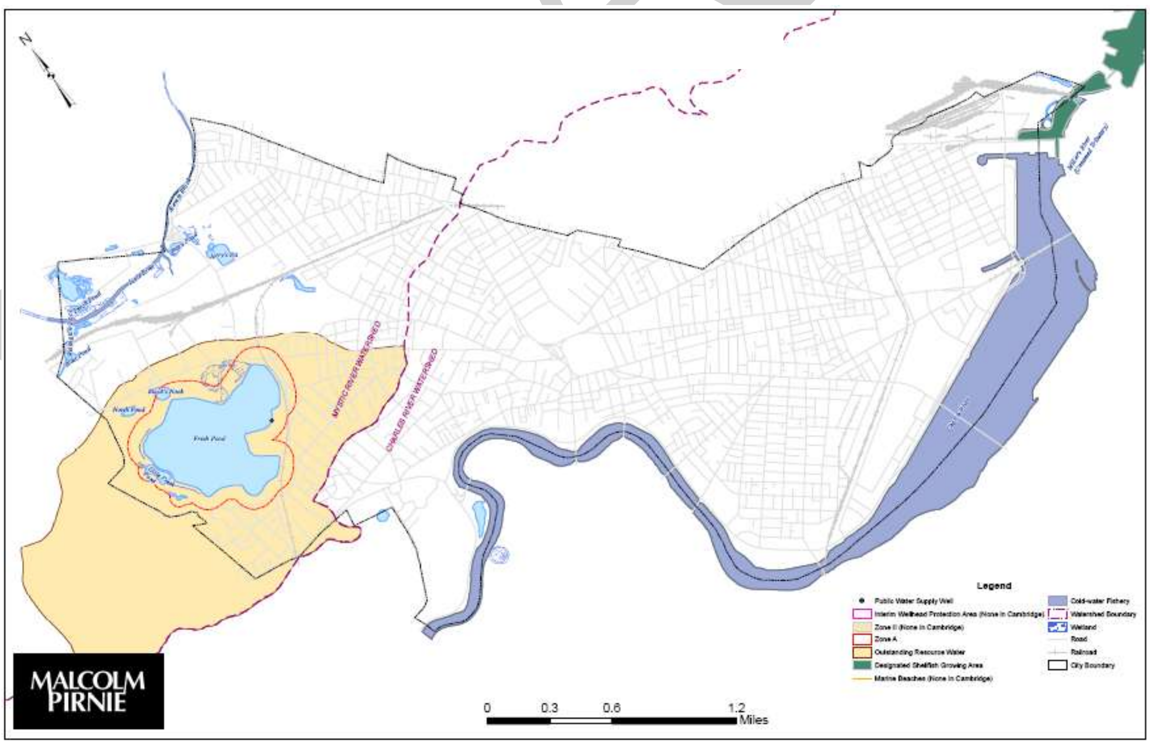
With the exception of the Charles River Buffer Zone, critical areas below have been defined by the MA DEP. For the purposes of this Guidance document, the following areas are considered critical areas:

- **Shellfish Growing Areas:** Land under the ocean, tidal flats, rocky intertidal shores and marshes, and land under salt ponds when any such land contains shellfish.
- **Bathing Beaches:** Public and semi-public bathing beaches as defined by the Massachusetts Department of Public Health (MA DPH). The MA DPH maintains an inventory of bathing beaches.

- **Outstanding Resource Waters or Special Resource Waters:** Published in the Surface Water Quality Standards. The list includes Class A public water supplies approved by MA DEP and their tributaries, active and inactive reservoirs approved by MA DEP, certain waters within Areas of Critical Environmental Concern, certified vernal pools, and wetlands bordering Class A waters. Wetlands bordering Class B, SB, or SA ORWs are also considered Outstanding Resource Waters. MA DEP may designate as Special Resource Waters certain waters of exceptional significance such as waters in national or state parks and wildlife refuges.
- **Recharge Areas for Public Water Supplies:** Zone I, Zone II, and Interim Wellhead Protection Area for groundwater sources; and Zone A for surface water sources.
- **Cold-water Fisheries:** Water in which the mean of the maximum daily temperature over a seven-day period generally does not exceed 68°F (20°C) and, when other ecological factors are favorable (such as habitat), are capable of supporting a year-round population of cold-water stenothermal aquatic life. Cold-water fisheries are designated by MA DEP and the Division of Fisheries and Wildlife.
- **Charles River Buffer Zone:** 1,000 ft. zone around Charles River in Cambridge.

Figure 3-2 identifies the locations of Critical Areas within Cambridge. A discharge is considered near a critical area, if there is a strong likelihood of significant impact occurring to said area, taking into account site-specific factors.

Figure 3-2: Critical Areas in Cambridge



3.2. Land Disturbance Regulation and Permit Process Overview

In order to achieve the City's stormwater goals and maintain continued compliance with the NPDES stormwater permit, Cambridge has established a Wastewater and Stormwater Drainage System Ordinance and Land Disturbance Regulation. Together these documents accomplish the following:

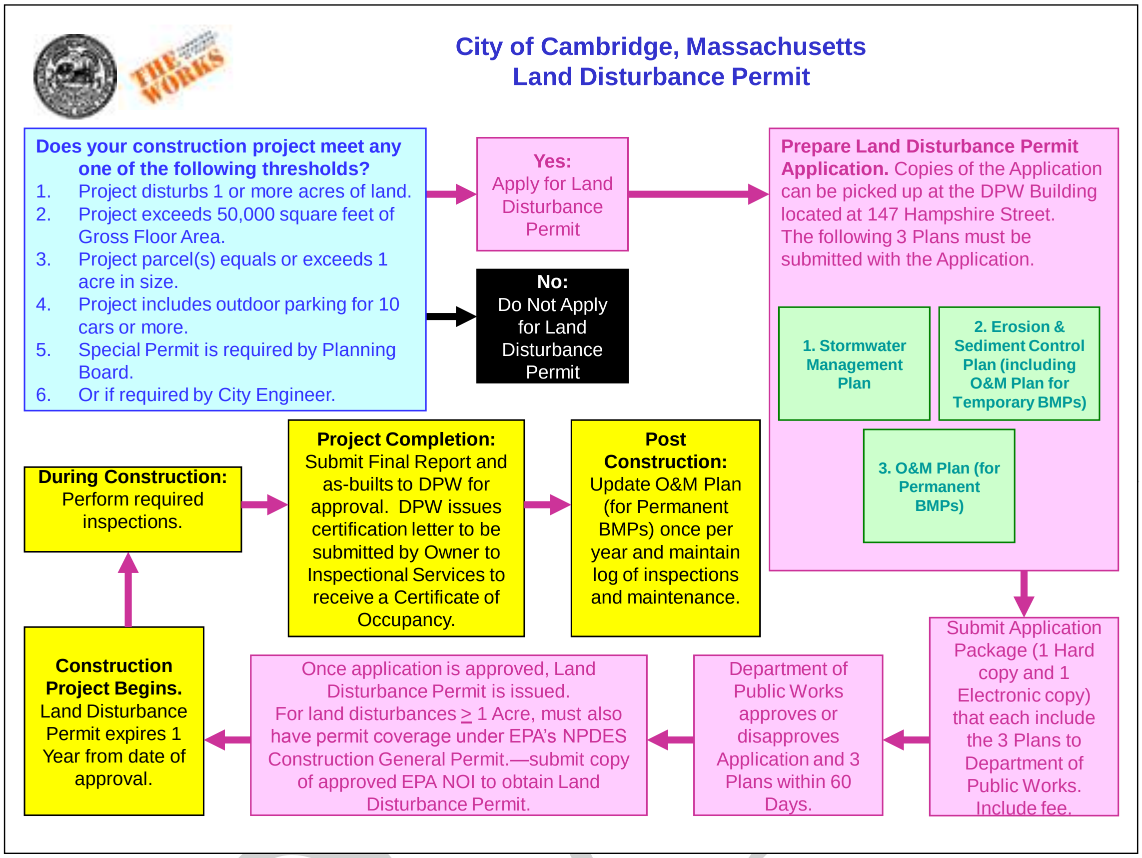
- Establish the legal authority for the City to ensure compliance and enforce stormwater management practices
- Assign responsibility for stormwater quality monitoring, inspections, and compliance
- Address stormwater flows during and after construction
- Create standard operating procedures for City departments responsible for ensuring compliance with the ordinance
- Outline steps that contractors and developers should take to ensure their site is in compliance

The following sections contain specific information regarding stormwater design standards and plan requirements established by the Land Disturbance Regulations. As discussed in Section 3.1, land disturbance activities within the City of Cambridge are subject to the Regulation and require a Land Disturbance Permit when meeting or exceeding certain thresholds. Figure 3-3 outlines the permit process.

Additional permits that may be required include a Stormwater and Wastewater Infrastructure Permit (SWIP), NPDES General Permit for Discharges from Large and Small Construction Activities as issued by EPA where applicable, and others. A Project Permits Checklist is located in Appendix G.

Detailed information regarding Plan requirements can be found in Section 4.

Figure 3-3: Land Disturbance Permit Process



3.3. Stormwater Management Standards

The following are the standards for controlling stormwater discharges to the City of Cambridge municipal drainage system, wetlands, and surface waters. When one or more of the Standards cannot be met, an applicant may demonstrate that an equivalent level of environmental protection will be provided.

Many of these standards have been adopted from the MA DEP's Stormwater Management Policy.

1. No new development/redevelopment (project) can discharge untreated stormwater directly to the municipal drainage system in Cambridge. Treated stormwater is defined to be stormwater that meets the requirements in Standards 2 through 9.
2. Stormwater management controls must be designed so that post- project peak discharge rates do not exceed pre-project peak discharge rates for any rainfall event. This must be verified for the 2-year, 10-year, 25-year and 100-year 24-hour storm events. Measurement of peak discharge rates must be calculated using the point of discharge or downgradient property boundary. The topography of the site may

require evaluation at more than one location if flow leaves the property in more than one direction. An applicant may demonstrate that a feature beyond the property boundary (e.g. culvert) is more appropriate as a design point. Applicants must demonstrate that they have considered how off-site stormwater (from upstream watershed flows) and catastrophic flows (flooding conditions) might affect their site and have some level of mitigation capability such events.

3. The post-project discharge hydrograph for the 25-year 24-hour rainfall event must be less than or equal to the 2-year 24-hour rainfall event pre-project discharge hydrograph as indicated in Section 3.1.1, item 2 , unless otherwise determined as specified in Section 3.1.1, item 3. The total volume of runoff generated between the pre-project 2-year 24-hour storm discharge and the post project 25-year 24-hour storm discharge must be retained or recharged on site. This requirement ensures that during an event up to and equal to the 25-year 24-hour event the municipal drainage system will not receive discharge in excess of the pre development 2-year-24 hour discharge. Refer to Figure 3-1 for hydrographs and Section 3.4 for information on BMPs.

4. Loss of annual recharge to groundwater will be minimized to the maximum extent practicable through the use of infiltration measures including environmentally sensitive site design, LID techniques, stormwater BMPs, and good operation and maintenance. The annual recharge from the post –development should not be less than the annual recharge from the pre-development or existing site conditions based on soil type. The project must at minimum, maintain the same level of groundwater recharge from the site. For infiltration of stormwater runoff from hot spot locations, discharges to the ground within an area with a rapid infiltration rate (greater than 2.4 inches per hour), and discharges to or near critical areas, at least 44% of the total suspended solids must be removed prior to discharge to the infiltration BMP. In instances where roof runoff from conventional roofs is infiltrated, the infiltrated volume may be subtracted from the total runoff volume, and this may be subtracted from that portion of the development required as being permeable.

   The following are the Groundwater Recharge Rules:

   - Required recharge volume must be infiltrated only to the maximum extent practicable if:
     - The site is comprised wholly of C and D soils and bedrock at land surface.
     - Recharge is proposed at or adjacent to a site that has

       Been classified as contaminated;
       Contamination has been capped in place;
       An Activity and Use Limitation (AUL) that precludes inducing runoff to the groundwater pursuant to MGL Chapter 21E and the Massachusetts Contingency Plan, 310 CMR 40;
       Has a solid waste landfill as defined in 310 CMR 19; or
       Groundwater from the recharge area that flows directly toward a solid waste landfill or 21E site.

- At least 44% of the TSS must be removed prior to discharge to an infiltration BMP if the discharge is near or within critical areas (see Section 3.1.4 for definition of critical area), from land uses with higher potential pollutant loads (hot spots), within an area with a rapid infiltration rate (greater than 2.4 inches per hour). Removal of TSS is expected to be accomplished through the use of a treatment train based on controls identified in Figures 3-4 through 3-8.
- Depth to groundwater: At a minimum there should be a two foot separation between bottom of structure and seasonal high groundwater. Bottom of structure must be installed below frost line. Estimate seasonal high groundwater based on soil mottles or through direct observation when borings are conducted in April or May, when groundwater levels are likely to be highest. If it is difficult to determine the seasonal high groundwater elevation from the borings or test pits, then use the Frimpter method developed by the USGS (Massachusetts/Rhode Island District Office) to estimate seasonal high groundwater. After estimating the seasonal high groundwater using the Frimpter method, re-examine the bore holes or test pits to determine if there are any field indicators that corroborate the Frimpter method estimate.
- Minimum infiltration rate: 0.17 inches per hour. All infiltration BMPs must be able to drain fully within 72 hours.
- General Setbacks:
  - Soil Absorption Systems for Title 5 Systems – 50 ft.
  - Private wells – 100 ft.
  - Public wells – Outside Zone I
  - Public reservoirs, surface water sources for public water systems and their tributaries – Outside Zone A
  - Other surface waters (includes bordering vegetated wetlands and land under water) – 50 ft.
  - Property Line – 10 ft.
  - Building foundations (including slabs) – >10 to 100 ft. depending on type of BMP. Specific BMPs have additional setback requirements. See Appendix A.

5. There must be no negative impact from drainage on abutting properties. Concentrated discharges from land development, including from stormwater practices, must not be discharged onto adjacent developed property without adequate conveyance in a natural stream or stormwater drainage system. The DPW may require drainage easements where stormwater discharges must cross an adjacent or off-site property before reaching an adequate conveyance.
6. For new development, stormwater management systems must follow the stormwater runoff treatment train prescribed for the site conditions and remove at minimum 80% of the average annual post construction load of Total Suspended Solids (TSS), as well

as remove trash to the MEP. Total suspended solids is considered the target pollutant constituent for many removal standards because of its widespread contribution to water quality and aquatic habitat degradation, because many other pollutant constituents including heavy metals, bacteria and organic chemicals adsorb to sediment particles, and because available data sets for BMP removal efficiency reveal that TSS has been the most frequently and consistently sampled constituent. It is presumed that this standard is met when:

- Suitable practices for source control and pollution prevention are identified and thereafter are implemented and maintained (see Appendix A for examples).
- Stormwater BMPs are designed in accordance with Appendix A and the Massachusetts Stormwater Handbook and sized to capture the required water quality volume.
- 80% TSS removal is achieved and treatment is provided in accordance with the prescribed treatment train.
- Stormwater management BMPs are maintained as designed.

This standard applies after the site has been stabilized. Since removal efficiency may vary with each storm, 80% TSS removal is not required for each storm; rather it is the average removal over the year that is required to meet the standard.

The required water quality volume, the runoff volume requiring TSS treatment, is calculated as follows:

- 1.0 inch of runoff times the total impervious area of the post-development project site for a discharge from a hot spot location, within an area with a rapid infiltration rate (greater than 2.4 inches per hour), or within or near a critical area.
- 0.5 inches of runoff times the total impervious area of the post-development site for all other discharges.

For new development, BMPs must be selected so that a total of 80% TSS removal is provided by one or more BMPs prior to discharge to the City's stormwater drainage system. Acceptable BMPs for meeting water quality standards discussed in this document are listed in Table 3-1.

Table 3-1.
Acceptable Water Quality BMPs

BMP	Standards/Performance Measures	TSS Removal Efficiency (based on MA DEP Stormwater Handbook, 2008)
SOURCE CONTROLS		
1.1 Street and Parking Lot Sweeping	Required Source Control - All parking lots swept on quarterly basis – owner's responsibility.	0-10%
1.2 Snow Removal and Deicing	Required Source Control	No TSS Removal Credit
1.3 Lawn and Grounds Maintenance	Required Source Control	No TSS Removal Credit
1.4 Materials and Waste Management	Required Source Control	No TSS Removal Credit
1.5 ♦Roof Gardens (Green Roofs)	Optional Source Control	May reduce required water quality volume. No TSS Removal Credit
PRETREATMENT CONTROLS		
3.1 Deep Sump Catch Basin with Hood	6-foot sump, Floatables and oil & grease hood	25% only if used for pretreatment and only if off-line.
3.2 Oil Grit Separator	Off-line systems only. Permanent pool at least 4 ft. deep. Watertight to prevent groundwater contamination.	25% only if used for pretreatment and only if off-line.
3.3 Proprietary Separator	Varies	Varies
3.4 Sediment Forebay	Size to hold 0.1 in./impervious acre to pretreat the water quality volume. Unless part of a wet basin, must completely drain within 72 hours.	25% if used for pretreatment.
3.5 ♦Vegetated Filter Strip	Must drain within 24 hours after a storm. Design flow depth must not exceed 0.5 in. Construct strip at least 2 ft. above seasonal high groundwater and 2 to 4 ft. above bedrock. Do not locate strip in soils with limited infiltration capability.	10% if at least 25 ft. wide, 45% if at least 50 ft. wide.
TREATMENT CONTROLS		
4.1 ♦Bioretention Area (including Rain Garden)	Depth of the soil media must be between 2 and 4 ft. Do not use filter fabric or sand curtains. Size bioretention area to be 5% to 7% of the area draining to it.	90% provided it is combined with adequate pretreatment.
4.2 Constructed Stormwater Wetland	Sediment forebay required. Select appropriate vegetation according to Appendix A. Demonstrate that a continuous supply of water is available to sustain the wetland.	80% provided it is combined with a sediment forebay.

BMP	Standards/Performance Measures	TSS Removal Efficiency (based on MA DEP Stormwater Handbook, 2008)
4.3 Extended Dry Detention Basin	Sediment forebay required. Minimum detention time for water quality volume is 24 hours. Side slopes no steeper than 3:1.	50% provided it is combined with a sediment forebay.
4.4 💧Gravel Wetland	Sediment forebay required. Designed off-line to handle water quality volume with excess diverted to a swale.	80% provided it is combined with a sediment forebay.
4.5 Proprietary Media Filter	Varies	Varies
4.6 Sand Filters/Organic Filter	Sediment forebay required. Off-line system. Use design filtration rate of 2 in./hr. Must drain completely within 24 hours.	80% provided it is combined with sediment forebay.
4.7 💧Treebox Filter	Suggested 6 ft. diameter concrete manhole riser filled with a 2ft. thick sand-compost mix (76% sand, 24% compost)	80% provided it is combined with adequate pretreatment.
4.8 Wet Basin	Sediment forebay required. Permanent pool must be sized to hold twice the water quality volume. Length to width ratio of at least 3:1. Slopes of the pools no steeper than 3:1.	80% provided it is combined with a sediment forebay.
	INFILTRATION CONTROLS	
5.1 💧Dry Well	Must fully drain within 72 hours. 12 in. below grade and 10 ft. setback from building foundation. Groundwater Recharge Rules apply.	80% for runoff from non-metal roofs; may also be used for runoff from metal roofs but only if metal roof is not located within a Zone II, or IWPA or at an industrial site.
5.2 💧Infiltration Basin	Must drain fully within 72 hours. Basin floor should be as flat as possible. In no case shall the longitudinal slope exceed 1%. Side slopes no steeper than 3:1. Groundwater Recharge Rules apply.	80% provided it is combined with adequate pretreatment (sediment forebay or vegetated filter strip, grass channel, water quality swale) prior to infiltration.
5.3 💧 Infiltration Trench	Use a void ratio of 0.4. Include vegetated buffers (20 ft. minimum) around surface trenches. Groundwater Recharge Rules apply.	80% provided it is combined with adequate pretreatment (sediment forebay or vegetated filter strip, grass channel, water quality swale) prior to infiltration.
5.4 Leaching Catch Basin	Off-line system. Deep sump catch basin pretreatment required. Use stone material with a void ratio of 0.39 or less. Groundwater rules apply.	80% provided a deep sump catch basin is used for pretreatment.

BMP	Standards/Performance Measures	TSS Removal Efficiency (based on MA DEP Stormwater Handbook, 2008)
5.5 Subsurface Structure	Must drain within 72 hours. Use a minimum draining time of 6 hours for pollutant removal. Inflow velocities should be less than 2 ft./s. Groundwater Recharge Rules apply.	80% provided they are combined with one or more pretreatment BMPs prior to infiltration.
	CONVEYANCE CONTROLS	
6.1 Drainage Channel	Side slopes of 3:1 or flatter. Longitudinal slope no greater than 5%. Maintain a non-erosive flow (less than 5 ft./s. Add an extra 0.3 to 0.5 ft. of freeboard depth if low velocities are expected (sediment accumulation).	For conveyance only. No TSS Removal Credit.
6.2 ♦Grassed Channels (formerly biofilter swales)	Velocity should not exceed 1 ft./s during the 24-hr. storm associated with the water quality event. Minimum Hydraulic Residence Time (HRT) of 9 minutes. Grass height of 6 in. or less.	50% if combined with sediment forebay or equivalent.
6.3 Water Quality Swale (wet &dry)	Side slopes no greater than 3:1 and bottom widths from 2 to 8 ft. Dry swale should completely empty between storms (no more than 72 hours to drain) and have a minimum HRT of 9 minutes. Size wet swales to retain the required water quality volume.	70% provided it is combined with sediment forebay or equivalent.
	OTHER CONTROLS	
7.1 Dry Detention Basin	Provide a minimum 24 hour detention time. Provide an emergency spillway. Side slopes of 3:1 or flatter.	For peak rate attenuation only. No TSS Removal Credit.
7.2 ♦Porous Pavement	Use the UNH storage bed design specifications. No winter sanding allowed. Aggressive maintenance required. Groundwater Recharge Rules apply.	80% if designed to prevent runon and with adequate storage capacity. Limited uses.
7.3 ♦Rain Barrel/Cistern	No pollutant removal benefits but may reduce volume requirements.	May reduce required water quality volume. No TSS Removal Credit.
7.4 Catch Basin Insert	Varies	Varies

The TSS removal efficiency percentages cannot be added directly to arrive at 80%. For example, if the first BMP in a system has a 60% removal rate, and the second BMP has a 20% removal rate, adding 60% and 20% will not achieve the desired 80% TSS removal rate; only 68% of the TSS will be removed. After the stormwater was routed through the first BMP, 60% of the sediment was removed. The remaining 40% was routed to the second BMP that removed 20% of that 40% (not 20% of the entire load). The second BMP therefore removed an additional 8%, leaving 12% still to be removed (60% + 8% = 68%; 80%-68%=12%).

Table 3-1 is meant to be used along with Figures 3-4 through 3-8 and Section 3.4 to assist in BMP selection for each site in Cambridge. Figures 3-4 through 3-8 follow and include the prescribed treatment trains for specific project areas and conditions. These processes were developed based on the MA DEP Stormwater Policy and changed to suit the City's needs. The treatment trains are for:

- Projects not near/within a critical area and not at a hot spot location
- Project areas at a critical area
- Projects at a hot spot location

It is important to note that infiltration BMPs have been included in all treatment trains but may not be appropriate for certain site conditions (e.g. where site is made up of C and D soils, or where sites have history of contaminants, etc.). Refer to the Groundwater Recharge Rules discussed under Standard 4 in Section 3.3 to determine the extent to which infiltration is appropriate for a project site. Where an infiltration BMP is not feasible, a treatment BMP can be used in its place within the treatment train.

Figure 3-4: Prescribed Treatment Train for Non-Critical/Non-Hot Spot Project Areas

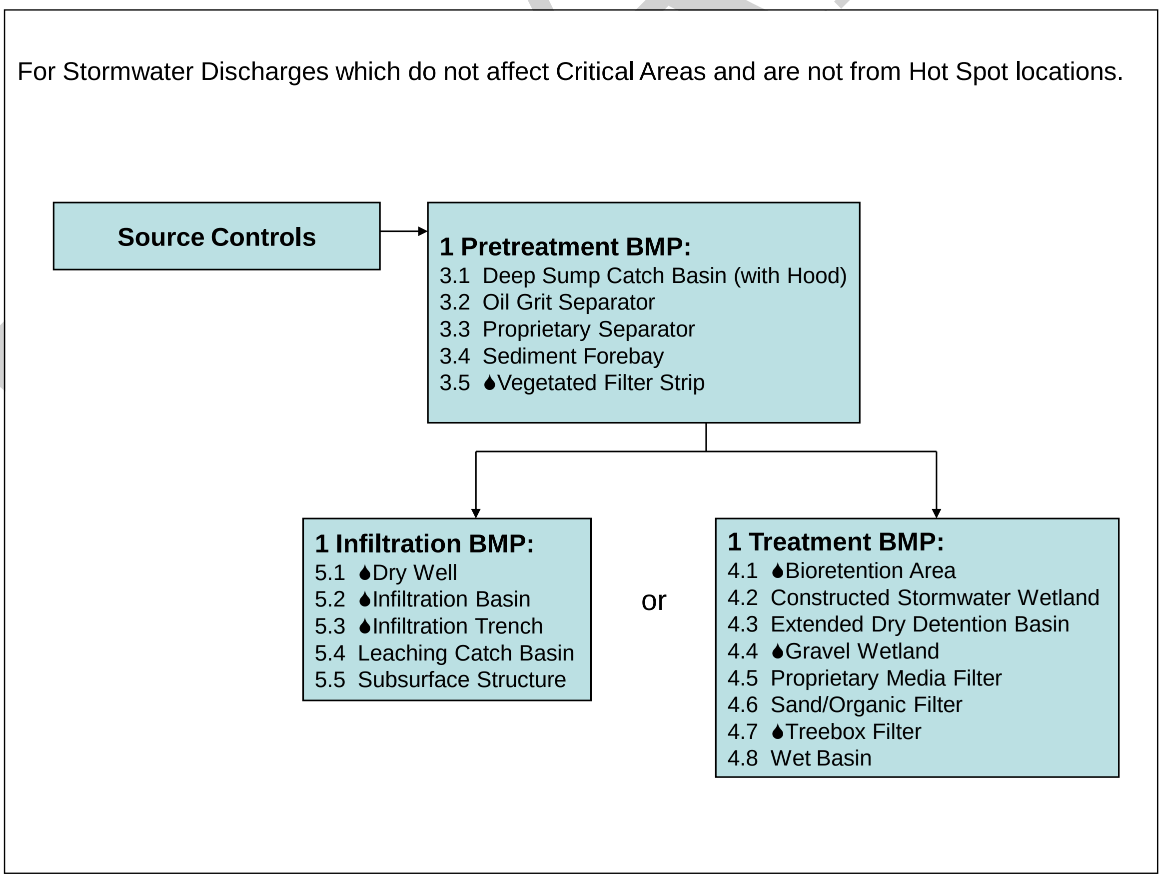
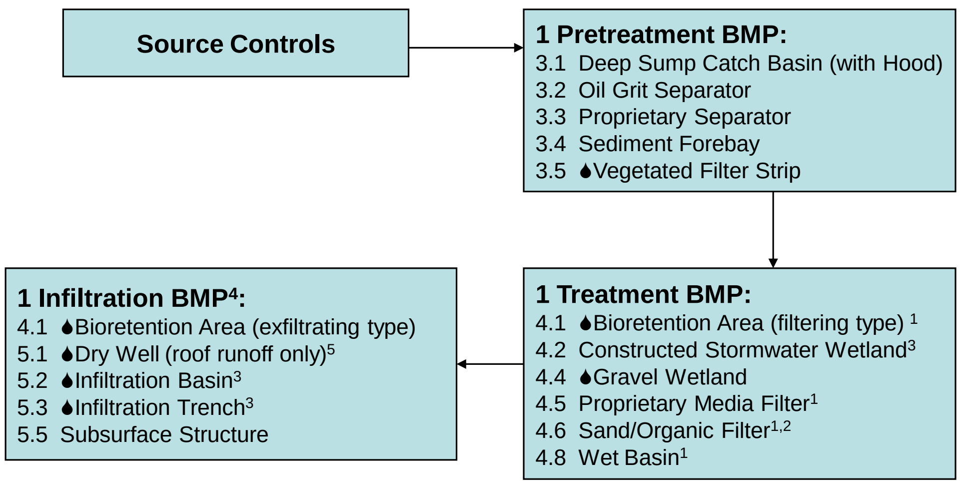


Figure 3-5: Prescribed Treatment Train for use Near Shellfish Growing Areas/Bathing Beaches

For Stormwater Discharges that may impact Shellfish Growing Areas and Bathing Beaches



1. Must be lined and sealed unless at least 44% of TSS has been removed prior to discharge to BMP.
2. Recommended
3. Highly Recommended
4. Where Infiltration BMP is not feasible, use an additional Treatment BMP.
5. Runoff from non-metal roofs and runoff from metal roofs located outside of the Zone II or IWPA of a public water supply and outside an industrial site only.

Notes from the MA DEP Stormwater Policy on this treatment train (Figure 3-5):

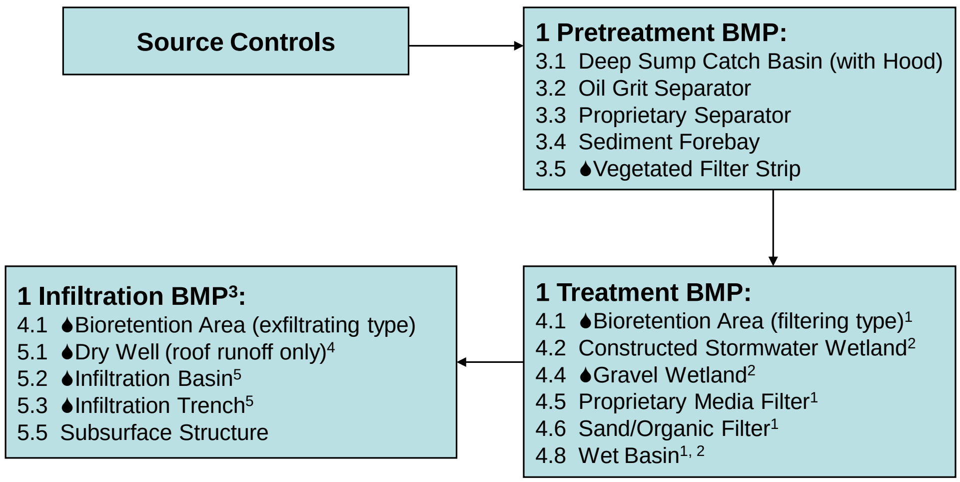
- If applicable, proponent must comply with Coastal Wetlands Regulations.
- All BMPs must be designed in accordance with specifications in Appendix A of this Guidance document and Volumes 2 and 3 of the Massachusetts Stormwater Handbook.
- Required Water Quality Volume = 1.0 inch times impervious area.
- At least 44% TSS removal must be provided prior to discharge to infiltration BMP.
- Proprietary BMPs may be used only for pretreatment, unless verified by Technology Acceptance Reciprocity Partnership (TARP) or Massachusetts Strategic Envirotechnology Partnership (STEP)[4] for other uses. For the purpose of this requirement, subsurface structures, even those that have a storage chamber

[4] Detailed TARP and STEP information can be found at www.mastep.net

that has been manufactured are not proprietary BMPs, since the pretreatment occurs in the soil below the structure, not in the structure itself.

Figure 3-6: Prescribed Treatment Train for use Near Critical Water Resources

For Stormwater Discharges that may impact Recharge Areas for Public Water Supplies and Outstanding Resource Waters (ORW) including Vernal Pools



1. Must be lined and sealed unless at least 44% of TSS has been removed prior to discharge to BMP.
2. Do not use near certified vernal pool.
3. Where Infiltration BMP is not feasible, use an additional Treatment BMP.
4. Runoff from non-metal roofs and runoff from metal roofs located outside of the Zone II or IWPA of a public water supply and outside an industrial site only.
5. Highly Recommended.

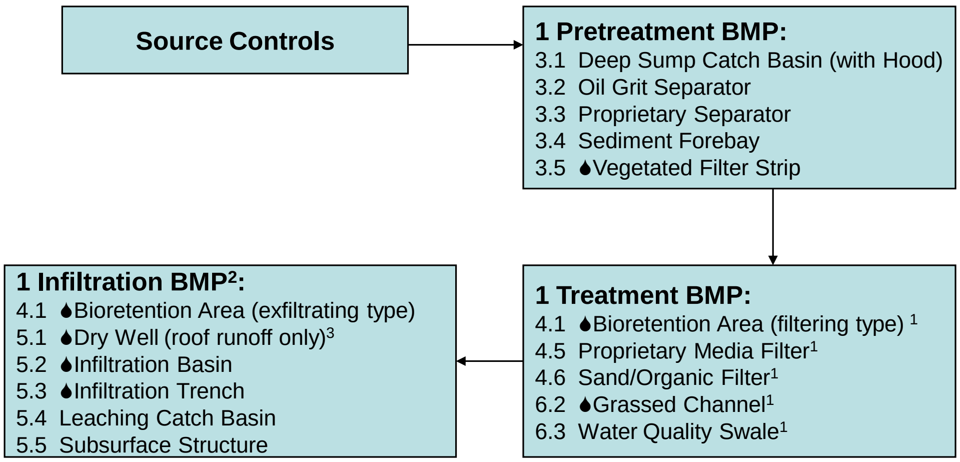
Notes from the MA DEP Stormwater Policy on this treatment train (Figure 3-6):

- Construction sites of 1 acre or more must file a Notice of Intent (WM 09) with MA DEP if they discharge to an ORW.
- Stormwater discharges to ORWs must be set back from the receiving water or wetland and receive the highest and best practical method of treatment.
- Stormwater BMPs must be set back 100 ft. from a certified vernal pool and comply with 310 CMR 10.60. Proponents must perform a habitat evaluation and demonstrate that the stormwater BMPs meet the performance standard of having no adverse impact on the habitat functions of a certified vernal pool.
- Unless essential to the operation of a public water system, stormwater BMPs are prohibited within the Zone A.
- Unless necessary to manage stormwater from essential drinking water facilities, no stormwater BMPs may be located within the Zone I.

- Proponents must comply with local source water protection ordinances, bylaws, and regulations.
- The Drinking Water Regulations, 310 CMR 22.21(2)(b)(7), require the development of land use controls in the Zone II that prohibit land uses that result in rendering 15% or 2500 square feet of a lot impervious, whichever is larger, unless a system of artificial recharge that does not degrade groundwater quality is provided. Developers can comply with these land use controls by designing, constructing, operating and maintaining a stormwater management system in compliance with the Stormwater Management Standards.
- All BMPs must be designed in accordance with specifications in Appendix A of this Guidance document and Volumes 2 and 3 of the Massachusetts Stormwater Handbook.
- Required Water Quality Volume = 1.0 inch times impervious area.
- At least 44% TSS removal must be provided prior to discharge to infiltration BMP.
- Proprietary BMPs may be used only for pretreatment, unless verified by TARP or STEP for other uses. For the purpose of this requirement, subsurface structures, even those that have a storage chamber that has been manufactured are not proprietary BMPs, since the pretreatment occurs in the soil below the structure, not in the structure itself.

Figure 3-7: Prescribed Treatment Train for Cold-water Fisheries

For Stormwater Discharges that may impact Cold-Water Fisheries



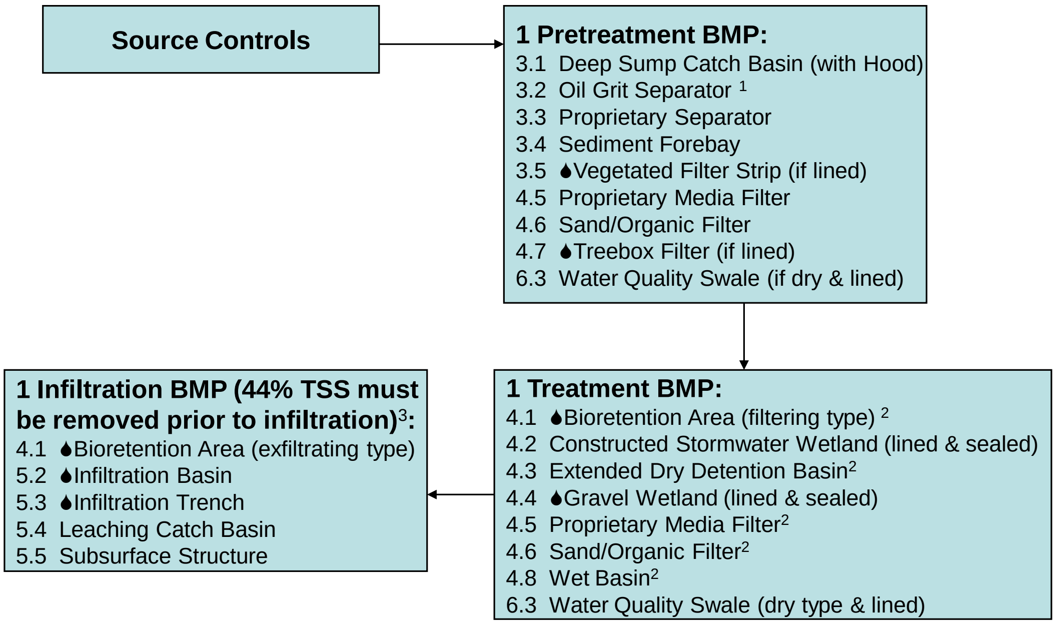
1. Must be lined and sealed unless at least 44% of TSS has been removed prior to discharge to BMP.
2. Where Infiltration BMP is not feasible, use an additional Treatment BMP.
3. Runoff from non-metal roofs and runoff from metal roofs located outside of the Zone II or IWPA of a public water supply and outside an industrial site only.

Notes from MA DEP Stormwater Policy on this treatment train (Figure 3-7):

- All BMPs must be designed in accordance with specifications in Appendix A of this Guidance document and Volumes 2 and 3 of the Massachusetts Stormwater Handbook.
- Required Water Quality Volume = 1.0 inch times impervious area.
- At least 44% TSS removal must be provided prior to discharge to infiltration BMP.
- Proprietary BMPs may be used only for pretreatment, unless verified by TARP or STEP for other uses. For the purpose of this requirement, subsurface structures, even those that have a storage chamber that has been manufactured are not proprietary BMPs, since the pretreatment occurs in the soil below the structure, not in the structure itself.

Figure 3-8: Prescribed Treatment Train for use in Hot Spot Locations

For Stormwater Discharges from Hot Spot locations



1. Recommended where there is a risk of petroleum spills.
2. Must be lined and sealed unless at least 44% of TSS has been removed prior to discharge to BMP.
3. Where Infiltration BMP is not feasible, use an additional Treatment BMP.

Notes from the MA DEP Stormwater Policy on this treatment train (Figure 3-8):

- Discharges from certain land uses with higher potential pollutant loads (hot spots) may be subject to additional requirements including the need to obtain an individual or general discharge permit pursuant to the MA Clean Waters or Federal Clean Water Act.
- All proponents must implement source control and pollution prevention.
- Many land uses have the potential to generate higher pollutant loads of oil and grease. These land uses include, without limitation, industrial machinery and equipment and railroad equipment maintenance, log storage and sorting yards, aircraft maintenance areas, railroad yards, fueling stations, vehicle maintenance and repair, construction businesses, paving, heavy equipment storage and/or maintenance, the storage of petroleum products, high intensity use parking lots , and fleet storage areas. To treat the runoff from such land uses, the following BMPs must be used to pretreat the runoff prior to discharge to an infiltration structure: oil grit separator, sand/organic filter, filtering bioretention area, or equivalent.

- All BMPs must be designed in accordance with specifications in Appendix A of this Guidance document and Volumes 2 and 3 of the Massachusetts Stormwater Handbook.
- Required Water Quality Volume = 1.0 inch times impervious area.
- At least 44% TSS removal must be provided prior to discharge to infiltration BMP.
- Until they complete the STEP or TARP verification process outlined in the Massachusetts Stormwater Handbook, proprietary BMPs may not be used as a terminal treatment device for runoff from hot spot locations. For the purpose of this requirement, subsurface structures, even those that have a storage chamber that has been manufactured are not proprietary BMPs, since the pretreatment occurs in the soil below the structure, not in the structure itself.
- Runoff from other portions of the project site that does not come into contact with hot spot areas or activities and does not mix with the runoff from these areas or activities can be treated using a different treatment train.

7. Redevelopment of previously developed sites must meet the Stormwater Management Standards to the maximum extent practicable. Proponents of projects for the redevelopment of previously developed sites must develop and implement a Stormwater Management Plan that fully complies with the requirements of these standards. All redevelopment projects must also improve existing conditions. "Redevelopment" projects are defined as follows:

   - Maintenance and improvement of existing roadways, including widening less than a single lane, adding shoulders, correcting substandard intersections and drainage, repaving;
   - Development, rehabilitation, expansion, and phased projects on previously developed sites, provided the redevelopment results in no net increase in impervious area; and
   - Remedial projects specifically designed to provide improved stormwater management, such as projects to separate storm drains and sanitary sewers and stormwater retrofit projects.

   These standards apply to City projects as well as private projects. Any portion of a property that is currently undeveloped is not a redevelopment and thus does not fall under Standard 7.

8. Erosion and sediment controls must be implemented to prevent impacts during construction or land disturbance activities. Examples of BMPs for erosion and sediment control are staked hay bales, filter fences, hydro seeding, and phased development and are discussed in detail in Appendix A. An Erosion and Sediment Control Plan must be prepared and implemented.

   All stormwater management systems must also have an Operation and Maintenance (O&M) Plan to ensure that systems function as designed.

The owner of the BMP is generally considered to be the landowner of the property on which the BMP is located, unless other legally binding agreements are established with another entity. Routine maintenance during construction and post development phases of the project as defined in the project's O&M Plan is essential to ensure the long-term viability of the BMP. O&M Plans must be prepared and implemented for both temporary and permanent stormwater BMPs.

9. Stormwater discharges from land uses with higher potential pollutant loads (hot spots) require the use of the specific source control and pollution prevention measures and the specific stormwater BMPs approved by the DPW for such use. The prescribed treatment train and BMP selections are illustrated in Figure 3-8.
10. Stormwater discharges near or discharging to critical areas require the use of the specific source control and pollution prevention measures and the specific stormwater BMPs approved by the DPW for such discharges. The prescribed treatment trains and BMP selections are illustrated in Figures 3-5 through 3-7.
11. All illicit discharges to the stormwater management system are prohibited. Report illegal dumping or suspicious discharges from outfalls to the DPW by calling (617) 349-4800 or (617) 349-4846, or by e-mail to: TheWorks@cambridgema.gov .

3.4. Typical Cambridge Best Management Practice (BMP) Controls

The controls outlined below are approved for use in Cambridge to achieve compliance with the Stormwater Management Standards. A detailed BMP fact sheet for each approved control can be found in Appendix A. BMPs are identified with a specific BMP number which corresponds to the fact sheet location in the Appendix.

3.4.1. Source Controls

Source controls are good housekeeping and pollution prevention techniques which are meant to prevent pollutants from being picked up by rain water and carried to structural controls or the stormwater drainage system. Source controls are required to be implemented at every site. Source controls include, but are not limited to:

1.1 Street and Parking Lot Sweeping
1.2 Snow Removal and Deicing
1.3 Lawn and Grounds Maintenance
1.4 Materials and Waste Management
1.5 ♦Roof Gardens

3.4.2. Pretreatment Controls

Pretreatment BMPs are the beginning of a stormwater treatment train. Their purpose is to remove coarse sediments and debris which can clog other BMPs. Pretreatment BMPs typically rely on a settling process, generating sediment that must be routinely removed. Since pretreatment controls are the first BMPs in the treatment train, they receive stormwater with the highest concentrations of suspended solids (during the first flush), and maintenance practices are critical to their performance. Some pretreatment devices such as the Oil Grit Separator are required to pretreat the runoff from certain hot spot locations, such as gas stations and high intensity use parking lots.

Pretreatment BMPs can be configured as on-line or off-line devices. On-line systems are designed to treat the entire water quality volume. Off- line practices are typically designed to receive a specified discharge rate or volume. A flow diversion structure or flow splitter is used to divert the design flow to the off-line practice. To receive TSS removal credit, oil grit separators and deep sump catch basins must be configured as off-line devices. Typical pretreatment BMPs include:

3.1 Deep Sump Catch Basin (with Hood)
3.2 Oil Grit Separator
3.3 Proprietary Separator
3.4 Sediment Forebay
3.5 ♦Vegetated Filter Strip

3.4.3. Treatment Controls

There are three main types of Treatment BMPs: Stormwater Treatment Basins, Constructed Stormwater Wetlands, and Filtration BMPs.

Stormwater Treatment Basins: These BMPs provide peak rate attenuation by detaining stormwater and settling out suspended solids. The basins that are most effective at removing pollutants have either a permanent pool of water or a combination of a permanent pool and extended detention, and some elements of a shallow marsh. Stormwater Treatment Basins include:

4.3 Extended Dry Detention Basin
4.8 Wet Basin

Constructed Wetlands: Constructed wetlands capitalize on natural wetland vegetation uptake and employ retention and settling techniques to remove pollutants from stormwater runoff. Gravel wetlands remove additional pollutants by filtering stormwater though a gravel substrate. Constructed Wetlands include:

4.2 Constructed Stormwater Wetland
4.4 💧Gravel Wetland

Filtration BMPs: Filtration systems use media to remove particulates from runoff. They are especially effective in circumstances where space is limited such as ultra-urban locations, or when removal of particular industrial or commercial pollutants such as hydrocarbons is necessary. Depending on site conditions and the pollutant characteristics, filtered runoff may be collected and returned to the conveyance system or allowed to partially exfiltrate into the soil. Filtration BMPs include:

4.1 💧Bioretention Areas including Rain Gardens (filtering type)
4.5 Proprietary Media Filter
4.6 Sand/Organic Filter
4.7 💧Treebox Filter

3.4.4. Infiltration Controls

Infiltration systems are designed primarily to reduce the quantity of stormwater runoff from a particular site, but can help treat stormwater runoff as well. Infiltration techniques reduce the amount of surface flow and direct the water back into the ground. As stormwater runoff filters through the soil, pollutants are removed. Infiltration practices typically cannot provide channel protection and overbank or extreme flood detention storage. All infiltration BMPs are subject to the Groundwater Recharge Rules discussed under Standard 4 in Section 3.3. Infiltration BMPs include:

4.1 ♦Bioretention Areas including Rain Gardens (exfiltrating type)
5.1 ♦Dry Wells
5.2 ♦Infiltration Basins
5.3 ♦Infiltration Trenches
5.4 Leaching Catch Basins
5.5 Subsurface Structures

3.4.5. Conveyance Controls

Conveyance BMPs collect and transport stormwater to other BMPs for treatment and/or infiltration. These practices may also treat runoff through infiltration, filtration, or temporary storage. Vegetated conveyance controls also prevent erosion, filter sediment, and provide some nutrient uptake benefits. Conveyance BMPs include:

6.1 Drainage Channel
6.2 ♦Grassed Channel (formerly biofilters swales)
6.3 Water Quality Swale (wet & dry)

3.4.6. Other Controls:

Some BMPs do not fit into any of the categories set forth above. These BMPs include:

7.1 Dry Detention Basin
7.2 ♦Porous Pavement
7.3 ♦Rain Barrel/Cistern
7.4 Catch Basin Insert

3.4.7. Hot Spot BMPs

Source control and pollution prevention must be implemented to the MEP in accordance with this Guidance document and the Massachusetts Stormwater Handbook to eliminate or reduce the discharge of stormwater runoff from such land uses. If through source control and/or pollution prevention all land uses with higher potential pollutant loads (hot spots) cannot be completely protected from exposure to rain, snow, snow melt, and stormwater runoff, the applicant must use the specific structural stormwater BMPs as determined by DPW to be suitable for such uses as provided in the Stormwater Management Standards. Specific controls for treating runoff from hot spot locations are outlined in Figure 3-8. The DPW expects that high rate proprietary devices (i.e. stormceptor and vortechnics, etc) will be most popular and effective for use in treatment of flows from hot spots in the City. The main objective of hot spot controls is to provide high levels of oil and grease and fine solids removal. Removal of fine solids down to the 10-micron size will ensure capture of solids larger than “fine silt”. Substantial removal of the heavy metals associated with particulates will result. For proprietary BMPs, the developer must provide prior treatment performance monitoring data to DPW (TARP or STEP preferred) prior to acceptance.

3.4.8. Additional Controls

Below are additional controls that have been used in Cambridge and may be approved for use or requested to be implemented by the DPW. Fact sheets for these controls are not provided.

- **Underground Retention Tanks:** Off-line underground storage tanks have been used in parts of Cambridge. These tanks are generally constructed of concrete box culvert sections or poured-in-place concrete structures. They have been used in Cambridge for both private and public projects, particularly where space is limited. Retention tanks, as opposed to detention tanks, have generally been used due to the shallowness of Cambridge storm conveyance systems. The form of retention system used on Cambridge public projects is called a burp storage system. Typically, weir overflow chambers from the conveyance system control the influent flow to retention tanks such that the mainline system does not surcharge. Stored flow is returned to the system via small post-event pumps after the storm event has passed and capacity has returned to the system. This type of underground storage technology is especially appropriate for the Alewife Brook sub-watershed. Deep sump catch basins are required for any paved tributary area upstream of the storage tank. Furthermore, underground storage tanks must have adequate entry points for cleaning operations. Finally, for projects within the 1-percent-annual-chance floodplain, underground retention tank systems can also be designed to allow unrestricted access by river floodwaters that would otherwise be displaced as a result of new structures being built within the floodplain, thus satisfying compensatory flood storage requirements.
- **Underground Detention Tanks:** Off-line underground storage tanks are used throughout Cambridge and are similarly constructed of concrete box culvert sections or poured-in-place structures. In a few instances, detention tanks, as opposed to retention tanks, have been used where there is sufficient grade to create storage that can temporarily impound peak flows, prior to conveying the flows back into the collection system via gravity. Typically, weir overflow chambers control the influent flow to detention tanks. Total outflow from the development is limited such that the peak flow for the 2-year, 24-hour storm is not exceeded. Deep sump catch basins are required when considering these systems.
- **Oversized Pipes:** Similar to detention tanks, oversized pipes are also used to reduce peak flow rates by providing temporary subsurface storage of stormwater runoff. An oversized pipe system is a large pipe that has a small outlet at its invert. When inflow rates are larger than the outflow rates in this pipe series, runoff is detained, generally on the order of a few hours. Oversized pipes are a retrofit alternative for existing stormwater drainage pipes in the upper portions of the drainage system. A careful analysis of the stormwater drainage system must be conducted to prevent water backup and flooding. Other variations of this concept include a manifold arrangement of stormwater drainage pipes and underground vaults. Oversized pipes are an effective way to reduce peak flows from small (less than 5 acres) sites and can be used in sites with insufficient space to construct larger detention structures. They

can also be used in retrofit projects. They have a higher cost than surface retention facilities. Design considerations include the following:

- Pipes should be located in areas where they can be accessed for maintenance. They should not be constructed under structures that cannot be excavated.
- Inflow and outflow rates should be defined in a drainage plan or stormwater drainage system analysis. Generally, inlets are sized to convey frequent runoff events from paved surfaces.
- Minimum diameter should be 72 inches, because smaller sizes are difficult to clean.
- The slope of the oversized pipe should be approximately 0.2%. A slight slope must be maintained to completely drain the pipe, but steep slopes reduce the amount of storage available.
- Emergency surface overflow paths should be located and sized to convey the 100-year runoff in the event that the oversize pipe inlet or outlet becomes plugged or inoperable.

- **Grit Sumps:** At the terminus of any connection from the private development to the existing municipal collection system, a manhole with a deep grit sump (3-foot depth below invert) shall be constructed. Grit sump manholes should be monitored for grit accumulations on a semi-annual basis and cleaned on an annual basis or when the sump accumulations reach a depth of 50%, whichever is sooner. Grit sump type manholes will be required for any upstream stormwater conveyance system manhole for which the peak influent flow velocity for the 3-month design storm is less than 2 ft/sec. The necessary design rainfall distributions for the developer to perform the calculations identified throughout this document are included in Appendix F.
- **Outlet Conveyance Capacity:** Outflow connection(s) from private developments will be limited to the pre-development 2-year, 24-hour peak flow rate for the entire area up to the 25-year 24-hour storm event. Discharges beyond the 25-year 24-hour event can be conveyed to the City's stormwater drainage system through overflow connections or other means. Flow restrictors such as orifices, vortex throttles (minimum 8-inch opening), or Hydroslides are acceptable. A comprehensive review of these technologies can be found in Chapter 9 of MOP No. 17 (ASCE-WEF, 1999).

4. PLAN REQUIREMENTS, INSPECTION PROCEDURES & FEE SCHEDULE

4.1. Plan Requirements

The following Plans are required by the Land Disturbance Regulations as part of the Land Disturbance Permit application package:

- **Stormwater Management Plan:** Overall plan to prevent and reduce the release of pollutants from a site.
- **Erosion and Sediment Control Plan (including Operation and Maintenance Plan for temporary BMPs):** Plan to minimize sediments or pollutants leaving the site, entering the public right-of-way or being deposited into any water body or stormwater drainage system during construction activities.
- **Operation and Maintenance Plan:** Long-term plan to address how permanent BMPs, source controls, pollution prevention procedures, and training will be implemented and maintained.

All Plans must adhere to the standards and requirements listed below and in the checklists located in Appendix G. Submission of the appropriate checklist with each Plan is required for consideration of an application.

4.1.1. Stormwater Management Plan

The Stormwater Management Plan is the overall plan to prevent and reduce the release of pollutants from a site. The Plan should include a narrative of techniques and comprehensive planning flow charts illustrating methods to control the quality and quantity of stormwater leaving the site. Applicants must identify site conditions, receiving waters and pollutants of concern, as well as the prescribed treatment train and stormwater BMPs to be utilized. Specific quality and quantity controls are discussed in Section 3 and Appendix A.

The Stormwater Management Plan must meet the following requirements:

1. The quality of stormwater leaving the site after development must be equivalent to or, to the extent practicable, better than the quality of stormwater leaving the site before development:

   - Water quality control facilities required for development must be designed, installed and maintained in accordance with Section 3 and Appendix A.

- Land use activities of particular concern as pollution sources (hot spots) will be required to implement additional pollution controls in accordance with Section 3.
- Stormwater BMPs installed at a development site must meet the requirements for removing pollutants of concern within the development watershed in accordance with Section 3 and all applicable federal, state and local laws, rules and regulations.
- Stormwater discharges near or discharging to critical areas require the use of the specific source control and pollution prevention measures and the specific stormwater BMPs approved by the DPW for such discharges. These BMPs are discussed in Section 3.
- No new stormwater conveyances (e.g., outfalls) may discharge untreated stormwater directly to or cause erosion in wetlands or Water Resources.

2. The peak discharge rate of stormwater leaving the site after development must be equal to or less than the peak discharge rate of stormwater leaving the site before development:
   - Stormwater discharges leaving the site during and after construction must not have a negative impact on adjacent or abutting properties.
   - Stormwater discharges from the site during and after construction will be infiltrated, treated or stored in accordance with Section 3, and Appendix A.
   - The DPW may exempt projects from the infiltration requirement if flow control is not desirable due to adverse soil conditions, most particularly conditions where infiltration will lead to the migration of contaminants.

A Stormwater Management Plan checklist is provided in Appendix G and must be completed, signed and included with Plan submission.

4.1.2. Erosion and Sediment Control Plan (including O&M Plan for temporary BMPs)

The objectives of the Erosion and Sediment Control Plan are to minimize sediments or pollutants leaving the site, entering the public right-of-way or being deposited into any Water Resource or stormwater drainage system. The most visible water quality impacts due to construction activities are erosion and sedimentation. Erosion is the process by which soil particles are removed from the land surface by wind, water, or gravity. Most natural erosion occurs at slow rates. Unprotected construction sites can erode at rates of over one hundred times the natural background rate of erosion. Sedimentation is the settling out of particles transported by water. Effective sediment control begins with proper erosion control, which minimizes the availability of particles for settling downstream. Since sediment particles can transport other pollutants that are attached to them, effecting Water Resources and aquatic life, it is important to develop and implement an approved Erosion and Sediment Control Plan for all land disturbing activities.

The Erosion and Sediment Control Plan must contain narrative, drawings, and details developed by a State of Massachusetts registered professional engineer (P.E.), a Certified Professional in Erosion and Sedimentation Control (CPESC), or landscape architect which includes best management practices, or equivalent measures designed to control surface runoff, erosion and sedimentation during pre-construction and construction related land disturbance activities. This plan also includes an Operation and Maintenance (O&M) Plan for temporary BMPs installed and operated during construction activities. Suggested Construction Controls are found in Appendix A.

The Plan must include information on how the applicant will accomplish the following:

- Implement measures (BMPs) intended to keep soil, spoil, imported friable building construction and site materials on site or out of Water Resources, stormwater drainage systems or the public right-of-way as the first step in any development. These measures must be made functional prior to any upslope development taking place. Applicants must demonstrate that they have chosen BMPs that are appropriate for site conditions.
- Dust Control measures (see City Specifications).
- Remove any soil that enters the public right-of-way.
- Protect any stormwater drainage system inlets with approved sediment control measures so that sediment-laden water cannot enter the inlets without first being properly treated.
- Implement measures to adequately address flood emergency response procedures so as to clean and make available stormwater inlets before, during and after flood events.
- Apply permanent or temporary soil stabilization to denuded development site areas in conformance with Appendix A.
- Plant replacement vegetative cover in accordance Appendix A.
- Secure or protect soil, spoil, imported friable building construction and site material stockpiles throughout the project with temporary or permanent stabilization measures. Protect all stockpiles on the site, and those transported from the site. All handling of soils must be done in accordance with Appendix A and all applicable federal, state and local laws, rules and regulations.
- Post signage on the site of the permitted land disturbing activity that identifies the DPW 24-hour Hotline Number (617-349-4800) and the name and number of the responsible City project manager/inspector.
- Sequence activities to minimize simultaneous areas of land disturbance.
- Maximize appropriately treated groundwater recharge as approved by DPW.
- Properly manage on-site construction and waste materials, including but not limited to discarded building materials, concrete truck wash out, chemicals, litter, and sanitary wastes.

- Site Dewatering: No construction dewatering from the site to the municipal stormwater drainage system may occur unless it has been permitted by The MWRA, the EPA (whichever is applicable) and the City of Cambridge. Water pumped from the site must be treated by temporary sedimentation basins, grit chambers, sand filters, upflow chambers, hydro-cyclones, swirl concentrators, granulated activated carbon filtration systems or other appropriate controls. Water must not be discharged in a manner that causes erosion or flooding of the site, receiving channels, or a wetland. In the case where a Stormwater and Wastewater Infrastructure Permit (SWIP) is granted for site construction dewatering, the owner must abide by the City of Cambridge Wastewater and Stormwater Drainage Use Regulations and all applicable federal, state and local laws, rules and regulations.
- Tracking: provide graveled roads, access drives and parking areas of sufficient width and length with sufficiently sized and maintained wash bays to prevent sediment from being tracked onto public or private roadways. Any sediment reaching a public or private road must be removed by street cleaning (not flushing) before the end of each workday.

When it is determined that special site conditions may prevent compliance with the above, additional erosion, sediment and pollutant control measures may be required by the DPW as set forth in Appendix A. Special site conditions may include but are not limited to the following:

- Slopes before development that are greater than 10 percent (1 Vertical: 10 Horizontal)
- Land disturbance of a natural vegetative buffer within 50 feet of a wetland and or water body.
- The development site is located entirely or partially within a Flood Plain Overlay District.
- Project timing is such that land disturbing activity will take place between October 1 and April 30.

Required additional control measures may include but are not limited to:

- Requiring that a State of Massachusetts registered P.E., other professional certified by the State of Massachusetts with experience or qualifications in preparing erosion and sediment control plans, a registered CPESC, or State of Massachusetts registered Landscape Architect prepare or implement the Erosion and Sediment Control Plan.
- Prohibiting or restricting land disturbing activities between October 1 and April 30.
- Limiting the amount of denuded soil at any given time.
- Requiring a bond, letter of credit or other guarantee.

The Operation and Maintenance (O&M) Plan (for Temporary BMPs) is to be included within the Erosion and Sediment Control Plan and should include information on how each BMP is to be properly operated and maintained during construction activities.

An O&M Plan should, at a minimum, identify:

- Stormwater management system(s) owner(s);
- The party or parties responsible for operation and maintenance;
- Schedules for inspection and maintenance; and
- The routine and non-routine maintenance tasks to be undertaken.

The plan must meet the following objectives applicable to all land disturbance activities:

- All temporary BMPs on site during construction must work and be maintained properly.
- Maintenance inspections must be performed in compliance with Section 4.2.
- Inspection and repairs must be made immediately after periods of rainfall.
- All temporary BMPs must be removed and the site restored at the end of construction.

An Erosion and Sediment Control Plan checklist is provided in Appendix G and must be filled out, signed and included with plan submission.

4.1.3. Operation and Maintenance Plan (for Permanent BMPs)

The Operation and Maintenance (O&M) Plan for Permanent BMPs includes information on how each BMP is to be properly operated and maintained after construction is finished. The owner is responsible for maintenance, inspections, recordkeeping and reporting of permanent stormwater management measures. Additionally, the O&M Plan must identify pollution prevention and source control procedures on site and how those procedures will be scheduled, implemented, and how maintenance staff will be trained.

Prior to a transfer of ownership of any property subject to an O&M Plan, the owner must inform the prospective owner of the requirements of the existing O&M Plan and of the requirement to file a new O&M Plan upon transfer of ownership. The new owner will be required to submit the O&M Plan to the DPW for approval within 60 days of the transfer of ownership. Until the new plan is approved by the DPW, the new owner must be bound by the provisions of the existing O&M Plan. The O&M Plan must meet the following requirements.

- If the O&M Plan identifies a person other than the owner (for example, a public agency or homeowners' association) as having the responsibility for maintenance, the plan must include documentation satisfactory to DPW of such person's obligation or agreement to assume this responsibility.
- Responsibility for maintenance should not be assigned or transferred to the owner or tenant of an individual property in a residential development or project, unless such owner or tenant owns or leases the entire residential development or project.

- The O&M Plan must include a schedule for preventative and corrective maintenance to maintain the function of the stormwater BMPs, including repairs or replacement to the structure, removal of sediment, debris or trash, restoration of eroded areas, snow and ice removal, fence repair or replacement, restoration of vegetation and repair or replacement or nonvegetated linings.
- The person responsible for maintenance identified above must maintain a detailed log of all preventative and corrective maintenance for the structural stormwater management measures (BMPs) incorporated into the design of the development, including a record of all inspections and copies of all maintenance-related work orders.
- The person responsible for maintenance identified above must evaluate the effectiveness of the O&M Plan at least once per year and must note certification of its effectiveness in the log, or in the event that it is no longer effective, must provide certification to that effect to DPW with a proposed revised plan for DPWs review and approval. The log must be submitted to DPW upon request.
- The person responsible for maintenance identified above must retain and make available, upon request by DPW, the O&M Plan, O& M documentation, inspection and maintenance logs, etc.
- The plan must include a list of source controls for the site, their corresponding schedules and inspection information. The person responsible for maintenance identified above must ensure that pollution prevention procedures are in place, implemented, and that staff receive regular training on how to perform these tasks. See Appendix A for Source Controls fact sheets.
- The provisions of any O&M Plan for a stormwater management facility that is dedicated to and accepted by the City for the City's ownership, operation or control must terminate upon the City's acceptance of ownership, operation or control of said facility.
- DPW may require the posting of a performance or maintenance guarantee.

The following General Requirements must be incorporated into any O&M Plan:

Access and Safety

- Access to ALL stormwater management systems should be safe and efficient.
- All egress and ingress routes should be maintained to design standards as discussed below for access routes:
  - Access routes should be inspected and maintained
  - Obstacles preventing maintenance personnel and/or equipment access should be removed
  - Walkways should be clear of obstructions and maintained to design standards

- Roadways should be maintained to accommodate the size and weight of vehicles that use the roadways
- Gravel or ground cover should be added if erosion occurs (for example, as a result of vehicle or pedestrian traffic)
- All fences should be maintained to preserve their functionality and appearance
- Collapsed fences should be restored to an upright position
- Jagged edges and damaged fences should be repaired or replaced

Drainage Structures

- Clean catch basins as often as necessary to maintain a 4ft. freeboard, or at minimum, semiannually
- Inspect and clean flow restrictors semiannually
- Inspect and clean, if necessary, sewers annually

Signage

- Signage should educate people about the importance or function of the property's stormwater protection measures (BMPs)
- Signage should discourage behaviors that adversely affect stormwater protection measures (BMPs)
- Broken or defaced signs should be replaced or repaired

Vegetation

- Special care should be taken to ensure that all vegetation is maintained in accordance with the design specifications for each system (BMP)
- Where possible, use native and drought-resistant vegetation. Vegetation should be irrigated regularly during the establishment phase and if necessary, during excessively dry periods for long-term maintenance
- Weedy and dead vegetation should be removed regularly to prevent clogging of BMP structures and to encourage the growth of desired vegetation
- Native vegetation should be mowed or burned regularly

Insects and Rodents

- Pest control measures should be taken when insects or rodents are known to be present
- Stagnant water, which is an environment for developing insect larvae, should be eliminated
- If pesticide sprays are used, a mosquito larvacide (such as *Bacillus thurengensis* or Altoside formulations) can be applied only if absolutely necessary and only by a licensed individual or contractor.
- Holes in the ground in and around the stormwater management system should be filled and compacted.

An Operation and Maintenance Plan checklist is provided in Appendix G and must be filled out, signed and included with plan submission.

4.1.4. Plan Review Procedures and Revisions to Plans

The application package for a Land Disturbance Permit should include the following:

- Completed Application Form which must be signed by all owners (original signatures required).
- Plans: 1 paper copy of 3-ring loose-leaf binder containing:
  - Stormwater Management Plan and Stormwater Management Plan checklist with original signature.
  - Erosion and Sediment Control Plan (including O&M Plan for temporary BMPs) and Erosion and Sediment Control Plan checklist with original signature.
  - Operation and Maintenance Plan and Operation and Maintenance Plan checklist with original signature.
- NPDES General Permit for Discharges from Large and Small Construction Activities (where applicable)
- Electronic Copy: 1 electronic copy of completed application package on CD.
- Video Inspection: A video inspection of existing conditions of the site, right-of-way, and access and egress points.
- Payment of Application and Review Fees

Plans that meet the requirements specified above will be reviewed in accordance with the Land Disturbance Regulations. The DPW will approve, approve with conditions, or deny the plans within 60 days following the date the application for approval is filed. Approval of the plans expires one year from the date of approval unless land disturbing activities have commenced in accordance with said plans. Extensions may be granted according to the Land Disturbance Regulations.

Prior to the approval of the plans, the applicant is required to post a surety bond, irrevocable letter of credit, cash or other acceptable security. The bond will be reviewed and approved in accordance with the Land Disturbance Regulations.

During development, the DPW or the owner or applicant may request revisions to the Land Disturbance Permit. The DPW may approve or deny all revisions.

The DPW may require revisions to any of the approved Plans when:

- It is determined that measures approved in the Plans do not meet the purposes set forth in Section 4.1.
- An alternate method, measure or control fails to perform as claimed by the owner or applicant.
- A change in project timing has occurred due to an adverse change in weather; or the project schedule has changed which results in development being conducted at a different time of year than originally accepted or approved.
- During development, relevant new information about soil, site, topography or water conditions is discovered.

- Changes to the area or type of land disturbing activity or equipment used are proposed or implemented.
- Additional or substitute construction or maintenance materials or chemicals will be used during development that require pollutant BMPs as set out in Section 3 and Appendix A.

Revised plans must show all actual and proposed changes made on the site, the new locations of drainage patterns, and the effect that the revisions will have on the site. The new plans must show how problems associated with the prior plan have been corrected, and indicate all new erosion, sediment and pollutant control measures. The DPW may require that the new plans be prepared by a State of Massachusetts registered professional engineer (P.E.), a State of Massachusetts registered Landscape Architect, or a CPESC, and that the revisions are stamped as such.

The owner or applicant must be solely responsible for the costs associated with any revisions, including but not limited to, any additional or alternate methods, measures, performance criteria or controls, or costs for any consultants that the DPW deems necessary to assist it with its review and approval of revisions.

4.2. Inspection Procedures

Inspections of both structural and non-structural BMPs are required during and after construction. The sections below detail the procedures for each inspection and inspector responsibilities throughout the life of the project.

The DPW or its authorized representative may conduct inspections whenever it is necessary to enforce any provisions of the Land Disturbance Regulations and to determine compliance with the regulation. When an inspection is occurring, the DPW or authorized representative must first present proper credentials to the responsible party and request entry. In the event that owner's or applicant's site inspections are not in accordance with the requirements as provided in this Section, the City or the City's agent will conduct inspections and the owner must reimburse the City for the cost of the inspections.

4.2.1. Construction Inspections

The Land Disturbance Regulations and Permit require inspections to be performed during certain stages of the project. The applicant or designated agent who conducts inspections must be a qualified inspector. A qualified inspector must be either a Massachusetts Registered Professional Engineer (P.E.) or a Certified Professional in Erosion and Sediment Control (CPESC), or other certifications in Erosion and Sediment Control as approved by the City Engineer. The qualified inspector must perform the required inspections, must approve that portion of the work complete or must notify the owner and the DPW within 12 hours if any work fails to comply with the Land Disturbance Permit.

The Land Disturbance Permit and associated plans, as approved by DPW, must be maintained at the site during the project. The required inspection events are as follows:

- **Pre-construction Meeting and Initial Site Inspection** Prior to starting clearing, excavation, construction, or land disturbing activity the applicant or designated agent, must meet with the DPW to review the approved plans and their implementation. The qualified inspector must inspect the project site and provide certification to the DPW of initial site inspection (prior to approval of any plan and before construction begins).
- **Project Progress Inspections** The qualified inspector must be responsible to observe and document the project progress at certain events, and must submit the inspection logs to DPW upon request. The owner must notify the DPW at least two (2) working days before each of the inspection events. Notification is required in writing, preferably by e-mail. The required project progress inspections are:
  - Erosion and sediment control measures are in place and stabilized.
  - Site clearing has been substantially completed.
  - Rough grading has been substantially completed.
  - Final grading has been substantially completed.
  - Close of the Construction Season.
  - Final Landscaping (permanent stabilization) and project final completion.
- **Owner Inspections** The qualified inspector must conduct and document inspections of all control measures no less than weekly or as specified in the Land Disturbance Permit, and prior to and following anticipated storm events. The purpose of such inspections will be to determine the overall effectiveness of the Erosion and Sediment Control Plan and the need for additional control measures. A copy of inspection reports should remain on site at all times and must be submitted to DPW upon request.
- **Bury Inspection** The DPW must be notified prior to backfilling of any underground drainage or stormwater conveyance structures so that inspection, if deemed necessary by the DPW, can take place.
- **Final Inspection** After the stormwater management system has been constructed and before the surety has been released, the applicant must submit a stamped record plan, stamped by a Massachusetts registered P.E. or a Massachusetts registered Land Surveyor, detailing the actual stormwater management system as installed. The record plan will include a statement box on the plan certifying the site review was conducted in accordance with the Land Disturbance Regulation and all items were constructed in accordance with the Land Disturbance Permit. The applicant or designated agent must request a final inspection site meeting with the DPW. The DPW must visit the site with the applicant or designated agent to confirm its "as-built" features. As-Built drawings of BMPs must be submitted to the DPW. A final

report as referenced in Section 4.3 must be submitted to the DPW for review and approval prior to the issuance of Certificate of Occupancy.

- **Other Inspections** Where the DPW has determined that special site conditions exist, the DPW may designate an inspector to monitor erosion, sediment and pollutant control at that site.

4.2.2. Post Construction Inspections

Inspections for permanent stormwater management measures in place after construction has ended are required as part of the O&M Plan (for Permanent BMPs). An inspection schedule and blank inspection form are required as part of the Plan which must be approved by DPW. Annual updates to the O&M Plan are also required.

Inspections are required for each BMP in accordance with Appendix A unless otherwise required by a maintenance agreement or by the manufacturer.

4.3. Final Report and As-Built Requirements

At completion of the project the owner must submit a final report of all structural stormwater controls and treatment BMPs. The as-built drawing must show all deviations from the approved plans and drawings, if any, and must be certified by a Massachusetts registered P.E. or a Massachusetts registered Land Surveyor.

The DPW will issue a letter certifying completion upon receipt and approval of the final reports and/or upon otherwise determining that all work completed pursuant to the Land Disturbance Permit has been satisfactorily completed in conformance with the Land Disturbance Regulation, which must be submitted by the owner or applicant to the City of Cambridge Department of Inspectional Services prior to the issuance of a Certificate of Occupancy.

4.4. Fee Schedule

5. WASTEWATER AND STORMWATER DRAINAGE USE REGULATIONS

5.1. Overview

The City's Wastewater and Stormwater Drainage System Ordinance in conjunction with the Wastewater and Stormwater Drainage Use Regulations apply to anyone who discharges to the City's wastewater and/or stormwater drainage systems. They identify allowable and prohibited discharges, corresponding violations procedures and penalties. They also provide the City with the legal authority to enter property and inspect and monitor for illicit connections to these systems.

The regulations require that anyone performing work on the City's wastewater or stormwater drainage system obtain approval from the DPW by way of one or more permits. The following wastewater and stormwater related activities require a Stormwater and Wastewater Infrastructure Permit (SWIP) issued by the DPW:

- Collection System Access
- Termination and Verification (cutting and capping)
- Stormwater Discharge
- Wastewater Discharge
- FOG (Fats, Wax, Oils and Grease)
- Excavation (in public ways)
- Demolition
- Temporary Construction Site Dewatering
- Direct Connection

In addition to a SWIP, a Sewer Use Discharge Permit may be required and will be jointly issued by the DPW and the MWRA. See Appendix G for the Project Permit Checklist.

The City also regulates the use of the sewers, combined sewers and stormdrains – both public and private. The City prohibits uncovering, excavating over, blocking access to, making any connection with or opening into, altering, or disturbing the City-owned wastewater or stormwater drainage systems. Private sewer, combined sewers and stormwater drainage systems are to be constructed, installed, maintained, repaired, funded, and operated by their owners; the DPW's jurisdiction applies only to discharges from these systems. The City is ultimately responsible for the discharges from all sewers, combined sewers and stormwater drainage systems.

5.2. Sanitary and Combined Sewers

Sanitary sewer controls are required to the maximum extent practicable on all development and redevelopment projects in Cambridge.

The City of Cambridge is an older, highly developed, City with a significant industrial past. The infrastructure system reflects that history. Much of the original sewer system was built over 150 years ago as a combined system, i.e. both sanitary flow and stormwater flows are carried in a single pipe, and were originally discharged directly into the rivers. Today, combined sewer flows are conveyed to the MWRA's Deer Island Treatment plant. During certain rainfall events combined sewer overflows (CSOs) can occur and discharge untreated sewerage into the Charles River and/or the Alewife Brook.

In the late 1930's separation of the combined sewer system began. Separated systems convey stormwater to the rivers and sanitary waste is conveyed to the treatment plant. Separation of the combined sewer systems continues today. The City's collection systems include approximately 115 miles of sanitary sewer, 78 miles of stormwater drains, 43 miles of combined sewer (sanitary sewerage and stormwater) and around 10,000 assorted sewer and drainage structures (manholes, catch basins, regulators, overflows, etc.) Today 40% of the City has been separated. Construction and rehabilitation of the wastewater and stormwater drainage systems has been accomplished through the use of Federal, State and local funds.

Over the past 20 years the City's approach to sewer separation has evolved into an approach that incorporates stormwater management as the major component of these projects. Sewer separation projects now address community flooding and stormwater quality issues and system maintenance as integral issues in reconstruction of municipal wastewater and stormwater infrastructure.

All private sewer connections in the Alewife Brook sub-watershed connect into the City's wastewater system, which discharges into the MWRA Alewife Brook Conduit. The MWRA interceptor system in this area is a combined sewer overflow (CSO) system that collects flow from the City of Cambridge and the City of Somerville combined sewer systems as well as those separated systems in Belmont and Arlington. This system discharges combined sewer overflows to the Alewife Brook during significant wet weather events.

All private sewer connections in the Charles River area also connect into the City's wastewater system, which ultimately discharges into the MWRA North Charles Relief

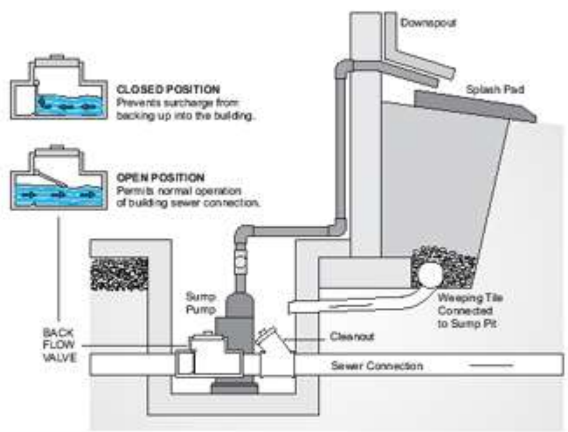
Sewer. This system discharges combined sewer overflows to the Charles River during significant weather events.

Future private development wastewater discharges will not be allowed to exacerbate existing combined sewer overflow volumes or frequencies. Dry weather flow rates and volumes must be restricted and all existing extraneous private property inflow sources to the wastewater system such as sump pumps, roof drains, area drains, and catch basins must be identified and removed for new development and to the maximum extent practicable for redevelopment projects. Any new development proposing to add additional wastewater to an existing wastewater system connection will be required to reduce infiltration/inflow sources at an equivalent rate such that there is no net additional flow to the system. Typically, this will require a 4 to 1 ratio of inflow/infiltration (I/I) removal at the 3-month 24-hour event or the storage of sanitary flow from the property for a period of 8 hours (at maximum flow) multiplied by a safety factor of 1.5, or a combination of both strategies to ensure that there is no adverse impact on CSO events. The City Engineer reserves the right to determine the appropriate means of mitigation. The applicant must provide sufficient calculations and /or measurements for approval by the City Engineer. Appropriate means of controlling deposition, sediment and odor must also be provided for approval.

Additionally, the following Best Management Practices should be followed when developing/redeveloping in Cambridge.

Backwater Valves: Major rain events can cause overland flooding and sewage backups into homes or businesses in low-lying areas. Overland flooding cannot always be prevented; however, sewage backups can be minimized if homes or businesses are properly equipped with a backwater valve. All existing or new building drains from plumbing fixtures subject to a backflow from a City public sewer, or a private sewer connected to a City public wastewater system, are required to be fully separated and have backwater valves installed at the owner's expense. Any plumbing fixture located at an elevation below the elevation of the roadway adjacent to the property, will be considered to be subject to backflow. Backwater valves must be installed in accordance with the *Uniform State Plumbing Code, 248 CMR, Section 2.09:(4)*. Additional required practices are listed below:

BEST MANAGEMENT PRACTICES FOR BACKWATER VALVES



BACK FLOW VALVES AND SUMP PUMPS ARE EFFECTIVE MEANS OF AVOIDING BASEMENT FLOODING
In existing homes experiencing basement flooding due to sewer backup, an effective prevention strategy is to install a sump pump and a back flow valve. This type of installation must normally be approved by the municipality and it is recommended to have the work performed by a qualified plumbing contractor.

DESCRIPTION

A backwater valve is a one-way valve device designed to prevent sanitary sewer backups through private plumbing fixtures such as sinks, toilets, showers, and laundry tubs. A backwater valve is designed to close when the sewer is flowing beyond its capacity, as can occur during heavy rains or blockages.

REQUIRED PRACTICES

- Only in-line backwater valves are acceptable. Backflow devices that are not in-line and screw directly onto a floor drain are not acceptable devices because they cannot withstand the pressure of a large sewer backup.
- Backwater valves should be installed by a licensed plumber.
- Ensure that your valves are covered with a cover plate and that the cover plate can be removed easily.
- Do not place permanent carpet or other flooring over top of the cover plate – the valve must be accessible at all times.
- Check the valve regularly and remove any material that may prevent the valve from operating properly.

TIPS

- Discuss possible limitations of these devices with your plumber.
- Backwater valves are designed to be closed during sewer surcharge conditions, to keep water from the sewer from getting into the building. When the backwater valve closes, water from the inside of the building also cannot get out. When there is a risk of sewer surcharge, such as during a heavy rainstorm, you should avoid using the toilet, sink, shower, washer, dishwasher, or any other appliance that releases water to the sanitary sewer system.
- Regardless of whether or not you install a backwater valve, if stormwater from your property still enters the sanitary sewer system, you are increasing the risk that your property and the properties around you may flood.

DESIGN CONSIDERATIONS

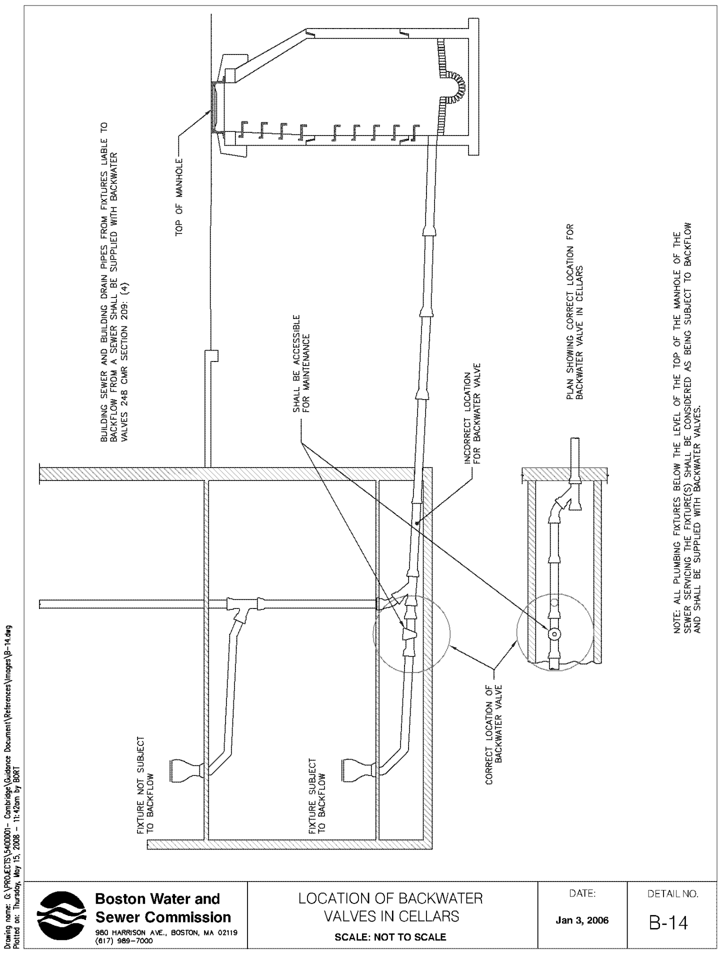
- There are two types of in-line valves; normally-closed and normally-open. Normally-closed valves may be more reliable; however a normally-open valve may be required because of the plumbing configuration of the building.

REFERENCE

- Diagrams: Canada

- Have a qualified plumber inspect the device regularly to ensure proper operation.

Backwater valves should be located as shown in the Boston Water and Sewer Commission diagram below:

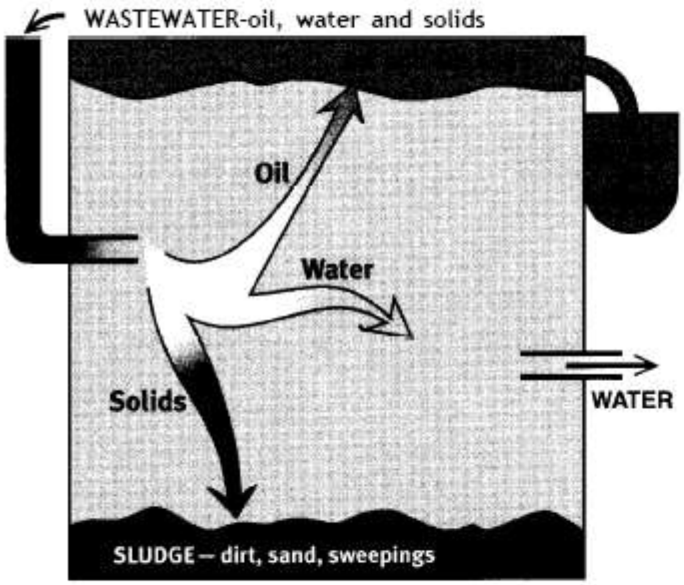


Mortgage and Housing Corporation and Boston Water and Sewer Commission

- City of Saskatoon, Protective Plumbing guide
- City of Worcester, Massachusetts DPW and Parks, Backwater Valve Rebate Program

Oil/Water Separators for Garages Oil/water separators are required on sewers directly or indirectly tributary to the City's wastewater system from existing and new garages, service stations, enclosed parking areas, and other establishments capable of discharging petroleum-based oil or grease, flammable wastes, sand, or other harmful substances. Discharges from oil/water separators must be directed to a sanitary or combined sewer and not to a stormwater drain.

BEST MANAGEMENT PRACTICES FOR OIL/WATER SEPARATORS AT VEHICLE MAINTENANCE GARAGES



DESCRIPTION

The *Uniform State Plumbing Code* requires that floor drains in vehicle parking, repair, and washing facilities pass through a separator device. An oil/water separator allows substances lighter than water to float (oil) and substances heavier than water (sediment) to sink. Many oil/water separators also have baffles, coalescers, and oil skimmers to speed-up or enhance separation of these substances.

REQUIRED PRACTICES

- Prevent spills from ever reaching the shop floor by installing secondary containment in storage areas; using safety cans, drip pans and trays, and funnel drum covers when transferring fluids; and installing bulk, pressurized, overhead fluid delivery systems, where appropriate.
- Immediate cleanup of spills can be promoted if employees carry rags for small spills; clean with reusable cloth rags; use absorbent materials such as hydrophobic mops to remove larger spills; wring out absorbed fluids into suitable containers; and carefully mark and make available all spill cleanup material.
- Use dry methods for cleaning and minimize the amount of wash water reaching the oil/water separator. Keep

TIPS

- By routinely checking vehicles for leaks, excessive dripping and spilling of fluids can be prevented.

DESIGN CONSIDERATIONS

- Units should be designed in accordance with the State Plumbing Code 248 CMR 10 and approved by DPW**.**

REFERENCE

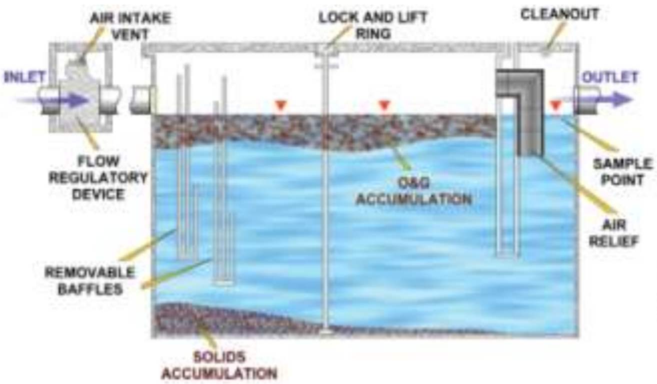
- Diagram and BMP information: EPA Best Environmental Practices for Auto Repair and Fleet Maintenance
- US EPA Business Workbook for Drinking Water Protection
- City of Palo Alto’s Regional Water Quality Control Plan Selected Requirements and BMPs for Facility/Property Mangers and Their Contractors
- MassPort Environmental Standard Operating Procedure for Oil/Water Separator Inspection and Maintenance

the floor clean and dry by sweeping everyday; using only a damp mop for general cleanups; never hosing work areas; and sealing the shop floor with impervious materials, if possible.

- Where possible, wash vehicles without detergents. Emulsifying cleaning compounds (detergents) disperse oil in wash water and make oil/water separators ineffective such that oil passes right through to the sewer. High pressure water or non-emulsifying cleaners are sufficient for most cleaning applications.
- Minimize the amount of solids and oils that enter the oil/water separator. The less solids and oils that reach the unit, the less frequently sludge and floating oil must be removed from the oil/water separator and the better it will work. There are several techniques for keeping oil and solids out including, filtering with progressively finer grates and screens over the drains to the unit, using oil-only absorbents to separate and recycle oil from the unit, and using microbes to digest oil in the unit.
- Inspect the oil/water separator every six months and clean out at least annually. If the accumulated sediment in an oil/water separator exceeds a 10-in. depth or if there is an oil layer, a cleaning must occur. The contents of the cleaning must be disposed of in accordance with the *Massachusetts Hazardous Waste Regulations 310 CMR 30*. Document inspections and cleaning events.
- Develop and implement spill prevention and response procedures.

Grease Traps The City of Cambridge has developed a FOG Removal program to control the discharge of grease from restaurants and food preparation facilities into the wastewater system. These facilities are required to install grease traps as described below and may be required to install a sampling port or manhole for FOG sampling purposes.

BEST MANAGEMENT PRACTICES FOR FATS, WAX, OILS AND GREASE (FOG)



Grease Trap Diagram

This diagram shows the basic design and flow within a grease trap. Your system may or may not look exactly like this diagram.

DESCRIPTION

The presence of FOG in wastewater results in major operational problems in the sewers and at the wastewater treatment facilities. Grease from food preparation operations solidifies on the inside of sewers restricting the flow of sewage. Grease has fouled equipment and controls at treatment facilities, and high concentrations of FOG in the wastewater inhibits biological processes used to treat domestic sewage. Grease discharges are predominantly generated from washing and cleaning operations. By installing and maintaining a properly sized grease recovery unit (GRU), also called a grease trap, these discharges can be controlled and minimized.

REQUIRED PRACTICES

In accordance with the *Uniform State Plumbing Code (248 CMR 10.09 (2)(c))*, plumbing fixtures to be protected by grease traps and interceptors at the specified facilities include: pot sinks (with bowl depths exceeding ten inches), scullery sinks (with bowl depths exceeding ten inches), floor drains, floor sinks, automatic dishwashers regardless of temperature, pre-rinse sinks, soup kettles or similar devices, wok stations, and automatic hood wash units.

- Train kitchen staff and other employees about how they can help ensure BMPs are implemented.
- Post "No Grease" signs above sinks and on the front of dishwashers.

TIPS

- You can learn more about Cambridge's FOG Removal program and how you can help by visiting: http://www.cambridgema.gov/TheWorks/

DESIGN CONSIDERATIONS

Two types of GRUs are acceptable for installing in Cambridge:

- **Automatic Electrical/Mechanical GRU.** This type is small, which allows installation in the kitchen under the sink or elsewhere. This type removes grease daily, collecting it neatly in a small bucket from which it can be disposed in a dumpster or recycled with other grease through a rendering firm. Maintenance, which is done daily, is fast and extremely easy to do.
- **Large in-ground passive GRU.** This type must have a capacity of at least 15 gallons per seat in the restaurant with a minimum capacity of 1000 gallons. It is larger and must be installed underground outside the facility. Maintenance includes monthly inspections to determine the grease layer thickness and the regular pumping of the grease by a certified waste hauler. Pumped out grease must be hauled to special facilities for processing or incineration.

REFERENCE

- Diagram: Warwick Sewer Authority, Warwick, Rhode Island, Quick Guide

- Signage for areas which discharge to the grease trap must be in compliance with the *Uniform State Plumbing Code (248 CMR 10.09 (2)(m)(3.))* which states: A laminated sign shall be stenciled on or in the immediate area of the grease trap or interceptor in letters one-inch high. The sign shall state the following in exact language: *IMPORTANT This grease trap/interceptor shall be inspected and thoroughly cleaned on a regular and frequent basis. Failure to do so could result in damage to the piping system, and the municipal or private drainage system(s).*
- Use a three-sink dishwashing system, which includes sinks for washing, rinsing, and sanitizing in a 50-100ppm bleach solution. Use water temperatures less than 140 F in all sinks, especially the pre-rinse sink before the mechanical dishwasher.
- Recycle waste cooking oil.
- “Dry wipe” pots, pans, and dishware prior to dishwashing.
- Dispose of food waste by recycling and/or solid waste removal.
- Witness all grease trap or interceptor cleaning/maintenance activities to ensure the device is properly operating.
- Clean undersink grease traps weekly. If traps are more than 50% full when cleaned weekly, then cleaning frequency needs to be increased.
- Clean underground grease traps routinely. The cleaning frequency will be a function of the type of establishment, the size of the trap, and the volume of flow discharged by the establishment.
- Keep a maintenance log.
- Use a leak-proof grease disposal dumpster or storage container and/or use secondary containment. Keep storage units covered and away from storm drain catch basins. Protect storm drain catch basins during grease trap maintenance activities.
- Routinely clean kitchen exhaust system filters. If grease and oil escape through the exhaust, it can accumulate on the roof and eventually enter the stormwater drainage

to Restaurant Discharge Maintenance

- Oregon Association of Clean Water Agencies, FOG BMP Manual system during a rain event.

5.3. Stormwater Drainage System

In addition to regulating land disturbance activities in order to prevent polluted stormwater from reaching surface waters, the City regulates discharges from wastewater and stormwater drainage systems. Discharges to stormwater drains which are authorized by these Regulations are as follows:

- Discharges composed entirely of stormwater
- Discharges for which the owner has obtained both a SWIP from the DPW and an NPDES Permit, coverage under an NPDES General Permit, or an NPDES Permit Exclusion from the EPA
- Water line flushing
- Landscape irrigation
- Diverted stream flows
- Rising ground waters
- Uncontaminated groundwater infiltration
- Uncontaminated pumped groundwater
- Discharge from potable water sources
- Foundation drains
- Air conditioning condensation
- Irrigation water and springs
- Water from crawl space pumps
- Footing drains
- Lawn watering
- Individual resident car wash waters
- Flows from riparian habitats and wetlands
- Dechlorinated swimming pool discharges
- Street wash water by methods approved by the City
- Residential building wash waters, without detergents
- Discharges or flows from emergency fire fighting activities

With the exception of those discharges authorized above, no person shall cause or allow any non-stormwater discharges to the City's stormwater drainage system without having first obtained an SWIP from the DPW. Discharges to stormwater drains that require an SWIP include, but are not limited to, dewatering drainage, subsurface drainage, non-contact cooling water, non-contact industrial process waters, uncontaminated cooling water, uncontaminated industrial process water, or water associated with the excavation of a foundation or trench, hydrological testing, groundwater treatment/remediation, removal or installation of an underground storage tank, foundation drains, crawl space pumps, footing drains or utility access chamber discharges The decision to issue an SWIP rests entirely with the DPW. Such discharges shall comply with all other applicable requirements.

Persons seeking to discharge stormwater pursuant to an SWIP shall also obtain an NPDES Permit, coverage under an NPDES General Permit or an NPDES Exclusion for the discharge, a copy of which shall be provided to the DPW.

The SWIP issued to the user may stipulate special conditions and terms as deemed necessary or appropriate by the DPW.

An authorized discharge, from a given property or site shall be denied, revoked, suspended or reissued with different requirements   if the DPW determines that the discharge, whether singly or in combination with others, is or may cause or contribute to a water quality problem, or may cause or contribute to a violation of the City's NPDES Permit.

In the case of construction site dewatering, the duration of the permit shall not exceed the time period necessary to keep a site dewatered during construction. A permittee may apply to the DPW for an extension of an SWIP for construction site dewatering if so approved by the appropriate state or federal agency. Such application shall be submitted to the DPW a minimum of fourteen 14 days prior to the expiration of the existing permit.

Below are BMPs for selected allowable discharges to the Stormwater Drainage System.

BEST MANAGEMENT PRACTICES FOR RESIDENTIAL WASH WATERS

DESCRIPTION

Wash waters from washing building facades, rooftops, awnings, vehicles, and streets can readily degrade water quality as the runoff and loosened solids typically travel directly into the stormwater drainage system. Wash waters can be contaminated with suspended solids, metals, and other pollutants which can harm aquatic life and the environment, and contaminate recreational sites and drinking water supplies, even if cleaning solutions are labeled nontoxic or biodegradable. Washing is an activity that can help improve the quality of our waters when done properly. By cleaning surfaces and properly disposing of the wastes, there is less chance of pollutants ending up in our waterways.

REQUIRED PRACTICES

- Use dry methods for surface pre-cleaning, such as using absorbents on small oil spots and sweeping up trash, debris, and dirt before wet washing.
- Use a mop or rags to pre-clean vehicles and other equipment.
- Identify where all area storm drains are located and locate property high and low spots. Identify the flow path wash water will take.
- Minimize water use by using high pressure, low volume nozzles.
- Use the minimal amount and least toxic detergents (Phosphate Free or Biodegradable) and degreasers to complete the job.
- If soaps and detergents are used and the surrounding area is paved, use a water collection device that enables the collection of wash water and associated solids. The resulting wastewater cannot be discharged to the

POLLUTANTS OF CONCERN

- Sediment (H)
- Trash (H)
- Metals (H)
- Bacteria (H)
- Oil and Grease (H)
- Organics (H)

TIPS

- You can hire a mobile washer who collects and recycles the water or complies with the required practices.
- If a painted surface being washed is painted with lead or other heavy-metal bearing paint (such as chromium or cadmium), consider using a commercial pressure washing service that can collect, test, and properly dispose of the wastewater.
- When working with electrical equipment in wet environments, it is important to understand and comply with all applicable health/safety and electrical codes and use appropriate safety equipment.
- Berms, storm drain covers and mats, containment pools, vacuums/pumps, and booms can all be used to contain and collect wash water that cannot be discharged to the stormwater drainage system.

DESIGN CONSIDERATIONS

- If it is expected that a building or structure will stormwater drainage system and must be properly collected, treated, and disposed. Any wash chemical/detergent residue must be rinsed from the surface and removed with wastewater.

- No wash residue is to remain on the washing surface.
- If soaps or detergents are NOT used, and the surrounding area is paved, wash water runoff does not have to be collected but must be screened. Use filter fabric catch basin inserts or some other type of screening device on the ground and/or in the catch basin to trap the particles in wash water runoff.
- If you are washing on a grassed area (with or without soap), runoff must be dispersed as sheet flow as much as possible, rather than as a concentrated stream. The wash water runoff must infiltrate into the grass and not drain to the pavement or stormwater drainage system. Discharge of wash water to land must not create a nuisance condition or contaminate soil with hazardous waste.
- If you are diverting wash water to landscaped areas, avoid damage to plants and soil by minimizing or eliminating the use of soaps detergents, and chemicals. Filter out any solids that would be visible on the ground after discharge. Minimize the use of water to avoid overflow from these areas.

be washed regularly, design the landscaping and paving to accommodate the required practices.

- Catch basin inserts, configured for debris removal, may remove some of the pollutants in runoff from this activity. Catch basin inserts require frequent maintenance to be effective.

REFERENCE

- Photo: H20 Power Washing of San Diego
- City of Lawrence, Kansas Public Works Stormwater Division, BMPs for Pressure Washing and Surface Cleaning
- King County, Washington Department of Natural Resources and Parks, Stormwater Pollution Prevention Manual
- City of Boulder, Colorado, Partners for a Clean Environment, BMP Library
- City of Corona, California Public Works BMP Program

BEST MANAGEMENT PRACTICES FOR SWIMMING POOL MAINTENANCE

Goldstar Swimming Pool
Cambridge, MA

DESCRIPTION

The way you maintain your swimming pool, spa, or fountain can make a significant difference in the City's surface water quality. The City's regulations allow for swimming pool water discharges to the stormwater system only if the required practices below are met. If it is determined by the DPW and the MWRA that there is no reasonable alternative, then swimming pool water may be discharged to the sanitary or combined sewers with written approval by the City and the MWRA.

REQUIRED PRACTICES

- Pool and spa water should be allowed to stand for one week prior to draining and be dechlorinated (less than one ppm chlorine) if it is to be emptied into a ditch, on the ground/lawn, or to the stormwater drainage system.
- Discharges to the environment should be directed over a vegetated surface so that some level of filtration can occur.
- Discharges must not create any erosion.
- The pH must be between 6.5 and 8.5 before the water is discharged.
- The water should be within ambient temperature. This means heated water should be allowed to cool to air/standing temperature.
- Algaecides such as copper or silver should not be used.
- Total suspended solids must be below 60 mg/l.

POLLUTANTS OF CONCERN

- Chlorine (H)
- Temperature/pH (H)
- Suspended Solids (M)

TIPS

- Contact your pool chemical supplier to obtain the neutralizing chemicals you will need.
- You can hire a professional pool service company to collect all pool water for proper disposal. Remember that you are responsible for the practices of your contractors. Be sure to know how your contractor will be disposing of any pool, spa, wash water and backwash.

REFERENCE

- Idaho Department of Environmental Quality BMP Catalog
- University of Minnesota Duluth Storm Water Steering Committee Pollution Prevention/Good Housekeeping BMPs
- Alameda Countywide Clean Water Program, San Francisco California Stormwater BMPs
- City of Boulder, Colorado, Partners for a Clean Environment, BMP Library

Suspended particles should be allowed to settle out and the water should not appear murky. Settled material should not be discharged to the environment.

- Provide drip pans or buckets beneath drainpipe connections to catch leaks.
- Draining of the pool or spa should not coincide with any significant rain event.
- Water discharged to the ground or a lawn should not cross property lines and should not produce runoff.
- Diatomaceous earth used in pool filters cannot be disposed of in surface waters, on the ground, into stormwater drainage systems, or into septic systems. Dry it out as much as possible; bag it in plastic, and dispose of it at a landfill. Never clean a filter in the street or near a storm drain.
- Dispose of filter rinsewater and backwash into the soil or sanitary sewer connection.
- Train all employees and contractors who perform pool maintenance on these BMPs.

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