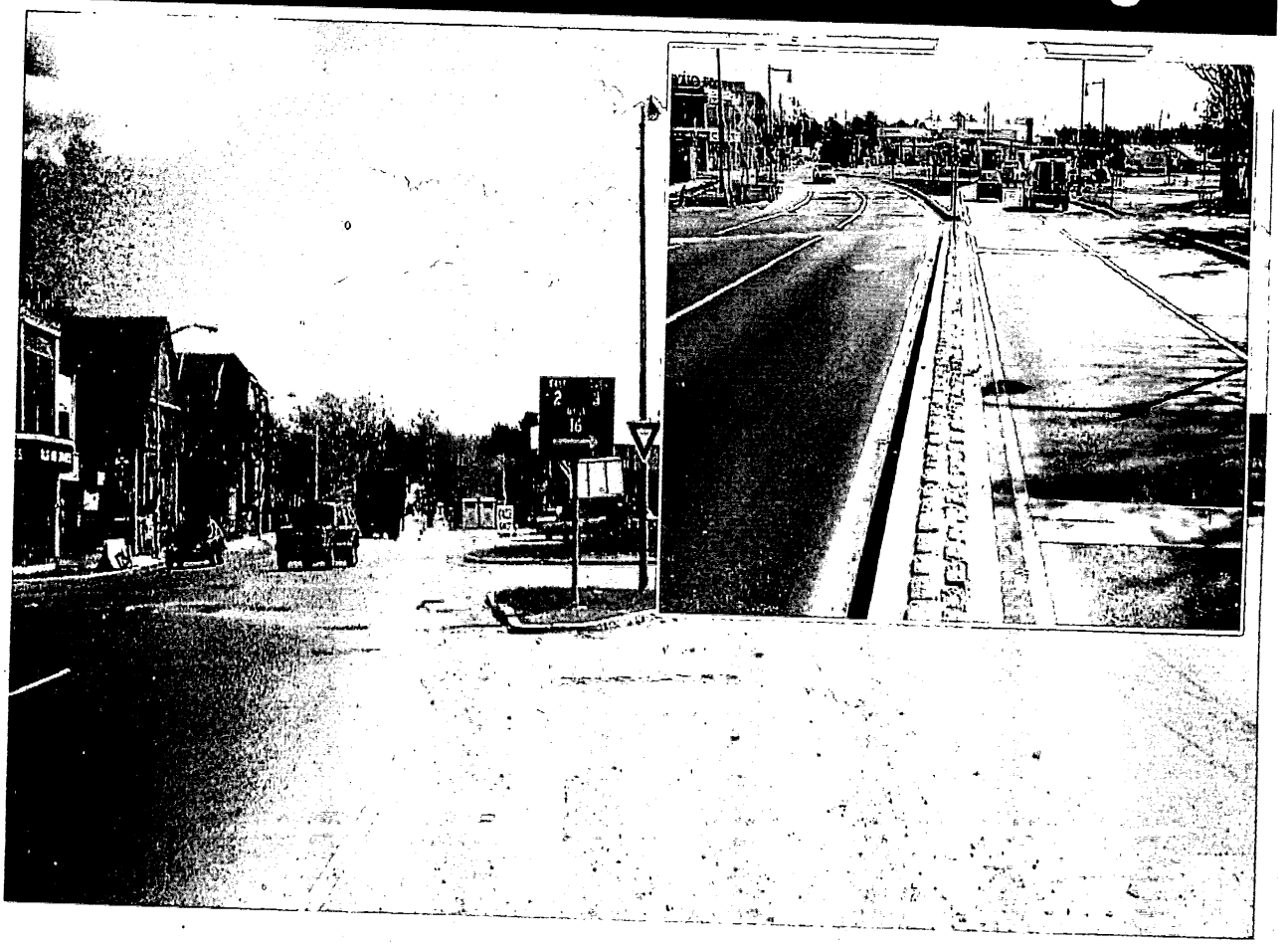
# "Constructing a Better Cambridge"



THE WORKS
CAMBRIDGE DEPARTMENT OF PUBLIC

## 1. PROGRAM OVERVIEW.

The Department of Public Works' Stormwater Management and Sewer Separation Program encompasses the entire City - the business districts, the residential areas, the schools and universities, and recreational areas. Construction of these projects impacts the traffic and transportation systems and many of the City's public services. The goals of the sewer separation and stormwater management program include:

- Improving Cambridge's waterways,
- Making the Charles River "swimmable and fishable",
- Creating a vibrant, ecologically diverse, and environmentally restored river way along the Alewife Brook,
- Alleviating the frequent flooding that occurs in many of the residential and commercial areas,
- Reducing/eliminating sanitary sewer backup problems throughout the city,.
- Minimize community disruption, and
- Proceeding in a fiscally prudent and responsible manner.

## 2. HOW THE SYSTEM WORKS TODAY.

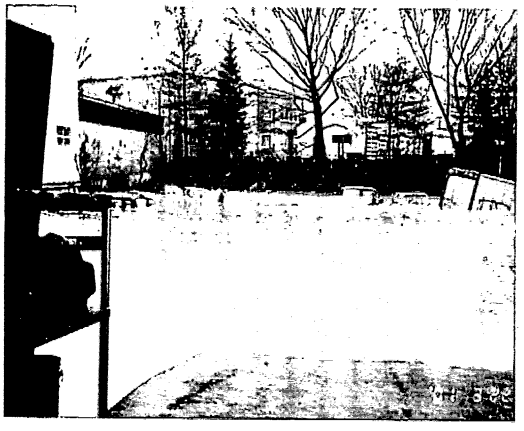
The City of Cambridge's collection systems include approximately 118 miles of sanitary sewer, 42 miles of combined sewer (collects and transports sanitary, stormwater and non -sanitary waste), 81 miles of stormwater drains and approximately 10,000 assorted sewer and drainage structures (manholes, catch basins siphons, lampholes, regulators, overflows, and dry weather connections). The system is characteristic of an older industrial city with a variety of pipe styles and materials. Over 150 years ago the system was originally built as a combined system, i.e. both the sanitary flows and stormwater flows were carried in a single pipe directly to the river. In the late 1930's separation of the combined sewer system began. Stormwater was conveyed to the river and sanitary flow was conveyed in a separate pipe to the treatment plant. Separation of the systems in the City has continued and today approximately 50% of the City has been separated. Construction and rehabilitation of the system has been accomplished through the use of Federal, State, Local and private funds.

The sanitary and combined sewer systems discharge to the Massachusetts Water Resources Authority (MWRA) interceptor system. There is approximately 13 miles of MWRA interceptor pipes in the City and they, as their name suggests, intercept City sewer and combined sewer pipes before they reach the river. Flows are then conveyed to the Deer Island Treatment Works. During intense rainfall events when the interceptor system is overwhelmed the systems overflow and discharge combined sewer into both the Charles and the Alewife at what are called combined sewer overflow (CSOs) structures. Within the City there are 6 CSO structures on the Alewife Brook and 7 CSO structures on the Charles. We own 5 of the 6 on the Alewife and 5 of the seven on the Charles. MWRA charges each community for its share of wastewater treatment that is transported to the Deer Island facility. Many of the projects the City together with MWRA are undertaking are projects to eliminate or minimize CSO impacts.

Cambridge's topography is very flat and this makes the design, operations and maintenance of gravity systems problematic. In addition, Cambridge's flat system is further disadvantaged by bordering and discharging to receiving waterways that are controlled by dam systems causing many of the City's outfalls to be submerged. A recent study of 11 outfalls found significant sedimentation and blockage of the system. This situation is due to both the inability of the pipe system to flush itself and due to deposition in the pipe by the river. Seven outfalls were partially blocked and four were completely blocked or abandoned. One of our major challenges in constructing new systems is trying to build them in a way that makes them easy to clean and to convey enough water to improve the present level of flood protection service.

## 3. RECENT ACCOMPLISHMENTS.

Over the past twenty years the City's approach to sewer separation and stormwater management has become much more rigorous in its approach. In the past four years we have begun to construct systems that address community flooding issues, maintenance issues, and water quality issues. The most notable accomplishments in the past four years are that our rivers have gotten cleaner, and in those areas where stormwater management systems have been constructed, flooding has diminished measurably. We have met court ordered start dates for the sewer separation work in the Alewife watershed area (CAM 002/004), we have exceeded the State Department of Environmental Protection (DEP) expectations with regard to removing illicit connections and common manholes, and we are a state leader in our approach to the development and implementation of stormwater management initiatives. Finally, and most importantly, we believe we have done this in a manner that, while at times has been unavoidably and extraordinarily disruptive in neighborhood areas, has also been genuinely sensitive of community needs and has addressed them in a consistently considerate way.



Since 1998, nine large-scale infrastructure projects have been started and completed throughout the City by the Department of Public Works. These projects have included five sewer separation and stormwater management projects in the Alewife watershed, three in the Charles River watershed and one project that has involved construction in both. This year we anticipate starting another five such projects, most of which are of a smaller scale. The largest of the five Alewife watershed projects, the $20 million Fresh Pond Parkway sewer separation, stormwater management and surface enhancement project is over 90 percent complete with all of the below ground piping and stormwater management structures in place.

The Department has purchased new cleaning and maintenance equipment over the past four years as well and has developed a more rigorous, focused system maintenance program. DPW, as the pilot department, has used the Hansen infrastructure management system and the City GIS system to assist in the development of a preventative maintenance program. Prior to 1998 our maintenance crews were called weekly to perform emergency cleaning of sewer lines in Harvard and Central Squares. Today due to both our discharge compliance initiative and our maintenance regime we rarely get dry weather emergency calls in these areas.

In the Agassiz area we have completed two major sewer separation, stormwater management and flood prevention projects over the past three years. The first of these projects was constructed in the Scott/ Holden area in 1999 and the second, which will be completed this spring, has been constructed in the Carver/Crescent area. These projects have incorporated unique flood prevention and stormwater management technologies. Large tanks have been placed under City streets to store water during storm events.

These areas are very low lying and are subject to significant flooding. It is impossible to improve the capacity of the pipe systems to convey enough water out of the system to alleviate the flooding problem. After a storm event the water is pumped out of the tanks and back into the pipe systems where it eventually makes its way to the Charles River. In addition, the street profiles have been constructed to maximize overland conveyance capacity further helping to maximize flood protection.

The Department of Public Works requires that all new development in the City is sensitive to the conveyance capacity and operations of our stormwater and sanitary conveyance systems. We require that they significantly reduce the runoff from their property thereby generating additional capacity in the system during more significant storm events. This is typically done by storing water underground in holding tanks, or holding it on roof areas or recharging the stormwater back into the ground via leaching systems. Projects adjacent to the Cardinal Medeiros MWRA interceptor are also required to store sanitary flow on their properties. Finally, we require that new developments incorporate stormwater treatment devices in their internal infrastructure to assure the quality of the stormwater that eventually discharges to our system.

Finally, we are in the process of developing new regulations at the Department of Public Works that covers the use of our stormwater, sanitary and combined sewer systems. These regulations will provide the Department with a firmer basis to properly manage discharges and proposed modifications to and from the system. These regulations will allow us to more fully implement the new requirements that are required under the federal NPDES (National Pollution Discharge Elimination System) Phase II rule. Under this rule we will be responsible for all discharges to waterways from our stormwater system and we will be required to manage our system to the "Maximum Extent Practicable" by implementing the following six minimum control measures:

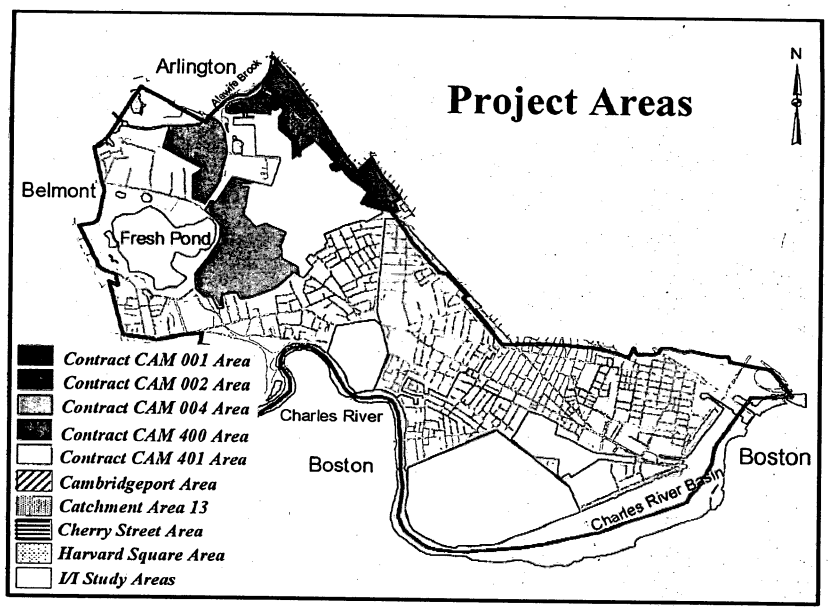
- Public education and outreach,
- Public involvement and participation,
- Illicit discharge detection and elimination,
- Construction site stormwater runoff control,
- Post-construction stormwater management, and
- Pollution prevention and good housekeeping for municipal operations.

## 4. THE PROGRAM

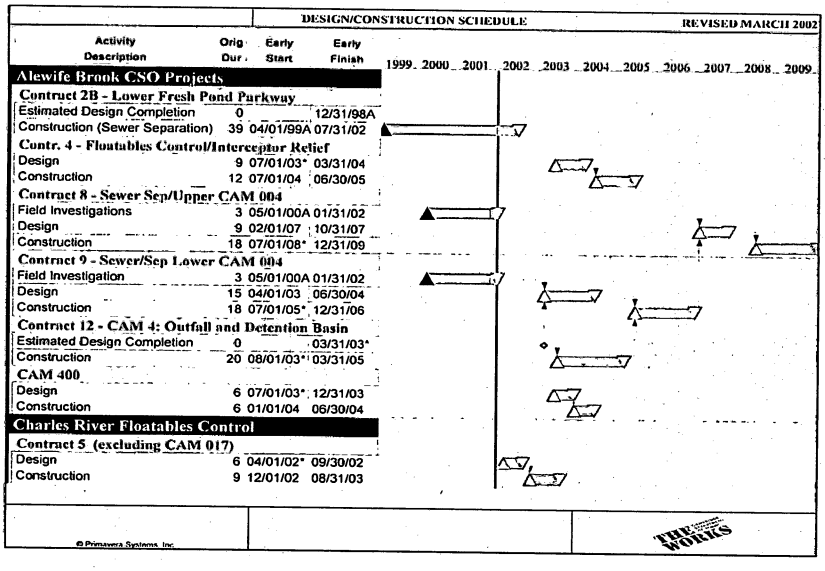
The following are some of the more prominent elements of the ongoing program.

### The Alewife Sewer Separation, Stormwater Management and CSO Control Program

This program as presently articulated involves sewer separation and stormwater management of the Fresh Pond neighborhood (210 acres) as well as common manhole removal in the Whittemore Avenue neighborhood and modifications to some of the Cambridge and MWRA CSO structures and connections along the Alewife Brook. The program as presently proposed will result in an 84% reduction in combined sewer overflow volumes to the Alewife Brook. It will also result in more significant flood protection for the Fresh Pond community. In order to provide this flood protection a new outfall must be provided to the Alewife brook. To ensure that this new outfall will not cause further downstream flooding in either Cambridge or Arlington a detention basin has been proposed in the Alewife Reservation. The proposed basin will be designed to further clean the stormwater and will hold it during a storm and release it slowly afterwards to insure that there is no net increase in discharge to the river. We are presently in the midst of the MEPA process associated with this project and are working closely with the MWRA, who are under Court Order



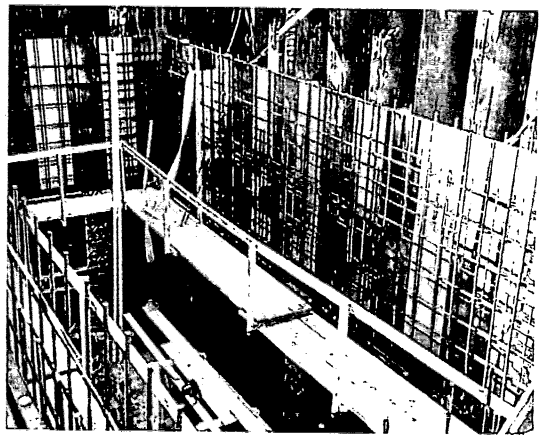

to reduce CSO volumes and activations to the Alewife Brook. The present schedule for this work estimates that it will take 8 years and approximately $70m to complete.




Approximately 50% of the cost will be paid by the City in providing flood relief to the community. Approximately $20m has been spent to date, primarily on Fresh Pond Parkway.

**New Street Pump Station:**

In addition to the MWRA court mandated sewer separation work along Fresh Pond Parkway, DPW is also undertaking additional stormwater management work in this area to address significant flooding. Construction of a new pump station and stormwater retention tank is complete and will increase the capacity at the existing pump station facility. The value of this project was $3,000,000.



**Agassiz Sewer Separation & Stormwater Management:**

This project includes the design of new sewers, stormwater drains and stormwater management facilities for a 400-acre area to eliminate a City CSO on the Charles River, to revitalize the area infrastructure, to minimize significant flooding and to reduce/eliminate sewer backups. Surface and basement flooding containing both rainwater and sewage is a pervasive problem throughout the Agassiz area. Several of the lowest topographic areas within the City are in this area. All wet weather flows not captured by the piping system flow down streets during major storms and flood those low-lying areas. In 1999, the City of Cambridge initiated a stormwater management program to provide drainage service throughout this area for a 25-year 24-hour storm event. The central features of the stormwater management program are construction of underground stormwater storage tanks under streets, new stormwater drains, and automatic flushing systems that will continue to keep the system clean. The construction schedule to separate the sewers in this area is expected to take up to 15 years and cost in excess of $100m. Approximately $20m has been spent thus far in the Scott/Holden and Carver/Crescent areas.

**The Harvard Square Sewer Separation & Stormwater Management Program:**

The Harvard Square area has been subject to significant backup problems over the years due to the limited conveyance capacity of the existing system and intense fats, oils, and grease discharge problems in the area. The Department of Public Works has begun reconstructing the conveyance systems in this area. We anticipate that within three years that the conveyance capacity will have improved to such an extent that it will be able to carry rainfall events as intense as three inches in one hour. We anticipate doing this work in a way that minimizes disruption to the business community and in concert with the enhancement project proposed for the area. Furthermore, because of the development of a preventative maintenance program and a discharge compliance program those problems caused by grease related backup problems have been minimized. The construction program will cost approximately $2m to complete.

**The Area 4 and South Massachusetts Avenue Sewer Separation & Stormwater Management Program:**

In the placement of the new storm drainage system along South Massachusetts Avenue we have constructed a system that will eventually allow us to solve the serious flooding problem that people living in the Area 4 neighborhood have experienced over the years. Now that the South Massachusetts drain line is complete we anticipate designing and constructing satellite stormwater management systems Area 4 starting this summer, with construction anticipated in the Spring/Summer of 2003. Area 4 and the Cardinal Medeiros corridor also experience serious backup problems during mild rainfall events. The Department of

Public Works has been working with the Massachusetts Water Resources Authority to try to address this issue. These problems are primarily caused by the MWRA system along Cardinal Medeiros and the combined sewer systems in Somerville. The overall cost of the stormwater management program is approximately $50m and we anticipate the program will take approximately ten years to complete. $10m have been spent in constructing the trunk line between Lafayette Square and Memorial Drive.

**Common Manhole Separation:**

Much of the present infrastructure was constructed by placing the stormwater pipe systems immediately above the sanitary sewer systems. Access to both systems was provided by common manholes. Typically the sanitary and storm systems are separated by large steel plates that were fitted into the common manhole. These plates need to be lifted from inside in order to maintain the sewer system. Over the years many of these large plates have been removed, broken or have been left ajar. As a result during small storm events most of the rainfall discharges through the common manhole into the sanitary system and is treated by the MWRA. During more significant rainfall events the sanitary system is no longer capable of conveying all of the storm and sanitary flow. The sanitary system backs up and discharges combined sewerage to the river through the stormwater system..

We are under an Administrative Consent Order from the Department of Environmental Protection (DEP) to separate all common manholes throughout the City. The City has a total of 430 common manholes. Approximately 70 common manholes have been separated to date. 50 additional common manholes are scheduled for separation in 2002. The City anticipates spending $2.5 million annually for the to eliminate all common manholes for a total cost of $12,000,000. Separation of common manholes results in significant benefits to the City including: inflow reduction to the sanitary and storm systems, reduced costs for wastewater treatment, reduced combined sewer overflows to receiving waters, elimination of sanitary sewer overflows to homes and businesses, and ease of access to both systems for maintenance.

**Bellis Circle:**

The residents in the Bellis Circle area experience frequent and severe flooding due to insufficient capacity in the Sherman Street drainage system. We anticipate constructing a new drainage system for this area in the spring of this year. The project proposed consists of enhancing the flood protection aspect of the created wetland in Danahey Park, constructing a storm water storage tank in the adjacent parking lot and pumping excess stormwater out along the pipe that runs down the railway track from the area using a large capacity underground pump station. It is anticipated that the project will take approximately one year to complete and we expect to begin construction in the late spring.

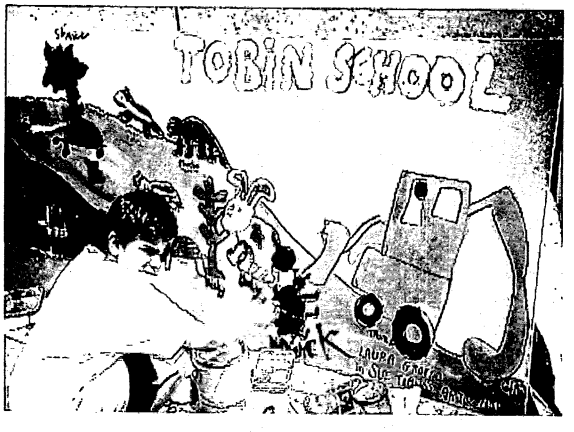
**Cambridgeport Sewer Separation and Stormwater Management:**

The City recently completed a comprehensive investigation of the Cambridgeport area including building surveys, infrastructure numbering system, catch basin inspections, cleaning and internal television inspections of sewers and storm drains, remedial support, flow monitoring GIS update, sanitary sewer assessment, hydraulic modeling, stormwater management and development of Best Management Practices. The initial impetus to this investigation was to develop sewer and drain system improvements in support of a roadway reconstruction project sponsored by the Cambridge Community Development Department. This area is approximately 400 acres in size and is bounded by River Street on the west, Massachusetts Avenue on the north, and the Charles River on the east and south. The major deficiencies in this system are the lack of storm drain outfalls and the resulting inflow into the MWRA through dry weather connections and missing separation plates within common manholes. We estimate that almost 30 million gallons of combined sewerage is discharged to the river during a storm event whose expected frequency is once every two years.

Of the six stormwater outfalls for this area, three are blocked with sediment, two are in poor condition and one was abandoned in the 1970's. The study area contains one combined sewer subarea and six-separated sewer subareas. The existing stormwater drain systems are undersized for the areas being served and they are provided hydraulic relief by the sanitary system. The separation project planned for this area includes improving stormwater outlet conveyance to the Charles River; creation, rehabilitation and reestablishment of stormwater outfalls; removal of common manholes; and, elimination of the combined sewer system. This work will be done over the next 6-8 years in support of extensive roadway construction projects that are planned. The cost of design and construction of this project is estimated at $20,000,000. Project benefits include a reduction of 105 MG per year of inflow into the MWRA system and related treatment charges, flood alleviation, improved stormwater quality stormwater through Best Management Practices, potential reduction in CSO activations, and recharge of the Charles River.

## 5 Conclusion:

Our mission is to improve the environment both in our waterways and in our neighborhoods. This also extends to the process associated with constructing new infrastructure. The preeminent issue at all design and construction efforts is the impact on our community. Our goal in reconstructing our drainage systems is that we provide a significantly higher level of service at the least cost and with a minimum of neighborhood disruption. Over the last ten years, we have spent in excess of $100m toward achieving these goals, these continued efforts will require the continued support of Leadership in the City.




# GLOSSARY

## GLOSSARY

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| BMP | Best management practices: Methods that have been determined to be the most effective, practical means of preventing or reducing pollution from stormwater runoff. These include schedules of activities, prohibitions or practices, maintenance procedures, and other management practices. BMPs also include treatment requirements, operating procedures, and practices to control plant site runoff, spillage or leaks, sludge or waste disposal, or drainage from raw material storage. |
| boundary conditions | Water quality conditions at the edge of a study area, for example, upstream of a receiving water. |
| BRP | Bureau of Resource Protection (Division within DEP) |
| CAM | City of Cambridge Permitted Combined Sewer Overflow Discharge Structure |
| catch basin | A chamber or well, usually at the street curbline, for the admission of surface water to a sewer or subdrain, having at its base a sediment sump to retain grit and detritus below the point of overflow; whereas, a stormwater drain inlet does not have a sump and does not trap sediment. |
| cfs | Cubic feet per second. Typical unit of stormwater flow measurement. |
| Class B | Waters designated as a habitat for fish, other aquatic life, and wildlife, and for primary and secondary contact recreation. Where designated they shall be suitable as a source of public water supply with appropriate treatment; suitable for irrigation and other agricultural uses; and for compatible industrial cooling and process uses. |
| Class B $_{CSO}$ | Water quality standard which permits exceedances of Class B Standards, a maximum of 5% of the time in a year period. It is based on the assumption that further CSO control would result in economic hardship and not yield additional water quality benefit. |
| conduit | Any channel intended for the conveyance of water, whether open or closed. |
| combined sewer | A sewer intended to transport surface runoff, sanitary sewage and industrial wastes. |
| CSO (combined sewer overflow) | Flow from a combined sewer, in excess of the sewer capacity, that is discharged into a receiving water. |
| CSO frequency | The number of rainfall events during which a CSO outfall or group of CSO outfalls activates within a typical annual period, usually determined from an annual simulation. |
| CSO volume | The volume discharged through a CSO outfall during a storm event or over a typical year, usually determined through hydraulic modeling. |
| DEM | Department of Environmental Management (Commonwealth agency) |
| DEP | Department of Environmental Protection (Commonwealth agency) |
| DPW | Department of Public Works |

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| design storm | A historical storm of a specific occurrence frequency, whose duration is chosen based on system size and the response time used to assess system performance. |
| dry-weather flow (DWF) | Usually refers to the flow in a combined sewer system without stormwater. In a separate stormwater system, dry weather flow generally indicates illegal sewer connections and/or infiltration. |
| EOEA | Executive Office of Environmental Affairs – the Massachusetts Cabinet Office overseeing all state environmental agencies. |
| floatables | Floating material usually characteristic of sanitary wastewater and storm runoff. |
| fps | Feet per second. Unit of flow measurement for velocity. |
| gps | Gallons per day. Unit of flow measurement for volume per day. |
| gpm | Gallons per minute. Unit of flow measurement for volume per minute. |
| hydraulic grade line | The profile along a sewer or drainage system that represents the elevation free water surface (non-surcharge conditions) or the water pressure in the pipe (surcharge conditions). |
| hydraulic modeling | Computer simulation of the flows within and performance of a wastewater collection system, including stormwater, I/I, sanitary flow and combined sewage. |
| I/I | Infiltration/inflow. (see definitions below) |
| I/I analysis | An engineering and, if warranted, economic analysis of sewers exhibiting possible excessive non-excessive infiltration/inflow. |
| illicit connection | Any physical connection to the stormwater conveyance system which drains illegal discharges not entirely composed of stormwater and is not authorized by a NPDES permit. |
| infiltration | The surface water or groundwater which enters a sewer system through defective pipes, joints, connections, and manhole walls. Infiltration does not include and is distinguished from inflow. |
| inflow | The quantity of water discharged into a sewer system from roof leaders, foundation and surface drains, streams, catch basins, tide gates, weirs, etc. It does not include and is distinguished from infiltration. |
| interceptor | A sewer that intercepts and transports flows from tributary collection systems to treatment facilities. |
| MBTA | Massachusetts Bay Transportation Authority |
| MCP | Massachusetts Contingency Plan |
| MDC | Metropolitan District Commission |
| MEPA | Massachusetts Environmental Policy Act |
| mgd | Million gallons per day. Unit of flow measurement for volume per day. |

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| MHD | Massachusetts Highway Department |
| MWRA | Massachusetts Water Resources Authority |
| NCRS | North Charles Relief Sewer |
| NGVD | National Geodetic Vertical Datum |
| NPC | Notice of Project Change |
| NPDES | National Pollutant Discharge Elimination System. The national program for issuing, modifying, revoking and reissuing, terminating, monitoring, and enforcing permits, and imposing and enforcing pretreatment requirements, under Section 307, 402, 318 and 405 of the Clean Water Act (CWA). The CWA prohibits discharge of pollutants into waters of the United States unless special permit is issued by EPA, a state, or, where delegated, a tribal government on an Indian Reservation. |
| one-year storm | A storm selected from historical storms of approximately 24-hour duration from long-term Logan Airport records as having a recurrence interval of one year. Recurrence interval is defined as the average interval between the occurrence of an event of specified characteristics and an equal or larger event. |
| receiving waters | Surface water bodies into which materials (flow and pollutants) are discharged. |
| regulator | A structure that controls the amount of combined sewage entering an interceptor by storing flow in the upstream trunk line or by diverting some portion of the flow to an outfall. |
| relief sewer | A sewer built to carry the flows in excess of the capacity of an existing sewer. |
| sewage | The waste matter carried by sewers. |
| sewerage | A system of sewers - sewer system. |
| sewer separation | Separating storm drainage and sanitary sewerage, usually by constructing new piping systems. |
| storm sewer | A system of pipes (separate from sanitary sewers) that carries only water runoff from buildings and land surfaces. |
| stormwater | Stormwater runoff, snowmelt runoff, and surface runoff and drainage. |
| SWMM | Stormwater Management Model |
| three-month storm | A storm selected from historical storms of approximately 24-hour duration from long-term Logan Airport records as having a recurrence interval of three months. Recurrence interval is defined as the average interval between the occurrence of an event of specified characteristics and an equal or larger event. |
| typical year | Modified year 1992 rainfall to represent the average rainfall year from 40 years of historical rainfall data at Logan Airport. |
| U.S.ACOE | U.S. Army Corps of Engineers |

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| U.S. EPA | U.S. Environmental Protection Agency |
| water quality standards | A threshold value or concentration enforced by law as a requirement to maintain acceptable environmental water-quality conditions; usually chosen based on laboratory observations of organism response. |
| wet-weather flow | Usually refers to the flow in a combined sewer system with stormwater, but may also constitute the flow in a separate storm drainage system or a separate sanitary drainage system with I/I. |

S-91

April 1, 2002 Roundtable

Water & Sewer Issues

S-91