Minimizing Municipal Costs for Infiltration & Inflow Remediation

A Handbook for Municipal Officials

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Prepared for:
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Introduction

Forty-four percent of the total annual flow making its way to the Mass Water Resources Authority's Deer Island Sewer Treatment Plant is not sewage at all, but rather is clean groundwater or "infiltration" that finds its way into cracked pipes, leaky joints and aging manholes. Another 8% of the flow reaching Deer Island is rainwater or "inflow" that finds its way into the sewer system through illegal down spout connections, yard drains, sump pumps and other plumbing problems.

This infiltration and inflow, or "I/I", causes sanitary sewer overflows into streams and homes and drains away clean groundwater that might otherwise benefit our wetlands, waterways and water supplies. Excessive I/I can lead to state-imposed sewer connection moratoriums, and costly requirements to enlarge wastewater treatment plants or sewer interceptors.

What's more, ratepayers underwrite the cost of treating all those extra gallons of clean water once they get mixed with the "real" sewage. For towns sending their wastewater to Deer Island that extra 52% costs ratepayers $1,565 per million gallons in wholesale sewer costs—for many towns that means an extra $3,000 to $5,000 or more per day!

The responsibility for managing I/I falls largely on individual municipalities, and nearly every town sewer system in Massachusetts has at least one sub-area that is experiencing significant I/I problems. For many towns with older infrastructure, the I/I rate is substantially higher than the 52% MWRA average.

Even though removing I/I can be a net cost-saver, the work required to remove it from a sewer system isn't cheap. Municipalities need to be strategic in designing their I/I remediation efforts and do whatever they can to minimize the cost impact of the program on ratepayers and taxpayers. This document is designed to help municipalities do just that.

This is not a technical engineering guide for evaluating the cost-effectiveness of individual I/I remediation projects or identifying the best repair methods. Excellent guidance along these lines is already available from the MassDEP—see "Guidelines for Performing Infiltration/Inflow Analyses and Sewer System Evaluation Survey" at www.mass.gov/dep/water/laws/iiguidln.doc and "Optimizing Operation, Maintenance, and Rehabilitation of Sanitary Sewer Collection Systems" at www.mass.gov/dep/water/laws/omrguide.pdf.

This document is designed to provide municipalities with assistance in planning for an effective I/I remediation program and identifying sometimes overlooked ways to finance an I/I program and carry it out as cost effectively as possible. Most importantly, it provides an "I/I program evaluation checklist" to help municipalities make sure they haven't missed any pieces of the I/I remediation puzzle.

How Infiltration & Inflow Cost Towns Money

What is I/I?

Although the term “infiltration and inflow,” or “I/I”, is commonly used as if it was a single phenomenon, the two “I’s” have totally separate causes and create largely separate problems. They are even measured and remediated differently.

Infiltration is groundwater that enters a sewer system through cracked, crushed or leaky pipes, leaky joints, leaky manholes or other avenues (other than inflow). Infiltration can occur in town-owned sewer lines under the street or in the privately-owned sewer laterals that connect homes to the street. Groundwater leaks into faulty sewer pipes whenever the pipes are below groundwater levels. Infiltration is a slow but (more or less) continuous process that over the course of a year ends up intercepting massive amounts of groundwater. The goal of infiltration remediation is to reduce the “average daily flow” in the sewer system. Infiltration is remediated by lining, repairing or replacing sewer pipes and joints.

Inflow, by contrast, is rain-water or surface-water that enters a sewer system, generally through illegal connections to the sanitary sewers, from sources such as roof leaders, cellar drains, sump pumps, yard drains, area drains, drains from swampy areas, cross-connections to the drainage system, or improperly piped catch basins. As is the case with infiltration, inflow can occur in the publicly-owned components of the sewer system such as a catch basin, or may enter through the private portion of the sewer system such as a sump pump discharging into a private sewer lateral.

Where infiltration is slow but steady, inflow enters the sewer system in short-lived but massive spikes of extra water. These spikes of inflow are enormous during and immediately following rainstorms, but because they are relatively infrequent, inflow is less of a contributor to total annual flow. However, the large quantities of inflow during big rainstorms can exceed the carrying capacity of sewer pipes, resulting in surcharging, sewer backups into homes and sanitary sewer overflows or “SSOs” into streams and wetlands. Thus the goal of inflow remediation is primarily to reduce “peak flow rates” (rather than average daily flow) in the sewer system.

What Are the Costs of Excessive Infiltration and Inflow?

Some level of I/I is an unavoidable fact of life for all sewer collection systems, but excessive I/I imposes substantial costs on municipalities and thereby sewer ratepayers in ways that are sometimes obvious and other times not so obvious.

Excessive Sewer Fees

More than half of the annual flow in the Massachusetts Water Resources Authority ("MWRA") sewer system is not sanitary sewage at all, but instead comes from infiltration and, to a lesser degree, inflow. Forty-four percent of MWRA sewer flow is from infiltration and 8% is from inflow. Towns are billed for sewer service by the MWRA according to a complicated fee structure, a large portion of which is based on the volume of total sewer flow (including I/I) that each town contributes to the system.

In the MWRA system, the average 2007 flow-based portion of the wholesale sewer fee is $1,565 per million gallons, or stated another way, 57¢ per gallon per day per year. Since an I/I remediation project will typically keep I/I out of the system for at least 20 years, an MWRA community saves roughly $11.40 per gallon of I/I removed in MWRA flow charges alone. Even before allowing for costs at the municipal level, this savings usually compares favorably with the actual cost of undertaking I/I removal projects. I/I removal projects, as discussed further below, vary widely in cost but over the years have averaged around $4.90 per gallon of I/I removed in MWRA communities. Outside of the MWRA system, the costs of I/I are measured by what it costs to "transport and treat" each GPD of I/I that makes it into the sewer system.

Treatment and Collection Capacity Expansion

While the short term "operating costs" of transporting and treating I/I are substantial, the long-term capital cost of building oversized pipes and treatment plants or expanding existing infrastructure to accommodate excessive I/I can be even larger. One of the greatest benefits of I/I reduction is the avoidance of increased capital costs.

SSOs

A sanitary sewer overflow ("SSO") is the uncontrolled release of sewage from a separate sanitary sewer system that occurs when flows exceed the carrying capacity of the system. During an SSO, sewage spills out of the system at low points which may be inside buildings or at low-lying manholes. Inflow is the primary cause of SSOs, although infiltration is also a contributing factor.

SSOs typically result in property and/or environmental damage, threats to public health and resultant cleanup costs. Because SSOs violate the legal prohibition against un-permitted wastewater discharges, they normally result in enforcement action. Most communities that have experienced SSOs in the last few years are under administrative consent orders ("ACOs") from the MassDEP banning new sewer connections and extensions until I/I remediation has been completed. As discussed further below, these ACOs generally require the affected municipality to create an I/I "bank" to finance needed system improvements.

Municipalities that have not yet experienced SSOs may have sewer lines that are surcharging. Surcharging occurs when sewage begins to back-up in the system, rising into manholes above the pipes, but does not actually overflow. Failure to address surcharging problems may eventually lead to SSOs.

Groundwater and Water Supply Depletion

Infiltration, and to a lesser extent inflow, can deplete groundwater resources which may impact water supplies directly or contribute to a “stressed river” regulatory determination which can impact water supply activities indirectly. Developing additional water supply sources and implementing strict MassDEP stressed basins requirements can be very expensive. Water lost to I/I may have a very significant impact on an aquifer. For example, according to MWRA figures, from 1995 to 1997, an annual average of 6.6 billion gallons of water per year was diverted from the upper Neponset River Watershed as I/I.

Increased Water Pollution Costs

Where I/I contributes to reduced streamflow it may also be contributing to increased water pollutant concentrations. As noted above, infiltration, and to a lesser extent inflow, can deplete groundwater which ordinarily dilutes pollutants in surface water. As a result, violations of state surface water quality standards can be more frequent or severe. Water pollution problems often impose significant costs on industries and new development through additional stormwater or wastewater treatment requirements. Water pollution also reduces waterfront property values. This problem can be particularly acute in waterways downstream of sewage treatment works, such as on the Assabet River. High phosphorus levels in the Assabet have forced costly treatment plant upgrades.

Access to SRF Funds

I/I remediation projects are themselves eligible for low interest State Revolving Fund (“SRF”) loans. However, to obtain SRF funding for many other water pollution abatement projects, an applicant must demonstrate that I/I has been or will be adequately controlled. According to MassDEP’s website, “one of the prerequisites for obtaining approval of a Tier 1 or Tier 2 (sewage treatment facility) project is the applicant's demonstration that the proposed treatment works will not be subject to excessive I/I.” Also, under the SRF regulations at 310 CMR 44.08(3)(a), “major complicated or controversial wastewater projects” require the development of a Comprehensive Wastewater Management Plan which generally includes an I/I analysis.

Evaluating the Severity of I/I Problems and Developing Program Goals

Before worrying about how to finance I/I remediation, municipalities should first determine whether they have a significant I/I problem and, if so, what kind of problem they have. With that information in hand, communities can create clear goals and objectives for their I/I remediation efforts and design a program to meet those goals.

Sizing-up I/I Problems

Ultimately communities with active I/I reduction programs will need to assess the nature and extent of their I/I problems by undertaking an "I/I analysis" and a "sewer system evaluation survey." Short of these measures, there are a number of more easily undertaken ways to begin sizing up the nature and extent of a community's I/I problem.

How Do We Rate?

One of the easiest ways to gauge the seriousness, and nature, of a community's I/I problem is by reviewing the MWRA's infiltration and inflow statistics. The MWRA meters sewer flows for each of its 43 member communities and analyzes the flows in order to estimate how much of the flow is sewage or "sanitary" flow, how much is inflow, and how much is infiltration. These figures are presented both in terms of total millions of gallons of I/I per day or "MGD," and in terms of gallons per day per inch diameter mile or "GPD/IDM." The GPD/IDM figure is especially useful, as it allows smaller towns with smaller sewer systems to compare their I/I rate to communities with larger service areas. Although these figures are only estimates (with the infiltration estimate being the trickiest), they provide a good starting point for discussion.

In addition, the MWRA data provides a "ranking" of each town in terms of its total annual infiltration and/or inflow volume compared to other towns within the MWRA sewer system. If you find your community at the high end of the ranking for inflow or infiltration, you are likely to have a significant problem. Given that average I/I rates for MWRA communities are fairly high, even communities in the middle of the rankings likely have room for substantial improvement and communities that find themselves at the "good" end of the ranking, based on average I/I on a town-wide basis, may have subsystems with room for cost-effective improvement.

The MWRA flow data is summarized for Neponset Valley communities in the table below. The complete report, "*MWRA CY 03 Community*

Wastewater Flow Data" (which will soon be updated through 2005) is available at www.mwra.state.ma.us/harbor/pdf/infinf04_letter.pdf. Note that the figures below do not include I/I in the MWRA's own sanitary sewer interceptors.

Table 1. I/I Statistics for Neponset Valley Communities Based on MWRA 2003 Flow Data

	I/I Annual Daily Average MGD	Inflow Average GPD/IDM	Inflow GPD/IDM Ranking among 43 MWRA Towns	Infiltration Average GPD/IDM	Infiltration GPD/IDM Ranking among 43 MWRA Towns
Canton	1.98	829	16	2,663	24
Dedham	4.49	1,348	7	4,958	2
Milton	3.17	1,206	9	3,456	13
Norwood	4.59	1,599	3	4,417	7
Quincy	9.22	920	15	3,793	10
Randolph	2.18	325	38	1,591	41
Stoughton	2.76	660	22	3,784	11
Walpole	1.51	451	34	2,166	34
Westwood	1.31	399	35	1,691	38

Cities and towns inside and outside of the MWRA system can also get an idea of their infiltration rate by comparing the number of gallons of water sold to the gallons found in their sewer lines during the same time period. To the extent that there is more water in sewer pipes than the amount of water sold, it is likely to be due to infiltration (and, to a lesser extent, inflow). It is best to do this comparison for winter months when there is no lawn watering and thus most of the water sold should end up in the sewers. Be sure also to factor in septic systems, as well as industrial and institutional consumption, because all their water does not necessarily end up in the sewer.

Even if a municipality has no access to measured sewer flow data, an assessment of the age and type of material used to construct the sewer collection system is another tried and true approach. Towns with many old sewer lines are likely to have serious infiltration problems, especially if the pipes were built with clay or other antiquated material. Town records should be checked to identify the extent and location of such sewer pipes.

Inflow and Existing or Anticipated Capacity Problems

Because inflow into public sewers is illegal, there is no “acceptable” level of inflow. However, communities that are experiencing SSOs clearly have a serious inflow problem. All SSOs are illegal under the Federal Clean Water Act, but the more frequent or severe the SSO, the greater the chance that the community will be subject to enforcement action. Massachusetts has no set “design storm” for which sewer pipes must be sized; however at a minimum sewers should be able to pass the 1-year-6-hour storm (or smaller). Note, however, that an SSO, even one occurring after a 100 year storm, is still illegal and will necessitate an immediate effort to remediate I/I.

Even where a system is not suffering from SSOs, systems experiencing surcharging may be good candidates for inflow reduction, as are systems where significant new growth is expected and existing collection system infrastructure may be inadequate or marginal for handling new customers.

Finally, just as collection system capacity problems may indicate excessive inflow, the same can be said for treatment plant capacity problems.

Excessive Infiltration

Although the MassDEP does not specifically identify how much infiltration it deems to be “excessive,” its **“***Guidelines for Performing I/I Analyses and Sewer System Evaluation Survey*,” (hereinafter referred to as the “MassDEP I/I Guidelines” and available at www.mass.gov/dep/ water/laws/iiguidln.doc) states, “an extensive manhole inspection and flow isolation program can be recommended for all subsystems exhibiting an infiltration rate equal to or greater than 4,000 GPD/IDM. Further work on subsystems with a lesser rate can be justified on a case-by-case basis."

In the New England Interstate Water Pollution Control Commission (NEIWPCC) publication “*Optimizing Operation, Maintenance, and Rehabilitation of Sanitary Sewer Collection Systems*,” (hereinafter referred to as the “NEIWPCC O&M handbook” and available at www.mass.gov/dep/water/laws/omrguide.pdf/), the recommended maximum acceptable level of infiltration is 200 GPD/IDM for existing sewer lines of 24” diameter or less.

As is the case for inflow, there may also be anecdotal indications of problems with excessive infiltration. These may be expressed as undesirable impacts to water supply operations, streams or wetlands due to groundwater diversion via infiltration, or where high infiltration is a contributing factor to SSOs or other capacity problems.

Developing Written Program Goals

Before any I/I remediation commences, municipalities need to set goals for what they wish to accomplish. If their only concern is prevention of SSOs, then inflow remediation will have the most direct impact, though infiltration remediation may also help significantly. If an SSO is occurring in a specific area of town, of course, I/I remedial projects must of necessity be undertaken “upstream” on the sewer line that is experiencing the SSO.

If a community is interested in reducing the sewer fees it pays to the MWRA or wishes to prevent depletion of local groundwater, inflow remediation will have relatively little effect because significant inflow only occurs a few times each year. If concerned about both infiltration and inflow, communities can target half of their remediation projects to each, or set some other appropriate ratio.

If new development is occurring largely in a specific part of town, it may be appropriate to target I/I remediation there as well. In the town of Weymouth, which was experiencing serious SSOs at a number of different locations, MassDEP required that any new sewer connection be offset by I/I reductions occurring the same "sub area" as the new flow.

With a basic understanding of the dimensions and nature of its local I/I problems, municipalities will be well served by developing a set of written goals to help guide the development of an I/I remediation program. A clear set of goals is an important tool for keeping the many stakeholders involved in the implementation of any I/I program focused, and for building a constituency for implementing the program. Goals that identify the problem that will be fixed or prevented through reducing either inflow or infiltration, and a target timeline will be especially helpful in prioritizing the actions to be undertaken. The following is a brief sampling of possible goals:

- To reduce ratepayer costs for the transportation and treatment of wastewater by implementing all cost-effective infiltration reduction projects within 10 years.
- To minimize regulatory liability, water pollution and public health risks by eliminating any and all sanitary sewer overflows in storm events up to and including the 10 year storm.
- To save ratepayers $XX per day in transport and treatment costs by reducing annual infiltration by 25% over 10 years.
- To eliminate sufficient inflow and infiltration to avoid the capital costs of sewer treatment plant capacity expansion in anticipation of 10% population growth over the next 20 years.
- To eliminate sufficient inflow and infiltration to avoid the capital costs of interceptor expansion which will be needed to support the build-out of a certain neighborhood.
- To eliminate enough infiltration to offset the environmental and regulatory impact of sewer system expansion and increased water demand over the next 15 years.

Laying the Foundation for an Effective I/I Reduction Program

Once a qualitative understanding of the I/I problem is established and goals have been set, its time to put the basic building blocks of the I/I program in place. These building blocks include a strong set of sewer use regulations and a prioritized list of potential I/I remediation projects.

Sewer Use Regulations

The sewer use regulations are the foundation of legal authority that underpins all aspects of any I/I remediation program. It is the sewer use regulations that give the local sewer department the authority to prohibit private sources of inflow such as sump pumps and roof downspouts. The sewer use regulations establish the rules for new sewer connections and extensions and thereby ensure that new sewers are built properly and tested rigorously to minimize infiltration. If there are areas of town that are suitable for onsite wastewater systems (that totally eliminate I/I and interbasin transfer) the sewer use regulations will largely determine whether or not that water stays local. The sewer use regulations are also the key to implementing some of the more innovative approaches to I/I reduction, such as time-of-sale remediation requirements for private infiltration as well as I/I banking, that are discussed in the later sections of this handbook.

NEIWPCC's O&M handbook contains excellent guidance on the development of a strong set of Sewer Use Regulations.

While the details of developing a strong set of sewer use regulations are beyond the scope of this handbook, every set of regulations should include the following minimum features:

- Prohibition against discharge of inflow to the sewer system.
- Standards for maximum acceptable levels of infiltration for existing private sewer laterals.
- A right of entry to inspect for violations of the sewer use regulations on private property and the authority to order (or initiate) repairs if needed.
- Design and construction standards for new or repaired/expanded connections to ensure than new sewers are free of inflow and infiltration.
- Procedures for field inspection and testing of new or repaired connections to verify that things are "built-right" from the start.

- Elimination of any requirement that wastewater from new development be discharged to the sewer if appropriate onsite treatment alternatives are available.

Prioritizing I/I Projects to Maximize Goal Attainment

In communities with high I/I, program managers will be faced with a multitude of different I/I remediation projects from which to choose. Choosing which projects to work on first is one key to minimizing costs and meeting your goals. While it is certainly possible (and in some cases may be desirable) to begin implementing I/I remediation projects without a comprehensive plan, such an approach is likely to result in missed opportunities and, for infiltration projects, could simply result in transferring the problem further down the sewer line.

I/I Analysis and SSES

To facilitate the process of prioritizing I/I remediation efforts, MassDEP's I/I Guidelines lay out a detailed, two-step process that begins with an "I/I Analysis" study and proceeds to a "Sewer System Evaluation Survey" or "SSES." The I/I Analysis is a more limited study that involves measuring sewer flow levels in key sewer collection subsystems to demonstrate the non-existence, existence or possible existence of excessive I/I and to estimate the extent of I/I flows. If the I/I Analysis indicates problems, it is followed by the SSES which involves a much more extensive internal inspection of pipes, manholes and other structures in order to identify and quantify specific sources of I/I that could be repaired. The SSES also involves estimating the cost of each repair and performing a cost-effectiveness analysis.

An I/I Analysis and/or SSES is generally required to obtain State Revolving Fund loans and whenever MassDEP takes enforcement actions related to SSOs or other I/I problems. Even where an I/I Analysis and SSES are not required, they provide the program manager with a comprehensive picture of all the I/I issues in the system, making it possible to develop a more effective long term strategy for remediating problems as quickly and efficiently as possible in light of the community's I/I goals. The I/I Analysis and SSES are also critical tools in building support for funding and/or implementing I/I remediation measures.

Keeping overall project goals in mind is critical as the program manager develops the I/I strategy. A community whose primary goal is to reduce transport and treat costs would end up with a very different strategy than a community whose primary goal was to eliminate SSOs.

Understanding Cost Effectiveness

Infiltration and inflow remediation is considered cost-effective if it is less expensive to remove the I/I than it is to "transport and treat" it at the receiving facility, when both capital costs of increased capacity and operating costs are included. For communities outside the MWRA system, MassDEP's I/I Guidelines give detailed instructions for calculating "transport and treat" costs.

If your community is in the MWRA sewer system and it costs you less to remediate an I/I source than you would pay in additional flow-based sewage fees to send that water to Deer Island over the next 20 years, then the remediation project is cost-effective. But remember that MWRA fees alone do not include municipal operating and capital costs, so you may need to use the MassDEP I/I Guidelines to more accurately calculate cost-effective.

The cost per gallon removed of I/I remediation projects is highly variable. However, based on its experience with 208 projects funded through the MWRA I/I Grant-Loan Program since 1993, the MWRA has calculated that the average cost of I/I remediation projects is $4.90 per GPD removed. The average costs for the 47 remedial projects completed since August, 2004 is $8.45 per gallon. Not surprisingly, infiltration projects are often more cost effective than inflow projects because of the constant nature of infiltration. Even without considering local capital costs, this compares favorably with current MWRA flow-based sewer charges of approximately $11.40 per GPD over 20 years.

The MassDEP I/I Guidelines caution, however, that a cost-effectiveness analysis for infiltration must be done on a system-wide basis, as opposed to the traditional point source approach. This is because groundwater infiltration has a tendency to migrate from rehabilitated to non-rehabilitated locations. That is, if a sewer line is repaired to eliminate infiltration at one point, some of that water may reenter at the next point on the line where it can find its way into the sewer pipes, thus making the first repair relatively ineffective. Thus the benefits of infiltration may not be fully realized until a subsystem has been renovated in its entirety. For this reason, some program managers advocate a bottom-up approach to implementing infiltration remediation measures in a given subsystem.

Understanding Value Effectiveness

While it is clearly in a community's economic self interest to implement every available cost effective I/I project as soon as possible, there are situations where the community will also want to implement I/I projects that are not cost effective. A value effective project is one that would result in significant technical, environmental or health benefits. SSOs, for example, violate the Clean Water Act ban on un-permitted discharge of pollutants, and therefore must be eliminated regardless of cost-effectiveness. Even when not mandatory, however, towns may want to undertake non cost-effective infiltration or inflow remediation if, for example, I/I is a significant factor causing a popular recreational pond to dry up; if I/I is impacting sensitive wetland resources; where infiltration is impacting water supply activities; or where I/I reduction can provide a regulatory offset for increased water withdrawals. Where such situations exist, the community may actually want to implement the value effective I/I projects before undertaking cost effective projects.

Planning Ahead for Measuring Results

Every municipality should plan ahead to evaluate the results and effectiveness of each of its completed I/I remediation projects. Measuring results is critical in the effort to win support for the continuation of any program and provides ongoing feedback that will allow program managers to adapt and refine the overall program strategy and be as efficient as possible in its future efforts.

While measuring results is important, such evaluations are not easy. Often estimates, rather than precise measurements, will have to be made of the amount of I/I removed.

Measuring and Estimating Inflow Reduction

The challenge in measuring inflow reduction is related to the ephemeral nature of the inflow problem. A given source, such as a downspout connection will produce a given amount of inflow during the one year storm, but a different amount in the 10 year storm. The MassDEP I/I Guidelines explain how to measure the rate of inflow prior to remediation efforts, and the same measurements can be used to determine post-remediation inflow. The Guidelines contain (in Table 7 of the Technical Exhibits) "guidance for reasonable [estimates of] inflow volume by type of inflow source." The estimates that municipalities should use are contained in the column entitled "Total Inflow Volume," which is based on inflow from the 1 year / 6 hour storm. For example, Table 7 indicates that removal of a downspout or driveway drain is estimated to remove 1,000 GPD. Table 7 cannot be used, however, to calculate inflow reduction from sump pump removal. Where MassDEP has ordered municipalities to remove sump pumps, it has had them use a 500 GPD removal estimate. Table 7 of the Guidelines says that sump pump removal removes three to six gallons per minute, which over six hours would amount to more than 500 GPD. However, sump pumps do not run continuously during rainstorms.

Based on the above-described estimates, if the amount of inflow that should have been removed through remedial measures is less than the amount actually found by flow monitoring, chances are that either not all inflow sources were identified in the first place and/or that some disconnected inflow sources have reconnected to the sewers.

Measuring and Estimating Infiltration Reduction

The underlying challenges in measuring infiltration reduction are the natural variability in groundwater levels before and after construction and the tendency of infiltration to migrate to areas which have not been rehabilitated.

NEIWPCC recommends that infiltration testing occur when the groundwater table is more than 4 feet below the average ground surface. However, groundwater levels and other weather conditions may change completely in the time between the "before" and "after" measurements. To address this problem, some communities simply assume a 50% success rate relative to the before measurement. Weymouth uses the 50% figure, but assumes 100% success for manhole-to-manhole liners. Few real studies have been done to measure success rates for infiltration remediation.

Also bear in mind that virtually all municipal infiltration remediation projects occur on the infrastructure located in the public rights-of-way, yet private sewer laterals can be responsible for a large percentage of the infiltration entering public sewers. The DEP I/I Guidance states:

> *Engineering judgment (sic) shall be used to estimate the percent infiltration removal based on the observed defects, general pipe condition, percent of infiltration flow from*

private sources vs. percent of infiltration flow from sources in public right-of-way, etc. For example, test and seal rehabilitation of a cross-country sewer with no service connections might reasonably be expected to result in a high percent removal.

Conversely, a low percent removal estimate might be appropriate where televising showed a high percent of infiltration attributable to house service laterals.

Whatever methods are used to measure or estimate I/I reductions, it is best to consider the various alternatives and define the preferred methods in advance of program implementation activities. In most cases, it is advisable for comparable standards to be codified as part of the sewer use regulations.

Minimizing Impacts on Ratepayers and DPW Budgets: Pick the Low Hanging Fruit

Once the basics of the I/I program are established with a solid set of sewer use regulations, a prioritized strategy for undertaking project, and a plan for measuring results, it is time to take advantage of some simple strategies to help advance the goals of your I/I program while minimizing the financial impact of the program on ratepayers, what we have dubbed “the low hanging fruit.”

MWRA I/I Grant/Loan Program

For communities located in the MWRA system, the MWRA's I/I Local Financial Assistance Program has provided a total of $147 million to fund local I/I reduction and sewer system rehabilitation projects in all 43 MWRA communities. Another $73 million has been approved through Fiscal Year 2015. Eligible projects include:

- pipeline replacement
- public and private inflow source removal
- I/I reduction planning
- sewer rehabilitation construction
- engineering design
- engineering services during construction

I/I Local Financial Assistance Program funds are allocated to member sewer communities based on their percent share of MWRA’s wholesale sewer charge. Phase 1 and 2 funds (total of $64 million) were distributed for approved projects as 25 percent grants and 75 percent interest-free loans. The grant/loan split was revised for Phases 3 to 6 (total of $157 million) and now stand at a 45 percent grant and 55 percent interest-free loans. Interest-free loans are repaid to MWRA over a five-year period beginning one year after distribution of the funds. For more information see: www.mwra.state.ma.us/comsupport/iiprogram.html. In spite of the fact that this is “free” money awarded through a non-competitive process, it often goes underutilized.

State Revolving Fund (SRF) Loans

Under the regulations at 310 CMR 44.00, I/I projects are eligible for State Revolving Fund or "SRF" loans. I/I projects are defined in the regulations as "projects that remove infiltration and inflow (i.e., water other than wastewater) from a sewer system, including construction associated with I/I rehabilitation." According to DEP's website, SRF funding may be given for "the planning and design" of I/I projects. As noted above, I/I remediation is frequently required as part of other SRF-funded water pollution abatement projects. SRF loans may be available at lower interest rates than standard financing. Details are available at www.mass.gov/dep/water/wastewater/wastewat.htm#srf.

State Permitting Mitigation Requirements

At least for larger new developments, the Massachusetts Environmental Policy Act permitting process (the "MEPA process") provides a mechanism by which municipalities can request the implementation of I/I reduction measures as part of an overall environmental mitigation package. Less frequently, similar requests can be made through other state permitting programs such as the Interbasin Transfer Act, Wetlands Act and Water Management Act.

Integrating I/I into the Annual Public Works Program

When I/I leads to SSO problems, the state is generally insistent that remedial work take place with some haste. Even where all SSOs have been eliminated, however, I/I will still be a problem as sewer pipes age and as the system's service population grows over time. Integrating I/I remediation into a municipality's normal public works maintenance operating budget and activities can translate into reduced finance costs, eliminating redundant efforts (repairing sewers at the same time as repaving), and economies of scale. Furthermore, an incremental approach to continuous I/I improvement can help to defer capacity expansion projects indefinitely. As NEIWPCC' O&M handbook states:

> *Proactive rehabilitation and replacement planning provides the best opportunity for capital cost savings. By rehabilitating or replacing sewers and other components before they fail, the utility automatically avoids costs such as emergency contractor fees, staff overtime, unplanned repairs, and SSO cleanup costs. Additional savings can be achieved through coordination of sewer construction with other construction projects, replacing longer segments, and phasing construction over a period of years.*

Indeed, practically all of NEIWPCC's "Optimizing Operation, Maintenance and Rehabilitation of Sanitary Sewer Collection Systems" deals with the advantages of integrating all aspects of sewer and other public works maintenance activities.

Cost Savings from a Comprehensive Approach

As noted above, without a town-wide I/I Analysis and SSES, it is impossible to identify the most cost-effective projects to undertake first. In addition, if I/I remediation work is undertaken by outside contractors, the cost of each gallon of I/I removal will be lower the larger the job is.

Regardless of whether a contractor or the municipality does the repair work, though, it is important to remember that infiltration tends to migrate "downstream." To eliminate infiltration in a municipality, then, each subsystem of the sewer system must be individually and comprehensively remediated before moving onto the next subsystem.

Working with Neighboring Municipalities

Due to infiltration migration, it is critical that municipalities located on the same sewer line coordinate their I/I remediation efforts. Economies of scale can be achieved when municipalities coordinate their I/I work, especially if they share a single contractor. Sharing amongst municipalities of expensive or high-maintenance equipment such as television and metering equipment reduces the overall costs of obtaining and operating the equipment.

Reducing Sanitary Flow Rather than I/I

In some situations, reducing sanitary flow through indoor water conservation may be an attractive alternative or complement to I/I reduction. The Town of Weymouth is under a MassDEP ACO due to SSOs that requires the reduction of 6 gallons of I/I for every new gallon of sewage introduced to the sewer system. However, because Weymouth has water supply as well as SSO problems, the Department allows it to implement water conservation measures to count for 2 of those 6 gallons. The conservation measure that Weymouth has used for this offset is installation of 300 low flow toilets every year in public and private buildings.

Setting Design and Testing Standards for new Sewers and Sewer Laterals

To prevent, or at least delay, future infiltration problems, sewer use ordinances should always set design and testing standards. The NEIWPCC Handbook, Section 4.1, provides some good samples of bylaw language that can be used.

Addressing Private I/I

Many municipal I/I programs focus on eliminating I/I from the publicly owned portions of the wastewater collection system. However this "public" I/I is only part of the I/I problem and sometimes just a small part. Private inflow from sump pumps, yard drains, downspouts and similar sources usually represent a large portion, if not a majority, of total inflow. Private infiltration, from deteriorated sewer laterals, foundation drains and other sources can make up a substantial portion of total infiltration. For many municipalities, it will be impossible to achieve I/I reduction goals without addressing sources of private I/I. Just as importantly, it will often be more cost-effective to address private I/I than to limit remediation to the public potions of the system.

Private Inflow

The elimination of SSOs and other inflow-related problems is likely to be impossible without identifying and removing private inflow sources. These sources include downspouts, cellar drains, yard drains and basement sump pumps and are identified by inspecting private plumbing arrangements through door-to-door surveys, dye testing and/or smoke testing.

In many communities, disconnecting private roof leaders and downspouts may be the most cost-effective and least politically difficult category of private inflow to tackle. Downspouts can contribute very large volumes of flow to a sewer system, and fixing downspouts often does not require entry into the interior of homes or businesses. Connected downspouts are particularly prevalent in urban areas, and the City of Boston, to cite one example, has obtained excellent results from its "Downspout Disconnect" program.

Finding and removing private sump pumps and ensuring they stay disconnected is another important, although in some ways more challenging piece of the puzzle. The first challenge arises from the need to enter private property to conduct inspections and/or repairs. Even once a problem sump-pump has been found and removed, it may be quickly reconnected to the sewer system, unless expensive arrangements are made to "hard pipe" these flows into a storm drain.

Perhaps the most difficult decision a municipality has to make in designing a sump pump removal (or other private inflow removal) program, is how to apportion the cost of repairs between the homeowner and the town. Saugus, Burlington and Weymouth all have sump pump removal programs, and each takes a different approach on who pays. Saugus has an inspection program and orders people with sump pumps to hire contractors to remove them and, where appropriate, attach them to nearby storm sewers. In Burlington, developers wishing to tie into the sewer system pay contractors to remove private sump pumps, with homeowners required only to provide access. Weymouth's program is similar to Burlington's, but homeowners sometimes bear a portion of the cost.

The MassDEP I/I Guidelines provide advice for establishing such programs, and the NEIWPCC O&M handbook provides excellent and detailed guidance as well. To be successful every private *inflow* program will need to do the following:

- Clearly establish authority to enter private property under the sewer use regulations.
- Create a strong program of technical assistance to help homeowners design an alternative discharge method for the flows.
- Establish a clear policy regarding who pays for the cost of repairs. Having the municipality underwrite some or all of the cost of repairs can greatly facilitate public acceptance of such a program.
- Establish the municipality's authority to order the remediation of the problem by the homeowner, even if the municipality plans to cover the cost of disconnecting the flows itself.
- Have a well defined process of coordination among the sewer authority and plumbing inspector and other interested agencies.
- Include a program of follow up inspections immediately after repairs are made and periodically thereafter such as at time of property transfer.
- Finally, and most importantly, establish a strong public outreach and education component so that the public is aware of the problem and the benefits of inflow reduction. This is absolutely critical to the success of any program that involves inspection or repair on private property.

Private Infiltration

Municipal programs to identify and eliminate private inflow are fairly common, while private *infiltration* remediation programs are more unusual. However, in some municipalities, as much as 40% of total sewer system infiltration occurs on private portions of the system. This can leave efforts to eliminate infiltration chasing diminishing returns as program managers attempt to eliminate public infiltration while ignoring the private side of the problem. It can also seriously hamper efforts to reduce ratepayer transport and treat costs.

The first step in addressing private infiltration is to make sure that the community's sewer use regulations establish guidelines for "acceptable" levels of infiltration, and establish the municipalities' authority to inspect private plumbing for infiltration and order repairs.

In some cases areas of high private infiltration may be identified in the course of preparing an I/I Analysis or SSES on the public portions of the sewer system. In these cases, individual properties can be targeted for follow up inspection.

However, a more thorough effort to eliminate private infiltration will require direct internal inspection of private lines or even water tightness testing. One model for implementing such a program is to require inspection of private sewer laterals at appropriate intervals using a “discharge permit renewal” type model. Another approach is to require inspection and, if needed, repair of private laterals at time of property transfer. Such a program can be integrated with private inflow inspection programs as well.

NEIWPCC’s O&M Handbook provides model language for a bylaw or Sewer Use Ordinance provision to establish such a “Time of Transfer Inspection and I/I Remediation Program.” In order to adopt such a program, it is important that the bylaw makes private infiltration illegal and establishes standards for unacceptable infiltration rates on both new and existing sewer connections.

> *Any person owning or occupying a tract or parcel of land upon which sanitary sewer service lines are located which flow into public lines in (municipal) streets alleys and easements…shall be responsible for the inspection, maintenance, repair and operational integrity of such private sanitary sewer service line.*
>
> *Prior to the original connection, reconnection or transfer of…sewer service to a tenant or property owner, the (municipality) may inspect or require the inspection of private sanitary sewer service lines thereon for the purpose of determining the amount of I and I into such lines, if any. Inspections shall be made or required when, based upon local I and I conditions and experience, the director of public works has determined that such inspections are necessary. Any conditions discovered in such line inspections causing or allowing I or I shall be repaired by the property owner or tenant, or agent thereof, prior to such original connection, reconnection or transfer of (municipal)…sewer service.*

I/I Banking

I/I banking is another valuable tool that some municipalities may be able to use to deal with collection system or treatment plant capacity problems and, perhaps, to address water supply and streamflow issues as well.

The idea behind an I/I bank is quite simple. It is established so that new and expanding sewer users will offset the amount of new flow they want to add to the sewer system by reducing (or paying for the reduction of) a *greater* amount of existing infiltration and/or inflow. The number of gallons of I/I which must be remediated for each new gallon permitted to be discharged into the sewer is set by an “offset ratio.” In this way, sewer capacity will be improved, reducing the potential for SSOs and the other negative consequences of infiltration and inflow.

Once the bank is set up, private or municipal implementation of projects that eliminate I/I create “credits” that go into the I/I Bank. For each new gallon of sewage that a sewer connection or extension permit allows to be discharged, the appropriate number of credits must be taken out of the bank.

To date most, but by no means all, I/I banks in Massachusetts have been implemented as the result of enforcement actions by MassDEP due to SSOs or treatment plant capacity problems. The details of I/I banks that must be established are spelled out in administrative consent orders (ACOs) between MassDEP and the affected municipality. However, in certain circumstances, even communities without ACOs may set up I/I banks and establish their own rules, so that new development (rather than current ratepayers) can help pay for their I/I remediation efforts.

Circumstances When a Bank is Allowed

Although there are circumstances under which a municipality may establish an I/I bank in the absence of a MassDEP ACO, such banks may raise legal questions associated with imposing fees and/or mitigation requirements on new and expanding sewer users that are not also applied to existing users.

The legal rationale for I/I banking is that, where a municipality is experiencing SSOs or has a serious sewage treatment capacity problem, MassDEP *or* the local sewer agency has the authority to declare a moratorium on new sewer connections and extensions. Therefore, under this legal reasoning, the municipality should also have the authority to grant exemptions from the moratorium if a permit applicant is willing to spend money to increase capacity by remediating I/I. That is, they may legally single out new and expanded sewer users to undertake or pay for sufficient I/I removal to offset their new flows rather than simply prohibiting those flows.

Where a municipality has no current or anticipated capacity problems in its system, however, placing a special I/I mitigation requirement only on new users, particularly in the form of a fee rather than a mitigation requirement, would most likely be viewed by the courts as a tax that is being assessed unfairly against new but not current sewer users.

Even where an I/I bank was originally established to deal with a capacity problem, continued operation of the bank after the problem is fully resolved is probably not legally permissible. However, an I/I Bank can continue to operate until there is no foreseeable risk of recurrence of the capacity problem in light of continuing system aging and service population growth. Thus municipalities should be sure that their capacity issues are truly solved before dissolving their I/I bank. Even once an SSO or other capacity problem has been largely eliminated, it may still be legal to require I/I mitigation for large new developments whose unplanned-for new flows could result in long term capacity problems.

Where a municipality or development supplies its own water from local sources and disposes of wastewater via a wastewater treatment plant located in a different sub-basin (e.g., when it is sent to MWRA's Deer Island Treatment Plant), it may also be possible to establish an I/I mitigation requirement for new development in order to offset the loss of groundwater (via drinking water withdrawal) in the donor basin. This rationale for establishing an I/I bank would be particularly strong if the water supply sources are located in a hydrologically stressed stream basin.

It is important to note that none of these rationales for establishing an I/I bank have been fully tested in the courts; there is currently a highly significant case pending over the legality of Saugus' I/I bank and fee system. Municipal officials should consult with counsel before implementing an I/I bank in the absence of a MassDEP enforcement action.

Establishing Appropriate Authority

As with any component of an I/I program, the first step is to establish necessary legal authority, above and beyond what is normally contained in basic sewer use regulations. If a municipality is setting up an I/I bank because it is required to do so by MassDEP under an administrative consent order, then no other legal authorization is necessary.

If the municipality is establishing an I/I bank on its own initiative, it should first make a formal finding that spells out the capacity deficiencies or other problems that the I/I bank is being set up to address. This finding should also include justification for key elements of the bank such as fee levels and offset ratios (which are discussed below). Then the municipality must establish adequate legal authority in its bylaws or ordinances.

The following model language for an I/I bank comes from an ordinance adopted by Fall River in 1988. Note, however, that because MassDEP has just dramatically raised the size threshold for its review and issuance of state sewer connection and extension permits, it may be advisable to link the mitigation requirement to the issuance of a local, rather than state, sewer connection permit.

Any project which is of sufficient discharge capacity and requires a state sewer extension permit pursuant to Massachusetts Sewer System Extension and Connection Permit Program...must contribute to the reduction of infiltration and inflow to the public sewer system. This may be in the form of a limited inflow/infiltration study, actual removal of inflow/infiltration by pipeline rehabilitation, combined sewer separation, storm drain installation, specific pipeline maintenance projects, a permit fee or other method as approved by the sewer commission and department of public works. Such inflow/infiltration reduction must establish an effective removal or planned removal of five times that volume proposed to that which is being introduced.

Establishing I/I Remediation Fees

If a community decides to require new sewer users to pay a fee instead of doing the I/I remediation work themselves, or if it offers payment of a fee as an option (see "Who Will Do the Work and Where?" below), it will need to determine how much the fee should be. When setting I/I fees, the community should document clearly how the fees are "reasonably related" to the cost of I/I removal. The I/I fees must be placed in a dedicated account and not lumped together with other municipal accounts for sewer work; this account may not be used for normal sewer operation and maintenance activities.

The best way to establish I/I mitigation fees is to do so with the benefit of an up-to-date Sewer System Evaluation Survey, which will provide a list of prospective I/I projects to be implemented in order to achieve program goals along with their estimated I/I reduction in gallons and an associated cost estimate. The base fee can then be estimated by totaling the cost of all cost- and value-effective rehabilitation projects with the expected reduction in gallons to derive a per gallon fee.

In practice, an SSES with updated cost information is not always available when a bank is first being set up. In the absence of more site specific cost estimates, an alternative approach would be to set the fee at the estimated cost of "transporting and treating" sewage. The transport and treat costs define the upper limit of those projects that will be cost effective (though not necessarily the upper limit of those that will be value effective).

Another approach to setting an I/I banking fee when up-to-date local cost estimates are not available is to refer to remediation cost data from I/I projects undertaken in other area communities. MWRA staff have reviewed 208 I/I remediation construction projects funded by the MWRA Grant-Loan Program to tabulate the project cost per quantity of infiltration or inflow estimated to be removed for each project. Since it began funding local I/I remediation projects in 1993, the average cost per GPD removed (weighted by number of projects) is $4.90, with the average cost of projects since 2004 rising to $8.45 per GPD. Refer to the table below for a complete summary of the MWRA cost data.

Whatever method is used to establish fees initially, once a community has clear data on its actual costs for I/I remediation work, the fee should be reset to reflect that amount. Again, the fee cannot include the cost of other public works activities, such as general sewer operation and maintenance. To pass legal muster, fees must be set no higher than the level that “compensates the governmental entity providing the services for its expenses.” (Emerson College v. Boston, 391 Mass 415.)

Among the seven communities with I/I banks surveyed for this project (see “Case Studies of Existing I/I Banks in Massachusetts,” below), I/I fees ranged from $1.50 per GPD in Burlington to $9 per GPD in Billerica. Burlington, however, uses a 5:1 offset ratio, bringing the cost to discharge one new gallon of sewage to $7.50, while Billerica has no offset ratio, making $9 its total charge (see “Establishing Offset Ratios,” below).

Factoring in the offset ratio, Canton charges $16 per GPD, Weymouth $17, and Saugus $18. Rockport has no commercial growth, and charges residential users based on the number of bedrooms rather than gallons. In fact, in all seven communities, I/I fees for small residential sewer connections are a much smaller flat fee.

Waltham, which charges $12 per GPD (including its 4:1 ratio), says its fee is so far below its actual I/I remediation costs that it no longer gives commercial developers the option of paying the fee but instead requires them to do the remediation work themselves.

Table 2. Eligible Project Cost per Gallon of I/I Removal
(Based on review of MWRA I/I Local Financial Assistance Program):

Program Phase	**Project Cost per GPD of Inflow Removal (number of projects)**	**Project Cost per GPD of Infiltration Removal (number of projects)**
Phase 1 Beginning May 1993:	$1.40/GPD (28)	$3.80/GPD (22)
Phase 2 Beginning August 1995:	$0.90/GPD (10)	$4.40/GPD (28)
Phase 3 Beginning August 1998:	$4.20/GPD (8)	$6.40/GPD (21)
Phase 4 Beginning August 2001:	$3.20/GPD (10)	$4.80/GPD (34)
Phase 5 Beginning August 2004:	$16.20/GPD (9)	$6.50/GPD (30)
Phase 6 Beginning August 2006:	$8.70/GPD (1)	$6.80/GPD (7)
Average (weighted by number of projects):	**$4.10/GPD (66)**	**$5.30/GPD (142)**

If an MWRA community adopted an offset ratio of 4:1 and set the base mitigation fee equal to the MWRA transport and treat cost (ignoring local operating and capital costs), the resultant fee would total $45.60 per gallon of new sewage. Perhaps not surprisingly, none of the municipalities interviewed said its I/I fee, even with application of an offset ratio, fully covers its I/I remediation costs.

Offset Ratios

I/I banks require that new or expanded sewer connections reduce I/I by a volume greater than the amount that will be added by the new connection. This multiplier is referred to as an "offset ratio." The application of an offset ratio reflects, among other things, the uncertainty as to how much flow will actually be removed from the system by a given remediation project. This uncertainty arises from the difficulties of accurately measuring or estimating the volume of flow removed, the uncertainty as to whether removed inflow sources might have reconnected to the sewer, and the tendency of infiltration to migrate to other areas of the system, partially negating the impact of the remediation efforts.

If a municipality is ordered by MassDEP to set up an I/I bank, Mass DEP will establish the offset ratio in its ACO. MassDEP ratios have generally been set somewhere between 4:1 and 10:1, although it will often amend an ACO to reduce high ratios once significant progress in remediating I/I has been made. In Saugus, the ACO automatically reduced a 10:1 ratio to 6:1 once 250,000 GPD of inflow had been removed, and the ratio will go to 4:1 once 500,000 GPD removal is reached.

MassDEP offset ratios have been based on two major factors. First is the frequency and severity of I/I related problems. For example, an SSO that floods an unpopulated upland area is treated as less severe than one that occurs in a densely developed area or in a Zone A of a public water supply. The second factor is how well a municipality has responded in the past to similar I/I related problems.

Communities without an ACO will need to make their own determination of what offset ratio will be utilized. Because offset ratios are directly related to the cost of complying with the mitigation requirement, they must be considered carefully when designing the I/I bank. Furthermore, it is advisable that the offset ratio be periodically revisited after a reasonable amount of remediation work has been completed and its level of success has been measured.

Choosing a Bank Operating Model

The final step in designing an I/I bank is to select an operating model. The choice is between a "traditional" bank model which functions like a child's piggy bank (where one can't take out more than one has put in), and an "alternative" bank model which allows the bank to loan credits to developers before they have actually been created by I/I remediation projects. Each approach has its own pros and cons.

The Traditional I/I Bank Model

To date, when MassDEP has entered into administrative consent orders (ACOs) with municipalities requiring them to set up I/I banks, it has always used the "traditional" bank model. In these situations MassDEP has mandated that I/I reductions be accomplished prior to the issuance of new sewer connection or extension permits. In other words, I/I removal credits are entered into the bank only after an I/I remediation project has been completed and the results estimated or measured. Only when adequate credits are in the bank may they be withdrawn by new or expanding sewer users.

If the Bank is not holding any credits, sewer connection and extension permits may not be issued. The developer must then complete the I/I remediation work (or the town must complete the work using fees paid by the developer) to create the necessary credits before connecting to the sewer.

In the past, MassDEP has refused to issue state sewer connection or extension permits until adequate remediation has been clearly demonstrated. However in the wake of regulatory changes adopted in January, 2007, only the very largest sewer connections and extensions now require state permits. DEP does have the authority, though, to order municipalities to deny local connection and extension permits where it has ordered I/I banking. And, of course, municipalities may do so without any mandate from MassDEP.

To provide more flexibility in the traditional bank model, most municipalities with banks use their own funds to undertake I/I projects that generate credits for an "initial deposit" into the bank. The party applying for the permit withdraws credits from the bank up front but must then perform, or pay a fee for the town to perform, additional I/I remediation to replenish the withdrawn credits in the bank after the fact.

Note that when a bank is operated under a DEP ACO, if a sewer connection permit applicant conducts or pays for an I/I remedial action, and the expected level of flow reduction does not occur, MassDEP will require that additional I/I reduction measures be taken before the connection permit may be issued. A municipality should make a decision before its bank is established as to whether the applicant or the municipality is responsible for making up any discrepancy.

Another important design issue to be addressed in a traditional I/I bank is how credits will be allocated among competing interests when there aren't enough credits to go around. Because they are exempt from local bylaws, so-called "40B" residential developments are generally given the highest priority. Nevertheless a complete hierarchy of potential user types should be established. Burlington, for example, has established the following prioritization: 40B projects, municipal projects, residential developments requiring more than 499 GPD, all other projects.

For the future, MassDEP is considering other options for municipalities that experience sewer or sewage treatment capacity problems. In some cases, they may simply require cities and towns to remove specific amounts of I/I within a specified period of time, without prescribing the local mechanisms for funding I/I removal work. Such communities may be given the liberty of determining if establishment of an I/I bank is the preferred approach. Without a specific I/I banking requirement from MassDEP, municipalities may in the future have more flexibility in the design model they choose for their bank.

The traditional I/I bank model may still be the best one to use if there is an immediate danger of an SSO in a populated or environmentally sensitive area so that sewer capacity must be increased rapidly before any new connections to the sewer may be allowed.

The "Alternative" I/I Bank Model

While the traditional I/I bank model can be a powerful motivator to accomplish rapid I/I reduction, it is also fairly rigid. To address this problem, a number of communities have begun using I/I banks that allow the municipality to “loan” remediation credits to a developer when the bank is empty, so long as the “borrower” has paid a fee that will cover the required I/I removal or committed to a timetable for undertaking the remediation him or herself. Canton, Billerica and other municipalities have adopted this model, with Canton collecting fees before any I/I remedial work at all has commenced.

This model is probably not acceptable in situations where a severe capacity issue exists and new connections would only exacerbate the problem, such as where an SSO is likely to occur in the next large rainstorm. The alternative model may be appealing, however, in municipalities with less urgent capacity issues that have not yet undertaken their I/I Analysis or Sewer System Evaluation Survey (SSES) and therefore haven’t yet prioritized I/I remediation projects. Indeed, communities can charge I/I remediation fees to help pay for the I/I Analysis and SSES, as well as for physical remediation activities.

As with the traditional I/I bank model, the municipality should establish in advance whether it or the applicant will be liable to pay for any additional I/I remediation if the original remedial project did not achieve the expected results.

Exemptions and Projects Subject to Lower I/I Fees

For practical and political reasons, most communities with I/I banks set a standard, lower I/I fee for residences, usually based on the number of bedrooms. Some apply this to two-family homes and some even to new real estate developments. A few communities even waive or set lower fees for projects with minimal new or expanded flows. In any case, communities with I/I banks need to establish a clear policy as to what constitutes “new or increased flows” which trigger the application of the I/I mitigation requirement. Some of the situations to be considered include:

- How will changes in wastewater flow be calculated or estimated? Based on actual usage, Title V wastewater generation volumes or some other basis?
- Does the requirement apply only when buildings are being expanded, or does a change of use which generates higher flows also trigger the requirement?
- Does the requirement apply if a building has been vacant for a certain period of time, even though the new tenant’s sewer discharges are no larger than the previous tenant’s?
- Does the requirement apply if there is a change of tenant but not of use?

In all seven communities with I/I banks surveyed in the preparation of this handbook, a change of use at a given location triggers a mitigation requirement if the expected flow is greater than the previous use. Saugus always charges a fee to reconnect new businesses to vacant buildings, while Waltham only does so if the site has been vacated for 6 months or more.

Who Will Do the Work and Where?

All I/I banks must have a clear policy as to who will undertake the actual work of I/I removal, and what types of projects will be eligible for inclusion in the program.

Some I/I banks allow (and some even require) developers to undertake I/I projects using their own work force or subcontractors. Others allow them to hire firms from a pre-qualified list selected by the municipality. Most also provide the developer with the option of making a payment to a dedicated fund that will be used by the town to undertake the work using municipal staff or contractors. Others mandate that all developers pay the I/I remediation fee, so that the municipality can maintain full control over the quality of workmanship.

Letting the developer do the work is generally cheaper and less time consuming, partially because there are no competitive bidding requirements. While this option would appear to save the municipalities staff time and administrative headaches, some cities and towns using the system have found that the effort of overseeing and evaluating the effectiveness of the remediation work is not worth it.

Of the seven communities with I/I banks surveyed, only Canton does not allow developers to do the work themselves, though Billerica said that no developer has expressed an interest in doing so. In Waltham, commercial developments are *required* to do I/I remediation themselves, since its bank reserves what little credits it has on hand for residential sewer connections.

Assuming developers are allowed to do the work themselves, the question arises as to which I/I remedial projects they should be allowed to undertake. The developer, if given the option, will obviously choose the least costly way of creating bank credits, but this then leaves the more costly projects for the municipality and/or future developments (though the municipality could raise its I/I fees to cover the additional cost of later projects). Where developers are allowed or required to do the remedial work, many municipalities with I/I banks either designate a specific project or provide them with a list of eligible projects. Some communities allow the mitigation requirement to be satisfied only with remediation projects undertaken on the publicly owned portions of the sewer system, while others allow the requirement to be satisfied through the remediation of private I/I such as sump pumps and downspouts.

Burlington lets developers choose remedial projects on a “first come, first served” basis, with the result that new developments are far less likely to choose this option today since the cheapest projects have already been completed. Saugus allows developers to propose which remedial project they would like to undertake, subject to its approval.

Some of the same issues have arisen when municipalities have had to decide whether to use I/I fees to do the remedial work themselves or bid it out to a contractor. Some municipal departments who have done the work themselves have found that I/I fee revenues do not always result in the town hiring adequate new staff, so that other necessary municipal work doesn’t get done. Any work done by contractors, however, must have municipal oversight, particularly if the contractor is to determine the success of his or her own work. Nevertheless, most of the communities in our survey have used contractors to do at least some I/I remediation.

A Plan for Measuring Results

A community setting up and I/I bank will need to determine up front how the results of the remediation efforts will be measured. Will actual pre- and post-construction field measurements be required, or will removal be estimated based on volume estimates from an SSES or other source and an assumed success rate. If there are to be pre- and post-construction measurements, who will make them, the permittee, town staff or a designated consultant? Whether removal will be measured or estimated, the methodology should be established in advance. If measurements indicate that less than the targeted level of reduction was achieved, is the permittee responsible for undertaking additional remediation projects to fully satisfy the target?

Correctly Calculating Credits from Inflow Remediation

Most, if not all municipalities with I/I banks use the MassDEP I/I Guidelines to estimate the number of gallons of water that are removed from the sewers by eliminating various sources of inflow. These estimates determine the number of credits to be entered into their I/I banks when these inflow removals occur. MassDEP bases these estimates on the total inflow expected from the 1-year / six-hour storm. Table 7 of the MassDEP Guidelines states, for example, that a driveway downspout and a drain each account of 1,000 gallons of inflow (assuming a 1,100 sq. ft. area of discharge). Use of these MassDEP estimates to calculate bank credits from inflow removal is fine if a community's only goal is to decrease peak sewer flow so that SSOs don't occur or POTWs aren't overwhelmed during major rainstorms.

However, use of I/I bank credits created from inflow reduction projects to offset new sewer connections can result in an *increase* in average daily sewer flow, which would increase MWRA fees or other costs of "transporting and treating" wastewater. This is because inflow occurs only after significant rainstorms, so that removal, say, of a downspout which is hooked into the sanitary sewer doesn't reduce sewer flows at all on the days when it does not rain. Yet new sewer connections result in new flow every day (or nearly every day) of the year.

If a municipality wants to set up an I/I bank not only to prevent SSOs, then, it could require developers to pay for (or create) separate inflow and infiltration reduction credits; i.e., require them to reduce (or pay for the reduction) of both inflow and infiltration before allowing them to hook into the sewer system. It is not necessary, of course, to charge developers two separate fees, but then it is all the more critical that a municipality have an appropriate mix of inflow removal projects to cut down peak flows as well as infiltration remediation projects to reduce average daily flow.

Case Studies of Existing I/I Banks in Massachusetts

Existing I/I banks were examined in Burlington, Canton, Billerica, Weymouth, Waltham, Saugus, and Rockport, and a summary of the findings are found below and in Table 3.

Rationale for Banks

Five of the seven I/I banks studied were set up in response to DEP ACOs issued after the municipality had experienced either SSOs, CSOs or inadequate sewage treatment plant capacity. Weymouth had so many SSOs that DEP required them to establish sub-areas where sewer connection and extension permits are contingent on I/I remediation in the same sub-area. All seven municipalities also gave other reasons for establishment of their I/I banks, such as reduction of MWRA sewer fees and groundwater protection. In Waltham, leaking sewer pipes were not only causing infiltration, but were allowing sewage to "exfiltrate" into the Charles River in violation of the Clean Water Act. Canton has sewer capacity issues and Interbasin Transfer Act restrictions that its bank is meant to address, even though it has no SSOs and sends it sewage to Deer Island.

Bank Model Used

Canton and Billerica (which are not under DEP ACOs) have "loan" model banks (i.e., developers can hook into the sewers after paying an I/I fee even if the bank contains no I/I credits at the time). Rockport has a mix of the traditional and "loan" models, requiring that credits be in the bank before issuing sewer connection permits, but issuing such permits despite the lack of demonstrable progress in overall I/I reduction (though Rockport says progress may be hidden by three unusually wet years in a row). Rockport has an ACO with DEP due to POTW issues, but no sewer moratorium, though that is expected to change soon. The other four communities use the traditional bank model.

Fees, Offset Ratios, and other I/I Remediation Requirements

Fees and offset ratios vary widely, from 4:1 to 10:1. As for costs to developers (i.e., applicants for sewer connection and extension permits), when offset ratios are factored in with the fees, costs range from $7.50 to $18 per gallon of new flow (though single homes pay far less). It should be noted that the town of Saugus is currently being sued by 4 developers who object to paying the fee. Rockport, which has not experienced any new commercial development, charges a flat $550 per bedroom (which includes the offset ratio). As explained below, Waltham also only collects fees for residences and charges a flat $750 for single family homes.

Although in some cases I/I fees may have once fully covered remediation costs, not one of these municipalities said they this is true today (generally remediation costs rise with time since the most cost effective projects are done first). Waltham's $12 per gallon fee is deemed so inadequate to fund I/I remediation work that the Engineering Department makes commercial developments do the I/I work themselves (what few credits the Bank holds are reserved for residential users). I/I work in nearly all 7 communities is funded not only by I/I banking fees but by other sources such as SRF loans, MWRA loans and grants, general revenues and sewer user fees.

Municipalities' Self-Assessment of Their I/I Banks

Of the communities studied, Burlington has done the most extensive I/I remediation and seems happiest with the results of its I/I bank. Burlington has experienced a very high demand for commercial space, which allowed it to successfully set a very tough 11:1 offset ratio (now reduced to 5:1). It has also had large MWRA grants to subsidize its remedial work. Weymouth is also generally happy with its Bank. Saugus' Bank has been effective, though as noted above, four developers are questioning the legality of its I/I fees in court.

Waltham, on the other hand, faults extremely low fees set by the City Council for the paucity of I/I credits in its Bank and thus its slow progress in I/I remediation. DEP has seen no measurable reduction in flows to Rockport's sewage treatment plant despite considerable I/I remediation, and is expected to amend its ACO to impose a sewer moratorium (though Rockport feels its progress has been masked by 3 straight years of above average rainfall). Canton and Billerica are just beginning active I/I Banking programs and so are reserving judgment.

Table 3: Summary of Massachusetts Existing I/I Bank Case Studies

	Burlington	Canton	Billerica	Weymouth	Waltham	Saugus	Rockport
Did DEP mandate I/I Bank due to SSOs?	Yes	No, but sewer capacity issues	No, though was an ACO in 80s	Yes	Yes	ACO not due to SSOs	ACO not due to occasional SSOs
Other reasons for I/I Bank	Reduce MWRA sewer fees	Part of WRMP rqd by DEP	Insuff. POTW capacity	MWRA fees, water conserv	MWRA fees; also exfiltration	CSOs; old leaky sewers	ACO re/POTW capacity probs
Remediation mainly of inflow or infiltration?	Orig'ly inflow now infiltration	Too early to say	Too early to say	1st inflow, now infiltration	Both	infiltration, but some inflow	Both
Offset Ratio	Orig'ly 11 to1; now 5 to 1	4 to 1	None	6 to1; 2 may be water conserv.	4 to 1	10 to 1; then 6 to 1; may be 4 to 1	10 to 1, but flat fee includes ratio
Traditional or Alternative model?	Traditional	Alternative	Alternative	Traditional	Traditional	Traditional	Mix - see # 11
I/I Fee Amount and basis	$7.50 GPD, incl 5:1; originally actual cost	$16 GPD incl 4:1 Based on transp & treat	$9 GPD for I/I remed & POTW expansion	$17 GPD, incl 6:1 ratio	$12, incl 4:1, but commerc. May not pay fee	$18 GPD incl 6:1 ratio	$550 a bedroom no commercial proj's in town
Does fee cover full I/I remediation. costs?	Fees don't cover full costs (now)	Fees raising $ for later remed.	Fees not meant to cover costs	No	No; "not even close"	No	No
Is a Contractor used?	K'er & DPW	Yes	Yes	Yes	Yes	K'er & DPW	K'er & DPW
Applicant allowed to remediate him or herself?	Yes; allowed	No	Yes, but no interest	Yes, but only largest have	Rqd cause not enough credits	Yes; allowed	Yes, but none have done it
Other I/I remediation funding aside from I/I Bank fees?	MWRA grant/loan	MWRA grant/loan	Gen'l Revenues	MWRA; some gen'l revs	SRF	MWRA & local sewer fees	SRF $ for I/I study; gen revs
Self assessment of I/I Bank	Very successful town-wide prog. Public ed is key.	Too early to tell	Too early to tell	Very good. Remed rqd in same subzone as new flow.	Fees too low so work too slow. Commerc. users rqd to do own remed.	Excellent but being sued. Ratios reduce automatically with success.	No success shown, but may be due to wet weather. ACO amend. will create sewer moratorium.

I/I Program Evaluation Checklist

In planning an I/I program, or reviewing an existing one, municipal officials need to gather information and make decisions as to:

1. Which I/I problems are worth fixing and which should be remediated first; and

2. How costs of remediation can be minimized for ratepayers and taxpayers.

The following is a checklist of questions you should answer in order to establish the most cost-effective I/I remediation program appropriate for your community. Details on what to consider in making your decisions are provided above in this Handbook and the documents referenced in it.

Which I/I Problems are Worth Fixing?

A. Infiltration Indicators:

i. (For MWRA communities) How do we rank in comparison to the other 42 MWRA communities as to extent of infiltration? [See p. 7 - 8]

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ii. Where are there sewer lines that are known or likely to be in ill repair based on age, materials, lack of recent maintenance, etc.?

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iii. What is the difference in amount of water sold (excluding lawn watering months and industrial water users) to the amount of sewage flow? [See page 8]

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iv. Where are there sewer subsystems with infiltration rates of 4,000 GPD/IDM or greater that should definitely be examined in greater detail? [See p. 9]

B. Inflow Indicators:

i. (For MWRA communities): How do we rank in comparison to the other 42 MWRA communities as to extent of inflow? [See pp. 7 - 8]

ii. For each sewer subsystem, what has been the frequency of surcharging and SSOs, and what is each system's capability for passing the one year/six hour storm?

iii. What is the peak flow rate in each sewer subsystem compared to capacity? [See MassDEP I/I Guidelines referenced on p. 43]

iv. Which sewer lines were identified in an I/I Analysis as having high inflow rates? [See MassDEP I/I Guidelines referenced on p. 43]

C. Prioritization of I/I Remediation Projects

i. What is the "transport and treat" cost for each gallon of I/I entering the sewer compared to estimated remediation costs of each sewer subsystem? [See pp. 12-13 and MassDEP I/I Guidelines referenced on p. 43]

ii. Are there “value effective” I/I remediation projects with particular technical, environmental or health benefits? [See p. 13]

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iii. What are the costs to the town (including limitations on development and reduction in property values) resulting from SSOs?

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iv. (Except for MWRA communities) If the sewage treatment plant is close to capacity due, in part, to I/I, what is the estimated cost to expand or replace it?

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v. (For municipalities with a local water supply) What is the cost of pumping or buying additional water where current groundwater levels (due at least in part to infiltration) place limitations on pumping of local groundwater? [See p. 5]

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Program Goals

Based on local problems resulting (at least in part) from I/I, what are the goals of our I/I remediation program [See pp. 9 – 10]?

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Reducing Costs of I/I Remediation.

A. Are we eligible for an SRF loan or MWRA Financial Assistance Grant/Loan Program? [See pp. 17 - 18]

B. Have we incorporated regular I/I remediation into our annual Public Works (including highway) maintenance budget? [See p. 18 and NEIWPCC Handbook referenced on p. 43]

C. Have we considered town-wide I/I remediation and inter-municipal cooperation? [See pp. 18 – 19 and NEIWPCC Handbook referenced on p. 43]

D. Have we considered indoor water conservation to reduce sewer discharges as an alternative to some I/I remediation projects? [See p. 19]

E. Have we used the MEPA EIR process to ask for I/I remediation as mitigation for large new development projects?

F. Have we established infiltration standards for construction of new sewer lines in order to minimize future I/I remediation costs? [See p. 19 and NEIWPCC Handbook referenced on p. 43, Section 4.1]

Private I/I

A. Do we have a cost-effective program to remove (or require removal) of privately owned inflow and infiltration sources? [See pp. 21 – 23]

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Designing an I/I Bank

A. May we legally make applicants for new sewer connection and extension permits (rather than rate or taxpayers) finance remediation of existing I/I? [See pp. 25 – 26]

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B. Do we have adequate legal authority (municipal bylaw or ACO)? [See pp. 26 – 27]

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C. Which bank "model" should we use? [See pp. 29 – 31]

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D. What fees and offset ratios should we use? [See pp. 27 – 29]

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E. Who should perform the remedial work? [See pp. 32 – 33]

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F. Which types of new development should be given priority to use available bank credits [See p. 30]

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G. How should we calculate bank credits? [See p. 33]

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H. Who, if anyone should be exempt from I/I fees or subject to reduced fees? [See p. 31]

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Resources for Further Investigation

1. MassDEP *"Guidelines for Performing Infiltration/Inflow Analyses and Sewer System Evaluation Survey;"* Revised January, 1993 is available at: http://www.mass.gov/dep/ water/laws/iiguidln.doc.

   This guidance document details DEP's recommended methodology for conducting I/I analyses and phase 1 and 2 Sewer System Evaluation Surveys (SSES). The guidelines are mandatory for communities seeking financial assistance under the state revolving fund (SRF). For other projects, the guidelines are recommended by DEP and MWRA.

2. The New England Interstate Water Pollution Control Commission (NEIWPCC) document *"Optimizing Operation, Maintenance, and Rehabilitation of Sanitary Sewer Collection Systems;"* December 2003 is available at http://www.mass.gov/dep/water/laws/omrguide.pdf or at http://www.neiwpcc.org/neiwpcc_docs/finalwebomr.pdf.

   This document was prepared on behalf of the New England states and New York. It provides guidance on O&M and sewer evaluation and rehabilitation, and is particularly helpful in setting up effective O&M and I/I management programs. It includes model bylaw language, excellent tips on public outreach, and much additional useful information.

3. MWRA's I/I Task Force *"Infiltration/Inflow Task Force Report; A Guidance Document for MWRA Member Sewer Communities and Regional Stakeholders*;" March 2001 is available from MWRA by emailing kristina.hall@mwra.state.ma.us.

   The Task Force included representatives from MWRA and all it's member communities, as well as relevant watershed associations. It contains detailed strategies for reducing or eliminating sewer system backups and SSOs, educating and involving the public, developing O&M Programs, and improving funding mechanisms for I/I identification and removal.