

Report

Town of Dedham, MA

Infiltration and Inflow Investigation and
Rehabilitation Annual Program

February 2013

Weston&Sampson

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**Town of Dedham, Massachusetts
Weston & Sampson Project No. 2120285**

February 26, 2013

Jason L. Mammone, PE
Director of Engineering
55 River Street
Dedham, Massachusetts 02026

RE: Infiltration and Inflow (I/I) Investigation and Rehabilitation Annual Program

Dear Mr. Mammone:

Weston & Sampson is pleased to submit this report to the Town of Dedham for the development of the Infiltration and Inflow (I/I) Investigation and Rehabilitation Program (Annual I/I Program) and updated sewerage transportation and treatment (T&T) cost.

One of Dedham's primary goals is to reduce wastewater flow to the Massachusetts Water Resource Authority (MWRA) and decrease user charges. One option to reduce wastewater flow is through the reduction of I/I. Establishing an Annual I/I Program to investigate and rehabilitate the collection system on a regular basis will allow the town to identify and repair I/I sources to reduce flow. There are many benefits of an Annual I/I Program, including but not limited to:

- Minimizing health/environmental hazards, damage to public and private property, and liability/insurance claims associated with Sanitary Sewer Overflows (SSOs)
- Reducing emergency response (and associated costs)
- Increasing hydraulic capacity in the sewer system
- Providing for identification and removal of I/I and potential reduction of MWRA user charges
- Reducing wear and tear on sewer system and pump stations
- Improving the town's ability to evaluate, prioritize, and address system needs
- Decreasing operating and capital costs
- Sustaining the town's large investment in wastewater infrastructure

The activities included in the Annual I/I Program will also help the Town of Dedham continue to responsibly operate and maintain their sewer collection system in a pro-active manner and uphold their legal responsibility to prevent SSOs.

System Description

The Town of Dedham, Massachusetts is a residential community located southwest of Boston. Wastewater collected in the town drains east to the Boston line where it enters the MWRA interceptor. The flow is

ultimately treated at the Deer Island Wastewater Treatment Plant. The town's wastewater collection system consists of approximately 95 miles of gravity sewer with an average daily flow of 4 million gallons per day (MGD). Figure 1 shows each sewer subarea and the limits of the wastewater collection system. Table 1 is a summary of the gravity sanitary sewer subareas.

Previous Projects

The town is involved in an ongoing process to identify and remove excessive I/I. The following services and reports were supplied to the town by Weston & Sampson:

SERVICE/REPORT TITLE	REPORT/SERVICE DATE
Design/Bid and Award/Construction/Construction Services	January/December 2008
Town-Wide Flow Monitoring Program Report	October 2011
Municipal Building Inspections	October 2012
2012 Inflow Investigation	February 2013

In addition to the reports listed above, the following specific work was performed on the sewer system between 2007 and 2012 to identify and remove I/I.

- An estimated 659,000 linear feet of sewers were cleaned and television inspected.
- An estimated 1,734 manholes were inspected.
- Testing and sealing of approximately 48,400 linear feet of sewer main, testing and sealing of 560 service connections, installation of 79,000 linear feet of cured-in-place pipe (CIPP), installation of 1,620 linear feet of short liners, and rehabilitation of 5,150 vertical feet of sewer manholes.

Transportation and Treatment (T&T) Cost Development

Weston & Sampson reviewed current fiscal year finances for the town and existing MWRA billing and flow information. This information was used to develop current fiscal year T&T costs for the town. The T&T cost consists of capital costs to expand and upgrade the wastewater system plus annual operation and maintenance costs. Operation and maintenance costs are directly related to the quantity of flow being discharged to pump stations and treatment facilities. Increased usage will be reflected by increased operation and maintenance costs for electricity, cleaning, equipment repair, etc.

The calculated T&T cost for Dedham, using MWRA and the Town of Dedham's O&M and capital costs, is \$0.9877/gpd. In accordance with DEP Guidelines, the present worth of this T&T cost must be extended over the life of the rehabilitation method, estimated at 20 years, using a discount rate (or annual percentage rate) of 4.125% (DEP FY13). The present worth of the T&T costs for the Town of Dedham, assuming a 20-year rehabilitation life cycle, is \$13.27/gpd. A memorandum explaining the calculation of T&T costs may be found in Appendix A.

The computation of T&T costs for a particular I/I source is based on the portion of I/I that can be eliminated through rehabilitation. The percentage of I/I that can be removed depends upon the individual sources and rehabilitation method. Infiltration and indirect inflow removal is typically limited to 50 percent due to the potential for migration of the flow from one repaired defect to a nearby defect that may not have been

identified. Inflow is usually considered 100 percent removable because the source can be permanently eliminated from the sewer.

Annual I/I Program Development

While the town has aggressively pursued the removal of infiltration over the past several years, I/I still exists in the sewer system. As part of our Annual I/I Program development, Weston & Sampson compiled data from previous I/I studies and rehabilitation projects as well as information from town personnel. For this priority evaluation, all of the town's sewer subareas were ranked based on the I/I rates estimated through the 2011 Town-Wide Flow Monitoring effort and other pertinent information. Based on our review of the data, we developed recommendations for future investigations which are incorporated into the town's Annual I/I Program.

The data from the 2011 Town-Wide Flow Monitoring Program was used to rank each subarea by the amount of infiltration and inflow that they contribute to the sewer system. Table 2 is an infiltration summary ranked by peak infiltration rates. Table 3 is an inflow summary ranked by the percentage of inflow contribution to the sewer. The DEP guidelines recommend investigating subareas which contribute 80% of the estimated inflow in the system.

Two of the most effective ways to identify inflow sources is through smoke and dye testing and building inspections. The smoke and dye testing is most effective in identifying public inflow sources while the building inspections are effective in identifying private inflow sources. The town wishes to identify and remove public sources prior to identifying and removing private inflow sources.

The Town of Dedham performed smoke and dye testing to investigate areas identified as having excessive inflow in the 2011 Town-Wide Flow Monitoring Program in Subareas HH, II, JJ, NN, PP, TT and WW in October and November 2012. Additional smoke and dye testing is recommended in the remaining seven subareas that contribute 80% of the estimated inflow in Year One of this Annual I/I Program.

It is recommended that the Town of Dedham develop a Private Inflow Removal Program. When establishing and implementing this type of program it is important to tailor it to the specific needs of the community. Since a Private Inflow Removal Program has not been implemented to date, Weston and Sampson recommends performing building inspections in Year Four and Five in the 14 subareas that contribute 80% of the estimated inflow. This will allow for time to implement the program and educate the public regarding inflow sources.

The town performed building inspections of all 21 public buildings in 2012 and no major sources of I/I were identified on these properties.

Table 4 shows the subareas ranked according to the above-mentioned criteria. Year One includes infiltration investigations in Subareas OO, TT and VV because they appear to have the highest estimated peak infiltration. It is assumed that once an area is inspected and rehabilitated, it will not require additional work within the cycle of the investigation and rehabilitation program. However, this may not be the case, and the program may be evaluated yearly based on problems that develop in the collection system.

Schedule and Costs

A ten-year operation and maintenance program schedule was developed to evaluate an estimated 49,600 lf of sewer per year. This includes infiltration investigations and does not account for increased footages in

Year One, Four and Five for inflow investigations. The anticipated schedule is shown in Table 4. It is assumed that each year of the program will include the following items:

- Sewer System Evaluation Survey Work/Investigation and Reporting:
 - Television Inspection
 - Manhole Inspections
 - Smoke and Dye Testing (Year One)
 - Private Building Inspections (Years Four and Five)
 - Evaluation of Data
 - Cost-Effectiveness Analysis (CEA)
 - GIS Mapping Updates
- Rehabilitation Design
- Database Update / Data Entry
- Contract Bid and Award
- Construction
- Construction Services

It is estimated that the above items will take approximately 12 months to complete for each year of the program.

Yearly costs are presented in Table 4 and include I/I investigations and construction (assuming evaluation of data, CEA, GIS mapping and database updates, design, bid and award and construction services will be completed by the Engineering Department).

A summary of calculations and assumptions used to develop the yearly costs is included as Appendix B. The total estimated cost per year was increased by 4% annually to provide reasonable cost estimates to plan for work performed in future years.

I/I Reduction Evaluation

The I/I removed during each year of the program will vary. However, using the flow monitoring data from 2011 and historical references, an estimated removable infiltration and associated cost was developed for each year of the program. This estimate can be used to determine how much the town will save over the life of the repair versus how much is spent on construction. An estimated amount of removable inflow could not be determined because we are not including any construction of inflow sources in our planning level costs.

Removable infiltration estimates were developed by reviewing past projects in similar communities. It is assumed that during the investigation phase, the town will likely identify approximately 60% of the infiltration that was estimated in the flow monitoring program. This discrepancy is typical and caused by many factors that include varying groundwater levels, flow from inflow sources that were assumed to be infiltration, and service connection and private flow that could not be verified from the mainline during television inspection (unidentified service connection flow). Of this identified infiltration, 50% is considered removable using current construction technologies. The T&T cost was then used to estimate the amount of money the town could save each year.

Throughout the course of the investigation and rehabilitation program, the estimated removable I/I will be recorded. In order to gauge the amount of I/I removed from the system after repairs are completed, MWRA flow meter data may be evaluated and compared to previous records.

Summary and Conclusions

Based on data from previous studies, rehabilitation projects, and information provided by town personnel, Weston & Sampson has developed a ten-year Annual I/I Program for the wastewater collection system. Each year of the program includes approximately 49,600 lf of sewers for investigation and repair.

The Annual I/I Program includes infiltration investigations (television and manhole inspections) and projected estimated construction costs for each of the program years. In the first year of the program, smoke and dye testing for inflow are included for selected subareas so that subareas in town with inflow issues are addressed. Years Four and Five also include private building inspections to identify private inflow sources in the fourteen recommended sewer subareas during those two program years.

The program starts with an estimated total cost of \$1,016,350 for the first year of the program and includes approximately 57,658 lf of sewers (not including 147,646 lf of smoke testing investigations). For subsequent years, the annual linear footage is approximately 49,600 lf per year. Costs for subsequent years of the program were generated based on the per linear foot cost escalated by 4.0% per year. These are planning level costs and will be adjusted based on market pricing each year. These costs do not include pre- and post-rehabilitation flow isolation or evaluation of flow data.

Construction of repairs identified during the inflow investigations was not included in our planning level costs. The type and amount of repairs found during inflow investigations vary greatly on a case-by-case basis. Also, if inflow sources are found on private property during the investigations, the town may require that they be removed by property owners. The cost associated with removal of private inflow sources can also vary widely.

The program is designed so that subareas with high I/I areas are addressed first. Should additional problems be encountered during the course of the program, changes to the plan can be made easily. The program can also be revised on a yearly basis. For example, if not enough problems are identified to warrant a rehabilitation project during one year of the program, money can be saved on design and procurement by foregoing a rehabilitation project for one year and including the rehabilitations with the next year's construction phase. The program schedule may also be altered to coincide with other projects in town, such as roadway construction or private developments.

It is recommended that the town perform a town-wide flow monitoring program after year five of the program to re-evaluate the program. This scope item and associated cost has been included in Table 4, Priority Evaluation.

By implementing this Annual I/I Program, the town will most effectively be able to identify and remove I/I to help reduce MWRA charges, avoid SSOs, increase hydraulic capacity of the sewer system, reduce the need for emergency response, reduce wear and tear on the sewer system and pump stations and decrease operating and capital costs.

Mr. Jason L. Mammone, PE
February 26, 2013
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Weston & Sampson appreciates this opportunity to have been of service to the Town of Dedham and looks forward to helping the town implement this Annual I/I Program. Special thanks to you and your staff, particularly Ron Lawrence for your assistance in developing this program. We are available to meet with you at your earliest convenience to discuss this report. Please do not hesitate to contact me, Pat Cotton or Nathan Michael at (978) 532-1900 with any questions or comments you may have.

Very truly yours,

WESTON & SAMPSON



Donald G. Gallucci, PE
Vice President/Program Manager

cc: Ronald Lawrence, Project Engineer
Deborah A. Finnigan, PE, Infrastructure Engineer

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FIGURE ONE

TABLES

TABLE 1
TOWN OF DEDHAM, MASSACHUSETTS
I/I INVESTIGATION AND REHABILITATION PROGRAM
SUBAREA SUMMARY

Subarea	Flow Meter(s) MH(s)¹	Estimated Linear Footage (ft)	Inch*Miles	Estimated Manholes
AA	AA5	17,171	28.22	114
BB	Unmetered	9,054	14.11	60
CC	CC110	10,987	16.98	73
DD	CC10	20,729	32.51	138
EE	EE16	14,356	23.62	96
FF	FF10	21,712	34.28	145
GG	GG20	26,768	44.77	178
HH	JJ1080	29,903	48.94	199
II	LL480, Unmetered	29,755	45.76	198
JJ	JJ130, JJ570	23,997	62.48	160
KK	KK60, KK180	15,044	22.77	100
LL	LL480, Unmetered	17,000	25.14	113
MM	MM160, Unmetered	17,930	28.40	120
NN	JJ130	11,412	17.97	76
OO	OO10	25,824	52.77	172
PP	PP10	20,730	35.66	138
QQ	QQ20	12,163	20.75	81
RR	RR10	19,376	29.72	129
SS	SS15	31,471	51.80	210
TT	TT50	18,030	28.29	120
UU	UU10	17,642	29.64	118
VV	VV30	13,804	24.16	92
WW	WW10	21,666	37.76	144
XX	YY10	16,279	25.02	109
YY	YY10	16,092	26.02	107
ZZ	ZZ400, Unmetered	16,911	24.69	113
		495,806	832.23	3,305

Notes:

1 Flow metering was performed in the spring of 2011.

**TABLE 2
TOWN OF DEDHAM, MASSACHUSETTS
I/I INVESTIGATION AND REHABILITATION ANNUAL PROGRAM
INFILTRATION SUMMARY**

Subarea	Flow Meter(s) MH(s)	Estimated Linear Footage (ft)	Inch*Miles	Estimated Manholes	Estimated Peak Infiltration (gpd)	Estimated Peak Infiltration (gpd/m)	Estimated Average Infiltration (gpd)
TT	TT50	18,030	28.29	120	390,000	13,786	292,500
VV	VV30	13,804	24.16	92	225,652	9,340	169,239
LL ¹	LL480, Unmetered	17,000	25.14	113	162,946	6,482	122,210
II ¹	LL480, Unmetered	29,755	45.76	198	285,204	6,233	213,903
SS	SS15	31,471	51.80	210	322,632	6,228	241,974
RR	RR10	19,376	29.72	129	176,842	5,950	132,632
EE	EE16	14,356	23.62	96	136,667	5,786	102,500
KK	KK60, KK180	15,044	22.77	100	127,368	5,594	95,526
UU	UU10	17,642	29.64	118	143,333	4,836	107,500
CC	CC110	10,987	16.98	73	80,000	4,711	60,000
OO	OO10	25,824	52.77	172	211,739	4,012	158,804
MM ¹	MM160, Unmetered	17,930	28.40	120	112,336	3,955	84,252
FF	FF10	21,712	34.28	145	130,000	3,792	97,500
XX	YY10	16,279	25.02	109	90,520	3,618	67,890
WW	WW10	21,666	37.76	144	134,444	3,560	100,833
YY	YY10	16,092	26.02	107	89,480	3,439	67,110
DD	CC10	20,729	32.51	138	107,143	3,296	80,357
GG	GG20	26,768	44.77	178	140,000	3,127	105,000
AA	AA5	17,171	28.22	114	72,941	2,585	54,706
JJ ¹	JJ130, JJ570	23,997	62.48	160	125,872	2,015	94,404
PP	PP10	20,730	35.66	138	54,000	1,514	40,500
HH	JJ1080	29,903	48.94	199	39,879	815	29,909
NN	JJ130	11,412	17.97	76	0	0	0
QQ	QQ20	12,163	20.75	81	0	0	0
ZZ ¹	ZZ400, Unmetered	16,911	24.69	113	0	0	0
BB	Unmetered	9,054	14.11	60	N/A	N/A	N/A
		495,806	832.23	3,305	3,358,998	4,106	2,519,249

Notes
1 Subarea II, LL, JJ, MM and ZZ Peak Infiltration is estimated for entire subarea.
2 Total does not include Subarea BB.
N/A - Indicates no available data.

**TABLE 3
TOWN OF DEDHAM, MASSACHUSETTS
I/I INVESTIGATION AND AND REHABILITATION PROGRAM
INFLOW SUMMARY**

Subarea	Flow Meter(s) MH(s)	Estimated Linear Footage (ft)	Inch*Miles	Estimated Peak Design Storm Inflow (gpd)	Estimated Peak Design Storm Inflow (gpdim) ¹	Percent of Total Design Storm Inflow	Estimated Average Design Storm Inflow (gpd)
HH	JJ1080	29,903	48.94	1,035,096	21,150	12.2%	5,976
JJ ¹	JJ130, JJ570	23,997	62.48	693,622	11,102	8.2%	4,005
II ¹	LL480, Unmetered	29,755	45.76	617,943	13,504	7.3%	3,568
WW	WW10	21,666	37.76	590,000	15,625	7.0%	3,406
TT	TT50	18,030	28.29	573,678	20,278	6.8%	3,312
PP	PP10	20,730	35.66	550,000	15,423	6.5%	3,175
NN ¹	JJ130	11,412	17.97	416,378	23,171	4.9%	2,404
KK	KK60, KK180	15,044	22.77	398,315	17,493	4.7%	2,300
OO	OO10	25,824	52.77	380,000	7,201	4.5%	2,194
LL ¹	LL480, Unmetered	17,000	25.14	353,051	14,043	4.2%	2,038
SS	SS15	31,471	51.80	349,740	6,752	4.1%	2,019
GG	GG20	26,768	44.77	310,000	6,924	3.7%	1,790
QQ	QQ20	12,163	20.75	270,000	13,012	3.2%	1,559
RR	RR10	19,376	29.72	260,000	8,748	3.1%	1,501
DD	CC10	20,729	32.51	240,000	7,382	2.8%	1,386
UU	UU10	17,642	29.64	240,000	8,097	2.8%	1,386
EE	EE16	14,356	23.62	217,413	9,205	2.6%	1,255
FF	FF10	21,712	34.28	210,000	6,126	2.5%	1,212
VV	VV30	13,804	24.16	180,000	7,450	2.1%	1,039
CC	CC110	10,987	16.98	140,000	8,245	1.6%	808
XX	YY10	16,279	25.02	103,647	4,143	1.2%	598
YY	YY10	16,092	26.02	102,456	3,938	1.2%	592
MM ¹	MM160, Unmetered	17,930	28.40	98,383	3,464	1.2%	568
ZZ ¹	ZZ400, Unmetered	16,911	24.69	82,614	3,346	1.0%	477
AA	AA5	17,171	28.22	73,438	2,602	0.9%	424
BB	Unmetered	9,054	14.11	N/A	N/A	N/A	N/A
		495,806	832.23	8,485,773	10,372		48,993

Notes
1 Subarea II, LL, JJ, MM, NN and ZZ Peak Inflow is estimated for entire subarea.
2 Total does not include Subarea BB.
 N/A - Indicates no available data.

**TABLE 4
TOWN OF DEDHAM, MASSACHUSETTS
I/I INVESTIGATION AND REHABILITATION ANNUAL PROGRAM
PRIORITY EVALUATION**

Subarea	Flow Meter(s) MH(s)	Estimated Linear Footage (ft)	Estimated Peak Infiltration (gpd)	Estimated Peak Design Storm Inflow (gpd)	Estimated Infiltration Identified	Estimated Infiltration Removed	Estimated T&T Cost of Infiltration Removed ²	Estimated Yearly Cost	Comments
TT	TT50	18,030	390,000	573,678	234,000	117,000	\$1,552,590	\$297,495	
VV	VV30	13,804	225,652	180,000	135,391	67,696	\$898,321	\$227,766	Sewer Rehabilitation Performed in 2011
OO	OO10	25,824	211,739	380,000	127,043	63,522	\$842,933	\$426,096	Sewer Rehabilitation Performed in 2011
	Smoke Testing	147,646						\$65,000	Subareas GG, KK, LL, OO, QQ, RR and SS
YEAR 1							\$3,293,844	\$1,016,357	
LL ¹	LL480, Unmetered	17,000	162,946	353,051	97,768	48,884	\$648,689	\$291,720	Sewer Rehabilitation Performed in 2011
II ¹	LL480, Unmetered	29,755	285,204	617,943	171,122	85,561	\$1,135,397	\$510,596	Sewer Rehabilitation Performed in 2011
CC	CC110	10,987	80,000	140,000	48,000	24,000	\$318,480	\$188,537	Sewer Rehabilitation Performed in 2011
YEAR 2							\$2,102,566	\$990,853	
SS	SS15	31,471	322,632	349,740	193,579	96,790	\$1,284,398	\$561,644	
RR	RR10	19,376	176,842	260,000	106,105	53,053	\$704,008	\$345,792	
YEAR 3							\$1,988,406	\$907,436	
EE	EE16	14,356	136,667	217,413	82,000	41,000	\$544,071	\$266,451	Sewer Rehabilitation Performed in 2011
KK	KK60, KK180	15,044	127,368	398,315	76,421	38,210	\$507,052	\$279,220	
UU	UU10	17,642	143,333	240,000	86,000	43,000	\$570,609	\$327,440	
	Building Inspections	155,493						\$184,725	Subareas HH, II, JJ, NN, PP, TT and WW
YEAR 4							\$1,621,732	\$1,057,837	
WW	WW10	21,666	134,444	590,000	80,666	40,333	\$535,222	\$418,212	
FF	FF10	21,712	130,000	210,000	78,000	39,000	\$517,530	\$419,099	Sewer Rehabilitation Performed in 2011
BB	Unmetered	9,054	N/A	N/A			N/A	\$174,766	Sewer Rehabilitation Performed in 2011
	Building Inspections	147,646						\$245,670	Subareas GG, KK, LL, OO, QQ, RR and SS
YEAR 5							\$1,052,752	\$1,257,748	
MM ¹	MM160, Unmetered	17,930	112,336	98,383	67,401	33,701	\$447,208	\$359,941	Sewer Rehabilitation Performed in 2011
XX	YY10	16,279	90,520	103,647	54,312	27,156	\$360,360	\$326,797	
	Town-Wide Flow Monitoring Program to Re-Evaluate Annual Program							\$182,498	Flow Metering Program will Re-Evaluate Priority Schedule
YEAR 6							\$807,568	\$869,236	
YY	YY10	16,092	89,480	102,456	53,688	26,844	\$356,220	\$335,965	
DD	CC10	20,729	107,143	240,000	64,286	32,143	\$426,536	\$432,775	Sewer Rehabilitation Performed in 2011
AA	AA5	17,171	72,941	73,438	43,765	21,882	\$290,378	\$358,492	Sewer Rehabilitation Performed in 2011
YEAR 7							\$1,073,135	\$1,127,232	
GG	GG20	26,768	140,000	310,000	84,000	42,000	\$557,340	\$581,210	Sewer Rehabilitation Performed in 2011
PP	PP10	20,730	54,000	550,000	32,400	16,200	\$214,974	\$450,108	
YEAR 8							\$772,314	\$1,031,318	
JJ ¹	JJ130, JJ570	23,997	125,872	693,622	75,523	37,762	\$501,098	\$541,886	Sewer Rehabilitation Performed in 2011
HH	JJ1080	29,903	39,879	1,035,096	23,927	11,964	\$158,758	\$675,251	Sewer Rehabilitation Performed in 2011
YEAR 9							\$659,856	\$1,217,137	
NN	JJ130	11,412	0	416,378	0	0	\$0	\$268,007	Sewer Rehabilitation Performed in 2011
QQ	QQ20	12,163	0	270,000	0	0	\$0	\$285,644	Sewer Rehabilitation Performed in 2011
ZZ ¹	ZZ400, Unmetered	16,911	0	82,614	0	0	\$0	\$397,149	
YEAR 10							\$0	\$950,799	
		495,806	3,358,998	8,485,773			\$13,372,171	\$10,425,952	

Notes

- 1 Subarea II, LL, JJ, MM and ZZ Peak I/I is estimated for entire subarea
- 2 Based on 60% of Peak Infiltration being Identified and 50% of Identified Infiltration being Removed.
- N/A - Indicates no available data.

APPENDIX A
T&T COST MEMORANDUM

MEMORANDUM

DATE: December 12, 2012

FROM: Nathan Michael

TO: File 2120285.A

SUBJECT: T&T costs for Dedham, Massachusetts using MWRA methodology

Fiscal year 2012 Transportation & Treatment (T&T) costs for sewerage in the Town of Dedham can be calculated using both the MWRA Operation & Maintenance (O & M) and Capital charges, and the town's O & M and Capital costs. Therefore, MWRA charges are based mainly on sewage flow exiting the Town of Dedham. MWRA's FY12 sewerage charges to the Town of Dedham are shown in Table A, and Table B shows Dedham's FY12 O & M and Capital costs.

TABLE A - MWRA CHARGES TO THE TOWN OF DEDHAM

ITEM	FLOW (gallons/year)	FLOW (gallons/day)	MWRA CHARGE	COST (\$/GPD)
Average Strength Flow*				
Annual Wastewater Volume	1,454,819,000	3,985,805	\$1,232,630	\$0.3093
Total Suspended Solids (O & M and Capital)	1,454,819,000	3,985,805	\$416,366	\$0.1045
Biochemical Oxygen Demand (O & M and Capital)	1,454,819,000	3,985,805	\$326,350	\$0.0819
Maximum Monthly Flow	N/A	7,230,000	\$781,617	\$0.1081
Population **	1,454,819,000	3,985,805	\$2,162,592	N/A
TOTAL			\$4,919,555	\$0.6038

NOTE:

*MWRA's charges only apply to average strength flow.

**MWRA's population charges are not flow based, so it is not to be included in T & T cost.

TABLE B – TOWN OF DEDHAM SEWERAGE COSTS

ITEM	FLOW (gallons/year)	FLOW (gallons/day)	DEDHAM COST	COST (\$/GPD)
Debt Service (Capital Costs)	1,454,819,000	3,985,805	\$400,000	\$0.1004
O & M	1,454,819,000	3,985,805	\$1,130,000	\$0.2835
TOTAL			\$1,530,000	\$0.3839

Therefore, the total FY12 T&T cost for both the MWRA charges and the Town of Dedham’s costs are \$0.9877 /GPD (\$0.6038 + \$0.3839).

According to the Department of Environmental Protection’s (DEP) Guidelines for Performing I/I Analyses and SSES this cost of \$0.9877/GPD needs to be extended throughout the life of a rehabilitative measure. The life cycle for a rehabilitative measure can be set by good engineering judgement as well as backup documentation, depending on the type of rehabilitation. For this study, Weston & Sampson will use a life cycle of twenty years.

To find the present worth of a rehabilitative measure over a twenty-year period, a discount rate, or annual percentage rate, is required. According to the DEP, the discount rate for FY13 is 4.125%. To calculate the T&T cost in order to account for this twenty-year period, a present worth analysis must be done. The following formula will calculate the present worth of the T&T cost for the next twenty years:

PRESENT WORTH ANALYSIS:

Discount Rate = 4.125% (DEP FY13 Information)

Present Worth Factor:

$$\frac{(1+i)^n - 1}{i (1+i)^n} \quad \text{where: } i = \text{discount rate, or interest rate}$$

$$n = \text{number of years}$$

$$\frac{(1 + 0.04125)^{20} - 1}{0.04125 (1 + 0.04125)^{20}} = 13.44$$

Present Worth T&T Cost:

$$(\text{Present Worth Factor}) \times (\text{FY12 T \& T cost})$$

$$13.44 \times \$0.9877/\text{GPD} = \$13.27/\text{GPD}$$

Therefore, the T&T cost for the Town of Dedham, utilizing a present worth of the rehabilitation for a twenty-year period, with a discount rate of 4.125%, is \$13.27/GPD.

Town of Dedham T&T costs were derived using MWRA sewerage costs.

APPENDIX B
ASSUMPTIONS AND CALCULATIONS

ASSUMPTIONS & CALCULATIONS

Costs include (assuming that the town will perform the data evaluation, cost-effectiveness analysis (CEA), GIS mapping and database updates, preliminary and final design, bid and award and construction services through its Engineering Department):

- Sewer System Evaluation Survey Work/Investigation and Reporting:
 - Television Inspection
 - Manhole Inspections
 - Smoke and Dye Testing (selected subareas)
 - Private Building Inspections (selected subareas)
 - Evaluation of Data
 - Cost-Effectiveness Analysis (CEA)
 - GIS Mapping Updates
- Rehabilitation Design
- Database Update / Data Entry
- Contract Bid and Award
- Construction
- Construction Services

Costs for the first year of the investigation and rehabilitation program were calculated based on the following assumptions. A total of 57,658 lf (does not include 147,646 lf of smoke testing investigations) of sewer is to be included.

Infiltration Investigation:	\$ 144,150
Inflow Investigation:	\$ 65,000
Construction:	\$ 807,200
Total:	\$1,016,350

In order to develop costs for each year of the program \$1,016,350 is taken as the base figure and yearly per linear foot costs were developed based on this value. A per linear foot cost was developed for both infiltration and inflow investigations. The per linear foot cost of construction was developed with the assumption that the town will primarily use manhole-to-manhole cured-in-place pipe technology.

Each year the estimated cost per linear foot is increased by 4.0% to account for inflation and increase in product costs.

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