

MWRA SEP COMPLETION REPORT FOR LOW-FLOW TOILETS

Supplemental Environmental Project
USOA File No. 2008V00633; DOJ Case No. 90-5-1-1-08990
U.S. v. Metropolitan District Commission et al., Civil Action No. 85-0489-RGS;
Conservation Law Foundation of N. E., Inc. v MDC, et al.,
Civil Action No. 83-1614-RGS

JANUARY 2010

PREPARED BY:
MASSACHUSETTS WATER RESOURCES AUTHORITY

PREPARED FOR:
U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION 1

This project was undertaken in connection with the settlement of an enforcement action, United States v. Massachusetts Water Resources Authority, taken on behalf of the U.S. Environmental Protection Agency under the Clean Water Act.

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1. Summary of MWRA SEP for Low-Flow Toilets

This supplemental environmental project (SEP) report for the installation of the low-flow toilets has been completed by the Massachusetts Water Resources Authority (MWRA) pursuant to the Stipulation and Order between the United States and the MWRA entered in the federal court action on September 8, 2008, as referenced below:

Supplemental Environmental Project
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This report includes documentation of the location where each low-flow toilet installation occurred and the expenditures for each installation, including copies of MWRA grant reimbursement checks issued to communities and community supplied purchase orders and invoices. The report also includes a description of the environmental and public health benefits resulting from implementation of the SEP.

In January 2010, MWRA completed a \$100,000 supplemental environmental project for purchase/installation of 336 low-flow (1.6 gallons-per-flush or less) toilets replacing older, higher-flow toilets within 28 participating MWRA member sewer communities. The \$100,000 in funds was distributed to the participants as grant reimbursements following the documented completion of the toilet retrofit work. The low-flow toilet replacements resulted in both a water use savings and wastewater generation reduction of an average of 2.3 gallons per flush per toilet (a total 770 gallons per flush for all 336 toilet retrofits).

For the 336 toilet replacements, total water use savings and wastewater generation reduction is estimated at 9250 gallons per day (gpd); about 3.1 million gallons per year; and more than 60 million gallons over twenty years. The corresponding water retail charge savings is \$15,000 over one year and more than \$300,000 over twenty years. Including both water and sewer retail charges, the one year estimated water/sewer use savings is \$40,000 and more than \$800,000 over twenty years.

Although MWRA's grant expenditure was capped at \$100,000 for the SEP toilet retrofit project (an average of approximately \$300 per toilet for the total 336 toilet retrofits), many communities used the grant funds to cover only the cost of new toilet fixtures and not labor costs. Based on discussions with community representatives involved with the toilet retrofits, a representative full cost per installation was about \$500 per toilet retrofit including the purchase of the new low-flow toilet and installation labor. At this unit rate, the 336 low-flow toilet retrofits would have cost about \$170,000 to install. Based only on representative water retail charges in MWRA communities, the low-flow toilet installation costs would be recouped in about 10 years. Including both water and sewer retail charges, the low-flow toilet installation costs would be recouped in about 4 years.

2. Community Outreach and Allocation of SEP Grant Funds

For the SEP low-flow toilet grant project, MWRA performed an outreach campaign to all 43 member sewer communities beginning in October 2008. An informational flyer was developed that presented the details and requirements of the program and was used as the primary marketing tool for the outreach campaign. The flyer was mailed to community public works departments, water superintendents, municipal managers/administrators, and municipal housing authorities. This initial mailing was supplemented with numerous follow-up letters and e-mails. A description of the project and link to the informational flyer was also posted on MWRA's web page at www.mwra.com.

MWRA's target total expenditure of \$100,000 in grants was initially allocated among the 43 member sewer communities based on their percent share of MWRA sewer charges. The initial community allocations are listed in Table 1 – MWRA SEP Toilet Project Summary of Grant Allocations.

Communities interested in participating in the low-flow toilet retrofit grant project were required to contact MWRA by January 30, 2009 to reserve their allocated grant funds for toilet retrofits. Communities were also given the option to designate their grant allocation to the local housing authority. Participants were required to identify specific locations of toilet retrofits by May 1, 2009. All toilet retrofit work and grant reimbursement requests were targeted to be completed by November 1, 2009. Funds initially allocated to communities that chose not to participate in the MWRA grant program were subsequently reallocated to other participants based on demonstrated need and ability to meet the project schedule. The reallocation of funds forfeited by communities that determined they could not participate in the program is documented in the various allocation columns on Table 1. Ultimately, 28 communities participated in the project. All low-flow toilet retrofit work and subsequent processing of grant reimbursement checks from MWRA to participants was completed by January 2010.

Table 1

MWRA SEP Toilet Project Summary of Grant Allocations

Community	Initial Allocation	Assigned Funds 2/2009	Assigned Funds 5/2009	Final Allocation	MWRA Check Issued	Comments
Arlington	\$1,800	\$2,100	\$2,100	\$2,100	3/23/09	
Ashland	\$500	\$800	\$0	\$0		Forfeited funds 5/6/09.
Bedford Housing Authority	\$800	\$1,100	\$1,100	\$1,100	5/7/09	Assigned funds to HA.
Belmont	\$1,100	\$1,400	\$0	\$0		Forfeited funds 5/6/09.
Boston Housing Authority	\$28,400	\$28,400	\$29,500	\$28,860	12/31/09	Assigned funds to HA.
Braintree	\$1,900	\$0	\$0	\$0		Forfeited funds 1/30/09.
Brookline	\$2,900	\$3,200	\$3,200	\$2,986	5/28/09	
Burlington	\$1,100	\$1,400	\$1,400	\$1,554	10/1/09	
Cambridge	\$5,500	\$5,800	\$5,800	\$4,987	11/19/09	
Canton Housing Authority	\$900	\$1,200	\$1,200	\$1,700	11/19/09	Assigned funds to HA.
Chelsea	\$1,400	\$1,700	\$1,700	\$2,051	10/29/09	
Dedham	\$1,300	\$1,600	\$2,600	\$2,572	11/19/09	
Everett Housing Authority	\$1,700	\$2,000	\$3,000	\$3,000	8/6/09	Assigned funds to HA.
Framingham	\$2,500	\$0	\$0	\$0		Forfeited funds 1/30/09.
Hingham S.D.	\$400	\$0	\$0	\$0		Forfeited funds 1/30/09.
Holbrook	\$300	\$0	\$0	\$0		Forfeited funds 1/30/09.
Lexington	\$1,600	\$0	\$0	\$0		Forfeited funds 1/30/09.
Malden	\$2,700	\$0	\$0	\$0		Forfeited funds 1/30/09.
Medford	\$2,700	\$3,000	\$3,000	\$3,058	10/1/09	
Melrose	\$1,300	\$1,600	\$1,600	\$0		Forfeited funds 10/9/09.
Milton Housing Authority	\$1,200	\$1,500	\$1,500	\$1,490	5/7/09	Assigned funds to HA.
Natick	\$1,100	\$1,400	\$0	\$0		Forfeited funds 5/5/09.
Needham	\$1,400	\$1,700	\$2,700	\$2,700	8/27/09	
Newton Housing Authority	\$4,500	\$4,800	\$5,800	\$4,911	11/19/09	Assigned funds to HA.
Norwood	\$1,500	\$1,800	\$1,800	\$1,821	11/19/09	
Quincy Housing Authority	\$4,400	\$4,700	\$5,700	\$6,591	12/31/09	Assigned funds to HA.
Randolph Housing Authority	\$1,300	\$1,600	\$2,600	\$3,407	11/19/09	Assigned funds to HA.
Reading Housing Authority	\$1,000	\$1,300	\$2,300	\$2,311	11/5/09	Assigned funds to HA.
Revere	\$2,100	\$2,400	\$2,400	\$0		Forfeited funds 11/3/09.
Somerville Housing Authority	\$3,300	\$3,600	\$0	\$0		Forfeited funds 4/24/09.
Stoneham	\$1,000	\$1,300	\$1,300	\$1,446	11/19/09	
Stoughton Housing Authority	\$1,000	\$1,300	\$2,300	\$7,260	11/19/09	Assigned funds to HA.
Wakefield	\$1,300	\$0	\$0	\$0		Forfeited funds 1/30/09.
Walpole	\$800	\$1,100	\$1,100	\$1,155	6/4/09	
Waltham	\$3,000	\$3,300	\$3,300	\$3,300	11/5/09	
Watertown	\$1,300	\$1,600	\$1,600	\$1,800	11/19/09	
Wellesley	\$1,300	\$1,600	\$2,600	\$1,615	6/18/09	
Westwood	\$500	\$800	\$800	\$800	2/26/09	
Weymouth	\$2,400	\$2,700	\$0	\$0		Forfeited funds 4/27/09.
Wilmington Housing Authority	\$500	\$800	\$800	\$0		Forfeited funds 10/29/09.
Winchester	\$900	\$1,200	\$1,200	\$1,215	5/7/09	
Winthrop Housing Authority	\$700	\$1,000	\$1,000	\$1,210	11/19/09	Assigned funds to HA.
Woburn	\$2,700	\$3,000	\$3,000	\$3,000	6/11/09	

\$100,000	\$99,800	\$100,000	\$100,000
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3. Documentation of Fixture and Installation Costs and Location of Work

Low-flow toilet retrofits were installed by communities or housing authorities at pre-approved locations using their own staff or a plumbing contractor. At the conclusion of the project, 336 low-flow toilet retrofits were completed through the distribution of \$100,000 in reimbursement grants to 28 participants as listed in Table 2. Table 2 also details the calculated water use savings for each community. Program participants applied to MWRA for grant rebates by submitting a Low-Flow Toilet Retrofit Rebate Project Reimbursement Request Form along with a copy of the purchase order and/or installation receipt, and before/after photos to document the retrofit installation. Sample before/after photos are displayed in Figures 1 and 2, below.

Table 2

MWRA SEP Toilet Grant Project Summary Table

Community	Actual Reimbursement	MWRA Check Issued	Number of Toilets Replaced	Old Flow Rate (GPF)	New Flow Rate (GPF)	Water Savings Per Flush	Total Water Savings (GPF)
Arlington	\$2,100	3/23/09	5	3.4	1.6	1.8	9.0
Bedford Housing Authority	\$1,100	5/7/09	2	5.0	1.6	3.4	6.8
Boston Housing Authority	\$28,860	12/31/09	54	3.5	1.28	2.22	119.9
Brookline	\$2,986	5/28/09	6	6.0	1.6	4.4	26.4
Burlington	\$1,554	10/1/09	3	5.0	1.6	3.4	10.2
Cambridge	\$4,987	11/19/09	18	3.5	1.5	2	36.0
Cambridge			3	4.5	1.5	3	9.0
Canton Housing Authority	\$1,700	11/19/09	8	3.0	1.5	1.5	12.0
Chelsea	\$2,051	10/29/09	1	5.0	1.6	3.4	3.4
Chelsea			5	3.5	1.6	1.9	9.5
Dedham	\$2,572	11/19/09	25	3.6	1.6	2	50.0
Everett Housing Authority	\$3,000	8/6/09	20	6.0	1.6	4.4	88.0
Medford	\$3,058	10/1/09	6	3.5	1.6	1.9	11.4
Milton Housing Authority	\$1,490	5/7/09	5	3.4	1.6	1.8	9.0
Needham	\$2,700	8/27/09	13	3.5	1.6	1.9	24.7
Newton Housing Authority	\$4,911	11/19/09	11	3.5	1.6	1.9	20.9
Norwood	\$1,821	11/19/09	2	3.5	1.6	1.9	3.8
Norwood			2	4.0	1.6	2.4	4.8
Quincy Housing Authority	\$6,591	12/31/09	33	3.5	1.6	1.9	62.7
Randolph Housing Authority	\$3,407	11/19/09	21	3.0	1.6	1.4	29.4
Reading Housing Authority	\$2,311	11/5/09	32	3.5	1.2	2.3	73.6
Stoneham	\$1,446	11/19/09	3	3.0	1.5	1.5	4.5
Stoughton Housing Authority	\$7,260	11/19/09	30	3.5	1.2	2.3	69.0
Walpole	\$1,155	6/4/09	2	5.0	1.6	3.4	6.8
Waltham	\$3,300	11/5/09	4	3.5	1.6	1.9	7.6
Waltham			1	5.0	1.6	3.4	3.4
Watertown	\$1,800	11/19/09	4	3.5	1.6	1.9	7.6
Wellesley	\$1,615	6/18/09	2	3.5	1.6	1.9	3.8
Westwood	\$800	2/26/09	1	3.5	1.6	1.9	1.9
Winchester	\$1,215	5/7/09	4	6.0	1.6	4.4	17.6
Winthrop Housing Authority	\$1,210	11/19/09	5	6.0	1.6	4.4	22.0
Woburn	\$3,000	6/11/09	5	3.0	1.6	1.4	7.0

\$100,000

336

771.7

Figure 1 - Sample High-Flow Toilet Before Retrofit



Figure 2 - Sample Low-Flow Toilet After Retrofit



4. Estimate of Water Use and Wastewater Generation Reduction and Cost Savings from Low-Flow Toilet Retrofits

Water use and wastewater generation reduction from low-flow toilet retrofits included toilets in residential applications (221 toilet retrofits in municipal housing authority units), as well as, municipal buildings (72 toilet retrofits in city/town halls, fire stations, DPW garages, senior centers, etc. and 43 toilet retrofits in local schools). A summary of the residential and non-residential applications is provided in Table 3.

The installation of a low-flow toilet (1.6 gpf or less) can significantly improve water efficiency. Pre-1980, toilet water use typically ranged from 5 to 5.5 gpf and even up to 7 gpf for pre-1950 toilets. During the 1980s, water use for toilets decreased to a range of 3.5 to 4.5 gpf. In 1989, Massachusetts became the first state to require all new or retrofitted toilets use 1.6 gpf or less. Subsequently, the federal maximum water use requirements lowered the allowable flow rate for toilets nation-wide to 1.6 gpf in 1994 (residential toilets) and 1997 (most commercial toilets).

Toilets are estimated to be the largest household water user for non-conserving homes. Average residential use for toilets is about 19 gpcd¹ or about 27 percent of a typical 70 gpcd non-conserving household. The frequency of toilet flushing in residential sites averages about five flushes per person per day¹. For non-residential sites (office buildings, schools, etc.), toilet fixture use generally ranges from 1 to 3 uses per person per day¹; higher for females than males when urinals are an available option. Estimated water savings from low-flow toilets installed in non-residential sites is reported to range from about 20 to 50 gallons per day¹ depending on the type of facility and flow rate of the old toilets being replaced. Based on this information, MWRA has estimated (conservatively) an average frequency of toilet flushing in non-residential sites (municipal buildings and schools) of ten flushes per day.

To estimate water use and wastewater generation reduction from the 336 low-flow toilets installed under the MWRA SEP grant project, the following assumptions were made:

- Of the total 336 toilets retrofitted, 221 toilets were located in public housing units that were assumed to have usage similar to an average household (2.6 residents per unit and five flushes per person per day)¹ for a total of 13 flushes per day per toilet;
- For the total 221 residential toilets retrofitted, the total water savings per flush was based on the old versus new gallons-per-flush rate reduction reported by the community for each toilet retrofit.
- For the total 221 residential toilets retrofitted, the total water savings was approximately 513 gallons per flush as shown on Table 3 and the water savings were anticipated to be achieved 365 days per year.
- Of the total 336 toilets retrofitted, 115 toilets were non-residential sites located in public buildings (72 toilets) or schools (43 toilets) that were assumed to have usage of ten flushes per fixture per day.
- For the total 115 non-residential toilets retrofitted, the total water savings was approximately 258 gallons per flush as shown on Table 3 and the water savings were anticipated to be achieved 260 workdays per year.

¹ Vickers, Amy; *Handbook of Water Use and Conservation*, WaterPlow Press, Amherst, MA 2001

Table 3

MWRA SEP Toilet Grant Project Summary Table

Community	Actual Reimbursement	MWRA Check Issued	Number of Toilets Replaced	Old Flow Rate (GPF)	New Flow Rate (GPF)	Water Savings Per Flush	Total Water Savings (GPF)
Bedford Housing Authority	\$1,100	5/7/09	2	5.0	1.6	3.4	6.8
Boston Housing Authority	\$28,860	12/31/09	54	3.5	1.28	2.22	119.9
Canton Housing Authority	\$1,700	11/19/09	8	3.0	1.5	1.5	12.0
Everett Housing Authority	\$3,000	8/6/09	20	6.0	1.6	4.4	88.0
Milton Housing Authority	\$1,490	5/7/09	5	3.4	1.6	1.8	9.0
Newton Housing Authority	\$4,911	11/19/09	11	3.5	1.6	1.9	20.9
Quincy Housing Authority	\$6,591	12/31/09	33	3.5	1.6	1.9	62.7
Randolph Housing Authority	\$3,407	11/19/09	21	3.0	1.6	1.4	29.4
Reading Housing Authority	\$2,311	11/5/09	32	3.5	1.2	2.3	73.6
Stoughton Housing Authority	\$7,260	11/19/09	30	3.5	1.2	2.3	69.0
Winthrop Housing Authority	\$1,210	11/19/09	5	6.0	1.6	4.4	22.0
Subtotal Housing Units	\$61,840		221				513.3
Arlington	\$2,100	3/23/09	5	3.4	1.6	1.8	9.0
Brookline	\$2,986	5/28/09	6	6.0	1.6	4.4	26.4
Burlington	\$1,554	10/1/09	3	5.0	1.6	3.4	10.2
Cambridge	\$4,987	11/19/09	18	3.5	1.5	2	36.0
Cambridge			3	4.5	1.5	3	9.0
Chelsea	\$2,051	10/29/09	1	5.0	1.6	3.4	3.4
Chelsea			5	3.5	1.6	1.9	9.5
Dedham	\$2,572	11/19/09	25	3.6	1.6	2	50.0
Medford	\$3,058	10/1/09	6	3.5	1.6	1.9	11.4
Needham	\$2,700	8/27/09	13	3.5	1.6	1.9	24.7
Norwood	\$1,821	11/19/09	2	3.5	1.6	1.9	3.8
Norwood			2	4.0	1.6	2.4	4.8
Stoneham	\$1,446	11/19/09	3	3.0	1.5	1.5	4.5
Walpole	\$1,155	6/4/09	2	5.0	1.6	3.4	6.8
Waltham	\$3,300	11/5/09	4	3.5	1.6	1.9	7.6
Waltham			1	5.0	1.6	3.4	3.4
Watertown	\$1,800	11/19/09	4	3.5	1.6	1.9	7.6
Wellesley	\$1,615	6/18/09	2	3.5	1.6	1.9	3.8
Westwood	\$800	2/26/09	1	3.5	1.6	1.9	1.9
Winchester	\$1,215	5/7/09	4	6.0	1.6	4.4	17.6
Woburn	\$3,000	6/11/09	5	3.0	1.6	1.4	7.0
Subtotal Town Buildings/Schools	\$38,160		115				258.4

\$100,000

336

771.7

- For the total 336 toilets retrofitted (both residential and non-residential applications), the wastewater generation reduction was assumed to be equal to the water use savings.
- In the MWRA service area, the average retail customer water charge for 2008 was \$447.82² based on an annual water consumption of 12,000 cubic feet (approximately 90,000 gallons). The average retail customer water rate calculates to \$3.73 per 100 cubic feet or \$4,987 per million gallons; and,
- In the MWRA service area, the average retail customer sewer charge for 2008 was \$737.28² based on an annual water consumption of 12,000 cubic feet (approximately 90,000 gallons). The average retail customer sewer rate calculates to \$6.14 per 100 cubic feet or \$8,214 per million gallons.

Based on these figures, the total 221 low-flow toilets installed in public housing units are estimated to produce a water use savings of 6,670 gpd and 2.43 million gallons per year. The total 110 low-flow toilets installed in public buildings and schools are estimated to produce a water use savings of 2,580 gpd and 0.67 million gallons per year. In total, the 336 low-flow toilets installed under the \$100,000 SEP grant project are estimated to produce a water use savings of 9,250 gpd and 3.1 million gallons per year. Over the next twenty years, the estimated water use savings is more than 60 million gallons. The corresponding water retail charge savings is \$15,000 for one year and more than \$300,000 over twenty years. The 336 low-flow toilet retrofits are estimated to produce an equivalent wastewater generation reduction as was calculated for water use savings: 3.1 million gallons per year and more than 60 million gallons over twenty years. Including both water and sewer charges, the one year estimated water/sewer use savings is \$40,000 and the twenty year savings is \$800,000. Water use and cost savings are summarized in Table 4, below.

Table 4

Water Use Reduction and Cost Savings from Low-Flow Toilet Retrofits					
	Estimated Number Installed	Water Savings (gpd)	Water Savings (MG/year)	Annual Water Only Cost Savings	Annual Water and Sewer Cost Savings
Low-Flow Toilets at Public Housing	221	6,670	2.43	\$12,000	\$32,000
Low-Flow Toilets at Public Buildings	115	2,580	0.67	\$3,000	\$8,000
TOTAL	336	9,250	3.1	\$15,000	\$40,000

² MWRA Advisory Board; Joseph E. Favaloro, Executive Director; *Annual Water and Sewer Retail Rate Survey*; December 2008