Potential Reductions of Street Solids and Phosphorus in Urban Watersheds from Street Cleaning, Cambridge, Massachusetts, 2009-2011

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Prepared in cooperation with
Massachusetts Dept. of Environmental Protection, U.S. Environmental Protection Agency, and the City of Cambridge

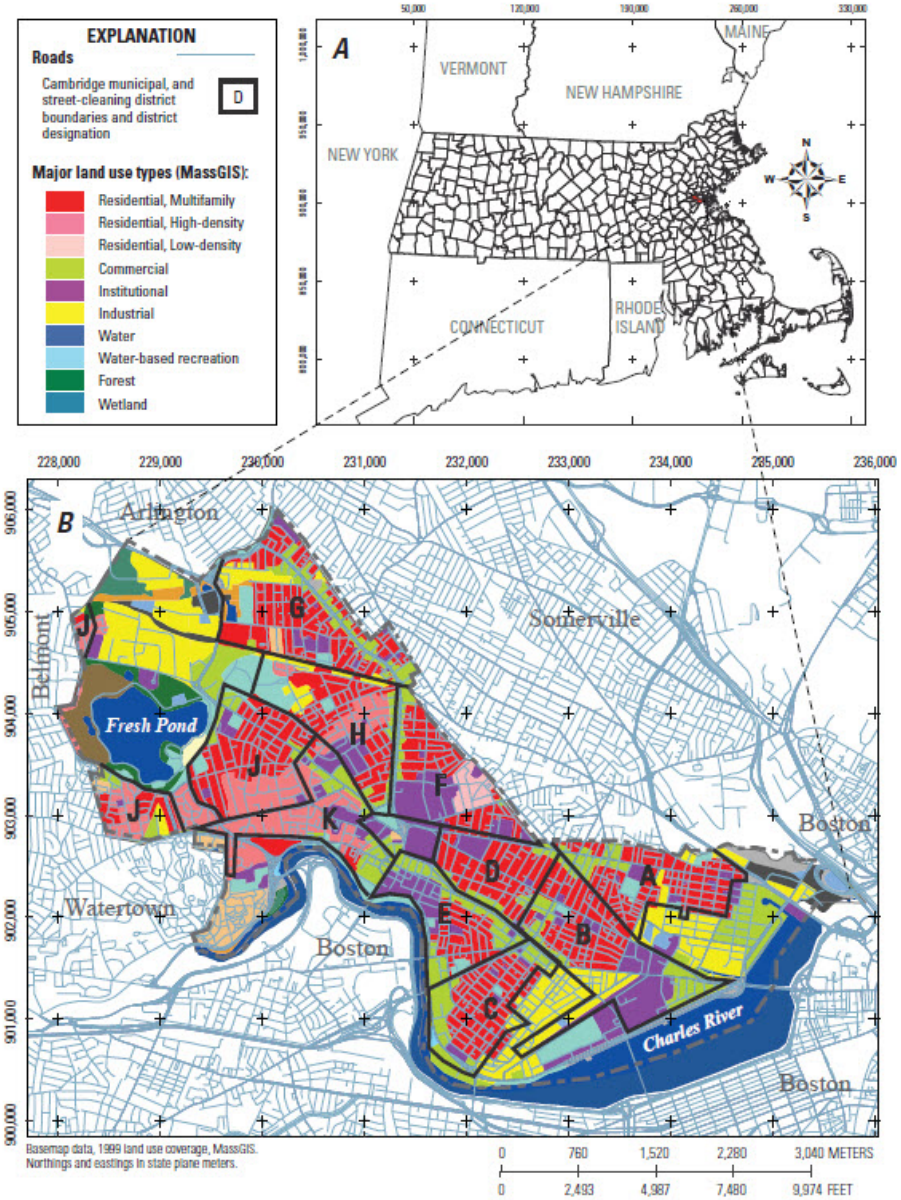
AMERICAN RECOVERY AND REINVESTMENT ACT OF 2009

Problem

- Lower Charles River Basin TMDL estimates the City of Cambridge must reduce total phosphorus loading by 65.2%

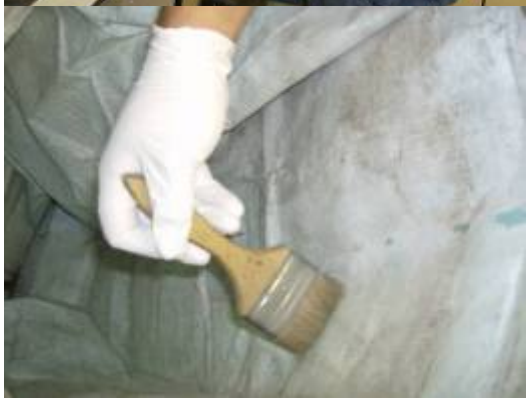
- Structural BMP mitigation techniques in urban areas is often limited by the lack of usable space

- Monitoring load reductions in urban runoff as a result of street cleaning is very difficult, and regulators need to develop load-reduction credits for street cleaning and other BMPs



Objectives

1. Determine accumulation rates and wash-off of street solids due to precipitation
2. Concentrations of 32 trace elements in street solids
3. Develop a productivity function for a high-efficiency (HE) street cleaner in areas representing two well-defined land-use categories
4. Develop, calibrate and verify a Source Loading and Management Model (SLAMM) to simulate the effectiveness of a HE street cleaning program at reducing phosphorus loading to the Lower Charles River



Results

1. Street solid yields are similar to other parts of the U.S.
2. Yields increase after spring cleanup to largest yields at the end-of winter (EOW)
3. About 86% of total street solid yield was greater than very fine sand (≥0.125 mm)

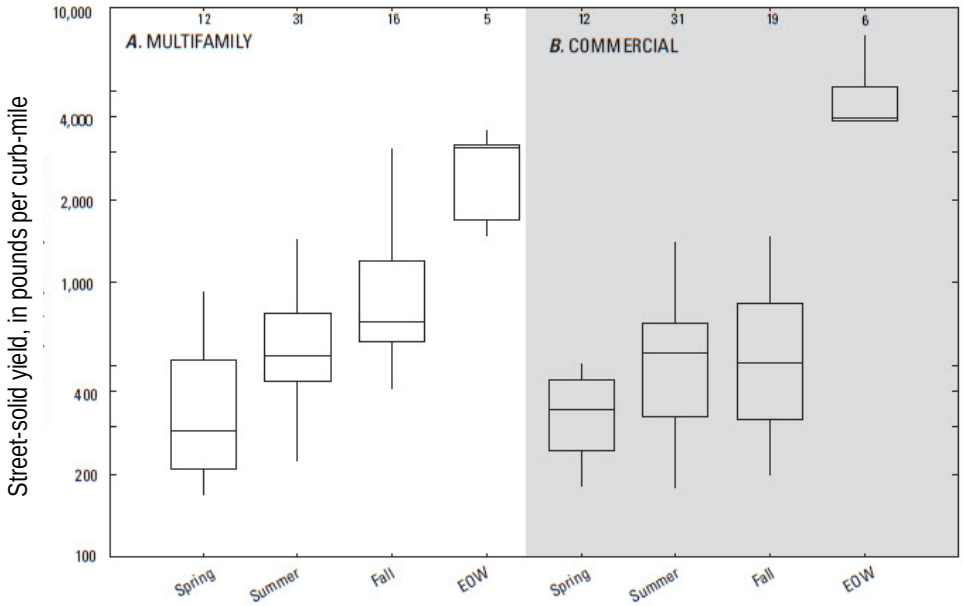


Table 7. Comparison of Cambridge, Massachusetts, street-solid yields by land-use type to those in other areas of the United States (Modified from Selbig and Bannerman, 2007).

[--, no data; all values in pounds per curb-mile]

Statistic	Cambridge, Massachusetts	Madison, Wisconsin[1]	Champaign, Illinois[2]	Bellevue, Washington[3]	Seattle, Washington[4]	San Jose, California[5]	Baltimore, Maryland[6]	U.S. Nationwide[7]
				Multifamily				
Mean	740	614	408	815	970	310	645	391
Median	602	569	--	705	1,060	--	--	--
				Commercial				
Mean	522	--	--	--	--	509	--	302
Median	467	--	--	--	--	--	--	--

[1]Selbig and Bannerman, 2007.

[2]Bender and Terstriep, 1984.

[3]Pitt, 1985.

[4]Seattle Public Utilities and Herrera Environmental, 2009.

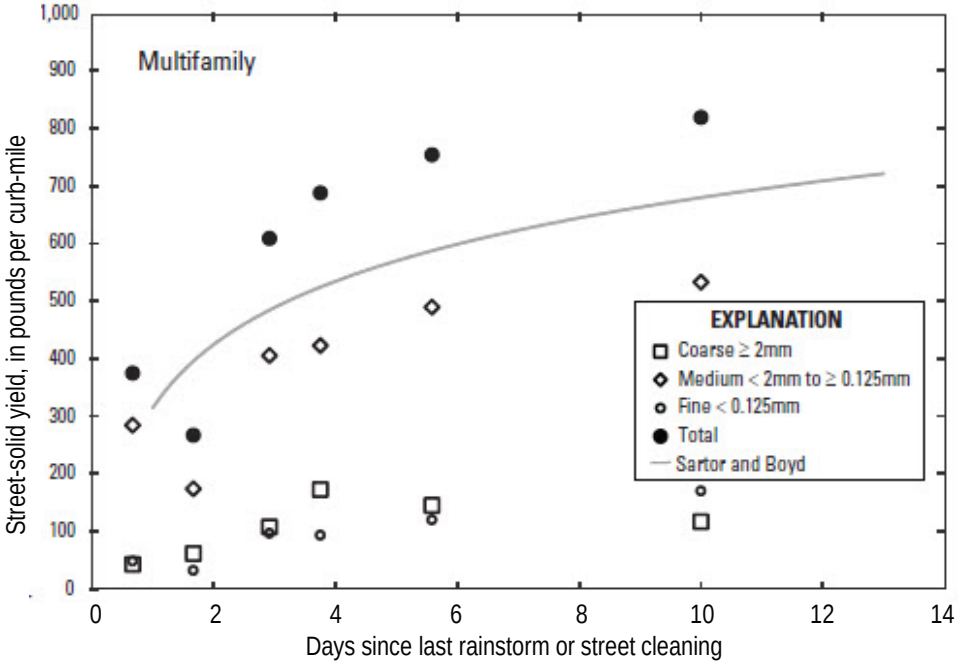
[5]Pitt, 1979.

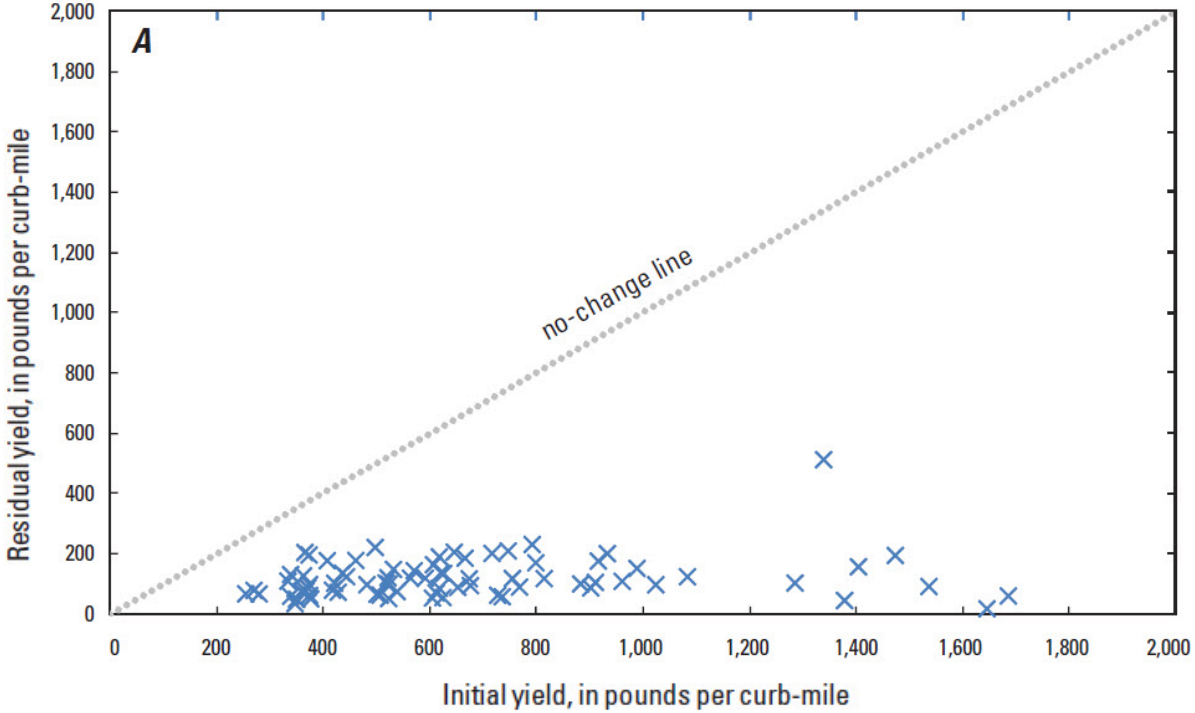
[6]Law and others, 2008.

[7]Sartor and Boyd, 1972.

Results

4. Street solid washoff was about 38% and accumulation to pre-rainstorm yields occurs in about 1 to 3 days
5. Median total mass of organic C and total P on Multifamily streets were 68% and 75% greater than Commercial streets, respectively
6. Regenerative air total street solid removal efficiency was about 81% total P about 72% on average





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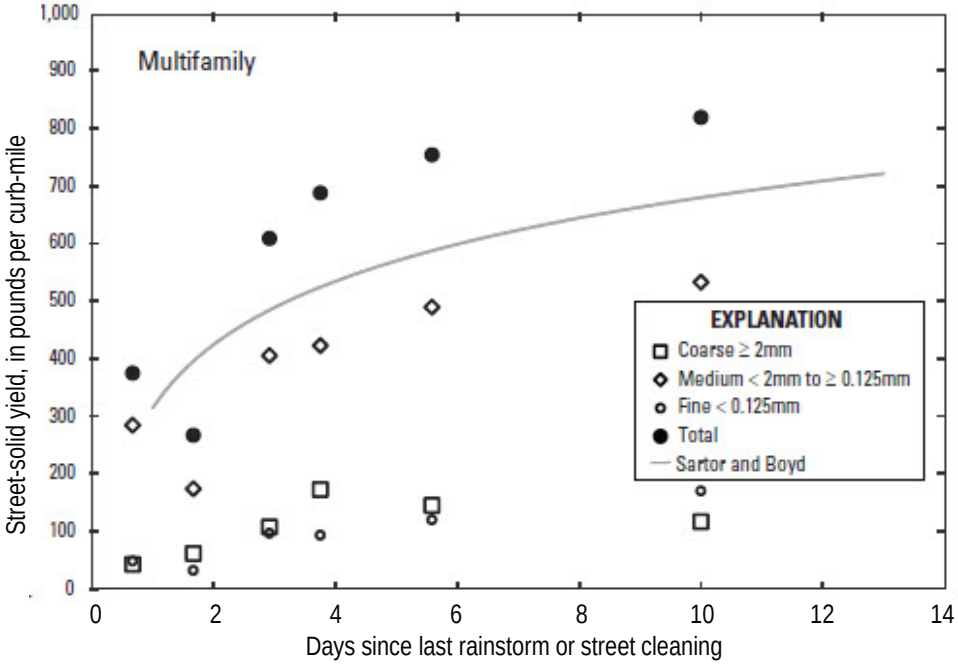

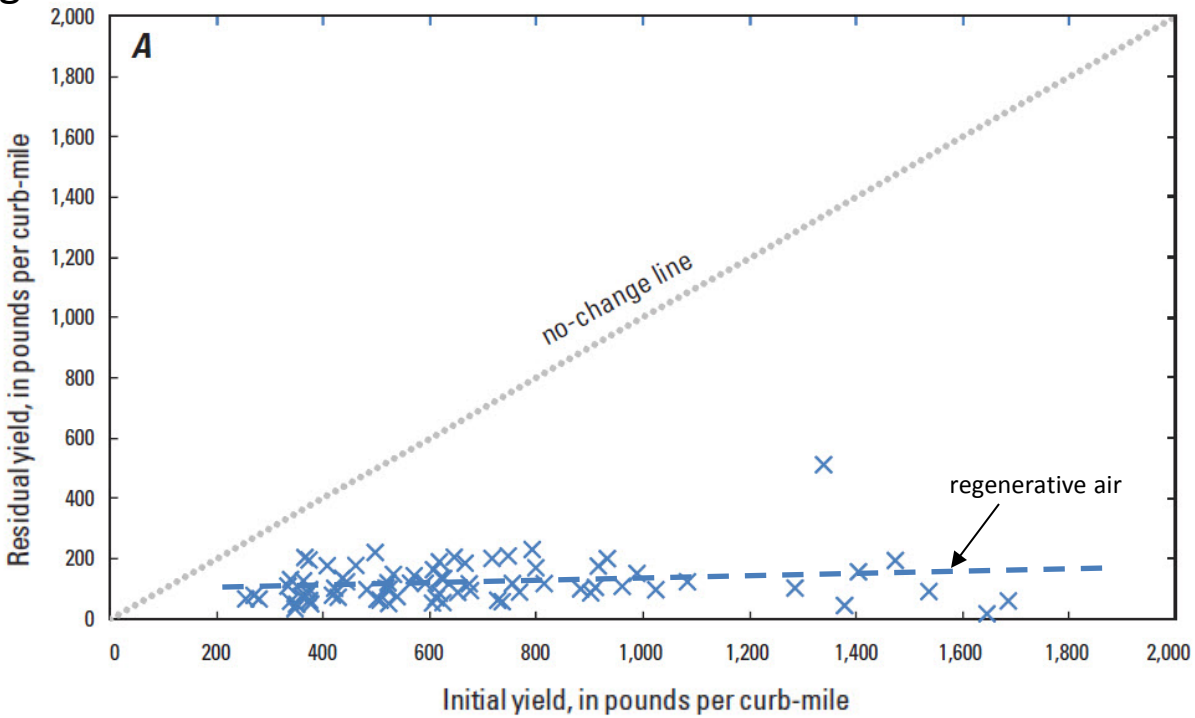

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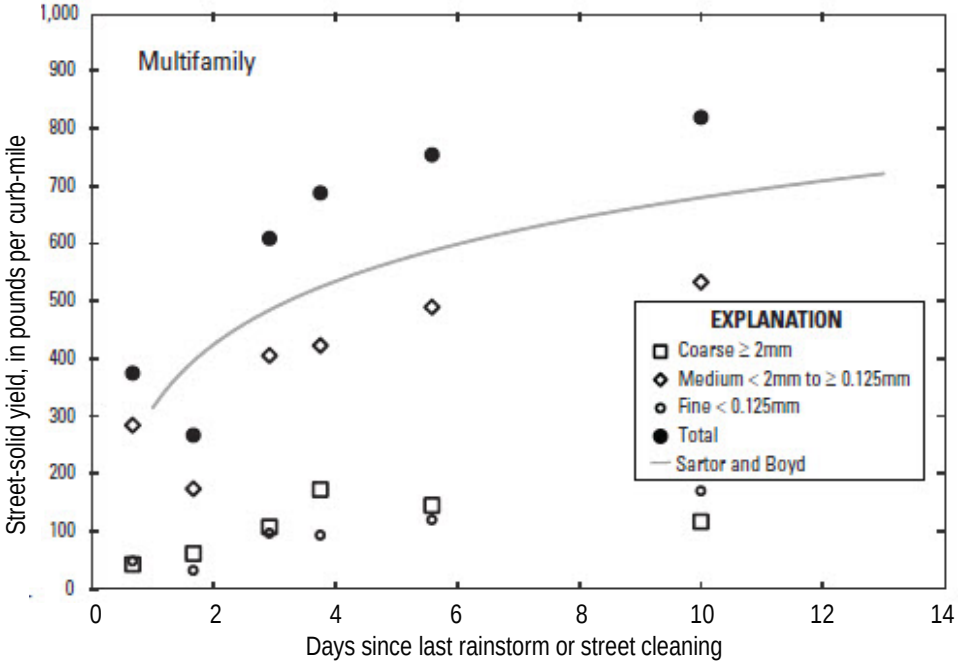
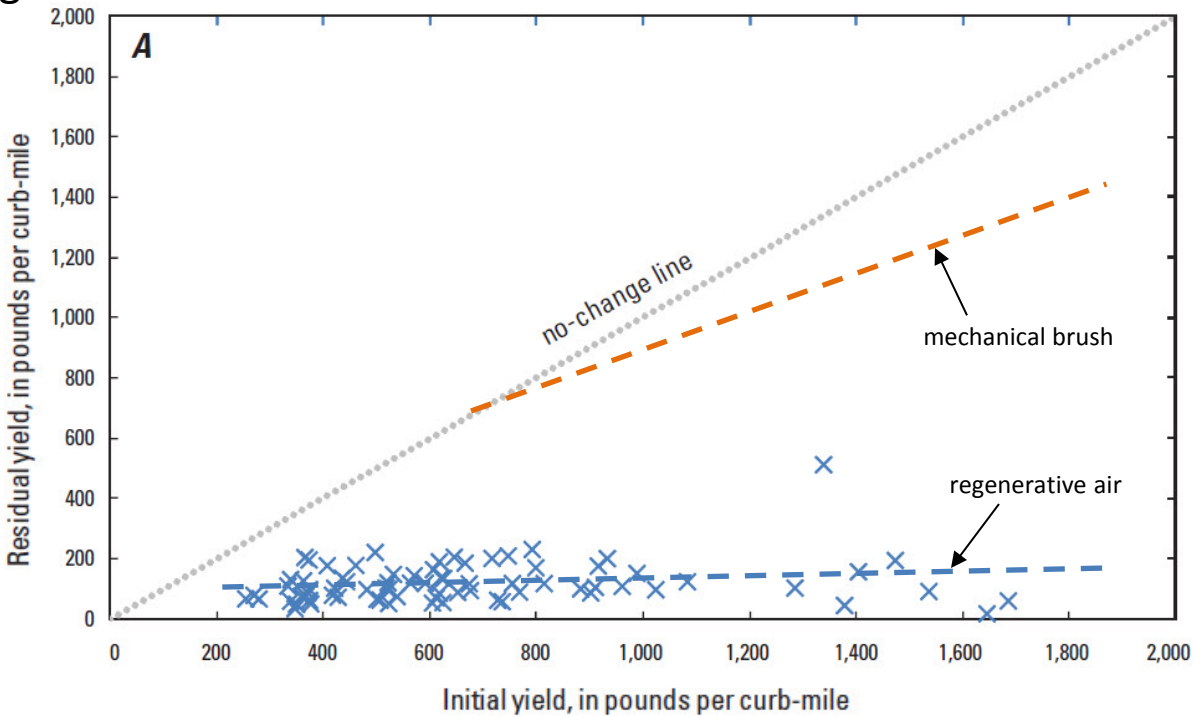
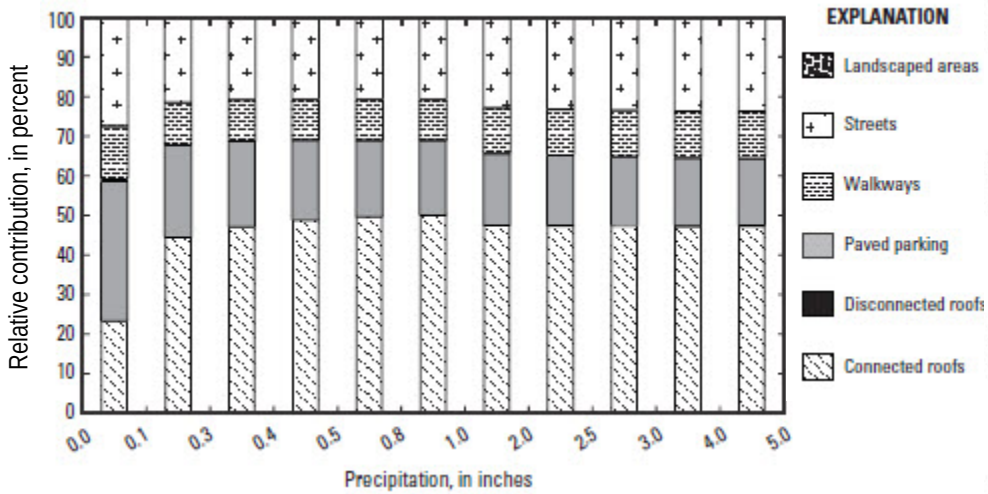




Conclusions

- WinSLAMM ver 9.4.0 (Pitt and Voorhees, 2002) was applied to a 21.8 acre subcatchment consisting of mostly Commercial land-use type
- Curb-and-gutter drainage on streets with intermediate surface texture, heavy on-street parking and parking controls



- Rainwater runoff from rooftops represent 20-50% of the total sub-catchment runoff, streets only about 20% of the total

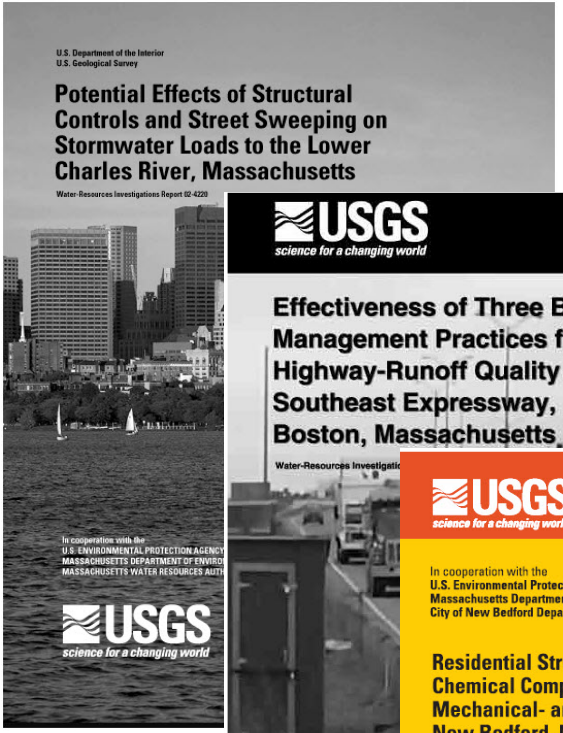
Conclusions

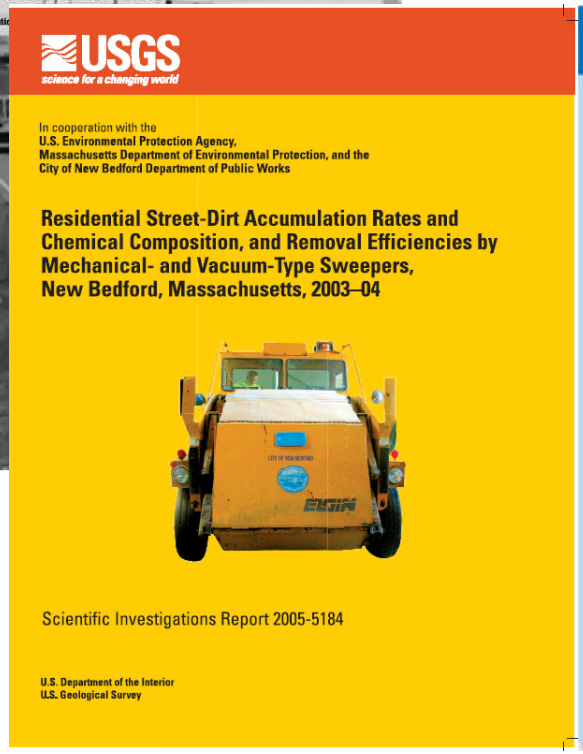
- Evaluating three different street-cleaning technologies, simulated runoff showed 3% to 16% and 6% to 19% reductions in total solids based on monthly and three-times per week street cleaning
- Simulated runoff showed 1% to 8% and 3% to 9% reductions in total P based on monthly and three-times per week street cleaning

Constituent	Mechanical brush percent reduction (model supplied)	Vacuum-assisted percent reduction (model supplied)	Regenerative-air percent reduction (Cambridge tested)
Monthly street cleaning			
Total solids	2.7	5.2	16
Total phosphorus	1.4	2.7	8.0
Bimonthly street cleaning			
Total solids	3.3	7.0	18
Total phosphorus	1.7	3.7	8.3
Weekly street cleaning			
Total solids	4.2	9.6	18
Total phosphorus	2.1	5.0	8.7
Street cleaning three times per week			
Total solids	6.0	14	19
Total phosphorus	3.0	7.4	9.3

- Future simulations of an entire municipality or large urban area with a focus on street cleaning within specific land-use types, before storms or during seasons with large street-solid yields combined with other SCMs
- Conduct cost benefit analyses

Questions





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