

# PAVEMENT CLEANING

## WHY CLEAN?

Pavement cleaning will reduce urban stormwater pollution and help a community satisfy its NPDES stormwater management requirements.

**Most cost-effective:** Pavement cleaning is the most cost-effective BMP based on “*dollars per pound of pollutant removed from the stormwater.*” A study of structural BMPs by Caltrans indicates the cost per pound of pollutant removed (as TSS) of \$10 to \$60, not including land costs. In contrast, our studies indicate new mechanical brush sweepers reduce TSS in stormwater at a cost of \$5 to \$10 per pound, and regenerative air and vacuum-assisted sweepers, at a cost of \$2 to \$5 per pound.

**Most effective:** In the built environment, street cleaning has the broadest potential impact on urban stormwater pollution reduction because two thirds of all of the rain that falls on potentially impervious surfaces in the urban landscape is falling on pavement. In the past 5 years, many new street cleaners have entered the market that are much more efficient at picking up accumulated contaminants when compared to the broom/mechanical sweepers owned by most communities today.

**Most immediate impact:** It will take decades to retrofit communities with structural stormwater treatment systems. Street cleaning is immediately employed, and therefore has an immediate impact on urban stormwater pollution reduction.

**Most flexible:** Once a structural BMP is constructed, it cannot be moved. In contrast, a sweeping program can be altered to reflect shifts in sweeping technology, budgets, and changes in traffic patterns and land use, and therefore pollutant loadings.

**Most secondary benefits:** Sweeping reflects the community’s pride in its aesthetics, resulting in positive attitudes and ownership by residents. Most significantly, high efficiency cleaning also benefits air quality and in turn adverse public health effects associated with air pollution.

## WHY ANALYZE?

The question is not whether to clean or sweep, as most communities already sweep in some manner. Rather, it is how to most effectively use the existing sweeping budget, and expand it over time. Street cleaning is not just for aesthetics since it has the potential for becoming your community’s most important asset in meeting NPDES requirements. Relevant questions are: How effective is the community’s current equipment fleet? How should the fleet be upgraded over time and with which equipment? Which streets should be swept, and what is the most cost-effective frequency of sweeping by street category? What are the stormwater pollutant loadings without sweeping? What are the stormwater pollutant load reductions associated with the existing and alternative future street cleaning programs? To answer these questions effectively, a study is needed.



*We Think the World of Water*

**PACIFIC**

**WATER RESOURCES, INC.**

4905 SW Griffith Drive, Suite 200, Beaverton, Oregon 97005

503.671.9709  
fax: 503.671.0711  
info@pacificwr.com  
www.pacificwr.com

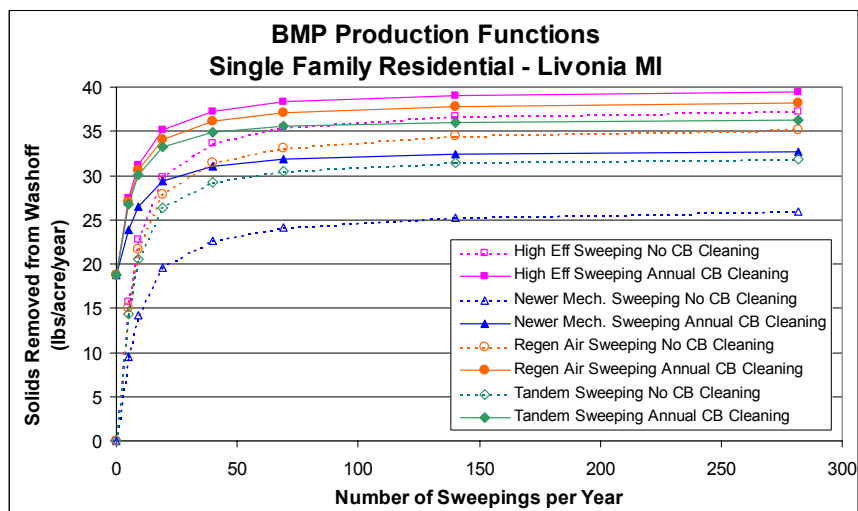
## WHY PACIFIC WATER RESOURCES (PWR)?

PWR is the only firm with the tools and experience needed to answer a community's important questions about street cleaning. PWR has developed a unique stormwater quality model called **SIMPTM** that has been used for years to answer street cleaning related questions. PWR has conducted street cleaning related studies in the following communities:

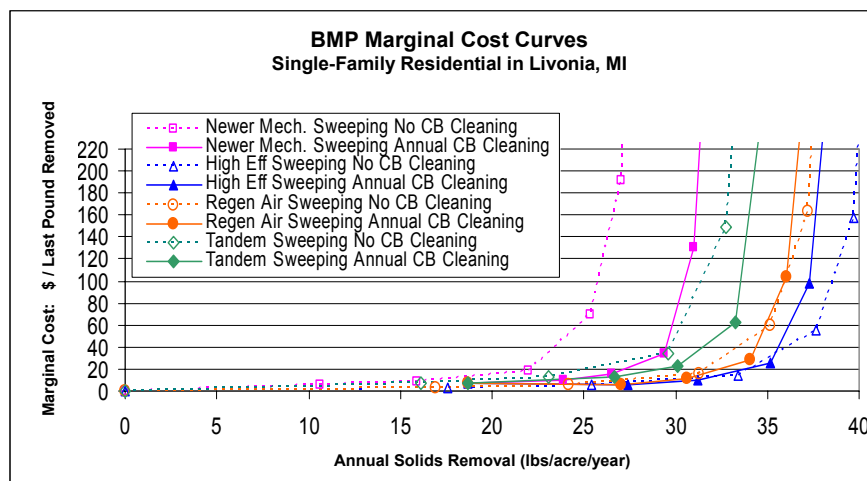
Bellevue, Washington  
 Gresham, Oregon  
 Jackson, Michigan  
 Livonia, Michigan  
 Portland, Oregon

Port of Seattle, Washington  
 Reno, Nevada  
 Washington County, Oregon  
 West Linn, Oregon  
 Tel Aviv, Israel

Below is an example of the sweeping related information that can be obtained through a cleaning study. Production functions show the relationship between effort (i.e. number of sweepings per year) and pollutant removal (i.e. solids removed from stormwater washoff).



Marginal cost, shown below, is essentially the cost of removing the last incremental pound of pollutant (in this case, solids or TSS).



Optimal cleaning, in this example, involves operations that remove pollutants at a cost of approximately \$10 to \$20 for the last pound removed well before the marginal cost starts to rapidly increase.

# PAVEMENT CLEANING

## A SIMPLIFIED PROCEDURE FOR A FIRST-ORDER ESTIMATE OF POLLUTANT WASHOFF REDUCTION

The following presents four steps for a first-order estimate. Explanatory footnotes are provided for each step. Following the development of the first-order estimate is guidance on how you can refine the estimate, through the gathering of additional information.

STEP 1	Identify the total amount of material that is currently removed annually by the sweeping of your streets. <sup>a</sup>	_____ Cubic Yards
STEP 2	Calculate the amount of sediment <sup>b</sup> in weight by assuming one ton per cubic yard (or use actual weight if known)	_____ Tons
STEP 3	Calculate the amount of sediment that would have reached the storm drain system, if it had not been removed by sweeping. Assume that 10 to 25% would have reached the storm drains, giving you a range of sediment. Multiply the result for STEP 2 by 0.10 to 0.25. <sup>c</sup>	_____ Tons TO _____ Tons
STEP 4	Calculate the total amount of toxic pollutants kept from the storm drains. Multiply STEP 3 times 40 to 160 pounds/ton. <sup>d</sup>	_____ Pounds TO _____ Pounds

- a. We presume that the street department keeps records given the need for disposal. If not, begin to accumulate this information. What they remove has both street dirt (sediment) or gross solids, which includes litter. If possible, distinguish dirt from gross pollutants by a simple sieve test of sweepings that have been stored at the shop yard.
- b. Sediment is considered less than 1/8 inch or 2000 microns. Material greater than 1/8 inch is considered gross solids and should be determined as well.
- c. Larger material (greater than 1/8 inch) on the pavement is not generally washed from the pavement due to its size and CA's relatively mild storms. Only a small fraction of the accumulated sediment is thought to be washed from the street. Regardless, larger materials tend to have much lower concentrations of pollutants than finer materials.
- d. "Toxic pollutants" include petroleum hydrocarbons (TPH), metals and pesticides. Of these, TPH dominates. A recent review of National data of stormwater quality found a median TPH concentration of 4 mg/L. All metals in the aggregate are typically less than 1 mg/L. Pesticides and all other toxic organics are much less than 1 mg/L. The ratios given you are derived from literature values of street dirt chemistry gathered by Pacific Water Resources.

## **HERE ARE SOME FURTHER REFINEMENTS YOU CAN MAKE AS RELATED TO QUANTITIES**

The following will improve your estimate from STEP 4

1. Analyze your sediment (i.e. less than 2000 microns) for the amount (mg/Kg) of key pollutants such as TPH, metals (zinc, copper, lead, cadmium), phosphorus and nitrogen. Redo STEP 4 for each pollutant separately.
2. What are the total curb miles of streets swept each year (curb miles swept times annual frequency of sweeping). Calculate the unit amount of material and pollutants removed per curb mile swept.
3. Quantify the amount of sediment collected from the different basic types of streets that are swept – arterial, commercial, residential, industrial. Redo STEPs 1 through 4, but for each street type.

## **PROGRAMMATIC EVALUATION**

The following will provide insights into the effectiveness of your current sweeping program, and how it might be improved.

1. What is the total annual budget spent for sweeping? Calculate the cost of sweeping per curb mile swept, using information from #2 above
2. What is the population of your community? What is the cost of sweeping per capita. How does this compare to other nearby communities. If significantly different, discuss with other communities to try to determine why.
3. Do you have mechanical sweepers? Talk to the street department about purchasing more efficient vacuum or regenerative air sweepers as each of the currently owned sweepers is retired. If you are moving from mechanical to more efficient sweepers, you can conservatively assume that you will increase the total amount of toxic pollutants that are removed by sweeping by 30% to 50% (STEP 4 times 1.3 to 1.5).
4. What is the frequency of the sweeping of arterial streets with high traffic volumes? If less than weekly, consider weekly sweeping.
5. What is the frequency of the sweeping of commercial streets with moderate traffic volumes? If less than monthly, consider bi-weekly to monthly sweeping.
6. What is the frequency of the sweeping of residential streets with low traffic volumes? If less than quarterly, consider monthly to quarterly.