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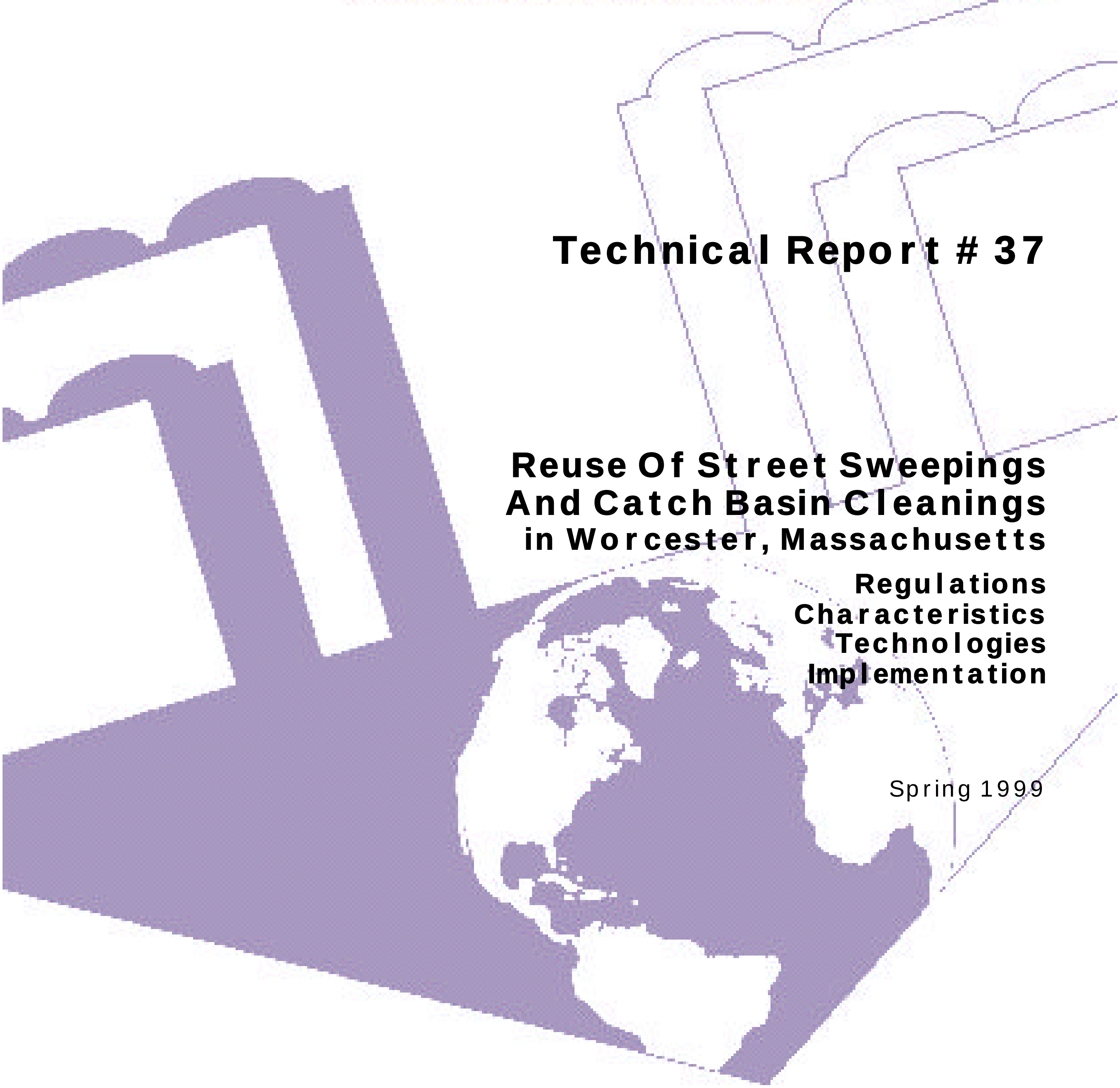

# Technical Report # 37

# Reuse Of Street Sweepings And Catch Basin Cleanings in Worcester, Massachusetts

## Regulations
## Characteristics
## Technologies
## Implementation

Spring 1999

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# Reuse of Street Sweepings And Catch Basin Cleanings in Worcester, Massachusetts

## Regulations
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## Chelsea Center for Recycling and Economic Development Technical Research Program

Spring 1999

 This project is funded by the University of Massachusetts' Chelsea Center for Recycling and Economic Development, through the Executive Office of Environmental Affairs and the Clean Environment Fund, which is comprised of unredeemed bottle deposits.

The Chelsea Center for Recycling and Economic Development, a part of the University of Massachusetts' Center for Environmentally Appropriate Materials, was created by the Commonwealth of Massachusetts in 1995 to create jobs, support recycling efforts, and help the economy and the environment by increasing the use of recyclables by manufacturers. The mission of the Chelsea Center is to develop an infrastructure for a sustainable materials economy in Massachusetts, where businesses will thrive that rely on locally discarded goods as their feedstock and that minimize pressure on the environment by reducing waste, pollution, dependence on virgin materials, and dependence on disposal facilities. Further information can be obtained by writing the Chelsea Center for Recycling and Economic Development, 180 Second Street, Chelsea, MA 02150.

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# PREFACE & ACKNOWLEDGEMENTS

This project was initiated by the Commonwealth of Massachusetts, Executive Office of Environmental Affairs (EOEA) and the Chelsea Center for Recycling and Economic Development. Funding was provided by the Donahue Institute of the University of Massachusetts.

These agencies are cooperatively seeking to identify environmental-sound, cost-effective reuse alternatives to the landfilling of street sweepings and catch basin cleanings. This project was intended to meet this objective, and also provide a high quality internship experience for graduate student interns at Worcester Polytechnic Institute (WPI).

Accordingly, this report represents the combined efforts of Paul Graves, Jennifer Roberge, and Hasan Osdilek, three graduate students who were advised by Paul Mathisen at WPI. Much of the report preparation (with the exception of Chapter 4) can be attributed to Paul J. R. Graves. The material presented in this report served as the foundation of Paul Graves thesis in support of his Master of Science (MS) degree, which included an in-depth analysis of reuse alternatives for the City of Worcester, MA. The analyses presented in Chapter 4 were coordinated by Jennifer A. Roberge and further analyzed by Hasan G. Ozdilek, who also provided additional technical contributions pertaining to alternative reuse options. WPI is grateful to the Chelsea Center, Donahue Institute, EOEA and Mass. DEP for their assistance in providing valuable educational opportunities to these graduate students.

WPI is also grateful for technical information that was graciously provided from numerous sources cited herein, particularly from Camp, Dresser and McKee, Inc (CDM) and the City of Worcester, Department of Public Works (DPW). The Worcester DPW and the Department of Environmental Protection (DEP) Central Regional Office were especially helpful in providing information and answering questions. In addition, the Worcester DPW directly assisted in the development and completion of the sampling program presented in Chapter 4.

The authors wish to extend their appreciation for the contributions of the agencies and groups noted above, and in particular to the following people:

- Gail Harris, Chelsea Center for Recycling and Economic Development
- Joseph Buckley, Worcester DPW
- Kurt Jacobson, DEP
- Daniel Duffy, CDM

# EXECUTIVE SUMMARY

The need to dispose of street sweepings and catch basin cleanings in an economical and environmentally appropriate manner is a problem that all cities and towns must address. Hence, this report could be considered as an introductory approach for any community investigating reuse alternatives.

However, this report focuses on a specific location, the City of Worcester, Massachusetts, for several reasons. First, regulations on solid wastes are generally set by the state, but maintenance and disposal practices tend to vary by community. The quantities of sweepings and cleanings vary from place to place. Likewise, the types and concentrations of contaminants found in sweepings and cleanings can vary in different areas. Most importantly, the reuse options are limited by what is available in each municipality. Therefore, this report focuses on a specific municipality to avoid over-generalization.

The City of Worcester, MA currently disposes of all street sweepings and catch basin cleanings in the Ballard Street Landfill, the City's only active disposal site. However, that landfill has reached capacity, and is scheduled to be capped in the year 2000. The street sweepings and catch basin cleanings are being deposited for grading purposes. All other municipal wastes are either recycled or incinerated, and leaves collected by the City are composted.

In order to reduce or eliminate the quantities of street sweepings and catch basin cleanings that will have to be transported for disposal outside the City in the near future, the City is considering reuse of these wastes. This report was prepared to address the following questions, to assist the City in planning a reuse program:

- What regulations and policies govern the reuse of street sweepings and catch basin cleanings?
- What are the quantities, composition and characteristics of these materials?
- In what ways can these materials be reused? Is treatment necessary? If so, what methods are appropriate?
- How have other communities approached this problem? Have they been successful?
- How should Worcester proceed in implementing a reuse program?

The findings are summarized below.

Federal, state and local policies and regulations govern the collection, transportation, disposal, and reuse of street sweepings and catch basin cleanings to various degrees. These materials have long been classified as solid wastes. Disposal and reuse of these materials is subject primarily to state laws and regulations. Massachusetts DEP policy establishes pre-approved reuse alternatives for street sweepings only, as landfill daily cover, fill in public ways, or compost additive, subject to certain limiting conditions (e.g., buffer from wetlands or water supply, not for residential use, etc.) Other beneficial uses (not specified) are subject to DEP approval on a case-by-case basis. The only approved disposal option for catch basin cleanings is in landfills.

Street sweepings and catch basin cleanings are generally composed of sand, silt, and water, with lesser amounts of pebbles, concrete, organics, salt, leaves, twigs, litter, garbage, animal wastes, metals, petroleum products, plastics, rubber, glass, solvents, pesticides, fertilizers, and other chemicals. The contaminants of concern are usually metals (arsenic, barium, cadmium, chromium, lead, and sodium), polyaromatic hydrocarbons (PAH's), total petroleum hydrocarbons (TPH's), volatile organic compounds (VOC's), polychlorinated biphenyls (PCB's), and chloride. Catch basin cleanings are generally wetter and contain more decaying matter, and therefore are more odoriferous than street sweepings, and also contain more silt. Previous sampling and analyses confirm that street sweepings and catch basin cleanings generally have acceptable contaminant levels for restricted use alternatives.

The available literature lists numerous potential reuse alternatives for the soil components of street sweepings and catch basin cleanings, including the following:

- Landfill daily/weekly cover
- Road sanding (anti-skid material)
- Compost additive
- Roadway fill/backfill
- Component in asphalt or cement concrete pavement
- Land reclamation fill
- Sale as fines, coarse sand, and gravel
- Fill in crash attenuation barriers
- Containment/absorption medium for hazardous materials spill response
- Blending material to bulk up or dilute contaminated soils for thermal desorption

It is important to note that, of these potential reuse alternatives, only several are pre-approved, and those are subject to stipulations, as previously described. All other potential reuse alternatives would require DEP approval of a Beneficial Use Determination on a case-by-case basis.

Technologies used in preparing the street sweepings and catch basin cleanings for reuse include source separation, dewatering, and screening. Treatment technologies for reducing or immobilizing contaminants include washing, thermal destruction, composting, biological degradation, and use as aggregate in bituminous or cement concrete. Pre-approved reuse alternatives for street sweepings do not require treatment.

A dozen studies or initiatives completed by others on characterizing street sweepings and catch basin cleanings and identifying reuse alternatives have been reviewed for this report. Four of the initiatives reviewed included reuse programs in operation; of those, three were qualified successes, and one is an apparent failure due to strict regulations.

The City of Worcester sweeps about 14,000 curb miles per year, collecting about 7,000 cubic yards of street sweepings. In separate street sweepings in the fall, the City collects about 60,000 cubic yards of leaves. The City also cleans about 7,000 of its 14,338 catch basins per year, on average, collecting about 5,000 cubic yards of cleanings. While 100% of the leaves are composted in the City's state-of-the-art facility, 100% of the street sweepings and catch basin cleanings are currently disposed of in the Ballard

Street Landfill, for grading purposes. Since the landfill is reaching capacity and is scheduled to be capped in the year 2000, Worcester is faced with either trucking the street sweepings and catch basin cleanings to landfills in other municipalities, or reusing them.

The following actions are suggested to facilitate reuse of street sweepings and catch basin cleanings in Worcester:

- Identify current and projected demands for street sweepings and catch basin cleanings (e.g., road improvement projects, winter sanding, etc.)
- Test the geotechnical characteristics of representative samples of street sweepings and catch basin cleanings for comparison with material specifications of various reuse alternatives to be considered.
- Seek information from the DEP on the approval process for other beneficial uses (i.e. other than the pre-approved uses).
- Identify and estimate costs of available sites for stockpiling, processing, and treatment facilities as appropriate to the alternatives under consideration.
- Identify and estimate costs of facilities, staff, and equipment needed for implementing reuse or transfer programs
- Identify and estimate costs of any design, permitting, sampling, and laboratory analyses, public participation, administrative approval, funding, training, or other intermediate steps necessary for implementing reuse or transfer programs
- Investigate the marketability of street sweepings and catch basin cleanings to other communities for reuse alternatives, and the costs of disposal of these materials.
- Identify any agreements necessary for sale of these materials or disposal of materials in other communities.
- Prepare benefit/cost analyses for the various alternatives under consideration
- Select the alternative (or combination of alternatives)that provides the most advantageous benefit/cost ratio, and which is the most appropriate from the perspective of public health and safety, environmental protection, and practical application

A flow chart summarizing the suggested implementation strategy is provided in Section 6.

# 1.INTRODUCTION

## 1.1 Statement of the Problem

The City of Worcester, Massachusetts is facing a problem common to many communities: the City's landfill space is approaching capacity. In fact, in the year 2000, Worcester's only operating disposal site, the Ballard Street Landfill, is scheduled to be capped. The only materials still being deposited at the landfill are street sweepings and catch basin cleanings, placed for grading purposes. Al other municipal wastes are either recycled or incinerated, except for leaves collected by the City, which are composted. Subsequently, the City plans to transport its municipal wastes to a landfill or incinerator in another community.

In order to minimize transport and tipping fees, the City is considering reuse of street sweepings and catch basin cleanings in anticipation of the landfill capping. Until recently, state legislation required disposal of these materials in landfills, as with other solid wastes. However, recognizing the potential for beneficial uses of these materials, the State has issued policies allowing their reuse under certain conditions.

Prior to implementing a reuse program, City officials need answers to the following questions:

- What regulations and policies apply to reuse of street sweepings and catch basin cleanings?
- What are the quantities, composition and characteristics of these materials?
- In what ways can these materials be reused? Is treatment necessary? If so, what methods are appropriate?
- How have other communities approached this problem? Have they been successful?
- How should Worcester proceed in implementing a reuse program?

The purpose of this report is to provide answers to the above questions. Although this report is prepared specifically with regard to the City of Worcester, it is also intended to provide general guidance for other communities and state agencies considering reuse of street sweepings and catch basin cleanings.

## 1.2 Definitions

- **Street sweepings and catch basin cleanings:** In this report, the materials to be considered are limited to street sweepings and catch basin cleanings of a standard nature, in other words not at the site of a hazardous waste spill or illicit dumping, and not following a parade or street fair. In general, these materials consist primarily of sand, silt, and water; with lesser amounts of leaves, twigs, litter, garbage, animal wastes; and minor amounts of metals, petroleum products, plastics, rubber, glass, and chemical contaminants. In this report, the focus will be on the geological solid components of street sweepings and catch basin wastes (i.e., sand and silt). It is assumed that these materials can be effectively dewatered, and the drained water discharged to the drainage system or treatment facility as appropriate. Likewise, it is assumed that the geological components can easily be separated from most organic materials, which can then be composted, landfilled or incinerated as appropriate. This report does not cover pavement millings, roadway demolition or construction waste materials. While these may be significant items to consider, there are usually established reuse options for these materials.

It is important to note that while street sweepings and catch basin cleanings are classified as solid wastes, they are actually for the most part useful materials with some value. In this sense, they may be only "temporary wastes" until they are returned to use.

- **Disposal:** The American Heritage Dictionary defines the verb form of this term as "to get rid of". However, in order to differentiate "disposal" and "reuse", which both "get rid of" street sweepings and catch basin cleanings, we will consider disposal as "discarding of permanent wastes".

- **Reuse:** On the other hand, we will consider reuse as "beneficial uses of temporary wastes". In this sense, the term "reuse" is considered similar to "recycling", as defined in The American Heritage Dictionary: "to extract and reuse (useful substances found in waste); to use again, esp. to reprocess in order to use again; to recondition and adapt to a new use or function."

## 1.3 Methodology and Report Outline

The methodology for this project generally consists of data gathering and review to address key issues and identify appropriate areas for further action. Data available from other investigations were acquired primarily from the following sources:

- Worcester Polytechnic Institute library search/ literature review
- reports available through various government agencies
- reports available from commercial entities
- telephone interviews with representatives of selected universities
- telephone interviews and meetings with various government employees

Chapter 3 summarizes the results pertaining to regulations and polices, while Chapter 3 summarizes the results pertaining to the general characteristics of street sweepings and catch basin cleanings. However, since the available data on wastes from street sweepings and catch basin cleanings are extremely limited, a sampling program was included as part of this investigation to improve the available information regarding these materials. The objectives for this sampling effort involved identification of geotechnical characteristics and contaminant concentrations for different land use areas. The results of the sampling program are summarized in Chapter 4. After the general characteristics of street sweepings and catch basin cleaning are presented, the report includes a review of the technologies that are available for reusing these wastes in Chapter 5, followed by a review of reuse initiatives that have been undertaken by other communities in Chapter 6. Finally, Chapter 7 describes an approach that can be followed by communities to initiate programs to reuse their street sweepings and catch basin cleanings.

## 1.4 Scope and Related Topics

This report is not intended to provide comprehensive coverage of every aspect of street sweepings and catch basin cleanings. There are a number of related topics which are beyond the scope of this report, such as the following:

- public health concerns
- environmental impacts
- aesthetics
- reduction
- generation
- collection
- transport
- exposure pathways
- risk assessment
- economic analyses
- storm water management

These topics are addressed in solid waste management textbooks, environmental engineering textbooks, and many of the references listed at the end of this report.

## 1.5 Current Practices in the City of Worcester

To initiate a discussion of the significance of the wastes that result from street sweeping and catch basin cleaning operations, it is appropriate to address the current practices that lead to the generation of these wastes. For this purpose, the City of Worcester is selected as an example of one of the numerous municipalities that have to address this problem. The City's Department of Public Works (DPW) performs the routine street and catch basin maintenance in Worcester. The following items summarize the current practices related
to collection and disposal of street sweepings and catch basin cleanings:

- **Infrastructure:** The DPW maintains approximately 830 curb-miles of roadways and an estimated 14,338 catch basins.

- **Maintenance schedule:** The residential sections of the City, comprising about 554 curb miles, are usually swept twice per year, once in the spring to remove road sand and once in the fall to remove leaves. Commercial and industrial areas, with arterial roadways comprising about 217 curb miles, are generally swept about once every two weeks throughout the year when snow is not present. Central business district streets, comprising about 59 curb miles, are swept every night throughout the year when snow is not present. Altogether, the City sweeps about 14,000 curb miles per year.

  Catch basins are generally cleaned once every two years on average; therefore, about 7,000 catch basins are cleaned per year. Those in more dense areas and areas subject to flooding are cleaned as frequently as four times per year, while those in less sensitive areas are cleaned once every four years.

- **Quantities:** The DPW measures the overall volumes of materials collected, but does not separate and measure the percentage of the various constituents. Annually, about 7,000 cubic yards of unclassified materials are collected via street sweepings, about 5,000 cubic yards of unclassified materials are collected via catch basin cleanings, and about 60,000 cubic yards of leaves are collected during the special sweepings in the fall.

- **Analysis:** Camp Dresser & McKee, Inc. conducted analyses of street sweepings in the City of Worcester during 1994-95. The University of Massachusetts Transportation Center also conducted analyses statewide in 1996, including two samples from Worcester. The findings of those analyses are provided in Appendix D. In all cases, the contaminant concentrations were found to be within acceptable levels (i.e., the street sweepings were not found to be "hazardous wastes").

- **Disposal:** 100% of the materials collected via street sweepings and catch basin cleanings are disposed of in the City's Ballard Street landfill, except for the leaves, which are composted in the City's state of the art facility.

- **Reuse:** 100% of the leaves collected during the special sweepings in the spring and fall are composted by the City, producing soil conditioners used in City landscaping projects and for commercial sale.

- **Sanding:** Refer to the leaflet in Appendix C of this report for information on the City's snow removal operations.

General information about the City of Worcester (such as population, area, government, etc.) and a street map of the City are provided in Appendix A.

# 2.REGULATIONS & POLICIES

The disposal and reuse of street sweepings and catch basin cleanings are governed by an array of policies and regulations on the local, state, and federal levels. Perhaps the most important of these are the state laws which have historically assigned these materials as solid wastes and limit the permissible disposal and reuse options, and the local practices for addressing the practical solutions associated with disposal and reuse. However, the federal rules are also important in setting acceptable contaminant levels and serving in some cases as the impetus for the state and local regulations.

It should be noted that the "regulations and policies" referenced herein may have different degrees of legal force. Nonetheless, the general practice is for state regulations to equal or be more stringent than the federal regulations, and likewise, for local policies to equal or be more stringent than state regulations. However, the municipality is typically expected to deliver mandated results without funding from the state or federal level, and therefore must be creative and sometimes minimal in its approach.

## 2.1 Federal Government

- **Resource Conservation and Recovery Act, 1976:** This superseded the Solid Waste Disposal Act of 1965 and the Resource Recovery Act of 1970. RCRA directed the Environmental Protection Agency to develop guidelines for comprehensive waste management plans. Some of these guidelines, such as 40 CFR 256 - Guidelines for State Solid Waste Management Plans and 40 CFR 257 - Solid Waste Facility Criteria, helped shape the state regulations listed in Section 2.2 of this report.

- **Clean Water Act, 1977:** This implemented the National Pollutant Discharge Elimination System (NPDES) permits. The Street Maintenance Program described in Section 2.3 of this report was required under 40 CFR 122.26(d)(2)(iv)(A)(3) as part of Worcester's compliance with the NPDES stormwater discharge requirements.

## 2.2 Commonwealth of Massachusetts

- **Massachusetts General Law Chapter 111, Section 150A:** Classifies street sweepings and catch basin cleanings as solid waste, potentially subject to the following regulations (as applicable):

- **310 CMR 16 - Site Assignment Regulations for Solid Waste Facilities**
- **310 CMR 19 - Solid Waste Management Facility Regulations**
- **310 CMR 19.060 - Beneficial Uses of Solid Wastes**
- **310 CMR 19.130 (15) - requirements for landfill daily cover material**
- **310 CMR 30 - Hazardous Waste Regulations**
- **310 CMR 40 - Massachusetts Contingency Plan:** Among other things, this sets the Reportable Concentration soil standards. These are shown in the analytical test results for street sweepings included in Appendix C.

Copies of all Massachusetts regulations, including those listed above, may be purchased from the State House Bookstore, (617) 727-2834. Further information on these regulations is included in the items listed below.

- **Classification and Reuse Options for Street Sweepings and Catch Basin Cleanings, DEP Memorandum 1/6/95:** This document is included in Appendix B. Generally, street sweepings must either be disposed of in landfills or used as landfill daily cover, or application can be made for "beneficial use" subject to Department approval. Catch basin cleanings must be disposed of in landfills, or application can be made for "beneficial use" subject to Department approval.

- **Reuse and Disposal of Street Sweepings, DEP Final Policy # BWP-94-092:** This document is included in Appendix B. Generally, street sweepings must either be disposed of in landfills, used as landfill daily cover or fill in roadways, used as a compost additive (subject to stipulations such as use outside residential areas, or placement above the water table and outside buffer zones for wetlands and water supplies), or an application can be made for "beneficial use" (not specified) subject to Department approval. Catch basin cleanings are not mentioned in this document.

## 2.3 City of Worcester

- **Street Maintenance Program:** In response to the federal Clean Water Act of 1977, the City of Worcester developed a formal street maintenance program. Excerpts thereof are included in Appendix B of this report. However, that program description focuses on collection of wastes, and does not address disposal and reuse. Currently, the City disposes of all its street sweeping and catch basin wastes in the Ballard Street landfill, but the City is exploring ways to reuse these wastes.

- **Snow Clearing Operations:** Over the years, the City has developed strategies to provide clear roads with a minimum of sanding. A leaflet included in Appendix B describes the City's snow clearing operations.

## 2.4 Other Municipalities

Although a comprehensive survey of programs from other municipalities is beyond the scope of this report, several examples from the available literature are provided for comparison.

- **Bloomington, Minnesota:** This city has reduced the volume of street sweepings landfilled by 90% through use of a screener and washer to produce clean sand that can be reused as anti-skid material or blended with compost. This is further described in a paper in Appendix E.
- **Colorado Springs, Colorado:** This city has achieved 100% reduction of the landfilled volume of catch basin cleanings through development of its own dewatering facility, screening and blending with compost. This is further described in an article in Appendix E.
- **Snohomish County, Washington:** This consortium of communities has conducted a study showing that its street sweepings and catch basin cleanings are suitable for composting, if the Total Petroleum

Hydrocarbons test can be modified or the acceptable limit can be adjusted to realistically address the field conditions. In the meantime, these communities face high treatment and disposal costs as a result of stringent state regulations. This is further described in an article in Appendix E.

- **Long Beach, CA:** Long Beach completed a pilot program which demonstrated that its street sweeping wastes were suitable for composting. Consequently, the City is implementing a full-scale program. Efforts are underway to expand this program to other communities. This is further described in an article in Appendix E.
- **Portland, Oregon:** This municipality is currently completing a study and also a pilot test to evaluate the feasibility of reducing concentrations of Total Petroleum Hydrocarbons in its street sweeping wastes to levels that would be suitable to allow for the reuse of these wastes in composting. The project's relevance to this report is detailed in Appendix G.

## 2.5 Other States

Although a comprehensive survey of policies and regulations from other states is beyond the scope of this report, several examples from the available literature are provided for comparison.

- **Connecticut:** This state has prepared a guidance document, "Municipal Management Practices for the Reuse of Road Sand Sweepings", which is included in Appendix B. The document is similar to Massachusetts' Policy on Street Sweepings, except that Connecticut's policy also includes guidelines on highway construction demolition, debris management and a list of associated recycling facilities.
- **New Jersey:** This state has prepared a "Guidance Document for the Management of Road Wastes", which is included in Appendix B. The Document is similar to Massachusetts' Policy on Street Sweepings, except that New Jersey's policy includes catch basin cleanings and requires sampling and analysis of wastes to be reused.
- **Washington:** This state has prepared a document for guidance, "Best Management Practices (BMP's) for Management and Disposal of Street Wastes", which is included in Appendix B. The document is more detailed than Massachusetts' Policy in that it includes specific examples and characteristics.

## 3.CHARACTERISTICS OF SWEEPINGS & CLEANINGS

### 3.1 Quantities

Solid waste textbooks indicate that:

- Street sweepings and catch basin cleanings are generally considered to comprise 1% to 10% (2% typical) of the total municipal solid wastes, by weight.

- Street sweepings are typically generated at a rate of 0.25 to 0.3 lb/capita/day.

- Catch basin cleanings are typically generated at a rate of 0.04 lb/capita/day.

- Street sweeping can reduce sediment loading to drainage system by about 8%, but is not effective at removing fines. Hence, catch basin cleanings generally contain a higher percentage of fines.

According to the City of Worcester DPW:

- Worcester's fall street sweepings for leaf collection, on arterial and residential streets (771 miles), on average totals 60,000 to 65,000 cubic yards per year.

- Worcester's annual volume of street sweeping material collected (not including leaf sweepings) is about 7,000 cubic yards, from about 14,000 curb-miles swept per year.

- Worcester's annual volume of catch basin material collected is about 5,000 cubic yards, from a total of 14,338 catch basins, about 7,000 cleaned per year.

From the above data, using a rounded population of 170,000 and an assumed material density of 100 lb/$ft^3$, it can be shown that:

- 0.3 lb/cap/day x 170,000 cap x 365 days/year x 1 $ft^3$/100 lb x 1 $yd^3$/27 $ft^3$ = 6,895 $yd^3$/year street sweepings generated _ about 7,000 cubic yards collected annually. Therefore, Worcester seems to be within the typical range of street sweepings generated (not including leaf collection).

- 0.04 lb/cap/day x 170,000 cap x 365 days/year x 1 $ft^3$/100 lb x 1 $yd^3$/27 $ft^3$ = 919 $yd^3$/year catch basin wastes generated _ about 5,000 cubic yards collected annually. Therefore, Worcester seems to have a much higher generation rate for catch basin wastes than the typical value. This could be because Worcester generally receives significant snowfall (hence, requires sanding), and the City is quite hilly, resulting in higher transport of suspended solids into drainage structures.

## 3.2 Composition

The following statements illustrate several qualities of street sweepings and catch basin cleanings, namely that they are highly variable, are related to land and travel characteristics, and change with time:

> "Owing to the fact that street dirt is composed of variable ingredients mixed in variable proportions, no analysis or series of analyses is capable of exactly indicating its composition. It is too indefinite a substance to be definitely described."
>
> -George A. Soper, *Modern Methods of Street Cleaning*, 1909

> "Composition of street sweepings: These consist of pulverized stone, earth and horse droppings, with more or less of all kinds of matter which are unlawfully thrown into the street, such as fruit skins, pieces of paper, matches, etc. Also, great quantities of leaves in the fall on streets provided with shade trees. The increasing use of automobiles has slightly reduced the amount of horse droppings, but has added oil to the extent of about 2 per cent in some cases."
>
> -A. Prescott Folwell, *Municipal Engineering Practice*, 1916

> "Street waste can be extremely variable in types and amounts of contaminants. These contaminants vary depending on land use, illicit discharges, accidental spills, and frequency of cleaning. Street waste can cause high turbidity, or contain oil and petroleum products, pesticides, fertilizers, fecal material, metals, and other substances that present a threat to human health and the environment."
>
> -Washington State Department of Ecology, *Best Management Practices (BMPs) For Management and Disposal of Street Wastes*, 1995

Street sweepings and catch basin cleanings are generally composed of sand, silt and water, with lesser amounts of pebbles, concrete, organics, water, salt, leaves, twigs, litter, garbage, animal wastes, metals, petroleum products, plastics, rubber, glass, solvents, pesticides, fertilizers, and other chemicals. Catch basin cleanings are generally wetter and contain more silt and decaying matter, and therefore are more odoriferous than street sweepings.

## 3.3 Contaminants

The contaminants of concern are usually metals (arsenic, barium, cadmium, chromium, lead and sodium), polyaromatic hydrocarbons (PAHs), total petroleum hydrocarbons (TPHs), volatile organic compounds (VOCs), polychlorinated biphenyls (PCBs), and chloride. Further listings of materials are included in Table 3-1a on the following page.

**Table 3-1a – List of analytes tested for and detected state-wide**

ORGANICS
- VOC's (8260)
  - Tetrachloroethene
  - Xylenes
  - n-Butylbenzene
  - sec-Butylbenzene
  - o-chlorotoluene
  - Naphthalene
  - 1,3,5-Trimethylbenzene
  - 1,2,4-Trimethylbenzene
- TPH (8100M)
  - Fuel Oil #2/Diesel
  - Fuel Oil #6
  - Motor Oil
  - Kerosene
- TPH (8015M)
  - Xylenes
  - Heavy Ends
- PAH (8270)
  - Flouranthene
  - Napthalene
  - Benzo(a)anthracene
  - Benzo (a)pyrene
  - Benzo(b)flouranthene
  - Benzo(k)flouranthene
  - Benzo(b,k)flouranthene
  - Chrysene

PAH (8270) [continued]
- Benzo (g,h,I)perylene
- Flourene
- Phenanthrene
- Dibenzo (a,h)anthracene
- Indeno (1,2,3-cd) pyrene
- Pyrene
- 1-Methylnaphthalene
- 2-Methylnaphthalene

PCBs (8080)
- Arochlor 1254
- Arochlor 1260

INORGANICS
- Specific Conductance
- Total Solids
- Chloride

TOTAL METALS
- Arsenic
- Barium
- Cadmium
- Chromium
- Lead
- Sodium

TCLP METALS
- Barium
- Cadmium
- Lead

From: *Development of Guidelines for Presampling Street Sweepings for Toxicity and Beneficial Reuse*. University of Massachusetts, Dartmouth, February, 1997.

To assess the significance of these contaminants, the contaminant concentrations can be compared to hazardous waste criteria. Sampling and analyses by others have shown that contaminant concentrations are generally at acceptable levels in street sweepings and catch basin cleanings. Additional analyses obtain for the City of Worcester are consistent with these analyses. However, the acceptable levels are dependent on the intended uses. For example the contaminant concentrations might be acceptable for use as fill in roadways but not in residential areas. Of particular note is the fact that TPH tests have often been inconclusive or perhaps inaccurate due to the presence of other organics. This problem is addressed in more detail in association with Washington State's policy and the Snohomish County, Washington initiative in Appendix B.

## 3.4 Physical Characteristics

As previously stated, street sweepings and catch basin cleanings vary considerably. In general, however, these materials can be characterized as silty sand, with bits of litter and organic matter mixed in. Street sweepings typically have a low moisture content, while catch basin cleanings generally have a much higher moisture content. Street sweepings are generally coarser (larger than 1 mm in diameter), dryer, and less odoriferous (due to less moisture and less organics) than catch basin cleanings. Some basic physical properties of street sweepings (and soil in general), such as the density, grain sizes, gradation, soil classification, and permeability are tabulated in Appendix E. In general, however, the available information on the physical characteristics of street sweepings and catch basin cleanings is extremely limited.

## 3.5 Chemical Characteristics

Since street sweepings and catch basin cleanings are generally classified as solid wastes (i.e., not hazardous or radioactive wastes), it is assumed that they are not significantly corrosive, flammable, explosive, toxic, harboring extremely dangerous biological agents or undergoing nuclear decay. Some basic chemical properties of street sweepings (and soil in general), such as chemical constituents and energy content, are tabulated in Appendix C. Flow charts of typical exposure pathways are also provided in Appendix C. Additional laboratory analyses of wastes from Worcester, MA, completed as part of this investigation, are summarized in Chapter 4.

# 4. LABORATORY ANALYSES OF SWEEPINGS & CLEANINGS

Street sweeping and catch basin wastes are difficult to describe quantitatively due to the limited available data on these wastes. In particular, for Worcester, MA, limited data are available for street sweepings and no data are available for catch basin cleanings. Therefore, a sampling program was developed to better understand the characteristics of street sweeping and catch basin cleaning wastes in Worcester, MA. This program included a set of laboratory analyses obtained to better characterize these wastes in the City of Worcester, and also to review the implications of these results. This chapter summarizes the results of this sampling program.

## 4.1 Approach and Methodology

Since the objective of this project was to characterize the road waste associated with the city of Worcester, the approach was to develop a sampling program that provides a representation of street sweeping and catch basin cleaning waste in the city. For the purposes of this project, sample locations were selected to provide a general representation of the various land uses and roadway characteristics in Worcester. Accordingly, laboratory samples were obtained by analyzing catch basins cleanings and street sweepings collected from a range of locations selected to provide a representation of different land uses and road traffic levels. These data were compared to other investigations, and used to assess the effects of land use and traffic volume on the physical and chemical characteristics of these road surface wastes. The overall distribution of land use areas within the City of Worcester is summarized in Table 4-1. As is evident in Table 4-1, land within Worcester's city limits encompasses a wide range of land use designations. Moreover, different land uses are often quite intermingled (as can be seen by the high numbers listed under frequency of occurrence) with residences often located directly adjacent to commercial and industrial areas.

Table 4-1 Land use distribution as for City of Worcester (developed from GIS by Worcester DPW)

| Land Use Type | Area (ac) | Percent | Frequency |
|---|---|---|---|
| Educational properties: Colleges and Universities | 697.9770 | 2.83 | 160 |
| General Boarding Houses | 275.1560 | 1.12 | 446 |
| Parking and Garages Facilities | 235.6130 | 0.96 | 297 |
| Single Family | 5632.3600 | 22.88 | 22244 |
| Two Family | 764.7410 | 3.11 | 3809 |
| Three Family | 725.1090 | 2.95 | 5031 |
| 4-8 Apartments | 192.7500 | 0.78 | 1124 |
| Manufacturing and Warehouses | 1411.0100 | 5.73 | 696 |
| Agricultural Related Uses | 16.8251 | 0.07 | 8 |
| Automotive Related Businesses | 239.9500 | 0.97 | 392 |
| Nursing, Daycare, Hospital, Charity and Housing Auth. | 1225.8500 | 4.98 | 670 |
| Recreational Uses | 335.0710 | 1.36 | 29 |
| Shopping Centers and Supermarkets | 388.1670 | 1.58 | 729 |
| Business offices and Hotels/Motels | 312.3030 | 1.27 | 681 |
| Eating and Drinking Establishements | 74.7264 | 0.30 | 213 |
| Vacant: Developable and undevelopable | 2478.8900 | 10.00 | 4045 |
| 9 + Apartments | 435.3290 | 1.77 | 3548 |
| Governments: Fed., state, local | 3339.1000 | 13.56 | 976 |

Consequently, in order to facilitate interpretation of results, each sampling location was selected to serve as a representation of a single generalized land use designation. Collection of multiple samples also provided more representative results since the complicating effect of extremely high or low concentrations due to illicit dumping, natural accumulation, or any other circumstances can be accounted for. The sampling sites and their associated land use designations are listed along with average daily traffic (ADT) volumes in Table 4-2. This information can be used to assess the relationship between land use, ADT, and the quality of road surface wastes.

Table 4-2 - Sampling sites

| **Sample ID** | **Street** | **From** | **To** | **Land use type** | **ADT*** |
|---|---|---|---|---|---|
| 1,2,3,4 | Mill Street | June St | Mahar St | Light Residential | 9000 |
| 5,6 | Vernon Street | W.Upsala St | Accommodation St | Dense residential | 4700 |
| 7, 8 | Freemont Street | Webster | Sutton | Industrial | <1000 |
| 9,10 | Chestnut Street | @Lindon St | @Harvard St | Central business | 7550 |
| 12 | Worcester Center Blvd | Thomas St | School St | Central business | 15200 |
| 13 | Elm Street | Merrick St | Fruit St | Dense Residential | 6750 |
| 14 | Coppage Drive | Goddard Mem Dr | End | Industrial | <1000 |
| 15 | Meadow Lane | Prouty Lane | Prouty Lane | Light Residential | <1000 |
| 16 | Commercial Street | Foster St | Thomas St | Commercial | 3000 |
| 17,18 | Stafford Street | Young St | Curtic Pkwy | Commercial | 16700 |
| 19 | Lincoln Street | @ Country Club Blvd | | Commercial | 19022 |

* ADT = Average Daily Traffic Volume

To define the characteristics of the sampling sites more accurately, the City of Worcester provided maps of the sites developed using their ARCINFO Geographical Information System (GIS). The files for these maps can be used to obtain accurate estimates of slopes, contributing runoff areas, catch basin locations. An example of one of these maps is included on Page 18 as Figure 4-1. This map shows topographical contours (at 2-foot intervals), roads, property lines, and catch basins in the area of Worcester Center Blvd. All coordinates for the GIS information are referenced against the Massachusetts State Plane Coordinate System. Information on utilities and streams was also provided, although it was not included in Figure 4-1. As a final supplement to background information, Worcester's traffic department provided traffic counts for the various areas. These traffic volumes are listed in Table 4-2.

To illustrate the characteristics of these locations, pictures were taken during the field visits. Two of these pictures are shown on Page 19 in Figures 4-2a and 4-2b. Figure 4-2a shows a view along Vernon Street that illustrates one of the many dense residential areas of Worcester. Worcester's terrain is quite hilly, and Vernon Street provides one example of a street with a steep gradient. Figure 4-2b shows a view along Worcester Center Blvd (as viewed from the West). This figure illustrates the urban nature of Worcester's Central Business District (CBD).

As noted previously, the sampling program was developed in coordination with the Worcester Department of Public Works (DPW). Physical analyses included particle size and total solids. Chemical analyses included RCRA for eight metals, total petroleum hydrocarbons (TPH's), polynuclear aromatic hydrocarbons (PAH's), sodium, and chloride. Sample collection and preparation procedures were developed in accordance with established protocols (e.g DEP's street sweeping protocol dated Nov 10, 1994). Worcester DPW staff assisted with acquisition of samples. A total of 20 composite samples were obtained, including 2 street sweeping samples, 16 catch basin samples, and 1 sample of clean sand which provided a baseline for comparison. All samples were sent for analysis at Alpha Analytical Laboratories, a certified laboratory. The composite samples were prepared and placed into appropriate containers in accordance with the specifications of Alpha Analytical Laboratory. The tests completed for each street sweeping and catch basin sample are listed in Table 4-3. In addition to the tests listed in Table 4-3, one street sweeping sample and four catch basin cleaning samples were subjected to tests for PCB's and Toxicity Characteristic Leaching Procedures (TCLP) tested for PCB's.

When collecting street sweepings, each street sweeping truck collects material from a relatively large stretch of roadway. Therefore, the material in each street sweeping truck provides an appropriate representation for a relatively large area. Consequently, to obtain a representative composite sample, three samples were obtained from three different locations within a street sweeping truck. A number of street sweeping samples have already been collected in Worcester for previous investigations. Therefore, two composite street sweeping samples were considered to sufficient for the purposes of this project. These samples provided a basis for comparison with previous data. In addition, since contractual timing for this project resulted in samples that were collected in the fall, the two samples complement the results of the previous sampling efforts, which were primarily completed in the late spring months.

When collecting catch basin cleanings, each truck can remove waste from two to three catch basins. Furthermore, within each catch basin, the solids are saturated since they are submerged in water and their properties also vary depending on their location within the catch basin. Consequently, for catch basin cleanings, composite samples were obtained by combining three samples obtained from different locations in the waste material removed from the catch basin cleaning truck immediately when it arrived at the Ballard Street landfill.

## 4.2 Physical Characteristics

Tables 4-4a and 4-4b summarize the physical characteristics of street sweepings and catch basin cleanings, respectively. As a control, both Tables 4-4a and 4-4b include a column showing the results for the Worcester DPW's sand/salt mixture (i.e. the road sand/salt mixture before it is applied to the road.) As noted in Chapter 3, the physical characteristics of street sweepings and catch basin cleanings are known to vary considerably, and street sweepings are generally coarser (with larger particle sizes) and dryer than catch basin cleanings. The collected material and physical data generally support this generalization. As would be expected, the catch basin cleanings do appear to have an average increase in the finer portion of the grain size distribution. Since only two street sweeping samples were obtained as part of this investigation, no generalizations can be ascertained regarding the physical characteristics of the street sweepings.

Table 4-3 - Selected tests to be completed for each sample.

| **General constituent category** | **Test** | **Specific constituents** |
|---|---|---|
| Specific conductance | 9050A | |
| Total solids | 2540G | |
| Chloride | 9251 | |
| Particle size analysis | 12/D422 | >53 m, 20-53 m, 5-20 m, 2-5 m, <2 m |
| Total metals | 3051 | As, Ba, Cd, Ch, Pb, Hg, Se, Ag, Na |
| Volatile organic compounds by GC/MS | GC/MS 8260 | Methylene chloride,1,1-dichloroethane, chloroform,carbon tetrachloride,1,2-dichloropropane,dibromochloromethane, 1,1,2-trichloroethane,2-chloroethylvinyl ether, tetrachloroethane, chlorobenzene, trichlorofluoromethane, 1,2-dichloroethane,1,1,1-trichloroethane,bromodichloromethane,trans-1,3-dichloropropene,cic-1,3-dichloropropene,1,1-dichloropropene,bromoform,1,1,2,2-tetrachloroethane,benzene,Toluene, Ethylbenzene, chloromethane,bromomethane,vinyl chloride, chloroethane,1,1-dichloroethene, trans-1.2dichloroethane, Trichloroethene, 1,2-dichlorobenzene,1,3-dichlorobenzene,1,2-dichlorobenzene,methyl tert butyl ether, p/m-Xylene, o-Xylene, cis-1,2-dichloroethene, dibromethane, 1,4-dibromethane, iodomethane, 1,2,3-trichloropropane,styrene,dichlorodifluoromethane,acetone, carbon disulfide,2-butanone, vinylacetate, 4-methyl-2-pentanone, 2-hexanone, ethyl methacrylate, acrolein, acrylonitrile, bromochloromethane,tetrahydrofuran, 2,2-dichloropropane, tetrahydrofuran,, 2,2-dichloropropane,1,2-dibromoethane, 1,3-dichloropropane, 1,1,1,2-terachloroethane, bromobenzine, n-butylbenzene, sec-butylbenzene, tert-butylbenzene, o-chlorotoluene, p-chlorotoluene, 1,2-dibromo-3-chloropropane, hexachlorobutadiene, isopropylbenzene, p_isopropyltoluene, natphthalene, n-Propylbenzene, 1,2,3-trichlorobenzene, 1,2,4-trichlorobenzene, 1,3,5-trimethylbenzene, 1,2,4-trimethylbenzene,trans-1,4-dichloro-2-butene,ethyl ether |
| Polynuclear aromatic hydrocarbons | GC/MS 8270 | Acenaphthene, 2-chloronaphthalene,Fluoranthene, Napthalene, Benzo(a) anthracene, Benzo(a) pyrene, Benzo(b) fluoranthene, Benzo(k) fluoranthene, Chrysene, Anthraphthylene, Anthracene, Benzo(ghi)perylene, Fluorene, Phenanthrene, Dibenzo (a,h)anthracene, Indeno(1,2,3-cd)pyrene, Pyrene, 1-Methylnaphthalene, 2-Methylnaphthalene |
| Petroleum hydrocarbons by GC-GRO | GC-GRO 8015M | Benzene, Toluene, Ethylbenzene, Xylenes, Gasoline rage organics |
| Petroleum hydrocarbons by GC-DRO | GC-DRO 8100M | Diesel range organics |

## 4.3 Chemical Characteristics

Tables 4-5a and 4-5b show the laboratory results for chemical analyses of street sweepings and catch basin cleanings, respectively. The column showing the results for the sand/salt mix serves as a control showing that essentially clean sand is spread on the roads as an antiskid material. As can be seen in Tables 4-5a and b, high concentrations of some polynuclear aromatic hydrocarbons (PNA's) were found in street sweepings and catch basin cleanings in the Mill Street area. However, it was later determined that paving had been completed near the date of sampling in this area, and the paving process could provide an explanation for the high concentrations found in this area. Furthermore, an additional catch basin sample taken from another light residential area yielded much lower PNA concentrations. With exception of the high concentrations that were found for the light residential area of Mill Street (which were likely associated with recent construction), all contaminant levels for street sweepings are acceptable in terms of hazardous waste classification. Also, no PCB's were detected in any of the PCB analyses, and no metals were detected in the TCLP tests.

Further review of Table 4-5b also shows that the concentrations in the industrial, commercial, and urban areas tend to be higher than the concentrations in the residential areas. However, as noted previously, the nature of the catch basin cleanings is highly variable so it is still difficult to quantify any of these trends. It is also noted that some of the catch basin samples contained relatively high concentrations of lead (Pb) and Total Petroleum Hydrocarbons (TPH). While the lead concentration exceeded the S1 standard for a number of cases, it did not exceed the S2 standards for any cases. In addition, while TPH exceeded the noted standards, it can be pointed out that the generalized TPH (the TPH - 8100M, as specified by Alpha Analytical) was used a "qualitative fingerprint" to compare with previous results. As noted previously, previous investigations have noted that TPH tests have often been inconclusive or perhaps inaccurate due to the presence of other organics (as addressed in the article on the Snohomish County initiative in Appendix B). The more detailed TPH laboratory analyses (TPH-DRO and TPH-GRO, which provide information on diesel and gasoline range organics, respectively) yielded concentrations that did not exceed hazardous waste standards.

## 4.4 Implications

Since regulations regarding the disposal of street sweeping wastes are defined separately for residential and non-residential areas, the quantities of residential and non-residential street sweepings and catch basin cleanings are also of interest. Separate consideration of the central business district (CBD) is also important since previous investigations have shown that concentrations for metals and petroleum hydrocarbons are high for road wastes collected from this district.

To illustrate the relative importance of the residential and non-residential areas, the quantities of road waste resulting from these types of land uses can be estimated using relative percentages of road lengths for the various land uses. These quantities, which assume that the generation of waste (which is closely related to road sand application) is equivalent for residential and non-residential land uses, are shown in Table 4-4.

Given these assumptions, residential areas contribute approximately two-thirds of the total road surface waste generated in Worcester.

Table 4-4 - Quantities of Road Surface Wastes

| | Road miles | | Catch basin cleanings | Street Sweepings |
|---|---|---|---|---|
| | (mi) | % of total | Volume ($yd^3$) | Volume ($yd^3$) |
| Central business district | 59 | 7 | 350 | 500 |
| Other urban and industrial | 217 | 26 | 1300 | 1800 |
| Residential | 554 | 67 | 3350 | 4700 |
| Total | 830 | 100 | 5000 | 7000 |

As discussed in Chapter 3, Camp Dresser & McKee, Inc. conducted analyses on street sweepings in Worcester during 1994-1995. The University of Massachusetts Transportation Center also conducted a statewide analysis and two samples were collected from Worcester. Summary information regarding the results from these and other previous investigations is included in Appendix C. Results from the current laboratory tests are generally consistent with previous data from Worcester as well as with previous data from the other sources. The street sweeping and catch basin cleaning wastes do contain concentrations of lead and petroleum hydrocarbons, although the levels of these concentrations do not exceed hazardous waste criteria in most instances.

Since a recommendation regarding the optimal disposal and/or reuse alternatives in Worcester would require a full cost benefit analysis, a formal recommendation is not included in this report. Rather, the results and considerations presented in this chapter are intended to serve as a basis for future work regarding the recommendations for the disposal of road surface wastes in Worcester. However, to fully address the potential for reuse of these wastes, it is also necessary to consider the feasible reuse technologies that may be available to process and reuse these wastes. These technologies are reviewed in Chapter 5.


Figure 4-1 – Arcview file for Worcester Center Blvd (obtained from files provided by Worcester DPW)

Figure 4-2a - Vernon Street (as viewed from the North)

Figure 4-2b - Worcester Center Blvd (as viewed from the south)

## Table 4-4a Street Sweepings - Physical Analyses

| **ANALYSIS REPORT** | | | Sand Mix | Mill St | Stafford |
|---|---|---|---|---|---|
| **Sample ID:** | | | 11 | 3 | 18 |
| **Date:** | | | 10/16/98 | 8/20/98 | 11/9/98 |
| Land use | | | --- | Lt. Res. | Comm |
| **Parameter:** | | | | | |
| **Solids** | | % | 87 | 90 | 84 |
| **Particle size by hydrometer** | | | | | |
| >53 µm | Sand | % | 90 | 91 | 99 |
| 20-53 µm | Coarse s | % | 7.3 | 5.6 | 1.1 |
| 5-20 µm | Medium s | % | 2.3 | 2.4 | 0.1 |
| 2-5 µm | Fine silt | % | 0.2 | ND | 0.1 |
| 2< µm | Clay | % | 0.1 | 0.5 | ND |

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## Table 4-4b Catch Basin Cleanings - Physical Analyses

| **ANALYSIS REPORT** | | | Sand Mix | Mill St | Mill St | Vernon St | Vernon St | Fremont | Fremont S | Harvard S | Harvard S | *WCB ** | Elm St | *Coppage* | Meadow L | Commerc | Stafford | Lincoln |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sample ID:** | | | 11 | 1 | 2 | 5 | 6 | 7 | 8 | 9 | 10 | 12 | 13 | 14 | 15 | 16 | 17 | 19 |
| **Date:** | | | 10/16/98 | 8/20/98 | 8/20/98 | 9/23/98 | 9/23/98 | 9/30/98 | 9/30/98 | 10/16/98 | 10/16/98 | 10/22/98 | 10/22/98 | 10/22/98 | 10/22/98 | 10/23/98 | 10/23/98 | 12/1/98 |
| **Land use:** | | | --- | Lt.Res. | Lt.Res. | Ds.Res | Ds.Res | Ind | Ind | CBD | CBD | CBD | Ds.Res. | Ind | Lt.Res. | Comm | Comm | Comm |
| **Parameter:** | | | | | | | | | | | | | | | | | | |
| **Solids** | | % | 87 | 31 | 50 | 34 | 76 | 67 | 78 | 58 | 70 | 75 | 61 | 73 | 71 | 65 | 69 | 79 |
| **Particle size by hydrometer** | | | | | | | | | | | | | | | | | | |
| >53 µm | Sand | % | 90 | 69 | 79 | 81 | 96 | 88 | 88 | 86 | 90 | 91 | 87 | 90 | 96 | 54 | 77 | 94 |
| 20-53 µm | Coarse silt | % | 7.3 | 13 | 11 | 9.1 | 1.5 | 5.6 | 4.8 | 5.8 | 4.3 | 3.3 | 7.2 | 5.8 | 2.6 | 18 | 12 | 2.7 |
| 5-20 µm | Medium s | % | 2.3 | 14 | 7.5 | 6.6 | 1.6 | 4.4 | 4.7 | 6.9 | 4.9 | 4 | 4.7 | 3 | 0.4 | 17 | 8 | 1.2 |
| 2-5 µm | Fine silt | % | 0.2 | 2.3 | 1.5 | 0.2 | 0.4 | 1.2 | 1 | 0.9 | 0.6 | 1.6 | 1.2 | 1 | 1 | 4.8 | 2.4 | 1.5 |
| 2< µm | Clay | % | 0.1 | 1.8 | 1.2 | 2.9 | 0.3 | 0.9 | 1.4 | 0.1 | 0.1 | 0.4 | 0.3 | 0.3 | 0.3 | 5.7 | 1 | 0.5 |

## Table 4-5a Street Sweepings - Chemical Analyses

| ANALYSIS REPORT | | Sand Mix | Mill St | Stafford | STANDARDS | | |
|---|---|---|---|---|---|---|---|
| **Sample ID:** | | 11 | 3 | 18 | | | |
| **Date:** | | 10/16/98 | 8/20/98 | 11/9/98 | **Oil and/or Hazardous Material** | | |
| **Land use:** | | --- | Lt. Res. | Comm | **S1/GW1** | **S2/GW1** | **S3/GW1** |
| **Parameter:** | | | | | | | |
| **Specific Cond.** | µmhos/c | 40 | 50 | 140 | | | |
| **Sodium** | mg/kg | | | 160 | | | |
| **Chloride** | mg/kg | 250 | 33 | 50 | | | |
| **Hydrocarbons,To** | mg/kg | 78 | | 2800 | 500 | 2500 | 5000 |
| **Total Metals** | | | | | | | |
| As | mg/kg | 2.9 | 5 | 8.2 | 30 | 30 | 30 |
| Ba | mg/kg | 12 | 14 | 26 | 1000 | 2500 | 2500 |
| Cd | mg/kg | ND | ND | 1.4 | 30 | 80 | 80 |
| Ch | mg/kg | 4.8 | 7.4 | 56 | 1000 | 2500 | 5000 |
| Pb | mg/kg | ND | 15 | 77 | 300 | 600 | 600 |
| Hg | mg/kg | ND | ND | ND | 10 | 60 | 60 |
| Se | mg/kg | ND | ND | ND | 300 | 2500 | 2500 |
| Ag | mg/kg | ND | ND | ND | 100 | 200 | 200 |
| **Volatile organics by GC/MS 8260** | | | | | | | |
| Toluene | µg/kg | ND | ND | ND | 90000 | 500000 | 1000000 |
| Ethylbenzene | µg/kg | ND | ND | ND | 80000 | 1000000 | 500000 |
| Vinyl chloride | µg/kg | ND | ND | ND | 100 | 300 | 500 |
| Trans-1.2dichloroe | µg/kg | ND | ND | ND | 4000 | 1000000 | 1000000 |
| Trichloroethene | µg/kg | ND | ND | ND | 300 | 3000 | 3000 |
| p/m-Xylene | µg/kg | ND | ND | ND | 300000 | 500000 | 1000000 |
| o-Xylene | µg/kg | ND | ND | ND | 300000 | 500000 | 1000000 |
| cis-1,2-dichloroeth | µg/kg | ND | ND | ND | 3000 | 400000 | 500000 |
| acetone | µg/kg | ND | ND | 140 | 3000 | 60000 | 60000 |
| 2-butanone | µg/kg | ND | ND | 410 | | | |
| n-butylbenzene | µg/kg | ND | ND | ND | | | |
| sec-butylbenzene | µg/kg | ND | ND | ND | | | |
| p_isopropyltoluene | µg/kg | ND | ND | ND | | | |
| natphthalene | µg/kg | ND | 49 | ND | 4000 | 1000000 | 1000000 |
| n-Propylbenzene | µg/kg | ND | ND | ND | | | |
| 1,3,5trimethylbenz | µg/kg | ND | ND | ND | | | |
| 1,2,4trimethylbenz | µg/kg | ND | ND | ND | | | |

| ANALYSIS REPORT | | Sand Mix | Mill St | Stafford | STANDARDS | | |
|---|---|---|---|---|---|---|---|
| **Sample ID:** | | 11 | 3 | 18 | | | |
| **Date:** | | 10/16/98 | 8/20/98 | 11/9/98 | | | |
| **Land use:** | | --- | Lt. Res. | Comm | **Oil and/or Hazardous Material** | | |
| **PNA'S by GC/MS SIM 8270M** | | | | | | | |
| Acenaphthene | µg/kg | ND | ND | ND | 20000 | 2500000 | 2000000 |
| Fluoranthene | µg/kg | ND | 7400 | ND | 600000 | 2000000 | 600000 |
| Naphthalene | µg/kg | ND | ND | ND | 4000 | 1000000 | 1000000 |
| Benzo(a) anthrace | µg/kg | ND | 2600 | ND | 1000 | 1000 | 1000 |
| Benzo(a) pyrene | µg/kg | ND | 2400 | ND | 700 | 700 | 700 |
| Benzo(b) fluoranth | µg/kg | ND | 2800 | ND | 1000 | 1000 | 1000 |
| Benzo(k) fluoranth | µg/kg | ND | 2600 | ND | 10000 | 10000 | 10000 |
| Chrysene | µg/kg | ND | 3300 | ND | 10000 | 10000 | 10000 |
| Anthracene | µg/kg | ND | ND | ND | 1000000 | 2500000 | 1000000 |
| Benzo(ghi)perylen | µg/kg | ND | ND | ND | 100000 | 2500000 | 100000 |
| Fluorene | µg/kg | ND | ND | ND | 400000 | 2000000 | 1000000 |
| Phenanthrene | µg/kg | ND | 3300 | ND | 700000 | 2500000 | 100000 |
| Indeno(1,2,3-cd)py | µg/kg | ND | ND | ND | 1000 | 1000 | 1000 |
| Pyrene | µg/kg | ND | 5600 | ND | 500000 | 2500000 | 500000 |
| 1-Methylnaphthale | µg/kg | ND | ND | ND | | | |
| 2-Methylnaphthale | µg/kg | ND | ND | ND | 700 | 20000 | 7000 |
| **Petroleum Hydrocarbons by GC-DRO** | | | | | | | |
| Diesel Range Organics | mg/ | 112 | 336 | 505 | | | |
| **Petroleum Hydrocarbons by GC-GRO** | | | | | | | |
| Benzene | µg/kg | ND | | ND | 10000 | 60000 | 60000 |
| Toluene | µg/kg | ND | | ND | 90000 | 500000 | 1000000 |
| Ethylbenzene | µg/kg | ND | | ND | 80000 | 1000000 | 500000 |
| Xylenes | µg/kg | ND | | ND | 800000 | 500000 | 1000000 |
| Gasoline Range or | µg/kg | ND | | ND | | | |

# Table 4-5b Catch Basin Cleanings - Chemical Analyses

| ANALYSIS REPORT | | Sand Mix | Mill St | Mill St | Vernon St | Vernon St | Fremont | Fremont S | Harvard S | Harvard S | *WCB* * | Elm St | *Coppage* | Meadow | Commerc | Stafford | Lincoln |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sample No:** | | 11 | 1 | 2 | 5 | 6 | 7 | 8 | 9 | 10 | 12 | 13 | 14 | 15 | 16 | 17 | 19 |
| **Date:** | | 10/16/98 | 8/20/98 | 8/20/98 | 9/23/98 | 9/23/98 | 9/30/98 | 9/30/98 | 10/16/98 | 10/16/98 | 10/22/98 | 10/22/98 | 10/22/98 | 10/22/98 | 10/23/98 | 10/23/98 | 12/1/98 |
| **Land use:** | | --- | Lt.Res. | Lt.Res. | Ds.Res | Ds.Res | Ind | Ind | CBD | CBD | CBD | Ds.Res. | Ind | Lt.Res. | Comm | Comm | Comm |
| **Parameter:** | | | | | | | | | | | | | | | | | |
| **Specific Cond.** | µmhos/c | 40 | 640 | 1200 | 1500 | 660 | 310 | 810 | 1900 | 230 | 1500 | 400 | 240 | 450 | 1900 | 910 | 390 |
| **Sodium** | mg/kg | | | | | | | | | | | 1100 | 380 | 1100 | 7000 | 2400 | 970 |
| **Chloride** | mg/kg | 250 | 5800 | 6800 | 13000 | 2300 | 1400 | 200 | 6800 | 1100 | 4900 | 1200 | 990 | 1800 | 7500 | 2900 | 1000 |
| **Hydrocarbons,To** | mg/kg | 78 | | | 4400 | 1700 | 7300 | 14000 | 3300 | 2000 | 13000 | 10000 | 1300 | 1700 | 5000 | 7300 | 2600 |
| **Total Metals** | | | | | | | | | | | | | | | | | |
| As | mg/kg | 2.9 | 18 | 12 | 9.8 | 3.8 | 7 | 11 | 8.4 | 5.8 | 9.2 | 10 | 16 | 6.3 | 16 | 15 | 6.7 |
| Ba | mg/kg | 12 | 52 | 42 | 71 | 12 | 58 | 55 | 24 | 19 | 37 | 54 | 32 | 16 | 60 | 48 | 19 |
| Cd | mg/kg | ND | 1.8 | ND | ND | ND | 0.88 | 1.7 | ND | ND | 1.1 | 0.92 | 0.71 | ND | 1.1 | 0.71 | 0.32 |
| Ch | mg/kg | 4.8 | 39 | 28 | 30 | 7.6 | 27 | 75 | 26 | 18 | 30 | 23 | 18 | 7.3 | 31 | 44 | 24 |
| Pb | mg/kg | ND | 200 | 64 | 260 | 39 | 160 | 210 | 150 | 87 | 100 | 380 | 62 | 18 | 320 | 540 | 73 |
| Hg | mg/kg | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Se | mg/kg | ND | 1.8 | 1.2 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Ag | mg/kg | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| **Volatile organics by GC/MS 8260** | | | | | | | | | | | | | | | | | |
| Toluene | µg/kg | ND | 4800 | 4300 | 2500 | 110 | 420 | 1000 | 97 | 130 | 14 | 540 | ND | 34 | 230 | 180 | ND |
| Ethylbenzene | µg/kg | ND | 65 | 69 | 29 | ND | 34 | 45 | ND | 13 | ND | 20 | ND | ND | 11 | 29 | ND |
| Vinyl chloride | µg/kg | ND | ND | ND | ND | ND | 220 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Trans-1.2dichloroe | µg/kg | ND | ND | ND | ND | ND | 13 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Trichloroethene | µg/kg | ND | ND | ND | ND | ND | 21 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| p/m-Xylene | µg/kg | ND | 210 | ND | ND | ND | 120 | 160 | 10 | 7.4 | 7.4 | 9.9 | ND | ND | 28 | 70 | ND |
| o-Xylene | µg/kg | ND | ND | ND | ND | ND | 33 | ND | ND | ND | ND | ND | ND | ND | 7.7 | 18 | ND |
| cis-1,2-dichloroeth | µg/kg | ND | ND | ND | ND | ND | 74 | 50 | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| acetone | µg/kg | ND | ND | ND | ND | ND | 280 | 330 | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| 2-butanone | µg/kg | ND | ND | ND | ND | ND | ND | 140 | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| n-butylbenzene | µg/kg | ND | 76 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| sec-butylbenzene | µg/kg | ND | ND | 58 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| p_isopropyltoluene | µg/kg | ND | ND | 2500 | 97 | ND | ND | 110 | ND | 75 | ND | 43 | ND | ND | ND | ND | ND |
| natphthalene | µg/kg | ND | 170 | 160 | ND | ND | 170 | 330 | ND | ND | ND | 67 | ND | ND | 40 | 120 | ND |
| n-Propylbenzene | µg/kg | ND | 100 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| 1,3,5trimethylbenz | µg/kg | ND | 160 | ND | ND | ND | 220 | 350 | ND | ND | ND | ND | ND | ND | 42 | 150 | ND |
| 1,2,4trimethylbenz | µg/kg | ND | 750 | ND | ND | ND | 82 | ND | ND | ND | ND | ND | ND | ND | ND | 50 | ND |

Table 4-5b Catch Basin Cleanings - Chemical Analyses (continued)

| **ANALYSIS REPORT** | | Sand Mix | Mill St | Mill St | Vernon St | Vernon St | Fremont | Fremont S | Harvard S | Harvard S | *WCB ** | Elm St | *Coppage* | Meadow | Commerc | Stafford | Lincoln |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample No: | | 11 | 1 | 2 | 5 | 6 | 7 | 8 | 9 | 10 | 12 | 13 | 14 | 15 | 16 | 17 | 19 |
| **Date:** | | 10/16/98 | 8/20/98 | 8/20/98 | 9/23/98 | 9/23/98 | 9/30/98 | 9/30/98 | 10/16/98 | 10/16/98 | 10/22/98 | 10/22/98 | 10/22/98 | 10/22/98 | 10/23/98 | 10/23/98 | 12/1/98 |
| **Land use:** | | --- | Lt.Res. | Lt.Res. | Ds.Res | Ds.Res | Ind | Ind | CBD | CBD | CBD | Ds.Res. | Ind | Lt.Res. | Comm | Comm | Comm |
| **PNA'S by GC/MS SIM 8270M** | | | | | | | | | | | | | | | | | |
| Acenaphthene | µg/kg | ND | ND | 6900 | ND | ND | 860 | 730 | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Fluoranthene | µg/kg | ND | 20000 | 66000 | 5200 | 1700 | 11000 | 18000 | ND | ND | 7500 | 3800 | 7100 | ND | ND | ND | ND |
| Naphthalene | µg/kg | ND | ND | ND | ND | ND | 720 | 750 | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Benzo(a) anthrace | µg/kg | ND | ND | 22000 | 1800 | 600 | 3600 | 5600 | ND | ND | ND | ND | 2100 | ND | ND | ND | ND |
| Benzo(a) pyrene | µg/kg | ND | ND | 19000 | 1800 | 530 | 3200 | 3800 | ND | ND | ND | ND | 2000 | ND | ND | ND | ND |
| Benzo(b) fluoranthe | µg/kg | ND | ND | 18000 | 1900 | ND | 3000 | 3500 | ND | ND | 2700 | ND | 2400 | ND | ND | ND | ND |
| Benzo(k) fluoranth | µg/kg | ND | ND | 17000 | 1700 | ND | 3200 | 3800 | ND | ND | ND | ND | 1900 | ND | ND | ND | ND |
| Chrysene | µg/kg | ND | 7900 | 25000 | 2500 | 820 | 4500 | 6000 | ND | ND | 3100 | ND | 3000 | ND | ND | ND | ND |
| Anthracene | µg/kg | ND | ND | 14000 | ND | ND | 1600 | 3800 | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Benzo(ghi)perylene | µg/kg | ND | ND | 7800 | 1200 | ND | 2100 | 1900 | ND | ND | ND | ND | 1400 | ND | ND | ND | ND |
| Fluorene | µg/kg | ND | ND | 10000 | ND | ND | 990 | 1800 | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Phenanthrene | µg/kg | ND | 12000 | 58000 | 3600 | 1000 | 8200 | 17000 | ND | ND | 5800 | ND | 4800 | ND | ND | ND | ND |
| Indeno(1,2,3-cd)py | µg/kg | ND | ND | 11000 | ND | 1000 | 2200 | 2300 | ND | ND | ND | ND | 1700 | ND | ND | ND | ND |
| Pyrene | µg/kg | ND | 15000 | 50000 | 4400 | 1400 | 8700 | 13000 | ND | ND | 5900 | ND | 5400 | ND | ND | ND | ND |
| 1-Methylnaphthaler | µg/kg | ND | | | | | 790 | 1300 | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| 2-Methylnaphthaler | µg/kg | ND | | | | | 900 | 1800 | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| **Petroleum Hydrocarbons by GC-DRO** | | | | | | | | | | | | | | | | | |
| Diesel Range Organics | mg | 112 | 1750 | 3400 | 1620 | 614 | 3490 | 5370 | 1570 | 1700 | 1300 | 1500 | 782 | 480 | 3140 | 2520 | 784 |
| **Petroleum Hydrocarbons by GC-GRO** | | | | | | | | | | | | | | | | | |
| Benzene | µg/kg | ND | | | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Toluene | µg/kg | ND | | | 2000 | 170 | 690 | 640 | 86 | 170 | ND | 240 | ND | 340 | ND | ND | ND |
| Ethylbenzene | µg/kg | ND | | | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Xylenes | µg/kg | ND | | | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| Gasoline Range or | µg/kg | ND | | | ND | ND | 5100 | 31000 | ND | ND | 2000 | 1100 | ND | 380 | 490 | 1800 | ND |

# 5.TECHNOLOGIES

There are numerous alternatives for reusing or recycling street sweepings and catch basin cleanings. Most of these could be considered methods of disposal, if the definition, "to get rid of" from The American Heritage Dictionary is applied. However, if we consider disposal as "discarding of permanent wastes" and reuse or recycling as "beneficial uses of temporary wastes", then there are indeed many reuse options and only one allowable disposal option. These options are summarized in this chapter

## 5.1 Disposal Options

Depositing street sweepings and catch basin cleanings in landfills (as bulk wastes rather than as daily or weekly cover), or dumping these wastes on the land or in the ocean (other than for beneficial uses such as fill, reclamation, etc.), comprise the disposal options available. In most cases, dumping on the land or in the ocean (except for approved purposes) is no longer allowed, so the only acceptable disposal option is usually in landfills.

To dispose of street sweepings and catch basin cleanings in a landfill, there is generally no need for processing or treatment technologies such as those described in Sections 5.3 and 5.4. Of course, collection, transfer, dumping, and compaction techniques are important, but those are beyond the scope of this report.

## 5.2 Reuse Options

The available literature lists numerous potential reuse alternatives for street sweepings and catch basin cleanings, such as the following:

- landfill daily/weekly cover
- road sanding (anti-skid material)
- compost additive
- fill/backfill in construction projects
- fill in crash attenuation barriers
- fill for potholes (w/ asphalt binder)
- aggregate in asphalt pavement
- aggregate in cement concrete pavement
- land reclamation
- park improvements
- sale as fines, coarse sand and gravel
- blending w/ aggregate to produce gravel
- containment/absorption medium for hazardous materials spill response

It is important to note, however, that certain restrictions may apply to these uses. For instance, sand reused as anti-skid material may have to meet certain grain size requirements, should be angular instead of rounded, and may have to meet certain contaminant standards. Likewise, compost additive may either have to be demonstrated to be "clean" or the compost may be limited to specified uses. Furthermore, placement in roadways or as fill may be restricted to non-residential uses, placement above the water table, and subject to certain buffers from wetland or water supplies. The guidelines included in Appendix B and the specifications included in Appendix D address such limitations in more detail.

The following sections describe techniques for processing and treating street sweepings and catch basin cleanings to produce usable materials. Note that this is not intended to be a comprehensive description of alternatives, rather a summary of typical methods. Also, these methods (or others developed) should only be utilized as necessary to meet specifications and acceptable contaminant concentrations for the selected uses.

## 5.3 Processing Technologies

The goals of processing the street sweepings and catch basin cleanings are to separate usable components and remove excess moisture. The common methods are:

- **Source separation:** This involves separate collection and stockpiling of materials with differing characteristics, for example, segregating leaf sweepings and sand sweepings, segregating street sweepings and catch basin cleanings, and segregating urban vs. non-urban street sweepings. This facilitates reuse by precluding the need for mechanical separation of components, for example, leaves for composting vs. sand for fill, street sweepings for fill vs. catch basin cleanings for composting, or urban sweepings for landfill daily cover vs. residential sweepings for anti-skid material.

- **Dewatering:** This is accomplished by stockpiling the materials and letting them drain. The draining process is typically accompanied by periodic spreading and turning to enhance evaporation. More advanced methods used for sludge dewatering, such as convection drying and vacuum filtration could also be utilized, but are not generally necessary (since the street sweepings and catch basin cleanings should be fairly well-draining due to their relatively high sand content). The Department of Environmental Protection should be consulted to determine the acceptability of discharging the drained water via drainage features, or if it should be directed to a sanitary sewer or onsite treatment facility.

- **Screening:** The materials are scooped into hoppers feeding vibrating or rotary screens (such as pictured in Appendix D, except fitted with finer mesh), which allow smaller particles to pass-through while retaining larger particles. In this way, the various gradations indicated in the specifications (in Appendix D) can be prepared. Furthermore, this will remove much of the undesirable constituents such as litter and twigs (in the Snohomish County, Washington experience, these residuals were approximately 10% of the original volume of the screened materials).

Examples of equipment for some of these techniques are included in Appendix D.

## 5.4 Treatment Technologies

The goals of treating the street sweepings and catch basin cleanings are to decontaminate, disinfect, or immobilize contaminated materials. The common methods are:

- **Water wash:** This is utilized by the City of Bloomington, Minnesota during their screening process, apparently to remove fines from sand. However, it is likely that this also rinses some contaminants off the sand. The wash water is directed to a settling basin.

- **Catalyzed peroxide wash:** This was identified as a potential treatment method in the Snohomish County, Washington article in Appendix B. The reported cost is between $40 and $55 per ton. Due to the high cost, this method was not utilized, so its performance is not reported.

- **Thermal destruction:** This involves moving the soil through a rotary kiln, which operates at extremely high temperatures and volatilizes organics. The costs of this method can be very high, and air quality could become an issue.

- **Composting:** This achieves some biological decomposition of organics and some thermal desorption of volatile organics. The process is relatively simple, involving windrows of material periodically wetted and turned to enhance oxidation and biological activity. Inorganics are often blended with organics in this process to prepare a suitable end product, usually topsoil or mulch.

- **Biological Degradation:** The biological decomposition of organics (either in composting, stockpiles, or within catch basins) can be enhanced through mixing in commercially available additives containing bacteria and nutrients. One such additive, MicroSorb, is described in Appendix D.

- **Immobilizing:** By using contaminated soils as aggregate in bituminous or cement concrete, the contaminants become trapped and therefore less hazardous. Physical characteristics (e.g. granular shape, grain size distribution, etc.) of street sweeping and catch basin cleaning wastes are important considerations for the use of these wastes in asphalt or concrete. For example, use of these materials in asphalt would require detailed physical tests such as a sieve analysis, an uncompacted flow test, and a fine aggregate granularity test. Furthermore, the materials used should not compromise the quality of the product. A discussion of aggregate qualities is provided in Appendix D.

The current policy promulgated by the Massachusetts DEP does not require analysis or treatment of street sweepings for pre-approved uses. Therefore, if sufficient demand exists for those pre-approved uses, Worcester can forego treatment altogether (although processing might be necessary to prepare materials for intended uses).

However, if Worcester applies for Department approval of other "beneficial uses", the current policy requires characterization of the chemical composition of the waste on a case-by-case basis, and treatment might be required depending on the intended uses. The type of treatment necessary would depend on the intended uses and the maximum contaminant levels allowed for such uses. In considering a program of beneficial use (other than pre-approved alternatives), a cost-benefit analysis should be prepared to determine the feasibility of the necessary analyses and treatment.

Examples of equipment for some of these techniques are included in Appendix D.

# 6.REUSE INITIATIVES

In preparing this report a number of related initiatives were discovered. Attempts were made to contact various agencies, as well as local colleges/universities, to determine the status of studies on this topic. Note that a comprehensive survey of research facilities, companies, agencies, and institutions is beyond the scope of this project. Rather, the approach was to contact those authors/agencies referenced in available sources, or by word-of-mouth, and to contact the larger, more technically-oriented colleges/ universities in New England. The results of our informal survey are summarized below.

| group/agency | reuse initiative? | comments |
|---|---|---|
| City of Worcester, MA | Yes | See below. |
| City of Newton, MA | Yes | " " |
| Mass DEP | Yes | " " |
| Bloomington, MN | Yes | " " |
| Colorado Springs, CO | Yes | " " |
| United Waste Systems | Yes | " " |
| Univ. of South Florida | Yes | " " |
| Snohomish County, WA | Yes | " " |
| CT DEP | Yes | " " |
| NJ DEP | Yes | " " |
| WA DOE | Yes | " " |
| Boston University | No | No comment. |
| Clark University | No | " " |
| College of the Holy Cross | No | " " |
| Harvard University | No | " " |
| M.I.T. | No | " " |
| Northeastern University | No | " " |
| UMass Amherst | Yes | In association with Massachusetts Highway Dept. (MHD) . |
| UMass Dartmouth | Yes | In association with UMass Amherst; see below. |
| UMass Lowell | No | No comment. |
| UConn Storrs | No | " " |
| Univ. New Hampshire. | No | Taylor Eighmy's research involves reuse of pavement millings. |
| Univ. Vermont | No | No comment. |
| Univ. Maine Orono | No | " " |

| | | | |
|---|---|---|---|
| Univ. R.I., Kingston | No | " | " |

Based on the above data and referenced information, there are twelve initiatives identified which involve reuse of street sweepings and catch basin cleanings. The table below identifies which are policies, analysis, and/or programs.

| reuse initiative | policy | analysis | program | comments |
|---|---|---|---|---|
| City of Worcester, MA | | X | | sweepings only |
| City of Newton, MA | | X | | sweepings & cleanings |
| MA DEP | X | | | sweepings only |
| CT DEP | X | | | sweepings only |
| NJ DEP | X | | | sweepings & cleanings |
| WA DOE | X | X | | sweepings & cleanings |
| Bloomington, MN | | | X | 90% success, sweepings |
| Colorado Springs, CO | | | X | 100%success, cleanings |
| Snohomish Co., WA | | X | X | unrealistic TPH criteria |
| Univ. South Florida | | X | | study on-going |
| United Waste Systems | | X | X | study on-going |
| UMass/MHD | | X | | sweepings only |

The available policies are included in Appendix B. The available analyses are included in Appendix C. The referenced reuse programs are documented in Appendix E.

As summarized in Section 2.4, the reuse programs in other communities, were qualified successes in three out of the four identified. The cities of Bloomington, Colorado Springs and Long Beach all successfully reused all or nearly all of their sweepings and cleanings, respectively. Snohomish County argues that the County could have achieved success, apparently, if not for overly stringent state regulations.

The policies reviewed from other states are similar to those in Massachusetts. Compared with the policies in New Jersey and Washington, the Massachusetts policy is somewhat less restrictive because it does not require analyses for pre-approved uses; however, it is somewhat more restrictive in that it does not pre-approve reuse alternatives for catch basin cleanings.

The laboratory results for street sweepings in Worcester are similar to those available from the other locations listed. Laboratory results for catch basin cleanings, obtained as part of the current investigation (and summarized in Chapter 4), indicate that catch basin cleanings are also similar to the results from other locations. In general, the relatively low contaminant concentrations in these materials indicate that alternatives are available that could accommodate effective reuse of street sweepings and catch basin cleanings.

# 7.IMPLEMENTING A REUSE PROGRAM

In order to consider a reuse program for a city such as the City of Worcester, one must first determine the applicable regulations, material characteristics, and available technologies. Another bit of useful information is the outcome of reuse programs in other communities. These issues are covered in Sections 2 - 5.

Next, practical considerations should be addressed, such as "How much street sweeping and catch basin cleaning materials can the City currently use?" and "What actions should be taken?" A logical decision process for these considerations is shown on the Implementation Flowchart in Figure 7-1 on the next page. The following is a narrative description of that process:

1. There are three primary options for street sweepings: disposal, pre-approved reuse alternatives, or other beneficial uses.

2. There are three pre-approved reuse alternatives for street sweepings: landfill daily cover, roadway fill, or compost additive.

3. There are two primary options for catch basin cleanings: disposal or other beneficial uses.

4. A cost-benefit analysis should be prepared for each option or alternative. The analysis should be done on a unit basis for comparison of the various choices. Theoretically, the option or alternative with the best cost-benefit ratio should be selected, contingent upon other considerations.

5. For the first pre-approved reuse alternative, landfill daily cover, an immediate concern is that the landfill in Worcester is scheduled to be capped in the year 2000, so this alternative may not be practical for the long term.

6. At this point, an inquiry is needed to determine the demand for selling street sweepings to other municipalities for use as landfill daily cover. (It is assumed herein that sale of these materials is allowable, as long as the buyer is a responsible entity who will comply with the DEP policies.)

7. If the answer to #5 is "no" (no demand), then disposal is the only sure option.

8. If the answer to #5 is "yes" (there is a demand), then a cost-benefit analysis should be prepared for sale of these materials.

9. For the second and third pre-approved reuse alternatives, roadway fill and compost additive, there is assumed to be a long-term demand in the City of Worcester. The first inquiry would be to quantify the demands for roadway fill and compost additive in the City.

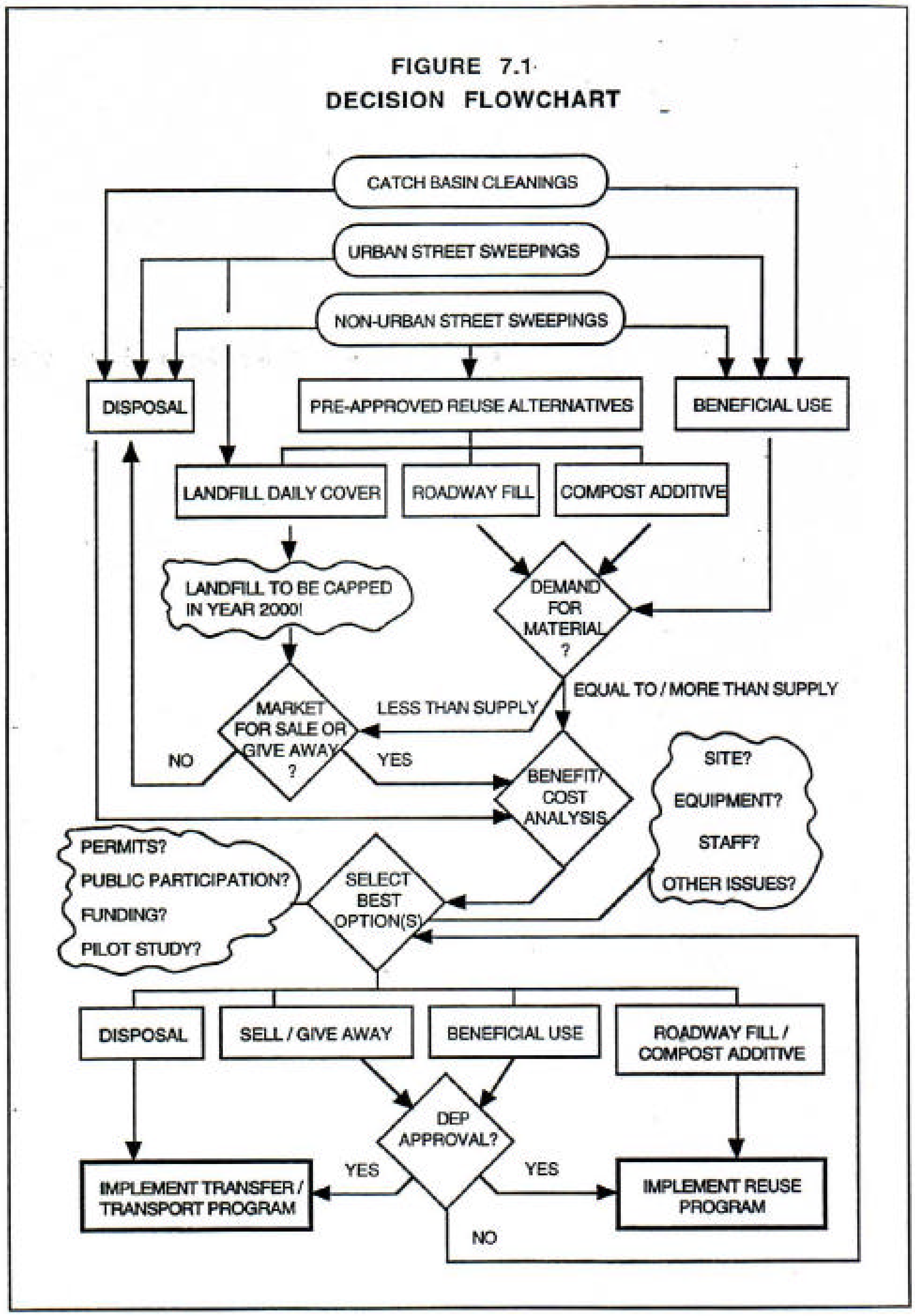


**Figure 7-1 – Implementation Flowchart**

10. If the answer to #8 is "demand equals or exceeds supply", then a cost-benefit analysis should be performed.

11. If the answer to #8 is "supply exceeds demand", then the inquiry about demands for sale of these materials would be a logical action (step #5). It is assumed herein that stockpiling materials (beyond annual demands) is not an option.

12. When the four different cost-benefit analyses have been prepared, the results can be compared to determine which option (or combination of options) is most advantageous.

13. If disposal or sale of materials is part of the most advantageous strategy, then a transfer/transport program should be implemented.

14. If reuse of materials as roadway fill or compost additive is part of the most advantageous strategy, then a reuse program should be implemented.

15. If other beneficial uses are part of the most advantageous strategy, then DEP approval is necessary. If approval is granted, a reuse program should be implemented. If approval is not granted, then the cost-benefit analyses should be reconsidered, and a new most advantageous strategy selected.

Implicit in the final actions is that any design, permitting, municipal agreements, public participation, funding requests, equipment acquisition, personnel allocation and training, transfer/processing/treatment site development, or other intermediate steps will be considered and taken as appropriate. Furthermore, there may be other considerations not included herein that might modify the decision process or logical outcomes.

Gathering the data and performing cost-benefit analyses in accordance with the suggested implementation strategy is beyond the scope of this report. An example cost-benefit analysis is included in Appendix F for reference. Furthermore, a Master of Science thesis by Graves (1998) applied a cost benefit analysis to provide a preliminary assessment of management options for catch basin cleanings and street sweepings in Worcester, MA. Consequently, the reader is also referred to the Graves (1998) for an illustration of this approach.

# 8.CONCLUSIONS & RECOMMENDATIONS

## 8.1 Conclusions

The information reviewed for this report supports the following conclusions:

1. There is a need to at least consider reuse of street sweepings and catch basin cleanings.

2. State policy supports reuse of street sweepings and catch basin cleanings.

3. There are no pre-approved reuse alternatives for catch basin wastes, so DEP approval is required on a case-by-case basis.

4. Sampling and analyses confirm that street sweepings and catch basin cleanings generally have acceptable contaminant levels.

5. Technologies are available for processing and treating these materials.

6. Treatment is not required for pre-approved reuse alternatives for street sweepings.

7. Other communities have successfully implemented reuse programs.

8. A logical decision process based on cost-benefit analyses of alternatives will help identify appropriate actions.

## 8.2 Recommendations

The following actions are suggested for evaluating disposal and reuse alternatives:

1. Identify current and projected demands for street sweepings and catch basin cleanings, at least in the pre-approved reuse alternatives (landfill daily cover, roadway fill, compost additive) and perhaps in other beneficial uses as well (refer to Section 4.2 for some examples).

2. Test the geotechnical characteristics of representative samples of street sweepings and catch basin cleanings, for comparison with material specifications for the various reuse alternatives to be considered.

3. Seek information from DEP on the approval process for other beneficial uses.

4. Identify and estimate costs of available sites for stockpiling, processing, and treatment facilities as appropriate to the alternatives under consideration.

5. Identify and estimate costs of facilities, staff & equipment needed for implementing reuse or transfer programs.

6. Identify and estimate costs of any design, permitting, sampling and laboratory analyses, public participation, administrative approval, funding, training, or other intermediate steps necessary for implementing reuse or transfer programs.

7. Investigate the marketability of street sweepings and catch basin cleanings to other communities for reuse alternatives, and the costs of disposal of these materials.

8. Identify any agreements necessary for sale of materials or disposal of materials in other communities.

9. Prepare cost-benefit analyses for the various alternatives under consideration.

10. Select the alternative (or combination of alternatives) that provides the most advantageous cost-benefit ratio, and which is most appropriate from the perspective of public health and safety, environmental protection, and practical application.

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