ROADWASTE:

ISSUES AND OPTIONS

FHWA-OR-RD-99-05

by

Jay Collins

for

Oregon Department of Transportation
Research Unit
Suite B-240
200 Hawthorne Street SE
Salem, OR 97310

and

Federal Highway Administration
Washington, D.C. 20590

1. Report No. FHWA-OR-RD-99-05	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle ROADWASTE: ISSUES AND OPTIONS		5. Report Date June 1998 6. Performing Organization Code
7. Author(s) Jay Collins, Environmental Program Coordinator		8. Performing Organization Report No.
9. Performing Organization Name and Address Oregon Department of Transportation Research Unit 200 Hawthorne SE, suite B-240 Salem, Oregon 97310		10. Work Unit No. (TRAIS) 11. Contract or Grant No.
12. Sponsoring Agency Name and Address Oregon Department of Transportation Research Unit 200 Hawthorne SE, Suite B-240 Salem, Oregon 97310 and Federal Highway Administration Washington, D.C. 20590		13. Type of Report and Period Covered Phase 1 Final Report 1990 – 1998 14. Sponsoring Agency Code
15. Supplementary Notes		

16. Abstract

The Oregon Department of Transportation is conducting a study to determine roadwaste management options. Phase 1 consisted of a thorough review of regulations and standards, roadwaste characterization, current management practices, and new technology. This report documents the finds from Phase 1, focusing on road sweepings and stormwater vactor residuals, though the findings also help to clarify proper management of other roadwaste materials. No one set of regulations was identified that covers roadwaste management. Consequently, hazardous and solid waste, water quality, cleanup, and other rules are reviewed. Roadwaste characterization evolved during the 1990s; many tests were run and results varied widely. Total petroleum hydrocarbon (TPH) tests, used at underground storage tank (UST) cleanup sites, are not appropriate for evaluation of roadwaste due to H-C bond interference from natural organic constituents. Now, carcinogenic PAHs (seven heavy petroleum compounds) and heavy metals drive evaluation of risk. Fine particles (clays and silts) are more contaminated than coarse fractions. Dissolved contaminants in vactor liquids are low; however, high contamination loadings are often adsorbed to suspended solids. Identifying and separating differing roadwastes allows more ready management while requiring less frequent analysis. Practices reviewed address hot load separation, mainstream roadwaste, and vactor waste management. Many possibilities are identified for trials; it is expected that Phase 2 (Trial Implementation) will lead to further important finds. The report recommends that trials lead to the development of Best Management Practices to support statewide plan development by ODOT in Phase 3.

17. Key Words		18. Distribution Statement	
STREET WASTE, WASTE MANAGEMENT, SWEEPINGS, STORMWATER, ENVIRONMENT, VACTOR WASTE		Available through the Oregon Department of Transportation Research Unit	
19. Security Classification (of this report)	20. Security Classification (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	284	

Technical Report Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

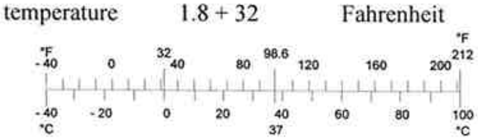
SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
LENGTH				
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
AREA				
in^2	square inches	645.2	millimeters squared	mm^2
ft^2	square feet	0.093	meters squared	m^2
yd^2	square yards	0.836	meters squared	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	kilometers squared	km^2
VOLUME				
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	meters cubed	m^3
yd^3	cubic yards	0.765	meters cubed	m^3
NOTE: Volumes greater than 1000 L shall be shown in m^3.				
MASS				
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams	Mg
TEMPERATURE (exact)				
°F	Fahrenheit temperature	5(F-32)/9	Celsius temperature	°C

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
LENGTH				
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
AREA				
mm^2	millimeters squared	0.0016	square inches	in^2
m^2	meters squared	10.764	square feet	ft^2
ha	hectares	2.47	acres	ac
km^2	kilometers squared	0.386	square miles	mi^2
VOLUME				
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	meters cubed	35.315	cubic feet	ft^3
m^3	meters cubed	1.308	cubic yards	yd^3
MASS				
g	grams	0.035	ounces	oz
kg	kilograms	2.205	pounds	lb
Mg	megagrams	1.102	short tons (2000 lb)	T
TEMPERATURE (exact)				
°C	Celsius temperature	1.8 + 32	Fahrenheit	°F



* SI is the symbol for the International System of Measurement

(4-7-94 jbp)

ACKNOWLEDGEMENTS

The author wishes to thank the following individuals and organizations for their contributions to this effort: Elizabeth Hunt and ODOT Research Unit staff and management; Jeffrey T. Moore of ODOT Region 1 for his vision, direction, and support; Karla Keller, Tom Lauer, Jerry Gausnell and ODOT operations management and staff; Don Newell and Multnomah County Transportation Division for involvement and support; Fred Bromfeld, Ernie Schmidt, Dave Kunz, Ranei Nomura, Rich Sedman and others with the Oregon Department of Environmental Quality (DEQ); Jeff Graham and the Federal Highway Administration; Kendra Smith of Unified Sewerage Agency for an excellent collection of materials on this topic; Tony Barrett and the Washington Department of Ecology; Doug Pierce, Norm Payton, and the Washington Department of Transportation for their leadership in addressing roadwaste issues; Bob Campbell and Snohomish County Public Works for pioneering contributions and continuing efforts in the field of roadwaste characterization and management; Roy Harris and the City of Everett for ongoing valuable work on roadwaste characterization and management; Doug Putschler and Lane County Department of Public Works; Brian Elliott and City of Eugene Public Works; Jim Lenhart and Stormwater Management Inc.; Snohomish County Health Department; Massachusetts Highway Department, University of Massachusetts Transportation Center, and Massachusetts Department of Environmental Protection; Minnesota Department of Transportation; Transportation Research Board; Garnet Elliott and the ODOT Library; other participating transportation and public works agencies, and roadwaste researchers in Oregon and elsewhere.

DISCLAIMER

This document is disseminated under the sponsorship of the Oregon Department of Transportation and the United States Department of Transportation in the interest of information exchange. The State of Oregon and the United States Government assume no liability of its contents or use thereof.

The contents of this report reflect the views of the authors, who are responsible for the facts and accuracy of the data presented herein. The contents do not necessarily reflect the official policies of the Oregon Department of Transportation or the United States Department of Transportation.

The State of Oregon and the United States Government do not endorse products of manufacturers. Trademarks or manufacturers' names appear herein only because they are considered essential to the object of this document.

This report does not constitute a standard, specification, or regulation..

EXECUTIVE SUMMARY

Oregon Department of Transportation (ODOT) has accepted the task of developing environmentally sound and workable solutions to roadwaste management issues in Oregon. Roadwaste generation from Oregon highways has been estimated at 1.4 kilotons per road kilometer (5 tons per road mile) annually. ODOT Region 1 has estimated $950,000 per year for sweepings disposal alone.

This report concludes Phase 1 of ODOT's three-phase roadwaste research project, scheduled for completion by June 2000. The goal of Phase 1 has been to better understand the issues surrounding roadwaste management and to identify and develop options other than costly solid waste landfilling. Phase 2 is trial implementation, and Phase 3 is development of guidance to assist in the development of a statewide roadwaste management plan for ODOT. This report focuses on road sweepings and stormwater vactor residuals, which are higher priority wastes. The findings also help to clarify proper management of other roadwaste materials. The Oregon Department of Environmental Quality (DEQ) has stated that if significant progress toward implementation of protective solutions is not forthcoming, it may fall back to actively enforcing regulations from a wide variety of programs not developed to address roadwaste issues.

No one set of regulations covers roadwaste management. This report reviews pertinent solid and hazardous waste, cleanup, water quality, and other DEQ and local rules to better define roadwaste issues. Sweepings and vactor solids are currently classed as solid waste, which must be managed only at permitted facilities unless otherwise approved by DEQ. Normal roadwaste is not hazardous waste, although spills, illegal dumping, or other special circumstances leading to contamination of given loads can trigger the rigorous requirements for hazardous waste management. Significant water quality concerns are posed not only from discharge of contaminants, but also by significant loading from clean sediments and natural organic materials; roadwaste must be managed without discharge to surface waters and without direct discharge to groundwater. Cleanup and sludge application levels provide guidance for agencies evaluating risks posed by roadwaste contaminants. ODOT may propose management solutions involving reuse of roadwaste above these levels if the reuses are shown to be protective of human health and the environment.

Roadwaste characterization has evolved during the 1990s. Early on, interest in roadwaste contaminants focused on petroleum. Workers in Washington State found that natural organic materials in roadwaste interfere with standard total petroleum hydrocarbon (TPH) tests. Standard test methods count hydrogen-carbon bonds, prevalent in natural organic matter. Clean leaves, mulch, sawdust, walnuts, etc. often test higher in petroleum hydrocarbons than roadwaste. TPH tests are appropriate for most underground storage tank (UST) cleanup sites, but not for evaluation of roadwaste. New Northwest TPH methods using an acid clean-up step to remove organic acids have been approved by EPA; however, interference is still present from non-acid natural constituents. Chapter 3 presents an argument that TPH results should not be used to evaluate roadwaste, unless the sweepings and vactor waste are grossly impacted (e.g., from a petroleum spill).

Not using TPH levels, actual constituents of concern must be identified. Evaluating risks from roadwaste contaminants now centers on carcinogenic polyaromatic hydrocarbons (CPAHs), heavy metals (arsenic, cadmium, chromium and lead), and the presence of broken glass and other sharps. Heavy metal concentrations are not observed above the EPA hazardous waste threshold, although there is a concern that elevated lead levels in sump materials pre-dating the ban on leaded gasoline may be more heavily impacted and thus deserve special handling and frequent testing. Potentially hazardous or otherwise problem wastes should be culled out; this will reduce the amount of highly contaminated material in mainstream roadwaste. Heavy metal concentrations in mainstream roadwaste are very low on average and do not pose sufficient risk to require special care. Slightly elevated total arsenic levels have been seen in some roadwastes; however, naturally occurring high arsenic background levels may be a contributing factor.

CPAH levels are the most important factor for evaluation of risks posed by disposition of roadwastes. CPAHs degrade slowly in the environment and most traditional treatment methods do not provide a remedy. CPAH levels in sweepings are at or near the DEQ cleanup threshold, while most vactor wastes test above that level. Cleanup levels help us to understand risks associated with roadwaste, but are not necessarily the determining factor. CPAHs are relatively immobile in the environment; ingestion is the exposure pathway driving risk, rather than potential to impact groundwater. A WsDOT paper made a good case for reuse of vactor residuals and sweepings in highway medians (thereby limiting human exposure) in a recent presentation to the Transportation Research Board. *(Pierce, 1998)*

A great deal of sampling has been done and roadwaste contaminant levels vary widely. Finer particles, especially clay fractions, charge up with contaminants at far greater concentration than relatively clean gravel and coarse sand fractions. This finding has led to easier reuse of road sanding materials. However, it is still difficult to draw definitive conclusions on the effects of land use, climate, recent rainfall, frequency of maintenance, and traffic levels (ADT) on roadwaste contaminant levels. If we can better define and segregate sub-categories of roadwaste, we lift significant burdens of cost for ongoing lab analyses and operations manpower, and we ease the path to reuse for some roadwastes. The Massachusetts Department of Environmental Protection's sweepings reuse policy (see Appendix B2) differentiates between sweepings from urban center roads and other sweepings, creating a category of less contaminated sweepings approved for ready reuse. Massachusetts allows limited reuse of sweepings, but requires that stormwater vactor wastes be landfilled. Besides Washington, very few other states have developed programs addressing roadwaste. Data protocols should be established, including a standard set of tests and a system for capturing all pertinent information on roadwaste samples (discussed further in Chapter 7); a clearinghouse could then store and analyze this information.

Chapter 5 discusses use of other agency and private facilities, including partnering for disposal or reuse. Effectiveness, workability, and liability issues provide the main focus. A variety of management methods are discussed in Chapters 5 and 6, including the following: use in asphalt and concrete; thermal treatment; passive and active bioremediation; phyto-remediation;

composting; separation by particle size fraction; road sand reuse; use of chemical deicers and anti-icing agents; sidecasting from low traffic roads in rural areas; disposal or recycling of litter; development of roadwaste landfills; various reuses as fill; and, advertisement campaigns to reduce littering. A variety of concerns are identified, and special care must be taken with options that place materials in reuse outside of agency control.

Stormwater catch basins and sumps are cleaned out using powerful vacuum powered trucks. "Vactor" trucks use fresh water to capture liquid and solid wastes, preventing clogging and flooding of roadways while also reducing stormwater contaminant loading to surface waters. Vactor wastes are a special case due to their liquid content. Vactor liquids are high in suspended particles. Vactor sediments are mainly in the size range of sand, with the remainder of the solids composed of organic matter, litter, etc. As more attention is paid to stormwater issues and more systems are established to detain and capture these materials, more of these wastes will be generated. In the field, crews must pour off accumulated wastewater to make more room in the tank for solids, or travel to a waste management site frequently. Dumping the liquids is termed "field decanting" and was traditionally done right back into storm sewers. Although contaminant levels dissolved in vactor liquid fraction may be very low, particles suspended in the liquid (suspended solids) can carry high levels of contaminants. Field decanting back into storm drains is not an appropriate practice unless suspended solids can be removed and prior approval is obtained from DEQ. Currently, crews must decant to sanitary sewer, meeting pretreatment requirements for contaminants and suspended solids.

Prior to solid waste disposal or other traditional management, vactor waste must be de-watered. Most often, de-watering is done on a large, sloped pad, often with a high roof to accommodate dumping by large vactor trucks. Construction costs average $250,000 per facility and these facilities do not function very well. Pipes clog with fines, requiring constant maintenance, and wastes must be moved promptly from initial dumping areas to piles for long-term de-watering. De-watering can take up to several months. Container de-watering has been suggested as a cheaper, more flexible and potentially more workable option. One problem with container de-watering is the loss of fines through metal mesh or clogging of material filters. Flocculent has been used to retain fines with the other sediments, increasing the efficiency of container de-watering. Use of flocculent also makes vactor crews more efficient by settling solids in the truck, which eases field decanting requirements allowing for longer runs in the field. Snohomish County, Washington, uses flocculent in their vactor trucks to easily meet sanitary sewer pretreatment requirements. (Snohomish County is also working to clean their liquid decant to the point that state authorities will allow discharge directly back into storm sewers.)

In Chapter 7, the discussion centers on how to develop a roadwaste management plan and how to pursue further meaningful efforts to clarify roadwaste management issues. Identifying and separating differing roadwastes allows more ready management while requiring less frequent analysis. Management practices are offered to address mainstream roadwaste, vactor waste management issues are synthesized, and many possibilities are identified for Phase 2 trials.

ODOT plans to build on the experience gained during Phase 2 to further define specific workable and cost efficient roadwaste management methods. It is hoped that a set of roadwaste Best

Management Practices (BMPs) can be developed and offered to DEQ for approval. These approved BMPs would then be used to help ODOT Maintenance Districts develop roadwaste management plans specific to their individual needs.

ROADWASTE: ISSUES AND OPTIONS

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

LIST OF ACRONYMS

ACDP	Air Contaminant Discharge Permit [DEQ permit]
ADT	Average Daily Traffic [average number of trips over a given roadway]
BTEX	Benzene, Toluene, Ethylbenzene, and Xylenes [laboratory test]
BMPs	Best Management Practices
BOD	Biological Oxygen Demand [laboratory test]
CALTRANS	California Department of Transportation
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CMA	Calcium Magnesium Acetate [road de-icing compound]
CPAH	Carcinogenic Polyaromatic Hydrocarbon
CWA	Clean Water Act [EPA]
DEP	Massachusetts Department of Environmental Protection
DEQ	Oregon Department of Environmental Quality
DOE	Washington Department of Ecology
EPA	[United States] Environmental Protection Agency
Mn/DOT	Minnesota Department of Transportation
MPCA	Minnesota Pollution Control Agency
MTCA	Model Toxics Control Act [Washington DOE]
NCHRP	National Cooperative Highway Research Program
ND	Non-detect [laboratory test result]
NPDES	National Pollutant Discharge Elimination System [water quality permit]
NWTPH	Northwest Total Petroleum Hydrocarbon [laboratory test]
NWTPH-Dx	Northwest Total Petroleum Hydrocarbon - Diesel extended [laboratory test]
O&G	Oil and Grease [laboratory test]
OAR	Oregon Administrative Rules
ODOT	Oregon Department of Transportation
ORS	Oregon Revised Statutes
OSU	Oregon State University
PAH	Polycyclic Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyl
PCS	Petroleum Contaminated Soil
PNA	Polynuclear Aromatic [*see* PAH]
POTW	Publicly Owned treatment Works [*see* WWTP]
ppm	Parts Per Million [*often expressed in* mg/kg]
PRG	Preliminary Remediation Goals
RCRA	Resource Conservation and Recovery Act
SoClean	Soil Cleanup Table [DEQ threshold values]
SOLV	Stop Oregon Litter and Vandalism
SPLT	Synthetic Precipitation Leachate Test [laboratory test]
STP	Sewage Treatment Plant [*see* WWTP]

TAC	[ODOT Research] Technical Advisory Committee
TCLP	Toxicity Characteristic Leaching Procedure [laboratory test]
TEF	Toxicity Equivalency Factor
TPH	Total Petroleum Hydrocarbons [laboratory test]
TPH-D	Total Petroleum Hydrocarbons in the Diesel range [laboratory test]
TPH-G	Total Petroleum Hydrocarbons in the Gasoline range [laboratory test]
TPH-HCID	Total Petroleum Hydrocarbon Identification [laboratory test for ranges]
TSS	Total Suspended Solids [laboratory test]
UCI	Ultra Coatings Inc. [bioremediation contractor]
USA	Unified Sewerage Agency [of Washington County]
UST	Underground Storage Tank
VOC	Volatile Organic Compound
WPCF	Water Pollution Control Facility [DEQ permit]
WsDOT	Washington Department of Transportation
WSU	Washington State University
WWTP	Wastewater Treatment Plant

1.0 INTRODUCTION

1.1 DEFINING THE PROBLEM

Oregon Department of Transportation (ODOT) maintenance yards – and other transportation and public works agency facilities – are filling up with roadwaste materials. Environmental concerns have been raised over these materials, especially street sweepings and vactor wastes. ODOT has recognized that wastes generated in maintaining Oregon's roadways must be managed in an environmentally responsible manner. This report is the product of a six-month research effort to better define roadwaste management problems and provide information to assist ODOT in the development of a roadwaste management plan. Many different technologies, methods, and procedures are evaluated to offer a selection of recommended practices that are environmentally sound, cost effective, and workable. Through proper management of roadwaste, ODOT may avoid contamination of storage sites and groundwater and protect against potential health risks associated with unrestricted reuse of these materials.

The problem most frequently associated with roadwaste is the impact stormwater runoff can have on streams and wetlands. ODOT's current interest in roadwaste materials stems from its stormwater quality program. As a team member of Governor Kitzhaber's Salmon Recovery Plan, ODOT is committed to enhancing the health of Oregon's surface waters. An effective roadwaste management effort can make a substantial contribution to these goals.

Concerns have been voiced from maintenance operation employees and management who question whether their current methods for handling roadwaste protect the environment. Some complaints from the public have been heard, and issues have been raised to the Oregon Department of Environmental Quality (DEQ). DEQ has recognized the need to better define roadwaste compliance issues and has asked ODOT to develop a plan addressing how to best manage these materials. Without significant progress by ODOT, DEQ may be compelled by public complaints or individual acts of noncompliance to enforce a variety of regulations not designed to best address roadwaste management. (Alternately, DEQ might take independent action, adopting rules that force agencies to manage roadwaste in an environmentally sound manner of DEQ's choosing.) DEQ is committed to supporting ODOT's project to develop workable solutions; DEQ remains involved by encouraging ODOT and reviewing its efforts.

1.2 SELECTION OF WASTES FOR THIS STUDY

This study focuses on sweepings and vactor waste, collectively termed "roadwaste." (For our purposes, "vactor waste" includes liquids and solids from the clean out of stormwater catch basins and sumps.) Is it appropriate to apply the term "waste" to materials generated from roadway maintenance? Besides the stigma, using the term "waste" implies a regulatory classification. Still, roadwaste is a term accepted in the industry and, until each method of reuse is proven beneficial, high priority roadway generated materials face scrutiny as waste from regulators. The current status of ODOT's highway generated waste is described in Table 1.1.

Table 1.1: ODOT's Highway Generated Waste

MATERIAL OR WASTE	CURRENT PRACTICE	COMPLIANCE ISSUES	CONSEQUENCES	COMPLIANCE OPTIONS
Litter **(misc. litter is often mixed with sweepings or various material piles)**	Litter patrol (landfilled at permitted facility). Recycling. Stockpiled with mixed debris (sweepings, brush, etc.) and used as a fill material.	Litter may not be stored, stockpiled, or landfilled at a non-permitted disposal site.	ODOT may be fined for stockpiling, storing, or landfilling litter at non-permitted disposal sites.	Separate litter from sweepings: Expand Region 1 screening program or use another process. Landfill separated litter at a DEQ permitted landfill facility. Landfill mixed debris containing litter at a permitted landfill facility.
Street sweepings	Screening out litter. Stockpiling. Recycling. Sidecasting. Used as fill material (with mixed debris). Landfilled at permitted facility.	Street sweepings are considered contaminated (hydrocarbons and metals) unless tested otherwise. Contaminated street sweepings must be landfilled at permitted disposal sites.	ODOT may be fined for stockpiling, storing, or landfilling sweepings at non-permitted disposal sites.	Dispose at permitted landfills. Characterize sweepings for pollutant levels and manage appropriately. Develop a process to remediate/recycle sweepings where and if possible. Develop and permit specific sites for sweepings disposal (possibly as project needed fill – limited option). Assess storage sites for environmental issues (wetlands, potential for site or groundwater contamination, etc.). Address containment of material for proper erosion control.
Vactor waste	Stockpiling. Random disposal sites.	Vactor waste must be separated into liquid and solid components prior to disposal. Waste must be disposed of at separate liquid and solid permitted disposal facilities (sewer and landfill).	ODOT may be fined for disposing of vactor waste at non-permitted disposal sites. (ODOT currently lacks a facility to separate this waste into liquid and solid components.)	Develop an ODOT vactor decant facility that will separate vactor waste into liquid and solid waste. Manage liquid and solid waste appropriately. Partner with other jurisdictions in use or development of a decant facility. Develop and permit an alternative method for managing vactor waste (flocculation, bio-remediation, etc.). Assess storage sites for environmental issues (wetlands, potential for site or groundwater contamination, etc.). Address containment of material for proper erosion control.

MATERIAL OR WASTE	CURRENT PRACTICE	COMPLIANCE ISSUES	CONSEQUENCES	COMPLIANCE OPTIONS
Brush and Landscaping debris	Stockpiled. Composting and mulching. Landfilled (with mixed debris) Burning. Chipping.	Landscape debris must be landfilled or burned at a permitted disposal site. It is expected composting will require a permit in the near future.	ODOT may be fined for stockpiling, landfilling, or burning landscape debris at non-permitted disposal sites	Keep landscape debris separate from mixed debris piles. Composting and mulching Burning (limited) Chipping. Landfill all materials containing mixed landscape debris at permitted sites.
Ditching materials (clean)	Stockpiled. Used as fill.	Storage sites must be suitable (proximity to wetlands or streams). Material must be contained appropriately (erosion control).	ODOT may be fined for improper storage. Material considered clean fill, but this status is in question.	Assess storage and fill sites for environmental issues (wetlands, etc.). Address containment of material for proper erosion control.
Slide debris (clean)	Stockpiled. Used as fill.	Storage sites must be suitable (proximity to wetlands or streams). Material must be contained appropriately.	ODOT may be fined for improper storage. Material is generally considered clean fill.	Assess storage and fill sites for environmental issues (wetlands, etc.). Address containment of material for proper erosion control.
Sand and Gravel (clean)	Stockpiled	Storage sites must be suitable (proximity to wetlands or streams). Material must be contained appropriately.	ODOT may be fined for improper storage. Material is generally considered clean fill.	Assess storage and fill sites for environmental issues (wetlands, etc.). Address containment of material for proper erosion control.

The findings represented in this table point out the need for stormwater management and erosion control in storing any of these materials. Use of materials as fill is discussed again under Regulatory Issues (see the section on inert materials) and again under Roadwaste Management Options. Tables presented in the chapters that follow more closely delineate categories of sweepings and vactor waste and list and discuss appropriate management methods.

Management options for roadside litter are not specifically addressed in this report. DEQ has made it clear in the past that in order to reuse roadwaste materials, litter must first be separated and disposed at approved facilities. ODOT has worked on developing a screening process to separate litter from street sweepings. Previous work on separation and recycling of roadside litter found that recycling the various components from litter can be difficult. The present view within ODOT is that when litter is screened from sweepings it is more economical to handle the separated mixed litter and debris as waste rather than sort and recycle it. ODOT now separates and disposes litter from sweepings around the Portland Metro area. ODOT should remain open to recycling as more and easier recycling alternatives continue to be introduced and landfill costs continue to rise.

Studies have found that contaminant concentrations in ditching wastes pose less of a concern than the levels found in sweepings and vactor waste. ODOT generally stores ditching spoils for reuse as fill material. However, ditching spoils may also merit attention as waste, especially if they display heavy impacts from petroleum constituents or if they may have been impacted by a spill of hazardous material. The management methods discussed in this report for sweepings and vactor waste can be applied to ditching materials, also.

Brush is managed by burning in some areas, but composting has become the more popular method and is now regulated by DEQ.

1.3 THE DEVELOPMENT OF ROADWASTE ISSUES

The general development of roadwaste issues in the literature focuses on progress in waste characterization, management of liquids, management of materials generated from roadways and stormwater management systems, and regulatory issues. As reflected in the bibliography in Section 8.0, the bulk of the work on this topic has been published since 1992.

Early waste characterization efforts raised concerns over heavy metal and hydrocarbon concentrations. Hydrocarbon test methods were then discussed and their applicability to roadwaste was put into question. Currently, interest focuses on specific hydrocarbon fractions.

Liquids management began by field decanting vactor liquid back into storm sewers; solids were dumped on open ground or in pits. Now, it is generally recommended that field decant be done to sanitary sewers and de-watering of solids conducted on impermeable pads. New technologies – such as in truck flocculation of solids and de-watering in mobile containers – may offer better solutions for the environment and for road maintenance organizations.

Management of sweepings and vactor residuals has progressed considerably over the last few years. Agencies have moved away from dumping roadwaste in quarries and maintenance facility back lots to disposing these materials in permitted landfills. Many are now considering roadwastes as reusable materials.

A wide range of regulations effect roadwaste management and reuse. Environmental regulatory concerns range from storage to treatment, to runoff impacting streams, to berming, to setbacks and leachate collection systems. Environmental regulations continue to tighten, with new rules promulgated to address newly recognized challenges to the environment. ODOT's project has put considerable effort into examining environmental regulations and how they might apply to roadwaste materials and their reuse.

DEQ is a continuing partner with ODOT in developing this research project and has offered guidance in identifying environmental regulations that effect roadwaste management. DEQ has also offered suggestions as to how ODOT can develop a roadwaste management plan in compliance with the existing regulatory framework. By proposing protective Best Management Practices (BMPs) for roadwaste management, ODOT can offer solutions that are effective in addressing DEQ's environmental concerns and that are efficient for ODOT and other agencies. In this way, ODOT hopes to assist DEQ at the same time it provides ODOT Maintenance Districts with recommendations to help them institute practical roadwaste management plans.

Public agencies and private parties face the same predicaments. Partnering should be encouraged to enable economies of scale. Shared resources promote efficient methods and enable practices that protect our environment. ODOT should support the creation of methods and infrastructure that make it easy to do the right thing for the environment. An improved environment now means less stringent requirements in the future.

1.4 A PHASED APPROACH TO DEVELOP BETTER SOLUTIONS

This research report is Phase 1 of a project intended to provide information to assist in the development of an ODOT roadwaste management plan. This report identifies and evaluates types of roadwaste, describes the regulatory environment, discusses liquid waste management issues, and lists and evaluates different treatment, storage and disposal methods for sweepings and vactor solids.

Roadwaste management options and possible field trials are listed in Chapter 7. The list is based on an evaluation of the methods and technologies reviewed in the literature, in discussion with other agencies and industry, and developed internally. ODOT maintenance managers and other appropriate ODOT staff, with input from the Roadwaste Technical Advisory Committee (TAC) will choose options for trial implementation. These trials will comprise the bulk of Phase 2 and will test selected methods for cost effectiveness and workability in the field. Efforts in research on cost and waste characterization will supplement the field trials. This work should assist ODOT management by better defining the problem and providing an understanding of solutions.

1.4.1 Phase 1 – Research Report Examines Roadwaste and Investigates Reuse

During Phase 1, the problems presented by roadwaste were studied. Roadwastes contaminants were evaluated and found to present less a threat than had been thought. Having carefully characterized sweepings and vactor waste, and having examined the pertinent environmental regulatory requirements, we can make reasonable arguments supporting limited reuse of these materials.

Roadwaste characterization was conducted in light of the requirement to protect the environment and with an eye to laying the groundwork for efficient management practices. A number of roadwaste management methods were compiled. A variety of options are included to address varied operational situations faced by ODOT crews and local agencies across Oregon. Of course, this review is not exhaustive and new technologies are always being developed in response to new concerns, or as better answers to known problems. To best address regulatory issues, we propose the eventual adoption of BMPs rather than regulation through site-specific DEQ water quality permits and solid waste permits.

Much of the value of Phase 1 is identifying available resources — information resources, ODOT resources, and partnering opportunities — and promoting the development of a network of resources that support the efficient and environmentally sound management of roadwaste.

1.4.2 Phase 2 - Trial Implementation

Upon completion of Phase 1 tasks, the Roadwaste Technical Advisory Committee (TAC) will reconvene. The TAC originally recommended that trial implementation be conducted by ODOT Region 1 Maintenance in partnership with Multnomah County in both urban and rural locations. The findings of Phase 1 should provide substantial input on how ODOT proceeds with Phase 2.

The findings of this report will be used to select waste management techniques for field trials. A cost analysis/feasibility assessment may be performed for solutions not suitable for field trials. ODOT and local agencies will be responsible for coordinating site set-up and implementation. Woodward-Clyde Consultants, funded by Multnomah County, are expected to provide technical support regarding sampling plans and analysis of data. $60,000 has been set aside in the ODOT Research Unit budget for Phase 2 coordination, for laboratory costs to evaluate treatment methods and bridge data gaps, and for other information gathering costs as needed.

The data collected in Phase 2 will be reviewed and analyzed. Some management methods will undergo cost analyses to assess cost effectiveness. Results of the field trials and testing to date will be compiled in a report and recommendations will be summarized.

1.4.3 Phase 3 - ODOT Roadwaste Plan

We anticipate that the results of Phases 1 and 2 will be used to develop recommendations for roadwaste management in Phase 3 of this study. It is anticipated that ODOT management and maintenance forces will develop roadwaste management plans at the District level. This way, ODOT Districts can involve local agencies and business partners in arriving at the most efficient waste management alternatives. Selected alternatives may be adopted statewide as part of all ODOT District roadwaste management plans. DEQ will be involved throughout this process.

Based on its interpretation of the findings and recommendation of this project, DEQ expects to take a more formal position towards roadwaste management, hopefully approving ODOT's BMPs in lieu of enforcing current permitting requirements. DEQ staff have anticipated the possibility that DEQ might then go into rulemaking, adopting standards and practices similar to those set forth by ODOT, in the effort to more meaningfully regulate roadwaste management and promote practices that protect Oregon's natural environment.

2.0 REGULATORY ISSUES

Sweepings and vactor waste have long been managed without the involvement of regulatory agencies. More recently, environmental regulators have identified problems with roadwaste management practices. Regulators have highlighted instances of decant water mismanagement impacting surface water environments.[1] Regulators have voiced concerns over stormwater runoff and leachate from stockpiled waste,[2] the potential for site contamination and human exposure issues[3] – problems all closely associated with waste mismanagement. ODOT has accepted the challenge of finding environmentally sound and workable solutions to the problems posed by roadwaste.

The Oregon Department of Environmental Quality (DEQ) is the primary waste management regulator in Oregon. DEQ enforces a wide range of both state and federal regulations in pursuit of its mission to protect human health and the environment. In examining regulatory issues, emphasis has been placed on laws, rules, and guidelines established by DEQ and the federal government.

2.1 DEQ INVOLVEMENT IN ROADWASTE ISSUES

If ODOT is going to have a meaningful say in developing roadwaste management options that meet DEQ compliance standards, now is the time. DEQ has supported this study, recognizing the need to clarify issues and identify options. In part, this study stems from DEQ's request that ODOT identify workable management options for roadwaste generated from Oregon's highway system. DEQ continues to review ODOT work in developing roadwaste management alternatives. DEQ expects a formal proposal from ODOT, and expects to be able to approve ODOT's recommended practices. DEQ asks ODOT to stay on its timetable leading to full-scale implementation. Public complaints and individual acts of mismanagement or widespread inaction on this issue, combined with the current level of concerns over stream health, could trigger DEQ to move forward on its own unless ODOT remains in the lead by developing and implementing solutions promptly. DEQ understands that ODOT will need time to implement changes in roadwaste management practices. DEQ staff involved in this project have suggested

---

1 Water Quality violations have been sited concerning vactor liquid mismanagement in the San Francisco Bay (telephone conversation with Tom Mumley, California Water Resources Control Board, re: Contra Costa County's vactor waste facility), Seattle (Wash. DOE, November 1996) and other Puget Sound areas (1/98 conversation with Doug Pierce, WsDOT).
2 Runoff and leachate concerns voiced by the City of Portland led to removal of roadwaste from an ODOT facility near the Columbia Slough in N. Portland (3/11/96 telephone conversation with Jeff Moore, ODOT).
3 Washington DOE, 1996. Recommendation for the Management of Street Wastes (Draft) places restrictions on public access to roadwaste largely based on health concerns over polycyclic aromatic hydrocarbons (PAHs).

June 2000 as a date DEQ would consider reasonable for statewide implementation of an ODOT roadwaste management plan.[4]

Traditionally, environmental regulations establish standards and regulators enforce those standards. When ongoing oversite of an environmental impact is seen as necessary, a permit within a specific media (e.g., air, water, or disposal on land) is often required. DEQ collects annual fees to cover the costs of compliance oversite and program administration, as well as permit application review and filing fees.

In 1993, ODOT responded to various DEQ concerns by inviting DEQ to conduct a technical assistance review of its operations across the state. DEQ issued a report providing findings, "Summary Report on Joint DEQ/ODOT Technical Assistance Project," on November 16, 1993. While mainly noting water quality and hazardous waste concerns, the report touched on sweepings and vactor waste. Among its recommendations, DEQ wrote that ODOT should:

> *Develop a state wide policy, in cooperation with DEQ's Solid Waste Program, regarding the management and disposal of street sweepings. This policy should ... give a clear direction on how to dispose of street sweepings and prohibit these wastes being dumped or stored anywhere other than an appropriate disposal site.*

So, with its understanding of the issue at that time, DEQ proposed that the material be taken to "an appropriate disposal site." DEQ was familiar and comfortable with that method of solid waste management. If a better solution cannot be found, this remains DEQ's fall back position.

ODOT argued that more workable solutions needed to be found. DEQ agreed, asking ODOT to propose alternatives. DEQ also needs evidence to show that the alternatives protect the environment. Through its continuing involvement on the Roadwaste Management Technical Advisory Committee (TAC), DEQ Solid Waste staff have participated in ODOT's efforts to identify environmentally sound and workable roadwaste management methods.

2.2 HOW THE PROBLEM STANDS IN OREGON

A DEQ Solid Waste permit is currently required for every facility treating or storing roadwaste, even on a temporary basis, unless an alternative is approved by DEQ. Tipping fees vary widely. In the Portland Metro area, typical landfilling fees are $66 per kiloton. This charge does not include costs for de-watering, transport, and expensive laboratory tests. If roadwaste landfills are sited and DEQ Solid Waste permits obtained, the operator assumes long term responsibilities; e.g., DEQ could require groundwater monitoring for petroleum hydrocarbons and other contaminants.

DEQ insists that roadwaste be managed in compliance with all pertinent environmental regulations. However, DEQ has agreed to a temporary and unofficial moratorium on roadwaste related enforcement actions while ODOT develops workable solutions. As mentioned above,

[4] Conversation with Fred Bromfeld, DEQ Solid Waste Program, April 20, 1998.

significant instances of non-compliance or verified complaints from the public regarding improper roadwaste management could compel DEQ to proceed with formal enforcement action, probably on a case-by-case basis.

Unless other workable solutions can be agreed upon, roadwaste management faces high costs and close regulatory scrutiny.

2.3 FINDINGS IN WASHINGTON STATE

Special mention should be made of findings in Washington State. Agencies in Washington have been well out in front of everyone in clarifying the issues surrounding roadwaste management.

Many important parallels exist between Oregon and Washington in regards to roadwaste management, including geographic location, climate regimes, size and population. The states' similarities in environmental regulation stem from federally promulgated rules. The Environmental Protection Agency (EPA) has authorized each state to enforce the requirements of various federal programs, including the Clean Water Act and the Resource Conservation and Recovery Act (RCRA).

The most important difference in the states' regulatory positions is that, in Washington, county health departments enforce solid waste regulations rather than the state. This has led to some inconsistency in roadwaste regulation from one county to the next. Another difference is that the Washington Department of Ecology (DOE) Water Quality Program heads up their examination of roadwaste issues, due to limited staffing in their Solid Waste Program. As a natural extension of their interest in stormwater quality, DOE's Water Quality Program drafted guidelines in 1994 for the management of roadwaste *(DOE, May 1997)*. However, after several revisions, these Best Management Practice (BMP) guidelines remain in draft. Before giving its final approval, DOE is still concerned over the resolution of two issues: polycyclic aromatic hydrocarbons (PAHs are large, complex organic molecules found in heavy petroleum fractions) and management of waste liquids. As we shall see, Oregon faces these same two challenges in the search for cost-effective and protective roadwaste management solutions.

The Washington State Department of Transportation (WsDOT) has moved ahead, managing roadwaste under the draft BMPs. WsDOT reports that costs for landfilling WsDOT's sweepings and vactor solids would top $3,000,000 per year, not including costs for lab tests typically required by landfills. *(Pierce, 1998)*

2.4 REGULATIONS IMPACTING ROADWASTE MANAGEMENT

This chapter provides a comprehensive review of the environmental laws, rules and guidelines that may be applicable to roadwaste management. Conducting a careful review is important, as roadwaste does not have a clear standing in environmental regulations. Instead, agencies managing roadwaste face scrutiny from a variety of DEQ programs. Lack of a clear understanding of the regulations or the positions adopted by regulators can lead to inadvertent non-compliance and environmental degradation or, conversely, to expensive "remedies" that may not address the real problem. A careful review can also identify exemptions from many of the requirements that otherwise face us. For instance, contaminant levels DEQ adopted for cleanup sites may help ODOT construct an argument that similar levels of contaminants should be acceptable in roadwaste materials going for reuse.

This examination includes DEQ and federal hazardous waste, solid waste, water quality, cleanup, biosolids, and air quality rules, policies and guidelines, as well as selected local land use, zoning and solid waste requirements. The impact of these regulations is summarized at the end of the chapter and other states' regulatory positions are examined as points of reference. Requirements typically imposed by waste management facilities (e.g., landfills, sanitary sewers, etc.) are addressed in Chapter 4.

2.5 HAZARDOUS WASTE REGULATIONS

Early in the process of examining the regulatory status of roadwaste, the question was whether roadwastes were hazardous wastes. If so, significant and costly restrictions would apply to roadwaste management.

In 1976, the US Congress passed the Resource Conservation and Recovery Act (RCRA) in response to events such as Love Canal. This effort was made to prevent future catastrophic releases resulting from improper management of hazardous wastes. This legislation instituted "cradle to grave" responsibility for generators of hazardous waste. RCRA gave EPA and authorized states the authority to cite penalties of up to $10,000 per day per violation. Regulators imposed and publicized stiff penalties for significant violations, giving environmental regulators an imposing reputation. The bulk of the federal hazardous waste regulations are found in Chapter 40 Code of Federal Regulations (CFR) Parts 260-266, 268, 270-272 and 279. DEQ is authorized by EPA to enforce these requirements. Oregon adopted the RCRA rule by reference and has established certain other requirements, including a set of Oregon-only hazardous wastes. *(DEQ, August 1, 1996)*

All waste generators face at least two formal requirements. Besides having to dispose or manage their waste properly, every generator must determine, for each waste that is generated, whether that waste is a hazardous waste. This important obligation applies to every outfit. If a facility generates more than 100 kg (220 lb) of hazardous waste in any given month, additional management, disposal, tracking and reporting requirements then apply.

2.5.1 Conducting a Hazardous Waste Determination

What makes a waste hazardous? The answer is complicated by RCRA regulations that attempt to provide direction for every industry and to account for the most significant and common threats posed by toxic wastes. As a result, a waste can be extremely toxic, yet fall outside the classification "hazardous waste." Another waste, significantly less toxic, may be so common that mismanagement could pose a substantial threat to the environment. To best address the observed need, the less toxic of these two wastes may be the one classed as "hazardous waste."

Under RCRA, hazardous wastes are a subset of solid wastes. So, if a material is not a solid waste, it cannot be a hazardous waste. For instance, commercial chemical products being used for their intended purpose are not wastes. Some type of materials that are recycled are not wastes and as such are exempt from regulation as hazardous waste. Sweepings and vactor waste are commonly recognized as solid wastes (see below).

Every waste must undergo a hazardous waste determination to assess if it is hazardous waste. For most waste, for example candy wrappers, you can use "knowledge of process" to determine that your waste is not hazardous. Otherwise, waste characterization is a step by step process.

The first step is to determine if the waste is a listed waste. Some wastes are listed by a specific process or industry. Discarded commercial chemical products may be listed wastes. Roadwastes do not fall into any of these listings except when impacted by spills of specific compounds. RCRA's mixture rule states that any substance containing a hazardous waste falls under the same regulations as the hazardous waste it contains. As spills occur, hazardous materials are generally removed and managed separately as part of a Haz-Mat (hazardous materials response) event.

The final step is to determine whether the waste exhibits a "hazardous characteristic." Normally, roadwaste tests nowhere near ignitable (D001), corrosive (D002) or reactive (D003) hazardous waste. Each of the remaining 40 toxicity characteristics are specific constituents each of which are listed by a specific concentration threshold. For liquids, these regulatory thresholds are defined as total concentration; for solids, these thresholds apply to the concentration expected to leach out of the solid in the acidic environment of a landfill (instead of total concentration).

RCRA's approved hazardous waste leaching test for the chemical analysis of solids is the Toxic Characteristic Leaching Procedure (TCLP). This test is run in a twenty to one dilution of solid sample to acid bath. If total cadmium in a solid sample was 10.0 parts per million (ppm), and if all the cadmium leached from the sample into the acid bath, the sample still could not test as a D006 hazardous waste. The TCLP value for cadmium in the sample could be no greater than 10 ppm/20 = 0.5 ppm, which is below the regulatory threshold of 1.0 ppm.

To evaluate a sample of roadwaste, liquids and solids would be separated and lab tests run. For example, waste that tests equal to or greater than 1.0 ppm cadmium (total cadmium if dissolved into solution or via the TCLP method for solids) is a D006 hazardous waste. Cadmium is one of eight listed metals (see Table 2.1). Other toxic constituents include specific chemical pesticides, wood preservatives, and solvents, all of which are very rare in roadwaste.

Table 2.1: RCRA Characteristic Heavy Metals

HAZARDOUS WASTE CODE	"TCLP METALS"	REGULATORY THRESHOLD
D004	Arsenic	5.0
D005	Barium	100.0
D006	Cadmium	1.0
D007	Chromium	5.0
D008	Lead	5.0
D009	Mercury	0.2
D010	Selenium	1.0
D011	Silver	5.0

Regulators have questioned whether roadwaste is a hazardous waste for toxic metals content and are concerned that spills or other incidents may impact certain loads.

2.5.2 Roadwaste is No Longer Considered Hazardous Waste

Much work has been done to characterize roadwaste. These efforts have been discussed in detail in Chapter 3. Roadwastes have undergone a surprising amount of testing in recent years and the analytical data clearly indicates that normal roadwaste is not hazardous waste. DEQ's Solid Waste program agrees that roadwastes are not normally hazardous waste. Although Washington adopted Dangerous Waste regulations in place of the framework of RCRA, DOE's waste determination process is similar. DOE agrees with findings in Oregon and elsewhere:

> *In the recent past environmental agencies suspected that street sweepings were hazardous waste due to oils, metals, and chemicals on the roadways. However, that suspicion has been largely laid to rest.*
>
> *"No," says Tony Barrett, an environmental planner in the water quality program in Washington's Department of Ecology, "We don't have any concern that street sweepings are hazardous. I don't want to say that unequivocally because there certainly could be areas where street sweepings could be hazardous due to spills or other situations, but that would be site specific. It is our belief, based on the characterization data we've been gathering for years, that street sweepings do not classify as dangerous waste." (Boyce, 1997)*

Besides spills of hazardous materials impacting specific loads, the only roadwastes now likely to exhibit a hazardous characteristic are sediments from blind sumps accumulated prior to the elimination of leaded gasoline. Waste sediments from such sumps run the chance of exhibiting the toxicity characteristic for lead and merit testing. The small amount of lead in roadwastes currently generated no longer approach the regulatory threshold of 5 ppm TCLP.

> *The US EPA and the Minnesota Pollution Control Agency (MPCA) agree. In Minnesota the feeling is that the phasing out of leaded gasoline has had a profound impact on street sweepings.*
>
> *"The street sweepings that we analyzed way back when had a lead content that could have been determined to be hazardous," says the MPCA's Gene Soderbeck. "The unleaded gasoline process is working because we don't see the lead content that we used to see. We don't view the amounts we see now as a significant health risk." (Boyce, 1997)*

Concerns regarding the presence of benzene, a carcinogenic petroleum compound found in gasoline, were also proven unfounded. Any waste having a TCLP value of greater than 0.5 ppm for benzene is a D018 characteristic hazardous waste. Because of constant weathering, whatever is volatile does not last long in roadwaste; and benzene, being highly volatile, is not present in significant concentrations in roadwaste. Besides the possibility that benzene may be present from a recent gasoline spill, no other gas, diesel, or lube oil fraction lost onto roadways from vehicles has a listed hazardous waste concentration threshold. Total petroleum hydrocarbon (TPH) concentrations are a non-factor in determining if a waste is hazardous waste.

2.5.3 The Question of Hot Loads

The validity of any hazardous waste determination is contingent on the determination being done on a representative sample of the waste. If the inputs into a waste generating process and the process itself remain the same, then DEQ can be satisfied that a previous waste characterization is still valid without the need for further testing. The wide variation in what goes into roadwaste has led regulators in some other states to ask for ongoing waste analyses. Lab tests are expensive. Instead, to establish and rely on a waste characterization for roadwaste, a method is needed to identify and screen out loads that do not fit within identified parameters and as such do merit testing or other special handling.

If we cannot effectively cull out most of the hot loads, we might be stuck with testing all our loads. Washington DOE draft guidelines require testing on roadwaste from any new location. CALTRANS keeps track of the location of spills to assist them later with roadwaste characterization and management; DOE also recommends this method. With the high cost of analytical work, the frequency of testing should be kept to a necessary minimum. The issue of testing is important to waste characterization and management and will be touched on throughout this report.

So far, we have determined that normal roadwastes are not hazardous wastes. Exceptional loads of roadwaste that are determined to be hazardous waste must be managed in accordance with the hazardous waste regulations.

2.5.4 Responsibility for Hot Loads

Environmental law requires property owners to correctly manage any wastes on their property, even if dropped off by an unidentified party. However, if a load of roadwaste tests as hazardous waste and the contamination is clearly from illegal dumping, an exemption form can be filed with DEQ.[5] Requesting that the waste not count against the generator can be important because of the more stringent management and reporting requirements, and fees, that apply when a generator exceeds 100 kg (220 lb) of hazardous waste in any month. 100 kg is well under one 55-gallon drum.

Metro has a program offering free field screening, free pickup, and free disposal of hazardous waste illegally dumped within its boundaries. The waste must be properly containerized. To meet its DEQ permitting requirements, Metro can only accept waste that could likely have been generated by a conditionally exempt generator (under 100 kg per month). Metro and DEQ can help with this judgement call. DEQ can also investigate to determine whether the generator can be identified. To contact the Metro Hazardous Waste Program, telephone Jim Quinn, Program Supervisor, at (503) 797-1662. Telephone your local DEQ office for assistance with hazardous waste issues.

---

[5] This form is part of DEQ's "Abandoned Hazardous Waste" fact sheet. A copy in provided in the Appendix.

Further discussion of the requirements for managing hazardous waste is beyond the scope of this report. However, we may have reason, given the management options we adopt, to manage non-hazardous but problem wastes separately from the main waste stream. This may be especially true of wastes impacted by substantial releases of petroleum products.

2.5.5 From Disposal as Hazardous Waste to Examining Reuse First

Roadwaste entered the regulatory arena at a time when hazardous waste authorities were seeking to raise the level of concern over all wastes in an effort to stem the threat toxic waste posed to the environment. If roadwastes were first discussed in the present regulatory climate, waste reduction and reuse would be examined first.

Recent efforts in hazardous waste legislation have established non-enforcement Hazardous Waste Technical Assistance programs to assist generators. With this change has come an emphasis on pollution prevention. Some industries, by changing processes or by reducing the toxicity of materials going into those processes, have reduced their hazardous waste generation substantially and thus have become more efficient and more profitable. Reuse, recycling and waste reclamation options are now promoted over costly long-term waste storage and destruction technologies.

The promotion of alternatives to disposal is finding its way into the regulations. For example, mercury-contaminated fluorescent lights and thermostats, batteries, and pesticides are now handled under Universal Wastes Rules rather than as hazardous waste. These commonly generated wastes now face less stringent requirements and are easier to recycle. Managing Universal Waste is far less burdensome than facing hazardous waste requirements, but some recordkeeping, registration and storage limitations still apply.

Legislators know that rules cannot cover every contingency. Legislators created sweeping authority for environmental regulators. They also built in loopholes to enable regulators to exempt specific wastes when the rules placed inappropriate burdens. Even within the stringent hazardous waste regulations, there existed early on an exemption for materials that are beneficially reused.[6] We will find that the solid waste rules have similar built-in exemptions. Regulators are called on to use their professional judgement in allowing these exemptions.

To some degree, roadwaste still suffers from its early perception as a problem waste. Concerns over unknowns are natural. The fact that normal roadwaste is not hazardous waste does not mean that concerns are unwarranted or that roadwaste is free from constituents of concern. As discussed below, roadwaste includes low levels of carcinogenic petroleum compounds, other more common petroleum constituents, and low levels of heavy metals. Spilled toxic materials, broken glass, hypodermic needles, and other hazardous materials can also be found in some roadwastes.

[6] Telephone conversation with Gary Calaba, DEQ Hazardous Waste program, 2/18/98.

2.5.6 Hazardous Waste Regulatory Summary

We have discussed the requirement to conduct a hazardous waste determination. We have determined that roadwaste is not normally hazardous waste. Roadwastes impacted by a release of hazardous waste or hazardous materials may be hazardous waste. We have found that regulators are often called upon to use professional discretion when questions arise as to the applicability of a rule to a situation at hand. The hazardous waste regulations are very prescriptive and this is often viewed as a negative. Although other DEQ programs provide more flexibility, it is not always clear which of their requirements apply to roadwaste management.

2.6 SOLID WASTE REGULATIONS

DEQ's Solid Waste program is taking the lead in developing DEQ's position on roadwaste. Oregon's Solid Waste regulations are set forth in Oregon Administrative Rule (OAR) Chapter 340, Divisions 93 through 97. *(DEQ, July 1997)* The federal rules are listed under 40 CFR parts 257, 258, and 259.

2.6.1 What is a Solid Waste?

Oregon Revised Statute (ORS) 459.10 and OAR 340-093-0030(83) define solid waste:

> *"Solid waste" means all useless or discarded putrescible and non-putrescible materials, including but not limited to garbage, rubbish, refuse, ashes, paper and cardboard, sewage sludge, septic tank and cesspool pumpings or other sludge, useless or discarded commercial, industrial, demolition and construction materials, discarded or abandoned motor vehicles or parts thereof, discarded home and industrial appliances, manure, vegetable or animal solid and semi-solid materials, dead animals and infectious waste, as defined in ORS 459.386. Solid waste does not include:*
>
> > *(a) Hazardous waste as defined in ORS 466.005.*
> >
> > *(b) Materials used for fertilizer or for other productive purposes or which are salvageable as such materials and are used on land in agricultural operations and the growing or harvesting of crops and the raising of animals.*

The reader will note that the Oregon statute is not consistent with RCRA, which says that for a waste to be a hazardous waste it must first be a solid waste. Oregon's Solid Waste Program predates the federal program, and DEQ lives with this inconsistency. DEQ's Solid Waste Program has two main areas of interests: traditional municipal and industrial landfills; and, new solid waste reduction and recycling programs.

The Massachusetts Department of Environmental Protection (DEP) states: "unless there is an indication that [roadwastes] have been subject to mixture with a hazardous waste, the Department will not require street sweepings or catch basin cleanings … to be routinely tested before disposal. Therefore, street sweepings and catch basin cleanings will typically be classified as solid waste. As is the case with any waste, the generator has the ultimate responsibility for determining whether the waste is a hazardous waste." *(Mass. DEP, April 1995)* DEQ's position is in agreement with DEP. DEQ sees the solid waste regulations as the most applicable to roadwaste management and DEQ Solid Waste staff see more testing as unnecessary for management at permitted DEQ solid waste landfills.

2.6.2 What is an Inert Material?

One way wastes are exempted from solid waste requirements is as inert material. OAR 340-093-0030(47) offers this definition:

> *"Inert" means containing only constituents that are biologically and chemically inactive and that, when exposed to biodegradation and/or leaching, will not adversely impact the waters of the state or public health.*

Materials that DEQ accepts as inert are few. DEQ defines clean fill under OAR 340-093-0030(13). DEQ recognizes the following materials as clean fill: uncontaminated dirt, sand and rock, concrete, brick, and weathered asphalt. Wastes with a high organic content are not considered inert because, as they degrade, they release nitrogen and other compounds that may contaminate groundwater. High organic content materials make poor fill due to settling and drainage problems.

For any other material to be exempted from solid waste requirements as an inert material, a DEQ Inerts Determination is required. Each determination is made on a case-by-case basis. DEQ charges $500 for conducting each Inerts Determination and requires laboratory tests and site evaluations.

Recognizing the regulatory difficulties facing municipalities and street sweeping businesses in managing sweepings, DEQ asked member organizations of the Metro Street Waste Group whether a case could be made to exclude street sweepings from regulation as waste, perhaps as an inert material.[7] Members of the group did not pursue an inert materials classification. The group suggested that other remedies to the problem of street waste management be sought. Given waste characterization studies published to this point, it would be highly unlikely that DEQ would find it protective to include sweepings in its list of inert materials and members did not want to specify contaminant levels as that could necessitate costly ongoing analysis.

2.6.3 Roadwaste Storage, Disposal and/or Treatment Sites

Unless allowed by DEQ's Solid Waste program, any facility storing waste must have a DEQ Solid Waste facility permit. DEQ Solid Waste staff has stated that they are open to permitting roadwaste landfills.

Monies paid to DEQ for issuance and oversite of these permits are small compared with the agency expense to site the landfills, prepare permit applications, possibly monitor groundwater

[7] Dave Kunz, DEQ Solid Waste Program, at the November 11, 1997, Metro Street Waste Group meeting.

for contaminants, provide security, and provide in-house oversite sufficient to insure that permitted facilities are operated in compliance with permit conditions. Given the immobile nature displayed by the contaminants in roadwaste, landfilling represents a sound environmental alternative. The advantages of landfilling must always be evaluated against the potential for future liability. Evaluation of agency-operated landfills must also consider eventual costs associated with landfill closure. Landfilling options, DEQ requirements, and examples in Oregon and Washington are discussed in Chapter 6.

2.6.4 Recycling and Reuse

Roadwaste materials going for reuse may be exempt from solid waste management requirements. OAR 340-093-0030(76) defines reuse:

> *"Reuse" means the return of a commodity into the economic stream for use in the same kind of application as before without changing its identity.*

This provides a substantial exemption for materials going for use as compared to wastes *per se*. Of course, professional judgement plays a large role in determining when this exemption should apply. If roadwaste sent for reuse had a lot of garbage or contaminants along for the ride, DEQ would very likely disallow this exemption. However, if the materials were screened, the trash managed to a landfill permitted to accept municipal garbage, a case for reuse begins to be built. And if no contaminant posed a hazard to human health or the environment in the methods of reuse selected, then DEQ would very likely rule the reuse legitimate.

The definition states that the material was returned for "the same kind of application as before." Screening and washing sand applied on icy roads for reuse meets this last condition completely. It would seem likely that DEQ would see reuse in concrete or asphalt mix, road subgrade, construction soil, soil amendment — more or less any applications usual for soil, sand or gravel – as meeting this requirement.

To determine reasonable levels of roadwaste contaminants for particular reuses, we will examine Oregon's cleanup regulations later in this chapter. The discussion in this and later chapters helps define reasonable conditions for reuse.

2.6.5 Composting Regulations

Composting requirements bear examination. Although not specifically inclusive of roadwaste, composting regulations are generally less restrictive than solid waste landfill and transfer station requirements. The composting requirements discuss two different inputs, green waste and non-green waste. Green waste is plant material, such as leaves and trimmings, etc., which if properly managed can undergo decomposition into mulch. If managed improperly, nuisance odors or fires often result. Non-green wastes face more stringent requirements to protect against pathogens and strong odors from composting dead animals, animal parts, household and restaurant wastes. Roadwaste does not fit neatly into either category.

A useful exemption from the requirement to register with DEQ as a composter and/or obtain a permit are extended to, "Composting facilities or agricultural composting operations utilizing less than or equal to 20 tons of green or non-green feedstocks for composting in a calendar year." *(DEQ, September 1997)* This exemption may be useful for maintenance yards that bring in very small amounts of material. Such operations could conduct composting on-site without a permit, which would otherwise be required after February 1, 1999. With the approval of DEQ's Solid Waste Program, maintenance yards could choose to screen roadwaste, dispose of the litter, and compost the rest with its green waste.

2.6.6 The Impact of Solid Waste Regulations on Roadwaste Management

DEQ wants to prevent solid waste contaminants from entering groundwater and to prevent problems related to erosion and stormwater run-off. These concerns apply to roadwaste storage. The materials storage requirements for composting facilities may form a good model for roadwaste management facility BMPs, though other models may be equally valuable. Ongoing problems with odors, fires, high levels of human pathogens, and vectors (disease carrying rodents, birds and insects) led DEQ to develop rules specific to municipal landfills and composting operations. Except for the high organic content in municipal leaf and tree trimmings cleanup, none of these concerns apply to the normal run of sweepings or catch basin waste. To provide the greatest operational flexibility, roadwaste management is best kept out of the permit process.

For roadwaste, professional judgement could allow DEQ to replace solid waste facility permit requirements for any facility storing or treating waste with a set of Best Management Practices (BMPs) that address concerns specific to roadwaste. Such BMPs could be developed by the agencies with DEQ input, come out in the form of a policy statement from DEQ, or be adopted in rulemaking specific to roadwaste. DEQ will be encouraged to use flexibility in applying its standard solid waste requirements if ODOT proposes roadwaste management solutions that are protective of the environment.

2.7 WATER QUALITY REGULATIONS

2.7.1 General Water Quality Statutes

Oregon's Water Quality statutes prohibit water pollution except as allowed under the conditions set forth in a permit issued by DEQ. ORS 468B.025(1) states:

> *"... no person shall:*
> *(a) Cause pollution of any waters of the state or place or cause to be placed any wastes in a location where such wastes are likely to escape or be carried into the waters of the state by any means."*

Surface waters are streams, lakes, ponds, and wetlands. In Oregon, groundwater is also protected as waters of the state.

2.7.2 Water Quality Permits

Water Pollution Control Facility (WPCF) permits protect groundwater. Oregon's WPCF program addresses on-site sewage disposal, treatment lagoons, holding tanks and holding ponds. National Pollution Discharge Elimination System (NPDES) permits protect surface waters, setting limits for direct discharge from industry and municipal sewage treatment plants. The federal Clean Water Act mandates NPDES requirements. DEQ implements these programs in Oregon, testing water quality in Oregon streams and setting discharge limits to protect aquatic environments. The practice of field decanting vactor truck liquids back into the storm sewer is an activity regulated under the Clean Water Act and, technically, requires a separate NPDES permit for each point of "process water" discharge.

2.7.3 Non-point Source Pollution

EPA realized that significantly reducing the impact of industrial and municipal wastewater discharges alone was not resulting in healthy streams. Regulators identified non-point source pollution as a major source of contaminants. Non-point source pollution includes run-off from roads, farms, construction sites, and other properties and structures that can negatively impact stream health. Stormwater permits are now being required of certain agencies and industries (including larger construction sites) that discharge non-point source pollutants through stormwater systems.

The Clean Water Act stipulates that the operator of any public stormwater out fall must be covered under a permit. ODOT permits stormwater out-falls in the municipalities that currently have DEQ municipal stormwater permits: the major metropolitan areas of Portland, Salem, and Eugene. However, with the second tier of stormwater permits coming on line, the area impacted by this rule will expand into smaller communities. (ODOT is considering whether or not to pursue its own statewide operating permit in lieu of entering into permit agreements with many smaller municipalities; this subject passes outside the scope of this report.)

No stormwater requirement exists as yet specific to roadwaste management facilities. The general requirements of the statute take precedence. In its 1993 Summary Report, DEQ discusses stormwater discharge.

> *Even though ODOT is not required to obtain [stormwater discharge] permits for the majority of facilities, ODOT has a potentially serious environmental problem created by rainwater falling on its facilities becoming contaminated and then carrying that contamination off the facility. This issue needs to be addressed for the purpose of limiting ODOT's liability. (DEQ, 1993)*

For our purposes, this means that rain must not be allowed to come into contact with roadwaste contaminants and transport these contaminants to surface waters. Concern must also be given to prevent movement through dry wells, cracked bedrock, gravel, sand, soil, or through any other porous medium into the subsurface where contaminants may impact groundwater.

2.7.4 Contaminants of Concern

It is important to recognize that contaminants that may easily biodegrade in the oxygenated environment at the ground surface, or are elsewhere part of the natural world, may not break down in the oxygen-depleted environment of groundwater. Nitrogen compounds, for instance, are necessary to support plant life. However, nitrogen compounds pose significant health concerns when concentrations develop in the groundwater table.

For surface water, the discussion is also not limited to contaminants such as petroleum. A wide range of metals and chemical compounds are contaminants of concern in the aquatic environment, and regulatory levels often trigger at much lower concentrations than on land. Measurements that have no impact on site contamination – such as Total Suspended Solids (TSS) and Biological Oxygen Demand (BOD) – can cause serious negative impacts in streams. The general turbidity rule limits TSS, from the point surface water enters a property until it leaves the property, to a 10 percent increase. This rule is meant to discourage siltation of stream beds and to keep stream waters clear. Fish spawning areas are destroyed when the gravel beds are buried in sediment. Clear water makes for a healthier environment for fish. Biological Oxygen Demand measures the amount of oxygen that bacteria take out of the water while processing a food source. High BOD wastes can reduce the amount of oxygen available to aquatic life; acute releases of nutrient-rich wastes have often led to fish kills impacting a stream for miles.

2.7.5 DEQ's Water Quality Division: Concerns and Non-Issues

In conversations with DEQ, field decant of vactor waste was discussed. DEQ's Water Quality Division provided preliminary approval to field decant vactor liquids in areas where waters of the state will be protected.[8] Oregon DEQ recommends an end to the current practice of field decanting back into storm drain catch basins, stating that vactor liquids should be disposed to the sanitary sewer. Washington DOE's guidelines are still in draft partly due to uncertainty as to whether field decant to storm sewers can be managed in such a way that the environment is protected. DOE's draft guideline requires 24-hour detention of the decant solution to promote solids drop out. This requirement is thought difficult to manage and little data is available to show that this method prevents the eventual discharge of the contaminants in the suspended solids to streams. Field decant to sanitary sewer is the best alternative, where available. Field decant to designated surface areas may be the next best method.

Good general practices and procedures for limiting impacts to water quality can be found in numerous sources, including publications by EPA, DEQ, and the City of Portland's Bureau of Environmental Services. These practices include management on impermeable surfaces to protect groundwater, inside bermed areas with water retention and treatment to protect surface water. Many maintenance facilities are located close to wetlands or surface water; reasonable

[8] Jurisdictions such as Springfield, Oregon, have in the past chosen not to clean sediment and debris from their storm sewers because affordable methods of liquid and solid waste management were not available to them. This certainly can lead to more problems than approving protective measures raising minimal environmental concerns.

setbacks from storage and treatment areas, moving waste out of flood plains, and other sound measures should be taken to minimize the chance of releases impacting the environment.

DEQ's Water Quality program has sweeping powers. The water quality statute allows DEQ to regulate any discharge or threat discharge, which means they could regulate anything. The powers possessed by DEQ's Water Quality program demand judicious use of its discretionary authority. In many areas, Water Quality staff must act more on the basis of their professional judgement than on written requirements.

ODOT is involved in Oregon's Salmon Recovery Plan, has stormwater permits facing tightening requirements DEQ's effort to enhance and protect stream health, and has projects facing tighter scrutiny. ODOT should plan so that it is easy to do the right thing; a proactive stance towards partnering with other agencies and private operations is one way. That way the environment wins and ODOT wins in the future. On the other hand, if stream health continues to deteriorate, ODOT should plan on facing much more stringent and potentially inflexible requirements.

2.8 DEQ'S CLEANUP PROGRAMS

How do DEQ's cleanup programs relate to managing roadwaste? The short answer is that they don't – at least not directly. But when we look for numbers to justify solutions other than managing the material at permitted landfills, we need a starting place to make a case that the solutions we propose are protective of the environment. This discussion is best considered in light of input from DEQ's cleanup programs. To determine whether contaminants pose a risk, you must evaluate the proposed use for the site or the waste material.[9]

Cleanup levels themselves are changed due to new findings regarding risk. Recently, industry pushed for risk-based action levels that can be applied on a site-by-site basis, rather than relying on numeric thresholds for individual contaminants. DEQ and US EPA have moved to address these concerns by adopting Toxicity Equivalent Factors (TEFs), which could help describe pathways to protective reuse of roadwaste. The action levels discussed in the following sections are representative of DEQ cleanup levels as they now stand. These numbers will probably remain the default, except where additional findings or constituents of concern are recognized. Standards can change, however, and we may find ourselves trying to hit a moving target.

Regardless of the care taken characterizing a waste, the possibility always exists that a threat to the environment not yet fully recognized may later cause us to revise our methods or revisit past practices. This concern should not paralyze our efforts. However, given the wide range of contaminants that might impact roadwaste, management methods that minimize potential human exposure and environmental impact merit heightened consideration. Long-term environmental liability established under federal Superfund laws highlights the importance of thinking ahead.

[9] Telephone conversation with Michael Anderson, DEQ UST Cleanup Program, 2/6/98.

2.8.1 Underground Storage Tank (UST) Cleanup

In looking to clarify regulatory thresholds for roadwaste, agencies often look to their state's UST cleanup program for non-action levels for petroleum contaminants. County health departments in Washington State look to DOE's Model Toxics Control Act (MTCA) for numeric guidelines. UST cleanup levels can provide useful guidelines, but these numbers do not constitute a regulatory threshold except for cleanup of petroleum contamination at UST cleanup sites. DEQ has not extended these action levels to other materials or sites except on a site-by-site basis. This said, DEQ's UST soil cleanup values for diesel fraction petroleum hydrocarbons range from 100 to 1000 ppm, depending on depth to groundwater, annual rainfall, soil type, groundwater resources, and potential receptors. *(DEQ, January 1995)*

As discussed in detail in Chapter 3, laboratory tests traditionally applied to determine petroleum hydrocarbons concentrations at UST cleanup sites often produce inaccurate results when used to analyze roadwaste. Natural organic matter falsely elevates total petroleum hydrocarbon (TPH) results. We should also emphasize that compared to the high concentrations of gasoline and diesel normally found at UST cleanup sites, lab tests on roadwaste identify hydrocarbons that are larger and much less mobile, generally starting at the high end of the diesel range. Petroleum compounds in roadwaste are tightly sorbed to particles and can be bound up in organic matter. These problems limit the usefulness of UST cleanup thresholds to roadwaste management.

Unmodified use of UST cleanup levels for diesel contaminated sites overstates the risk posed by most petroleum compounds found in roadwaste, even if a TPH test suitable for roadwastes is developed. Risks from TPH alone should not hold roadwaste management to requirements as stringent as those imposed on UST cleanup materials.

However, we know that roadwaste generally contains low levels of petroleum hydrocarbons and it would be foolish to disregard the UST cleanup model altogether. DEQ has developed petroleum cleanup guidance also of value to roadwaste management. As we shall see in Chapter 6, treatment technologies developed to meet the needs of UST cleanups may find application in roadwaste management. For reference, DEQ's one-page "Policy for Reuse of Petroleum Contaminated Soil" *(DEQ, September 16, 1992)* is provided in Appendix H4. Models for proper storage of roadwastes can be seen in "Treatment of Petroleum Contaminated Soil" and other DEQ UST Cleanup guidance referenced in our Bibliography. *(DEQ, March 1995; et al)*

2.8.2 Superfund, SoClean, and Risk-Based Cleanups

Superfund is the common name for the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA). Congress passed Superfund to establish requirements for long term environmental liability. Similar to RCRA's cradle to grave requirements, CERCLA places the responsibility for environmental contamination on the waste generator. However, CERCLA goes beyond the generator to include any party that benefited from the practices which led to the contamination problem. Persons who hired a chrome plater, disposed in another's landfill, or accepted other's waste could be held liable for an eventual cleanup if an environmental threat was recognized resulting from actions that were of benefit to them.

Superfund also reaches into the past to cover waste management practices prior to hazardous waste laws, applying to waste management practices which lead to environmental clean ups not specifically addressed under RCRA and UST Cleanup laws.

DEQ developed numerical soil cleanup numbers for non-petroleum contaminants. DEQ's Soil Cleanup rule also provides toxicity information and most likely pathways to impact human health. These standards apply to simple soil cleanups, only; if groundwater is impacted, a more complicated procedure (developed by EPA) is usually required. "SoClean" is the common name given to DEQ's Soil Cleanup rule. As with UST Cleanup levels, SoClean "no further action" levels are not directly applicable to roadwaste management. However, if the contaminants in roadwaste test below the applicable cleanup threshold, a good argument can be made that roadwaste is appropriate for reuse.

As we shall see in Chapter 3, lessening concerns over total petroleum hydrocarbons led researchers to a closer examination for other potential hazards. Research has shown that petroleum hydrocarbon concentration in roadwaste declines substantially during storage of sweepings and damp storage of vactor waste. Even in relatively high TPH loads, weathering alone often reduces concentrations below no further action under DEQ's UST Cleanup protocol. Naturally occurring bacteria were credited with degrading these petroleum products and returning them to the carbon cycle. A small fraction of the hydrocarbons did persist even under the best conditions for natural biodegradation. Why? It was found that multi-ringed hydrocarbon molecules, polycyclic aromatic hydrocarbons (PAHs), were present in the waste. (PAHs are sometimes referred to as "Polynuclear Aromatics" [PNAs].) Larger PAHs are difficult for naturally occurring bacteria to degrade and some of the large PAHs found in roadwaste are known carcinogens (CPAHs). CPAHs are very slow to degrade in the natural environment.

Seven PAHs have been listed as known carcinogens. The residential cleanup level for each CPAH is 0.1 ppm; the industrial cleanup level is 1.0 ppm. SoClean cleanup levels for selected PAHs are listed in Table 3. Since PAHs are relatively immobile, significant risk in soil is based on the potential that the dirt is ingested (eaten). This is quite unusual, as exposure pathways are normally based on contaminants leaching to groundwater.

Table 2.2: Selected PAHs from the Oregon Soil Cleanup Table
(mg/kg = ppm)

Selected PAHs	Maximum Residential Cleanup Standard	Maximum Industrial Cleanup Standard	Acceptable Leachate Concentration Level (mg/l)	Minimum Threshold for Cleanup Action	Adverse Health Effect	Pathway
Anthracene	80,000	600,000	10	20,000	++	A
Benzo(a)anthracene	0.1	1	0.002	0.1	Cancer	C, E
Benzo(a)pyrene	0.1	1	0.002	0.1	Cancer	C
Benzo(b)fluoranthene	0.1	1	0.002	0.1	Cancer	C, E
Benzo(k)fluoranthene	0.1	1	0.002	0.1	Cancer	C, E
Chrysene	0.1	1	0.002	0.1	Cancer	C, E
Dibenzo(a,h)anthracene	0.1	1	0.002	0.1	Cancer	C, E
Fluoranthene	10,000	80,000	60	8,000	Noncancer 2, 3, 4	A
Indeno(1,2,3-cd)pyrene	0.1	1	0.002	0.1	Cancer	C, E
Pyrene	8,000	60,000	100	6,000	Noncancer 2	A

(DEQ, April 1994)

Pertinent Notes from the Oregon Soil Cleanup Table Key:

A = Concentration is based on potential leaching to groundwater
C = Concentration is based on incidental soil ingestion and an excess cancer risk of 1 in a million
E = Based on the potency of Benzo(a)pyrene
H = Leachate concentration is derived from a concentration that is based on water ingestion and an excess cancer risk of 1 in a million
I = Leachate concentration is derived from the drinking water maximum contaminant level
K = Leachate Concentration

Adverse Health Effects:

1 = adverse gastrointestinal effects
2 = adverse effects
3 = adverse liver effects
4 = adverse blood effects
7 = adverse central nervous effects
12 = adverse skin effects
++ = No observed effects noted

The values in the table are applied to soil cleanups in roughly the following manner. The site assessment process identifies contaminated areas and contaminants of concern. A sampling plan is developed and soils from impacted areas are tested for these contaminants. If they test below minimum action levels, no further action is usually required.

If contaminant concentrations are above minimum action levels, samples are further tested to determine whether contaminants could leach in sufficient quantities to impact groundwater. SoClean leachate concentrations can be evaluated using either the TCLP or the Synthetic Precipitation Leaching Test (SPLT; EPA Method 1312) methodologies. If the samples test below the leachate concentration threshold value, the easier to meet cleanup levels in the appendix apply. If leachate values are above acceptable levels, the site must be cleaned up to meet the more stringent standards of the primary table, listed here as the minimum cleanup action threshold. If more than one contaminant of concern is present, evaluation of risk can become complicated even under the easier to meet appendix values; cumulative risk must then be assessed prior to closure. This is a general sketch. Given specific site conditions, DEQ may invoke other requirements including an examination of ecological risk.

Appendix 1 to Oregon DEQ's Soil Cleanup Table presented in the DEQ Cleanup Manual (*DEQ, April 1994)* provides values for residential and industrial cleanups. Residential cleanups are usually held to a standard excess cancer risk of one in a million. Industrial cleanups are usually held to excess cancer risk of one in 100,000. As a condition for site closure, DEQ often negotiates deed restrictions to allow contaminant levels to exceed cleanup values. Future use of the property is usually limited to industrial applications thereafter.

Reviewing data from the many reports collected for this study, Total PAHs in roadwaste were not seen above 700 ppm. As can be seen from the cleanup values in Table 2.2, it is highly unlikely that non-carcinogenic PAHs would ever pose a significant risk from roadwaste. However, roadwaste is usually found to have individual CPAHs above the 0.1 ppm residential cleanup threshold, and sometimes above the 1.0 ppm industrial cleanup threshold.

In response to industries call for risk-based cleanups, EPA re-evaluated the risk posed by the seven different CPAHs. Risk had been based on the most carcinogenic PAH, benzo(a)pyrene. Toxicity Equivalent Factors (TEFs) evaluate the carcinogenicity of each CPAH. TEFs allowed EPA to propose Preliminary Remediation Goals (PRGs) for CPAHs above 1.0 ppm at industrial sites depending on which CPAHs are present. The State of Oregon accepted the use of TEFs if CPAH concentrations exceed SoClean thresholds. However, Oregon has not selected which PRGs to use. This rule is currently in flux, and EPA is wavering on their proposed guidelines. PRGs for CPAHs will be discussed in more detail in Chapter 3.

When heavy metal contamination is present, leachate tests are always required. The leachate concentration cleanup levels are the same values as the minimum cleanup thresholds. If the leachate number is met, the site must still not exceed the maximum cleanup levels. Risk to human health is sometimes considered on a cumulative basis if more than one contaminant of concern is present. Table 2.3 presents leachate and total concentrations for metal contaminants.

Table 2.3: Selected Heavy Metals from the Oregon Soil Cleanup Table
(mg/kg = ppm)

Selected Heavy Metals	Maximum Residential Cleanup Level	Maximum Industrial Cleanup Level	Acceptable Leachate Concentration Level (mg/l)	Adverse Health Effect	Pathway
Arsenic	0.4	3	0.004	Cancer	H
Cadmium	100	1,000	0.5	Noncancer	I
Chromium	1,000	1,500	10 (total)	Noncancer 3	I
Copper	10,000	80,000	100	Noncancer	I
Lead	200	2,000	2	Noncancer	K
Mercury	80	600	0.2	Noncancer 2, 7	I
Silver	1,500	10,000	5	Noncancer 12	I

(DEQ, April 1994)

2.9 SPILL REGULATIONS

DEQ's Spill Program has provided input on how spills can lead to petroleum getting into roadwaste.[10] Some spills come from slow leaks, impacting long stretches of roadway. These events are difficult to clean up. Sometimes, the agency in charge of the road will sand to improve traction problems from slick diesel sheen. This sand material is not normally collected promptly, getting moved to the side of the road by traffic. ODOT sometimes argues that removal of petroleum contamination in a shoulder would weaken that section of shoulder and pose a threat to public safety. DEQ makes allowances to help ODOT keep traffic moving safely. Care with shoulder work is a reasonable precaution, but loading of contaminants into materials along the corridor should be carefully considered when making the decision on when cleanup contractors should halt work.

2.10 BIOSOLIDS AND INDUSTRIAL SLUDGE APPLICATION

Programs setting standards for land application of biosolids and industrial sludge offer different input. "Biosolids" are sludges from sewage treatment. At DEQ, the biosolids application program is managed under the Water Quality program; this program handles sludge from wastewater treatment plants. Industrial sludges come from industrial processes. As with cleanup levels, concentration guidelines established by these programs do not define allowable contamination thresholds for roadwaste reuse.

EPA sludge application guidelines proposed a standard of 15 ppm for CPAHs.[11] This is for an agronomic rate of fertilizer applied infrequently to non-truck crops. No thresholds have been developed in Oregon for contaminants in fertilizers, but action will probably be taken on this issue over the next several years.[12] Careful consideration must be given to whether biosolids thresholds or cleanup thresholds are more appropriate for CPAHs. Where roadwaste is used as a soil amendment, perhaps the protective value lies between the two numbers?

2.11 AIR QUALITY REGULATIONS

DEQ air quality regulations should have little impact on roadwaste management. Most air quality regulations pertain to facilities operating under a state Air Contaminant Discharge Permit (ACDP) or a federal Title V Permit. Most emission thresholds are defined by rule at 10 tons for state permits and 100 tons (10 tons for any one hazardous air pollutant) for federal permits. The only instance an air permit might be required to manage roadwaste is when a treatment process requires a categorical ACDP permit. For instance, treatment of petroleum contaminated soil in a thermal desorption unit requires an ACDP.

However, the "Fugitive Emissions" rule, OAR 340-21-050 through 060, sets general standards applicable to all facilities. For roadwaste management, this means that dust from waste

---

10 Telephone conversation with Loren Garner, DEQ Spill Program, 2/18/98.
11 Telephone conversation with Tony Barrett, Washington DOE's Water Quality Program (January 1998).
12 Telephone conversation with Bruce Henderson, DEQ Biosolids Application Program (February 1998). An EPA Fact Sheet "Waste Derived Fertilizers" is attached in the Appendix.

screening or waste storage must not be allowed to cause nuisance conditions on other properties. Nor may nuisance odor conditions result from composting, roadwaste treatment or storage. This one page rule is provided for reference in Appendix H8. Violations of these provisions may constitute actionable nuisance conditions.

DEQ's "Rules for Open Burning," OAR 340 Division 23, set limits on waste disposal via outdoor burning. Certain wastes may not be burning anywhere in Oregon at any time: wet garbage, plastics and petroleum, food waste and any waste that releases dense black smoke or noxious odors. This prohibition probably includes roadwaste, due to trash and petroleum products. These rules also include the general policy statement that DEQ discourages disposal through open burning. In the past, DEQ has cited ODOT for violation of commercial open burning rules. If burning is an ongoing disposal method at a facility, a DEQ Solid Waste Disposal Facility permit may be required.

An exemption for public agencies is listed in DEQ's open burning rules:

> *Fires set or permitted by any public agency when such fire is set or permitted in the performance of its official duty for the purpose of weed abatement, prevention or elimination of a fire hazard, or a hazard to public health or safety or instruction of employees in the methods of fire fighting, which in the opinion of the agency is necessary. (OAR 340-23-035(3))*

This seldom used exemption pre-dates composting programs now in place in most metropolitan areas. Open burning regulations vary between geographic regions and with population density. Burning is often banned near urban areas. Local fire departments and the State Fire Marshal's Office also regulate open burning, setting burn days and establishing other requirements.

2.12 LOCAL REQUIREMENTS

Local land use, water quality, and zoning regulations can impact roadwaste management.

- Clackamas County instituted a moratorium on new composting facilities.

- Cottage Grove placed a moratorium on petroleum contaminated soil remediation. Other cities have banned off-site treatment. While such regulations typically apply only to petroleum contaminated soils from UST cleanups, it is fair to say that this interest or separate initiatives may in the future be directed towards problems perceived at roadwaste facilities.

- Metro has developed a composting licensing program similar to DEQ's new program. In its public notice, DEQ states, "An intergovernmental agreement allowing composters within the boundaries of Metro to enjoy 'one-stop shopping' for both their Metro license and DEQ permit should be finalized soon." *(DEQ, February 1998)*

- The City of Portland required that ODOT move roadwaste located near the Columbia Slough, citing potential water quality impact.

This list is by no means comprehensive. These local regulations are mentioned to alert the reader to the possibility that local requirements might impact roadwaste management. Given that ODOT operates within so many different jurisdictions, ODOT should take a proactive stance to protect the relative flexibility which local regulations normally provide for management of roadwaste.

2.13 OTHER ROADWASTE PROGRAMS

Most state environmental regulatory programs have not yet developed a position specifically addressing roadwaste management. Requirements for roadwaste management in most other states are in the early stage of development. Very few departments of transportation have roadwaste management programs; known examples are discussed here. Some work is being done at the local level, and many agencies in Oregon have solutions for some roadwastes (e.g., de-watering, composting, sand recovery); but no agency has a comprehensive system in place.

WsDOT has conducted several large-scale roadwaste application projects at interchanges and along highways. WsDOT mixes roadwaste with mulch and barkdust prior to application. They have done analytical work on the sites, the materials applied, and followed up with tests for mobility of contaminants. WsDOT is publishing reports now on their progress.

WsDOT is following DOE draft guidelines from "Recommendations for Management of Street Waste." *(Wash. DOE, November 1996)* As was stated earlier in this chapter, DOE's guidelines and report remain in draft due to concerns over CPAHs and whether field decant of vactor liquids to storm drains can be done protectively. DOE states: "This document does not constitute regulation, but is a recommendation for those entities that have regulatory authority … Jurisdictional Health Districts (solid waste), some Public Owned Treatment Works (liquids), and the Department of Ecology (dangerous waste, liquids, and cleanup standards)."

DOE has created four classes of street waste solids, as follows:

1. Construction Street Waste (allowed for reuse from the property of origin);

2. Uncontaminated Street Waste Solids (grass and leaves; coarse road sand, which reflects low traffic impacts and can expect to be uncontaminated [>50% coarse sand fraction], is reusable for road sanding once screened for litter);

3. Solid Waste Street Waste ("vast majority of street waste"; limited reuse allowed – for further information see the two-page selection from DOE's draft guidance attached in Appendix B3);

4. Dangerous Waste (known or suspected hazardous wastes are segregated and handled under DOE's Dangerous Waste regulations).

DOE states that because of a lack of analytical data, their policy does not apply to sediments "from newer types of stormwater facilities, such as infiltration basins, compost filters, and catch basin inserts." The DOE guidelines recognize that some reuses in non-industrial commercial and public settings outside highway corridors can be protective, but because of varying future land use do not recommend reuse in these areas except in special cases. Non-industrial reuse areas might be good candidates for deed restrictions similar to those facilitated by DEQ's cleanup programs. For industrial areas, DOE argues that even though roadwaste CPAH levels are commonly above cleanup thresholds, that fact does not make cleanup sites out of application sites since the reuse does not pose a threat to human health or the environment.

Snohomish County Health Department has adopted DOE's draft guidelines. A short document from the health department is attached in Appendix B4. Contamination levels define two tiers for roadwaste reuse. If possible, Oregon should avoid the use of threshold values in specific loads to avoid the delays and costs associated with lab tests. Whenever possible, management guidelines should be adopted that identify protective roadwaste management alternatives without the requirement of ongoing analysis.

Massachusetts Department of Environmental Protection (DEP) has approved limited reuse for street sweepings after litter is separated and disposed appropriately. *(Massachusetts DEP, April 1997)* They do not require analytical testing unless there is evidence of unusual contamination. (A copy of this policy as attached in Appendix B2.) Vactor solids, which they consider too contaminated to allow for ready reuse and required to be landfilled, are not included in this program, nor are sweepings impacted by spills of oil or hazardous materials. The following requirements apply to all reuse and storage of sweepings: above the groundwater table; 30 meter setback from surface waters or wetlands; 150 meter setback from ground or surface drinking water supply; and, approval of the property owner. Reuse in public ways as fill (under paved surfaces and on shoulders) and reuse mixed with compost is allowed in public ways outside residential areas; sweepings collected on "Urban Center Roads" are not acceptable for these reuses. The policy recommends sweepings for beneficial reuse, but the only beneficial use for sweepings from Urban Center Roads is as daily cover at landfills, a use that the policy recognizes as a diminishing need. DEP plans to consider other beneficial uses on a case-by-case basis. Additional requirements for storage: site under control of generator, with protection from stormwater runoff and wind migration. Disposal is approved to DEP permitted lined or unlined landfills without testing.

Iowa DOT takes a conservative approach to roadwaste management. Sweepings are landfilled, and each maintenance facility must maintain records to show that their sweepings meet landfill requirements. Areas of vehicle accidents, spills, or abandoned drums are to be avoided by sweepers. Sweepings are stored at maintenance facilities, under cover apart and from other materials. Disposal of all accumulated sweepings is required at least once per month.[13]

The reuse methods recommended in Washington State, as practiced by WsDOT, and Massachusetts will be discussed in greater detail in Chapters 6 and 7.

---

[13] Alameda County (California) has a similarly conservative program.

2.14 ENVIRONMENTAL COMPLIANCE SUMMARY

As in most other states, roadwaste issues in Oregon come under a variety of regulations from many different environmental programs. Stormwater rules and guidelines touch on the subject, and water quality regulations continue to tighten. Solid waste rules apply to accumulation points and to treatment and disposal facilities. Cleanup and biosolids application programs provide information pertinent to managing contaminated materials. Cleanup requirements apply to facilities and to groundwater. Hazardous waste regulations place restrictions and requirements on potentially hot loads.

DEQ has recently recognized roadwaste as an environmental priority, partly due to the increasing volumes generated. To be in full compliance with environmental regulations today, roadwaste would have to be immediately hauled to a permitted facility upon generation without intermediate storage. Not only is this option expensive, but landfills commonly require roadwaste to be tested and laboratory tests take time. DEQ involvement could smooth out the process. If management practices are followed, a DEQ policy could state that contamination of roadwastes should fall within approved parameters and laboratory tests should not be required. However, vactor residuals must be de-watered prior to disposal, and de-watering facilities need solid waste treatment facility permits unless the requirement is waived by DEQ.

2.15 CONCLUSIONS

Roadwaste is neither inert material nor hazardous waste. Important exceptions and exemptions exist in Solid Waste and even Hazardous Waste regulations for materials going for reuse. Sweeping powers granted by Oregon's Legislature require DEQ Water Quality program staff to evaluate environmental need and to apply the rules with judgement. Although many different regulations have bearing on the problems of roadwaste management, none of the regulations directly addresses how best to manage roadwaste. DEQ often approaches problems via Best Management Practice (BMP) when different programs' rules are involved and no one program's rules address all of the concerns.

2.15.1 Recommendation that ODOT Pursue Regulatory Clarification by Proposing a Set of Best Management Practices to DEQ

A BMP approach offers definite advantages for transportation and public works agencies and for regulatory agencies. Roadwaste can be better managed under clear guidelines that address concerns specific to roadwaste. This approach would best protect the environment, making compliance easier to assess for the generator and for the regulatory agency, both of which would otherwise be left trying to evaluate roadwaste management through a variety of rules and rule interpretations.

Roadwastes do not present the public health hazards (pathogens and disease) associated with municipal solid waste. Reasonable arguments for reuse can rely on the development of an accepted characterization for roadwaste and on management methods being found or developed to limit to acceptable levels the risks posed by the chemical contaminants and physical hazards that are present.

In working toward this goal, road maintenance managers should be aware that BMPs are not a one-way ticket out of the regulations. Standards must met or all pertinent regulations again apply. If BMPs are not met, we are back to DEQ requiring a Solid Waste Facility permit for any location where roadwaste is stored, treated or disposed. Water Quality permits might also be required. BMPs failed for composting facilities; many composters operated outside guidelines and caused fires, improper water quality impacts, and nuisance odor problems. This failure led to a permitting process recently imposed by DEQ. Good BMPs are only part of the answer.

Development of BMPs should be an ongoing process as better and more efficient management methods are examined during trial implementation. While working with DEQ, local agencies and ODOT must not disregard land use regulations and local requirements, which have the potential to place substantial burdens on roadwaste management in the future.

3.0 ROADWASTE CHARACTERIZATION

The study of roadwaste contaminants developed as a branch of the study of stormwater impacts on surface waters. Roadwaste characterization became a truly independent topic in the 1990s. Many reports in the Bibliography focus on roadwaste characterization and a great deal of analytical work has been conducted. DEQ has suggested to ODOT that with the recent and sizeable waste characterization efforts in Washington, California, and by local Oregon agencies, further laboratory work to characterize roadwaste may be unnecessary. Though roadwaste contains a wide spectrum of contaminants at very low levels, carcinogenic PAHs and heavy metals are the constituents posing significant risk.

The first step in managing roadwaste is tracking how much is generated and how and where it is stored or disposed. DEQ has already stated that litter must be removed and disposed at permitted landfills; materials containing trash will not be approved for reuse. Protective reuse of the more contaminated roadwastes may involve hazard mitigation through periodic testing, limiting access to reused materials, and preventing runoff and groundwater impacts.

3.1 ROADWASTE DATA

Data on roadwaste contaminants comes from many, disparate sources. Inconsistent sampling protocols and lack of information about samples prevents us from simply compiling the information in a table and drawing statistical conclusions. Sampling points vary from catch basins to vactor trucks; from fresh storage piles to weathered piles to roadwaste dumpsites. Some liquid samples were taken after 24-hour settling, some after filtration, and some fresh from the truck. Various different sets of contaminants were tested for and different laboratory methods used. Often, important information was unavailable or was not captured. When was the road was last swept, the catch basin cleaned; had it been rainy or a long dry spell; was the waste from a residential, commercial or industrial area; how much average daily traffic (ADT) travels the roadway? Lack of information combines with a lack of follow-up work when well-intentioned studies fall short in funding. Several studies have observed that questionable loads are more likely to get tested and more likely to have results reported; this may skew generally available data, also. *(Lenhart, 1994)* This said, there has been enough work on roadwaste characterization and enough data collected that we can form good general conclusions about contaminant levels in roadwaste.

3.2 ROADWASTE CONTAMINANTS

Having been tested for a wide variety of contaminants, interest in roadwaste characterization properly focuses on petroleum compounds and heavy metals. Only in the rare instances do releases of other hazardous compounds impact roadwaste. For instance, testing for pH has found values hovering around neutral, ranging from 6.5 to 7.9, except for isolated, hot loads. One catch basin tested at pH 11.1. *(Eugene Public Works, 1996)* For a catch basin's pH to be that high, a release of a substantial quantity of concentrated caustic material would be required.

General findings can be stated with confidence. Highly volatile compounds are not found in roadwaste; low flash solvents and benzene are below detection limits, but less volatile petroleum constituents (such as toluene, ethylbenzene, and xylenes) are found. Certain semi-volatile organics are found; these generally come from petroleum products and from incomplete combustion of petroleum. Halogenated compounds are rarely observed; if one is detected it is most often in extremely low concentration. Pesticides are normally below detection limits and, if detected, are below treatment levels. PCBs are not found, although blown transformers or specific spill events may cause such impacts in specific instances. The flash point of roadwaste poses no concerns. Heavy metals are found and are discussed below. Petroleum hydrocarbons are found and recent efforts have focused on identifying petroleum fractions that persist at low levels in weathered roadwaste.

3.3 ROADWASTE PETROLEUM CONTAMINANT STUDIES

Early reports identified the presence of petroleum contamination in roadwaste as a serious problem. While petroleum contaminants can significantly impact stormwater runoff, more recent studies have shown that petroleum compounds found in sweepings and vactor solids pose less of a problem than was once thought if the wastes are well managed.

A 1992 Washington State University (WSU)/WsDOT study, "Total Petroleum Hydrocarbons in Highway Maintenance Waste" *(Martin, 1992)*, is often quoted when discussing roadwaste characterization. This study used EPA Method 418.1 to evaluate total petroleum hydrocarbon (TPH) concentrations. Two years later, Snohomish County Public Works and WsDOT were already questioning whether 418.1 and other methods commonly used to evaluate petroleum contamination from underground storage tank cleanup sites were appropriate to test roadwaste. They showed that natural organic matter present in roadwaste was causing elevated readings in the accepted TPH tests. While the TPH results published in the 1992 study are undoubtedly elevated above the actual concentrations in the wastes analyzed, the study's conclusions draw important distinctions that have held up well over time and merit close attention.

Differences were found in TPH concentrations between road sweepings, vactor waste, and ditch spoils. Vactor waste was observed to be more contaminated than sweepings, which in turn were more contaminated than ditch spoils. More variation in TPH values was observed in sweepings, some exceeding the range for vactor wastes and some with virtually no observed TPH.

Differences in TPH concentration (mg/kg or ppm) were also found in different particle size fractions (see Figure 3.1). The study analyzed particle size versus TPH contamination, looking at three particle size groups: > 2 mm; 2 mm to 0.25 mm; and < 0.25 mm. These fractions correspond to gravel, sand, and silt/clay fractions, respectively. The smaller particles were found to have significantly higher TPH concentrations per kg. Low levels of TPH contamination were observed in the gravel fraction. Much more elevated levels were found in the sand fraction, and yet higher concentrations were found in the silt/clay fraction. These findings should not be surprising.

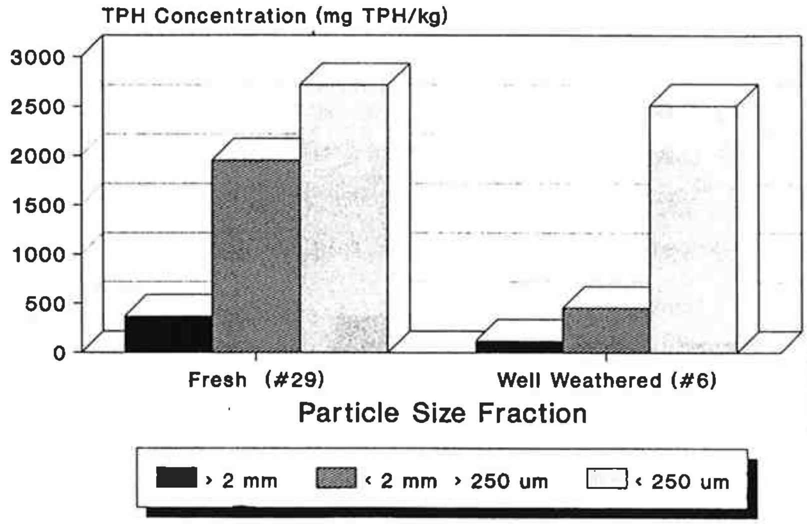


Figure 3.1: TPH Concentration by Particle Size Fraction in Fresh and Weathered Sweepings
(Martin, 1992)

Figure 3.2 is taken from *Soils and Geomorphology. (Birkeland, 1984)* Surface area in silts and clays averages 100-1,000 times greater than in gravels, and 10-100 times greater than in sand. Contaminants adhere to particle surfaces through a mechanism called adsorption. Finer particles have far more surface area on which contaminants may adsorb.

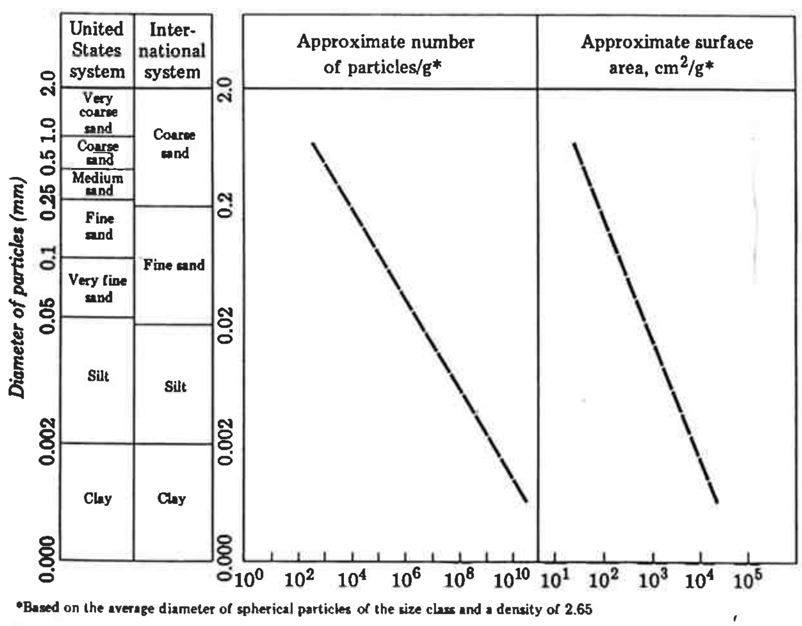
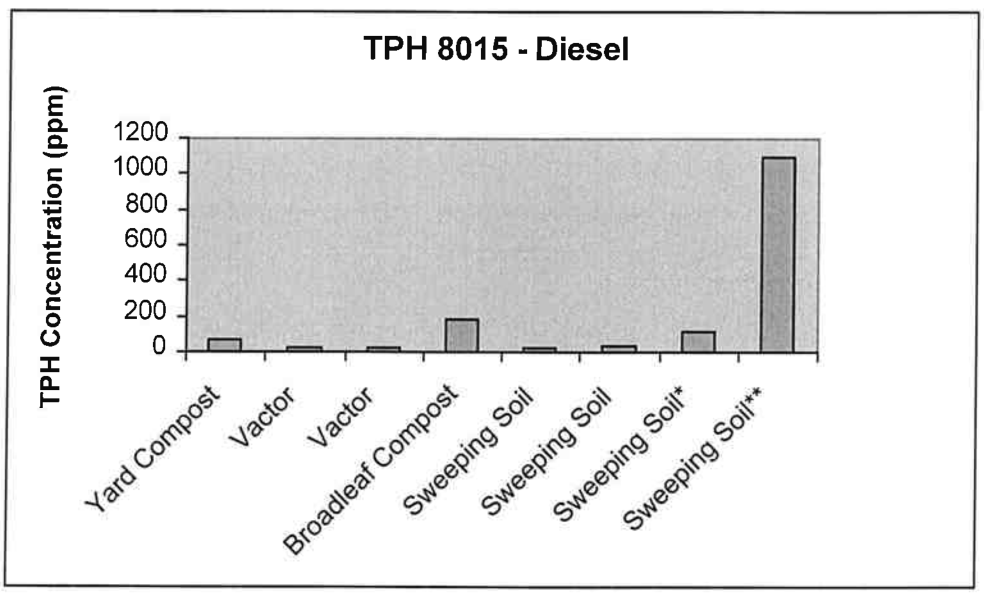


Figure 3.2: Particle Size Classes Used in Pedology and Some of Their Properties
(Birkeland, 1984)

A follow-up study proposed that elevated TPH levels observed in sand was largely due to cross contamination from silt and clay particles. Loss of the fines substantially reduces observed TPH concentrations in the sand fraction. *(Hindin, 1993)* Worn road sanding materials are usually washed before reuse, as fines are difficult to remove from sand by simple screening. These finding are important in help us identify the relative contaminant levels in various particle sizes.

The 1992 WSU/WsDOT study also found differences in weathered versus non-weathered sweepings. Well-weathered sweepings showed a substantial reduction in TPH concentrations (again, see Figure 3.1). This was partly due to a loss of some finer particles. However, biodegradation was a likely contributor to the observed TPH reductions. Concentrations in the gravel and sand fractions were reduced to 25% of the original values. Concentrations in the silt/clay fraction were only slightly reduced. This study did not find substantial reductions in TPH concentrations in well-weathered vactor solids, which had been allowed to dry out. However, this finding could be due to the presence of natural organic matter interfering in TPH tests, or from a lack of sufficient moisture to allow microbes access to hydrocarbon compounds. (Vactor waste weathering is discussed further below.) Weathered ditch spoils were not analyzed.

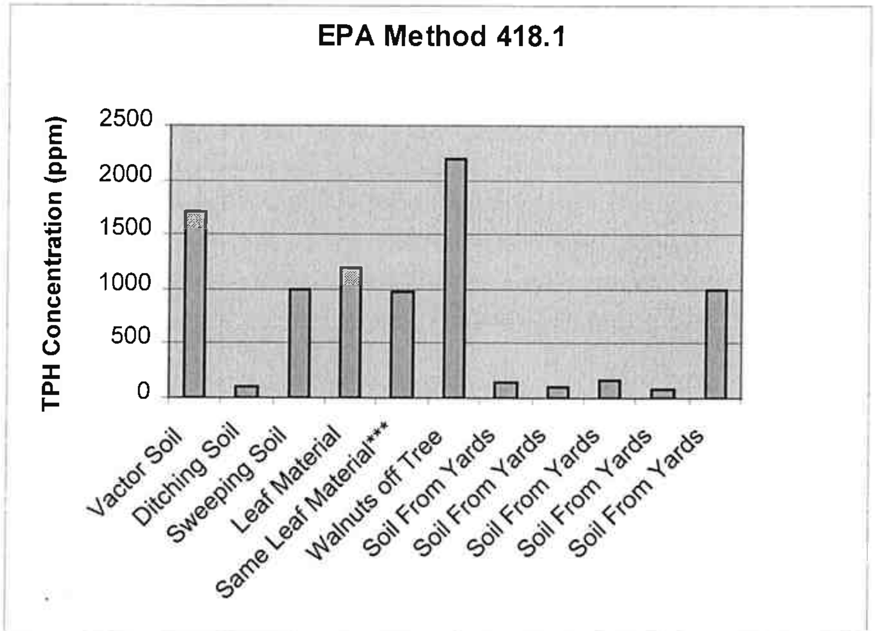
Snohomish County Public Works, the City of Everett, and WsDOT produced interesting findings on roadwaste TPH concentrations. Interference from natural organic matter in TPH tests is clearly shown in Figures 3.3 and 3.4. Figure 3.3 shows broadleaf compost with no known source of petroleum contamination testing higher than several other randomly selected samples of City of Everett roadwaste. Figure 3.3 also shows results of diesel range hydrocarbons versus heavy oil range concentrations. The result is typical for roadwaste, "heavy oil" fractions being observed at significantly higher concentrations.



* Extended TPH Method 8015, for diesel range contaminants.
** Extended TPH Method 8015, for heavy oil range contaminants.

Figure 3.3: Natural Organic Matter Interference When Using TPH 8015 for Diesel Range (Data supplied by the City of Everett, Washington)

Figure 3.4 shows more TPH results from the City of Everett, this time using EPA Method 418.1. Leaves and walnuts were observed to have as high or higher petroleum concentrations than roadwaste, and soil from yards was also observed to be impacted by petroleum contaminants. Even using NWTPH methods recently adopted in Oregon and Washington to eliminate false positives due to organic matter, TPH concentrations observed in leaf material declined only 20 percent.[14]



*** TPH Method 418.1, plus 4 silica gel cleanups.

Figure 3.4: Natural Organic Matter Interference When Using EPA TPH Method 418.1
(Data supplied by the City of Everett, Washington)

TPH tests count hydrogen-carbon bonds. However, hydrogen-carbon bonds are present in natural organic matter as well as petroleum compounds. NWTPH methods remove most of the organic acids, thus eliminating that source of hydrocarbon interference. However, with interference from other natural hydrocarbons, TPH tests do not provide actual levels. This leaves generators and regulators alike without an effective tool in trying to determine whether petroleum in roadwaste is managed correctly.

Figures 3.5 and 3.6 clearly indicate that NWTPH methods using the acid cleanup step result in substantial and consistent reductions in observed hydrocarbon levels. WsDOT conducted tests on four sweeping samples and four vactor solid samples. The effect on vactor solids results is startling. NWTPH-diesel extended with acid cleanup is recommended as the best method for analyzing TPH in roadwaste, but interference from naturally occurring hydrocarbons must still be expected. This problem is discussed again below.

---

[14] In Washington State, NWTPH methods are often called 'WTPH' methods. DEQ has posted further information on NWTPH methods and testing for hydrocarbons on its website at "www.deq.state.or.us/lab".

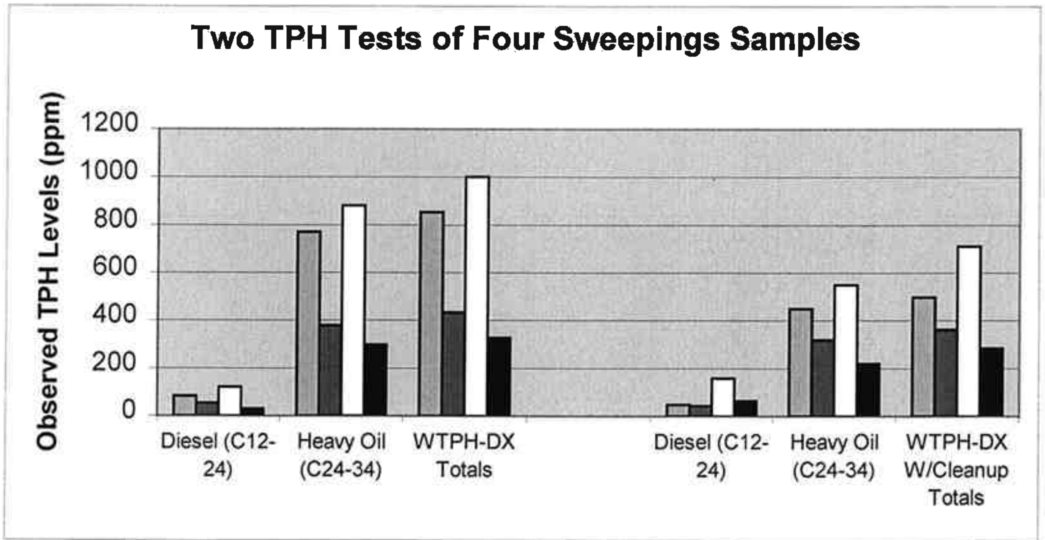


Figure 3.5: Comparison of TPH Results for Four Samples of Highway Sweepings Using the Current TPH Test Method With and Without Acid Cleanup
(Data supplied by WsDOT)

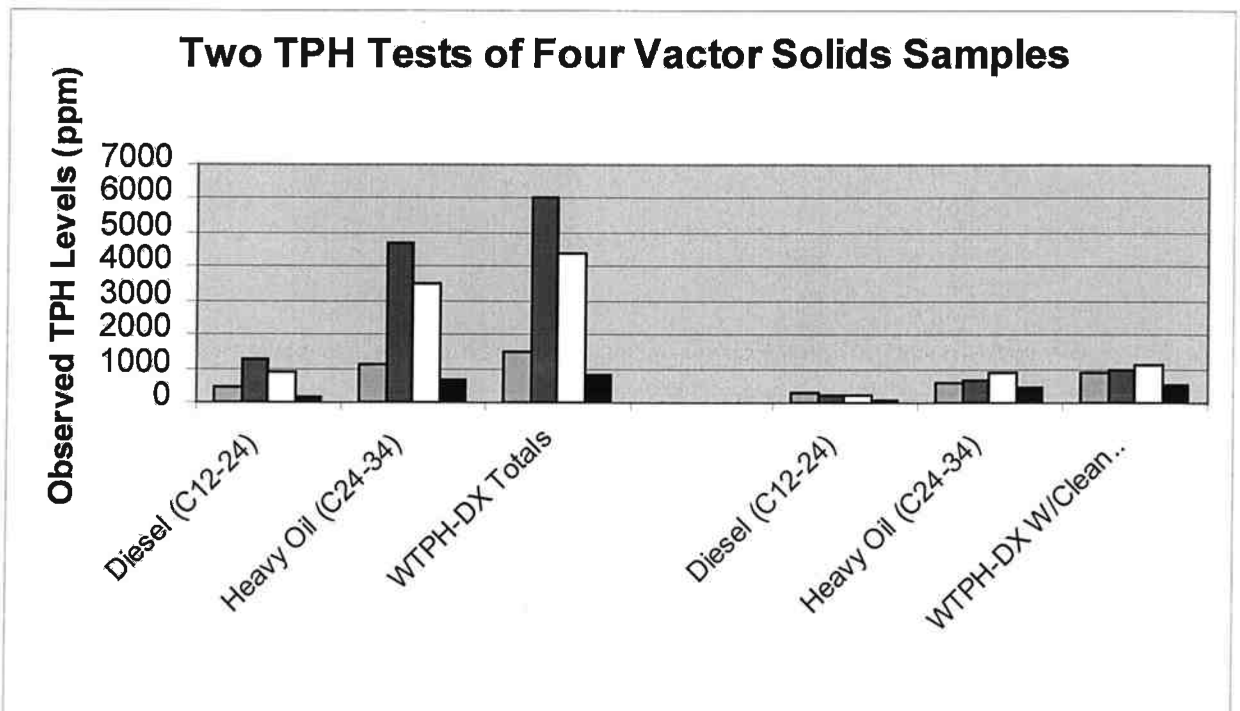


Figure 3.6 Comparison of TPH Results for Four Samples of WsDOT Vactor Solids Using the Current TPH Test Method With and Without Acid Cleanup
(Data supplied by WsDOT)

WSU conducted a study on biodegradation of TPH in weathered roadwaste piles that were kept damp. *(Watts, 1998)* This studied showed TPH levels in vactor solids dropping to near non-detect when piles were kept damp (but not saturated). Natural biodegradation was identified as the most likely cause for TPH reduction, although loss to leachate was recognized as another possible factor, especially in a pile that was treated with surfactants. (Active and passive forms of roadwaste bioremediation are discussed and evaluated in Chapters 6 and 7.)

Some tests analyze TPH concentrations for different size hydrocarbons based on the number of carbon atoms in the molecules. Gasoline, diesel, and heavy oil fractions test for the ranges C6-C12, C12-C24, and C24-C34, respectively. TPH-HCID tests provide data on the size of hydrocarbon molecules in the sample, and the follow-up TPH test is calibrated to that range. Unless impacted by a release of gas or diesel, hydrocarbons in roadwaste start in the diesel range and but are found mostly in the heavy oil range.

Larger hydrocarbon molecules are less mobile in the environment and DEQ is little concerned with the heavy oils themselves. Rather, their interest in heavy petroleum centers on polycyclic aromatic hydrocarbons (PAHs).[15] DEQ uses heavy oil TPH results as an indicator of the presence of PAHs.[16] Seven carcinogenic PAHs (CPAHs) have been identified and were discussed in Chapter 2. Current data on roadwaste CPAH concentrations is provided in the roadwaste solids characterization below.

3.4 HEAVY METAL CONTAMINANTS IN ROADWASTE

Trace levels of heavy metals are found everywhere in natural ecosystems and normally do not pose a significant risk to human health or the environment. The mechanism of adsorption is again at work, fixing metals to soil particle surfaces and to organic matter. However, high concentrations of heavy metals or sufficient concentrations mobile in the environment can pose risks. Heavy metals found in roadwaste include arsenic, cadmium, chromium, mercury, and lead. Normally, roadwaste heavy metal concentrations are well below cleanup action levels, but levels are high enough to merit evaluation.

In the 1970s, we were warned of high lead concentrations along roadsides. Lead concentrations dropped with the advent of unleaded gas. The low levels now found in roadwastes may be from lead weights commonly used to balance tires. Levels surpassing 2.0 ppm leachable lead over the past few years are only observed in sludge from sumps not cleaned since the ban on leaded gasoline. The limited data available to this study on wastes recently sampled from these sumps in Oregon report leachable lead levels ranging from 0.15 to 3.4 ppm. At values greater than 5.0 ppm TCLP for lead, wastes are hazardous waste and face stringent management and disposal requirements.[17] Old sump wastes merit separate attention unless further testing shows they will not test as hazardous waste. Even then, agencies could choose to manage these materials apart from normal roadwaste if they find elevated heavy metal or hydrocarbon levels.

---

[15] Another term for these compounds is Polynuclear Aromatics (PNAs).
[16] Conversation with Bruce Scherzinger, DEQ UST Cleanup Program.
[17] The TCLP test was discussed in more detail in the Chapter 2.

Roadwastes are well-washed materials; most of the mobile constituents have already moved on by the time the materials are picked up by crews. This fact helps us understand the low levels of heavy metals observed in roadwaste leachate tests. One mechanism holding metals in place is adsorption to particle surfaces. There is some absorption into organic matter, as well. And a large amount of the total metals are still bound up in bits and pieces of products that originally contained them.

As natural organic matter decomposes – releasing CO_2, water, methane, and nitrogen compounds – substantial reductions can be seen in roadwaste volumes. With less mass to offset the stationary metals and less organic matter to bind them, total and leachable heavy metal concentrations can be expected to rise slightly in weathered samples. Acidic environments tend to make metals more mobile, also. Organic acids generated from the decomposition of leaves and woody waste may increase the mobility of lead and other heavy metals.

3.5 WASTE CHARACTERIZATION OF ROADWASTE SOLIDS

The levels of contamination normally observed in roadwaste highlight the need to limit human contact, prevent site or groundwater contamination and runoff to surface waters, and identify and separately manage potentially hot loads. Hydrocarbon and heavy metal levels in normal roadwaste do pose concerns, and the risks posed by human exposure should be minimized.

3.5.1 Constituents of Concern

Heavy metals and CPAHs are the main hazardous constituents driving action on roadwastes. PAHs with up to three rings degrade in the presence of microorganisms found everywhere. Larger PAHs, including the carcinogenic PAHs, are believed to persist in the environment; bioremediation of CPAHs currently involves the use of targeted active treatment technologies. Therefore, unless CPAHs can be held below cleanup standards, care must be given to the long-term management of such roadwaste.

While some hydrocarbons in roadwaste migrate readily in soil and in high concentrations have the potential to impact groundwater quality, CPAHs are largely immobile. Exposure scenarios developed by EPA for CPAHs rely on the unusual exposure pathway of ingestion, since the other exposure pathways present significantly less risk. Concerns over direct contact bring up worker safety issues, and use of appropriate gloves, dust protection, and thorough washing are obvious considerations.[18]

While addressing CPAHs, we should not forget heavy metals and physical hazards such as broken glass, hypodermic needles, and elevated levels of bacteria. These hazards point to the benefits of proper worker safety and hygiene practices. Limiting human contact may be the simplest way to address exposure concerns.

[18] One of the first cases of industrial cancer was identified in chimney sweeps in England. The combination of exposure to CPAHs in chimney soot and not taking regular baths led to cancer developing in many of these young men.

3.5.2 Data Considered in this Study

These criteria were used in selecting roadwaste data for evaluation:

- Data on roadwaste collected by transportation and public works agencies.
- Use of current test methods: TCLP metals, total metals, NWTPH (extended with acid cleanup) in the diesel and heavy oils ranges, and semi-volatile analysis for CPAHs.
- Data from fresh roadwaste and from stockpiled roadwaste.
- Where possible, stress is laid on state highway roadwaste data, but local data is considered to widen the breadth of this evaluation.

Roadwaste from local agencies, especially from low ADT roadways in residential areas, is considered less contaminated on average. Since we wish to arrive at the most widely applicable answers to effective roadwaste management, stressing results from high ADT roadways makes sense. It is undesirable to accept requirements that tie roadwaste generators to expensive ongoing laboratory tests to determine contaminant thresholds. Including data on stockpiled and fresh roadwaste will help us develop management alternatives for the roadwaste we have on hand and the roadwaste we will generate in the future.

Data used for evaluating contaminant levels in sweepings and vactor solids was taken from sampling events conducted by ODOT, WsDOT, Washington DOE, Massachusetts Highway Department and University of Massachusetts Transportation Center, Snohomish County Public Works, the City of Everett, and the City of Eugene.[19] Findings of a number of studies were reviewed during the preparation of this waste characterization. For instance, DOE's "Contaminants in Vactor Truck Wastes" *(Washington DOE, 1993)* provides valuable information on metals and CPAHs in vactor solids collected within the Puget Sound area.[20]

3.5.3 Evaluation of Heavy Metals Data

Table 3.1 compares DEQ heavy metal cleanup levels, EPA biosolids application maximums (sewage sludge applied to farmland), and hazardous waste thresholds to roadwaste levels. Data is provided on metals released from normal vehicle wear – arsenic (As), cadmium (Cd), chromium (Cr), and lead (Pb,) – and on mercury (Hg).

Background levels may come into play as a reference concentration. For example, elevated arsenic concentrations have been found in soils in the three counties around Portland. DEQ's cleanup program does not require action below total arsenic levels below 10 ppm in the Portland Metro area.[21]

---

[19] Note: Selected sweepings and vactor solids data are provided in the Appendix.

[20] DOE's study confirmed that PCBs and pesticides are rarely seen in vactor wastes, all samples being non-detect for these compounds. This study, with samples presenting data on residential, commercial and industrial areas, also provides information on a great number of volatile and semi-volatile compounds.

[21] During a conversation in DEQ's Northwest Region office on April 20, 1998, Jim Anderson of DEQ's Voluntary Cleanup Section stated that background in area soils is an order of magnitude above the cleanup threshold for

Table 3.1: Comparing Roadwaste Heavy Metal Values to Regulatory Thresholds
(averaged values in mg/kg [or mg/l] = ppm)

Heavy Metal	Residential Cleanup Level	Industrial Cleanup Level	Sweepings	Vactor Solids	RCRA Hazardous Waste Levels	Biosolids Application Ceilings
Total Arsenic	0.4	3	2.85	6.7	N/A	75
Total Cadmium	100	1,000	0.29	1.04	N/A	85
Total Chromium	1,000	1,500	17.1	51.1	N/A	3000
Total Mercury	80	600	ND[22]	0.074	N/A	57
Total Lead	200	2,000	46.3	114.9	N/A	840
TCLP As	0.004	0.004	0.91	ND	5.0	N/A
TCLP Cd	0.5	0.5	0.1	ND	1.0	N/A
TCLP Cr	10	10	0.25	>0.01	5.0	N/A
TCLP Hg	0.2	0.2	ND	ND	0.2	N/A
TCLP Pb	2	2	1.17	0.14	5.0	N/A

Except for arsenic levels, which may not be much above background, the average contaminant levels observed in roadwastes are well below the cleanup standards, and spikes above RCRA Hazardous Waste thresholds were not observed. We should note again that these results are averages of sampling events with wide variety in conditions and location. A potentially important point was again recognized while reviewing this data: Variation in contaminant levels is sometimes wider between industrial and residential areas than between vactor solids and sweepings from the same area. (We may also find this true on average for other distinguishing factors.) Localized variation in contaminant levels and the need for ready reuse options may fuel further work with existing data or with further data collection. Adequate sample populations and consistent protocols may allow us to draw important distinctions, resulting in ready reuse for major subcategories of roadwaste and, perhaps, further treatment or disposal as solid waste for others.[23]

3.5.4 Evaluation of Hydrocarbon Data

Even with the new test methods, it is clear that organic materials present in roadwaste falsely elevate observed TPH levels. However, this report would not appear complete without some statement assessing TPH concentrations. Samples recently analyzed by Snohomish County Public Works and WsDOT observed TPH concentrations in sweepings ranging from 40 to 160 ppm for diesel fractions (averaging 67.5 ppm), and 190 to 620 ppm for heavy oil fractions (averaging 395 ppm). Vactor solids TPH results ranged from 94 to 270 ppm for diesel fractions (averaging 211 ppm) and from 420 to 860 ppm for heavy oil fractions (averaging 627 ppm).

---

arsenic. This may be the biggest gap they have seen over so widespread an area. Mr. Anderson stated that virgin soils at the bottom of a 30' pit dug at Lewis and Clark College tested far above the cleanup threshold for arsenic.

[22] ND means "not detected". Mercury is detected only rarely in sweepings.

[23] Woodward-Clyde Consultants were asked, given the amount of data now available, if they could provide an analysis that could create such subcategories. Their answer was that it would be very costly to conduct such a study. They voiced concerns similar to earlier researchers: without consistent sampling protocols, analysis is anything but straightforward; and, there is so much local variation that a large data-set would most likely be required to insure that statistically valid conclusions could be reached.

DEQ developed the cleanup values – given in Table 3.2 – to address petroleum releases from underground storage tanks (USTs).[24] Level 1 sites are the most sensitive, having some combination of high groundwater table, high annual rainfall, and/or groundwater used as a drinking water supply.[25] These "matrix levels" only apply to contaminants found above the seasonal high water table.

Table 3.2: DEQ's UST Matrix for Petroleum Hydrocarbon Cleanup
(values in ppm)

PETROLEUM FRACTION	LEVEL 1	LEVEL 2	LEVEL 3
Gasoline	40	80	130
Diesel	100	500	1000

(Oregon DEQ, January 1995)

At first, Washington's Department of Ecology (DOE) stipulated that their MTCA cleanup level of 200 ppm for diesel and heavy oils should apply to roadwaste. However, it is now DOE's position that raw TPH data should not be a factor determining roadwaste reuse.

> *"The present MTCA [Model Toxics Control Act] Method A soil criteria for TPH analysis is 200 mg/kg for diesel and heavy fuel hydrocarbons. This limit was set to protect ground water from the mobile constituents included in the TPH analysis. Street waste sampling, to date, nearly universally gives values higher than 200 mg/kg for TPH analysis, but these values are from immobile petroleum hydrocarbons and natural organic material. The mobile hydrocarbons that are of concern for ground water protection are generally not retained in street waste solids. ...Ecology's Toxics Cleanup Program is working to develop methods other than TPH to determine cleanup standards for petroleum contamination." (Washington DOE, November 1996)*

Other research validates DOE's assessment. While roadwaste grossly impacted by petroleum products does merit separate management, for normal roadwastes we should look to the actual constituents to determine what risk is posed by a prospective management option. For diesel fractions, the presence of semi-volatiles such as toluene, ethylbenzene and xylenes drive much of the risk analysis. To some degree, the TPH-D test acts as a tracer for the likelihood that these compounds are present. The November 1996 DOE report stated of 72 sampling sites, "One or two samples exceeded MTCA cleanup guidelines for xylenes, toluene, tetrachloroethylene or methylene chloride." In reviewing vactor samples analyzed by DOE *(DOE, 1993)*, we observe spikes in ethylbenzene, toluene and xylenes concentrations above the DEQ's Soil Cleanup minimum level for action, but well below DEQ's SoClean maximum allowable residential concentrations. Given that vactor solids are well washed, it is unlikely that roadwaste contaminants would exceed leachate levels; using the residential cleanup maximums to evaluate these diesel constituent concentrations shows no significant risk.

---

[24] However, DEQ often applies these levels as guidelines in evaluating the risks posed by petroleum hydrocarbons in other situations.

[25] Note: Sites with actual groundwater impacts face more stringent Corrective Action Plan (CAP) requirements, including groundwater monitoring.

DEQ expresses few concerns about heavy oils, with the exception of CPAHs. In the case of heavy oils, TPH data can act as an important tracer, where the presence of CPAHs is the major determining risk factor. Risks from non-CPAH heavy oils are less than those posed by diesel due to the relative immobility of heavy oil fractions. DEQ cleanup levels for gasoline are substantially tighter than those for diesel because of gasoline's mobility in the environment over and above the risk posed by benzene and fuel additives. Following this logic, we can reason that non-carcinogenic heavy oils merit higher allowable levels than the more mobile and hazardous diesel fraction. Since diesel fraction levels in roadwaste are generally low and CPAHs are discussed separately, it is realistic to propose that the normal run of roadwaste should not face restrictions based on TPH findings alone.

3.5.5 Evaluation of Carcinogenic PAH Data

The data we are using to evaluate risks posed by CPAHs comes largely from state departments of transportation. We want to guarantee that the roadwaste management methods we adopt are protective and we want to achieve the most widely applicable solutions. The higher contaminant levels in DOT roadwaste reflect impacts from high traffic corridors rather than residential streets. Please note that while values for the compound indeno(1,2,3-cd)pyrene were not available for most of the analyses reviewed below, its carcinogenicity is similar to that of benzo(a)anthracene and as such its impact would be very unlikely to change our overall evaluation.

CPAH levels in sweepings vary. Two composite samples of weathered sweepings from ODOT's metro area yards are well below SoClean's industrial standard and barely above the residential standard. If these results are fully representative of the materials (further sampling is needed to answer this question), we could assume that reuse in industrial settings would be more than protective. Given the CPAH levels in wastes from the Marquam yard, a further review for other contaminants could provide the basis of an argument to allow uncontrolled use even in residential settings. Risk analysis is difficult for roadwaste, and with the glass and other physical hazards present, use in residential areas is not recommended.[26] But low levels of contamination provides more ready management options including ready reuse at these levels.

On the other hand, values from Massachusetts Highway Department sweepings are high, with dibenzo(a,h)anthracene levels exceeding DEQ's SoClean industrial cleanup value. The spikes in the table reflect the variability in contaminant levels. Besides random variability, the data from Massachusetts also reflects variations in CPAH concentrations between districts. Sweepings from their Districts 4 and 5 have CPAH values clearly exceeding Oregon's SoClean threshold levels, while their District 2 has relatively low values. (The raw data is attached as Appendices G1 through G4.) Representative data on CPAH levels in sweepings is presented in Tables 3.3 and 3.4.

[26] Use of sweepings in compost is being pursued by many agencies and may be protective for sweepings from local jurisdictions, especially sweepings from residential areas.

Table 3.3: CPAH Levels Observed in Sweepings
(values given in mg/kg = ppm)

Carcinogenic PAHs	WsDOT[27] (fresh)			WsDOT (weathered)		
	Average	Low	High	Average	Low	High
Benzo(a)anthracene	0.560	0.395	0.875	0.400	0.375	0.425
Benzo(a)pyrene	0.406	0.352	0.467	ND	ND	ND
Benzo(b)fluoranthene	0.433	0.410	0.465	0.508	0.410	0.605
Benzo(k)fluoranthene	0.393	0.375	0.410	0.399	0.375	0.438
Chrysene	0.350	0.350	0.350	ND	ND	ND
Dibenzo(a,h)anthracene	0.387	0.387	0.387	ND	ND	ND
Indeno(1,2,3-cd)pyrene	(no results provided for this compound)					

Table 3.4: More CPAH Levels Observed in Sweepings
(values given in mg/kg = ppm)

Carcinogenic PAHs	MASS Highway[28]			ODOT[29] (weathered)	
	Median	Low	High	Marquam	Wilsonville
Benzo(a)anthracene	0.685	0.160	7.30	0.097	0.13
Benzo(a)pyrene	0.580	0.150	2.40	0.095	0.092
Benzo(b)fluoranthene	0.865	0.290	3.00	0.089	0.11
Benzo(k)fluoranthene	0.725	0.250	2.60	0.089	0.11
Chrysene	0.745	0.260	3.70	0.11	0.17
Dibenzo(a,h)anthracene	1.365	0.330	2.40	ND	ND
Indeno(1,2,3-cd)pyrene	(no results provided for this compound)			ND	0.052

Weathering has been thought to have little effect on CPAH concentrations. However, the data we have from WsDOT seems to indicate that benzo(a)anthracene, benzo(a)pyrene, and dibenzo(a,h)anthracene might be weathering in sweepings. It is difficult to say if this is due to natural biodegradation or losses in leachate. It would be more than surprising to find that loss of these contaminants was due to wind-blown fines, since some CPAH concentrations rose instead of dropped.[30] If the CPAH levels we observe dropping are due to losses in leachate, areas where large volumes of roadwaste were stored might be significantly impacted.

The City of Everett has found CPAH levels in their sweepings to average less than 1.0 ppm for total CPAHs, paving the way for ready reuse. The City found their vactor solids total CPAH

[27] (Hindin, 1993) This data is from WsDOT highway maintenance. Their data table is attached in Appendix G2. Results listed as "ND" were below detection limit of 0.330 mg/kg.

[28] (Jackivicz, 1997) This data is from MASS/Highway. Their data tables are attached in Appendix G4.

[29] Individual results of composite samples taken from weathered sweepings stockpiled at the Wilsonville and Marquam ODOT maintenance yards in the Portland Metro area. These data are attached in Appendix G1.

[30] Further research on leachate from sweepings could help to identify if this is a significant long-term method of transport for certain CPAHs. This could be done through testing roadwaste leachate or modeling from solubility values or from SPLT or TCLP results. If CPAHs are not escaping in the leachate, and observed reductions in certain CPAHs are verified, we must assume that biodegradation or other natural attenuation is occurring.

levels averaging between 2-3 ppm, requiring greater care.[31] The higher CPAH levels in vactor solids are consistent with findings from other agencies. Table 3.5 presents data on vactor solids.

Table 3.5: CPAH Levels Observed in Vactor Sediment
(values in mg/kg = ppm)

Carcinogenic PAHs	WsDOT (fresh/wet)			Washington DOE[32] (based on dry weight)		
	Average	Low	High	Average	Low	High
Benzo(a)anthracene	ND	ND	ND	1.33	0.09	6.5
Benzo(a)pyrene	ND	ND	ND	1.59	0.09	13.0
Benzo(b)fluoranthene	0.375	0.375	0.375	1.82	0.05	15.0
Benzo(k)fluoranthene	0.475	0.475	0.475	1.52	0.05	12.0
Chrysene	ND	ND	ND	1.88	0.80	11.0
Dibenzo(a,h)anthracene	ND	ND	ND	0.64	0.21	1.2
Indeno(1,2,3-cd)pyrene	(no results provided for this compound)			1.16	0.80	8.1

Loss of water is widely recognized to increase relative CPAH concentrations in vactor sludge. This is supported by the data seen in Table 3.5. Still, the difference between wet and dry wastes does not explain the wide difference in values found by WsDOT and Washington DOE. The Washington DOE values are well above DEQ's industrial cleanup thresholds while the WsDOT values are well below those thresholds. The DOE study analyzed far more samples; again, we are going with the conservative value in conducting our assessment of risk.

CPAH data on weathered vactor solids is difficult to obtain, and could be impacted by type of storage, leachate control, local weather, etc. As we shall see in coming chapters, issues for vactor solids are more complex than for sweepings; e.g., while TPH in sweepings treats out well under normal weathering conditions, vactor solids seem to require a specific range of moisture.

3.5.6 Using PRGs to Evaluate Risks Posed by CPAH Exposure

Early on, the cleanup rules assumed all CPAHs to have the same risk posed by benzo(a)pyrene, the most carcinogenic of the PAHs. In an effort to provide a framework supporting risk-based cleanups, EPA Region 9 developed Preliminary Remedial Goals (PRGs) reflecting the relative toxicity of each CPAH in both residential and industrial settings.

We evaluate roadwaste CPAH contamination using the risk-based PRGs for several reasons. Roadwaste is usually above residential SoClean values for sweepings and above the industrial SoClean values for vactor solids (see data tables below). Since uncontrolled use of sweepings in industrial areas is above the residential cleanup standard, even sweepings reuse sites could face long-term restrictions using criteria applied at cleanups. Sites with CPAH levels such as those found in vactor solids could require a special exemption from cleanup action. Using PRGs provides information to more closely evaluate risk; these values are presented in Table 3.6.

[31] Telephone conversation with Roy Harris, City of Everett Public Works, 2/20/98.

[32] (Washington DOE, 1993) Non-detect results were given a value of one-half the detection limit, except for dibenzo(a,h)anthracene. The data table is attached in the Appendix.

Table 3.6:Regulatory Thresholds for CPAHs
(values given in mg/kg = ppm)

Carcinogenic PAHs	Industrial Cleanup Level	Residential Cleanup Level	EPA Region 9 Industrial Cleanup Standard (PRG)	EPA Region 9 Residential Cleanup Standard (PRG)
Benzo(a)anthracene	1.0	0.1	2.6	0.61
Benzo(a)pyrene	1.0	0.1	0.26	0.061
Benzo(b)fluoranthene	1.0	0.1	2.6	0.61
Benzo(k)fluoranthene	1.0	0.1	26	6.1
Chrysene	1.0	0.1	7.2	7.2
Dibenzo(a,h)anthracene	1.0	0.1	0.26	0.061
Indeno(1,2,3-cd)pyrene	1.0	0.1	2.6	0.61

Oregon's cleanup rules allow use of any PRGs, not stipulating values or sources; theoretically, we could draw values from a hat. DEQ currently uses the Region 9 PRG values as guidance when evaluating risk at cleanup sites. Problems have been recognized and EPA has stepped back from full support of its PRG values for CPAHs. However, we are using the best tools we have to assist us in evaluating risk. We should make our best effort to assess risk so that we can focus our management practices to best protect against these risks.

Dividing the test result for each CPAH by its industrial or residential PRG value and adding the results allows us to assess cumulative risk for CPAHs. If CPAH numbers add to more than 1.0, then cancer risk for that material is greater than one in one million in that setting.[33] Results of PRG analysis for the CPAH values presented above are given in Tables 3.7 and 3.8. Again, these evaluations are based largely on state department of transportation roadwastes and may not reflect levels in local roadwastes or roadwastes collected in a specific ODOT District.

Table 3.7: Evaluation of Risk Posed by CPAHs in Industrial Settings
(values = level/PRG)

CPAHs	Fresh Sweepings[34]	Weathered Sweepings[35]	Fresh Vactor Wastes[36]
Benzo(a)anthracene	0.215	0.153	0.511
Benzo(a)pyrene	1.561	0.634	6.115
Benzo(b)fluoranthene	0.166	0.195	0.700
Benzo(k)fluoranthene	0.015	0.015	0.058
Chrysene	0.048	0.022	0.261
Dibenzo(a,h)anthracene	1.488	0.634	2.461
Indeno(1,2,3-cd)pyrene	(no data was available to analyze risks for this compound)		0.446
PRG CPAH Totals	3.493	1.653	10.552

[33] Telephone conversation with Richard Sedman, Ph.D., Toxicologist, DEQ Voluntary Cleanup Program, 5/1/98.
[34] Based on average WsDOT fresh sweepings values presented in Table 8.
[35] Based on average WsDOT weathered sweepings values presented in Table 8.
[36] Based on Washington DOE dry weight vactor solids analysis presented in Table 9.

Table 3.8: Evaluation of Risk Posed by CPAHs in Residential Settings
(values = level/PRG)

CPAHs	Fresh Sweepings[37]	Weathered Sweepings[38]	Fresh Vactor Wastes[39]
Benzo(a)anthracene	0.918	0.655	2.180
Benzo(a)pyrene	6.655	(2.704)[40]	26.065
Benzo(b)fluoranthene	0.709	0.832	2.983
Benzo(k)fluoranthene	0.064	0.065	0.249
Chrysene	0.048	(0.022)	0.261
Dibenzo(a,h)anthracene	6.344	(2.704)	10.491
Indeno(1,2,3-cd)pyrene	(no data was available to analyze risks for this compound)		1.901
PRG CPAH Totals	14.178	6.982	44.130

These preliminary findings indicate that for state DOT roadwaste to find protective reuse in residential settings, it would have to be from a subcategory of less contaminated material outside the normal run of roadwaste or undergo treatment that reduces its potential impacts to a protective level. Sweeper units pick up only a smaller percentage of the available fines; this may account for some of the differences in contaminant concentrations observed in vactor and sweepings. Even using conservative values for sweepings, we can see that use in industrial areas should be achievable, although more readily for sweepings (especially for weathered sweepings) than for vactor solids.

3.5.7 Conclusions Regarding Roadwaste Solids Contaminants

The efforts presented above walk roadwaste characterization through the steps required at a potential cleanup site. We have not discussed ecological risk assessment nor have we fully evaluated the potential impacts from multiple contaminants. However, the general guidelines we have followed have brought us closer to assessing the hazards posed by roadwaste and can provide valuable insight when examining roadwaste management methods.

Does roadwaste exceed established criteria for cleanup sites? That is difficult to say. Problems with sampling protocol, lack of differentiation to account for local variation and insufficient data on CPAHs do not let us state definitive conclusions. This analysis is by no means the final word. In examining whether DOT roadwastes can pose significant risks, we have shown that roadwaste does deserve serious attention. Unless our management method successfully mediates against the risks identified for high traffic DOT roadwastes, we must conduct a waste characterization to determine whether a proposed management method is protective for wastes we generate.

Total arsenic levels are sometimes elevated, but we have seen background levels for arsenic that are much higher and roadwaste metals have low leachate concentrations. Lead has been a concern, but leachable lead is not seen above 2.0 ppm (except in old sump wastes, which deserve separate characterization and management). We have shown that TPH levels do not translate well to assessment of the risks posed by roadwaste. CPAH levels in average sweepings appear to

[37] Based on average WsDOT fresh sweepings values presented in Table 8.
[38] Based on average WsDOT weathered sweepings values presented in Table 8.
[39] Based on Washington DOE dry weight vactor solids analysis presented in Table 10.
[40] Non-detect values are assumed to be half the detection limit for this risk evaluation.

be within the acceptable range for some industrial reuses, while management of vactor solids deserves tighter scrutiny due to higher observed CPAH levels.

3.5.8 Clearing the Road for Reuse

If roadwaste does exceed established cleanup criteria can it be reused protectively? Given the wide range of contaminants that may impact roadwaste, one expects some small percentage of samples to show spikes over cleanup action levels for individual compounds. In the sweep and mixture of roadwaste materials, these spikes appear to wash out and should not present a substantial roadblock to limited reuse. DOE emphasizes this point in its draft guidance on roadwaste reuse, going farther to state that exceeding a cleanup threshold should not prevent reuse if that reuse can be shown to be protective. *(Washington DOE, November 1996)*

Furthermore, placement of roadwaste is not analogous to leaving in place contamination all through the soil matrix at a cleanup site. Using a shallow (< 0.4 meters) application as a beneficial soil amendment on a one-time per location basis, the contaminant levels in the materials would not fairly characterize the property since the materials would be worked into the existing soil, thus yielding lower overall levels. A look at EPA's proposed guideline of 15 ppm for total CPAHs for land application of sewage sludge for beneficial use on farmlands shows us a different view on contaminant levels.[41] Assuming mixture with an existing matrix explains the logic behind EPA's biosolids application level.

Mixing roadwaste with organic matter, such as barkdust and compost, dilutes contaminant levels, and might ease regulatory requirements. WsDOT uses such a mixture. Besides diluting the contaminants and helping the use of roadwaste as a soil amendment, organic matter is known to fix PAHs both through adsorption and absorption. Roadwaste metals also fix into these organic materials. This mixture is thought to mediate against the risk posed by hazardous constituents.

Washing to remove fines allows for ready reuse of sand and gravel fractions. Since contaminant levels in sweepings vary widely, we need to address this variability in our discussion of management methods. More contaminated sweepings may merit management in the same risk category as vactor solids, but creating a protective area to weather roadwaste may address these concerns.

If we are unable to develop protective reuse or inexpensive disposal options for the range of vactor materials we encounter, we may be compelled to accept the requirement for ongoing analysis of vactor solids and a tiered approach to their management. In the effort to accommodate affordable reuse, we may be able create waste subcategories to distinguish which roadwastes are ready for which reuses, and what treatment or management options can be established for our other roadwastes. In addition, field methods to cull out hot loads for separate management could lead to overall reductions in observed contaminant levels for mainstream roadwastes.

[41] Telephone conversation with Tony Barrett, Washington DOE, 1998.

We can propose management methods we believe are protective for roadwastes that tests above DEQ's cleanup thresholds. However such methods must be carefully evaluated. CPAHs and heavy metals present known risks to human health. We need to address all known concerns when pursuing management options for roadwaste. A good beginning in managing common vactor solids is to exclude public access, place them only in areas protected against runoff, above the water table, and out of the flood plain, and to carefully track roadwaste placement. We will revisit mediation against known risk in our examination of roadwaste management options in Chapters 6 and 7. Again, we should recognize that risk is not based solely on the material itself but on how that material is placed in the environment.

3.6 CONTAMINANTS PRESENT IN VACTOR LIQUIDS

Much data has been collected on stormwater contaminants. Research shows that metals and petroleum compounds in vactor liquids are almost all fixed to suspended solids. Settling or flocculation or filtering can separate the liquid and solid fractions. 24-hour settling has been shown to meet sanitary sewer pretreatment requirements. (See discussion in Chapter 4, *et al.*) Low levels of dissolved metals remain after settling of the solids and some oil and grease remains in liquid fraction. These levels are below cleanup action levels, but above discharge levels to surface waters or the storm sewer system. Most of the free oil and grease is lighter than water and separates to form a sheen. The sanitary sewer offers an easy disposal method once designs can accommodate settling to meet pretreatment requirements. If a heavy sheen is present. The oils can be removed using floating sorbent pads.

3.7 FURTHER TESTING

3.7.1 Reasons to Conduct Further Tests

We test waste to characterize it. This characterization could be for our own needs or to fulfill a requirement set forth in a regulation or established by a treatment or disposal facility.

For our purposes, currently available CPAH data is less than adequate to fully characterize varying types of roadwaste.[42] Few TCLP or SPLT leachate tests results are available on roadwaste non-metals, which can raise questions as to whether reuse is protective. As the project proceeds into Phase II and testing is conducted to determine a baseline to evaluate the effectiveness of treatment options, some of this baseline data could be used to evaluate CPAH levels and for verification that leachate is below threshold levels.

Sump materials pre-dating the ban on leaded fuels should be tested for leachable and total lead, at least until more about these old sump wastes is known. Blind sump wastes might be charged

---

[42] The University of S. Florida is conducting comprehensive analyses for contaminants in Florida's sweepings. This study is planned for publication in June 1998 (see Chapter 7, "Studies Currently Underway"). Similar studies may be underway elsewhere.

up with semi-volatiles, also. TPH totals can be used as a tracer for toluene, ethylbenzene and xylenes, and to evaluate whether sump wastes fall into roughly the same parameters as other roadwaste materials.

Data used to characterize contaminant levels in roadwaste may not be representative of roadwaste generated by a specific jurisdiction. Residential sweepings have often been observed to contain lower concentrations of contaminants than industrial or high ADT roadways. Efforts have been made to begin to quantify differences in contaminant levels present in roadwastes generated from residential, commercial, and industrial areas. Efforts have also been made to document contaminant reductions in well-swept areas and routinely maintained catch basins. Findings on these issues are difficult to assess. While contaminant level data points are somewhat scattered, roadwaste in residential areas and low traffic areas is generally less contaminated. Instances of illegal dumping and spills, and uncontrolled discharges from local industry activity impact individual catch basins and can impact sweepings, also. If a jurisdiction is interested in a reuse option not recommended in this report, further testing may show that contaminant levels in their sweepings or vactor solids are protective for that reuse.

A statewide sampling plan could characterize roadwaste generated in different ODOT districts under different conditions. Analyses conducted on variables such as land use, location, ADT, time between maintenance runs, and effects of rainfall could help us build sub-categories of roadwaste. Tighter and more reliable waste characterizations ease handling and limits the need for ongoing analysis. This idea is discussed again in Chapter 7 under Recommendations for Further Study.

3.7.2 Running Tests that Make Sense

Some tests are applicable to the general run of roadwaste and some are not.

The TCLP metals test can be run. (Mercury is a separate laboratory procedure and most roadwaste will be non-detect; mercury is occasionally found in roadwaste samples in spike concentrations, however, so testing to establish a baseline characterization could include it.) Standard roadwaste have not tested as hazardous waste, so TCLP metals data is mainly useful when examining leachate concentrations to help determine whether reuse is protective. The total metals test is less expensive and should provide data sufficient to make determinations for roadwaste reuse, handling and disposal if further data is required. As we saw in Chapter 2, TCLP maximums can be found by dividing total metals results by the 20 to 1 dilution factor in the TCLP test.

"TPH-HCID" is normally unnecessary, as we are looking for "heavy oil" and high diesel range hydrocarbons. However, if a gasoline release is suspected, running TPH-HCID can make sense. "NWTPH-Dx with acid cleanup" should be run when test results for hydrocarbon levels are required. Otherwise, agencies should only test for TPH levels to establish a baseline or evaluate a treatment method, as collecting more general TPH data is unnecessary. When run, two TPH tests can be run to evaluate diesel range and heavy oil range concentrations.

Although relatively immobile in the soil matrix, CPAHs are the current contaminants of concern in roadwaste and do merit testing when establishing a baseline or considering whether a particular management method is protective. CPAHs are constituents in the standard semi-volatiles scan, which also analyzes for PCBs, toluene, ethylbenzene and xylenes, some solvents, and some pesticides. Focusing this test on CPAHs may reduce the cost of analysis. Testing for volatiles does not make sense, except when there is reason to suspect a specific load, because of a known spill or high chemical odors, may contain these compounds.

Other tests might be required for special circumstances, such as spill events, abandoned drums, or waste illegally dumped along roadways. Field waste characterization relies on qualitative observations – color, odor, sheen – but could be backed up by pH stick tests or other tests easy to conduct in the field. As stated earlier, it is important to capture the pertinent information about samples, including sampling protocols and all pertinent information about sampling locations.

3.8 VOLUMES OF ROADWASTE GENERATED

In conducting this study, ODOT surveyed Oregon road maintenance agencies several private firms to determine the status of generation and methods used to manage roadwaste in Oregon. The results of this survey are attached in Appendix C.

ODOT Region 1 looked at sweepings generation and disposal costs. They found that ODOT generated 5,930 cubic meters (7,750 cubic yards) of sweepings in Region 1 in 1995. Solid waste landfilling costs for Region 1 were estimated at $741,675 per year ($844,833 with hauling costs) unless an alternative could be developed. (See Appendix C.)

WsDOT estimated annual generation totals at 37,000 cubic meters of sweepings and 8,300 cubic meters of vactor solids. *(Pierce, 1998)* WsDOT estimates disposal costs at more than $3,000,000 per year if forced to landfill all this waste.

By Washington DOE estimates, urban street waste generation averages about 90 kg per capita, with two to ten times more sweepings than vactor solids. The City of Everett generates 69,000 M^3 of street sweepings, vactor solids, and excavation material per year. Street sweeping in Everett averages 0.7 cubic meters per land mile swept. Total street wastes generated in Alameda County (California) averages 71 kg per resident with 97 percent sweepings. *(DOE, November 1996)*

Figure 3.7 shows annually generated roadwaste volumes from municipalities in and around the Unified Sewerage Agency service area in Washington County, Oregon. This area has seen large population growth since this survey was conducted in 1994.

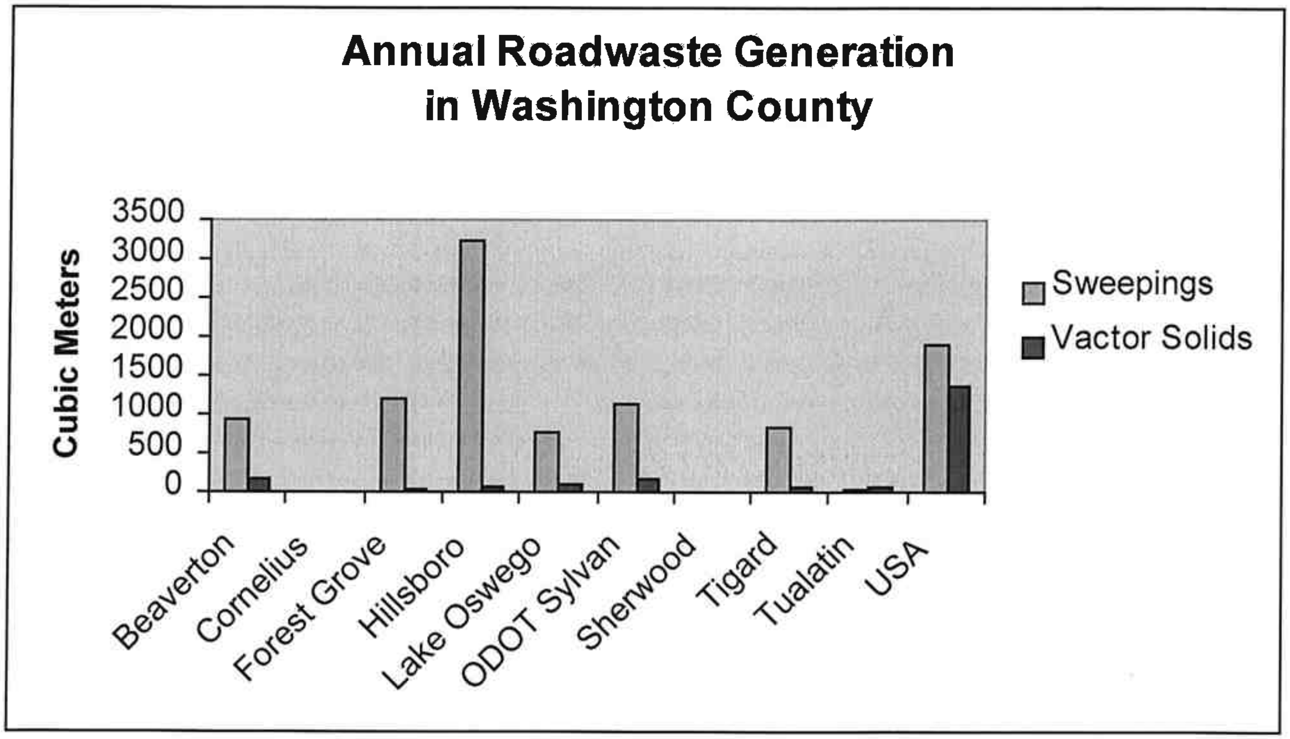


Figure 3.7: Annual Roadwaste Generation in Washington County
(Donovan Enterprises, 1994)

4.0 VACTOR WASTE ISSUES

The high water content in vactor waste creates management problems that deserve special attention. We begin this discussion by presenting a condensed summary of *Management of Stormwater Facility Maintenance Residuals*,[43] a report prepared for ODOT as part of Phase 1 by a consultant. *(Lenhart, 1998)* This report provided facts and recommendations to assist ODOT in developing a management plan for stormwater vactor wastes.[44] After discussing the consultant's report, additional information is provided from ODOT site visits, contacts, and literature review. In Chapter 7, we summarize these findings and offers concise recommendations on running a successful operation through the de-watering process.

4.1 SUMMARY OF CONSULTANT'S REPORT

Historically, storm sewers were cleared of accumulated sediment and debris to prevent clogging and flooding. Today, agencies also maintain storm sewers to reduce pollutant levels in stormwater and meet regulatory requirements. The proliferation of stormwater systems and increased maintenance has greatly increased the volume of stormwater residuals. Regulators are calling for improved waste management methods for this growing waste stream. However, these materials are extremely variable, the regulations ambiguous, and handling can be costly and difficult.

Storm drain appurtenances include catch basins, pipelines, ditches, and sumps. Some catch basins are cleaned annually, others once every decade. Crews use large, vacuum-powered eductor trucks to maintain storm sewer appurtenances. This equipment is also used for tasks such as vault de-watering, excavation of mud, pole hole drillings, etc. If a truck spends the majority of the day cleaning out mud from a small slope failure, the material does not need to be treated prior to disposal. The operator should be trained not to mix clean material with stormwater wastes as commingling of wastes can incur substantially higher disposal costs.

It is more cost and time efficient to field decant rather than visit a de-watering facility every time the tank is full of liquid. Typically, the operator will find a sanitary sewer line and decant the fluids to make more room in the tank. Discharge of vactor fluids to storm systems or natural drainage ways, though allowed in the past, is now prohibited. One way to minimize sediment loading to sanitary sewers is to establish "field decant" facilities. 24-hour settling of suspended solids will bring liquids into compliance for discharge to sanitary sewer. *(Eugene Public Works, 1995)* A primary settling vault removes most of the suspended solids, oil, and grease. Truck

[43] Copies of Jim Lenhart's report, written under contract to ODOT's Roadwaste Project, are available from ODOT's Research Unit upon request.

[44] Methods for managing vactor solids and rules impacting waste management are discussed in other chapters; Mr. Lenhart's findings have contributed to those discussions.

operators then periodically clean out the vault. Field decanting sites should be selected with the approval of local sanitary sewer authorities.

Vactor solids are typically de-watered on concrete pads or sometimes in pits. Several de-watering facilities are reviewed below. Given capital expense, operation time and maintenance costs, and the limited success of both pad and pit de-watering facilities, the consultant recommends that ODOT further investigate alternatives, such as de-watering in filter containers. Vactor solids have various options, including: landfilling, selected land applications away from waterways (e.g., reuse in medians), screening and reuse as aggregate, and reuse in asphalt and concrete.

4.1.1 Characterizing Vactor Waste

Vactor solids are composed of storm water sediments, organic material such as decayed leaves or wood, and litter including metals, paper, and plastics. Most litter is wind-blown from dumpsters or carelessly discarded by the public. Primary control mechanisms for litter are public education, litter laws, litter patrols, and street sweeping. Litter can prevent reuse of vactor solids, unless it can be screened out. Though not common, items such as hypodermic needles pose potential hazards to maintenance workers. Basically, any garbage on the street can end up in the storm sewer system.

Vactor sediment ranges from clays to cobbles (some of which approach diameters of 15.0 cm). However, vactor sediment is typically characterized as grit due to the sand fraction averaging 72%. *(DOE, 1993)* The particle size distribution for sediments is highly variable, but sand appears to be a major component, probably due to sand settling in sumps while finer particles are transported through the conveyance system. Larger sizes move as bed load in pipes and settle quickly into sumps or channels where water velocities slow. The finer particles remain in suspension anywhere from a few minutes to many hours. Extremely small clay and colloid particles can remain in suspension indefinitely. Oils and heavy metals generally attach themselves to the surface of sediment particles – particularly clay particles, which have a negative charge and bond with cationic pollutants. Many types of facilities have been developed to trap pollutants, including detention ponds, swales, created wetlands, and a variety of new technologies. *(Watershed Management Institute, 1997)* Trapped residuals will have more vegetative matter and finer sediments than those seen in sumps and catch basins.

Numerous characterization studies of residuals have been performed in both Oregon and Washington. A major theme is the extreme variability in the physical and chemical characteristics of stormwater system residuals. This raises significant questions about testing needs and sampling protocol.

Data indicates that TPH and PAHs are the constituents of concern. Problems with measurement of petroleum hydrocarbons include significant interference with common organic materials such as pine needles; TPH data can be misleading.[45] PAHs are hazardous organic compounds; some

[45] For heavy oil fractions, the risk is from CPAHs, since heavy oils themselves pose few concern and are relatively immobile—Jay Collins.

are carcinogenic. Generated from automotive combustion *(Takada, 1991)* and tire dust,[46] they are found in soils and sediments in urban environments. These pollutants are still being evaluated with respect to their impact on stormwater residuals management. PAHs are not mobile in the environment and under correct management might not pose a substantial risk.[47] *(Woodward Clyde, 1996)*

Though heavy metals can pose concerns, TCLP tests have shown that heavy metals leach from roadwaste in only very low concentrations. Based on available data, heavy metals do not appear to be a significant concern for vactor waste management. *(Perla, 1996; WsDOT, 1993; Jacobson, 1993; Woodward Clyde, 1996)* As such, frequent TCLP metals tests will not likely be required.

Biological pollutants are primarily of risk to maintenance workers. Fecal coliform bacteria are consistently found in stormwater runoff. Maintenance workers need to use sanitation practices that minimize exposure to soil and waterborne pathogens.

Smell and visual sheen seem to be two strong indicators of transportation related fuel and greases and can be used in the field to evaluate the possibility of a "hot spot".

Vactor liquids are an aqueous suspension of fine sediments, sometimes with a visible sheen from oil and grease. Vactor liquid content varies widely, dependent on the catch basin and the length of time between cleaning. The ratio of fluids to solids depends on the catch basins and how much fresh water the operator used during clean out. Typically, vactor fluids range from pH 6 to 8 [pH 7 is neutral]. Total suspended solids (TSS) values of 111,000 mg/l have been recorded. *(Washington DOE, 1993)* Because the large majority of pollutants in vactor liquids are adsorbed to suspended particles, TSS is used by some agencies as a benchmark to quantify pollutant removal efficiencies. However, TSS is not an evaluation of dissolved pollutant levels.

One expects vactor waste from urban areas to have higher pollutant levels. Hence, it is anticipated that management practices in heavily urbanized [and high ADT] areas will face more stringent regulatory requirements. The large variance in waste characteristics is loosely associated with land use, though it has been well established that even areas known for low pollutant levels can still see occasional spikes. For example, illegal dumping of motor oil and paint solvents is well documented. Truck operators indicate that many catch basins have unique "personalities" and can be totally different from surrounding catch basins. Frequently maintained facilities appear to have lower pollutant loads.

During summer, pollutants tend to accumulate on paved surfaces. First flush runoff from early fall rains typically have the highest pollutant concentrations; the first high-energy rains of the season will have the highest sediment loadings. During the late fall, leaves provide high organic loading. During the winter and spring, deicing sand may be found. The volume and nature of residuals is strongly dependent on the weather. Many municipalities will schedule increased maintenance operations to account for seasonal loadings.

---

[46] Mr. Lenhart in communication with Roy Harris, City of Everett, WA, 1998.
[47] Also, Mr. Lenhart in communication with Tony Barrett, Washington DOE, 1998.

Noting differences in wastes suggest that a source separation program could be cost effective. This in turn suggests that operator training is key to any successful management program. Since ODOT operates year-round and statewide, there will likely be significant variation in its vactor waste.

4.1.2 A Look at Other Agencies

Although vactor wastes are highly variable, the approach to vactor waste treatment has been relatively low tech. Treatment practices typically range from a convenient disposal site – such as an abandoned quarry or unused low lying portion of a maintenance facility – to constructing facilities to separate the solids and liquids to accommodate disposal needs. Most jurisdictions have either constructed or designated facilities.

The City of Everett has a source separation program and has trained operators to make field determinations.[48] If the crew suspects – by odor, color, or sheen – that a load may be contaminated, they record their observations and proceed to the next destination without removing the waste. A "special run" is then scheduled to handle the waste. Operators decant free liquids to sanitary sewer mains only. The City is considering adding flocculent to loads to reduce solids going to the sanitary sewer.

The City has a three-step process to separate out liquids. Loads settle in the truck for ½ hour, then free liquid is decanted to a series of trapped settling basins. The load is then dumped into a concrete box with flashboards to retain the solids. Over a period of days to a week, the solids lose most of the remaining water. The de-watered solids are removed with a loader and placed on a sloped asphalt surface. The solids remain on the asphalt up to four months (dependent on the time of year) until dry. The City plans to add a salting shed to store drying materials to minimize re-wetting from rainfall.

The City manages vactor solids by recycling. A ½" screen separates the "bigs" which are used as aggregate material. The fines are used in areas without direct drainage to streams or wetlands and with little chance for human contact; e.g., medians and controlled roadsides. Fines are tested for TPH, TCLP and PAHs prior to reuse. To date, they have not cause a "spike" using draft guidelines prepared by the Washington Department of Ecology.

The City of Portland is presently constructing a new facility. The Inverness facility used a sloped dump pad with a central de-watering trough, but was too small to meet the City's needs. The City also noted difficulties in getting solids to de-water in a timely manner.

Lane County has partnered with the Cities of Eugene and Springfield. They field decant to designated manholes in the Cities' sanitary sewer systems and operate a $250,000 de-watering facility.[49] Three to four loads are processed daily. Liquids collect in the central, concrete trench

[48] Mr. Lenhart gathered this information in communication with Roy Harris, City of Everett. Mr. Harris should be considered as source of information as to how ODOT could provide operator training in the future.
[49] Summary of field visit by Jay Collins, ODOT, 1998. The partners plan to open the facility for others use, planning to charge about $250 per load. For more information on this facility, see this report in Appendix F1.

and pass to a settling tank. Once de-watered, solids are added to the garbage going to the county landfill; the facility is located at a Lane County Solid Waste Transfer Station.

The City of Gresham has a two-year-old de-watering facility. The City is the sole user of the facility as it is small, even for them. (Appendix F3 contains a set of plans for this facility.) The $200,000 facility has a footprint of 15 m x 15 m with a wash rack. A drainage trough runs down the middle, discharging liquids to a baffled vault for extended settling. The effluent meets the City's sanitary sewer discharge standards. The de-watering process takes from three to four weeks in the winter and two weeks in the summer. They does not pile solids as high as other facilities, nor do they "pre-decant" the free liquids prior to dumping onto the de-watering slab. The City disposes solids at $63.80 per metric ton at Hillsboro Landfill. Solids are tested quarterly for TCLP metals and TPH.[50]

The City of Gresham reports that their facility is too small and the high roof does not keep out the rain. The vertical drop at the truck dump has worked well, preventing "slop" from getting the truck or the operator dirty. A small "runway" extending from the vertical drop should give the operator a better position to clean out the containment vessel. Operators need more training and the facility needs more management than anticipated. Dryer solids should be kept away from the dumping area to prevent re-wetting and to keep more height on the pile. Field practices include source separation: if the operator knows the load came from a construction site, the solids are handled separately from the usual vactor waste.

The City of Olympia shares their de-watering facility with the Cities of Lacey and Tumwater and with Thursten County. The City of Olympia's $140,000 covered facility has been in operation for four years. The facility is about 12 m x 18 m with a drainage trough down the center. It can process a maximum of about 24 m^3 per week. In 1996, operational costs were about $30,000 for 217 m^3 of material. They decant free liquids prior to dumping, significantly reducing residence time on the pad. They charge $137 per m^3 to accept material, inspect loads, and retain right-of-refusal. Piles can exceed two meters, but they plan to raise walls and pile even deeper. Liquids pass through an oil/grit separator and meet sanitary sewer discharge standards. For $53/metric ton, solids are taken to Holnam Concrete for casting into ecology blocks after thermal destruction of TPH and organics. Comments provided by the City: the facility is undersized; the sides need shielding from the rain.

The City of Seattle operates two concrete pit de-watering facilities, accepting residuals from catch basins and electrical vaults. Liquid overflows to settling basins prior to discharge to sanitary sewer. The solids are taken to a solid waste landfill.

4.1.3 Findings from Review of Vactor Waste De-watering Facilities

De-watering presents the most significant challenge to efficient vactor was management. Most de-watering facilities include a flat or sloped concrete floor. The contents of the eductor truck are dumped onto the pad surface with the notion that the fluids will run to a collection drain, leaving the solids behind. Although not completely satisfied with facility performance, operators

[50] Given what is known about vactor waste and street sweepings, this testing should not be required – Jay Collins.

have reported some successes. Findings commonly reported from de-watering facilities include the following:

- The pads are too small, both not long enough and not wide enough.
- Capital costs are very high, particularly for facilities with roofs and complex concrete slabs.
- The solids take too long to de-water. Frequently, it takes many weeks to reduce moisture content to levels allowing disposal as solid waste.
- After de-watering, vactor solids contain approximately 20% water.
- A roof is typically needed to keep rain from delaying the drying process. However, the roof must be high to accommodate dumping of loads, and wind-blown rain then enters the facility.
- A ledge in the pad appears to minimize splashing on workers and on trucks.
- Facility design needs to accommodate use of loader to work the material.
- Facilities should decant free liquids prior to dumping on the de-watering pad.
- Facilities have a difficult time developing effective barriers to remove solids from suspension; most barriers are ineffective or plug very quickly.
- Due to pore pressure, deeply piled sludge de-waters more quickly than when spread thin, just like a sponge set on end loses water more quickly than a sponge set flat.
- Disposal costs are often tied to weight, so materials should be as dry as possible.
- Vactor waste requires management.

Standard oil/water separators utilizing multiple chambers and baffles provide sufficient pretreatment prior to discharge to sanitary sewer. Sediments are cleaned from the units with eductor equipment. If excess oils are observed, they can be removed using sorbent pads. If TSS remains an issue for discharge to sanitary, use of flocculent might solve this problem. In the dryer portions of the state, it may be possible to evaporate the liquids rather than discharge to sanitary; where available, sanitary sewer connection is probably more cost effective.

4.1.4 Recommended Management Options

ODOT should identify treatment options and use material volume estimates to project costs of handling vactor residuals. The recommended approach includes enhanced worker training, development of a statewide master plan and evaluation of some waste treatment technologies.

Once ODOT establishes a final list of preferred practices, their plan should be submitted to DEQ for official review and approval. ODOT is working with DEQ in evaluating the following preliminary practices:

- Field decant to designated points along sanitary sewers only. Land apply clean sediment and water from construction, etc., to areas without runoff to surface waters.[51]
- Discharge de-watering facility liquids only to sanitary sewers.

[51] Note by Jay Collins: DEQ's Water Quality Program suggests, in areas where sanitary sewer connection is not available for field decant, agencies designate areas for land application and infiltration of stormwater clean out liquids. (Email and conversations with Ranei Nomura and Rajeev Kapur of DEQ, January-February 1998.) See Section 4.2 below.

- Investigate recycling of vactor solids in growing media placed in ODOT-owned and controlled areas. Prevent human exposure, runoff to surface waters, direct groundwater connectivity. Require 30-meter setbacks from a stream or wetland across any open ground.
- Investigate discharges of high levels of pollutants to ODOT controlled storm sewers. Actions can range from public education to encourage better stormwater quality at the source to enforcement actions perhaps involving DEQ or local authorities.
- Cull out and handle suspect loads as potentially hazardous wastes.
- A successful program should include source separation, multistage de-watering processes, and a variety of disposal options.

The consultant provided a flowchart illustrating how vactor waste is normally managed (see Figure 4.1). This flowchart can provide information valuable in the development of ODOT plans for vactor waste management.

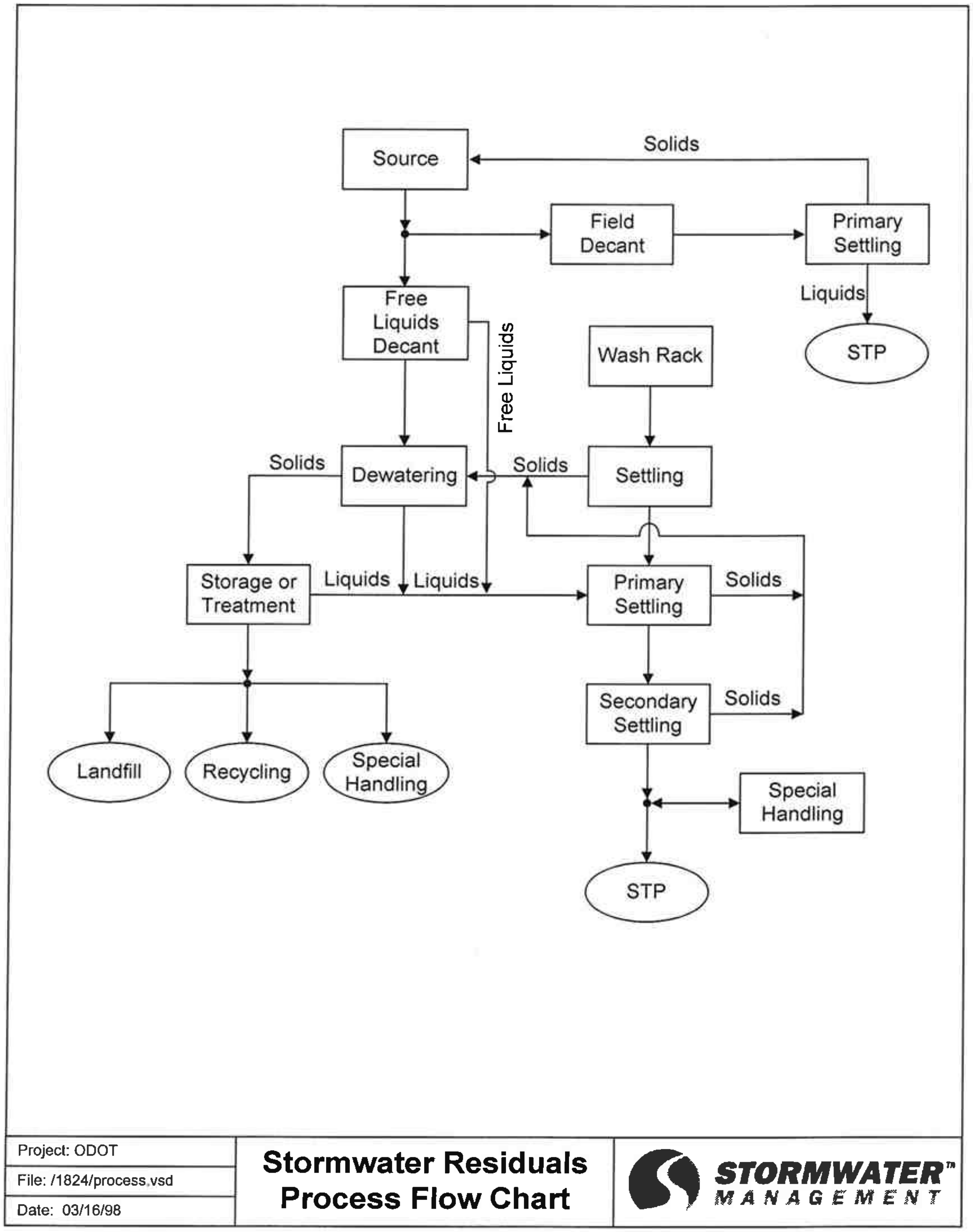


Figure 4.1: Stormwater Residuals Process Flowchart
(Lenhart, 1998)

Trucks should be washed off so they do not transport solids back onto the streets. Typically, de-watering facilities have a wash rack to service the trucks; wastewater from truck washing can be routed through the de-watering facility settling chamber to the sanitary sewer. It is recommended that every de-watering facility have a vehicle washing station.

Empowering workers to make decisions in the field is a necessary component of meeting regulatory requirements while minimizing costs. Besides OSHA training, worker training program elements should include:

- An understanding of pollutants, the environment, and current regulations
- Sanitation practices, including personal sanitation and vehicle washing
- Field identification of "hot spots" based on odor, sheen, color and consistency
- Source separation. Clean materials should be kept separate. Suspected "hot" materials should also be managed separately (prior to testing, at a minimum) to reduce risks to workers and prevent higher management costs, and to keep management options open.
- Source detection: worker identification and tracking of stormwater pollutant sources. Workers should be encouraged to raise concerns to generators, management, and/or regulatory officials.
- De-watering facility operation, to reduce de-watering times and minimize handling costs

ODOT should develop plans at the district level, identifying locations and facilities to de-water and field decant. ODOT should evaluate the need for siting field decant stations. District plans should identify solids disposal options. Each district should establish a selection of options based on waste characterizations, cost and operational efficiency.

4.1.5 Recommendations for Further Investigation

ODOT should determine how much waste it generates in each district. ODOT could then estimate implementation costs of various methods. Costs of constructing facilities and purchasing equipment should be considered alongside operating, maintenance, testing, and materials disposition costs. The State should also project costs for the expected increase in maintenance of stormwater quality facilities in the future, taking into account increased volumes of waste and considering the benefits of regular and frequent maintenance versus emergency-driven maintenance. Less time between stops means workers spend less time per facility on regular maintenance duty.

Recent research by Snohomish County reports that adding flocculent (VGT-2000 by Delta Pollution Control) to the eductor tank substantially increases decant water quality. *(Snohomish County Public Works, 1997)*

It is assumed that rural loads are less contaminated than urban loads. ODOT may wish to further characterize residuals generated outside urban [or high-ADT] areas with the idea that less contaminated materials face less stringent requirements. Since clay particles tend to adsorb pollutants, finer fraction solids will have the highest probability of triggering a regulatory threshold. Road sanding material can be recycled, especially if picked up quickly after snow and ice clear. This method also minimizes the impact of road sanding on stormwater facility maintenance.

Reprocessing and Reuse of Street Waste Solids provides an extensive summary of other technologies that may be used for liquids and solids separation. *(Washington State Dept. of Community, Trade & Economic Development/Clean Washington Center, 1997)* These technologies include screw washing, screening, and solids separation by floatation.

A different de-watering method utilizes filter containers. [See Flo Trend Systems product diagrams and price list in Appendix F4; container volumes range up to 20 cubic meters.] Solids de-water on an inner screen. Vactor trucks can dump onto a unit that funnels the waste into a container. Once the container is full, it is removed from the pad and set aside to finish de-watering by gravity, expressing liquids, or using pumps. An empty container can then be moved into place under the funnel. The full container can be covered with a tarp to keep out the rain. Roll-off containers can be drawn onto the back of trucks for transport to a disposal, treatment or re-use location. Another style of container can tip to dump out solids after de-watering. Advantages to container de-watering include the following: reduction in capital, materials handling, and operational costs; operational flexibility; and easier source separation. Container de-watering may also allow ODOT to pursue a uniform management strategy across the state.

The City of New York has adopted a process similar to this. A mesh size of 30 (30 openings to the inch or 11.8 openings to the centimeter) appears to provide a good aperture size for de-watering. Within a 24-hour period this methodology reduced water content by 49%.

The consultant suggested the following de-watering and recycling technologies for ODOT to further evaluate:

- Establish a pilot study to evaluate use of containers for de-watering. This could be a cost efficient alternative to high capital costs of constructing concrete facilities with roofs.
- Perform a pilot study to recycle de-watered solids. Examine reuse for roadside median top dressing. ODOT can also evaluate the idea of immobilizing fines by mixing them with finished compost.

4.2 REVIEW OF CONSULTANT'S FINDINGS

In New York City, a clam shell digger is used to clean out stormwater catch basins, rather than a vactor unit. They find that much of the waste they accumulate is litter and all their solids are disposed at the municipal waste landfill. The City uses container filters to collect stormwater residuals, both roll-off and lugger-type boxes. Use of the container units has been very successful for them; within a maximum of 24 hours their waste passes the paint filter test and is ready for landfilling.[52] The only vactoring they do is sewer sludge spill cleanup. This vactor material is de-watered using pad technology.[53] When asked whether higher loadings with fines would make container de-watering impractical for vactor wastes due to expected clogging of filters, they suggested that we contact Flo Trend Systems to discuss our de-watering needs, recommending the company as easy to work with and able to meet a variety of needs.

Discussions with Flo Trend Systems provided valuable input. They did not feel that our wastes would be significantly different than the wastes from New York. They did suggest that use of a flocculent could trap much of the fines in the coarser materials and improve liquid separation efficiencies. They verified that they have had success with applying a vacuum to the boxes and drawing out liquids from other types of waste. Often, de-watering is done as a multi-stage process. For example, using different screen sizes could allow up-front pre-screening for litter and/or aggregate. As is the case with other forms of de-watering, sanitary sewer usually require that fines suspended in the effluent be removed prior to discharge; besides settling, Flo Trend can offer centrifuging as an option.[54] If container management does not meet our needs, we are left with partnering with others and/or constructing our own de-watering facilities.

Concerns have been raised about whether container de-watering is compatible with weathering or with active biological treatment. (Bioremediation of vactor sludge is discussed in Chapters 6 and 7.) Of course, use of a method or technology must be integrated into the overall plans for management of a given waste. This said, container de-watering is a potentially valuable technology easy to recommend for field trials. The containers are well sized for trial use and the technology has a lot to offer if it works for Oregon vactor waste.

Flocculent has been in use for many years in treating wastewater. It is a flexible and sensible technology. Application to stormwater vactor waste management is new, offers many advantages and few disadvantages.[55]

---

[52] The City has an agreement with neighbors to never store any vactor waste more than 24-hours due to odor concerns from ripening waste. If odor complaints have been received on 24-hour detention, imagine the odor problems associated with pit dewatering. See Mark Ghezzi's report in the Appendix for a discussion of odor problems at pit facilities in the Seattle area. (Multnomah County Transportation Division,1997)

[53] April 3, 1998, telephone conversation with Tom Bentsen of New York City's Department of Environmental Protection, Transportation Section.

[54] April 24, 1998, telephone conversation with Gary Skinner, Flo Trend Systems, Inc., 1-800-762-9893.

[55] From review of Snohomish County's 1997 report, and from 1998 telephone conversations with Bob Campbell of Snohomish County Public Works and with Stuart Lindor of Delta Pollution Control. Mr. Lindor has agreed to provide a day or two of assistance if ODOT wishes to pursue a trial program.

Advantages of flocculent use:

- Time saved by field crews on field decant and trips to de-watering facilities
- More efficient crews may mean fewer vactor trucks required
- Effluent meets sanitary sewer pretreatment requirements
- Initial phase separation can make de-watering more efficient at facilities. This may substantially reduce space requirements, thus reducing large capital costs.
- May further assist de-watering by fixing fines and increasing the porosity of vactor sludge
- Use of flocculent can be good for the environment by minimizing contaminant return to the stormwater system
- Easy to use: dump fifty pounds of flocculent into the tank at the start of the run
- Delta Pollution Control's flocculent is an inert silica material

Disadvantages of flocculent use:

- Product cost
- Workers must use dust protection while handling flocculent due to airborne silica hazard
- Flocculent use may not work as efficiently as it could with current truck designs
- The flocculent must be managed along with the vactor waste solids

22 kg (50 lbs) of flocculent is recommended for each load, although light loads might get by with 11-14 kg (25-30 lbs); cost for the flocculent is $3.30 per kg ($1.50 per lb) in bulk, plus delivery from Everett, WA; flocculent cost comes to $60 to $80 per dumped load. It is difficult to assess the impact, if any, on contaminant concentrations; the weight of contaminant-free flocculent may be matched with the contaminants trapped in fines that might otherwise be lost during field decant.

Again, it is easy to recommend that ODOT conduct trials on the use of flocculent. The projected operational advantages of flocculent use could be substantial and are easy to translate into timesaving for agency crews, and into equipment and capital cost savings. Snohomish County estimates potential net savings in operational costs of $156,000. *(Snohomish County Public Works, 1997)* Delta Pollution Control main goal for the product is to increase in operational efficiency 100-300%.

DEQ has tentatively approved land application of stormwater vactor liquids in areas where sanitary sewer connection is not available. Sites should be pre-selected by qualified specialists. Sites should not have direct connectivity with groundwater, and risk of human contact and runoff must be minimal. Level grassy areas well above the seasonal high water table and the 50-year flood plain can make good choices. Even then, overuse should be avoided to minimize the potential for site contamination. In the San Francisco Bay Area, CALTRANS uses grassy areas for field decant; CALTRANS moves field decanting to new sites about once a year. DEQ asks that ODOT approach the DEQ Aqua-Stormwater subcommittee with a more formal proposal if ODOT plans to use this method more than rarely (or at all in areas where sanitary sewer connection is available).[56] In Washington State, Delta Pollution Control is in negotiation with

[56] February 6, 1998, telephone conversation with Ranei Nomura, DEQ.

Washington DOE to approve field decant of flocculated liquids to stormwater systems. An opacity meter on the discharge hose may be required to help operators make sure that solids are not discharged.[57]

The consultant offered the idea that de-watering facilities in dry areas might evaporate vactor liquids as an alternative to sanitary sewer disposal. East of the Cascades, high evapotranspiration rates tend to dry things out very quickly. While this phenomenon can be used to advantage in some areas, at the same time care must be taken that contaminated fines are not allowed to blow out of dry settling basins, causing concerns for contamination of downwind properties or waterways. Roofing de-watering facilities in dry areas seems unnecessary; instead, an adequately sized evaporation basin could capture stormwater runoff, as well.

4.3 ADDITIONAL FINDINGS BY ODOT

ODOT needs to establish procedures for the evaluation of wastes at de-watering facilities and in the field. Snohomish County Public Works has developed an excellent waste screening procedure to defend their de-watering facility against hot loads.[58] This waste acceptance procedure can be extended to materials in catch basins and sumps prior to pumping. Developing effective field screening procedures is an iterative process – we will learn more as we go and use what we learn to ask better questions. Testing of potentially hot catch basins will provide more information on what to cull out for management outside normal roadwaste, what makes for a hot load. This review process will also help agencies define subcategories of waste, allowing for easier handling of some wastes and easier recognition of wastes that require special handling. Agency maintenance crews may need support from hazardous materials staff, especially while getting up to speed on potentially hot loads.

In the Portland area, the Unified Sewerage Agency (USA) runs a de-watering facility and has established field decant stations on its sanitary sewer lines. The USA facility is a very simple, uncovered pad bounded by stackable concrete blocks. USA disposes vactor solids to Hillsboro Landfill. USA currently operates three field decant stations in Washington County and plans to construct six more over the next two years. USA is open to partnering and has allowed other agencies to use its field decant stations. Marion County constructed a small de-watering facility at Brooks using its own labor and equipment for about $40,000. This facility is a small, uncovered pad that is sufficient for the few demands placed on it; due to volume and hazardous waste liability issues, Marion County is not open to others' use of this facility.[59] Both of these de-watering facilities are located adjacent to a sewage treatment plant (STP) – USA next to Rock Creek Plant and Marion County next to the City of Brooks wastewater treatment lagoons. Siting de-watering facilities next to STPs makes sense because of the expertise plant operators have in

[57] Telephone conversations with Stuart Lindor of Delta Pollution Control and Bob Campbell of Snohomish County Public Works, 1998.

[58] This waste acceptance procedure is quoted in the Appendix and discussed in further in Chapters 6 and 7.

[59] These facilities are discussed in the memo "Selected Oregon Decant Facilities" attached as Appendix E. Detailed plan sets for the Brooks facility and for the USA field decant stations are attached as Appendices F1 through F5. The Brooks facility offers an inexpensive design for locations having little throughput.

dealing with wastewater and sludge, and the fact that potential impacts from sediments on the sanitary sewer system are minimized.

The City of Forest Grove and the City of Beaverton also run de-watering facilities in the Portland Metro area. Forest Grove operates on a roofed pad with a chambered holding tank for settling prior to effluent discharge to sanitary. Truck operators try to pour off free water prior to dumping the solids, but the loads are well mixed; so, the outlet from the pad to the settling tank often clogs during dumping. They have tried to de-water sanitary sewage sludge in a container on site, but do not have a convenient means to transfer the material from the container for transport off-site. The City of Beaverton runs a two-phase de-watering process. Vactor loads are dumped at their old wash rack, where liquids go through an oil/water separator prior to discharge to sanitary. Solids are scooped out and piled in an unroofed drying area bounded by stacked wooden planks. These sludges are very slow to dry.

Don Newell of Multnomah County has visited a number of de-watering facilities in the Northwest. He recommends a two-stage de-watering facility design. A small, unroofed de-watering area is used for initial de-watering, saving a lot of money versus pouring a large, sloped pad. (Wastewater goes through a standard baffled chamber or settling tank prior to discharge to the sanitary.) Then the vactor sludge is piled deep in a drying shed for final de-watering. This shed would be much less expensive to construct than a high roof over a de-watering pad; it could also be compartmentalized for storage of other materials, such as sand. If container de-watering does not work out, a facility constructed along these lines could be investigated. Similar savings might be achieved by dumping onto a pad using a roll back tarp; however, effective segregation of new and drying wastes must be achieved.

Separation of vactor waste fractions may be easier to achieve in the liquid state. Since vactor wastes are harder to screen than sweepings, it is better to capture litter in sweepings than in vactor waste. Larger pieces of litter might be screened from vactor wastes by dumping full loads onto a wide mesh. Next, a skimmer could remove floating wastes and wastes brought to the surface by adding air. The waste could then be agitated, and gravel and coarse sand removed on screens. These materials are known to be relatively uncontaminated and may be ready for immediate reuse as product, especially if washed to remove fines. Settling or flocculation then could remove fines, which are the most contaminated. The fines could pass through a treatment process prior to reuse or be de-watered and disposed in a solid waste landfill with the litter fraction. Fines captured in settling chambers and oil/water separator pretreatment units merit solid waste landfilling or other special handling, as these extra-fine materials are likely to contain a greater concentration of contaminants. Rather than reintroducing extra-fine fraction to the main de-watering unit, separate management may ease reuse options for other vactor solids.

We have looked at many examples and ideas in this chapter. One overarching principle: for vactor waste management to be efficient, a cohesive plan is required.

5.0 PARTNERING AND USE OF OTHERS' FACILITIES

While most of the requirements imposed by facilities that accept sweepings, vactor liquids, or vactor solids are not set by law, they can be operationally similar. In this chapter, we discuss arrangements that may be made to reduce the impact of these requirements. We also discuss concerns that generators of roadwaste should exercise in their choice of facilities, focusing on liability issues and whether typically employed treatment methods are applicable to roadwaste contaminants. Use of these types of facilities will be evaluated for cost effectiveness and workability against many other options in Chapters 6 and 7.

5.1 LIABILITY CONCERNS

When waste is taken to another's facility for treatment or disposal, it normally faces additional requirements beyond the generator's own waste management procedures. Waste management facilities take pains to screen wastes, often requiring laboratory tests on roadwaste prior to acceptance. Concerns about hazardous waste liability and the potential for site contamination are important operating issues. Will hazardous constituents "along for the ride" disrupt the treatment process? Will the contaminants make the resultant product unusable, even expensive to dispose? Will effluent or sludges be more difficult to manage? If the facility was not designed with a specific contaminant in mind, it may more easily escape containment and lead to contamination of facility property or other sites, possibly resulting in a costly cleanup. Besides meeting their own concerns, most waste management facilities must meet requirements established by DEQ, showing that their waste acceptance and treatment process is within permit conditions and protective of the environment.

Similarly, care must be taken in the selection of waste management facilities. Besides facility imposed requirements to reduce potential liabilities, the generator must consider their own potential for liability. Regardless whether a hauler or waste management facility waives a generator's liability and accepts full responsibility for a waste, Superfund and hazardous waste laws take precedence. The ultimate responsibility remains with the generator. If a treatment process fails to destroy or render harmless a hazardous constituent, responsibility for any impacts of that constituent on human health or the environment may fall on the generator. Furthermore, if a waste management site is found contaminated and cleanup is required, and if constituents of concern are identified in a generator's waste, that generator will likely be asked to pay a share of the cleanup costs. When a treatment process results in creation of a product that goes for reuse, the potential for liability extends beyond the treatment facility to any location or person who may come into contact with the treated material. Involvement in a cleanup can occur in situations where the generator's specific wastes were managed by the facility without impact to the environment, as this can rarely be proven. If the generator is a public agency perceived to have deep pockets, involvement in such a cleanup is even more likely.

Concerns over liability and what can often amount to needless testing sometimes leads agencies to build their own facilities and to keep their doors closed to outside parties. However, partnering is important for efficient waste management. If doing the right thing can be made cost effective, everybody should be allowed to participate and the environment should benefit. Benefits to the environment can reduce the stringency of future requirements imposed by DEQ.

5.2 SOLID WASTE LANDFILLS

DEQ-permitted, clay-lined municipal solid waste landfills are unlikely candidates to pose future environmental liabilities. Permitted landfills have some financial assurance against the threat of contamination, and have leachate collection and treatment systems to prevent contaminants from posing a risk to the environment. Solid waste landfills are limited in waste types they may accept; wastes are screened prior to acceptance. Different landfills have different designs, accept different materials, and place different requirements on waste generators. Solvents and other toxic constituents may pose problems to efficient management of landfill leachate. Landfills are required to take only dry wastes; wastes that fail the "paint filter test" are not acceptable.[60] DEQ typically require landfills to monitor the groundwater around their facilities for potential impacts. Roadwaste contaminants are typically well washed and do not pose a hazard to leach from a lined landfill. Given the immobile nature of the contaminants in roadwaste, landfills appear to be an attractive management option.

Operators of solid waste landfills screen out most hazardous waste. The TCLP test screens out wastes from regulated hazardous waste generators with high levels of leachable heavy metals or other toxins of concern. The TCLP test (discussed earlier in this report) was designed to mimic long term leaching in the acidic environment of a landfill. Wastes that fail this test are hazardous waste. While some hazardous waste still enters landfills, this amount of hazardous waste is expected to pose few or no significant problems down the line. Regulated generators can landfill hazardous waste only at permitted hazardous waste disposal facilities; the one facility in Oregon landfilling hazardous waste is the Arlington USA Waste facility.

Solid waste landfills also tend to limit petroleum concentrations and other constituents at their discretion. Hillsboro Landfill limits TPH to 50,000 ppm. Testing roadwaste to determine whether it is under this value should not be required unless visual signs or excessive odors indicate a potentially hot load. However, this does not prevent a landfill from requiring testing for each load. Working with a landfill to build a productive relationship can be important to reducing the testing required for roadwaste disposal.

Besides accepting only dry wastes, landfills' high tipping fees are the only obstacle to efficient and safe disposition of roadwaste. WsDOT estimates that they would spend $3,000,000 per year on roadwaste disposal were they to use landfills exclusively. One way to reduce or eliminate landfill fees is to get roadwaste accepted for use as daily cover at reduced rates or at no charge. For the standard six-inch daily cover of garbage cells, landfills ask for consistent amounts of materials with minimal contamination. Materials that can blow away, attract pests, or pose a

[60] If liquid can leak through a paint filter from a representative sample of waste, the waste is too wet to accept.

threat to the environment are poor candidates. Any waste not posing these hazards and which has good compaction might be approved. However, generators of many other wastes have pursued use of their waste as daily cover. Recently, fluff from crushed oil filters has been approved for use as daily cover. Petroleum contaminated soil from UST cleanups was often used for daily cover, but that has changed. With more ready and reliable sources of cover material, disposal of petroleum-contaminated soils has become a significant source of income for some landfills. Hillsboro landfill, for instance, has ready sources of clean-fill material from construction contractors; the landfill can store clean fill on site with few concerns and have it ready for use.[61] In the Portland Metro area, a big surplus of clean-fill material is available with few alternatives for placement. This may be the case in other heavily developed areas, as well.

Other types of landfills can provide protective management methods for roadwaste. Clean-fill sites and industrial landfills may be options. A clean-fill disposal site in Washington County is charging $3.50 per cubic yard for street sweepings disposal. Such sites are operated with or without DEQ approval. Long term liability of a lined landfill is minimal, but clean-fill sites are typically unlined pits. ODOT should only dispose roadwaste in landfills that have DEQ's approval to accept the roadwaste in question. ODOT should attempt to keep TPH levels in the wastes taken to unlined landfills to protective minimums. If the sites are taking largely clean fill, then there would be less of a concern that roadwaste acceptance might eventually pose a threat to groundwater. Farmington Landfill is interested in developing a program to manage roadwaste materials, perhaps in a monofill within its clean-fill site after screening and perhaps offering some simple pre-treatment for organics and petroleum fractions.

Solid waste reduction, and waste reuse and recycling programs have gained wide acceptance in the effort to reduce landfill usage and prolong the working life of sanitary landfills. If costs are similar, reuse is a better approach than disposal at a sanitary landfill if environmental concerns over the reuse have been satisfied. Remember that with new methods and technologies, reuse can become more efficient over time, while landfilling cannot, and costs have been escalating. However, for litter removed from roadwaste and for roadwaste fractions without viable reuse, landfilling remains a reasonable alternative.

Several agencies in Clackamas County have expressed interest in a clean-fill and/or roadwaste dumpsite. The possibility of siting our own landfill or partnering with other jurisdictions in siting such landfills will be discussed again in Chapters 6 and 7 in conjunction with passive and active treatment technologies.

5.3 SANITARY SEWERS

DEQ has stipulated that liquid wastes from vactoring storm sewers cannot be placed back into storm sewers. Wherever possible, the sanitary sewer should be used for disposal of this wastewater. Sanitary sewer systems have several different concerns. The wastewater treatment plants (WWTP) must be able to meet discharge limits set by DEQ. To operate efficiently, wastewater must fit within certain parameters. Wastewater must not have excessive levels of

[61] Grant Gauthier of Farmington Landfill during a meeting on April 3, 1998.

dissolved metals or certain other contaminants that may pass through untreated or pose problems in application or disposal of WWTP biosolids (sludge). If wastewater entering a WWTP contains high levels of chemicals or metals that can kill the microorganisms which process sewage, sewage will pass through the plant virtually untreated. In high volumes, compared to a WWTP's size, concentrated wastes may place oxygen demands (required to support intense biological activity) that are difficult to meet. Trash and sediments can clog sewer lines. To meet the various concerns, sanitary sewers impose pretreatment limits on discharges to their sewers.

Sewer systems also require that wastewater not be excessively caustic, and not contain concentrations of contaminants that may escape the sewerage system or pose toxic hazards for sewage line workers. Gasoline and other volatile compounds can pose explosion hazards in sewers. Vactor liquids normally do not pose any of these hazards, the contaminants being limited to some heavy metals and heavier, non-volatile petroleum fractions. However, potentially hot loads may merit testing prior to release of liquids to the sanitary sewer.

Sanitary sewer pretreatment requirements may vary. For instance, the City of Salem is concerned over copper due to high background levels of copper in its water source. A small, community WWTP might be challenged by the biological oxygen demand from a substantial quantity of vactor liquids and special care should be taken to meet these needs.

Huge volumes of rainfall that can overwhelm a WWTP, resulting in an untreated discharge called a "by-pass," and sewer authorities are working to keep rainfall separate from sanitary systems. If ODOT sites a waste management facility, the local sanitary sewer may require rainfall onto open storage areas be kept separate from the sewer. Similarly, concern should be exercised to determine whether the waste management facilities that accept our wastes have addressed leachate and runoff concerns.

5.3.1 Meeting Pretreatment Requirements

Although vactor decant is a small waste stream that would have limited impacts on the huge volume of wastewater going to most municipal WWTPs, every industry can say that. If that argument were allowed to pass for every industry, sanitary sewers would be overwhelmed. Still, some leniency may be allowed for vactor liquids.

Laboratory tests have shown that a large majority of the contaminants in vactor wastes are tightly adsorbed to particulate matter suspended in the liquid. Pretreatment requirements can normally be met by elimination of suspended solids from the wastes by 24-hour detention to allow for settling. (Oils able to form a heavy sheen would merit removal prior to disposal to sanitary sewer, also.) In a 1996 study, City of Eugene Public Works stated:

> *A total of 123 samples of liquids and solids were taken.... It is apparent that levels of certain heavy metals were near or exceeded the wastewater regulatory limits prior to any pretreatment. Analysis indicated that allowing the waste liquids to settle for just 24 hours in the sedimentation basins produced a significant decrease in the levels of total metals. (Eugene Public Works, 1996)*

The Unified Sewerage Agency (USA) of Washington County has taken this approach. With needs for vactor decant extending beyond city limits to areas not served by high flow sewers, USA has constructed three field decant stations that do allow for 24-hour settling. Their design allows for a maximum of three vactor loads per day.[62] USA has scheduled the construction of six more field decant stations over the next two years. USA has worked out agreements with other jurisdictions to allow use of their field decant stations. USA's field decant station designs are attached in Appendix F5.

The City of Eugene has since met their concern over sedimentation of sewers by allowing field decant of vactor liquids at designated points in high flow sewers. The City of Springfield intends to join in this area-wide effort by designating several high flow sewers points on its lines, also.

Recently, a vactor truck flocculent study was released by Snohomish County Public Works with interesting results that will be addressed in Chapters 6 and 7. Sanitary sewers are traditionally the lowest cost alternative for waste disposal and offer a positive model for partnering. It is important to most forms of efficient roadwaste management to have ready access to sanitary sewers for the disposal of wastewater.

5.4 VACTOR SOLIDS DE-WATERING FACILITIES

De-watering facilities are covered at length in the next chapter so this review will be kept to requirements and concerns. Local facilities are just now starting to share resources. In Washington, Snohomish County Public Works has developed an excellent waste acceptance procedure that will be discussed in Chapter 5.

5.5 THERMAL DESORPTION FACILITIES

Thermal desorption facilities operate on the principle that organic compounds can be removed from soils, sludges and sediments by volatilization. These airborne contaminants pass through a chamber where they are destroyed, or they are captured and managed properly. There are two main types of thermal desorption facilities: low-temperature and high-temperature.

5.5.1 Low-Temperature Thermal Desorption

These types of facilities are often used in the treatment of soil contaminated by a release of gasoline or diesel from an underground storage tank. Temperatures in the soil usually reach 200° C (400° F). Treated soil has been used as an additive to compost and is commonly used as clean fill. There are concerns that low-temperature thermal desorption is not an appropriate treatment method for roadwaste.

> *There are several types of low-temperature thermal units, however they are all designed to treat volatile and low-boiling semi-volatile organic compounds. These compounds are not generally found to accumulate in highway maintenance waste, i.e. road sweepings, vactor sludges, and ditch spoils.*

[62] See the attached report, "A Visit to Oregon Decant Facilities."

> *Because of the preponderance of middle and high boiling semi-volatile and non-volatile compounds in the highway maintenance waste, low temperature thermal systems will not be considered. (Hindin, 1993)*

As such, the PAHs in roadwaste, identified as a concern earlier in this report, may be passing through this treatment process unaffected. Given the nature of the concern regarding these compounds and lacking evidence to show that these compounds are destroyed, it would be unwise to employ this expensive treatment process only to face liability for materials posing similar risks to human health and the environment. An additional consideration is the cost of testing. "TPS requires that all material that they accept be non-hazardous. Analytical tests would be required for TPH, metals, BTEX, HVOCs, pesticides, and PCBs." *(Woodward-Clyde, 1996)* This is an expensive testing protocol.

5.5.2 High-Temperature Thermal Treatment

High temperature thermal units are commonly used for the destruction of hazardous waste. Although their destruction capacities are much greater, waste characterization requirements for generators may be similar to those imposed by low temperature thermal desorption facilities.

> *High temperature thermal systems that operate 1400 to 1800 degrees F [750° to 1000° C] are capable of destroying all types of organic material found in highway maintenance wastes. ... The gases from the primary chamber are sent to a secondary chamber where the refractory organics e.g. PAHs/PNAs and Dioxins are destroyed and the non-volatile heavy metals are calcined into a more stable form. Due to the large heat sink capacity of the inert material in highway maintenance waste and the highly variable heat value of the waste, auxiliary heating would be required. ... The cooled solids can be disposed in landfills or used as roadfill provided the total and leachable heavy metals meets federal and state requirements. (Hindin, 1993)*

High temperature thermal destruction is too expensive for treatment of the organic contaminants found in roadwastes. It does not remove heavy metals, but should fix them. Landfilling would be cheaper and, given the immobile nature of the contaminants, virtually as safe an option. The one main benefit of high temperature treatment is that PAHs are completely oxidized, eliminating that potential environmental liability.

5.5.3 Findings Regarding the Use of Thermal Desorption

Due to expensive testing and expensive processing costs, these technologies do not merit use except for exceptional loads. For example, roadwaste heavily impacted by a gasoline or diesel spill above the limit of 50,000 ppm allowed at Hillsboro Landfill may merit low temperature thermal desorption if facilities relax testing requirements for roadwaste.

Roadwaste contains PAHs that may not be released at the lower operating temperature as well as low concentrations of heavy metals that this process cannot treat. In addition, treated materials may come in contact with the general public. The low-temperature thermal desorption process does not seem to provide adequate benefits to the processing of roadwaste.

High-temperature thermal destruction technology is usually limited to the disposal of hazardous wastes and costs regularly exceed $13 per kg ($6 per lb). While taking roadwaste to a well-run facility using this technology virtually eliminates the threat of liability, costs are simply too high.

At present, thermal treatment technologies do not seem appropriate for the normal management of roadwaste.

5.6 COMPOST FACILITIES

Composters make a product. For that product to be usable, glass, needles, and other general trash must be removed and concentration levels of all hazardous constituents must be below thresholds of concern. Composters usually require street sweepings to be tested for TPH and heavy metals, but exact requirements vary.[63]

5.6.1 Composting Sweepings and Vactor Wastes

Both Grimm's Fuel in Tualatin and Scotts' Hyponex in Clackamas have tried composting with street sweepings but may discontinue their programs. Scotts' cites elevated levels of broken glass and litter in the sweepings coming into them as a real problem. They must screen out the litter and dispose it at a landfill. It is difficult to screen out broken glass and hypodermic needles. The presence of these materials in the end product, even in small quantities makes it undesirable for sale to the public market. The City of Portland has a trial program running. Cities have access to sweepings with a much higher organic content than picked up along most highway corridors. With more experience in pre-composting screening, the City of Portland is having limited success and may eventually expand their program to accept others' materials. ODOT sweepings from high traffic flow corridors may be more heavily contaminated than sweepings collected largely from residential areas by a city agency.

One firm in the Portland Metro area tried composting vactor wastes unsuccessfully. The composting process uses water to replace water lost to evaporation because of the heat given off by the decomposition process. So if composting with vactor waste could be made a success, ready use could be made of some of the water generated with vactor solids.

5.6.2 The Applicability of Composting to Roadwaste Contaminant Reduction

The use of commercial composters has limited applicability to the management of roadwaste solids. Good composting operations generate good products while minimizing impacts on their neighbors. However, even well run composting operations do not and cannot be expected to have the level of sophistication required to insure that petroleum contaminants are removed. As with low temperature thermal desorption, PAHs in roadwaste may be passing through this

[63] Fife Sand and Gravel (FSG) of Puyallup, Washington, requires <30,000 ppm diesel range and <10,000 ppm gasoline range hydrocarbons, and does not accept hazardous materials. (Woodward-Clyde, 1996)

treatment process unaffected. Especially with the larger, more carcinogenic PAHs, bacteria that can effectively degrade these compounds are rare in the natural environment. In addition, it is known that PAHs and other large petroleum hydrocarbons may absorb into the matrix of the organic materials and not be available for biological activity. *(Weissenfels, 1992)*

Testing of compost products to measure the reduction in petroleum hydrocarbon contamination has not conclusively shown reductions. Elevated TPH levels can be blamed on interference of vegetative matter on the test results, while reductions may be explained by dilution and absorption into compost. Further, the composting process may concentrate heavy metals. While metals do fix to organic matter, organic acids generated in the composting process may make heavy metals more mobile. Thus, some question exists as to whether it is protective to manage roadwaste in compost going for public consumption.

5.6.3 Composting In-house

Composting is a process that must be managed. It can be done right and done wrong, and if it is done wrong, problems can include fires if the compost pile is allowed to overheat and noxious odors if it is not properly turned for oxygenation (see Chapter 2 for odor regulations). Composting takes room and time and attention. ODOT may choose to hire an outside firm to do its composting at ODOT site(s), or at the composter's site if the end product is set aside for ODOT's exclusive use. Selling or even giving away roadwaste compost product may be inappropriate without testing for PAHs and for physical hazards from sharps.

As mentioned in the review of composting regulations in Chapter 2, agencies may compost up to 20 tons (~18,100 kg) of green and non-green wastes per year per site and not have to obtain a DEQ composting permit (and, around Portland, a Metro permit). Local zoning requirements still must be addressed; e.g., in Clackamas County there is a moratorium on new composting operations.

With preliminary approval from Washington DOE, WsDOT uses screened but otherwise untreated street sweepings and vactor wastes in a soil amendment product for use in WsDOT highway medians and controlled areas. This option will be discussed in Chapters 6 and 7.

5.7 ASPHALT OR CEMENT MANUFACTURE

Use in either asphalt or concrete manufacturing can be an environmentally sound option for sweepings. Besides concerns for contamination and liability, these manufacturers may require testing to insure that roadwaste does not cause them to exceed DEQ Air Contaminant Discharge Permit conditions. These facilities also must insure that raw materials meet specifications for their product.

PAH concentrations have not been shown to be a significant concern in the matrix of asphalt, although they may pose a concern in elevated concentrations in waste asphalt. This concern is currently under study by Oregon State University as part of project concerned with leachate from waste asphalt and by others. However, asphalt itself contains long-chain hydrocarbons, similar in nature and level of concern to the great majority of TPH fractions found in roadwaste.

Petroleum contaminated soils have often been used in asphalt manufacture. Sterling Asphalt in Washington State is a case in point:

> *They have been certified by regional regulatory agencies to provide a solidifying/stabilizing treatment. While the soil is allowed elevated levels of petroleum content, a maximum TPH of 50,000 ppm is allowed and other hazardous materials such as heavy metals are not allowed. The waste must be free of wood waste and have limited moisture content. A certification that the waste soil meets the Sterling Asphalt criteria must be made by a qualified private assessor.*
>
> *Sterling Asphalt has the capacity to process 2,000 ton per day and estimates and actual quantity of 50,000 ton processed per year. (W&H Pacific, 1993)*

Of course, specifications, such as particle size distribution and material content, would vary between manufacturers.

Cement manufacturers usually establish similar sorts of conditions. In Washington State, Holnam's use of a cement kiln to treat vactor wastes effectively eliminates concern over PAHs and all other petroleum hydrocarbons, which should be completely destroyed in this process.

> *The end product of the vactor solids treatment is substituted for sand in the production of Portland Cement. The treatment of vactor solids is performed in a rotary kiln where it reaches 3000 degrees F [1600° C] with a residence time of about two and a half hours. (Woodward-Clyde, 1996)*

For use in Holnam's concrete production process, specifications include being free of oversized materials and debris, which can largely be addressed by pre-screening. (As discussed elsewhere, screening is a simpler process for sweepings than for vactor solids.) Holnam also requires that vactor wastes be tested for the eight TCLP metals. *(Woodward-Clyde, 1996)*

Getting roadwaste materials to consistently meet certain specs can be difficult. If a reuse option is pursued with an asphalt or concrete manufacturer, the company will require consistent volumes and consistent materials. Manufacturers would likely be interested in ongoing testing of contaminant levels, properties of the materials, or both. Waste generators usually favor refraining from ongoing testing of their wastes, also preferring to generate wastes on their own schedule and having a ready place to drop it off. Waste generators also want to know that the manufacturing process and eventual use has the minimum potential for future liabilities. A situation that benefits both parties is required. Such a relationship would likely be pursued under an agreement with guarantees for both parties. If the amount of ongoing material and the cost situation justifies the effort, generators and waste re-users can work together to achieve a win-win scenario.

5.8 MAKING PARTNERING WORK

The City of Portland processes some of ODOT's used sanding materials from the Metro area. ODOT receives screened and washed sand for the price of new sand, entirely avoiding costs for disposal. The City has reserved right of refusal. ODOT has not been able to insure that used sand is picked up within a week of a storm's passing. When ODOT crews can get out to sweep, the materials have been exposed for an average of three weeks. By that time, the sanding materials have usually picked up too much litter and have been too crushed up by traffic to be worth recycling as sanding materials. Only about ten percent of ODOT's Metro-area sanding materials eligible for recycling make it into this program.[64]

Lane County Public Works has partnered with the cities of Eugene and Springfield in a vactor waste facility that is now opening up for public use. Prior to construction of this facility, these agencies had no acceptable option for management of vactor wastes. Springfield chose to not clean out their storm sewers for a year. Lane County used an old roadwaste dumpsite, but was very uncomfortable doing so. Now, the agencies have a number of vactor liquid field decant locations in the Eugene-Springfield area and a modern de-watering facility allowing them to efficiently and safely manage their wastes. The facility was constructed on Lane County property in centrally located Glenwood. The solids are taken to a DEQ-permitted landfill by Lane County's solid waste authority, which has long operated a transfer station at that site. This facility is now opening up to private enterprise and other agencies. It is hoped that fees will help defray some of the construction costs.

De-watering facilities are often located next to sewage treatment plants. The expertise in wastewater management and the proximity of the facilities have proven useful to agencies in the management of wastewater.

Agencies in Washington County have developed a consortium of agencies that share resources. USA has made agreements to open its field decant facilities to other operations. Similar agreements can probably be reached with most other jurisdictions.

ODOT and Multnomah County have committed to a partnering effort in Phase 2 trial implementation. This effort will likely focus on a shared vactor solids de-watering process due to the pressing need for efficient de-watering and cost efficiencies in scale. ODOT is interested in developing public sector and private sector partners as more effective management methods for roadwaste are sought out statewide.

5.9 SUMMARY AND PRELIMINARY EVALUATION

The potential for environmental liability turns the use of a waste management facility into a long-term partnership. As such, using others' waste management facilities should not be treated casually. Building relationships with other agencies and companies that insures responsible reuse or disposal of roadwaste has the potential to substantially reduce costs. Building relationships that companies and other agencies can rely on is not within the scope of this Phase

[64] Jeff Moore of ODOT's Region 1 during an ODOT Roadwaste Project meeting on April 3, 1998.

1 research report. That kind of working relationship is developed on the ground, but the concepts in this chapter can be valuable towards making informed decisions.

Most of the examples of partnering provided above focused on wastewater management or on partnerships developed between waste generators and waste re-users. However, the volumes required to maximize the cost efficiency of some screening, sand and gravel washing, and wide scale reuse programs merit a serious look at shared resources for processing, also. We shall revisit these and similar options in Chapters 6 and 7.

Having an accepted waste characterization is extremely important to efficiently managing wastes at others' facilities. Multnomah County spends more money meeting testing requirements than they do on actual roadwaste treatment and disposal.[65] To avoid costs for analytical tests, or to minimize them, we need to be able to base roadwaste characterization on knowledge of process, and we need waste management facilities to accept our characterizations without requiring frequent testing. As discussed in our recommendations in Chapter 7, consistent use of a field evaluation method to eliminate hot loads would reduce the level of uncertainty regarding normal roadwaste and make our waste characterizations more generally acceptable. DEQ could have a hand in getting general acceptance for roadwaste characterizations made from knowledge of process, perhaps even stipulating their understanding of the hazards normally presented by roadwastes in policy or rule. In some cases, establishing a generally accepted characterization of contaminants and material properties may come down to roadwaste generators and waste management or reuse operations working together. This process might benefit from involvement by DEQ to help establish appropriate waste criteria and waste characterization standards.

Concerns have been voiced within ODOT over potential liability issues. While running a facility does raise the question of liability, ODOT's potential liability is unlikely to lessen with use of others facilities except in the case of DEQ permitted sanitary landfills or sanitary sewers. Although care must be taken when operating a waste management facility, care must also be taken when selecting a waste management facility. When you run the facility, insuring proper management of the waste is within your control. A well-designed and well-operated facility can be the best defense against potential liability, whether it is run by ODOT, by another agency, or by a private concern.

[65] Comments made during the March 19, 1998, Roadwaste Technical Advisory Committee meeting by Don Newell, Systems Administrator for Multnomah County Transportation Division.

6.0 ROADWASTE MANAGEMENT METHODS

Many roadwaste management methods were discussed at length in earlier chapters. In this chapter, we round up roadwaste management methods, giving make or break factors for effective use. Some alternatives not previously discussed are examined in detail. We briefly evaluate the methods, then consider how different technologies used together may impact operational efficiency. In the next chapter, we discuss specific applications to roadwaste management in Oregon.

6.1 INTRODUCTION

The ideal roadwaste management method would accomplish four main objectives: 1) protection of human health (including worker safety) and the environment, 2) cost efficiency, 3) operational efficiency, and 4) compliance with environmental regulations. The need for efficient alternatives was highlighted earlier; e.g., WsDOT has estimated costs at $3,000,000 per year if all their roadwaste was sent for solid waste disposal. Enough information on roadwastes is now available to implement protective management solutions and to start addressing the issue of cost.

Until recently, good waste management practices began by characterizing the waste you happen to generate, addressing the recognized hazards in your normal routine, and taking special care with wastes which are likely exceptions to the norm.[66] This formula still provides a workable model. However, looking more closely at the processes generating the waste often yields surprisingly positive results.

The current paradigm for waste management is based on the three R's: "Reduce, Reuse, then Recycle." Waste is reduced through using less, finding benign substitutes for hazardous materials, and improving processes. Finding ways to cut down littering, reducing water volumes from catch basin clean out, and reducing contaminants at the source are ways to reduce roadwaste. Reusing waste means putting waste back into service as a product. This can be as simple as laundering clothes or turning over an old sheet of paper; for roadwaste, reuse includes screening deicing sand for reapplication. Recycling means processing to change waste material into a useful item. For roadwaste, recycling usually involves some kind of treatment. "Dispose" is the last option; an unstated option, it remains an important element in waste management. The "three R" hierarchy provides the framework for the discussion that follows.

6.2 REDUCE

Pollution prevention and waste minimization are buzz-words in the waste management industry. The current emphasis is to find ways to reduce waste generation rather than to manage or treat pollutants once they have been generated. Waste reduction can save on the front end and on the

[66] See discussion of potentially hot loads in Chapter 7.

back end. For instance, substituting hot water for a toxic solvent can save costs on solvent purchases and on toxic waste disposal – as well as reducing workplace safety concerns and those associated costs. These ideas have helped some businesses save millions of dollars annually. More businesses and government agencies are recognizing waste management as a significant cost. Waste management costs are starting to be charged against the processes and operations generating the waste – costs for waste management are no longer treated as an external factor.

Using paints with low heavy metal content could reduce levels found in roadwaste. ODOT is moving to low VOC paints to reduce air pollution and considers heavy metal content when evaluating paint purchases. In Sweden, different colors of aggregate have replaced paint for road marking; lasting longer, this also reduces roadway down time and pollution from repainting.

We may be able to support reduction of CPAHs at the source by promoting alternative fuels (natural gas, electric, alcohol) or mass transit. Investigation into combustion products and combustion efficiency – as well as CPAHs from tires, asphalt and other products – may eventually result in substantial reductions in roadwaste contaminant levels. These types of reductions in CPAH contamination may be difficult to pursue directly at the state and local level.

One way to reduce roadwaste contaminant levels is to reduce contaminant levels in industrial and commercial stormwater discharges. While ODOT does not want a piece of the environmental regulatory business, we could expand our efforts to identify heavy contaminant levels coming from neighboring sources and challenge them to improve. DEQ and local stormwater authorities may be called on to offer technical assistance. Excessive discharges or unresponsive parties could be reported to DEQ for investigation or face independent legal action to recover ODOT costs for managing high contaminant loadings.

Spills have also been identified as a source of some contaminants in roadwastes. Where possible, requiring that roadside cleanups meet DEQ no further action levels may reduce contaminant loadings in roadwaste. If spilled wastes are allowed to remain in place above cleanup levels, ODOT could establish a fee to cover management of expected contaminant loadings in roadwaste (and ODOT should also address the potential for other future liability).

Picking up deicing sand within a week or two after snowmelt makes sand reuse easier. When deicing sand is beaten down to finer particles, it often needs a washing step. Sand washing requires a lot more time and generates more fines requiring further management. Using good, weathered sand that stands up to use on roadways increases the life of sanding materials and supports ready reuse. Good sand is available around Portland, but this has not been the case in the Seattle area; their sand comes from glacial till and turns to mud quickly under heavy use.

Not sanding is another alternative. Some roadwaste volume reduction may be achieved through use of alternative deicers and anti-icing agents. CMA (calcium magnesium acetate) is a popular compound, though there are many others.

Cleaning out catch basins during drier weather and using less fresh water both reduce the volumes of wastewater we must manage. Clean out before the first flush of fall rains should reduce contaminant loadings to streams and may help ODOT meet tightening stormwater requirements. Jumping ahead, use of flocculent could take solids out of suspension, meaning that water from the waste tank might be approved for cleaning, resulting in less fresh water use; Snohomish County argues that flocculent use should make discharge to storm drains acceptable.

Advertising has proven effective for litter reduction. "Don't Mess with Texas" is a very successful program, involving area athletes and celebrities to get the message out. In California, advertising was found to be as cost effective as picking up litter. As a long-term strategy, it might prove more cost effective. Less litter to screen from sweepings and vactor solids may also make for cost savings. Advertising and improvements in the look of Oregon roadsides might improve tourism. Besides SOLV and similar organizations, partnering opportunities might be found in the tourism industry. One simple way to reduce litter is to get the word out that rest areas have trashcans.

In some sparsely populated areas, ODOT sidecasts sweepings to the road shoulder; we expect sweepings from these areas to be only minimally contaminated. Sidecasting in minimally traveled areas could be a protective solution. Sidecasting should never impact surface water or drainage ways washing to surface water. Placing low contaminant level sweepings on road shoulders to smother weeds, in place of herbicide use, might yield positive gains for the environment, also.[67]

Another method to reduce contaminated materials is to prevent contaminated materials from contaminating cleaner and fresh materials, and from contaminating storage sites. Segregation of wastes from known spill areas, potentially hot catch basins, and old sump materials could reduce contaminant levels in the usual run mixed of roadwaste. (More frequent maintenance is thought of as another way to reduce contaminant levels.) Sweepings and vactor solids could then better fit into the materials category rather than the waste category, paving the way for ready reuse. Clean materials should be stored separately, and run-on, run-off, and leachate impacts should be tightly controlled.

6.3 REUSE

The line between reuse and recycling is sometimes difficult to draw. Under reuse, we can argue that we never actually generated a waste. If a waste is reprocessed for another use, a waste was generated and waste management requirements apply. Regulatory agency evaluations are often made with regard to whether the reuse includes use on land and whether contaminants are along for the ride.

Screening out trash goes a long way toward making a viable argument that screened sweepings are not wastes. Sweepings can be separated by particle size; the gravel and sand fractions of sweepings usually contain little in the way of contaminants. (A washing step may be required to remove the fines stuck onto sand.) Trials in Washington State found screening sweepings twice substantially reduced the level of fines over screening once. *(Wash. State Dept. of Community, Trade & Economic Development, 1997)* Litter and sediment particle size separation is more

[67] Suggested by Jeff Moore of ODOT in conversation during March 1998.

difficult in vactor wastes, and vactor materials generally test as more contaminated. We touch on liquid phase separation of vactor wastes at the end of this chapter.

Some parties have taken the position that if material comes from a roadway corridor, placement back into use in a roadway corridor constitutes reuse. WsDOT reuses their roadwaste in a soil amendment mixture in highway medians and interchanges. WsDOT is also digging out their old roadwaste dumps, having found reuse the best option for these materials. Removal of old roadwastes from dumpsites limits the chances for long-term impacts to groundwater. Carefully tracked use in medians could be a good way to manage fines and the more contaminated end of normal roadwaste materials. Reminding us that risks posed by CPAH contamination is based ingestion, WsDOT provides a good argument for reuse in highway medians: if a child is eating dirt in a roadway median, we have more important things to worry about than a 1-in-100,000 excess cancer risk.[68] While WsDOT is vigorously pursuing this option, they are carefully studying their method, also. Manner, source, volume, contaminant level and location of placement carefully tracked by WsDOT. *(WsDOT, April 1998)* They are also conducting studies to evaluate the impacts of these placements. More than a year in place, very little movement of contaminants has been observed more than six inches below the applied layer and their mixture has proven to be an effective growing medium. They have found that application should not take place in wet weather as depth of material and other factor become difficult to control.

If ODOT pursues the WsDOT reuse option, we need to carefully evaluate areas for placement and keep permanent records of where these materials are placed and in what quantity. DEQ's UST Cleanup program provides the following recommendations for petroleum contaminated soil (PCS) placement: 30 m setback from surface water, 0.7 m elevation over the seasonal high water table, and 0.3 m of clean cover. DEQ prohibits placement of PCS in floodplains.[69] PCS guidelines could be useful for evaluating areas for potential roadwaste reuse. Like WsDOT, ODOT should also expect to have to carefully evaluate its progress using this new method, at least in the early stages.

Sweepings reuse might follow the Massachusetts guidelines, with threshold values only coming into play for wastes from "Urban Center Roads." These options include: fill under roadway surfaces, use as shoulder material, or use in compost along public ways. The contamination already present in roadway corridors helps make the case that responsibly managed placement is protective. It has been noted by many sources that roadwaste used as fill material under roadways must be carefully chosen as most roadwaste has compaction and drainage problems, and often suffers volume reduction as organic matter decomposes potentially leaving open pockets encouraging road surface settling and cracking. Material specifications should be verified prior to reuse as fill under roadways or on shoulders.

The Snohomish County Health Department allows reuse if roadwaste materials test below certain contaminant levels. This policy (attached in Appendix B4) creates two contaminant tiers for roadwaste reuse and as such requires ongoing testing – the high costs of ongoing analysis should be avoided if at all possible. However, the County suggests the following additional options for

---

[68] Doug Pierce's Transportation Research Board presentation abstract is attached in the Appendix.

[69] Conversation with Jim Parr, DEQ UST Cleanup Section, at the Salem DEQ office on 4/16/98.

less contaminated materials: fill in commercial and industrial zones, pipe bedding, and utility trench backfill. Suggestions for more contaminated materials include use in concrete or asphalt manufacture, landfill daily cover, or further treatment.

6.4 RECYCLE

Unless contaminant levels in a roadwaste have been fully characterized and meet criteria established for a specific reuse, that reuse cannot be considered protective. Ongoing roadwaste analysis is not planned, except when contaminant levels in materials going for a specific reuse are near the maximum threshold for that reuse.

Recycling the components in litter is become more viable as new recycling alternatives are developed while disposal costs continue to rise. Region 1 is screening sweepings, and recycles some materials. The more easily marketable materials (e.g., metals salvage) may start this process statewide. Recycling into bins already built in maintenance yards may make this option more attractive.

Asphalt and concrete production issues were discussed in Chapter 5. We found that these manufacturers have specifications that may require us to tailor roadwaste materials to meet their needs, including particle size, organic matter content, trash content, degree of wetness, and consistency and consistent availability of materials. Asphalt production uses heavy end petroleum fractions as a binder, so TPH is not a concern, and other contaminants are bound into the asphalt. Concrete production can destroy CPAHs and other hydrocarbons if materials are introduced into the kiln. Heavy metals are then bound into the concrete. Both asphalt and concrete manufacturers are concerned about taking hazard waste. However, ongoing testing of normal roadwastes should not be agreed to except as necessary to verify material specifications.

6.4.1 General Considerations for Roadwaste Reprocessing

Agencies need to maintain control of roadwaste materials unless they are below residential cleanup levels and no sharps hazards are present, or unless the reuse carefully reviewed to verify that potential risks do not raise significant concerns.

A WSU study *(Watts, 1998)* on bio-attenuation of TPH in weathered roadwaste piles showed that piles that were kept damp readily treated out TPH and were able to treat lighter end PAHs. The length of time for this passive treatment was more than one year, which did include three months of freezing weather where no treatment was expected. This study did not address leachate control: were contaminants washed out of the matrix and carried off in leachate? This study did consider use of oxidizing agents; however, the agents did little to significantly accelerate treatment. One agent is believed to have acted as a surfactant, and losses are attributed to leachate. The use of a surfactant or other catalyst to free PAHs (and other heavy hydrocarbons) from adsorption may assist oxidizers in initiating the PAH decomposition process.

Chemical oxidation is not a technology ready for application to roadwaste. Oregon State University is researching ammonia (NH_3) use. Ammonia readily goes to ammonium hydroxide (NH_3OH^-) in the presence of water, then the OH^- radical then can replace a bond in the PAH structure, cracking the PAH and allowing more ready biodegradation. This mechanism is the start of the natural cycle for degrading large hydrocarbons. It is expected that for most PAHs, enzyme activity from normal microorganisms can then take over; microorganisms either convert the cracked PAH to CO_2 and water in the production of energy or use it as cell building material. Surfactants might be useful in mobilizing contaminants into leachate for more ready treatment or for disposal as wastewater.

As was discussed in Chapter 3, weathering has been thought to have little effect on CPAH concentrations. However, our data, although inconclusive, seems to indicate that benzo(a)anthracene, benzo(a)pyrene, and dibenzo(a,h)anthracene might be weathering in sweepings. It is difficult to say if this is due to natural biodegradation or losses in leachate. It would be more than surprising to find that loss of these contaminants was due to wind-blown fines, since some CPAH concentrations rose instead of dropped.[70]

UCI of Washington has been successful in reducing CPAH contamination at cleanup sites and have shrunk processing times from months (or years) down to 10-14 days. They have studied vactor solids bio-remediation at de-watering sites, leaving them in a unique position to assist in roadwaste bioremediation. UCI is prepared to make a commitment to getting a working vactor waste bioremediation effort up and running. Other considerations: the type of de-watering program we institute could effect the workability of a bioremediation program.

Phytoremediation is an interesting alternative using plants to capture or destroy contaminants. Some plants are able to selectively remove and concentrated heavy metals. Growing and harvesting such crops on contaminated media is a technology often used in Europe. Some plants are able to absorb solvents and petroleum compounds. There have been some findings regarding destruction of PAHs by phytoremediation. This technology should be further examined. (Contacts at a phytoremediation contractor and a university research program both familiar with phytoremediation of PAHs and heavy metals are provided in Appendix A.)

Thermal desorption was discussed in Chapter 4, where we recommended against use of these technologies for run of the mill roadwaste. Roadwastes heavily impacted by diesel, gasoline, or lube oil spills may merit thermal desorption. Testing requirements for batches will probably be unavoidable, since normal roadwaste will be handled through other methods (see evaluation chart below). However, testing can be limited to pertinent compounds and test methods, as detailed in Chapter 3.

Composting was discussed in Chapter 4 and these findings are summarized below.

---

[70] Further research on leachate from sweepings could help to identify if this is a significant long-term method of transport for certain CPAHs. This could be done through testing roadwaste leachate or modeling from solubility values or from SPLP or TCLP results. If CPAHs are not escaping in the leachate, and observed reductions in certain CPAHs are verified, we must assume that biodegradation or other natural attenuation is occurring.

6.4.2 Use of Reprocessed Roadwaste

DOE, Massachusetts DEP, Snohomish County and WsDOT guidelines have been discussed. Contaminant parameters and materials specifications clarify applicable reuse options.

6.5 DISPOSE

Disposal used to be the first option. Now it is the last option.

Use of municipal landfills is covered in Chapter 4. We found that solid waste landfilling of normal roadwastes should not require testing; requirements for mainstream roadwaste should be eliminated. Use of roadwaste as daily cover at little or no expense is a reasonable idea, especially for screened roadwaste with good compaction. However, with many sources of daily cover available (and the lack of clean fill sites, especially around Portland and other urbanized areas), landfills are unlikely to be interested in this option.

The City of Salem operates a DEQ-permitted landfill for clean-fill, sanitary sewer vactor wastes, and roadwastes. Due to limited space remaining in the facility, they cannot consider accepting others' materials. However, the City of Salem fill site provides valuable information. This study included a visit to the Salem Airport Landfill, review of landfill documentation, and review of DEQ's file on the site. The site has been in use for more than two decades. Covering several acres, it is surrounded on all sides by a cyclone fence. Complaints from members of the local community that the City dumped inappropriate materials into the fill led to DEQ's involvement. A DEQ Solid Waste Facility permit was required for the site. DEQ site closure plan requirements have recently been amended to include long-term groundwater monitoring. Groundwater monitoring may not be required as part of closure for all landfills that accept roadwaste, nor will groundwater monitoring necessarily be required as a part of all landfill closure plans. At the Salem site, de-watering is accomplished by mixing wet wastes with surface materials. This eliminates the need for a de-watering step, substantially reducing initial processing costs. Following this procedure increases the likelihood of site impacts and makes more likely an eventual DEQ requirement for a closure plan and groundwater monitoring. Material high in organic content is kept at the surface and allowed to compost. This material will provide a layer in final cover. Although DEQ has approved placement of stumps in the wet pit, the City feels it is more protective to grind the stumps and place this wood waste into its compost process. Currently, Salem Airport security offers vigorous surveillance of public activity around the airport, including the adjacent landfill site. Many times, security has found private parties trying to sneak their wastes onto the property.

Farmington Landfill in Aloha is examining the possibility of creating a cell for roadwaste thirty meters above the seasonal high water level. Farmington Landfill is considering offering screening, de-watering or other services. Other valuable services could include an area to compost high organic content roadwaste (to be stored for use as final cap material), passive bioremediation, or active bioremediation; these services would mediate against risks posed by immediate landfilling, especially important for more contaminated roadwaste. Durham Pit in Tualatin sometimes takes sweepings from local agencies at a minimal charge, as do many other closed quarry clean fill sites throughout the state. Potential for long-term liability was discussed in Chapter 4; prior to disposing roadwaste in any unlined landfill and any non-DEQ-permitted landfill, agencies should be sure that contaminants from their roadwastes do not pose a significant future liability to the environment or to their budgets. Security is an important issue and the potential for illegal dumping to must be evaluated when assessing risk of future liability.

Hazardous waste landfills are not a reasonable option for normal roadwastes. However, some hot loads may be drummed and end up at permitted hazardous waste treatment or disposal sites.

6.6 EVALUATING MANAGEMENT METHODS

It is difficult to evaluate these options because many have not been tried and costs and long-term consequences are often unknowns. Below, we supply some cost estimates developed in earlier work. In Chapter 7, some options for subcategories of roadwaste highlights are clarified and many roadwaste management options are proposed for field trials. It should be said that the more you know about the waste you have, the easier it is to determine the best protective and cost effective disposal or reuse option. However, analysis and staff time must be covered; agencies may end up with a slightly more conservative waste management method on average than if cost factors allowed for more careful waste characterization. This will be especially true for early efforts as agencies try to guarantee protection of human health and the environment. As further work is completed, more accurate waste characterization should become easier.

6.6.1 Evaluation Matrix

Table 6.1 provides a very rough estimate of costs. We simply do not know a lot of the answers regarding costs of methods, or indirect costs such as testing and transport. We want the best answers for roadwaste management; not knowing necessitates that we try things, evaluating workability and cost in a variety of operational arenas.

6.6.2 Additional Comments and Considerations on the Evaluation Matrix

Unless further information proves that low temperature thermal desorption removes the CPAHs commonly found in roadwaste, roadwaste processed in these units must be assumed to still contain CPAHs. High temperature thermal destruction is a costly alternative; the fact that it destroys CPAHs is more than offset by its considerable cost.

Chemical oxidation has not been fully developed as a treatment method for roadwaste contaminants and trial methods have not proven very effective, but that may be due to improper combinations or lack of catalysts. *(Watts, 1997)* Using ammonium hydroxide to break up CPAHs is a newer possibility and is recommended for further research in Chapter 7.

Solvent extraction is costly and is unlikely to ever meet our needs efficiently.

Table 6.1: Waste Clean-Up and Treatment Technologies

PROCESS	COST*	QUANTITY	ADVANTAGES**	DISADVANTAGES**
Thermal Destruction (rotary kiln incineration)	$1,500,000	1000 LBS/HR	Removes a variety of waste products	Not very mobile, High capital and O/M cost
Chemical Oxidation	$50-$100	Ton	Quick Method	Not yet a full scale process, Post treatment required, Moderate O/M cost
Solvent Extraction (Organics Removal)	$130-$900	Ton	Removes most organic compounds and some metals, solvent recyclable	Moderate O/M cost
Solvent Extraction (Triethylamine)	$100-$400	Ton	Solvent is biodegradable	Moderate O/M cost
Solids Washing	$7-$30	Ton	Proven Technology, Low O/M cost	Multi-step Process
Solids Washing and drying	$60-$120	Ton	Cleaned soil can be used as fill	Moderate O/M cost
Bioremediation	$40-$100	Ton	Enclosed system, low O/M cost	Slow method
Bioenvelope	$25-$100	Ton	Enclosed system, low O/M cost	Not a mobile system, slow method
Land Farming (Open)	$15-$35	Cubic Yard	Simple system, low O/M cost	Takes a lot of space, not a mobile operation, slow method
Land Farming (Closed)	$50-$100	Cubic Yard	Faster process than open system with more control on process	More complex system, not mobile, higher cost than open system, slow method
Composting	$32-$100	Cubic Yard	Simple, cheap system Low O/M cost	Slow method, not mobile

*All costs are operational costs, except for thermal destruction which includes capital and first years operation costs.
**O/M cost are operational and maintenance costs.

(Hindin, 1993)

Solids washing, for instance sand washing (or liquid phase particle size separation), is a proven technology that we can make work for some roadwastes. Concerns include site contamination from improper wastewater handling, disposition of the fines, and interference from vactor truck flocculent use.

Soil washing and drying is more problematic, but may end up as a reasonable alternative for vactor sludges. This extraction process might require a surfactant to free bound CPAHs and metals.

Many newer and more active technologies for bacterial treatment of organic contaminants come under the term "bioremediation". Costs for bioremediation are coming down and effectiveness and efficiency is going up. Again, controls on wet processes are necessary to insure that contaminants do not escape treatment cells, which may lead to site contamination or impacts to surface water or groundwater.

"Bio-envelope" is a term used when contaminated media is placed in a sheath, perhaps with nutrients, water, other media, and bacteria works in a managed environment. Air flow is often managed, as well as addition of water, more nutrients, or additional bacteria. The bio-envelope idea is a well supported technology for treatment of petroleum contaminated soil. The Minnesota Department of Transportation has costs down to $15 per cubic meter and treatment efficiencies for gasoline and diesel range hydrocarbons are vary high. However, it is not widely thought that the bio-envelope method substantially reduces CPAHs, the organic contaminants of concern in roadwaste. Of course, heavy metal concentrations are not reduced except when diluted by the addition of uncontaminated media. Metals tend to be fixed by organic media;

however, this may be off-set by the tendency of metals to be mobilized by organic acids generated during the decomposition of organic matter.

"Land farming" is also a petroleum contaminated soil treatment method. Land farming – placement and tilling (sometimes with further re-tilling) of contaminated media into existing uncontaminated soils – has been shown to be only marginally effective for treating heavy end hydrocarbons. Land farming has been shown to have difficulties in treating TPH levels to below concentrations present in normal roadwaste, in any case. This method is at its most effective in treating gasoline-contaminated soils in a thin surface layer, largely due to evaporation and oxidation at or near the surface.

Studies with significant work on composting sweepings or vactor solids have not been published. Having been recommended as a possibility by some, and tried out by others, reports conflict as to whether petroleum treats out during composting or gets hidden in the organic matrix. Given known problems with organic fraction interference in TPH tests, it is difficult to prove either case. It is known that petroleum compounds, including larger molecules such as CPAHs, can be absorbed into organic material. Here they are less a ready threat, but they are also not bioavailable for treatment. Given that sharps are a hazard and contaminant levels vary, compost containing significant amounts of roadwaste should probably be retained by the agency for uses that minimize the chance for public contact.

This evaluation would not be complete without considering disposal at a landfill. Lined solid waste landfills in Oregon charge between $20 to $80 per metric ton. Of course, vactor sludge (the best candidate for landfilling as solid waste due to higher contaminant levels) is too wet to be landfilled unless properly de-watered. Roadwaste landfills charge on the order of $5 to $10 per cubic meter but may pose liabilities if significantly contaminated wastes are not properly managed, if they are otherwise managed poorly, or if liabilities beyond the facility's control are encountered.

It is hard to evaluate costs for reuse. As methods are tried, information allowing better cost estimates should be gathered and evaluated. The days when waste disposal costs could be thought of as a minor external factor are behind us. Waste management costs are now being tied to the generating process, resulting in significant cost lines in some budgets.

6.7 THE VACTOR LIQUIDS PROBLEM

As we found in Chapter 5, vactor wastes present a special problem. Evaluation of de-watering options is difficult since the traditional pad or pit methods have proven costly and difficult to manage; other technologies merit further investigation. Problems include vactor water disposal or reuse, field decant, de-watering vactor wastes, separation of particles size fractions and trash in the liquid and solid phases. Special mention should be made regarding the potential impact of container de-watering and flocculent for suspended solids reduction; further investigation of these technologies may rewrite the book on management of stormwater residuals. This discussion continues in Chapter 7 where a summary of known vactor waste practices and exciting new alternatives are presented.

6.8 AN INTEGRATED MANAGEMENT PLAN

Various management methods exist for different roadwaste liquids or solids. Options we select for one type of roadwaste might include a facility helpful to managing another type. On the other hand, a process we select, such as sand washing, can leave us with useable sand and wet fines with higher contaminant concentrations on the other.

The need for an integrated management plan is most apparent when we look at vactor wastes. Where will the water go? How do we handle litter and contaminants? If we de-water on a pad, then we have to move the waste with a front loader for long-term de-watering, and load them later for disposition. If we de-water in a container, we have to be able to move the container, dump the container, or otherwise efficiently move the waste and remove it from the container. Screening vactor solids for litter is much more difficult than screening sweepings. If we screen out litter in the wet phase, we may want to separate organic materials by floatation and to separate particle sizes, removing gravel and sand for ready reuse. If we flocculate out fines to manage vactor liquids more efficiently in field decant, that might make liquid phase separation more difficult. If we do remove sand and gravel from vactor waste or sweepings, we are left with fines and often with wastewater. After sand washing, the fines could go through a further step – treating out the contaminants which may result in approval for general reuse – or be considered for limited uses, such as mixtures into soil amendment for use in roadway medians. Fines are more highly contaminated and may face higher management costs (solid waste landfilling is a reasonable option), including more attention and increased need for analysis if going for reuse. Mixing vactor wastes with street sweepings could reduce de-watering times and speed reuse, but if landfilling is the option, we pay for each kilogram of water we take to the dump and vactor sludge might contain more than its dry weight in water. If a subcategory of vactor waste is identified as a good candidate for reuse in medians as a soil amendment, it might be mixed while wet with compost, bark, wood chips, or other amendments for ready land application. From catch basin to reuse could end up being a quick process as we become familiar catch basins or areas known to generate few contaminants. Sites would have to be pre-identified and ready, and weather conditions would have to permit application. Starting up an application process for vactor sludge from end of summer clean out could make sense down the road.

Management methods must also consider workability and worker safety. Our knowledge of roadwaste contaminants points out worker safety needs (gloves, hand washing and dust protection), limiting contact, and reuse free of public contact and which limit worker contact as the most likely appropriate ways to address roadwaste hazards. Concerns include chemical hazards (CPAHs and metals), biological hazards for workers (especially with vactor waste), and physical hazards of sharps (such as broken glass and hypodermic needles). Workability and effective waste management have been seen as opposing forces. However, use of flocculent in vactor trucks could increase the number of clean outs performed on each run, ease field decanting requirements, and improve de-watering times. To find means to improve service and at the same time better manage waste, agencies should remain be open to how maintenance does business as a whole.

6.9 OTHER METHODS TO CONSIDER

The Clean Washington Center's excellent report on roadwaste recycling is a good reference for all roadwaste recyclers. *(Wash. State Dept. of Community, Trade & Economic Development, 1997)*

Treatment methods developed for managing wastewater and industrial sludge are rarely applied to management of stormwater vactor waste. These methods are perceived as expensive and capital intensive. Sometimes this is true, since the scale of municipal and large industrial wastewater treatment plants makes it much easier to cost out more complicated systems. *The Treatment of Industrial Wastes (Besselievre, 1969)* and *Standard Handbook of Environmental Engineering (Corbitt, 1990)* provide a number of alternatives that may merit further examination, including:

- Centrifuges (solid bowl, basket, and disk)
- Drying Beds
- Heat Treatment (flash, rotary, toroidal, multiple hearth, spray)
- Lagoons
- Pressure Filters
- Belt Filters
- Vacuum Filters
- Membrane Filters
- Vibratory Systems
- Carver-Greenfield oil method
- Emulsion Breaking (perhaps using a surfactant[71])
- Multi-pass Hydro-cyclones[72]

Besides de-watering technologies, many other wastewater management, solid waste management, and cleanup technologies are known. As we develop a better understanding of costs, we will better be able to evaluate the potential of these other methods to yield positive results for roadwaste management.

[71] Surfactant use suggested by H.M. (Marty) Laylor of ODOT's Research Unit in conversation, February 1998.
[72] Ibid.

7.0 ROADWASTE TOOLBOX

In this chapter, we discuss how to construct roadwaste management plans. A good management plan will take into account subcategories of roadwaste and the need to screen out and separately manage hot loads. We list options for mainstream roadwaste and synthesize vactor waste findings into meaningful alternatives.

During Phase 2 of the roadwaste research project, ODOT will implement alternatives on a trial basis; a great number of possible field trials are discussed below. Publication of a guidance manual, synthesizing these findings and the findings of trial implementation into clear-cut procedures, should assist ODOT Districts as they establish their roadwaste management plans.[73] Pending DEQ approval, a guidance manual could stand as one set of Best Management Practices, providing methods known to be protective and helping to clarify the issue of compliance.

Other work on roadwaste issues in progress is discussed. We conclude this report with recommendations for further study.

7.1 HOW TO CONSTRUCT A ROADWASTE MANAGEMENT PLAN

Roadwaste management is a combination of operations and risk management. Roads and storm drains must be maintained and wastes must be managed. Waste management methods must adequately address risks posed by the types of waste generated. To know that our management methods successfully mediate against the significant risks, adequate waste characterizations must be performed. To know what we have, some testing is required; some testing has been done, and this testing is adequate to assess risk management concerns for some methods of handling some types of waste. Less testing is required as we gain more knowledge, and more knowledge will lead to use of more suitable and less costly waste management alternatives. To be able to cost and best decide between roadwaste management methods, it is usually necessary to know the volumes of the various types of roadwaste the agency generates.

Roadwaste management is still in a new subject. As more is known about roadwaste contaminant assessment and about the ability of public agencies to implement roadwaste management methods, it will be easier to assess which methods can be pursued most effectively and efficiently. Such efforts will also clarify whether further testing will be required for use of a management method for a specific type of waste.

Agencies should choose options that fit well with each other, with their overall operations, and with the operations' of their roadwaste management partners. As field trials provide more input, procedures can be written to assist crews to successfully mediate risk while easing

[73] Discussion with Jeff Moore of ODOT, 5/5/98.

implementation. Effective partnering offers substantial rewards both in economies of scale and in development of efficient reuse alternatives.

7.1.1 Establishing Roadwaste Subcategories

We do know that some wastes merit exclusion from normal sweepings and vactor solids. Potentially hazardous wastes merit separate management; and when a waste is relatively benign, separate management can ease reuse. In the San Francisco Bay area, CALTRANS tracks spill events, treating wastes from areas of spills as potentially hot loads, and tests wastes generated from all new locations; Washington DOE also recommends this method. As more is known about roadwaste characterization, agencies will be in better and better positions to discriminate between waste/material types. A good general goal is to eliminate the need for ongoing tests of mainstream roadwaste. However, cost efficient management alternatives may be able to absorb costs for some ongoing testing, which may be required for effective risk management.

7.1.1.1 Old Wastes from Sumps

Citing an example of potential problem waste, old sump materials are likely to be charged up with a variety of contaminants. This is especially true for blind sumps (they have no outlet) not cleaned since the ban on leaded gasoline and may be important for stormwater detention areas (see Chapter 3). Capturing information on when sumps and catch basins were last serviced and when roads were last swept can assist agencies in managing roadwastes generated in the future. Removing older materials accumulated in the system is also a good idea. A net reduction in observed contaminant levels should be observed with improved maintenance schedules. *(Lenhart, 1998)* The materials generated should also be more consistent, which means less required testing and easier overall management. Until more is known, management of old sump wastes should follow the protocol for potentially hot loads.

7.1.1.2 Cleaner Materials

The chart in Chapter 1 discusses brush and landscaping debris, slide materials, and sand and gravel as relatively benign materials. Road agencies generate brush and, on the local level, often accept yard wastes from residents. These materials can be handled using green waste management alternatives available locally, or by developing other composting alternatives.

Street sweepings from low ADT roads are generally considered cleaner on average; however, we do not know the effects of local use until we better characterize the waste. Characterization can be done either by running sufficient tests on the waste itself or by using factors developed to assess likely contaminant loadings, verifying these findings by running a few samples. Citing a similar example, if vactor wastes from low ADT rural highways are found to pose few significant concerns and good field characterization procedures are in place, ODOT may decide to field decant to the land and then place the vactor sludge nearby to de-water to the ground for eventual ready reuse.

7.1.2 Potentially Hot Loads

The question of how to identify potentially hot loads is important. Gross measurements such as odor, color and consistency have been noted. Besides noting these qualities, simple field tests such as pH or conductivity can provide valuable information. The waste acceptance procedure developed at Snohomish County's Vactor Waste facility provides good information (a copy of this procedure is attached in Appendix B5). Identifying and segregating potentially hot loads requires training and experience; hazards must be managed correctly, but we cannot afford to test every load. Some agencies sweep around areas of known spills or oily discoloration, and some return with a truck designated to pick up these potentially problem wastes for separate management. Initial procedures should be based on the knowledge of field crews, hazardous materials coordinators, and available references. Waste screening field procedures should undergo further development as more information, including initial field indications and sampling results, is captured as part of the record.

Until we know more, suspect loads should be managed as potentially hazardous waste.

1. Do not mix potentially hot loads with other wastes. And if vactoring, use as little water as possible to adequately clean out the material since it all must be managed separately from mainstream roadwaste. Special equipment might be used.

2. Pull out and manage in sealed containers, separate from other wastes, out of the weather, on an impermeable surface, in an area that is often inspected. Only workers having the proper training and exercising caution should manage these wastes.

3. Immediately label the containers as sweepings or catch basin waste awaiting sample results to complete the hazardous waste determination; provide the date the waste was first picked up (generated) and the date that the sample was submitted for analysis.

4. Send samples to a laboratory for analysis promptly. Testing can include metals, volatiles and semi-volatiles, pH, flash point, or specific others tests as events direct.

5. Conduct a hazardous waste determination. Strict rules apply to hazardous waste management; if the waste is a hazardous waste, manage it appropriately. Free hazardous waste technical assistance is available from your local DEQ office. A list of DEQ office locations and phone numbers is provided in Appendix A.

6. Washing out vactor trucks or other equipment directly to the sanitary sewer avoids generation of more potentially hazardous waste.

Manage the waste as appropriate. If analysis shows that contaminant levels are consistent with normal roadwastes, the waste can be managed with normal roadwaste as desired. If elevated levels of heavy metals or other contaminants are present but do not trigger hazardous waste levels, an assessment should be made on whether to manage the waste apart from normal roadwaste. In any case, the method selected must be protective of human health and the environment.

If a load of roadwaste tests out as hazardous waste and the source of the contaminants are clearly from illegal dumping, a DEQ exemption form should be filed. This can be important because of more stringent requirements and fees apply to generators exceeding 100 kg of hazardous waste in any month. (Note: 100 kg is well under one 55-gallon drum.) DEQ's *Abandoned Hazardous Waste* fact sheet and exemption form are attached in Appendix H8.

In the Portland area, Metro has a program offering free field screening and pickup of illegally dumped hazardous waste. The waste must be properly containerized. To meet its DEQ permitting requirements, Metro can only accept waste that could likely have been generated by a conditionally exempt generator. DEQ and Metro can help with this determination. DEQ can also investigate to determine whether the generator can be identified. To contact the Metro Hazardous Waste Program, telephone Jim Quinn, Program Supervisor, at (503) 797-1662.

7.1.3 Special Notes for Local Agencies

Less contamination means a greater number of options for materials. If it is shown that sweepings (or vactor waste) from residential areas or waste from frequently maintained areas – or waste distinguished by other factors – is less contaminated, managing that waste separately could open up more ready options for reuse.

Street wastes from construction sites has been identified as one subcategory. Washington DOE recommends reuse of these materials on the construction site. Local governments might want to pursue making this a requirement, unless desired and ready reuse by the agency itself is at hand.

Another possibility is that ODOT might use some local agency roadwaste for soil amendment in roadway medians. This depends on ODOT volumes, DEQ approval, the characterization of the roadwaste in question, and ongoing evaluation of roadwaste reuse in highway medians.

7.1.4 Options for Managing Mainstream Roadwastes Solids

We need to know more about the effectiveness cost or workability of some methods, but many untested options are promising and merit field testing or other evaluation. Urban roadwaste from high traffic areas, at least finer fractions, should test on the high end of the scale for normal roadwaste and as such merits close attention. Of course, ODOT expects to continue picking up more roadwaste in urban environment than in less traveled areas. As these concerns are addressed, ODOT will likely find that most intensive roadwaste management will be centered in urban environments. If expected low levels of CPAH and metals contamination are verified for roadwaste generated in rural areas, less intensive management methods can be used and a great number of options open up for reuse of these materials.

These technologies are gathered from earlier discussions in the report. Technologies specific to vactor waste management are discussed in the next section.

- Screening
- Road Sand Reuse
- Sand Washing
- Soil Washing
- Particle Size Separation
- Recycling of Litter Components
- Sidecasting

Use as Fill:
- *Shoulders*
- *Under Parking Lots*
- *Roadbase*
- *General Construction Fill (Low Public Contact)*
- *Pipe Bedding*
- *Utility Trench Fill*

Use in Products:
- *Asphalt Manufacture*
- *Concrete Manufacture*
- *Other Products*

Use as Soil Amendment *(Especially in Roadway Medians)*

Use as Shoulder Cover in place of a Herbicide

Composting:
- *In-House*
- *Commercial Composter (for Agency Use; for Industrial or Farm Use; for Sale to Public)*

Landfilling:
- *Solid Waste Landfill (preferably as Daily Cover)*
- *Roadwaste Landfill (with or without Clean-fill or other Fill)*
- *Hazardous Waste Landfill*

Treatment:
- *Bioremediation (Passive or Active)*
- *Phyto-remediation*
- *Chemical Oxidation*
- *Solvent Extraction*
- *Landfarming*
- *Bio-envelope*
- *Surfactants (to improve operational efficiency; for Soil Washing or to Speed De-watering)*

Waste Minimization and Pollution Prevention Techniques:
- *Product Substitution (Toxics Use Reduction – VOCs and Heavy Metals in Paints)*
- *Replacing road Sand with Chemical De-icers*
- *Reducing Production of CPAHs*
- *Public Education (Anti-Litter Campaigns; Stormwater Pollutants from Business Runoff)*
- *Preventing Site Contamination*
- *Controlling Stormwater Run-on and Run-off*
- *Preventing Contamination of Cleaner or Fresh Materials*

This list should not be considered final. It does not cover all the possibilities or their interrelated uses. This is an attempt to capture known methods to provide information helpful to the eventual selection of methods for further development into a set of Best Management Practices. Integrated roadwaste management plans are expected to be completed at the local level. These plans may select from BMPs developed in this process or choose other protective methods that best meet their needs.

7.1.5 Vactor De-watering and Field Decanting Issues

For vactor waste management to be efficient, a cohesive management plan is required. A system for field decanting and a list of de-watering options is presented below. Findings on field decant of vactor liquids from trucks and de-watering vactor sludge were presented in great detail in Chapter 5; questions regarding the methods presented below are referred to that discussion.

In Chapter 5, trial use of flocculent was highly recommended. Flocculent provides many advantages and suffers few disadvantages. The operational advantages alone make wide trial use of flocculent easy to recommend, since trucks can more easily meet field decant pretreatment requirements; more of the liquid can be meaningfully separated, so trucks should also be able to clean out more catch basins per run. Flocculating vactor loads can also make the de-watering process easier and more cost efficient. Operational advantages should be weighed against product cost and other disadvantages when developing a roadwaste management plan.

Currently, de-watering and vactor liquids management are treated as stand-alone issues. However, choices about de-watering impact the applicability of other methods. Examples of known concerns include the following: active bioremediation and weathering techniques may not work efficiently with container de-watering; once suspended solids have been flocculated out of solution, fines may be hard to separate making use of management methods by particle size separation difficult or unworkable.

In the future, alternatives may be found for protective reuse of vactor liquids or for reuse of vactor sludge without a de-watering step, and such developments are to be encouraged.

7.1.5.1 A System for Field Decanting

Stormwater vactor liquids can no longer be discharged back into storm drains. Field decant should go to the sanitary sewer and this requires prior approval of the local sewerage agency. Vactor liquids may be decanted to designated points along high flow sewers, sewers adjacent to wastewater treatment plants, to most other sewer lines after 24-hour detention to settle suspended solids or if flocculent is used to reduce suspended solids to minimal levels.

- Field decant vactor liquids to designated points along sanitary sewers where available.
- Land apply clean sediment and water from construction and similar activities to areas without runoff to surface waters.
- In areas where sanitary sewer connection is not available for field decanting, DEQ's Water Quality Program suggests that agencies pre-designate sites under their control for land

application and soil infiltration of stormwater clean out liquids. Overuse of such sites or abuse of this method may lead to site contamination.

7.1.5.2 De-watering Options

Most successful programs will have multi-stage de-watering processes, allow for source separation, and work well with a variety of disposal options. Any de-watering process works better when the liquid fraction is decanted from the load. De-watering facility liquids should only be discharged to sanitary sewer unless other protective methods are carefully identified.

Traditional Pad De-watering

Pad de-watering facilities are the most popular type of facility in Oregon. Despite problems with making them work efficiently, several facilities have been built in the last year in Oregon and several others are in the planning stages. WsDOT provides funds to local agencies in Washington for construction of de-watering facilities; besides allowing WsDOT long-term free use, these facilities must allow for separate de-watering of WsDOT waste for eventual reuse in highway medians. Construction costs for the pad, roof and settling system normally run $250,000 per facility.

Don Newell of Multnomah County has suggested another design. Since vactor sludge must be removed from the initial dumping area to a longer term de-watering pile, the dump pad should not be roofed. Instead, the sludge is moved to a smaller, high-walled and short-roofed bay. This system eliminates the cost for a wide, high roof, reduces wind blown rain on the de-watering pile, and should reduce pad size.

Use of flocculent should dramatically reduce the constant trouble with clogging, overflowing, and plumbing and settling chamber maintenance, and should also dramatically reduce the convoluted settling chamber systems seen at so many facilities. A simple two-chamber system or an oil/water separator should be sufficient to allow for ready discharge to sanitary if flocculent is used. Perhaps most importantly, use of flocculent should substantially reduce the length of de-watering pads runs. These advantages should directly translate into construction cost savings.

Container De-watering

In theory, container de-watering appears more efficient than pad de-watering. On a pad, water must work its way to the bottom of the pile and seep to the edge to exit the sludge. In containers, there is minimal pore back pressure, and water can exit the sludge from the entire bottom surface, dramatically decreasing de-watering times. The problem has been loss of fines and heavier fractions through the mesh or the clogging of filter material. Flocculent use holds the fines in place, which may address most of these problems. Pumps have been used to increase de-watering efficiencies. Container de-watering is a much more flexible and substantially less cost intensive approach. If it can be made to work efficiently, it should present a very cost-effective and option with many operational benefits including ease of source separation. Container models that are transportable or that side dump further reduce management time. Examples of such units are given in Appendix F4.

Pit De-watering Facilities

Due to problems noted in Chapter 5, pit de-watering does not currently appear a workable solution. Flocculent use may make pit de-watering work well as primary settling stage in an overall de-watering process, however, removal of sludge from the pit would add a step to any process. Nuisance odor potential and site contamination from unsealed pits also remain as problems.

De-watering to Land

At the Salem Airport Landfill, both stormwater and sanitary sewer vactor waste is de-watered by mixture with surface materials. This mixture is managed in a unit above the water table. DEQ is comfortable with this practice given long-term groundwater monitoring that is part of the facility's closure plan. This option is of limited use, otherwise, accept perhaps in rural areas where low contaminant levels have been verified. Mixture of sludge with dry wastes for landfilling is an option; the cost of liquid disposal must be weighed against the cost of further de-watering. Mixing sludge with other wastes may encourage the drying process under specific conditions, especially in dry, hot weather.

Other De-watering Technologies

This study has not uncovered use of centrifuges, presses and other de-watering technologies with stormwater vactor wastes. Few new methods are applied to vactor waste management because of concerns over costs and it is difficult to say whether any of these methods will be found applicable in the future.

Variations in vactor wastes volumes in different locations effect the question of which method will be most efficient. Municipal sewage treatment plants servicing millions of gallons daily can cost out expensive equipment. In areas where very low volumes are generated, and a pad or container system is not efficient, use of alternative methods may prove surprisingly efficient.

7.1.6 Where We Stand with Roadwaste Management

We must protect the environment, manage roadwastes in compliance with environmental and local requirements, and protect against future liability. We do not have all the answers and much work is left to do. However, many exciting possibilities have been raised for better managing roadwaste that also have the potential to improve the overall efficiency of current operations.

7.2 RECOMMENDED PRELIMINARY PRACTICES

Until the roadwaste management practices recommended above can be integrated into maintenance operations, observing the following general guidelines will address many of the known environmental concerns and compliance issues surrounding roadwaste management. As such, these guidelines also merit attention during investigation of options and trial implementation. Note: Potentially hot loads merit special attention and should be managed separately from normal roadwastes per the discussion above.

7.2.1 Sweepings

Screen the regular run of sweepings, disposing all trash and litter only at DEQ-permitted landfills. The screened materials should be stored in such a manner that rainfall will not cause runoff that could impact other areas of the site or carry into wetlands or surface waters. Sweepings should be stored in a manner that minimizes the potential for site impacts from roadwaste contaminants. Storage on an impermeable surface with leachate collection and/or protection from heavy rainfall is preferable. Tarps may be used for cover or berms may be used to contain runoff. Sanding materials may be collected and reused once screened and sized. If reuse is practiced, sand washing may be needed if a lot of fines are present. Sand washing should be performed in a manner that minimizes site impacts, allows for the collection of the fine particles, and prevents runoff (pretreatment by settling or flocculation then permitted discharge to sanitary sewer is a sound practice). During storage and processing, fines should not be allowed to become airborne. Fall-out of particulate off ODOT property or roadway visibility reduction should never be allowed to occur. Screened materials collected from areas known to have low impacts from roadwaste contaminants may be screened for trash and used as poor grade fill in ODOT-owned and controlled areas. Sidecasting of minimally contaminated sweepings onto shoulders can be appropriate if these roadsides are not adjacent to surface waters, wetlands, or stormwater management systems with discharge to surface waters, wetlands or the subsurface.

7.2.2 Vactor Waste

Liquid fractions may not be disposed back into stormwater catch basins or collection systems that discharge to surface waters, wetlands, or the subsurface unless, as in rare instances, the decant water is known to carry no pollutants of concern. Instead, these liquids should be disposed, after approval is obtained, to a sanitary sewer. Sanitary sewers often require placement of vactor decant only into high flow sewers or only into detention systems that allow 24 hours to settle out the suspended solids. Where sanitary sewers are not available, ODOT may identify ODOT-owned areas where public access is limited for field decanting of vactor liquids. Sites for land application of these liquids should be chosen on the basis that they minimize the chance for runoff and will hold petroleum contaminants in the top layer of soil to insure the best chance for treatment in that oxygen rich environment. Overuse of these sites should be avoided, as contaminants sorbed to the fine particles suspended in the liquid may lead to concerns over site contamination. The discussion above regarding sweepings applies to vactor solids, as well. However, vactor solids tend to have slightly more elevated concentrations of contaminants. This is especially true of vactor solids generated from the clean out of sumps. Being harder to screen for trash and with less ready reuse options, vactor solids are a good candidate for disposal at a permitted landfill. An agreement to provide this material for use as landfill daily cover can substantially reduce disposal costs. All waste disposed at permitted landfills must be dry enough to pass the "paint filter test" and may face other requirements. Some local agencies have invested in de-watering facilities and may be open to partnering. Other options for de-watering are discussed above.

7.3 FACILITIES OPEN TO MANAGING ROADWASTE

This is a very abbreviated list of facilities that may be open to managing others' roadwaste. DEQ will have a list of permitted composters when DEQ's new composting rule comes into effect in February 1999. DEQ can also provide information on permitted landfills in your area and other waste management facilities. The facilities listed in Table 7.1 do not include the many and various partnerships that could be formed for use of roadwaste materials in products.

Table 7.1: Potential Partnerships for Roadwaste Management in Oregon

FACILITY	LOCATION	CONTACT	TITLE	TELEPHONE	FACILITY TYPE
Durham Wood and Dirt (Durham Pit)	Tualatin	Glenn Jay	Superintendent for Leahy Construction	(503)357-2193	Cleanfill; Potential Roadwaste Landfill
Farmington Landfill	Aloha	Grant Gauthier	General Manager	(503)649-5047	Cleanfill; Potential Roadwaste Landfill
Grimm's Fuel	Tualatin	Jeff Grimm or Dan Grimm	Vice Presidents	(503)625-6532	Composting Sweepings
Lane County Partnership	Eugene (Glenwood)	Doug Putschler	Road Maintenance Manager	(541)682-6993	De-watering Facility
City of Portland, Bureau of Maintenance	Portland	Jeanne Nyquist	Operations Manager	(503)823-1798	Composting Sweepings; Sand and Gravel Recovery
TPS Technology	Portland	Steve Emmons	Director of Sales and Marketing	(800)828-8778	Thermal Desorption (Low Temperature or up to 500 degrees C)
Unified Sewerage Agency	Washington County	Ted Claussen	Maintenance Supervisor	(503)681-7093	De-watering Facility and Field Decant Stations
United Soil Recycling	Woodburn	John C. Bova	Vice President of Sales Marketing	(503)981-9159	Modified Low Temperature Thermal Desorption

7.4 POSSIBLE PHASE 2 FIELD TRIALS

7.4.1 ODOT Region 1 Maintenance

The Roadwaste Technical Advisory Committee identified Region 1 as providing enough geographic variation as well as concentrated resources to allow for effective field trials for most options. It is recommended that local agencies and other ODOT Districts pursue implementation under the Interim Guidelines provided in Chapter 1 or by trying methods discussed in this report. Districts may also try other alternatives if the method used is protective for the roadwaste in question. Consideration should be given to the likelihood of waste disposition leading to future environmental liability.

7.4.1.1 Wilsonville Maintenance Yard

Brian Newby is interested in pursuing various projects at his yard, including: screening out litter (being done); composting green waste; composting with sweepings; sand recovery; or sweepings processing by weathering for eventual reuse. Other Region 1 maintenance yards will likely be open to hosting trials, also.

7.4.1.2 Use of Flocculent in Vactor Trucks

ODOT should try using flocculent in vactor trucks. Not only should this assist ODOT in management of vactor wastes, but it supports crews by allowing more clean outs between trips to drop sludge. Sanitary sewer wastewater pretreatment requirements may be met by use of flocculent, easing field decanting, which again helps crews. Flocculent may assist the de-watering process by fixing fines in the sludge (meaning less settling chambers, less clogging, reduced requirements for de-watering pad size, and making container de-watering more than a possibility) and increased porosity in sludge (which can reduce de-watering time). Delta Pollution Control has agreed to provide ODOT with assistance in the use of its product during trials testing the efficiency of the product and how best to make it work in a waste management system.

7.4.1.3 City of Portland De-icing Sand Recycling

More vigorously pursue our relationship with the City of Portland. By sweeping within one week to ten days of a storm's passing next winter, we should be able to recycle all of the road sanding materials ODOT collects around the Metro area.

7.4.1.4 Partnership with City of Portland Composting Street Sweepings

The City of Portland has stated some interest in the possibility of processing ODOT sweepings in their sweepings compost stream. Much of their material is greenwaste from residential areas. They may market to the public, so this alternative bears careful consideration prior to ODOT involvement.

7.4.2 Possible Partnerships with Multnomah County Transportation Division

Don Newell and Multnomah County have been very interested and supportive in this effort. The County wishes to actively pursue alternatives, partnering with ODOT to benefit from shared resources. The County has some space at their site to conduct trials and is hiring a consultant to assist with sampling plans, data analysis and other Phase 2 tasks. The trials listed below could be conducted with the County, or separately by any interested agency.

7.4.2.1 Construction of an Urban Decant Facility

7.4.2.1.1 Vactor Waste De-watering Containers

Container de-watering technology is well sized for trials. Flo Trend container information is available in Appendix F4; Gary Skinner of Flo Trend is available to assist us in getting together a de-watering system that will suit our needs.

7.4.2.1.2 Vactor Waste De-watering Pad

This may not be suitable for Phase 2 trial. ODOT should investigate the possibility of funding local agency construction of vactor sludge de-watering facilities, again following the lead of WsDOT, which has established a number of these facilities.

7.4.2.2 Field Decant Projects

7.4.2.2.1 Multnomah County Stations

Field decant on a sanitary sewer line with approval of the sewerage agency.

7.4.2.2.2 ODOT-sited Stations

Field decant on a sanitary sewer line with approval of the sewerage agency.

7.4.2.2.3 Remote Field Decant Land Application

Investigate use of grassy infield or other area with no ready discharge to stormwater or surface water systems. This is reserved for areas where sanitary sewer is not available.

7.4.2.3 Roadwaste Treatment Project

7.4.2.3.1 Weathering of Sweepings

Establish a site to weather TPH from sweepings, making them more ready for reuse. The operation should be run on an impermeable surface to facilitate collection of leachate and run-off and to prevent site contamination. Weathering sweepings may be done in a shed. High organic content in local sweepings or in high green waste content sweepings commonly lead to elevated temperatures. High greenwaste materials require active management to insure that sufficient oxygen is getting into the pile to aerobically compost the organics (anaerobic composting leads to an inferior product and creates strong and offensive odors) and that the moisture content remains adequate to control temperature. In large green waste piles, spontaneous fires are a common problem.

7.4.2.3.2 Weathering of Vactor Solids

Establish a site to weather TPH from vactor solids, making them more ready for reuse. The operation should be run on an impermeable surface to facilitate collection of leachate and run-off and to prevent site contamination. As we have seen, vactor wastes require the addition of water to treat TPH concentrations, so leachate and run-off are especially important to vactor wastes. Given that a high moisture content must be maintained but must not reach saturation, active management is required. *(Watts, 1997)*

7.4.2.3.3 UCI Bioremediation Project

Work with UCI or another equally qualified firm to establish a bioremediation program for vactor solids. The bioremediation program must be able to address TPH in low concentrations and must be able to effectively treat out CPAHs well below the residential cleanup standard of 0.1 mg/kg. Contamination concerns should be addressed. Bioremediation can eliminate CPAHs, making some of our more contaminated wastes ready for reuse. Although this promising technology may require up front investment in terms of operational time and cost, it should be investigated. Bioremediation offers a solution that minimizes risk posed by roadwaste materials, significantly reduces landfilling and other long-term management concerns including the potential for environmental liability, and is a cost we can control and hopefully reduce with continued operation.

7.4.2.3.4 Composting of Sweepings

Small-scale projects may be tried to determine if compost operations fit well alongside existing maintenance duties. Composting with sweepings may generate a product useful in agency operations, however control of the compost should be maintained by the agency. Placement of the material should be tracked unless testing or other adequate characterization shows that use of the material poses no significant risk.

7.4.2.3.5 Sand Recovery

Whenever possible, agencies sweep roads within a week to ten days after snowmelt to recapture sanding materials before they get too ground up to merit processing for reuse. Road sanding materials with no significant litter fraction and few fines may be ready for immediate reuse. Other sanding materials require a screening step and separate management of the fines.

7.4.2.3.6 Sand and Gravel Washing

Multnomah County currently has a sand-washing program that may provide a partnering opportunity. Considerations include potential for wastewater to transport fines, which may lead to site contamination issues.

7.4.2.3.7 Recovery of coarse fractions from vactor wastes

This could be an experimental wet process. Alternatives for such a process are discussed briefly in Chapter 6. Use of flocculent should make this process more difficult.

7.4.2.4 Roadwaste Reuse Project

7.4.2.4.1 Reuse in Roadway Medians per Washington or Massachusetts

A trial program should be monitored closely. Details on WsDOT's carefully conducted trials were presented in Chapter 6.

7.4.2.5 Roadwaste Data Project

7.4.2.5.1 Roadwaste Sampling Protocols and Data Clearinghouse

Establish roadwaste sampling protocols for use by agencies in Oregon and perhaps elsewhere. Create a clearinghouse for this information. The goal of this effort is to allow easy waste characterization based on known factors. Creating reliable subcategories for roadwaste will ease requirements prior to reuse and help eliminate the high cost of ongoing laboratory analysis. (See Section 7.10.8)

7.4.3 Other Field Decanting and Decant Facility Partnerships

7.4.3.1 Unified Sewerage Agency (USA)

Partner in use of the USA field decant stations or in use of their de-watering facility. USA is also interested in construction of a new facility and may be interested trading access rights for partial funding from ODOT.

7.4.3.2 Lane County/Cities of Eugene and Springfield De-watering Facility

Partner in use of their existing facility. Cost for dumping is currently estimated at $250 per load. Dumping fees include disposal of wastewater in the sanitary sewer and disposal of de-watered sludge at the local sanitary landfill.

7.4.4 Partnership with an Oregon Compost Manufacturer

Less contaminated wastes, usually meaning sweepings from clean areas of low-ADT roads, are candidates for commercial composting. The issues of sharps and litter screening must be addressed. Sweepings should probably be held to a very low percentage of process inputs or be held back for agency use to limit human contact. Product destination is also an issue. If the product goes to a farmer, we can be less concerned than if it goes to households. Perhaps farmers would be interested in composting sweepings with their regular compost. Cost is also an issue. It would be odd to find the right combination of low ADT sweepings near a substantial commercial composting operation. ODOT currently takes some green wastes to commercial composters, which is a completely sound alternative.

7.4.5 Use of a Roadwaste Landfill

ODOT should consider involvement in a roadwaste landfill. This involvement could be as a customer at a commercial clean fill that also takes some roadwaste. ODOT may pursue an interest in siting or helping to site an agency roadwaste and clean fill landfill. (See discussion of the Salem Airport Landfill and other roadwaste disposal site issues in Chapter 6.) Most roadwaste is marginally contaminated and, aside for heavily impacted wastes such as high-ADT, urban vactor wastes, disposal at a lined landfill may be too conservative and costly given the minimal risks posed by the waste. Still, we must carefully consider this option prior to active involvement, as the potential for long-term environmental liability can be significant.

7.4.6 Deicing Sand Waste Reduction

Depending on the amounts of material collected, ODOT Maintenance Districts outside Region 1 might also trial a sand recovery or sand and gravel washing program. The same screens used for preliminary screening of deicing sand can be used to screen regular sweepings prior to stockpiling, with the litter fraction taken to a DEQ-permitted landfill. Another way to reduce generation of waste sanding materials is through use of chemical de-icing agents; discussion of methods is outside the scope of this project, but ODOT is currently investigating use of these compounds.

7.4.7 Reducing Litter through Advertising

ODOT could partner with SOLV (Stop Oregon Litter and Vandalism), other agencies, and tourism advocates in an advertisement campaign to reduce littering. CALTRANS and the State of Texas ("Don't Mess with Texas") recently conducted successful campaigns. Partnering can make a program more cost effective.

7.4.8 An Active Campaign to Reduce Roadwaste Contamination

As discussed in Chapter 6, agencies might be able to substantially reduce contaminant levels in vactor waste and stormwater by working with commercial and industrial problem sources. While this technique may be especially effective in the case of hot loads resulting from inappropriate discharges (where ODOT should consider seeking damages), providing education may help to limit contaminant loadings from stormwater runoff. This effort could be pursued as problem areas are identified. ODOT might refer problems with recalcitrant problem sources to DEQ for further investigation. Similarly, initiating a program to requiring either complete cleanups along roadsides or a fee for ODOT to manage the contaminants in place and in its roadwaste would place more of the cost for managing contaminants on the responsible parties.

7.5 EVALUATION OF PHASE 2 FIELD TRIALS

Capturing adequate records of Phase 2 trials is essential. These reports will allow ODOT to evaluate methods and develop statewide guidelines. Field trials should be evaluated considering the following goals: 1) protection of human health (including worker safety) and the environment, 2) cost efficiency, 3) operational efficiency, and 4) compliance with environmental regulations.

7.6 ADDRESSING PAST PRACTICES

Besides correctly managing roadwaste we generate in the future, the impact of past practices should be evaluated. Roadwaste dumps may face action from DEQ as non-permitted solid waste landfills, as water quality hazards, or as potential cleanup sites. Facilities where roadwaste was previously stored may also be contaminated. Rains or leachate might have released CPAHs, metals, or hydrocarbons in concentrations sufficient to pose long-term impacts. When these sites are revisited, site assessments should consider a wider set of contaminants than are found in normal roadwastes. Not having a procedure to screen out hot loads in the past means that there is a greater likelihood that other contaminants may be present. In Canby, a roadwaste dumpsite also found use an impromptu public dump; Canby is now working with DEQ's voluntary cleanup program to evaluate this site.[74] WsDOT has looked into many of their old sites and has found reuse a viable option for much of these stockpiled materials, as we have seen; however, at one of their former facilities, petroleum fractions have been found in groundwater just above 1.0 ppm DOE action levels. Requirements for further action are under evaluation at both sites.

7.7 STUDIES CURRENTLY UNDERWAY

A pertinent NCHRP Survey of transportation environmental issues is in draft. The Survey is a roundup of a dozen different topics. Roadwaste is touched on, but not in very much depth. Findings from the draft were reviewed in developing ODOT's report.

At the University of S. Florida, Dr. Robert Brinkman is conducting a comprehensive study of contaminants found in sweepings. The project analyzes for a broad range of possible contaminants and should help answer whether any other contaminants of concern may commonly be present in sweepings. This study is scheduled to conclude in June 1998. Samples analyzed in this study are from roadways in Florida, where sediments found on roadways tend heavily toward clay fractions. Dr. Brinkman can be reached by telephone at (813) 974-4883.

From Washington State, Dr. Richard Watts' *Treatment of Vactor Wastes* is coming final. This study evaluates TPH and three-ringed PAH reductions in vactor solids that are kept moist but not saturated. The study also touches on sweepings.

More attention is being focused on CPAH destruction, leading to important findings. Researchers may soon provide simple and cost efficient methods to decompose CPAHs, greatly simplifying roadwaste reuse.[75]

We should encourage the City of Portland, Grimm's Fuel and Scott's Hyponex to publish findings on composting with sweepings.

7.8 RECOMMENDATIONS FOR FURTHER STUDY

Some of these recommendations could be pursued directly by ODOT, while some may be more appropriate for university study or for the involvement of policy makers.

[74] In a conversation on April 20, 1998, Jim Anderson, Project Manager with DEQ's Northwest Region, said that the City of Canby had entered DEQ's Voluntary Cleanup Program to address a small roadwaste dumpsite. Evidently, local citizens also had elected to use this pit as an informal dump. As of the date of this report, issues at this site have not yet been further delineated. At one WsDOT site, preliminary tests of petroleum hydrocarbon concentrations in the groundwater found levels above DOE groundwater cleanup standards of 1.0 ppm. This site is also currently undergoing further evaluation.

[75] Dr. Ken Williamson at Oregon State University's Civil Engineering Department, Environmental Engineering Program, conducts research on PAH breakdown and keeps abreast of the current literature on this topic.

7.8.1 Roadwaste Regulation Under BMPs

ODOT should continue working with DEQ on roadwaste issues. DEQ might choose to formalize roadwaste Best Management Practices into a policy or rule as needed to best pursue its mission. Permits may be required and appropriate for some management options. If ODOT remains in the lead on roadwaste issues, achieving workable results on its project schedule, ODOT should continue to have a significant role regarding how roadwaste management is regulated in Oregon.

7.8.2 Ditch Spoils

In this study, data has become available that shows ditch spoils can have significant levels of contaminants. DEQ has seen data showing high levels of contaminants in ditch surface materials. If surface materials at the ditch bottom are shown to contain the majority of the contaminants, removal and separate management of these surface materials may reduce the level of concern over other ditching spoils, perhaps indicating that management of these materials as soil is again appropriate.[76]

7.8.3 Decanting: Truck Design for Storm Sewer Maintenance

Trucks currently on the market for maintaining storm sewers (eductor trucks) do not appear to have the best design for efficient decanting of liquids. It is often difficult to separate liquids from solids that have already left suspension and have settled at the bottom of the tank. During decant, these solids can be re-suspended. High suspended solids in field decant can lead to violation of sanitary sewer pretreatment requirements or plugging and more frequent maintenance of field decant settling stations. Solids lost with the liquids can plug de-watering systems with suspended particles. Crews try to remove as much water as possible to make the solids de-watering process more efficient. Allowing time for settling is one way. Use of flocculent should also help. However, observing dumping at de-watering facilities, the question naturally arises whether the trucks are well designed to allow for efficient liquids/solids separation.

The decanting process may be improved using an outlet pipe that floats at the top of the load, allowing settled solids to remain in the bottom of the tank. Designs, which allow liquid to be drawn off at any level would also address this need. These concerns might already have been addressed in some eductor truck designs currently available. If so, agencies' purchasing decisions should recognize the benefits of efficient decanting from eductor trucks. If such designs are not available, or in the effort to better serve the customer, eductor truck companies may wish to look into designs that support efficient decanting. Designs that best support use of flocculent or that trap settled solids thereby preventing re-suspension (perhaps belly-dumping the solids after decant from the top) appear to be worth further investigation.

[76] Based on report draft review comments supplied by DEQ's Fred Bromfeld, dated April 2, 1998.

7.8.4 Other Sources of Information on Contaminant Risk

Other guidelines on the evaluation of contamination – such as allowable sediment contaminant levels established by EPA and other agencies or agency-generated environmental risk assessments using bioassay methods – may also be pertinent to the discussion of whether prospective reuses are protective. Cleanup programs are developing "hot spot" guidance to better delineate when cleanup action is always justified; this guidance might be useful in the discussion of contaminant level cut off points for simple roadwaste landfills.

7.8.5 The Source of CPAHs in Roadwaste

Why do CPAHs appear in roadwaste? If CPAHs come from tires, can we reduce or eliminate that source? Combustion of petroleum is one source of CPAHs; are CPAHs mainly a product of automotive or truck exhaust; diesel or gasoline? If PAHs are mainly generated by combustion, can we reduce the generation of PAHs from changes in the combustion of fuels? Is changing fuel types feasible? Can changes in combustion chamber design or oxygen inputs effect CPAH production? Should we add a high temperature combustion chamber? Can we increase the residence time for combustion? Another potential source of CPAHs is asphalt; this is under study at OSU and elsewhere. Will reuse of CPAH contaminated materials in asphalt create a significant risk in waste asphalt in the future?

7.8.6 Tire Dust, Asphalt Particles, and Petroleum Hydrocarbons

The City of Everett and other agencies have put forward the idea that a significant amount of the petroleum hydrocarbons observed in roadwaste may be bound into tire dust and asphalt particles and thus not be available to readily impact receptors in the environment. This idea may be of value in studying stormwater runoff as well as roadwaste, and may have been addressed previously. If further research shows that raw heavy end TPH concentrations in mainstream roadwaste do in fact pose significant concerns other than for CPAHs, further research into this topic may prove especially valuable to roadwaste management. As it is, further research into this topic may help show that an existing binding mechanism can mediate against risks posed by some part of petroleum fraction found in roadwaste.

7.8.7 Further Improvements for TPH Testing

We still lack a TPH test that does not suffer from interference from natural organic matter. Perhaps a factor can be determined to account for known levels of interference from different materials. TPH values in varying materials would then be given as a percentage of the TPH test values for the given matrix. As mentioned in Chapter 3, one idea to screen out this interference is by using a factor to reduce raw TPH test results. The factor could be based on the success of the acid cleanup step to reduce known interference. The percentage reduction would be assumed to be the percentage of the total non-petroleum hydrocarbons removed by the cleanup. The raw acid cleanup TPH result would then be reduced by the remaining percentage of known interference.[77] Another factor could be based on percent organic matter present in the material being tested.

7.8.8 Roadwaste Leachate Tests

In Chapter 3, we discussed the observation that benzo(a)anthracene, benzo(a)pyrene, and dibenzo(a,h)anthracene concentrations appeared to decline significantly during weathering. Further research on leachate from sweepings could help to identify if this is a significant long-term method of transport for certain CPAHs. One might approach this problem by testing leachate from sweepings or modeling from known solubility values or from SPLP or TCLP results. If CPAHs are not escaping in the leachate, and observed reductions in certain CPAHs are verified, we must assume that biodegradation or other natural attenuation is occurring. In fact, CPAH concentrations would be expected to increase in weathered roadwaste due to loss of organic matter due to decomposition and de-watering. If the relative concentrations of CPAHs change, that would provide strong evidence that a selective transport or destruction mechanism is at work. Research protocols and testing should take into account the fact that PAHs tend to bind into organic matrices. Similarly, it is expected but not known that CPAHs do not leach from roadwaste in significant quantities. Do we need to conduct more leachate tests on roadwaste to help us determine whether our management methods are truly protective?

7.8.9 Consistent Sampling of Roadwastes

A consistent sampling protocol should be developed for sampling roadwaste, capturing all of the necessary information. To track that information, a data clearinghouse should be established, and all data should be sent to that central location. This step would allow easier analysis of roadwaste data to better define the variation seen in contaminant levels. This process would assist ODOT and local agencies in identifying whether expected trends in contaminant levels based on weather, land use, intervals between maintenance, and ADT are significant. Reliable sub-categories of roadwaste would allow for wider and more ready reuse of qualifying materials.

A good start on such a protocol can be found in the University of Massachusetts Transportation Center/Massachusetts Highway Department publication, "Development of Guidelines for Presampling Street Sweepings for Toxicity and Beneficial Reuse." *(Jackivicz, 1997)* In developing an approach to study sweepings collected after the passing of winter in Massachusetts, researchers identified the need to develop a "Samplers Instruction Manual." They included this manual in full in their paper. It provides an approved list of sampling equipment, sampling procedures (including a standard label and log sheet, and fully adequate QA/QC procedures), and instructions for sampling logging which capture traffic volume, road classification, land use, color and composition ("e.g., 'red sand'"), and whether the site was coastal or non-coastal. This study did not seek to capture rainfall information, and rainfall may be an important factor impacting roadwaste contaminant levels in Oregon. The Massachusetts study might have left out rainfall information because all the samples were all taken from sweepings collected at the same time of year. Because the major sweeping effort there is

[77] From telephone conversations with Bob Campbell, Snohomish County Public Works, January and February 1998.

conducted at the same time once per year, they also did not seek to capture the last date of maintenance; again, time since last maintenance is very important to a complete assessment of roadwastes in the Northwest. Further, the type of sweeper truck used and whether the pavement was damp should be noted. Sweeper trucks models vary widely in their ability to pick up fines *(Lenhart, 1997)*, which are the most contaminated particle size fraction; and, fines will bind together with other materials when damp, making the fines easier to sweep up. Without this information about the samples, statistical noise might drown out important distinctions.

Of course, their manual does not offer a protocol for sampling wastes removed from catch basins and sumps. Sampling vactor solids should consider factors such as water content (considering dry weight versus weight when sampled and/or percentage of holding capacity) and a means to capture local variation. We could sample vactor solids dumped from trucks or sample catch basin and sumps independently. To sample the sludge dumped from a vactor truck and be able to draw distinctions between waste categories would require our vactor truck to have serviced only catch basins or only sumps in certain types of areas under certain conditions. If we sample individual catch basins, we can expect to see large variations in contaminant levels often due to location of parking lots, runoff from industrial activity, and individual acts of illegal dumping. Another factor potentially impacting stormwater catch basin contaminant levels may be how much surface area they serve.

Finally, we should identify the reason that a sample is taken. If a sample is taken to evaluate a suspect load, care should be taken so the sample is not later used to assess contaminant levels normally observed in roadwastes.

This effort could be pursued as part of Phase 2. Woodward-Clyde could assist Multnomah County and ODOT in the development of that protocol. ODOT could then work toward acceptance of consistent protocols and roadwaste data sharing in Oregon and elsewhere.

7.9 SUMMARIZING THE STATUS OF ROADWASTE RESEARCH

The findings and recommendations provided in this report are based on what is currently known about roadwaste contaminants and management methods. Many transportation, public works, and environmental regulatory agencies are becoming aware of roadwaste as an issue requiring their attention. Much work is currently underway by these agencies and by independent researchers on roadwaste characterization, management methods, and regulation, and new partnerships are being built to promote more protective and efficient management. New approaches and better overall methods for use in Oregon are a likely outcome as ODOT puts further effort into developing workable and efficient solutions in Phase 2 of this project.

8.0 ROADWASTE BIBLIOGRAPHY

NOTE: This bibliography replaces the list of references normally attached to reports published by the ODOT Research Unit. All documents cited in Roadwaste: Issues and Options are listed here; however some of the documents on roadwaste management listed below are not cited in the text of this report. Given the recent growth in roadwaste as an issue and the fact that an inclusive roadwaste bibliography has not recently been published, it is valuable to provide a list that is as complete and as up-to-date as possible.

AGI Technologies. 1996. *Street Sweeping and Vactor Debris: Handling, Disposal, and Worker Exposure*. May 1996. Portland, OR.

AGI Technologies. 1997. *Street Waste Study.* Brian Phillips, Staff Engineer, AGI. Prepared for Jeff Moore, ODOT. April 30, 1997. Portland, OR.

Alexander, Martin. 1985. Biodegradation of organic chemicals. *Environmental Science & Technology*. Vol. 18, No. 2, pp. 106-111.

Applied Geotechnology. 1994. *Sampling and Testing Results; Existing Street Sweep and Sand Wash Debris Piles; Stanton Yard, Bureau of Maintenance.* David Rankin, PG, and Annette M. Jakubiak. Portland, OR.

Beak Consultants. 1993. *Report on the Sampling and Analysis of Water and Sediment from Detention Ponds along Interstate 84.* Prepared for ODOT. August 1993. Portland, OR.

Besselievre, Edmund B. 1969. *The Treatment of Industrial Wastes*. McGraw-Hill. New York.

Birkeland, Peter W. 1984. *Soils and Geomorphology*. Oxford University Press. New York.

Bloomington, City of.1997. *Reduce and Reuse Street Sweepings*. Bloomington, Minnesota, Department of Public Works. Bloomington, MN.

Boyce, John. 1997. Disposing of Sweepings Debris. *Pavement Maintenance & Construction.* October/November 1997: 38-40.

Braden, Brent, and Mark Ryckman. 1997. Enzyme-Based Bioremediation Accelerators; Enhancing Bioremediation of Petroleum Products. *Soil & Groundwater Cleanup Magazine.* Pre-print, February-March 1997 (obtained from the Remtech Engineers website.)

Britton, Larry N. 1984. Microbial Degradation of Aliphatic Hydrocarbons. *Microbial Degradation of Organic Compounds.* David T. Gibson, ed. Pp. 89-129. Marcel Dekker, Inc. New York.

Corbitt, Robert A. 1990. *Standard Handbook of Environmental Engineering*. McGraw-Hill. New York.

Donovan Enterprises. 1994. *Vactor Waste & Street Sweepings; Disposal Options; Final Report.* For Unified Sewerage Agency (USA). December 1994. Portland, OR.

Environmental Protection Agency (EPA). 1996. Availability of Permits Improvement Team Concept Paper on Environmental Permitting and Task Force Recommendations; Correction; Notice. *Federal Register*. August, 6 1996, Volume 61, No. 153. FRL-5546.

Environmental Protection Agency (EPA). 1997. *Waste-Derived Fertilizers.* EPA Office of Solid Waste. Fact Sheet. December 1997. Washington, DC.

Eugene Public Works. 1996. *Summary of the Catchbasin Waste Characterization Study (Conducted October 1995).* Brian Elliott, Maintenance Planning. February 1996. Eugene, OR.

Forsyth, Raymond A., and Joseph P. Egan, Jr. 1976. Use of Waste Materials in Embankment Construction. *Use of Waste Materials and Soil Stabilization.* TRR 593, pp. 3-8. Transportation Research Board. Washington, DC.

Gibson, David T., and Venkiteswaran Subramanian.1984. Microbial Degradation of the Aromatic Hydrocarbons. *Microbial Degradation of Organic Compounds.* David T. Gibson, ed. Pp. 181-252. Marcel Dekker, Inc. New York.

Golder Associates Inc. 1993. *Report: City of Portland, Oregon; Drainage Sump Study*. For City of Portland, BES. June 14, 1993. Redmond, WA.

Hindin, Ervin, 1993. *Management of Hazardous Waste from Highway Maintenance Operations*. Report prepared for Washington State Transportation Commission research project. Report No. WA-RD 286.1. March 1993. Washington State University.

Jackivicz, Thomas Paul. 1997. *Development of Guidelines for Presampling Street Sweepings for Toxicity and Beneficial Reuse*. Department of Civil and Environmental Engineering, University of Massachusetts Dartmouth. Research conducted for Massachusetts Highway Department. University of Massachusetts Transportation Center. February 1997. Amherst, MA.

Jacobson, Michael A. 1993. *Data Summary of Catch Basin and Vactor Waste Contamination in Washington State, Final Report*. Prepared for Urban Nonpoint Management Unit, Washington Department of Ecology. February 1993.

KCM, Inc. 1997. *Boeing Commercial Airplane Group; Renton Decant Facility*. Study done under contract with Boeing. June 11, 1997. Seattle, WA.

Kamnikar, Brian, P.E. 1996. Biomounds pass tests in Minnesota; Field evaluation proves biomounds clean soil economically. *Soil and Groundwater Cleanup*. May 1996: 34-43.

KATSUMI, Takeshi, and Masashi KAMON. 1998. Management and reuse of waste sludge from construction works in Japan. Paper presented at 77th annual meeting of the Transportation Research Board, January 1998, in Washington, DC.

King County. 1993. *Draft Vactor Waste Disposal Plan.* Surface Water Management Division, Water Quality Unit. October 29, 1993. Seattle.

King County. 1994. *Model Plan for Regional Vactor Waste Disposal.* Surface Water Management Division, Water Quality Unit. March 1994. Seattle.

King, Hugh, Street Division Manager, Colorado Department of Transportation. 1996. Colorado Springs Street Division 'Reuses It Again." *Public Works.* July 1996: 33-35.

Landau Associates. 1995. *Snohomish County Street Waste Characterization; Snohomish County, Washington.* Prepared for Snohomish County Public Works Department. December 29, 1995. Edmonds, WA.

Lenhart, James H. 1994. *Vactor and Street Sweeping Waste Characteristics.* APWA Maintenance Practices Workshop. Feb. 3, 1994. Portland, OR.

Lenhart, 1998. Draft. *Management of Stormwater Facility Maintenance Residuals.* Prepared by Stormwater Management Inc. under contract to ODOT; report part of Phase 1 of ODOT's Roadwaste Project. April 1998. Salem, OR.

Martin, Craig A., Ervin Hindin, and Ed Hannus. Total Petroleum Hydrocarbons in Highway Maintenance Waste. *Air Quality, Environment, and Energy.* Transportation Research Board. TRR 1366, pp. 44-48. Washington, DC.

Massachusetts Department of Environmental Protection (DEP). 1994. *Interim Final Petroleum Report: Development of Health-Based Alternative to the Total Petroleum Hydrocarbon (TPH) Parameter.* By the DEP Office of Research and Standards and by ABB Environmental Services. Prepared for the DEP Bureau of Waste Site Cleanup. August 1994. Boston.

Massachusetts Department of Environmental Protection (DEP). 1995. *Classification and Re-use Options for Street Sweepings and Catch Basin Cleanings.* Memo from Richard Gioiosa. January 6, 1995. Boston.

Massachusetts Department of Environmental Protection (DEP). 1997. *Re-use and Disposal of Street Sweepings.* Carl F. Dierker, Assistant Commissioner, Bureau of Waste Prevention. Final Policy #BWP-94-092. Signed April 17, 1997. Boston.

Meegoda, Jay M., Robert T. Mueller, and Frank Palise. 1996. Salvaging Petroleum-Contaminated Soils for Highway Construction. *TR News.* May-June 1996. No. 184, pp. 40-42.

Minnesota Department of Transportation (Mn/DOT). *Description of the Mn/DOT Petroleum Contaminated Soil Treatment Process.* Office of Environmental Services, Mn/DOT. One Page Summary. Oakville, MN.

Minnesota Department of Transportation (Mn/DOT). *Hazard Analysis and Risk Management of Road Subbase Materials Using the Comparative Risk Bioassay Methodology*. Bruce L. Johnson, CHMM, Mn/DOT; David A. Beluck, Ph.D., Minnesota Pollution Control Agency; and, Ann M. Melby, Mn/DOT. Office of Environmental Services, Mn/DOT. Oakville, MN.

Minnesota Department of Transportation (Mn/DOT). *Hazardous Waste Management Manual*. Office of Environmental Services, Mn/DOT. Implemented in 1994. Revisions through 1997. Oakville, MN.

Minnesota Department of Transportation (Mn/DOT). 1997. *Pollution Prevention Summary Report; Fiscal Year 1997*. Oakville, MN.

Multnomah County Transportation Division. 1997. *Decant Site Investigation Summary.* Memo from Mark Ghezzi, Multnomah County Public Works Intern (University of Washington), to Don Newell, Transportation Division Systems Administrator. September 26, 1997. Portland, OR.

Oregon Department of Environmental Quality (DEQ). 1990. *Benefiting from Toxic Substance and Hazardous Waste Reduction; A Planning Guide for Oregon Businesses*. October 1990. Portland, OR.

Oregon Department of Environmental Quality (DEQ). 1992. *Policy for Reuse of Petroleum Contaminated Soils*. Michael Downs, Division Administrator, Environmental Cleanup Division. Policy 550. Signed September 16, 1992. Portland, OR.

Oregon Department of Environmental Quality (DEQ). 1993. *Hazardous Waste Determination Handbook.* Waste Reduction Assistance Program. June 1993. Portland, OR.

Oregon Department of Environmental Quality (DEQ). 1993. *Small Quantity Hazardous Waste Generator Handbook.* Waste Reduction Assistance Program. April 1993. Portland, OR.

Oregon Department of Environmental Quality (DEQ). 1993. *Summary Report on Joint DEQ/ODOT Technical Assistance Project.* Phil Berry. DEQ Waste Reduction Assistance Program. November 16, 1993. Portland, OR.

Oregon Department of Environmental Quality (DEQ). 1994. *Bioremediation Alternatives for Petroleum Contaminated Soil; September 1993-July 1994.* Karen L. Lawson. Portland, OR.

Oregon Department of Environmental Quality (DEQ). 1994. *Environmental Cleanup Manual.* June 1994. Portland, OR.

Oregon Department of Environmental Quality (DEQ). 1994. *Soil Cleanup Manual.* Waste Management and Cleanup Division. April 1994. Portland, OR.

Oregon Department of Environmental Quality (DEQ). 1995. *Options for Handling Petroleum Contaminated Soils from Underground Storage Tank Cleanup Projects*. UST Cleanup Section, Waste Management and Cleanup Division. March 1995: Four Pages. Portland, OR.

Oregon Department of Environmental Quality (DEQ). 1995. *Treatment of Petroleum Contaminated Soils*. Four Page Document. UST Cleanup Section, Waste Management and Cleanup Division. March 1995. Portland, OR.

Oregon Department of Environmental Quality (DEQ). 1995. *UST Cleanup Manual*. UST Cleanup Section, Waste Management and Cleanup Division. January 1995. Portland, OR.

Oregon Department of Environmental Quality (DEQ). 1996. *Hazardous Waste Rules; Contains Rule Changes Effective on August 1, 1996*. Waste Reduction Assistance Program. Portland, OR.

Oregon Department of Environmental Quality (DEQ). 1996. *Permits Handbook; A Guide to Oregon Department of Environmental Quality Permits and Requirements*. September 1996. Portland, OR.

Oregon Department of Environmental Quality (DEQ). 1997. *Administrative Rules; Solid Waste Management; Divisions 93-97*. July 1997. Portland, OR.

Oregon Department of Environmental Quality (DEQ). 1997. *Composting Facilities in Oregon*. September 1997. Portland, OR.

Oregon Department of Environmental Quality (DEQ). 1998. *DEQ's Composting Facility General Permit*. Notice out for Public Comment. February 1998. Portland, OR.

Oregon Department of Transportation (ODOT). 1997. *Maintenance Management System; Water Quality and Habitat Guide; Best Management Practices*. June 1997. Salem, OR.

Palmer, David A. 1987. Formates as Alternative Deicers. *Innovation, Winter Maintenance, and Roadside Management*. Transportation Research Board. Pp. 34-36. Washington, DC.

Perla, Martha J. 1996. *Questioning Street Waste Regulations*. Public Works, July 1996, pp. 36-39.

Pierce, Douglas. 1998. *Managing Street Waste Through Reuse*. Washington State Department of Transportation. Paper presented at 77th annual meeting of the Transportation Research Board, January 1998, in Washington, DC.

Portland, City of; Bureau of Environmental Services (BES). 1992. *Residential Sump Sediment Study*. Prepared by Duane Linnertz, BES. Portland, OR.

Portland, City of; Bureau of Environmental Services (BES). 1993. *BES Sediment Management Project; Technical Memorandum*. Prepared for BES by Roger Sutherland, PE, and Kendra Smith, with OTAK, Inc., Kurahashi & Associates, et al. November 1993. Portland, OR.

Portland, City of; Bureau of Environmental Services (BES). 1994. *Final Revised Version: BES Sediment Management Project; Technical Memorandum*. January 1994. Portland, OR.

Salem, City of; Public Works Department. 1995. *Operations Manual; Salem Airport Disposal Site*. February 1995. Salem, OR.

Sansalone, John J., Steven G. Buchberger, Joseph M. Koran, and Joseph A. Smithson. 1997. Relationship Between Particle Size Distribution and Specific Surface Area of Urban Roadway Stormwater Solids. *Environmental Issues in Transportation.* Transportation Research Board. TRR 1601, pp. 95-108. Washington, DC.

Schick, Randle J. 1997. Risked Based Cleanup Objectives, Land Use, and Transportation. *Environmental Issues in Transportation.* Transportation Research Board. TRR 1601, pp. 84-94. Washington, DC.

Snohomish County Public Works. 1997. *Sweepings Testing Final Report.* Bob Campbell, Operations Planning Specialist, Road Maintenance Division. October 21, 1997. Snohomish, WA.

Snohomish County Public Works. 1997. *Vactor Grit Liquid/Solids Separation; Eductor Truck Liquid Flocculation Pilot Study.* Bob Campbell, Operations Planning Specialist, Road Maintenance Division. In association with Delta Pollution Control, Inc. September 10, 1997. Snohomish, WA.

Snohomish Health District. 1995. *Policy Statement Regarding Street Waste Solids Recycling and Disposal.* Robert A. Pekich, Director, Environmental Health Division. Signed effective January 1, 1995. Everett, WA.

Spencer, Cynthia J., Patrick C. Stanton and Richard J. Watts. 1994. On-Site Treatment of Contaminated Soils and Wastes from Transportation Maintenance Activities Using Oxidative Processes. *Transportation, Environmental Issues: Air, Noise, Water, Mitigation Processes, and Alternative Fuels.* Transportation Research Board. TRR 1444, pp. 47-50. Washington, DC.

TR News. 1994. Research Pays Off: Minnesota Develops Method To Recycle Petroleum-Contaminated Soil. Editorial. November-December 1994. No. 175, pp. 30-31.

Takada, Hideshige. 1990. Distribution and Sources of Polycyclic Aromatic Hydrocarbons (PAH's) in Street Dust From the Tokyo Metropolitan Area. *The Science of the Total Environment.* 107 (1991) 45-69,1991. Elseveir Science Publishers. B.V. Amsterdam.

Transportation Research Board. 1993. *Disposal of Roadside Litter Mixtures; A Synthesis of Highway Practice.* Dorothy L Andres. NCHRP Synthesis 184. Washington, DC.

Transportation Research Board. 1996. *Remediation of Petroleum-Contaminated Soils; A Synthesis of Highway Practice.* David J. Friend. NCHRP Synthesis 226. Washington, DC.

Transportation Research Board. 1997. *Best Management Practices for Environmental Issues Related to Highway and Street Maintenance; A Synthesis of Highway Practice.* NCHRP Project 20-5, Topic 28-01. First Draft. Washington, DC.

Trudgill, Peter W.. 1984. Microbial Degradation of the Alicyclic Ring; Structural relationships and metabolic pathways. *Microbial Degradation of Organic Compounds.* David T. Gibson, ed. Pp. 131-180. Marcel Dekker, Inc. New York.

Tymco Regenerative Air Sweepers. 1993. *Best Management Practices: Street Cleaning; National Pollution Elimination System Relating to Storm Water Quality.* Waco, TX.

US Geological Survey. 1983. *Storm runoff as related to urbanization based on data collected in Salem and Portland, and generalized for the Willamette Valley, Oregon.* Water Resources Investigation Report 83-4143. Portland, OR.

W&H Pacific, Inc. 1993. *Vactor and Street Sweeping Treatment and Disposal Options; Snohomish County, Washington.* Prepared for Snohomish County Public Works Department, Solid Waste Management Division. December 6, 1993. Bellevue, WA.

W&H Pacific, Inc. 1994. *Vactor and Street Sweeping Characteristics; Snohomish County, Washington.* Prepared for Snohomish County Public Works Department, Solid Waste Management Division. February 14, 1994. Bellevue, WA.

Washington State Department of Community, Trade & Economic Development. 1997. *Reprocessing and Reuse of Street Waste Solids.* The Clean Washington Center Recycling Technology Assistance Partnership (ReTAP) Program. In cooperation with Land Technologies Inc., Price-Moon Enterprises, and Snohomish County Road Maintenance Division. June 1997. Seattle, WA.

Washington State Department of Ecology (DOE). 1991. *Summary of Criteria and Guidelines for Contaminated Freshwater Sediments.* Compiled by Jon Bennett and Jim Cubbage, Environmental Investigations and Laboratory Services Program. Produced for DOE's Sediment Management Unit. September 1991. Olympia, WA.

Washington State Department of Ecology (DOE). 1993. *Contaminants in Vactor Truck Wastes.* Dave Serdar, Environmental Investigations and Laboratory Services Program, Toxics, Compliance and Ground Water Section. April 1993. Olympia, WA.

Washington State Department of Ecology (DOE). 1996. *Recommendations for Management of Street Waste.* Water Quality Program. Draft: November 1996. Olympia, WA.

Washington State Department of Ecology (DOE). 1997. *Interim Interpretive and Policy Statement: Cleanup of Total Petroleum Hydrocarbons (TPH).* Toxics Cleanup Program. January 1997. Olympia, WA.

Washington State Department of Ecology (DOE). 1997. *Recommendations for Management of Street Waste.* Water Quality Program. Working Draft: May 1997. Olympia, WA.

Washington State Department of Transportation (WsDOT). 1992. *WsDOT Stormwater Runoff Management, Appendix B8, Catch Basin Solid and Liquid Wastes Statewide.* Prepared by

Herrera Environmental Consultants for ENTRANCO Engineers and WsDOT. September 1992. Seattle, WA.

Washington State Department of Transportation (WsDOT). 1993. *WsDOT Stormwater Runoff Management, Appendix B8, Catch Basin Solid and Liquid Wastes Statewide*. By Ervin Hindin, Ph.D., Washington State Transportation Center, Civil and Environmental Engineering Department, Washington State University. March 1993. Pullman, WA.

Washington State Department of Transportation (WsDOT). 1998. *How Pit Vactor samples (sample results); SR 512 & Steel St. Street Waste Reuse (sample results)*. Reports from Sound Analytical Services on March 10 and 19, respectively. Documentation supplied by Norm Payton, WsDOT Environmental Section. Olympia, WA.

Washington State Department of Transportation (WsDOT). 1998. *State Route 16 Street Waste Application Project*. Norm Payton, WsDOT Environmental Section. April 16, 1998. Olympia, WA.

Watershed Management Institute. 1997. *Operation, Maintenance and Management of Stormwater Management Systems*. In cooperation with the Office of Water, USEPA. August 1997. Washington, DC.

Watts, Richard J., Alexander Jones, and Michael Harrington. 1997. (Draft). *Treatment of Vactor Wastes*. Draft report prepared for Washington State Transportation Commission research project T9902-18. Draft: August 1997. Washington State University.

Wayne, Delancey D. 1976. Waste Use in Highway Construction. *Use of Waste Materials and Soil Stabilization*. Transportation Research Board. TRR 593, pp. 9-12. Washington, DC.

Weissenfels, Walter D., Hans-Jurgen Klewer and Joseph Langhoff. 1992. Adsorption of polycyclic aromatic hydrocarbons (PAHs) by soil particles: influence on biodegradability and biotoxicity. *Applied Microbiology and Biotechnology*, 36:689-696.

Woodward-Clyde. 1996. *Vactor Solids Disposal Options.* Steve Anderson, P.E., and Geoff Compeau, Ph.D. Letter to Jonathan L. Brand, PE, Hydraulics Division, Kitsap County Department of Public Works. October 4, 1996. Seattle.