ROADWASTE MANAGEMENT: FIELD TRIALS

Final Report

SPR 385

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by

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16. Abstract

The Oregon Department of Transportation is concluding a study on roadwaste management. The first phase of the study provided a thorough regulatory analysis and synthesis of known fact compiled in *Roadwaste: Issues and Options*. The main emphasis of the second phase was hands-on study of the most efficient and environmentally sound management options for street sweepings and stormwater system residuals. This report documents the second phase investigations, which include field trials conducted by ODOT crews and those conducted in cooperation with the City of Portland. Dewatering, treatment methods (from composting to thermal treatment), and reuse were investigated. Field observations from crews, operators, managers, and the ODOT Principal Investigator provide an on-site account showing why some options worked and under what circumstances some methods performed poorly.

Laboratory analysis was used to further characterize roadwaste materials. The data was also used to analyze the effectiveness of selected management options. Some options for trials were not followed-up, and some were pursued only on the bench scale. These preliminary findings and discussion of other promising technologies are also presented. Central to efficient management is the question of shared facilities, which is discussed in its own chapter.

The findings of the second phase of the roadwaste management study were used to support the recommendations for a set of effective management options presented in the Phase 3 report, *Roadwaste Management: A Tool for Developing District Plans*. Phase 4 is planned to assist ODOT Maintenance Districts and local jurisdictions with planning and implementation. ODOT expects the documented observations to help maintenance personnel select workable methods to best address roadwaste management issues in their Districts, and to help field crews more efficiently implement the field methods, understanding that not all situations encountered in the field can be anticipated in a study.

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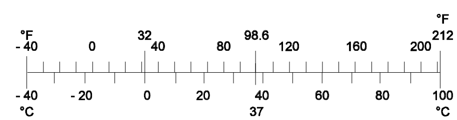
APPROXIMATE CONVERSIONS TO SI UNITS

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

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EXECUTIVE SUMMARY

Background

Oregon Department of Transportation (ODOT) highways generate large amounts of waste material such as litter, highway sweepings, sediment from drainage catch basins, and landslide debris. Managing roadwaste in an environmentally responsible way can be both difficult and expensive. As part of a four-year Roadwaste Research Project initiated in 1997, ODOT recently completed a number of field trials designed to test and develop new roadwaste management technologies. The field trials were focused on improving ODOT waste management efficiencies and minimizing negative environmental impacts associated with roadwaste materials.

The ODOT Roadwaste Research Project began with a literature review that identified roadwaste environmental issues and concerns. This first phase of the project also recommended new emerging technologies that might be used to better manage ODOT roadwaste materials (see **Roadwaste: Issues and Options**, *Collins 1998*).

Phase Two of the project focused on testing and further developing these recommended roadwaste management technologies through field trials. Field trials were developed for those roadwaste management methods thought to be both easy to implement and effective in reducing negative environmental impacts. Management of urban street sweepings and vactor waste was the main focus of these trials, since these wastes have a high potential to damage the environment and are difficult and expensive to manage. Because urban centers tend to generate large volumes of roadwaste materials, trials were conducted in the Portland area.

Significant roadwaste field trials included:

- Compost Study – Road sweepings were mixed with standard compost to look at pollutant remediation and containment.
- Berm Use – Roadwaste was used to construct a rock fall safety berm. The berm was monitored for pollutant levels and pollutant migration.
- Decant Opportunities – Roadwaste dewatering facilities located in the Portland area were identified and assessed for ODOT use and access. The possibility of sharing roadwaste dewatering facilities among local highway agencies was considered.
- Flocculant Studies – Various types of flocculant were laboratory tested for dewatering roadwaste materials. The most effective flocculant was selected and tested in the field.
- Stockpile Investigations – Roadwaste piles were analyzed for typical toxic pollutants. Sampling was done to characterize roadwaste in terms of pollutant load and environmental risk.
- Thermal Treatment – Thermal treatment facilities were considered as a disposal alternative for contaminated roadwaste. Testing was done to determine effectiveness of thermal treatment methods in reducing and containing pollutant loads.

The field trials focused on developing waste management practices that are protective of the environment, affordable, and easily implemented. Pollutant monitoring and data analysis were included as part of the field trials where appropriate. Data were collected to characterize pollutants associated with roadwaste materials and to assess the efficiency of the various management practices being tested.

Findings and Recommendations

Many of the trials, such as the compost and flocculant studies, showed new roadwaste technologies to be very promising, but more work is needed before these technologies can be developed into actual best management practices. The roadwaste field trials also indicated that if ODOT chooses to develop roadwaste management plans, plans should be developed on a local level and employ multiple management methods that take advantage of local resources and geography.

Recommendations that came out of the study for managing roadwaste in the Portland area include the following:

- Pursue sorting of roadwaste material. Defining low risk roadwaste material through pollutant characterization will result in more low-cost disposal or reuse options, such as use in compost or use as general fill in appropriate locations on ODOT right-of-way.
- Pick up winter sand and gravel quickly to allow for more efficient recycling of this material.
- Take advantage of local partnering opportunities.
- Pursue new dewatering technologies, such as flocculant, that can enhance the operation of existing dewatering facilities.

Conclusions

Phase Two field trials were successful in furthering ODOT's understanding of the environmental risks associated with roadwaste materials and in pursuing new roadwaste management technologies. The trials pointed out a need to further characterize pollutant loads typically associated with various roadwaste materials so that environmental risks can be better assessed. Typical roadwaste materials should not be considered hazardous as defined by environmental regulators. In some instances, roadwaste may be considered clean fill, although minimum treatment and/or testing may be required to meet this definition.

New technologies could be very useful in better managing roadwaste materials, but additional resources will be necessary to further develop them. ODOT could manage its roadwaste more efficiently by simply sorting it for environmental risk. It is also likely that partnering with other highway management agencies and sharing roadwaste management facilities could result in substantial cost savings for ODOT.

ODOT ROADWASTE FIELD TRIALS

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PREFACE

The field trials documented in this report were not conducted as rigorous academic research. A different standard was used with a different goal in mind: How do theories on improving roadwaste management play out under field conditions? Mark Ghezzi, ODOT's principal investigator for these field trials, reviewed products and vendors, evaluated bench-scale and field tests, and documented the efforts and observations of ODOT field crews. In addition, he provided his own observations on the trials and on data collection. This report documents his research and observations in an effort to help the reader to develop and implement an efficient roadwaste management program.

The scope of the trials was very ambitious. We were not able to accomplish everything we would have liked. Recommendations for further investigations, more sampling, and additional work are noted throughout the text. For example, further work is needed to get flocculant to perform in ODOT eductor trucks as well as it does in bench-scale tests. Ultimately we were not able to investigate every promising technology.

For the most part, lab results demonstrated the efficiency of the waste management method being tested and offered general guidelines for expected pollutant levels. However, for several trials results were inconclusive and further analysis was recommended. For example, more work is needed to better establish accurate contaminant-level baselines for the different roadwaste types, especially on the local level.

Besides ODOT Research, ODOT Maintenance, and ODOT's Clean Water program, many agencies, companies, and individuals have participated in the Roadwaste Research Project. The participation of the City of Portland in these trials deserves special note in helping us meet our goals. Partnering with Katie Bretsch of the City's Bureau of Environmental Services on vactor waste issues gave the project research team access to an active dewatering facility, a dewatering filter box, sanitary sewer pretreatment, and a good pool of data on urban vactor residuals. The participation of Stuart Lindor of Delta Pollution Control of Preston, Washington also deserves special recognition. His company's flocculant product and his ideas for implementation are discussed at length in the text.

The ODOT Research Group and project participants hope these observations and findings prove useful in the development of more efficient roadwaste management programs.

Jay Collins
Oregon Department of Transportation and
Oregon Department of Environmental Quality
Portland, Oregon
September 20, 2000

LIST OF ACRONYMS

ADT	Average Daily Traffic [number of vehicles that pass daily over a given roadway]
BES	Bureau of Environmental Services, City of Portland
BTEX	Benzene, Toluene, Ethylbenzene, and Xylenes [laboratory test]
BMPs	Best Management Practices
Caltrans	California Department of Transportation
C.O.P.	City of Portland, Oregon
CPAH	Carcinogenic Polyaromatic Hydrocarbon
DEQ	Oregon Department of Environmental Quality
DOE	Washington Department of Ecology
EPA	U.S. Environmental Protection Agency
HMIS	Hazardous Material Identification System
MnDOT	Minnesota Department of Transportation
ND	Non-detect [laboratory test result]
NPDES	National Pollutant Discharge Elimination System [water quality requirements]
NWTPH	Northwest Total Petroleum Hydrocarbon [laboratory test]
NWTPH-Dx	Northwest Total Petroleum Hydrocarbon - Diesel extended [laboratory test]
ODOT	Oregon Department of Transportation
PAH	Polycyclic Aromatic Hydrocarbon
Pb	Lead
PCB	Polychlorinated Biphenyl
PNA	Polynuclear Aromatic [*see* PAH]
POTW	Publicly Owned Treatment Works [*see* WWTP]
ppm	Parts per million [*often expressed in* mg/kg *or* mg/L]
ppb	Parts per billion
SoClean	Soil Cleanup Table [Oregon DEQ threshold values for cleanups]
STP	Sewage Treatment Plant [*see* WWTP]
TAC	[ODOT Research] Technical Advisory Committee
TCLP	Toxicity Characteristic Leaching Procedure [lab test; often for "TCLP" metals]
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]
USA	Unified Sewerage Agency [of Washington County, Oregon]
UST	Underground Storage Tank
WsDOT	Washington Department of Transportation
WWTP	Wastewater Treatment Plant

Vactor This term originates from a brand of vacuum eductor truck manufactured by Vactor® Manufacturing, Inc. Streator, IL. The term is used generically in this document to refer to eductor trucks in general and also to the waste materials extracted by them (e.g. "vactor waste").

1.0 INTRODUCTION

Oregon Department of Transportation (ODOT) highways generate large amounts of waste material such as litter, highway sweepings, sediment from drainage catch basins, and landslide debris. Managing roadwaste in an environmentally responsible way can be both difficult and expensive. As part of a four-year Roadwaste Research Project initiated in 1997, ODOT recently completed a number of field trials designed to test and develop new roadwaste management technologies. The field trials were focused on improving ODOT waste management efficiencies and minimizing negative environmental impacts associated with roadwaste materials.

The ODOT Roadwaste Research Project began with a literature review that identified roadwaste environmental issues and concerns. This first phase of the project also recommended new emerging technologies that might be used to better manage ODOT roadwaste materials (see **Roadwaste: Issues and Options**, Collins 1998).

Phase Two of the project focused on testing and further developing these recommended roadwaste management technologies through field trials. Field trials were developed for those roadwaste management methods thought to be both easy to implement and effective in reducing negative environmental impacts. Management of urban street sweepings and vactor waste[1] was the main focus of these trials, since these wastes have a high potential to damage the environment and are difficult and expensive to manage. Because urban centers tend to generate large volumes of roadwaste materials, trials were conducted in the Portland area.

Pollutant monitoring and data analysis were included as part of the field trials where appropriate. Data collected was used both to characterize pollutants associated with roadwaste materials and to assess the efficiency of the various management practices being tested.

Many roadwaste management products, vendors, and methods have been identified in the course of these investigations. Not all have led to complete and successful field trials, but information that is pertinent has been documented in the following chapters. Chapter 2 includes a discussion of treatments considered for street sweeping waste. Chapter 3 includes documentation of treatments considered for vactor waste materials. Chapter 4 discusses existing waste disposal facilities in the Willamette Valley. Chapter 5 discusses shared roadwaste management facilities. Chapter 6 presents the study's conclusions.

Phase Three of the project includes a separate report, *Roadwaste Management: A Tool for Developing District Plans*. That document will provide guidance to ODOT Maintenance on the protective and cost efficient management of roadwaste materials.

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[1] "Vactor waste" is so named after a brand of eductor truck made by Vactor Manufacturing, Inc., commonly used to vacuum out catch basins, sumps and storm sewer lines.

2.0 STREET SWEEPING WASTE

Street sweeping waste consists of sand, dirt, debris, and litter cleaned from highway surfaces during regular highway maintenance activities. Two issues are associated with managing street sweepings. The first is disposal. Since street sweepings are often contaminated with hydrocarbons and metals, they may require disposal at a permitted waste disposal facility. Second, street-sweeping stockpiles can contaminate adjacent land, streams, or wetlands, either through the physical erosion of the stockpiled material or through the migration of chemical pollutants carried by stormwater runoff. The investigation of managing street sweeping materials in light of these issues is described below.

2.1 COMPOST STUDY: BALDOCK MAINTENANCE YARD, WILSONVILLE

Introduction: Composting is a waste management technique used to promote the natural breakdown of organic waste into a useful soil amendment. Although it is typically used to manage agricultural wastes, composting can be used to break down organic components of any waste stream. It can also be effective in reducing pollutant levels by breaking down large toxic molecules into their smaller non-toxic components. Minnesota Department of Transportation reports reducing the pollutant levels of its sweepings through composting at a cost of $17/ton ($19/Mg) (*MnDOT 1997*). Composting ODOT street sweepings could help reduce pollutant levels, eliminate waste disposal fees, and supply landscape crews with needed compost material.

Goals/Purpose: Investigate the reduction of streetwaste pollutants through composting. Examine street sweeping stockpiling as a passive pollutant treatment method. Investigate pollutant loads carried by stormwater runoff from street sweeping stockpiles.

What we did: ODOT landscape crews from the Baldock Maintenance Yard constructed a series of seven compost bins using 2x4s and plywood. Each bin was lined with a plastic impervious barrier and held approximately 1.5 yd^3 (1.1 m^3) of compost material. A drain hole was installed in each bin to allow the collection of runoff water for sampling. Street sweepings were collected and screened for trash, with the trash disposed at a local landfill. Then screened sweepings, dry mulch, and green mulch material were placed into the constructed bins in various ratios for composting. Material ratios ranged from 4 parts organics/1 part sweepings to 100% sweepings. Over a nine-month period samples were taken approximately every two months to track pollutant breakdown and pollutant migration in water runoff. (For specific details regarding the study design and testing protocols, refer to the Compost Work Plan in Appendix A.)

The sweepings used in these trials were first analyzed for pollutant levels approximately 2 weeks after they were collected. Results included:

- Heavy Oil Range Hydrocarbons 2030 mg/Kg;
- Total Metals for Copper 63.4 mg/Kg, Lead 83 mg/Kg, and Zinc 294 mg/Kg; and

- Non-detect for PCBs and PAHs.

After screening for litter removal, the sweepings were analyzed a second time. Heavy Oil Range Hydrocarbons were reduced to 1060 mg/Kg; all other detected parameters remained somewhat consistent.

What we found: Once compost mixtures were placed in their respective cells, sample analysis detected the presence of PAH contamination. The cells that contained more organic mulch and less street sweeping material tested higher in PAH levels. Any pollutant breakdown or remediation that occurred in the sweepings as a result of composting was negligible and difficult to confirm. Pollutant values were inconsistent and varied widely for each cell.

The most important finding from this investigation was that there was minimal pollutant loading seen in the stormwater runoff collected from the compost cells. Analysis of runoff water samples found no PAHs and observed only a trace amount of TPH (less than 1 ppm). The trace TPH levels that were seen may have resulted from the high number of bark beetles present or decomposing leaves that had blown into the collection devices. Again, data we collected did not indicate that composting had reduced pollutant levels. For a complete list of analytical data refer to Appendix B.

Did we reach our goal? We were unable to demonstrate pollutant remediation via composting. However, we did find there was only minimal migration of pollutants from the compost mixtures into stormwater run-off. This is important information that may support the use of sweepings in compost mixes.

What would have improved our success? Collecting and analyzing more samples may have resulted in more statistically valid and representative pollutant data. This was typical of all our Phase 2 trials where we saw a wide variation in sampling results. Unfortunately, sampling budgets were limited, precluding additional sampling. For the purpose of this trial, observing no pollutant migration via water movement was valuable. We had also hoped to see indications of pollutant treatment, but this was not observed in our wide range of sample test results.

Narrative review of project by maintenance personnel: Baldock landscape crews are interested in composting screened street sweepings. Composting this material produces a high quality, dark nutrient material, useful for landscape projects along state roadways. The high percentage of sand in street sweepings discourages weed growth and decreases the amount of maintenance necessary to manage landscapes. ODOT landscape crews purchase large amounts of compost material for application along state roads; thus producing ODOT compost could save landscape dollars.

Contact: Brian Newby, ODOT Landscape (503) 229-5304

Author's editorial comments[2]: Once trash is removed by screening, street sweepings with low level pollutants could be used to create compost. The use of select, screened street sweepings in the production of compost may be a viable, environmentally sound, and cost efficient waste

[2] Author's comments are provided by Mark Ghezzi, Principal Investigator for *ODOT Roadwaste Field Trials*.

management method. During this investigation we discovered only minimal migration of pollutants via stormwater. Natural breakdown of pollutants is expected with composting, but this was not documented during these trials. More testing and pollutant monitoring is needed. Because of limited pollutant migration, it seems possible that a sweepings/compost product could be used for landscaping purposes on select areas of ODOT right-of-way that have limited public access.

2.2 USE IN BERMS: ROCK FALL BERM AT ROCKY BUTTE

Introduction: During late spring of 1998, a landslide occurred along the I-205/I-84 interchange at Rocky Butte in Portland. Large boulders from the slide made their way down to the freeway, damaging the concrete barriers that had been set to protect the highway from rock fall. The potential for future landslides at Rocky Butte raised concerns about public safety. To protect the highway from future falling debris, the excess slide material and damaged concrete barriers were used to construct a protective safety berm adjacent to the highway. Roadwaste sweepings were then added to the berm to bulk up its size and make it large enough to withstand another large landslide.

The slide site located below Rocky Butte where this berm was placed is not accessible to the public and has no direct surface water flow to streams or wetlands. For these reasons this site was identified as an appropriate location to place roadwaste materials.

Goal/Purpose: Investigate pollutant remediation that might result from stockpiling roadwaste sweeping materials and observe any associated pollutant migration.

What we did: The Rocky Butte safety berm was bulked up using street sweepings collected by ODOT's East Portland maintenance crew. Sweepings were first screened to remove litter and trash and then mixed with or placed over the existing berm. After construction, the berm was planted with grass seed to control erosion. Random composite samples of the berm, adjacent soils, and runoff water were then collected and analyzed to track pollutant remediation and migration. Samples were collected over approximately a two-year time period. Composite samples were taken from three different random sites on the berm for every testing event. (For specific details regarding the study design and testing protocols, refer to the Rocky Butte Berm Study in Appendix A.)

What we found: The first composite sample was collected on July 1, 1998. Few contaminants were found above detection limits:

- Total Copper 28.00 ppm,
- Total Lead 40.00 ppm,
- Total Zinc 140 ppm,
- TCLP Copper 0.13 ppm,
- TCLP Zinc 2.30 ppm and
- Heavy Oil Range Hydrocarbons 2000 ppm.

Testing over the next two years detected various contaminants. Total Metals test results over the two-year period found the following average values:

- Arsenic 4.15 ppm,
- Chromium 42.85 ppm,
- Cadmium 1.20 ppm,
- Copper 35.96 ppm,
- Lead 65.53 ppm, and
- Zinc 176.38 ppm.

TCLP Lead and Cadmium were also detected, at low average levels of 0.02 ppm and 0.27 ppm, respectively. Polyaromatic Hydrocarbon (PAH) contamination was detected later, in subsequent tests. Heavy Oil Range Hydrocarbons appeared to be the only contaminant to have any significant reduction over the two-year period. Composite sampling techniques used were unable to capture consistent representative samples of the berm material. However, average sample values did yield valuable information.

Migration of contaminants via rainwater runoff was a concern. After rain events, water samples were taken to determine if pollutants were washed off the berm. Lab tests detected minimal stormwater pollutants in trace amounts including copper, lead, and zinc. Soils adjacent to the berm were also sampled for pollutant migration. Analytical values for Metals in these soils were in the range of naturally occurring background levels, but Heavy Oil Hydrocarbons on the front side of the berm were detected at 900 ppm. Maintenance and service equipment may have contaminated these soils during or after construction activities. Or soils could have been contaminated prior to the berm's placement, with pollutants originating from I-205 traffic. This heavy oil contamination was not detected on the back side of the berm, where soils could not have been exposed to pollutants prior to the landslide or berm construction. For a complete list of analytical data refer to Appendix B.

Did we reach our goal? The berm site allowed us to examine passive remediation of sweepings in stockpiles. We found reductions in simple hydrocarbon compounds. This is consistent with other roadwaste trial findings. We showed that minimal, if any, pollutant migration occurred. In addition, we were able to gain a better understanding of typical pollutant levels associated with roadwaste sweeping materials.

What would have improved our success? As can be seen from the data presented in Appendix B, far more sample results were needed to provide accurate pollutant characterization of the berm material. Taking more composite samples from more locations along the berm may have helped achieve this. Pollutant levels varied widely, and simple hydrocarbons were the only contaminant of concern that showed a statistically valid reduction in toxic levels over time.

Narrative review of project by maintenance personnel: This project was well received by maintenance personnel. The berm was easy to construct and environmental concerns easy to manage. The project used a large amount of roadwaste material, allowing for efficient handling and significant cost savings. ODOT crews around the state may have similar sites where they could place recycled streetwaste material for safety purposes. The East Portland crew would like to continue to have the option of placing roadwaste in right-of-way locations for safety purposes and passive remediation.

Contact: Randy Inloes, ODOT East Portland Maintenance Manager (503) 257-4339

Author's editorial comments: It is my opinion that the placement of roadwaste in designated right-of-way locations is a practice ODOT could reasonably pursue. However, placing roadwaste will require approval from environmental regulators. Evaluations should be made to determine environmental impact on a per-site basis, factoring in adjacent surface water, public contact, and characteristic pollutant levels of the roadwaste intended for placement. One placement technique that may be worth considering is capping contaminated materials with clay soils to better contain pollutants. Although encapsulation would retard oxidation and slow passive treatment, it could be appropriate at some locations.

2.3 AIR KNIFE SORTING: MEETING AT VANCE PIT

Introduction: By using precision-engineered air jets, air knives direct and utilize high-velocity air to separate and sort materials by weight or density. General Kinematics Corporation is a company that develops air knife industrial equipment that may be capable of sorting roadwaste into components of sand, silt, and organic debris. Sorting is a common practice in the waste management industry and can result in more efficient management and recycling of waste materials.

Goal/Purpose: Examine air jet technology as a means to sort the various solid waste components often found mixed in roadwaste.

What we did: In August 1999 sales representatives from General Kinematics met with investigators from the ODOT Roadwaste Research Project and members of the Multnomah County Road Maintenance Division. This meeting took place at Multnomah County's Vance Pit Maintenance Yard. Multnomah County was interested in sorting a large pile of old roadwaste debris at the yard for disposal and reuse. General Kinematics was hoping to demonstrate how air knife equipment could be used to sort street sweepings. During this meeting, however, the decision was made to cancel the air knife trials because the sweeping stockpile at the Vance yard was not suitable for air knife sorting.

Why it wouldn't work: The challenge was to separate over 20 years of accumulated waste generated by the Multnomah County Road Maintenance crews. The waste included sweepings, slide material, and a large variety of miscellaneous road debris. It was quickly apparent that the wide range of material present, all of different size, density, and consistency, would have made separating the waste with an air knife a long and costly process. The sheer volume and complexity of the material made air knife sorting unrealistic.

What would have made it work: Pre-screening of material to remove large rocks, debris, and trash may have made the air knife a more workable solution. Air knives are designed for sorting large volumes of material that have a fairly uniform consistency. Material components should have a small range in size but vary in density. This means air knives could be effective in sorting coarse road sand from fine silt and soil, or lightweight trash and leaves from otherwise clean sand, if material is somewhat uniform and dry.

Contacts: Don Newell, Multnomah County Roads Department (503) 248-3888
Frank Tucker, Sales Representative, General Kinematics Corporation (847) 381-2240

Author's editorial comments: The General Kinematics Air Knife has the potential to be an environmentally sound and effective device to sort select types of roadwaste material. For example, an air knife could possibly augment the current City of Portland method of washing street sandings and help reduce dirty water discharges. The air knife would not require the use of water and could still sort sanding material from fine silts and trash. Developing an air knife sorting system may require a large initial investment but would generate long-term cost savings, especially for ongoing recycling efforts like the City of Portland's sand and gravel recovery program.

2.4 STOCKPILE INVESTIGATIONS

Introduction: Characterizing pollutant loads for various types of roadwaste is very important in managing roadwaste in an efficient and cost effective manner. The majority of analytical data on roadwaste pollutant levels has been generated from roadwaste collected in large metropolitan areas from roads with high average daily traffic (ADT) counts. It is generally assumed that high-volume road systems generate higher pollutant levels than low-ADT roads.

Goals/Purpose: To determine pollutant levels typical of low-ADT roads by testing selected roadwaste stockpiles.

What we did: A list of roadwaste stockpiles that had been generated from low-traffic road systems was compiled, and six piles were selected for pollutant testing (Sandy Maintenance, Newberg-Bell Rd., Sweet Home Maintenance, Bend M.P. 135, Veneta Maintenance, and the Whiskey stockpile). Low-traffic roads were defined as less than 30,000 ADT. Composite samples were then taken from these sites. The samples were analyzed for Total Metals, TCLP Metals, TPH, and CPAHs – our "standard panel" of roadwaste pollutants.

What we found: TPH analysis conducted on all six sample locations showed non-detects for Gasoline and Diesel Range Hydrocarbons. Heavy Oil Range Hydrocarbons were detected but in small amounts. PAH analysis on five of the sites showed non-detects. The Bend site alone did have three detections for PAHs: Ideno(1,2,3-cd)pyrene (224 ppb), Phenanthrene (125 ppb), and Pyrene (130 ppb). Total Metal analysis on all six sample locations detected various low levels of arsenic, cadmium, chromium, copper, lead and zinc. TCLP Metals showed very low levels. TCLP Zinc was detected in trace amounts in four out of the six samples taken, but this may reflect local natural Zinc deposits. Trace amounts of chromium and lead were detected at the Sweet Home Maintenance Yard: 0.024 ppm and 0.221 ppm, respectively. For a complete list of analytical data refer to Appendix B.

Did we reach our goal? The analysis conducted on roadwaste from these low-ADT roads supports the theory that less pollutant loading will be observed on low-traffic road systems. The amount of data collected was minimal and is considered only a first attempt at characterizing pollutant levels associated with low-ADT roadwaste. More testing will be necessary to fully understand pollutant loading on low-traffic roads.

What would have improved our success? Increased tracking of roadwaste pollutant data and roadwaste origins will help ODOT better understand pollutant loading and how it relates to ADT. Tracking this information could potentially identify areas of high pollutant loading and lead to more efficient management and handling/disposal techniques. If roadwaste is determined to be more contaminated in one geographical region than another, wastes can be kept separate and managed appropriately.

Contacts: Jeff Moore, ODOT (503) 731-8289

Author's editorial comments: ODOT could centrally store all roadwaste pollutant data and track for a variety of parameters (ADT, concrete or asphalt road surface, adjacent land use, etc.). This data bank would help create a better understanding of roadwaste pollutants statewide and could yield substantial cost savings by reducing repetitive pollutant testing.

2.5 GENERAL FINDINGS ON SWEEPINGS

This section has focused on street sweepings management techniques and practices. The Rocky Butte Berm investigation and the compost investigation showed that minimal pollutant migration occurs from roadwaste via surface water movement. These findings agree with other roadwaste research projects and tests.

During the compost project we looked at ODOT Region 1's use of the "Reed Screen-All" to remove trash. It was confirmed that screening could have a large beneficial impact on managing roadwaste. Screening removes trash and litter and is the first step in cleaning sweepings for reuse. During the compost project we observed a 50% reduction in TPH levels after sweeping materials had been screened. It is suspected that screening aerates the sweeping debris, increasing natural microbial decomposition of petroleum and natural organic compounds.

In Section 2.3, we looked at use of an air knife to sort street sweepings. Although we were unable to test this technology, air knives may still be useful in managing winter road sand sweepings. An air knife can theoretically separate large sand particles from pulverized rock and silt, providing recycled sand for icy winter roads. This sorting can be accomplished without the use of water, eliminating the risk of discharging contaminated fines to surface waterways.

The Phase 2 field trials examined street sweepings for pollutant loads for over a two-year time period. Sweepings from both high- and low-ADT road systems were tested. High-ADT roads appear to be much more likely to generate contaminated sweepings, with TPH, Metals, and CPAHs being the main roadwaste pollutants of concern. Contaminant levels of these pollutants are consistently well below hazardous waste thresholds; however, they do occasionally exceed recommended industrial and residential pollutant cleanup levels, especially in roadwaste generated from high-traffic urban roadways.

Sorting sweepings for high and low pollutant levels could result in more efficient reuse and disposal of roadwaste materials. Sweepings from areas known for higher pollutant concentrations should be managed more conservatively, using treatment or disposal methods that will contain pollutants of concern. Less polluted sweepings could be handled under less conservative methods; reuse in designated projects such as safety berms or composting. Tracking and placement guidelines will likely be required in the management of contaminated sweepings, with lower contaminant levels triggering less stringent management strategies. Identification of clean roadwaste materials is also desirable. The City of Portland operates a clean-fill exchange program. Excess ODOT construction site soils, slide debris, and other clean-tested roadwaste material could go to this or other material exchange programs.

More roadwaste tests and negotiations with waste regulators will be necessary before ODOT can firmly define best management practices (BMPs) for composting or placing roadwaste materials. But these trials did indicate that these management methods are worth pursuing and could be both environmentally responsible and cost effective. It is expected that the information and data collected here will be valuable in negotiating and developing an effective ODOT roadwaste management program.

3.0 VACTOR WASTE MANAGEMENT

Vactor waste[3] consists of the mixed liquid and solid debris that is cleaned from highway stormwater catch basins and sumps. Unless a protective reuse is found for the mixed slurry, vactor waste must be separated into its liquid and solid components prior to disposal. Each waste must then be managed or disposed at an appropriate permitted waste disposal facility. This chapter considers separating the liquid and solid components of vactor waste and disposal management options.

3.1 FLOCCULANT STUDIES

3.1.1 Stage I – Identification of Potential Products

Introduction: There are many flocculants designed to separate solids from a liquid slurry, but few work well on the ODOT vactor waste generated from highway storm drains in the Portland urban area. ODOT's Portland vactor slurries typically contain a high proportion of clay particles. This waste requires a flocculant that will quickly aggregate fine soils, enabling them to settle to the bottom of a vactor truck or a holding container. Pollutants typically adhere to oppositely charged fine soil particles. If fine soils can be settled or separated from vactor liquid, many of the attached pollutants will also be captured or removed. This might allow for ready discharge of the remaining vactor liquids to a sanitary sewer.

Goal/Purpose: Identify flocculants that can increase separation rates of solid-liquid slurries in order to improve vactor waste treatment/disposal efficiencies.

What we did: This trial began with a literature search that identified commercial flocculants typically used for sewerage treatment and industrial wastewater operations. Flocculants were then selected for field trials based on their functionality, ease of adaptation to ODOT needs, cost, and environmental and worker safety. Finally, flocculant product samples were obtained and bench-scale tests were performed on ODOT eductor ("vactor") truck waste.

What we found: Our investigation identified many flocculant products developed for waste water treatment and industrial separation of bi/multi-component waste streams. Products were evaluated on their physical chemistry, HMIS[4] rating, effective dose (lb/kg waste), cost ($/lb) and ease of use. This evaluation narrowed the list down to five products appropriate for ODOT bench-scale tests:

(1) CP-100 Cationic Polymer form Environmental Solutions, Inc.,

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[3] "Vactor waste" is so named after a brand of eductor truck made by Vactor Manufacturing, Inc., commonly used to vacuum out catch basins, sumps and storm sewer lines.
[4] Hazardous Materials Identification System

(2) Chargepac from Ashland Chemical – Drew Industrial Division,
(3) VGT-2000 series from Delta Pollution Control, Inc.,
(4) Fiberfloc from Coastal Products & Chemicals, and
(5) Hydrofloc Polymer by Aqua Ben Corporation.

Testing was then conducted, adding the manufacture's recommended dose of flocculant to a sample of ODOT vactor slurry. The flocculants performed in a variety of ways, but most relied on electrostatic charges to function and were pH balance dependent. That is, many needed pH to be buffered or adjusted in order to perform to their maximum efficiency.

Our bench tests provided us with two types of observable flocculation. The first was an emulsification, in which the vactor slurry became cloudy, turbid and thick. Fine particles coagulated and became suspended in the liquid matrix. In order for these particles to be completely separated a second filtering step was needed, such as filtering through a screen or a belt press.

The second type of flocculation was seen only with Delta Pollution Control's VGT–2000 polymers and was much more dramatic. With mixing, large particles resembling flakes in a Christmas snow globe congealed out of the slurry. With time, these particles settled out of suspension, leaving a clear separation between liquids and solids. This flocculant was also able to trap motor oil in the settled solid fraction, leaving an upper liquid or water portion of the sample that appeared very clear. Based on these findings, the VGT-2000 series product line became the main focus of our flocculant studies.

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Chris Johnson, Ashland Chemical – Drew Industrial Division (360) 951-5950
Stuart Lindor, Delta Pollution Control, Inc. (425) 222-4544
Audris Steinkampf, Coastal Products and Chemicals (713) 658-9000
Jeff Wallace, Aqua Ben Corporation (714) 771-6040

Author's editorial comments: A flocculant product capable of separating a vactor slurry of water and soil via gravitational forces seemed most appropriate for ODOT's needs.

3.1.2 Stage II – ODOT/City of Portland Flocculant Trials

Introduction: City of Portland partnered with ODOT in the following flocculant investigations.

Goals/Purpose: Investigate the efficiency of selected flocculants in removing total suspended solids (TSS) from vactor effluent. Determine if TSS removal reduces effluent lead levels.

What we did: On February 2, 2000, ODOT, Oregon DEQ and the City of Portland ran field trials on four flocculants, comparing how efficient they were in removing TSS from vactor decant water. The four flocculants tested were:

(1) CIBA Percol 798 (the flocculant used at Portland's Columbia Wastewater Treatment Plant),
(2) Flo Trend 600-L polymer,

(3) magnesium hydroxide suspension (ordinary Milk of Magnesia), and
(4) VGT-2000 series polymers.

Trials were run on vactor effluent held in a large settling tanks at City of Portland's Inverness vactor decant treatment facility. For each of the four products tested, two volumetric ounces of flocculant were added to a sample of vactor effluent in a 5-gallon bucket. Flocculants were mixed thoroughly and adequate contact time allowed for polymers to take effect. Pre- and post-treatment samples were taken for data analysis.

A secondary trial was conducted using the VGT-2000 product. For this trial, an additional 20 oz (570 g) of soil from the dewatering pad was added to determine if the flocculant could effectively treat an increased soil-to-water ratio. A sample of the added soil material was analyzed to determine baseline contaminants.

What we found: The Flo Trend product and CIBA Percol 798 created a very slimy liquid. These products coagulated fine particles, but samples would have required another filtration step to remove suspended particles.

The magnesium hydroxide suspension did not have any observable effect on the sample.

The VGT-2000 series product worked very effectively. All suspended solids appeared to congeal and settle to the bottom of the sample bucket after mixing. The secondary trial yielded similar results. Even with the increased soil load, VGT-2000 still performed the same. The only difference between the initial trial and secondary trial of this product was an increase in mixing time to allow the flocculant to work effectively.

Data analysis established a baseline of contaminants in the buckets prior to treatment:

- Arsenic 0.00222 mg/l,
- Cadmium 0.00144mg/l,
- Chromium 0.0104 mg/l, and
- Lead 0.545 mg/l.

The Flo Trend polymer, the magnesium hydroxide, and the CIBA Percol 798, had negligible effects in reducing the contaminant level in the liquid fraction. The VGT-2000 series product yielded an 82.4% reduction in Chromium levels and an 81.1% reduction in lead levels. Arsenic and Cadmium levels were not detected in VGT-2000 sediment, which was not surprising considering their low baseline contaminant levels.

The secondary trial yielded very strong analytical results. Analysis of the 20 ounces of additional soil added to the sample showed it to contain the following contaminants:

- Arsenic 5.75 mg/kg,
- Chromium 18.4 mg/kg and
- Lead 591mg/kg.

Adding this soil to the vactor effluent sample significantly increased the baseline contaminant levels of arsenic to 0.0151 mg/l and lead to 2.26 mg/l.

After treatment with VGT-2000, the contaminants in the effluent liquid were dramatically reduced. Arsenic was reduced by 78%, cadmium by greater than 85%, chromium by 97% and lead by 99.5%. The overall Total Suspended Solids removed in this secondary trial was greater than 99.8% from a base line of 5450 mg/l to non-detect with a reporting limit of 10mg/l. (For complete vactor waste study data refer to Appendix C.)

Did we reach our goal? Although only one product proved workable, a lot of quality information was gained regarding flocculant use in this trial. A flocculant able to efficiently reduce TSS through gravitational settling could prove to be very cost effective for treating this vactor effluent. The importance of mixing was also emphasized. Good mixing must be achieved to maximize the efficiency of any flocculant. Data from the second trial showed a strong relationship between the removal of Total Suspended Solids and Total Metal contamination.

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3.1.3 Stage III – Field trial of VGT-2000 series flocculant

Introduction: During Stages I and II, VGT-2000 products stood out in their ability to physically separate the soil and liquid portions of vactor waste and to reduce liquid pollutant levels. VGT-2000 products are designed by Delta Pollution Control, an environmental company that designs turnkey systems to separate solids from liquids for various water treatment and by-product industrial operations. The chemical polymers they produce are the basis of their systems.

VGT-2000 products were first used to treat highway vactor waste by Snohomish County in northwestern Washington. Delta worked with Snohomish County to produce a "fish-friendly" flocculant that could remove pollutants from highway vactor water, in hopes that this would allow water discharges from vactor trucks to storm drains in outlying rural areas. From the experience gained from the Stage I and II investigation and the discussions with Delta and Snohomish County, ODOT research developed a pilot project to test VGT-2000 in ODOT vactor trucks.

Goals/Purpose: Test VGT-2000 for liquid/solid separation in ODOT vactor trucks and for reducing pollutant loads in vactor liquids.

What we did: Both the Baldock Maintenance Yard and the East Portland Maintenance Yard participated in this study. Baldock vactor operators were the first ODOT crew to try the Delta VGT-2000 product and focused on how to introduce the flocculant into the vactor trucks in a way that ensured proper mixing. VGT-2000 was sucked both wet and dry up through the vactor truck hose. Flocculant was also placed directly into a catch basin prior to cleaning. This approach allowed mixing to occur as waste was cleaned from the catch basin and sucked into the vactor.

Investigations with East Portland Maintenance Yard focused on quantifying the effects of flocculant on pollutant levels in pre/post treated vactor waste. This part of the investigation was conducted along with a mobile retention pond field trial (see Section 3.2). Flocculant was added to vactor trucks prior to dumping their slurry loads into a temporary holding pond. Samples were taken before the addition of the flocculant and afterward. Post-flocculation samples were taken out of the back-gate decant valve, from splash captured when the tank's back gate was opened, or directly out of the receiving holding pond.

What we found: When flocculant was added dry to the vactor through the suction hose, it would often cake on the waste tank's rear gate latch and mixing would not occur. To address this problem, the crew tried mixing the flocculant with water prior to sucking it into the vactor hose. While this did help, the VGT-2000 did not always dissolve completely and caking on the latch still occurred. Mixing with water also added a work step to vactor operations. Adding VGT-2000 gradually to the truck by mixing it directly with material to be cleaned from the catch basin seemed to work best.

Visual observations of the effects of the flocculant were difficult without the use of the rear tank valve, which was often plugged. Occasionally, we could observe clean decant water followed by dark water when the rear gate was opened for dumping. But the explosive movement of water from the gate when it was opened usually masked any separation effects the flocculant may have had on the vactor load. This brought us to investigate the use of a decant pond with East Portland.

Investigations with the East Portland crew showed that water from flocculated loads of vactor waste did have reduced pollutant levels compared to non-flocculated loads. Increased settling time for flocculated slurries also helped to reduce pollutant levels. However, reductions were not of the same magnitude as seen in our other Flocculant Studies (Sections 3.1.1 and 3.1.2) nor what we saw in the Mechanical Mixing Study (Section 3.5). (For complete study data refer to Appendix C.)

Did we reach our goal? We were able to view and verify analytically the positive effects of the VGT-2000 flocculant. But because we were unable to achieve good mixing of the VGT-2000 in the vactor slurry, we were not able to observe this product working as efficiently as we had seen in earlier bench tests.

What would have improved our success? Having the ability to decant water from a vactor truck decant valve is critical. The back valve on the ODOT vactor trucks was usually clogged with caked VGT-2000 or debris. The addition of a deflection shield might help keep this valve clear. Most important is achieving adequate mixing inside the truck's holding tank; this would dramatically increase the effectiveness of the flocculant. Increased agitation during transport or continuous injection of flocculant during vactor operations might improve mixing. (See Section 3.6 for vactor truck retrofit ideas.)

Narrative review by maintenance personnel: ODOT vactor operators' main concern with this product was that additional handling could slow catch basin cleaning operations. If the flocculant could ultimately save time by reducing haul or disposal time, maintenance would be willing to support further efforts to develop use of this product.

Snohomish County is very pleased with the performance of VGT-2000. It takes time to haul vactor slurries cleaned from storm systems back to the County's vactor waste management facility. Flocculating in the truck allows the liquid portion of the vactor load to be decanted to a sewer system while the truck is still in the field. This reduces the vactor truck load and saves on haul time. Snohomish County's goal is to eventually clean vactor truck effluent to the point where it can be discharged directly back to storm sewers. This would essentially allow field decanting of vactor liquids anywhere in the County.

Information on Snohomish County's work with Delta Pollution Control in developing this polymer and their field trials can be found in **Roadwaste: Issues and Options** (*Collins 1998*), and in a report published jointly by Snohomish County and Delta Pollution Control.

Contacts: Bill Miller, ODOT Baldock Maintenance Manager (503) 229-5303
Dave Millican, ODOT North Portland Maintenance Manager (503) 283-5810
Randy Inloes, ODOT East Portland Maintenance Manager (503) 257-4339

Author's editorial comments: The VGT-2000 flocculant is a very powerful product and has the capability to efficiently remove pollutants from vactor liquids. More work is needed to further investigate field methods that would allow ODOT to use this product effectively. High water-to-soil ratios should allow for more complete mixing of the flocculant in the vactor holding tank. With some standard maintenance operations, such as bridge washing, it may be possible to adequately mix the flocculant by simply adding it to the vactor holding tank.

3.2 DEWATER POND STUDY: EAST PORTLAND MAINTENANCE YARD

Introduction: Containment is the first step in managing vactor waste unloaded from a truck. In this study, we examined the use of a mobile pond to contain vactor slurry. The pond was composed of lightweight plastic units shaped like standard concrete barriers. The units could be hooked together, made water tight, and weighted with water. Environmental Barricades manufactures the mobile barricades and supplied them free of charge for this trial. The mobile pond served as a cheap method to confine vactor waste and was easy to move and store.

Goals/Purpose: Investigate the use of the mobile pond for temporary and/or field applications to contain vactor waste. Observe separation of water and soil fractions of flocculated loads.

What we did: The mobile pond was constructed and the fitted units filled with water. Water tight seals were installed between the plastic units to prevent the sides of the pond from leaking. The bottom of the pond was not sealed, but a one foot thick layer of soil and rock was placed around the base of the pond units. This layer was to prevent the bottom edge of the pond from leaking yet still allow for liquid infiltration. Flocculated vactor loads were then dumped into the pond.

As described earlier (Section 3.1.3) Delta Pollution Control manufactures both a "fish-friendly" flocculant (VGT-2002) and a somewhat more efficient "non-fish-friendly" (VGT-2000) flocculant product. The initial vactor loads analyzed in this trial were treated with fish-friendly VGT-2002. Later loads were treated with VGT-2000. We saw only a marginal difference between the two flocculant products during this trial.

What we found: The pond was easy to install and maintain, and it adequately contained the solid components of our vactor waste. Liquids, however, were able to escape from the pond in two ways: water would percolate into the ground below the pond (this was the intended method of dewatering); or water would seep under the barriers onto the surrounding surface (this was an installation flaw). If more time were spent sealing the bottom of the mobile units, it is likely we would have prevented any leakage.

Even with some loss, the pond was able to contain a large amount of liquid. But the high rate of liquid leaving the pond did not allow for proper settling. The channeling and movement of water kept particles in movement, making it hard to determine the effectiveness of the flocculant. Once flocculated samples were removed from the pond, settling occurred in the sample bottles before they were dropped off at the lab for analysis. This settling was attributed to the effects of the flocculant. (For complete study data refer to Appendix C.)

Did we reach our goal? Even though the pond did not completely contain vactor liquids, with proper installation and construction it seems this would have been possible. The second goal of observing liquid/solid separation was not achieved.

What would have improved our success? Properly sealing the bottom and/or lining the pond with an impermeable barrier may have helped the pond function more efficiently and allowed more efficient settling of flocculated soils.

Narrative review by maintenance personnel: The East Portland maintenance crew felt the mobile decant pond may be useful for some of their operations. However, the pond did not fit their normal vactor needs because it was not durable enough to stand up to daily use. They felt this pond would be more suitable in rural areas that had low levels of vactor service.

Contacts: Randy Inloes, East Portland Maintenance Manager (503) 257-4339
Mike McKinney, Environmental Barricades (503) 637-6860

Author's editorial comments: The mobile pond could not withstand the daily vactor use of the East Portland crew. During the week-long trial, several components sustained damage. However, the ponds might be efficiently used on the east side of the state where annual vactoring activities may only last several weeks. Dewatering by evaporation may be possible during the summer months. Ground infiltration is also appropriate if water pollutant levels are low. Further mobile pond testing could be considered for small eastern towns or rural situations.

3.3 UNIFIED SEWERAGE AGENCY (USA) FIELD DECANT TRIAL

Introduction: This section discusses a pilot project in which ODOT attempted to share the use of a vactor field decant facility owned by the Unified Sewerage Agency and operated by the City of Tualatin. Shared waste disposal facilities can save time and money. They can reduce travel and haul time and allow agencies to share roadwaste disposal costs and equipment. This project has identified a number of waste management partnering opportunities ODOT could pursue. In Section 4.1 we list existing waste management facilities in Oregon and cite those currently being used as shared facilities. Chapter 5 discusses shared use of roadwaste management facilities.

Goals/Purpose: Determine if ODOT vactor trucks can dewater to sanitary sewers and/or dump loads of vactor waste at shared facilities to reduce travel and haul time and maximize waste management efficiencies. It was also hoped that field decanting might help ODOT address the issue of weight restrictions. Vactor trucks normally exceed weight restrictions, a source of concern for public safety and highway degradation.

What we did: An agreement was reached between USA, the City of Tualatin, and ODOT that allowed ODOT use of the Tualatin vactor dewatering facility. Representatives from USA requested ODOT to characterize the effluent that would be discharged into their system. In addition, the City of Tualatin requested that ODOT crews haul and dispose of their solid waste if slurry was dewatered on site. ODOT presented a waste characterization to USA and a green light was given to use the facility. Unfortunately, ODOT was unable to follow through with its use of this facility because of equipment limitations.

Why it didn't work: ODOT vactor trucks can not pump or discharge only the liquid portion from the top of their waste tank like some other vactor trucks. To dump any portion requires that the trucks back gate be opened. This means vactor slurry will be discharged and ODOT would have been required to haul and dispose of the wet solids. Managing and handling vactor slurry solids at the Tualatin facility would not have been practical.

What would have made it work: Having the ability to effectively decant water off the top of the load would have made this trial possible. See Vactor Truck Design Options (Section 3.6) for more information on this topic.

Narrative review by maintenance personnel: Baldock Maintenance crews would like to have the option of using shared facilities when far away from their maintenance yard. This would decrease transit time and increase productivity. Baldock vactor truck operators found their larger vactor trucks difficult to move in the space provided at the Tualatin decant facility. The lack of a clean decant method combined with the tight operating space left them without the simple in/out operation they had hoped for in this shared facility.

Contacts: Dan Gibson, City Of Tualatin Maintenance Manager (503) 692-2000
Chris Bowles, USA Representative (503) 681-7023
Bill Miller, ODOT Baldock Maintenance Manager (503) 229-5303
Jeff Moore, ODOT (503) 731-8289

Author's editorial comments: The decision to suspend this trial until efficient decanting of water from ODOT vactor trucks can be achieved was a smart call. Equipment or operating modifications will need to be made before ODOT can discharge vactor liquids to the Tualatin facility. However, shared dewatering facilities should not be eliminated as a vactor waste management option. They still can offer real cost savings and may help address concerns such as haul time and weight restrictions. In siting or choosing facilities, however, ODOT will have to consider many factors, including such things as physical operations, cost, agreements, location, road conditions, and neighborhood impacts.

3.4 DEWATERING BOX TRIALS

3.4.1 Stage I – Identification of Potential Products

Introduction: This study focused on the use of mobile dewatering boxes. These boxes are similar to those typically used to haul industrial trash but are designed to hold and drain wet materials. Vactor waste can be dumped into a box, the liquids drained to a sanitary sewer, and remaining solids hauled to a solid waste facility. These boxes could be located close to vactor work zones, reducing haul time and increasing waste disposal efficiencies.

What we did: An investigation was conducted to identify mobile dewatering containers currently on the market. Containers were evaluated on ease of use, design, ease in hauling, cost, and other factors.

What we found: Two likely containers were identified:

Baker Tanks has a large industrial box fitted with a perforated liner and air spurging lines. The box is designed for hauling with a roll-off truck. The perforated liner consists of a metal sheet drilled with small holes and sits in the floor of the box above the spurge lines. This liner acts as filter screen, capturing solids and allowing liquids to pass. The underlying spurge line can be used to force air up through the perforated liner if holes plug during the dewatering process.

Flo Trend also has a variety of different sizes and styles of dewatering boxes. They range from large roll-off style boxes to small self-dumping containers that can be easily moved around by a forklift. These containers have fine metal mesh filter screens, lining both the bottom and sides of the box, to filter liquid from wet material. Both Baker and Flo Trend boxes have bottom port drains for liquid extraction and can be fitted with a vacuum pump to assist with dewatering.

PACTEC, Inc. also produces a filter fabric and structural plastic matrix liner that can be used as an insert to convert any heavy materials transport box into a filter dewatering box (not yet tested).

Contacts: Marvin Hurt, Baker Tanks Sales Representative (503) 775-7211
Gary Skinner, Flo Trend Sales Representative (800) 762-9893
Matthew Davidson, Antec Corporation (representative for PACTEC) (425) 888-9090

Author's editorial comments: Close attention must be paid to box design. Almost all the boxes considered had sides too high to allow for direct dumping from the vactor truck into the box. Most dewatering boxes will also easily plug with fines and can easily turn into stagnant pools. Flocculants may help address this issue by increasing particle sizes and improving the porosity of solids that settle to the bottom of the box.

3.4.2 Stage II – Trial of Potential Products at City of Portland Inverness Facility

Introduction: Stage I of the trial study provided two possible dewatering box options for field trials. The City of Portland Sewage Treatment Division had recently purchased one of the Flo Trend boxes for its own dewatering operations. City of Portland maintenance crews borrowed the box to run a field trial with their vactor waste.

Goal/Purpose: Investigate the efficiency of the Flo Trend dewatering box in separating water/soil from stormwater system residuals (flocculated and un-flocculated).

What we did: The City of Portland maintenance crew relocated the dewatering box to the Inverness decant facility. Vactor crews from the City of Portland filled the box with their normal run of un-flocculated material. It took only two vactor loads to fill the box. The box confined the material well but the waste did not dewater as fast as was hoped. It took 23 days before the material could pass a paint filter test. Clogged filter screens slowed dewatering.

Filter box dewatering time was similar or improved over standard City of Portland dewatering practices where vactor waste is dewatered on a concrete pad. Unfortunately, the Flo Trend box was scheduled for retrofitting by the City's sewerage staff, and we did not have time to conduct another trial on flocculated material.

What we found: The fines in the un-flocculated slurry plugged the mesh filter in the bottom of the box. In Section 3.5, we present our examination of a Flo Trend box lined with a 50 micron mesh filter that was successfully used to dewater flocculated vactor material. We believe that if we could properly flocculate, the vactor waste would not plug the metal mesh filter in this box.

Did we reach our goal? Our attempts to dewater raw vactor material in the boxes were only marginally successful. Future testing of flocculated vactor waste will help to determine whether dewatering boxes are cost effective for managing this waste.

What would have improved our success? Conducting these trials using flocculated vactor loads would have answered questions regarding efficiency and cost. Adequate mixing is crucial to the successful use of flocculant and will be an issue during any future trials.

Contacts: Katie Bretsch, City of Portland (503) 823-4390

Author's editorial comments: It is doubtful these boxes could be efficiently used as widespread mobile dewatering stations in the field. The boxes are expensive and require hauling. To tip a vactor load into a box can be difficult and messy and may require adjustments to allow the vactor gate to clear the high walls of the box. The boxes only hold two truckloads of vactor waste. Flocculant will likely be required to make these boxes drain efficiently. Still, in certain situations, these boxes could augment dewatering activities. The City of Seattle relies on dewatering boxes as part of their normal vactor waste management operations.

3.5 MECHANICAL MIXING DEVICE INVESTIGATION

Introduction: The flocculant study showed that mixing is critical in using VGT-2000 products. The more solids the polymer mixes with, the more particles it can entrap, allowing it to create larger and heavier particles that will fall out of solution. In Stage III of the flocculant study (Section 3.1.3) and in the City of Portland settling tank study (Section 3.7) we observed that inadequate mixing limited flocculant efficiency. Knowing this, we wanted to improve flocculant mixing and see if this would improve separation rates.

Goal/Purpose: Maximize separation efficiency of the VGT-2000 series flocculant on a large scale in a field trial, with consideration to future handling, management and disposal of eductor truck material.

What we did: Arrangements were made with Stuart Lindor from Delta Pollution Control, Inc., to bring two pieces of mixing equipment to the City of Portland Inverness Facility. The first was a large 350-400 gallon (1,300-1,500 L) cone-shaped vessel equipped with a bladed mechanical mixer similar to a small electric boat motor. The cone shaped vessel was designed with decant valves to direct effluent flow from the bottom in two directions. One effluent line went to a filter bag and the other line to a small 2.5 yd^3 (1.9 m^3) Flo Trend box. This particular Flo Trend box was not designed for decanting, so we lined it with 50-micron filter paper to simulate a dewatering box.

The second mixer was a smaller, 25 gallon (95 L) vessel, also equipped with a bladed motor. This device had only one valve located on the bottom that directed effluent to a filter bag. Trials with the flocculant were run once in each vessel to examine mixing and separation efficiencies.

We pumped standing water off the top of the Inverness decant pad into the large vessel and allowed it to mix a few minutes. This ensured a well-mixed, uniform liquid, prior to adding any flocculant. A sample was then taken to establish a baseline analysis for the untreated slurry.

Approximately two cups of flocculant were added and mixed for about one minute. We observed the flocculant changing the physical characteristics of the liquid. The valves were opened, and the effluent was drained to the filter bag and the dewatering box. Samples were taken from these outflow points for later analysis. Both samples were extremely clear.

The second trial was conducted in the smaller vessel. The second test was an attempt to see how the product worked with a heavy loading of solids. Once again we pumped standing water off the top of the decant pad and filled the vessel about 2/3 full. We then added eight shovels of solid material from the decant pad to the vessel. This created a thicker slurry/sludge, similar in texture to thick pancake batter. A representative sample of the solid material from the pad was taken for analysis. The small vessel was allowed to mix for a few minutes to ensure a uniform slurry. A sample was then taken to set baseline analysis levels.

One cup of flocculant was added to the vessel and mixed for approximately one minute. The change observed was not as noticeable as in our first trial; however a slight change in the consistency of the sludge was noted. A few air bubbles percolated up from the bottom of the mixer and the sample acquired a more grainy texture. In this trial, there was no observable separation of liquid and solid layers. We turned the valve on the bottom of the vessel to allow the effluent to pass down into the filter bag and obtained a sample. Once again, we had good flow and achieved a surprisingly clear sample, free of particulate matter.

What we found: Data analysis performed on our samples was kept simple. Our first focus was to determine if adequate mixing would maximize the efficiency of the flocculant and separate a large volume of vactor slurry into liquid and solid components. Our second focus was to see if we could reduce lead levels in the liquid fraction. This would allow ready disposal to the City's sanitary sewer. (For complete study data refer to Appendix C.)

<u>Separation of Liquid and Solid Components</u>

The analysis of the solids loading in the liquid fraction of the waste stream showed:

- In the pre-flocculated sample the large vessel had 69,200 mg/kg in Total Solids, and
- 51,400 mg/l Total Suspended Solids.

This was a sample of water pumped off the top of the decant pad into the large vessel and mixed thoroughly before flocculant was added. After flocculation and mixing, two post-flocculation samples were collected and analyzed. The effluent sample that passed through the filter bag had:

- 488 mg/kg Total Solids, and
- 42.0mg/l Total Suspended Solids.

The reduction was 99.1% in Total Solids and 99.9% in Total Suspended Solids.

The effluent sample that passed through the filter box had:

- 3,550 mg/kg Total Solids and
- 2,330 mg/l Total Suspended Solids.

The reduction was 94.9% in Total Solids and 95.5% in Total Suspended Solids.

Although the reduction in solids for the filter box looks good, they could be better or worse if we had used an actual Flo Trend dewatering box for this trial.

In the small vessel we had a higher proportion of solids. Remember for this trial, we not only took liquid off the vactor dewatering pad, but we also added extra soil to make a thicker slurry. The sample of extra soil added from the pad had:

- 589,000mg/kg Total Solids, consisting of 61.8% soil and 38.2% water.

In the small vessel we had a baseline of:

- 167,000 mg/kg Total Solids and
- 161,000mg/l Total Suspended Solids.

The Total Solids and Total Suspended Solids loading in the small vessel were 2.4 and 3.1 times, respectively, greater than that of the large vessel.

Post-flocculation, the effluent passed through the filter bag had:

- 920mg/kg Total Solids and
- 34.0mg/l Total Suspended Solids.

The reduction was 99.4% in Total Solids and 99.98% in Total Suspended Solids. From this finding, it appears that the flocculant works effectively even with heavier loading, as long as adequate mixing occurs.

Reduction of Lead

All samples were analyzed for both Total Lead and TCLP Lead. Discharge requirements for the City of Portland Inverness facility are based upon Total Lead standards. The results published by our lab show the analyte (in this case Total Lead) to be Not Detected (ND) with reporting limits set at 0.200 mg/l.

In the large vessel, we had a baseline of 8.54 mg/kg Total Lead. The effluent sample that passed through the filter bag had 0.0102 mg/kg Total Lead. The reduction was 99.9% in Total Lead. The effluent that passed through the filter box had 0.358 mg/kg Total Lead. The reduction was 95.8% in Total Lead.

In the small vessel we had a baseline of 23.9 mg/kg Total Lead. The effluent passed through the filter bag had a result of Not Detected (ND) for the sample with a reporting limit of 0.00500 mg/kg. This result shows a reduction in Total Lead greater than 99.98%. (Note: the representative sample of the solid material from the decant pad added to the small vessel had 85.5 mg/kg Total Lead.)

Did we reach our goal? We did achieve our primary goal for this investigation. We confirmed that large volumes of vactor slurry could be separated into liquid and solid components, provided there is adequate mixing of VGT-2000. We were also able to see a correlation between lead levels and Total Suspended Solids. Reducing TSS in vactor effluent reduced effluent lead levels, which allows for discharge to the sanitary sewer.

Narrative review by maintenance personnel: Maintenance personnel have seen many demonstrations and trials using flocculants. They have observed the capability of the VGT-2000 product and how it may be used to treat vactor waste. Maintenance personnel are very interested in the use of this product, but more work is needed to understand how to use it to improve their vactor operations. Cost of flocculant is also a big maintenance concern. It is not clear yet if treatment of vactor waste with flocculant would be cost effective. Maintenance personnel would like to meet with Delta Pollution Control to discuss how this product could be most efficiently used.

Contacts: Stuart Lindor, Delta Pollution Control, Inc. (425) 222-4544
Katie Bretsch, City of Portland (503) 823-4390
Jeff Moore, ODOT (503) 731-8289

Author's editorial comments: The VGT-2000 product provided by Delta Pollution Control has proven its ability to separate vactor liquids and solids in several trials, but achieving adequate mixing can be difficult. It might be helpful to further discuss use of VGT-2000 with representatives from Delta Pollution Control and Snohomish County, to determine how the product can be best used to improve ODOT vactor operations.

3.6 EDUCTOR TRUCK DESIGN AND RETROFIT OPTIONS

Introduction: The design of ODOT's eductor trucks can limit vactor waste management options. Retrofitting trucks could allow for easier field decanting or flocculant mixing. This study investigated possible retrofits to ODOT Vactor trucks. [5]

Goal/Purpose: Investigate options to retrofit ODOT eductor trucks in order to maximize efficiency of soil/water separation and fleet operations.

What we did: We discussed possible retrofits to ODOT's Vactor 2000 equipment with Peabody-Myers and BEN-KO-MATIC.

What we found: Deflection shields could be installed that would help keep the vactor tank's dewatering valve clear. Currently, the trucks are dewatered through a simple six-inch (150 mm) port opening with a valve that is covered by a large screen; the valve often clogs during routine maintenance activities.

Trash pumps can be installed inside the Vactor debris reservoirs that could pump liquid off the top of the tank. On August 26, 1998, BEN-KO-MATIC quoted a price of $6,100 to install a trash pump on a specific truck in the ODOT fleet. Prices may vary with vehicle model and pump equipment.

Various polymer injection units are available that would allow efficient flocculant mixing directly in the vactor truck's tank. Discussions have taken place with both BEN-KO-MATIC and Flo Trend Systems, Inc. regarding polymer injection units with an estimated cost of $5,000 per vehicle. These units would mix flocculant more efficiently than simply adding the flocculant through the debris inlet.

[5] Vactor truck by Peabody-Meyers: Retrofit Design Options

Narrative review by maintenance personnel: ODOT Maintenance's largest complaint regarding ODOT vactor trucks is the inability to decant water from the back tank due to clogging of the decant valve.

Contacts: Jim Lowe, BEN-KO-MATIC Sales/Service (503) 255-9055

Author's editorial comments: Retrofits to trucks and possible changes to vactor operations could be discussed following this research project. ODOT Maintenance will need to determine what type of vactor waste management techniques they wish to pursue before vactor truck retrofits can be made.

3.7 SETTLING TANK TRIAL: CITY OF PORTLAND

Introduction: The City of Portland Inverness Decant Facility is required to meet Total Lead batch discharge requirements set for the City's sanitary sewer system. Because Inverness discharges vactor effluent to the City's sanitary sewer, vactor effluent lead levels at the facility are continually monitored. The City has recently observed an increase in Total Lead in their vactor effluent. In this trial we tried using VGT-2000 to reduce these lead (Pb) levels.

Goal/Purpose: Examine whether Delta Pollution Inc. VGT-2000 series flocculant can remove Total Suspended Solids from the Inverness vactor effluent settling tank and reduce lead levels to meet sewage discharge requirements.

What we did: Two separate attempts were made to flocculate the contents of the large vactor effluent settling tank at Inverness. For the first attempt we added nine gallons (34 L) of flocculant to the holding tank and then used a large trash pump to circulate its contents. For the second attempt, we added approximately 30 gallons (114 L) of flocculant and used two large trash pumps to mix the tank's contents.

What we found: Both attempts failed to flocculate the effluent held in the large settling tank. However, in the second attempt, we could see that liquid and solid separation was starting to occur. Using increased pump circulation and additional flocculant in this trial did seem to be more effective. Test samples were taken from untreated liquids. Post-test samples were not taken because flocculation did not appear successful.

What would have improved our success? The volume of the tank is now known to be less than half of what we thought it was when we estimated the flocculant application rates for this trial. Knowing this, the amount of flocculant used for the second trial should have been more than adequate to separate liquids and solids. The problem was probably a matter of mixing. It is not clear that sufficient mixing was ever achieved during this trial.

The amount of suspended sediment in the effluent used for these trials was also very low. Total Suspended Solids were typically below 40 mg/L. The effectiveness of VGT-2000 may be somewhat dependent on TSS levels, so these low levels could have also inhibited separation.

Contacts: Katie Bretsch, City of Portland (503) 823-4390

Author's editorial comments: VGT-2000 is capable of treating the effluent held in the Inverness Facility Settling Tank. With the tank's high volume and complex shape, however, even two large trash pumps could not achieve adequate mixing. The Inverness facility may benefit from a polymer injection treatment system that could mix flocculant with effluent prior to it reaching the tank. This type of treatment could eliminate the need for such a large settling tank system.

3.8 CORE TESTING OF SEDIMENT SUMPS: CITY OF PORTLAND

Introduction: As discussed in the previous section, the Inverness Dewatering Facility has recently seen an increase in Total Lead levels in its vactor effluent. This increase in lead levels seems to coincide with efforts by the City to clean and maintain some of the longest neglected and dirtiest sumps in the City's storm drain system. Many of these old sumps have not been cleaned since the use of leaded gasoline was banned in the 1980s. If a correlation between age of sump waste and lead levels can be demonstrated, it could help the City develop waste management techniques for this special waste stream. This project has not yet been completed and additional sampling and testing is planned for the summer and fall of 2001.

Goals/Purpose: Test the stratified layers of sump deposits to determine if lead contamination can be tied to older stratified layers. Determine if Total Lead levels are substantially higher in sediments dating from the leaded gasoline era.

What we did: Sixteen core samples were extracted from old undisturbed sumps on the east side of Portland. Top and bottom layers were tested for Total Lead and exotic pollutants. This investigation focused only on Total Lead levels.

What we found: Core sampling proved more difficult than originally thought. Material in the sumps had a very soft and wet consistency, making it difficult to obtain continuous core samples. Of the 16 core samples collected, only half produced viable samples for analysis. A final report by the City of Portland on this investigation is pending.

The preliminary data available showed seven of eight samples with heavier loading of Total Lead in the bottom sump stratum compared to the top. In these seven sumps, Total Lead levels from the bottom stratum ranged from 3.7 - 7.2 times higher than the Total Lead levels found in the top stratum. The eighth sump showed the opposite result, with a concentration of Total Lead in the top stratum 3.6 times higher than that of the bottom stratum.

Did we reach our goal? Overall, we were able to successfully identify higher Total Lead concentrations in the bottom stratum of older sumps compared to the top layer. Due to sampling difficulties, however, we were unable to estimate the dates of the strata and determine if Total Lead levels were related to the phase-out of leaded gasoline.

What would have improved our success? Using alternative sampling techniques to capture samples from intermediate strata levels may have improved results. Continuous sampling from the top to the bottom of the sump may yield data that has a stronger correlation between Total

Lead and the age of the sump sediments. This project is not complete. Additional sampling and testing is planned. The City of Portland will prepare a separate report when the project is finished.

Contact: Katie Bretsch, City of Portland (503) 823-4390

Author's editorial comments: The sump core study by the City of Portland proved to be a very worthwhile investigation. The results yielded a strong relationship between old and new deposits of lead in sump basins. The information could lead to special management of older sump deposits. If future core testing shows similar relationships with other pollutants, I would suggest alternative sampling techniques in order to obtain more discrete samples at different depths. Obtaining data that are more precise would help to better define pollutant trends.

3.9 HIGH-ADT RETENTION POND STUDY: ODOT I-84 PONDS

Introduction: ODOT owns and operates a number of ponds in the Portland metropolitan area that are designed to collect and retain highway stormwater runoff from urban freeways. These ponds also trap highway sediments and pollutants that ODOT must routinely remove and dispose. Toxic contaminants can be a concern, and characterization of pollutant levels is required to determine proper handling and disposal methods for this waste.

Goals/Purpose: Determine typical pollutant loads for sediment collected from urban freeway stormwater settling ponds. Identify appropriate management methods for these sediments.

What we did: Four years ago, three detention ponds located along the I-84 freeway in East Portland required cleaning because of high bacteria levels. Since that time, annual samples have been collected to examine what pollutant accumulation in the ponds looks like over time.

What we found: Analysis showed relatively low concentrations of Total Metals, and a range of concentrations (from non-detection limits to trace amounts) of TCLP Metals. TPH analysis yielded non-detection for gasoline and diesel fractions. Heavy Oil Range Hydrocarbons ranged from 2,000-13,000 ppm. Only one pond showed any detection of PAHs. (The data sets are included in Appendix C.) Analysis of the liquid component of the ponds found them virtually free of persistent contaminants. (Adequate levels of sediment for soil sampling did not accumulate until the second year.)

Did we reach our goal? More data is still needed to determine how pollutant levels will build over time for these high-ADT detention pond sediments. Analysis has shown that handling and disposal of material accumulated in the ponds over the last three years is not yet a concern. The data so far supports the concept that if ponds are cleaned frequently, fewer contaminants are collected, and the sediment is easier to manage.

Contact: Jeff Moore, ODOT (503) 731-8289

3.10 GENERAL FINDINGS ON VACTOR WASTE MANAGEMENT

Our field trials supported earlier roadwaste findings that identified petroleum, CPAHs, and heavy metals (lead) as the major pollutants of concern found in ODOT vactor waste. Toxic pollutants from commercial sources, spills, and illegal dumping are also a concern, but our investigations never documented any vactor waste that actually contained hazardous pollutant levels. Vactor waste management plans should incorporate handling techniques for hazardous loads, but they should primarily focus on the normal pollutants typically associated with this waste.

Field trials identified a very promising product for treating vactor waste slurries. VGT-2000, a flocculant from Delta Pollution Control, was able to dramatically reduce Total Suspended Solids in vactor liquids. The flocculant also reduced liquid pollutant levels of metals, simple petroleum, and complex organic contaminants. Some flocculant trials were very successful, but more investigation is still needed to determine how flocculant products might be used effectively. The City of Portland estimates flocculant treatment could cost as much as ten cents per gallon, and for this reason may not be affordable.

Successful use of VGT-2000 in vactor trucks was limited by truck design. ODOT trucks were unable to efficiently mix flocculant or discharge treated liquid from their waste holding tanks. This situation limited the efficiency of the flocculant and its ability to improve ODOT vactor field operations. Vactor truck retrofit design options were investigated. Retrofits could improve the mixing and dewatering capabilities of ODOT vactor trucks and should be investigated further. Retrofits could allow for more efficient flocculant use as well as improve ODOT's ability to decant vactor liquids in field situations.

The research project also investigated dewatering boxes and mobile decant ponds as alternative dewatering devices. The dewatering box study was only partially completed due to equipment scheduling problems. Un-flocculated loads of vactor waste did not dewater as efficiently as we would have liked. However, box dewatering was as efficient as using a traditional and more costly dewatering concrete pad system. At a minimum, this research supports the use of dewatering boxes in select situations, possibly where the capital cost of a dewatering facility cannot be justified. Use of dewatering boxes should be further investigated using flocculant, which may greatly improve the efficiency of these boxes.

The mobile dewatering pond was not durable enough for the high vactor use typical of urban situations. It may serve, however, as a cheap and efficient means to dewater low-pollutant vactor slurries in areas where vactor maintenance is infrequent or for special projects.

The City of Portland investigated high lead (Pb) levels typically associated with its older sumps that have not been cleaned since the 1980s. The City found a strong correlation between high lead levels and old undisturbed sump sediment deposits. The study could lead to the development of new maintenance practices that will better manage older sump sediment and debris.

The data collected during these trials will put ODOT maintenance on better footing in terms of understanding real environmental risks associated with vactor waste. These trials should also help ODOT make wiser choices in regard to developing vactor waste management techniques that meet growing environmental concerns and regulations.

4.0 EXISTING WASTE DISPOSAL OPTIONS

4.1 EXISTING DEWATERING PRACTICES

Listed below are vactor waste dewatering facilities and resources currently used to dewater vactor waste or waste slurries in Oregon. Additional coverage of this topic may be found in Chapter 5 and Appendix E of this report. The topic is also addressed in the Roadwaste Management Study's Phase 1 Reports: **Roadwaste: Issues and Options** (*Collins 1998*) and **Management of Stormwater Facility Residuals** (*Lenhart 1998*).

This report has already discussed a number of dewatering tools that could be considered for use to dewater ODOT vactor waste. Delta Pollution Control flocculant and wastewater sludge-bag collection systems, Environmental Barricades mobile ponds, and Flo Trend filter box technology were all discussed in the previous chapter. In addition, NPZ Enterprises of Tigard, Oregon, sells sludge bagging and drying equipment that could be tested for managing ODOT vactor waste. A contact for NPZ: Nick Zorich (503) 524-7196.

The following are more traditional waste management facilities designed for the specific purpose of managing and disposing highway vactor waste in Oregon. Agency owners along with their vactor decant facilities are listed in Table 4.1 below:

Table 4.1: Vactor decant facilities in Oregon

Agency	Location
Lane County	Eugene/Springfield
City of Portland	Inverness
Unified Sewerage Agency	Beaverton Tualatin Rock Creek Cornelius Forest Grove Canyon Road
Marion County	Brooks
Clackamas County	Clackamas
City of Gresham	Gresham

Some of these dewatering facilities have already been discussed in detail in this project's earlier reports. Many are designed around the use of a flat, slightly sloping, dewatering pad. Vactor slurry is dumped on the pad, and the pad's sloping surface promotes liquid runoff and gravitational settling. USA's facilities are, for the most part, simple field-decant stations. These are designed to filter and settle only the liquid portion of a vactor truck's load. Often these systems consist of a series of settling tanks tied to a sewer system. Although many of the facilities listed are used for waste generated by a sole agency, Lane County and USA both share the use of their facilities with other agencies and may consider accepting additional users. This report discusses public agencies sharing roadwaste management facilities in Chapter 5.

4.2 LANDFILL INFORMATION

4.2.1 General Landfill Information

Roadwaste collected during the routine maintenance of state and local roadways has been found to contain toxic pollutants. By in large, however, pollutant levels in this waste have been found to be within an acceptable range for most local landfills. Certain restrictions may apply; but unless a hot load is encountered, roadwaste disposal at DEQ-permitted landfills should be allowed without much, if any, pollutant testing. Some landfills use roadwaste materials for construction of landfill cells, others may use it to construct caps for the landfill or for daily cover. Landfill disposal costs for roadwaste will vary widely. No extended hazardous material liability is expected when well-characterized roadwaste is disposed in a permitted landfill.

4.2.2 Farmington Landfill

In May 1998, the ODOT Research Group received a letter from Grant L. Gauthier of Farmington Landfill. The letter introduced the idea of a shared landfill facility specifically designed to dispose of highway sweepings and possibly other types of roadwaste. His letter stated there was an interest by local transportation agencies to create a new landfill that would specialize in managing and disposing roadwaste. The facility would offer substantial cost savings over other local landfills that are currently charging to dispose of this waste. The facility would be located in Aloha, Oregon just west of S.W. 209th Avenue on Farmington Road, the site of an old rock quarry. Interested agencies include the City of Forest Grove, City of Hillsboro, City of Tigard and the City of Beaverton.

The operation would require Oregon DEQ approval. Debris would be hauled to the facility and screened to separate trash from inert material. The trash would be hauled to the Grabhorn Landfill for disposal. Inert material would be tested for contaminant loading. If the inert material did not meet DEQ requirements for disposal at the new roadwaste facility, it could be hauled to Hillsboro and disposed under a favorable price agreement.

Inert screened material meeting DEQ requirements would be put in a mono-fill area on site at the 250-foot (76 m) elevation and above. Placement at the 250-foot elevation would keep the debris 100 feet (30 m) above the groundwater table. Because the material would be screened, fairly uniform, and characterized for pollutant levels, it could be managed at minimum cost. Potential prices can not be estimated without further development of a plan. Mr. Gauthier does understand, however, that disposal prices will have to be considerably cheaper than a traditional landfill to make this project worthwhile.

Author's editorial comments: This proposal for a shared roadwaste landfill facility should be given some serious consideration. Many agencies have voiced concerns regarding the liabilities of commingling waste in a shared facility. This already occurs, however, whether public agencies realize it or not. Every time they bring waste to a public landfill, they mix their waste with everyone else's. If a public landfill is listed as a Superfund site, it is the large companies and public agencies responsible for generating toxic contaminants that fund the clean up. With a properly managed shared roadwaste landfill facility, pollutant loading would be known and assumed risks could be calculated. Concern regarding the occasional hot load or spike is valid; but ODOT already faces this existing risk. A shared landfill would implement management techniques that would take this risk into account, as well as other environmental concerns.

Contact: Grant L. Gauthier, Farmington Landfill (503) 591-8280

4.3 THERMAL TREATMENT

Petroleum-contaminated soils have been managed by thermal treatment for many years. Thermal treatment technology is used to remediate contaminated soils from underground petroleum storage tank clean up sites, old oil refineries, and Superfund sites. In today's competitive industrial market, the technologies are not as rare or nearly as expensive as they once were.

In Oregon different options exist for thermal treatment: from waste-to-energy facilities burning your household trash to large treatment facilities for high-efficiency remediation of CPAH-contaminated soils. One of the largest facilities of its kind in the nation is TPS Technologies, Inc., located in North Portland. Another company located about 26 miles south of Portland along the I-5 Corridor is United Soil Recycling, Inc. Below is a brief description of what types of services these companies offer as well as pre- and post-treatment data to support their treatment technologies. (Copeland Paving also operates a thermal treatment facility in Roseburg, which also may be appropriate for treating CPAH- and petroleum-contaminated roadwaste.)

4.3.1 TPS Technologies, Inc.

Introduction: TPST offers treatment of contaminated soils. A major player in the field for some years (formerly known as Oregon Hydrocarbon), TPST is a high-volume facility. Their facility operates in the Rivergate district in North Portland. Their treatment process heats soils in a large, fixed rotary kiln. It normally achieves temperatures in excess of 700° F (370°C) – much higher than mobile rotary kilns. TPST tries to burn off the carbon-based contaminants or volatilize them for destruction in a high-temperature afterburner. TPST markets their finished materials as clean fill for industrial use. They are unable to accept hazardous waste.

Goals/Purpose: Investigate the treatment process of TPST; to determine if their high temperature thermal desorption treatment is capable of adequately remediating typical highway roadwastes.

What we did: Pre-treatment vactor waste samples were analyzed for pollutant levels. The source of the waste was the City of Portland (vactor solids from urban, high-ADT streets). The vactor waste was then treated by TPST and post-treatment waste samples were analyzed.

What we found: Prior to thermal treatment, analysis on the sediment from the Inverness Facility Decant Pad showed the following pollutants:

- Heavy Oil Range Hydrocarbons at 2550 mg/Kg;
- PAH contaminants ranging from non-detect to 1320 micrograms/Kg (parts per billion or ppb) for Fluoranthene.

Following treatment by TPST, analysis showed a considerable reduction in pollutant levels. Heavy Oil Range Hydrocarbons were non-detect with a reporting limit of 100mg/Kg – a greater than 96% reduction. All PAHs detected in the pre-treatment analysis were non-detect after treatment, with a reporting limit of 26.8 micrograms/Kg. This represents greater than 93.9% - 97.9% reduction with pollutant concentrations below levels of environmental concern. (For complete listings of pre- and post-treatment analysis, refer to the City of Portland Thermal Treatment Stormwater Facility Memorandum in Appendix D.)

Did we reach our goal? The treatment and services provided by TPST were found to be capable of treating this roadwaste.

Contacts: Steve Emmons, TPS Technologies, Inc. (800) 828-8778
Katie Bretsch, City of Portland (503) 823-4390

4.3.2 United Soil Recycling, Inc.

Introduction: United Soil Recycling is one of the largest soil recycling facilities in the state. USR accepts petroleum-contaminated soils only. Located in Woodburn, USR uses Enhanced Thermal Conduction combined with Vapor Extraction as the basis of their soil remediation services. Enhanced Thermal Treatment remediates soil contaminated with petroleum products, including heavy oils, PAHs, and chlorinated substances.

USR's remediation process is straightforward. Contaminated soils are placed into a three-layered cell. Each layer contains 4-inch (100 mm) steel pipes, attached to 12-inch (300 mm) manifolds running the length of the 80-foot (24 m) cell. Burners are attached to the 12-inch manifolds on each level. The burners provide air at approximately 1300° F (704° C). A galvanized steel Quonset hut is assembled over the entire soil cell to prevent the escape of volatiles. Heat is transferred from the pipes to the soil by conduction; the soil is heated to temperatures between 500° and 800° F (260° – 430° C). The soil is heated over a period of four to seven days. During this time, contaminants volatize and migrate to the space between the soil and the steel cover. Volatized contaminants are drawn into the thermal oxidizer and destroyed. At the completion of the treatment process, USR issues a certificate of recycling to indicate soils have been treated and recycled as per DEQ specifications.

Goal/Purpose: Investigate the treatment process of USR to determine if Enhanced Thermal Treatment is capable of treating roadwaste to reduce or eliminate toxic pollutants.

What we did: City of Portland vactor waste samples were taken and analyzed for pollutant levels. The vactor waste was then treated by USR, and a post-treatment sample was analyzed to determine if pollutant treatment occurred.

What we found: The pre-treated vactor waste was found to contain the following pollutants:

- Heavy Oil Range Hydrocarbons at 2120 mg/Kg;
- PAH contaminants ranging from non-detect to 1184 micrograms/Kg for Fluoranthene.

Following treatment by USR, test results indicated non-detects in carbon-based contaminant levels. Heavy Oil Range Hydrocarbons were non-detect with a reporting limit of 100mg/Kg – greater than a 95.3% reduction. All PAHs detected in the pre-treatment analysis were non-detect after treatment, with a reporting limit of 20.1 µg/Kg. This represents a greater than 98.3% - 92.4% reduction. (For complete listings of pre- and post-treatment analysis, refer to the City of Portland Thermal Treatment Stormwater Facility Memorandum in Appendix D.)

Did we reach our goal? The treatment services provided by USR were capable of reducing or eliminating the toxic hydrocarbon pollutants found in this vactor roadwaste.

Contacts: Morgan Buenger, United Soil Recycling (503) 981-9159
Katie Bretsch, City of Portland (503) 823-4390

5.0 SHARED FACILITIES[6]

5.1 FACILITY FUNCTIONS

Many public highway management agencies are currently finding they need to design and construct waste management facilities to properly manage the roadwaste materials that their highways generate. These roadwaste management facilities provide the following functions:

- Proper storage of roadwaste, to protect people and the environment;
- Dewatering of wet roadwaste, to meet waste disposal requirements;
- Segregation and sorting of roadwaste, to facilitate efficient waste management; and
- Isolation of contaminated roadwaste, to ensure safe management of toxic pollutants.

Highway agencies need facilities that can provide these functions to manage roadwaste. Not all highway agencies, however, can afford to own and operate roadwaste facilities that fulfill all of these functions.

5.2 WHY SHARE FACILITIES?

When multiple highway agencies generate similar kinds of roadwaste in the same geographical area, development of shared facilities makes sense. Building additional capacity into a planned facility so that it can serve multiple users will be far cheaper than creating a second, duplicate facility. Some jurisdictions generate so little roadwaste that constructing a facility to manage this specialized waste is cost prohibitive. Others may avoid performing needed highway maintenance activities, because properly managing the generated waste will not be affordable. In many cases, low-cost, environmentally protective roadwaste management options simply are not available. A shared roadwaste management facility can make environmentally sound waste management affordable to all local users.

Segregating roadwaste by type is the first step in efficiently managing this special waste stream. Collecting similar roadwaste from multiple users can allow cost savings that come with economies of scale. If a highway agency collects highly contaminated roadwaste, such as catch basin and manhole cleanings from high-ADT urban roads, a facility will be needed to provide safe storage for this waste, one that protects both groundwater and stormwater. Dewatering the roadwaste solids will also be required. Waste liquids will need to be discharged to a sanitary sewer. Local environmental and waste disposal permits may generate other requirements. Developing many different highway waste facilities in the same area that all meet these needs will not be efficient or cost effective.

[6] This section was written for this report by Katie Bretsch, City of Portland, Bureau of Environmental Services.

The bottom line is that the cost per ton for management of roadwaste material will be less with shared facilities. At least one vactor waste decant facility in Oregon, and several facilities in Washington State, are shared for this reason.

5.3 ISSUES AND OPTIONS FOR SHARED FACILITIES

Establishing clear lines of responsibility and advance agreements regarding joint operation will help build a good base for successful management of a shared roadwaste management facility. Besides necessary and mundane management issues, resolving questions around environmental liability and hazardous loads will be central. There are two types of environmental risk involved in operation of a shared facility: routine risks associated with normal operations, and unusual risks associated with rare, contaminated loads. Worker safety, agency responsibility, and site security all need to be considered.

5.3.1 Risks Associated with Normal Material and Operations

All users of a shared roadwaste management facility must fully characterize their waste. This means identifying the wastes' typical pollutant levels, which define associated environmental and health risks. Typical pollutants will include petroleum hydrocarbons (analyzed as TPH), leachable lead (TCLP Pb), and carcinogenic polyaromatic hydrocarbons (CPAHs). See the ODOT publication, **Roadwaste: Issues and Options** (*Collins 1998*), for an extensive discussion of contaminants typically found in roadwaste.

Depending on pollutants, roadwaste can pose health risks to people and the environment. If all users at a joint facility collect roadwaste from similar sources in the same geographic area, it is likely that their roadwaste will be similar in character and associated risks. This means the users' collective roadwastes can be managed together as if it were one waste. If the roadwaste brought to the shared facility by the different users differs greatly in pollutants and risks, the different wastes may require different management methods. The design of a shared facility will need to take this into account.

Roadwaste can contaminate groundwater if it contains leachable pollutants and is stored on open ground. Contamination of stormwater can occur if roadwaste is not adequately contained and pollutants migrate with rain runoff. Other environmental impacts such as noise, smell, and even the use of electric lights at night, may need to be addressed when actively managing roadwaste material. Successfully managing environmental risks associated with a roadwaste facility will require planning design and operations so that activities of all users are taken into account.

Table 5.1 lists typical risks and health issues associated with operating a roadwaste management facility. It also lists how facility design and operation can address these risks and concerns. Although risks and protective measures may differ, all users of a shared roadwaste facility must be committed to implementing the best protective measures for managing their specific roadwaste.

Table 5.1: Shared roadwaste facilities: examples of options for managing routine risks

Issue	Example Design Measures	Example Operating Measures
Stormwater Protection	Plan site drainage carefully. Paved areas curbed and drained. Provide sedimentation manholes for site drainage. Provide truck wash-off area.	Wash off trucks only in designated areas. Avoid splashing, tracking or spillage of material off of paved and drained surfaces.
Groundwater Protection	All paved areas sealed or lined. All materials storage sealed or lined, or both. Decant discharged to sanitary system only.	Pavement breaks repaired promptly. Pavement re-sealed periodically. Storage seal inspected and repaired as needed.
Noise Protection	Avoid use of plates or lids that slam, or clatter when driven over. Design the facility to avoid routine equipment backing. Use passive mechanical designs as much as possible.	Make most efficient use of all power equipment. Avoid unnecessary backing of equipment. Avoid unnecessary early and late operations.
Water Conservation	Locate near, or design in a re-use water source. Provide on-site well for truck and facility washing.	Re-use water or use on-site well water if available. Use sweepers to clean paved areas rather than flushing.
Energy Conservation	Use passive solar to dry material. Maximize use of natural light. Locate facility to minimize total transit distances for material.	Plan equipment travel routes to minimize energy use.
Air Quality Protection	Avoid placing foot or vehicle traffic paths over stored material. Locate facility to minimize total material transit distance from gathering to final disposal.	Dampen too-dry material before handling. Avoid driving or walking over stored dry material. Minimize trip distances. Minimize equipment idling.
Human Health	Provide crew washroom. Provide well-designed fences, gates, guardrails, and steps.	Provide personal protective equipment and training. Provide appropriate equipment. Provide safety plan. Provide appropriate site security. Provide clean-up opportunity before meals and breaks. Discourage eating and drinking on site, or provide a separate, clean area for these activities.

The basics of good planning apply. A thorough assessment of shared facility design and operational needs by all users will provide the best roadwaste management and facility operating plans.

5.3.2 Authority and Responsibility

Responsibility for planning, design, and operation of the facility may be joint or collaborative. For accountability and effective decision making, however, management authority should be centralized and clearly vested. Diffuse authority and complicated communication channels make effective management of environmental risks too difficult. A single plan for operation of the facility that covers all risk issues and concerns should bind all users.

5.3.3 Worker Safety

Worker safety is discussed separately in this document (see Appendix F). A joint worker safety plan should be adopted for all the facility users. Because equipment and operational activities of different users may vary, each user may need to develop additional or separate safety plans. The assignment of responsibility for safety should be made very clear. Responsible managers should agree on the safety risks involved with the facility's routine operations. They should also agree on how these risks are managed, although all users may not need to manage risks identically. Handling of unusually contaminated loads will require a single, jointly implemented plan, which makes worker safety its top priority.

5.3.4 Site Security

Proper care for site security needs to be considered and will help to avoid future headaches. An open facility is more convenient, especially in a shared operation. Open access, however, invites prowling, dumping, and other problems that can come with unwanted visitors. Prevention of unauthorized dumping is a major concern; but the primary focus of proper security should be protection of your workers, equipment, and the public.

It is recommended that shared facilities which serve private operators as well as public operators be staffed during all open hours to insure that all loads are managed to appropriate standards. A shared facility in Washington that accepts private as well as public vactor waste has operated successfully for several years on this model.

5.3.5 Risks Associated with Unusually Contaminated Loads

Any operation that manages roadwaste needs to be prepared to deal with unusually contaminated loads. (See the chapter on managing hot loads in **Roadwaste Management: A Tool for Developing District Plans.** (*Collins and Moore 2000*)) At a shared facility, additional considerations pertain. Primary concerns will include isolating unusually contaminated material, allocating appropriate clean-up and management costs, and clarifying responsibility and liability.

Illegal dumping on roads and in drainage facilities does occur, but the incidence of "hot" roadwaste loads is very infrequent. The City of Portland, which generates the largest volumes of vactor waste in Oregon, has had only two unusually contaminated loads in four years, and neither of these warranted designation as "hazardous waste." This said, any roadwaste facility must be prepared to deal with unusually contaminated and thus potentially hazardous loads.

Some special strategies used successfully by organizations operating shared facilities are shown in Table 5.2.

Table 5.2: Shared roadwaste facilities: examples of options for unusually contaminated loads

Issue	Example Design Measures	Example Operations Measures
Separation of Loads	Separate, valved-off bins for questionable loads pending screening test results.	Acceptance procedure. Material not consolidated until screening complete. Bins tagged to match manifest.
Hazard Screening	Well lit facility. Separate bins to accommodate individual loads.	Staffed facility. Initial inspection of each load. Shipping papers required for acceptance.
Cost Allocation back to Generator	[not applicable]	Careful tracking of costs associated with each "hot" load.
Chain of Custody	Limited access and single entry path. Video surveillance.	Manifests required for acceptance. Staffed facility.
Prevent Interruptions to Operations	Lots of lined paved area to ease equipment movement. No overhead obstructions.	Material isolated until known safe to commingle. Excessively contaminated material removed to appropriate disposal ASAP.
Protect Worker Safety	Well designed and lit facility.	Safety plan covering all identified risks observed by all users. Use private vendor emergency response services for potentially hazardous loads.

Shared facilities operate successfully in both Washington State and Oregon. In Oregon, Lane County has partnered in a shared facility with the cities of Eugene and Springfield. In Washington, the Washington Department of Transportation has successfully partnered with many local agencies to build shared facilities, some of which also accept stormwater clean-out waste from private parties. Clark County operates a facility it opens to other governmental users. More discussion and examples of shared facilities can be found in Appendix E and the appendices to **Roadwaste: Issues and Options** (*Collins 1998*).

5.4 COST ALLOCATION IN SHARED FACILITIES

"Cost of service" principles are the normal standard for allocating utility costs among users. Under cost of service principles, all the facility and operating costs are aggregated and allocated back to users, based on some agreed-upon measure of usage. Offsets are usually provided for in-kind contributions. The following table illustrates some approaches in applying cost of service principles to a shared use roadwaste facility.

Table 5.3: Costs to be aggregated for sharing among users

Cost Categories	Example Costs
Capital	♦ Facility Construction (amortized)
Maintenance	♦ Repair ♦ Site cleanup ♦ Safety Inspections
Operations	♦ Water service ♦ Electric power service ♦ Remediation, recycling and/or disposal costs ♦ Staffing (if required) ♦ Insurance (if required)

Example offsets to aggregated costs include:

- Recovery or reuse value of recyclable material
- Contributed equipment and services

Possible allocation bases for a shared facility include:

- Tons or yards of material processed, by type
- Loads dumped, by type

Under the cost of service model, usual and common activities that are more economically combined are subject to cost allocation. Unusual costs – which are easily segregated and do not apply to all users, such as special handling and disposal costs for unusually contaminated loads – are charged back to the generator.

5.5 CONCLUSIONS ON SHARED FACILITIES

Facilities needed to manage roadwaste can be successfully shared. Sharing these facilities can reap benefits to all users, the most obvious benefit being lower cost per ton for appropriate processing of roadwaste materials. Well operated, shared facilities will allow for better and more efficient control of environmental risks and liability. These benefits far outweigh the risks often perceived when considering commingling wastes from several agencies in a shared roadwaste facility.

6.0 FINAL CONCLUSIONS

6.1 GENERAL CONCLUSIONS

The roadwaste pilot trials helped to better define pollutants and environmental risks associated with street sweepings and highway vactor waste. They also identified waste management techniques and new technologies that might help ODOT to more efficiently manage roadwaste materials. Our trials looked at pollutant remediation as well as re-use, recycling, and disposal options. We found that pollutant levels will vary widely in roadwaste, from clean to dirty, but hazardous levels will be encountered only very rarely. We found that, with careful management, migration of roadwaste pollutants could be controlled. We also identified many products and people available to help manage, contain, and treat roadwaste.

Many of the waste management resources and findings presented in this report will require further development and evaluation. ODOT roadwaste management plans will also need to be developed and implemented on the local level, taking advantage of local resources and local partnerships. Summarized below are suggested roadwaste management activities that have come out of this study. They are offered here as a possible starting point in utilizing the information we have presented, to better manage ODOT roadwaste materials.

6.2 STREET SWEEPINGS

Street sweepings can consist of everything from clean soil to heavily polluted silt, grit, and trash picked up along high-traffic transportation corridors. The first thing to do in managing this waste is to categorize its pollutant levels and determine its environmental and health risks. Once pollutants and risks are known, a cost effective management or disposal option can be chosen.

Sweepings consisting of clean soil, sand or gravel can be freely reused or recycled, with erosion and containment being the only concern. Sweepings that are slightly contaminated with low pollutant loads could possibly be used in manufacturing compost, or as fill material in special highway projects where they can be isolated and managed (such as in berm construction). Stockpiling for passive remediation (by natural microbial degradation) might also be an option. When managing low level contaminated street sweepings, if they are reused, the reuse plans will require approval from environmental and waste regulators. Heavily polluted sweepings should be landfilled or heat-treated by local vendors.

Sweepings that are screened to remove litter and trash prior to reuse should be analyzed for pollutants after screening. The screening process can lower pollutant levels. Sweepings generated under winter icy conditions are often high in coarse sands. The longer sanding material remains on a road surface, the more it is pulverized into fines. Picking up this material promptly will reduce silt levels. It will also reduce pollutant loads, since coarser material is less likely to bond with pollutants and there will be less contact with pollutants over time. The air knife investigated in this research project could possibly be useful in recycling winter sand.

Overall, the most important activity in managing sweeping materials is to characterize pollutant loads and try to find appropriate ways to reuse them locally. Sweepings that are generated from the same road under much the same conditions are likely to have fairly consistent pollutant levels. Sweepings from roads that are similar in geographic settings, traffic counts, etc. may also have similar pollutant loads. The ability to characterize street sweepings based on origin could help save costs associated with analyzing pollutant loads and increase efficiency in choosing cost effective street sweeping management and disposal options.

6.3 VACTOR GENERATED WASTE

Like street sweepings, vactor waste has the potential for a wide range of pollutant levels. Once again, the waste should be categorized, so that efficient handling techniques and management practices can be selected that will reduce risk and comply with environmental regulations.

Within the same geographical region, vactor waste can have a wide range of pollutant levels. Cleaning sumps and catch basins will usually generate low water-to-soil ratios and high pollutant loads. Fine silts are usually abundant and often there is long-term contact time with pollutant loads. (Frequent cleaning schedules can reduce pollutant loads.) Cleaning storm drains from bridge and overpass systems usually yields cleaner waste. These systems have high water-to-soil ratios and are rarely contaminated. They collect larger debris and no fine silts. There is also short contact time with pollutants, since they are often washed quickly through the structures.

To handle most vactor wastes effectively, liquids will need to be separated from the solids. Many large metropolitan areas use decant and dewatering facilities for separation. Such facilities are expensive and often suffer from limited processing output capability. Most facilities are too inflexible in design and operation to efficiently treat vactor loads that vary in water/soil ratios.

In our study of flocculant products we identified a product capable of separating vactor liquids from solids. VGT-2000 flocculant from Delta Pollution Control is capable of removing fine suspended particles and pollutants from vactor liquids. This flocculant may offer some efficiency and flexibility in treating a wide variety of vactor wastes.

ODOT Maintenance could develop new handling techniques and management practices around flocculant technology. The use of flocculants can increase the efficiency and productivity of maintenance activities and ease disposal. VGT-2000 could be used to treat loads in the field, allowing discharge to fixed field decant stations or to approved, pre-designated sanitary sewers.

Mobile dewatering boxes and retention ponds also have their merits. If used with flocculants, they have the potential to increase the efficiency of handling material from some maintenance activities. Mobile devices could also serve seasonal needs of maintenance crews that conduct minimal vactor activities. Use of mobile devices could offer large savings over construction of traditional decant facilities with large covered concrete dewatering pads.

7.0 REFERENCES

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APPENDICES

APPENDIX A: Study Work Plans (Detailed)
Compost Study
Rocky Butte Berm Study

APPENDIX B: Street Sweeping Waste Data Tables
Compost Study
Rocky Butte Berm Study
Various ADT Road Stockpile Study

APPENDIX C: Vactor Waste Data Tables
Flocculant Study – Stage II (1 data set)
Flocculant Study – Stage III Summary Data (1 data set)
Dewater Pond Study (2 data sets)
Mechanical Mixing Study (1 data set)
Portland High-ADT Retention Pond Study (1data set)

APPENDIX D: City of Portland Thermal Treatment Memorandum - Stormwater Facility Sediments: Untreated and Treated

APPENDIX E: Report on Selected Decant Facilities

APPENDIX F: Roadwaste Worker Safety Procedures

APPENDIX A

Study Work Plans (Detailed)

Compost Study
Rocky Butte Berm Study

Compost Study Work Plan

Compost Facility Location:

The Wilsonville stockyard was selected as the temporary research compost facility.

Construction Designs:

Landscape crewmembers from Baldock framed compost bins using 2x4's and plywood. These bins were then lined using plastic liners and fitted with drainage ports to allow the collection of water runoff for analysis. Compost bins hold approximately 1.5 yards of material per bin.

Compost mixture formulas:

Mixture ratios are listed in the following order:
Sweeping material : Mulch Material : Chipped Green Material

Cell # 1	1:0:0	Cell # 5	1:0:2
Cell # 2	1:1:0	Cell # 6	1:0:4
Cell # 3	1:2:0	Cell # 7	1:0:0
Cell # 4	1:2:2		

Sampling strategies:

Pre/post screened samples of sweeping material used in this study were collected on 04/05/1999. Following construction of the compost bins and placement of compost material, initial composite soil samples were collected for each bin on 04/30/1999. Composite soil samples were taken approximately every 2-3 months to evaluate and measure pollutant levels as a function of time. The last composite soil sample for this study was collected on 01/14/2000. Water samples were collected during soil sampling events when available.

Lab Analysis Conducted:

<u>Soil Tests</u>
Total and TCLP Metals (Cd, Cu, Pb, Zn)
NW TPH-HCID
TPH-Gx, Dx scan if necessary
PAH by HPLC

<u>Water Tests</u>
Total and TCLP Metals (Cd, Cu, Pb, Zn)
pH
TSS
TKN
5-day BOD
Conductivity
Ammonia Nitrogen, Nitrate
Total Phosphate, ortho-phosphorus
Total Oils & Grease
NW TPH-HCID
THP-Gx, Dx scan if necessary
PAH by HPLC

Rocky Butte Berm Study Work Plan

Rocky Butte Berm Location:

The Rocky Butte safety berm and stockpile study was conducted at the foot of Rocky Butte on the east side. The berm is located in a designated fenced-off area of ODOT right-of-way located along the I-84 interchange on-ramp to I-205.

Construction Design:

The berm was constructed using GM barriers that were damaged as a result of a landslide that occurred in late spring of 1998. Debris generated from the landslide was then placed on top of the GM barriers. Screened street sweeping material was brought to the site to be placed over the existing material to create a sufficient buffer to prevent future slide material from reaching the interchange between I-84 and I-205.

Sampling strategies:

Composite soil samples from the berm were collected approximately every 2-3 months following construction of the berm. Adjacent water samples were collected, when available, monitoring for possible pollutant migration from the berm. Adjacent soil samples were collected from the water sampling sites when surface water was not present towards the end of the project.

Lab Analysis Conducted:

<u>Soil Tests</u>
Total and TCLP Metals (Cd, Cu, Pb, Zn)
NW TPH-HCID
TPH-Gx, Dx scan if necessary
PAH by HPLC

<u>Water Tests</u>
Total and TCLP Metals (Cd, Cu, Pb, Zn)
pH
TSS
TKN
5-day BOD
Conductivity
Ammonia Nitrogen, Nitrate
Total Phosphate, ortho-phosphorous
Total Oils & Grease
NW TPH-HCID
THP-Gx, Dx scan if necessary
PAH by HPLC

APPENDIX B

Street Sweeping Waste Data Tables

Compost Study
Rocky Butte Berm Study
Various ADT Road Stockpile Study

Project Name: Compost Study

Compost Cell # 1 - Sweeping Material - Flat

CHEMICAL ANALYSIS OF SOIL

Wilsonville

Parameter	4/30/99	6/21/99	8/5/99	11/30/99	1/4/00	AVERAGE
Total Metals (ppm)						
Cadmium	ND	0.669	1.1	1.22	0.658	0.91
Copper	41.4	4.68	50.1	30.8	23.1	30.02
Lead	33.1	53.2	64.6	33.3	88.8	54.60
Zinc	159.0	165	183	140	127	154.80
TCLP Metals (ppm)						
Cadmium	ND	ND	ND	ND	ND	ND
Copper	ND	ND	ND	ND	ND	ND
Lead	ND	ND	ND	ND	ND	ND
Zinc	1.50	1.56	1.59	1.59	1.92	1.63
TPH - HCID (ppm)						
Gasoline	ND	ND	ND	ND	ND	ND
Diesel	ND	ND	ND	ND	ND	ND
Heavy Oil Range Hydrocarbons	469.00	DET	442	637	430	494.50
EPA Method 8310 (ppb)						
Acenaphthene	ND	ND	ND	ND	ND	ND
Acenaphthylene	ND	ND	ND	ND	ND	ND
Anthracene	ND	ND	ND	ND	ND	ND
Benzo(a)anthracene	ND	ND	ND	ND	39.9	39.90
Benzo(a)pyrene	ND	ND	96.2	89.2	76	87.13
Benzo(b)fluoranthene	ND	ND	ND	ND	ND	ND
Benzo(g,h,I)perylene	ND	ND	ND	ND	92.3	92.30
Benzo(k)fluoranthene	ND	ND	ND	ND	38	38.00
Chrysene	318	103	190	ND	43.9	163.73
Dibenzo(a,h)anthracene	ND	ND	ND	ND	ND	ND
Fluoranthene	ND	ND	541	ND	110	325.50
Fluorene	ND	ND	ND	ND	ND	ND
Indeno(1,2,3-cd)pyrene	ND	ND	ND	ND	147	147.00
Naphthalene	ND	ND	ND	ND	ND	ND
Phenanthrene	221	ND	90.3	ND	39.1	116.80
Pyrene	423	100	110	123	187	188.60

Averages are computed by the sum of the total detected analytes divided by the number of detections. These values do not include Non Detects

ND = Non Detected or below analytical reporting limits

N/A = Samples were not available at the time of field collection

DET = Detected

Project Name: Compost Study
Compost Cell # 1 - Sweeping Material - Flat
CHEMICAL ANALYSIS OF WATER
Wilsonville

Parameter	4/30/99	6/21/99	8/5/99	11/30/99	1/4/00	AVERAGES
Metals (ppm)						
Cadmium	N/A	N/A	ND	ND	ND	ND
Copper	N/A	N/A	0.171	0.0301	0.0123	0.07
Lead	N/A	N/A	0.0935	ND	ND	0.09
Zinc	N/A	N/A	0.628	0.0118	0.0068	0.22
TCLP Metals (ppm)						
Cadmium	N/A	N/A	ND	ND	ND	ND
Copper	N/A	N/A	ND	ND	ND	ND
Lead	N/A	N/A	ND	ND	ND	ND
Zinc	N/A	N/A	ND	0.511	0.548	0.53
TPH - HCID (ppm)						
Gasoline	N/A	N/A	ND	ND	ND	ND
Diesel	N/A	N/A	ND	ND	ND	ND
Heavy Oil Range Hydrocarbons	N/A	N/A	ND	ND	ND	ND
EPA Method 8310 (ppb)						
Acenaphthene	N/A	N/A	ND	ND	ND	ND
Acenaphthylene	N/A	N/A	ND	ND	ND	ND
Anthracene	N/A	N/A	ND	ND	ND	ND
Benzo(a)anthracene	N/A	N/A	ND	ND	ND	ND
Benzo(a)pyrene	N/A	N/A	ND	ND	ND	ND
Benzo(b)fluoranthene	N/A	N/A	ND	ND	ND	ND
Benzo(g,h,I)perylene	N/A	N/A	ND	ND	ND	ND
Benzo(k)fluoranthene	N/A	N/A	ND	ND	ND	ND
Chrysene	N/A	N/A	ND	ND	ND	ND
Dibenzo(a,h)anthracene	N/A	N/A	ND	ND	ND	ND
Fluoranthene	N/A	N/A	ND	ND	ND	ND
Fluorene	N/A	N/A	ND	ND	ND	ND
Indeno(1,2,3-cd)pyrene	N/A	N/A	ND	ND	ND	ND
Naphthalene	N/A	N/A	ND	ND	ND	ND
Phenanthrene	N/A	N/A	ND	ND	ND	ND
Pyrene	N/A	N/A	ND	ND	ND	ND
Other						
pH	N/A	N/A	9.29	8.21	7.67	8.39
Total Suspended Solids (TSS)	N/A	N/A	210	11	ND	110.50
Total Kjeldahl Nitrogen (TKN)	N/A	N/A	51	1.02	0.609	17.54
5-Day BOD	N/A	N/A	26.7	ND	ND	26.70
Conductivity	N/A	N/A	1280	318	179	592.33
Ammonia Nitrogen	N/A	N/A	1.28	ND	ND	1.28
Nitrate	N/A	N/A	21.6	2.07	0.453	8.04
Total Phosphate	N/A	N/A	0.854	0.068	0.0735	0.33
ortho-Phosphate	N/A	N/A	ND	ND	0.0411	0.04
Total Oil & Grease	N/A	N/A	N/A	ND	ND	ND

Averages are computed by the sum of the total detected analytes divided by the number of detections. These values do not include Non Detects

ND = Non Detected or below analytical reporting limits

N/A = Samples were not available at the time of field collection

DET = Detected

Project Name: Compost Pilot Study
Compost Cell # 2 - 1 Sweeping Material : 1 Mulch – Mound
CHEMICAL ANALYSIS OF SOIL
Wilsonville

Parameter	4/30/99	6/21/99	8/5/99	11/30/99	1/4/00	AVERAGES
Total Metals (ppm)						
Cadmium	0.686	0.582	0.802	1.28	0.636	0.80
Copper	ND	15.5	42.2	30.5	26	28.55
Lead	32.8	46.6	41.9	41.3	33.3	39.18
Zinc	321	148	151	162	136	183.60
TCLP Metals (ppm)						
Cadmium	ND	ND	ND	ND	ND	ND
Copper	ND	ND	ND	ND	ND	ND
Lead	ND	ND	ND	ND	ND	ND
Zinc	0.737	0.88	1.07	0.98	1.55	1.04
TPH - HCID (ppm)						
Gasoline	ND	ND	ND	ND	ND	ND
Diesel	ND	ND	ND	ND	ND	ND
Heavy Oil Range Hydrocarbons	482.00	DET	710	520	452	541.00
EPA Method 8310 (ppb)						
Acenaphthene	ND	ND	ND	ND	ND	ND
Acenaphthylene	ND	ND	ND	ND	ND	ND
Anthracene	ND	ND	ND	ND	ND	ND
Benzo(a)anthracene	174	ND	ND	101	ND	137.50
Benzo(a)pyrene	ND	ND	ND	ND	59.2	59.20
Benzo(b)fluoranthene	ND	ND	ND	200	ND	200.00
Benzo(g,h,I)perylene	ND	ND	ND	ND	98.6	98.60
Benzo(k)fluoranthene	ND	ND	ND	ND	ND	ND
Chrysene	216	113	177	ND	ND	168.67
Dibenzo(a,h)anthracene	ND	ND	ND	ND	ND	ND
Fluoranthene	ND	ND	ND	ND	ND	ND
Fluorene	ND	ND	ND	ND	ND	ND
Indeno(1,2,3-cd)pyrene	ND	ND	ND	ND	98.1	98.10
Naphthalene	ND	ND	ND	ND	ND	ND
Phenanthrene	ND	ND	ND	ND	ND	ND
Pyrene	241	160	183	164	95.6	168.72

Averages are computed by the sum of the total detected analytes divided by the number of detections. These values do not include Non Detects
ND = Non Detected or below analytical reporting limits
N/A = Samples were not available at the time of field collection
DET = Detected

Project Name: Compost Study
Compost Cell # 2 - 1 Sweeping Material : 1 Mulch - Mound
CHEMICAL ANALYSIS OF WATER
Wilsonville

Parameter	04/30/99	6/21/1999	8/05/1999	11/30/1999	1/04/2000	AVERAGES
Metals Total (ppm)						
Cadmium	N/A	N/A	N/A	ND	ND	ND
Copper	N/A	N/A	N/A	0.0505	0.0262	0.04
Lead	N/A	N/A	N/A	0.00514	0.0036	0.00
Zinc	N/A	N/A	N/A	0.0562	0.0397	0.05
TCLP Metals (ppm)						
Cadmium	N/A	N/A	N/A	ND	ND	ND
Copper	N/A	N/A	N/A	ND	ND	ND
Lead	N/A	N/A	N/A	ND	ND	ND
Zinc	N/A	N/A	N/A	ND	0.516	0.52
TPH - HCID (ppm)						
Gasoline	N/A	N/A	N/A	ND	ND	ND
Diesel	N/A	N/A	N/A	0.608	ND	0.61
Heavy Oil Range Hydrocarbons	N/A	N/A	N/A	0.75	ND	0.75
EPA Method 8310 (ppb)						
Acenaphthene	N/A	N/A	N/A	ND	ND	ND
Acenaphthylene	N/A	N/A	N/A	ND	ND	ND
Anthracene	N/A	N/A	N/A	ND	ND	ND
Benzo(a)anthracene	N/A	N/A	N/A	ND	ND	ND
Benzo(a)pyrene	N/A	N/A	N/A	ND	ND	ND
Benzo(b)fluoranthene	N/A	N/A	N/A	ND	ND	ND
Benzo(g,h,I)perylene	N/A	N/A	N/A	ND	ND	ND
Benzo(k)fluoranthene	N/A	N/A	N/A	ND	ND	ND
Chrysene	N/A	N/A	N/A	ND	ND	ND
Dibenzo(a,h)anthracene	N/A	N/A	N/A	ND	ND	ND
Fluoranthene	N/A	N/A	N/A	ND	ND	ND
Fluorene	N/A	N/A	N/A	ND	ND	ND
Indeno(1,2,3-cd)pyrene	N/A	N/A	N/A	ND	ND	ND
Naphthalene	N/A	N/A	N/A	ND	ND	ND
Phenanthrene	N/A	N/A	N/A	ND	ND	ND
Pyrene	N/A	N/A	N/A	ND	ND	ND
Other						
pH	N/A	N/A	N/A	7.96	7.86	7.91
Total Suspended Solids (TSS)	N/A	N/A	N/A	22	ND	22.00
Total Kjeldahl Nitrogen (TKN)	N/A	N/A	N/A	8.61	2.5	5.56
5-Day BOD	N/A	N/A	N/A	4.72	ND	4.72
Conductivity	N/A	N/A	N/A	544	351	447.50
Ammonia Nitrogen	N/A	N/A	N/A	0.33	ND	0.33
Nitrate	N/A	N/A	N/A	ND	ND	ND
Total Phosphate	N/A	N/A	N/A	0.838	0.299	0.57
ortho-Phosphate	N/A	N/A	N/A	0.394	0.169	0.28
Total Oil & Grease	N/A	N/A	N/A	ND	ND	ND

Averages are computed by the sum of the total detected analytes divided by the number of detections. These values do not include Non Detects

ND = Non Detected or below analytical reporting limits

N/A = Samples were not available at the time of field collection

Project Name: Compost Study

Compost Cell # 3 - 1 Sweeping Material : 2 Mulch - Mound

CHEMICAL ANALYSIS OF SOIL

Wilsonville

Parameter	4/30/99	6/21/99	8/5/99	11/30/99	1/4/00	AVERAGES
Total Metals (ppm)						
Cadmium	0.758	0.642	0.971	1.22	0.693	0.86
Copper	29.5	3.71	43.6	28.8	21.3	25.38
Lead	37.5	38.7	38.1	58.9	34.8	41.60
Zinc	163	145	155	223	110	159.20
TCLP Metals (ppm)						
Cadmium	ND	ND	ND	ND	ND	ND
Copper	ND	ND	ND	ND	ND	ND
Lead	ND	ND	ND	ND	ND	ND
Zinc	0.682	0.675	0.621	1.16	1.33	0.89
TPH - HCID (ppb)						
Gasoline	ND	ND	ND	ND	ND	ND
Diesel	ND	ND	ND	ND	ND	ND
Heavy Oil Range Hydrocarbons	802.00	DET	441	580	339	540.50
EPA Method 8310 (ppb)						
Acenaphthene	ND	ND	ND	ND	ND	ND
Acenaphthylene	ND	ND	ND	ND	ND	ND
Anthracene	ND	ND	ND	ND	ND	ND
Benzo(a)anthracene	ND	ND	ND	ND	ND	ND
Benzo(a)pyrene	ND	87.3	141	42.2	68.3	84.70
Benzo(b)fluoranthene	ND	188	196	98.9	101	145.98
Benzo(g,h,I)perylene	ND	ND	ND	ND	148	148.00
Benzo(k)fluoranthene	ND	ND	ND	ND	41.2	41.20
Chrysene	259	119	218	ND	34.7	157.68
Dibenzo(a,h)anthracene	ND	ND	ND	ND	ND	ND
Fluoranthene	457	ND	196	ND	ND	326.50
Fluorene	ND	ND	ND	ND	ND	ND
Indeno(1,2,3-cd)pyrene	ND	ND	ND	ND	106	106.00
Naphthalene	ND	ND	ND	ND	ND	ND
Phenanthrene	ND	ND	103	41	38.9	60.97
Pyrene	239	220	143	71.9	132	161.18

Averages are computed by the sum of the total detected analytes divided by the number of detections. These values do not include Non Detects

ND = Non Detected or below analytical reporting limits

N/A = Samples were not available at the time of field collection

DET = Detected

Project Name: Compost Study
Compost Cell # 3 - 1 Sweeping Material : 2 Mulch - Mound
CHEMICAL ANALYSIS OF WATER
Wilsonville

Parameter	4/30/99	6/21/99	8/5/99	11/30/99	1/4/00	AVERAGES
Total Metals (ppm)						
Cadmium	N/A	N/A	N/A	1.22	ND	1.22
Copper	N/A	N/A	N/A	28.8	0.0229	14.41
Lead	N/A	N/A	N/A	58.9	0.0069	29.45
Zinc	N/A	N/A	N/A	223	0.0463	111.52
TCLP Metals (ppm)						
Cadmium	N/A	N/A	N/A	ND	ND	ND
Copper	N/A	N/A	N/A	ND	ND	ND
Lead	N/A	N/A	N/A	ND	ND	ND
Zinc	N/A	N/A	N/A	ND	0.73	0.73
TPH - HCID (ppm)						
Gasoline	N/A	N/A	N/A	ND	ND	ND
Diesel	N/A	N/A	N/A	ND	ND	ND
Heavy Oil Range Hydrocarbons	N/A	N/A	N/A	ND	ND	ND
EPA Method 8310 (ppb)						
Acenaphthene	N/A	N/A	N/A	ND	ND	ND
Acenaphthylene	N/A	N/A	N/A	ND	ND	ND
Anthracene	N/A	N/A	N/A	ND	ND	ND
Benzo(a)anthracene	N/A	N/A	N/A	ND	ND	ND
Benzo(a)pyrene	N/A	N/A	N/A	ND	ND	ND
Benzo(b)fluoranthene	N/A	N/A	N/A	ND	ND	ND
Benzo(g,h,I)perylene	N/A	N/A	N/A	ND	ND	ND
Benzo(k)fluoranthene	N/A	N/A	N/A	ND	ND	ND
Chrysene	N/A	N/A	N/A	ND	ND	ND
Dibenzo(a,h)anthracene	N/A	N/A	N/A	ND	ND	ND
Fluoranthene	N/A	N/A	N/A	ND	ND	ND
Fluorene	N/A	N/A	N/A	ND	ND	ND
Indeno(1,2,3-cd)pyrene	N/A	N/A	N/A	ND	ND	ND
Naphthalene	N/A	N/A	N/A	ND	ND	ND
Phenanthrene	N/A	N/A	N/A	ND	ND	ND
Pyrene	N/A	N/A	N/A	ND	ND	ND
Other						
pH	N/A	N/A	N/A	8.03	7.3	7.67
Total Suspended Solids (TSS)	N/A	N/A	N/A	ND	ND	ND
Total Kjeldahl Nitrogen (TKN)	N/A	N/A	N/A	6	3.97	4.99
5-Day BOD	N/A	N/A	N/A	4.02	ND	4.02
Conductivity	N/A	N/A	N/A	541	390	465.50
Ammonia Nitrogen	N/A	N/A	N/A	0.11	ND	0.11
Nitrate	N/A	N/A	N/A	ND	ND	ND
Total Phosphate	N/A	N/A	N/A	0.917	0.712	0.81
ortho-Phosphate	N/A	N/A	N/A	0.709	0.56	0.63
Total Oil & Grease	N/A	N/A	N/A	ND	ND	ND

Averages are computed by the sum of the total detected analytes divided by the number of detections. These values do not include Non Detects

ND = Non Detected or below analytical reporting limits

N/A = Samples were not available at the time of field collection

Project Name: Compost Study

Compost Cell # 4 - 1 Sweeping Material : 2 Mulch : 2 Green Material - Mound

CHEMICAL ANALYSIS OF SOIL

Wilsonville

Parameter	4/30/99	6/21/99	8/5/99	11/30/99	1/4/00	AVERAGES
Total Metals (ppm)						
Cadmium	ND	0.891	0.818	1.2	0.826	0.93
Copper	11.7	14.4	21.8	25.5	34	21.48
Lead	15.7	40.4	27.2	30.5	27.7	28.30
Zinc	76.1	198	118	114	125	126.22
TCLP Metals (ppm)						
Cadmium	ND	ND	ND	ND	ND	ND
Copper	ND	ND	ND	ND	ND	ND
Lead	ND	ND	ND	ND	ND	ND
Zinc	0.930	2.23	0.753	1.36	1.48	1.35
TPH - HCID (ppm)						
Gasoline	ND	ND	ND	ND	ND	ND
Diesel	DET	ND	ND	ND	ND	ND
Heavy Oil Range Hydrocarbons	DET	DET	1000	425	504	643.00
EPA Method 8310 (ppb)						
Acenaphthene	ND	ND	ND	ND	ND	ND
Acenaphthylene	ND	ND	ND	ND	ND	ND
Anthracene	ND	ND	ND	ND	ND	ND
Benzo(a)anthracene	ND	ND	ND	ND	ND	ND
Benzo(a)pyrene	ND	ND	103	ND	57.8	80.40
Benzo(b)fluoranthene	ND	ND	ND	ND	ND	ND
Benzo(g,h,I)perylene	ND	ND	ND	ND	103	103.00
Benzo(k)fluoranthene	ND	ND	ND	ND	34.1	34.10
Chrysene	ND	124	156	ND	47	109.00
Dibenzo(a,h)anthracene	ND	ND	ND	ND	ND	ND
Fluoranthene	ND	ND	ND	ND	79.6	79.60
Fluorene	ND	ND	ND	ND	105	105.00
Indeno(1,2,3-cd)pyrene	ND	ND	ND	ND	ND	ND
Naphthalene	ND	ND	ND	ND	ND	ND
Phenanthrene	ND	125	90.1	ND	ND	107.55
Pyrene	374	147	205	99.3	174	199.86

Averages are computed by the sum of the total detected analytes divided by the number of detections. These values do not include Non Detects

ND = Non Detected or below analytical reporting limits

N/A = Samples were not available at the time of field collection

Project Name: Compost Study

Compost Cell # 4 - 1 Sweeping Material : 2 Mulch : 2 Green Material - Mound

CHEMICAL ANALYSIS OF WATER

Wilsonville

Parameter		4/30/99	6/21/99	8/5/99	11/30/99	1/4/00	AVERAGES
Total Metals (ppm)							
	Cadmium	N/A	N/A	N/A	ND	ND	ND
	Copper	N/A	N/A	N/A	0.0492	0.0513	0.05
	Lead	N/A	N/A	N/A	0.0079	0.0108	0.01
	Zinc	N/A	N/A	N/A	0.0922	0.0856	0.09
TCLP Metals (ppm)							
	Cadmium	N/A	N/A	N/A	ND	ND	ND
	Copper	N/A	N/A	N/A	ND	ND	ND
	Lead	N/A	N/A	N/A	ND	ND	ND
	Zinc	N/A	N/A	N/A	1.08	0.873	0.98
TPH - HCID (ppm)							
	Gasoline	N/A	N/A	N/A	ND	ND	ND
	Diesel	N/A	N/A	N/A	0.762	ND	0.76
	Heavy Oil Range Hydrocarbons	N/A	N/A	N/A	0.734	ND	0.73
EPA Method 8310 (ppb)							
	Acenaphthene	N/A	N/A	N/A	ND	ND	ND
	Acenaphthylene	N/A	N/A	N/A	ND	ND	ND
	Anthracene	N/A	N/A	N/A	ND	ND	ND
	Benzo(a)anthracene	N/A	N/A	N/A	ND	ND	ND
	Benzo(a)pyrene	N/A	N/A	N/A	ND	ND	ND
	Benzo(b)fluoranthene	N/A	N/A	N/A	ND	ND	ND
	Benzo(g,h,I)perylene	N/A	N/A	N/A	ND	ND	ND
	Benzo(k)fluoranthene	N/A	N/A	N/A	ND	ND	ND
	Chrysene	N/A	N/A	N/A	ND	ND	ND
	Dibenzo(a,h)anthracene	N/A	N/A	N/A	ND	ND	ND
	Fluoranthene	N/A	N/A	N/A	ND	ND	ND
	Fluorene	N/A	N/A	N/A	ND	ND	ND
	Indeno(1,2,3-cd)pyrene	N/A	N/A	N/A	ND	ND	ND
	Naphthalene	N/A	N/A	N/A	ND	ND	ND
	Phenanthrene	N/A	N/A	N/A	ND	ND	ND
	Pyrene	N/A	N/A	N/A	ND	ND	ND
Other							
	pH	N/A	N/A	N/A	7.35	7.36	7.36
	Total Suspended Solids (TSS)	N/A	N/A	N/A	19	ND	19.00
	Total Kjeldahl Nitrogen (TKN)	N/A	N/A	N/A	4.84	3.21	4.03
	5-Day BOD	N/A	N/A	N/A	9.06	6.37	7.72
	Conductivity	N/A	N/A	N/A	312	248	280.00
	Ammonia Nitrogen	N/A	N/A	N/A	ND	ND	ND
	Nitrate	N/A	N/A	N/A	ND	ND	ND
	Total Phosphate	N/A	N/A	N/A	0.775	0.72	0.75
	ortho-Phosphate	N/A	N/A	N/A	0.584	0.512	0.55
	Total Oil & Grease	N/A	N/A	N/A	ND	ND	ND

Averages are computed by the sum of the total detected analytes divided by the number of detections. These values do not include Non Detects

ND = Non Detected or below analytical reporting limits

N/A = Samples were not available at the time of field collection

Project Name: Compost Study
Compost Cell # 5 - 1 Sweeping Material : 2 Green Material - Mound
CHEMICAL ANALYSIS OF SOIL
Wilsonville

Parameter	4/30/99	6/21/99	8/5/99	11/30/99	1/4/00	AVERAGES
Total Metals (ppm)						
Cadmium	0.963	0.55	0.593	1.32	0.943	0.87
Copper	42.2	1.44	28.5	28.3	31.4	26.37
Lead	44.3	34.3	31.2	42.1	30.2	36.42
Zinc	163	128	132	147	121	138.20
TCLP Metals (ppm0						
Cadmium	ND	ND	ND	ND	ND	ND
Copper	ND	ND	ND	ND	ND	ND
Lead	ND	ND	ND	ND	ND	ND
Zinc	1.42	1.17	0.898	1.78	1.75	1.40
TPH - HCID (ppm)						
Gasoline	ND	DET	ND	ND	ND	ND
Diesel	DET	ND	ND	ND	ND	ND
Heavy Oil Range Hydrocarbons	1230.00	DET	716	489	491	731.50
EPA Method 8310 (ppb)						
Acenaphthene	ND	ND	ND	ND	ND	ND
Acenaphthylene	ND	ND	ND	ND	ND	ND
Anthracene	ND	ND	ND	ND	ND	ND
Benzo(a)anthracene	ND	ND	ND	ND	74.8	74.80
Benzo(a)pyrene	ND	ND	ND	99.8	86	92.90
Benzo(b)fluoranthene	ND	ND	ND	ND	86	86.00
Benzo(g,h,I)perylene	ND	ND	ND	ND	ND	ND
Benzo(k)fluoranthene	ND	ND	ND	ND	49	49.00
Chrysene	212	153	183	ND	87.1	158.78
Dibenzo(a,h)anthracene	ND	ND	ND	ND	ND	ND
Fluoranthene	ND	240	203	287	155	221.25
Fluorene	ND	ND	ND	ND	130	130.00
Indeno(1,2,3-cd)pyrene	ND	ND	ND	ND	157	157.00
Naphthalene	ND	ND	ND	ND	ND	ND
Phenanthrene	446	118	156	ND	226	236.50
Pyrene	315	163	255	267	142	228.40

Averages are computed by the sum of the total detected analytes divided by the number of detections. These values do not include Non Detects
ND = Non Detected or below analytical reporting limits
N/A = Samples were not available at the time of field collection
DET = Detected

Project Name: Compost Study

Compost Cell # 5 - 1 Sweeping Material : 2 Green Material - Mound

CHEMICAL ANALYSIS OF WATER

Wilsonville

Parameter	4/30/99	6/21/99	8/5/99	11/30/99	1/4/00	AVERAGES
Total Metals (ppm)						
Cadmium	N/A	N/A	N/A	ND	ND	ND
Copper	N/A	N/A	N/A	0.0333	0.0281	0.03
Lead	N/A	N/A	N/A	0.0042	0.0047	0.00
Zinc	N/A	N/A	N/A	0.0464	0.0405	0.04
TCLP Metals (ppm0						
Cadmium	N/A	N/A	N/A	ND	0.01	0.01
Copper	N/A	N/A	N/A	ND	ND	ND
Lead	N/A	N/A	N/A	ND	ND	ND
Zinc	N/A	N/A	N/A	0.922	0.925	0.92
TPH - HCID (ppm)						
Gasoline	N/A	N/A	N/A	ND	ND	ND
Diesel	N/A	N/A	N/A	0.873	ND	0.87
Heavy Oil Range Hydrocarbons	N/A	N/A	N/A	0.925	ND	0.93
EPA Method 8310 (ppb)						
Acenaphthene	N/A	N/A	N/A	ND	ND	ND
Acenaphthylene	N/A	N/A	N/A	ND	ND	ND
Anthracene	N/A	N/A	N/A	ND	ND	ND
Benzo(a)anthracene	N/A	N/A	N/A	ND	ND	ND
Benzo(a)pyrene	N/A	N/A	N/A	ND	ND	ND
Benzo(b)fluoranthene	N/A	N/A	N/A	ND	ND	ND
Benzo(g,h,I)perylene	N/A	N/A	N/A	ND	ND	ND
Benzo(k)fluoranthene	N/A	N/A	N/A	ND	ND	ND
Chrysene	N/A	N/A	N/A	ND	ND	ND
Dibenzo(a,h)anthracene	N/A	N/A	N/A	ND	ND	ND
Fluoranthene	N/A	N/A	N/A	ND	ND	ND
Fluorene	N/A	N/A	N/A	ND	ND	ND
Indeno(1,2,3-cd)pyrene	N/A	N/A	N/A	ND	ND	ND
Naphthalene	N/A	N/A	N/A	ND	ND	ND
Phenanthrene	N/A	N/A	N/A	ND	ND	ND
Pyrene	N/A	N/A	N/A	ND	ND	ND
Other						
pH	N/A	N/A	N/A	7.24	7.19	7.22
Total Suspended Solids (TSS)	N/A	N/A	N/A	21	13	17.00
Total Kjeldahl Nitrogen (TKN)	N/A	N/A	N/A	2.59	2.01	2.30
5-Day BOD	N/A	N/A	N/A	11.4	ND	11.40
Conductivity	N/A	N/A	N/A	265	169	217.00
Ammonia Nitrogen	N/A	N/A	N/A	ND	ND	ND
Nitrate	N/A	N/A	N/A	ND	ND	ND
Total Phosphate	N/A	N/A	N/A	0.285	0.723	0.50
ortho-Phosphate	N/A	N/A	N/A	0.123	0.141	0.13
Total Oil & Grease	N/A	N/A	N/A	ND	ND	ND

Averages are computed by the sum of the total detected analytes divided by the number of detections. These values do not include Non Detects

ND = Non Detected or below analytical reporting limits

N/A = Samples were not available at the time of field collection

Project Name: Compost Study

Compost Cell # 6 - 1 Sweeping Material : 4 Green Material - Mound

CHEMICAL ANALYSIS OF SOIL

Wilsonville

Parameter		4/30/99	6/21/99	8/5/99	11/30/99	1/4/00	AVERAGES
Total Metals (ppm)							
	Cadmium	ND	ND	1	1.3	ND	1.15
	Copper	21.4	16.6	27.8	47.8	18.6	26.44
	Lead	37.6	38.6	40.4	55.4	20.7	38.54
	Zinc	106	113	124	166	71.5	116.10
TCLP Metals (ppm)							
	Cadmium	ND	ND	ND	ND	ND	ND
	Copper	ND	ND	ND	ND	ND	ND
	Lead	ND	ND	ND	ND	ND	ND
	Zinc	1.14	1.32	1.13	1.43	1.3	1.26
TPH - HCID (ppm)							
	Gasoline	ND	DET	DET	ND	ND	ND
	Diesel	DET	ND	ND	ND	DET	ND
	Heavy Oil Range Hydrocarbons	DET	DET	867	627	250	581.33
EPA Method 8310 (ppb)							
	Acenaphthene	ND	ND	ND	ND	ND	ND
	Acenaphthylene	ND	ND	ND	ND	ND	ND
	Anthracene	ND	ND	ND	ND	ND	ND
	Benzo(a)anthracene	ND	ND	ND	919	65.2	492.10
	Benzo(a)pyrene	ND	ND	ND	396	72.8	234.40
	Benzo(b)fluoranthene	ND	ND	ND	738	ND	738.00
	Benzo(g,h,I)perylene	ND	ND	ND	199	76.7	137.85
	Benzo(k)fluoranthene	ND	ND	ND	292	39.3	165.65
	Chrysene	180	153	170	1340	71.8	382.96
	Dibenzo(a,h)anthracene	ND	ND	ND	ND	217	217.00
	Fluoranthene	ND	240	ND	3150	131	1173.67
	Fluorene	ND	ND	ND	ND	ND	ND
	Indeno(1,2,3-cd)pyrene	ND	ND	ND	ND	121	121.00
	Naphthalene	ND	ND	ND	ND	ND	ND
	Phenanthrene	228	156	89.1	438	37.3	189.68
	Pyrene	228	247	164	2813	113	713.00

Averages are computed by the sum of the total detected analytes divided by the number of detections. These values do not include Non Detects

ND = Non Detected or below analytical reporting limits

N/A = Samples were not available at the time of field collection

DET = Detected

Project Name: Compost Study
Compost Cell # 6 - 1 Sweeping Material : 4 Green Material - Mound
CHEMICAL ANALYSIS OF WATER
Wilsonville

Parameter		4/30/99	6/21/99	8/5/99	11/30/99	1/4/00	AVERAGES
Total Metals (ppm)							
	Cadmium	N/A	N/A	N/A	ND	ND	ND
	Copper	N/A	N/A	N/A	0.0224	0.0211	0.02
	Lead	N/A	N/A	N/A	0.0042	0.0053	0.00
	Zinc	N/A	N/A	N/A	0.0504	0.041	0.05
TCLP Metals (ppm)							
	Cadmium	N/A	N/A	N/A	ND	ND	ND
	Copper	N/A	N/A	N/A	ND	ND	ND
	Lead	N/A	N/A	N/A	ND	ND	ND
	Zinc	N/A	N/A	N/A	0.567	0.862	0.71
TPH - HCID (ppm)							
	Gasoline	N/A	N/A	N/A	ND	ND	ND
	Diesel	N/A	N/A	N/A	0.6	ND	0.60
	Heavy Oil Range Hydrocarbons	N/A	N/A	N/A	ND	ND	ND
EPA Method 8310 (ppb)							
	Acenaphthene	N/A	N/A	N/A	ND	ND	ND
	Acenaphthylene	N/A	N/A	N/A	ND	ND	ND
	Anthracene	N/A	N/A	N/A	ND	ND	ND
	Benzo(a)anthracene	N/A	N/A	N/A	ND	ND	ND
	Benzo(a)pyrene	N/A	N/A	N/A	ND	ND	ND
	Benzo(b)fluoranthene	N/A	N/A	N/A	ND	ND	ND
	Benzo(g,h,I)perylene	N/A	N/A	N/A	ND	ND	ND
	Benzo(k)fluoranthene	N/A	N/A	N/A	ND	ND	ND
	Chrysene	N/A	N/A	N/A	ND	ND	ND
	Dibenzo(a,h)anthracene	N/A	N/A	N/A	ND	ND	ND
	Fluoranthene	N/A	N/A	N/A	ND	ND	ND
	Fluorene	N/A	N/A	N/A	ND	ND	ND
	Indeno(1,2,3-cd)pyrene	N/A	N/A	N/A	ND	ND	ND
	Naphthalene	N/A	N/A	N/A	ND	ND	ND
	Phenanthrene	N/A	N/A	N/A	ND	ND	ND
	Pyrene	N/A	N/A	N/A	ND	ND	ND
Other							
	pH	N/A	N/A	N/A	7.02	8.11	7.57
	Total Suspended Solids (TSS)	N/A	N/A	N/A	21	14	17.50
	Total Kjeldahl Nitrogen (TKN)	N/A	N/A	N/A	2.59	2.47	2.53
	5-Day BOD	N/A	N/A	N/A	11.4	4.77	8.09
	Conductivity	N/A	N/A	N/A	207	174	190.50
	Ammonia Nitrogen	N/A	N/A	N/A	ND	ND	ND
	Nitrate	N/A	N/A	N/A	ND	ND	ND
	Total Phosphate	N/A	N/A	N/A	0.285	0.761	0.52
	ortho-Phosphate	N/A	N/A	N/A	0.123	0.528	0.33
	Total Oil & Grease	N/A	N/A	N/A	ND	ND	ND

Averages are computed by the sum of the total detected analytes divided by the number of detections. These values do not include Non Detects

ND = Non Detected or below analytical reporting limits

N/A = Samples were not available at the time of field collection

Project Name: Compost Study
Compost Cell # 7 - All Sweeping Material - Mound
CHEMICAL ANALYSIS OF SOIL
Wilsonville

Parameter		4/30/99	6/21/99	8/5/99	11/30/99	1/4/00	AVERAGES
Total Metals (ppm)							
	Cadmium	0.734	0.713	1.1	1.22	0.989	0.95
	Copper	34.9	32.6	42.1	30.9	40.5	36.20
	Lead	38.6	42.9	37.2	33.3	54.7	41.34
	Zinc	133	162	159	170	193	163.40
TCLP Metals (ppm)							
	Cadmium	ND	ND	0.01	ND	ND	0.01
	Copper	ND	ND	ND	ND	ND	ND
	Lead	0.705	ND	ND	ND	ND	0.71
	Zinc	1.42	1.45	1.49	1.9	2.39	1.73
TPH - HCID (ppm)							
	Gasoline	ND	ND	ND	ND	ND	ND
	Diesel	221.00	ND	ND	ND	ND	221.00
	Heavy Oil Range Hydrocarbons	931.00	DET	715	662	634	735.50
EPA Method 8310 (ppb)							
	Acenaphthene	ND	ND	ND	ND	ND	ND
	Acenaphthylene	ND	ND	ND	ND	ND	ND
	Anthracene	ND	ND	ND	ND	ND	ND
	Benzo(a)anthracene	ND	ND	ND	ND	56.1	56.10
	Benzo(a)pyrene	ND	ND	89.2	ND	103	96.10
	Benzo(b)fluoranthene	ND	ND	ND	ND	104	104.00
	Benzo(g,h,I)perylene	ND	ND	ND	ND	188	188.00
	Benzo(k)fluoranthene	ND	ND	ND	ND	51.1	51.10
	Chrysene	ND	144	137	ND	61.5	114.17
	Dibenzo(a,h)anthracene	ND	ND	ND	ND	ND	ND
	Fluoranthene	ND	231	ND	ND	150	190.50
	Fluorene	ND	ND	ND	ND	ND	ND
	Indeno(1,2,3-cd)pyrene	ND	ND	ND	ND	155	155.00
	Naphthalene	ND	ND	ND	ND	ND	ND
	Phenanthrene	ND	ND	ND	ND	72.7	72.70
	Pyrene	ND	118	133	118	204	143.25

Averages are computed by the sum of the total detected analytes divided by the number of detections. These values do not include Non Detects
ND = Non Detected or below analytical reporting limits
N/A = Samples were not available at the time of field collection

Project Name: Compost Study

Compost Cell # 7 - All Sweeping Material - Mound

CHEMICAL ANALYSIS OF WATER

Wilsonville

Parameter	4/30/99	6/21/99	8/5/99	11/30/99	1/4/00	AVERAGES
Total Metals (ppm)						
Cadmium	N/A	N/A	N/A	ND	ND	ND
Copper	N/A	N/A	N/A	0.0478	0.0326	0.04
Lead	N/A	N/A	N/A	ND	ND	ND
Zinc	N/A	N/A	N/A	0.0228	0.0173	0.02
TCLP Metals (ppm)						
Cadmium	N/A	N/A	N/A	ND	ND	ND
Copper	N/A	N/A	N/A	ND	ND	ND
Lead	N/A	N/A	N/A	ND	ND	ND
Zinc	N/A	N/A	N/A	ND	0.565	0.57
TPH - HCID (ppm)						
Gasoline	N/A	N/A	N/A	ND	ND	ND
Diesel	N/A	N/A	N/A	1.83	ND	1.83
Heavy Oil Range Hydrocarbons	N/A	N/A	N/A	1.88	ND	1.88
EPA Method 8310 (ppb)						
Acenaphthene	N/A	N/A	N/A	ND	ND	ND
Acenaphthylene	N/A	N/A	N/A	ND	ND	ND
Anthracene	N/A	N/A	N/A	ND	ND	ND
Benzo(a)anthracene	N/A	N/A	N/A	ND	ND	ND
Benzo(a)pyrene	N/A	N/A	N/A	ND	ND	ND
Benzo(b)fluoranthene	N/A	N/A	N/A	ND	ND	ND
Benzo(g,h,I)perylene	N/A	N/A	N/A	ND	ND	ND
Benzo(k)fluoranthene	N/A	N/A	N/A	ND	ND	ND
Chrysene	N/A	N/A	N/A	ND	ND	ND
Dibenzo(a,h)anthracene	N/A	N/A	N/A	ND	ND	ND
Fluoranthene	N/A	N/A	N/A	ND	ND	ND
Fluorene	N/A	N/A	N/A	ND	ND	ND
Indeno(1,2,3-cd)pyrene	N/A	N/A	N/A	ND	ND	ND
Naphthalene	N/A	N/A	N/A	ND	ND	ND
Phenanthrene	N/A	N/A	N/A	ND	ND	ND
Pyrene	N/A	N/A	N/A	ND	ND	ND
Other						
pH	N/A	N/A	N/A	8.32	7.68	8.00
Total Suspended Solids (TSS)	N/A	N/A	N/A	ND	10	10.00
Total Kjeldahl Nitrogen (TKN)	N/A	N/A	N/A	3.27	1.94	2.61
5-Day BOD	N/A	N/A	N/A	ND	ND	ND
Conductivity	N/A	N/A	N/A	432	306	369.00
Ammonia Nitrogen	N/A	N/A	N/A	ND	ND	ND
Nitrate	N/A	N/A	N/A	2.64	1.86	2.25
Total Phosphate	N/A	N/A	N/A	0.109	0.0674	0.09
ortho-Phosphate	N/A	N/A	N/A	ND	ND	ND
Total Oil & Grease	N/A	N/A	N/A	ND	ND	ND

Averages are computed by the sum of the total detected analytes divided by the number of detections. These values do not include Non Detects

ND = Non Detected or below analytical reporting limits

N/A = Samples were not available at the time of field collection

Project Name: Compost Study

Pre-Compost Analysis

CHEMICAL ANALYSIS OF SOIL

Wilsonville

Parameter		Unscreened Sweepings 4/5/99	Screened Sweepings 4/5/99
Total Metals (ppm)			
	Cadmium	ND	ND
	Copper	29.70	63.4
	Lead	81.80	83.1
	Zinc	180.00	294
TCLP Metals (ppm)			
	Cadmium	ND	0.196
	Copper	0.13	0.147
	Lead	ND	0.285
	Zinc	2.41	3.04
TPH - HCID (ppm)			
	Gasoline	ND	ND
	Diesel	ND	ND
	Heavy Oil Range Hydrocarbons	2030.00	1060
EPA Method (ppm)			
	Aroclor 1016	ND	ND
	Aroclor 1221	ND	ND
	Aroclor 1232	ND	ND
	Aroclor 1242	ND	ND
	Aroclor 1248	ND	ND
	Aroclor 1254	ND	ND
	Aroclor 1260	ND	ND
EPA Method 8310 (ppb)			
	Acenaphthene	ND	ND
	Acenaphthylene	ND	ND
	Anthracene	ND	ND
	Benzo(a)anthracene	ND	ND
	Benzo(a)pyrene	ND	ND
	Benzo(b)fluoranthene	ND	ND
	Benzo(g,h,I)perylene	ND	ND
	Benzo(k)fluoranthene	ND	ND
	Chrysene	ND	ND
	Dibenzo(a,h)anthracene	ND	ND
	Fluoranthene	ND	ND
	Fluorene	ND	ND
	Indeno(1,2,3-cd)pyrene	ND	ND
	Naphthalene	ND	ND
	Phenanthrene	ND	ND
	Pyrene	ND	ND

ND = Non Detected or below analytical reporting limits
N/A = Samples were not available at the time of field collection

Project Name: Rocky Butte Berm Study

CHEMICAL ANALYSIS OF SOIL

Revised 3/15/2000	**07/01/98**	**11/13/98**	**1/28/99**	**3/10/99**	**6/11/99**	**9/21/99**	**11/30/99**	**2/1/00**	**AVG**	**6/11/99**	**2/1/00**
Parameter											
Total Metals (ppm)										Runoff	
Arsenic	N/A	N/A	N/A	N/A	N/A	3.82	4.48	N/A	**4.15**	N/A	N/A
Chromium	N/A	N/A	N/A	N/A	N/A	37.9	47.8	N/A	**42.85**	N/A	N/A
Cadmium	ND	ND	0.6	ND	ND	0.814	1.84	1.54	**1.20**	ND	ND
Copper	28.00	34	33	4	52	54.9	41.2	40.6	**35.96**	28	40
Lead	40.00	ND	51	80	78	70.7	80.4	58.6	**65.53**	49	ND
Zinc	140.00	160	120	170	230	193	203	195	**176.38**	110	50.7
TCLP Metals (ppm)											
Arsenic	N/A	N/A	N/A	N/A	N/A	ND	ND	N/A	**ND**	N/A	N/A
Chromium	N/A	N/A	N/A	N/A	N/A	ND	ND	N/A	**ND**	N/A	N/A
Cadmium	ND	ND	ND	ND	ND	ND	0.022	ND	**0.02**	ND	ND
Copper	0.13	34	0.1	0.09	0.4	ND	ND	ND	**6.94**	ND	ND
Lead	ND	ND	ND	ND	0.5	0.0477	ND	ND	**0.27**	0.2	ND
Zinc	2.30	6.1	1.9	1.7	2.9	1.12	2.5	1.96	**2.56**	1.5	ND
TPH - HCID (ppm)											
Gasoline	ND	ND	ND	ND	ND	ND	ND	ND	**ND**	ND	ND
Diesel	ND	ND	ND	ND	ND	ND	ND	ND	**ND**	ND	ND
Heavy Oil Range Hydrocarbons	2000	1100	2000	0.6	ND	547	495	560	**957.51**	900	ND

Project Name: Rocky Butte Berm Study

CHEMICAL ANALYSIS OF SOIL (continued)

Revised 3/15/2000	**07/01/98**	**11/13/98**	**1/28/99**	**3/10/99**	**6/11/99**	**9/21/99**	**11/30/99**	**2/1/00**	**AVG**	**6/11/99**	**2/1/00**
Parameter											
EPA Method 8310										Runoff	
Acenaphthene	ND	ND	ND	ND	ND	ND	ND	ND	**ND**	ND	ND
Acenaphthylene	ND	ND	ND	ND	ND	ND	ND	ND	**ND**	ND	ND
Anthracene	ND	ND	ND	ND	ND	ND	ND	14.6	**14.60**	ND	ND
Benzo(a) anthracene	ND	ND	ND	ND	ND	145	ND	68.2	**106.60**	ND	ND
Benzo(a) pyrene	ND	0.17	0.14	0.061	ND	167	85.1	101	**58.91**	0.05	ND
Benzo(b) fluoranthene	ND	ND	ND	ND	ND	225	ND	57.2	**141.10**	ND	ND
Benzo(g,h,I) perylene	ND	ND	ND	0.3	ND	214	ND	109	**107.77**	ND	ND
Benzo(k) fluoranthene	ND	ND	ND	ND	ND	78.8	ND	41.8	**60.30**	ND	ND
Chrysene	ND	ND	ND	ND	ND	237	105	77.5	**139.83**	ND	ND
Dibenzo(a,h) anthracene	ND	ND	ND	ND	ND	ND	ND	ND	**ND**	ND	ND
Fluoranthene	ND	ND	ND	ND	ND	301	ND	128	**214.50**	ND	ND
Fluorene	ND	ND	ND	ND	ND	ND	ND	ND	**ND**	ND	ND
Indeno(1,2,3-cd) pyrene	ND	ND	ND	ND	ND	329	ND	89.4	**209.20**	ND	ND
Naphthalene	ND	ND	ND	ND	ND	ND	ND	ND	**ND**	ND	ND
Phenanthrene	ND	ND	ND	ND	ND	159	ND	38.4	**98.70**	ND	ND
Pyrene	ND	ND	ND	ND	ND	378	124	132	**211.33**	ND	ND
EPA Method 8082											
Aroclor 1016	N/A	N/A	N/A	N/A	N/A	N/A	N/A	ND	**ND**	N/A	N/A
Aroclor 1221	N/A	N/A	N/A	N/A	N/A	N/A	N/A	ND	**ND**	N/A	N/A
Aroclor 1232	N/A	N/A	N/A	N/A	N/A	N/A	N/A	ND	**ND**	N/A	N/A
Aroclor 1242	N/A	N/A	N/A	N/A	N/A	N/A	N/A	ND	**ND**	N/A	N/A
Aroclor 1248	N/A	N/A	N/A	N/A	N/A	N/A	N/A	ND	**ND**	N/A	N/A
Aroclor 1254	N/A	N/A	N/A	N/A	N/A	N/A	N/A	ND	**ND**	N/A	N/A
Aroclor 1260	N/A	N/A	N/A	N/A	N/A	N/A	N/A	ND	**ND**	N/A	N/A

Averages are computed by the sum of the total detected analytes divided by the number of detections. These values do not include Non Detects

ND = Non Detected or below analytical reporting limits

N/A = Samples were not available at the time of field collection

Project Name: Rocky Butte Berm Study
CHEMICAL ANALYSIS OF WATER

Revised 3/15/2000

Parameter	11/13/98	1/28/99	3/10/99	2/1/00	AVERAGES
Total Metals (ppm)					
Cadmium	ND	ND	ND	ND	ND
Copper	ND	ND	ND	0.00532	0.00532
Lead	ND	ND	ND	0.00218	0.00218
Zinc	0.02	0.04	ND	0.016	0.02533333
TCLP Metals (ppm)					
Cadmium	ND	ND	ND	ND	ND
Copper	ND	ND	ND	ND	ND
Lead	ND	ND	ND	ND	ND
Zinc	0.08	0.29	ND	ND	0.185
EPA Method 8310 (ppb)					
Acenaphthene	ND	ND	ND	ND	ND
Acenaphthylene	ND	ND	ND	ND	ND
Anthracene	ND	ND	ND	ND	ND
Benzo(a)anthracene	ND	ND	ND	ND	ND
Benzo(a)pyrene	ND	ND	ND	ND	ND
Benzo(b)fluoranthene	ND	ND	ND	ND	ND
Benzo(g,h,I)perylene	ND	ND	ND	ND	ND
Benzo(k)fluoranthene	ND	ND	ND	ND	ND
Chrysene	ND	ND	ND	ND	ND
Dibenzo(a,h)anthracene	ND	ND	ND	ND	ND
Fluoranthene	ND	ND	ND	ND	ND
Fluorene	ND	ND	ND	ND	ND
Indeno(1,2,3-cd)pyrene	ND	ND	ND	ND	ND
Naphthalene	ND	ND	ND	ND	ND
Phenanthrene	ND	ND	ND	ND	ND
Pyrene	ND	ND	ND	ND	ND
TPH - HCID (ppm)					
Gasoline	N/A	N/A	ND	ND	ND
Diesel	N/A	N/A	ND	ND	ND
Heavy Oil Range Hydrocarbons	N/A	N/A	0.6	ND	0.6
Other					
Conductivity (µS/cm)	310	24000	260	110	6170
pH	N/A	N/A	8.93	7.57	8.25
Total Suspended Solids	N/A	N/A	8	24	16
Total Oil & Grease	ND	ND	N/A	ND	ND
Nitrate	ND	0.2	ND	ND	0.2
ortho phosphate	ND	ND	ND	ND	ND
BOD 5-day	ND	ND	ND	ND	ND
Total Kjeldahl Nitrogen	0.6	3.5	ND	68.2	24.1
Total Phosphorus	0.06	ND	0.1	0.12	0.09333333
Ammonia Nitrogen	ND	ND	ND	ND	ND

Averages are computed by the sum of the total detected analytes divided by the number of detections. These values do not include Non Detects
ND = Non Detected or below analytical reporting limits
N/A = Samples were not available at the time of field collection

Project Name: Various ADT Road Stockpile Study

CHEMICAL ANALYSIS OF SOIL

Revised 7/25/2000	**Sandy Maintenance Yard 4/6/00**	**Newberg-Bell Rd. 4/11/00**	**Sweet Home Maintenance 4/11/00**	**Bend M.P. 135 Hwy 99 4/13/00**	**Veneta Maintenance 4/12/00**	**Whiskey Stockpile 4/14/00**
Parameter						
Total Metals (ppm)						
Arsenic	N/A	3.45	2.21	ND	1.74	ND
Cadmium	ND	0.821	0.837	0.778	1.16	ND
Chromium	N/A	20.2	29.2	10	17.9	5.14
Copper	16.1	18.8	34.6	21	28.7	13.3
Lead	28.8	25.7	67	10.4	45.8	ND
Zinc	101	64.6	81.1	49.4	92.5	19.6
TCLP Metals (ppm)						
Arsenic	N/A	ND	ND	ND	ND	ND
Cadmium	ND	ND	ND	ND	ND	ND
Chromium	N/A	ND	0.024	ND	ND	ND
Copper	ND	ND	ND	ND	ND	ND
Lead	ND	ND	0.221	ND	ND	ND
Zinc	0.667	ND	0.6	0.885	0.848	ND
EPA Method 8310 (ppb)						
Acenaphthene	ND	ND	N/A	ND	ND	ND
Acenaphthylene	ND	ND	N/A	ND	ND	ND
Anthracene	ND	ND	N/A	ND	ND	ND
Benzo(a)anthracene	ND	ND	N/A	ND	ND	ND
Benzo(a)pyrene	ND	ND	N/A	ND	ND	ND
Benzo(b)fluoranthene	ND	ND	N/A	ND	ND	ND
Benzo(g,h,I)perylene	ND	ND	N/A	ND	ND	ND
Benzo(k)fluoranthene	ND	ND	N/A	ND	ND	ND
Chrysene	ND	ND	N/A	ND	ND	ND
Dibenzo(a,h)anthracene	ND	ND	N/A	ND	ND	ND
Fluoranthene	ND	ND	N/A	ND	ND	ND
Fluorene	ND	ND	N/A	ND	ND	ND
Indeno(1,2,3-cd)pyrene	ND	ND	N/A	224	ND	ND
Naphthalene	ND	ND	N/A	ND	ND	ND
Phenanthrene	ND	ND	N/A	125	ND	ND
Pyrene	ND	ND	N/A	130	ND	ND
TPH - HCID (ppm)						
Gasoline	ND	ND	ND	ND	ND	ND
Diesel	ND	ND	ND	ND	ND	ND
Heavy Oil Range Hydrocarbons	DET	DET	DET	DET	DET	DET

ND = Non Detected or below analytical reporting limits
N/A = Samples were not available at the time of field collection
DET = Detected

APPENDIX C

Vactor Waste Data Tables

Flocculant Study – Stage II (1 data set)
Flocculant Study – Stage III Summary Data (1 data set)
Dewater Pond Study (2 data sets)
Mechanical Mixing Study (1 data set)
Portland High-ADT Retention Pond Study (1data set)

Project Name: Flocculant Investigation – Stage II

City of Portland Inverness Facility Settling Pond

Chemical Analysis

	Parameter	Baseline From Pond	Treatment With Flow Trend Polymer	Treatment With Milk-O-Magnesia	Treatment With CIBA Percol 798	Treatment With Delta VGT-2000 Polymer	Heavy Loading Baseline From Pond	Treatment of Heavy Loading With Delta VGT-2000 Polymer
	Metals							
(mg/l)	Arsenic	0.00222	0.00387	0.00207	ND	ND	0.0151	0.00339
ppm"	Cadmium	0.00144	ND	0.00130	ND	ND	0.00659	ND
"	Chromium	0.0104	0.0149	0.0108	0.0108	0.00183	0.0571	0.00166
"	Lead	0.545	0.659	0.546	0.519	0.103	2.26	0.0112
	Physical Solids							
(mg/l)	Total Suspended Solids	N/A	472	N/A	167	21.0	5450	ND

ND = Non Detected or below analytical reporting limits
N/A = Samples were not available at the time of field collection

Project Name: Flocculant Investigation – Stage III, Summary Data

North Portland

Chemical Analysis

		Pre-Treatment (Decant fr. Truck)	Pre-Treatment (Sample fr. Pond)	Post-treatment (Splash sample fr. Truck)	Post-Treatment (Sample From Pond)	Initial Post-treatment (Sample From Pond)	Initial Post-Treatment (Sample From Pond)
	Sample Matrix	**Water**	**Soil**	**Water**	**Soil**	**Water**	**Soil**
	Parameter	**6/22/99**	**6/22/99**	**8/26/99**	**8/26/99**	**8/27/99**	**8/27/99**
	Metals						
(mg/l)	Cadmium	0.0190	1.37	0.00850	1.72	0.0184	1.13
(mg/Kg dry)	Copper	1.28	80.1	0.340	49.7	0.689	40.1
ppm	Lead	2.21	122	.514	58.0	1.80	94.2
"	Silicon	7.12 (SiO2)	594	29.1	1060	20.2	763
	Zinc	7.20	499	2.00	235	3.35	198
	TCLP Metals						
(mg/l) ppm	Cadmium	ND	ND	ND	ND	ND	ND
"	Copper	ND	0.161	ND	ND	ND	ND
	Lead	ND	ND	ND	ND	ND	1.04
	Zinc	ND	3.38	ND	2.11	ND	1.58
	EPA Method 8310						
(µg/l) or	Acenaphthene	ND	ND	ND	ND	ND	ND
(µg/Kg dry) ppb	Acenaphthylene	ND	ND	ND	ND	ND	ND
"	Anthracene	ND	ND	ND	ND	ND	ND
	Benzo(a)anthracene	0.388	144	ND	ND	ND	167
	Benzo(a)pyrene	0.574	217	ND	49.5	ND	147
	Benzo(b)fluoranthene	0.638	267	ND	89.7	ND	218
	Benzo(g,h,I)perylene	0.596	226	ND	ND	ND	203
	Benzo(k)fluoranthene	0.262	108	ND	ND	ND	79.2
"	Chrysene	0.532	218	ND	ND	ND	266
"	Dibenzo(a,h)anthracene	ND	ND	ND	ND	ND	ND
"	Fluoranthene	0.648	301	ND	77.2	ND	272
"	Fluorene	ND	ND	ND	ND	ND	ND
"	Indeno(1,2,3-cd)pyrene	0.466	214	ND	ND	ND	329
"	Naphthalene	ND	ND	ND	ND	ND	ND
"	Phenanthrene	ND	152	ND	49.0	ND	94.6
"	Pyrene	0.586	365	ND	117	ND	264
	TPH - HCID (+/-)						
	Gasoline	DET	ND	ND	ND	ND	ND
	Diesel	DET	ND	DET	ND	ND	ND
	Heavy Oil	DET	DET	DET	DET	DET	DET
	Other						
	Dry Weight	N/A	69.3	N/A	72.1%	N/A	75.4
	Conductivity	125	N/A	395	N/A	181	N/A
	pH	7.73	N/A	7.23	N/A	6.70	N/A
	Total Suspended Solids	2150	N/A	1340	N/A	3240	N/A
"	Total Oil & Grease	ND	N/A	ND	N/A	ND	N/A
"	Nitrate	0.395	N/A	204	N/A	1.80	N/A
"	ortho phosphate	0.0383	N/A	ND	N/A	0.0597	N/A
"	BOD 5-day	24.5	N/A	113	N/A	64.8	N/A
"	Total Kjeldahl Nitrogen	10.6	N/A	11.1	N/A	21.3	N/A
"	Total Phosphorus	7.96	N/A	3.02	N/A	7.59	N/A
"	Ammonia Nitrogen	0.360	N/A	1.26	N/A	0.269	N/A

ND = Non Detected or below analytical reporting limits
N/A = Samples were not available at the time of field collection
DET = Detected

Project Name: Dewater Pond Study

VGT-2002 (Fish-friendly) Flocculant Investigation – Chemical Analysis

North Portland 7/26/1999

		Initial Post Treatment (Decant From Truck)	Final Post Treatment (1st Sample From Pond)	Pond Treatment (Settled Sample From Pond)	Post Treatment (Soil Sample From Pond)
	Sample Matrix	**Water**	**Water**	**Water**	**Soil**
	Parameter	**7/26/99**	**7/26/99**	**7/26/99**	**7/26/99**
	Metals				
(mg/l) or	Cadmium	0.0155	0.0130	0.0100	1.39
(mg/Kg dry)	Copper	0.938	0.611	0.441	65.7
ppm	Lead	6.14	2.50	2.16	333
"	Silicon	9.89 as SiO2	13.7 as SiO2	14.7 as SiO2	1180
"	Zinc	3.47	2.77	2.39	201
	TCLP Metals				
(mg/l)	Cadmium	ND	ND	ND	ND
ppm	Copper	ND	ND	ND	ND
"	Lead	ND	ND	ND	0.414
"	Zinc	ND	ND	ND	1.36
	EPA Method 8310				
(µg/l) or	Acenaphthene	ND	ND	ND	ND
(µg/Kg dry)	Acenaphthylene	ND	ND	ND	ND
ppb	Anthracene	ND	ND	ND	ND
"	Benzo(a)anthracene	0.201	ND	ND	ND
"	Benzo(a)pyrene	0.349	ND	0.205	ND
"	Benzo(b)fluoranthene	0.383	ND	0.213	ND
"	Benzo(g,h,I)perylene	1.42	1.16	0.763	ND
"	Benzo(k)fluoranthene	0.151	ND	0.153	ND
"	Chrysene	0.362	0.200	0.350	568 µg/kg dry
"	Dibenzo(a,h)anthracene	ND	ND	ND	ND
"	Fluoranthene	0.412	0.147	0.265	ND
"	Fluorene	ND	ND	ND	ND
"	Indeno(1,2,3-cd)pyrene	0.311	ND	ND	ND
"	Naphthalene	ND	ND	ND	ND
"	Phenanthrene	ND	ND	ND	ND
"	Pyrene	0.433	0.301	0.518	550 µg/kg dry
	TPH - HCID (+/-)				
	Gasoline	ND	ND	ND	ND
	Diesel	ND	ND	ND	ND
	Heavy Oil	ND	DET	DET	DET
	Other				
%	Dry Weight	N/A	N/A	N/A	68.4
µS/cm	Conductivity	118	171	173	N/A
pH Units	pH	6.87	6.89	7.20	N/A
mg/l	Total Suspended Solids	4310	2820	1560	N/A
"	Total Oil & Grease	ND	ND	ND	N/A
"	Nitrate	ND	ND	ND	N/A
"	ortho phosphate	0.0858	ND	ND	N/A
"	BOD 5-day	49.8	109	80.4	N/A
"	Total Kjeldahl Nitrogen	19.0	35.8	24.3	N/A
"	Total Phosphorus	7.69	6.85	0.620	N/A
"	Ammonia Nitrogen	0.724	2.26	2.22	N/A

ND = Non Detected or below analytical reporting limits
N/A = Samples were not available at the time of field collection

Project Name: Dewater Pond Study

VGT-2000, Flocculant Investigation - Chemical Analysis

North Portland

		Pre-Treatment (Decant From Truck)	Pre-treatment (Sample From Pond)	Post treatment (Decant From Truck)	Post treatment (Sample From Pond)	Post treatment 13:00 (Decant From Truck)	Post treatment 17:30 (Decant From Pond)	Post treatment 13:00 (Sample From Pond)
	Sample Matrix	**Water**	**Soil**	**Water**	**Soil**	**Water**	**Water**	**Soil**
Parameter		**7/8/99**	**7/8/99**	**7/8/99**	**7/8/99**	**8/5/99**	**8/5/99**	**8/5/99**
	Metals							
(mg/l) or	Cadmium	0.0460	0.669	ND	1.75	0.0270	0.0205	1.40
(mg/Kg dry)	Copper	1.15	41.2	0.175	105	0.768	0.612	77.9
ppm	Lead	2.00	63.8	0.716	608	1.08	0.732	97.9
"	Silicon	20.7	783	11.9	186	15.7	16.5	699
"	Zinc	5.38	236	0.838	306	3.97	3.23	326
	TCLP Metals							
(mg/l)	Cadmium	0.0250	0.0140	ND	0.0260	ND	ND	0.0130
ppm	Copper	0.229	ND	ND	0.227	ND	ND	ND
"	Lead	ND	ND	ND	1.19	ND	ND	ND
"	Zinc	4.00	1.99	ND	2.77	ND	ND	3.38
	EPA -Method 8310							
(µg/l) or	Acenaphthene	ND	ND	ND	ND	ND	ND	ND
(µg/Kg dry)	Acenaphthylene	ND	ND	ND	ND	ND	ND	ND
ppd	Anthracene	ND	ND	ND	ND	ND	ND	440
"	Benzo(a)anthracene	ND	ND	ND	731	ND	ND	812
"	Benzo(a)pyrene	ND	85.1	ND	890	ND	ND	977
"	Benzo(b)fluoranthene	ND	ND	ND	ND	ND	ND	993
"	Benzo(g,h,I)perylene	ND	ND	ND	ND	ND	ND	696
"	Benzo(k)fluoranthene	ND	ND	ND	438	ND	ND	395
"	Chrysene	ND	ND	ND	1050	ND	ND	1080
"	Dibenzo(a,h)anthracene	ND	ND	ND	ND	ND	ND	ND
"	Fluoranthene	0.113	ND	ND	1300	0.425	ND	2050
"	Fluorene	ND	ND	ND	ND	ND	ND	235
"	Indeno(1,2,3-cd)pyrene	ND	ND	ND	ND	ND	ND	571
"	Naphthalene	ND	ND	ND	ND	ND	ND	ND
"	Phenanthrene	ND	ND	ND	840	ND	ND	1870
"	Pyrene	0.187	137	0.100	1290	0.604	ND	2500

Project Name: Dewater Pond Study
VGT-2000, Flocculant Investigation - Chemical Analysis (continued)
North Portland

		Pre-Treatment (Decant From Truck)	Pre-treatment (Sample From Pond)	Post treatment (Decant From Truck)	Post treatment (Sample From Pond)	Post treatment 13:00 (Decant From Truck)	Post treatment 17:30 (Decant From Pond)	Post treatment 13:00 (Sample From Pond)
	Sample Matrix	**Water**	**Soil**	**Water**	**Soil**	**Water**	**Water**	**Soil**
	Parameter	**7/8/99**	**7/8/99**	**7/8/99**	**7/8/99**	**8/5/99**	**8/5/99**	**8/05/1999**
	TPH - HCID (+/-)							
	Gasoline	ND	ND	ND	ND	ND	ND	ND
	Diesel	ND	ND	ND	ND	ND	ND	ND
	Heavy Oil	DET	DET	ND	DET	DET	DET	DET
	Other							
%	Dry Weight	N/A	97.1	N/A	68.4	N/A	N/A	
µS/cm	Conductivity	351	N/A	53.0	N/A	712	722	N/A
pH Units	pH	7.54	N/A	6.13	N/A	7.21	6.67	N/A
mg/l	Total Suspended Solids	5810	N/A	1960	N/A	2000	3110	N/A
"	Total Oil & Grease	ND	N/A	ND	N/A	6.15	ND	4540*
"	Nitrate	0.224	N/A	139	N/A	11.9	1.17	N/A
"	ortho phosphate	0.0554	N/A	0.0291	N/A	0.147	0.0260	N/A
"	BOD 5-day	103	N/A	13.5	N/A	121	233	N/A
"	Total Kjeldahl Nitrogen	13.4	N/A	7.33	N/A	40.5	47.9	N/A
"	Total Phosphorus	10.9	N/A	13.3	N/A	5.77	6.64	N/A
"	Ammonia Nitrogen	1.09	N/A	ND	N/A	15.4	7.05	N/A

* Total Oil & Grease 4540
Oil & Grease (non-polar) 847
Oil & Grease (polar) 3690

Project Name: Mechanical Mixing Study
Chemical Analysis

Parameter	Pre Flocced Slurry In Large Vessel	Post Flocced Sample From Flow Trend Box	Post Flocced Sample From Filter Bag	Pre Flocced Sample From Small Vessel	Post Flocced Sample From Filter Bag	Soil From Inverness Decant Pad
	4/5/00	4/5/00	4/5/00	4/5/00	4/5/00	4/5/00
Total Lead (mg/Kg) or mg/l	8.54	0.358	0.0102	23.9	ND	85.5
TCLP Lead (mg/l)	ND	ND	ND	ND	ND	0.202
Total Solids (mg/Kg)	69,200	3,550	488	167,000	920	589,000
Total Suspended Solids (mg/l)	51,400	2,330	42.0	161,000	34.0	N/A

ND = Non Detected or below analytical reporting limits
N/A = Samples were not available at the time of field collection

Project Name: Portland High-ADT Retention Pond Study

Chemical Analysis of Water

		148th Retaining Pond	148th Retaining Pond	181st West Retaining Pond	181st West Retaining Pond	181st East Retaining Pond	181st East Retaining Pond
		7/16/98	6/21/99	7/16/98	6/21/99	7/16/98	6/21/99
Parameter		**Concentration (ppm)**					
Metals							
	Cadmium	ND	ND	ND	ND	ND	ND
	Calcium	8.3	N/A	24	N/A	21.00	N/A
	Copper	ND	ND	ND	ND	ND	ND
	Lead	ND	ND	ND	ND	ND	ND
	Magnesium	0.54	N/A	1.9	N/A	0.91	N/A
	Zinc	ND	0.05	ND	0.05	ND	ND
	Total Hardness	23	N/A	68	N/A	56.00	N/A
TCLP Metals							
	Cadmium	ND	ND	ND	ND	ND	ND
	Copper	ND	ND	ND	ND	ND	ND
	Lead	ND	ND	ND	ND	ND	ND
	Zinc	ND	0.05	0.09	0.02	ND	ND
TPH - HCID (+/-)							
	Gasoline	N/A	ND	N/A	ND	N/A	ND
	Diesel	N/A	ND	N/A	ND	N/A	ND
	Heavy Oil Range Hydrocarbons	N/A	4	N/A	4	N/A	ND
Other							
	Fecal Coliform or Total Coliform	340 F	4100 T	4 F	14,400 T	<2 F	42 T
	Total Dissolved Solids	190	N/A	120	N/A	140.00	N/A
	Total Suspended Solids	16	16	6	14	17.00	9
	Total Oil & Grease	ND	N/A	ND	N/A	ND	N/A
	pH	N/A	7.27	N/A	7.85	ND	0.5
	ortho Phosphate	N/A	ND	N/A	170	N/A	140
	Total Phosphorus	N/A	0.3	0.1	0.6	N/A	8.12
	Nitrate	ND	0.8	5	9	N/A	ND
	Biochemical Oxygen Demand	36	12	N/A	ND	N/A	ND
	Chemical Oxygen Demand	250	N/A	N/A	0.1	13.00	9
	Ammonia Nitrogen	1.1	0.5	43	N/A	71.00	N/A
	Conductivity (µS/cm)	N/A	170	0.6	0.5	ND	0.5
	Total Kjeldahl Nitrogen	7.8	3.8	1.7	1.4	1.40	1.2
EPA Method 8310							
	Acenaphthene	N/A	N/A	N/A	ND	N/A	ND
	Acenaphthylene	N/A	N/A	N/A	ND	N/A	ND
	Anthracene	N/A	N/A	N/A	ND	N/A	ND
	Benzo(a)anthracene	N/A	N/A	N/A	ND	N/A	ND
	Benzo(a)pyrene	N/A	N/A	N/A	ND	N/A	ND
	Benzo(b)fluoranthene	N/A	N/A	N/A	ND	N/A	ND
	Benzo(g,h,I)perylene	N/A	N/A	N/A	ND	N/A	ND
	Benzo(k)fluoranthene	N/A	N/A	N/A	ND	N/A	ND
	Chrysene	N/A	N/A	N/A	ND	N/A	ND
	Dibenzo(a,h)anthracene	N/A	N/A	N/A	ND	N/A	ND
	Fluoranthene	N/A	N/A	N/A	ND	N/A	ND
	Fluorene	N/A	N/A	N/A	ND	N/A	ND
	Indeno(1,2,3-cd)pyrene	N/A	N/A	N/A	ND	N/A	ND
	Naphthalene	N/A	N/A	N/A	ND	N/A	ND
	Phenanthrene	N/A	N/A	N/A	ND	N/A	ND
	Pyrene	N/A	N/A	N/A	ND	N/A	ND

ND = Non Detected or below analytical reporting limits
N/A = Samples were not available at the time of field collection

Project Name: Portland High-ADT Retention Pond Study
Chemical Analysis of Soil

Parameter	148th Retaining Pond 7/16/98	148th Retaining Pond 6/21/99	181st West Retaining Pond 7/16/98	181st West Retaining Pond 6/21/99	181st East Retaining Pond 7/16/98	181st East Retaining Pond 6/21/99	201st Drainage 7/16/98
	Concentration (ppm)						
Total Metals							
Cadmium	1.90	3.7	2	1.1	1	1.4	2
Copper	53.00	33	30	32	37	28	28
Lead	60.00	48	51	39	53	44	41
Zinc	300.00	130	210	190	210	180	130
TCLP Metals							
Cadmium	0.03	ND	0.02	0.03	0.03	ND	ND
Copper	0.12	0.4	0.05	ND	0.09	ND	0.07
Lead	ND	0.3	ND	0.3	ND	0.3	ND
Zinc	5.00	3.3	2.4	4.9	4.1	4.6	1.5
TPH - HCID (+/-)							
Gasoline	ND	ND	ND	ND	ND	ND	ND
Diesel	ND	ND	ND	ND	ND	ND	ND
Heavy Oil Range Hydrocarbons	DET	3000	13,000	12,000	10,000	6,000	3,000
EPA Method 8310							
Acenaphthene	ND	ND	ND	ND	ND	ND	ND
Acenaphthylene	ND	ND	ND	ND	ND	ND	ND
Anthracene	ND	ND	ND	ND	ND	ND	ND
Benzo(a)anthracene	ND	ND	ND	ND	0.3	ND	ND
Benzo(a)pyrene	0.02	ND	ND	ND	0.02	ND	ND
Benzo(b)fluoranthene	ND	ND	ND	ND	ND	ND	ND
Benzo(g,h,I)perylene	ND	ND	ND	ND	ND	ND	ND
Benzo(k)fluoranthene	ND	ND	ND	ND	ND	ND	ND
Chrysene	ND	ND	ND	ND	ND	ND	ND
Dibenzo(a,h)anthracene	ND	ND	ND	ND	ND	ND	ND
Fluoranthene	ND	ND	ND	ND	ND	ND	ND
Fluorene	ND	ND	ND	ND	ND	ND	ND
Indeno(1,2,3-cd)pyrene	ND	ND	ND	ND	ND	ND	ND
Naphthalene	ND	ND	ND	ND	ND	ND	ND
Phenanthrene	ND	ND	ND	ND	ND	ND	ND
Pyrene	ND	ND	ND	ND	ND	ND	ND

ND = Non Detected or below analytical reporting limits
N/A = Samples were not available at the time of field collection

APPENDIX D

City of Portland Thermal Treatment Memorandum - Stormwater Facility Sediments: Untreated and Treated

City of Portland
Bureau of Environmental Services
Environmental Investigations Division

MEMORANDUM

Date: **July 18, 2000**

To: **Katie Bretsch**

From: **Atina Casas**

Subject: **Stormwater Facility Sediments - Untreated and Treated**

Stormwater facility sediment samples were collected before and after thermal remediation to gauge the performance of this treatment technology. Two treatment facilities were involved in this study: TPS Technologies, Inc. (=) in Portland, OR and United Soil Recycling, Inc. (USR) in Woodburn, OR. Untreated samples were collected at the Inverness vactor pad. Treated samples were collected at the respective treatment facility. Sampling methodology involved collecting three subsample cores and compositing them for analysis.

Table 1 presents an analytical summary of the study results.

<u>TPST</u>

The untreated sample (FOO00517) was collected at the Inverness vactor pad on April 14, 2000. The treated sample (FOO00626) was collected at the TPST facility on May 4, 2000. Petroleum hydrocarbons and PAHs were not detected in the treated sample. While TCLP lead was higher in the treated sample (0.2 mg/L) than the untreated sample (0.136 mg/L), levels were still below the regulatory limit for hazardous waste determination of 5 mg/L, as well as the Oregon State Department of Environmental Quality residential soil clean up standard of 2 mg/L.

<u>USR</u>

Two sediment loads were hauled to USR for combined treatment. The untreated samples (FOO00653 and F0000728) were collected at the Inverness vactor pad on May 12 and May 24, 2000, respectively. The treated sample (FOO00916) was collected at the USR facility on June 28, 2000. Petroleum hydrocarbons and PAI-Is were not detected in the treated sample. TCLP lead was lower in the treated sample (0.062 mg/L) than the untreated sample (average of 0.315 mg/L). For this sample set, total lead was also measured. The average total lead in the untreated samples was 230 mg/Kg compared to 180 mg/Kg in the treated sample.

Stormwater Facility Sediments: Thermal Remediation Performance Confirmation Study

Table 1: Analytical Summary of Untreated and Treated Stormwater Facility Sediments

Composite Parameters	Units	TPST		USR		
		Untreated	Treated	Untreated	Untreated	Treated
		FO000517	FO000626	FO000653	FO000728	FO000916
Gasoline Range Hydrocarbons	mg/Kg	<20	<20	<20	26.7	<20
Diesel Range Hydrocarbons	mg/Kg	<50	<50	<50	<250	<50
Heavy Oil Range Hydrocarbons	mg/Kg	2550	<100	1710	2530	<100
Acenaphthene	µg/Kg	<838	<26.8	<67.0	<168	<20.1
Acenaphthylene	µg/Kg	<168	<26.8	<67.0	<168	<20.1
Anthracene	µg/Kg	<168	<26.8	137	310	<20.1
Benzo(a)anthracene	µg/Kg	439	<26.8	<268	387	<20.1
Benzo(a)pyrene	µg/Kg	537	<26.8	286	531	<20.1
Benzo(b)fluoranthene	µg/Kg	468	<26.8	<268	640	<20.1
Benzo(ghi)perylene	µg/Kg	510	<26.8	338	290	<20.1
Benzo(k)fluoranthene	µg/Kg	466	<26.8	<268	405	<20.1
Chrysene	µg/Kg	719	<26.8	397	853	<20.1
Dibenzo(a,h)anthracene	µg/Kg	<168	<26.8	<268	<168	<20.1
Fluoranthene	µg/Kg	1320	<26.8	748	1620	<20.1
Fluorene	µg/Kg	<168	<26.8	80.3	183	<20.1
Indeno(1,2,3-cd)pyrene	µg/Kg	441	<26.8	<268	187	<20.1
Naphthalene	µg/Kg	<168	<26.8	108	676	<20.1
Phenanthrene	µg/Kg	927	<26.8	481	1060	<20.1
Pyrene	µg/Kg	1120	<26.8	473	1320	<20.1
TCLP Lead	mg/L	0.136	0.2	0.172	0.465	0.062
Total Lead	mg/Kg	120	N/A	160	300	180

N/A = Not applicable

APPENDIX E

Report on Selected Decant Facilities

OFFICE MEMORANDUM ... DEPARTMENT OF ENVIRONMENTAL SERVICES

To: Don Newell

From: Mark Ghezzi

Date: 09/26/97

Subject: Decant Site Investigation Summary

On September 17th and 18th, 1997 personnel from Multnomah County and the Oregon Department of Transportation (ODOT) investigated operational decant facilities in the Puget Sound area. The purpose of these visits were to find out what type of technologies are being used by other municipalities and government agencies within the region to help address the problem of road waste disposal.

Site investigations were performed at: (1) Snohomish County located south of Snohomish Valley, Washington. (2) King County located north east of Renton, Washington. (3) And the City of Seattle with facilities located in West Seattle and North Seattle, Washington. (4) In addition to the facilities located in the Puget Sound area I will also include the decant facility operated and owned by the City of Gresham, Oregon in this summary. Personnel attending the Puget Sound area site investigations include; Jeff Moore from the Oregon Department of Transportation, Don Newell and Mark N. Ghezzi from the Multnomah County Transportation and Land Use Planning Division. The City of Gresham site investigation was performed at an earlier date by Wayne Kelsey and Mark N. Ghezzi from the Multnomah County Transportation and Land Use Planning Division.

1) The Snohomish County decant station is one part of a Solid Waste disposal landfill facility located south of Snohomish Valley, Washington. The current operational decant station had a construction cost of approximately 1.5 million dollars in 1995. Snohomish County received a 700 thousand dollar grant from the Washington Department of Transportation to aid the construction cost. A roof for the facility was never constructed due to a lack of funds on the over budgeted construction cost. The facility receives material from *known government agencies and established private sector customers from city contracts within the county. A complete set of design prints can be obtained for this facility, however for the use of this report I will only offer a brief description.

The facility consisted of two levels constructed of concrete. The main level was 79' long and 78' wide. The first 15' of length had a 10% grade toward the back of the slab made of non-skid brushed concrete. The remaining 64' had a 3% grade to the back and a diagonal grade of 2.1% to the drain pit. Specific details on the construction of the drain pit will be left out of this report. See designs for details. Material is decanted in the respective vactor

*known : A documented history of bringing in consistently treatable loads. Such agencies or customers now includes, but not limited in the future to: Snohomish County Roads, Snohomish County Solid Waste, Snohomish County Surface Water, Washington State Department of Transportation and Snohomish County Cities and Towns.

first, weighed on a truck scale and then unloaded on the non-skid area farthest from the drain pit. The material separates as it travels to the drain pit. Once partially separated a scoop piles the material up and is allowed to separate over a period of time. Once dried, the material is relocated to the upper level. It is placed in cells formed by ecology blocks for further drying and storage until disposal. The water entering the drain pit joins the original decanted water from the vactor and is processed by the onsite leachate recovery control system associated with the landfill. Once dried the material is then placed in a landfill. In the past the material was stored on site at the Snohomish County Landfill. When the original landfill was full and capped, a new landfill was constructed adjacently. The newly constructed landfill is not being used at this time because the current County Commissioner would like to have the area surrounding the facility zoned for residential housing. The material is now being shipped out to a Rabanco landfill east of the Cascades at a cost of $40/ton. Snohomish County charges customers a flat $31.60 visit fee for dumping their decant liquid which also covers administrative costs. This fee is charged whether solids are dumped or not. In addition to this fee the customer is charged $5 1.00/ton for solids delivered to the facility. The disposal fees were created in an effort to pay for the construction and operational price of the facility, however at the present time they are losing money and in the process of increasing disposal fees.

The Decant facility works well and meets the disposal needs for Snohomish County and their users. The facility's design allows for a turn around time of 4-10 days pending weather from time of drop off until it is ready to be disposed of at a landfill. There are a few key design features that allow for this quick turn around rate. The first key feature is the long 3% back slope and the 2.1% diagonal slope. These long slopes allow the material to travel a great distance and separate in the process. Second, after the initial water has run off, the piling of the material allows gravity to help drive out the excess water. The third feature is storing the material in the ecology block cells. This allows the material to dry further in a location that directs the water to the drain pit for treatment while waiting to be shipped and disposed of One key design feature that would aid the turn around time would be construction of the initially planned roof. This would prevent the wet weather conditions from the Pacific North West from prolonging unnecessary processing time. One other design feature that would be helpful to the operation of the facility would be a small lip at the beginning of the 10% non-skid sloping concrete slab. This feature would help contain the material to the slab. Many of the maintenance workers commented that the material quite often splashes forward during the unloading process depending on the consistency of the load. Running heated piping under the slab fueled by the methane emissions from the adjacent landfill could also be a possible method of speeding up the drying process.

This facility appears to work well for Snohomish County. The existing leachate recovery control system helps the onsite processing of the decant liquid. This is an option that most agencies do not have. If possible, construction of a decant station with such a treatment facility associated with it would be beneficial. However, I feel this level of treatment is not necessary to meet regulatory requirements.

2) The King County decant facility is located outside of the city of Renton, Washington at one of the King County Roads Department quarries. The decant station consists of an asphalt lift with a 3-5% central slope and a 1% cross slope to the drainage system. The lift is designed to drain centrally from one side into a series of manholes. Attached to the decant station is a truck wash for cleaning the vactors and an oil/water separator. The building is 160' by 50' and is divided in to multiple sections by ecology blocks. Each section is designated for various types of waste and by generators. King County paved the asphalt lift themselves and contracted the building/roof structure of the facility at an estimated cost of 192 thousand dollars. A bid of 14 thousand dollars has just been accepted by King County for the construction of an underground baffle system. In the future King County will be constructing smaller versions of this decant station around the county. The Decant station receives material from the King County Roads Department and the City of Renton Roads Department This plant processes an estimated 5,000 tons of material annually. A loaded vactor first decants the water from the truck and discharges it into the drain. The vactor operator then proceeds to a truck scale and weighs in. Once weighed the load is dropped in the appropriate ecology block cell. After removing the material, the vactor is cleaned and weighed empty. The material is turned over and stacked inside the cells as needed to keep it piled up. The decanted water

makes its way to the drain pipe and into the manhole system. After the decanted water effluent passes through the manhole system it is discharged in to an existing sanitary sewer line. The dried material is removed and disposed of in a landfill at a price generally between 30 and 50 dollars per ton. In the future, street sweepings may be handled in a similar fashion after pre-screening treatment. However this is still under investigation.

This design incorporates some good ideas. The slopes guide the decanted water to the drainage system a rate which allows for separation. The ability to move walls constructed of ecology blocks make the system more versatile while maintaining the integrity of the decanting system. The sanitary sewer line should be adequate to treat any parameters present in the effluent discharge to meet regulatory requirements. The largest concern regarding the effluent discharge would probably be the amount of suspended particles entering the sanitary sewer line. Future considerations may need to be taken to incorporate some type of control system for containing suspended particles. This may be accomplished by the recently designed underground baffle system to be constructed in the upcoming year. Over all this decant station appears to work well for the price of construction. My only concern for this facility is the shared liability between the City of Renton and King County in case of a contaminated load. This facility is equipped with concrete vaults to contain such loads until proper disposal methods can be determined. My only recommendation for this facility is to construct a two foot wall along the back two sides of the decant station to contain run-off and direct all decanted water to the drainage system.

3) The City of Seattle currently has two operational decant stations that process vactor waste generated by the City of Seattle Roads Department. The primary station is located in West Seattle and the secondary station in the Halliday area of North Seattle. Both of these decant stations have dramatically different designs than previous facilities mentioned in this report.

The West Seattle decant station is a pit approximately 30'x 15'x 15' (length x width x depth). Vactor waste is loaded into the pit and allowed to separate over a long period of time. Decanted liquid passively travels to a drain three feet down in the pit. The liquid then passes through a large screen to catch debris from clogging the drainage system . The drainage system consists of a series of manholes and sumps. The decant liquid is then discharged into the sanitary sewer line. Solid material from the pit is removed by an excavator and placed in ecology-block cells until transport to a landfill for disposal. This station was constructed by the City of Seattle at an estimated cost of 40 thousand dollars. Landfill disposal fees for the solid material is generally between 30 and 50 dollars per ton.

The Halliday decant station is a 30'x 15'x 15' (length x width x depth) pit with a 30' ramp entering the pit. A custom made mobile truck box is placed inside the bottom of the pit. This box is designed to receive the vactor waste and decant the liquid through a system of drain pipes. After the decanted liquid exits the box it separates again in the pit and debris is screened before entering the sanitary sewer line. When all liquid has been decanted the loaded box is removed from the pit. The remaining material in the pit is removed by a scoop and placed in the box. The box is then stored onsite until transport to a landfill for disposal. This station was constructed by the City of Seattle at an estimated cost of 30 thousand dollars. The truck boxes were designed by Capital Industries, Inc., however a construction price was not available.

Both of these facilities did not work as well as originally planned. The drainage systems needed constant attention and maintenance at both facilities. The screening system at the West Seattle decant station allowed material and debris into the drainage system requiring back flushing and removal on a regular basis. 'Me truck box drain pipes clog easily and prevents the liquid component of the vactor waste from decanting effectively at the Halliday decant station. Here too the system needed back flushing to remove debris from the drainage system before entering the sanitary sewer line. Both of these facilities require redesigning and the appropriate retrofitting in order to operate efficiently.

4) The City of Gresham has a newly constructed decant station located in Gresham, Oregon. This facility serves the City of Gresham Street Maintenance and Storm water Divisions. The Gresham Decant station consists of a concrete slab, a truck washing station and an underground baffle system that feeds into the sanitary sewer line. The decant portion of the concrete slab is approximately 40' x 60' with a 3% central slope to a drainage line. The decant station receives vactor material on the sides from short docking bays. The material is accessed from the front of the decant station to be turned and pilled. The decanted liquid drains into the central drainage line and into the baffle system. The baffle system is accessed by manholes and two large metal plates. After passing through the baffle system, decanted liquid is discharged into the sanitary sewer line.

This facility does not work as well as the City of Gresham would like. The vactor waste is too fluid to work in this design. The concrete slab is too steep at 3% and too short with a 20' travel distance to the drainage line. The decant station does not separate the liquid and solid components adequately and the baffle system requires cleaning often. The City of Gresham has tried using Bio-Bags to slow the rate of movement in order to allow more time for the material to separate. This has been somewhat effective but still not efficient enough to meet their disposal needs. Since the decant station has been in operation the amount of material processed has drastically decreased. The City of Gresham is now reviewing the decant station design in an attempt to increase its efficiency.

Summary

During our investigation, observations of key design features responsible for high efficiency operations were made. The use of small slopes between 1%@3% over distances of 40'-60'+ seemed to allow adequate time for separation of most vactor waste. However, in some cases media such as bio-bags or mulch may be needed to slow the rate of movement depending on the consistency of the material and design of facility. After initial separation, pilling of the material allows gravity to help drive out excess liquid. Storage of this material in a covered dry area that allows for drainage will ensure complete separation of the liquid and solid components of the waste. The use of ecology-blocks for temporary walls and storage cells made these facilities more versatile to handle various needs. Drainage systems need to be easily accessible for cleaning and incorporate a filtration system for removal of debris.

Proposal

After taking part in the decant investigations and reviewing parameters present in vactor waste generated by the Multnomah County Transportation and Land Use Planning division, I would like to offer a few comments and design ideas for the construction of a decant facility by Multnomah County. A long 1%-3% sloped slab or lift of impervious material with an associated drainage system would be appropriate. The longer distance of travel and greater surface area, the larger amount of time the solid and liquid components of the waste will be allowed to separate. A series of easily accessible screens should be used to remove debris and prevent clogging of the drainage system. A baffle system would also be appropriate. This would allow a secondary system to remove any suspended solids from the decanted liquid. There have been no chemical parameters of concern present in laboratory reports requiring treatment of the liquid component before discharge into a sanitary sewer line. Total Petroleum Hydrocarbons (TPH) have been present, however these parameters will affix to the solid component of the waste. Discharge requirements into the sanitary sewer line should be met by removing the suspended solids from the decanted liquid. A specific investigation should be done with state and federal regulatory agencies to confirm sanitary sewer discharge requirements.

Mark N. Ghezzi

cc: Bob Thomas, Don Hauskins, Mike Snyder, Jeff Moore

A VISIT TO OREGON DECANT FACILITIES

January 20, 1998

As recorded by Jay Collins, Principal Investigator, ODOT

On January 20, 1998, Doug Pierce from WsDOT and Tony Barrett from Washington DOE joined Don Newell from Multnomah County, Jeff Moore from ODOT Clean Water Section, and Jay Collins from ODOT Research Unit on a tour of three Oregon decant facilities.

Lane County Decant Facility at Glenwood

Lane County partnered with the City of Springfield and the City of Eugene to build a vactor waste decant facility in centrally located Glenwood, Oregon. The urban Eugene-Springfield area has a population greater than 175,000. Each agency was represented on the design team. This team reviewed the designs of a variety of decant facilities in the Northwest and adopted the construction design for the Lane County facility. The facility cost $250,000 to construct and began operating in October 1996. A $250 per load dump fee for the partners covers ongoing operational costs and improvements.

We met with Doug Putschler, Road Maintenance Manager for Lane County Public Works, on site at 10:30 AM. The facility has an 80' square, sloped, concrete pad with walls on three sides (illustrations and a photograph log are attached). A concrete water collection trench runs from the center of the back wall most of the way across the pad. This trench is sided by hay bails at the back and by curbing that limits drainage to the trench. These features help to drop solids out of solution. Boards form a dike that separates the main collection trench from the outflow point. A small tube allows water to flow from the main trench into the outflow chamber prior to gravity piping to an underground tank for final settling. Wastewater is drawn off this tank and is disposed into a high flow sanitary sewer connection on site. A high roof covers the pad to keep rainfall off the drying vactor wastes and to reduce stormwater accumulation.

Three to four loads per day are dumped at the facility. Vactor trucks dump waste from the high point at the rear of the pad. Once the material is semi-solid, a front loader is used to move the waste from the dumping side to deeper, 4' high piles on the solids drying side. Piling the wastes increases pressure, which encourages further dewatering. They are weighing loads coming in and going out to calculate the percentage water removed. However, changes to operations have made this determination difficult, so far. Solids are mixed into the garbage at the adjacent solid waste handling facility and are taken to a sanitary landfill.

In the field, vactor trucks decant the identifiable water fraction into specified high-flow sanitary sewers. These high-flow sewer sites were selected to eliminate the need for pretreatment (e.g., suspended solids removal). Eugene spearheaded discussions with sanitary sewer authorities; four locations in Eugene are in use. Three field decant sites to the sanitary sewer are expected to be approved soon in Springfield.

This decant facility has agreed in principle to accept waste from one private company. However, coming up with an appropriate dump fee for parties who did not participate in construction costs has stalled their participation. Lane County and the Cities are interested in MOT as a potential partner in this facility.

As operations continue at the facility, possible improvements to the facility's design are identified, Mr. Putschler has very little time to devote to oversite of the facility, but several positive changes have been made. While the County is not yet entirely happy with how the facility runs, some problems were expected, and they are making it work. Doug shared the following comments:

> Plans are set to build an asphalt berm around the truck dump area. This will route vactor truck slop back into the treatment area through a slot to be cut in the back wall.
>
> They want to raise the back wall 3-4'. (At the time of the visit, the final dewatering piles nearly filled their area. Higher walls should allow higher stacking, which would increase storage/treatment capacity and should promote more efficient dewatering.)
>
> The slope on the dewatering pad is such that the front loader has to drive through the muck to get at the solids. This means that when the front loader leaves the area, the tires must be washed. A pad that slopes to the back would be better for placement of wastes and the majority of the solids would be easier to remove. The slight dish at the front of the pad would not be required, either, as the walls would provide the containment. This would allow for a longer dewatering slope on the same size pad.
>
> They have tried a variety of outflow pipe configurations from the trench outflow area. Shortly after operations began, the County installed a standpipe permitting only overflow to enter the pipe to the underground tank. This allowed the outflow area to act like an oil/water separator -- providing another settling point -- and reduced clogging in the pipe. What has worked best is a perforated standpipe. The perforations plug as solids accumulate in the trench outflow area, gradually moving the outflow point up the pipe. This also offers a visual check on how much material has accumulated.
>
> They are still experimenting with detention barriers to more efficiently drop out suspended solids onto the pad.

The line from the settling trench to the underground tank sometimes clogs, but this line (6" or possibly 8") is easy to blow out with vactor trucks. It does require maintenance but is not considered a design problem.

Management of the facility has also become an issue. Having sited the facility at an existing solid waste handling yard, the partners thought that Lane County Solid Waste would naturally take over management of the facility once it was constructed. This has not been the case. Operations have gradually improved, offering more efficient treatment and better performance for crews. However, solid waste or wastewater management professionals may be a more natural fit for management of such facilities.

Don Newell said that the facility's design would be useful for storage of sand or other roadway materials if its use as a decant facility was seasonal.

Mr. Putschler agreed to participate in ODOT's roadwaste management study, forwarding information on Lane County's vactor waste volumes, waste characterization (analyses), and the facility design plans.

Marion County Decant Facility at Brooks

We met with D.H. Garland from Marion County at the decant facility in Brooks at 1:30 PM. The pad is 45' square, with two settling tanks, and is operated without a roof The construction cost was $44,000. The facility gets 3 to 4 loads per week from the County and began operating in November 1997. Marion County does not field decant from their vactor trucks, so their loads have a high water content. They are interested in reducing the amount of water in their loads.

Most of the solids fall out where the material is unloaded to the pad. Liquid is kept from running off the pad by three short concrete walls and a sloped entrance. A slight slope also runs from left to right across the pad, and grating running along the right-hand wall is the outflow collection point. At one point, absorbent pads were placed on this grating to trap more solids and any oils. The liquids then flow into two underground storage tanks in series for more settling. Absorbent pads are maintained in the first tank to remove oil. The effluent is discharged to the immediately adjacent City of Brooks wastewater treatment lagoons.

So far, only a small amount of solids have accumulated. Once they need to be cleared away and solids removed from the tanks, Marion County plans to take the wastes either to the Marion County Landfill and/or to a thermal desorption facility (petroleum-contaminated soil burner) located in N. Marion County.

Marion County is not interested in sharing the facility, both due to size constraints and to concerns voiced from the City of Brooks regarding hazardous waste liabilities from hot loads,

Bruce Visser, Emergency and Environmental Manager for Marion County Public Works, would change the slope of the pad. He also intends to place some kind of barrier on the pad, perhaps an old fire hose filled with rock, to. act as an obstacle to get more solids to fall out before the drain trench. They also are considering the possibility of roofing the facility.

Mr. Visser provided facility design plans for ODOT's roadwaste management study (attached).

Unified Sewerage Agency (USA) Dewatering Facility at Rock Creek WWTP

We met Ted Clausen, SWM Maintenance Supervisor, at the USA offices in Hillsboro at 3:15 PM We then traveled to Rock Creek Wastewater Treatment Plant (Rock Creek WWTP), an impressive and modern WWTP complete with aerobic digesters and tertiary treatment for nitrogen and phosphorous compounds.

Very little money had been put into the vactor decant facility, but Mr. Clausen said that it worked better than any facility so far. Field decant of identifiable liquids is done into three field decant stations. These stations are sanitary sewer connections with 3-stage vaulted settling chambers on the front end to help remove suspended solids to avoid plugging. USA plans to establish three more field decant stations in each of the next two years and operate nine in total. The vactor trucks come into Rock Creek WWTP in the evening and sit overnight to allow more settling. Identifiable water is decanted to the WWTP prior to placement of the remaining vactor wastes in the dewatering area.

The dewatering area is very simple: a drain is located toward the back; long concrete blocks are stacked to form walls on three sides; vactor trucks dump waste on the pad; liquids run towards the drain. (The dewatering area shares a common wall with a similarly designed area used for dewatering of treated WWTP sludge. The WWTP sludge had a noticeable odor.) Dewatered wastes are removed with front loaders. USA disposes the solids at Hillsboro landfill at a cost of $60 per ton. Liquids are piped into Rock Creek WWTP for treatment.

Mr. Clausen said that USA plans to put more money into improving the dewatering facility now that they know this operation will remain on site for a few years.

Mr. Clausen was asked if they have plans to install a roof over their facility. He said that USA is looking into it, but the price tag for an 18' roof was a lot of the cost of building a new facility. Roof pluses and minuses were discussed. The main drawback sited was cost. Don Newell offered the suggestion of covering the final dewatering area only. This would eliminate the need for a high roof to accommodate the vactor trucks, providing much of the benefit of a roofed facility at a fraction of the usual cost. Mr. Newell suggested an exaggerated slope, starting at 5 to 7%, going to 3%, and ending at 2%. The solids would be pulled out and dewater under cover.

Ted Clausen said that USA was interested in partnering with ODOT, allowing use of the field decant stations and/or the dewatering facility for a fee. He said that the City of Beaverton operates a decant facility but the City has not been open to partnering. He also said that Forest Grove has an interesting way of dewatering their vactor wastes, using dumpsters. Jeff Moore said that he heard that New York City was using something similar and liked the operational flexibility and performance of the units.

Jay Collins requested information for ODOT's study on USA's vactor waste volumes, waste characterization (analyses), and any facility plans.

APPENDIX F

Roadwaste Worker Safety Procedures

by Katie Bretsch, City of Portland, Bureau of Environmental Services

Environmental Services, City of Portland

Collection Systems Operations and Maintenance Division

Sediment Management Plan

Section 1.0	**Worker Safety Issues and Strategies: Roles and Responsibilities**
Creation Date:	**14 September 2000**
Revision Date:	**14 September 2000**

The following discussion is designed to clarify the roles and responsibilities involved in management of safety issues related to City of Portland sediment operations. This discussion applies to the operation of the BES Inverness Stormwater Sediment Dewatering Facility, and to any other facilities at which joint sediment management operations are organized.

Because sediment operations are operated jointly by BES and BOM, both bureaus have roles.

The BOM Safety Manager has primary responsibility for defining the safety methods used by BOM personnel, including all safety issues related to operating methods and equipment.

The BES Wastewater Group Safety Officer has primary responsibility for defining the safety methods used by BES personnel and assessing safety needs of the site. The BES Wastewater Group Safety Officer, BES Program Manager and the BES Safety Committee will do a site survey at least once each year. Based on this inspection, the BES WG Safety Officer will create an action list of needed improvement items and take responsibility for monitoring implementation by the BES Program Manager.

The BOM Supervisor(s) have responsibility for monitoring risks, especially of equipment and facility operation, and implementing required safety methods, including making sure that needed personal protective equipment is supplied and available to all workers on site, in the equipment building (generator building North of the decant tank). The BOM Supervisor also has responsibility for any site or facility improvements to be accomplished by BOM.

The BES Program Manager has responsibility for monitoring risks, especially those related to the sediment and its contaminants, and any chemical or special treatment processes such as flocculation, including making sure that any needed personally protective equipment is supplied at the site and available to all workers in the equipment building (generator building North of the decant tank). The BES Program Manager also has responsibility for implementing needed facility improvements to the operating facilities to be accomplished by BES.

The BES Wastewater Group Facilities Manager is responsible for implementing needed general facility improvements, such as maintaining access for employees to a working washroom and site security, as well as coordinating with the BES Program Manager on issues that may impact the operation, such as improvements planned for other purposes.

Contractors are responsible for the safety of their own employees when engaged in work at the site.

All parties are responsible for promptly sharing information concerning risks, safety methods, and operational changes, and for coordinating with all other involved parties.

Environmental Services, City of Portland

Collection Systems Operations and Maintenance Division

Sediment Management Plan

Section 1.1	**Worker Safety Issues and Strategies: Routine Stormwater Sediment and Decant Operations**
Creation Date:	**14 September 2000**
Revision Date:	**14 September 2000**

This section addresses routine handling of normal stormwater facility sediment and decant. Suspect loads are handled based on standard hazardous materials protocols and are addressed in a separate section. Safety plans for any specific products and processes that require them will also be addressed in separate sections, if required. This section addresses concerns involved in routine handling of normal material, including chemical and gross contaminants, injury risks and noise.

Chemical Risk Factors

Substantial work has been done to quantify the contaminants in roadwaste, by City of Portland Environmental Services, by the Oregon Departments of Transportation and Environmental Quality, and by other jurisdictions in the Northwest. The findings are very consistent. In normal loads which have not been contaminated by specific incidents of illegal dumping, the following contaminants of concern will typically be found:

- lead,
- petroleum products and by-products, and,
- carcinogenic polyaromatic hydrocarbons.

These contaminants are largely bound to the ultra-fine clay particles that typically make up the base of the sediment. They are typically found at levels near or in excess of residential and/or industrial soil clean up standards. To date, no sediment loads handled at Inverness have tested hazardous. This includes even the few loads which have been contaminated by specific known dumping incidents.

Because the contaminants appear at relatively low levels and are bound to the fine sediment particles, **the risk of chemical exposures comes from ingestion**. Consequently, protective measures are designed to prevent ingestion.

Recommended protective measures include:

- Use gloves, safety glasses, boots and overalls when handling material.
- Clean up and wash thoroughly before lunch, breaks and quitting time.
- In dry conditions, use dust masks to avoid inhaling sediment dust.

Gross Contaminants

Anything that gets dropped onto streets is likely to end up in stormwater sediments. Trash and other larger identifiable wastes are referred to as "gross contaminants". The following kinds of trash are very typical:

- waste paper,
- cigarette butts and matches,
- cups and other fast food containers,
- golf balls,
- whole and broken bottle glass.

The following have all been observed, but more rarely:

- syringes,
- live ammunition,
- animal waste,
- human waste.

Because Vactor© operations result in substantial washing of the material with chlorinated tap water, a portion of the risks associated with these exposures are reduced. Nonetheless, protective measures are important.

Recommended protective measures for gross contaminants include the following:

- Avoid direct handling of sediments. Use shovels or mechanical equipment.
- Use gloves, safety shoes or boots, overalls and safety glasses when handling material.

Injury Risk Factors

Mechanical risk factors of the Inverness site include normal wastewater risks, including falls and falls into open liquid tanks, and improper use of high volume water hoses. Recommended protective strategies include:

- wearing safety shoes,
- working in pairs,
- fall prevention training, and
- placement of life rings near open tanks.

Noise

Some Vactor© operations generate high noise levels. Hearing protection is recommended when working on or near these operations.