March 30, 2007

Sandra Howell
FORCE Co-Director
C/O Assistant County Administrator, Sumter County
209 N. Florida St.
Bushnell, FL 33513

Re: **Environmental Assessment of Products Derived from Florida Yard Trash**
KCI Project No.: 06-07.00F

Dear Ms. Howell:

Kessler Consulting, Inc (KCI) is pleased to submit the attached three reports to Sumter County for the Florida Organics Recycling Center for Excellence (FORCE) project. These reports are part of our scope of work for a research project in Year 6 performed on existing data and documentation for herbicides, pesticides and heavy metals in yard waste compost and mulch. We assessed this issue from three methodologies:

- *Chemical Contamination of Yard Trash and Yard Trash Compost: A Literature Review* – With the assistance of Aziz Shirlapour, KCI conducted a literature search and summarized existing knowledge regarding the fate and transport of pesticides and heavy metals in yard trash products. The research and results are presented in *Appendix A*

- *Environmental Assessment of Home Landscape and Yard Pesticides* – KCI identified the herbicides and pesticides utilized by professional applicators and available for retail sale for home lawns and gardens, and analyzed Materials Safety Data Sheets for the products to determine their half life and other factors associated with environmental persistence and hazards. The research and results are presented in *Appendix B.*

- *Chemical Contamination of Florida Yard Trash Products: A Telephone Survey* – Contacted major producers, brokers, and consumers of Florida yard trash compost and mulch, and worked to obtain existing analyses and report actual levels of these contaminants found in Florida products. The research and results are presented in *Appendix C.*

KEY FINDINGS

The Literature Review found that chemical contaminants in yard trash, with a few specific exceptions discussed below, meet the most stringent environmental standards in Florida, namely the Soil Cleanup Target Levels for direct residential exposure (SCTL-R-

2005). It should be noted that these are standards for soil; not the products that may be mixed into, and thus diluted in, the soil.

- One study (Miller et al., 1992 as quoted in Strom, 2000) reported levels above the SCTL-R-2005 for Atrazine, Heptachlor Epoxide, and Lindane. Concentrations reported elsewhere in the literature fall well below the SCTL-R-2005 standards.

- Levels above the SCTL-R-2005 were reported in one source each for Arsenic and Copper. Shiralapour, 2002 reported an Arsenic concentration of 22 mg/kg in a California yard trash compost (SCTL-R-2005 standard is 2.1 mg/kg). Lisk, 1992 listed a Copper concentration of 327 mg/kg (SCTL-R-2005 standard is 150 mg/kg). However, these maximum concentrations reported in the literature fall well below Florida's standard for unrestricted use of biosolids products (Class AA compost), which are 41 mg/kg and 1,500 mg/kg for Arsenic and Copper, respectively.

In KCI's opinion, there appears to be little reason for broad-based regulatory concern regarding chemical contaminants in yard trash products after an analysis of the Literature Review.

The Pesticide Assessment identified a short list of pesticides that are both persistent in the environment and potentially hazardous or carcinogenic – Copper Sulfate, Imidacloprid, Pendimethalin, Disulfoton, and Prodiamine. The first four chemicals are found in very few retail products (less than 3 of the 125 products identified by this research), and the last is used only by professional applicators. Therefore, it is believed that their presence in the environment in general and yard trash in particular is very low. And thus, there appears to be very little potential for them to accumulate in yard trash products such as mulch and compost to a level that would pose a regulatory concern.

Finally, our survey of major yard trash processors and handlers in Florida found that not all yard waste mulch and compost producers and handlers conduct tests for pesticides, herbicides and trace elements. They are not required to do so by regulation, but are motivated by the desire to protect themselves and their customers from any damage that may be caused by possible contamination in their products. Most importantly, they want to produce a product that creates economic sustainability for their business.

In the tests reviewed, only two chemicals were found in measurable quantities: (1) Clopyralid (2.0 ug/kg) and (2) Metolochlor (17.0 ug/kg). All other chemicals analyzed were not detected. With regard to the three trace elements that were analyzed, the maximum levels measured were as follows: (1) Arsenic at 17.2 mg/kg, (2) Chromium at 7.5 mg/kg, and (3) Copper at 16 mg/kg. These levels are well below Florida's standards for Class AA compost (Arsenic 41 mg/kg and Copper 1,500 mg/kg). Florida has no standard for Chromium.

SUMMARY

KCI believes that, taken as a whole, the results of these three studies demonstrate there should be very little concern from a regulatory perspective regarding chemical contaminants in yard trash products.

This work was undertaken as a FORCE Year 6 research project. It is intended to assist the Florida Department of Environmental Protection (FDEP) evaluate whether or not products derived from yard trash (e.g. mulch and compost) should be regulated with regard to pesticides and trace elements. We anticipate that FDEP staff will review the documentation, have questions, and then provide additional direction for the documents in Year 7. Additionally, we will follow up this report with a yard/food waste demonstration project at the Sumter County solid waste, recycling, and composting facility (SWRCF) in Year 7.

We appreciate this opportunity to assist Sumter County FORCE with its work. Please do not hesitate to contact me if you have any questions or comments regarding this report.

Sincerely,

Kessler Consulting, Inc.

Peter Engel
Senior Associate

Enclosures

xc: Christie Revennaugh, Sumter County, Public Works, FORCE
Stacie Stokes/Jimmy Wise, Sumter County SWRCF
Jackey Jackson, Sumter County, Public Works, FORCE
Tommy Hurst/Denise Warnock, Public Works, Sumter County
Francine Joyal/Jan Rae Clark, Department of Environmental Protection
Richard Tedder, Department of Environmental Protection
Chris Snow, Recycle Florida Today, Organics Committee Chairperson
Miriam Zimms/Mitch Kessler, Kessler Consulting, Inc.

FORCE REPORT - MARCH 2007

ENVIRONMENTAL ASSESSMENT OF PRODUCTS DERIVED FROM FLORIDA YARD TRASH

Prepared for: Sumter County – FORCE
209 N. Florida St.
Bushnell, FL. 33513

Prepared by: Kessler Consulting, Inc.
14620 N. Nebraska Avenue
Bldg D
Tampa, FL 33613

APPENDIX A

CHEMICAL CONTAMINATION OF YARD TRASH AND YARD TRASH COMPOST: A LITERATURE REVIEW

INTRODUCTION & METHODOLOGY

A comprehensive literature review was undertaken to identify and compile existing data on chemical contaminants in yard trash and yard trash compost. This work was performed by Aziz Shiralipour, Ph.D. Associate Director (retired) of Biomass Programs at University of Florida. Trade journals, scientific periodicals, and academic research publications were reviewed to identify any research that analyzed yard trash or yard trash compost for pesticides, herbicides, or heavy metals. Publications were reviewed, abstracted, and quantitative results compiled. The results for each are provided in the following paragraphs (literature is presented in order from most recent to oldest).

RESULTS

1. **Heavy Metal Accumulation in a Sandy Soil and in Pepper Fruit Following Long-term Application of Organic Amendment**
   Ozores-Hampton, Monica, et al. *Compost Science & Utilization*. 2005; Vol. 13, No. 1, 60-64.

Abstract:
The objective of the research was to study the effects of long-term organic amendment application on the accumulation of heavy metal pollutants in soil and subsequent contamination in pepper fruits. Organic amendments, including yard trash were applied yearly to replicate large plots during 1996 to 2000 in Immokalee, Florida. Different organic amendments were applied every year to simulate grower organic amendment availability throughout long-term application. Chemical analysis of all organic amendments was performed during 1993 to 2000 seasons. Pollutant concentrations of the organic amendments were below maximum acceptable levels under Florida DEP (1989) and Federal Clean Water Act standards. Analysis of trace elements in Palm Beach yard trash measured during 1995-1997 is presented here:

Chemical Analysis of Palm Beach Yard Trash Waste (mg/kg dry weight)
Applied to the Soil During 1995 to 1997 Seasons

Element	*Yard Trash*
Cd	3.0
Cu	161
Pb	60.2
Mn	111
Ni	8.2
Zn	266

2. **Pesticide Screening in a Commercial Yard Waste and Biosolids Compost**
Wilson, P. Chris, et al., *Compost Science & Utilization*. 2003, Vol. 11, No. 4, 282-288.

Abstract:
The purpose of this study was to screen for the presence of selected pesticides in raw yard trash, milled yard trash, and finished compost at a commercial facility near Fort Pierce, Florida during 2001. Fifty pesticides were assessed in raw yard trash, milled yard trash, and finished compost (yard trash-Biosolids) at a commercial compost facility in Florida. These pesticides were comprised of 38 herbicides, 8 insecticides and 2 fungicides. Of the pesticides monitored for in this study, only atrazine, 4,4-DDE, alpha chlordane, gamma chlordane, and endosufan I were detected, and were only present in raw yard trash. The results are shown in the following table:

Chemical Contaminants in a Commercial Florida Yard Trash

		Concentration (SD)		
Analyte	*Detection Limit*	*Raw YT*	*Milled YT*	*Finished Compost*
Herbicides				
2,4-D	0.3 µg/kg	ND	ND	ND
2,4-DB	0.3 µg/kg	ND	ND	ND
2,4,5-T	0.3 µg/kg	ND	ND	ND
2,4,5-TP (Silvex)	0.3 µg/kg	ND	ND	ND
Alachlor	0.3 µg/kg	ND	ND	ND
Ametryn	0.3 µg/kg	ND	ND	ND
Atrazine	0.3 µg/kg	1.6 mg/kg (0.3)	ND	ND
Bromacil	0.3 µg/kg	ND	ND	ND
Butylate	0.3 µg/kg	ND	ND	ND
Chlorpropham	0.3 µg/kg	ND	ND	ND
Cyanzine	0.3 µg/kg	ND	ND	ND
Cycloate	0.3 µg/kg	ND	ND	ND
Dalapon	0.3 µg/kg	ND	ND	ND
Dicamba	0.3 µg/kg	ND	ND	ND
Dichloroprop	0.3 µg/kg	ND	ND	ND
Dinoseb	0.3 µg/kg	ND	ND	ND
Diphenamid	0.3 µg/kg	ND	ND	ND
EPTC	0.3 µg/kg	ND	ND	ND
Floridone	0.3 µg/kg	ND	ND	ND
Hexazinone	0.3 µg/kg	ND	ND	ND
MCPA	0.3 µg/kg	ND	ND	ND
MCPP	0.3 µg/kg	ND	ND	ND
Metibuzin	0.3 µg/kg	ND	ND	ND
Metolachlor	0.3 µg/kg	ND	ND	ND
Molinate	0.3 µg/kg	ND	ND	ND

Napropamide	0.3 µg/kg	ND	ND	ND
Norflurazon	0.3 µg/kg	ND	ND	ND
Pebulate	0.3 µg/kg	ND	ND	ND
Prometon	0.3 µg/kg	ND	ND	ND
Pronamide	0.3 µg/kg	ND	ND	ND
Propachlor	0.3 µg/kg	ND	ND	ND
Propazine	0.3 µg/kg	ND	ND	ND
Simetryn	0.3 µg/kg	ND	ND	ND
Tebuthiuron	0.3 µg/kg	ND	ND	ND
Terbacil	0.3 µg/kg	ND	ND	ND
Terbutryn	0.3 µg/kg	ND	ND	ND
Trifluralin	0.3 µg/kg	ND	ND	ND
Vernolate	0.3 µg/kg	ND	ND	ND
Insecticides				
4,4-DDE	0.1 µg/kg	7.0µg/kg (1.7)	ND	ND
Chlorpyrifos	0.3 µg/kg	ND	ND	ND
Ethoprop	0.3 µg/kg	ND	ND	ND
Alpha Chlordane	0.1 µg/kg	5.7µg/kg (1.2)	ND	ND
Gamma Chlordane	0.1 µg/kg	6.8µg/kg (0.9)	ND	ND
Endosulfan I	0.1 µg/kg	2.3µg/kg (0.3)	ND	ND
Methyl paraoxon	0.3 µg/kg	ND	ND	ND
Meviphos	0.3 µg/kg	ND	ND	ND
Fungicides				
Fenarimol	0.3 µg/kg	ND	ND	ND
Triademefon	0.3 µg/kg	ND	ND	ND
Miscellaneous				
Atraton	0.3 µg/kg	ND	ND	ND
Butachlor	0.3 µg/kg	ND	ND	ND
Dichlorvos	0.3 µg/kg	ND	ND	ND
Stirofos	0.3 µg/kg	ND	ND	ND
Tricyclazole	0.3 µg/kg	ND	ND	ND

ND = not detected; SD = standard deviation of three replicate sub-samples analyzed from the composite sample.

3. **Compost Utilization - Concern for Plant, Animal and Human Health**
   Shiralipour, A., *Composting in Southeast Conference and Exposition – Recycle Organics 02*. Palm Harbor, FL. 2002.

Abstract:
Potential users of compost are concerned about the presence of environmentally hazardous components, especially pathogens, heavy metals and toxic organic compounds. This research focused on the uptake of trace elements and toxic compounds by certain plants in Santa Barbara, CA during 1992-94. Three compost products were selected for

this experiment: yard trash, yard trash/biosolids and municipal solid waste (MSW). Chemical analyses were performed on soil, compost products and plant tissues. The trace element content of composts, including the heavy metals, was much lower than EPA 503 regulation limits. The trace element content of plants tissues was below the critical levels for plants, animals and human health. Except for a few toxic organic compounds in very low concentrations, no other toxic compounds could be detected in either soil or compost products.

The chemical analyses of organic toxic compounds and trace elements for yard trash and yard trash/biosolids performed on a composite sample. Results are shown below:

Toxic Organic Compounds in Yard Trash and Yard Trash/Biosolids Compost (ppm)

		Compost Type	
Analyte	*Detection Limit*	*YT*	*YT/Biosolids*
4,4-DDD	0.003	0.008	0.005
4,4-DDE	0.003	0.03	0.02
4,4-DDT	0.003	ND	0.005
Aldrin	0.016	ND	ND
Alpha-BHC	0.016	ND	ND
Beta-BHC	0.016	ND	ND
Delta-BHC	0.016	ND	ND
Gamma-BHC (Lindane)	0.016	ND	ND
Alpha-chlordane	0.016	0.03	0.03
Gamma-chlordane	0.016	0.03	0.01
Dieldrin	0.016	ND	ND
Endosulfan I	0.016	ND	ND
Endosulfan II	0.016	ND	ND
Endosulfan sulfate	0.016	ND	ND
Endrin	0.016	ND	ND
Endrin aldehyde	0.016	ND	ND
Endrin ketone	0.016	ND	ND
Heptachlor	0.016	ND	ND
Heptachlor epoxide	0.016	ND	ND
Methoxychlor	0.08	ND	ND
Toxaphane	0.016	ND	ND

Trace Elements in Yard Trash and Yard Trash/Biosolids Compost (mg/kg dry weight)

	Compost Type	
Analyte	*YT*	*YT/Biosolids*
As	22	20
B	50	30
Cd	1.5	2.2
Cu	58	70
Cr	24	22
Pb	42	30
Hg	0.45	0.61
Ni	28	26
Zn	240	220

4. Pesticides in Yard Waste Compost
Strom, Peter F., *Compost Science & Utilization*. 2000; Vol. 8, No. 1, 54-60.

Samples from six yard trash composting facilities in New Jersey were analyzed for a wide range of pesticide residues during 1993. Chlordane was found at low levels (0.3-3.2 mg/kg) in all samples; no other pesticide was detected.

Chlordane Concentrations (mg/kg dry weight) in Six New Jersey Yard Waste Composts

Site Number	*Sample A*	*Sample B*	*Average*
1	1.91	3.23	2.57
2	0.66	2.01	1.34
3	1.61	0.49	1.05
4	0.29	0.32	0.31
5	0.50	0.81	0.66
6	0.36	0.66	0.51
Average			1.07

The author sites the work of other scientists conducted in other parts of the country as shown in the following tables. The author concluded that "it appears likely that the source of the chlordane is the residential soil incorporated with the raw yard waste during collection. Based on these finding, routine analysis of yard waste compost for pesticide residues does not appear warranted."

Pesticides Detected in Croton Point, New York, Leaf Compost (ppm)

Analyte	*Average*	*Std. Dev.*	*Standards**
Captan	0.0052	0.0050	0.05-100*
Total chlordane	0.0932	0.1190	0.03*
Lindane	0.1810	0.2057	1.0-7.0*
Total 2,4-D	0.0025	0.0033	0.05-1.0*

* USDA tolerance levels for pesticides in food, 40 CFR Chapter, Part 180. Pesticides levels found in compost were compared to USDA tolerances for food products. Only chlordane, with average concentration of 0.09 ppm, exceeded the food tolerance standard of 0.03. From Richard and Chadsey, 1990. *BioCycle*, 31 (4): 42-46. Based on screening for 200 Pesticides in 12 samples of finished leaf compost collected in June, 1989.

Pesticides in Two Yard Trimmings Composts from Portland, Oregon (mg/kg dry weight)

			Concentration	
Analyte	*Total Samples*	*Sample > DT*	*Mean*	*Maximum*
2,4-D	16	0	ND	_
2,4-DB	16	0	ND	_
2,4,5-T	16	0	ND	_
Aldrin	16	1	0.007	0.007
Casoron (dichlobenil)	8	T	_	_
Chlorodane	19	17	0.187	0.37
Dalapon	4	0	ND	_
DDE	14	3	0.011	0.019
DDT	8	0	ND	_
opDDT	14	2	0.005	0.006
ppDDT	14	4	0.016	0.035
Diazinon	14	0	ND	_
Dicamba	16	0	ND	_
Dichloroprop	14	0	ND	_
Dieldrin	13	1	0.019	0.019
Dinoseb	5	1	0.129	0.129
Dursban (chlorpyrifos)	15	1	0.039	0.039
Endrin	16	0	ND	_
Lindane	16	0	ND	_
Malathion	14	0	ND	_
MCPA	16	0	ND	_
MCPP	16	0	ND	_
Parathion	14	0	ND	_
Pentachlorophenol	14	9	0.229	0.53
Silvex	16	0	ND	_
Trifluralin	10	T	_	_

From Hegberg et al.1991(personal communication). DT = Detection Limit; ND = Not Detectable; T = Trace: detectable, but not quantifiable.

Pesticide in Raw and Finished Materials (ppm) from 11 Illinois Landscape Waste Composting Sites

	Raw YT			*Finished Compost*		
Analyte	*Samples*	*Avg.*	*Max.*	*Samples*	*Avg.*	*Max.*
Herbicides						
2,4-D	44	1.04	9.88	44	0.268	7.92
2,4,5-T	35	0.788	5.97	38	1.15	8.30
Alachlor	40	0.749	2.71	39	0.304	1.48
Atrazine	35	4.61	33.0	25	3.03	28.0
Dichlobinil	41	0.014	0.127	37	0.013	0.12
Metolachlor	37	1.06	3.30	34	0.972	4.77
Trifluralin	40	0.142	1.29	30	0.156	0.75
Organo-chlorine Insecticides						
Chlordane	44	0.526	1.76	43	0.40	1.38
DDD	43	0.064	0.279	43	0.051	0.364
DDE	34	0.05	0.20	32	00.8	0.48
Dieldrin	44	0.010	0.038	44	0.008	0.032
Heptachlor	1	0.009	_	0	_	_
Heptachlor Epoxide	44	0.022	0.29	44	0.015	0.072
Lindane	42	0.495	4.61	42	0.314	2.61
Methoxychlor	29	0.314	1.49	19	0.507	2.25
Organo-phosphate Insecticides						
Chlorpyrifos	39	0.01	0.039	40	0.008	0.025
Diazinon	25	0.991	4.77	17	0.587	6.08
Fonofos	20	0.011	0.069	9	0.005	0.026
Malathion	36	0.313	1.05	27	0.169	0.485
Parathion	30	0.235	1.20	26	0.104	0.296
Carbamate Insecticides						
Carbaryl	38	22.5	75.1	41	11.0	49.3

From Miller et al. 1992. Based on 44 samples of both “raw” landscape waste and “finished” compost, 1 sample of each from each of 11sites on 4 separate dates in 1991. Limits = 0.0001 ppm; average is of levels detected.

5. **Occurrence and Fate of Pesticides in Compost and Composting Systems**
   Buyukosnmez, Fatih, et al. *Compost Science & Utilization*. 2000; Vol. 8, No. 1, 61-81.

This is a literature review paper and studies the available publications regarding the occurrence and the transformation of pesticides through the composting process and the use of compost. It reviews the research completed in various parts of the US dealing with the occurrence and the fate of pesticides in different raw materials and composts. The pesticide concentrations monitored in yard trash and yard trash compost in Seattle, Washington (1990), and in Illinois (1992) were presented in the following tables.

Pesticide Concentrations (ppm) in Yard Trimmings and Yard Trimmings Compost in Seattle, WA in 1990

Analyte	*YT (Day 0)*	*YT Compost (Day 90)*	*% Change*
Herbicides			
2,4-D	ND	ND	
2,4-DB	ND	ND	
2,4,5-T	ND	ND	
Dalapon	ND	ND	
Dicamba	ND	ND	
Dinosep	ND	ND	
Silvex	ND	ND	
Organochlorine Insecticides			
4,4-DDD	ND	0.00414	
4,4-DDE	0.0143	0.00108	-25%
4,4-DDT	0.0466	0.0159	-66%
Aldrin	ND	ND	
Alpha-BHC	0.0018	ND	
Beta-BHC	ND	ND	
Delta-BHC	ND	ND	
Gamma-BHC	0.00394	0.0068	-93%
Alpha-Chlordane	0.00789	0.0057	28%
Gamma-Chlordane	0.00567	0.0051	-10%
Dieldrin	0.00932	0.0119	+27%
Endosulfan i	ND	ND	
Endosulfan ii	0.00542	ND	
Endosulfan Sulfate	ND	ND	
Endrin	ND	ND	
Endrin Ketone	ND	ND	
Heptachlor	ND	ND	
Heptachlor epoxide	ND	ND	
Methoxychlor	0.00932	0.00623	-33%
Toxapane	ND	ND	

ND = not detectable.
Source: Herrera Environmental Consultants et al. 1991.

6. **Nutrient Availability and Changes in Microbial Biomass of Organic Amendments During Field Incubation**
He, Z. L., et al., *Compost Science & Utilization*. 2000; Vol. 8, No. 4, 293-302.

Abstract:
The objective of this investigation was twofold: 1) to examine the changes in concentrations of available N, P, K, Mn, Zn, Fe, and Cu in the organic amendments

during field incubation, and 2) to evaluate effects of increased availability of these elements on microbial biomass-C, and –P in surface-applied organic amendments and in the soil beneath each amendment. Three compost types including yard trash compost were incubated under field conditions in a citrus grove on a sandy soil to evaluate the release and bioavailability of nutrients and potential toxic elements from composts in 1999 in Homestead, Florida. The concentrations of potentially toxic elements such as Cu, Cd, Pb, Ni, and Zn in the yard trash were generally below maximum permissible concentrations for these elements in soil. The analysis included heavy metals and microbial biomass. Chemical properties of the organic amendments are shown in the following table:

Chemical Properties of Yard Trash Compost (mg/kg dry weight)

Analyte	*Concentration*
Cu	8
Cd	0
Pb	12
Mn	21
Ni	1
Zn	30

Microelements were measured using EPA method 3050 (US EPA 1978)

Extractable Nutrients in the Yard Trash (mg/kg dry weight)

Analyte	*Concentration*
Cu	3
Fe	177
Mn	10
Zn	20

7. **Heavy Metal, Pesticide and Pathogen Concerns in Composting**
   Marshal, et al., M. R., *Annual Report of Center for Biomass Programs, University of Florida*. 1997; pp 43-58.

Abstract:
The overall goal of this project was to develop experimental data concerning the safety and environmental impact of heavy metals and pesticides remediation in compost during 1997. This research evaluated heavy metals, pesticides content and pathogen survival in compost from four producers in the State of Florida. Specific objectives were 1) to sample and quantify certain heavy metals and pesticides content in composts from four commercial compost facilities 2) to determine rate and fate of degradation of radiolabel led atrazine using four different feedstock from commercial producers in a laboratory scale compost system; and 3) examine the survival of pathogen (E. coli) through composting. All samples were analyzed for certain trace elements, two herbicides (2,4-D

and silvex) and four insecticides (lindane, endrin, methoxychlor, and toxaphane) and pathogens. The data are shown in following tables:

Trace Elements in three Florida composts (mg/kg dry weight)

Analyte	*YT/Animal Manure*	*YT*	*YT/Biosolids*
As	2.18	2	6.18
Cd	0.31	0.55	1.67
Cr	4.64	10.05	22.1
Cu	45.87	28.32	192.67
Pb	2.98	31.55	27.73
Hg	0.06	0.10	1.04
Ni	1.33	4.23	12.6
Zn	135.33	143.5	299.17

Pesticides Levels at Two Commercial Composting Sites (ppm)

Analyte	*YT Compost*	*YT Mulch*
2,4-D	<0.1	<0.1
Silvex	<0.1	<0.1
Lindane	<0.05	0.05
Endrin	<0.1	<0.1
Methoxychlor	<0.1	<0.1
Toxaphene	<2	<2

"<" indicates that no pesticide could be detected below this level.

Pesticides Level in Two Compost Facilities (ppm)

Analyte	*Yard Trash/Animal Manure*	*Yard Trash*	*MDL**
Atrazine	<MDL	<MDL	0.25
Chlorpyrifos	<MDL	<MDL	0.1
Diazinon	<MDL	<MDL	0.1
Chlorothalonil	ND	ND	ND
2,4-D	ND	ND	ND

ND = Not Detectable; *MDL = Minimum Detection Levels.

8. **Management of Yard Waste Composting For Soil Amendment and Corn Yield**
   Gallaher, R. N. & R. McSorley, *Proceeding of the 1994 Southern Conservation Tillage Conference for Sustainable Agriculture, Columbia, South Carolina*. 1994.

Abstract:

The objective of this study was to determine the effect of yard trash compost on soil properties, corn nutrition, phytoparasitic nematodes and yield of corn during 1992 near Gainesville, Florida. Treatments applied on a field were 60 or 120 tons yard trash compost /acre compared to controlled plots receiving no yard trash compost. Nitrogen, P, K, Ca, MG, Cu, Fe, Mn, and Zn concentrations were determined in corn leaf, tissue, and the yard trash compost. Soil organic matter decreased with soil depth and increased significantly over the growing season, especially in the 120 ton yard trash compost/acre plot. All nematode numbers were greater at time of corn maturity compared to numbers at the beginning of the study. Trace elements in yard trash compost used in the Haufler farm were as follows:

Analysis of Yard Trash Compost used in Haufler Farm Demonstration Plots (ppm)

Compost Sample Site		
Analyte	Haufler Farm	Company Yard
Cu	11.7	11.8
Fe	1580	1448
Mn	146	176
Zn	91.2	151.3

9. Composting of Yard Waste and Wastewater Treatment Plant Sludge Mixtures
Reinhart, D. R., et al., *Compost Science & Utilization*. 1993; Vol. 1, No. 2, 58-64.

Abstract:
Composting of yard trash and sludge/yard trash mixtures was investigated during laboratory and field testing during 1991-1992 in Orange County, Florida. Yard Trimmings were collected from a total of 1,136 homes voluntarily participating in this program. The collected material consisted primarily of grass, brush, leaves, branches and Christmas trees. Yard trimmings, wastewater treatment facility sludge, and compost were analyzed for metals, pesticides, and nutrients. Compost quality was excellent, with pesticides below detection limit (0.05 mg/kg) and low concentrations of heavy metals. The only metals found at significant concentration were copper and zinc.

Results of metal analysis are presented in table below:

Final Product Chemical Composition

Elements	Yard Trash Compost	Yard Trash + Sludge Compost	Sludge	Florida Regulations*
Copper	-	57	119	450
Arsenic	<0.1	<0.1	<0.1	-
Cadmium	<0.1	0.12	<0.1	15
Barium	1.7	-	-	-

Silver	<0.1	-	4.72	-
Lead	8.13	2.00	<0.1	500
Selenium	0.31	-	<0.1	-
Chromium	1.7	-	<0.1	-
Nickel	-	0.65	<1.5	50
Zinc	-	36.9	58.1	900

"-" = analysis not done.
"<" indicates that analyte could not be detected below this level.
* Florida Department of Environmental Regulation, 1989.

10. Survey of Toxicants and Nutrients in Composted Waste Materials
Lisk, Donald J., et al., *Archives of Environmental Contamination and Toxicology*. 1992; 22:190-194.

Abstract:
A nationwide analytical survey was conducted of 21 toxic and nutrient elements, polychlorinated biphenyls (PCBs) and gamma emission in 26 composts (including 7 yard trash composts) sampled nationwide in 1991. Of the seven yard trash composts, one was composted in aerated static pile and six were composted in unaerated windrow. Biosolids and MSW composts tended to be higher in metals such as Cd, Cu, Hg, and Zn as compared to yard trash compost. PCBs and gamma emission were low or not detected in most compost samples. The elements Al, B, Ca, Cd, Co, Cr, Cu, Fe, K, Mg, Mn, Mo, Na, Ni, P, Pb, V, and Zn were analyzed by emission spectrometry.

Results for the seven yard trash compost samples are provided in the following table.

Concentrations of elements and other constituents in composted yard trash sampled throughout the United States

	Yard Trash Compost Sample Number						
	1	*2*	*3*	*4*	*5*	*6*	*7*
Analyte	*(ppm - dry weight)*						
B	33.4	5.8	16.5	49.5	36.6	45.5	42.1
Cd	0.39	0.33	ND	ND	0.42	0.81	ND
Co	ND	1.53	ND	ND	ND	ND	ND
Cr	44.7	111	72.4	236	95.6	8.4	78.9
Cu	66.8	169	73.4	327	166	22.7	107
Hg	0.16	0.04	0.09	0.21	0.19	0.12	0.12
Mn	392	125	481	465	656	191	615
Mo	ND	0.67	ND	1.09	0.73	ND	ND
Ni	26.6	61.0	39.4	152	61.5	3.27	50.9
Pb	197	24.0	53.9	235	39.1	11.4	132
Se	0.55	0.10	0.17	0.33	0.30	0.20	0.35
V	ND	2.89	ND	1.23	0.44	0.63	ND

Zn	227	41.6	118.5	295	149	100	217
PCBs	ND	ND	.06	.05	.05	ND	.04

ND = Not detectable; PCB = Polychlorinated biphenyls.

SUMMARY

The following tables summarize the range of values reported in the literature reviewed for this project. Only values for yard trash materials are considered – for example, values for a material that included yard trash and biosolids are not reported in this summary table because the focus of this project is yard waste contamination only.

Insecticide Concentrations in Yard Trash Reported in the Literature (ug/kg dry weight)

	Raw YT		*YT Compost*	
Analyte	*Min.*	*Max.*	*Min.*	*Max.*
Chlorinated Insecticides				
4,4-DDD	ND	280	4.14	360
4,4-DDE	7.0	200	ND (<0.3 ug/kg)	480
4,4-DDT	46.6	46.6	ND (<0.3 ug/kg)	35
Aldrin	ND		ND (<16 ug/kg)	7
alpha-BHC	1.8	1.8	ND (<16 ug/kg)	
beta-BHC	ND		ND (<16 ug/kg)	
delta-BHC	ND		ND (<16 ug/kg)	
gamma-BHC (Lindane)	3.94	4,160	ND (<16 ug/kg)	2,610
Chlordane	5.67	1,760	ND (<0.3 ug/kg)	1,380
Dieldrin	9.32	40	ND (<16 ug/kg)	320
Endosulfan I	ND	2.3	ND (0.3 ug/kg)	
Endosulfan II	5.42	5.42	ND (<16 ug/kg)	
Endosulfan sulfate	ND		ND (<16 ug/kg)	
Endrin	ND		ND (<16 ug/kg)	
Endrin aldehyde	ND		ND (<16 ug/kg)	
Endrin ketone	ND		ND (<16 ug/kg)	
Heptachlor	ND	10	ND (<16 ug/kg)	
Heptachlor epoxide	ND	290	ND (<16 ug/kg)	70
Methoxychlor	ND (<100 ug/kg)	1,490	ND (<80 ug/kg)	2,250
Pentachlorophenol				530
Toxaphene	ND		ND (<16 ug/kg)	
Phosphate Insecticides				
Chlorpyrifos	ND (0.1 ug/kg)	40	ND (0.1 ug/kg)	39
Diazinon	ND	4,770	ND	6,080
Dichlorvos	ND (0.3 ug/kg)		ND (0.3 ug/kg)	
Ethoprop	ND (0.1 ug/kg)		ND (0.1 ug/kg)	
Fonofos		70		30
Malathion		1,050		480

Methyl paraoxon	ND (0.3 ug/kg)		ND (0.3 ug/kg)	
Mevinphos	ND (0.3 ug/kg)		ND (0.3 ug/kg)	
Parathion		1,200		300
Tetrachlorvinphos (Stirofos)	ND (0.3 ug/kg)		ND (0.3 ug/kg)	
Carbamate Insecticides				
Carbaryl		75,100		49,300

Herbicide Concentrations in Yard Trash Reported in the Literature (ug/kg dry weight)

	Raw YT		*YT Compost*	
Analyte	*Min.*	*Max.*	*Min.*	*Max.*
Chlorinated Herbicides				
2,4-D	ND (0.3 ug/kg)	9,880	ND (0.3 ug/kg)	7,920
2,4-DB	ND (0.3 ug/kg)		ND (0.3 ug/kg)	
2,4,5-T	ND (0.3 ug/kg)	5,970	ND (0.3 ug/kg)	8,300
2,4,5-TP (silvex)	ND (0.3 ug/kg)		ND (0.3 ug/kg)	
Alachlor	ND (0.3 ug/kg)	2,700	ND (0.3 ug/kg)	1,480
Dichlobenil		130		120
Metolachlor	ND (0.3 ug/kg)	3,300	ND (0.3 ug/kg)	4,770
Other Herbicides				
Ametryn	ND (0.3 ug/kg)		ND (0.3 ug/kg)	
Atraton	ND (0.3 ug/kg)		ND (0.3 ug/kg)	
Atrazine	ND	33,000	ND (0.3 ug/kg)	28,000
Bromacil	ND (0.3 ug/kg)		ND (0.3 ug/kg)	
Butachlor	ND (0.3 ug/kg)		ND (0.3 ug/kg)	
Butylate	ND (0.1 ug/kg)		ND (0.1 ug/kg)	
Chlorpropham	ND (0.1 ug/kg)		ND (0.1 ug/kg)	
Cyanzine	ND (0.3 ug/kg)		ND (0.3 ug/kg)	
Cycloate	ND (0.1 ug/kg)		ND (0.1 ug/kg)	
Dalapon	ND (0.3 ug/kg)		ND (0.3 ug/kg)	
Dicamba	ND (0.3 ug/kg)		ND (0.3 ug/kg)	
Dichloroprop	ND (0.3 ug/kg)		ND (0.3 ug/kg)	
Dinoseb	ND (0.3 ug/kg)		ND (0.3 ug/kg)	129
Diphenamid	ND (0.1 ug/kg)		ND (0.1 ug/kg)	
EPTC	ND (0.3 ug/kg)		ND (0.3 ug/kg)	
Floridone	ND (0.3 ug/kg)		ND (0.3 ug/kg)	
Hexazinone	ND (0.1 ug/kg)		ND (0.1 ug/kg)	
MCPA	ND (0.3 ug/kg)		ND (0.3 ug/kg)	
MCPP	ND (0.3 ug/kg)		ND (0.3 ug/kg)	
Metibuzin	ND (0.3 ug/kg)		ND (0.3 ug/kg)	
Molinate	ND (0.1 ug/kg)		ND (0.1 ug/kg)	
Napropamide	ND (0.3 ug/kg)		ND (0.3 ug/kg)	
Norflurazon	ND (0.3 ug/kg)		ND (0.3 ug/kg)	
Pebulate	ND (0.1 ug/kg)		ND (0.1 ug/kg)	

Prometon	ND (0.1 ug/kg)		ND (0.1 ug/kg)	
Pronamide	ND (0.1 ug/kg)		ND (0.1 ug/kg)	
Propachlor	ND (0.1 ug/kg)		ND (0.1 ug/kg)	
Propazine	ND (0.1 ug/kg)		ND (0.1 ug/kg)	
Simetryn	ND (0.3 ug/kg)		ND (0.1 ug/kg)	
Tebuthiuron	ND (0.1 ug/kg)		ND (0.1 ug/kg)	
Terbacil	ND (0.1 ug/kg)		ND (0.1 ug/kg)	
Terbutryn	ND (0.1 ug/kg)		ND (0.1 ug/kg)	
Trifluralin	ND (0.1 ug/kg)	1,290	ND (0.1 ug/kg)	750
Vernolate	ND (0.1 ug/kg)		ND (0.1 ug/kg)	
<u>*Fungicides*</u>				
Captan				5.2
Fenarimol	ND (0.3 ug/kg)		ND (0.3 ug/kg)	
Triademefon	ND (0.3 ug/kg)		ND (0.3 ug/kg)	
Tricyclazole	ND (0.3 ug/kg)		ND (0.3 ug/kg)	

Heavy Metal Concentrations in Yard Trash Reported in the Literature (mg/kg dry weight)

	YT Compost	
Analyte	*Min.*	*Max.*
As	2	22
Cd	0.55	3
Cu	8	327
Cr	10.05	111
Pb	12	235
Hg	0.10	0.45
Mn	21	656
Ni	1	152
Zn	30	295

APPENDIX B

ENVIRONMENTAL ASSESSMENT OF HOME LANDSCAPE AND YARD PESTICIDES

INTRODUCTION

Florida Organics Recycling Center for Excellence (FORCE) is a legislatively funded project involving Sumter County and the Florida Department of Environmental Protection (FDEP). The ambition of FORCE is to promote organics recycling, research, and education within Florida. The FORCE Technical Advisory Group (TAG) collaborated and resolved to set forth a series of research and development projects for the 6th year of operation.

One of these projects was an environmental assessment of products derived from Florida yard trash, namely compost and mulch. The project objective was to consider whether herbicides, pesticides and heavy metals may be present in yard trash compost and mulch at levels that would cause regulatory concern. This project entailed three work activities:

- Conduct a literature search and summarize existing knowledge regarding the fate and transport of pesticides and heavy metals in yard trash products
- Identify pesticides utilized for lawn and garden care in Florida and assess their environmental persistence and hazards
- Contact major producers, brokers, and consumers of Florida yard trash compost and mulch, and work to obtain existing analyses and report actual levels of these contaminants found in Florida products

This Pesticide Assessment Report presents the results of the second work activity. It was researched and prepared by Kessler Consulting, Inc. (KCI).

Many government agencies have developed legislation for a broad range of activities such as agriculture, bioremediation, environmental control, pesticide registration and labeling, regulation and compliance. There are also a variety of publicly available sources including brand-specific labels, product information databases, pesticide information profiles, and the Material Safety Data Sheet (MSDS) provided by manufacturers and manufacturers' web sites. The purpose of this phase of the study is to identify lawn care chemicals in the marketplace, and research the toxicology of chemicals identified. This portion of the study was conducted primarily using the World Wide Web and email communications with various EPA and FDEP contacts.

METHODOLOGY

<u>Identifying Chemicals Available in Retail Products</u>

To determine the active chemical ingredients found in pesticide available for retail sale in Florida, KCI utilized the Household Chemical Database of the National Library of Medicine, located at http://householdproducts.nlm.nih.gov/ (accessed June 2006).

From the "Landscaping/Yard" category, KCI compiled a list of all household products listed in the following categories: Garden (Subcategory: Weed killer); Herbicide (Subcategories: Crabgrass control; Fertilizer w/ weed control; Grass, weed control; Weed control/turf); Insecticides - all; Lawn care (Subcategory: Weed control); Pesticide (Subcategory: Adjuvant); and Weed killer.

After eliminating duplicate products/types, the result was a final list of 125 products by Brand Name. For each Brand Name, the ingredients listed on the MSDS/label and their CAS (Chemical Abstracts Service) Registry Number were entered in an Excel spreadsheet. The occurrences of each chemical in the 125 products were counted, and the percentages of the occurrences calculated. Then duplicate chemicals were deleted from the list based on CAS Registry Number, resulting in 98 unique chemicals.

Certain active chemical ingredients were dropped because they were determined to be of minor concern with regard to environment and public health. These were:

- Pheromones (4):
    - Eugenol (CAS No. 97-53-0)
    - Geraniol (CAS No. 106-24-1)
    - 2-Phenyl ethyl propionate (CAS No. 122-70-3)
    - Japonilure (CAS No. 64726-91-6)
- Fertilizers (8):
    - Urea (CAS No. 57-13-6)
    - Potassium sulfate (CAS No. 7778-80-5)
    - Ammonium sulfate (CAS No. 7783-20-2)
    - Sulfur (CAS No. 7704-34-9)
    - Potassium chloride (CAS No. 7447-40-7)
    - Ammonium phosphate, dibasic (CAS No. 7783-28-0)
    - Ammonium Phosphate, monobasic (CAS No. 7722-76-1)
    - Phosphoric acid (CAS No. 7664-38-2)
    - Potassium magnesium sulfate (CAS No. 17855-14-0)
- Aqueous/emulsion diluent (CAS No. 999999-64-1)
- Bacillus thuringiensis (CAS No. 68038-71-1)
- Butane (CAS No. 106-97-8)
- Ferrous sulfate (CAS No. 7782-63-0)
- Iron(II) sulfate, monohydrate (CAS No. 17375-41-6)
- Isobutane (CAS No. 75-28-5)
- Mineral oil USP (CAS No. 8012-95-1)
- Nuisance dust (CAS No. 999999-60-8)
- Propane (CAS No. 74-98-6)
- Pyrethrum (CAS No. 8003-34-7)
- Pyrethrum (Pyrethrins) (CAS No. 999999-61-5)
- Quartz (CAS No. 14808-60-7)
- Rotenone (CAS No. 83-79-4)

- Sodium nitrite (CAS No. 7632-00-0)
- Water (CAS No. 7732-18-5)

After eliminating these 28 ingredients, 70 chemicals remained on the Excel spreadsheet for analysis. It was determined that two chemicals had more than one CAS numbers for the same compound:

- Mecoprop (MCPP) is represented by both CAS No. 7085-19-0 and CAS No. 93-65-2.
- Metaldehyde is represented by both CAS No. 9002-91-9 (monomeric form) and CAS No. 108-62-3 (polymeric form).

KCI then compiled information about the remaining 68 chemicals (*see Appendix i*). The table includes the following information:

- Chemical name, CAS number, usage type, and chemical class
- Number and percentages of occurrence in Florida household products
- World Health Organization (WHO) Acute Hazard Rankings
- Florida SCTL – Residential
- EPA Inert Chemical listing
- Cancer Classification
- Aerobic Soil Half-life
- Persistence classification from EXTOXNET Pesticide Information Profiles
- Pesticide Movement Rating, Soil Half-life, Soil Persistence and Water Solubility from the Oregon State University (OSU) Extension Pesticide Properties Database

The spreadsheet is organized in order according to occurrences in products currently on the market, sorted from most occurring to least occurring.

<u>Identifying Chemicals Utilized by Professional Applicators</u>

To identify pesticide that may be applied to Florida residential lawns and gardens, KCI obtained a report prepared by the Toxics Actions Network entitled “Refuse to Use ChemLawn – Be Truly Green.” This document published in 2005 lists all products utilized by ChemLawn and the products’ active ingredients. The document lists a total of 22 chemicals, of which 9 are included in the list of publicly available chemicals in Appendix i. The remaining 13 chemicals are utilized only by ChemLawn. KCI compiled the information listed regarding them (*see Appendix ii*).

<u>Researching Chemical Characteristics, Environmental Persistence and Hazards</u>

In order to identify chemical characteristics, environmental persistence and hazards, KCI reviewed numerous federal and state governmental agency websites regarding waste clean-up and remediation legislation and regulations or guides that include or could possibly include data on environmental persistence and hazards. The most applicable agencies included:

- Arizona Secretary of State
- Florida Department of Agriculture and Consumer Services
- Florida Department of Environmental Protection
- New Jersey Department of Human Health and Senior Services
- Office of Citizen Services and Communications, U.S. General Services Administration
- State of Connecticut Department of Environmental Protection
- U.S. National Library of Medicine (TOXMAP)
- U.S. Department of Agriculture
- U.S. Department of Health and Human Services Agency for Toxic Substances and Disease Registry
- U.S. Department of Health and Human Services National Toxicology Program
- U.S. Environmental Protection Agency
- Washington State Department of Transportation

KCI identified the chemical characteristics associated with environmental persistence and hazards through the websites of international agencies, educational programs, coalitions, professional organizations and panels. The most applicable sources include:

- American Chemistry Council Propylene Glycol Ethers Panel
- Beyond Pesticides/NCAMP
- Extension Toxicology Network
- Fluoride Action Network Pesticide Project
- National Institutes of Health
- National Pesticide Information Center
- National Pesticide Telecommunications Network
- Northwest Coalition for Alternatives to Pesticides
- Oregon State University Extension Service (EXTOXNET)
- Pesticide Action Network North America
- Physical & Theoretical Chemistry Laboratory
- Purdue Research Foundation
- Regulatory Compliance Systems, LLC (PESTICIDE.NET)
- Rutgers University IR-4 Project
- The Pesticide Stewardship Alliance
- University of Florida's Pesticide Information and Education Program
- World Health Organization

Material Safety Data Sheets were also examined to determine chemical information. MSDSs were obtained from several sources, including brand-specific labels, product information databases, and manufacturers and manufacturers' web sites.

Other sources include the book *A Review of the Scientific Literature as it Pertains to Gulf War Illnesses, Volume 8: Pesticides* by Gary Cecchine and others, and the website *Wikipedia: Chemical sources* by Wikimedia Foundation, Inc.

RESULTS & DISCUSSION

The research resulted in extensive information regarding 68 unique publicly available chemicals and 13 chemicals used only by professional lawn care providers (*see Appendices i and ii*). Research results for these categories of information are presented in the paragraphs below.

Use Type

The Use Type describes the most common use(s) for a pesticide active ingredient.

Chemical Usage Classification for Household Chemicals

Usage	Number of Chemicals	Usage	Number of Chemicals
Insecticide	27	Nematicide	3
Herbicide	26	Algaecide	1
Fungicide	6	Desiccant	1
Plant growth regulator	4	Insect growth regulator	1
Solvent & Adjuvant	4	Insect repellant	1
Defoliant	3	Rodenticide	1
Molluscicide	3	Synergist	1
Nematicide	3	Use type undetermined	5

Notes:
Totals do not add up because some chemicals may have multiple use types.
Adjuvant – used to increase effectiveness of active ingredients, make the product easier to apply, or to allow several active ingredients to mix in one solution. Solvents, emulsifiers, and spreaders fall in this category.
Synergist – a chemical compound that reacts with an active ingredient to accentuate its effectiveness.

Chemical Usage Classification for ChemLawn Chemicals

Usage	Number of Chemicals	Usage	Number of Chemicals
Herbicide	8	Fungicide	2
Insecticide	3	Solvent	1

Note:
Totals do not add up because some chemicals may have multiple use types.

Occurrence

Various products available on the market use the same chemicals. The following table indicates the most commonly used chemicals in household products that are readily available to the public.

Occurrence of Chemicals in Household Products

Chemical	**Number Products Containing It**
Permethrin	24
2,4-D	17
Mecoprop (MCPP)	15
Dicamba	13
Atrazine	11
Malathion	10
Tralomethrin & Piperonyl butoxide	8
Biphenthrin, Tetramethrin, & Glyphosate (isopropylamine salt)	7
lambda-Cyhalothrin & Metaldehyde	6
Diquat dibromide, Carbaryl, & Dicamba (dimethylamine salt)	5
Diazinon, Heptane, & Distillates (petroleum, hydrotreated light paraffinic)	4

All other chemicals occur in 3 or less of the 125 products.

Of the 68 unique chemicals that are found in the 125 household products listed above, 9 of these unique chemicals were determined to be active ingredients in pesticides available for use through a major residential lawn care provider. The other 13 unique chemicals utilized by this major residential lawn care provider are discussed in *Appendix ii*.

Florida SCTL

The Brownfields Redevelopment Act legislature directed the Florida DEP to incorporate Risk Based Corrective Action principles and to adopt appropriate soil cleanup target levels (SCTLs). The legislature mandated that for "direct exposure" levels (applicable in the top two feet of soils) the SCTLs be based upon consideration of calculations using a lifetime cancer risk level of 1×10^{-6}; a hazard index of 1 or less; the best achievable detection limits; or the naturally occurring background concentration.

SCTLs are risk-based cleanup target levels for chemicals of concern in soil based on direct human contact and migration of chemicals of concern from soil to groundwater. The lower the SCTL (mg/kg) is, the greater the concern for the presence of the chemical.

SCTLs are post-incident driven. Once a chemical has been identified, and then a target level determined, it is cleaned up to that level. Therefore, many SCTLs are for chemicals that don't break down quickly or have negligible degradation.

Household Chemicals

Of the 68 unique chemicals researched, 24 chemicals had SCTLs established for residential scenario cleanups in Table II of Chapter 62-777, of the Florida Administrative Code (F.A.C.):

Florida Residential Soil Clean-up Target Levels for Identified Chemicals

Chemical	SCTL	Chemical	SCTL
Disulfoton	3.3 mg/kg	1,1,1-Trichloroethane	730.0 mg/kg
Atrazine	4.3 mg/kg	2,4-D	770.0 mg/kg
Naphthalene	55.0 mg/kg	Mecoprop (MCPP)	800.0 mg/kg
Diazinon	70.0 mg/kg	Prometon	1200.0 mg/kg
Trifluralin	92.0 mg/kg	Malathion	1500.0 mg/kg
Acephate	120.0 mg/kg	Dicamba	2300.0 mg/kg
Diquat dibromide	190.0 mg/kg	Resmethrin	2500.0 mg/kg
Captan	230.0 mg/kg	Butanol	2900.0 mg/kg
Chlorpyrifos	250.0 mg/kg	Pendimethalin	3200.0 mg/kg
Propoxur	280.0 mg/kg	Permethrin	4200.0 mg/kg
Thiram	400.0 mg/kg	Carbaryl	7700.0 mg/kg
Methoxychlor	420.0 mg/kg	Acetone	11000.0 mg/kg

The remaining 44 chemicals do not have SCTLs established.

ChemLawn Chemicals

Of the 13 additional chemicals identified, 2 chemicals had SCTLs established for residential scenario cleanups in Table II of Chapter 62-777, of the Florida Administrative Code (F.A.C.):

Florida Residential Soil Clean-up Target Levels for Identified Chemicals

Chemical	SCTL
Glyphosate	8,800 mg/kg
MCPA	35 mg/kg

The remaining 11 chemicals do not have SCTLs established.

<u>EPA Inerts</u>

An inert ingredient is a substance, other than an active ingredient, which is intentionally included in a pesticide product and may play a role in its effectiveness. Most pesticide labels do not list their inert ingredients, but simply list the percent of inert ingredients in the product. For this project all named ingredients were listed and researched; some of which are classified as inert ingredients.

Since 1987, EPA has been actively evaluating new and existing inert ingredients for their toxicity before allowing their use in pesticide products. Most "inert" ingredients do not pose health or environmental concerns; however, EPA has long known and acknowledged that some inert ingredients are not benign to human health or the environment. It is possible that "inert" ingredients in some products may be more toxic or pose greater risk than the active ingredient.

EPA has divided the approximately 1,200 intentionally-added inert ingredients currently contained in pesticide products into four toxicity categories:

1. Inert of toxicological concern (List 1).
2. Potentially toxic inerts/high priority for testing (List 2).
3. Inert of unknown toxicity (List 3).
4. Inert of minimal concern (List 4).
   - List 4A: Minimal risk inert ingredients.
   - List 4B: Other ingredients for which EPA has sufficient information to reasonably conclude that the current use pattern in pesticide products will not adversely affect public health or the environment.

[The two critical distinctions between List 4A minimal risk substances and List 4B substances are that, while the Agency does not establish a use pattern or use limitation for a List 4A chemical substance, a List 4B may have such restrictions. Also, List 4 chemicals that are chemicals of higher acute toxicity are generally classified as List 4B, so that the Agency can evaluate the labeling and require the use of protective equipment. The substances on List 4B have no relevance to the provisions in FIFRA 25(b) for deregulated or exempted products.]

Household Chemicals

Of the 68 unique chemicals identified in this study, 10 were inert ingredients classified by the EPA in one of four categories of toxicological concern:

- List 2: Many List 2 inert ingredients are structurally similar to chemicals known to be toxic; some have data suggesting a concern:
  - Distillates, petroleum, hydrotreated light paraffinic
  - 1,1,1-Trichloroethane
  - Propylene glycol butyl ether
- List 3: An inert ingredient was placed on List 3 if there was no basis for listing it on any of the other lists. The EPA will continue to evaluate these chemical substances, and consider reclassification as additional information becomes available:
  - Acetone
  - Copper sulfate
  - Dimethylamine
  - Heptane
  - Naphthalene
  - Piperonyl butoxide

- List 4B: ingredients for which EPA has sufficient information to reasonably conclude that the current use pattern in pesticide products will not adversely affect public health or the environment:
    - Butanol
    - Copper sulfate
- The remaining 58 chemicals were not classified as inert by the EPA.

Please note that totals do not add up because Copper sulfate is listed on both List 3 and List 4B.

ChemLawn Chemicals

Of the 13 additional chemicals identified, 1 was an inert ingredient classified by the EPA:

- List 2: Many List 2 inert ingredients are structurally similar to chemicals known to be toxic; some have data suggesting a concern:
    - Naphtha, heavy aromatic (Aromatic 200)
- The remaining 11 chemicals were not classified as inert by the EPA.

<u>Cancer Classification</u>

The EPA report “The List of Chemicals Evaluated for Carcinogenic Potential” provides an overview of chemicals evaluated for carcinogenicity by the Health Effects Division of the Office of Pesticide Programs. This list includes pesticide active ingredients that have been submitted to EPA for registration, re-registration, or special review. The list contains 40 of the 68 chemicals identified in this study.

EPA issued its first set of principles to guide evaluation of human cancer potential in1976. In 1986, EPA issued updated guidance, which included a six-category alphanumeric classification system (A, B1, B2, C, and D) for designating degree of carcinogenic potential. In 1996, EPA released “Proposed Guidelines for Carcinogen Risk Assessment,” which used descriptive phrases rather than the alphanumeric classification to classify carcinogenic potential. By 1999, the science related to carcinogens had advanced significantly. EPA issued draft guidelines that continued the greater emphasis on characterization discussions. In March, 2005, EPA released its final *Guidelines for Carcinogen Risk Assessment* (EPA/630/P-03/001B), representing the culmination of a long development process, replacing EPA’s original cancer risk assessment guidelines (1986) and its interim final guidelines (1999).

Carcinogenic Potential of Identified Household Chemicals

Cancer Classification	**Definition**	**Number of Chemicals**
Group B – Probable Human Carcinogen (1986)	Group B2 -- Sufficient evidence from animal studies and “inadequate evidence" or "no data" from epidemiologic studies	2

Group C – Possible Human Carcinogen (1986)[1]	Limited evidence of carcinogenicity in animals in the absence of human data	6
Group D – Not Classifiable as to Human Carcinogenicity (1986)	Inadequate human and animal evidence of carcinogenicity or for which no data are available	8
Group E – Evidence of Non-carcinogenicity for Humans (1986)	No evidence for carcinogenicity in at least two adequate animal tests in different species or in both adequate epidemiologic and animal studies	6
Known/Likely (1996)[2]	Likely to be Carcinogenic to Humans at High Doses (Acifluorfen sodium); Likely to be carcinogenic to humans following prolonged, high-level exposures (Captan)	2
Not likely (1996)	Not Likely to be Carcinogenic to Humans at Low Doses (Acifluorfen sodium)	1
Likely to be Carcinogenic to Humans (1999) [3]	Available tumor effects and other key data are adequate to demonstrate carcinogenic potential to humans	4
Suggestive evidence of carcinogenicity (1999)	Evidence from human or animal data is suggestive of carcinogenicity, which raises a concern for carcinogenic effects but is judged not sufficient for a conclusion as to human carcinogenic potential	4
Not likely to be Carcinogenic to Humans (1999)	Available data are considered robust for deciding that there is no basis for human hazard concern	7
Likely to be Carcinogenic to Humans (2005) [4]	Weight of the evidence is adequate to demonstrate carcinogenic potential to humans but does not reach the weight of evidence for the descriptor "Carcinogenic to Humans"	1
Suggestive evidence of carcinogenic potential (2005)	Weight of evidence is suggestive of carcinogenicity; a concern for potential carcinogenic effects in humans is raised, but the data are judged not sufficient for a stronger conclusion	1
Not classified by the EPA[5]		28

Notes:
[1]The fo1ur chemicals identified in Group C (1986) are Acephate, Bifenthrin, Pendimethalin, Piperonyl butoxide, Tetramethrin and Trifluralin.
[2]The two chemicals identified as Known/Likely (1996) are Acifluorfen sodium and Captan.

[3]The six chemicals identified as Likely to be Carcinogenic to Humans (1999) Triforine, Carbaryl, Permethrin and Thiophanate-methyl.
[4]The one chemical identified as Likely to be Carcinogenic to Humans (2005) is Resmethrin.
[5]The remaining 28 chemicals were not classified by the EPA.

Please note that totals do not add up because Acifluorfen sodium is classified as both "Likely to be Carcinogenic to Humans at High Doses" and "Not Likely to be Carcinogenic to Humans at Low Doses", and Triforine is classified as both "Suggestive Evidence of Carcinogenicity, but Not Sufficient to Assess Human Carcinogenic Potential" and "Likely to be Carcinogenic to Humans."

Carcinogenic Potential of Identified ChemLawn Chemicals

Cancer Classification	**Definition**	**Number of Chemicals**
Group C – Possible Human Carcinogen (1986)[1]	Limited evidence of carcinogenicity in animals in the absence of human data	1
Group D – Not Classifiable as to Human Carcinogenicity (1986)	Inadequate human and animal evidence of carcinogenicity or for which no data are available	2
Group E – Evidence of Non-carcinogenicity for Humans (1986)	No evidence for carcinogenicity in at least two adequate animal tests in different species or in both adequate epidemiologic and animal studies	2
Not likely (1996)	Not Likely to be Carcinogenic to Humans at Low Doses	2
Likely to be Carcinogenic to Humans (1999) [2]	Available tumor effects and other key data are adequate to demonstrate carcinogenic potential to humans	1
Not likely to be Carcinogenic to Humans (1999)	Available data are considered robust for deciding that there is no basis for human hazard concern	5
Not classified by the EPA[3]		1

Notes:
[1]The one chemical identified in Group C – Possible Human Carcinogen (1986) is Prodiamine.
[2]The one chemical identified as Likely to be Carcinogenic to Humans (1999) is Trichlorfon. Note that Trichlorfon is both Likely to be Carcinogenic to Humans (High Doses), and Not Likely to be Carcinogenic to Humans (Low Doses).
[3]The remaining 1 chemical was not classified by the EPA.

Please note that totals do not add up because Trichlorfon is classified as both "Likely to be Carcinogenic to Humans (High Doses)" and "Not Likely to be Carcinogenic to Humans (Low Doses)."

Persistence and Soil Half-life

In hazard assessment, the soil half-life is a standard measure of the persistence of a pesticide in soil, and varies widely depending on many factors. In addition to inherent degradability of the compound itself, "typical soil half-life" value is an approximation and is affected by where the compound is found (soil, water, air, etc.) temperature, moisture, amount of organic matter present, etc.

The aerobic soil half-life is amount of time required for half of the pesticide to degrade in soil under aerobic conditions. Aerobic soil half-life was not found for 36 of the 68 chemicals.

The Oregon State University (OSU) Extension pesticide properties database provides a uniform classification of persistence based soil half-life as follows:

- Non-persistent: degrading to half the original concentration in less than 30 days
- Moderately persistent: degrading to half the original concentration in 30 to 100 days
- Persistent, taking longer than 100 days to degrade to half the original concentration.

Household Chemicals

Of the 68 chemicals identified, 29 were listed in the OSU database and 39 were not.

OSU Persistence Classification of Identified Chemicals

Chemical	*Soil Half Life*	*Persistence*
2,4-D, dimethylamine salt	10	non-persistent
Acephate	3	non-persistent
Acifluorfen sodium	14	non-persistent
Atrazine	60	moderately persistent
Bifenthrin	26	non-persistent
Captan	2.5	non-persistent
Carbaryl	10	non-persistent
Chlorpyrifos	30	moderately persistent
Diazinon	40	moderately persistent
Dicamba, dimethylamine salt	14	non-persistent
Disulfoton	30	moderately persistent
Esfenvalerate	35	moderately persistent
Fluazifop-P butyl ester	15	non-persistent
Glyphosate, isopropylamine salt	47	moderately persistent
lambda-Cyhalothrin	30	moderately persistent
Malathion	1	non-persistent
Mecoprop (MCPP) dimethylamine salt	21	non-persistent
Metaldehyde	10	non-persistent
Methoxychlor	120	persistent
Pendimethalin	90	moderately persistent

Permethrin	30	moderately persistent
Prometon	500	persistent
Propoxur	30	moderately persistent
Resmethrin	30	moderately persistent
Thiram	15	non-persistent
Tralomethrin	27	non-persistent
Triclopyr, triethylamine salt	46	moderately persistent
Trifluralin	60	moderately persistent
Triforine	21	non-persistent

EXTOXNET Pesticide Information Profiles (PIPs) provide specific pesticide information relating to health and environmental effects. Of the 68 chemicals identified in this study, 32 were categorized by EXTOXNET and 36 were not classified.

EXTOXNET Persistence Classification of Identified Chemicals

Chemical	*Persistence*
2,4-D	low persistence
Acephate	non-persistent
Acifluorfen sodium	moderately persistent
Atrazine	highly persistent
Cacodylic acid	low to moderate persistence
Captan	low persistence
Carbaryl	low persistence
Chlorpyrifos	moderately persistent
Copper sulfate	persist indefinitely
Deltamethrin	low persistence
Diazinon	low persistence
Dicamba	moderately persistent
Diquat dibromide	highly persistent
Disulfoton	low to moderate persistence
Esfenvalerate	moderately persistent
Fluazifop-P butyl ester	low persistence
Glyphosate, isopropylamine salt	moderately persistent
Imidacloprid	moderately persistent
lambda-Cyhalothrin	moderately persistent
Malathion	low persistence
Mecoprop (MCPP)	moderately persistent
Mecoprop (MCPP) dimethylamine salt	moderately persistent
Metaldehyde	low persistence
Methoxychlor	very persistent
Pendimethalin	moderately persistent
Permethrin	low to moderate persistence

Propoxur	low to moderate persistence
Resmethrin	low to moderate persistence
Thiram	low to moderate persistence
Triclopyr, triethylamine salt	moderately persistent
Trifluralin	highly persistent
Triforine	non-persistent

ChemLawn Chemicals

Of the 13 additional chemicals identified, 7 were listed in either the EXTOXNET or OSU databases. Persistence was reported as follows.

OSU and EXTOXNET Persistence Classification of Identified Chemicals

Chemical	*Persistence (EXTOXNET)*	*Soil Half-life (days) (OSU)*	*Soil Persistence (OSU)*
Cyfluthrin		30	moderately persistent
Glyphosate	moderately persistent		
MCPA	low persistence		
Myclobutanil		66	moderately persistent
Prodiamine		120	persistent
Trichlorfon	low persistence	10	non-persistent
Triclopyr	moderately persistent		

<u>WHO Acute Hazard Ranking</u>

The World Health Organization publication, *"The WHO recommended classification of pesticides by hazard and guidelines to classification: 2004"* classifies chemicals based on acute risk to human health taking into consideration the toxicity of the technical compound and its common formulations.

Household Chemicals

Of the 68 unique chemicals researched:

- 1 chemical is classified as IA = Extremely hazardous;
- 14 chemicals are classified as II = Moderately hazardous;
- 11 chemicals are classified as III = Slightly hazardous;
- 12 chemicals are classified as U = Unlikely to present acute hazard in normal use;
- No chemicals are classified as IB = Highly hazardous; FM = Fumigant, not classified; or O = Obsolete as pesticide, not classified;
- The remaining 31 chemicals are not listed on the *WHO Recommended Classification of Pesticides by Hazard.*

ChemLawn Chemicals

Of the 13 additional chemicals identified:

- 2 chemicals are classified as II = Moderately hazardous;
- 3 chemicals are classified as III = Slightly hazardous;
- 3 chemicals are classified as U = Unlikely to present acute hazard in normal use;
- No chemicals are classified as IA = Extremely hazardous; IB = Highly hazardous; FM =Fumigant, not classified; or O = Obsolete as pesticide, not classified;

The remaining 5 chemicals are not listed on the *WHO Recommended Classification of Pesticides by Hazard*.

SUMMARY

Landscape and garden pesticides that are either available for retail sale or utilized by professional applicators contain a broad range of chemicals. This study compiled a comprehensive list of chemicals that may be present in products used in Florida and researched various attributes of them, including toxicity and persistence in the environment.

Those chemicals that may be of greatest regulatory concern with regard to yard trash products (e.g. mulch and compost) would generally be those that are persistent – that do not readily degrade into non-toxic compounds – and are known to pose a significant risk to the environment or public health. This study identified a number of pesticides that are considered to be highly persistent from a general environmental perspective:

- Household pesticides – Copper Sulfate, Diquat Bromide, Dithiopyr, Imidacloprid, Methoxychlor, Pendimethalin, Prometon, and Disulfoton
- Professional applicator pesticides – Clopyralid and Prodiamine

It is important to note that our research found no comprehensive information regarding the how these chemicals react to high temperature as would be encountered at a yard trash processing or composting facility. Although it is known that most organic molecules break down more rapidly when subjected to heat.

The next point of concern is whether these chemicals pose any notable risk to the environment or public health. The following paragraphs provide additional information about chemicals that were determined to have high persistence and/or long half-life.

Copper Sulfate – Copper will persist indefinitely since it is an element. Copper sulfate is classified as moderately hazardous and non-carcinogenic. Copper is adsorbed to organic materials, and the degree of adsorption to soils depends on the acidity or alkalinity of the soil. Because copper sulfate is highly water soluble, it is considered one of the more mobile forms of the metal in soils. However, because of it binding capacity, its leaching potential is low in all but sandy soils. Copper sulfate is found in 1 of the 125 products.

Diquat Dibromide – is highly persistent and classified as non-carcinogenic; it does not have a WHO hazard rating. It is very well adsorbed by soil organic matter. Although it is water soluble, its capacity for strong adsorption to soil particles suggest that it will not easily leach through the soil, be taken up by plants or soil microbes, or broken down by sunlight. Field and laboratory tests show that diquat usually remains in the top inch of soil for long periods of time after it is applied. Diquat dibromide has an aerobic soil half-life of 3,450 days. The residential Florida SCTL is 190.0 mg/kg. Diquat dibromide is found in 5 of the 125 products.

Dithiopyr – is highly persistent, unlikely to be hazardous, and classified as non-carcinogenic. Dithiopyr has an aerobic soil half-life of 871 days and an anerobic soil half-life of 21,700 days. It is found in 3 of the 125 products.

Imidacloprid – is highly persistent, moderately hazardous, and considered non-carcinogenic. It has a half-life in soil as 48-190 days, depending on the amount of ground cover (it breaks down faster in soils with plant ground cover than in fallow soils). Imidacloprid has an aerobic soil half-life of 997 days. There is generally not a high risk of groundwater contamination with Imidacloprid if used as directed. The chemical is moderately soluble, and has moderate binding affinity to organic materials in soils. However, there is a potential for the compound to move through sensitive soil types including porous, gravelly, or cobbly soils, depending on irrigation practices. Imidacloprid is listed on the WHO Recommended Classification of Pesticides by Hazard as II, Moderately Hazardous. Imidacloprid is found in 1 of the 125 products.

Methoxychlor – is very persistent in soil, unlikely to be hazardous, and classified as non-carcinogenic. It has a reported representative half-life of approximately 120 days. However, rates may be as fast as 1 week in some instances. Methoxychlor degrades much more rapidly in aerobic soil than in anaerobic soil. Methoxychlor is tightly bound to soil and is insoluble in water, so it is not expected to be very mobile in moist soils. Methoxychlor has a residential Florida SCTL of 420.0 mg/kg. Methoxychlor is found in 3 of the 125 products.

Pendimethalin – is moderately persistent, slightly hazardous, and a possible carcinogen. It has a field half-life of approximately 40 days. Pendimethalin is strongly adsorbed by most soils. Increasing soil organic matter and clay is associated with increased soil binding capacity. It is practically insoluble in water, and thus will not leach appreciably in most soils, and should present a minimal risk of groundwater contamination. Pendimethalin has an aerobic soil half-life of 1,320 days. Pendimethalin is found in 3 of the 125 products.

Prometon – is moderately persistent in soil, unlikely to be hazardous, and listed as non-classifiable as a carcinogen. It adsorbs moderately to soil. Prometon has an aerobic soil half-life of 459 days, and the residential Florida SCTL is 1200.0 mg/kg. Prometon is found in 3 of the 125 products.

Disulfoton – has a low to moderate persistence in soils, is classified as extremely hazardous, and listed as non-carcinogenic. It is not strongly bound to soil, and its soil mobility decreases as organic matter content increases. Disulfoton has a residential Florida SCTL of 3.3 mg/kg.

Disulfoton is from the chemical class organophosphorus, and most are cholinesterase inhibitors, causing neurotoxicity in both insects and humans. Disulfoton is found in 1 of the 125 products.

Clopyralid – does not have a persistence classification by EXTOXNET or OSU, but has an aerobic soil half-life of 151.5 days, so it can be considered highly persistent. It is not on the WHO list, and in classified as unlikely to be carcinogenic. Clopyralid is from the chemical class Pyridinecarboxylic acid, which are herbicidal compounds with low acute toxicity. After its introduction to the marketplace in the early 1990s, Clopyralid was found to persist through active composting. The chemical persisted through composting and killed nursery plants grown in potting soil that contained the yard waste compost. After extensive research and pressure, the chemical's use was restricted to professional applicators only, and its use in the residential market is now very limited. Since that time, major yard trash composters and compost users have continued to test their materials for Clopyralid, and it appears that the problem has been solved by restricting the chemicals usage.

Prodiamine – is persistent in soil, classified as unlikely to be hazardous, and classified as a possible carcinogen. It has an extremely low pesticide movement rating, and has an aerobic soil half-life of 106 days. Prodiamine is from the chemical class 2,6-Dinitroaniline. While these compounds are not acutely toxic to animals, many of them are possible human carcinogens.

Based on this assessment it appears that only a small handful of pesticides are persistent and potentially hazardous or carcinogenic – Copper Sulfate, Imidacloprid, Pendimethalin, Disulfoton, and Prodiamine. The first four chemicals are found in very few retail products (less than 3 of the 125 products identified by this research), and the last is used only by professional applicators. Therefore, it is believed that their presence in the environment in general and yard trash in particular is very low. And thus, there appears to be very little potential for them to accumulate in yard trash products such as mulch and compost to a level that would pose a regulatory concern.

Appendix i

Household Pesticide Chemical Information

	Chemical	CAS #	Use Type	Chemical Class	Occurs in *xx* of 125 Products[1]	%	Hazard Rankings[2]	SCTL[3] (mg/kg)	EPA Inert[4]	Cancer Class	Soil Persistence[5]	Soil Persistence[6]	Soil Half-life[6] (days)	Solubility (mg/l)	Pesticide Movement[6]
1	Permethrin	052645-53-1	Insecticide	Pyrethroid	24	19.20%	II, Moderately Hazardous	4200.0		Likely	low to moderate persistence	moderately persistent	30	0	Extremely Low
2	2,4-D	000094-75-7	Herbicide, Growth Regulator	Chlorophenoxy acid or ester	17*	13.60%	II, Moderately Hazardous	770.0		Group D--Not Classifiable	low persistence			890	Moderate
3	Mecoprop (MCPP)	000093-65-2 007085-19-0	Herbicide	Chlorophenoxy acid or ester	15*	12.00%	III, Slightly Hazardous	800.0		-	moderately persistent			660,000	High
4	Dicamba	001918-00-9	Herbicide	Benzoic acid	13*	10.40%	III, Slightly Hazardous	2300.0		Group D--Not Classifiable	moderately persistent				
5	Atrazine	001912-24-9	Herbicide	Triazine	11	8.80%	U, Unlikely to be Hazardous	4.3		Not Likely	highly persistent	moderately persistent	60	33	High
6	Malathion	000121-75-5	Insecticide	Organophosphorus	10	8.00%	III, Slightly Hazardous	1500.0		Suggestive Evidence but Insufficient	low persistence	non-persistent	1	130	Extremely Low
7	Piperonyl butoxide	000051-03-6	Synergist	Unclassified	8	6.40%	U, Unlikely to be Hazardous		3	Group C--Possible	not classified				
8	Tralomethrin	066841-25-6	Insecticide	Pyrethroid	8	6.40%	Not listed			-	not classified	non-persistent	27	0	Extremely Low
9	Bifenthrin	082657-04-3	Insecticide	Pyrethroid	7*	5.60%	II, Moderately Hazardous			Group C--Possible	not classified	non-persistent	26	0	Extremely Low
10	Glyphosate, isopropylamine salt	038641-94-0	Herbicide	Phosphonoglycine	7	5.60%	Not listed			-	moderately persistent	moderately persistent	47	900,000	Extremely Low
11	Tetramethrin	007696-12-0	Insecticide	Pyrethroid	7	5.60%	U, Unlikely to be Hazardous			Group C--Possible	not classified				
12	Metaldehyde	000108-62-3 009002-91-9	Molluscicide	Aldehyde	6	4.80%	II, Moderately Hazardous			Suggestive Evidence	low persistence	non-persistent	10	230	Low
13	Lambda-Cyhalothrin	091465-08-6	Insecticide	Pyrethroid	6	4.80%	II, Moderately Hazardous			Group D--Not Classifiable	moderately persistent	moderately persistent	30	0	Extremely Low
14	Diquat dibromide	000085-00-7	Herbicide, Dessicant	Bipyridylium	5	4.00%	Not listed	190.0		Group E--Non-carcinogenic	highly persistent			718,000	Extremely Low
15	Carbaryl	000063-25-2	Insecticide, Growth Regulator, Nematicide	N-Methyl Carbamate	5*	4.00%	II, Moderately Hazardous	7700.0		Likely	low persistence	non-persistent	10	120	Low
16	Dicamba, dimethylamine salt	002300-66-5	Herbicide	Benzoic acid	5	4.00%	Not listed			-	not classified	non-persistent	14		Very High

Appendix i: Household Pesticide Chemical Information

	Chemical	CAS #	Use Type	Chemical Class	Occurs in *xx* of 125 Products[1]	%	Hazard Rankings[2]	SCTL[3] (mg/kg)	EPA Inert[4]	Cancer Class	Soil Persistence[5]	Soil Persistence[6]	Soil Half-life[6] (days)	Solubility (mg/l)	Pesticide Movement[6]
17	Diazinon	000333-41-5	Insecticide	Organophos phorus	4	3.20%	II, Moderately Hazardous	70.0		Not Likely	low persistence	moderately persistent	40	60	Low
18	Heptane	000142-82-5			4	3.20%	Not listed		3	-	not classified				
19	Distillates, petroleum, hydrotreated light paraffinic	064742-55-8	Insecticide, Adjuvant	Petroleum derivative	4	3.20%	Not listed		2	-	not classified				
20	Pendimethalin	040487-42-1	Herbicide	2,6-Dinitroanilin e	3*	2.40%	III, Slightly Hazardous	3200.0		Group C--Possible	moderately persistent	moderately persistent	90	0	Very Low
21	Dithiopyr	097886-45-8	Herbicide	pyridazones/ pyridinones	3*	2.40%	U, Unlikely to be Hazardous			Group E--Non-carcinogenic	not classified				
22	Methoxychlor	000072-43-5	Insecticide	Organochlori ne	3	2.40%	U, Unlikely to be Hazardous	420.0		Group D--Not Classifiable	very persistent	persistent	120	0	Extremely Low
23	Prometon	001610-18-0	Herbicide	Triazine	3	2.40%	U, Unlikely to be Hazardous	1200.0		Group D--Not Classifiable	not classified	persistent	500	720	Very High
24	Acifluorfen sodium	062476-59-9	Herbicide	Diphenyl ether	3	2.40%	Not listed			Likely at High Dose Unlikely at Low Dose	moderately persistent	non-persistent	14	250,000	Moderate
25	Esfenvalerate	066230-04-4	Insecticide	Pyrethroid	3	2.40%	II, Moderately Hazardous			Group E--Non-carcinogenic	moderately persistent	moderately persistent	35	0	Very Low
26	Resmethrin	010453-86-8	Insecticide	Pyrethroid	3	2.40%	III, Slightly Hazardous	2500.0		Likely	low to moderate persistence	moderately persistent	30	0	Extremely Low
27	Thiram	000137-26-8	Fungicide	Dithiocarba mate	3	2.40%	III, Slightly Hazardous	400.0		Not Likely	low to moderate persistence	non-persistent	15	30	Low
28	Fluazifop-P butyl ester	079241-46-6	Herbicide	Aryloxyphen oxy propionic acid	3	2.40%	III, Slightly Hazardous			-	low persistence	non-persistent	15	2	Very Low
29	Propylene glycol butyl ether	005131-66-8			3	2.40%	Not listed		2	-	not classified				
30	Phenothrin	026002-80-2	Insecticide	Pyrethroid	3	2.40%	U, Unlikely to be Hazardous			-	not classified				
31	S-Bioallethrin	028434-00-6	Insecticide	Pyrethroid	3	2.40%	Not listed			Suggestive Evidence but Insufficient	not classified				
32	Chlorpyrifos	002921-88-2	Insecticide, Nematicide	Organophos phorus	2	1.60%	II, Moderately Hazardous	250.0		Group E--Non-carcinogenic	moderately persistent	moderately persistent	30	0	Very Low

Appendix i: Household Pesticide Chemical Information

	Chemical	CAS #	Use Type	Chemical Class	Occurs in *xx* of 125 Products[1]	%	Hazard Rankings[2]	SCTL[3] (mg/kg)	EPA Inert[4]	Cancer Class	Soil Persistence[5]	Soil Persistence[6]	Soil Half-life[6] (days)	Solubility (mg/l)	Pesticide Movement[6]
33	Triclopyr, triethylamine salt	057213-69-1	Herbicide	Chloropyridinyl	2	1.60%	Not listed			Group D-- Not Classifiable	moderately persistent	moderately persistent	46	2,100,000	Very High
34	Deltamethrin	052918-63-5	Insecticide	Pyrethroid	2	1.60%	II, Moderately Hazardous			Not Likely	low persistence				
35	Acephate	030560-19-1	Insecticide	Organophosphorus	2	1.60%	III, Slightly Hazardous	120.0		Group C-- Possible	non-persistent	non-persistent	3	818,000	Low
36	Disodium octaborate tetrahydrate	012008-41-2	Insecticide	Inorganic	2	1.60%	Not listed			-	not classified				
37	Triforine	026644-46-2	Fungicide, Insecticide	Unclassified	2	1.60%	U, Unlikely to be Hazardous			Suggestive Evidence but Insufficient	non-persistent	non-persistent	21	30	Moderate
38	Mecoprop (MCPP) dimethylamine salt	069237-09-8	Herbicide	Chlorophenoxy acid or ester	2	1.60%	Not listed			-	moderately persistent	non-persistent	21	660,000	High
39	2,4-D, dimethylamine salt	002008-39-1	Herbicide	Chlorophenoxy acid or ester	2	1.60%	Not listed			-	not classified	non-persistent	10	796,000	Moderate
40	D-Allethrin	042534-61-2	Insecticide	Pyrethroid	2	1.60%	Not listed			-	not classified				
41	Copper sulfate	007758-98-7	Fungicide, Algaecide, Molluscicide	Inorganic-Copper	1	0.80%	II, Moderately Hazardous		3, 4B	-	persist indefinitely				
42	Imidacloprid	138261-41-3	Insecticide	-	1*	0.80%	II, Moderately Hazardous			Group E-- Non-carcinogenic	moderately persistent			Moderate	
43	Trifluralin	001582-09-8	Herbicide	2,6-Dinitroaniline	1	0.80%	U, Unlikely to be Hazardous	92.0		Group C-- Possible	highly persistent	moderately persistent	60	0	Very Low
44	Propoxur	000114-26-1	Insecticide	N-Methyl Carbamate	1	0.80%	II, Moderately Hazardous	280.0		Group B2 -- Probable	low to moderate persistence	moderately persistent	30	1,800	High
45	Cacodylic acid	000075-60-5	Herbicide, Defoliant	Organoarsenic, Heavy metal	1	0.80%	III, Slightly Hazardous			Group B2 -- Probable	low to moderate persistence				
46	Disulfoton	000298-04-4	Insecticide, Nematicide	Organophosphorus	1	0.80%	Ia, Extremely Hazardous	3.3		Group E-- Non-carcinogenic	low to moderate persistence	moderately persistent	30	25	Low
47	Captan	000133-06-2	Fungicide	Thiophthalimide	1	0.80%	U, Unlikely to be Hazardous	230.0		Likely at prolonged, high-level exposures	low persistence	non-persistent	2.5	5	Very Low
48	Butanol	000071-36-3	Solvent	Alcohol/Ether	1	0.80%	Not listed	2900.0	4B	-	not classified				

Appendix i: Household Pesticide Chemical Information

	Chemical	CAS #	Use Type	Chemical Class	Occurs in *xx* of 125 Products[1]	%	Hazard Rankings[2]	SCTL[3] (mg/kg)	EPA Inert[4]	Cancer Class	Soil Persistence[5]	Soil Persistence[6]	Soil Half-life[6] (days)	Solubility (mg/l)	Pesticide Movement[6]
49	Naphthalene	000091-20-3	Insecticide, Insect Repellent		1*	0.80%	Not listed	55.0	3	-	not classified				
50	Acetone	000067-64-1	Solvent	Unclassified	1	0.80%	Not listed	11000.0	3	Group D--Not Classifiable	not classified				
51	Dimethylamine	000124-40-3	Fungicide	Phenoxy Herbicide	1	0.80%	Not listed		3	-	not classified				
52	Sodium cacodylate	000124-65-2	Herbicide, Defoliant, Rodenticide	Organoarsenic, Heavy metal	1	0.80%	Not listed			-	not classified				
53	Calcium acid methanearsonate	005902-95-4	Herbicide, Defoliant	Organoarsenic, Heavy metal	1	0.80%	Not listed			Not Likely	not classified				
54	Isooctyl ester of 2,4,-D acid	025168-26-7	Herbicide	Chlorophenoxy acid or ester	1	0.80%	Not listed			-	not classified				
55	DMA salt of MCPA	002039-46-5	Herbicide	Chlorophenoxy acid or ester	1	0.80%	Not listed			Not Likely	not classified				
56	Thiophanate-methyl	023564-05-8	Fungicide	Benzimidazole precursor	1	0.80%	U, Unlikely to be Hazardous			Likely	not classified				
57	Prallethrin	023031-36-9	Insecticide	Pyrethroid	1	0.80%	II, Moderately Hazardous			Not Likely	not classified				
58	d-Mecoprop (Mecoprop-P)	016484-77-8	Herbicide	Chlorophenoxy acid or ester	1	0.80%	III, Slightly Hazardous			Suggestive Evidence Insufficient	not classified				
59	Halofenozide	112226-61-6	Insecticide	Diacylhydrazine	1	0.80%	U, Unlikely to be Hazardous			-	not classified				
60	Cube resins (unspecified)	000000-28-2		No data are currently available.	1	0.80%	Not listed			-	not classified				
61	1,1,1-Trichloroethane	000071-55-6	Solvent	Halogenated organic	1	0.80%	Not listed	730.0	2	Group D--Not Classifiable	not classified				
62	d-trans-Allethrin	028057-48-9	Insecticide	Pyrethroid	1	0.80%	Not listed			-	not classified				
63	2-(2,4-Dichlorophenoxy)propionic acid isooctyl ester	028631-35-8	Herbicide, Growth Regulator	Chlorophenoxy acid or ester	1	0.80%	Not listed			-	not classified				
64	DMA salt of 2,4-DP (2-(2-methyl-4-chlorophenoxy) propanoic acid)	053404-32-3	Herbicide, Growth Regulator	Chlorophenoxy acid or ester	1	0.80%	Not listed			-	not classified				
65	d-Methoprene	065733-16-6	Insect Growth Regulator		1	0.80%	Not listed			-	not classified				

Appendix i: Household Pesticide Chemical Information

	Chemical	CAS #	Use Type	Chemical Class	Occurs in xx of 125 Products[1]	%	Hazard Rankings[2]	SCTL[3] (mg/kg)	EPA Inert[4]	Cancer Class	Soil Persistence[5]	Soil Persistence[6]	Soil Half-life[6] (days)	Solubility (mg/l)	Pesticide Movement[6]
66	(+)-R-2-(2-methyl-4-chlorophenoxy)propionic acid	066423-09-4	Herbicide	Chlorophenoxy acid or ester	1	0.80%	Not listed			-	not classified				
67	(R,Z)-5-(1-Decenyl) Dihydro-2(3H) Furanone	999999-80-5		-	1	0.80%	Not listed			-	not classified				
68	Phthalic/glycerol alkyl resin	999999-99-9		-	1	0.80%	Not listed			-	not classified				

Notes:
[1] Chemicals marked with an asterisks (*) are also active ingredients in ChemLawn products
[2] World Health Organization Acute Hazard Ranking
[3] Florida Residential Soil Clean-up Target Level (mg/kg)
[4] US EPA, Inert (Other) Pesticide Ingredients in Pesticide Products (http://www.epa.gov/opprd001/inerts/lists.html)
[5] Source: EXTOXNET
[6] Source: OSU

	Chemical	Persistence[1]
1	Permethrin	Permethrin is of low to moderate persistence in the soil environment, with reported half-lives of 30 to 38 days. Permethrin is readily broken down, or degraded, in most soils except organic types. Permethrin is tightly bound by soils, especially by organic matter. It is not very mobile in a wide range of soil types. Because permethrin binds very strongly to soil particles and is nearly insoluble in water, it is not expected to leach or to contaminate groundwater.
2	2,4-D	2,4-D has low soil persistence. The half-life in soil is less than 7 days. Soil microbes are primarily responsible for its disappearance. Despite its short half-life in soil and in aquatic environments, the compound has been detected in groundwater supplies in at least five States and in Canada. Very low concentrations have also been detected in surface waters throughout the U.S..
3	Mecoprop (MCPP)	The duration of mecoprop's residual activity in soil is about two months. Adsorption of mecoprop increases with an increase in organic matter in the soil. Unaged MCPP and its salt forms are very mobile in a variety of soils. Because of this high mobility, it may potentially leach into groundwater. However, in general, phenoxy herbicides such as MCPP are not sufficiently persistent to reach groundwater.
4	Dicamba	Dicamba is moderately persistent in soil. The half-life of dicamba in soil is typically 1 to 4 weeks. Under conditions suitable for rapid metabolism, the half-life is less than 2 weeks. Metabolism by soil microorganisms is the major pathway of loss under most soil conditions. The rate of biodegradation increases with temperature and increasing soil moisture, and tends to be faster when soil is slightly acidic. When soil moisture increases above 50%, the rate of biodegradation declines. Dicamba slowly breaks down in sunlight. Volatilization from soil surfaces is probably not significant, but some volatilization may occur from plant surfaces. It is stable to water and other chemicals in the soil. Dicamba does not bind to soil particles and is highly soluble in water. It is therefore highly mobile in the soil and may contaminate groundwater. In humid areas, dicamba will be leached from the soil in 3-12 weeks.
5	Atrazine	Atrazine is highly persistent in soil. Chemical hydrolysis, followed by degradation by soil microorganisms, accounts for most of the breakdown of atrazine. Hydrolysis is rapid in acidic or basic environments, but is slower at neutral pHs. Addition of organic material increases the rate of hydrolysis. Atrazine is moderately to highly mobile in soils with low clay or organic matter content. Because it does not adsorb strongly to soil particles and has a lengthy half-life (60 to >100 days), it has a high potential for groundwater contamination despite its moderate solubility in water.
6	Malathion	Malathion is of low persistence in soil with reported field half-lives of 1 to 25 days. Degradation in soil is rapid and related to the degree of soil binding. Breakdown occurs by a combination of biological degradation and nonbiological reaction with water. It is moderately bound to soils, and is soluble in water, so it may pose a risk of groundwater or surface water contamination in situations which may be less conducive to breakdown.
7	Piperonyl butoxide	Researchers evaluated the degradation of piperonyl butoxide in soil at three sites, and the maxium half-life was 4.3 days. They did not detect residues after 30 days. It has a moderate to low leaching potential. Researchers evaluated the disappearance of piperonyl butoxide in soil and water and determined that the chemical is short-lived in the environment. It has a moderate to low potential to contaminate groundwater. If released to soil, piperonyl butoxide is expected to have moderate to low mobility based upon Koc values in the range of 399-830. Volatilization from moist soil surfaces is not expected to be an important fate process based upon an estimated Henry's Law constant of 8.9X10-11 atm-cu m/mole. Piperonyl butoxide is not expected to volatilize from dry soil surfaces based on its estimated vapor pressure. Piperonyl butoxide is rapidly degraded in soil, with a half-life of 14 days in aerobic soils. If released into water, piperonyl butoxide is expected to adsorb to suspended solids and sediment based upon the Koc.

Appendix i: Household Pesticide Chemical Information

	Chemical	Persistence[1]
8	Tralomethrin	If released to soil, tralomethrin is expected to have no mobility based upon a Koc range of 43,796 to 675,667. Volatilization from moist soil surfaces is not expected to be an important fate process based upon an estimated Henry's Law constant of 3.9X10-10 atm-cu m/mole. Tralomethrin is not expected to volatilize from dry soil surfaces based upon its vapor pressure. Tralomethrin's half-life in soil has been reported to have a range of 64-84 days. If released into water, tralomethrin is expected to adsorb to suspended solids and sediment based upon its Koc. Volatilization from water surfaces is not expected to be an important fate process based upon this compound's estimated Henry's Law constant.
9	Bifenthrin	Bifenthrin does not move in soils with large amounts of organic matter, clay and silt. It also has a low mobility in sandy soils that are low in organic matter. Bifenthrin is relatively insoluble in water, so there are no concerns about groundwater contamination through leaching.
10	Glyphosate, isopropylamine salt	Glyphosate is moderately persistent in soil, with an estimated average half-life of 47 days. Reported field half-lives range from 1 to 174 days. It is strongly adsorbed to most soils, even those with lower organic and clay content.
11	Tetramethrin	Degradation up to 24% occurs after 28 days incubation. The substance degrades rapidly in water, particularly in neutral and alkaline conditions. Degradation is about 34% after 120 h at pH 4. When Tetramethrin was exposed to artificial sunlight for 28 days, degradation up to 18% occurred.
12	Metaldehyde	Metaldehyde is of low persistence in the soil environment. It is weakly sorbed by soil organic matter and clay particles, and is soluble in water. Due to its low persistence, it is not a significant risk to groundwater.
13	Lambda-Cyhalothrin	Lambda cyhalothrin is moderately persistent in the soil environment. Its field half-life is probably close to 30 days in most soils. It shows a high affinity for soil; the reported Koc is 180,000. Lambda cyhalothrin is not expected to be appreciably mobile in most soils. There is little potential for groundwater contamination. Soils with high sand content or with very low organic matter content may tend to retain the compound to a lesser degree. In field studies of Karate, leaching of lambda cyhalothrin and its degradates from the soil were minimal.
14	Diquat dibromide	Diquat dibromide is highly persistent. It is very well adsorbed by soil organic matter and clay. Although it is water soluble, its capacity for strong adsorption to soil particles suggest that it will not easily leach through the soil, be taken up by plants or soil microbes, or broken down by sunlight (photochemical degradation). Field and laboratory tests show that diquat usually remains in the top inch of soil for long periods of time after it is applied.
15	Carbaryl	Carbaryl has a low persistence in soil. Degradation of carbaryl in the soil is mostly due to sunlight and bacterial action. It is bound by organic matter and can be transported in soil runoff. Carbaryl has a half-life of 7 to 14 days in sandy loam soil and 14 to 28 days in clay loam soil.
16	Dicamba, dimethylamine salt	Dicamba has a relatively short half-life of 1 to 4 weeks. Dicamba is biodegraded by soil microbes and aquatic microorganisms.
17	Diazinon	Diazinon has a low persistence in soil. Bacterial enzymes can speed the breakdown of diazinon and have been used in treating emergency situations such as spills. Diazinon seldom migrates below the top half inch in soil, but in some instances it may contaminate groundwater.
18	Heptane	When released into the soil, this material may biodegrade to a moderate extent. When released into the soil, this material is not expected to leach into groundwater. When released into the soil, this material is expected to quickly evaporate. When released into water, this material may biodegrade to a moderate extent. When released to water, this material is expected to quickly evaporate.
19	Distillates, petroleum, hydrotreated light paraffinic	An environmental fate analysis is not available for this specific product. Plants and animals may experience harmful or fatal effects when coated with petroleum products. Petroleum-based (mineral) lubricating oils normally will float on water. In stagnant or slow-flowing waterways, an oil layer can cover a large surface area. As a result, this oil layer might limit or eliminate natural atmospheric oxygen transport into the water. With time, if not removed, oxygen depletion in the waterway may be sufficient to cause a fish kill or create an anaerobic environment. This material contains phosphorus which is a controlled element for disposal in effluent waters in most sections of North America. Phosphorus is known to enhance the formation of algae. Severe algae growth can reduce oxygen content in the water possibly below levels necessary to support marine life.
20	Pendimethalin	Pendimethalin is moderately persistent, with a field half-life of approximately 40 days. It does not undergo rapid microbial degradation except under anaerobic conditions. Slight losses of pendimethalin can result from photodecomposition and volatilization. Pendimethalin is strongly adsorbed by most soils. Increasing soil organic matter and clay is associated with increased soil binding capacity. It is practically insoluble in water, and thus will not leach appreciably in most soils, and should present a minimal risk of groundwater contamination.
21	Dithiopyr	Dithiopyr is broken down in the soil by both chemical and microbial degradation. Very little vertical or lateral movement of dithiopyr occurs. Therefore, there is little chance of groundwater contamination when dithiopyr is used according to label directions.
22	Methoxychlor	Methoxychlor is very persistent in soil, with a reported representative half-life of approximately 120 days. However, rates may be as fast as 1 week in some instances. Methoxychlor degrades much more rapidly in soil that has a supply of oxygen (aerobic) than in soil without oxygen (anaerobic). Methoxychlor is tightly bound to soil and is insoluble in water, so it is not expected to very mobile in moist soils. Actual mobility will depend on site-specific factors (e.g., soil organic matter and rainfall). Movement of the pesticide is more likely via adsorption to suspended soil particles in runoff.
23	Prometon	When prometon is applied to soil, it will adsorb moderately to the soil. Prometon is moderately persistent in soil. It is not known whether it degrades by a chemical or microbial process . In a greenhouse experiment using a ryegrass bioassay it took between 4.5 and 20 weeks and >60 wks for 50% and 80% of prometon activity to disappear when the herbicide was applied at 0.25 lb/acre . At an application rate of 1.0 lb/acre >60 weeks were required for half of its phytotoxicity to disappear. No prometon degraded during the course of a 24-day volatilization experiment performed in a special chamber using moist San Joaquin sandy loam at a temperature of 25 deg C . An important mechanism by which prometon is lost from soil is by volatilization. Prometon rises to the soil surface with evaporating water and as the concentration of the herbicide at the soil-air interface increases, its adsorption to the soil decreases and the amount of prometon volatilizing increases.

Appendix i: Household Pesticide Chemical Information

	Chemical	Persistence[1]
24	Acifluorfen sodium	Acifluorfen is moderately persistent in soils. Microbial action accounts for the majority of the compound's loss from soil. No leaching of the chemical below 3 inches was observed.
25	Esfenvalerate	Esfenvalerate is moderately persistent with a half-life ranging from about 15 days to three months depending on soil type. Esfenvalerate and its breakdown products are relatively immobile in soil and thus pose little risk to groundwater. The compounds ability to bind to soil increases with increasing organic matter. It is very insoluble in water.
26	Resmethrin	Resmethrin is of low to moderate persistence in the soil environment. Its half-life has been estimated at 30 days. Resmethrin is tightly bound to soil and would not be expected to be mobile or to contaminate groundwater, especially in light of its extremely low solubility in water.
27	Thiram	Thiram is of low to moderate persistence. It is nearly immobile in clay soils or in soils high in organic matter. Because it is only slightly soluble in water (30 mg/L) and has a strong tendency to adsorb to soil particles, thiram is not expected to contaminate groundwater. The soil half-life for thiram is reported as 15 days. Thiram degrades more rapidly in acidic soils and in soils high in organic matter. In a humus sandy soil, at pH 3.5, thiram decomposed after 4 to 5 weeks, while at pH 7.0, thiram decomposed after 14 to 15 weeks. Thiram persisted for over 2 months in sandy soils, but disappeared within 1 week from a compost soil.
28	Fluazifop-P butyl ester	Fluazifop-p-butyl is of low persistence in moist soil environments, with a reported half-life in these conditions of less than 1 week. Fluazifop-p-butyl breaks down rapidly in moist soils to the fluazifop acid, which is also of low persistence. Fluazifop-p-butyl and fluazifop-p are both reported to be of low mobility in soils and not to present appreciable risks for groundwater contamination. The reported soil adsorption coefficient for fluazifop-p indicates a moderate to low affinity for soil.
29	Propylene glycol butyl ether	Environmental Testing of Propylene Glycol Ethers Most of the propylene glycol ethers are considered readily biodegradable based on U.S. Environmental Protection Agency (EPA) criteria. Only the tertiary-butyl compounds (PGtBE and DPGtBE), which biodegrade at a slightly slower rate, do not meet these stringent criteria. No propylene glycol ethers would be expected to be persistent in the environment. Many propylene glycol ethers (including PGME, PGMEA, PGBE, PGPhE, DPGME, DPGBE, and TPGME) have been tested in a wide variety of aquatic organisms (including daphnia magna, fathead minnows and guppies) to assess short term environmental toxicity. Most of the studies have found propylene glycol ethers to be "relatively harmless" under U.S. Fish and Wildlife criteria; in a few tests the compounds fell in the "practically non-toxic category."
30	Phenothrin	No data are currently available.
31	S-Bioallethrin	No data are currently available.
32	Chlorpyrifos	Chlorpyrifos is moderately persistent in soils. Soil half-life was not affected by soil texture or organic matter content. In anaerobic soils, the half-life was 15 days in loam and 58 days in clay soil. Adsorbed chlorpyrifos is subject to degradation by UV light, chemical hydrolysis and by soil microbes. When applied to moist soils, the volatility half-life of chlorpyrifos was 45 to 163 hours, with 62 to 89% of the applied chlorpyrifos remaining on the soil after 36 hours. In another study, 2.6 and 9.3% of the chlorpyrifos applied to sand or silt loam soil remained after 30 days. Chlorpyrifos adsorbs strongly to soil particles and it is not readily soluble in water. It is therefore immobile in soils and unlikely to leach or to contaminate groundwater. TCP, the principal metabolite of chlorpyrifos, adsorbs weakly to soil particles and appears to be moderately mobile and persistent in soils.
33	Triclopyr, triethylamine salt	In natural soil and in aquatic environments, the ester and amine salt formulations rapidly convert to the acid, which in turn is neutralized to a relatively nontoxic salt. It is effectively degraded by soil microorganisms and has a moderate persistence in soil environments. The half-life in soil ranges from 30 to 90 days, depending on soil type and environmental conditions, with an average of about 46 days. The half-life of one of the breakdown products (trichloropyridinol) in 15 soils ranged from 8 to 279 days, with 12 of the tested soils having half-lives of less than 90 days. Longer half-lives may occur in cold or arid conditions. Triclopyr is not strongly adsorbed to soil particles and has the potential to be mobile.
34	Deltamethrin	In soil, degradation occurs within 1-2 weeks.
35	Acephate	Acephate dissipates rapidly with half-lives of <3 and 6 days in aerobic and anaerobic soils, respectively. The major metabolite was CO_2 in both soil types. TLC and soil column studies indicate acephate is mobile in most soils but that aged residues (excluding acephate and its degradate methamidophos) are immobile in sandy loam soil. Most of the applied acephate and degradate methamidophos degrade to immobile compounds in 20 days. Methamidophos and carbon dioxide were identified as the major soil metabolites.
36	Disodium octaborate tetrahydrate	Boric Acid/Borate Salt: Relatively high water solubility results in the chemical reaching aquatic environments. It is assumed to adsorb to soil particles and aluminum and iron minerals. Adsorption can be either reversible or irreversible, depending on soil characteristics. Boric acid is mobile in soil.
37	Triforine	The half-life of triforine in soil is approximately 3 weeks. A range of non-fungitoxic metabolic end-products are formed, presumably including piperazine. It is considered non-persistent in soil.
38	Mecoprop (MCPP) dimethylamine salt	The duration of mecoprop's residual activity in soil is about two months. Adsorption of mecoprop increases with an increase in organic matter in the soil. Unaged MCPP and its salt forms are very mobile in a variety of soils. Because of this high mobility, it may potentially leach into groundwater. However, in general, phenoxy herbicides such as MCPP are not sufficiently persistent to reach groundwater.
39	2,4-D, dimethylamine salt	No data are currently available.

Appendix i: Household Pesticide Chemical Information

	Chemical	Persistence[1]
40	D-Allethrin	No data are currently available.
41	Copper sulfate	Breakdown in soil and groundwater: Since copper is an element it will persist indefinitely. Copper is bound, or adsorbed, to organic materials, and to clay and mineral surfaces. The degree of adsorption to soils depends on the acidity or alkalinity of the soil. Because copper sulfate is highly water soluble, it is considered one of the more mobile metals in soils. However, because of its binding capacity, its leaching potential is low in all but sandy soils. When applied with irrigation water, copper sulfate does not accumulate in the surrounding soils. Some (60%) is deposited in the sediments at the bottom of the irrigation ditch, where it becomes adsorbed to clay, mineral, and organic particles. Copper compounds also settle out of solution.
42	Imidacloprid	The half-life of imidacloprid in soil is 48-190 days, depending on the amount of ground cover (it breaks down faster in soils with plant ground cover than in fallow soils). There is generally not a high risk of groundwater contamination with imidacloprid if used as directed. The chemical is moderately soluble, and has moderate binding affinity to organic materials in soils. However, there is a potential for the compound to move through sensitive soil types including porous, gravelly, or cobbly soils, depending on irrigation practices.
43	Trifluralin	Breakdown in soil and groundwater: Trifluralin is of moderate to high persistence in the soil environment, depending on conditions. Trifluralin is subject to degradation by soil microorganisms. Trifluralin remaining on the soil surface after application may be decomposed by UV light or may volatilize. Reported half-lives of trifluralin in the soil vary from 45 to 60 days to 6 to 8 months. After 6 months to 1 year, 80 to 90% of its activity will be gone. It is strongly adsorbed on soils and nearly insoluble in water. Because adsorption is highest in soils high in organic matter or clay content and adsorbed herbicide is inactive, higher application rates may be required for effective weed control on such soils. Trifluralin has been detected in nearly 1% of the 5590 wells tested. However, it has been detected at very low concentrations, typically ranging from 0.002 ug/L to 15 ug/L.
44	Propoxur	Breakdown in soil and groundwater: Propoxur is of moderate to low persistence in the soil environment, with reported field half-lives of 14 to 50 days. It has a low affinity for soil binding, and so may be mobile in many soils. Because it is highly soluble in water, is moderately persistent, and does not adsorb strongly to soil particles, propoxur has a high potential for groundwater penetration. In one study, there was practically no loss of propoxur from a silt-loam soil to which it was applied during a 6-month period, but 25% of applied Baygon was lost from sand in 100 days. In another study, propoxur was very mobile in sandy loam, silt loam and silty clay soils. The rate of biodegradation in soil increases in soils that have been previously exposed to propoxur or other methylcarbamate pesticides.
45	Cacodylic acid	Cacodylic acid has low to moderate persistence in soil. Cacodylic acid is quickly inactivated upon contact with the soil by adsorption to soil particles and ion exchange. Soil microorganisms degrade most of the cacodylic acid in the soil. A breakdown product, arsenic, competes with phosphorus in the soil. It forms insoluble salts with chromium, silver, or other metals.
46	Disulfoton	Breakdown in soil and groundwater: Disulfoton has a low to moderate persistence in soils. Disulfoton is not strongly bound to soil. Some metabolites are more mobile than the parent disulfoton in sandy loam, clay loam, and silty clay loam soils. Mobility decreases as organic matter content of soil increases. In addition, these metabolites can persist longer than disulfoton. In a study on sandy loam soils, disulfoton had a half-life of 1 week, and 90% loss in 5 weeks. One metabolite had a half-life of 8 to 10 weeks, and another was fairly stable for 42 weeks. Disulfoton has been found in groundwater in Virginia and Wisconsin at levels up to 1 mg/L.
47	Captan	Captan has a low persistence in soil, with a half-life of 1 to 10 days in most soil environments. Captan was not detected in field studies of its mobility at application rates of up to 42 kg active ingredient per hectare.
48	Butanol	When released into the soil, this material is expected to readily biodegrade. When released into the soil, this material is expected to leach into groundwater. When released into the soil, this material may evaporate to a moderate extent. When released to water, this material is expected to quickly evaporate. When released into water, this material is expected to readily biodegrade. This material has a log octanol-water partition coefficient of less than 3.0. This material is not expected to significantly bioaccumulate. When released into the air, this material is expected to be readily degraded by reaction with photochemically produced hydroxyl radicals. When released into the air, this material is expected to have a half-life between 1 and 10 days.
49	Naphthalene	Naphthalene can become weakly attached to soil or pass through the soil into underground water. Naphthalene binds weakly to soils and sediment. It easily passes through sandy soils to reach underground water. In soil, some microorganisms break down naphthalene. When near the surface of the soil, it will evaporate into air. Healthy soil will allow the growth of microorganisms which break down most of the naphthalene in 1 to 3 months. If the soil has few microorganisms, it will take about twice as long. Microorganisms may change the chemical structure of naphthalene. Some common bacteria grow on naphthalene, breaking it down to carbon monoxide.
50	Acetone	Acetone is also a natural metabolic byproduct found in and released from plants and animals. Much of the acetone released into the environment will volatilize into the atmosphere where it will be subject to photo-oxidation (average half-life is 22 days). Volatilization from surface waters is moderately rapid (estimated half-life about 20 hours from a model river). If released onto the ground, acetone will both volatilize and leach into the soil and relatively little will be adsorbed to soil particles (HSDB, 1995). Acetone has been detected in groundwater and drinking water. When released into the soil, this material is expected to readily biodegrade. When released into the soil, this material is expected to leach into groundwater. When released into the soil, this material is expected to quickly evaporate. When released into water, this material is expected to readily biodegrade. When released to water, this material is expected to quickly evaporate. This material has a log octanol-water partition coefficient of less than 3.0. This material is not expected to significantly bioaccumulate. When released into the air, this material may be moderately degraded by reaction with photochemically produced hydroxyl radicals. When released into the air, this material may be moderately degraded by photolysis. When released into the air, this material is expected to be readily removed from the atmosphere by wet deposition.
51	Dimethylamine	When released into the soil, this material is expected to quickly evaporate. When released into the soil, this material may leach into groundwater. When released into the soil, this material may biodegrade to a moderate extent. When released into water, this material is expected to readily biodegrade. When released into the water, this material is expected to have a half-life between 1 and 10 days. This material has an estimated bioconcentration factor (BCF) of less than 100. This material is not expected to significantly bioaccumulate. When released into the air, this material is expected to be readily degraded by reaction with photochemically produced hydroxyl radicals. When released into the air, this material is expected to have a half-life of less than 1 day. When released into the air, this material is expected to be readily removed from the atmosphere by wet deposition.
52	Sodium cacodylate	When released into the soil, this material is not expected to leach into groundwater.

Appendix i: Household Pesticide Chemical Information

	Chemical	Persistence[1]
53	Calcium acid methanearsonate	No data are currently available.
54	Isooctyl ester of 2,4,-D acid	No data are currently available.
55	DMA salt of MCPA	No data are currently available.
56	Thiophanate-methyl	No data are currently available.
57	Prallethrin	No data are currently available.
58	d-Mecoprop (Mecoprop-P)	No data are currently available.
59	Halofenozide	No data are currently available.
60	Cube resins (unspecified)	No data are currently available.
61	1,1,1-Trichloroethane	No data are currently available.
62	d-trans-Allethrin	No data are currently available.
63	2-(2,4-Dichlorophenoxy)propionic acid isooctyl ester	No data are currently available.
64	DMA salt of 2,4-DP (2-(2-methyl-4-chlorophenoxy) propanoic acid)	No data are currently available.
65	d-Methoprene	No data are currently available.
66	(+)-R-2-(2-methyl-4-chlorophenoxy)propionic acid	No data are currently available.
67	(R,Z)-5-(1-Decenyl) Dihydro-2(3H) Furanone	No data are currently available.
68	Phthalic/glycerol alkyl resin	No data are currently available.

Note:
[1] Source: EXTOXNET

Appendix ii

Additional Chemicals Used by Major Residential Lawn Care Providers

	Chemical	CAS #	Use Type	Chemical Class	Hazard Rankings[1]	SCTL[2] (mg/kg)	EPA Inert[3]	Cancer Class	Solubility (mg/l)	Persistence				Pesticide Movement[5]
										Soil Half-life[4] (days)	Soil Half-life[5] (days)	Soil Persistence[4]	Soil Persistence[5]	
1	Naphtha, heavy aromatic Aromatic 200	64742-94-5	Insecticide, Solvent	Petroleum derivative	Not listed		2	-		-				
2	Carfentrazone-ethyl	128639-02-1	Herbicide	Unclassified	Not listed			Not Likely	300,000	0.58	40		moderately persistent	Very high
3	Clopyralid	1702-17-6	Herbicide	Pyridinecarboxylic acid	Not listed			Not Likely		151.5				
4	Cyfluthrin	68359-37-5	Insecticide	Pyrethroid	II, Moderately Hazardous			Not Likely	0.002	59.5	30	not classified	moderately persistent	Extremely low
5	Glyphosate	1071-83-6	Herbicide	Phosphonoglycine	U, Unlikely to be Hazardous	8800		Group E--Non-carcinogenic	900,000	-	47	moderately persistent	moderately persistent	Extremely Low
6	Halosulfuron, Halosulfuron-methyl	100784-20-1	Herbicide	Sulfonylurea	Not listed			Not Likely		51.0				
7	MCPA	94-74-6	Herbicide	Chlorophenoxy acid or ester	III, Slightly Hazardous	35		Not Likely		-		low persistence		
8	Myclobutanil	88671-89-0	Fungicide	Azole	III, Slightly Hazardous			Group E--Non-carcinogenic	142	-	66		moderately persistent	Moderate
9	Prodiamine	29091-21-2	Herbicide	2,6-Dinitroaniline	U, Unlikely to be Hazardous			Group C--Possible	0.013	106.0	120		persistent	Extremely low
10	Quinclorac	84087-01-4	Herbicide	-	U, Unlikely to be Hazardous			Group D--Not Classifiable		-				
11	Trichlorfon	52-68-6	Insecticide	Organophosphorus	II, Moderately Hazardous			Likely at High Doses Unlikely at Low Doses	120,000	6.58	10	low persistence	non-persistent	High
12	Triclopyr	55335-06-3	Herbicide	Chloropyridinyl	III, Slightly Hazardous			Group D--Not Classifiable		-		moderately persistent		
13	Trifloxystrobin	141517-21-7	Fungicide	Strobin	Not listed			Not Likely		35.0				

Notes:
[1] World Health Organization Acute Hazard Ranking
[2] Florida Residential Soil Clean-up Target Level (mg/kg)
[3] US EPA, Inert (Other) Pesticide Ingredients in Pesticide Products (http://www.epa.gov/opprd001/inerts/lists.html)
[4] Source: EXTOXNET
[5] Source: OSU

Appendix ii: Additional Chemicals Used by Major Residential Lawn Care Providers

	Chemical	Persistence[1]
1	Naphtha, heavy aromatic Aromatic 200	No data are currently available.
2	Carfentrazone-ethyl	No data are currently available.
3	Clopyralid	No data are currently available.
4	Cyfluthrin	Cyfluthrin is sensitive to breakdown by sunlight. On the surface of soils, its half-life is 48-72 hours. It has a half-life of 56-63 days in German loam and sandy loam soils, respectively, and has similar persistence in soils under conditions of low oxygen (anaerobic). Cyfluthrin is very immobile in soils, and is not considered a threat to contaminate groundwater. The primary breakdown products of cyfluthrin are carbon dioxide and 4-fluoro-3-phenyl-benzaldehyde (a compound of considerably lower toxicity than the parent compound).
5	Glyphosate	Glyphosate is moderately persistent in soil, with an estimated average half-life of 47 days. Reported field half-lives range from 1 to 174 days. It is strongly adsorbed to most soils, even those with lower organic and clay content. Thus, even though it is highly soluble in water, field and laboratory studies show it does not leach appreciably, and has low potential for runoff (except as adsorbed to colloidal matter). One estimate indicated that less than 2% of the applied chemical is lost to runoff. Microbes are primarily responsible for the breakdown of the product, and volatilization or photodegradation losses will be negligible.
6	Halosulfuron, Halosulfuron-methyl	No data are currently available.
7	MCPA	MCPA and its formulations are rapidly degraded by soil microorganisms and it has low persistence, with a reported field half-life of 14 days to 1 month, depending on soil moisture and soil organic matter. Decreased soil moisture and microbial activity, as well as increased soil organic matter, will prolong the field half-life for MCPA. With less than 10% organic matter in soil, the compound is degraded in 1 day and, with greater than 10% levels in soil, it takes 3 to 9 days to degrade. The half-life is 5 to 6 days in slightly acidic to slightly alkaline soils. MCPA readily leaches in most soils, but its mobility decreases with increasing organic matter. MCPA and its formulations show little affinity for soil.
8	Myclobutanil	No data are currently available.
9	Prodiamine	No data are currently available.
10	Quinclorac	No data are currently available.
11	Trichlorfon	Trichlorfon breaks down, or degrades, rapidly in aerobic soils, with a half-life of between 3 and 27 days. An average half-life of 10 days has been reported. Its major breakdown product is dichlorvos (DDVP). Trichlorfon is of low persistence in soil environments. Trichlorfon does not adsorb strongly to soil particles, is readily soluble in water, and is very mobile in soils of varying textures and organic contents. It is therefore likely to contaminate groundwater. Soil organic matter content does not appear to influence trichlorfon's movement in soil.
12	Triclopyr	In natural soil and in aquatic environments, the ester and amine salt formulations rapidly convert to the acid, which in turn is neutralized to a relatively nontoxic salt. It is effectively degraded by soil microorganisms and has a moderate persistence in soil environments. The half-life in soil ranges from 30 to 90 days, depending on soil type and environmental conditions, with an average of about 46 days. The half-life of one of the breakdown products (trichloropyridinol) in 15 soils ranged from 8 to 279 days, with 12 of the tested soils having half-lives of less than 90 days. Longer half-lives may occur in cold or arid conditions. Triclopyr is not strongly adsorbed to soil particles and has the potential to be mobile.
13	Trifloxystrobin	No data are currently available.

Note:
[1] Source: EXTOXNET

APPENDIX C

CHEMICAL CONTAMINATION OF FLORIDA YARD TRASH PRODUCTS: A TELEPHONE SURVEY

INTRODUCTION & METHODOLOGY

The purpose of this task was to compile recent testing data for yard trash mulch and compost produced in Florida. This work was performed by Kessler Consulting, Inc. (KCI). Major Florida mulch and compost producers, soil blenders, and brokers were contacted during 2006 to determine if they test their materials for herbicides, pesticides or heavy metals. If so, KCI requested their test results. The following organization and individuals were contacted:

- C&C Peat
- Consolidated Resource Recovery
- Florida Potting Soil
- Palm Beach Solid Waste Authority
- Peterson Organics
- Reedy Creek Improvement Authority
- Reliable Peat
- Verlite Soils

In addition to these sources, KCI contacted City of St. Petersburg which had analyzed hurricane yard trash after the 2004 hurricane season for persistent chlorinated pesticides as well as three heavy metals associated with pressure-treated wood (arsenic, chromium, and copper).

RESULTS

Results for the eight organizations listed above are as follows:

- Two test periodically for herbicides, pesticides, and heavy metals and were able to share results with KCI (referred to as Company A and Company B below)
- One tests for heavy metals but not herbicides and pesticides and shared their results with KCI (referred to as Company C below)
- Three others test periodically for heavy metals and were not willing to share results
- Two do not use any yard trash materials in their products

City of St. Petersburg provided results from analyses that it performed on hurricane yard trash mulch from four locations in the Tampa Bay area.

<u>Company A Results</u>

Company A produces soil mixtures that contain yard waste compost. It began analyzing its product in 2006. Results are presented the following tables.

Company A – Pesticides in Potting Soil Material (ug/kg dry weight)

Organochlorine Pesticides		**Organophosphorus Pesticides**	
Analyte	**Concentration**	**Analyte**	**Concentration**
4,4-DDD	ND (<0.607)	Azinphos-ethyl	ND (<4.84)
4,4-DDE	ND (<0.459)	Azinphos-methyl	ND (<5.50)
4,4-DDT	ND (<0.672)	Bolstar	ND (<6.07)
Aldrin	ND (<0.325)	Carbophenothion	ND (<2.96)
alpha-BHC	ND (<0.300)	Chlorfenvinphos	ND (<3.14)
alpha-Chlordane	ND (<0.395)	Chlorpyrifos	ND (<4.36)
beta-BHC	ND (<0.391)	Coumaphos	ND (<5.71)
Chlordane	ND (<0.094)	Demeton-o	ND (<3.66)
delta-BHC	ND (<0.351)	Demeton-s	ND (<1.95)
Dieldrin	ND (<0.442)	Diazanon	ND (<8.06)
Endosulfan I	ND (<0.412)	Dichlorvos	ND (<18.5)
Endosulfan II	ND (<0.532)	Dimethoate	ND (<3.68)
Endosulfan sulfate	ND (<0.646)	Dioxathion	ND (<10.7)
Endrin	ND (<0.584)	Disulfoten	ND (<4.18)
Endrin aldehyde	ND (<0.384)	EPN	ND (<3.09)
Endrin ketone	ND (<2.44)	Ethion	ND (<5.19)
gamma-BHC (Lindane)	ND (<0.326)	Ethoprop	ND (<3.81)
gamma-Chlordane	ND (<0.444)	Famphur	ND (<6.09)
Heptachlor	ND (<0.382)	Fensulfothion	ND (<3.50)
Heptachlor epoxide	ND (<0.336)	Fenthion	ND (<12.0)
Methoxychlor	ND (<1.46)	Leptophos	ND (<3.54)
Toxaphene	ND (<2.24)	Malathion	ND (<2.95)
		Merphos	ND (<3.16)
		Mevinphos	ND (<4.11)
		Monocrotophos	ND (<12.7)
		Naled	ND (<9.63)
		Parathion-ethyl	ND (<3.48)
		Parathion-methyl	ND (<3.90)
		Phorate	ND (<3.16)
		Phosmet	ND (<3.14)
		Phosphamidon	ND (<5.30)
		Ronnel	ND (<6.35)
		Stirophos	ND (<3.08)
		Sulfotep	ND (<4.78)
		TEPP	ND (<12.2)
		Terbufos	ND (<3.56)
		Tokuthion	ND (<3.34)
		Trichloronate	ND (<3.64)

Company A – Chlorinated Herbicides in Potting Soil Material (ug/kg dry weight)

Analyte	Concentration	Analyte	Concentration
2,4,5-T	ND (<2.76)	Dalapon	ND (<13.3)
2,4,5-TP (Silvex)	ND (<1.66)	DCPA diacid	ND (<1.39)
2,4-D	ND (<2.74)	Dicamba	ND (<3.01)
2,4-DB	ND (<2.93)	Dichloroprop	ND (<2.39)
3,5-Dichlorobenzoic Acid	ND (<3.39)	Dinoseb	ND (<4.57)
4-Nitrophenol	ND (<18.9)	MCPA	ND (<727)
Acifluorfen	ND (<3.24)	MCPP	ND (<1040)
Bentazon	ND (<1.46)	Pentachorophenol	ND (<1.45)
Chloramben	ND (<4.19)	Picloram	ND (<2.76)

Company A – Trace Elements in Potting Soil Material (mg/kg dry weight)

Analyte	Concentration
Arsenic	ND (<1.19)
Cadmium	ND (<0.170)
Copper	18.1
Lead	1.95
Mercury	0.0203
Molybdenum	ND (<3.57)
Nickel	ND (<0.680)
Selenium	ND (<3.23)
Zinc	51.7

<u>Company B Results</u>

Company B also produces soil mixtures. It has tested for Clopyralid since 2003 and began analyzing for other chemicals in 2005. The results are presented in the following tables.

Company B – Chemicals and Trace Elements in Potting Soil Materials

Analyte	Number of Samples	Minimum	Maximum
Chemicals (ug/kg dry weight)			
2,4-D	4	ND (<1.0)	ND (<1.0)
Atrazine	6	ND (<1.0)	ND (<10.0)
Clopyralid	14	ND (<1.0)	2.0
Metolachlor	4	ND (<10.0)	17.0
Pendamethalin	1	ND (<5.0)	ND (<5.0)
Trace Elements (mg/kg dry weight)			
Arsenic	2	1.6	17.2

Company B – Chlorinated Herbicides in Potting Soil Material (ug/kg dry weight)

Analyte	Concentration	Analyte	Concentration
2,4,5-T	ND (<4.0)	Dacthal	ND (<20.0)
2,4,5-TP (Silvex)	ND (<4.0)	Dalapon	ND (<50.0)
2,4-D	ND (<20.0)	Dicamba	ND (<5.0)
2,4-DB	ND (<50.0)	Dichloroprop	ND (<20.0)
3.5-Dichlorobenzoic Acid	ND (<10.0)	Dinoseb	ND (<20.0)
4-Nitrophenol	ND (<10.0)	MCPA	ND (<4000)
Acifluorfen	ND (<10.0)	MCPP	ND (<4000)
Bentazon	ND (<50.0)	Pentachorophenol	ND (<2.0)
Chloramben	ND (<10.0)	Picloram	ND (<10.0)
Clopyralid	ND (<5.0)		

Company C Results

Company C produces biosolids compost using yard waste as a bulking agent in the process. Finished compost is regularly tested for regulatory compliance. Results for 2003 and 2006 are presented in the following table.

Company C – Trace Elements in Compost (mg/kg dry weight)

Analyte	Avg Concentration – 2003	Avg Concentration – 2006
Arsenic	5.01	2.39
Cadmium	2.04	1.24
Chromium	13.49	8.39
Copper	125.83	107.14
Lead	16.42	10.26
Mercury	0.29	0.48
Molybdenum	6.69	1.40
Nickel	9.78	4.78
Selenium	2.65	0.94
Zinc	201.67	190.8

City of St. Petersburg

During 2005 the City of St. Petersburg undertook an analysis of mulch produced at four different processing sites from the City's 2004 hurricane debris. The city tested for chlorinated pesticides and for trace elements associated with pressure-treated wood. The results of these tests are provided in the following table.

Chemicals and Trace Elements in Hurricane Debris Mulch

Analyte	Number of Samples	Minimum	Maximum
Chlorinated Pesticides (ug/kg dry weight)			
4,4-DDD	4	ND (<11)	ND (<13)
4,4-DDE	4	ND (<9.7)	ND (<12)
4,4-DDT	4	ND (<41)	ND (<50)
Aldrin	4	ND (<15)	ND (<18)
alpha-BHC	4	ND (<27)	ND (<33)
beta-BHC	4	ND (<20)	ND (<25)
Chlordane	4	ND (<480)	ND (<590)
delta-BHC	4	ND (<22)	ND (<25)
Dieldrin	4	ND (<13)	ND (<16)
Endosulfan I	4	ND (<11)	ND (<14)
Endosulfan II	4	ND (<15)	ND (<18)
Endosulfan sulfate	4	ND (<22)	ND (<27)
Endrin	4	ND (<15)	ND (<118)
Endrin aldehyde	4	ND (<21)	ND (<30)
gamma-BHC (Lindane)	4	ND (<23)	ND (<28)
Heptachlor	4	ND (<34)	ND (<41)
Heptachlor epoxide	4	ND (<12)	ND (<15)
Methoxychlor	4	ND (<28)	ND (<34)
Toxaphene	4	ND (<560)	ND (<680)
Trace Elements (mg/kg dry weight)			
Arsenic	4	1.0	2.5
Chromium	4	3.2	7.5
Copper	4	11	16

SUMMARY

The survey found that not all yard waste mulch and compost producers and handlers conduct tests for pesticides, herbicides and trace elements. They are not required to do so by regulation, instead they are motivated by the desire to protect themselves and their customers from any damage that may be caused by possible contamination in their products.

In the tests reviewed, only two chemicals were found in measurable quantities:

- Clopyralid at 2.0 ug/kg dry weight
- Metolochlor at 17.0 ug/kg dry weight

All other chemicals analyzed were not detected. With regard to trace elements that were analyzed, the maximum levels measured were as follows:

- Arsenic at 17.2 mg/kg dry weight
- Chromium at 7.5 mg/kg dry weight
- Copper at 16 mg/kg dry weight

These levels are well below Florida's standards for Class AA compost (Arsenic 41 mg/kg and copper 1,500 mg/kg; Florida has no standard for chromium.