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Toxicity Profile of Disposed Waste Generated Within San Francisco

PREFACE

This study is one part of a waste characterization project performed for the San Francisco Department of the Environment by the following team of consultants:

- Environmental Science Associates, which provided project management, methodology development, visual waste characterization, and report preparation and production.
- CalRecovery, Inc., which provided methodology development, research, sample analysis, and report preparation.
- Sage Environmental, which provided methodology development.
- Cascadia Consulting Group, which provided methodology and database development, data analysis, and report preparation, as well as hand sorting of waste samples through their subcontractor Sky Valley Associates.
- Matthew J. Southworth, who provided tonnage stream data and sample planning.
- Eagle Eye Editing, which provided data entry, report preparation, and editing services.

The purpose of this project was to identify the major constituents in the San Francisco municipal solid waste stream. The study methods were designed to enable City staff to prioritize future efforts to divert wastes from disposal through the development of new waste reduction and recycling options for San Francisco businesses and residents. Samples from nearly 1,000 loads of solid waste from refuse collection route trucks, individual businesses, City departments, and private citizens were manually sorted or visually examined to compile profiles of waste stream constituents. This study focuses on the toxicity of materials found in many of those samples; a companion report describes the more general methods and findings for the project.

The study effort has been assisted at every step by the management and workers at the local affiliates of Norcal Waste Systems, Inc., and by staff in the Department of the Environment, the Department of Public Works, and the Recreation and Park Department. The assistance of these companies, agencies, and individuals is gratefully acknowledged.

SECTION I
Introduction

This report presents the results of a comprehensive characterization and analysis of nonregulated hazardous wastes (NHW) found in the disposed waste stream from generators located in San Francisco. The primary purpose of the study is to provide data and guidance for the City and County of San Francisco (City) to use in improving and/or implementing new programs to further reduce the toxicity of wastes generated and disposed within San Francisco. To meet this overall objective, the study addresses the quantities of NHW in solid waste disposed by generators within the city, estimates the toxicity of the NHW, and recommends methods of toxicity reduction that are indicated by the results of the analysis. CalRecovery, Inc. performed the characterization and analytical work under a subcontract agreement with Environmental Science Associates.

The San Francisco Department of the Environment operates a successful waste diversion and toxicity reduction program. The toxicity reduction program includes programs to reduce the toxicity of chemicals purchased by the City and to accept, process, treat, and/or properly dispose of toxic materials based on the characteristics and level of contamination.

The City desires to improve the quality of life in San Francisco through implementation of programs that protect public health and the environment. While specific regulations are directed toward controlling and minimizing the quantities of regulated hazardous waste that enter the solid waste stream, small amounts of toxic and otherwise hazardous substances enter the solid waste management system via discarded NHW. NHW is hazardous waste that is not subject to hazardous waste regulations because the quantities discarded by the generator are below the regulatory limit for that specific type of waste or the wastes are exempt from hazardous waste regulations. Under State of California regulations, households and businesses can legally dispose of small quantities of toxic wastes or items containing hazardous materials.

Two of the purposes of this study are to: (1) determine the quantities of NHW entering San Francisco's solid waste management system, and (2) estimate the relative hazards and risks posed by them. With this information, the toxicity of the solid waste stream has been estimated in order to provide a basis for evaluating the impact of NHW entering San Francisco's solid waste management system, and for identifying and prioritizing programs and strategies to reduce the impacts of this type of waste on solid waste workers, the public, and the environment.

This study presents a new method of estimating the relative hazards and risks posed by NHW in disposed waste for use as a planning tool by the City. This approach does not employ methods typically used in a classical health and environmental risk assessment, such as emitted chemical concentrations, air dispersion modeling (to estimate impacts on downwind receptors), and health

risk analyses. Rather, the method is a synthesis of qualitative and quantitative parameters and utilizes toxicological and other information published by a number of organizations and governmental agencies.

The report is divided into three sections: methodology, results, and conclusions and recommendations. The Methodology section explains how NHW materials were found in waste samples and how they were analyzed; it also describes the toxicity profiling methods developed for this study. The Results section shows the outcome of applying the profiling methods to the data obtained both from waste samples and from scientific literature. The Conclusions and Recommendations section summarizes the findings and makes several recommendations for reducing waste stream toxicity and for measuring it more accurately.

Below are definitions of several terms that have specific meanings in the context of this study.

The *gross weight* of an item is the weight of a container and its contents. The *net weight* is the weight of the contents alone.

The materials that make up an item determine its waste *category*. Typical categories for items in wastes include Corrugated Cardboard, Aluminum Cans, Grass Clippings, Food Waste, etc. To classify items with a high potential for toxicity, it is useful to define more specific categories, such as Solvent-Based Adhesives/Glues, Mercury Thermostats/Switches, or Cosmetics. More general groupings of wastes, such as Organics, Metals or Hazardous Wastes, are referred to as waste *types*.

NHW Categories are those categories that encompass nonregulated hazardous wastes. This does not include categories like Grass Clippings, but does include categories like Mercury Thermostats/Switches.

Causative agents are the substances in a waste that can cause harm when they contact a person or are released into the environment. A waste item may contain several causative agents, only one of which is of immediate concern for the purposes of this study. For example, in a mercury thermostat or switch, the mercury in the switch is the causative agent of concern. The glass vial that contains the mercury could, if broken, cut someone, but it is the toxicity of the mercury that is of concern for this study.

SECTION II
Methodology

A. NHW in Disposed Waste

The composition of NHW in the City's disposed waste stream was estimated based on the results of two 1-week quantitative field characterization studies, performed in September 2004 and February 2005. The field characterization of NHW was a parallel analysis to the two disposed waste stream characterization field studies performed by Environmental Science Associates and Cascadia Consulting Group (2005).

During each of these field characterization studies, quantities of NHW were measured for a number of categories. The categories are described in Table 1. Appendix A presents a more detailed description of the NHW categories and provides examples of items included in each category.

As a consequence of the results of the first field characterization study (performed in September 2004) and some preliminary analysis of the potential toxicity of materials in certain NHW categories, two subcategories of NHW were identified and used during the second field study. The subcategories are chemically treated wood as part of the Treated Wood main category (as opposed to varnished or painted wood), and hair dye as part of the main category Cosmetics.

The work associated with the characterization of NHW consisted of the following. NHW items segregated by Sky Valley Associates were transferred to CalRecovery for categorization and subsequent analyses. After identifying the appropriate category for each item, CalRecovery determined the gross weight of the item. The objective of this analysis was to judge the potential toxicity and other hazards presented by disposed wastes; therefore, CalRecovery employed methods to determine the actual weights of potentially toxic materials in the City's disposed waste as opposed to relying on the gross weights of items, which typically overestimates the weights of the causative agents in or adhered to the bulk NHW items. The method is similar to that used by CalRecovery to assess the risks associated with NHW for the Puget Sound Council of Governments (CalRecovery, 1985). Using the CalRecovery method, if the potentially hazardous residue in or on the item could be segregated easily (e.g., liquid in a container), then CalRecovery personnel removed and weighed the residue separately. For example, the liquid or semiliquid materials in many metal, plastic, and glass containers were relatively easy to drain from the containers. In some cases, solids could also be removed from their containers, but in a number of cases the required effort was unreasonable because the solids had adhered to the container walls. For the small portion of the NHW items where the effort to remove the adhered

TABLE 1
NHW CATEGORIES USED IN THE TOXICITY PROFILING ANALYSIS

64. Latex Paints–Reusable
65. Latex Paints–Nonreusable
66. Solvent-Based Adhesives/Glues
67. Water-Based Adhesives/Glues
68. Petroleum-Based Paint
69. Pesticides/Herbicides/Wood Preservatives
70. Dry Cell Batteries–Nonrechargeable
71. Dry Cell Batteries–Rechargeable
72. Wet Cell Batteries
73. Gasoline/Kerosene/Diesel
74. Coolants/Antifreeze
75. Used Motor Oil
76. Other Motor Vehicle Fluids
77. Oil Filters
78. Asbestos-Containing Materials
79. Treated Wood
80. Explosives
81. Pharmaceuticals
82. Medical Wastes–Sharps
83. Medical Waste–Other
84. Incandescent Light Bulbs
85. Fluorescent Light Bulbs
86. Other Light Bulbs
87. Mercury Thermometers
88. Mercury Thermostats/Switches
89. Nonempty Compressed Gas Tanks/Cylinders
90. Televisions
91. Computer Monitors–liquid crystal display (LCD)
92. Computer Monitors–cathode ray tube (CRT)
93. CPUs
94. Other Computer Equipment
95. Other Electronics
96. Oxidizers
97. Acids
98. Bases
99. Other Chemicals or Cleaning Products
100. Solvents and Other Solvent-Based Products
101. Waxes
102. Cosmetics
103. Inks and Dyes
104. Other Potentially Harmful Wastes

material was unreasonable or impossible, CalRecovery personnel estimated the weight of the residue. The weight of the residue removed from its container is called the “net residue.”

Two portable electronic scales were employed to measure the weights of materials and wastes. Large items were weighed on an A&D Company Model FV-15OKA1 platform scale, which has a resolution of 0.01 lbs. Small items and residues were weighed on an Ohaus Scout scale, which has a resolution of 0.01 grams. CalRecovery personnel recorded the weights of NHW materials on data collection sheets, along with other data relevant to the sample or source of waste. An example data collection form is provided in Appendix B.

B. Toxicity Profiling of NHW Constituents

Generally, the risk associated with the toxicity of waste materials is based on the type of agent, its concentration at the point of exposure, the susceptibility of the receptor, the route of exposure,

and the duration of the exposure. The scope of work for the study called for a qualitative assessment of the potential toxicity of NHW in the City's disposed waste stream. Consequently, the types and levels of hazards and risks used to support the analysis were not based on a quantitative risk assessment methodology. Where feasible, CalRecovery used previous studies and lists of hazardous materials and wastes promulgated by governmental entities to assess the degree of risk or hazard (e.g., the State of California's list of known carcinogens, commonly called the "Prop 65 List"). Overall, CalRecovery estimated the relative risk of hazard to receptors based on: (1) the concentration of NHW in the disposed waste stream, (2) a composite hazard rating for each NHW category based on some representative constituents, and (3) the relative risk of exposure to materials in each NHW category. The values of relative risk were subsequently used to identify and prioritize potential categories of NHW for improved management or for further study.

The toxicity profile of the disposed waste stream was estimated using the following steps:

- Identification and selection of generic parameters that characterize the types of potential risks that NHW poses to humans and to the environment (e.g., acute toxicity or corrosivity, etc.). The environment of concern is that in and around land disposal facilities.

- Identification and selection of causative agents: representative chemical compounds and other agents in NHW that can be used to characterize the potential risk presented by the generic parameters (e.g., chemical compounds for acute toxicity, and type of microorganisms for pathogenecity, etc.).

- Estimation of the concentrations of materials in NHW categories in disposed solid waste generated in San Francisco.

- Estimation of the relative risk or probability of exposure of humans (workers or the public) or of the environment to the causative chemical compounds or other agents.

Since one of the fundamental bases of risk analysis is the type of causative agent, CalRecovery selected representative types of agents associated with each of the NHW categories. The scope of the study excluded performing chemical analyses on NHW items (or residues obtained therefrom) found during the field sampling and sorting work. Therefore, representative constituents or agents, primarily chemical compounds and elements, were selected based on several sources of information:

- Labels attached to NHW items found in waste samples during the quantitative field characterization studies

- Literature available in the public domain

- Previous data and information collected by CalRecovery on chemical compounds found in or identified with NHW

Information on labels attached to NHW items found during the sorting program was given the highest priority. However, other information sources were also used to characterize the contents of NHW found in the study because: (1) many NHW items found in the study did not have labels

or the labels were not legible, and (2) previous studies of NHW in disposed waste have found that the contents of some NHW items are sometimes different than might be expected based on the type of container or the information available on the container label.

Appendix C presents a list of the categories of NHW used in the study and the chemical compounds and other agents that were selected to characterize each category.

Based on the selected causative agents, CalRecovery estimated the severity or level of hazard for each toxicity parameter (e.g., carcinogenicity, etc.) using a variety of information sources. The severity was estimated based on a governmental listing (e.g., Prop 65 List) if possible or, lacking a listing, on chemical or other properties of the agent (e.g., pH to determine degree of corrosivity). The sources of information and bases for these judgments are presented in Appendix D. CalRecovery estimated the severity of the hazard or degree of toxicity of each NHW category based on the rating for each hazard parameter and on the relative weighting assigned to each of the parameters. The severities of the hazards for the toxicity profiling parameters (e.g., corrosivity) and for each NHW category are provided in Appendix E. The method employed to assign weighting factors consisted of the following. The higher-value weightings were assigned to those hazard or toxicity parameters that would likely cause chronic, serious human health problems. Lower-value weightings were given to those hazard or toxicity parameters that would be likely to yield primarily acute, short-term effects on human health. Thus, the highest weighting of 20 was given to those hazard characteristics and chemical agents that exhibit characteristics of carcinogenicity/reproductivity toxicity, neurotoxicity, and endrocrine modification. This value served as one of the key bases for selecting values of weighting factors for the other hazard characteristics. The values of the weighting factors are listed in Table 2.

Another important purpose of the weighting factors was to normalize the relative contribution of each hazard characteristic to the overall hazard rating for a particular NHW category so that the overall hazard rating of that category was reasonable when compared to the ratings of the other categories. The normalization process is required because the numeric values assigned to represent levels of effect, risk, etc. within a particular hazard category (e.g., acute toxicity) are arbitrary when compared to those used for the other hazard categories.

CalRecovery computed the toxicity hazard rating for a particular NHW category by summing the ratings for each chemical or agent (e.g., lead, HIV, etc.) used to represent the chemical/pathogen content of that NHW category, and then multiplying the sum by the weighting assigned to each hazard category (e.g., 20 points for constituents that cause cancer or exhibit reproductive toxicity, etc.). The overall toxicity rating for each NHW category was then determined by summing the totals for each of the hazard characteristics.

TABLE 2
WEIGHTING FACTORS FOR THE HAZARD CHARACTERISTICS USED IN THE ANALYSIS

Hazard Characteristic	Weighting
Carcinogens/Reproductive Toxins	20
Neurotoxins	20
Pathogenicity	5
Ozone-Depleting Substances	3
Toxicity	5
Ignitability	3
Endocrine Modifiers	20
Surface or Groundwater Contamination	5
Corrosivity	3
Mechanical Injury (e.g., punctures)	1
Greenhouse Gases	3
Hypersensitivity (allergic) Reactions	1
Irritancy	1

As part of the analysis, CalRecovery also estimated the probability of exposure of humans (workers or the public) or the environment to the causative agent based on the NHW category and the most likely routes of exposure. This estimation is qualitative since a more rigorous and definitive analysis of exposure levels was outside the scope of the study. The values assigned to the estimated probabilities of exposure to NHW are listed by NHW category in Table 3. The values of exposure probability range from a value of 1, corresponding to a low risk or probability of exposure (e.g., individuals exposed to items containing latex paint), to a value of 8, corresponding to high risk of exposure (e.g., individuals exposed to televisions with a picture tube that might explode during processing). For a particular toxic hazard criterion, the probability of exposure and, therefore, the assigned numerical value varies depending on the type of receptor and on the subjective judgement of the analyst assigning the relative values.

The level of exposure to causative agents was assumed in the analysis to be represented by the concentration of materials in the particular NHW category in the disposed waste stream.

To define a judgment parameter for estimating the relative risk of hazard for each of the three types of receptors as a function of NHW category, CalRecovery assumed that the risk of hazard is directly proportional to: (1) the prevalence (i.e., the concentration of net residue) of materials in the NHW category, (2) the toxicity or hazard rating, and (3) the probability of exposure. Thus, the relative risk of hazard is greatest in those cases where the highest values are indicated for each of these factors for a particular NHW category and lowest where the values are uniformly low. Hazard values in between the maximum and the minimum occur in those instances where values for the three factors are in the mid-range, or in cases where low values for some factors are offset by high values for others.

TABLE 3
RELATIVE RISK OF EXPOSURE

	Relative Risk of Exposure		
	Occupational	**Public**	**Environment**
64. Latex Paints–Reusable	1	1	2
65. Latex Paints–Nonreusable	1	1	2
66. Solvent-Based Adhesives/Glues	3	3	6
67. Water-Based Adhesives/Glues	3	3	3
68. Petroleum-Based Paint	2	4	6
69. Pesticides/Herbicides/Wood Preservatives	7	7	7
70. Dry Cell Batteries–Nonrechargeable	1	1	2
71. Dry Cell Batteries–Rechargeable	1	1	4
72. Wet Cell Batteries	2	3	8
73. Gasoline/Kerosene/Diesel	5	5	8
74. Coolants/Antifreeze	6	6	2
75. Used Motor Oil	5	5	5
76. Other Motor Vehicle Fluids	5	5	5
77. Oil Filters	5	5	5
78. Asbestos-Containing Materials	6	3	6
79. Treated Wood (chemically treated only)	3	7	7
80. Explosives	3	3	3
81. Pharmaceuticals	2	2	1
82. Medical Wastes–Sharps	8	8	3
83. Medical Waste–Other	8	3	3
84. Incandescent Light Bulbs	4	4	4
85. Fluorescent Light Bulbs	6	4	4
86. Other Light Bulbs	4	2	2
87. Mercury Thermometers	2	4	8
88. Mercury Thermostats/Switches	4	2	8
89. Nonempty Compressed Gas Tanks/Cylinders	8	5	8
90. Televisions	8	5	8
91. Computer Monitors (LCD)	5	2	8
92. Computer Monitors (CRT)	7	3	8
93. CPUs	1	1	6
94. Other Computer Equipment	6	3	6
95. Other Electronics	3	1	6
96. Oxidizers	3	2	3
97. Acids	3	2	3
98. Bases	3	2	3
99. Other Chemicals or Cleaning Products	5	3	5
100. Solvents and Other Solvent-Based Products	5	3	5
101. Waxes	2	2	3
102. Cosmetics	2	4	7
103. Inks and Dyes	3	3	4
104. Other Potentially Harmful Wastes	3	3	3

The results obtained by applying the above method are dependent on the choices of specific chemicals and other agents to represent each NHW category, and on the numeric values assigned to the weighting factors.

C. Toxicity Profiling of Other Material Categories

In addition to NHW materials, disposed wastes include large volumes of other materials such as food, paper, plastics, etc. While these materials are generally thought to contribute little or nothing to the toxicity of disposed wastes, they do contain concentrations of some toxic chemical compounds, elements, and other agents. Consequently, these major categories also contribute to the toxicity profile of the City's disposed solid waste. There is no consensus method of comparing the toxicities of NHW material types with those of the major material categories. Therefore, CalRecovery examined some of the key differences among the characteristics of NHW and the major material categories, specifically the chemical compounds that are typically present in each. Some of the elemental metals that CalRecovery used to characterize and analyze the toxicity of NHW are also commonly found in the major material categories. This fact, coupled with the fact that most of the other types of toxic compounds and agents (i.e., non-metals) are primarily present only in NHW, means that the concentrations of metals can serve as a distinguishing feature between the two generic types of materials (i.e., NHW and the major material categories), and can be used to compare the toxicity of the two generic groups of wastes. CalRecovery analyzed information on the types of metals in NHRW and the major material categories and selected lead, nickel, and zinc as representative for the purposes of comparing the relative risk of hazard.

SECTION III
Results

A. Quantities and Composition of NHW in Disposed Waste

Figure 1 shows the estimated composition (as-received weight percentage [wt %]) of NHW net residue, broken down by the source of the materials sampled. The highest percentage of NHW was found in the Front Loader Multi-Family (FLMF) source, at approximately 2.5 wt %. The net residue value depicted in Figure 1 for the Roll-Off Compactor Multi-Family (ROCMF) source (approximately 0.06 wt %) excludes one outlier that resulted from a large, 50-lb discarded electronic device. This device constituted a high percentage of the weight of the sample and, if included, would have raised the average percentage of NHW in the ROCMF source to about 6.1%. Of all the samples analyzed, this sample was the only one that CalRecovery considered to contain an outlier.

Table 4 shows the estimated composition of NHW based on the weight of the net residue. The most prevalent NHW material category found in the study was Treated Wood, with a concentration of approximately 0.37 wt %. However, the majority of materials found in this category during the field study were painted or varnished wood, as opposed to chemically treated wood. Only one identifiable, significant item of chemically treated wood was found during the sampling and characterization field work—a single piece of chemically treated wood, weighing approximately 6.8 lbs, or about 0.02 wt % of the total weight of the samples. In the case of both painted/varnished and chemically treated wood materials found during the study, the vast majority of the weight reported as net residue was the mass of the wood, in contrast to the coatings or chemical compounds applied to the wood surface.

The second most prevalent category of NHW in the City's disposed waste was "Other Electronics"; the concentration of net residue for this category was approximately 0.20 wt %. This concentration does not include the large, discarded electronic item described earlier. Inclusion of this outlier would have increased the net residue concentration of Other Electronics to approximately 0.37 wt %.

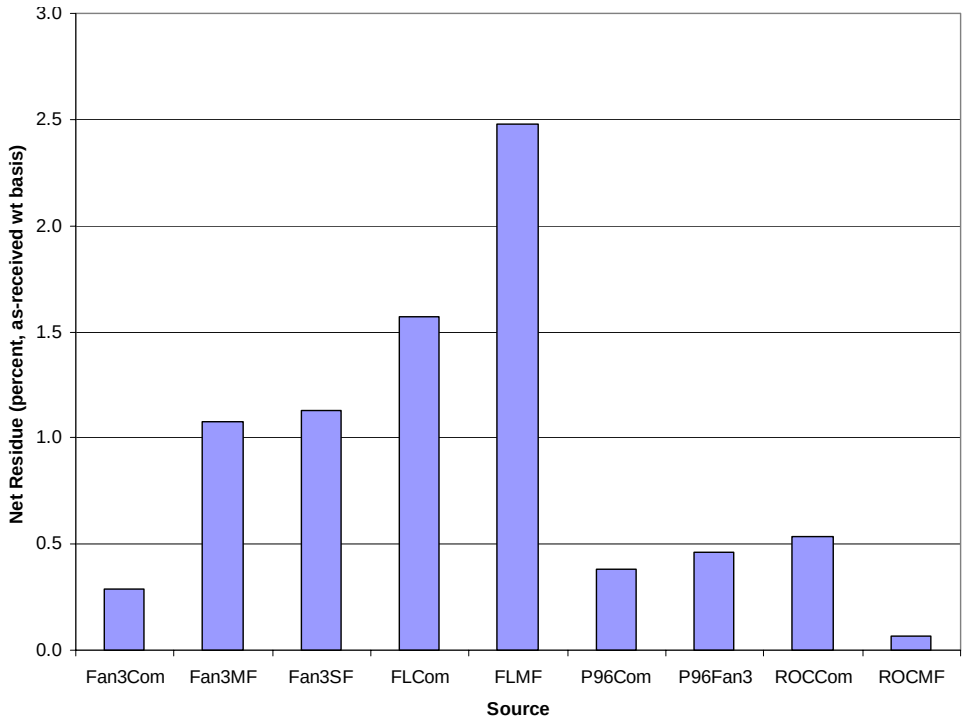

Figure 1. Percent Net Residue of NHW by Waste Source (as-received weight basis) Combined Results Autumn 2004 and Spring 2005

Legend for Sources of Wastes

Fan3Com	=	Fantastic 3/commercial	P96Com	=	Pier 96/commercial line
Fan3MF	=	Fantastic 3/multi-family	P96Fan3	=	Pier 96/Fantastic 3 line
Fan3SF	=	Fantastic 3/single family	ROCCom	=	Roll-off compactor/commercial
FLCom	=	Front loader/commercial	ROCMF	=	Roll-off compactor/multi-family
FLMF	=	Front loader/multi-family			

After Treated Wood and Other Electronics, a substantial drop-off occurs in the concentration of NHW. The third most prevalent category of NHW materials was Cosmetics, whose net residue was approximately 0.06 wt % in the disposed waste. The next most prevalent NHW categories after Cosmetics were Other Computer Equipment and the miscellaneous category Other Potentially Harmful Wastes, whose concentrations of net residues were slightly lower than the concentration estimated for Cosmetics.

Ten categories of NHW did not yield identifiable items or measurable quantities of residue based on the samples analyzed during the field characterization program. These categories were:

- Latex Paints–Reusable
- Wet Cell Batteries
- Coolants/Antifreeze
- Asbestos-Containing Materials
- Mercury Thermometers
- Mercury Thermostats/Switches
- Televisions
- Computer Monitors (LCD)
- Computer Monitors (CRT)
- Oxidizers

TABLE 4
COMPOSITION OF NHW IN SAN FRANCISCO'S DISPOSED WASTE

Category	% in Disposed Waste
79. Treated Wood	0.36874
95. Other Electronics	0.19788
102. Cosmetics	0.05689
94. Other Computer Equipment	0.05143
104. Other Potentially Harmful Wastes	0.04790
82. Medical Wastes–Sharps	0.02335
81. Pharmaceuticals	0.02221
93. CPUs	0.02067
70. Dry Cell Batteries–Nonrechargeable	0.01927
86. Other Light Bulbs	0.01866
65. Latex Paints–Nonreusable	0.01794
85. Fluorescent Light Bulbs	0.01455
68. Petroleum-Based Paint	0.01397
84. Incandescent Light Bulbs	0.01378
83. Medical Waste–Other	0.00567
99. Other Chemicals or Cleaning Products	0.00561
100. Solvents and Other Solvent-Based Products	0.00469
71. Dry Cell Batteries–Rechargeable	0.00359
67. Water-Based Adhesives/Glues	0.00191
80. Explosives	0.00167
69. Pesticides/Herbicides/Wood Preservatives	0.00142
103. Inks and Dyes	0.00098
75. Used Motor Oil	0.00079
76. Other Motor Vehicle Fluids	0.00047
66. Solvent-Based Adhesives/Glues	0.00034
73. Gasoline/Kerosene/Diesel	0.00027
98. Bases	0.00012
101. Waxes	0.00007
89. Nonempty Compressed Gas Tanks/Cylinders	0.00001
77. Oil Filters	0.00001
97. Acids	0.00001
64. Latex Paints–Reusable	0.00000
72. Wet Cell Batteries	0.00000
74. Coolants/Antifreeze	0.00000
78. Asbestos-Containing Materials	0.00000
87. Mercury Thermometers	0.00000
88. Mercury Thermostats/Switches	0.00000
90. Televisions	0.00000
91. Computer Monitors (LCD)	0.00000
92. Computer Monitors (CRT)	0.00000
96. Oxidizers	0.00000

In addition, no identifiable hair dye was found among the samples analyzed during the February 2005 field work, when this subcategory of Cosmetics was specifically targeted for observation and analysis.

Figure 2 shows the estimated concentrations of NHW as a function of the type of solid waste collection service. The highest concentrations of NHW were present for Treated Wood (both painted/varnished and chemically treated) and Other Electronics.

B. Toxicity Profiling of NHW Categories

A key step in compiling a toxicity profile of NHW in the City's disposed waste was estimating the hazard rating of each NHW category based on their representative chemical compounds and other agents. The estimated hazard ratings of the 41 NHW categories ranged from a high value of 205 (for Solvent-Based Adhesives and Petroleum-Based Paint) to a low value of 1 (for Incandescent Light Bulbs). The hazard rating is based on the characteristics of the materials and does not reflect the influence of the chemical concentration at the point of exposure, the route of exposure, the probability of exposure, or the type of receptor. The basis of the calculated hazard ratings for each NHW category is provided in Appendix E.

The hazard rating of each of the 41 NHW categories is shown in descending order in Table 5. Generally, a particular NHW category has a high hazard rating if it contains constituents that cause cancer or reproductive toxicity or are endocrine modifiers. For example, the hazard rating of 37 for Acids was derived by summing its ratings for surface or groundwater contamination (30), corrosivity (6), and hypersensitivity (1). For all other hazard rating criteria, the ratings for Acids were zero.

The rating for Treated Wood is based on chemical constituents that are characteristic of *chemically* treated wood, since exposure to chemically treated wood generally presents a greater risk to human health than exposure to painted or varnished wood.

The relative risk of hazard estimated for each NHW category and type of receptor is plotted logarithmically in Figure 3 in order to capture the wide range of values. As shown by the data in the figure, the range of values spans approximately four orders of magnitude.

If a risk of hazard value of approximately 10 is selected in Figure 3 as the first-tier priority level, then the following NHW categories exhibit the higher risk of hazard.

- Petroleum-Based Paints
- Treated Wood (chemically treated)
- Other Computer Equipment
- Other Electronics
- Cosmetics

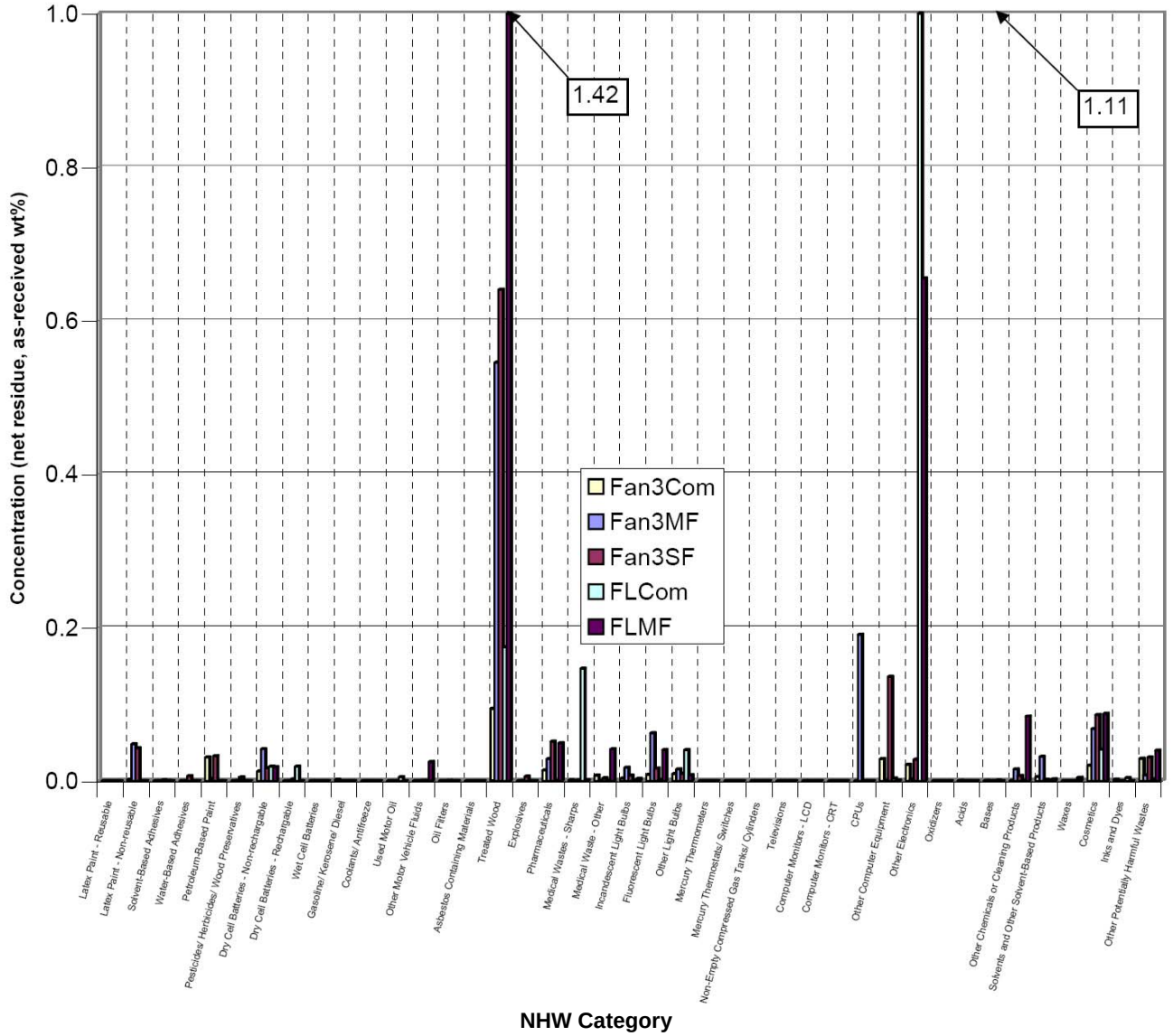

Figure 2. Concentration of NHW in San Francisco's Disposed Waste as a Function of Source

TABLE 5
HAZARD RATING OF NHW CATEGORIES
(ZERO = LOWEST HAZARD)

Category	Hazard Rating
66. Solvent-Based Adhesives/Glues	205
68. Petroleum-Based Paint	205
64. Latex Paints–Reusable	161
65. Latex Paints–Nonreusable	161
67. Water-Based Adhesives/Glues	161
79. Treated Wood	126
69. Pesticides/Herbicides/Wood Preservatives	125
90. Televisions	100
92. Computer Monitors (CRT)	100
93. CPUs	100
94. Other Computer Equipment	100
95. Other Electronics	100
103. Inks and Dyes	100
72. Wet Cell Batteries	79
102. Cosmetics	76
100. Solvents and Other Solvent-Based Products	74
73. Gasoline/Kerosene/Diesel	69
86. Other Light Bulbs	61
87. Mercury Thermometers	61
85. Fluorescent Light Bulbs	60
71. Dry Cell Batteries–Rechargeable	60
88. Mercury Thermostats/Switches	60
104. Other Potentially Harmful Wastes	59
98. Bases	39
97. Acids	37
74. Coolants/Antifreeze	33
82. Medical Wastes–Sharps	29
75. Used Motor Oil	26
76. Other Motor Vehicle Fluids	26
77. Oil Filters	26
70. Dry Cell Batteries–Nonrechargeable	20
78. Asbestos-Containing Materials	20
91. Computer Monitors (LCD)	20
96. Oxidizers	16
80. Explosives	13
89. Nonempty Compressed Gas Tanks/Cylinders	13
101. Waxes	13
99. Other Chemicals or Cleaning Products	12
81. Pharmaceuticals	8
83. Medical Waste–Other	8
84. Incandescent Light Bulbs	1

C. Toxicity Profiling of Other Material Categories

In the Methodology section above, it was noted that non-NHW categories of disposed wastes contain concentrations of some toxic chemical compounds, elements, and other agents that may contribute to the overall toxicity of the disposed waste stream. For this study, certain metals—lead, nickel and zinc—were used to evaluate the relative risk of hazard from these non-NHW material categories.

Similar to the case of estimating relative risk among the NHW material categories, CalRecovery computed the relative risk based on the estimated concentration of the material type in the disposed waste; the relative hazard rating for lead, nickel, and zinc; and the relative risk or probability of exposure. The relative hazard rating of the three metals is 89, which would place materials with this value at approximately the bottom of the top one-third of the list of ratings shown in Table 4. The relative risk of exposure used in the analysis for occupational, public, and environment receptors are 1, 1, and 3, respectively. These relatively low risks reflect the fact that the elemental metals are inherently bound, chemically or physically, in the items composing the major material categories, and also that the primary exposure would be due to events at a landfill facility that could liberate the metals into the environment (as opposed to, for instance, the lower risk that these bound metals would pose to waste collection personnel or to the waste-generating public).

Based on the conditions of this analysis, the higher values of relative risk associated with major material types are those calculated for food waste (values of approximately 30 and 90, depending on the type of receptor, as shown in Table 6). Because of the method employed by CalRecovery to compute the relative risk, these high values of risk for food waste are primarily due to the high concentration of food waste in the City's disposed waste stream, as opposed to a high inherent hazard posed by the constituents of food waste.

Mixed paper is the major material category representing the next highest value of relative risk among the major material categories. The values are approximately 17 and 50, depending on the type of receptor. As in the case of food waste, the high concentration of mixed paper is prompting a high value of relative risk of hazard.

In a separate but related analysis, CalRecovery estimated the total loading of lead, nickel, and zinc in the City's disposed waste using chemical fingerprints of major waste types that the company developed from several waste characterization studies and laboratory analyses of waste types. Based on this analysis, CalRecovery estimates that food wastes and mixed paper contribute approximately 19% and 12%, respectively, of the loading of the three metals from all waste types. Therefore, while the relative magnitude of the risk of hazard mentioned above for these two material categories may be overstated, these material categories apparently contribute substantially to the metal loading of wastes being disposed.

TABLE 6
RELATIVE RISK OF HAZARD ASSOCIATED WITH MAJOR MATERIAL TYPES [a]

Material	Wt %	Relative Risk of Exposure		
		Occupational	Public	Environment
Corrugated cardboard	4.9%	4.3	4.3	13.0
Newsprint	4.3%	3.8	3.8	11.5
Mixed Paper	18.6%	16.6	16.6	49.7
Plastic	12.6%	11.2	11.2	33.6
Yard Waste	1.8%	1.6	1.6	4.7
Wood	2.1%	1.9	1.9	5.7
Food Waste	33.6%	29.9	29.9	89.8
Textiles	4.5%	4.0	4.0	12.1
Other Organic	5.6%	5.0	5.0	15.0
Ferrous	3.2%	2.9	2.9	8.7
Aluminum	0.5%	0.4	0.4	1.2
Glass	2.8%	2.5	2.5	7.5
Other Inorganic	3.3%	2.9	2.9	8.7

[a] Hazard rating (based on lead, nickel and zinc) = 89

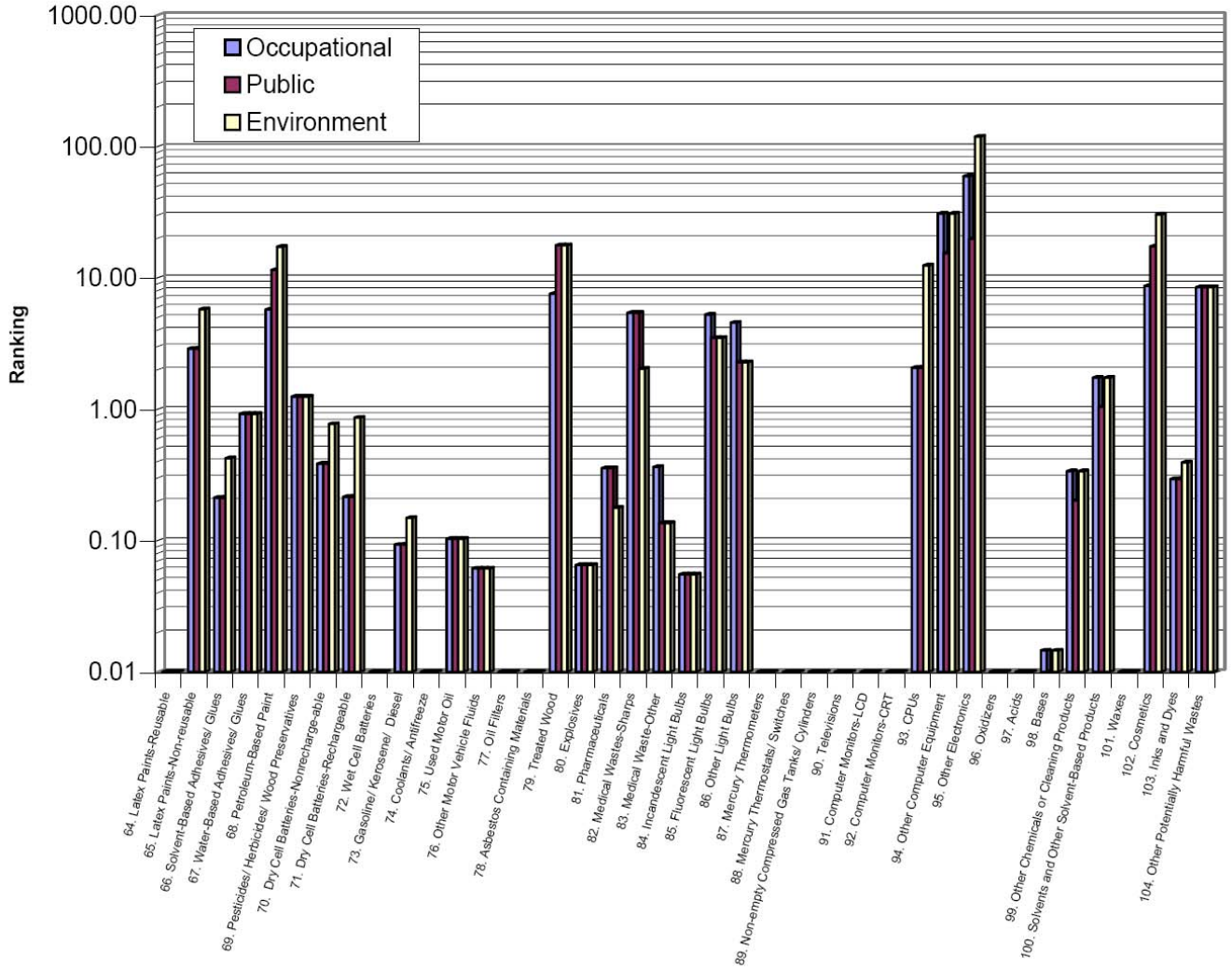

Figure 3. Relative Risk of Hazard as a Function of NHW Category

SECTION IV
Conclusions and Recommendations

The methodology described in this study can be used as a tool to manage NHW in the disposed waste stream. The key conclusions and recommendations of the study are described below. The net residue of NHW in San Francisco's disposed waste is approximately 0.9 wt %. The net residue ranged from approximately 0.1 wt % for roll-off compactors from multi-family generators to 2.5 wt % for front loaders servicing multi-family residences.

In terms of net residue, the most prevalent NHW in the City's disposed waste stream, in descending order, are:

- Treated Wood
- Other Electronics
- Cosmetics
- Other Computer Equipment
- Other Potentially Harmful Wastes

Using the methodology developed for the study, CalRecovery has identified the following five NHW categories as those representing the greatest potential risk to humans and the environment:

- Petroleum-Based Paints
- Treated Wood (chemically treated)
- Other Computer Equipment
- Other Electronics
- Cosmetics

A. Recommended Measures

The substitution of latex paints for petroleum-based paints would assist in reducing the toxicity of paint materials in the disposed waste stream. Furthermore, emphasizing the need (or offering incentives to paint users) to use up the contents of paint containers and to recycle leftover paint, whether petroleum-based or latex, would decrease the toxicity of the City's disposed waste stream.

The concentration of treated wood (painted, varnished, and chemically treated) in the disposed waste stream as well as its estimated relative toxicity indicate that this waste category should be targeted for reduction and/or diversion programs. For example, a program to recover treated wood, remove the surface coatings, and market the "clean" wood materials would increase the City's waste diversion level and reduce the toxicity of waste being landfilled, assuming the

hazardous residues from wood processing and recovery were properly treated and/or disposed. The City would need to determine the feasibility of implementing this type of program as well as the types of waste generators to target (e.g., commercial enterprises, construction companies, etc.).

Implementation of additional recovery and recycling programs for electronic equipment would decrease the quantities of Other Computer Equipment and Other Electronics. The State mandate for jurisdictions to implement programs to better manage Universal Waste in 2006 may represent an opportunity to target Other Computer Equipment and Other Electronics for separate collection, processing, and recycling.

The last category in the above priority list is Cosmetics. It would likely be difficult to identify and implement practical methods of reducing the contribution of this category of NHW to the overall toxicity of the disposed waste stream. Analysis of the cosmetic samples taken during the field study indicates that reducing the contribution from Cosmetics would be difficult for several reasons: the sheer number of cosmetic products and their disparate formulations, the likely poor yield of marketable ingredients if containers are processed, and the fact that much of the discarded material is unusable.

While medical sharps do not pose one of the more substantial risks identified in the study, they were present in many samples of waste. The risks associated with medical sharps in the City's disposed waste (primarily solid waste workers suffering punctures or scrapes from sharps) could conceivably be reduced by programs directed toward increasing the segregation of sharps from other wastes by the generator and separate packaging of the segregated sharps in dedicated sharps containers. Alternately, fully automated waste collection methods would reduce the risk to collection workers due to punctures from sharps. However, processing staff that handle or sort mixed waste for material recovery would be at risk of punctures from sharps and subsequent infections if they are not properly protected.

B. Need for Comparative Data

CalRecovery performed an exhaustive analysis of potential hazard criteria and methods for valuing the degree of hazard for each of the NHW categories that were the subject of this study. The company found that a system is lacking for characterizing and judging the toxicity of the solid waste stream. Lack of published toxicity characterization data from a single source is the most important barrier to developing more effective analytical tools for managing NHW. For this research, CalRecovery reviewed data from dozens of organizations and agencies in order to adequately characterize the NHW materials and the risks posed by them. Much of the data was in conflict or was ambiguous, or its reliability could not be determined. In some cases, lists promulgated by federal or state agencies were available and helpful, but those instances were few. While CalRecovery constructed a qualitative method of evaluation for this study, a lack of reliable and organized data precludes cost-effective quantitative evaluations of the risks posed by NHW. Efforts to improve data quality and to develop a consensus method of systematic analysis would yield a better management tool for use by scientists and decision-makers.

The results obtained by applying the method developed by CalRecovery are particularly sensitive to the specific chemicals and other agents that were selected to represent each NHW category, and to the numeric values of the weighting factors. Selection of more and/or other chemicals or agents to characterize the NHW categories or of different weighting factors could lead to results that are different than those obtained in this analysis.

SECTION V
References

1. *Characterization of San Francisco's Disposed Waste, 2004–2005*, prepared by Cascadia Consulting Group and Environmental Science Associates for the City and County of San Francisco, August 2005.

2. Characterization and Impacts of Nonregulated Hazardous Waste in the Solid Waste of King County, prepared by CalRecovery for Puget Sound Council of Governments, December 1985.

APPENDIX A

Detailed Description of NHW Categories Used in the Study

2005 SAN FRANCISCO WASTE COMPOSITION STUDY
NONREGULATED HAZARDOUS WASTE CATEGORIES

64. Latex Paints–Reusable	Water-based paints and similar products that are reusable (e.g., smooth liquid devoid of significant chips or clumps).
65. Latex Paints–Nonreusable	Water-based paints and similar products that are not reusable (e.g., high viscous liquid or liquid having significant chips or clumps).
66. Solvent-Based Adhesives/Glues	Oil/resin/volatile-solvent-based glues and adhesives, including epoxy, rubber cement, two-part glues and sealers, and auto body fillers.
67. Water-Based Adhesives/Glues	Water-based glues, caulking compounds, grouts, and spackle.
68. Petroleum-Based Paint	Solvent-based paints, varnishes, and similar products.
69. Pesticides/Herbicides/Wood Preservatives	Variety of products with the purpose of discouraging or killing insects, weeds, or microorganisms. Fungicides and wood preservatives, such as pentachlorophenol, are also included.
70. Dry Cell Batteries–Nonrechargeable	Dry cell batteries of various sizes and types as commonly used in households (includes button cell batteries).
71. Dry Cell Batteries–Rechargeable	Rechargeable batteries of various sizes and shapes (includes cell phone batteries).
72. Wet Cell Batteries	Wet cell batteries of various sizes and types as commonly used in automobiles.
73. Gasoline/Kerosene/Diesel	Gasoline, diesel fuel, and fuel oils.
74. Coolants/Antifreeze	Coolants such as propylene and ethylene glycol.
75. Used Motor Oil	Lubricating oils primarily used in vehicles, but including other types with similar characteristics.
76. Other Motor Vehicle Fluids	Motor vehicle fluids other than gasoline and lubricating fluids (e.g., grease, and hydraulic, transmission, and brake fluids).
77. Oil Filters	Metal oil filters used in cars and other equipment.
78. Asbestos-Containing Materials	Asbestos and wastes containing primarily asbestos fibers.
79. Treated Wood	79 A. Painted or Varnished Wood: Lumber and wood products that have been painted or varnished (with generally 5% or more of the surface area coated).
	79 B. Chemically Treated Wood: Lumber or wood that has been chemically treated.
80. Explosives	Gunpowder, unspent ammunition, picric acid, and other potentially explosive chemicals.
81. Pharmaceuticals	Any medicine intended for human or veterinary use, including both prescription and nonprescription drugs.
82. Medical Wastes–Sharps	Sharp medical instruments and devices such as hypodermic and IV needles and scalpels.
83. Medical Waste–Other	Health care materials other than sharps, such as IV tubing and patient drapes, specimen containers, and petri dishes.

84. Incandescent Light Bulbs	Incandescent light bulbs of various sizes.
85. Fluorescent Light Bulbs	Fluorescent light tubes and compact fluorescents containing mercury vapor and fluorescent coating on the inner surface of the glass.
86. Other Light Bulbs	Light bulbs other than incandescent or fluorescent, including mercury, sodium vapor, and halogen lamps.
87. Mercury Thermometers	Thermometers containing liquid mercury.
88. Mercury Thermostats/Switches	Thermostats containing mercury switches and other switches containing liquid mercury.
89. Nonempty Compressed Gas Tanks/Cylinders	Pressure tanks, vessels, or cylinders whose gaseous content is under pressure.
90. Televisions	Television devices or sets containing a cathode ray tube (CRT) or flat panel screen.
91. Computer Monitors (LCD)	Computers or computer monitors containing liquid crystal displays.
92. Computer Monitors (CRT)	Computer monitors containing cathode ray tubes.
93. CPUs	Central processing units.
94. Other Computer Equipment	Computer peripherals not containing monitors, such as mice, keyboards, disk drives, printers, copiers, and toner cartridges.
95. Other Electronics	Other equipment containing electronic “chips,” integrated circuits, or circuit boards, such as cell phones, fax machines, PDAs, stereos, radios, tape decks, VCRs, games, and toys.
96. Oxidizers	Compounds that give up oxygen easily or remove hydrogen from another compound, or attract negative electrons (e.g., hydrogen peroxide).
97. Acids	Strong and weak acids (e.g., hydrochloric acid).
98. Bases	Strong and weak bases (e.g., sodium hydroxide).
99. Other Chemicals or Cleaning Products	Cleaners other than those containing acids, bases, or petroleum-based products.
100. Solvents and Other Solvent-Based Products	Solvent-based products of petroleum origin other than those specifically listed elsewhere in the list (e.g., petroleum-based paints). For example, this category would include but not be limited to chlorinated and flammable solvents, paint strippers, solvents contaminated with other products such as paints, degreasers and some other cleaners if the primary ingredient is (or was) a solvent, or alcohol such as methanol and isopropanol.
101. Waxes	Substances containing petroleum products used to polish surfaces (e.g., floor, car, and furniture waxes).
102. Cosmetics	102 A. Hair Dye Products: Preparations and products designed to color or tint human hair. 102 B. Non-Hair-Dye Products: Preparations and products designed to beautify the human body (e.g., fingernail polish and eye shadow, but excluding hair dye preparations and products).
103. Inks and Dyes	For example, clothing dyes, writing and printing inks.
104. Other Potentially Harmful Wastes	Other chemicals or potentially harmful wastes that do not fit into the above categories, including unidentifiable materials that may pose a risk to human health or safety.

APPENDIX B

Data Collection Form Used for the Field Characterization Study

Location: SF Transfer Station | Route: _____

Sample ID No.: _____ Total HHW Wt (lb): _____ | Data Recorder: _____

Sample Capture Date: _____ | Sector: _____

Sort Date: _____ | Sample Count No.: _____

			Gross Wt of Items		Item Total Volume				
Item #	**Description**	**No. of Item(s)**	**Value**	**Units**	**Value**	**Units**	**Phase (L, G, or S)**	**Est'd Remain. Residue Fraction**	**Notes**
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									
16									
17									
18									
19									
20									
Notes:									

APPENDIX C

List of NHW Categories and Chemical Compounds and/or Other Agents Selected to Characterize the Hazards of Each Category

Category	Description	Problematic Chemicals/Constituents [a]
64. Latex Paints–Reusable	Water-based paints and similar products that are reusable (e.g., smooth liquid devoid of significant chips or clumps).	Resins, glycol ethers, esters, pigments, phenyl mercuric acetate METHYL ETHYL KETONE TOTAL XYLENES ACETONE CHROMIUM LEAD ZINC *Phenylmercuric acetate*
65. Latex Paints–Nonreusable	Water-based paints and similar products that are not reusable (e.g., high viscous liquid or liquid having significant chips or clumps).	Resins, glycol ethers, esters, pigments, phenyl mercuric acetate (Assumed similar characteristics to #64)
66. Solvent-Based Adhesives/Glues	Oil/resin/volatile-solvent-based glues and adhesives, including epoxy, rubber cement, two-part glues and sealers, and auto body fillers.	Hydrocarbons, including volatile organic compounds (VOCs), toluene, xylenes (Assumed similar characteristics to #68)
67. Water-Based Adhesives/Glues	Water-based glues, caulking compounds, grouts, and spackle.	(Assumed similar characteristics to #64)
68. Petroleum-Based Paint	Solvent-based paints, varnishes, and similar products.	Hydrocarbons, including toluene, xylenes, heavy metals Ethyl benzene Xylene Toluene Acetone CHROMIUM LEAD ZINC Unknown Prop. 65 chemical

Category	Description	Problematic Chemicals/Constituents [a]
69. Pesticides/ Herbicides/Wood Preservatives	Variety of products with the purpose of discouraging or killing insects, weeds, or microorganisms. Fungicides and wood preservatives, such as pentachlorophenol, are also included.	Hydrocarbons, including chlorinated; arsenic; copper Fipronil 1,1,2,2 TETRACHLOROETHANE ETHYL BENZENE *Arsenic* *Copper*
70. Dry Cell Batteries– Nonrechargeable	Dry cell batteries of various sizes and types as commonly used in households. Includes button cell batteries.	Heavy metals (e.g., mercury) *Mercury* COPPER ZINC
71. Dry Cell Batteries– Rechargeable	Rechargeable batteries of various sizes and shapes. Includes cell phone batteries.	Heavy metals (e.g., nickel, copper, cadmium) Copper Cadmium Nickel
72. Wet Cell Batteries	Wet cell batteries of various sizes and types as commonly used in automobiles.	Heavy metals (e.g., lead), acids (e.g., sulfuric) *Lead* Sulfuric acid
73. Gasoline/ Kerosene/Diesel	Gasoline, diesel fuel, and fuel oils.	Hydrocarbons (e.g., benzene, etc.) *Gasoline (unleaded)* *Benzene*
74. Coolants/ Antifreeze	Coolants such as propylene and ethylene glycol.	Propylene glycol, ethylene glycol *Propylene glycol* *Ethylene glycol*
75. Used Motor Oil	Lubricating oils, primarily used in vehicles, but including other types with similar characteristics.	Hydrocarbons *Used motor oil*
76. Other Motor Vehicle Fluids	Motor vehicle fluids other than gasoline and lubricating fluids (e.g., grease, and hydraulic, transmission, and brake fluids).	Hydrocarbons, including VOCs (Assumed similar characteristics to #75)
77. Oil Filters	Metal oil filters used in cars and other equipment.	Hydrocarbons *Used motor oil*
78. Asbestos-Containing Materials	Asbestos and wastes containing primarily asbestos fibers.	Asbestos *Asbestos*
79. Treated Wood	Lumber and wood products that have been chemically treated or painted (with generally 5% or more of the surface area coated).	Copper, pentachlorophenol, arsenic *Arsenic* *Copper* *Pentachlorophenol*
80. Explosives	Gunpowder, unspent ammunition, picric acid, and other potentially explosive chemicals.	*Butane*
81. Pharmaceuticals	Any medicine intended for human or veterinary use, including both prescription and nonprescription drugs.	Cancer-therapeutic Butylated hydroxytoluene
82. Medical Wastes– Sharps	Sharp medical instruments and devices such as scalpels and hypodermic and IV needles.	HIV, Hepatitis C *HIV, Hepatitis C*

Category	Description	Problematic Chemicals/Constituents [a]
83. Medical Waste–Other	Health care materials other than sharps, such as IV tubing and patient drapes, specimen containers, and petri dishes.	*Pathogens*
84. Incandescent Light Bulbs	Incandescent light bulbs of various sizes.	*Tungsten*
85. Fluorescent Light Bulbs	Fluorescent light tubes and compact fluorescents containing mercury vapor and fluorescent coating on the inner surface of the glass.	*Mercury*
86. Other Light Bulbs	Light bulbs other than incandescent or fluorescent, including mercury, sodium vapor, and halogen lamps.	Heavy metals (e.g., mercury) *Mercury*
87. Mercury Thermometers	Thermometers containing liquid mercury.	*Mercury*
88. Mercury Thermostats/ Switches	Thermostats containing mercury switches and other switches containing liquid mercury.	*Mercury*
89. Nonempty Compressed Gas Tanks/Cylinders	Pressure tanks, vessels, or cylinders whose gaseous content is under pressure.	Flammable gas Butane
90. Televisions	Television devices or sets containing a cathode ray tube (CRT) or flat panel screen.	Heavy metals Lead Copper Nickel
91. Computer Monitors–LCD	Computers or computer monitors containing liquid crystal displays.	*Barium* [b] Chromium [b]
92. Computer Monitors–CRT	Computer monitors containing cathode ray tubes.	Lead [c] Copper Nickel
93. CPUs	Central processing units.	Lead [c] Copper [c] Nickel [c]
94. Other Computer Equipment	Computer peripherals not containing monitors, such as mice, keyboards, disk drives, printers, copiers, and toner cartridges.	(Assumed similar characteristics to #93)
95. Other Electronics	Other equipment containing electronic “chips,” integrated circuits or circuit boards, such as cell phones, fax machines, PDAs, stereos, radios, tape decks, VCRs, games, and toys.	(Assumed similar characteristics to #93)
96. Oxidizers	Compounds that give up oxygen easily or remove hydrogen from another compound, or attract negative electrons (e.g., hydrogen peroxide).	Oxygenated compounds, including hydrogen peroxide *Hydrogen peroxide*
97. Acids	Strong and weak acids (e.g., hydrochloric acid).	Hydrochloric, sulfuric, nitric acids *Nitric acid* *Sulfuric acid*
98. Bases	Strong and weak bases (e.g., sodium hydroxide).	Sodium hydroxide, ammonium hydroxide Sodium hydroxide Sodium hypochlorite

Category	Description	Problematic Chemicals/Constituents [a]
99. Other Chemicals or Cleaning Products	Cleaners other than those containing acids, bases, or petroleum-based products.	Trisodium phosphate Trisodium phosphate
100. Solvents and Other Solvent-Based Products	Solvent-based products of petroleum origin other than those specifically listed elsewhere in the list (e.g., petroleum-based paints). For example, this category would include but not be limited to chlorinated and flammable solvents, paint strippers, solvents contaminated with other products such as paints, degreasers and some other cleaners if the primary ingredient is (or was) a solvent, or alcohol such as methanol and isopropanol.	Hydrocarbons, including chlorinated, xylenes, toluene *Xylene* Isopropyl alcohol Toluene
101. Waxes	Substances containing petroleum products used to polish surfaces (e.g., floor, car, and furniture waxes).	Hydrocarbons, including VOCs *Xylene*
102. Cosmetics	Preparations and products designed to beautify the human body (e.g., fingernail polish and eye shadow).	Acetone, xylenes, amines, diamines, toluene, phthalate, parabens Triethanolamine Toluene *Xylene* Diethyl phthalate
103. Inks and Dyes	For example, clothing dyes, writing and printing inks.	CHROMIUM COPPER LEAD ZINC
104. Other Potentially Harmful Wastes	Other chemicals or potentially harmful wastes that do not fit into the above categories, including unidentifiable materials that may pose a risk to human health or safety.	Sodium phosphate Xylene Methyl (n-amyl) ketone Ethyl benzene

Notes:

[a] General chemical classes and constituents if listed immediately to the right of the category name are taken from various literature sources. Within each category, representative chemicals and other agents are listed below the general chemical classes and agents. Unless otherwise noted, the problematic chemicals/constituents: in lowercase font are based on information recorded from labels on Sort 1 and 2 NHW items, in UPPERCASE font are based on information from CalRecovery (1985), and *italic* font are based on other literature sources or CalRecovery experience.

[b] Senate Bill 20 Report, *Determination of Regulated Elements in Discarded Laptop Computers, LCD Monitors, Plasma TVs and LCD TVs*, Hazardous Materials Laboratory, California Department of Toxic Substances Control, December 2004.

[c] Product Profile: Computer/CPUs, Oregon Department of Environmental Quality, March 2001.

Chromium is assumed to be present as Chromium VI.

APPENDIX D

Sources of Information and Basis of Hazard Ratings

Toxicity Profiling Parameter	Sources and Basis of Ratings
Carcinogen/Reproductive Toxicity	State of California Proposition 65 list of agents known to cause cancer or reproductive toxicity: Known = 1, not listed = 0, na = not applicable
Neurotoxicity	Cholinesterase inhibitor listed by the State of California Department of Pesticide Regulation or listed in Section 313 of the Emergency Planning and Community Right-to-Know Act of 1986. Listed = 1, not listed = 0.
Pathogenecity	HIV and Hepatitus B are the primary pathogen risks for NHW per Dr. Edward Wei, Professor, School of Public Health, University of California (Berkeley). Serious disease potential = 5, slight disease potential = 1, nonpathogenic = 0.
Ozone-Depleting Substances	U.S. Environmental Protection Agency (US EPA) listing of ozone-depleting substances (www.epa.gov/ozone/ods.html), May 19, 2005. Listed = 1, not listed = 0.
Toxicity	Acute toxicity ratings based on US EPA toxicity rankings if supported by U.S. National Toxics Program Acute Toxicity Studies. Acute toxicity to rats based on oral (LD_{50}), dermal (LD_{50}), and inhalation (LC_{50}). High = 3, moderate = 2, slight = 1, not acutely toxic = 0. Pesticide Action Network Pesticide Database (www.pesticideinfo.org).
Ignitability (degrees Celsius)	Material Safety Data Sheets and other references. US EPA standard for ignitability characteristic (less than or equal to 60 degrees C): <60 deg C = 1, 60 deg C = 0.
Endocrine Modifiers	Listed by the State of Illinois Environmental Protection Agency (IL EPA) (Endocrine Disruptors Strategy, February 1997) as a known, probable, or suspected endocrine disruptor. Known = 3, probable = 2, suspect = 1, on IL EPA list.
Surface or Groundwater Contamination	Potential for contamination of water resources is assumed a function of solubility in water. Handbook of Chemistry and Physics, CRC Press, 56th edition. Insoluble = 0, slightly soluble = 1, soluble = 2, very soluble/miscible = 3.
Corrosivity	Material Safety Data Sheets and other references; US EPA standard for corrosivity characteristic: pH > 12.5 or < 2.
Mechanical Injury (e.g., punctures)	CalRecovery. Criterion: potential of NHW item to inflict mechanical injury. High potential = 1, low potential = 0.
Greenhouse Gas Precusors	CalRecovery. Criterion: potential to form greenhouse gases (e.g., carbon dioxide, methane, and nitrous oxide) as by-products of biological decomposition of chemical compounds. High potential = 1, low or no potential = 0.
Hypersensitivity (allergic) Reactions	Material Safety Data Sheets. No data or not irritant = 0, slight = 1, moderate = 2, severe = 3.
Irritancy	Material Safety Data Sheets and/or Western Regional Pollution Prevention Network website (www.wrppn.org) information: Eye or Skin or Inhalation. No data or not irritant = 0, slight irritant = 1, irritant = 2, severe irritant = 3.

APPENDIX E

Hazard Rating Criteria – NHW Categories

Category	Problematic Chemicals/ Constituent [a]	Carcinogen/ Reproductive Toxicity	Neurotoxins	Pathogenicity	Ozone-Depleting Substances	Toxicity	Ignitability	Endocrine Modifiers	Surface or Groundwater Contamination	Corrosivity	Mechanical Injury (e.g., punctures)	Greenhouse Gas Precusors	Hypersensitivity (allergic) Reactions	Irritancy
64. Latex Paints–Reusable	Resins, glycol ethers, esters, pigments, phenyl mercuric acetate	40	0	0	0	15	12	40	30	3	0	12	0	9
	METHYL ETHYL KETONE	0	0	0	0	1	1	0	3	0	0	1	0	3
	TOTAL XYLENES	0	0	0	0	1	1	0	0	0	0	1	0	2
	ACETONE	0	0	0	0	1	1	0	3	0	0	1	0	2
	CHROMIUM	1	0	0	0	isd	0	0	isd	0	0	0	0	0
	LEAD	1	0	0	0	isd	0	2	isd	0	0	0	0	0
	ZINC	0	0	0	0	isd	0	0	isd	0	0	0	0	0
	Phenylmercuric acetate	0	0	0	0	isd	1	0	isd	1	0	1	0	2
65. Latex Paints–Nonreusable	Resins, glycol ethers, esters, pigments, phenyl mercuric acetate	40	0	0	0	15	12	40	30	3	0	12	0	9
	(Assumed similar characteristics to #64)													
66. Solvent-Based Adhesives/ Glues	Hydrocarbons, including VOCs, toluene, xylenes	100	0	0	0	20	12	40	15	0	0	12	0	6
	(Assumed similar characteristics to #68)													
67. Water-Based Adhesives/Glues	(Assumed similar characteristics to #64)	40	0	0	0	15	12	40	30	3	0	12	0	9
68. Petroleum-Based Paint	Hydrocarbons, including toluene, xylenes, heavy metals	100	0	0	0	20	12	40	15	0	0	12	0	6
	Ethyl benzene	1	0	0	0	1	1	0	0	0	0	1	0	0
	Xylene	0	0	0	0	1	1	0	0	0	0	1	0	2

Category	Problematic Chemicals/ Constituent [a]	Carcinogen/ Reproductive Toxicity	Neurotoxins	Pathogenicity	Ozone-Depleting Substances	Toxicity	Ignitability	Endocrine Modifiers	Surface or Groundwater Contamination	Corrosivity	Mechanical Injury (e.g., punctures)	Greenhouse Gas Precusors	Hypersensitivity (allergic) Reactions	Irritancy
	Toluene	1	0	0	0	1	1	0	0	0	0	1	0	2
	Acetone	0	0	0	0	1	1	0	3	0	0	1	0	2
	CHROMIUM	1	0	0	0	isd	0	0	isd	0	0	0	0	0
	LEAD	1	0	0	0	isd	0	2	isd	0	0	0	0	0
	ZINC	0	0	0	0	isd	0	0	isd	0	0	0	0	0
	Unknown Prop. 65 chemical	1	isd	isd	isd	isd	isd	isd	isd	isd	isd	isd	isd	isd
69. Pesticides/ Herbicides/Wood Preservatives	Hydrocarbons, including chlorinated; arsenic; copper	60	20	0	0	15	3	0	15	3	0	9	0	0
	Fipronil	0	0	0	0	isd	0	0	1	0	0	1	0	0
	1,1,2,2 TETRACHLOROETHANE	1	0	0	0	2	0	0	2	1	0	1	0	0
	ETHYL BENZENE	1	0	0	0	1	1	0	0	0	0	1	0	0
	Arsenic	1	0	0	0	isd	0	0	isd	0	0	0	0	0
	Copper	0	1	0	0	isd	0	0	isd	0	0	0	0	0
70. Dry Cell Batteries– Nonrechargeable	Heavy metals (e.g., mercury)	20	0	0	0	0	0	0	0	0	0	0	0	0
	Mercury	1	0	0	0	isd	0	2	isd	0	1	0	0	0
	COPPER	0	1	0	0	isd	0	0	isd	0	0	0	0	0
	ZINC	0	0	0	0	isd	0	0	isd	0	0	0	0	0
71. Dry Cell Batteries– Rechargeable	Heavy metals (e.g., nickel, copper, cadmium)	40	20	0	0	0	0	0	0	0	0	0	0	0
	Copper	0	1	0	0	isd	0	0	isd	0	0	0	0	0
	Cadmium	1	0	0	0	isd	0	0	isd	0	0	0	0	0
	Nickel	1	0	0	0	isd	0	0	isd	0	0	0	0	0
72. Wet Cell Batteries	Heavy metals (e.g., lead), acids (e.g., sulfuric)	20	0	0	0	0	0	40	15	3	0	0	1	0

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	Lead	1	0	0	0	isd	0	2	isd	0	0	0	0	0
	Sulfuric acid	0	0	0	0	isd	0	0	3	1	0	0	1	0
73. Gasoline/ Kerosene/Diesel	Hydrocarbons (e.g., benzene, etc.)	40	0	0	0	5	6	0	10	0	0	6	0	2
	Gasoline (unleaded)	1	0	0	0	0	1	0	0	0	0	1	0	0
	Benzene	1	0	0	0	1	1	0	2	0	0	1	0	2
74. Coolants/ Antifreeze	Propylene glycol, ethylene glycol	0	0	0	0	5	0	0	15	3	0	6	0	4
	Propylene glycol	0	0	0	0	0	0	0	3	1	0	1	0	2
	Ethylene glycol	0	0	0	0	1	0	0	0	0	0	1	0	2
75. Used Motor Oil	Hydrocarbons	20	0	0	0	0	3	0	0	0	0	3	0	0
	Used motor oil	1	0	0	0	0	1	0	0	0	0	1	0	0
76. Other Motor Vehicle Fluids	Hydrocarbons, including VOCs	20	0	0	0	0	3	0	0	0	0	3	0	0
	(Assumed similar characteristics to #75)	1	0	0	0	0	1	0	0	0	0	1	0	0
77. Oil Filters	Hydrocarbons	20	0	0	0	0	3	0	0	0	0	3	0	0
	Used motor oil	1	0	0	0	0	1	0	0	0	0	1	0	0
78. Asbestos-Containing Materials	Asbestos	20	0	0	0	0	0	0	0	0	0	0	0	0
	Asbestos	1	0	0	0	isd	0	0	0	0	0	0	0	0
79. Treated Wood	Copper, pentachlorophenol, arsenic	40	20	0	0	15	0	40	5	3	0	3	0	0
	Arsenic	1	0	0	0	isd	0	0	isd	0	0	0	0	0
	Copper	0	1	0	0	isd	0	0	isd	0	0	0	0	0
	Pentachlorophenol	1	0	0	0	3	0	2	1	1	0	1	0	0
80. Explosives		0	0	0	0	0	3	0	10	0	0	0	0	0

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	Butane	0	0	0	0	0	1	0	2	0	0	0	0	0
81. Pharmaceuticals	Cancer-therapeutic	0	0	0	0	5	0	0	0	0	0	3	0	0
	Butylated hydroxytoluene	0	0	0	0	1	0	0	isd	0	0	1	0	0
82. Medical Wastes–Sharps	HIV, Hepatitis C	0	0	25	0	0	0	0	0	0	1	3	0	0
	HIV, Hepatitis C	0	isd	5	isd	isd	isd	isd	isd	isd	0	1	isd	isd
83. Medical Waste–Other		0	0	5	0	0	0	0	0	0	0	3	0	0
	Pathogens	isd	isd	1	isd	isd	isd	isd	isd	isd	0	1	isd	isd
84. Incandescent Light Bulbs		0	0	0	0	0	0	0	0	0	1	0	0	0
	Tungsten	0	0	0	0	isd	0	0	isd	0	0	0	0	0
85. Fluorescent Light Bulbs		20	0	0	0	0	0	40	0	0	0	0	0	0
	Mercury	1	0	0	0	isd	0	2	isd	0	0	0	0	0
86. Other Light Bulbs	Heavy metals (e.g., mercury)	20	0	0	0	0	0	40	0	0	1	0	0	0
	Mercury	1	0	0	0	isd	0	2	isd	0	0	0	0	0
87. Mercury Thermometers		20	0	0	0	0	0	40	0	0	1	0	0	0
	Mercury	1	0	0	0	isd	0	2	isd	0	0	0	0	0
88. Mercury Thermostats/ Switches		20	0	0	0	0	0	40	0	0	0	0	0	0
	Mercury	1	0	0	0	isd	0	2	isd	0	0	0	0	0
89. Nonempty Compressed Gas Tanks/Cylinders	Flammable gas	0	0	0	0	0	3	0	10	0	0	0	0	0
	Butane	0	0	0	0	0	1	0	2	0	0	0	0	0
90. Televisions	Heavy metals	40	20	0	0	0	0	40	0	0	0	0	0	0
	Lead	1	0	0	0	isd	0	2	isd	0	0	0	0	0
	Copper	0	1	0	0	isd	0	0	isd	0	0	0	0	0
	Nickel	1	0	0	0	isd	0	0	isd	0	0	0	0	0

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91. Computer Monitors (LCD)		20	0	0	0	0	0	0	0	0	0	0	0	0
	Barium [b]	0	0	0	0	isd	0	0	isd	0	0	0	0	0
	Chromium [b]	1	0	0	0	isd	0	0	isd	0	0	0	0	0
92. Computer Monitors (CRT)		40	20	0	0	0	0	40	0	0	0	0	0	0
	Lead [c]	1	0	0	0	isd	0	2	isd	0	0	0	0	0
	Copper	0	1	0	0	isd	0	0	isd	0	0	0	0	0
	Nickel	1	0	0	0	isd	0	0	isd	0	0	0	0	0
93. CPUs		40	20	0	0	0	0	40	0	0	0	0	0	0
	Lead [c]	1	0	0	0	isd	0	2	isd	0	0	0	0	0
	Copper [c]	0	1	0	0	isd	0	0	isd	0	0	0	0	0
	Nickel [c]	1	0	0	0	isd	0	0	isd	0	0	0	0	0
94. Other Computer Equipment	(Assumed similar characteristics to #93)	40	20	0	0	0	0	40	0	0	0	0	0	0
95. Other Electronics	(Assumed similar characteristics to #93)	40	20	0	0	0	0	40	0	0	0	0	0	0
96. Oxidizers	Oxygenated compounds, including hydrogen peroxide	0	0	0	0	0	0	0	15	0	0	0	1	0
	Hydrogen peroxide	0	0	0	0	isd	0	0	3	0	0	0	1	0
97. Acids	Hydrochloric, sulfuric, nitric acids	0	0	0	0	0	0	0	30	6	0	0	1	0
	Nitric acid	0	0	0	0	isd	0	0	3	1	0	0	0	0
	Sulfuric acid	0	0	0	0	isd	0	0	3	1	0	0	1	0
98. Bases	Sodium hydroxide, ammonium hydroxide	0	0	0	0	0	0	0	30	6	0	0	1	2
	Sodium hydroxide	0	0	0	0	isd	0	0	3	1	0	0	0	0

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	Sodium hypochlorite	0	0	0	0	isd	0	0	3	1	0	0	1	2
99. Other Chemicals or Cleaning Products	Trisodium phosphate	0	0	0	0	0	0	0	10	0	0	0	0	2
	Trisodium phosphate	0	0	0	0	isd	0	0	2	0	0	0	0	2
100. Solvents and Other Solvent-Based Products	Hydrocarbons, including chlorinated, xylenes, toluene	20	0	0	0	15	9	0	15	0	0	9	0	6
	Xylene	0	0	0	0	1	1	0	0	0	0	1	0	2
	Isopropyl alcohol	0	0	0	0	1	1	0	3	0	0	1	0	2
	Toluene	1	0	0	0	1	1	0	0	0	0	1	0	2
101. Waxes	Hydrocarbons, including VOCs	0	0	0	0	5	3	0	0	0	0	3	0	2
	Xylene	0	0	0	0	1	1	0	0	0	0	1	0	2
102. Cosmetics	Acetone, xylenes, amines, diamines, toluene, phthalate, parabens	20	0	0	0	10	6	0	20	3	0	12	0	5
	Triethanolamine	0	0	0	0	0	0	0	3	1	0	1	0	1
	Toluene	1	0	0	0	1	1	0	0	0	0	1	0	2
	Xylene	0	0	0	0	1	1	0	0	0	0	1	0	2
	Diethyl phthalate	0	0	0	0	0	0	0	1	0	0	1	0	0
103. Inks and Dyes		40	20	0	0	0	0	40	0	0	0	0	0	0
	CHROMIUM	1	0	0	0	isd	0	0	isd	0	0	0	0	0
	COPPER	0	1	0	0	isd	0	0	isd	0	0	0	0	0
	LEAD	1	0	0	0	isd	0	2	isd	0	0	0	0	0
	ZINC	0	0	0	0	isd	0	0	isd	0	0	0	0	0

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104. Other Potentially Harmful Wastes		20	0	0	0	10	6	0	10	0	0	9	0	4
	Sodium phosphate	0	0	0	0	0	0	0	2	0	0	0	0	0
	Xylene	0	0	0	0	1	1	0	0	0	0	1	0	2
	Methyl (n-amyl) ketone	0	0	0	0	isd	0	0	0	0	0	1	0	2
	Ethyl benzene	1	0	0	0	1	1	0	0	0	0	1	0	0

Notes:

[a] General chemical classes and constituents if listed immediately to the right of the category name are taken from various literature sources. Within each category, representative chemicals and other agents are listed below the general chemical classes and agents. Unless otherwise noted, the problematic chemicals/constituents: in lowercase font are based on information recorded from labels on Sort 1 and 2 NHW items, in UPPERCASE font are based on information from CalRecovery (1985), and *italic* font are based on other literature sources or CalRecovery experience.

[b] Senate Bill 20 Report, *Determination of Regulated Elements in Discarded Laptop Computers, LCD Monitors, Plasma TVs and LCD TVs*, Hazardous Materials Laboratory, California Department of Toxic Substances Control, December 2004.

[c] Product Profile: Computer/CPUs, Oregon Department of Environmental Quality, March 2001.

Chromium is assumed to be present as Chromium VI.

isd = insufficient data