DONALD BREN SCHOOL OF
ENVIRONMENTAL SCIENCE & MANAGEMENT
UNIVERSITY OF CALIFORNIA, SANTA BARBARA

Pharmaceuticals in Wastewater Streams: Disposal Practices and Policy Options in Santa Barbara

A Master's Project for the Donald Bren School of Environmental Science and Management

May 2007

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The Group Project is required of all students in the Master's of Environmental Science and Management (MESM) Program. It is a four-quarter activity in which small groups of students conduct focused, interdisciplinary research on the scientific, management, and policy dimensions of a specific environmental issue. This Final Group Project Report is authored by MESM students and has been reviewed and approved by:

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May 2007

Acknowledgements

We would like to thank the National Marine Sanctuaries Foundation and the Shoreline Preservation Fund for funding support, and Jenny Phillips for her help with grant-writing. We would also like to thank our clients, external advisors, and faculty reviewers for their knowledge and time: Jenny Phillips - Community Environmental Council; Leslie Robinson - County of Santa Barbara Public Works Department, Resource Recovery and Waste Management Division; Kira Schmidt - Santa Barbara Channelkeeper; Dr. Patricia Holden - Professor, Bren School; Dr. Arturo Keller - Professor, Bren School; Dr. Hunter Lenihan - Associate Professor, Bren School. Our gratitude also goes out to William (Wen-Yu) Lee, and Paolo Gardinali, Associate Director at the UCSB Social Science Survey Center.

We would especially like to thank our project advisor, Dr. Matthew Kotchen, whose guidance and support proved invaluable throughout the group project process.

ACRONYMS AND ABBREVIATIONS

BAPPG	Bay Area Pollution Prevention Group
CCL	Contaminant Candidate List
CCR	California Code of Regulations
CCS	Central Coast Survey, a phone survey conducted by the University of California, Santa Barbara Social Science Survey Center
CFR	Code of Federal Regulations
CIWMB	California Integrated Waste Management Board
CV	Contingent valuation
CWA	Clean Water Act
DEA	United States Drug Enforcement Agency
DDT	Dichloro-Diphenyl-Trichloroethane, a pesticide
DTSC	California Department of Toxic Substances Control
EA	Environmental assessment
EPA	United States Environmental Protection Agency
FDA	United States Food & Drug Administration
kg	Kilogram
µg	Microgram
µg/L	Micrograms per liter
L	Liter
MWMA	Medical Waste Management Act
n	Sample size
NEPA	National Environmental Policy Act
NPDWR	National Primary Drinking Water Regulations
ODC	Office of Diversion Control, United States Drug Enforcement Agency
ppb	Parts per billion
ppt	Parts per trillion
RCRA	Resource Conservation and Recovery Act
SCCWRP	Southern California Coastal Water Research Program
SDWA	Safe Drinking Water Act
UCSB	University of California, Santa Barbara
USGS	United States Geological Survey
WCRC	Washington Citizens for Resource Conservation
WTP	Willingness-to-pay
WWTP	Wastewater treatment plant

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ABSTRACT

Many studies in the last ten years have detected pharmaceutical compounds in treated wastewater effluent, rivers, lakes, and groundwater. The continuous exposure to low levels of pharmaceuticals can harm aquatic communities. For example, chronic exposure to endocrine disruptors, such as the compounds used in birth control, can feminize male fish and debilitate their capacity to reproduce. The two main sources of pharmaceuticals in the environment are excretion and disposal to wastewater treatment systems, which are not equipped to remove these compounds. Our project focuses on the disposal of pharmaceuticals. We conducted surveys to determine household and institutional disposal practices in Santa Barbara County and to estimate the public's willingness-to-pay for a pharmaceutical disposal program. We used our survey results to evaluate the desirability of different disposal programs and policy options. Based on our findings, a recycling program is not recommended at this time, as most institutions do not have medications appropriate for donation, and most facilities dispose of only a small percentage of their pharmaceutical stock. Our findings do suggest that an education campaign is necessary: the drain and trash are the most common disposal habits among the public, which are not best-practice disposal routes. We also recommend implementing a disposal program for the public. Based on a prescription surcharge, contingent valuation study, we find that Santa Barbara residents are willing to pay $1.55 per prescription in order to support a pharmaceutical disposal program. Based on this estimate, the total annual value to the public of a disposal program ranges from $621,181, assuming one prescription per person, to $7,329,937, assuming the national average prescription rate of 11.8 prescriptions per person. Both values exceed the cost of other programs that are being implemented across the country.

EXECUTIVE SUMMARY

Introduction

Recent advances in analytical technology have led researchers to discover trace amounts of pharmaceuticals in wastewater effluents, rivers, lakes and groundwater. Pharmaceuticals have also been detected in soil samples and fish tissues. Based on the wealth of published occurrence data, it seems probable that most, if not all, urban wastewater is contaminated with pharmaceutical compounds, differing only in the type and abundance of the substances present.

This presents a problem to the aquatic environment because pharmaceutical compounds are specifically designed to affect biological organisms. While environmental concentrations are below acutely toxic levels, the main concern is the chronic and/or synergistic effects of the "cocktail" of pharmaceuticals humans have created in the water. Endocrine disruption is the most widespread and documented effect that pharmaceuticals have on aquatic organisms. The presence of synthetic estrogens, among other known endocrine disruptors has contributed to the feminization of male fish in waters receiving treated wastewater effluents. Also of concern is the development of antibiotic resistant bacteria populations. A number of studies have shown a decrease in antibiotic effectiveness due to its widespread presence in the environment.

Pharmaceuticals reach the environment via two main pathways: excretion and disposal to wastewater treatment systems, which are not equipped to remove these compounds. This study focuses on the disposal of pharmaceuticals, examines regional disposal practices, and evaluates different ways Santa Barbara County can divert this waste from its water.

There are no laws that regulate how end-users (i.e. patients) dispose of their drugs. The Drug Enforcement Agency (DEA) and other governmental agencies recommend the drain or trash as disposal methods; however, both these disposal routes can lead to water contamination. A better way to dispose of pharmaceuticals is through hazardous waste incineration, but this method requires a centralized disposal program. While some counties and municipalities across the country have begun to implement disposal programs, one noted barrier to implementation is DEA regulations that prohibit the take-back of controlled substances. DEA regulations make disposal programs confusing, as most programs must exclude controlled substances (and most people do not know which medications are classified as "controlled") or get DEA approval. This study concludes with a look at the barriers to implementation and recommends a range of disposal program options for Santa Barbara County.

Disposal programs that are currently being considered by the research and decision-making community include:

- permanent collection boxes at pharmacies or police stations;
- mail-back programs;
- periodic collection events.

Another option that is being considered is a drug recycling program. In California, counties may pass an ordinance to collect unused, unexpired pharmaceuticals from nursing homes, wholesalers, and manufacturers and redistribute them to low-income, uninsured residents.

Project Objectives

This group project seeks to accomplish two primary research objectives:

- Determine household and institutional behaviors and disposal practices related to pharmaceuticals in Santa Barbara County.
- Recommend policy options that would improve pharmaceutical disposal practices in Santa Barbara County.

Methodology

Two surveys were conducted to determine the disposal practices of institutions and end-users in Santa Barbara County. For the institutions, a 15-question telephone survey was conducted by the authors. Institutions included in this study were pharmacies, hospitals, nursing homes, and hospices in Santa Barbara County. These institutions were surveyed because they handle a large volume of pharmaceuticals and may be a major source of pharmaceuticals in the environment. In addition, institutions are a source of information and education to the public, and it is important to gauge the extent of this contact between the public and institutions. Survey questions covered the following topics:

- current disposal practices;
- contact with the public;
- likelihood to supply/support a recycling program;
- likelihood to support a disposal program for the public.

A five-question end-user survey was conducted to gain insight into residents' medicine use, disposal habits, awareness of pharmaceuticals in surface water, and willingness to participate in a disposal program. A contingent valuation (CV) question was also included to determine the value of a disposal program through people's willingness-to-pay (WTP). The questions were part of the Central Coast Survey, an annual survey of Ventura and Santa Barbara county residents conducted by the UCSB Social Science Survey Center. The CV question was written in a referendum format and asked whether the respondent would be willing to pay a disposal surcharge per prescription. A surcharge amount was randomly drawn for each respondent; amounts ranged from $0.05 to $2.50.

Institutional Survey

In total, 116 facilities were contacted, 87 of which were usable for this study; 42 responses were obtained for a total response rate of 48 percent. Most of the responses were from pharmacies (29 out of 42); thus, the data primarily represent the pharmacies. The majority of institutions contract with reverse distributors to dispose of unused medications. A reverse distributor is a service that arranges for the return of any unwanted pharmaceuticals back to manufacturers for credit or for the destruction or disposal of non-creditable products. Few institutions use the trash or drain as disposal

methods. This result indicates that institutions probably are not large contributors of pharmaceuticals to the environment.

Institutions were asked whether their patients/customers have asked how to dispose of unwanted pharmaceuticals. Ninety percent of pharmacies said "yes"; lower percentages were found for nursing homes and hospitals. This result indicates that if a disposal program is implemented in the future, institutions – and pharmacies in particular – should be properly educated to provide accurate information to the public.

As mentioned previously, one of the potential policy options is a drug recycling program. This study found, however, that most institutions in Santa Barbara County would not have unused, unexpired medications to donate to a drug recycling program. When asked if the facility would have medications that could be donated, 33 of 40 institutions (82.5 percent) answered "no." These institutions do not have medications to donate because most dispose of less than 5 percent of their stocks, and they usually dispose of expired medications, which are unsuitable for a recycling program. This implies that there is not likely to be a consistent supply of usable medications to support a drug recycling program.

Responses reveal that the majority of institutions are genuinely concerned about pharmaceutical contamination, which is manifested in a shared sentiment of cooperation among the respondents. This finding is encouraging and signals that if the County government were to implement a disposal program for the public, the institutions would support the move. Respondents were asked whether they would house a drop-off box for an end-user disposal program. Many of the pharmacies said they would. "Maybe" was the second most-common answer among pharmacies, saying they would have to ask their corporate headquarters. Pharmacies may be the best location to collect unwanted medications from end-users.

It is worth noting that when asked which entity should take responsibility to address the pharmaceutical-disposal issue, many said that a collective effort is needed, and "government" was the most common response. Therefore, this finding suggests the local government will likely need to instigate the movement toward establishing policy solutions.

End-user survey

In total, 1,005 responses were obtained from residents in Santa Barbara and Ventura counties. The most common responses for typical pharmaceutical disposal practices are trash (45 percent), toilet/drain (28 percent), and store at home (12 percent). These results are the opposite of the disposal practices reported by institutions, which rarely use the trash, toilet, or drain as disposal methods.

A majority of the respondents (54 percent) are not aware that medicinal compounds have been found in treated wastewater and surface waters, indicating that education on the issue may be beneficial. An education or advertising campaign may help move people's disposal habits away from the trash, toilet, and sink. Respondents also show a strong

willingness-to-participate in a drug disposal program, with 79 percent of respondents indicating that they would be very likely or somewhat likely to return their medicines to their pharmacy.

The CV data were used to estimate a logit model that predicts the probability of a "yes" response based on the surcharge amount and other predictive variables. Consistent with economic theory, we find that demand decreases as the given bid amount increases. The WTP for a disposal program is also influenced significantly by age. The effect is in the expected direction, with older respondents, who tend to buy more prescriptions, having a lower WTP. Gender and political party also influence WTP, with women and democrats placing a higher value on a disposal program. Hispanic respondents also place more value on a disposal program. Surprisingly, respondents who were aware of the issue were less likely to respond "yes" to the surcharge. One explanation for this result is that awareness is correlated with education level and educated respondents may also be aware of other social and environmental issues. Their "no" response may indicate that they do not feel a disposal program is a priority problem.

Overall, the average WTP is $1.55 per prescription. Using the average WTP, the value of the pharmaceutical disposal program in Santa Barbara County is $621,181, assuming 1 prescription per person per year. Using the national per capita prescription rate of 11.8, the annual value jumps to $7,329,937.

The results show that the trash and drain are common disposal routes for the public, indicating that a disposal program, along with an education campaign, in Santa Barbara County, would be a beneficial investment. Local residents also place a remarkably high value on a disposal program. In addition, a disposal program is a good investment because the regions' residents are also quite willing to participate in a disposal program.

Conclusions

The survey results were used to evaluate different disposal programs and policy options. Our primary findings and recommendations for Santa Barbara County are the following:

1. A drug recycling program is not recommended at this time, as evidence for a reliable and consistent supply of usable medicines was not found.
2. A campaign to educate residents is necessary: The drain and trash are the most common disposal habits among the public, which are not best-practice disposal methods.
3. A permanent collection program is recommended to ensure that residents have an effective and legal way to properly dispose of their medications.

Because the successful implementation of a permanent disposal program is constrained by regulatory and institutional barriers, we have outlined a range of end-user disposal program options. The options presented below are ordered from the most recommended and ideal option, but also the most difficult to implement program, to the least recommended option.

Option A: Apply for a DEA exemption for drop-off box collection at pharmacies. This program option would allow for permanent drop-off box collection of both controlled and non-controlled medications. The boxes would be located at pharmacies and serviced by a reverse distributor.

Option B: Collection at police stations. Another solution for a permanent collection program that includes controlled substances is collection at police stations; police are allowed to take-back controlled substances from end-users, and no DEA exemption would be required. We recommend that the County of Santa Barbara approach law enforcement officials to gauge their willingness to participate in a drug collection program.

Option C: Collection of non-controlled medication at hazardous waste facilities. Although hazardous waste facilities are not authorized to collect controlled substances, they can collect non-controlled medications for hazardous waste incineration. This service should be prominently advertised within the community.

Option D: Special collection events. If none of the other options can be implemented, Santa Barbara County should hold special collection events at a minimum. Although less than ideal because they are not as convenient as a permanent disposal program, collection events would allow residents to get rid of their unwanted medications and have the added benefit of educating consumers about the environmental and safety issues associated with pharmaceutical disposal.

I. INTRODUCTION

The release of pharmaceuticals into the environment is an emerging and important environmental concern. Researchers have found trace amounts of pharmaceuticals in wastewater effluents, rivers, lakes, sea water, and groundwater in Europe and North America. Pharmaceuticals have also been detected in soil samples and fish tissues. Based on the abundance of data, it seems probable that most, if not all, urban wastewater is contaminated with pharmaceutical compounds, differing only in the type and concentrations of the substances present.

Scientific literature indicates that the presence of pharmaceuticals in the environment can negatively impact aquatic organisms. While the measured concentrations are not lethally toxic, the primary risk is the chronic, synergistic effects of the "cocktail" of pharmaceuticals humans are creating in the water. Endocrine disruption is the most widespread and documented effect that pharmaceuticals have on aquatic organisms. The presence of synthetic estrogens, among other known endocrine disruptors, has contributed to the feminization of male fish in waters receiving treated wastewater effluents. Also of concern is the effect antibiotics have on bacteria populations. A number of studies have shown a decrease in antibiotic effectiveness due to its widespread presence in the environment.

There are many pathways a pharmaceutical can take before entering surface and ground water, including human consumption and subsequent excretion and human disposal to wastewater treatment plants (WWTPs). Modern WWTPs are generally not equipped to effectively remove these compounds from water. The proportional contribution of different means of entry (i.e. excretion, disposal) to the overall quantity of pharmaceuticals entering the environment is unknown. While many researchers claim that the majority of pharmaceuticals entering the environment are from excretion, these claims are based on intuition, not empirical evidence. This study does not look at excretion because tackling excretion necessitates extensive research and intervention at the water treatment level (WWTPs), which involves larger and more expensive infrastructure changes.

Instead, this study focuses on the disposal of pharmaceuticals, which is a simple and less costly place to begin reducing the amount of pharmaceuticals that reach the environment. Compliance to prescription medication regimens is suboptimal: the average compliance rate is about 50 percent (Wright 1993; Boudes 1998; Vrijens & Urquhart 2005). This lack of compliance represents a source of unused medications that may find their way into ground and surface waters through improper disposal. Education and take-back programs are relatively easy and quickly implemented at low cost and provide the added benefit of reducing opportunities for misuse of stored drugs. The ultimate destruction method currently considered to be the best option to remove these active compounds from the environment is hazardous waste incineration.

OBJECTIVES

To address disposal, our two main project objectives are to:

1. Determine household behavior and institutional disposal practices in Santa Barbara County
2. Recommend policy options that would address pharmaceutical disposal in Santa Barbara County

Overall, the objectives of this study were to determine how institutions and residents (referred to as the "end-user") are disposing of their medication, and suggest programs or policies that will prevent improper disposal of pharmaceuticals. Disposal practices, along with awareness of the issue, willingness to participate in a disposal program, and other topics were determined through surveys. We contacted an exhaustive list of pharmacies, nursing homes, hospitals, and hospices in Santa Barbara County, and nearly half the institutions participated in the survey. A survey was also administered to approximately 1,000 residents in Santa Barbara and Ventura counties to obtain information on end-user medicine use, disposal habits, awareness, willingness-to-participate, and willingness-to-pay. This is the first study that performs a contingent valuation of a disposal program.

In order to frame many of the survey questions, potential disposal program options – ones that are being considered in the research and decision-making communities – were identified. Programs that are currently being implemented across the nation include: permanent collection boxes at pharmacies or police stations; collection at household hazardous waste facilities; mail-back programs; or periodic collection events. Another policy option in California, which has the potential to reduce the amount of wasted pharmaceuticals, is a drug recycling program. In California, counties may pass an ordinance to collect unused, unexpired pharmaceuticals from nursing homes, wholesalers, and manufacturers and redistribute them to low-income residents.

Certain pharmaceuticals meeting guidelines regarding potential for abuse, accepted medicinal use, and safety are classified as controlled substances. Controlled substances are strictly regulated by the Drug Enforcement Agency (DEA) and present a barrier to implementing any collection program because only law enforcement officials can handle controlled substances once they have been dispensed to the end-user. To comply with controlled substance regulations, a disposal program can do one of the following: refuse to accept controlled substances, involve law enforcement officials, or apply for an exemption from the DEA.

SCOPE

Human prescription and over-the-counter pharmaceutical medications are the primary focus of this research. Personal care products, such as fragrances and antibacterial soaps, as well as veterinary pharmaceuticals were excluded. Both these categories are extremely important, however, and should be addressed in future research.

The geographical scope of this project is Santa Barbara County. We chose Santa Barbara County as the study area because the Santa Barbara County Public Works department and a local non-profit are stakeholders in this project and are interested in establishing a disposal program in Santa Barbara County.

This final report provides a template that will guide other counties pursuing information and solutions. In addition, the report includes a comprehensive review of scientific literature, an assessment of disposal practices and sentiments, and an evaluation of several actions that could be implemented to mitigate the release of pharmaceuticals to wastewater.

II. BACKGROUND

OVERVIEW

Pharmaceuticals and medicine manufacturing is one of the fastest growing industries in the United States (BLS 2005) generating $116 billion in pharmaceutical preparation sales in the United States in 2005, up from $79 billion in output in 2000 (U.S. Census 2007). Over 3.4 billion prescriptions were sold countrywide in 2005, up from 2.9 billion in 2000 (U.S. Census 2007). The market for pharmaceutical products is expected to remain strong regardless of future economic uncertainties (BLS 2005), especially with the increasing average age of the population, as prescription medication use increases with age among adults (NCHS 2006).

There are many pathways for medications to get from the manufacturer to the environment. Figure 1 on page 11 shows the life of a pharmaceutical through the various institutions, people, treatment processes, and transport it encounters. While Figure 1 is not an exhaustive look at every potential pathway, it gives a good overview of the complexity and variability that is involved in looking at the release of pharmaceuticals in the environment.

This project focuses specifically on institutional and end-user disposal practices and how to prevent pharmaceutical compounds from entering the environment. In order to understand the environmental implications and regulatory environment of this issue, we reviewed existing literature, studied current and proposed legislation, and sought expert counsel. To assess current practices and quantify the impact of disposal, we examined the handful of previous studies and surveys documenting the disposal practices of institutions and end-users. This section summarizes our findings in the following areas:

- Presence in the environment
- Human, environmental, and ecological effects
- Pathways to the environment
- Regulation
- Previous studies and surveys
- End-user disposal: programs and options

PRESENCE IN THE ENVIRONMENT

Recent innovations in analytical methods (Ternes et al. 2004) are showing that the burgeoning pharmaceutical industry is a cause for concern, as pharmaceuticals and their metabolites have been established as nearly ubiquitous environmental pollutants in ground and surface waters (Dove 2006). In the past ten years, pharmaceutical compounds have been detected in almost all types of water sources including treated wastewater effluent, streams, lakes, seawater, and groundwater (Jones et al. 2003; Roberts and Thomas 2006; Kolpin et al. 2002; Weigel et al. 2004). Pharmaceuticals have also been detected in sediments and fish tissues (Thacker 2005; Brooks et al. 2005). Measured concentrations generally range from the parts per trillion (ppt) to low parts per billion (ppb) level.

Table 1: Concentrations of selected pharmaceuticals found in wastewater effluent, surface water, and groundwater. WE=wastewater effluent, SW=surface water, and GW=groundwater. µg/L = micrograms per liter

Compound: Therapeutic Family	Influent Concentration µg/L	Effluent/Sample Concentration µg/L	WE	SW	GW	Reference
Salicylic Acid: Painkiller/ Anti-Inflammatory	325	2.8	X			Metcalfe et al. 2003
		.036		X		Moldovan 2006
		0.015		X		Brun et al. 2006
		0.29			X	Montforts 2004
Diclofenac: Painkiller/ Anti-inflammatory	1.3	ND	X			Metcalfe et al. 2003
	1.0	0.29	X			Roberts & Thomas 2006
	0.022-0.030	0.040-0.063	X			Cone 2006
	ND	ND	X			Carballa et al. 2004
		0.015		X		Brun et al. 2006
		0.006			X	Montforts 2004
Ibuprofen: Painkiller/ Anti-inflammatory	38.7	4.1	X			Metcalfe et al. 2003
	28.0	3.0	X			Roberts & Thomas 2006
	4.7-6.6	0.043-0.052	X			Cone 2006
	2.75	0.97	X			Carballa et al. 2004
		0.084		X		Moldovan 2006
		0.20		X		Kolpin et al. 2002
		0.150		X		Brun et al. 2006
		0.003			X	Montforts 2004
Ketoprofen: Painkiller/ Anti-inflammatory	5.7	ND	X			Metcalfe et al. 2003
	28.0	3.0	X			Roberts & Thomas 2006
		0.015		X		Brun et al. 2006
Naproxen: Painkiller/ Anti-inflammatory	41.0	9.5	X			Metcalfe et al. 2003
	3.78-5.10	0.035-0.074	X			Cone 2006
	1.8-4.6	0.8-2.6	X			Carballa et al. 2004
		0.044		X		Brun et al. 2006
Propranolol: Beta-blocker	70	304	X			Roberts & Thomas 2006

Compound: Therapeutic Family	Influent Concentration µg/L	Effluent/Sample Concentration µg/L	WE	SW	GW	Reference
Bezafibrate: Lipid Regulator	0.6	0.2	X			Metcalfe et al. 2003
		0.015		X		Brun et al. 2006
		0.027			X	Montforts 2004
Gemfibrozil: Lipid Regulator	0.7	1.3	X			Metcalfe et al. 2003
	2.30-3.02	0.733-1.11	X			Cone 2006
		0.048		X		Kolpin et al. 2002
		0.015		X		Brun et al. 2006
Clofibric Acid: Lipid Regulator	ND	ND	X			Metcalfe et al. 2003
	0.34	0	X			Roberts & Thomas 2006
		ND		X		Brun et al. 2006
		0.27			X	Montforts 2004
Carbamazepine: Anti-epileptic	0.7	0.7	X			Metcalfe et al. 2003
	0.058-0.095	0.093-0.133	X			Cone 2006
	ND	ND	X			Carballa et al. 2004
		0.0716		X		Moldovan 2006
Fluoxetine: Antidepressant	<10	13-18	X			Cone 2006
		0.012		X		Kolpin et al. 2002
Tamoxifen: Hormone	0.15	0.20				Roberts & Thomas 2006
Sulfa-methoxazole: Antibiotic	0.320-0.882	0.742-0.919	X			Cone 2006
	0.58	0.25	X			Carballa et al. 2004
		0.15		X		Kolpin et al. 2002

1. Metcalfe et al. (2003) study took place in Canada with variable treatment plants. Reported median concentration
2. Roberts & Thomas (2006) study in the U.K. Reported median concentrations.
3. Cone (2006) is an informal article reporting concentrations. Effluent sample were not timed to coincide with influent samples, thus, some effluent concentrations are larger than the influent concentrations. Data reported as ranges.
4. Carballa et al. (2004) study took place in Galicia, Spain; population 100,000. Water went through secondary treatment. Reported median concentration.
5. Brun et al. (2006) study looked at surface water downstream of WWTPs in Canada. Reported median concentrations.
6. Kolpin et al. (2002) looked at 139 streams across the U.S. Reported median concentrations
7. Moldovan (2006) looked at rivers in Romania. Reported median concentration

An abundance of research has reported pharmaceuticals in treated wastewater. The wastewater in turn may contaminate other water bodies. For example, a landmark United States Geological Survey (USGS) study conducted in 1999 confirmed the pervasiveness of pharmaceuticals and other man-made organic compounds in U.S. surface waters (Kolpin et al. 2002). The study of 139 streams in over 30 states detected 17 pharmaceutical compounds as well as a number of antibiotics and hormones in stream samples; concentrations ranged from approximately 0.01 micrograms per liter (µg/L) to 0.42 µg/L (Kolpin et al. 2002). Table 1 includes measured concentrations for various effluents and surface waters.

Low concentrations of pharmaceuticals have also been detected in groundwater and drinking water supplies (Montforts 2004; Webb 2004). There are no government standards regarding accepted levels of pharmaceuticals in drinking water or in effluent released into streams or lakes. Water districts and sewage treatment facilities are not required to look for them, and most do not (Cone 2006). However, as this issue gains more visibility on the national level, it is likely that more facilities will begin to look for these compounds.

HUMAN, ENVIRONMENTAL AND ECOLOGICAL EFFECTS

The term "pseudopersistent" has been used to describe the continual introduction of pharmaceuticals into the environment, and little is known about the human or ecological hazards possible from cumulative exposure to multiple substances (Daughton 2002). Not only are the individual and cumulative human, environmental, and ecological effects of many of these pollutants uncertain (Daughton & Ternes 1999; Thacker 2005), but the range of synergistic actions possible within the "cocktail" of pharmaceuticals and metabolites in the waste stream is currently impossible to predict (Ternes et al. 2004; Daughton 2003).

For human toxicology, the existing data on direct and indirect adverse effects of environmental concentrations of pharmaceuticals on the human population is inadequate for drawing definitive conclusions, as most studies rely on comparisons of single pharmaceuticals to the therapeutic or lethal dose (Webb et al. 2003; Schwab et al. 2005; Falconer et al. 2006; Harvey & Everett 2006). Single drug studies, however, ignore the possible additive, synergistic, or antagonistic effects of chronic exposure to mixtures of pharmaceutical compound present in the environment. Synergistic effects between chemicals in the environment have been shown to increase individual effects by up to six orders of magnitude (Arnold et al. 1996; Daughton 2003).

The environmental toxicology of pharmaceuticals is a growing research field, and some of the negative effects of pharmaceuticals in aquatic communities are starting to appear. Currently, endocrine disruption is the most widespread and documented effect that pharmaceuticals have on aquatic organisms (Jobling et al. 1998; Chambers & Leiker 2006; Rempel et al. 2006). The presence of natural (e.g. 17B-estradiol) and synthetic estrogens (e.g. 17a-ethinylestradiol) among other known endocrine disruptors have contributed to the feminization of male fish in waters receiving treated wastewater

effluents. The effects range from gender-bending males that can produce eggs (Chambers & Leiker 2006; Jobling et al. 1998) to males with elevated levels of estrogenic activity in areas near wastewater outfalls (Schlenk et al. 2005; Rempel et al. 2006). Also of concern is the effect antibiotics have on bacteria populations. A number of studies have shown a decrease in antibiotic effectiveness due to its widespread presence in the environment (Kummerer 2004a; Kummerer & Henninger 2003; Halling-Sorensen 2001). In addition, it may interfere with the proper function of denitrifying bacteria in the wastewater treatment process (Amin et al. 2006; Halling-Sorensen 2001).

Overall, the ecotoxicity of pharmaceuticals can be characterized as a game of risk. In the past, small concentrations of anthropogenic pollutants have had big effects (e.g. DDT). The possibility of negative impacts is present, and a number of researchers are trying to quantify the risk posed by various pharmaceuticals (Hernando et al. 2006; Sanderson et al. 2004a). Risk assessments rely on models that predict the physical, chemical, and biological properties and the corresponding ecotoxicity potential of non-assessed compounds by comparing them to assessed compounds. Sanderson et al. (2004b) prioritized drug classes in terms of their predicted toxicity. Sedatives and anti-psychotics ranked as a high priority, while anti-epileptics ranked lower on the priority list. Hernando et al (2006) calculated risk quotients from known toxicology data, and identified ibuprofen, naproxen, diclofenac, ketoprofen and carbamazepine as high risk pharmaceuticals.

In summary, the resulting environmental problems associated with pharmaceuticals in the environment will likely be complicated and variable, and increasing demands on the world's freshwater supplies will likely lead to greater incidences of indirect and direct water reuse situations, so the potential for adverse effects should not be overlooked (Heberer 2002).

PATHWAYS TO THE ENVIRONMENT

Disposal of pharmaceutical waste may occur at different stages along the product lifecycle (Figure 1); the result may be direct or indirect introduction of pharmaceuticals and their by-products to the aquatic environment. The stages of the lifecycle include but are not limited to:

1. Manufacturing and production by pharmaceutical companies;
2. Wholesale distribution;
3. Dispensing or prescription in hospitals, medical offices, hospices, nursing homes, and clinics;
4. Retail sale or prescription in pharmacies and drug stores;
5. Reverse distribution[1];
6. Consumer (end-user) use, excretion, and disposal of drugs.

[1] Reverse distribution originated as a term referring specifically to the return of controlled substances from institutions back to manufacturers, but it is now used more generally to refer to the return of any unwanted pharmaceuticals from institutions back to manufacturers for credit, by companies known as reverse distributors. Many reverse distributors also arrange for the destruction or disposal of non-creditable products.

End-user disposal of pharmaceuticals is the least regulated route of entry into the environment. Disposal methods are apparently driven by personal preference and include dumping down the drain and throwing into the trash. A survey in King County, Wash., found that 52 percent of respondents disposed of medications in the trash while 20 percent flushed drugs down the toilet or sink (WCRC 2006).

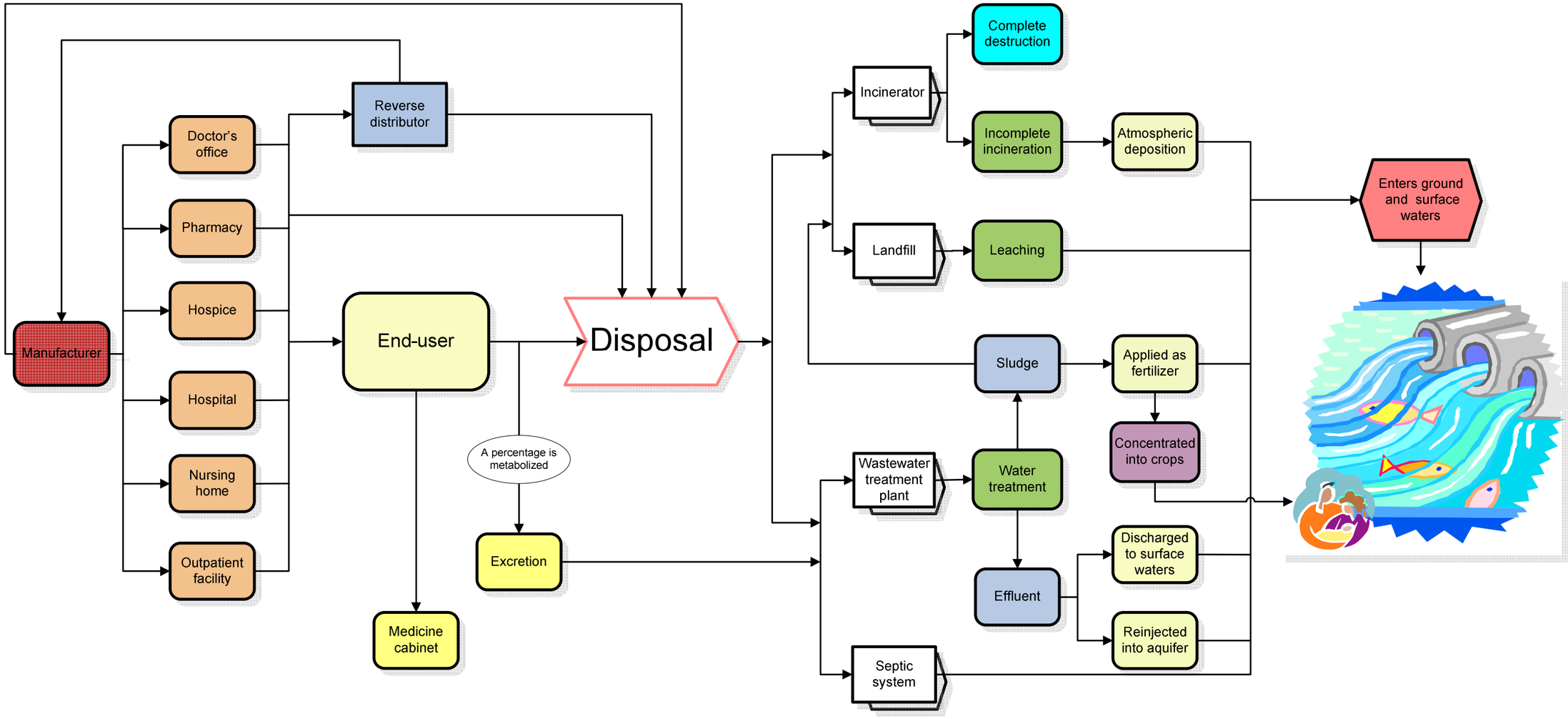
Discarded pharmaceuticals may enter the aquatic environment through various routes, including effluent from WWTPs, leachate from trashed and landfilled pharmaceuticals, leachate from landfilled sewer sludge, and leachate from septic systems.

Traditional WWTPs treat influent by adding chemicals (alum, ferric chloride and/or synthetic polymers) to encourage coagulation (neutralizing suspended sediments) and flocculation (aggregating particles). The resulting bigger particles (flocs) are then able to be filtered out, as sewer sludge. The residual liquid is then disinfected, often with chlorine in the United States and ozonation in Europe. This system is optimized to remove pathogens, other biological material, and dissolved organic carbon (Ellis 2006), not pharmaceuticals or other chemicals; consequently, these conventional treatment processes appear to be insufficient in removing pharmaceutical compounds (Ellis 2006; Brun et al. 2006; Snyder et al. 2003). Considering the ineffectiveness of water treatment processes, WWTPs should be considered an important and continuous source of pharmaceuticals to the environment (Brun et al. 2006).

Pharmaceuticals may not only be “pseudopersistents” (Hernando et al. 2006), but many pharmaceutical compounds are very stable once released to the environment. Some compounds have been shown to bioaccumulate in commercial shellfisheries downstream of wastewater treatment plants, and groundwater studies have indicated that some can survive intact after eight to ten years of migration through the soil (Ellis 2006).

Pharmaceuticals are introduced to landfills directly by disposal of unused medications by the public and industry through municipal trash, or through the landfilling of sewage sludge. Leachates from municipal solid waste landfills are similar in composition to those from mixed or hazardous landfills (Slack 2005; Schrab et al. 1993; Kjeldsen 2002). Even in modern landfills with engineered barriers and leachate collection systems, the risk of leachate contaminating groundwater still exists. Cases of landfill leachate that has contaminated groundwater have been documented in the scientific literature (Christensen et al. 2001; Kjeldsen 2002). The composition of the leachate is extremely variable due to the heterogeneity of specific waste composition and the characteristics and conditions in the specific landfill. Certainty concerning the fate of contaminants after their deposition is very limited, especially as conditions change from anaerobic to more aerobic outside the landfill boundaries. Pharmaceuticals have been identified in leachate from unlined as well as leaking, lined landfills (Schwarzbauer 2002; Kummerer 2004b).

Figure 1: Life of a pharmaceutical



Approximately 25 percent of households in the United States (though only 9 percent in Santa Barbara County) are on septic systems, which continually release water to the environment in leach fields. Septic systems may be even more ineffective than WWTPs at removing or destroying pharmaceuticals due to poor placement, undetected failure, and anaerobic conditions typically prevailing in these systems (Swartz et al. 2006). Endocrine disrupting pharmaceutical compounds have been found in septic field leachate plumes (Swartz et al. 2006). The liquid released from septic systems can percolate to groundwater and surface waters, both of which are potential sources of drinking water, potentially contaminating them with medicinal compounds.

When trying to determine the fate of any one pharmaceutical compound, no simple, all-encompassing rules can be applied. An enormous variety of medications are available on the market, and even within the same functional category, compounds can vary significantly in molecular weight, structure, functionality, salt forms, polymorphs, etc. (Kummerer 2004b). Various combinations of structures and compounds can cause the drug to behave differently in the environment in terms of bioavailability, solubility, dissolution rate, chemical and physical stability, melting point, color, filterability, density, and flow properties (Kummerer 2004b).

REGULATION

From the standpoint of regulation, disposal is one of the most important methods of introduction of pharmaceuticals to the environment. Regulating the disposal of pharmaceuticals is likely the simplest and least costly place to begin reducing the amount of pharmaceuticals that reach the environment. Considering the low compliance rate to prescription medication regimens, averaging about 50 percent (Wright 1993, Boudes 1998, Vrijens & Urquhart 2005), a large amount of unused medications may find their way into ground and surface waters through improper disposal. Education and take-back programs are relatively easy and quickly implemented at low cost, and provide the added benefits of reducing opportunities for misuse of stored drugs.

In the United States, regulation of pharmaceutical waste and disposal is managed at different stages by various government agencies with distinctive agendas. Regulations by these agencies are often overlapping or poorly defined and may not be enforced. In many cases, there is no regulation; disposal by end-users is currently not regulated by any agency. The three government agencies that have the most authority to regulate the disposal of pharmaceuticals are the Food and Drug Administration (FDA), the Environmental Protection Agency (EPA) and the DEA.

The FDA

Given that the FDA is charged with regulating the safety of medicinal compounds for human use (FDA 2007), the agency has the potential to take the lead in addressing the issue of their presence in the environment. Under the National Environmental Policy Act (NEPA), federal agencies are required to conduct an environmental assessment (EA) for any major federal action under consideration “significantly affecting the quality of the

human environment" (NEPA 2007). Applied to the FDA, NEPA stipulates that before the agency can approve any new drugs, an EA of the drug must be carried out.

However, the FDA takes a more lenient approach than would be assumed based on NEPA, as the agency categorically excludes the majority of actions regarding drugs from the requirement of an EA (Vincent 1993; Eirkson et al. 2005). A categorical exclusion is granted by the FDA for a "category of actions which do not individually or cumulatively have a significant effect on the human environment and which have been found to have no such effect" (CFR 2006). Instead of strengthening its requirements, the FDA has been making categorical exclusions easier to obtain. In the 1990s, the FDA established "additional categorical exclusions" and "reevaluated and revised its environmental regulations to reduce the number of EAs required to be submitted by industry" (DHHS 1998).

The FDA only requires that pharmaceutical companies perform an environmental assessment of a new product if their stated anticipated production of the drug is more than 40,000 kilograms per year, ignoring the possibility of inputs from multiple companies that might all be making the same drug (Thacker 2005). When a categorical exemption is not requested or granted and an EA is necessary, the procedure may not accurately assess the potential impact of the drug on the environment, as many of the assumptions that underlay the FDA policies are inaccurate or incomplete (DHHS 1998).

The EPA

Water Regulations

There are no EPA programs that specifically regulate the presence of pharmaceuticals in ground or surface waters. The presence and potential effects of pharmaceuticals may be addressed under other EPA programs, however, such as the standards set in place to regulate the safety of drinking water. These become especially important in situations of groundwater recharge or intentional reuse of wastewater. Though not intended to address the safety of drinking water sourced from municipal wastewater, the Safe Drinking Water Act (SDWA) and the National Primary Drinking Water Regulations (NPDWR) have served as starting points for developing water quality standards for reclaimed water (CDM 2004). Pharmaceuticals are but one of many groups of chemicals that have yet to be closely examined for their potential environmental risks. These significant data gaps have limited the ability of EPA to regulate pharmaceuticals (Conerly 2005). Much more research will be required before any decision can be made as to which individual types of pharmaceuticals (if any) might necessitate further attention (Daughton 2000). The EPA claims to be researching and monitoring pharmaceuticals in waterways and studying the potential risks associated with the trace amounts found (Miller 2005).

There are other existing programs which could be expected to take a role in regulations designed to address this issue. The EPA administers the Contaminant Candidate List (CCL), which identifies and lists contaminants unregulated by existing regulations "known or anticipated to occur in public water systems" that may require future regulation under the SDWA (EPA 2007). The SDWA requires EPA's Office of Water to set maximum levels for contaminants in water delivered to public water systems with

emphasis on the best available peer-reviewed science and the protection of sensitive populations. There are currently no existing regulations for specific pharmaceuticals (Conerly 2005). Criteria for pharmaceuticals as toxics could be developed under the Clean Water Act (CWA) if adequate supporting data becomes available (Conerly 2005). Other CWA approaches that could help control the levels of pharmaceuticals in ambient waters include the Effluent Guidelines program for the regulation of point sources (e.g., the pharmaceutical manufacturing industry and the aquaculture industry), the Combined Animal feeding Operations Rule, and the Fish Advisory Program (Conerly 2005).

Disposal Regulations

Pharmaceutical waste generated by end-users, households and certain small, non-household generators known as Conditionally Exempt Small Quantity Generators (CESQGs) is not regulated as hazardous waste (DTSC 2003). Some pharmaceutical waste is classified as hazardous waste under the Resource Conservation and Recovery Act (RCRA) and the Code of Federal Regulations (CFR) (40 CFR Part 261), enforced by the EPA and authorized states. In California, the Department of Toxic Substances Control (DTSC) is the authorized agency regulating pharmaceutical waste considered hazardous under RCRA (DTSC 2003). Hazardous waste management involves specific management practices including permits, special transportation manifests, and specific bans against land disposal without treatment (Musson & Townsend 1998). Hospitals, pharmacies, and reverse distributors are required to follow specific guidelines regarding the destruction of drugs that are deemed hazardous waste. It has been shown, however, that many of these institutions are either unaware of their RCRA obligations or choose to ignore them (Oliver 2003).

There are two ways a pharmaceutical can be considered hazardous waste: as a listed waste or as a characteristic waste. A pharmaceutical or its sole active ingredient may be specifically listed in 40 CFR Part 261 Subpart D on the P list or the U list. A characteristic waste meets the characteristics of ignitability, corrosivity, or toxicity. A number of common drugs meet the definition of hazardous waste, including epinephrine, nitroglycerin, warfarin, nicotine, and many chemotherapy agents (Smith 2002). Approximately 5 percent of the current pharmaceutical products on the market would be regulated as RCRA hazardous waste if discarded by an entity other than a private household or CESQG (Smith 2005).

The RCRA regulations have not been significantly updated since 1976 and have not kept up with drug development (Smith 2005). Compliance with RCRA regulations has proved difficult due to the difficulties of implementation and enforcement within a health care setting, as well as a lack of interpretive guidance from the EPA (Smith 2005).

Some wastes that are not regulated as hazardous under RCRA are identified as hazardous in California. If a waste contains a substance listed under Title 22 of the California Code of Regulations (CCR), sections 66261.24(a)(1) and 66261.24(a)92) at a concentration above the specified limit, the waste is considered hazardous in California (DTSC 2003). Waste that is toxic when inhaled or that is fatal to certain type of fish in laboratory tests is also considered a hazardous waste in California (DTSC 2003). Pharmaceutical wastes

that meet California's definition of hazardous waste as well as generators that are not regulated by RCRA are subject to the Medical Waste Management Act (MWMA) (Division 104, Part 14 California Health and Safety Code) and fall under the regulatory authority of DTSC and the California Department of Health Services (DTSC 2003; TDC Environmental 2004). Currently there is no accurate list identifying which wastes are California hazardous wastes and which are not (TDC Environmental 2004).

The DEA

The DEA limits its regulation of pharmaceuticals to those that are "controlled substances" or their precursors. Controlled substances include legal and illegal drugs meeting certain guidelines regarding potential for abuse, accepted medicinal use, and safety (FDA 2002). The DEA maintains a yearly program of registration of individuals within organizations or institutions that are legally able to handle controlled substances in specific capacities; these individuals are known as DEA registrants (ODC 2007b). DEA registrants include individuals that fall into, or are employed in one of the DEA approved categories: pharmacy, hospital, clinic, practitioner, teaching institution, mid-level practitioner, manufacturer, distributor, researcher, analytical laboratory, importer, exporter, domestic chemicals, and narcotic treatment programs (ODC 2007b). Disposal of controlled substances by DEA registrants is carefully regulated to ensure that the substance is rendered destroyed or unrecoverable. The agency accepts several methods of disposal, including flushing into the wastewater, as viable means of destruction for controlled substances (RDWG 2003). The DEA forbids the return of controlled substances from the end-user to any DEA registrant, or transfer to anyone except, in certain cases, a law-enforcement agent (ODC 2007a). The agency provides no guidance or recommendations regarding disposal at the level of the end-user or patient (ODC 2007a).

PREVIOUS SURVEYS AND FINDINGS

Institutional surveys

King County, which includes Seattle, Wash., gathered data on the quantity and nature of pharmaceutical waste streams and drug waste management practices from a variety of business types, including doctor's office, specialty outpatient, veterinary, ambulatory/surgical center, hospital, pharmacy, and nursing/boarding home (Oliver & Chapman 2003). The study found that a reverse distributor is the most common disposal route (6,500 pills) and down the drain is the second most common route (6,188 pills).

King County also completed a national telephone survey of 27 pharmaceutical reverse distributors to identify services offered, acceptance policies, and other general information about the industry (Chapman 2003). Of the 23 reverse distributors that provide services to King County, most provide only mail-in service and all accept controlled substances and legend (or prescription) drugs. Household drugs were typically accepted only under certain conditions, such as the drug was returned through the pharmacy that dispensed it; the drug was not a controlled substance; patient health information subject to privacy laws was protected; and the reverse distributor held the contract as a "returns department" for the manufacturer of the returned drug.

Kuspis and Krenzelok (1996) examined the disposal methods of 100 community-based pharmacies surrounding Pennsylvania. They found that pharmacies send all acceptable non-dispensed expired medications back to pharmaceutical companies for credit. For the remainder of the medications, 15 percent of pharmacists prefer on-site incineration, 17 percent preferred disposal by a biohazard waste company, and 68 percent dispose of medications by placing them in the garbage or flushing them down the sink or toilet.

A pharmacy-based survey by Braybrook, John, and Leong (1999) in the United Kingdom collected data for each patient return from 529 people at 18 pharmacies for eight weeks in order to analyze the reasons for medication return. Items were most commonly returned because the medication stopped or changed (42 percent), followed by excess supply or clean out (20 percent), patient died (16 percent), and medication stopped by patient (14 percent). If this survey was representative of the entire Health Authority in Britain, as much as £800,000 a year (or 1.5 percent of the annual prescribing budget) could be wasted.

Table 2: Summary of institutional surveys.

Survey	Whom surveyed	Location	Information collected
Oliver & Chapman 2003	60 businesses	King County, Wash.	Quantity and nature of pharmaceutical waste streams and drug waste management practices
Chapman 2003	27 reverse distributors	National	Identify services offered, acceptance policies, and other general information about the industry
Kuspis & Krenzelok 1996	100 community and hospital pharmacies	Tri-state region including Penn.	Disposal methods
Braybrook et al. 1999	Returns from 529 people at 18 pharmacies	United Kingdom	Reasons for return
Boivin 1997	An 85-bed nursing home	Ontario, Canada	Costs of wasted medications
Hauser 2006	51 patients of one hospice	Chicago, Ill.	Type, quantity, and costs of wasted medications
Crisostomo et al. 2006	Community-based pharmacy study of 572 patients	Portugal	Quantity and costs of wasted medications

A study in an 85-bed nursing home in Ontario, where nursing homes are required to keep appropriate records of surplus prescribed drugs, calculated the cost of medication waste for the period from Oct. 17 to Nov. 20, 1996 (Boivin 1997). Boivin calculated that 13.14 percent of dispensed medication is wasted (the total dollar value of medication waste divided by the total value of dispensed medication). The study also divided medication waste data into nine different categories. Topical agents were the most expensive class of medications returned (27.17 percent of total cost of returned medication), followed by

respiratory (26.09 percent), and neurologic and endocrinologic (17.65 percent) medications.

A retrospective chart review at one hospice of 51 patients who died examined the type, quantity, and value of wasted medications (Hauser 2006). A total of 4,762 milliliters (mL), 2,495.5 tablets, and 67 patches were wasted, averaging to 9.7 medicines per patient. The estimated cost of these medications was $5,558.75 if purchased as generics and $10,535.85 if purchased as brand names, or an average of $109.00 or $206.59 per patient, respectively.

End-User

Only a limited number of end-user surveys on pharmaceutical disposal have been completed, and even fewer have been rigorous surveys (Table 3). Surveys have been completed in a variety of locations and have collected information on patient disposal practices and reasons for disposal, beliefs, waste quantities and costs, number of medicine containers, and storage times. Kuspis and Krenzelok (1996), Morgan (2001), Seehusen and Edwards (2006), and BAPPG (2006) are surveys of convenience at a poison control center, retirement community, Army medical center, and pharmaceutical collection event, respectively. Bound and Voulvoulis (2005) and Washington Citizens for Resource Conservation (WCRC) (2006) are the most rigorous surveys to date; both are phone surveys with random samples.

Disposal practices

Table 4 summarizes information collected on disposal methods. Four surveys show that trash is the most common disposal practice, and two surveys found that the sink or toilet is the most common practice. As demonstrated in Table 4**,** even if surveys collected the same kind of information (e.g., disposal method), the method of data collection is not uniform (different disposal categories; some allow more than one answer for disposal method while others do not; etc.). The WCRC survey also compared the disposal practices for various demographic groups. For example, younger residents (aged 18 to 54 years) are more likely to dispose of unused or expired medicines in the trash, while residents aged 55 or older are more likely to use the sink or toilet. The WCRC survey (2006) is the only random sample survey that was conducted in the United States, and it is unclear whether its results apply uniformly to the rest of the nation. Because of this uncertainty, a similar question about disposal habits was included in the end-user survey for this study to explicitly learn the disposal practices of residents in the Santa Barbara area.

Willingness-to-participate in a disposal program

The WCRC is the only other survey to assess willingness-to-participate in a disposal program. Most respondents (80 percent) said they were likely to return their unused or expired medicines to a drop box at their pharmacy. A similar question about participation was included in the survey for this study to determine whether residents in this region are as likely to participate in a disposal program.

Table 3: Summary of end-user surveys.

Survey	Type of sample/ Sample size	Survey method	Location	Information collected
Kuspis & Krenzelok 1996	Convenience/ 500	Public callers to the Certified Regional Poison Information Center	Based in Pittsburgh, Penn.	Disposal methods
Bound & Voulvoulis 2005	Random/ 392	-	Southeastern England	Disposal methods; reasons for disposal; divided into drug types.
WCRC 2006	Random/ 410	Telephone	King County, Wash.	Quantity of medicines in household; plan to use medication; willingness to properly dispose and most convenient location; likelihood to return to a pharmacy; belief that it is the manufacturers' responsibility
BAPPG 2006	Convenience/ 1169	Collection events	San Francisco Bay Area, Calif.	Disposal method; reason for disposal; storage time
Seehusen & Edwards 2006	Convenience/ 301	Outpatient pharmacy	Fort Lewis, Wash.	Disposal methods; whether various disposal methods are "acceptable;" quantity of unused or expired medicine containers at home; quantity of current medications; pharmacy visits in prior 3 months; disposal advice given by a medical provider
Morgan 2001	Convenience/ 73	Retirement community	N.H.	Reasons for disposal; annual quantity and cost of medication waste; divided by drug classes
Boivin 1997	Random/ ?	Telephone	Sudbury and local districts, Ontario, Canada	Disposal methods

Table 4: Disposal methods and reasons for disposal found in residential surveys.

Residential Survey / Disposal Method	BAPPG 2006	Boivin 1997	Bound & Voulvoulis 2005	Kuspis & Krenzelok 1996	Seehusen & Edwards 2006	WCRC 2006
Trash	45.2%	31%	63.2%	54.0%	-	52%
Sink or toilet	28.0%	46% (toilet)	11.5%	35.4%	35.2% (sink); 53.8% (toilet)	20%
Pharmacy	-	17%	21.8%	1.4%	22.9%	2%
Doctor	-	-	-	-	-	1%
Return to a health care provider	-	-	-	-	14.0%	-
Physician	-	2%	-	-	-	-
Store at home	-	-	-	-	54.2%	-
HHW event	16.1%	-	-	-	-	-
Gave to someone else	2.1%	-	-	-	11.0%	-
Other	16.1%	4%	3.5%	-	-	1%
Does not apply	-	-	-	9.2%	-	23%

Note: Morgan 2001 is not included because it did not include disposal questions.

Additional survey knowledge

While this study could not cover all end-user disposal topics, other surveys have looked at other aspects of pharmaceuticals such as reasons for disposal, amount of pharmaceuticals in the house, and the disposal of different therapeutic classes of drugs. Typical reasons for disposal include: expired or no longer needed/condition resolved (BAPPG 2006). End-users also typically dispose of medications when they are cleaning their house, which indicates that a permanent disposal program, as opposed to a periodic collection event, will better accommodate residents' random house cleaning (Morgan 2001).

Two surveys have looked at the volume of medication end-user's store at home. WCRC (2006) found that the majority (60 percent) of respondents had less than ten medicine containers in their household, almost a third (31 percent) had 10 to 24 containers, and 7 percent had 25 to 50. Only 1 percent had more than 50 containers or no medicine

containers at all. Only one-third of residents reported they are currently using or planning to use all the medicines in their households in the next six months. Seehusen and Edwards (2006) surveyed patients at an Army medical center and found that less than half (43.6 percent) have no unused or expired medications at home, while almost half (48 percent) have 1-5 medications. Almost 20 percent had 6-10 medications. Many of these medications may end up being disposed of in the future.

Bound and Voulvoulis (2003) conducted a study in the United Kingdom that examines disposal habits for eight therapeutic classes of pharmaceuticals to examine how behavior varies by drug type. For example, while nearly 80 percent of people consume all painkillers, only 18 percent consume all antibiotics. Bound and Voulvoulis also used disposal data, pharmaceutical metabolism rates in the human body, and removal efficiencies of wastewater treatment works, to model how two different drugs, metoprolol and ibuprofen, differ in their pathway to the environment (e.g. from disposal to household waste to landfill to surface water, or from excretion to a wastewater treatment plant to surface water).

END-USER DISPOSAL: PROGRAMS AND OPTIONS

There is no clear solution for the proper disposal of pharmaceuticals by end-users. Disposal guidelines, such as those recently released by the White House Office of National Drug Control Policy (ONDCP), often advise residents to make pharmaceuticals unpalatable to discourage prescription drug abuse before throwing them in the trash (see Appendix A) (ONDCP 2007). The ONDCP guidelines also advise people to flush drugs down the toilet only if the label specifically mentions this action, and to take advantage of community pharmaceutical take-back programs if available.

Policy options to address pharmaceutical disposal include permanent collection at household hazardous waste facilities or other locations such as pharmacies; a mail-back program; special collection events; or drug recycling, which entails the donation of unused, unexpired pharmaceuticals from licensed medical facilities to low-income patients. Controlled substance regulations present a barrier to implementing any of these programs because only law enforcement officials may accept controlled substances from end-users.

Drug Recycling Programs

A policy option that has the potential to reduce the amount of wasted pharmaceuticals is a drug recycling program. California Senate Bill 798, sponsored by Sen. Joe Simitian, authorized counties to collect unused pharmaceuticals from nursing homes, wholesalers, and manufacturers and redistribute them to medically indigent patients. The medication cannot be a controlled substance and cannot have been in the possession of a patient or any individual member of the public. The confidentiality of any patient to whom the medicine may have been originally prescribed must be maintained (such as in the case of skilled nursing facilities where the end-user never took possession of the medication). The drugs must be unexpired, unopened, and in tamper-proof packaging. The bill also protects certain persons and entities accepting, disposing, and dispensing pharmaceuticals

against liability. Several other states have also passed legislation allowing drug recycling programs. Tulsa, Okla., for example, has a well-established recycling program in place.

San Mateo County is the only county in California that has set up a recycling program. Its pilot program, in place since August 2006, redistributes pharmaceuticals from the long term care wing of the County hospital to the medically indigent (Chiang 2007). Though it is too early to determine the success of this program, one difficulty it has encountered is the mismatch of medications donated, mostly from elderly patients, to medications needed (Chiang 2007).

A number of concerns surrounding drug recycling have to be addressed to set up a program. The privacy of the donating patient, as well as the safety of the receiving patient, needs to be protected. The donated drugs must be viable, not tampered with, and authentic. Proper handling and storage is required, as most medications are sensitive to temperature and humidity. These risks are minimized because California law stipulates that drug recycling programs can only use drugs that have been handled only by licensed medical facilities. Drugs wrapped in single-dose packaging would likely be the most appropriate candidates because the drug would be protected against tampering, and each dose would be labeled with the lot number and expiration date. The burden of administering the program presents another concern, as donated medications would have to be cataloged and tracked. This requirement could be especially taxing for small nursing homes (Miller 2005). A recycling program would also need an adequate, consistent supply of medications. These critiques do not change the fact that, as found by past surveys, a large dollar amount can be associated with unused pharmaceuticals disposed of by institutions (Boivin 1997; Hauser 2006; Crisostomo et al. 2006). Additionally, the two programs currently in place can be used as models to navigate through the difficulties.

Permanent collection programs

Some jurisdictions in the United States have implemented or are considering disposal programs for the public. To comply with controlled substance regulations, a disposal program can refuse to accept controlled substances or involve law enforcement officials. Another possibility is to apply for an exemption from the DEA, though no program has received such an exemption thus far. The most commonly available collection program in the United States is at household hazardous waste facilities, which cannot accept controlled substances. Medications from hazardous waste facilities ultimately undergo hazardous waste incineration. In general, residents should contact their local hazardous waste center for information about drug disposal. Other options include collection at pharmacies or police stations, or a mail-back program.

Pharmacies

Though collection programs at pharmacies must exclude controlled substances, they at least offer end-users a convenient way to get rid of medications. The Washington State pilot program, which currently collects unwanted pharmaceuticals at seven locations in five counties, plans to submit a protocol and waiver to the DEA for an exemption to

allow for the collection of both non-controlled and controlled pharmaceuticals in the same drop-off box (Johnson 2007).

Collection at pharmacies is more common internationally, where it is funded by the government, retailers, or manufacturers. In the European Union, 11 countries have pharmaceutical take back programs in place which allow citizens to return unwanted pharmaceuticals to local pharmacies (NWPSC 2007). Over half these programs are funded by the pharmaceutical industry or by retail pharmacies only, while the rest are funded by municipal or national taxpayers (NWPSC 2007). The programs are operated by retail pharmacies or by public or private waste contractors (NWPSC 2007).

The Return Unwanted Medications (RUM) Project in Australia, established in 1998 by the Commonwealth Department of Health, allows consumers to take unwanted and out-of-date medications to community pharmacies (Appel 2007). The program is operated by a national non-for-profit company and funded by the Australian government (Appel 2007). In 1998 the program received $3 million (Australian dollars) for three years, and in 2005 it received $6 million (Australian dollars) for a further four years (Appel 2007). Community pharmacies collect the medicines at no cost, and pharmaceutical wholesalers have agreed to a generous discount in charges for delivery and collection of RUM Project containers to pharmacies (Appel 2007). Each month an average of over 30 metric tons (30,000 kg) of unwanted medicines are collected across Australia and ultimately destroyed by high temperature incineration (Appel 2007).

Canada has ongoing disposal programs in a few provinces and regional "Medication Cabinet Cleanup" Campaigns (NAPRA 2002). In British Columbia the law requires manufacturers to take cradle-to-cradle responsibility for their products (TDC Environmental 2004). Ninety percent of pharmacies in British Columbia allow consumers to drop off unwanted pharmaceuticals as part of the British Columbia Medication Return Program (NAPRA 2002). Residents may also drop off unwanted medicines at pharmacies as part of a voluntary program in Prince Edward Island, Canada. Pharmacies transport the drugs to a solid waste management company, which pays for proper disposal (TDC Environmental 2004).

There are also some examples of drug collection programs at pharmacies in the United States. The Washington State pilot program, mentioned above, was launched in October 2006. As of February 2007 it had collected 60 buckets of medicine, with an average weight of eight pounds per bucket, at a cost of $200,000 for set-up and planning (Johnson 2007). People generally have been following the directions on what material to put in the container; the "non-drug" contamination rate has only been about 1 percent (Johnson 2007). The program has faced challenges with final disposal and with containers and supplies. Administrators are uncomfortable using the local waste-to-energy facility for environmental and political concerns. The hazardous waste disposal companies they have considered are required to inspect every container, creating security concerns, and do not have the required State Board of Pharmacy licenses. Also, the incinerators are far away, creating storage and transport difficulties, and disposal costs are quite significant (Johnson 2007). The program has procured pilot containers that cost $600. They have

also used a supplier in New Jersey for tamper-protected, U.N.-approved buckets because suppliers on the West Coast are prohibitively expensive, though this action entails high shipping costs (Johnson 2007).

Another collection program, in Clark County, Wash., is funded by the County and involves the participation of more than 80 percent of pharmacies (TDC Environmental 2004). Residents can drop off medications in their original containers if it includes the medication name, is sealed, and does not leak, and has all patient information removed or blacked out (TDC Environmental 2004). Residents can drop off controlled substances at the County Sheriff's Department (TDC Environmental 2004). Pharmacies ship the materials to the County's hazardous waste vendor (TDC Environmental 2004).

In California, the City of Palo Alto collects mediations at the Regional Water Control Plant (City of Palo Alto 2006). The Marin County Health Department collects pharmaceuticals at six pharmacies; it has collected over 300 pounds of pharmaceutical waste (North 2006).

Proposed legislation in California would require every retailer of pharmaceutical drugs to implement a drug collection program (SB 966). This bill may be intended just to generate awareness, as a bill requiring every retailer to fund and implement collection is not likely to pass. The bill also does not take into account controlled substances.

Police stations

Another solution for a permanent collection program that includes controlled substances is collection at police stations. San Mateo County launched its collection program at police stations in four cities, as well as the County Sheriff's Department, in September 2006 (Chiang 2007). The program has been successful thus far and has not encountered major implementation barriers. As of February 2007 it had collected 590 pounds of expired and unused drugs and had only cost the county $924 in disposal costs (Gordon 2007). The program has generated inquiries from other interested jurisdictions and has been replicated in Vacaville, Calif. (Gordon 2007). It uses white-painted mailboxes donated by the U.S. Postal Service with instructions written in English and Spanish (Chiang 2007). The police sort the contents to ensure nothing inappropriate is in the boxes (illegal substances, sharps, mail, etc.); a high incidence of misplaced items has not been reported (Chiang 2007). Police officers take the contents of the boxes to the Maguire Correctional Facility, a trip officers already make on a regular basis. A licensed hazardous waste collector then collects the drugs for incineration (Chiang 2007).

Mail-back

A mail-back program may be a good option for rural areas, where residents are more dispersed, and would be especially beneficial if it allows for the collection of controlled substances. Agencies in the San Francisco Bay Area are applying to the DEA for an exemption to allow residents to mail pharmaceuticals to a reverse distributor (Zarrehparvar 2007). Reverse distributors currently cannot accept pharmaceuticals from end-users. The Bay Area is still awaiting approval from the U.S. Postal Service to go ahead with a pilot program (Zarrehparvar 2007).

Legislation in Maine requires the Maine DEA to set up a mail-back program (Title 22 §2700). This program would distribute prepaid mail envelopes to the public at various locations such as pharmacies, physicians' offices, and post offices. This program allows for the collection of controlled substances, as only DEA personnel would receive and handle unwanted pharmaceuticals. Because it has lacked funding, the Maine DEA has not yet set up the program. Proposed legislation, however, calls for a one-time appropriation of $300,000 from the General Fund to set up the program (LD 411).

Special Collection Events

There are a number of examples of collection events. The Northeast Recycling Council, Inc. held eight pilot collection events as part of its project to develop effective and legal guidelines for the collection and destruction of pharmaceuticals from the public (Rubinstein 2006). It published a useful guide for holding collection programs. Another example is the regional collection event held in the San Francisco Bay Area. The event was a huge success: 1,500 residents disposed of 3,634 pounds of pharmaceutical waste at 39 pharmacies (BAPPG 2006). A complete summary of this collection event is available (BAPPG 2006).

Other pharmaceutical waste management programs

The Unused and Expired Medicine Registry (UEMR), an online registry for wasted pharmaceuticals, collects data to help understand the impact of unwanted medications and to improve pharmacy policy, patient safety and education, and options for more appropriate prescription of mediations (UEMR 2006).

The Stockholm County Council in Sweden takes a novel approach to pharmaceutical waste management. It gives prescription priority to pharmaceuticals that are not harmful to the environment and plans to influence the pharmaceutical industry to take into account environmental issues in the long term (Stockholm County Council 2006). The environmental risk and environmental hazard of medications marketed in Sweden are assessed and classified as part of this effort (Stockholm County Council 2006). The Council recommends taking into account the cost-effectiveness and environmental impact when comparing medications that are equally safe and suitable for their intended purpose (Stockholm County Council 2006).

III. PHARMACEUTICALS IN WASTEWATER: SANTA BARBARA COUNTY PERSPECTIVE

Disposal programs

No formal permanent pharmaceutical disposal program currently exists in Santa Barbara County, though many residents call the County to ask for disposal advice. The Recycling Resource Guide for Santa Barbara County advises residents to drop off medications at their local pharmacy or at one of two household hazardous waste facilities (CSBPW 2005). The authors contacted the City of Lompoc facility and verified that it accepts medications. The other facility listed in the guide, the Community Hazardous Waste Collection Center (CHWCC), is located on the University of California, Santa Barbara campus and run by Santa Barbara County. The County leases the space from the University, manages the program, and contracts to University employees to operate the program. The City of Santa Maria also has a permanent hazardous waste collection center.

Although the Community Hazardous Waste Collection Center at UCSB has accepted expired and unused medications in the past, recently the University administration has expressed concerns about liability issues (Robinson 2007b). The University has asked the County not to advertise collection of pharmaceuticals at the CHWCC (Robinson 2007b). The Hazardous Waste Program Manager at UCSB, Bruce Carter, informed the authors that the University is hesitant to allow the acceptance of any pharmaceuticals at the CHWCC because it is not allowed to collect controlled substances (Carter 2006a). In addition, the UCSB administration is concerned about advertising the facility as a place that accepts medications because of issues of privacy, theft, and an increase in participation and volume of materials (Carter 2006b). Carter also added that the majority of pharmaceuticals are not hazardous waste by definition, so UCSB does not want the facility to be the main place for disposal (Carter 2006b).

The County of Santa Barbara currently sponsors one day hazardous waste collection events in Santa Ynez and New Cuyama (Robinson 2007b). Pharmaceutical waste is accepted at these temporary events (Robinson 2007b).

There has been collection of drugs in Santa Barbara County as part of a “trash your stash” program intended to control substance abuse (TYS 2007). Community members can voluntarily dispose of legal and illicit drugs and narcotics in tamper-proof, secure depositories in Santa Barbara, Santa Maria, Lompoc, and Santa Ynez (TYS 2007). These boxes, often funded by hospitals, cost $4,000-$6,000 in the past and would be more expensive today (Gillingham 2007). Police officers collect and sort the drugs for destruction (Gillingham 2007). In the City of Santa Barbara, the Narcotics Division of the City of Santa Barbara took over the program in 2001 (Robinson 2007a). The tedious process of sorting drugs and the unintended use of boxes for disposal of sharps posed administration challenges, causing the police department to consider discontinuing the program (Robinson 2007a). The police department suspected that local doctors’ offices or clinics used the boxes for disposal of their drugs and sharps (Robinson 2007a).

Presence of pharmaceuticals

Although water testing in the Santa Barbara region has not been conducted, it is highly likely that pharmaceuticals would be detected. Research conducted in Spanish and Canadian municipalities with populations around 100,000 or less has revealed the presence of multiple pharmaceuticals in treated wastewater effluent (Carballa et al. 2004; Brun et al. 2006). In Southern California, a preliminary study done at Los Angeles County's Whittier Narrows Reclamation Plant found pharmaceuticals in wastewater effluent; compounds ranged from erythromycin (antibiotic) to fluoxetine (antidepressant). A San Diego study also looked at the presence of a handful of manmade compounds and detected ibuprofen and clofibric acid (Lorraine & Pettigrove 2006).

More presence data for Southern California will be available this year, as the Southern California Coastal Water Research Program (SCCWRP) is currently conducting a widespread survey of emerging pollutants in Ventura, Los Angeles, and Orange counties. The comprehensive survey will include wastewater influents, treated wastewater effluents, surface water, fish tissue, and sediments. The results are expected to be released in late 2007. The SCCWRP is also in the process of designing a Southern California Bight survey and will include pharmaceuticals in the scope of their project. The Bight Survey will also include parts of Santa Barbara County, but the organization is unsure what types of samples will be included.

Potential contamination from WWTPs, landfills, and septic tanks

WWTPs

To collect sewage from households and businesses, vast networks of pipelines run underground between the source and where it is treated. The Goleta Sanitary District (GSD 2002) alone services 120 miles worth of pipelines. Sewer pipe leakages could be a major source of contamination of pharmaceuticals to groundwater; 80 percent of groundwater samples have been exposed to sewer leaks and have tested positive for pharmaceutical compounds (Kummerer 2004b).

Ten wastewater treatment plants (WWTPs) collect and treat sewage in Santa Barbara County (Table 5) Conventional wastewater treatment consists of primary and secondary treatment. Primary treatment allows influent to partition based on density; solids that float or settle to the bottom are filtered out, while liquids and smaller particles pass through. A common secondary treatment process utilizes bacteria to break down organic material in an aerated tank; then, the material is allowed to settle and the water is filtered again. The majority of the treatment plants in the County utilize secondary treatment technology. The Goleta Sanitary District and La Purisima Wastewater Treatment Plant are notable exceptions. La Purisima only utilizes primary processes, while Goleta employs a blended primary/secondary process, and only a fraction of the total influent is treated using secondary technologies (GSD 2002; sbwater.org 2007). Sometimes a tertiary treatment process, usually chlorination, is utilized to further treat wastewater. Only two facilities in Santa Barbara use tertiary treatment

Table 5: Wastewater Treatment Plants (WWTPs) in Santa Barbara County.

Treatment Plant	Capacity (acre feet per year)	Level of Treatment	Recycled Water Uses	Effluent Discharge
Buellton WWTP	728	Secondary	Groundwater recharge	Percolation basins that recharge the groundwater aquifer south of the city
Carpinteria Sanitary District	2,240	Secondary	Treatment plant landscape irrigation	1000-foot outfall pipe to the ocean
Goleta and Goleta West Sanitary Districts	14,562	Blended primary and secondary; tertiary for recycled water	Landscape irrigation, toilet flushing	One-mile outfall pipe to the ocean
Laguna County Sanitation District	3,584	Tertiary	Pasture irrigation	Reverse osmosis effluent injected into a class 1 non-hazardous well; other effluent used for irrigation
La Purisima WWTP	448	Primary	Groundwater recharge; pasture/crop irrigation	Groundwater recharge and irrigation
Lompoc Regional Wastewater Reclamation Plant	5,600	Advanced secondary	Sewer line cleaning; dust control & compaction; city street tree irrigation	Santa Ynez River
Montecito Sanitary District	1,680	Secondary	None	1,600-foot pipeline to the ocean
City of Santa Barbara, El Estero WWTP	12,321	Secondary/ tertiary	Landscape irrigation; toilet flushing	8,720-foot pipeline to the ocean
City of Santa Maria WWTP	8,737	Secondary	Groundwater recharge; pasture irrigation	Groundwater aquifer recharge
Solvang WWTP	1,120	Secondary	Groundwater recharge	Percolation basins

Source: sbwater.org 2007

Risk of pharmaceutical environmental contamination resulting from WWTP effluent is minimal for much of the county, as four facilities pipe effluent to the ocean, employing a 120:1 ocean-effluent ratio of dilution (CSB 2007; CSD 2007; GSD 2002). The Lompoc facility, however, discharges its effluent to the Santa Ynez River (CL 2005). The

remaining plants utilize percolation basins to recharge groundwater aquifer (sbwater.org 2007). For these facilities, groundwater contamination is possible.

Septic Systems

A study of septic systems in Santa Barbara County was conducted in 2003 by the County's Department of Environmental Health Services. The study found that over 9,000 septic systems are currently in use countywide. Assuming an average household size of four people and an estimated County population of 400,000 (U.S. Census 2005), an estimated 9 percent of the county population uses septic systems instead of sewer lines. Though this number is lower than the national average (25 percent; Swartz et al. 2006), concern has been raised because many of the septic systems are located near surface waters where elevated bacteria levels have been recorded. Additionally, many of the systems are located inland where the leachlines allow discharge to percolate and contaminate groundwater aquifers that are used as a source for drinking water. Elevated nitrate levels have been found in Santa Barbara water supply wells located near areas with a high density of septic systems (Questa Engineering Corporation 2003). This is an indicator that septic systems may have contaminated groundwater. Approximately 75-85 percent of the County's commercial, industrial and agricultural water comes from groundwater aquifers.

The County Wastewater Ordinance was approved in 1999 and included changes related to septic tank siting and design, requirements for provision of septic tank access risers, prohibition and required abandonment of hollow seepage pits, and new inspection and reporting requirements for servicing septic systems. Leachlines are now the preferred method of disposal of septic tank wastewater. The vast majority of septic systems are of the traditional variety (with a septic tank, distribution box, and a drainfield); less than ten provide additional treatment or utilize a different disposal method (such as mounds or pressure-dosing leachfields) (Questa Engineering Corporation 2003).

Landfills in Santa Barbara County

There are five active solid waste landfills currently operating in Santa Barbara County: City of Lompoc Sanitary Landfill, Santa Maria Sanitary Landfill, Tajiguas Sanitary Landfill, the Vandenberg Air Force Base Sanitary Landfill, and the Foxen Canyon Sanitary Landfill (Table 6). There are an additional 28 closed solid waste disposal sites throughout the county. The majority of the County's solid municipal waste is collected and disposed of at the Tajiguas site. Only two of the landfills within the County have liners; the rest are unlined (CIWMB 2001b-f). Additionally, most are underlain by highly permeable sandy or silty soils that allow leachate to percolate fairly rapidly and contaminate groundwater (CIWMB 2001b-f).

These landfill conditions mirror the results of a study that analyzed 224 municipal solid waste landfills in California. The "typical California landfill" is:

> "publicly owned, active, located inland, either fully unlined or partially unlined (in the case of active sites), fully uncovered, and has no gas collection system. The typical landfill has a permitted disposal area of

> 55.5 acres and a permitted disposal volume of 2.7 million cubic yards. The typical landfill is underlain by sand and/or gravel, has a minimum depth to underlying groundwater of 34.5 feet, and receives an average annual precipitation of 16 inches" (CIWMB 2001a).

This CIWMB study describes some of the worst siting conditions for a landfill. Sand and gravel are extremely permeable, and without a liner there is no assurance that leachate is contained.

Table 6: Listing of sanitary landfills in Santa Barbara County.

Landfill Site	Size	Soils	Liner	Notes
City of Lompoc	115 acres	Clayey silts	None	
Santa Maria	290 acres	Primarily sand and gravel	Double composite liner	Site is immediately adjacent to Santa Maria River
Tajiguas	78 acres	Clays and sandy loam	Composite liner	
Vandenberg Air Force Base	172 acres	Sand that is interlaced with silty sand, clayey sand, clayey gravel and clay	None	Extraction system treats groundwater, then stores it to use for dust control and irrigation
Foxen Canyon	37 acres	Gravel, sand and clay	None	Surface runoff flows to Santa Ynez River

Source: CIWMB 2001b-f

IV. INSTITUTIONAL SURVEY

Because medical institutions such as hospitals and pharmacies need to keep a large stock of medications on hand to run their businesses, it follows that some of this stock expires or becomes obsolete before it is able to be sold. Consequently, drug waste from these institutions and others may be a major source of pharmaceutical compounds discharged to the environment. This hypothesis is supported by the results of past surveys regarding institutions, including Chapman (2003), Oliver and Chapman (2003), and Kuspis and Krenzelok (1996), discussed previously. Medical institutions also serve as the main suppliers of pharmaceuticals to the public, and it is important to gauge the extent of this direct contact. For these reasons, the present survey was conducted to gain an estimate of local quantities of wasted drugs, current disposal practices, feasibility of a drug recycling program, and likelihood to support a disposal program for the public.

Respondents were selected groups of institutions in Santa Barbara County, including pharmacies, nursing homes, hospitals, and hospices. These facilities are likely to have the greatest storage of pharmaceuticals on hand and thus the most potential for being significant contributors to pharmaceutical disposal. They are also the most relevant because, under current legislation, these facilities qualify to participate in a drug recycling program to redistribute unused medications to uninsured residents. Additional institutions that were considered but ultimately excluded from the survey were outpatient facilities, doctor's offices, and clinics because of their size and number; it wasn't feasible to contact all of them.

METHODOLOGY

The survey was conducted by the authors over the phone during December 2006. Each institution was asked 15 questions, both open-ended and categorical, and multiple responses were accepted for some of the questions. Although the meaning of each question was uniform across all institutions, the language of the questions was tailored to each category; for example, "resident" was substituted for "customer" when questioning nursing homes instead of pharmacies. Topics covered in the survey included:

- current disposal practices,
- contact with the public,
- likelihood to supply/support a recycling program,
- likelihood to support a disposal program for the public, and
- awareness of the issue.

Copies of the survey instruments have been included in Appendix B.

An attempt was made to contact all hospitals, nursing homes, hospices, and pharmacies in Santa Barbara County. The list of institutions was compiled from yellow page searches during the spring and fall of 2006. Santa Barbara County was chosen as the boundary in this survey because a representative from the County is one of the clients for this project; thus, our research was motivated by a need to present resulting recommendations in a

manner that would be applicable for the County, giving it a clear picture of practices and perspectives within its jurisdiction.

RESULTS AND DISCUSSION

Response rate
At the completion of the survey, 116 facilities were contacted, 87 of which fit the intended category; 42 responses were obtained, for a total response rate of 48 percent (Table 7).

Pharmacies were the most willing to answer the questions, having a response rate of 55 percent; consequently, our analysis is weighted toward to responses given by pharmacies. We were able to find only one hospice in the area, but because one response is not an analyzable sample, the responses were not included in the data analysis. Because of the large size of most hospitals, surveys were often directed to a management representative, and in one case the representative answered the questions on behalf of three chain sites. Nursing homes had the lowest response rate (33 percent); some representatives were unwilling to take the survey because they did not have time, didn't seem to have staff to answer phone calls, acted only as a "middle-man" between pharmacies and their residents, or didn't have any direct control over residents' medications.

Table 7: Summary of response rates of institutional survey.

Facility	Quantity attempted	Quantity applicable	Quantity surveyed	Percent surveyed (of applicable)
Pharmacy	60	53	29	54.7
Nursing home	47	27	9	33.3
Hospital	6	6	3	50
Hospice	3	1	1	100
Total	116	87	42	48.2

Trash and drain are not common disposal methods
Respondents were asked to rank how often their institutions used various disposal routes using a five-point Likert scale, where 1 was never and 5 was very frequently. The trash and drain (the most significant methods in terms of potential environmental impact) are not commonly used by the vast majority of the facilities.

For hospitals, trash and drain received low scores, as did incineration, indicating that unlike other locales, hospitals in Santa Barbara County do not have in-house incinerators. The two highest scoring methods for hospitals were reverse distributors and hazardous waste. Hospitals' use of hazardous waste to dispose of pharmaceuticals is unique when compared to responses from the other institutions.

Almost the only disposal method utilized by pharmacies is that of reverse distributor; "other" was also a common response, often meaning that waste is returned to a corporate warehouse. Here, too, trash and drain received very low scores.

In general, nursing homes scored trash more highly than other institutions. This departure from the other categories could stem from the fact that many nursing homes are small, and the resulting quantity of unwanted drugs is too small to hire a reverse distributor. Another possible explanation is that without a larger network, like a corporate headquarters for pharmacies, independent nursing homes are unaware of the benefits of using reverse distributors. Nursing home representatives who indicated another method stated that they return unwanted medications to their affiliated pharmacy. The most common reason that nursing homes dispose of pharmaceuticals is because their residents' prescriptions had changed; this need to dispose of residents' medications is similar to results found by Braybrook, John, and Leong (1999).

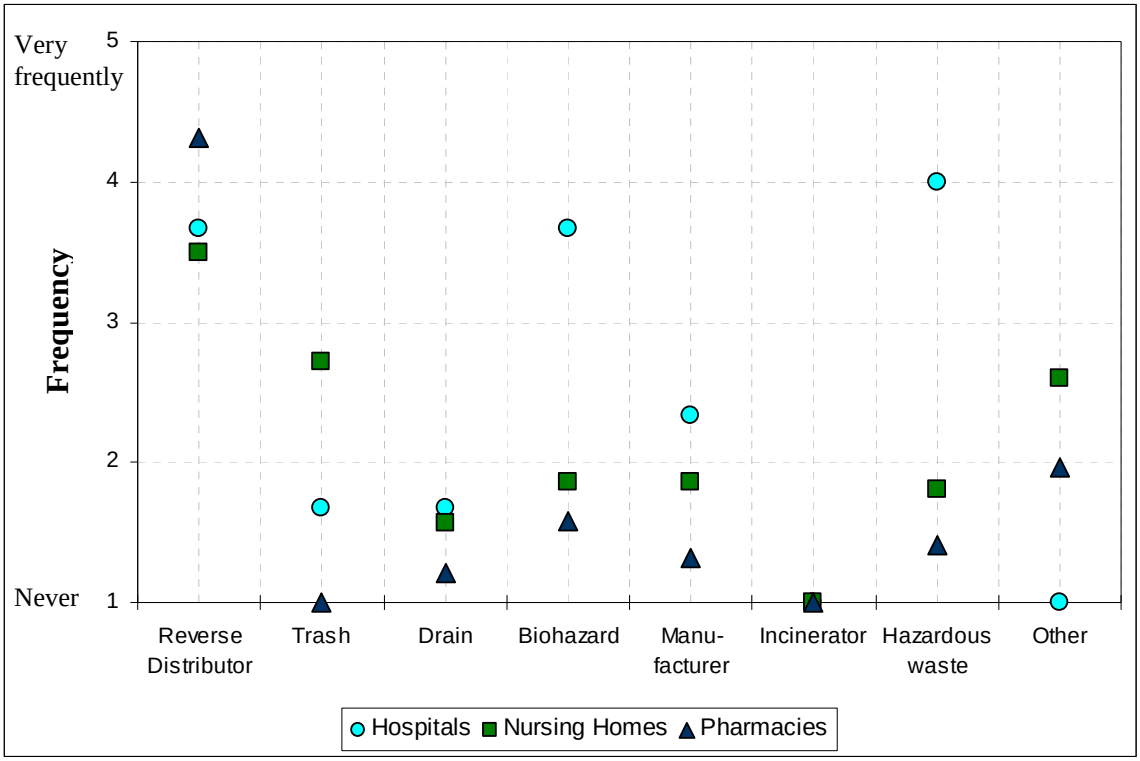


Figure 2: Average frequency scores of disposal methods used by institutions.

Taken as a whole, the frequency that institutions in Santa Barbara County utilize the drain or trash is very low. On the other hand, the frequency of use of a reverse distributor is almost exactly opposite that of the trash and drain (see Figure 3). Reverse distributors are also the most common disposal route among institutions in King County, Wash., but there the drain is a close second (Oliver & Chapman 2003). Results for Santa Barbara differed in that the use of a reverse distributor is much more common than dumping the pharmaceuticals down the drain. A trend identified in both studies is that individuals

within the industry often lack clear guidance concerning proper disposal options. The King County survey and the Santa Barbara survey deviate significantly from Kuspis and Krenzelok (1996), where reverse distributors were not mentioned as a disposal method at all.

It is not surprising that the majority of institutions contract with a reverse distributor; as discussed in the Background section, using reverse distributors is a good option for institutions because reverse distributors are efficient and allow facilities to return some unused medications for a credit, minimizing the facilities' economic loss. All institutions should be encouraged to follow this trend to utilize reverse distributors and divert their waste streams away from trash and drain.

Although across the County the low use of trash and drain is encouraging, room for improvement exists: Facilities that do utilize the trash and drain indicated that it is their main disposal method. Three of the four facilities (of 42) who responded 3 or higher for trash rated the method a 5 (very frequently); also, two of the three institutions who responded 3 or higher for drain indicated a 5 rating.

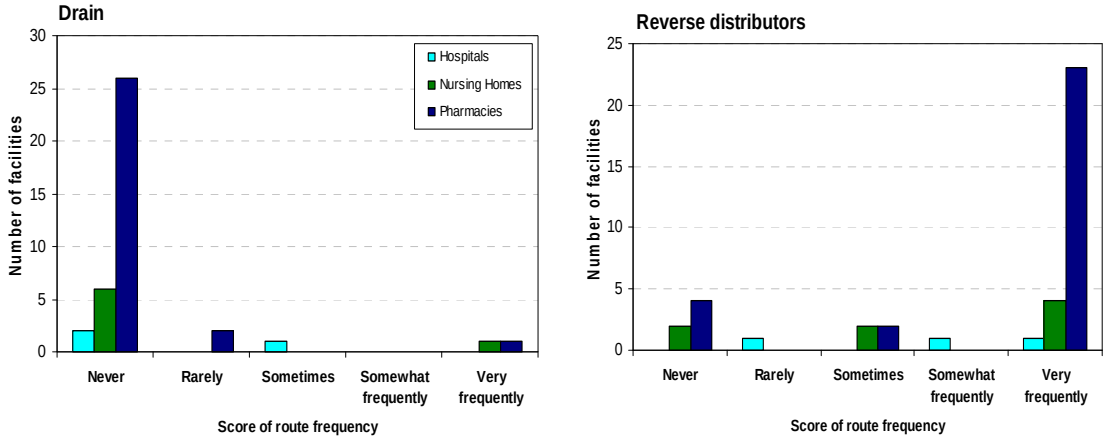


Figure 3: Comparison of drain and reverse distributor disposal methods. These graphs show more clearly the responses for use of drain and reverse distributors as disposal methods for all surveyed institutions; they are mirror opposites.

Educating consumers begins with educating pharmacies

Institutions were asked whether they have been questioned by the public concerning how best to dispose of unwanted pharmaceuticals. Ninety percent of pharmacies said "yes"; lower percentages were found for nursing homes and hospitals (see Figure 4). This result indicates that if a disposal program for the public is implemented in the future, institutions (and pharmacies in particular) should be informed to indirectly provide information to residents.

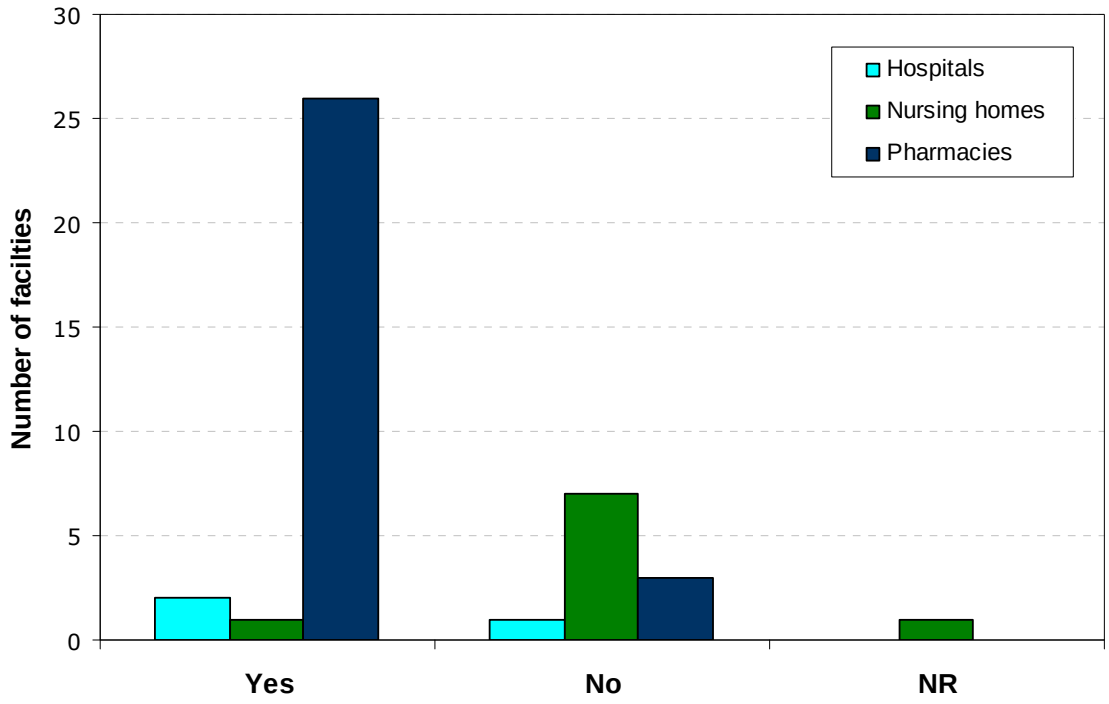


Figure 4: Institutions as suppliers of information to the public. When asked, "Do customers (or patients) ever ask how to dispose of their own medication," pharmacies showed the highest percentage of an affirmative response. Therefore, the majority of the public appears to choose pharmacies to determine the best disposal method for its leftover medications.

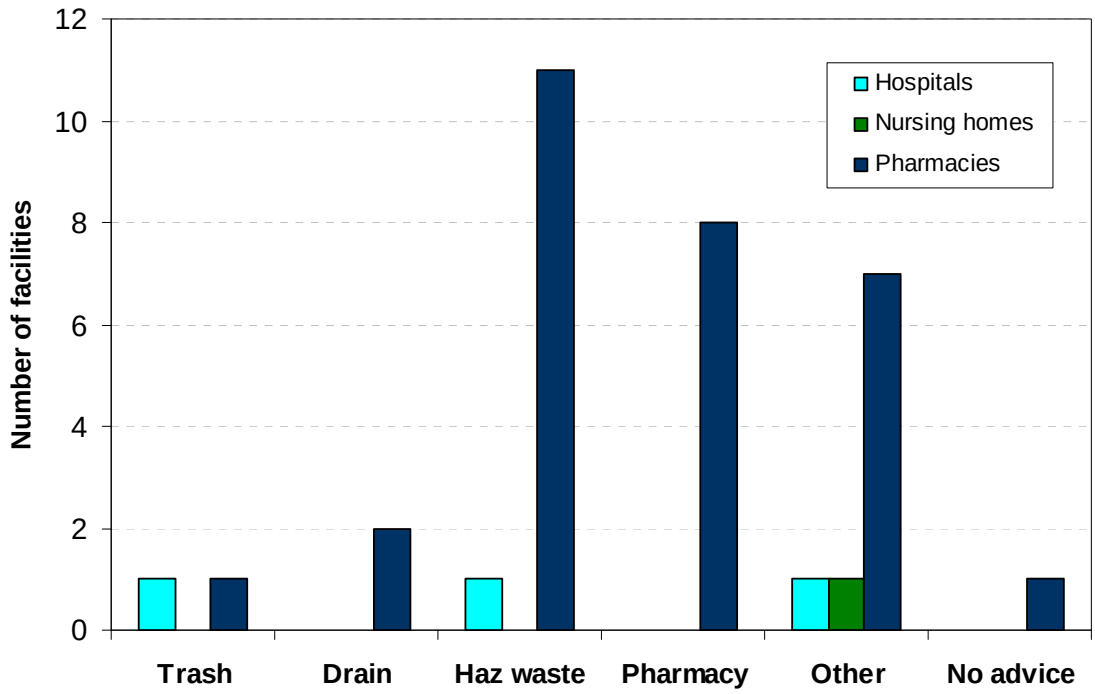


Figure 5: Disposal recommendations. The variety of disposal recommendations to the public indicates that an education campaign is needed.

As a follow-up question, institutions were next asked for their typical response. A variety of disposal recommendations are given, ranging from taking medications to a community hazardous waste center to dumping it down the drain (see Figure 5). These results suggest that confusion and uncertainty exists within the industry; thus, an education campaign could lead to better, more uniform recommendations to the public.

The most commonly recommended response is to take medications to the hazardous waste facility. As discussed in the previous section, this option is a limited one for residents; at least one of the hazardous waste facilities Santa Barbara County is hesitant to accept pharmaceuticals because of DEA regulations regarding controlled substances and other liability issues. This disconnect should be remedied as soon as possible.

Supply for recycling program

Recycling programs have been characterized as a solution to utilize unwanted, leftover pharmaceuticals from medical institutions; however, implementing a drug recycling program cannot be justified if there is insufficient supply of donated medications to support it. This study found that most institutions in Santa Barbara County would not have unused, unexpired medications to donate.

When asked if the facility would have medications that could be donated to a drug recycling program, 33 of 40 institutions (82.5 percent) answered “no” (see Figure 6). The explanation for this response came from a second question: what percentage of the total pharmaceutical stock was disposed of. Most respondents estimated the average to be less

than 5 percent. Moreover, of the seven institutions that would have drugs appropriate for a recycling program, only two dispose of more than 5 percent (see Figure 7).

Responses to an earlier question revealed that the most common reason institutions dispose of pharmaceuticals is because the drugs are expired. However, there is little chance the drugs would be donated pre-expiration because even a small opportunity to sell them creates an incentive to keep them as long as possible. Moreover, most facilities use a reverse distributor to return these expired medications for credit, minimizing their loss. Institutions would not receive these credits if they donated the medications.

The results from this survey indicate that there is not likely to be a consistent supply of usable medications to support a drug recycling program. However, this survey provides only a general idea of the amount of medications that go unused by institutions. Further evidence could come from establishing a monitoring program to catalogue the amount, frequency, and type of specific drugs that are disposed of.

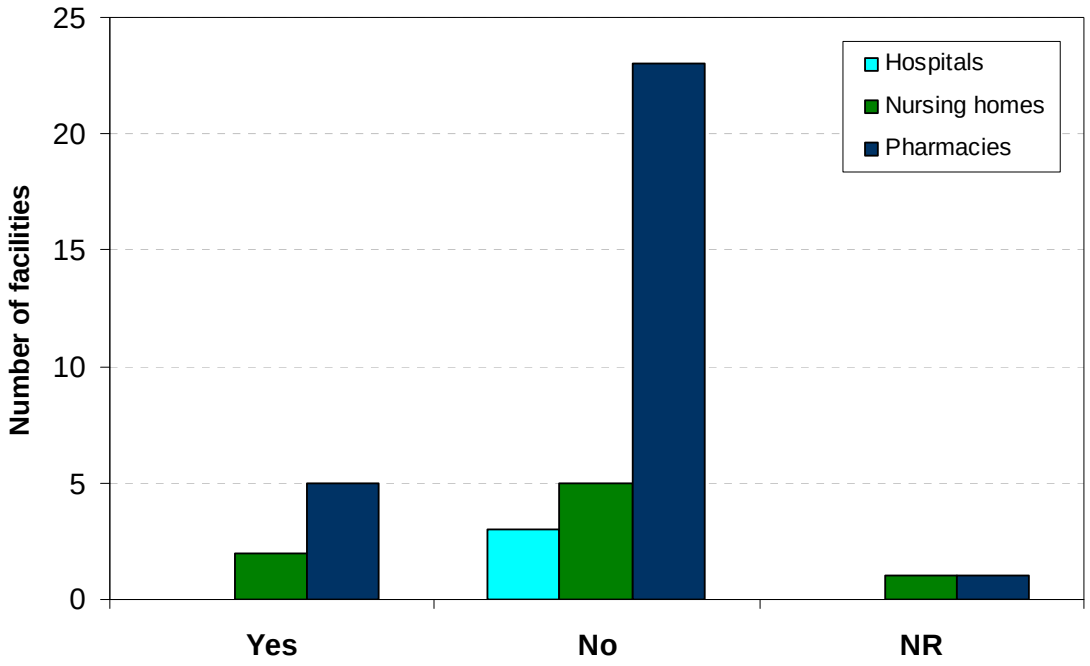


Figure 6: Recycling program supply. When asked if their facilities would have unused and unexpired medications suitable to donate to a drug recycling program, only seven of 40 institutions responded "yes."

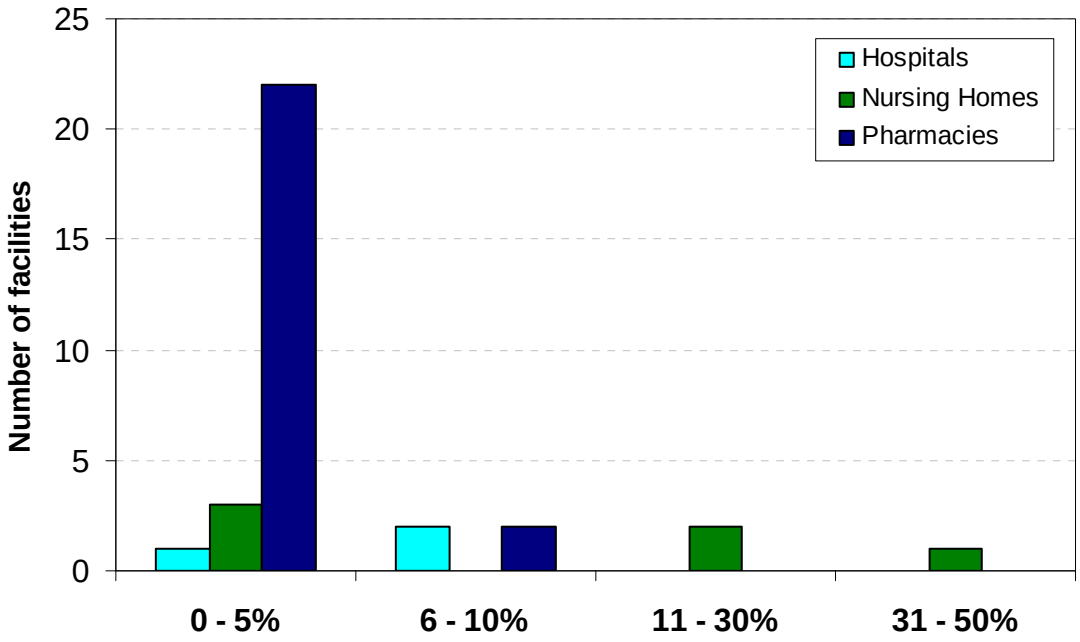


Figure 7: Percentage of pharmaceutical stock discarded. This graph depicts the percentage of pharmaceutical stock disposed of, as reported by each respondent. The vast majority of institutions estimate that they dispose of less than 5 percent of their total pharmaceutical stock. On average, nursing homes discard the greatest percentage. Several nursing homes commented that their residents' prescriptions were always changing, as often as every six months; consequently, this could explain why nursing homes are likely to dispose of more medications than other institutions.

Support for a disposal program

To gauge institutional support for a disposal program, the survey postulated a possible scenario: a permanent drop-off box to which the public could bring their unused medications. This question was directed only toward pharmacies and hospitals. When respondents were asked if their facilities would consider housing a drop-off box, many of the pharmacies said they would; conversely, only one hospital would consider installing a drop-off box. "Maybe" was the second most-common answer among pharmacies, saying they would have to ask their corporate headquarters (see Figure 8).

Nearly 80 percent of the respondents do consider the presence of pharmaceutical compounds in the water to be an environmental concern. The other 20 percent were uncertain, but not one respondent definitively thought it was not a problem (see Figure 9). This result may explain why facilities would support a disposal program. However, this outcome could also reflect a respondent's tendency to "yea-say," or try to respond in a manner that would please the interviewer.

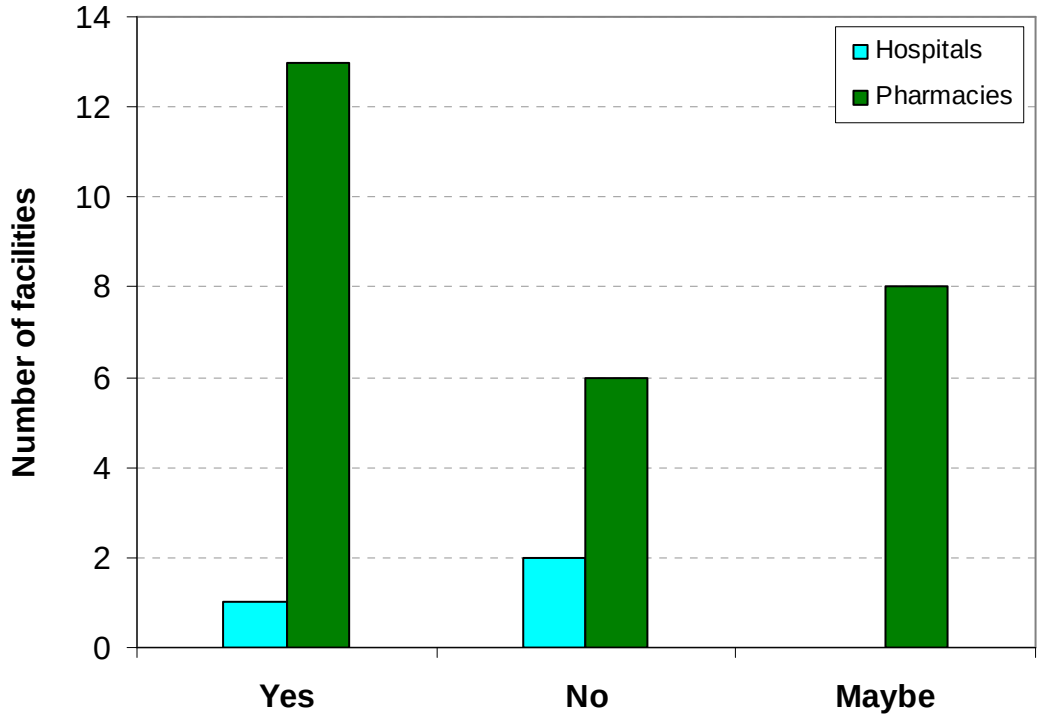


Figure 8: Drop-off box support. When asked if the respondent would consider housing a drop-off box where the public could bring their unwanted medications, many institutions responded positively. A smaller, but significant number, indicated "maybe" because they would have to ask their corporate headquarters.

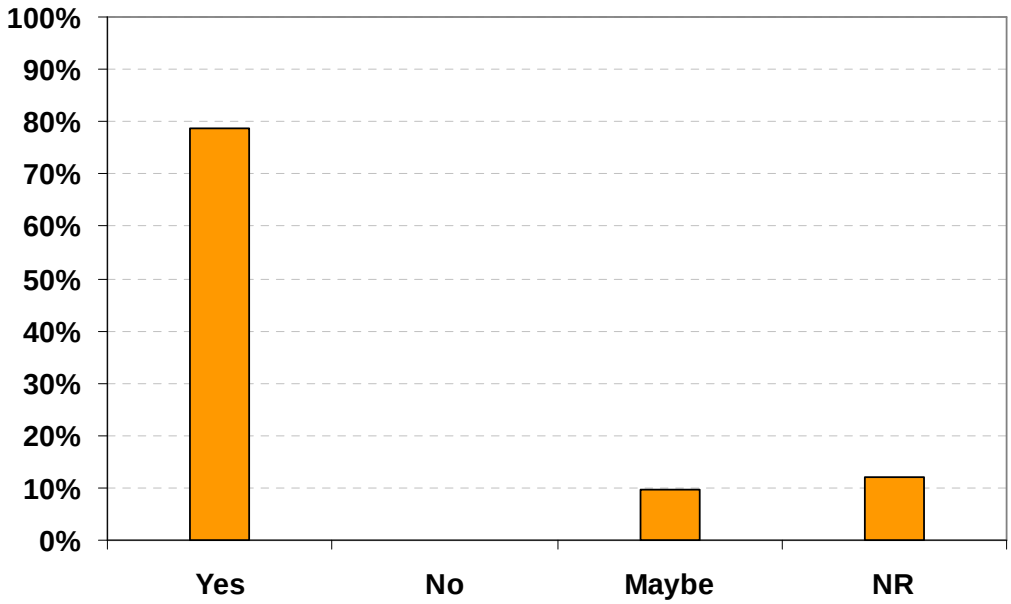


Figure 9: Concern about pharmaceuticals. The majority of respondents did believe that the presence of pharmaceutical compounds in surface waters was a legitimate environmental concern; in fact, no facility responded "no." This could explain why most facilities would support implementing a disposal program for the public.

CONCLUSION

This survey of selected Santa Barbara health care institutions resulted in a picture of disposal practices and sentiments of roughly half the facilities in the County. The results reveal that the majority of institutions contract with reverse distributors to dispose of unused medications. Additionally, institutions can serve as an indirect link to educate the public concerning proper pharmaceutical disposal practices. The results do not suggest that a recycling program would be successful in Santa Barbara, as supply may be too small to support it; more conclusive evidence could be obtained by establishing a program to monitor exact quantities and types of pharmaceutical waste.

Responses reveal that the majority of institutions are genuinely concerned about pharmaceutical contamination, which is manifested in a shared sentiment of cooperation among the respondents. This finding is encouraging and signals that if the County government were to implement a disposal program for the public, many institutions would support the move. It is necessary to note that when asked which entity should take responsibility to address the pharmaceutical-disposal issue, many said that a collective effort is needed, but "government" was the most common response. Therefore, this finding suggests the local government will likely need to instigate the movement toward establishing policy solutions.

V. END-USER SURVEY

Unlike the institutions, the end-user (the public) is not regulated in any aspect of pharmaceutical disposal, so end-users may dispose of their unused pharmaceuticals in any manner. Typical disposal methods include the trash and drain, and drugs disposed via these methods can contaminate ground and surface waters. Without a formal disposal program, end-users are left with few alternative options. Thus, the goal of this study is to determine the disposal practices of Santa Barbara residents and eliminate the disposal dilemma by proposing potential pharmaceutical disposal programs for Santa Barbara County and diverting waste from wastewater treatment plants (WWTPs) and landfills. To inform the disposal program recommendations, a five-question end-user survey was conducted to gain insight into residents' medicine use, disposal habits, awareness of pharmaceuticals in surface water, willingness to participate in a disposal program, and how much end-users value a disposal program.

SURVEY INSTRUMENT

The end-user survey was incorporated into the Central Coast Survey (CCS), which is a survey conducted by the University of California, Santa Barbara Social Science Survey Center. See Appendix C for a copy of the survey instrument. The CCS targets residents in Santa Barbara and Ventura counties and consists of questions on local issues including financial prosperity, housing, and transportation, among other topics. The survey was conducted by telephone on weeknights between January 8 and February 26, 2007. Telephone numbers were generated from a list of all prefixes in Santa Barbara and Ventura Counties. Randomly selected four-digit numbers were added to those prefixes, ensuring that both listed and unlisted numbers had an equal chance of being selected. Interviews were conducted in both English and Spanish and averaged 14 minutes in length. All survey respondents were at least 18 years of age. In total, 1,657 households were contacted, and 1,023 interviews were completed, for a cooperation rate of 62 percent.

Medicine use and awareness were binary yes/no questions and were included in the survey to examine the relationships between use and awareness and people's willingness-to-pay for a disposal program. Questions about disposal practices and participation were included in the survey to understand regional disposal behavior and sentiments; the data from these questions will add to the existing survey knowledge related to end-user disposal habits and willingness to participate in a pharmaceutical disposal program (Bound & Voulvoulis 2005; WCRC 2006). The disposal question was multiple-choice, where the respondent selected one option. A survey conducted in King County, Wash., determined that the most convenient location for medicine return was a pharmacy (WCRC 2006). As such, the willingness-to-participate question was framed as a disposal program where the respondent would return their medicines to their pharmacy. A five-point Likert scale was used to measure willingness-to-participate.

A contingent valuation (CV) question was included in the survey and is the first CV study for a pharmaceutical disposal program. A dichotomous choice referendum format was used for the CV question, which was motivated by a November 2006 proposal written by a study group in Maine and addressed to prominent personnel in federal departments that are involved in the permitting and regulation of pharmaceutical substances. See Appendix D for a copy of the proposal. The proposal called for a national pharmaceutical disposal program and a funding mechanism in the form of a $0.25 disposal fee on prescription drugs. The proposed funding mechanism was used to frame the contingent valuation question as follows:

"The presence of medicines in surface waters is a growing environmental concern. To address this concern, there is currently a proposal to add a surcharge to prescription medication to fund a national disposal program."

The explanation was followed with the question: "Would you be willing to pay [BID] per prescription you purchase?" Bid amounts were randomly assigned from the following options: $0.05, $0.10, $0.25, $0.50, $1.00, $1.50, $2.00, $2.50. The original bid values ranged from $0.05 through $1.50. After reviewing the first two weeks' data, the lower values, $0.05 and $0.10, were dropped and the higher values, $2.00 and $2.50, were added. Although the question asks WTP in the context of a national program in order to mirror the Maine proposal, we assume that the benefits from implementing a disposal program are mainly local, and the WTP for a national program will not differ from the WTP for a local program; thus, these benefits were analyzed from a local perspective.

ANALYTICAL METHODS

Pearson correlation coefficients were calculated to identify relationships between variables such as medicine use or awareness and demographic variables such as age and education. The data from the dichotomous choice contingent valuation question were used to estimate a logit model to predict the probability of a "yes" response based on the disposal fee amount (BID) and other indicator variables such as gender, age, awareness of issue, income, ethnicity, and political party. A higher BID is expected to result in lower probabilities of "yes" responses. Estimation of this multivariate model allows for the calculation of average willingness-to-pay (WTP). WTP was calculated using two equations. Equation 1 allows for the existence of negative WTP values and is a more conservative estimate (Hanneman 1984).

$$E(WTP) = \frac{\beta_0}{\beta_1} \qquad \textbf{Equation 1}$$

Another average WTP estimate assumes only positive values and is calculated using Equation 2 (Hanneman 1984).

$$E(WTP) = \frac{1}{\beta_1} \ln(1 + e^{\beta_0}) \qquad \textbf{Equation 2}$$

RESULTS AND DISCUSSION

The Central Coast Survey covers both Santa Barbara and Ventura counties, while this study focuses specifically on Santa Barbara County. County was not significantly correlated to survey question responses. Thus, data from both counties were used in the analysis.

It should be noted that the median age of the Central Coast Survey is 49, while the median age of Santa Barbara and Ventura counties are 34.4 and 35.5, respectively (U.S. Census 2005). A possible explanation for this difference is that younger residents often use a cell phone as their primary phone instead of a landline; the CCS only contacts households with landlines.

Survey data from the medicine use, disposal, awareness, and willingness-to-participate questions are summarized in Table 8.

Table 8: Results from end-user survey.

Question	Response	Percent
Have you taken any over-the-counter or prescription medicines in the past 24 hours? (n=1,003)	Yes	46.5 %
	No	53.5 %
How do you typically get rid of unwanted or expired prescription or over-the-counter medicines in your household? (n=817)	Trash	45.2 %
	Toilet or sink	28.0 %
	Pharmacy	5.9 %
	Hazardous Waste Center	5.1 %
	Store at Home	11.8 %
	Other	4.0 %
Are you aware that medicinal compounds have been found in treated wastewater and surface waters? (n=997)	Yes	43.4 %
	No	56.6 %
If a disposal program was implemented at local pharmacies, how likely would you be to return unwanted or expired medicines to your pharmacy for disposal? (n=987)	Very Unlikely	9.9 %
	Somewhat Unlikely	2.7 %
	Neutral	8.5 %
	Somewhat likely	10.9 %
	Very likely	67.9 %

Medicine Use

Forty-six percent of the respondents indicate that they have taken prescription and/or over-the-counter medication in the past 24-hour period. Medicine use is highly correlated to age, with a correlation coefficient of 0.280 (Table 9). This is consistent with other reports, which note that drug consumption increases with age (NCHS 2006). Because the

survey age is skewed toward older county residents, the estimation of medicine use may be an overestimate, as older residents are more likely to be taking medication.

Table 9: Pearson correlation coefficients (two-tailed) for medicine use and age; and awareness and education, medicine use, and disposal method. Variables: USE = medicine use in past 24 hours (no=0; yes=1); AWARE = whether aware of presence of medicine in water (no=0; yes=1); AGE = age of respondent; EDUC = education level of respondent (1=very little formal education; 8=graduate school education); DISPOSAL = whether respondent uses trash, toilet or drain as disposal route (no=0; yes=1).

	AGE	USE	EDUC	DISPOSAL
USE	0.280***	-	-	-
AWARE	-	0.081**	0.124***	-0.210***

Note: **, *** indicate significance at the 0.05 and 0.01 levels, respectively.

Disposal Practices

The most common responses for typical pharmaceutical disposal practices are trash (45 percent), toilet or drain (28 percent), and store at home (12 percent) (Table 8). These results are exactly opposite of the disposal habits of institutions, which rarely use the trash or drain as disposal methods.

Trash is the most common disposal practice, and this finding is similar to the results of the WCRC survey (2006), which observed that 52 percent of respondents typically dispose of their medicines in the trash. A lower percentage of respondents in the WCRC survey, 20 percent, dispose of their medicines in the toilet or sink. Another survey done in the United Kingdom found that only 11.5 percent of the respondents dispose of medicine in the toilet or sink (Bound & Voulvoulis 2005). The U.K. observation is much lower than the 28 percent observed in this survey, and is probably due to regional differences in awareness of the issue. In general, the United Kingdom and Europe have given higher priority to finding ways to mitigate the release of pharmaceuticals into the environment.

The third most common option “store at home” (12 percent) is much higher than the WCRC survey, which reported that “store at home” only reflected 2 percent of the respondents’ behavior. While storing drugs at home prevents their release into the environment, it becomes a household safety risk. Storing drugs at home has become a national health issue, as first-time drug users in the United States now experiment with prescription painkillers more than marijuana (DHHS 2006). Because most areas in the United States do not have formal drug disposal programs, the White House recently recommended that households dispose of their drugs by making them unrecoverable (i.e. mixing with cat litter) and throwing them in the trash (ONDCP 2007). As mentioned previously, incineration is currently the recommended method of destruction, so formal disposal programs would help divert pharmaceutical waste from the home, landfills, and WWTPs.

Awareness

A majority of the respondents, 54 percent, are not aware that medicinal compounds have been found in treated wastewater and surface waters, indicating that education on the issue may be beneficial. An education or advertising campaign may help move people’s

disposal habits away from the trash, toilet, or sink. As shown in Table 9, awareness is negatively correlated to trash/toilet/drain disposal; respondents that are aware of pharmaceuticals in the water are less likely to dispose of their medicines via the trash or plumbing. Awareness is positively correlated to education level; respondents with more formal education are more likely to be aware of the issue. In addition, awareness is weakly correlated to medicine use, indicating that people who take medicine may be more aware of issues surrounding pharmaceuticals.

Willingness-to-participate in a disposal program
Respondents show a strong willingness-to-participate in a drug disposal program, with 79 percent of respondents indicating that they would be very likely or somewhat likely to return their medicines to their pharmacy (Table 8). Only 13 percent of the respondents would be very or somewhat unlikely to take their drugs back to their pharmacy.

In the institutional survey, the results reveal that most pharmacies would be willing to house drop-off boxes as part of an end-user disposal program. Both parties involved – the pharmacies and end-users – show a strong interest in participating in a disposal program that requires dropping off unwanted medications at pharmacies.

CV of a disposal program
The contingent valuation analysis considers the influencing factors on a respondent's "yes" or "no" response to the referendum question. In addition to the BID (proposed disposal surcharge on prescription drugs), several socioeconomic and demographic variables are considered, including: GENDER (male=0, female=1); AGE, AWARENESS (whether respondent is aware medicines have been found in surface water, no=0, yes=1), political party, and ethnicity. Political party was coded into three groups: REPUBLICAN (no=0, yes=1), DEMOCRAT (no=0, yes=1), and OTHER PARTY (no=0, yes=1). REPUBLICAN was the reference category. Ethnicity was also coded into three groups: WHITE (no=0, yes=1), HISPANIC (no=0, yes=1), and OTHER ETHNICITY (no=0, yes=1). WHITE was the reference category. Income was also considered but was not significant.

Observations with missing data were excluded from the logit model evaluation. Thus, only 853 observations were used out of the 1,005 total observations. Political party and ethnicity had the highest non-response, with 114 and 67 missing data points, respectively. Different versions of the model were estimated, but the final logit model is reported in Table 10. The coefficients for OTHER PARTY and OTHER ETHNICITY were not significant and were dropped from the original model. This indicates that respondents from other political parties (e.g. Independent, Libertarian) answer the same as Republicans, and other ethnicities (e.g. Asian) answer the same as the white respondents.

Table 10: Logit model results for dichotomous choice responses, and mean WTP for a pharmaceutical disposal program. Response variable is the probability of a "yes" response (Pr[yes]). Model was Pr[yes]=f(bid, age, gender, democrat, Hispanic, awareness)

	Coefficient	SE
Constant	1.234***	0.325
BID	-0.513***	0.092
GENDER	0.343**	0.022
AGE	-0.016***	0.002
AWARENESS	-0.250*	0.150
DEMOCRAT	0.502***	0.183
HISPANIC	0.416*	0.203
Grand constant	0.796	
	Equation 1	*Equation 2*
MEAN WTP	**$1.55**	**$2.28**

Note: *, **, ***, indicate significance at the 0.1, 0.05, and 0.01 levels, respectively.

The coefficient signs for BID and AGE are as expected, with the probability of a "yes" response decreasing as both age and bid increase. This indicates that respondents are sensitive to higher prices. Older respondents are less likely to respond "yes," a finding that may be connected to the fact that older people are more likely to be consuming medication, so a surcharge would likely cost them more. The marginal relationship between CV responses and bid amount are displayed in Figure 10. A range of Pr[yes] values are plotted against different bid amounts. The figure is consistent with a typical downward sloping demand curve; as the bid amount goes up, the Pr[yes] goes down. Other variables were held constant by taking the mean values.

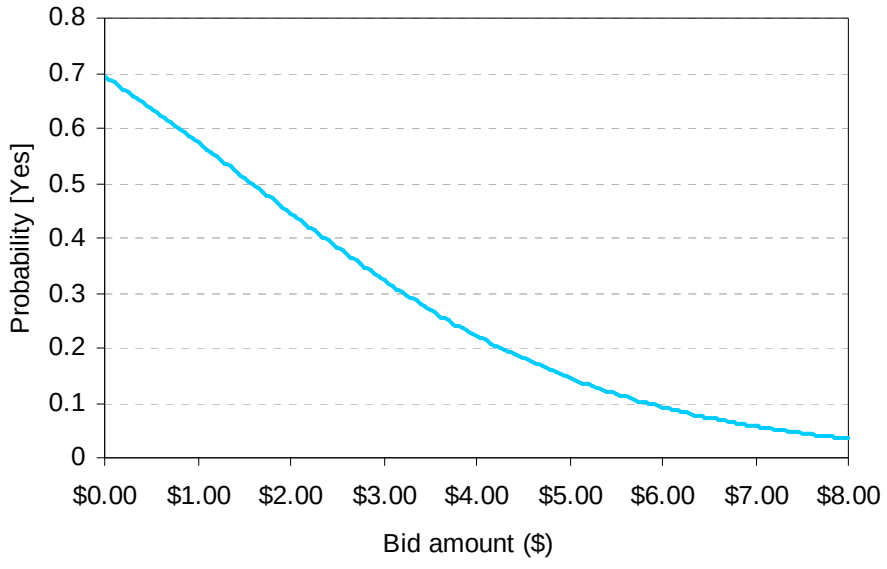


Figure 10: Relationship between the probability of a "yes" response and bid amount, holding all other variables constant. The slope is consistent with economic theory: As the bid price goes up, the probability of a "yes" goes down.

AWARENESS has a negative coefficient, which indicates that people who are aware that medicines have been found in the water were less likely to respond "yes" to the disposal surcharge. This result is opposite of what is expected, as it was assumed that people who are aware of the problem are more likely to say "yes." One possible explanation for this observation is that awareness is correlated with education level (Table 9), and educated respondents may also have awareness of other social and environmental issues. Their no response may indicate that they do not feel a disposal program is a priority problem. Another explanation is that the awareness variable is inflated due to respondent "yea-saying" to please the interviewer, and that not all respondents who responded "yes" are aware of the issue.

Conversely, the coefficient for DEMOCRAT was positive and statistically significant. Democrats are more likely to say "yes" to a surcharge than Republicans or other political parties (e.g. Independent, Libertarian). This result was expected because Democrats, in general, are more supportive of government intervention and social programs. Hispanic respondents are also more likely to respond "yes" to the disposal surcharge than white or other ethnicity respondents. It is unclear why Hispanic respondents are more likely to say "yes" to the surcharge.

The results from the logit equation in Table 10 are used to calculate the average WTP. The average values for AGE, GENDER, AWARE, DEMOCRAT, OTHER PARTY, HISPANIC, and OTHER ETHNICITY were multiplied by their respective coefficients and summed with the constant for a 'grand constant'. The grand constant was used to calculate the average WTP using Equations 1 and 2; results are displayed in Table 8. The conservative estimate of average WTP is $1.55 per prescription (Equation 1) and the larger estimate is $2.28 per prescription (Equation 2).

There are a number of different ways to convert average WTP into a total value of a disposal program. A simple way to calculate the value is to multiply the average prescription rate by the total population, which results in a total value of $7,471,807.[2] However, this number is likely overestimated because not all residents, including children, may buy that many prescriptions in a year. In addition, adding the surcharge to every prescription would burden the elderly with the cost of a disposal program, as prescription use increases with age. People in the 65 and above age group average 17.0 medications per year, while people that are 44 and under average around 3.0 medications per year (NCHS 2006).

To address the situation where elderly and infirm residents are burdened with disposal costs, we chose to estimate the total value of a pharmaceutical disposal program assuming residents pay the surcharge on only the first prescription of the year. This approach will prevent the costs from falling on a specific demographic. When residents only pay the surcharge on one prescription per year, the total annual value of a disposal program is $621,181. However, this calculation is an underestimate because the survey

[2] The national per capita prescription rate was reported as 11.8 in 2005, although the prescription rates for individual states may vary (U.S. Census 2006). The estimated 2005 population for Santa Barbara County is 400,762 (U.S. Census 2007).

asked respondents to answer based on all of their annual prescriptions – not just one prescription per year.

Table 11: Total annual value of a disposal program in Santa Barbara County

	1 prescription per year	11.8 prescriptions per year
Total Value of Program	$621,181	$7,329,937

CONCLUSIONS

Overall, the results show that the trash and drain are common disposal routes for the public, indicating that a disposal program, along with an education campaign, in Santa Barbara County would be a beneficial investment. The education will make a difference, as we observed that respondents who are aware of the issue are less likely to dispose of their medicine in the trash or plumbing. Local residents also place a remarkably high value on a disposal program. The costs of implementing a program are typically less than the amount the end-users value the program ($621,181); a cost comparison of various programs is discussed in the Recommendations chapter. If the cost of administering a disposal program is less than its value, the difference could be interpreted as economic benefits to the County and its residents. In addition, investing in a disposal program would not be wasted money because the regions' residents are also quite willing to participate in a disposal program.

VI. CONCLUSIONS AND RECOMMENDATIONS

This study focused on the disposal of unwanted medications as a source of pharmaceutical compounds in treated wastewater effluent, groundwater, and surface waters. There is currently no clear solution for proper disposal of pharmaceuticals in the United States, though various programs are either in place or being considered around the country. Program options include permanent collection at household hazardous waste facilities or other locations such as pharmacies; a mail-back program; special collection events; or drug recycling, which entails the donation of unused, unexpired pharmaceuticals from licensed medical facilities to low-income, uninsured patients.

We conducted surveys to determine household and institutional disposal practices in Santa Barbara County and used our survey results to evaluate different disposal programs and policy options. This section summarizes our recommendations for Santa Barbara County:

- We do not recommend a drug recycling program at this time, as we did not find evidence for a reliable, consistent supply of usable medicines.
- A campaign to educate residents is necessary: The drain and trash are the most common disposal habits among the public, which are not best-practice disposal routes.
- We recommend a permanent collection program to ensure that residents have an effective and legal way to properly dispose of their medications.

DRUG RECYCLING

One of the initial goals of this study was to evaluate the feasibility of a drug recycling program. Counties in California may pass an ordinance to collect unused, unexpired pharmaceuticals from nursing homes, wholesalers, and manufacturers and redistribute them to the low-income uninsured (H&SC §150200-150207). San Mateo County is the only county in California that has set-up a recycling program. Though it is too early to determine its success, one difficulty the program has encountered is the mismatch of medications donated, mostly from elderly patients, to medications needed (Chiang 2007). Several other states have also passed legislation allowing drug recycling programs. Tulsa, Okla., provides an example of successful drug recycling program.

Based on our institutional survey, we did not find evidence of an adequate supply for a drug recycling program in Santa Barbara County. Most facilities would not have unused, unexpired medications to donate, and most facilities only dispose of a minimal proportion of their pharmaceutical stock. Moreover, the most common reason that they do dispose of medications is that they are expired and therefore would not be appropriate for a drug recycling program. Institutions, namely pharmacies, have a disincentive to donate pharmaceuticals because it is in their interest to exploit any opportunity, however small, to sell their inventory. Another reason facilities may not have drugs to donate is that most use reverse distributors for disposal, which allow them to receive credits for excess drugs, minimizing their losses.

Because we did not find evidence for a consistent supply of usable medicines, we do not recommend a recycling program at this time. The lack of evidence for a supply, however, is more representative of pharmacies than other institutions because pharmacies comprise the majority of survey respondents. Another limitation of this survey is that it does not indicate the quantities of drugs wasted. If there is interest from some facilities in a drug recycling program, we recommend a monitoring program to catalogue the amount, frequency, and types of wasted medications.

EDUCATION

Education is a key component for a proper disposal program. As found in our end-user survey, the majority of residents (54 percent) are not aware that pharmaceuticals have been found in treated wastewaters and surface waters, and the most common disposal routes used are the trash and drain, which are not best-practice disposal routes. We also found that residents who are aware of this issue are less likely to dispose of their medications via the trash or toilet. Our institutional survey findings suggest that pharmacies, which are in direct contact with end-users, may be a good vehicle for education. Patients ask pharmacies for proper disposal advice more than other institutions; nearly 90 percent of pharmacies surveyed have received inquires. But pharmacies do not have a clear answer for consumers: when asked what disposal method they usually recommend, respondents reported a variety of methods, though a hazardous waste facility is the most common method recommended. Moreover, many, but not all, facilities (72 percent) indicated that they are aware that pharmaceuticals have been found in treated wastewaters and surface waters, so room for improvement of institutional awareness exists.

It behooves the County of Santa Barbara to have a recommended disposal option for residents in place before embarking on an education campaign. The only option for disposal is collection at hazardous waste facilities in Santa Barbara County. The Recycling Resource Guide for Santa Barbara County advises residents to drop off medications at their local pharmacy or at a household hazardous waste center (CSBPWB 2005). And, again, the most common disposal method pharmacies recommend to consumers is a hazardous waste facility. However, one of the two facilities listed in the guide, the Community Hazardous Waste Collection Center on campus at UCSB, is hesitant to accept any pharmaceuticals because they are not allowed to collect controlled substances (Carter 2006a). The workers at the hazardous waste center, who are contracted from UCSB, have requested that the County not advertise drug collection due to the risks associated with controlled substances. Our study reveals that while pharmacies and the County recommend for residents to bring their medications to a hazardous waste center, this is only a limited option for residents.

END-USER COLLECTION PROGRAM

We recommend the implementation of a permanent disposal program for residents in Santa Barbara County. Our survey results indicate that both institutions and end-users would support a program. Many pharmacies would consider housing a disposal drop-off

box for the public. One explanation for why institutions would support a drop-off box is that nearly 80 percent of facilities consider the presence of pharmaceuticals in waters to be an environmental concern. When asked whose responsibility it should be to address this issue, many institutions expressed that it should be a collective effort, but the most common response was "government." So while institutions may cooperate for a disposal program, it may be necessary for the government to take the lead.

Our end-user survey reveals that residents are both willing to participate in and willing to pay for a disposal program. Nearly 80 percent of respondents would participate in a disposal program implemented at pharmacies. In fact, the survey questions regarding awareness of the presence of pharmaceuticals in the water led so many respondents to ask what they should do with unwanted medications that the survey administrators requested a prepared response from the authors.

Even the minimum value of a disposal program to Santa Barbara residents exceeds the expected cost of a implementing a disposal program. Based on the conservative estimate of a willingness to pay for a disposal program of $1.55 per prescription, and a low per capita prescription rate of one prescription per year, Santa Barbara County residents value a disposal program at a minimum of $621,181. Using a higher per capita prescription rate of 11.8, the average national prescription rate reported for 2005, this value jumps to $7,329,937. Table 12 shows examples of the costs of various disposal programs gathered from experiences in other jurisdictions. Setting up a permanent collection program entails initial planning and infrastructure costs, and ongoing costs for program administration, and transport and final disposal of collected drugs. Advertising costs vary widely, as they depend on the preferences and needs of each particular jurisdiction. The over $600,000 annual value of a disposal program to Santa Barbara County exceeds the $200,000 spent by the Washington State pilot, which includes one-time set-up costs. It also exceeds the cost of collection at police stations in San Mateo County. It significantly exceeds the costs of any of the collection events in Table 12, with the exception of the San Francisco Bay Area event, which had high advertising costs. The annual value to Santa Barbara County residents is twice the one-time expected cost of $300,000 to establish a mail-back program in the state of Maine.

In addition to public support for a disposal program, our recommendations hinge on both the regulatory and political environment. Regulations of controlled substances present a major barrier to implementing a comprehensive collection program. Controlled substances are strictly regulated by the DEA and only law enforcement officials are legally permitted to handle them once they have been dispensed to the end-user. To comply with controlled substance regulations, a disposal program can refuse to accept controlled substances, involve law enforcement officials, or apply for an exemption from the DEA.

Table 12: Reported costs for existing programs.

Program	Description	Costs	Reference
Permanent collection program			
San Mateo County	Collection at police stations and Sheriff's department	$924 in four months for disposal	Gordon 2007
Washington State	Collection at seven pharmacies in five counties	$200,000 total in in-kind set-up and planning costs as of February 2007, five months after implementation; pilot containers $600 each	Johnson 2007
Collection event			
San Francisco Bay Area	Regional event at 39 pharmacies	Staff time: 1980 hours; disposal: $3,645; advertising: $86,360	BAPPG 2006
Montague, Massachusetts	At senior center; open to 25 towns	Total: $2447 Staff time: $1880; hazardous waste disposal: $450 ($150 for disposal and $300 for transportation); outreach: $112	Rubinstein 2006
Wilbraham, Massachusetts	With regional hazardous waste event; four town event	Total: $2380 Staff time: $1605; hazardous waste and sharps disposal: $475; tent rental: $300	Rubinstein 2006
Wolfeboro, New Hampshire	With permanent household waste collection; open to 27 towns	Total: $1576 Staff time: $1378; hazardous waste disposal: $138; copying and supplies: $60	Rubinstein 2006
South Portland, Maine	Regional event at pharmacy	Total: $4190 Staff time: $1965; hazardous waste disposal: $1150 ($900 for disposal and $250 for transportation); advertising: $1075	Rubinstein 2006
Rutland County, Vermont	County wide event with a blood drive at a mall	Total: $3603 Staff time: $2451; disposal: $742 ($517 for disposal and $225 for transportation); advertising: $975	Rubinstein 2006
Mail-back			
Maine	Proposed legislation to provide funds for the Maine Drug Enforcement Agency to set up a mail-back program for the public	One time appropriation of $300,000 from the General Fund	Bill LD 411

Ideally, we would recommend a permanent disposal program that easily allows for the collection of both controlled and non-controlled dugs in drop-off boxes located at pharmacies. Pharmacies are a logical and convenient location for residents due to there numerous locations, hours of operation, and contact with end-users. This disposal program would be funded by manufacturers, as they should share in the stewardship of their products. Pharmaceutical manufacturers fund pharmaceutical take-back programs in some European countries (NWPSC 2007) as well as in British Columbia, Canada, where manufacturers are required to take cradle-to-cradle responsibility for their products (TDC Environmental 2004). In order to make this program easy to implement, the DEA would need to change its regulations to allow for the collection of controlled substances in the same drop-off boxes as non-controlled substances. A program that only allows for the collection of non-controlled substances is incomplete and creates confusion among residents and administrators. Current DEA regulations of controlled substances do not take into account the need for disposal of pharmaceuticals; regulations assume that once a controlled substance passes to the end-user, it is in effect consumed, closing its life cycle.

The ideal program is not a realistic one at present though. Such sweeping changes in the way we think about pharmaceutical disposal will take a while to effect, and the effort required to effect those changes exceed the resources of the County. It should be noted though that current legislation in the California Senate is on the right track to providing a solution for the collection of pharmaceuticals, though it has some drawbacks. The proposed legislation would require every retailer of pharmaceutical drugs to implement a drug collection program (SB 966, proposed February 2007). This bill may be intended mainly to generate awareness, as a bill requiring every retailer to fund and implement collection is not likely to pass. Such a law would cause undue burden to retailers. The bill also does not take into account controlled substances. This bill should be modified to allow for the collection of controlled substances and to place some of financial responsibility for collection with manufacturers.

Because the successful implementation of a permanent disposal program is constrained by regulatory and political barriers, we have outlined a range of program options for the County. The options presented below are ordered from the most recommended, but also the most difficult to implement option, to a minimum recommendation, which would be easier to implement but not ideal.

Option A. Apply for a DEA exemption for drop-off box collection

We recommend the permanent collection of both controlled and non-controlled medications in drop-off boxes that are convenient for end-users, namely, at pharmacies. In order for this program to work, the County needs to apply for an exemption from the DEA, though such an exemption is unprecedented and it is uncertain whether the DEA would grant it. For example, the DEA could grant an exemption for a reverse distributor to service the drop-off boxes, which is desirable because reverse distributors are already trained to recognize, sort, and handle drugs. Appendix E lists reverse distributors that service institutions surveyed in Santa Barbara County. Reverse distributors could then destroy the waste via hazardous waste incineration, which is the ultimate destruction

method currently considered to be the best option to remove these active compounds from the environment. The Washington State pilot program, which currently collects unwanted pharmaceuticals at seven locations in five counties, plans to submit a protocol and waiver to the DEA for an exemption (Johnson 2007).

Though there are no examples of a permanent collection program that also takes back controlled substances without the involvement of enforcement officials, there are examples of collection programs in place that exclude controlled substances. A collection program at pharmacies may be held in conjunction with collection of controlled substances at the Sheriff's Department, such as in Clark County, Wash. There may be challenges in finding costly and appropriate collection containers and personnel to service the boxes, as the Washington State pilot program has experienced.

Option B. Collection at police stations

Another solution for a permanent collection program that includes controlled substances is collection at police stations. The collection program at police stations in San Mateo County provides a good example as it has been very successful and has not encountered major implementation barriers. The program is fairly low cost; the only cost it incurs is for the disposal of the drugs by a licensed hazardous waste collector (Table 12). Residents drop off unwanted medications in white painted mailboxes donated by the U.S. Postal Service, and the police sort the drugs and take them to a central location on their regular route, the correctional facility.

In Santa Barbara County, law enforcement officials have serviced drug disposal drop-off boxes as part of a "trash your stash" program intended to control substance abuse (TYS 2007). Community members can voluntarily dispose of legal and illicit drugs and narcotics in tamper proof, secure depositories (TYS 2007). In the City of Santa Barbara, the tedious process of sorting drugs and the unintended use of boxes for disposal of sharps posed administration challenges, causing the police department to consider discontinuing the program (Robinson 2007a). While this program does allow for drug disposal, it is not in place at the scale necessary for a county-wide residential pharmaceutical disposal program, as the boxes are both small in size and limited in location. And while the location of drop-off boxes outside for the anonymous disposal of drugs has the benefit of controlling substance abuse, it may result in unintentional, administratively burdensome uses of drop-off boxes.

If the County of Santa Barbara chooses to explore this option, we recommend that the County approach law enforcement officials in order to gauge their willingness to cooperate in a drug collection program.

Option C. Continue collection at hazardous waste facilities

A number of hazardous waste centers throughout the country accept unwanted medications. For example, hazardous waste centers in Los Angeles County accept non-controlled substances (LACSD 2007). In general, residents should contact their local

hazardous waste center for information. As discussed above, the Recycling Resource Guide for Santa Barbara County lists two hazardous waste facilities for residents to return unwanted medications (CSBPW 2005). While the City of Lompoc Household Hazardous Waste Collection Facility collects medications, the workers at the Community Hazardous Waste Collection Center on campus at UCSB do not encourage residents to bring in unwanted medications due to liability concerns (Carter 2007b). A third hazardous waste center exists in the City of Santa Maria.

This option is not ideal as collection at hazardous waste facilities is not as convenient for residents as pharmacies. In contrast to pharmacies, however, the infrastructure for collection and hazardous waste incineration is already in place at hazardous waste facilities. As the authors have not found any reported problems with pharmaceutical collection by hazardous waste facilities in the County in the past, these facilities should not discourage residents from bringing in their uncontrolled medications. If hazardous waste centers are the main collection location, more forthright advertising is advocated.

Option D. Special collection events

At a minimum, Santa Barbara County should hold special collection events. These events may be held in conjunction with other hazardous waste or electronic waste collection events. The County currently includes pharmaceuticals at its one day collection events in Santa Ynez and New Cuyama. Although less then ideal because they are not as convenient as a permanent disposal program, collection events would allow residents to get rid of their unwanted medications and have the added benefit of educating consumers about the environmental and safety issues associated with pharmaceutical disposal.

There are a number of examples of collection events. The Northeast Recycling Council, Inc. held eight pilot collection events as part of its project to develop effective and legal guidelines for the collection and destruction of pharmaceuticals from the public (Rubinstein 2006). It published a useful guide for holding collection events. Law enforcement officials were hired for these events so that controlled substances could be collected; a similar setup could be employed in Santa Barbara. Another example is the regional collection event held in the San Francisco Bay Area. The event was a huge success: 1,500 residents disposed of 3,634 lbs of pharmaceutical waste at 39 pharmacies (BAPPG 2006). A complete summary of this collection event is available (BAPPG 2006). The costs associated with these pilot collection events are included in Table 12.

RECOMMENDED FUTURE RESEARCH

Survey Studies

In the end-user survey, we surprisingly observed that respondents who were aware of pharmaceuticals in water were less likely to say “yes” to a surcharge. It would be useful to know why they responded yes. This could be determined by asking a question where the respondent ranks the priority of different environmental issues. It would also be

interesting to determine whether respondents said "no" to a disposal surcharge because they feel it is the manufacturer's responsibility.

Further research could also be conducted with the institutions, particularly regarding the amount of drugs available for a recycling program. If the County feels compelled, it could monitor institutions for the amount and types of drugs that would be appropriate for a drug recycling program. This would allow it to assess the amount available, as well as if the donations match the needs of low-income patients.

Scientific Studies

There are many data gaps regarding the issue of pharmaceuticals in the environment. Two specific research areas are highlighted in this section. First, the body of knowledge lacks any study attempting to determine the possible cumulative, antagonistic, or synergistic effects of chronic exposure to the existing "cocktail" of pharmaceuticals and their metabolites. Though ecological and environmental effects have already been shown, it seems likely that many government agencies are hesitant to impose expensive regulations without some proof of adverse human effects.

The second main unknown is the actual contribution of different means of entry (e.g., excretion, disposal, and manufacturing) to the overall quantity of pharmaceuticals entering the environment. While many researchers claim that the majority of pharmaceuticals entering the environment are from excretion, these claims are based on intuition rather than empirical evidence. It is known, though, that compliance to prescription medication regimens is suboptimal: the average compliance rate is about 50 percent (Wright 1993; Boudes 1998; Vrijens & Urquhart 2005). This lack of compliance represents one source of unused medications that may find their way into surface and ground water. Regardless of the contribution between excretion and disposal, education and take-back programs are relatively easy and quickly implemented at low cost, and provide the added benefits of reducing opportunities for misuse of stored drugs. Tackling excretion necessitates intervention at the water treatment level at wastewater treatment plants (WWTPs), which involves larger and more expensive infrastructure changes.

Chronic effects research

Research on the possible effects of chronic exposure to the mix of pharmaceuticals in ground and surface waters could be conducted. The study would need to be designed to withstand scrutiny from special interest or industry groups, as well as government agencies. The concentrations and combinations studied should be relevant to likely environmental exposure. This would likely be a time and money intensive study.

Contribution study

A rigorous program of water sampling could determine the main sources of pharmaceuticals and pharmaceutical by-products entering the environment. This knowledge is necessary for authorities and stakeholders to determine where intervention should occur and the most cost-effective program to address this problem. The sampling could be designed to reveal, for instance, the relative contributions of excretion and

disposal to the overall quantities present. The data could also show spatial and temporal variations in quantities. The proportions attributable to households, industry, and institutions could be determined from testing data.

With public pressure and knowledge from research facilitating the decision making process, the best solution could be determined to address the problem. If the majority of pharmaceutical compounds present in ground and surface waters are found to be the result of excretion, then the WWTPs will likely be the best candidate for intervention. Treatment at WWTPs is infrastructure intensive, and can take many forms. Additional processes that are not currently standard practice would need to be added to wastewater treatment in order to remove pharmaceuticals and their metabolites. These processes include but are not limited to: activated carbon, ozonation, ultraviolet (UV) light irradiation, filtration, and membranes. For detailed summaries of many of these processes see Snyder (2003).

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APPENDIX A: WHITE HOUSE PHARMACEUTICAL DISPOSAL RECOMMENDATIONS

Federal Guidelines:

- Take unused, unneeded, or expired prescription drugs out of their original containers and throw them in the trash.
- Mixing prescription drugs with an undesirable substance, such as used coffee grounds or kitty litter, and putting them in impermeable, non-descript containers, such as empty cans or sealable bags, will further ensure the drugs are not diverted.
- Flush prescription drugs down the toilet *only* if the label or accompanying patient information specifically instructs doing so.
- Take advantage of community pharmaceutical take-back programs that allow the public to bring unused drugs to a central location for proper disposal. Some communities have pharmaceutical take-back programs or community solid-waste programs that allow the public to bring unused drugs to a central location for proper disposal. Where these exist, they are a good way to dispose of unused pharmaceuticals.

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APPENDIX B: COPIES OF THE INSTITUTIONAL SURVEY INSTRUMENTS

Pharmacy Survey Form

	PHARMACY Survey Form	**Facility I.D.:**
	Screening Question: With whom is the appropriate person to discuss your facility's pharmaceutical waste disposal practices [if necessary: for example, gathering/collecting pharmaceutical waste, storing/securing pharmaceutical waste, disposing of pharmaceutical waste]? Contact information: ▪ Name ▪ Title ▪ Phone number	NAME: _____ TITLE: _____ PHONE: _____ EMAIL: _____
	Start of survey:	

Hello! My name is _____. I am a **graduate student at UC Santa Barbara** conducting research on pharmaceutical waste and disposal practices. I am conducting a brief survey, and I'm hoping that you will be willing to assist by answering a few questions. Could you spare a few minutes? [Be ready to respond with time estimate.]

Thank you! In these questions, when I say "pharmaceutical," I mean: any substance, whether in pill, liquid or other form, that contains prescription or over-the-counter medication. Also, when I say "disposal," I mean: any route by which an unusable pharmaceutical leaves your facility.

[*The purpose of the survey is to learn how institutions deal with waste or unusable pharmaceuticals. Your information will help us identify common disposal practices and summarize ways the disposal process could be more efficient. We will publish a report online and present it to the County, as a resource to help institutions like yours determine the most efficient method of pharmaceutical waste disposal.*]

Q1	Do you have a protocol for pharmaceutical disposal procedures?	YES NO
Q2	Do you have a separate protocol for controlled substances?	YES NO
Q3	Of the following options, how are employees informed of this protocol? Please indicate yes or no for each option. [Check all that apply.]	❑ Posted in a visible location ❑ Handbook ❑ Staff training ❑ Other _____ ❑ No set procedure
Q4	How is your facility informed of pharmaceutical disposal regulations?	
Q5	Do you keep records to track pharmaceutical disposal?	YES NO
Q6	Please rank how often your facility uses the following disposal routes. Answer on a scale of 1-5, where 1 is "never" and 5 is "very frequently".	a) Reverse distributor or return's company 1 2 3 4 5 b) Direct return to manufacturer 1 2 3 4 5 c) Trash 1 2 3 4 5

		d) Drain or other plumbing 1 2 3 4 5 e) Biohazard 1 2 3 4 5 g) Hazardous waste facility or service 1 2 3 4 5 h) Other significant route? 1 2 3 4 5
Q6-1	**[If reverse distributor used]** What is the name of the reverse distributor your facility uses?	
Q6-2	**[If hazardous waste facility used]** What is the name of the hazardous waste facility or service your hospital uses?	
Q7	On average, what is your best estimate of the percentage of your pharmaceutical stock that ends of being disposed of?	

Q8	Please rank the following reasons for having pharmaceutical waste at your facility. Please answer on a scale of 1-5, where 1 is "not an important reason" and 5 is "very important reason".	a) Expired 1 2 3 4 5 c) Overstock 1 2 3 4 5 e) Quality compromised 1 2 3 4 5 f) Prescription not picked up 1 2 3 4
Q9	Do customers ever ask about how to properly dispose of their own medication?	YES NO
Q9-1 Q9-2	[If yes] Of the following options, which disposal method do you usually recommend? [If no] Of the following options, which disposal method would you usually recommend? [Check all that apply.]	❑ Trash ❑ Drain ❑ Hazardous waste facility ❑ Return to a pharmacy ❑ Other: _____ ❑ No advice given [do not say]

	[Paragraph describing goals of a recycling program] California passed legislation last winter that allows California Counties to initiate a drug recycling program. This program would allow the donation of unexpired, unopened medications from licensed medical providers for redistribution to low-income community members. (County administered).	
Q10	Would your facility have unused and unopened pharmaceuticals that would be appropriate for a drug recycling program?	YES NO
Q10-1	[If yes] Of these unopened, unexpired pharmaceuticals, how likely is it that your facility would have each of the following pharmaceutical types to donate? Answer on scale of 1-5, where 1 is "never" and 5 is "very likely."	a) Painkillers **1 2 3 4 5** b) Antibiotics **1 2 3 4 5** c) Beta-blockers **1 2 3 4 5** d) Antiepileptics **1 2 3 4 5** e) Lipid regulators **1 2 3 4 5**
		f) Antidepressants **1 2 3 4 5** g) Hormone treatments **1 2 3 4 5** h) Antihistamines **1 2 3 4 5**
Q11	Are you aware that pharmaceutical compounds have been found in treated wastewaters or surface waters? Yes or no.	YES NO
Q12	Do you think this issue is an environmental concern?	YES NO
Q13	One possible way to address this concern is for Santa Barbara County to administer a pharmaceutical disposal program for community members. Would your facility consider housing a disposal drop-off box?	YES NO

Thanks!

Hospital Survey Form

	HOSPITAL Survey Form	**Facility I.D.:**
	Screening Question:	
	With whom is the appropriate person to discuss your facility's pharmaceutical waste disposal practices [if necessary: for example, gathering/collecting pharmaceutical waste, storing/securing pharmaceutical waste, disposing of pharmaceutical waste]? Contact information: ▪ Name ▪ Title ▪ Phone number	NAME: _____ TITLE: _____ PHONE: _____ EMAIL: _____
	Start of survey:	

Hello! My name is_____. I am a **graduate student at UC Santa Barbara** conducting research on pharmaceutical waste and disposal practices. I am conducting a brief survey, and I'm hoping that you will be willing to assist by answering a few questions. Could you spare a few minutes? [Be ready to respond with time estimate.]

Thank you! In these questions, when I say "pharmaceutical," I mean: any substance, whether in pill, liquid or other form, that contains prescription or over-the-counter medication. Also, when I say "disposal," I mean: any route by which an unusable pharmaceutical leaves your facility.

[*The purpose of the survey is to learn how institutions deal with waste or unusable pharmaceuticals. Your information will help us identify common disposal practices and summarize ways the disposal process could be more efficient. We will publish a report online and present it to the County, as a resource to help institutions like yours determine the most efficient method of pharmaceutical waste disposal.*]

Q1	Do you have a protocol for pharmaceutical disposal procedures?	YES NO
Q2	Do you have a separate protocol for controlled substances?	YES NO
Q3	Of the following options, how are employees informed of this protocol? Please indicate yes or no for each option. [Check all that apply.]	❑ Posted in a visible location ❑ Handbook ❑ Staff training ❑ Other_____ ❑ No set procedure
Q4	How is your facility informed of pharmaceutical disposal regulations?	
Q5	Do you keep records to track pharmaceutical disposal?	YES NO
Q6	Please rank how often your facility uses the following disposal routes. Answer on a scale of 1-5, where 1 is "never" and 5 is "very frequently".	a) Reverse distributor or return's company **1 2 3 4 5** b) Direct return to manufacturer **1 2 3 4 5** c) Trash **1 2 3 4 5**

		d) Drain or other plumbing **1 2 3 4 5** e) Biohazard **1 2 3 4 5** f) In-house incinerator **1 2 3 4 5** g) Hazardous waste facility or service **1 2 3 4 5** h) Other significant route? **1 2 3 4 5**
Q6-1	**[If reverse distributor used]** What is the name of the reverse distributor your facility uses?	
Q6-2	**[If hazardous waste facility used]** What is the name of the hazardous waste facility or service your hospital uses?	
Q7	On average, what is your best estimate of the percentage of your pharmaceutical stock that ends of being disposed of?	

Q8	Please rank the following reasons for having pharmaceutical waste at your facility. Please answer on a scale of 1-5, where 1 is "not an important reason" and 5 is "very important reason".	a) Expired **1 2 3 4 5** b) Death of patient **1 2 3 4 5** c) Overstock **1 2 3 4 5** d) Dose unfinished (i.e. for meds administered in liquid-form) **1 2 3 4 5** e) Quality compromised **1 2 3 4 5**
Q9	Do patients ever ask about how to properly dispose of their own medication?	YES NO

Q9-1 **Q9-2**	**[If yes]** Of the following options, which disposal method do you usually recommend? **[If no]** Of the following options, which disposal method would you usually recommend? [Check all that apply.]	❑ Trash ❑ Drain ❑ Hazardous waste facility ❑ Return to a pharmacy ❑ Other:_____ ❑ No advice given [do not say]
	[Paragraph describing goals of a recycling program] California passed legislation last winter that allows California Counties to initiate a drug recycling program. A drug recycling program would allow the donation of unexpired, unopened medications from licensed medical providers for redistribution to low-income community members. (County administered).	
Q10	Would your facility have unused and unopened pharmaceuticals that would be appropriate for a drug recycling program?	YES NO
Q10.1	**[If yes]** Of these unopened, unexpired pharmaceuticals, how likely is it that your facility would have each of the following pharmaceutical types to donate to a drug recycling program? Answer on scale of 1-5, where 1 is "never" and 5 is "very likely."	a) Painkillers **1 2 3 4 5** b) Antibiotics **1 2 3 4 5** c) Beta-blockers **1 2 3 4 5** d) Antiepileptics **1 2 3 4 5**
		e) Lipid regulators **1 2 3 4 5** f) Antidepressants **1 2 3 4 5** g) Hormone treatments **1 2 3 4 5** h) Antihistamines **1 2 3 4 5**
Q11	Are you aware that pharmaceutical compounds have been found in treated wastewaters or surface waters? Yes or no.	YES NO
Q12	Do you think this issue is an environmental concern?	YES NO
Q13	One possible way to address this concern is for Santa Barbara County to administer a pharmaceutical disposal program for community members. Would your facility consider housing a disposal drop-off box?	YES NO

Thanks!

Nursing Home Survey Form

	NURSING HOME Survey Form	**Facility ID:**
	Screening Question: With whom is the appropriate person to discuss your facility's pharmaceutical waste disposal practices [if necessary: for example, gathering/collecting pharmaceutical waste, storing/securing pharmaceutical waste, disposing of pharmaceutical waste]? Contact information: ▪ Name ▪ Title ▪ Phone number	NAME: _____ TITLE: _____ PHONE:_____ EMAIL:_____ Is there a specific person I can ask some questions I have about disposal of pharmaceuticals at your facility?
	Start of survey:	

Hello! My name is _____. I am a **graduate student at UC Santa Barbara** conducting research on pharmaceutical waste and disposal practices. I am conducting a brief survey, and I'm hoping that you will be willing to assist by answering a few questions. Could you spare a few minutes? [Be ready to respond with time estimate.]

Thank you! In these questions, when I say "pharmaceutical," I mean: any substance, whether in pill, liquid or other form, that contains prescription or over-the-counter medication. Also, when I say "disposal," I mean: any route by which an unusable pharmaceutical leaves your facility.

[*The purpose of the survey is to learn how institutions deal with waste or unusable pharmaceuticals. Your information will help us identify common disposal practices and summarize ways the disposal process could be more efficient. We will publish a report online and present it to the County, as a resource to help institutions like yours determine the most efficient method of pharmaceutical waste disposal.*]

Q1	Do you have a protocol for pharmaceutical disposal procedures?	YES NO
Q2	Do you have a separate protocol for controlled substances?	YES NO

Q3	Of the following options, how are employees informed of this protocol? Please indicate yes or no for each option. [Check all that apply.]	❑ Posted in a visible location ❑ Handbook ❑ Staff training ❑ Other_____ ❑ No set procedure
Q4	How is your facility informed of pharmaceutical disposal regulations?	
Q5	Do you keep records to track pharmaceutical disposal?	YES NO
Q6	Please rank how often your facility uses the following disposal routes. Answer on a scale of 1-5, where 1 is "never" and 5 is "very frequently".	a) Reverse distributor or return's company **1 2 3 4 5** b) Direct return to manufacturer **1 2 3 4 5** c) Trash **1 2 3 4 5** d) Drain or other plumbing **1 2 3 4 5**

		e) Biohazard 1 2 3 4 5 g) Hazardous waste facility or service 1 2 3 4 5 h) Other significant route? 1 2 3 4 5
Q6a	**[If reverse distributor used]** What is the name of the reverse distributor your facility uses?	
Q6b	**[If hazardous waste facility used]** What is the name of the hazardous waste facility or service your facility uses?	
Q7	On average, what is your best estimate of the percentage of your pharmaceutical stock that ends of being disposed of?	

Q8	Please rank the following reasons for having pharmaceutical waste at your facility. Please answer on a scale of 1-5, where 1 is "not an important	a) Expired 1 2 3 4 5
	reason" and 5 is "very important reason".	b) Death of resident 1 2 3 4 5 c) Overstock 1 2 3 4 5 d) Resident's prescription not finished 1 2 3 4 5 e) Quality compromised 1 2 3 4 5
Q9	Do residents ever ask about how to properly dispose of their own medication?	YES NO
Q9-1 Q9-2	**[If yes]** Of the following options, which disposal method do you usually recommend? **[If no]** Of the following options, which disposal method would you usually recommend? [Check all that apply.]	❑ Trash ❑ Drain ❑ Hazardous waste facility ❑ Return to a pharmacy ❑ Other:_____ ❑ No advice given [do not say]
	[Paragraph describing goals of a recycling program] California passed legislation last winter that allows California Counties to initiate a drug recycling program. This program would allow the donation of unexpired, unopened medications from licensed medical providers for redistribution to low-income	

	community members. (County administered).	
Q10	Would your facility have unused and unopened pharmaceuticals that would be appropriate for a drug recycling program?	YES NO
Q10-1	[If yes] Of these unopened, unexpired pharmaceuticals, how likely is it that your facility would have each of the following pharmaceutical types to donate to a drug recycling program? Answer on scale of 1-5, where 1 is "never" and 5 is "very likely."	a) Painkillers 1 2 3 4 5 b) Antibiotics 1 2 3 4 5 c) Beta-blockers 1 2 3 4 5 d) Antiepileptics 1 2 3 4 5 e) Lipid regulators 1 2 3 4 5 f) Antidepressants 1 2 3 4 5
		g) Hormone treatments 1 2 3 4 5 h) Antihistamines 1 2 3 4 5
Q11	Are you aware that pharmaceutical compounds have been found in treated wastewaters and surface waters? Yes or no.	YES NO
Q12	Do you think this issue is an environmental concern?	YES NO
Q14	Of the following options, whose responsibility do you think it should be to address this issue?	❑ Manufacturers ❑ Facilities that dispense pharmaceuticals ❑ Government ❑ Other_____ ❑ Not an issue
Q15	Do you have any additional comments or thoughts that you would like to share with us about these topics?	

Thanks!

Hospice Survey Form

	HOSPICE Survey Form	**Facility ID:**
	Screening Question:	
	With whom is the appropriate person to discuss your facility's pharmaceutical waste disposal practices [if necessary: for example, gathering/collecting pharmaceutical waste, storing/securing pharmaceutical waste, disposing of pharmaceutical waste]? Contact information: ▪ Name ▪ Title ▪ Phone number	NAME: _____ TITLE: _____ PHONE: _____ EMAIL: _____
	Start of survey:	

Hello! My name is _____. I am a **graduate student at UC Santa Barbara** conducting research on pharmaceutical waste and disposal practices. I am conducting a brief survey, and I'm hoping that you will be willing to assist by answering a few questions. Could you spare a few minutes? [Be ready to respond with time estimate.]

Thank you! In these questions, when I say "pharmaceutical," I mean: any substance, whether in pill, liquid or other form, that contains prescription or over-the-counter medication. Also, when I say "disposal," I mean: any route by which an unusable pharmaceutical leaves your facility.

[*The purpose of the survey is to learn how institutions deal with waste or unusable pharmaceuticals. Your information will help us identify common disposal practices and summarize ways the disposal process could be more efficient. We will publish a report online and present it to the County, as a resource to help institutions like yours determine the most efficient method of pharmaceutical waste disposal.*]

Q0	Do you care for patients in your own facility, at the patient homes or both?	❑ Own facility ❑ Patient In-home care ❑ Both
Q1	Do you have a protocol for pharmaceutical disposal procedures?	YES NO
Q2	Do you have a separate protocol for controlled substances?	YES NO
Q3	Of the following options, how are employees informed of this protocol? Please indicate yes or no for each option. [Check all that apply.]	❑ Posted in a visible location (1) ❑ Handbook (2) ❑ Staff training (3) ❑ Other (4)_____ ❑ No set procedure (5)
Q4	How is your facility informed of pharmaceutical disposal regulations?	
Q5	Do you keep records to track pharmaceutical disposal?	YES NO
Q6	Please rank how often your facility uses the following disposal routes. Answer on a scale of 1-5, where 1 is "never" and 5 is "very frequently".	a) Reverse distributor or return's company 1 2 3 4 5 b) Direct return to manufacturer 1 2 3 4 5 c) Trash 1 2 3 4 5

		d) Drain or other plumbing 1 2 3 4 5 e) Biohazard 1 2 3 4 5 g) Hazardous waste facility or service 1 2 3 4 5 h) Other significant route? 1 2 3 4 5
Q6-1	**[If reverse distributor used]** What is the name of the reverse distributor your facility uses?	
Q6-2	**[If hazardous waste facility used]** What is the name of the hazardous waste facility or service your facility uses?	
Q7	On average, what is your best estimate of the percentage of your pharmaceutical stock that ends of being disposed of?	
Q8	Please rank the following reasons for having pharmaceutical waste at your facility. Please answer on a scale of 1-5, where 1 is "not an important reason" and 5 is "very important reason".	a) Expired 1 2 3 4 5 b) Death of patient 1 2 3 4 5 c) Overstock 1 2 3 4 5 d) Dose unfinished (i.e. for meds administered in liquid-form) 1 2 3 4 5 e) Quality compromised 1 2 3 4 5
Q9	Do patients ever ask about how to properly dispose of their own medication?	YES NO
Q9-1 Q9-2	**[If yes]** Of the following options, which disposal method do you usually recommend? **[If no]** Of the following options, which disposal method would you usually recommend? [Check all that apply.]	❑ Trash ❑ Drain ❑ Hazardous waste facility ❑ Return to a pharmacy ❑ Other: _____ ❑ No advice given [do not say]

	[Paragraph describing goals of a recycling program] California passed legislation last winter that allows California Counties to initiate a drug recycling program. This program would allow the donation of unexpired, unopened medications from licensed medical providers for redistribution to low-income community members. (County administered).	
Q10	Would your facility have unused and unopened pharmaceuticals that would be appropriate for a drug recycling program?	YES NO
Q10-1	**[If yes]** Of these unopened, unexpired pharmaceuticals, how likely is it that your facility would have each of the following pharmaceutical types to donate to a drug recycling program? Answer on scale of 1-5, where 1 is "never" and 5 is "very likely."	a) Painkillers **1 2 3 4 5** b) Antibiotics **1 2 3 4 5** c) Beta-blockers **1 2 3 4 5** d) Antiepileptics **1 2 3 4 5** e) Lipid regulators **1 2 3 4 5** f) Antidepressants **1 2 3 4 5**
		g) Hormone treatments **1 2 3 4 5** h) Antihistamines **1 2 3 4 5**
Q11	Are you aware that pharmaceutical compounds have been found in treated wastewaters and surface waters? Yes or no.	YES NO
Q12	Do you think this issue is an environmental concern?	YES NO
Q14	Of the following options, whose responsibility do you think it should be to address this issue?	❑ Manufacturers ❑ Facilities that dispense pharmaceuticals ❑ Government ❑ Other _____ ❑ Not an issue
Q15	Do you have any additional comments or thoughts that you would like to share with us about these topics?	

Thanks!

APPENDIX C: CENTRAL COAST SURVEY: SURVEY INSTRUMENT

PRESCR6 . And can I verify that you live in Santa Barbara/Ventura County?
¿Puedo verificar que usted vive en el condado de Santa Barbara/Ventura?

Santa Barbara County resident
Ventura County resident

Approximately 55 questions precede the next section in the survey.
The full report is available to download in pdf form free of charge from:
http://www.survey.ucsb.edu/central-coast-survey/

PHA1
Have you taken any over-the-counter or prescription medicines in the past 24 hours?
¿Ha tomado algún medicamento de venta bajo receta o de venta libre en las últimas 24 horas?

Yes
No
Don't know
Refused

PHA2
How do you typically get rid of unwanted or expired prescription or over-the-counter medicines in your household?
¿Típicamente cómo descarta usted los medicamentos recetados o de venta libre no deseados o vencidos?

Yes
No
Don't know
Refused

PHA3
Are you aware that medicinal compounds have been found in treated wastewater and surface water?
¿Está usted enterado de que se han encontrado compuestos medicinales en agua reclamada y en las aguas superficiales?

Yes
No
Don't know
Refused

PHA4_1
The presence of medicines in surface waters is a growing environmental concern. To address this concern, there is currently a proposal to add a surcharge to prescription medication to fund a national disposal program. To implement this program, would you be willing to pay $.05 per prescription you purchase?
La presencia de medicinas en la superficie del agua es una preocupación ambiental en aumento. En respuesta a esta preocupación, actualmente existe una propuesta de agregar un recargo a los medicamentos de venta bajo receta para costear un programa nacional de eliminación de desechos. Para implementar este programa, ¿Estaría usted dispuesto a pagar $.05 por cada medicamento que compre?

Yes
No
Don't know
Refused

PHA4_2
The presence of medicines in surface waters is a growing environmental concern. To address this concern, there is currently a proposal to add a surcharge to prescription medication to fund a national disposal program. To implement this program, would you be willing to pay $.10 per prescription you purchase?
La presencia de medicinas en la superficie del agua es una preocupación ambiental en aumento. En respuesta a esta preocupación, actualmente existe una propuesta de agregar un recargo a los medicamentos de venta bajo receta para costear un programa nacional de eliminación de desechos. Para implementar este programa, ¿Estaría usted dispuesto a pagar $.10 por cada medicamento que compre?

Yes
No
Don't know
Refused

PHA4_3
The presence of medicines in surface waters is a growing environmental concern. To address this concern, there is currently a proposal to add a surcharge to prescription medication to fund a national disposal program. To implement this program, would you be willing to pay $.25 per prescription you purchase?
La presencia de medicinas en la superficie del agua es una preocupación ambiental en aumento. En respuesta a esta preocupación, actualmente existe una propuesta de agregar un recargo a los medicamentos de venta bajo receta para costear un programa nacional de eliminación de desechos. Para implementar este programa, ¿Estaría usted dispuesto a pagar $.25 por cada medicamento que compre?

Yes
No
Don't know
Refused

PHA4_4
The presence of medicines in surface waters is a growing environmental concern. To address this concern, there is currently a proposal to add a surcharge to prescription medication to fund a national disposal program. To implement this program, would you be willing to pay $.50 per prescription you purchase?
La presencia de medicinas en la superficie del agua es una preocupación ambiental en aumento. En respuesta a esta preocupación, actualmente existe una propuesta de agregar un recargo a los medicamentos de venta bajo receta para costear un programa nacional de eliminación de desechos. Para implementar este programa, ¿Estaría usted dispuesto a pagar $.50 por cada medicamento que compre?

Yes
No
Don't know
Refused

PHA4_5
The presence of medicines in surface waters is a growing environmental concern.

To address this concern, there is currently a proposal to add a surcharge to prescription medication to fund a national disposal program. To implement this program, would you be willing to pay $1.00 per prescription you purchase?
La presencia de medicinas en la superficie del agua es una preocupación ambiental en aumento. En respuesta a esta preocupación, actualmente existe una propuesta de agregar un recargo a los medicamentos de venta bajo receta para costear un programa nacional de eliminación de desechos. Para implementar este programa, ¿Estaría usted dispuesto a pagar $1.00 por cada medicamento que compre?

Yes
No
Don't know
Refused

PHA4_6
The presence of medicines in surface waters is a growing environmental concern. To address this concern, there is currently a proposal to add a surcharge to prescription medication to fund a national disposal program. To implement this program, would you be willing to pay $1.50 per prescription you purchase?
La presencia de medicinas en la superficie del agua es una preocupación ambiental en aumento. En respuesta a esta preocupación, actualmente existe una propuesta de agregar un recargo a los medicamentos de venta bajo receta para costear un programa nacional de eliminación de desechos. Para implementar este programa, ¿Estaría usted dispuesto a pagar $1.50 por cada medicamento que compre?

Yes
No
Don't know
Refused

PHA5
If a disposal program was implemented at local pharmacies, how likely would you be to return unwanted or expired medicines to your pharmacy for disposal? Please indicate your likeliness on a scale of 1 to 5, where 1 is very unlikely and 5 is very likely.
Si un programa de eliminación de desechos fuera implementado en las farmacias locales, cuán probable sería que usted devolviera a su farmacia los medicamentos no deseados o vencidos para que sean desechados? Por favor indique su preferencia en la escala del 1 al 5, donde 1 es muy improbable y 5 es muy probable.

Yes
No
Don't know
Refused

DINTRO
Finally, we have a few questions just for confidential classification purposes.
Finalmente tenemos algunas preguntas confidenciales con motivos de clasificación solamente.

D_3
For classification purposes only: what is the zip code where you live?
Sólo para el propósito de clasificación: ¿cuál es su código postal?

D_4
How long have you lived in Santa Barbara/Ventura County?

¿ Por cuánto tiempo ha vivido en el condado de Santa Barbara/Ventura County?

Less than 1 year
1 to 4 years
5 to 10 years
11 to 20 years
21 years or more
Don't know
Refused

D_5
What is your age?
¿Qué edad tiene usted?

D_5P
We really just need this for classification purposes. Could you tell us instead which of the following age groups you belong to?
Lo siguiente es con motivo de clasificación solamente. ¿Nos podría decir a qué grupo de las siguientes edades pertenece?

18 to 24 years
25 to 34 years
35 to 44 years
45 to 54 years
55 to 59 years
60 to 64 years
65 to 69 years
70 to 79 years
80 years and older
Don't know
Refused

D_6
Which of the following best describes your ethnic group?
De los siguientes grupos, ¿cuál describe mejor su grupo étnico?

White or Caucasian
Latino
Native American
African American
Asian
Multi-racial
Other [SPECIFY]
Don't know
Refuse

D_H2
Including yourself, how many people live in your household?
Incluyendo a usted mismo, ¿cuántas personas viven en su casa?

D_H3
How many of these people are NOT related to you? Note that related includes blood relatives and relatives by marriage
De estas personas, ¿cuántas NO son familiares de sangre o por matrimonio?

D_7

How many people are employed (either part time or full time)
[Students and retired people do not count as wage earners]
De estas personas, ¿cuántas son trabajadores y mayores de 18 años?

D_H4
How many children under the age of 18 live with you?
¿Cuántas niños menores de 18 viven con usted?

D_H5
How many of these children are in public school?
De estos niños, ¿cuántos van a una escuela pública?

D_10
What is the highest level of education that YOU have completed?
¿Cuál es el nivel educativo más alto que USTED ha completado?

No formal education
Elementary School
Junior High School
High School
Vocational or Trade School
Community College or Junior College
Some College
Four-year College
Graduate School
Don't know
Refused

D_P1
When it comes to politics, do you usually think of yourself as extremely liberal, liberal, slightly liberal, moderate or middle of the road, slightly conservative, conservative, or extremely conservative?
En cuánto a la polítca, ¿Se considera usted muy liberal, liberal, algo liberal, moderado, algo conservador(a), conservador(a), o muy conservador(a)?

Extremely liberal
Liberal
Slightly liberal
Moderate or middle of the road
Slightly conservative
Conservative
Extremely conservative
Don't know
Refused

D_P2
Generally speaking, do you usually think of yourself as a Republican, a Democrat, an independent or something else?
¿Se considera usted Republicano, Demócrata, Independiente, u otra cosa?

Democrat
Republican
Independent
Other [SPECIFY]
Don't know / refused

D_P3
Would you call yourself a strong or not very strong
¿Se considera usted un firme o no muy firme?

Strong
Not very strong
Don't know
Refused

D_P5
Do you think of yourself as closer to the Republican or the Democratic Party?
¿Se considera usted más cercano al partido republicano o al partido demócrata?

Republican party
Democratic party
Neither
Don't know
Refused

D_P7
Are you registered to vote
¿Está registrado para votar?

Yes
No
Don't know
Refused

D_P7MID
Did you vote in the Midterm Elections on November 6th, 2006?
¿Votó usted en las elecciones especiales del siete de noviembre del dos mil séis?

Yes
No
Don't know
Refused

D_9
Finally, which of the following categories best describes your total annual household income before taxes, from all sources? Please stop me when I get to the right category.
Y finalmente ¿cuál de las siguientes categorías describe mejor el total de los ingresos percibidos anualmente, antes de pagar impuestos, por todas las personas de su hogar? Por favor dígame cuando digo la categoría correcta.

Less than $15,000
$15,000 to under $25,000
$25,000 to under $35,000
$35,000 to under $45,000
$45,000 to under $65,000
$65,000 to under $80,000
$80,000 to under $100,000
$100,000 to under $125,000
$125,000 to under $150,000
$150,000 or more / $150,000
Don't know
Refused

D_P6
(NOT ASKED) **Language interview conducted in**

English
Spanish

PRESCR5
(not asked) **Respondent is:**
Male
Female

APPENDIX D: MAINE PROPOSAL FOR NATIONAL DISPOSAL PROGRAM

Maine Benzodiazepine Study Group
University of Maine Center on Aging
5723 Donald P. Corbett Building
Orono, Maine 04469-5723
Phone: 1 (207) 581-3444
Fax: 1 (207) 581-4490
Website: http://www.mainebenzo.org/

DATE: **November 22, 2006**

TO: **John P. Walters**
Director, Office of National Drug Control Policy
Executive Office of the President

Michael Chertoff
Secretary, Department of Homeland Security

Karen P. Tandy
Administrator, Drug Enforcement Administration

Andrew C. von Eschenbach
Acting Commissioner, Food and Drug Administration

Stephen L. Johnson
Administrator, Environmental Protection Agency

Scott Burns
Deputy Director, Office of State and Local Affairs,
Office of National Drug Control Policy

John C. Horton
Associate Deputy Director, Office of State and Local Affairs,
Office of National Drug Control Policy

FROM: **The Undersigned Individuals and Organizations**

RE: **Proposal for a National Unused Drug Disposal Program**

According to the National Survey on Drug Use and Health, over 15 million Americans misused psychotherapeutics and pharmaceuticals in 2005, including approximately 2.5 million Americans who misused pharmaceuticals for the first time, outpacing new

initiates for marijuana and cigarettes.1 "The illicit use of synthetic drugs such as methamphetamine and otherwise-legal prescription drugs," the President warned, "has become a severe and troubling problem, both at the national level and in affected communities."2

One of the most common sources of illicit pharmaceuticals is the home medicine cabinet. In many cases, large amounts of unused and expired pharmaceuticals are readily accessible to potential abusers through theft, diversion, or criminal resale. In most jurisdictions, no sanctioned mechanism exists to collect and dispose of unused pharmaceuticals, forcing legitimate users to stockpile unused medicine or dispose of them in an environmentally unsafe manner. "Greater educational efforts are needed regarding quick and safe disposal of unused and unneeded medications," an Administration official recently observed. 3

One strategy for responding to this alarming national problem that the undersigned support is the development of a national program that would oversee the collection and disposal of all unused pharmaceuticals. By ridding medicine cabinets of unused medicines, we would significantly reduce the availability of pharmaceuticals for illicit diversion, provide a mechanism for disposal more environmentally sound than "hush and flush," and remove a significant source of accidental and lethal poisonings among children.

The data gathered from sampled returns associated with such a national program will be valuable for analyzing waste in existing prescribing and compliance practices, generating significant savings for the national healthcare system.

Such a program would incorporate a mail-back and/or drop-off framework that permits residents to return pharmaceuticals to an alternative secure repository.

We recommend:

- Establishing a pilot mail-back program before instituting a national program; steps prudent to benchmark outreach, participation, volume, return and disposal practices; and
- Following evaluation, a standardized unused medicines collection, disposal, and education program should be established nationwide.

To ensure this program remains self-funded and reduces the burden on local jurisdictions, we propose a nominal 25 cent fee be assessed to each filled prescription.

We believe the effectiveness of an unused medicines disposal program will be resounding and can be measured through:

- A reduction in crime related to household prescription theft and diversion,
- A reduction of medication-related accidental poisonings among children,
- A decrease in new initiates of abused pharmaceuticals,

- A reduction in medication errors among older adults from excess stored medicines,
- A reduction in negative environmental impact from improperly disposed medicines, and
- A reduction in donation of inappropriate medicines following disasters.

We recognize that excess pharmaceuticals pose a national health, safety, and environmental threat that must be combated with a standardized program. We offer our assistance in developing such a system and encourage your thoughtful review of our recommendation.

1. *Results from the 2005 National Survey on Drug Use and Health: Detailed Tables*; Department of Health and Human Services, Substance Abuse and Mental Health Services Administration, Office of Applied Studies; September 2006.
2. *National Drug Control Strategy*, The White House, February 2006.
3. *Testimony before the House Government Reform Committee Subcommittee on Criminal Justice, Drug Policy, and Human Resources;* Joseph T. Rannazzisi, Deputy Assistant Administrator, Office of Diversion Control; July 26, 2006.

Stevan E. Gressitt, M.D.
Acting Secretary
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cc: Christopher Williamson, Ph.D., Lieutenant Commander, U.S. Navy, Policy Analyst, Office of Supply Reduction, Office of National Drug Control Policy, Executive Office of the President

---

Supporters of the Initiative
(As of November 22, 2006)

American Society of Health-System Pharmacists
(Kasey K. Thompson, Pharm.D., Director, Practice Standards and Quality Division, Director, Patient Safety)

Endorsers of the Initiative

(As of November 22, 2006)

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Dave Galvin
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(Phil Bobel, Manager Environmental Compliance Division)

Community Environmental Council, Santa Barbara, CA

(Jenny Phillips, Pollution Prevention Program Manager)

Unused and Expired Medicines Registry, Bellaire, TX
(Matthew Mireles, Ph.D., President and Director of Research)

Cuyahoga County District Board of Health, Parma, OH
(Erv Ball, R.S., Assistant Director of Environmental Health)

Day One, South Portland, ME
(David J. Faulkner, M.S.W., Executive Director)

EXP Pharmaceutical Services Corporation, Fremont, CA
(Mark Harvey, Director of Operations)

Health Care Without Harm, Arlington, VA
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(Michael P. Cantara, Commissioner)

Maine Drug Enforcement Agency, Augusta, ME
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Maine General Health, Waterville, ME
(Emilie van Eeghen, Vice President)

NeedyMeds.com, Gloucester, MA
(Richard J. Sagall, M.D., President)

North East Occupational Exchange, Bangor, ME
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Orange County Sanitation District, Fountain Valley, CA
(Thomas E. Gaworski, Principal Environmental Specialist)

Pharmaciens Sans Frontieres Comite Intl, Clermont-Ferrand, FRANCE
(Ghislaine Soulier, Communication Officer)

PharmEcology Assoc, LLC, Brookfield, WI
(Charlotte A. Smith, R.Ph., M.S., President)

Pleasant Point Health Center, Perry, ME

(Jack Martinez, Psy.D.)

Rutland County Solid Waste District, Rutland, VT
(Deane Wilson, Waste Reduction)

UMaine Center on Aging, Orono, ME
(Lenard W. Kaye, D.S.W./Ph.D.; Professor and Director)

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(Janis Bobrin, Washtenaw County Drain Commissioner)

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Jessica Winter, ME

Biruh Workeneh, M.D., ME

APPENDIX E: REVERSE DISTRIBUTOR LIST

The following companies provide reverse distribution services, as reported by institutions surveyed in Santa Barbara County. A reverse distributor is a licensed company that handles unwanted pharmaceuticals, arranging for destruction or return to manufacturers. Institutions can get credit back for returned drugs.

- **Guaranteed Returns**
  www.guaranteedreturns.com
  (800) 473-2138

- **EXP Pharmaceutical Services Corporation**
  www.expworld.com/exp/
  (800) 350-0397

- **Med-Turn International, Inc.**
  www.returns.org
  (888) 784-2323

- **Carolina Logistics Services**
  www.cls.inmar.com
  (336) 631-7663