Assessment of Alternatives for Garment Cleaning
FINAL REPORT
August 23, 2006

Summary

California is home to approximately 5040 dry cleaning facilities of which over 95 percent operate a single dry-cleaning machine[1]. Over 82 percent of the machines operate with perchloroethylene (perc) as the cleaning solvent. In 1992 the California Air Resources Board (CARB) issued an Airborne Toxic Control Measure (ATCM) for emissions of perchloroethylene from dry cleaning operations. The ATCM's requirements for closed-loop recycling succeeded in decreasing the volume of perc utilized in dry cleaning from 1.1 million gallons in 1992 to 378,000 gallons in 2003. CARB revisited the ATCM in 2006 and made several recommendations to the CARB Board. On May 25, 2006, the CARB Board voted to phase out perc statewide[2]. CARB staff have been tasked with preparing a new rulemaking to present to the Board in January 2007.

As the garment-cleaning industry in California makes the shift to less toxic alternatives, it is imperative that complete and accurate information be made available to both regulatory agencies and businesses on the economic impacts as well as worker, environmental and human health impacts of alternative garment cleaning methods. Failure to do so may result in moving a hazard from one environmental medium to another as in the case of MTBE[3], a gasoline additive designed to improve combustion efficiency that now contaminates California's water supply. A hazard may also be removed from an environmental medium only to inadvertently create an occupational exposure hazard. The replacement of CFCs with n-hexane as propellants in automotive repair brake cleaners, for example, resulted in damage to the central nervous systems of exposed workers[4].

We performed an analysis of existing literature on alternatives to perc for garment cleaning, and found that information on alternatives is not standardized, making cross-comparisons between alternatives difficult at best. Toxicity information on alternative cleaning technologies in particular is grossly inadequate. As a result of our review, we recommend full disclosure of chemical ingredients, consistent screening criteria for evaluation of new technologies, and the precautionary approach of limiting market access to those emerging technologies with the potential to negatively impact human health and the environment.

Major Findings

Information available on alternatives is not standardized

We performed a review of the existing literature on alternatives to perc for garment cleaning from 1998 to 2006. Assessments of different subsets of alternatives have been prepared, including analyses of economic factors, and health and environmental impacts. However, information is either focused on the viability of one particular alternative (e.g., wet cleaning), one aspect (e.g., energy efficiency) of several alternatives, or is a comprehensive analysis of a small subset of the large number of alternatives available (e.g., the US EPA Design for Environment Program's *Cleaner Technologies Substitute Assessment Fabricare Technologies*, 1998, which evaluated wet cleaning, perc and hydrocarbon alternatives.) The CARB Dry Cleaning Industry Technical Assessment Report prepared in October 2005 provides the most current and comprehensive analyses of alternatives to perchloroethylene use in garment cleaning. More recently, the Massachusetts Toxics Reduction Institute performed an alternatives assessment for the top three industrial uses of perc in Massachusetts. This assessment included a comprehensive review of garment cleaning alternatives. These studies, in common with other analyses, highlight a major gap in the information available on alternatives, namely the absence of adequate human health and environmental toxicity data, without which no useful comparison of alternatives can be made.

Toxicity information on garment cleaning alternatives is incomplete

The various information sources assessed in this review lead to questions of toxicity for each of the alternatives studied. The most complete toxicity information is available in Appendix G of the CARB Dry Cleaning Industry Technical Assessment Report where Cal/EPA's Office of Environmental Health Hazard Assessment (OEHHA) summarized current available data for most of the chemical alternatives in December, 2003.

Each of the currently available alternative technologies raises concerns about human health and environmental safety either during use or disposal of waste into air, water, and surrounding communities. Toxicity information remains incomplete or absent for most of the garment cleaning alternatives currently on the market.

Recommendations

We recommend that California and other state governments ensure that garment cleaning alternatives are as safe as possible by applying consistent health and safety criteria to all alternatives prior to their placement on the market. Screening criteria should require full manufacturer disclosure of chemical ingredients and associated toxicity information. Compliance with screening criteria should be evaluated by an independent third-party entity. State, local and municipal entities should continue to uniformly enforce existing regulations that protect air and water quality and human health while providing incentives to businesses to adopt the least toxic viable technological alternative.

In the interim, we recommend that the federal government follow California's lead and phase out perchloroethylene use in garment cleaning nation-wide. The state of California should also prohibit the use of smog-forming VOC options such as petroleum-based hydrocarbons as outlined by CARB staff in the draft amended Airborne Toxic Control Measure (2005).

Establish standardized criteria for evaluating new garment cleaning technologies

We recommend the development of a standardized set of environmental, health and safety criteria for emerging garment cleaning technologies to assist regulatory agencies and potential business owners in selecting the technology with the least possible impact on public health, worker health and the environment.

We further recommend that relevant regulatory agencies do not permit alternatives to be placed on the California market without complete disclosure of the chemical makeup and potential hazards of all alternative garment cleaning technologies.

Require manufacturer disclosure of toxicity information

We recommend that manufacturers be required to provide information on the potential human health and environmental toxicity of all chemical alternatives for garment cleaning. In addition, alternatives should be tested by an independent entity for impacts on human health and the environment through exposure to air and water discharges as well as occupational exposures.

Phase out perchloroethylene use in garment cleaning nationwide

There is ample evidence to demonstrate harmful environmental and human health impacts of perc use in garment cleaning. The U.S. EPA should follow California's lead in phasing out the use of perc in garment cleaning nationwide.

Prohibit smog-forming VOC options in California

The California Air Resources Board in May 2006 voted to phase out perc use in garment cleaning statewide. In the Initial Statement of Reasons (ISOR) for the draft amendments to the Airborne Toxic Control Measure CARB states that phasing out both perc and new VOC-containing systems would "provide the maximum protection from emissions of Perc while preventing an increase in VOC emissions from hydrocarbon solvents."[5] We recommend that CARB not only phase out perc but also new VOC-containing garment cleaning systems as outlined in its ACTM ISOR.

Actively promote CO_2 and professional wet cleaning

Federal and state government should provide financial incentives, information, demonstration sites, and technical assistance to businesses faced with the requirement to find an alternative to perchloroethylene in garment cleaning. We encourage CARB to more actively promote the incentives available under AB 998 to the garment cleaning business community for the adoption of alternatives to perc.

Continue to test environmental impacts of wet cleaning chemicals

Analysis of the current literature on alternatives to garment cleaning reveals that professional wet cleaning is a viable, cost-competitive alternative that minimizes impacts on human health and the environment. One key piece of information that is missing, however, is the chemical makeup of spotting chemicals marketed for use with professional wet cleaning technology. We recommend additional testing of effluent from professional wet cleaning facilities to assess the environmental impact of spotting chemicals.

Background

History of Dry Cleaning Solvent Use[6]

Commercial dry cleaning has utilized a series of chemicals solvents since its inception in the mid- to late-nineteenth century. Changes in solvent usage have occurred as dry cleaning moved from large plants in industrial areas to smaller shops in residential areas and as concerns were identified both in cleaning performance and health and safety issues for dry cleaning workers and neighboring communities. Commercial laundries and dry cleaning have both experienced expansion from the late 1800s through the present day as trends in both garments and fabrics have changed.

In the U.S. in the late nineteenth century, a shift occurred from home laundering to services provided by commercial laundries. At about the same time, the French discovered that camphene, an oil lamp fuel, could also clean oily stains off silk and wool garments without affecting the garment's color or damaging the fabric. Dry cleaning initially used gasoline as the cleaning solvent, and was located outside urban areas or in designated urban industrial zones presumably to minimize community hazards and exposure. Stoddard solvent was introduced in 1925, in part to address the flammability issues that required plants to be separated from residential areas.

Commercial garment cleaning continued to grow in the 1930s with the introduction of rayon and other synthetic fabrics, as well as with increased numbers of women entering the workforce. Alternatives to petroleum were introduced that allowed dry cleaning establishments to be based closer to residential areas, and a gradual shift occurred from large plants to smaller shops that required less initial investment. One-Hour Martinizing introduced perchloroethylene as a solvent in 1949 and emphasized quick service and multiple locations convenient to urban residents. By the 1950s, dry cleaning had been established as a professional garment cleaning service that utilized a chemical solvent such as perc, carbon tetrachloride, trichloroethylene, or a petroleum-

based hydrocarbon solvent.

Each of the solvents historically used in dry cleaning has had performance or safety issues. Carbon tetrachloride, while effective both as an industrial degreaser and garment cleaning agent, had a tendency to corrode machinery. While carbon tet was faster at cleaning and less flammable than petroleum, high emissions in the centralized dry cleaning plants and health effects among workers (including cancer and central nervous system effects) led to the search for other solvents. Trichloroethylene (TCE) also worked well as a degreaser, did not corrode equipment, and appeared to be less toxic to workers despite its fumes. It did, however, tend to bleed dyes in the cleaning process. Perchloroethylene addressed many of these performance issues, and did not appear to have acute human health hazards, and as a result became the dominant solvent in garment cleaning by the 1960s. Between 1970 and the early 1990s, sales of perchloroethylene to the garment cleaning industry accounted for 50 to 70 percent of the solvent's total sales.

History of Regulation of Perchloroethylene

National Regulation
In the late 1970s, the Consumer Products Safety Commission (CPSC) sought to classify perc as a human carcinogen based on studies done by the National Cancer Institute (NCI) and the National Institute of Occupational Safety and Health (NIOSH.) Manufacturers of the solvent blocked the CPSC action, citing the potential impact on the downstream garment cleaning industry. In 1985, the International Agency for Cancer Research (IARC) classified perc as a probable human carcinogen. The 1984 Hazardous and Solid Waste Amendments to the Resource Conservation and Recovery Act (RCRA) prohibited the disposal of hazardous waste to landfills and required the disposal of used solvent, sludge and filters to an appropriate hazardous waste facility. The 1990 Clean Air Act amendments increased regulation on perchloroethylene use as perc became one of 189 chemicals classified as a Hazardous Air Pollutant (HAPS) for which national emissions standards (National Emissions Standard for Hazardous Air Pollutants, NESHAPS) would be established.

California Regulation
In December 2002 the South Coast Air Quality Management District ruled that perc dry cleaning would be phased out for Los Angeles, Orange, Riverside and San Bernardino counties. Existing perchloroethylene machines will be permitted to operate until the end of their useful life, and no new perchloroethylene machines may be installed.

In October 2003, the California legislature passed AB 998, legislation that provides financial incentives for garment cleaning facilities to switch from perc dry cleaning to non-toxic and non-smog forming technologies including professional wet cleaning and carbon dioxide. In May 2005, the California Air Resources Board voted to phase out perc as a dry cleaning solvent statewide. The CARB Board instructed agency staff to develop financial incentive programs and other resources to assist the industry in shifting to less toxic alternatives.

Current Status of Dry Cleaning Industry in California

The California Air Resources Board in October 2005 prepared a Dry Cleaning Industry Technical Assessment Report as part of its evaluation of the existing Airborne Toxic Control Measure for Perchloroethylene Emissions from Dry Cleaning Operations (Dry Cleaning ACTM) originally adopted in 1993. This report provided the most current available assessment of the California dry cleaning industry, and is the source for all of the data provided below.

There are approximately 5040 dry cleaning facilities in California. California dry cleaners are typically small, independently owned, often family businesses employing fewer than five employees. Forty percent of California dry cleaners generate less than $100,000 in annual receipts, while 55% net between $100,000 and $500,000. Only 5% generate more than $500,000

in receipts. More than half of a typical dry cleaner's income comes from cleaning, with the remainder coming from laundry or garment alteration[7].

Over 95 percent of California cleaners operate a single dry-cleaning machine. Over 82 percent of the machines operate with perc as the solvent. There are approximately 4670 perc machines in operation in the state, down 12% from 1992. The total volume of clothing dry cleaned has not decreased; CARB therefore estimates that the volume of clothes cleaned by alternatives to perc to be approximately 13%. The amount of perc emissions statewide are estimated to have dropped by 70% upon implementation of the ACTM, dropping the volume of perc utilized in dry cleaning from 1.1 million gallons in 1992 to 378,000 gallons in 2003[8].

In 1992 the main alternatives to perc consisted of Stoddard solvent, CFC-113 and 1,1,1-trichloroethane (TCA.) The main alternatives currently are DF-2000, a high-flash synthetic hydrocarbon solvent manufactured by ExxonMobil, carbon dioxide (CO_2), water-based cleaning systems such as professional wet cleaning and GreenJet®. Other solvents include high flashpoint hydrocarbon solvents such as Stoddard solvent, PureDry®, EcoSolv®, and Shell SOL 140 HT. Non-hydrocarbon alternative technologies include GreenEarth®, a siloxane-based solvent, and Rynex, a propylene glycol ether based technology.

There are currently 37 dedicated wet cleaners in the state and an additional 43 mixed shops that combine professional wet cleaning with dry cleaning using another solvent. Most of these mixed shops are outside the South Coast Air Quality Management District. Between 100 and 146 facilities utilize GreenEarth®; the difference in numbers reflects facilities that responded to the 2003 CARB survey (100) and the number of facilities reported by the manufacturer of GreenEarth®, (146) in January 2005. CARB is aware of only one facility in California using Rynex®, and no facilities utilizing EcoSolv®.

Review of Existing Literature on Garment Cleaning Alternatives

A wide array of material is available on the health, environmental, economic and labor implications of alternatives to the use of perchloroethylene in garment cleaning. A summary of key assessments and the organizations that prepared them is provided below.

The **US Environmental Protection Agency's Design for Environment Program** in 1998 produced a *Cleaner Technologies Substitutes Assessment (CTSA): Professional Fabricare Processes.* This report provides a comprehensive economic, health and environmental assessment of alternatives to perchloroethylene use in garment cleaning. Unfortunately, as most alternative technologies were still emerging at the time of the CTSA, the report only compares perc with several hydrocarbon solvents (Stoddard solvent, 140^{o}F solvent and DF-2000) and "machine wet cleaning."

The **California Air Resources Board** generated the California Dry Cleaning Industry Technical Assessment Report in October 2005 in preparation for proposed amendments to the Airborne Toxic Control Measure for Perchloroethylene Emissions from Dry Cleaning Operations (Dry Cleaning ACTM) originally adopted in 1993.

This report provides an up to date analysis of the California garment cleaning industry and its use of various garment cleaning processes. The report provides extensive information on the economics of control measures for perchloroethylene as well as information on the health and environmental impacts of various alternatives to perchloroethylene garment cleaning. These alternatives include several hydrocarbon solvents, volatile methyl siloxane, propylene glycol ether (Rynex®), CO_2, professional wet cleaning, GreenJet®, and several emerging technologies. The Technical Assessment Report is by far the most current and comprehensive assessment of alternatives to perchloroethylene use for garment cleaning. The report includes an extensive analysis of current research literature conducted by Cal/EPA's Office of Environmental Health Hazard Assessment (OEHHA) for each of several alternatives (Technical Assessment Report,

Appendix G.) This analysis indicates that toxicity information for many, if not all, of the alternatives currently available on the market is incomplete.

The **Center for Neighborhood Technology** in Chicago, Illinois (CNT) conducted a series of surveys and case studies in the period from 1995 to 2000 to demonstrate the viability and cost effectiveness of technologies that reduce or eliminate the need for using hazardous materials, emphasizing the economic and performance viability of professional wet cleaning. CNT's reports include *Real World Wet Cleaning*, 2000 and *Pollution Prevention Products for Illinois Drycleaners: Testing and Recommendations of Chemicals for Wet Cleaning*, April 2004. CNT conducted detailed case studies of Illinois cleaners, their customers and communities. CNT found that wet cleaning is a viable technology for garment cleaning in a real setting when used with proper equipment, detergents and staff training. CNT's case studies profiled several shops that had adopted wet cleaning technology and found that it to be a financially viable option. Finally, CNT's 2004 study of wastewater agency concerns and analysis of wet cleaning products from nine manufacturers demonstrated that the products tested do not contain chemical levels that exceed regulatory guidelines. It is worth noting, however, that this analysis did not extend to spotting chemicals.

The **Institute for Research and Technical Assistance** in Los Angeles (IRTA) in August 2005 prepared a case-study-based evaluation of new and emerging technologies for textile cleaning for the California Air Resources Board and California Environmental Protection Agency and the U.S. Environmental Protection Agency, Region 9's Pollution Prevention office. This report profiled 14 garment cleaning facilities utilizing perchloroethylene, hydrocarbon, PureDry®, GreenEarth®, glycol ether, traditional wet cleaning, icy water, Green Jet® and carbon dioxide technologies. IRTA collected data on capital and operating costs, and sampled wastewater from each facility to evaluate potential health and environmental impacts.

The IRTA report concludes that cleaners who adopted alternative technologies were universally pleased with the results, even if conversion increased overall costs. Costs were lower than perc dry cleaning for hydrocarbon, Green Earth®, Green Jet®, icy water and traditional wet cleaning, and higher for glycol ether and carbon dioxide technologies. In the IRTA study, waste discharges from glycol ether, Green Earth® and carbon dioxide exhibited aquatic toxicity, while discharges from hydrocarbon technology did not. Contamination of wet cleaning effluent samples with perc and TCE were an issue, with spotting chemicals highlighted as a potential source for these solvents. IRTA summarized the results of the effluent sampling as follows:

> The findings indicated that the still bottom generated from distillation of the glycol ether, Green Earth and carbon dioxide exhibited aquatic toxicity whereas it did not for the hydrocarbon. Another waste stream, separator water from the glycol ether, Green Earth and hydrocarbon processes, did not exhibit aquatic toxicity. Four wash and rinse effluent samples from wet cleaning facilities were also analyzed. Although they did not exhibit aquatic toxicity, some of the streams contained PERC and/or trichloroethylene (TCE), another toxic chlorinated solvent. If wet cleaning effluent streams contain PERC and TCE above a certain threshold level, they would be classified as hazardous waste and they could not be discharged. The likely origin of the PERC and TCE is spotting chemicals. Work on alternative spotting chemicals is required to address this issue.

The **Pollution Prevention Education and Research Center at the Urban and Environmental Policy Institute, Occidental College** in Los Angeles has prepared a series of reports designed to address the health and environmental impacts of perchloroethylene and encourage the dissemination of professional wet cleaning technologies. These reports include *Fashioning a Greener Shade of Clean: Commercialization of Professional Wet Cleaning in the Garment Care Industry* (November 2004), *Evaluating Energy Efficiency in the Garment Care Industry: A Comparison of Five Garment Care Technologies* (September 2004), *Commercialization of Professional Wet Cleaning: An Evaluation of the Opportunities and Factors Involved in Switching to a Pollution Prevention Technology in the Garment Care Industry* (October 2002). These reports were prepared at the request of the South Coast Air Quality Management District or the Los Angeles Department of Water and Power.

PPERC's October 2002 report, *Commercialization of Professional Wet Cleaning: An Evaluation of the Opportunities and Factors Involved in Switching to a Pollution Prevention Technology in the Garment Care Industry* was the first study to evaluate the transition of multiple cleaners from perc to wet cleaning. The report details case studies of 5 drycleaners who switched from perc to wet cleaning to evaluate whether demonstration sites would be useful to move the industry to this alternative.

Capital costs of switching to wet cleaning were found to be approximately $35,000, less than a switch to a new perc machine (~$44,000). Maintenance costs are higher for perc machines, due primarily to the complex pollution control devices. No change was observed in labor costs; this was one of the key concerns for several of the case study cleaners. Water use is comparable for perc and wet cleaning because while water is a solvent in wet cleaning, pollution control devices in perc machines also utilize large volumes of water.

Analysis of the case studies demonstrated that facilities can switch from perc to wet cleaning without negative impact on their service, and that benefits include a decrease in operating costs and regulatory requirements traditionally associated with perc. Key issues in transition identified by this study include installation of new equipment, training, the availability of demonstration sites, and financial incentives. PPERC suggests the development of a qualified installer program to deal with this new equipment technology. PPERC also suggests that financial incentives can be funded by energy rebates or through funds created from regulatory fines.

The September 2004 PPERC study *Evaluating Energy Efficiency in the Garment Care Industry: A Comparison of Five Garment Care Technologies*, found that electricity use is lower in professional wet cleaning than with other dry cleaning methods. The report recommends more research to establish if there are in fact natural gas savings, and to clarify questions of water use. PPERC also suggests the development a rebate program for electricity savings as an incentive to adopt wet cleaning, and an extensive program of educational outreach, using existing wet cleaning shops as demonstration sites.

PPERC's November 2004 study, *Fashioning a Greener Shade of Clean: Commercialization of Professional Wet Cleaning in the Garment Care Industry* details PPERC's administration of a grant program designed to provide technical and financial assistance to 8 cleaners to serve as wet cleaning demonstration sites in the Los Angeles area. An extensive outreach campaign resulted in 140 cleaners contacting PPERC to participate in the program, 90 participated in workshops, and 23 applied for demonstration project status. Each of the 8 cleaners selected was converted to professional wet cleaning over a 22 month period. As in previous studies, evaluation of the conversion process revealed that cleaners were able to maintain their level of service during the conversion, and operating costs were lowered, as was electricity use. Training, proper equipment installation, and the availability of demonstration sites were confirmed as key elements in successful transition to professional wet cleaning.

The **Massachusetts Toxics Use Reduction Institute** (TURI) assessed alternatives for the top three industrial uses of perchloroethylene in the Five Chemicals Study commissioned by the Massachusetts state legislature. The report was delivered to the Massachusetts legislature on June 30, 2006 and included an assessment of alternatives to perchloroethylene use in dry cleaning, vapor degreasing and aerosol automotive cleaning. The assessment of available alternatives for dry cleaning provides a comparison of hydrocarbon, volatile methyl siloxane, glycol ethers, wet cleaning and carbon dioxide alternatives for garment cleaning. The report assesses these alternatives for technical, financial, environmental, human health and safety criteria. The report concludes that most of the alternatives took longer to clean than perc, but were generally less persistent in the environment. Costs were higher than perc for siloxane, glycol ether and carbon dioxide, while hydrocarbon and wet cleaning were cost-comparable. Flammability is a concern for all of the alternatives except water and carbon dioxide.

Review of Existing Analyses

Table 1: Alternatives considered by existing literature

Solvent	Commercial Name	Analysis
Perchloroethylene		CARB (2005), US EPA (1998), IRTA (2005), PPERC (2002, 2004), TURI (2006)
Hydrocarbon	DF-2000	CARB (2005), US EPA (1998), (PPERC, 2004), TURI (2006)
	PureDry®	CARB (2005), IRTA (2005)
	EcoSolv®	CARB (2005)
	Shell-Sol 140 HT®	CARB (2005), US EPA (1998)
	Stoddard solvent	CARB (2005), US EPA (1998)
Volatile methyl siloxane	D5, GreenEarth®	CARB (2005), IRTA (2005), TURI (2006)
Propylene glycol ether	Rynex®	CARB (2005), IRTA (2005), TURI (2006)
Carbon dioxide		CARB (2005), PPERC (2004), IRTA (2005), TURI (2006)
Professional wet cleaning		CARB (2005), IRTA (2005), US EPA (1998), PPERC (2002, 2004), CNT (2000, 2004), TURI (2006)
Emerging Technologies	Green Jet®	CARB (2005), IRTA (2005)
	Cold Water cleaning systems	CARB (2005), IRTA (2005)
dipropylene glycol normal butyl ether, DPNB	Resolve®	CARB (2005)
propylene glycol-based solution	Impress® solvent	CARB (2005)
mix of paraffins	Hydroclene®	CARB (2005)

Information available on alternatives is not standardized

Our analysis of the existing literature on alternatives to perchloroethylene revealed that while good information is available, it is hard to compare across studies that focus either on one aspect of (e.g., energy efficiency), the viability of one alternative (e.g., wet cleaning, which is the best documented alternative technology), or provides a comprehensive analysis of a subset of the available alternatives. The CARB Technical Assessment Report is the most current and complete assessment of the technical viability of existing alternatives, and the IRTA case study report provides case study information that complements the CARB Technical Assessment. While both of these studies are an excellent resource, more case study information and more complete information on the human health and environmental impacts of alternatives would be of great utility in order for regulatory agencies, businesses, and consumers alike to make educated decisions on the relatives risks of alternative garment cleaning technologies.

Toxicity information on emerging alternatives is incomplete

Information currently available in the literature on garment cleaning alternatives raises health and safety concerns for each of the available options.

Table 2: Health, safety and environmental concerns of garment cleaning technologies

Technology	Concern
Perchloroethylene	Probable human carcinogen
Carbon dioxide	Flammable
GreenEarth, D5, decamethylpentasiloxane	Causes uterine tumors in rats; suspected reproductive toxin
Hydrocarbon solvents	Potential neurotoxins, eye & respiratory irritation at high concentrations
Propylene glycol tert butyl ether, Rynex	Potential toxic effects on liver, kidney, nasal membranes; glycol ethers have varying degrees of reproductive toxicity Water pollution concern (tert butyl ether)
Professional wet cleaning	Unknown water impacts of spotting chemicals
Other emerging technologies	Little or no information on carcinogenicity, potential reproductive toxicity, etc.

A recent UC Berkeley report proposing a framework for a comprehensive California chemicals policy refers to three information gaps broadly as the Data Gap, the Safety Gap and the Technology Gap[9]. The Data Gap describes the pervasive lack of comprehensive and standardized information on toxicity and ecotoxicity of most chemicals, making for difficulties for business-owners, consumers, and workers alike to assess the hazards of chemicals in commercial use or evaluate alternatives. The Safety Gap describes the inability of government agencies to systematically identify and prioritize chemical hazards, while the Technology Gap describes the lack of both market and regulatory drivers for the U.S. chemical industry to invest in the development and promotion of greener technologies.

Each of these Gaps is present in the garment cleaning industry. Human and environmental health impact information exists to some extent for most alternatives. However, toxicity information is unavailable for many of the emerging solvent technologies (the Data Gap.) Even for professional wet cleaning, arguably the most comprehensively analyzed alternative technology, there are gaps in toxicity information, particularly in water impacts of spotting chemicals. In the absence of such systematic toxicity data, it is difficult at best to assess the potential hazards of emerging technologies, leading to the Safety Gap, where regulatory agencies are hampered in their efforts to protect public health and the environment. Finally, in the absence of data and clear criteria for greener technologies, a Technology Gap results whereby businesses are encouraged to adopt a marginally less toxic option at increased cost only to find that this option has human health and environmental impacts as well.

Conclusions and Recommendations

A review of existing literature on garment cleaning technologies reveals professional wet cleaning and carbon dioxide as two viable alternatives to perchloroethylene garment cleaning. Professional wet cleaning is comparable in cost to perchloroethylene garment cleaning and has none of the worker health or environmental health issues associated with organic solvent cleaners. Carbon dioxide cleaning has a high upfront capital investment cost and some potential health and safety hazards for workers. For a comparison of key garment cleaning technologies, see Appendix A.

CARB's 2003 survey of drycleaners indicates that 96% of existing facilities would buy a new machine, and at the time of the survey, indicated that the vast majority would buy either a perc machine, hydrocarbon, or siloxane alternative technology[10] (Table 3). Clearly, more educational outreach and incentives, both regulatory and financial, are necessary to assist businesses in the selection of the least toxic viable alternative technology.

Table 3: Summary of Future Machine Purchase for California dry cleaners

Machine Type	Solvent Type	Percentage*
Perchloroethylene	Perc	44%
DF-2000	Hydrocarbon	24%
GreenEarth®	Siloxane	15%
Wet cleaning	Water	13%
Carbon dioxide	Carbon dioxide	10%
Other		8%
PureDry®	Hydrocarbon	4%
Stoddard	Hydrocarbon	3%
Rynex®	Propylene glycol ether	2%
EcoSolv®	Hydrocarbon (paraffin)	1%

*Values total >100% because of multiple entries per facility

In addition, CARB's report also indicates that while only 2% of facilities statewide are co-located with residential facilities, many are close to other businesses, day care centers, schools, hospitals, senior centers. For this reason, we believe that regulatory agencies and businesses alike select and promote the alternative technology that has the least possible impact on worker health, public health, and the environment. More complete information must be required of manufacturers of alternative garment cleaning technologies, and such information must be presented in a standardized, accessible fashion, and critical criteria defined.

Establish standardized criteria for evaluating new garment cleaning technologies

We recommend the development of a standardized set of environmental, health and safety criteria for emerging garment cleaning technologies to assist regulatory agencies and potential business owners in selecting the technology with the least possible impact on public health, worker health and the environment. These standards must include an analysis of changes necessary in worker training and any possible impacts on worker health not only from chemical exposures, but from ergonomic changes in processes and machinery.

We further recommend that relevant regulatory agencies do not permit alternatives to be placed on the California market without complete disclosure of the chemical makeup and potential hazards of all alternative garment cleaning technologies. This information can be disclosed to a third-party certification organization in order to avoid issues of trade secret and proprietary business information.

Require manufacturer disclosure of toxicity information

Information on the toxicity of alternatives is sorely lacking, including detailed information on the potential reproductive toxicity of siloxane- and glycol-ether-based chemical garment cleaning alternatives, or of the potential environmental impacts of even the least toxic option currently available, professional wet cleaning, where no information is available on the content or impacts of spotting chemicals.

We recommend that manufacturers be required to provide information on the potential human health and environmental toxicity of all chemical alternatives for garment cleaning. In addition, alternatives should be tested by an independent agency for impacts on human health and the environment through exposure to air and water discharges as well as occupational exposures.

Actively promote CO2 and professional wet cleaning

Federal, state, local and municipal governments should provide financial incentives, information, demonstration sites, and technical assistance to businesses faced with the requirement to find an alternative to perchloroethylene in garment cleaning.

AB 998 requires the California Air Resources Board to develop and fund a Non-Toxic Dry Cleaning Incentive Program[11]. We encourage CARB to more actively promote the incentives available under AB 998 to the garment cleaning business community for the adoption of alternatives to perc. These incentives include grants and demonstration programs funded by a per-gallon--fee on the manufacturers and importers of perc for dry cleaning operations. Alternatives that currently meet CARB's criteria for incentives under AB 998 include professional wet cleaning and CO_2.

Continue to test environmental impacts of wet cleaning chemicals

Analysis of the current literature on alternatives to garment cleaning reveals that professional wet cleaning is a viable, cost-competitive alternative that minimizes impacts on human health and the environment. One key piece of information that is missing, however, is the chemical makeup of spotting chemicals marketed for use with professional wet cleaning technology. Analyses to date have specifically excluded spotting chemicals (e.g. CNT, 2004) or have found wastewater contamination potentially from the use of perc-based dry cleaning spotting chemicals in a mixed shop (IRTA, 2005.)

We recommend continued testing of chemicals utilized in professional wet cleaning, with an emphasis on spotting chemicals. Some data exist on the impacts on wastewater from detergents and other chemicals used with this technology, but additional data on these wet cleaning chemicals would also be of utility.

Appendix A: Comparison of Garment Cleaning Technologies
Appendix B: Annotated Bibliography

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[1] *California Drycleaning Industry Technical Assessment Report,* California Air Resources Board, October 2005, p. II-2

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[7] *California Drycleaning Industry Technical Assessment Report,* California Air Resources Board, October 2005

[8] Ibid. pp. II-1 – II-3.

[9] Michael Wilson et al. *Green Chemistry in California: A Framework for Leadership in Chemicals Policy and Innovation*, California Policy Research Center, University of California at Berkeley

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[11] California Air Resources Board, http://www.arb.ca.gov/toxics/dryclean/ab998.htm