About this Report

In 2013, California finalized its Safer Consumer Products (SCP) regulations, which establish a process for evaluating chemicals of concern and their potential alternatives in consumer products. This landmark legislation addresses the critical need to reduce toxic chemicals in consumer products—chemicals that are responsible for known human health and environmental harms. The regulations require "responsible entities" (which include manufacturers, importers, assemblers, and/or retailers) of a "priority product" (a consumer product containing a chemical of concern) to complete an alternatives analysis to determine whether feasible alternatives are available to minimize the public health and environmental impacts of their products. "Alternatives analysis" is synonymous with the term "alternatives assessment," defined as a process for identifying, comparing, and selecting safer alternatives to chemicals of concern (including those in materials, processes, or technologies) on the basis of their hazards, performance, and economic viability. The process is intended to provide guidance for assuring that chemicals of concern are replaced with safer alternatives that are not likely to prove regrettable at a later date—known as "regrettable substitutions."

The California SCP regulations divide alternatives analysis into two stages. Stage 1 includes the following primary components: an examination of the product's and chemical of concern's function and performance requirements; identification of candidate alternatives; identification of relevant comparison factors (for example, environmental, human health, and physicochemical properties); assessment of human and environmental health hazards of concern; and a work plan and associated timeline relevant to completion and submission of the Stage 2 assessment. Stage 2 involves a broader assessment, including life cycle impacts as well as an assessment of economic and technical feasibility for both the product and its chemicals of concern.

BizNGO—a collaboration of leaders from businesses, environmental groups, universities, and governments—initiated a demonstration project to draft a report on a priority product under the California SCP regulations: paint and varnish strippers with methylene chloride (also known as dichloromethane). The purpose of the process was to identify less hazardous alternatives to methylene chloride in paint/varnish strippers and to model and explore compliance with Stage 1 of the alternatives analysis requirements under the California SCP regulations. The goals of this demonstration project were three-fold: (1) to identify less hazardous alternatives to methylene chloride in formulated paint stripper products; (2) to identify candidate alternatives for methylene chloride in paint stripping formulations that will likely be considered in actual/future Stage 1 submissions for this "priority product" in California; and (3) to identify challenges and needs confronting compliance with the alternatives analysis process under the California SCP regulations.

The following report provides an example of the flow of a California SCP-type alternatives analysis, specifically the scoping and hazard assessment step as specified for Stage 1. The report follows the required format, including the executive summary. This report does not, however, substitute for specific compliance guidance to be issued by the California Department of Toxic Substances Control (DTSC) as additional details may be required.

This demonstration project was conducted from the perspective of a chemical formulator that manufactures a methylene chloride-based paint stripper consumer product —one of the entities that may be required to comply with the California regulations. However, the analysis summarized in the report *is not tied to any real or specific company or product.*

Highlights from the report, including summary of results and lessons learned in relation to the SCP regulations, are described in the last section of this report.

California Safer Consumer Products Regulations: Stage 1 Executive Summary

Paint stripping products are used to remove old, blistered, or cracked paint to ready the substrate for an application of coatings such as fresh paint. They are intended to remove surface coatings such as paint, lacquers, varnishes, or graffiti from a broad range of substrates (e.g., metal, wood, and concrete). There are generally three categories of paint stripper use: consumer, professional, and industrial.

This analysis models the perspective of a manufacturer of a methylene chloride-based paint stripper for consumers that seeks compliance with the California Safer Consumer Products (SCP) regulations. The category of paint strippers that is the subject of this alternatives analysis includes both consumer and professional uses. These uses include products readily purchased at consumer retail outlets, such as paint and hardware supply stores. Industrial uses of paint strippers are considered beyond the scope of this analysis given that these are not sold in the consumer marketplace.

Methylene chloride (CAS number 75-09-2)— the chemical of concern in paint strippers—is the primary stripping solvent. Methylene chloride in paint strippers functions through a combination of processes that involve penetrating the paint layers and breaking the bond between the paint and the substrate. As methylene chloride volatizes, it pushes up on the resulting painted film, tenting it away from the substrate, and making the paint easy to subsequently remove with a blunt metal surface such as a putty knife. The most important function of a solvent in a paint stripper is its diffusivity. Other primary functions include causing the target paints to swell and delivering activators to the interfaces of paints and substrates.

Paint strippers have two general performance requirements: (1) effective removal of surface coatings and (2) maintenance of the quality and integrity of the substrate surface. The American Society for Testing and Materials (ASTM) D6189-97 outlines testing procedures relevant to paint stripping. The two metrics examined in this standard include:

- amount (percentage ranking) of each layer of coating removed based on specified stripping times; and
- condition (qualitative ranking) of substrate after coating removal.

Performance factors considered in this standard include:

- compatibility with the substrate;
- effectiveness in removing a variety of paint/coating types (e.g., latex enamel, polyurethane, varnish, shellac, nitrocellulose lacquer, etc.); and
- stripping time.

Green Seal's GS52 standard for household cleaning products also includes a standard for graffiti removal.

There are three generally recognized categories of paint stripping methods:

- Physical/mechanical stripping, which involves the use of abrasion methods. Examples include: use of metal tools for scraping, sand paper, media blasting (e.g., plastic media blasting, wheat media blasting, liquid nitrogen blasting, etc.).
- Pyrolytic/thermal stripping, which involves the use of heat. Examples include: heat guns, steam, and laser stripping.
- Chemical stripping, which uses solvents or alkaline or acidic chemicals to strip paint.

Chemical alternatives prioritized in this Stage 1 analysis include those with a solvent function to replace the function of methylene chloride in the existing paint stripping product. In order to expand the range of alternatives relevant to chemical formulation manufacturers, this analysis will also examine chemical formulations that can strip paint via other functions, including acidic and alkaline chemicals that can strip paint via an acidic or caustic function.

While there are additional alternative paint strippers available in consumer retail outlets, including pyrolytic techniques and physical/mechanical techniques as noted above, these alternatives are not economically feasible for a chemical formulator to consider. For the purpose of this model Stage 1 analysis, the costs required of this hypothetical chemical formulator to change its business model to the manufacturing of metal products (e.g., metal scrappers) or paper products (e.g., sand paper), or the manufacturing of other articles (e.g., heat guns) would rank lowest among the alternatives, given the tremendously high capital and employee costs required. Required investments were assumed to include new plant infrastructure (capital

expenditures associated with building new plants, purchasing new manufacturing equipment, etc.) as well as personnel costs (e.g., unemployment/severances for downsized chemical staff). These costs render such a change financially infeasible.

Additional alternatives not considered for further screening in this report, because they are intended for uses in industrial facilities rather than consumer or professional settings, include media blasting and alkaline and acid chemical stripping that require use in immersion tanks.

The 11 alternatives prioritized for hazard screening are identified in Table A. These potential alternatives were identified through a review of publicly available reports from industry research, government, and/or government research sponsored institutions. The 11 alternatives were prioritized based on: (a) a review of existing MSDSs demonstrating that these alternatives are being used in paint strippers on the market today; (b) case study experience (including those listed on product specifications); and (c) those also likely to be prioritized by DTSC as they are referenced in its *Priority Product Profile: Paint Strippers Containing Methylene Chloride* report.

An alternative excluded from the hazard assessment was 1-Methyl-2-pyrrolidone (NMP). While this alternative was identified as a candidate given the same sources used for those identified in Table A, and is often found as a co-solvent with alternatives identified in Table A in products available on the market today, DTSC states in its *Priority Product Profile: Paint Strippers Containing Methylene Chloride*, that NMP alternatives for methylene chloride are not to be considered because "DTSC does not recognize NMP as a 'safer alternative' to methylene chloride." NMP is considered a reproductive and developmental toxicant under California's Proposition 65 and is included on DTSC's list of candidate chemicals. For these reasons, NMP was screened out of the assessment.

This hazard assessment uses GreenScreen® for Safer Chemicals version 1.2 hazard assessment method, which is based on the Globally Harmonized System (GHS) for Classification and Labeling. It uses national and international precedents from authoritative agencies regarding evidence classifications for specific hazard endpoints wherever feasible. It includes 12 human health endpoints (carcinogenicity, genotoxicity/mutagenicity, reproductive toxicity, developmental toxicity and endocrine activity, acute toxicity, systemic toxicity and organ effects, neurotoxicity, skin sensitization, respiratory sensitization, skin irritation, and eye irritation), two ecotoxicity endpoints (acute and chronic aquatic toxicity), and four physicochemical characteristics (persistence, bioaccumulation, reactivity, and flammability), two of which also reflect environmental fate (persistence and bioaccumulation).

Comparison factors including additional environmental impacts (e.g., ozone depletion and global warming potential), adverse waste and end-of-life impacts, and materials and resource consumption impacts will be addressed in the Stage 2 life cycle analysis of the California SCP regulations. Additional hazards not considered in the GreenScreen® assessment, such as environmental fate and additional environmental impacts, will be addressed in the Stage 2 assessment.

Results from the GreenScreen® hazard assessment are included in Table B.

TABLE A
Methylene Chloride Alternatives included in BizNGO Comparative Hazard Assessment

Chemical (or mixture)	CASRN	Molecular Formula
Benzyl alcohol	100-51-6	C_7H_8O
2-(2-Butoxyethoxy) Ethanol	112-34-5	$C_8H_{28}O_2$
Dimethyl-sulfoxide (DMSO)	67-68-5	C_2H_6OS
1,3-Dioxolane	646-06-0	$C_3H_6O_2$
Estasol (Mixture of 3 dibasic esters) **(a) Dimethyl succinate (15-25%)** **(b) Dimethyl glutarate (55-65%)** **(c) Dimethyl adipate (10-25%)**	95481-62-2	 (a) $C_6H_{10}O_4$ (b) $C_7H_{12}O_4$ (c) $C_8H_4O_4$
d-Limonene	138-36-3	$C_{10}H_{16}$
Hydrocarbon solvents (likely used as a mixture, but assessed individually) **(a) methanol** **(b) acetone** **(c) toluene**	 (a) 67-56-1 (b) 67-64-1 (c) 108-88-3	 (a) CH_4O (a) C_3H_6O (a) C_7H_8
Formic acid	64-18-6	CH_2O_2
Caustic soda	1310-73-2	HNaO

TABLE B

GreenScreen® Hazard Assessment Results

Chemical Name	CASRN	Group I Human					Group II & II Human									Ecotox		Fate		Physical	
								ST		N											
		C	M	R	D	E	AT	Single	repeated	Single	repeated	SnS	SnR	IrS	IrE	AA	CA	P	B	RX	F
Methylene chloride	75-09-2	H	NE	DG	DG	M	*M*	vH	H	*vH*	*vH*	L	DG	H	H	M	*L*	*vH*	vL	L	L
Benzyl alcohol	100-51-6	L	L	*L*	M	DG	M	L	L	*M*	*H*	H	*L*	L	H	L	L	vL	vL	*L*	L
2-(2-butoxyethoxy) ethanol	112-34-5	*L*	L	L	L	DG	L	L	H	DG	L	L	DG	*M*	H	L	L	vL	vL	*L*	M
Dimethyl sulfoxide	67-68-5	*L*	L	L	L	DG	L	L	L	L	L	L	L	*M*	*M*	L	*L*	*L*	vL	*L*	M
1,3-dioxolane	646-06-0	L	*M*	*M*	M	DG	L	M	M	M	L	L	DG	*M*	*H*	L	L	*M*	vL	*L*	H
Estasol (dibasic esters mixture)	95481-62-2	*L*	L	L	*M*	*M*	L	M	*M*	M	DG	L	DG	L	*M*	M	L	vL	vL	*M*	L
d-Limonene	5989-27-5	L	L	DG	L	DG	L	L	L	DG	DG	H	DG	H	*H*	vH	H	vL	M	*L*	M
Acetone	67-64-1	*L*	L	*M*	M	DG	L	*M*	M	M	*M*	L	DG	L	H	L	L	vL	vL	L	H
Methanol	67-56-1	NA	NA	NA	H	NA	H	vH	NA	NA	NA	NA	NA	NA	NA	L	*L*	vL	*vL*	NA	H
Toluene	108-88-3	DG	L	H	H	M	L	M	H	M	H	L	DG	H	L	H	*H*	*H*	vL	L	H
Formic acid	64-18-6	L	L	L	*L*	DG	H	vH	*H*	vH	DG	L	DG	vH	vH	M	M	vL	vL	L	M
Caustic soda	1310-73-2	*L*	L	*L*	*L*	*L*	H	vH	*L*	*L*	*L*	L	DG	vH	vH	M	DG	*L*	*vL*	*M*	L

Abbreviations

C = Carcinogenicity
M = Mutagenicity
R = Reproductive Toxicity
D = Developmental Toxicity
E = Endocrine Activity
AT = Acute Toxicity
ST = Systemic Organ Toxicity
N = Neurotoxicity
SnS = Skin Sensitization
SnR = Respiratory Sensitization
IrS = Skin Irritation
IrE = Eye Irritation
AA = Aquatic Toxicity
CA = Chronic Aquatic Toxicity
P = Persistence
B = Bioaccumulation
RX = Reactivity
F = Flammability

Note

Hazard levels (Very High (vH), High (H), Moderate (M), Low (L), Very Low (VL) in italics reflect estimated (modeled values, authoritative B lists, screening lists, weak analogues, and lower confidence. Hazard levels in BOLD are used with good quality data, authoritative A lists, or strong analogues. Group II Human Health endpoints differ from Group II Human Health endpoints in that they have four hazard scores (i.e., vH, H, M and L) instead of three (i.e., H, M and L), and are based on single exposures instead of repeated exposures. DG indicates insufficient data for assigning hazard level. NE indicates no determination was made (conflicting data).

The GreenScreen® Benchmark™ scores for methylene chloride and each of the candidate alternatives are described in Table C. Dimethyl sulfoxide (DMSO) was the only candidate alternative that received a Benchmark 3 score: "Use but Still Opportunity for Improvement." While the hazard severity of DMSO associated with the range of endpoints examined was deemed lower than other candidate alternatives, DMSO has the capacity to potentiate the toxicity of other chemicals that are included in the final product formulation or other chemicals that users are in contact with while using a DMSO-containing product. Should DMSO be further considered as a potential alternative given Stage 2 analysis of the Safer Consumer Products regulations, a deeper examination of the hazards of other formulation chemicals is essential since DMSO will increase the toxicity potency of chemicals contained in the formulation.

TABLE C
GreenScreen® Hazard Assessment Benchmarks

Chemical	CASRN	Benchmark	Benchmark Explanation	Benchmark Reason (Primary Hazard Endpoints of Concern)
Methylene chloride	75-09-2	1	Avoid Chemical of High Concern	"High" carcinogenicity
Benzyl alcohol	100-51-6	2	Use but Search for Safer Substitutes	"Moderate" developmental toxicity; "High" neurotoxicity (repeated dose) and skin sensitization
2-(2-butoxyethoxy) ethanol	112-34-5	2	Use but Search for Safer Substitutes	"High" systemic toxicity (repeated dose)
Dimethyl sulfoxide (DMSO)	67-68-5	3	Use but Still Opportunity for Improvement	"Moderate" toxicity associated with skin irritation & eye irritation; "Moderate" flammability
1,3-dioxolane	646-06-0	2	Use but Search for Safer Substitutes	"Moderate" mutagenicity, reproductive toxicity and developmental toxicity; "High" flammability
Estasol (dibasic esters mixture)	95481-62-2	2	Use but Search for Safer Substitutes	"Moderate" developmental toxicity and endocrine activity
d-Limonene	5989-27-5	2	Use but Search for Safer Substitutes	"Very high" acute ecotoxicity and "high" toxicity associated with skin sensitization
Acetone	67-64-1	2	Use but Search for Safer Substitutes	"Moderate" developmental toxicity & reproductive toxicity and "high" flammability
Methanol	67-56-1	1	Avoid Chemical of High Concern	"High" reproductive and developmental toxicity
Toluene	108-88-3	1	Avoid Chemical of High Concern	"High" developmental toxicity
Formic acid	64-18-6	2	Use but Search for Safer Substitutes	"Very High" toxicity associated with skin irritation, eye irritation & systemic toxicity (single dose) & neurotoxicity (single dose); "High" systemic toxicity (repeated dose)
Caustic soda	1310-73-2	2	Use but Search for Safer Substitutes	"Very High" toxicity associated with skin irritation, eye irritation & systemic toxicity (single dose)

CASRN = Chemical Abstracts Service Registration Number
■ GreenScreen Benchmark 1: Chemical of High Concern—Avoid.
■ GreenScreen Benchmark 2: Use but search for something safer.
■ Use but Still Opportunity for Improvement.

Table D lists chemicals that have been de-selected for further consideration. Methanol was classified as having "high" developmental toxicity, while toluene similarly demonstrated "high" developmental toxicity as well as "high" reproductive toxicity. As in the case of NMP described in Section 2.1, both methanol and toluene are considered reproductive/developmental toxicants under California's Proposition 65 and are included on DTSC's list of candidate chemicals. Given that these decision rules guided the de-selection of NMP, they should also guide the de-selection of methanol and toluene.

TABLE D
Chemicals De-Selected for Further Assessment in California SCP Stage 2 Alternatives Analysis

De-selected alternative	CASRN	Reason for De-selection
Methanol	67-56-1	Developmental toxicant – Listed on CA Prop 65 and DTSC's Candidate List of Chemicals
Toluene	108-88-3	Developmental & reproductive toxicant – Listed on CA Prop 65 and DTSC's Candidate List of Chemicals

Table E includes the nine chemicals that BizNGO will advance to the Stage 2 analysis of the SCP regulations. Stage 2 will focus, depending on the availability of data, on the evaluation of additional hazards not considered in the GreenScreen® assessment and additional environmental impacts. Stage 2 will also focus on preventing the shifting of negative impacts from one environmental or human heath endpoint to another by reviewing available multi-media life cycle information. Product performance and economic impacts will be assessed in Stage 2 as well.

The proposed final alternatives assessment work plan and associated schedule is described in Table F.

TABLE E

Chemicals Selected for Further Assessment in California SCP Stage 2 Alternatives Analysis

Chemical	CASRN
Benzyl alcohol	100-51-6
2-(2-butoxyethoxy) ethanol	112-34-5
Dimethyl sulfoxide (DMSO)	67-68-5
1,3-dioxolane	646-06-0
Estasol (dibasic esters mixture)	95481-62-2
d-Limonene	5989-27-5
Acetone	67-64-1
Formic acid	64-18-6
Caustic soda	1310-73-2

TABLE F

BizNGO Proposed Final Alternatives Analysis Work Plan and Schedule for Complying with California Safer Consumer Products Regulations

Action Item	Description	Completion Date*
Re-evaluation of relevant factors from preliminary alternatives assessment	Relevant factors identified in the Preliminary Alternatives Assessment will be reviewed and changes will be documented.	6 weeks
Review of product function and performance factors	The Performance Evaluation Module (Level 3) of the Interstate Chemicals Clearinghouse Alternatives Assessment Guide (version 1.0) will be followed for performance evaluation guidance. Performance standards identified in Section 1.3 will be used to evaluate key performance parameters and for determining the range of acceptable values for those parameters. The focus of the product function and performance evaluation will be on preventing burden shifting in the form of decreased safety. Given that methylene chloride is a non-flammable solvent, additional fire safety standards will be assessed. Those alternatives demonstrating high concern regarding fire safety will be screened out of the analysis.	10 weeks
Consideration of materials and resource consumption impacts	Existing life cycle inventories or life cycle assessments will be reviewed for relevant data. Where life cycle assessment data are lacking, data for proxy chemicals will be explored as a substitute. Results will be summarized and alternatives that demonstrate significant life cycle burden risk shifting will be screened-out.	14 weeks
Reassessment of hazards for other co-chemicals in the best performing formulations. Conduct literature review to ensure no new hazard information substantively changes the hazard classifications from Stage 1.	In order to minimize hazards in the total formulation, rather than only the chemical of concern, a screening hazard assessment will be performed on all co-chemicals in the formulation above 0.01% concentration (100 parts per million) in the formulation. The 4-5 best performing formulations will be screened for using more “quick screening” methods given the number of chemicals to be examined. These methods employ the use of authoritative lists. A literature review will be performed to ensure that new hazard information is considered that may substantively change the hazard classifications in Stage 1.	17 weeks
Review of economic factors	Cost and Availability Evaluation Module (Level 4) of the Interstate Chemicals Clearinghouse Alternatives Assessment Guide (version 1.0) will be followed to assess economic feasibility. It is anticipated that one or more of the alternatives will be selected for substitution of the chemical of concern; therefore, the economic impacts are expected to be positive from a burden shifting perspective. Economic factors, as specified in the regulations, will be researched and evaluated.	21 weeks
Review of priority product and alternatives/alternative selection decision	The Priority Product and the alternatives will be compared based on the relevant factors and one or more alternatives will be selected as the recommended option. Relevant factors will include factors identified, but not analyzed, in the preliminary alternatives assessment, plus relevant function, performance, and economic factors.	30 weeks
Submittal of final report	The scheduled submission date of final report.	40 weeks**

* Completion date: number of weeks after BizNGO receives Notice of Compliance for Preliminary Alternatives Assessment from DTSC.

** Note that BizNGO plans to submit its work plan 12 weeks before the required DTSC deadline of 52 weeks.

Standard Template for California Safer Consumer Products Regulations, Stage 1 Submission: Preparer Information

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"I certify that this document and all attachments were prepared or compiled under my direction or supervision to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person(s) directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that submitting false information or statements is a violation of law.

Responsible Entity Signature *** Date ***

Preparer Signature *** Date ***

*** This is a model assessment and not tied to any real or specific company or product. This information is not provided in this model assessment.

Standard Template for California Safer Consumer Products Regulations, Stage 1 Submission: Responsible Entity and Supply Chain Information

Preparer

Name	***
Organization	***
Address	***
Telephone	***
Email	***

Importer

Name	***
Organization	***
Address	***
Telephone	***
Email	***

Distributor (as identified on product label)

Name	***
Organization	***
Address	***
Telephone	***
Email	***

California Customer Identification
(to whom product was directly sold within the prior twelve months)

Customer A	***
Organization	***
Address	***
Telephone	***
Email	***
Customer B	***
Organization	***
Address	***
Telephone	***
Email	***

Direct Retail Sales Outlet Identification

Name	***
Organization	***
Address	***
Telephone	***
Email	***

*** This is a model assessment and not tied to any real or specific company or product. This information is not provided in this model assessment.