Green Screen Assessment Prepared By:
Name: Brian Penttila, Ph. D.
Title: Chemical Engineer
Organization: PNW Pollution Prevention Resource Center
Date: 30 June 2012

Quality Control Performed By:
Name: Alex Stone, Sc. D.
Title: Safer Chemical Alternative Chemist
Organization: WA Department of Ecology
Date: 17 April 2013

GreenScreen™ Assessment for Trichloroethylene (CAS #79-01-6)

GreenScreen™ Version 1.2 Draft Assessment
Note: Validation Has Not Been Performed on this Green Screen Assessment

Chemical Name: 1,1,2-Trichloroethylene (TCE)

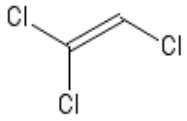
Confirm application of the de minimus rule[1]: (if no, what *de minimus* did you use?) Yes.

Chemical Name (CAS #): 1,1,2-trichloroethylene (CAS#79-01-6)

Also Called: Trichloroethylene, TCE, Ethene, trichloro-, Ethylene trichloride; Ethylene, trichloro-; Trichloride, Ethinyl; Trichloroethene; 1,1,2-Trichloroethene; 1,1-Dichloro-2-chloroethylene; 1,2,2-Trichloroethylene; 1-Chloro-2,2-dichloroethylene; Trilene, Triklone®

Chemical Surrogates, analogs or moieties used in this assessment (CASs #): None.

Chemical Structure(s):



Identify Applications/Functional Uses: (e.g. Cleaning product, TV casing)

1. Vapor degreasing and cleaning of metal parts.
2. Adhesives that require low-flammability solvents.
3. Chemical feedstock for HFCs, HCFCs, and pentachloroethane.
4. Various uses as a carrier solvent.

See Background section below for references.

Green Screen Rating[2]: Trichloroethylene was assigned a **Benchmark Score of 1** based on:

- Failure of Benchmark Rule 1c, due to very High persistence + High carcinogenicity.
- Failure of Benchmark Rule 1e, due to High carcinogenicity.

GreenScreen Hazard Ratings: Trichloroethylene																			
Group I Human					Group II and II* Human									Ecotox		Fate		Physical	
C	M	R	D	E	AT	ST		N		SnS*	SnR*	IrS	IrE	AA	CA	P	B	Rx	F
						single	repeat*	single	repeat*										
H	**M**	**M**	*M*	**DG**	**L**	**L**	**M**	**M**	**L**	**M**	*L*	**H**	**H**	**M**	**M**	**vH**	**vL**	**L**	**L**

Note: Hazard levels [Very High (vH), High (H), Moderate (M), Low (L), Very Low (vL)] in *italics* reflect estimated values and lower confidence. Hazard levels in **BOLD** font reflect values based on test data (See Guidance). NE indicates no determination was made (conflicting data) and DG indicates insufficient data for assigning hazard level.

[1] Every chemical in a material or formulation should be assessed if it is:
1. intentionally added and/or
2. present at greater than or equal to 100 ppm.

[2] For inorganic chemicals with low human and ecotoxicity across all hazard endpoints and low bioaccumulation potential, persistence alone will not be deemed problematic. Inorganic chemicals that are only persistent will be evaluated under the criteria for Benchmark 4.

Green Screen Assessment Prepared By:
Name: Brian Penttila, Ph. D.
Title: Chemical Engineer
Organization: PNW Pollution Prevention Resource Center
Date: 30 June 2012

Quality Control Performed By:
Name: Alex Stone, Sc. D.
Title: Safer Chemical Alternative Chemist
Organization: WA Department of Ecology
Date: 17 April 2013

Transformation Products and Ratings: Identify relevant fate and transformation products (i.e., dissociation products, transformation products, valence states) and/or moieties of concern[3]

Functional Use	Life Cycle Stage	Transformation Pathway	Transformation Products	CAS #	On CPA Red List[4]?	Green Screen Rating[5]
N/A	N/A	atmospheric oxidation/photooxidation	dichloroacetic acid	79-43-6		
"	"	"	dichloroacetyl chloride	79-36-7		
"	"	"	formyl chloride	2565-30-2		
"	"	"	phosgene	75-44-5		
"	"	"	hydrochloric acid	7647-01-0		

Transformation Product Summary
The European Union risk assessment (European Union 2004, listed below) discusses the likely impact of transformation products from the environmental release of trichloroethylene. While toxic degradates are created by normal abiotic processes, the report suggests that impact of these is likely low due to rapid degradation of the transformation products. Transformation products may form by other mechanisms, e.g., anaerobic transformation to vinyl chloride, however the mechanisms are somewhat speculative. Additional details are available in the European Union risk assessment report.

Substance Background
Trichloroethylene (TCE) is a chlorinated solvent used mainly in metal cleaning. Common uses include vapor degreasing, and cold cleaning by dipping or wiping. Trichloroethylene is also used as an ingredient in adhesives, electrical equipment cleaners, and paint strippers, used mostly for industrial purposes (NICNAS 2000). Degreasing operations occur in many industries, including furniture and fixtures, fabricated metal products, electric and electronic equipment, transport equipment and miscellaneous manufacturing industries. TCE is also used in plastics, appliances, jewelry, automobile, plumbing fixtures, textiles, paper, glass and printing industries (IARC 1995).

Most trichloroethylene is produced from ethylene or 1,2-dichloroethene (ethylene dichloride) by chlorinating or oxychlorinating using catalysts. Oxychlorination is used to produce tetrachloroethylene and trichloroethylene at the same facility (crude production figures may therefore include both chemicals). The resulting trichloroethylene/ tetrachloroethylene mixture is separated by distillation. Trichloroethylene and tetrachloroethylene may also be produced from oxychlorination of residues derived from vinyl chloride monomer manufacture. Trichloroethylene can also be produced by the catalytic hydrogenation of tetrachloroethene (European Union 2004, IARC 1995).

A European Union Risk Assessment Report indicates that purity is typically > 99.9 % w/w. The significant impurities (where stated) comprised some or all of the following (expressed as % w/w): Tetrachloroethylene <0.03%,Vinylidene chloride <0.01%, 1, 1, 1-Trichloroethane <0.01%, Chloroform <0.01%, Carbon tetrachloride <0.005%, Dichloromethane <0.001%, Bromodichloromethane < 0.1%, Water - trace. The impurities present vary according to the plant and production method (European Union 2004).

A variety of additives may be used with trichloroethylene depending on the intended application (European Union 2004). Additives used as stabilizers present in trichloroethylene available from various suppliers included the following (% w/w): Thymol < 1%, Triethylamine < 1%, Trimethyloxirane < 0.45%, Ethyl acetate < 0.7%,2, 4, 4-

[3] A moiety is a discrete chemical entity that is a constituent part or component of a substance. A moiety of concern is often the parent substance itself for organic compounds. For inorganic compounds, the moiety of concern is typically a dissociated component of the substance or a transformation product.
[4] The CPA "Red List" refers to chemicals 1. flagged as Benchmark 1 using the GreenScreen™ List Translator or 2. flagged as Benchmark 1 or 2 using the GreenScreen™ List Translator and further assessed and assigned as Benchmark 1. The most recent version of the GreenScreen™ List Translator should be used.
[5] The way you conduct assessments for transformation products depends on the Benchmark Score of the parent chemical (See Guidance).

Green Screen Assessment Prepared By:
Name: Brian Penttila, Ph. D.
Title: Chemical Engineer
Organization: PNW Pollution Prevention Resource Center
Date: 30 June 2012

Quality Control Performed By:
Name: Alex Stone, Sc. D.
Title: Safer Chemical Alternative Chemist
Organization: WA Department of Ecology
Date: 17 April 2013

Trimethylpentene 0.25 - 0.3%, Butanone 0.22 - 0.22%, Epoxybutane 0.22 - 0.3%, 1-Methylpyrrole 0.02 - 0.022%, Diisopropylamine < 0.005%, 2 -Methyl-3 butan-2-ol < 4%, 2, 4-Di-tertbutylphenol <50 ppm, 1, 2-Butylene oxide <0.6%, Glycidyl ether < 0.8%. Additional information on impurities and additives are available in the IARC monograph (IARC 1995) and the National Industrial Chemicals Notification and Assessment Scheme (NICNAS 2000).

Trichloroethylene may be absorbed via inhalational, dermal and oral routes. Vapor inhalation is typically the most significant route of exposure in occupational settings. Absorbed trichloroethylene can readily cross the placental and blood brain barriers and is distributed throughout the body. TCE may be stored in adipose tissue and the liver. The liver is the primary site of metabolism. Major metabolites include trichloroethanol, trichloroacetic acid and trichloroethanol glucuronide. Minor metabolites may include chloral hydrate, monochloroacetic acid, dichloroacetic acid and N-acetyl dichlorovinyl cysteine. In both humans and animals TCE may be metabolized via conjugation with glutathione with the formation of dichlorovinyl cysteine in the kidneys. Absorbed trichloroethylene is typically excreted in urine as metabolites, but TCE may also be exhaled unchanged (NICNAS 2000).

The NICNAS report mentions species differences in the metabolism of trichloroethylene. The rate of metabolism of trichloroethylene to trichloroacetic acid occurs more rapidly in mice than in rats. Saturation of the oxidative pathway has is reported in rats at 200 to 500 mg/kg while in mice saturation occurs at 2000 mg/kg. Saturation is also predicted to occur in humans at 2000 mg/kg (from physiologically based pharmacokinetic [PBPK] models) (NICNAS 2000).

In the environment trichloroethylene may decompose to form acidic products such as hydrogen chlorides. At high temperatures TCE decomposes to form phosgene and hydrogen chloride. In the presence of moisture, highly corrosive dichloroacetic acid and hydrochloric acid may be formed. Additional decomposition products include: carbon monoxide, trichloroethylene ozonides and trichloroethylene epoxide (NICNAS 2000). Additional discussion of breakdown products and risk assessment are provided in the European Union Risk Assessment Report (European Union 2004).

References:

NICNAS 2000, Trichloroethylene-Priority Existing Chemical Assessment Report No. 8, http://www.nicnas.gov.au/Publications/CAR/PEC/PEC8/PEC_8_Full_Report_PDF.pdf, accessed February 2012.

European Union 2004, Risk Assessment Report for Trichloroethylene, http://esis.jrc.ec.europa.eu/doc/existing-chemicals/risk_assessment/REPORT/trichloroethylenereport018.pdf, accessed February 2012.

IARC 1995, IARC Monographs on the Evaluation of Carcinogenic Risks to Humans, Volume 63, Dry Cleaning, Some Chlorinated Solvents and Other Industrial Chemicals. Available at: http://monographs.iarc.fr/ENG/Monographs/vol63/mono63-6.pdf

Green Screen Assessment Prepared By:
Name: Brian Penttila, Ph. D.
Title: Chemical Engineer
Organization: PNW Pollution Prevention Resource Center
Date: 30 June 2012

Quality Control Performed By:
Name: Alex Stone, Sc. D.
Title: Safer Chemical Alternative Chemist
Organization: WA Department of Ecology
Date: 17 April 2013

Hazard Classification Summary Section:
Group I Human Health Effects (Group I Human)

Carcinogenicity (C) Score (H, M or L): H

Trichloroethylene (TCE) was assigned a score of High for carcinogenicity based on European Union (EU) classification as Carcinogenicity Category 1B, H350 "May cause cancer" (GreenScreen Authoritative A list).

- ECHA CLP harmonized classification for TCE is Category 1B carcinogen. European Commission 2012, ECHA C&L Inventory Database, available at: http://clp-inventory.echa.europa.eu/SummaryOfClassAndLabelling.aspx?SubstanceID=124309&HarmOnly=no?fc=true&lang=en , accessed February 2012.
- The US EPA recently completed a full toxicological review of TCE for IRIS. TCE was described as "carcinogenic to humans by all routes of exposure." US EPA 2011, Toxicological Review of Trichloroethylene for IRIS, p. 6-11, available at: http://www.epa.gov/iris/supdocs/0199index.html, accessed February 2012.

Mutagenicity/Genotoxicity (M) Score (H, M or L): M

Trichloroethylene was assigned a score of Medium for mutagenicity based on EU classification as Mutagenicity Category 2, H341 "Suspected of causing genetic defects" (GreenScreen Authoritative A list).

- ECHA CLP harmonized classification for TCE is H341 "Suspected of causing genetic defects" and Mutagenicity Category 2. European Commission 2012, ECHA C&L Inventory Database, available at: http://clp-inventory.echa.europa.eu/SummaryOfClassAndLabelling.aspx?SubstanceID=124309&HarmOnly=no?fc=true&lang=en , accessed February 2012.
- The US EPA recently completed a full toxicological review of TCE for IRIS. The review concludes that there is significant evidence for mutagenicity of TCE and/or its metabolites: "Thus, uncertainties with regard to the characterization of TCE genotoxicity remain, particularly because not all TCE metabolites have been sufficiently tested in the standard genotoxicity screening battery to derive a comprehensive conclusion. However, the metabolites that have been tested, particularly DCVC [dichlorovinyl cysteine], have predominantly resulted in positive data, although to a lesser extent in DCVG [S-dichlorovinyl-glutathione] and NAcDCVC [N-Acetyl-S-dichlorovinyl-L-cysteine]. This supports the conclusion that these compounds are genotoxic, particularly in the kidney, where in situ metabolism produces and/or bioactivates these TCE metabolites." US EPA 2011, Toxicological Review of Trichloroethylene for IRIS, p. 4-83, available at: http://www.epa.gov/iris/supdocs/0199index.html, accessed February 2012.

Reproductive Toxicity (R) Score (H, M, or L): M

Trichloroethylene was assigned a score of Moderate for reproductive toxicity based on evidence suggesting male reproductive toxicity in animal models consistent with GHS Category 2.

- European Union 2004, Risk Assessment Report for Trichloroethylene, available at: http://esis.jrc.ec.europa.eu/doc/existing-chemicals/risk_assessment/REPORT/trichloroethylenereport018.pdf, accessed February 2012: An EU risk assessment report (RAR) concludes that
  - "In animals, the effects of long-term oral administration on fertility and reproductive performance have been extensively investigated in rats and mice. Trichloroethylene was shown to have some influences on reproduction and only at exposure levels that produce general toxicity. The observed effects included reduced sperm motility and reductions in neonatal bodyweight and survival in mice at high-dose levels and, in rats, disrupted copulatory behavior and reduced pup survival at high-dose levels, and reductions in the litter size and number of litters born to continuously bred animals. NOAELs for reproductive effects were 350 mg/kg/day in mice and 75 mg/kg/day in rats."
  - "Two studies in mice have suggested that short-term repeated inhalation exposure can influence sperm morphology; a NOAEL for this effect was 200 ppm. However, effects on sperm morphology were not seen

in rats, nor in large-scale studies in which mice received long-term exposure to high levels of trichloroethylene by the oral route."
  - "It is not possible to draw any firm conclusions about the reproductive toxicity of trichloroethylene on the basis of the available human data."
- The US EPA recently completed a full toxicological review of TCE for IRIS. The analysis suggests that male reproductive effects seen in mice are relevant to human toxicokinetics and mode-of-action:
  - "The toxicological database for TCE includes a number of studies that demonstrate adverse effects on the integrity and function of the reproductive system in females and males. Both the epidemiological and animal toxicology databases provide suggestive, but limited, evidence of adverse outcomes to female reproductive outcomes. However, much more extensive evidence exists in support of an association between TCE exposures and male reproductive toxicity. The available epidemiological data and case reports that associate TCE with adverse effects on male reproductive function are limited in size and provide little quantitative dose data (Lamb and Hentz, 2006). However, the animal data provide extensive evidence of TCE-related male reproductive toxicity. Strengths of the database include the presence of both functional and structural outcomes, similarities in adverse treatment-related effects observed in multiple species, and evidence that metabolism of TCE in male reproductive tract tissues is associated with adverse effects on sperm measures in both humans and animals (suggesting that the murine model is appropriate for extrapolation to human health risk assessment). Additionally, some aspects of a putative mode of action (e.g., perturbations in testosterone biosynthesis) appear to have some commonalities between humans and animals." US EPA 2011, Toxicological Review of Trichloroethylene for IRIS, available at: http://www.epa.gov/iris/supdocs/0199index.html, p 4-493, accessed February 2012. [References internal to the assessment.]

Developmental Toxicity incl. Developmental Neurotoxicity (D) Score (H, M or L): *M*

Trichloroethylene was assigned a score of Moderate for developmental toxicity based on evidence from animal studies consistent with GHS Category 2.

- A 2004 EU risk assessment report concludes that:
  - "The developmental toxicity of inhaled trichloroethylene at non-maternally toxic levels (up to 1,800 ppm) has been investigated in rats, mice and rabbits in conventional studies. No evidence of developmental toxicity was reported. In contrast, the results of a series of non-standard oral studies in rats raised some concerns about the potential for trichloroethylene to induce developmental neurotoxicity at dose levels in the range of 30-110 mg/kg/day. However, these studies were of limited scope and were considered not to provide sufficient basis on which to draw clear conclusions about the hazardous properties of trichloroethylene. To be able to draw clear conclusions regarding developmental neurotoxicity, further testing according to the draft OECD TG 426 Developmental Neurotoxicity guideline would be required." European Union 2004, Risk Assessment Report for Trichloroethylene, available at: http://esis.jrc.ec.europa.eu/doc/existing-chemicals/risk_assessment/REPORT/trichloroethylenereport018.pdf, accessed February 2012.
- The US EPA recently completed a full toxicological review of TCE for IRIS:
  - "In summary, an overall review of the weight of evidence in humans and experimental animals is suggestive of the potential for developmental toxicity with TCE exposure. A number of developmental outcomes have been observed in the animal toxicity and the epidemiological data, as discussed below. These include adverse fetal/birth outcomes including death (spontaneous abortion, perinatal death, pre- or postimplantation loss, resorptions), decreased growth (low birth weight, SGA [small for gestational age], IUGR [intrauterine growth restriction], decreased postnatal growth), and congenital malfor-mations, in particular cardiac defects. Postnatal developmental outcomes include developmental neurotoxicity, developmental immunotoxicity, and childhood cancer." US EPA 2011, Toxicological Review of Trichloroethylene for IRIS, available at: http://www.epa.gov/iris/supdocs/0199index.html, p. 4-556, accessed February 2012.
  - "Therefore, overall, based on weakly suggestive, but overall consistent, epidemiologic data, in combination with evidence from experimental animal and mechanistic studies, it can be concluded that TCE exposure

Green Screen Assessment Prepared By:
Name: Brian Penttila, Ph. D.
Title: Chemical Engineer
Organization: PNW Pollution Prevention Resource Center
Date: 30 June 2012

Quality Control Performed By:
Name: Alex Stone, Sc. D.
Title: Safer Chemical Alternative Chemist
Organization: WA Department of Ecology
Date: 17 April 2013

poses a potential hazard for congenital malformations, including cardiac defects, in offspring." US EPA 2011, Toxicological Review of Trichloroethylene for IRIS, available at: http://www.epa.gov/iris/supdocs/0199index.html, p. 6-11, accessed February 2012.

Endocrine Activity (E) Score (H, M or L): DG
Trichloroethylene was assigned a score of Data Gap for endocrine activity based on lack of data.

- TCE not listed as an endocrine disruptor in the following lists:
  - European Union Priority List of suspected endocrine disruptors.
  - OSPAR Convention for The Protection of the Marine Environment of the North-East Atlantic, List of Chemicals for Priority Action and List of Substances of Possible Concern
  - International Chemical Secretariat (ChemSec) Substitute it Now (SIN) List 2.0
  - The Endocrine Disruptor Exchange (TEDX) List of Potential Endocrine Disruptors
- No specific test data excluding endocrine activity was identified.

Group II and II* Human Health Effects (Group II and II* Human)
Note: Group II and Group II* endpoints are distinguished in the v 1.2 Benchmark system. For Systemic Toxicity and Neurotoxicity, Group II and II* are considered sub-endpoints and test data for single or repeated exposures may be used. If data exist for single OR repeated exposures, then the endpoint is not considered a data gap. If data are available for both single and repeated exposures, then the more conservative value is used.

Acute Mammalian Toxicity (AT) Group II Score (vH, H, M or L): L

Trichloroethylene was assigned a score of Low for acute mammalian toxicity based on lethal dose/concentration data in animal studies consistent with a low level-of-concern by all exposure pathways.

- European Union 2004, Risk Assessment Report for Trichloroethylene, available at: http://esis.jrc.ec.europa.eu/doc/existing-chemicals/risk_assessment/REPORT/trichloroethylenereport018.pdf, accessed February 2012:
  - Oral LD_{50}: "Values for trichloroethylene have been reported in the range 5,400 to 7,200 mg/kg body weight in rats and about 2,900 mg/kg in mice, the substance being given undiluted, in water or in vegetable oil (Aviado et al., 1976; Domenico et al., 1977; Jones et al., 1958; Kinkead and Wolfe, 1980; Smyth et al., 1962; Smyth et al., 1969)."
  - Dermal LD_{50}: "The LD50 value of trichloroethylene in rabbits when administered by the dermal route, using an occlusive dressing, has been reported as being greater than 29,000 mg/kg body weight (Smyth et al., 1962; Smyth et al., 1969). In another study, the LD_{50} value in the rabbit following a 24-hour exposure with a semi-occlusive dressing was reported to be > 20,000 mg/kg (Kinkead and Wolfe, 1980). No further details were given. No deaths occurred in guinea-pigs following dermal application of 7,800 mg/kg body weight of trichloroethylene using a similar method: the only sign of toxicity noted was reduced weight gain during the 35-day post-exposure observation period (Wahlberg and Boman, 1979)."
  - Inhalation LC_{50}: "In summary, 4-hour LC_{50} values of 12,000 ppm (65 mg/l) and 8,450 ppm (46 mg/l) have been reported for rat and mouse, respectively. The main signs of toxicity observed were those typical of CNS depression."

Systemic Toxicity/Organ Effects incl. Immunotoxicity (ST)
Group II Score (single dose: vH, H, M or L): L

Trichloroethylene was assigned a score of Low for systemic toxicity/organ effects based on single exposure as the only toxicologically significant results were for neurotoxicity (reported separately in the GreenScreen Neurotoxicity endpoint).

- ECHA CLP harmonized classification for TCE is STOT SE 3 for central nervous system effects. European Commission 2012, ECHA C&L Inventory Database, available at: http://clp-

inventory.echa.europa.eu/SummaryOfClassAndLabelling.aspx?SubstanceID=124309&HarmOnly=no?fc=true&lang=en , accessed February 2012.

- European Union 2004, Risk Assessment Report for Trichloroethylene, available at: http://esis.jrc.ec.europa.eu/doc/existing-chemicals/risk_assessment/REPORT/trichloroethylenereport018.pdf, accessed February 2012:
  - "Following single oral doses of trichloroethylene, LD_{50} values in the range 5,400 to 7,200 mg/kg body weight were reported for rats. A lower value, 2,900 mg/kg, was obtained for mice. CNS depression and effects on the liver (fatty infiltration, transient increases in serum enzyme markers of hepatic dysfunction) were the only signs of toxicity reported. Transient liver effects not significant enough for Category 1 or 2."
  - "Overall, the NOAEL for single inhalation exposures of animals to trichloroethylene are 400 ppm for 6 hours, 500 ppm for 4 hours, although subtle transient effects on mouse lung Clara cells were seen at 20 ppm for 6 hours; there was evidence to suggest that these effects have a high degree of species specificity. In general, mice were more sensitive to the toxic effects of single inhalation exposures to trichloroethylene than rats, and in all species in which alcohol pre-treatment was used, the effects of trichloroethylene were enhanced. Mode of action studies has indicated that the pulmonary toxicity seen in mice is unlikely to be of relevance to humans."

Group II* Score (repeated dose: H, M, L): M

Trichloroethylene was assigned a score of Moderate based on animal data consistent with GHS Category 2 for nephrotoxicity. The US EPA assessment reports evidence of human immunotoxicity combined with high confidence for animal immunotoxicity at doses consistent with GHS Category 1, but these results require interpretation of highly complex PBPK (physiologically based pharmacokinetic) modeling. Given the established High level-of-concern for carcinogenicity, TCE would remain a Benchmark 1 chemical regardless of the interpretation of its target organ toxicity. Further expert review of this data may be warranted for applications where TCE is chosen for use in spite of its Benchmark 1 status.

- European Union 2004, Risk Assessment Report for Trichloroethylene, available at: http://esis.jrc.ec.europa.eu/doc/existing-chemicals/risk_assessment/REPORT/trichloroethylenereport018.pdf, accessed February 2012:
  - "In animals, kidney toxicity appears to be the most sensitive endpoint for both long-term repeated inhalation and oral exposure. Comparing the human and animal data, there are no reports of trichloroethylene-related kidney toxicity in the human studies, but this endpoint has not been properly investigated in humans. Therefore, because of the paucity of human data for this endpoint, the animal data must be considered in the risk characterization."
    - PPRC: There is uncertainty about whether this mode of action is relevant to humans, but no data is available to rule it out. See pp. 148 and 190 of the report and additional data below.
  - "Overall, kidney toxicity appears to be the most sensitive endpoint for both long-term repeated inhalation and oral exposure. For inhalation exposure, the NOAEL is 100 ppm. For oral exposure a NOAEL of 50 mg/kg/day be identified."
    - PPRC: Inhalation NOAEL for kidney toxicity translates to 0.5 mg/L (100 ppm).
- REACH registration dossier available at: http://apps.echa.europa.eu/registered/data/dossiers/DISS-9c83a2d3-4a9f-1ff5-e044-00144f67d249/AGGR-3274bb6e-6dcb-4e5d-a449-c825f7dbcce7_DISS-9c83a2d3-4a9f-1ff5-e044-00144f67d249.html, accessed February 2012:
  - 1986 non-GLP study of carcinogenesis (reliability 2). 52 weeks, 4 or 5 days/wk, oral gavage. Evidence of general toxicity was limited to the observation of kidney tubule meganucleocytosis in 47% of males at 250 mg/kg/day only; females were not affected.
    - PPRC: LOAEL of 250 mg/kg/day corresponds to Low level-of-concern, but borders the Moderate range (<200 mg/kg/day). Only two dosages were studied, with 50 mg/kg/day showing no effects.
  - 1986 non-GLP study of carcinogenesis (reliability 2). Sprague-Dawley rates (male/female, >90 or each); 104 weeks, 5 days/wk, 7 hrs/day, inhalation exposure. Evidence of non-cancer toxicity was limited to the observation of kidney tubule meganucleocytosis in male rats of the 300 (incidence 20%) and 600 (78%) ppm groups. A NOAEL for kidney toxicity of 100 ppm can be identified from these data.

  - PPRC: LOAEL of 300 ppm translates to 1.6 mg/L or Low level-of-concern.
- The US EPA recently completed a full toxicological review of TCE for IRIS. The US EPA assessment of human and animal data reports (US EPA 2011, Toxicological Review of Trichloroethylene for IRIS, http://cfpub.epa.gov/ncea/iris/index.cfm?fuseaction=iris.showQuickView&substance_nmbr=0199, accessed February 2012):
  - Regarding nephrotoxicity: "Overall, multiple lines of evidence support the conclusion that TCE causes nephrotoxicity in the form of tubular toxicity, mediated predominantly through the TCE GSH conjugation product DCVC." p. 4-623.
  - Regarding immunotoxicity: "In summary, TCE treatment induces and exacerbates autoimmune disease in genetically susceptible strains of mice, and has also been shown to induce signs of autoimmune disease in a nongenetically predisposed strain. Although the mechanism for this response is not fully understood, a number of studies have been conducted to examine this issue. The primary conclusion to date is that metabolism of the TCE to its chloral or DCA metabolites is at least partially responsible for activating T-cells or altering T-cell regulation and survival associated with polyclonal disease in susceptible mice strains." [p. 4-424]
  - Additional discussion on immunotoxicity: "The human and animal studies of TCE and immune-related effects provide strong evidence for a role of TCE in autoimmune disease and in a specific type of generalized hypersensitivity syndrome. The data pertaining to immunosuppressive effects is weaker. It should also be noted that immune-related and inflammatory effects, particularly cell-mediated immunity involving cytokine production and activation of macrophages and NK cells, may influence a variety of other conditions of considerable public health importance, including cancer (tumor surveillance) and atherosclerosis. Thus, the relevance of immune-related effects of TCE are not limited to diseases affecting organs and tissues within the immune system." [p. 4-427]
  - Hazard summary on immunotoxicity: "Overall, the human and animal studies of TCE and immune-related effects provide strong evidence for a role of TCE in autoimmune disease and in a specific type of generalized hypersensitivity syndrome, while there are less data pertaining to immunosuppressive effects." [p. 6-8]
- US EPA Integrated Risk Information System Quickview for Trichloroethylene, available at: http://www.epa.gov/iris/subst/0199.htm, accessed May 2012:
  - US EPA IRIS Quickview: "For adult and developmental immunological effects, there is high confidence in the evidence of immunotoxic hazard from TCE. However, the available dose-response data for the most sensitive immunological effects (Keil et al., 2009; Peden-Adams et al., 2006) precluded application of BMD modeling. There are inadequate data on the active moiety for TCE-induced immunological effects, so PBPK modeling applied to Keil et al. (2009) used a generic dose metric. The PBPK model could not be applied to Peden-Adams et al. (2006) due to a lack of data on gestational and lactational transfer. Thus, due to the high confidence in the immunotoxic hazard coupled with the quantitative uncertainties in the dose-response assessment, the confidence in candidate RfDs derived from these studies is characterized as medium-to-high."
  - For the Peden-Adams et al. 2006 study, US EPA reports "POD= 0.37 mg/kg/day is the applied dose LOAEL (estimated daily dam dose).

Neurotoxicity (N)
Group II Score (single dose: vH, H, M or L): M

Trichloroethylene was assigned a score of Moderate for neurotoxicity based on single exposure European Union harmonized classification as GHS Category 3 (GreenScreen Authoritative A list).

- The EU classifies TCE as H336 "May cause drowsiness or dizziness" and STOT SE 3 for CNS depression. H336 translates to Moderate or Low level-of-concern. STOT SE 3 translates to Moderate level-of-concern. European Commission 2012, ECHA C&L Inventory Database, available at: http://clp-inventory.echa.europa.eu/SummaryOfClassAndLabelling.aspx?SubstanceID=124309&HarmOnly=no?fc=true&lang=en, accessed February 2012.

Green Screen Assessment Prepared By:
Name: Brian Penttila, Ph. D.
Title: Chemical Engineer
Organization: PNW Pollution Prevention Resource Center
Date: 30 June 2012

Quality Control Performed By:
Name: Alex Stone, Sc. D.
Title: Safer Chemical Alternative Chemist
Organization: WA Department of Ecology
Date: 17 April 2013

- Grandjean & Langridan list TCE as a known neurotoxicant. This translates to GreenScreen vH, H or M. Grandjean & Landrigan 2006, Developmental neurotoxicity of industrial chemicals, Lancet, v. 368: 2167–78.

Group II* Score (repeated dose: H, M, L): L

Trichloroethylene was assigned a score of Low for neurotoxicity based on European Union harmonized classification as H336 (GreenScreen Authoritative B List; report Low).

- The EU classifies TCE as H336 "May cause drowsiness or dizziness." EU H336 is listed as Authoritative B and translates to Moderate to Low level-of-concern (GreenScreen List Translator). European Commission 2012, ECHA C&L Inventory Database, available at: http://clp-inventory.echa.europa.eu/SummaryOfClassAndLabelling.aspx?SubstanceID=124309&HarmOnly=no?fc=true&lang=en, accessed February 2012.
- European Union 2004, Risk Assessment Report for Trichloroethylene, http://esis.jrc.ec.europa.eu/doc/existing-chemicals/risk_assessment/REPORT/trichloroethylenereport018.pdf, accessed February 2012:
  - "Overall, taking a precautionary stance in view of uncertainties regarding causal and dose-response relationships, functional CNS disturbance is considered to be the most sensitive endpoint in humans. The majority of Member States considered that a NOAEL of 50 ppm could be identified from the available human data. This value is therefore taken forward to the risk characterization for repeated exposure. However, it is noted that in animal studies, a clear NOAEL for neurotoxicity of 200 ppm has been identified for long-term inhalation exposure to trichloroethylene. In view of this, and given the uncertainties surrounding the identification of a reliable NOAEL for humans from the available data, it is possible that actual NOAEL for neurotoxicity in humans may be higher than 50 ppm." [p. 190]
    - PPRC: The 200 ppm dose appears to be an error based on additional data in the RAR report (see below). In any case, inhalation NOAEL for CNS in animals converts to 1 mg/L (200 ppm). This would indicate a LOAEL above 1 mg/L, consistent with a GHS Not Classified.
  - "Overall, giving most weight to the well-conducted 13-week study from The Dow Chemical Company (1993), a NOAEL of 250 ppm can be identified for neurotoxicity for long-term repeated exposure to trichloroethylene. At lower levels subtle changes have been observed in some studies, but these were of doubtful significance with respect to human health." [pp. 151-2]
    - PPRC: Inhalation NOAEL for CNS in animals translates to 1.3 mg/L (250 ppm). USEPA DfE criteria use NOAEL/LOAEL above 1 mg/L to indicate a low level-of-concern. 250 ppmV/6-hr/day is on the upper border of the dose range for GHS Category 2.
- US EPA 2011, Toxicological Review of Trichloroethylene for IRIS, available at: http://cfpub.epa.gov/ncea/iris/index.cfm?fuseaction=iris.showQuickView&substance_nmbr=0199, accessed February 2012:
  - "Therefore, overall, the strongest neurological evidence of human toxicological hazard is for changes in trigeminal nerve function or morphology and impairment of vestibular function, based on both human and experimental studies, while fewer and more limited evidence exists for delayed motor function, changes in auditory, visual, and cognitive function or performance, and neurodevelopmental outcomes." [p. 6-5]
- Grandjean & Langridan list TCE as a known neurotoxicant. This translates to GreenScreen vH, H or M. Grandjean & Landrigan 2006, Developmental neurotoxicity of industrial chemicals, Lancet, v. 368: 2167–78.

Skin Sensitization (SnS) Group II* Score (H, M or L): M

Trichloroethylene was assigned a score of Moderate for skin sensitization based on animal data consistent with GHS Category 1B. While human skin sensitization appears to be rare, GHS guidance states that "[n]egative human data should not normally be used to negate positive results from animal studies."

- EU RAR: "There are no data available from studies in animals on the potential of trichloroethylene to cause either skin or respiratory sensitization. In humans, there have been a few cases of individuals exposed to trichloroethylene apparently developing skin sensitization to the substance, but the sparsity of such cases and the extensive use of trichloroethylene suggest that skin sensitization is a highly idiosyncratic reaction and the substance should not be classified as a skin sensitizer." European Union 2004, Risk Assessment Report for

Trichloroethylene, http://esis.jrc.ec.europa.eu/doc/existing-chemicals/risk_assessment/REPORT/trichloroethylenereport018.pdf, accessed February 2012:

- REACH datasheet submission available at ECHA http://apps.echa.europa.eu/registered/data/dossiers/DISS-9c83a2d3-4a9f-1ff5-e044-00144f67d249/AGGR-3274bb6e-6dcb-4e5d-a449-c825f7dbcce7_DISS-9c83a2d3-4a9f-1ff5-e044-00144f67d249.html, accessed February 2012:
  - 2002, non-GLP-compliant, reliability 2 study: Intradermal induction at 10% wt./wt. "Trichloroethylene was considered a strong sensitizer, based on its sensitization rate (71.4%) and mean sensitization score (score of redness (22) / score of swelling (10) = 2.3)." Modified Magnusson & Kligman (GMPT) test [Guinea pig maximization test].
    - PPRC: ≥ 30% of animals responding at > 1% for intradermal induction dose corresponds to GHS sub-category 1B (GHS Rev. 4).
  - 2010, GLP-compliant, reliability 1 study: "The SI values calculated for the substance concentrations 5, 25 and 100% were 1.2, 3.6 and 14.1 respectively. These results indicate that the test substance could elicit an SI ≥ 3. An EC3 value (the estimated test substance concentration that will give a SI =3) of 20.0% was calculated. Based on these results and according to the recommendations made in the test guidelines, trichloroethylene would be regarded as skin sensitizer." OECD TG 429.
    - PPRC: EC3 value > 2% suggests GHS sub-category 1B (GHS Rev. 4).

Respiratory Sensitization (SnR) Group II* Score (H, M or L): *L*

Trichloroethylene was assigned a score of Low for respiratory sensitization based on lack of evidence for sensitization despite extensive use and study of TCE.

- EU-RAR: "There have been no reports of respiratory sensitization in humans. Given the large number of people that have been exposed to trichloroethylene by the inhalation route and considering the general toxicological characteristics of trichloroethylene, all the evidence indicates that this substance is not a respiratory sensitizer." European Union 2004, Risk Assessment Report for Trichloroethylene, http://esis.jrc.ec.europa.eu/doc/existing-chemicals/risk_assessment/REPORT/trichloroethylenereport018.pdf, accessed February 2012.

Skin Irritation/Corrosivity (IrS) Group II Score (vH, H, M or L): **H**

Trichloroethylene was assigned a score of High for skin irritation/corrosivity based on EU GHS classification as Category 2 consistent with GreenScreen high level-of-concern (GreenScreen authoritative source). Authoritative EU sources rank either high or moderate. Conservative interpretation suggests High rank.

- The European Union classifies TCE as Category 2, H315 "Causes skin irritation." EU H-statements are authoritative and H315 is consistent with a high level-of-concern. European Commission 2012, ECHA C&L Inventory Database, available at: http://clp-inventory.echa.europa.eu/SummaryOfClassAndLabelling.aspx?SubstanceID=124309&HarmOnly=no?fc=true&lang=en , accessed February 2012.
- EU-RAR: Xi; R36/38, also irritating to eyes and skin. EU R-phrases are authoritative and R38 is consistent with a GreenScreen high level-of-concern. European Union 2004, Risk Assessment Report for Trichloroethylene, http://esis.jrc.ec.europa.eu/doc/existing-chemicals/risk_assessment/REPORT/trichloroethylenereport018.pdf, accessed February 2012.

Eye Irritation/Corrosivity (IrE) Group II Score (vH, H, M or L): **H**

Trichloroethylene was assigned a score of High for eye irritation/corrosivity based on EU classification as Category 2 (GreenScreen authoritative source).

- The European Union classifies TCE as Category 2, H319 "Causes serious eye irritation European Commission 2012, ECHA C&L Inventory Database, available at: http://clp-inventory.echa.europa.eu/SummaryOfClassAndLabelling.aspx?SubstanceID=124309&HarmOnly=no?fc=true&lang=en , accessed February 2012.

Green Screen Assessment Prepared By:
Name: Brian Penttila, Ph. D.
Title: Chemical Engineer
Organization: PNW Pollution Prevention Resource Center
Date: 30 June 2012

Quality Control Performed By:
Name: Alex Stone, Sc. D.
Title: Safer Chemical Alternative Chemist
Organization: WA Department of Ecology
Date: 17 April 2013

- EU-RAR reports Xi; R36/38, also irritating to eyes and skin. GreenScreen List Translator indicates High or Moderate level-of-concern. European Union 2004, Risk Assessment Report for Trichloroethylene, http://esis.jrc.ec.europa.eu/doc/existing-chemicals/risk_assessment/REPORT/trichloroethylenereport018.pdf, accessed February 2012.

Ecotoxicity (Ecotox)

Acute Aquatic Toxicity (AA) Score (vH, H, M or L): M

Trichloroethylene was assigned a score of Moderate for acute aquatic toxicity based on animal test data consistent with GHS Category Acute 3 and EU risk phrase R52 (GreenScreen Authoritative A list).

- European Union 2004, Risk Assessment Report for Trichloroethylene, http://esis.jrc.ec.europa.eu/doc/existing-chemicals/risk_assessment/REPORT/trichloroethylenereport018.pdf, accessed February 2012:
  - Fish: A variety of studies with different species, 96 hr tests, both static and flow-through, LC_{50}s typically on the order of 20-60 mg/L. GHS Category Acute 3
  - R52-53 Harmful to aquatic organisms; May cause long-term adverse effects in the aquatic environment.
- IUCLID datasheet submission available at ECHA http://apps.echa.europa.eu/registered/data/dossiers/DISS-9c83a2d3-4a9f-1ff5-e044-00144f67d249/AGGR-3274bb6e-6dcb-4e5d-a449-c825f7dbcce7_DISS-9c83a2d3-4a9f-1ff5-e044-00144f67d249.html, accessed February 2012:
  - Invertebrates: Water flea (Daphnia magna), static, closed, 48 hour, Dutch std. method Concept NEN 6501, IC_{50} = 20.8 mg/l [Hermens et al. (1984)].
  - Invertebrates: 1986, non-GLP-compliant, reliability 2 study, guideline not specified: Americamysis bahia (reported as Mysidopsis bahia), exposure in closed glass containers, 96 hr LC_{50} = 14 mg/L.
  - Plants: 1994, non-GLP-compliant, reliability 2 study: 72 hr growth test with Chlamydomonas reinhardtii [green algae]. Sealed test cell method to better maintain exposure with volatile test agents. EC_{50} = 36.5 mg/L.
- European Commission 2012, ECHA C&L Inventory Database, available at: http://clp-inventory.echa.europa.eu/SummaryOfClassAndLabelling.aspx?SubstanceID=124309&HarmOnly=no?fc=true&lang=en , accessed February 2012: H412 "Harmful to aquatic life with long lasting effects."

Chronic Aquatic Toxicity (CA) Score (vH, H, M or L): M

Trichloroethylene was assigned a score of Medium for chronic aquatic toxicity based on EU R53 (GreenScreen Authoritative A list).

- European Union 2004, Risk Assessment Report for Trichloroethylene, http://esis.jrc.ec.europa.eu/doc/existing-chemicals/risk_assessment/REPORT/trichloroethylenereport018.pdf, accessed February 2012: "R52-53 "Harmful to aquatic organisms"; May cause long-term adverse effects in the aquatic environment."
- European Commission 2012, ECHA C&L Inventory Database, available at: http://clp-inventory.echa.europa.eu/SummaryOfClassAndLabelling.aspx?SubstanceID=124309&HarmOnly=no?fc=true&lang=en , accessed February 2012: H412 "Harmful to aquatic life with long lasting effects."

Environmental Fate (Fate)

Persistence (P) Score (vH, H, M, L, or vL): vH

Trichloroethylene was assigned a score of very High for persistence based on its half-life in air.

- Environment Canada lists TCE as "Yes" for Persistence. The GreenScreen List Translator indicates Very High or High level-of-concern. Environment Canada Categorization Decisions for Substances on the Domestic Substance List (DSL), http://www.ec.gc.ca/lcpe-cepa/default.asp?lang=En&n=5F213FA8-1&wsdoc=D031CB30-B31B-D54C-0E46-37E32D526A1F

- European Union 2004, Risk Assessment Report for Trichloroethylene, http://esis.jrc.ec.europa.eu/doc/existing-chemicals/risk_assessment/REPORT/trichloroethylenereport018.pdf, accessed February 2012:
  - "Trichloroethylene undergoes reactions with hydroxyl radicals in the atmosphere. The half-life of trichloroethylene due to this reaction is about one week. Trichloroethylene also reacts with ozone and nitrogen oxide in the atmosphere but with longer half lives under environmental conditions. Trichloroethylene can also react with chlorine atoms in the atmosphere. Overall, trichloroethylene is rapidly degraded in the atmosphere. Hydrolysis is not likely to be a significant removal process for trichloroethylene."
  - Closed bottle test (OECD guideline 301D). 2-10 mg/l trichloroethylene incubated with industrial activated sludge; 19% degradation after 28 days, Rott et al. (1982). Not readily biodegradable.
  - The results of biodegradation tests are variable. Trichloroethylene is not readily biodegradable according to the OECD test (301D) and is only slightly degraded in aerobic studies. Not readily biodegradable.
- US EPA PBT Profiler: Fate model predicts that 42% of TCE will reside in the air-phase. TCE is volatile and will partition substantially to air.US EPA PBT Profiler, http://www.pbtprofiler.net/default.asp (Appendix X).
- PPRC: TCE is volatile and will partition substantially to the air-phase. Half-life in air is on the order of 7 days.

Bioaccumulation (B) Score (vH, H, M, L, or vL): vL

Trichloroethylene was assigned a score of very Low for bioaccumulation based on measured values of BCF and log K_{ow}.

- European Union 2004, Risk Assessment Report for Trichloroethylene, http://esis.jrc.ec.europa.eu/doc/existing-chemicals/risk_assessment/REPORT/trichloroethylenereport018.pdf, accessed February 2012:
  - "In summary, bioaccumulation does not appear to occur to a significant extent. Whole body bioaccumulation factors measured for fish range from 17 to 90. Preference is given to results from flow through studies with concentration monitoring, such as Barrows et al. (1980). The bioconcentration factor predicted from Kow using the equation in the TGD is 17.6. This value is in good agreement with the Barrows et al. (1980) and Korte and Freitag (1984) results, and will be used in the assessment of risk from secondary poisoning."
  - "A log Kow of 2.6 for trichloroethylene is reported in The Official Journal of the European Communities (1992). It is not clear how this value was determined. The consolidated IUCLID data set presents values of 2.29 (measured) and 2.42 (calculated); the former value is reported in Rogers and McFarlane (1981), the latter in Hansch and Leo (1979, 1985). Further values of 2.42 and 2.98 are reported in Banerjee et al. (1980) and Korte and Greim (1981) respectively. The measured value of 2.29 will be used for modeling purposes."
- PPRC: Measured BCF values (≤ 100) reported in the EU RAR suggest very Low level-of-concern. Measured and calculated log K_{ow} values (≤ 4) also suggest very Low level of concern.

Physical Hazards (Physical)

Reactivity (Rx) Score (vH, H, M or L): L

Trichloroethylene was assigned a score of Low for reactivity based on a chemical structure inconsistent with explosive, reactive or oxidizing properties as reported by NITE/Japan and the EU RAR.

- Japanese National Institute of Technology and Evaluation (NITE), ID161 in the Microsoft Excel workbook found at http://www.safe.nite.go.jp/english/files/ghs_xls/classification_result_e(479chems).xls, accessed February 2012: NITE/Japan reports that classification is "not applicable" due to TCE "[c]ontaining no chemical groups with explosive properties."
- European Union 2004, Risk Assessment Report for Trichloroethylene, http://esis.jrc.ec.europa.eu/doc/existing-chemicals/risk_assessment/REPORT/trichloroethylenereport018.pdf, accessed February 2012:
  - According to the consolidated IUCLID data set, trichloroethylene is not explosive. However, violent decomposition is possible under certain conditions in the presence of aluminium (Metz and Roedig, 1949;

Archer and Simpson, 1977). Commercial grades of trichloroethylene have stabilizers added to prevent such reactions in normal use and storage.

- According to the consolidated IUCLID data set, trichloroethylene does not have oxidizing properties. This is consistent with the structure.

Flammability (F) Score (vH, H, M or L): L

Trichloroethylene was assigned a score of Low for flammability based on no measured flash point consistent with GHS "Not classified."

- REACH datasheet submission available at ECHA http://apps.echa.europa.eu/registered/data/dossiers/DISS-9c83a2d3-4a9f-1ff5-e044-00144f67d249/AGGR-3274bb6e-6dcb-4e5d-a449-c825f7dbcce7_DISS-9c83a2d3-4a9f-1ff5-e044-00144f67d249.html, accessed February 2012: 1975, reliability 2 study: "The substance has no flashpoint. Under certain conditions the substance can form flammable vapor/air mixtures which under normal circumstances are difficult to ignite. Classification as a flammable substance however is not required."
- European Union 2004, Risk Assessment Report for Trichloroethylene, http://esis.jrc.ec.europa.eu/doc/existing-chemicals/risk_assessment/REPORT/trichloroethylenereport018.pdf, accessed February 2012: "No flash point was presented in the consolidated IUCLID data set. Trichloroethylene does not have a flash point or fire point according to the chemical handbooks...Trichloroethylene would not be classified as "flammable" and it is unlikely that trichloroethylene would be flammable except in unusual circumstances - perhaps where vapor is contained in a sealed vessel and exposed to high energy ignition sources."

References

References provided within individual endpoint results.

Green Screen Assessment Prepared By:
Name: Brian Penttila, Ph. D.
Title: Chemical Engineer
Organization: PNW Pollution Prevention Resource Center
Date: 30 June 2012

Quality Control Performed By:
Name: Alex Stone, Sc. D.
Title: Safer Chemical Alternative Chemist
Organization: WA Department of Ecology
Date: 17 April 2013

Abbreviations / Acronyms / Initialisms

ASTDR	Agency for Toxic Substances and Disease Registry
CAMEO	CAMEO Chemicals Database of Hazardous Materials
CEPA-DSL	Canadian EPA Domestic Substances List
ChemSec	International Chemical Secretariat [prepares the Substitute it Now (SIN) List]
CPA	Clean Production Action
ECCSP	Environment Canada Chemical Substances Portal
EC-EDD	European Commission endocrine disrupting substance database
ECHA C&L	ECHA Classification and Labeling Inventory Database
ECHA	European Chemicals Agency
EPA HPV	US EPA High Production Volume Information System
EPA SRS	US EPA Substance Registry System
ESIS	European chemical Substances Information System
EU	European Union
GHS	Globally Harmonized System (of classification and labeling)
HSDB	Hazardous Substances Data Bank
IARC	International Agency for Research on Cancer
IPCS	International Program on Chemical Safety
IRIS	Integrated Risk Information System (US EPA)
ISSCAN	Chemical carcinogens database (Italy)
J-Check	Japan Chemicals Cooperative Knowledge database
KEMI	Swedish Chemicals Agency
MSDS	Material Safety Data Sheet
NFPA	National Fire Protection Association
NIOSH	National Institute of Occupational Safety and Health
NITE	National Institute of Technology and Evaluation (Japan)
NTP	National Toxicology Program
OECD	Organization for Economic Co-operation and Development
OSPAR	Oslo Paris Commission and convention for protection of the marine environment
PBT Profiler	US EPA's PBT Profiler
Prop 65	California Proposition 65 regulation and list of chemicals of concern
REACH	European Commission chemicals regulation
RoC	Report on Carcinogens (National Toxicology Program)
RTECS	Registry of Toxic Effects of Chemical Substances
SIDS	Screening Information Data Sets
TEDX	The Endocrine Disruptor Exchange
UNEP	United Nations Environment Program
US DOT	US Department of Transportation Hazardous Materials Regulations
US EPA	United States Environmental Protection Agency

Green Screen Assessment Prepared By:
Name: Brian Penttila, Ph. D.
Title: Chemical Engineer
Organization: PNW Pollution Prevention Resource Center
Date: 30 June 2012

Quality Control Performed By:
Name: Alex Stone, Sc. D.
Title: Safer Chemical Alternative Chemist
Organization: WA Department of Ecology
Date: 17 April 2013

Appendix A – US EPA PBT Profiler Results

Results

Orange or **red** highlights indicate that the EPA criteria have been exceeded.
Black-and-white version

Persistence	Bioaccumulation	Toxicity

79-01-6 Ethene, trichloro-

PBT Profiler Estimate = PBT

Media	Half-Life (days)	Percent in Each Medium	BCF	Fish ChV (mg/l)
Water	**38**	45%	**18**	**2.9**
Soil	**75**	13%		
Sediment	**340**	0%		
Air	**20**	42%