Benzyl Chloride (CAS#100-44-7) GreenScreen® for Safer Chemicals (GreenScreen®) Assessment

Prepared by:

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GreenScreen® Executive Summary for Benzyl Chloride (CAS #100-44-7)

Benzyl chloride is a clear, colorless liquid that is used primarily as a chemical intermediate in the manufacture of dyes, plasticizers, lubricants, gasoline additives, pharmaceuticals, tanning agents, and quaternary ammonium compounds.

Benzyl chloride was assigned a GreenScreen® Benchmark Score of 1 ("Avoid—Chemical of High Concern") as it has a high Group I Human Toxicity (carcinogenicity(C)). This corresponds to GreenScreen® benchmark classification 1e in CPA 2011. Data gaps (DG) exist for endocrine activity (E), neurotoxicity (single dose and repeated exposure, N) and respiratory sensitization (SnR*). As outlined in CPA (2013) Section 12.2 (Step 8 – Conduct a Data Gap Analysis to assign a final Benchmark score), benzyl chloride meets requirements for a GreenScreen® Benchmark Score of 1 despite the hazard data gap. In a worst-case scenario, if benzyl chloride were assigned a High score for the data gaps E, N and SnR*, it would still be categorized as a Benchmark 1 Chemical.

GreenScreen® Benchmark Score for Relevant Route of Exposure:
As a standard approach for GreenScreen® evaluations, all exposure routes (oral, dermal and inhalation) were evaluated together, so the GreenScreen® Benchmark Score of 1 ("Avoid—Chemical of High Concern") is applicable for all routes of exposure.

GreenScreen® Hazard Ratings for Benzyl Chloride

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	repeated*	single	repeated*										
H	M	*M*	M	DG	vH	M	H	DG	DG	H	DG	H	vH	H	vH	vL	*vL*	L	M

Note: Hazard levels (Very High (vH), High (H), Moderate (M), Low (L), Very Low (vL)) in *italics* reflect estimated values, authoritative B lists, screening lists, weak analogues, and lower confidence. Hazard levels in **BOLD** font 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. Please see Appendix A for a glossary of hazard acronyms.

GreenScreen® Assessment for Benzyl Chloride (CAS # 100-44-7)

GreenScreen® Version 1.2 Draft Assessment
Note: Verification Has Not Been Performed on this GreenScreen® Assessment

Chemical Name: Benzyl chloride

CAS Number: 100-44-7

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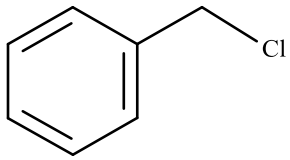
Date: June 25, 2014

Confirm application of the *de minimus* rule[1]: Not applicable for benzyl chloride; not a mixture.

Chemical Structure(s):



Benzyl chloride (CAS#100-44-7)

Also called: a-chlorotoluene; chloromethylbenzene; tolyl chloride (ChemIDplus 2014)

Chemical Structure(s) of Chemical Surrogates Used in the GreenScreen®: No surrogates were sought as the existing data satisfy the data requirement for the assigned benchmark.

Identify Applications/Functional Uses:
1. An intermediate in the manufacture of dyes, plasticizers, lubricants, gasoline additives, pharmaceuticals, tanning agents, and quaternary ammonium compounds (HSDB 2005).
2. As an irritant gas in chemical warfare (HSDB 2005)
3. Manufacture of photographic developer (HSDB 2005)

GreenScreen® Summary Rating for Benzyl Chloride[2]: Benzyl chloride was assigned a GreenScreen® Benchmark Score of 1 ("Avoid—Chemical of High Concern") as it has a high Group I Human Toxicity (carcinogenicity(C)). This corresponds to GreenScreen® benchmark classification 1e in CPA 2011. Data gaps (DG) exist for endocrine activity (E), neurotoxicity (single dose and repeated exposure, N) and respiratory sensitization (SnR*). As outlined in CPA (2013) Section 12.2 (Step 8 – Conduct a Data

[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.

Gap Analysis to assign a final Benchmark score), benzyl chloride meets requirements for a GreenScreen® Benchmark Score of 1 despite the hazard data gap. In a worst-case scenario, if benzyl chloride were assigned a High score for the data gaps E, N and SnR*, it would still be categorized as a Benchmark 1 Chemical.

Figure 1: GreenScreen® Hazard Ratings for Benzyl Chloride

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	repeated*	single	repeated*										
H	M	*M*	M	DG	vH	M	H	DG	DG	H	DG	H	vH	H	vH	vL	*vL*	L	M

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** font 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. Please see Appendix A for a glossary of hazard acronyms.

Transformation Products and Ratings:

Identify feasible and relevant fate and transformation products (i.e., dissociation products, transformation products, valence states) **and/or moieties of concern**[3]

Benzyl chloride is expected to undergo chemical hydrolysis to benzyl alcohol in water and moist soil based on a hydrolysis half-life of 14hrs. Its mobility in soil is moderate and volatilisation from water surface is not expected to be an important fate process. Benzyl chloride vapour is degraded in the atmosphere by the reaction with photochemically produced hydroxyl radicals.

Functional Use	Life Cycle Stage	Transformation Pathway	Transformation Products	CAS #	List Translator Results[4,5]
	End of life	Hydrolysis	Benzyl alcohol	100-51-6	Listed in Pharos: • R20: Harmful by inhalation, Benchmark unspecified • GHS-New Zealand: Irritating to the eye-6.4A, Benchmark unspecified • GHS-New Zealand: contact sensitiser-6.5B, Benchmark unspecified • GHS-New Zealand: slightly harmful to the

[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 GreenScreen® List Translator identifies specific authoritative or screening lists that should be searched to screen for GreenScreen® benchmark 1 chemicals (CPA 2012b). Pharos (Pharos 2013) is an online list-searching tool that is used to screen chemicals against the lists in the List Translator electronically.
[5] The way you conduct assessments for transformation products depends on the Benchmark Score of the parent chemical (See Guidance).

					aquatic environment or are otherwise designed • to biocidal action, 9.1D, Benchmark unspecified • GHS-New Zealand: Ecotoxic in the soil environment 9.2B, Benchmark unspecified • WHIMS: Class B3 combustible liquid • Listed in Grandjean and Landrigan neurotoxic chemicals: Known to be neurotoxic in man. .

Introduction

Benzyl chloride is a highly reactive and versatile chemical intermediate that readily interacts with a wide variety of other organic chemicals. It is an alkylating agent that reacts with water to form benzyl alcohol and HCl (HSDB 2005).

ToxServices assessed benzyl chloride against GreenScreen® Version 1.2 (CPA 2013) following procedures outlined in ToxServices' SOP 1.37 (GreenScreen® Hazard Assessment) (ToxServices 2013).

GreenScreen® List Translator Screening Results

The GreenScreen® List Translator identifies specific authoritative or screening lists that should be searched to identify GreenScreen® benchmark 1 chemicals (CPA 2012b). Pharos (Pharos 2014) is an online list-searching tool that is used to screen chemicals against the List Translator electronically. It checks all of the lists in the List Translator with the exception of the U.S. Department of Transportation (U.S. DOT) lists (U.S. DOT 2008a,b) and these should be checked separately in conjunction with running the Pharos query. The output indicates benchmark or possible benchmark scores for each human health and environmental endpoint. The output for benzyl chloride can be found in Appendix C, and classifications for specific endpoints can be found in the appropriate sections. When a classification from GHS New Zealand was available for any endpoint, it was converted to the harmonized GHS classifications using the "Correlation between GHS and New Zealand HSNO Hazard Classes and Categories" document from the New Zealand Environmental Protection Authority (N.Z. EPA 2009).

PhysicoChemical Properties of Benzyl Chloride

The physicochemical properties of benzyl chloride are summarized in Table 1. Benzyl chloride is a colorless liquid which fumes in moist air. It has a strong odor that is irritating to the mucous membrane and eyes. Benzyl chloride is insoluble in water and volatile at room temperature.

Table 1: Physical and Chemical Properties of Benzyl Chloride (CAS # 100-44-7)

Property	Value	Reference
Molecular formula	C_7H_7Cl	ChemIDplus 2014
SMILES Notation	c1(ccccc1)CCl	ChemIDplus 2014
Molecular weight	126.58	ChemIDplus 2014
Physical state	Liquid	ECHA 2014; HSDB 2005

Table 1: Physical and Chemical Properties of Benzyl Chloride (CAS # 100-44-7)		
Property	**Value**	**Reference**
Appearance	Colorless to slightly yellow liquid	ECHA 2014; HSDB 2005
Melting point	- 48 to -43°C	ECHA 2014
Vapor pressure	1.23 mmHg at 25ºC	ChemIDplus 2014
Water solubility	525 mg/L at 25ºC	ChemIDplus 2014
Dissociation constant	NA	
Density/specific gravity	1.1 g/cm^3 at 20ºC	ECHA 2014; HSDB 2005
Partition coefficient	2.3	ChemIDplus 2014

Hazard Classification Summary Section:

Group I Human Health Effects (Group I Human)

Carcinogenicity (C) Score (H, M, or L): H
Benzyl chloride was assigned a score of High for carcinogenicity based on being listed/classified in many authoritative lists as a possible human carcinogen. GreenScreen® criteria classify chemicals as a High hazard for carcinogenicity when they are listed as group B2 in EPA-C, as carcinogen category 2 in EU CMR (1), as carcinogen category 1B in EU CMR (2), as carcinogen group 1 or 2 in MAK, and when associated with EU R-phrase R45 and EU H-statement H350 (CPA 2012a).
Authoritative and Screening Lists

- *Authoritative:* U.S. EPA–IRIS Carcinogens (EPA-C): (1986) Group B2 – Possible human carcinogen
- *Authoritative :*Cal/EPA–Chemicals Known to Cause Cancer and Reproductive Toxicity (Prop 65): Cancer
- *Authoritative:* EC–REACH Annex XVII (EU CMR (1)) – Carcinogen Category 2 – Substances which should be regarded as they are carcinogenic to man
- *Authoritative:* EU R–Phrases: R45: May cause cancer
- *Authoritative:* EU H–Statement: H350: May cause cancer
- *Authoritative:* EC–CLP Inventory (EU CMR (2)) – Carcinogen – Category 1B
- *Authoritative:* German MAK–List of Substances (MAK) – Carcinogen Group 1 – Substances that cause cancer in man
- *Authoritative:* German MAK–List of Substances (MAK) – Carcinogen Group 2 – Considered to be carcinogenic for man
- *Screening*: Japan METI/MOE–GHS Classifications (GHS-Japan): Carcinogenicity – Category 2
- *Screening:* New Zealand HSNO/GHS (GHS-New Zealand): Known or presumed human carcinogens – 6.7A

- U.S. EPA 1989, ECHA 2014
  - Oral
    - No information is available on the carcinogenic effects of benzyl chloride in humans by the oral route of exposure.
    - In a National Cancer Institute (NCI) carcinogenicity bioassay, Fischer 344 rats (52/sex/dose) and B6C3F1 mice (52/sex/dose) were administered benzyl chloride via

gavage 3 times a week for 104 weeks at doses of 0, 6.4, or 12.85 mg/kg-day (rats) or 0, 21.4, or 42.85 mg/kg/day (mice). In female rats, significant increases in thyroid C-cell adenoma/carcinoma were reported at the high dose (12.85 mg/kg/day). In male mice, statistically significant increases in hemangioma/hemangiosacroma, forestomach carcinoma, and forestomach carcinoma/papilloma at 42.85 mg/kg/day, and hepatic carcinoma/adenoma at 21.4 mg/kg/day were reported. In female mice, a statistically significant increase in the incidence of forestomach carcinoma/papilloma and lung alveolar-bronchiolar adenoma/carcinoma was noted at 42.85 mg/kg/day. Although the study was not conducted according to a guideline, it was considered scientifically adequate and acceptable for the assessment and was reported in ECHA (2014) with a Klimisch score of 2 (Reliable with Restriction).

- U.S.EPA 1989, ECHA 2014
    - Dermal
        - Benzyl chloride was tested by two skin-painting studies on female specific pathogen-free ICR mice. In the first study, no tumors were observed in 11 mice treated with 10 µl benzyl chloride 3 times/week for 4 weeks, followed by 2 times/week until termination at 40 weeks. In the second study, 2.3 µl benzyl chloride was diluted to a final volume of 25 µl with benzene and applied to the skin of 7-week-old mice 2 times/week for 50 weeks. Two of 20 control animals developed lung adenomas, while 5/20 treated mice developed tumors, including 2 lung adenomas and 3 skin carcinomas. Two of the skin carcinomas metastasized to the primary lymphatic organs, liver, or kidneys. Although skin tumor incidences were not statistically significantly greater than controls, the authors considered that benzyl chloride is a weak carcinogen when applied topically. However, the validity of this study is questionable, because benzene, which is regarded as a carcinogen in animals, was used as solvent in the second study, and administration of benzyl chloride on its own caused no tumours in the first study and in rats by subcutaneous injection.
        - Benzyl chloride was also tested in rats by subcutaneous injections. Sarcomas at the injection site in rats were observed in 6/8 high-dose and 3/14 low-dose compared with none in controls.
- U.S. EPA 1989
    - Inhalation
        - Epidemiological studies in which exposure to benzyl chloride occurred by inhalation are inadequate as the studies reported only small numbers of cancer deaths and were based on exposures to mixtures of chlorinated compounds.

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

Benzyl chloride was assigned a score of moderate for mutagenicity/genotoxicity based on weight of evidence. GreenScreen® criteria classify chemicals as a moderate hazard for mutagenicity/genotoxicity when adequate data are available and they are classified to GHS category 2(CPA 2012a).

- Authoritative and Screening Lists
    - *Authoritative:* Not listed on any authoritative lists
    - *Screening:* Not listed on any screening lists.
- ECHA 2014
    - Benzyl chloride was considered mutagenic in *Salmonella typhimurium* strain TA100 and *Saccharomyces cerevisiae* strain D4, both with and without metabolic activation at

concentration up to 10 µL/plate, and weakly positive in *S. typhimurium* strain, TA 98 and TA1538 in the absence of metabolic activation at concentrations of 5 µL/plate.
    - In two *in vivo* micronucleus assays conducted similar to the OECD guideline 474, mixed results were reported. In the first assay, the injection of benzyl chloride to mice resulted in an increase in the number of micronucleated polychromatic erythrocytes in the bone marrow of treated animals. However, the increase was not dose dependent and the induction rate was lower than the 3-fold threshold generally recommended. Therefore benzyl chloride was considered as a potential mutagen. In the second assay, no increase in micronuclei in polychromatic erythrocytes was observed at any dose and benzyl chloride was not considered as a potent mutagen.
    - The mutagenicity of benzyl chloride was also evaluated in a sperm head abnormality test on (CBAxBALB/C) F1 male mice. Benzyl chloride did not induce a positive response in the sperm head abnormality test and was not considered as a potent mutagen for germ cells of mice.
- IARC 1999
    - Benzyl chloride is a direct alkylating agent and has been found to be biologically active without metabolic activation.
    - In *Drosophila melanogaster*, benzyl chloride induced somatic mutations more readily than sex-linked alterations. In Chinese hamster ovary cells, benzyl chloride was slightly mutagenic to DNA excision-repair deficient strains and weakly induced sister chromatid exchanges. It induced DNA strand breaks in cultured human cells but not unscheduled DNA synthesis or chromosomal aberrations.
- The weight of evidence for all genotoxicity testing indicates that benzyl chloride is a potential mutagen. According to GHS criteria, benzyl chloride is most appropriately classified to GHS category 2 (suspected of causing genetic defects).

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

Benzyl chloride was assigned a score of Moderate for reproductive toxicity based on being classified as GHS category 2 by a screening list. GreenScreen® criteria classify chemicals as a Moderate hazard for reproductive toxicity when the chemical is classified to GHS category 2 by a Japan GHS screening list (CPA 2012a).

- Authoritative and Screening Lists
    - *Authoritative:* Not listed on any authoritative lists.
    - *Screening:* Japan METI/MOE-GHS Classifications (GHS-Japan): Toxic to reproduction – Category 2
- UNEP 1998
    - No information is available on the reproductive effects of benzyl chloride in humans. There are no oral reproductive studies in animals. However, in male mice exposed to benzyl chloride subcutaneously (s.c.) at doses of 0, 125, 250, or 500 mg/kg-day or intraperitoneally (i.p.) at doses of 0, 50, 100, 200, or 400 mg/kg-day, small increases in sperm head abnormalities were observed at 500 mg/kg/day (s.c.) and 200 and 400 mg/kg-day (i.p.). The NOELs of 250 mg/kg/day in subcutaneous study and of 100 mg/kg/day in intraperitoneal study were established.
- The available data are very limited to classify benzyl chloride with regard to the reproductive endpoint. However, as it is classified by GHS-Japan as GHS category 2, a Greenscreen® score of Moderate was assigned.

Developmental Toxicity incl. Developmental Neurotoxicity (D) Score (H, M, or L): M
Benzyl chloride was assigned a score of Moderate for developmental toxicity based on weight of evidence. GreenScreen® criteria classify chemicals as a Moderate hazard for developmental toxicity when adequate data are available and when they are classified to GHS category 2 (CPA 2012a).

- Authoritative and Screening Lists
  - *Authoritative:* Not listed on any authoritative lists
  - *Screening:* Not listed on any screening lists
- Oral
  - UNEP 1998, ECHA 2014
    - In an oral teratogenic study, pregnant rats were administered benzyl chloride by gavage on gestation days (GD) 6-15 at doses of 0, 50, or 100 mg/kg/day. The number of implantations, resorptions, and live fetuses and the mean fetal weight were not affected at any dose level. No increase in the number of skeletal or visceral abnormalities was reported, although reduced fetal length was observed at 100 mg/kg/day. Based on the reduction of fetal length, NOEL of 50 mg/kg/day was established for fetal toxicity. The NOEL for teratogenicity was considered to be 100 mg/kg/day (highest dose tested) as no teratogenic changes were observed.
  - IARC 1999
    - In pregnant rats orally exposed to benzyl chloride at 0.00006, 0.0006, 0.006, or 208 mg/kg/day on GD 1-19, an increase in embryonic lethality was reported at 0.006 and 208 mg/kg/day. Fetal malformations were not observed at any dose; however, postnatal development of offspring was retarded at 208 mg/kg/day.
- Based on the available data, slight developmental changes were observed in rat fetuses and the no observed effect level was 50 mg/kg/day for developmental toxicity. According to GHS criteria, benzyl chloride is most appropriately classified to GHS category 2 (suspected).

Endocrine Activity (E) Score (H, M, or L): DG
Benzyl chloride was assigned a score of data gap for endocrine disruption based on a lack of data for this endpoint.

- Authoritative and Screening Lists
  - *Authoritative:* Not listed on any authoritative lists.
  - *Screening:* Not listed on any screening lists.
- Not listed as a potential endocrine disruptor on the EU Priority List of Suspected Endocrine Disruptors.
- Not listed as a potential endocrine disruptor on the OSPAR List of Chemicals of Possible Concern. No data were 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): vH
Benzyl chloride was assigned a score of Very high for acute toxicity based on inhalation LC_{50} values between 0.097 and 0.185 mg/L for vapors and on being classified as Class 6.1, group 2 by DOT authoritative list. GreenScreen® criteria classify chemicals as a Very High hazard for acute toxicity

when inhalation LC_{50} values are less than 2 mg/L for vapors and when listed as Class 6.1, group 2 by DOT authoritative list (CPA 2012a).

- Authoritative and Screening Lists
  - *Authoritative:* U.S EPA-AMT: Extremely Hazardous Substances
  - *Authoritative:* EU R-Phrases: R22: Harmful if swallowed
  - *Authoritative:* EU R-Phrases: R23: Toxic by inhalation
  - *Authoritative:* EU H-Statements: H302: Harmful if swallowed
  - *Authoritative:* EU H-Statements: H331: Toxic if inhaled
  - *Authoritative:* DOT: Class 6.1, group 2 – Poison Inhalation Hazard
  - *Screening:* GHS-Japan: Acute toxicity (inhalation: vapor) – Category 1
  - *Screening:* GHS-Japan: Acute toxicity (oral) – Category 4
  - *Screening:* GHS-New Zealand: Acutely toxic (inhalation) – 6.1B
  - *Screening:* GHS-New Zealand: Acutely toxic (oral) – 6.1D
- Oral -
  - UNEP 1998
    - LD_{50} of 1231 mg/kg (rats)
    - LD_{50} of 1500 mg/kg (mice)
- Inhalation -
  - UNEP 1998
    - LC_{50} of 0.74 mg/L (2hr, rats), equivalent to 0.185 mg/L[6] (4hr, rats).
    - LC_{50} of 0.39 mg/L (2hr mice), equivalent to 0.097 mg/L (4hr, mice)

Systemic Toxicity/Organ Effects incl. Immunotoxicity (ST)
***Group II Score (single dose)* (vH, H, M, or L): M**
Benzyl chloride was assigned a score of Moderate for systemic toxicity (single dose) based on association with EU risk phrase R37 and EU hazard statement H335. GreenScreen® criteria classify chemicals as a Moderate hazard for systemic toxicity (single dose) when they are associated with EU R-phrase of R37, and EU H-Statement of H335 (CPA 2012a)

- Authoritative and Screening Lists
  - *Authoritative:* EU R37: Irritating to respiratory system.
  - *Authoritative:* EU H335: May cause respiratory irritation.
  - *Screening:* GHS-Japan: Specific target organs/systemic toxicity following single exposure – Category 1
- UNEP 1998
  - In acute inhalation toxicity studies, rats and mice exposed to concentrations exceeding 0.1 mg/L (20 ppm) benzyl chloride for 2 hours exhibited irritation of the eyes, nose, and throat and decreased respiratory rate.

***Group II* Score (repeated dose)* (H, M, or L): H**
Benzyl chloride was assigned a score of High for systemic toxicity (repeated dose) based on a LOEL of 0.224 mg/L in a 14-day inhalation toxicity study in mice. GreenScreen® criteria classify chemicals as a High hazard for systemic toxicity (repeated dose) when animal studies identify inhalation LOAEL values less than 0.2 mg/L (the guidance value is adjusted to 1.3 mg/L based on study duration) (CPA 2012a).

[6] According to GHS criteria, guidance values for inhalation toxicity are based on 4 hours test in laboratory animals. Conversion of 2hr inhalation toxicity data to 4hr is by dividing by a factor of 4 for gases and vapors.

- Authoritative and Screening Lists
  - *Authoritative:* EU R-Phrases: R48/22: Harmful: danger of serious damage to health by prolonged exposure if swallowed.
  - *Authoritative:* EU H-Statements: H373: May cause damage to organs through prolonged or repeated exposure
  - *Screening:* New Zealand HSNO/GHS (GHS-New Zealand):Toxic to human target organs or systems (oral) – 6.9A
  - *Screening:* GHS-Japan: Specific target organs/systemic toxicity following repeated exposure – Category 1
- Oral
  - UNEP 1998
    - In a subchronic toxicity study, F-344 rats (10/sex) exposed to 0, 6.4, 12.9, 26.6, 53.6, or 107.1 mg/kg/day benzyl chloride by gavage for 26 weeks. All the males in the highest dose group died within the first 2 weeks. All females in the highest dose group and all males in the next highest dose group (53.6 mg/kg/day) died within 3 weeks of treatment. The deaths were reported to be due to severe acute or chronic gastritis of the forestomach, often with ulcers. A statistically significant depression of weight gain was observed in male rats at 26.6 mg/kg/day, while in female rats it was smaller (dose level was not specified). The NOAEL was identified as 12.9 mg/kg/day for males and 6.4 mg/kg/day for females (basis was not provided). According to GHS classification criteria, the guidance values are multiplied by a factor of 0.5 (13/26) from 13-week study to a 26-week study. Therefore, the guidance value is 5 mg/kg/day (10 x 0.5) for a 26-week study. The identified LOAEL of 6.4 mg/kg/day falls under GHS category 2.
    - In another subchronic toxicity study in B6C3F1 mice, animals exposed to 0, 2.7, 5.4, 10.7, 21.4, or 42.9 mg/kg/day benzyl chloride by gavage for 26 weeks. Severe hyperplasia of the liver was observed at 42.9 mg/kg/day, with more moderate hyperplasia observed at 2.7-21.4 mg/kg-day.
- Inhalation
  - UNEP 1998
    - In a subchronic toxicity study, Swiss OF1 mice were exposed to benzyl chloride at concentrations of 0, 22 or 46 ppm (equivalent to 0.107 and 0.224 mg/L, calculated by the document) for 6 h/day for 4, 9 and 14 days. Pathological change in both the anterior respiratory epithelium adjacent to vestibule and the olfactory epithelium in the dorsal meatus was observed at 46 ppm. This change was severe in 4-day and 14-day exposure groups and very severe in 9-day exposure group. No change of trachea and lungs was observed. Based on pathological change, a NOEL of 22 ppm (equivalent to 0.107 mg/L, calculated by the document) was established. According to GHS classification criteria, the GHS guidance values of 0.2 and 1.0 are multiplied by a factor of 6.5 (13/2) from 13-week study to a 2-week study. Therefore, the guidance values are 1.3 and 6.5 mg/L/6hr/day for a 14-day study. The identified LOEL of 46 ppm (equivalent to 0.224 mg/L) falls under GHS category 1.
- Based on the above data, repeated exposure of animals to benzyl chloride has been shown to injure the tissue in heart, stomach and liver. Benzyl chloride is associated with the R-phrase R48/22: Harmful: danger of serious damage to health by prolonged exposure if swallowed, and the H-statement H373: May cause damage to organs through prolonged or repeated exposure, which correspond to a score of Moderate. However, the identified inhalation LOAEL was within the

guidance values for GHS category 1 as explained above, and therefore the more conservative score of High was assigned.

Neurotoxicity (N)

***Group II Score (single dose)* (vH, H, M, or L):** DG

Benzyl chloride was assigned a score of data gap for neurotoxicity (single dose) based on a lack of data for this endpoint.

- Authoritative and Screening Lists
  - *Authoritative:* Not listed on any authoritative lists.
  - *Screening:* Not listed on any screening lists
- Not classified as a developmental neurotoxicant (Grandjean and Landrigan 2006, 2014).
- UNEP 1998
  - Behavioural changes of male Swiss-OF-1 mice were observed after inhalation exposure to 12, 17, 18 or 22 ppm benzyl chloride or fresh air for 4 hours. After exposure, swimming tests were conducted in a cylinder filled with water. Benzyl chloride caused a concentration-dependent extension of the immobility phase by 32, 52, 71 and 84 %. The authors considered this result to indicate a neurotoxic effect of benzyl chloride.
- Available information above is not sufficient to classify benzyl chloride under GHS criteria.

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

Benzyl chloride was assigned a score of data gap for neurotoxicity (repeated exposure) based on a lack of data for this endpoint.

- Authoritative and Screening Lists
  - *Authoritative:* Not listed on any authoritative lists.
  - *Screening:* Not listed on any screening lists
- Not classified as a developmental neurotoxicant (Grandjean and Landrigan 2006, 2014).
- No data were identified.

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

Benzyl chloride was assigned a score of High for skin sensitization based on being classified as a skin sensitizer following a well conducted OECD Local Lymph Node Assay (LLNA) in mice. GreenScreen® criteria classify chemicals as a High hazard for skin sensitization when adequate data are available and they are classified to GHS category 1A.

- Authoritative and Screening Lists
  - *Authoritative:* Not listed on any authoritative lists.
  - *Screening:* Not listed on any screening lists.
- ECHA 2014
  - A GLP compliant local lymph node assay (LLNA) (OECD 429) was conducted using female CBA mice. Mice were exposed to benzyl chloride at concentrations of 0, 10, 25, and 50% on three consecutive days, by open application on the ears. Proliferative responses occurred with stimulation indices (SI) of 6.1, 12.0 and 10.6 at 10, 25, and 50%, respectively. The EC3 value (the estimated test substance concentration that will give a SI = 3) was not determined. Following OECD and GHS (2011) criteria benzyl chloride is considered to be a sensitizing chemical as the SI values for all concentrations were greater than 3.0. Classifying benzyl chloride to GHS subcategory 1A or 1B for skin sensitization is not applicable since the EC3 value was not available. Therefore the most conservative classification was selected, which is GHS category 1A.

- Some evidence of skin sensitization was seen in guinea pigs exposed to 100 mg benzyl chloride by intradermal injections for 12 weeks. GLP status was not specified and the study was reported in ECHA as not adequate for assessment due to the lack of details (materials, methodology and results).

Respiratory Sensitization (SnR) Group II* Score (H, M, or L): DG
Benzyl chloride was assigned a data gap for respiratory sensitization based on lack of data for this endpoint.

- Authoritative and Screening Lists
  - *Authoritative:* Not listed on any authoritative lists.
  - *Screening:* Not listed on any screening lists.
- No data were identified

Skin Irritation/Corrosivity (IrS) Group II Score (vH, H, M, or L): H
Benzyl chloride was assigned a score of High for skin irritation/Corrosivity based on experimental data, and on presence on authoritative lists. GreenScreen® criteria classify chemicals as a High hazard for skin irritation when associated with EU R-phrase of R38 and H-Statement of H315 and when they are classified to GHS category 2 (CPA 2012a).

- Authoritative and Screening Lists
  - *Authoritative:* EU R38: Irritating to skin.
  - *Authoritative:* EU H315: Causes skin irritation.
  - *Screening:* GHS-Japan: Skin corrosion/irritation – Category 1
  - *Screening:* GHS-New Zealand: Corrosive to dermal tissue – 8.2B
- UNEP 1998, ECHA 2014
  - The primary skin irritation of benzyl chloride was evaluated in two studies conducted according to US CPSC (F.H.S.A 16CFR1500.41) and the US DOT (49CFR173 appendix A) guidelines. An unknown number of New Zealand rabbits were exposed to 0.5 ml benzyl chloride for 24 hours. In the D.O.T experiment, the New Zealand rabbits displayed moderate erythema and edema at 4h and 24h post exposure. In ten to fourteen days a defatting effect was observed, but no injury in depth was observed. No reversibility of the observed effects was reported. In the F.H.S.A. experiment, loosening of the edges of scabs was observed in rabbits' skin after 17 days of exposure to benzyl chloride and according to F.H.S.A the test substance should be classified as corrosive. However, based on the CLP regulation n° 1272/2008 EC, benzyl chloride should be classified as a skin irritant category 2 based on the defatting effect observed in the DOT experiment until the end of observation period (14 days).

Eye Irritation/Corrosivity (IrE) Group II Score (vH, H, M, or L): vH
Benzyl chloride was assigned a score of Very High for eye irritation based on severe irritation in humans with exposure to benzyl chloride vapors, and on presence on authoritative lists. GreenScreen® criteria classify chemicals as a Very High hazard for eye irritation when human data indicate that the chemical may be classified as GHS Category 1, and when it is associated with EU risk phrase of R41 and hazard statement of H318 (CPA 2012a).

- Authoritative and Screening Lists
  - *Authoritative:* EU H318: Causes serious eye damage.
  - *Authoritative*: EU R41: Risk of serious damage to eyes.
  - *Screening:* GHS-Japan: Serious eye damage/eye irritation – Category 1
  - *Screening:* GHS-New Zealand: Corrosive to ocular tissue – 8.3A

- ECHA 2014
    - The acute eye irritation effect of benzyl chloride was investigated in rabbits following a methodology similar to the OECD guideline 405. Six rabbits were exposed to 0.1 ml of benzyl chloride for 24hr. Immediately after the exposure, the rabbits exhibited discomfort. At 24 hours, areas of barely perceptible corneal dullness, severe erythema, slight to moderate edema and copious discharge were observed. After 10 days all the effects of exposure were completely reversible. Based on this benzyl chloride was considered as a mild irritant.
    - In another acute irritation study conducted according to the method of CFR, 16, 1500.42, instillation of 100 µL benzyl chloride to the rabbit eye for 24hr caused slight eye irritation.
- UNEP 1998
    - In acute inhalation toxicity studies, rats and mice exposed to concentrations exceeding 0.1 mg/L (20 ppm) benzyl chloride for 2 hours exhibited irritation of the eyes, nose, and throat and decreased respiratory rate.
    - Eye and respiratory tract irritation were observed in rabbits and cats exposed to benzyl chloride vapour at 463 mg/m^3 8 hours/day for 6 days. The extent was not reported.
- HSDB 2005
    - Benzyl chloride liquid is an extreme irritant to the eyes and mucous membranes. The vapour may cause permanent damage to eyes. Concentrations of 50-100 mg/m^3 cause weeping and twitching of eyelids in humans, and a concentration of greater than 160 mg/m^3 is unbearably irritating.
- OEHHA 1999
    - Exposure to 160 mg/m^3 benzyl chloride vapors for 5 minutes causes unbearable irritation in humans. Exposure to 6-8 mg/m^3 for 5 minutes causes slight conjunctivitis.
- Based on the weight of evidence, a score of Very High was assigned. Liquid benzyl chloride was irritating to the eyes of rabbits, and vapors were irritating to the eyes of rats, mice, rabbits, and cats. The vapors are severely irritating to the eyes of humans, and may cause permanent damage. As GHS guidance places emphasis on existing human data, this chemical may be classified as GHS Category 1 based on severe effects seen with short exposures to benzyl chloride gas. Benzyl chloride is also associated with H-statement H318: Causes serious eye damage and R-phrase R41: Risk of serious damage to eyes. Both of these listings by authoritative sources correspond to a score of Very High.

Ecotoxicity (Ecotox)

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

Benzyl chloride was assigned a score of High for acute aquatic toxicity based on L/EC_{50} values between 1 and 10 mg/L. GreenScreen® criteria classify chemicals as a High hazard for acute aquatic toxicity when acute aquatic toxicity values are between 1 to 10 mg/L (CPA 2012a).

- Authoritative and Screening Lists
    - *Authoritative:* Not listed on any authoritative lists.
    - *Screening:* GHS-Japan: Hazardous to aquatic environment (acute) - Category 1
- UNEP 1998
    - EC_{50} = 3.2 mg/L in *Daphnia magn*a (invertebrates, 48 hr)
    - EC_{50} = 4.2 mg/L in *Daphnia magn*a (invertebrates, 24 hr)
    - EC_{50} (Biomass) = 19.3 mg/l in *Selenastrum capricornutum* (green algae, 72 hr)
- ECHA 2014
    - LC_{50} = 4 mg/L in *Brachydanio rerio* (fish, 96 hr)

- LC_{50} = 16 mg/L in *Leuciscus idus* (fish, 96 hr)
- LC_{50} = 3-4.5 mg/L in *Leuciscus idus melanotus* (fish, 48 hr)
- LC_{50} = 4.7-7.8 mg/L in *Pimephales promelas* (fish, 96 hr)
- EC_{50} (immobilization) = 8.4 mg/L in *Daphnia magn*a (invertebrates, 24 hr)

Chronic Aquatic Toxicity (CA) Score (vH, H, M, or L): vH
Benzyl chloride was assigned a score of Very High for chronic aquatic toxicity based on NOEC value being 0.1 mg/L. GreenScreen® criteria classify chemicals as a Very High hazard for chronic aquatic toxicity when chronic aquatic toxicity values are less than or equal to 0.1 mg/L (CPA 2012a).

- Authoritative and Screening Lists
  - *Authoritative:* Not listed on any authoritative lists.
  - *Screening:* Not listed on any screening lists.
- UNEP 1998
  - EC_{50} (reproduction) = 0.24 mg/L in *Daphnia magn*a (invertebrates, 21 day); NOEC = 0.10 mg/L

Environmental Fate (Fate)

Persistence (P) Score (vH, H, M, L, or vL): vL
Benzyl chloride was assigned a score of Very Low for persistence based on experimental data supporting that this chemical meets the 10-day window in ready biodegradation tests. GreenScreen® criteria classify chemicals as a Very Low hazard for persistence when adequate data are available demonstrate that the chemical meets the 10-day window (CPA 2012a).

- Authoritative and Screening Lists
  - *Authoritative:* Not listed on any authoritative lists.
  - *Screening:* Environment Canada – Domestic Substances List (DSL): DSL substances that are persistent
- ECHA 2014
  - Benzyl chloride is rapidly hydrolysed to benzyl alcohol in water phase, and is readily biodegradable. In biodegradation studies, benzyl chloride was considered readily biodegradable; 71% degradation within 14 days in an OECD Ready Biodegradability: Modified MITI Test (Guideline 301 C) and 86% degradation after 20 days in a Closed Bottle Test.
- HSDB 2005
  - Benzyl chloride biodegraded significantly with the formation of dechlorinated products during a 2-day incubation period using raw sewage and raw sewage acclimated to non-chlorinated compounds.

Bioaccumulation (B) Score (vH, H, M, L, or vL): *vL*
Benzyl chloride was assigned a score of Very Low for bioaccumulation based on its estimated BCF of 12 in fish. GreenScreen® criteria classify chemicals as a Very Low hazard for bioaccumulation when BCFs/BAFs are less than 100 (CPA 2012a).

- Authoritative and Screening Lists
  - *Authoritative:* Not listed on any authoritative lists.
  - *Screening:* Not listed on any screening lists.

- HSDB 2005
    - An estimated BCF of 12 was calculated in fish for benzyl chloride, using a log K_{ow} of 2.3 and a regression-derived equation. According to GHS criteria, this BCF suggests the potential for bioconcentration in aquatic organisms is low.

Physical Hazards (Physical)

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

Benzyl chloride was assigned a score of Low for reactivity based on not being classifiable for reactivity under GHS (UN 2013). GreenScreen® criteria classify chemicals as a Low hazard for reactivity when adequate data available and GHS not Classified (CPA 2012a).

- Authoritative and Screening Lists
    - *Authoritative:* not listed in any authoritative lists
    - *Screening:* not listed in any screening lists
    - *Others:* New Zealand HSNO/GHS (GHS-New Zealand): Solids that emit flammable gas when in contact with water: medium hazard– 4.3B[7]
- HSDB 2005
    - Benzyl chloride will react with water or steam to produce toxic and corrosive fumes (HCl and chlorine gas) and can react vigorously with oxidizing materials. According to GHS criteria, a substance is classified for this endpoint when in contact with water, emits flammable gases. In case of benzyl chloride, the gases emitted upon reaction with water are HCl and chlorine, both are not flammable but toxic and corrosive. Accordingly, benzyl chloride is not classifiable under GHS criteria.

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

Benzyl chloride was assigned a score of Moderate for flammability based on a flash point being between 60 and 93°C. GreenScreen® criteria classify chemicals as a Moderate hazard for flammability when adequate data are available and they are classified to GHS category 4 for flammable liquid (CPA 2012a).

- Authoritative and Screening Lists
    - *Authoritative:* Not listed in any authoritative lists.
    - *Screening:* Not listed in any screening lists.
    - *Others:* Japan-GHS: Flammable liquids - Category 4
- ECHA 2014; HSDB 2005
    - Benzyl chloride has a flash point of 67°C based on a closed up method and 74°C in an open cup method.
- Based on the available data, benzyl chloride is classified to GHS category 4 for flammable liquids (liquids which have a flash point of > 60^oC and ≤ 93^oC).

[7] This GHS classification may be incorrect because benzyl chloride is a liquid, not a solid.

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APPENDIX A: Hazard Benchmark Acronyms
(in alphabetical order)

(AA) Acute Aquatic Toxicity

(AT) Acute Mammalian Toxicity

(B) Bioaccumulation

(C) Carcinogenicity

(CA) Chronic Aquatic Toxicity

(Cr) Corrosion/ Irritation (Skin/ Eye)

(D) Developmental Toxicity

(E) Endocrine Activity

(F) Flammability

(IrE) Eye Irritation/Corrosivity

(IrS) Skin Irritation/Corrosivity

(M) Mutagenicity and Genotoxicity

(N) Neurotoxicity

(P) Persistence

(R) Reproductive Toxicity

(Rx) Reactivity

(SnS) Sensitization- Skin

(SnR) Sensitization- Respiratory

(ST) Systemic/Organ Toxicity

APPENDIX B: Results of Automated GreenScreen® Score Calculation for Benzyl Chloride (CAS # 100-44-7)

TOXSERVICES
TOXICOLOGY RISK ASSESSMENT CONSULTING

GreenScreen® Score Inspector

Table 1: Hazard Table

			Group I Human					Group II and II* Human								Ecotox		Fate		Physical	
			Carcinogenicity	Mutagenicity/Genotoxicity	Reproductive Toxicity	Developmental Toxicity	Endocrine Activity	Acute Toxicity	Systemic Toxicity		Neurotoxicity		Skin Sensitization*	Respiratory Sensitization*	Skin Irritation	Eye Irritation	Acute Aquatic Toxicity	Chronic Aquatic Toxicity	Persistence	Bioaccumulation	Reactivity	Flammability
Table 2: Chemical Details									S	R *	S	R *	*	*								
Inorganic Chemical?	Chemical Name	CAS#	C	M	R	D	E	AT	STs	STr	Ns	Nr	SNS*	SNR*	IrS	IrE	AA	CA	P	B	Rx	F
No	Benzyl chloride	100-44-7	H	M	*M*	M	DG	vH	M	H	DG	DG	H	DG	H	vH	H	vH	vL	*vL*	L	M

Table 3: Hazard Summary Table

Benchmark	a	b	c	d	e	f	g
1	No	No	No	No	Yes		
2	STOP						
3	STOP						
4	STOP						

Table 4

Chemical Name	Preliminary GreenScreen® Benchmark Score
Benzyl chloride	1

Note: Chemical has not undergone a data gap assessment. Not a Final GreenScreen™ Score

Table 6

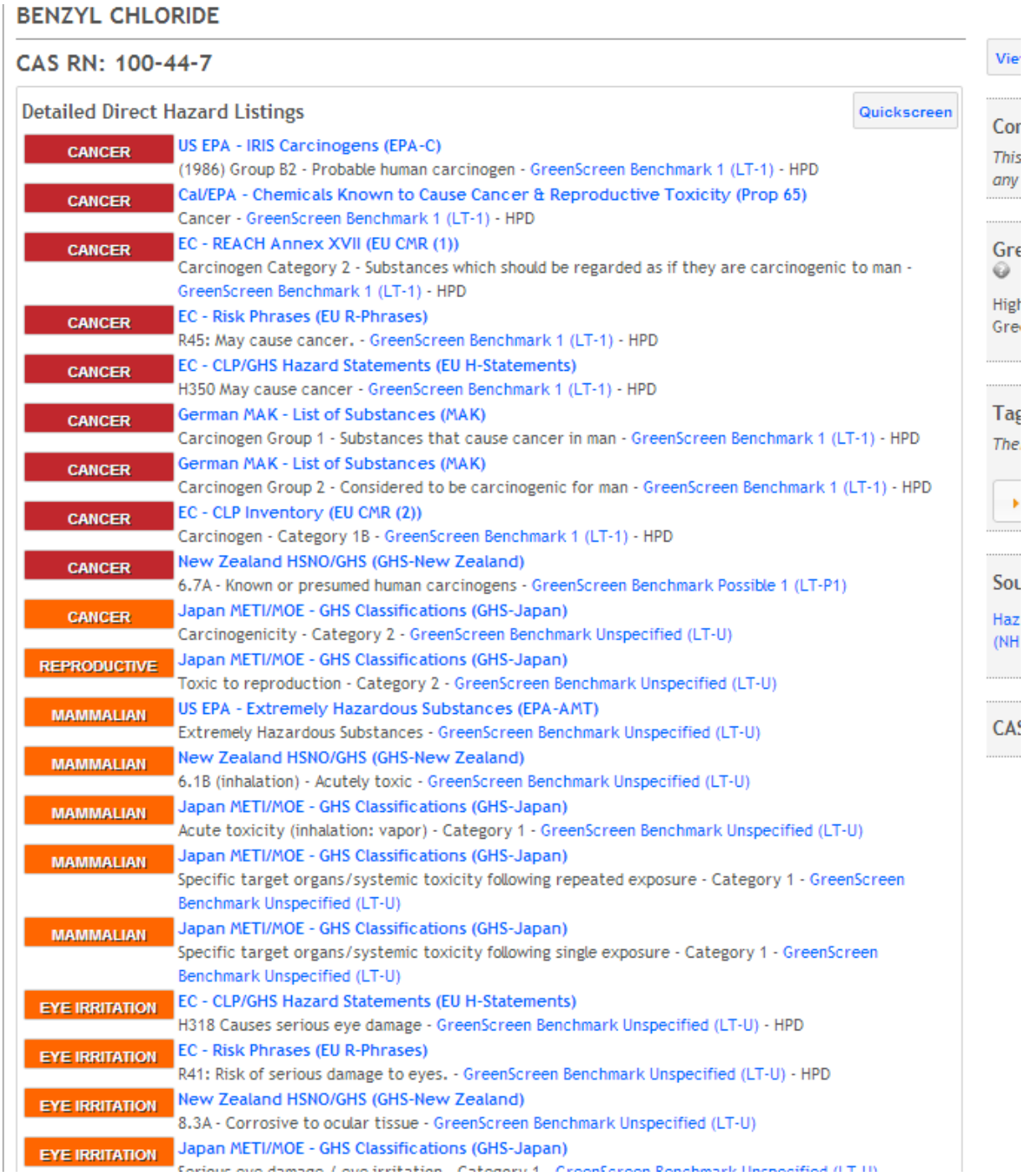
Chemical Name	Final GreenScreen® Benchmark Score
Benzyl chloride	1

After Data gap Assessment
Note: No Data gap Assessment Done if Preliminary GS Benchmark Score is 1.

Table 5: Data Gap Assessment Table

Datagap Criteria	a	b	c	d	e	f	g	h	i	j	bm4	End Result
1												1
2												
3												
4												

APPENDIX C: Pharos Output for Benzyl Chloride (CAS # 100-44-7)



BENZYL CHLORIDE

CAS RN: 100-44-7

Detailed Direct Hazard Listings — Quickscreen

CANCER	US EPA - IRIS Carcinogens (EPA-C) (1986) Group B2 - Probable human carcinogen - GreenScreen Benchmark 1 (LT-1) - HPD
CANCER	Cal/EPA - Chemicals Known to Cause Cancer & Reproductive Toxicity (Prop 65) Cancer - GreenScreen Benchmark 1 (LT-1) - HPD
CANCER	EC - REACH Annex XVII (EU CMR (1)) Carcinogen Category 2 - Substances which should be regarded as if they are carcinogenic to man - GreenScreen Benchmark 1 (LT-1) - HPD
CANCER	EC - Risk Phrases (EU R-Phrases) R45: May cause cancer. - GreenScreen Benchmark 1 (LT-1) - HPD
CANCER	EC - CLP/GHS Hazard Statements (EU H-Statements) H350 May cause cancer - GreenScreen Benchmark 1 (LT-1) - HPD
CANCER	German MAK - List of Substances (MAK) Carcinogen Group 1 - Substances that cause cancer in man - GreenScreen Benchmark 1 (LT-1) - HPD
CANCER	German MAK - List of Substances (MAK) Carcinogen Group 2 - Considered to be carcinogenic for man - GreenScreen Benchmark 1 (LT-1) - HPD
CANCER	EC - CLP Inventory (EU CMR (2)) Carcinogen - Category 1B - GreenScreen Benchmark 1 (LT-1) - HPD
CANCER	New Zealand HSNO/GHS (GHS-New Zealand) 6.7A - Known or presumed human carcinogens - GreenScreen Benchmark Possible 1 (LT-P1)
CANCER	Japan METI/MOE - GHS Classifications (GHS-Japan) Carcinogenicity - Category 2 - GreenScreen Benchmark Unspecified (LT-U)
REPRODUCTIVE	Japan METI/MOE - GHS Classifications (GHS-Japan) Toxic to reproduction - Category 2 - GreenScreen Benchmark Unspecified (LT-U)
MAMMALIAN	US EPA - Extremely Hazardous Substances (EPA-AMT) Extremely Hazardous Substances - GreenScreen Benchmark Unspecified (LT-U)
MAMMALIAN	New Zealand HSNO/GHS (GHS-New Zealand) 6.1B (inhalation) - Acutely toxic - GreenScreen Benchmark Unspecified (LT-U)
MAMMALIAN	Japan METI/MOE - GHS Classifications (GHS-Japan) Acute toxicity (inhalation: vapor) - Category 1 - GreenScreen Benchmark Unspecified (LT-U)
MAMMALIAN	Japan METI/MOE - GHS Classifications (GHS-Japan) Specific target organs/systemic toxicity following repeated exposure - Category 1 - GreenScreen Benchmark Unspecified (LT-U)
MAMMALIAN	Japan METI/MOE - GHS Classifications (GHS-Japan) Specific target organs/systemic toxicity following single exposure - Category 1 - GreenScreen Benchmark Unspecified (LT-U)
EYE IRRITATION	EC - CLP/GHS Hazard Statements (EU H-Statements) H318 Causes serious eye damage - GreenScreen Benchmark Unspecified (LT-U) - HPD
EYE IRRITATION	EC - Risk Phrases (EU R-Phrases) R41: Risk of serious damage to eyes. - GreenScreen Benchmark Unspecified (LT-U) - HPD
EYE IRRITATION	New Zealand HSNO/GHS (GHS-New Zealand) 8.3A - Corrosive to ocular tissue - GreenScreen Benchmark Unspecified (LT-U)
EYE IRRITATION	Japan METI/MOE - GHS Classifications (GHS-Japan)

EYE IRRITATION	Japan METI/MOE - GHS Classifications (GHS-Japan) Serious eye damage / eye irritation - Category 1 - GreenScreen Benchmark Unspecified (LT-U)
SKIN IRRITATION	New Zealand HSNO/GHS (GHS-New Zealand) 8.2B - Corrosive to dermal tissue - GreenScreen Benchmark Unspecified (LT-U)
SKIN IRRITATION	Japan METI/MOE - GHS Classifications (GHS-Japan) Skin corrosion / irritation - Category 1 - GreenScreen Benchmark Unspecified (LT-U)
SKIN SENSITIZE	Japan METI/MOE - GHS Classifications (GHS-Japan) Skin sensitizer - Category 1 - GreenScreen Benchmark Unspecified (LT-U)
ORGAN TOXICANT	EC - Risk Phrases (EU R-Phrases) R48: Danger of serious damage to health by prolonged exposure. - Not included in GreenScreen - HPD
ORGAN TOXICANT	New Zealand HSNO/GHS (GHS-New Zealand) 6.9A (oral) - Toxic to human target organs or systems - GreenScreen Benchmark Unspecified (LT-U)
ACUTE AQUATIC	Japan METI/MOE - GHS Classifications (GHS-Japan) Hazardous to the aquatic environment (acute) - Category 1 - GreenScreen Benchmark Unspecified (LT-U)
REACTIVE	New Zealand HSNO/GHS (GHS-New Zealand) 4.3B - Solids that emit flammable gas when in contact with water: medium hazard - GreenScreen Benchmark Unspecified (LT-U)
RESPIRATORY	EC - Risk Phrases (EU R-Phrases) R37: Irritating to respiratory system. - GreenScreen Benchmark Unspecified (LT-U)
MAMMALIAN	EC - Risk Phrases (EU R-Phrases) R22: Harmful if swallowed. - GreenScreen Benchmark Unspecified (LT-U) - HPD
MAMMALIAN	EC - Risk Phrases (EU R-Phrases) R23: Toxic by inhalation. - GreenScreen Benchmark Unspecified (LT-U) - HPD
MAMMALIAN	EC - CLP/GHS Hazard Statements (EU H-Statements) H302 Harmful if swallowed - GreenScreen Benchmark Unspecified (LT-U)
MAMMALIAN	EC - CLP/GHS Hazard Statements (EU H-Statements) H331 Toxic if inhaled - GreenScreen Benchmark Unspecified (LT-U) - HPD
MAMMALIAN	New Zealand HSNO/GHS (GHS-New Zealand) 6.1D (oral) - Acutely toxic - GreenScreen Benchmark Unspecified (LT-U)
MAMMALIAN	Japan METI/MOE - GHS Classifications (GHS-Japan) Acute toxicity (oral) - Category 4 - GreenScreen Benchmark Unspecified (LT-U)
SKIN IRRITATION	EC - Risk Phrases (EU R-Phrases) R38: Irritating to skin. - GreenScreen Benchmark Unspecified (LT-U) - HPD
SKIN IRRITATION	EC - CLP/GHS Hazard Statements (EU H-Statements) H315 Causes skin irritation - GreenScreen Benchmark Unspecified (LT-U) - HPD
ORGAN TOXICANT	EC - CLP/GHS Hazard Statements (EU H-Statements) H373 May cause damage to organs through prolonged or repeated exposure - GreenScreen Benchmark Unspecified (LT-U)
ORGAN TOXICANT	EC - CLP/GHS Hazard Statements (EU H-Statements) H335 May cause respiratory irritation - GreenScreen Benchmark Unspecified (LT-U)
FLAMMABLE	Japan METI/MOE - GHS Classifications (GHS-Japan) Flammable liquids - Category 4 - GreenScreen Benchmark Unspecified (LT-U)
PBT	Environment Canada - Domestic Substances List (DSL) DSL substances that are Persistent - GreenScreen Benchmark Unspecified (LT-U)
RESTRICTED LIST	ChemSec - Substitute List (SIN) Classified CMR (Carcinogen, Mutagen &/or Reproductive Toxicant) - GreenScreen Benchmark Possible 1 (LT-P1) - HPD

RESTRICTED LIST	ChemSec - Substitute List (SIN) Classified CMR (Carcinogen, Mutagen &/or Reproductive Toxicant) - GreenScreen Benchmark Possible 1 (LT-P1) - HPD
RESTRICTED LIST	German FEA - Substances Hazardous to Waters (VwVwS) Class 3 Severe Hazard to Waters - GreenScreen Benchmark Possible 1 (LT-P1) - HPD
RESTRICTED LIST	US EPA - Hazardous Air Pollutants (HAPs) Hazardous Air Pollutant subject to the Clean Air Act - Not included in GreenScreen
RESTRICTED LIST	Environment Canada - Toxic Substances List - Sched 1 (CEPA) CEPA Toxic - GreenScreen Benchmark Unspecified (LT-U)
RESTRICTED LIST	CA SCP Candidate Chemicals Full Candidate Chemical List - Not included in GreenScreen
RESTRICTED LIST	CA SCP Candidate Chemicals Initial Candidate Chemicals List - Not included in GreenScreen

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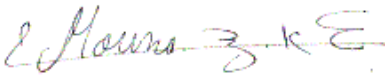

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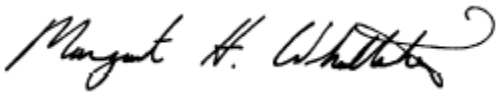

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