Di(2-ethylhexyl) terephthalate (DEHT) (CAS #6422-86-2)
GreenScreen™ Assessment

October 11th, 2012

TOXSERVICES
TOXICOLOGY RISK ASSESSMENT CONSULTING
1367 Connecticut Ave., N.W., Suite 300
Washington, D.C. 20036

TABLE OF CONTENTS

TABLE OF FIGURES

GreenScreen™ Assessment for Di(2-ethylhexyl) terephthalate (DEHT) (CAS #6422-86-2)

GreenScreen™ Version 1.2 Verified Assessment

Date of Verification:	**October 17, 2012**
Expiration Date:	**October 17, 2015**
Uses:	This complete report may be freely published and distributed by the Green Chemistry and Commerce Council (GC3).
Restrictions:	Clean Production Action does not confer licensing rights or authorize the use of the GreenScreen trademark on public or promotional materials for individual products comprised of the chemical assessed in this report. Any promotional use of the GreenScreen trademarks must be covered under a separate license agreement.

Chemical Name: Di(2-ethylhexyl) terephthalate (DEHT) (CAS #6422-86-2)

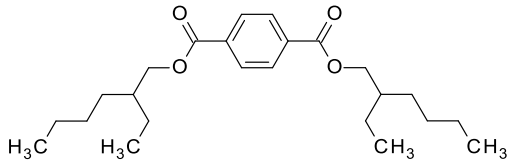
GreenScreen™ Assessment Prepared By:
Name: Chris Schlosser, M.F.S.

Title: Associate Toxicologist
Organization: ToxServices LLC
Date: February 27, 2012
Updated: April 18, 2012; October 10, 2012

Quality Control Performed By:
Name: Dr. Margaret H. Whittaker, Ph.D., M.P.H., CBiol., F.S.B., E.R.T., D.A.B.T.
Title: Managing Director and Chief Toxicologist
Organization: ToxServices LLC
Date: February 29, 2012
Updated: April 29, 2012; May 30, 2012; October 11, 2012

Confirm application of the *de minimus* rule[1]: N/A

Chemical Structure(s):



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

GreenScreen™ Summary Rating for DEHT[2]:

DEHT was assigned a GreenScreen™ Benchmark Score of 3_{DG} as it does not meet the data gap requirements for a Benchmark score of 4. Data gaps (dg) exist for Neurotoxicity (N) and Respiratory Sensitization (SnR). As outlined in CPA (2011c) Section III(1)(Benchmarking Chemicals With Data Gaps), DEHT meets requirements for a

[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.

GreenScreen™ Benchmark Score of 3. In a worst-case scenario, if DEHT were assigned a High score for N or SnR, it would be assigned a GreenScreen™ Benchmark Score of 2.

Figure 1: GreenScreen™ Hazard Ratings for Di(2-ethylhexyl) terephthalate (DEHT)

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*										
L	L	*L*	L	*L*	L	dg	L	dg	dg	L	dg	L	L	L	L	vL	L	*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).
Note: Please see Appendix A for a glossary of hazard acronyms.

Transformation Products and Ratings[3]:

Identify relevant fate and transformation products (i.e., dissociation products, transformation products, valence states) **and/or moieties of concern[4]**

Functional Use	Life Cycle Stage	Transformation Pathway	Transformation Products	CAS #	On CPA Red List[5]?	Green Screen Rating[6]
N/A	End of Life	Combustion	Carbon monoxide	630-08-0	Reproductive/developmental toxicant, neurotoxicant (CPA 2009)	End of Life
N/A	End of Life	Combustion	Carbon dioxide	124-38-9	Not present on the Red List of chemicals (CPA 2009)	End of Life

Introduction

Di(2-ethylhexyl) terephthalate (DEHT) is a phthalate alternative. DEHT is not considered to be a part of the common "phthalate ester" class as it is not *ortho*-substituted. DEHT is compatible with use in cellulose acetate-butyrate, cellulose nitrate, polymethyl methacrylate, polystyrene, polyvinyl butyral, and PVC resins (CPSC 2010).

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 2012). Pharos (Pharos 2012) is an online list-searching tool that is used to screen chemicals against the List Translator electronically. The output indicates benchmark or possible benchmark scores for each human health and environmental endpoint. No output was identified in Pharos for DEHT.

[3] Products that contain phthalates or phthalate alternatives are often plastics. Plastics are often disposed of via incineration. Therefore, health and environmental effects associated with combustion byproducts are of particular concern.
[4] 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.
[5] 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 (CPA 2011b).
[6] GreenScreen™ reviews of transformation products depend on the GreenScreen™ Benchmark Score of the parent chemical (See Guidance in CPA 2011c).

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

Carcinogenicity (C) Score (H, M or L): L
DEHT has been assigned a score of Low for carcinogenicity based on no evidence of carcinogenic effects or statistically significant increases in tumors following a two-year carcinogenicity assay in rats.

- Not listed as a known carcinogen by IARC, NTP, U.S. EPA, or CA Prop 65.
- Deyo 2007 –
    - A GLP compliant 104 week chronic toxicity/carcinogenicity study (EPA OPPTS 870.4200) was conducted using male and female Fischer 344 rats (50/sex/dose). Rats were administered doses of 0, 79, 324, and 666 mg/kg in males and 0, 102, 418, and 901 mg/kg (> 98% purity) in females daily in the diet. There was no evidence of a treatment-related effect on the incidence of any tumor type for any group of rats. There were no statistically significant dose-related differences in incidences of specific tumors between treated and control groups. Toxic responses were limited too reduced body weight gain and food conversion efficiency in the top two dose groups. A NOEL for tumorigenicity of 666 mg/kg in males and 901 mg/kg in females was established by the study authors.

Mutagenicity/Genotoxicity (M) Score (H, M or L): L
DEHT was assigned a score of Low for mutagenicity based on negative *in vitro* mutagenicity and clastogenicity assays. A low confidence scores was assigned as no *in vivo* assays were identified.

- Barber 1994 –
    - A non-GLP compliant bacterial reverse mutation assay (method not reported) was conducted utilizing *Salmonella typhimurium* tester strains TA98, TA100, TA1535, TA1537 and TA1538 at concentrations of up to 10,000 µg/plate with and without metabolic activation. No mutagenic activity was observed under the tested conditions and DEHT was reported as negative for mutagenicity.
    - A GLP compliant chromosomal aberration assay (similar to OECD 473) was conducted utilizing Chinese Hamster Ovary (CHO) cells at concentrations up to 1,000 nl/ml with and without metabolic activation. No increases in aberrations were identified and DEHT was reported as negative for clastogenicity.
    - A GLP compliant HGPRT assay (similar to OECD 476) was conducted utilizing CHO cells at concentrations of up to 20 nl/ml with and without metabolic activation. No statistically significant increases in mutation frequencies were reported when compared to controls. DEHT was reported as negative for mutagenicity under the tested conditions.

Reproductive Toxicity (R) Score (H, M, or L): *L*
DEHT was assigned a score of Low for reproductive toxicity based on no effects on reproductive parameters following a two-generation (OECD 416) reproductive toxicity study.

- Faber et al. 2007a –
    - A GLP compliant two generation reproductive toxicity study (OECD 416) was conducted using male and female Sprague-Dawley rats (30/sex/dose). Rats were administered doses of 0, 0.3, 0.6, and 1.0% (0, 258, 516, and 860 mg/kg in males, and 0, 294, 588, and 980 mg/kg in females[7]) of DEHT (purity not reported) in the diet from 70 days pre-mating to termination in the F0 generation and from PND 22 until termination in the F1 generation. Reproductive parameters (fertility, mating, days between pairing and coitus, gestation, parturition, and estrous cycling). Mean litter sizes, numbers of pups born, percentages of males per litter at birth and postnatal survival were unaffected. Female rats displayed systemic toxicity in the 516 and 860 mg/kg groups including decreased food consumption. Slight decreases in organ weights in the top dose F1 group were considered to be secondary to maternal toxicity. Additionally, no dose-response could be established. Based on available data, a NOAEL of 1.0% (860 mg/kg) was established by study authors. Study authors only reported absolute organ weights, and no evaluation or values for relative organ weights were identified. No evaluations

[7] Dose conversion estimates are based on default male and female Sprague Dawley food factor values from http://www.tera.org/Tools/ratmousevalues.pdf:
0.003 x 98,000 mg/kg (Food Factor for Females) = ~294 mg/kg
0.003 x 86,000 mg/kg (Food Factor for Males) = ~258 mg/kg

or data on corpora lutea or pre- and post- implantation loses were identified. Additionally, data on male organ weights in the table 4 were not reported correctly and evaluation of data is not possible.

- Based on the missing and inaccurately reported data, ToxServices considers the endpoint evaluation of DEHT to be of low confidence.

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

DEHT was assigned a score of Low for developmental toxicity based on the absence of fetal toxicity or teratogenicity following three developmental toxicity studies in rats and mice.

- Faber et al. 2007b –
  - A GLP compliant developmental toxicity study (OECD 414) with uterotrophic evaluations was conducted using female Sprague-Dawley rats (25/group). Rats were administered doses of 0, 229, 458, and 747 mg/kg (purity not reported) of the test substance on days 0 through 20 of gestation. In the uterotrophic examinations sexually immature rats were administered doses of 20, 200, and 2,000 mg/kg via oral gavage on days post natal days 19 to 21. Number of viable and non-viable fetuses, resorptions and implantation sites, and corpora lutea did not differ from controls. No visceral or skeletal anomalies and no signs of developmental toxicity were reported. In the uterotrophic assay for estrogenic activity DEHT exposure did not affect wet or blotted uterine weight parameters. A NOAEL of 747 mg/kg for developmental toxicity was established by the study authors.
  - A GLP compliant developmental toxicity study (OECD 414) was conducted using female CD-1 mice (25/group). Mice were administered doses of 0, 197, 592 and 1,385 mg/kg of DEHT (≥ 97.6%) in the diet on days 0-18 of gestation. No effects were observed on the number of malformations/skeletal variations, litter size, fetal body weights or sex ratios. No evidence of fetotoxicity or teratogenicity was observed even at maternally toxic doses. A NOEL of 1,385 mg/kg was identified for developmental toxicity by the authors.
- ECHA 2012 –
  - A (GLP status not reported) developmental toxicity limit test (method not reported) was conducted using female Sprague-Dawley rats (number not reported). Rats were administered doses of 0 or 750 mg/kg of DEHT (98% purity) on gestation day 14 through postnatal day 3 via oral gavage. No maternal toxicity, fetotoxicity, or teratogenicity was reported at any dose level. A NOEL of 750 mg/kg was reported by the study authors.
- Liu et al. 2005 –
  - An additional study was performed to investigate the gene expression in the fetal testis following *in utero* exposure to DEHT. While this not a standard guide-lined study and is not applicable to the GreenScreen scoring criteria, it does provide insight into the mechanistic nature and mode of action of phthalate on testicular effects. In this study it was found that DEHT did not alter gene expression following *in utero* exposure on gestation days 12 to 19.

Endocrine Activity (E) Score (H, M or L): *L*

DEHT has been assigned a Low for endocrine activity. Sufficient data have been provided to demonstrate that DEHT is not estrogenic or androgenic. Although no thyroid effects were observed, limited data were available to fully assess potential thyroid effects of DEHT and it was assigned a low confidence score.

- 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.
- Not listed as a potential endocrine disruptor on the Red List of Chemicals (CPA 2011b).
- Gray et al. 2000 –

  DEHT was tested for its potential to alter sexual differentiation of the male rat following perinatal exposure. DEHT was orally administered to pregnant dams from gestation day 14 to post natal day 3. Study results indicated that DEHT did not induce overt maternal toxicity or reduced litter sizes. No changes were observed in anogenital distance, testis weights, or nipple retention. Study authors concluded that DEHT was ineffective at 750 mg/kg at altering sexual differentiation in male rats. A slight decrease in serum testosterone was reported, but did not reach statistical significance. Spermatogenic assessment conducted during the 2-generation reproductive toxicity study appeared normal (Faber et al. 2007a). A slight decrease in serum testosterone was reported, but did not reach statistical significance. However, the lack of effects on reproductive organ weights in both the current

study and the 2-generation study, and lack of effects on the spermatogenic assessment in the 2-generation study indicate that DEHT is unlikely to affect the endocrine activity in male rats. Additionally, the lack of effects on estrogenic activity following the developmental toxicity and uterotrophic assay indicate that DEHT is unlikely to affect endocrine activity in female rats. Based on the available data, ToxServices concludes that there is no evidence of endocrine activity for DEHT in the available studies. However, limited data were available to assess potential thyroid effects of DEHT. Therefore, ToxServices has assigned a low confidence score for this endpoint.

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

DEHT was assigned a score of Low for acute mammalian toxicity based oral and dermal above 2,000 mg/kg, the GreenScreen™ cut off value for low toxicity (CPA 2011a).

- UNEP 2003 –
    - An oral LD_{50} value of greater than 5,000 mg/kg was identified in (strain not reported) rats.
    - An oral LD_{50} value of greater than 3,200 mg/kg was identified in (strain not reported) mice.
    - A dermal LD_{50} value of greater than 19,670 mg/kg was identified in (strain not reported) guinea pigs.

Systemic Toxicity/Organ Effects incl. Immunotoxicity (ST)

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

- No relevant data were identified for DEHT or structurally related chemicals.

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

DEHT was assigned a score of Low for systemic toxicity/organ effects (repeated exposure) based on no significant effects between 10 and 100 mg/kg and not being classified as a specific target organ toxicant following GHS Criteria.

- Deyo 2007 –
    - A GLP compliant 104 week chronic toxicity/carcinogenicity study (EPA OPPTS 870.4200) was conducted using male and female Fischer 344 rats (50/sex/dose). Rats were administered doses of 0, 79, 324, and 666 mg/kg in males and 0, 102, 418, and 901 mg/kg (> 98% purity) in females, daily, in the diet. Examination included clinical signs and mortality, body weight and body weight gain, food consumption and compound intake, ophthalmoscopic examination, hematology, clinical chemistry, urinalysis, organ weights, gross pathology, and histopathology. No treatment related effects were identified on clinical signs and mortality, food consumption, clinical chemistry, hematology, gross pathology, and neo-plastic histopathology. Body weights and body weight gain was significantly lower in the top dose group throughout the study and in the mid-dose group during the first-year of the study. In the eyes, a statistically significantly increased incidence of loss of the outer nuclear layer of the retina was seen in females in the mid and top dose groups. An increased incidence of prominent eosinophilic inclusions was observed in females in the mid and top dose groups (36/50 total and 47/50 total, respectively, vs. 29/50 total controls). ECHA (2012) authors reported that this may have been an exacerbation of an age-related finding. Only the mid-dose was statistically significant. Based on the available data authors established a NOAEL and LOAEL of 102 and 418 mg/kg, respectively.
- Barber and Topping 1995 –
    - A GLP compliant 90-day toxicity study (EPA 799.9310) was conducting using male and female Sprague-Dawley rats (20/sex/dose). Rats were administered doses of 0, 54, 277, and 561 mg/kg of DEHT in males, and 0, 61, 309, and 617 mg/kg of DEHT (98.4% purity) in the feed for 90-days. Examination included clinical signs and mortality, body weight and body weight gain, food consumption and compound intake, ophthalmoscopic examination, hematology, clinical chemistry, urinalysis, organ weights, gross pathology, and histopathology. No effects were reported on clinical signs and mortality, body weight and body weight gain, food consumption and compound intake,

ophthalmoscopic examination, clinical chemistry, urinalysis, gross pathology and histopathology. Mean hemoglobin, hematocrit, Mean Corpuscular Hemoglobin (MCH) and Mean Corpuscular Volume (MCV) were significantly lower than controls in the top dose male group (4-5% decreases). Mean MCH values were also lower in the mid-dose male rat group (2%). MCV and MCH values were significantly in mid- and top-dose female rats (3%). Authors concluded that changes in hematology were minimal in severity, and not clearly dose-dependent and were therefore not of biological significance. Absolute liver weight increases (9%) and liver weights relative to body weights ratio increase (11%) were observed in males in the top-dose group. Only relative liver weight changes reached statistical significance. In females, the absolute liver weight was increased by 7% and the relative liver weight was increased by 9% in the top-dose groups. Again only relative liver weight changes reached statistical significance. Based on the available data, study authors established a NOEL and LOEL of 277 and 561 mg/kg based on hematological and liver weight changes.

- DEHT is not classifiable as a GHS Specific Target Organ Toxicant as no significantly toxic effects were reported within the recommended guidance values of 10 to 100 mg/kg (UN 2011).

Neurotoxicity (N)
Group II Score (single dose)**(vH, H, M or L):** dg
DEHT has been assigned a data gap for neurotoxicity. Although it is not a known neurotoxicant, neurotoxicity testing has not performed on the chemical.

- Not classified as a developmental neurotoxicant (Grandjean and Landrigan 2006).
- Not listed as a potential neurotoxicant on the Red List of Chemicals (CPA 2011b).
- No relevant data were identified for DEHT or structurally related chemicals.

Group II* Score (repeated dose)**(H, M, L):** dg
DEHT has been assigned a data gap for neurotoxicity. Although it is not a known neurotoxicant, neurotoxicity testing has not performed on the chemical.

- Not classified as a developmental neurotoxicant (Grandjean and Landrigan 2006).
- Not listed as a potential neurotoxicant on the Red List of Chemicals (CPA 2011b).
- No relevant data were identified for DEHT or structurally related chemicals.

Skin Sensitization (SnS) Group II* Score (H, M or L): L
DEHT was assigned a score of Low for skin sensitization based on negative sensitization data following a human repeat patch test and a guinea pig sensitization study.

- UNEP 2003 –
    - A non-GLP compliant dermal sensitization study (method not reported) was conducted using guinea pigs (strain/sex not reported, n=5). Guinea pigs were exposed to a 1% solution of DEHT (purity not reported) via injection into the footpad followed by a 1% dermal application challenge dose. No signs of sensitization were observed and DEHT was reported as non-sensitizing under the tested conditions.
    - A dermal sensitization (modified Draize method) was conducted using human volunteers (9/sex) following good clinical practices. Humans were exposed nine dermal applications of 0.5% DEHT in acetone under semi-occlusive conditions over a three-week induction period. Following a two week rest period a challenge dose of 0.5% was applied to the skin. DEHT was non-irritating and non-sensitizing in all volunteers.

Respiratory Sensitization (SnR) Group II* Score (H, M or L): dg
DEHT was assigned a data gat for respiratory sensitization.

- No relevant data were identified for DEHT or structurally related chemicals.

Skin Irritation/Corrosivity (IrS) Group II Score (vH, H, M or L): L
DEHT was assigned a score of Low for skin irritation/corrosivity based on not being classified as an Irritant following GHS Criteria.

- ECHA 2012 –
    - A GLP compliant skin irritation/corrosion study (OECD 404) was conducted using male and female New Zealand white rabbits (2 male/1 female). Rabbits were exposed to 0.5 ml of undiluted test

material under occlusive conditions for 4 hours with a 72 hour observational period following exposure. Average scores of 0.0 were reported for erythema and edema, and DEHT was reported as non-irritating under the tested conditions.

- UNEP 2003 –
    - A non-GLP compliant skin irritation/corrosion study (method not reported) was conducted using Male Duncan-Hartley guinea pigs (n=3). Guinea pigs were exposed to 0, 4,920, 9,840, and 19,680 mg/kg of DEHT (purity not reported) under occlusive conditions for 24 hours. Two weeks after exposure the high dose animal showed moderate edema and slight desquamation and severe edema was reported in the low and mid- dose animals. DEHT was reported as slightly irritating under the tested conditions by the authors. However, current guidelines only specify a 4-hour exposure time and require at least 3 animals per exposure group. Therefore, the reliability of this study is limited.
    - A primary dermal irritation study (method not reported) was conducted using human volunteers (9/sex) following good clinical practices. Humans were exposed to 0.01, 0.05, 0.1, 0.2 and 0.5% of the test substance under semi-occlusive conditions for three 24-hour periods. Overall irritation scores ranged from 0.00 to 0.11 and the test substance was reported as non-irritating under the tested conditions.

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

DEHT was assigned a score of Low for eye irritation/corrosivity based on not being classified as an Irritant following GHS Criteria

- ECHA 2012 –
    - A GLP compliant eye irritation/corrosion study (OECD 405) was conducted using male and female New Zealand white rabbits (1 male/2 female). Rabbits were exposed to 0.1 ml of in one eye for 4 hours with a 72 hour observational period following exposure. No corneal opacity or iritis was observed during the study. Conjunctivitis and redness were reported up to 48 hours after administration. All reported effects were fully reversible within 72 hours and DEHT is not classifiable as a GHS eye irritant.
- UNEP 2003 –
    - A non-GLP compliant eye irritation/corrosion study (method not reported) was conducted using New Zealand white rabbits (n=6, sex not reported). Rabbits were exposed to 0.1 ml of the test substance in one eye. At 24 hours after exposure one rabbit showed adnexal staining of the nictitating membrane. At 48 hours after exposure all animals appeared normal. Following GHS criteria, DEHT is not classified as an irritant as all effects were reversible within a 48-hour time period.

Ecotoxicity (Ecotox)

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

DEHT was assigned a score of Low for acute aquatic toxicity based on no effects being expected at saturation levels of DEHT.

- ECHA 2012 –
    - An LC_{50} value of > 0.25 mg/L was identified in *Oncorhynchus mykiss* (fish, 7-day).
- UNEP 2003 –
    - A LC_{50} value of ≥ 984 mg/L was identified in *Pimephales promelas* (fish, 96-hr).
    - An EC_{50} value of > 1.4 µg/L was identified in *Daphnia magna* (aquatic invertebrate, 48-hr).
    - An EC_{50} value of > 0.860 mg/L was identified in *Selenastrum capriconutum* (algae, 72-hr).
- DEHT has a reported waster solubility of 0.4 µg/L (ECHA 2012). Based on the available data, no effects are predicted at saturation levels for DEHT. Therefore, DEHT is assigned a Low hazard score for acute aquatic toxicity.

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

DEHT was assigned a score of Low for chronic aquatic toxicity based on no effects at the highest concentrations tested in fish and daphnid. Additionally, DEHT is both rapidly biodegradable and not bioaccumulative following GHS Criteria (UN 2011). Chemicals with low acute toxicity which are rapidly biodegrade and do not bioaccumulate are not considered chronic aquatic toxicants.

- ECHA 2012 –
    - A NOEC of ≥ 0.28 mg/L was established in *Oncorhynchus mykiss* (fish, 60-day).
    - A NOEC of ≥ 0.76 µg/L was established in *Daphnia magna* (daphnid, 21-day).

Environmental Fate (Fate)

Persistence (P) Score (vH, H, M, L, or vL): vL
DEHT was assigned a score of Very Low for persistence based on meeting the ready biodegradable criteria following a GLP compliant OECD 301 B biodegradation study under modern guidelines.

- ECHA 2012 –
  - A GLP compliant biodegradation study (OECD 301B "Ready Biodegradation: CO_2 Evolution Test") was conducted under aerobic conditions at a concentration of 10 mg/L. DEHT was found to have a total of 73.05% biodegradation within 28 days and met the 10-day biodegradation window. DEHT was reported as readily biodegradable by study authors.
- UNEP 2003 –
  - A (GLP status not reported) 28-day shake flask biodegradation test (similar to OECD 301 B) was conducted under aerobic conditions at a concentration of 1.04 mg/L. DEHT was found to have 40.2% biodegradation after 28 days and was not considered to be readily biodegradable.
- Data from ECHA were considered preferable for this endpoint as the study is well-documented, provides sufficient details, was performed according to GLP, and did not deviate from OECD guidelines. Therefore, ToxServices assigned a hazard score of Very Low for persistence as DEHT is expected to meet the 10-day ready biodegradability window.

Bioaccumulation (B) Score (vH, H, M, L, or vL): L
DEHT was assigned a score of Low for bioaccumulation based on a measured BCF of 396, which is within the 100 to 500 range classified by GreenScreen™ as low for bioaccumulation.

- ECHA 2012 –
  - DEHT has a measured BCF of 393 in *Crassotrea virginica* following EPA OPPTS 850.1710 (Oyster Bioconcentation Test). Following GreenScreen™ criteria, chemicals with a BCF < 500 are considered to have low potential for bioaccumulation.

Physical Hazards (Physical)

Reactivity (Rx) Score (vH, H, M or L): *L*
DEHT was assigned a score of Low for reactivity based on the absence of functional groups containing high energy bonds or oxidizing species, which may cause reactivity.

- DEHT would not be classified as an oxidizing chemical as its chemical structure does not contain halogens, and oxygen atoms are only bonded to carbon or hydrogen (UN 2011). In addition, DEHT is not expected be explosive as it does not contain structural groups that would cause concern for explosion. Furthermore, the high flashpoint (212°C) supports that conclusion that DEHT is not a reactive chemical.

Flammability (F) Score (vH, H, M or L): L
DEHT was assigned a score of Low for flammability based on not being classified as a GHS Flammable Liquid.

- ECHA 2012 –
  - DEHT has a flash point of 212°C, which is above the 93°C cut-off criteria to be classified as flammable by GHS (UN 2011)[8].

[8] Table 2.6.1 of the GHS Purple Book.

References

Barber, E.D. 1994. Genetic Toxicology Testing of Di(2-ethylhexyl) Terephthalate. Environmental and Molecular Mutagenesis 23:228-233.

Barber, E.D., and D.C. Topping. 1995. Subchronic 90-Day Oral Toxicology of Di(2-ethylhexyl) Terephthalate in the Rat. Food and Chemical Toxicology. 33(11):971-978.

Clean Production Action (CPA). 2011a. The GreenScreen™ for Safer Chemical Version 1.2. Available: http://www.cleanproduction.org/Greenscreen.v1-2.php

Clean Production Action (CPA). 2011b. Red List of Chemicals. Available: http://www.cleanproduction.org/library/greenScreenv1-2/GS_v_1_2_Benchmark_1_Lists.pdf

Consumer Product Safety Commission (CPSC). 2010. Review of Exposure and Toxicity Data for Phthalate Substitutes. Available: http://www.cpsc.gov/about/cpsia/phthalsub.pdf

Deyo, James A. 2007. Carcinogenicity and Chronic Toxicity of Di-2-Ethylhexyl Terephthalate (DEHT) following a 2-year Dietary Exposure in Fischer 344 Rats. Food and Chemical Toxicology. 46:990-1005.

European Chemicals Agency (ECHA). 2012. Online substance information for DEHT. Available: http://apps.echa.europa.eu/registered/data/dossiers/DISS-9eb0e894-2a52-5415-e044-00144f67d031/DISS-9eb0e894-2a52-5415-e044-00144f67d031_DISS-9eb0e894-2a52-5415-e044-00144f67d031.html

Faber, W.D., James A. Deyo, Donald G. Stump, and Karen Ruble. 2007a. Two-Generation Reproduction Study of di-2-Ethylhexyl Terephthalate in Crl:CD Rats. Birth Defects Research (Part B) 80:69-81.

Faber, W.D., James A. Deyo, Donald G. Stump, and Karen Ruble. 2007b. Developmental Toxicity and Uterotrophic Studies with Di-2-Ethylhexyl Terephthalate. Birth Defects Research (Part B) 80:396-405.

Grandjean, P. and P.J. Landrigan. 2006. Developmental neurotoxicity of industrial chemicals. Lancet 368: 2167-2178.

Gray Jr, E. L., J. Ostby, J. Furr, M. Price, D.N. Rao Veermachaneni, and L. Parks. 2000. Perinatal Exposure to the Phthalates DEHP, BBP, and DINP, but Not DEP, DMP, or DOTP, Alters Sexual Differentiation of Male Rat. Toxicological Sciences 58:350-365.

Liu, K., K. P. Lehmann, M. Sar, S. S. Young, and K..W. Gaido. 2005. Gene Expression Profiling Following In Utero Exposure to Phthalate Esters Reveals New Gene Targets in the Etiology of Testicular Dysgenesis. Biology of Reproduction 73:180-192

United Nations (UN). 2011. Globally Harmonized System of Classification and Labeling of Chemicals, Fourth Revised Edition.

United Nations Environmental Programme (UNEP). 2003. Screening Information Dataset (SIDS) for DEHT. Organisation for Economic Development (OECD). Available: http://www.chem.unep.ch/irptc/sids/OECDSIDS/sidspub.html

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

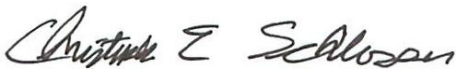
(SnS) Sensitization- Skin

(SnR) Sensitization- Respiratory

(ST) Systemic/Organ Toxicity

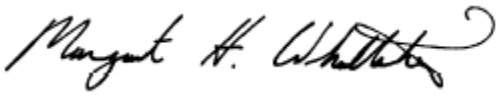
Authorized Reviewers

DEHT GreenScreen™ Evaluation Prepared By:



Christopher E. Schlosser, M.F.S.
Associate Toxicologist
ToxServices LLC

DEHT GreenScreen™ Evaluation QC'd By:



Margaret H. Whittaker, Ph.D., M.P.H., CBiol., F.S.B., E.R.T., D.A.B.T.
Managing Director and Chief Toxicologist
ToxServices LLC